

Alcatel-Lucent 1850

TRANSPORT SERVICE SWITCH (TSS-320) | RELEASE 2.0

PRODUCT INFORMATION AND PLANNING GUIDE

8DG 08136 AAAA
June 2009
ISSUE 03

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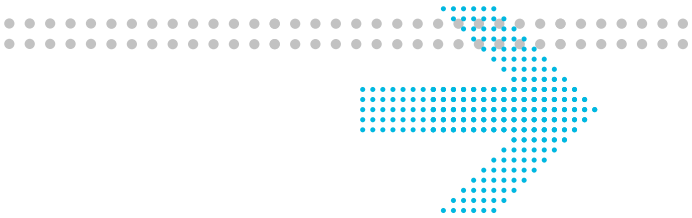
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PREFACE

Preliminary Information

WARNING

Alcatel-Lucent makes no warranty of any kind with regards to this manual, and specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Alcatel-Lucent will not be liable for errors contained herein or for damages, whether direct, indirect, consequential, incidental, or special, in connection with the furnishing, performance, or use of this material.

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To send your comments about this document please follow the indication on "Customer Documentation Feedback" on page 689.

For all the Technical Support needs (engeneering, installation, maintenance etc.) and product training, please contact your Local Alcatel-Lucent Technical Assistance Center (TAC).

SAFETY RECOMMENDATION

The safety recommendations below must be considered to avoid injuries on persons and/or damage to the equipment.

Service Personnel

Installation and service must be carried out by authorized persons having appropriate technical training and experience necessary to be aware of hazardous operations during installation and service, so as to prevent any personal injury or danger to other persons, and to prevent damaging the equipment.

Access to the Equipment

Access to the Equipment in use must be restricted to Service Personnel only.

Safety Rules

Recommended safety rules are indicated in this manual.

Local safety regulations must be used if mandatory. Safety instruction in this document should be used in addition to the local safety regulations. In case of conflict between safety instructions stated in this manual and those indicated in local regulations, mandatory local norms will prevail.If local regulations are not mandatory, than safety rules stated in this manual will prevail.

WARNING

THIS PRODUCT COMPLIES WITH D.H.H.S. RADIATION PERFORMANCE STANDARDS 21 CFR, 1040.10, FOR A CLASS 1 LASER PRODUCT.

DANGER

Invisible laser radiation is present when the optic connector is open. AVOID DIRECT EXPOSURE TO BEAM.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case users will be required to correct the interference at their own expense.

Service Personnel skill

Service Personnel must have an adequate technical background in telecommunications and in particular on the equipment subject of this document. An adequate background is required to properly install, operate and maintain equipment. Merely reading this document and associated documents listed on page 20 is not considered enough experience.

Applicability

This Product Information guide applies to the following product releases:

Table 1. Product release document applicability

PRODUCT			Part Number
1850 TSS-320			3AL 92101 AAAA
PRODUCT	**RELEASE**	**VERSION**	**Part Number**
1850 TSS-320	2.0		3AL 92102 AFAA

Scope

The scope of this document is to provide information regarding equipment presentation, the composition in terms of cards codes, position, notes, the functional and the units detailed description, technical characteristics, hardware maintenance, hardware setting documentation.

Intended audience: This Product Information guide addresses everyone carrying out work of any kind on 1850 TSS-320 systems.

History

EDITION	DATE	DESCRIPTIONS
01	March 2007	First validated and officially released issue of this document
02	December 2008	It has been issued to introduce corrections from reviewers
03	June 2009	It has been issued to add new hardware and new features (2WAYDCRR)

Related Documents

The complete list of documents related to the present product is inserted in the following table:

Table 2. 1850 TSS-320 Rel. 2.0 Documentation

REF	DOCUMENT	Part Number	THIS DOC
[1]	1850 TSS-320 Rel. 2.0 - **Product Information**	8DG 08136 AAAA	
	Provides information on Equipment description, composition, features of the equipment, detailed unit description, characteristics, hardware settings, and documents common units used in the different configurations of the product.		
[2]	1850 TSS-320 Rel. 2.0 - **Installation Guide**	8DG 08136 BAAA	
	Provide information on Hardware Equipment Installation procedures.		
[3]	1850 TSS-320 Rel. 2.0 - **Turn-Up and Commissioning Guide**	8DG 08136 CAAA	
	Provide information on Equipment Turn-On, Test and Operation procedures.		
[4]	1850 TSS-320 Rel. 2.0 - **Maintenance and Trouble Clearing Guide**	8DG 08136 DAAA	
	Provide information on Maintenance and Troubleshooting procedures.		
[5]	1850 TSS-320 Rel. 2.0 - **Craft Terminal Operation Guide**	8DG 08136 EAAA	
	Provides general Craft Terminal information, screens and operational procedure common to SONET/SDH, DATA, WDM.		
[6]	1850 TSS-320 Rel. 2.0 - **TL1 Operation Details**	8DG 08136 FAAA	
	Provides comprehensive resource to all Translator Language 1 commands available on the 1850 TSS-320.		
[7]	1850 TSS-320 Rel. 2.0 - **CLI Operation Details**	8DG 08136 GAAA	
	Provides comprehensive resource to all Command Line Interface commands available on the 1850 TSS-320.		
[8]	1850 TSS-320 Rel. 2.0 - **Safety Guide**	8DG 08136 HAAA	
	Provides information and safety guidelines to safeguard against personal injury and to prevent material damage to the equipment.		
[9]	1850 TSS-320 Rel. 2.0 - **Engineering and Planning Tool Operation Guide**	8DG 08136 _AAA	
[10]	1850 TSS-320 Rel. 2.0 - **Engineering Rules**	8DG 08136 _AAA	
	Privides the design constraints for engineering a DWDM line system using the 1850 TSS-320 DWDM capabilities.		

Table 3. Documentation on CD-ROM

See B.5 on page 607 for details on cd-rom organization

REF	Documentation CD-ROM TITLE	Part Number
	1850 TSS-320 Rel. 2.0 CD-ROM EN	8DG 08136 _AAA
	Containsdocuments listed in Table 2. on page 20 in electronic format.	

Document structure

This document has been developed according to the Alcatel-Lucent standards.

This document is divided into the following main chapters, as described in the table of contents:

PREFACE:	Contains general information as preliminary information, safety reccomendation, document scope, history, related documents. Furthermore, it describes the document structure and the customer documentation.
GENERAL:	Contains all the equipment's general introduction including its application in the telecommunication network.
PHYSICAL CONFIGURATION	Covers equipment composition, part lists with denomination, part number, quantity, units front view are displayed.
FUNCTIONAL DESCRIPTION:	Contains system description with detailed equipment features.
UNIT DESCRIPTION	Provides detailed unit description with block diagrams of common parts present in all the various equipment configurations are supplied.
TECHNICAL SPECIFICATIONS	Contains technical data of the equipment, norms and standard references, detailed data of common parts present in all the various equipment configurations
HARDWARE SETTING DOCUMENTATION:	Discusses unit hardware settings and operation of common components.
DISMANTLING & RECYCLING	Contains information for subrack/units dismantling and recycling, list of hazardous materials and waste code.
APPENDICES	Contains additional information on other topics not covered in this guide, for example, type of labels that might be affixed to the equipment, customer documentation organization, safety norms, etc.
ABBREVIATIONS:	Provides a list of abbreviations used in the document.
INDEX	Contains a list of index references.
CUSTOMER DOCUMENTATION FEEDBACK	Describes how customers can provide feedback on this document.

General Information on Documentation

Refer to "Related Documents" on page 20, for information about the Alcatel-Lucent CUSTOMER DOCUMENTATION organization.

1 System Overview

1.1 1850 TSS Portfolio

Classical transport networks originally designed for TDM (voice) traffic are being asked to meet the growing demand for a large variety of new services, for example data, with carrier class levels of reliability and fault tolerance.

A smooth evolution from a classic transport network based on SONET/SDH and PDH technologies towards an integrated network solution that can handle optical, TDM, and data services requires platforms capable of managing several technologies at the same time.

Two options are available for managing multi-service platforms

1) A multi NE approach involving many Network Elements (NEs), each one supporting different technologies; for example, legacy SONET/SDH ADM and WDM equipment along with Ethernet switch and/or routers. The main drawbacks to this approach are the extra costs associated with dedicating an NE to each technology and the cost of interconnecting those NEs.

2) A single NE approach based on one element integrating different technologies. Examples of this approach are:

   a) A TDM based matrix
   This option involves appending many dedicated Multi Service Provisioning Platform (MSPP) elements, ranging from dedicated “small” switching cards (for example, ATM, MPLS boards) to the central “big” TDM matrix. Although the typical layered approach of transport networksis retained in with this option, there are some scalability issues with data traffic since:
   - The data traffic must always cross the TDM matrix before reaching the appended packet switch
   - The packet traffic is typically a subset of TDM traffic and the size of the packet switch is limited. The overall packet matrix does not scale; it continues to operate as many “small” matrices in parallel, even when more than one switch in parallel is possible.

b) A packet based matrix
In this option, MSPP elements are organized around a “big” packet matrix (for example, those derived from Ethernet switches or routers) and are based on line cards coping with both Data and TDM traffic. This is a typical non-layered approach 528 abridging the usual functional (layered) implementation required by standard SONET/SDH networking. Drawbacks to this approach are:
- In collapsing connection functions and and modifying the functional chain, some behaviors that are allowed by a strict standard implementation, such as typically combination of protection schemes at different layers, are no longer possible.
- A port card dealing with TDM traffic, for example, SONET/SDH payloads, may become very complex and costly since in order to interface the packet matrix, it must terminate and convert to packets (cells) all the throughput both at higher and lower order being “a priori” unknown the real traffic map.
- The TDM/Packet adaptation function may either introduce a big delay on the lower order (low bit rate) traffic or lead to an under-utilization of the matrix capacity.

c) Two TDM and packet matrices working in parallel.
In this option, MSPP functionality is provided by interconnecting two “big” TDM and packet matrices. It is a layered approach but requiring the following:
- The full duplication of the switching parts
- An overhead and, therefore, the extra cost associated with interconnecting each port slot to both matrixes. Specifically, the implementation of such adaptation in the ‘server’ card implies inefficient dimensioning of the adaptation circuitry which should be dimensioned for the whole TDM capacity even if only part of the TDM capacity has to be ‘adapted’ to data (not optimized implementation of TDM boards whose density and integration is limited by the adaptation circuitry).

1.2 The 1850 TSS-320 approach

The new 1850 TSS-320 (Transport Service Switch) does not fall in any of the three categories discussed earlier in this chapter. Instead, it works around the Universal Matrix concept by integrating several network (matrix) layers (i.e. from ODU to SONET/SDH to packets) into a single chip . In this way, the whole Universal Matrix capacity can be freely partitioned between TDM and packet traffic (from 100% TDM and 0% packets to 0% TDM and 100% packets) with “slot” granularity.

This solution is made possible by the following key architectural concepts, which enable the signal processing associated with different network layers to be distributed among different boards.

– Payload matrix or matrices do not perform traffic processing; only cross connection

– Traffic processing inside a layer is performed on **Port Cards** specific to that layer and directly connected to the portion of the Universal Matrix belonging to the layer

– Optional **Adapter Cards** or **Plug-In Modules** (PIM) are used to interconnect different layers (matrices) either integrated or external to the Universal Matrix. These cards are equipped with the termination and adaptation functions required by a layered approach.

The main benefits of cost-effectiveness and scalability of the 1850 TSS-320 are achieved in the following manner:

– system complexity is handled by the port cards (working inside a layer) and the adapter cards or modules (working between different layers)
– system capacity is directly proportional to the port cards and adapter cards actually equipped
– the overall matrix capacity is shared among different layers and the amount of bandwidth per layer dynamically changed on "slot" basis

The following are the network layer and behaviors in 1850 TSS-320:

- **For TDM applications**
  - GR-253 and T1.105 for SONET along with ITU-T G.707 and G.783 (SDH)
  - ITU-T G.709 and G.798 (OTH)
- **For packet applications**
  - IEEE 802.17 (RPR)
  - IEEE 802.3 (Ethernet) and ITU-T G.8021
  - IETF RFC3031 (MPLS)
  - IETF RFC3032 (MPLS Label Stack Encoding)
  - ATM Forum (ATM)

Besides the electrical matrix, an optical wavelength switch is integrated in the system using a multi-shelf configuration as shown in Figure 1. "Simplified view of 1850 TSS-320 functional model" on page 26. By integrating the capabilities of many transport (server) layers, the 1850 TSS-320 provides a smooth evolutionary path from today's narrowband networks to future (data optimized) networks.

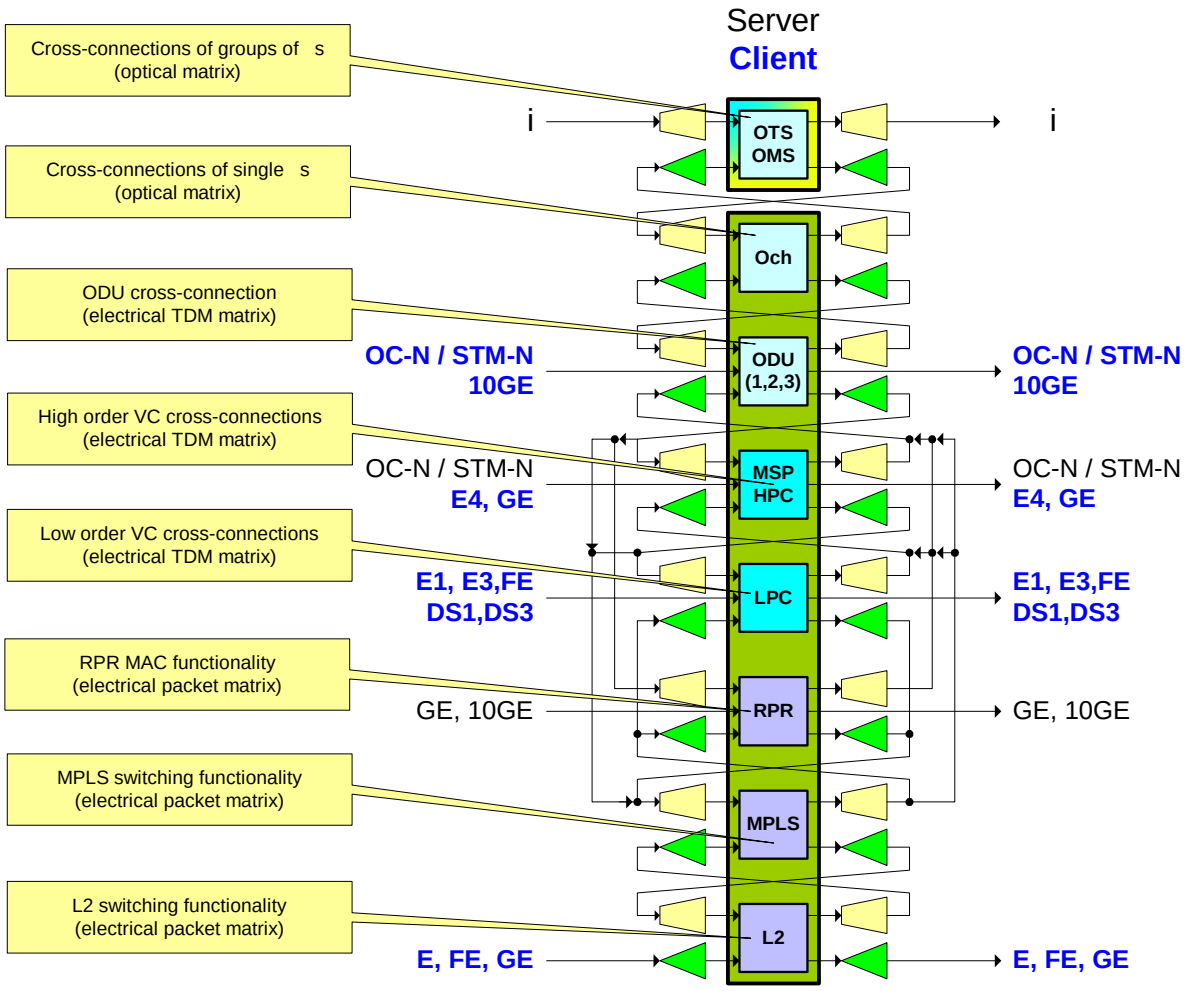


Figure 1. Simplified view of 1850 TSS-320 functional model

The 1850 TSS-320 allows network operators to easily enhance functionality and improve network performance using current infrastructures by combining SONET/SDH ADM, DCS and WDM Mux/Demux, multiservice data switching and aggregation capabilities (ATM, IP/MPLS, RPR, Ethernet) in one NE as shown in Figure 2.. and Figure 3.).

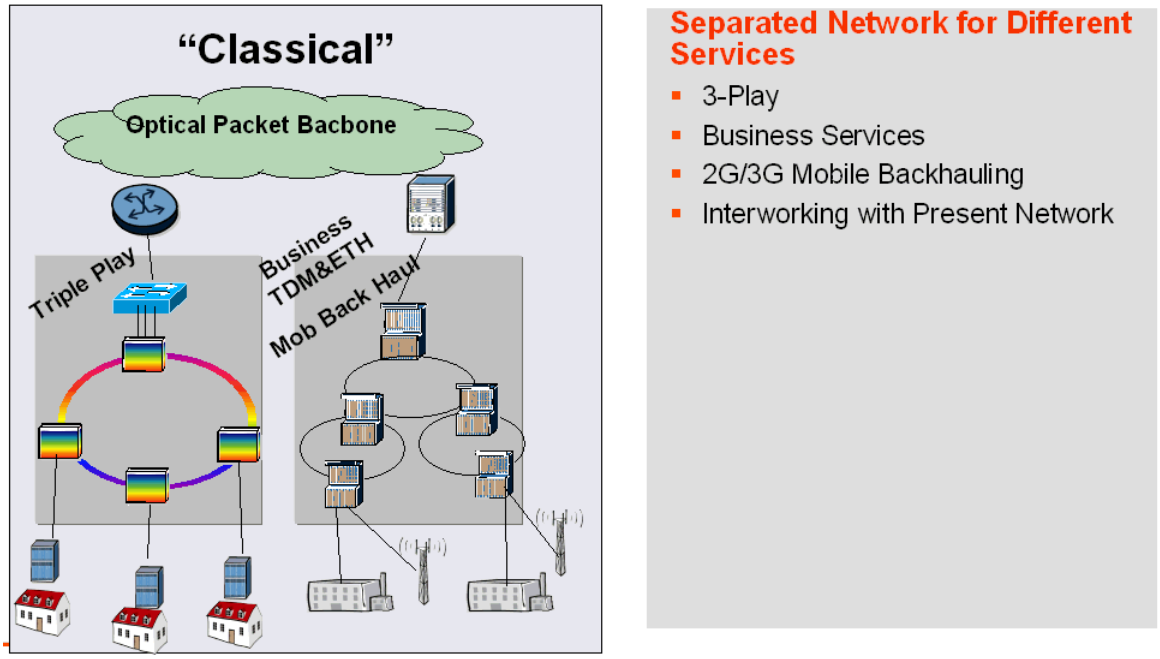


Figure 2. Multiservice aggregation "classical" network achitecture

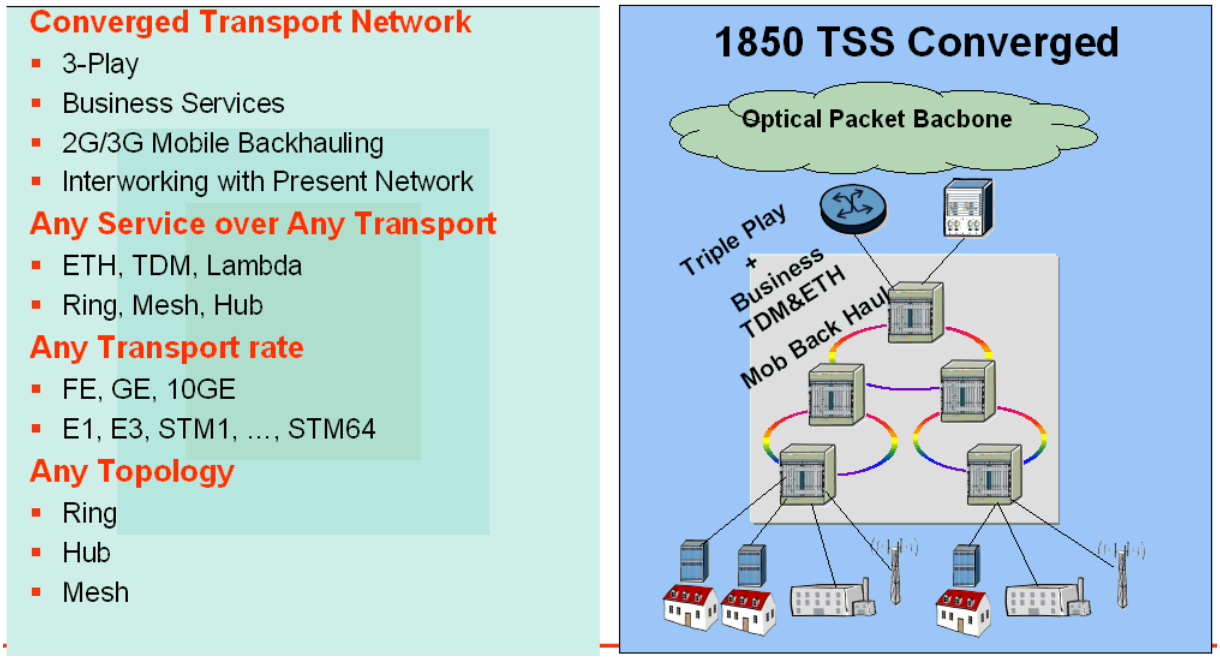


Figure 3. Multiservice aggregation network achitecture: 1850 TSS converged

1.3 Family overview

The **1850 TSS-320** equipment belongs to the 1850 TSS product family (refer to Figure 4. on page 30). It is made up of five Multiservice system (subrack) based on different sizes of the Universal Matrix.

– TSS-5:

– TSS-15: CPE size system (15 G switching capacity)

– TSS-40: Petit size system (40 G switching capacity)

– TSS-100: Small size system (100 G switching capacity)

– TSS-320: Medium size system (320 G switching capacity), **1850 TSS-320**

– TSS-640: Large size system (640 G switching capacity)

This family of products share the same functional model, architecture, boards, and components.

ROADM application is implemented in a multi-shelf architecture and is displayed as a single NE in the 1850 TSS-320 because of an integrated SW architecture and control plane (open to GMPLS unified control plane support).

1.4 Characteristics of the 1850 TSS-320

The main characteristics of the 1850 TSS-320 Medium node system are:

– **Multi-service integration of SONET/SDH, Data, DWDM, and PDH**

- SONET/SDH and PDH ports perform the payload processing functions through the optical access on the front face plates of the circuit packs and electrical access provided on a dedicated access panel.

  – The 1850 TSS-320 supports the following SONET/SDH port types:
    - OC-192/STM-64
    - OC-48/STM-16
    - OC-12**/**STM-4 or OC-3/STM-1

- DWDM (ROADM) is designed to efficiently address green field applications for new networks and links and to upgrade legacy platforms without traffic interruption. Using this state-of-the-art technology, carriers can keep their installed DWDM base and increase capacity by loading new wavelengths, thereby cutting down on cost.

  ROADM (Reconfigurable Optical Add/Drop Multiplexer) functionality in the 1850 TSS-320 is provided by the following packs:
  – Optical Amplifier packs (+16 dBm or +20 dBm, with 29 or 33 dB spans) with OSC and OSA
  – RDWDM Packs (Wavelength Routers, Optical Mux/Demux, Unidirectional and bidirectional 11G port, Optical Protection Switch)
  – Dispersion Compensation Modules (from 10 km to 140 km for SMF)

  The following ROADM features are supported in the 1850 TSS-320:

  - 44 wavelengths compliant with the ITU G.694.1 grid with 100GHz channel spacing in C-band, with 4-degree or 8-degree ROADM maximum mesh capability. Each degree (optical line) supports adding and dropping of all the 44 wavelengths and the following node types:
    - Line Terminal configuration with the equipage of a single optical line. This is also referred to as a 1-degree Reconfigurable Optical Add Drop Multiplexer (ROADM)
    - 1 to 4 degree ROADM that allows remote SW controlled connections between up to 4 fiber directions. It is based on WR4 and LDRXA/B packs
    - 1 to 8 degree ROADM that allows remote SW controlled connections between up to 8 fiber directions. 1 to 8 degree ROADM is based on WR8 and LDRXB packs
  - unrestricted add/drop and pass through capabilities for up to 100% of the wavelengths for each degree of a terminal/ROADM node
  - unrestricted bi-directional, uni-directional, protected, and unprotected wavelengths capabilities
  - optical drop and continue of a wavelength, where a wavelength is simultaneously dropped then continued at a node
  - wavelength transport to carry data and/or SONET/SDH traffic
  - capability for all degrees of a ROADM or ILA to terminate, reinsert, and use an Optical Supervisory Channel (OSC) operating at an OC-3 equivalent rate
  - capability to automatically adjust the per wavelength power at the network level to optimize system performance and without disruption of existing traffic with the introduction of Software Control Of Transmission (SCOT)
  - seamless in-service channel additions to the maximum capacity of the system configuration
  - seamless in-service degree upgrades to the maximum capacity of the system configuration, i.e. from max 4 degree configurations to max 8 degree.

- Data processing and switching split among dedicated ports (carrying also Ethernet accesses) with L2 termination, packet classification, buffering, encapsulation and scheduling and the centralized matrix, respectively;

  - Data ports type:
    - Gigabit Ethernet
    - 10 Gigabit Ethernet

- **Electrical "payload universal" matrix** device able to switch ODU, SDH HO/LO frame components, packets

- **Point-to-point links** between adjacent slots providing "matrix by-passing" connections either for data or WDM applications

- **EPS protection** (optional) is foreseen for common units (i.e. Controllers and Matrices) and for some specific I/O ports (i.e. PDH, Data) to meet levels of reliability required for carrier class deployments

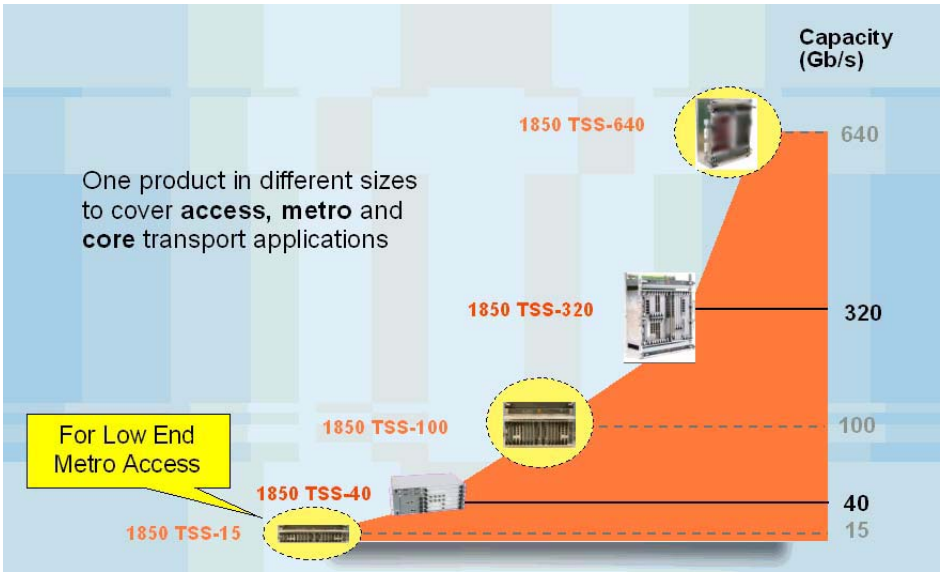


Figure 4. 1850 TSS equipments family

The 1850 TSS-320 equipment supports protected or unprotected linear, ring, and meshed applications and can be deployed in metropolitan networks configured for SONET/SDH, PDH, WDM, and DATA, as illustrated in Figure 5. on page 30

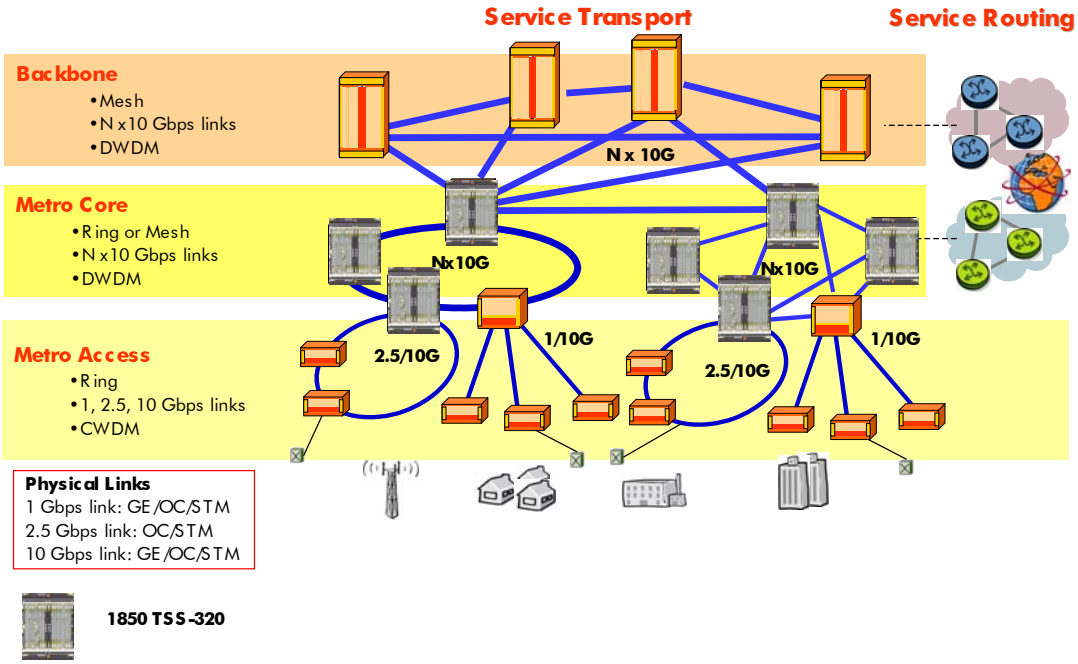


Figure 5. 1850 TSS-320: equipment solutions

1.5 Equipment bay frame

The **TSS ANSI Bay Frame** (ED-8C800-50) is designed to house high power consumption equipment and to accommodate the large number of cables and fibers needed during installation.

The useful height is 7’ 0” .

The Bay Frame is a stand-alone rack and has a 1-inch guard rail and a 6-inch guard rail cover with the closed duct or wide flange on the 1-inch guard rail side.

The Bay Frame design uses a 5.00-inch extruded steel channel with 43 vertical EIA mounting increments that use 12-24 tapped holes. The tapped-hole pattern provides for mounting shelf assemblies and ancillary equipment on the front and rear of the channels. The Bay Frames are typically mounted on concrete floors; but can also be bolted to wood or steel floors, and to raised tile floors.

The Bay Frame is built with untreated material to meet “ecological" standards. All plastic materials used are Halogen-free.

The mechanical structure of the TSS ANSI Bay Frame complies with the ETSI 300 119-3 standards and can house 19", 21" and 23” subracks.

The 19" subracks can be inserted through mechanical adaptors.

Equipment and packs are not assigned dedicated slots, allowing the TSS ANSI Bay Frame flexibility to be configured according to the plant requirements.

The parts list of the TSS ANSI Bay Frame is described in the plant documentation supplied by ALCATEL-LUCENT.

The TSS ANSI Bay Frame can be equipped with the **Top Rack Unit** - **GENTRU** as described in 1.5.1 on page 33.

Cables ducts **(1)** are located on the left and right of the TSS ANSI Bay Frame, as shown in Figure 6. on page 32.

Internal shelf cabling is done through openings at the top **(2)** and base **(3)** of the TSS ANSI Bay Frame.

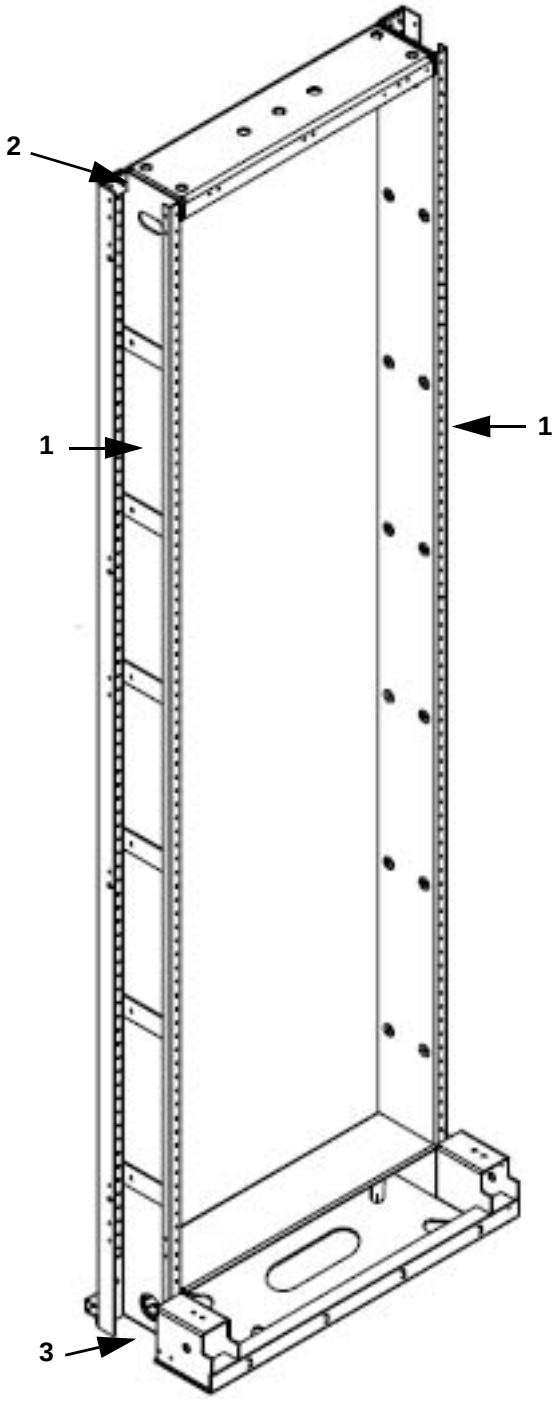


Figure 6. 1850 TSS-320 Bay Frame

1.5.1 GENTRU unit

The TSS ANSI Rack may be equipped with the **GENTRU Unit** - (see Figure 7. on page 33).

The GENTRU receives from the station:

- the Station Battery power supplies (BATT)
- the Service power supply (VSERV) (for future release in ANSI market)
  The VSERV is delivered from GENTRU to the housed assemblies.

The **Rack Lamps** unit on the GENTRU Unit generates optical indications (rack lamps) and transmits remote alarms to external sources by summing up the commands received from other NEs in the system.

The GENTRU unit provides 1+1 protection to the shelf via the following pre-mounted backup **power supply** units:

- **GENTRU Extension Bypass**
- **DC/DC Converter 3.5 kW Step-Up**

Using these units the input station power supply is delivered to the assemblies housed in the rack in 1+1 protection.

The **GENTRU Extension Bypass** units work like a pass through in the range 38.4V to 58.0V.

The **DC/DC Converter 3.5 kW Step-Up** unit works as following.

The GENTRU delivers power to the housed equipment by means of a DC/DC converter called “Step-up”.

- The distributed voltage is:
  - 58 VDC for ANSI market.
  - 65 VDC for ETSI market.

  The selection is done by means of the switch on the back of the Step-Up converter.

In order to obtain EMI/EMC performance, the **GENTRU Dummy Cover** unit is inserted into the empty power area into the GENTRU in the absence of main power supply units

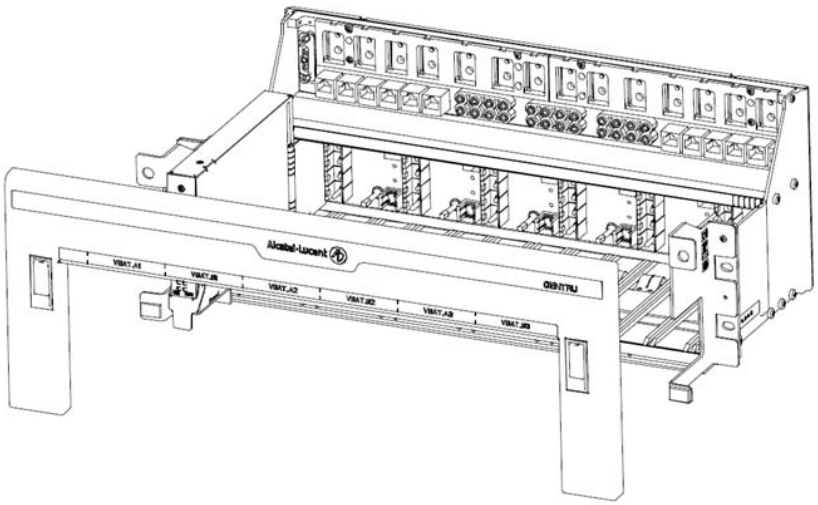


Figure 7. GENTRU unit

1.6 Applications and Configurations

System features and applications such as SONET/SDH, Data, WDM and PDH are discussed in this section.

The 1850 TSS-320 equipment performs Multi-Service integration of SONET/SDH, Data, WDM and PDH.

By combining SONET/SDH ADM and DCS, WDM Mux/Demux, multiservice data switching and aggregation capabilities in one NE, the 1850 TSS-320 allows network operators to easily enhance functionality and improve network performance by leveraging on current infrastructures.

1.6.1 SONET/SDH network configuration

The 1850 TSS-320 equipment is compliant with SONET/SDH Telcordia/ITU-T Recommendations.

The 1850 TSS-320 equipment be used in metropolitan networks configured for standard plesiochronous or synchronous systems. It can also interface the line with WDM applications by inserting the relevant board directly in the 1850 TSS-320 subrack.

The 1850TSS-320 supports linear, ring and hub networks and on protected or unprotected line links.

The equipment applications depend on the different types of networks available. Configuration options are disucssed below:

– **Terminal multiplexer configuration** (see Figure 8. on page 35).

  In terminal multiplexer configurations, the NE is provided with an OC-N (with N=3÷192) /STM-N (with N=1÷64) a station interface (and stand-by) to be connected to a Digital Electronic Cross-Connect or to a higher hierarchical line system.

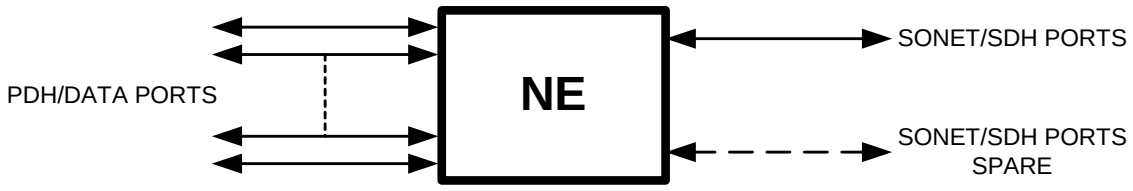


Figure 8. Terminal multiplexer

– **Add/Drop Multiplexer configuration** (see Figure 9. on page 35)

  In add/drop multiplexer configurations, the NE can be programmed to drop (insert) signals from (into) the OC-N (with N=3÷192) /STM-N (with N=1÷64) stream, with signal pass-through between the line sides as shown in Side A and Side B in Figure 9. on page 35.

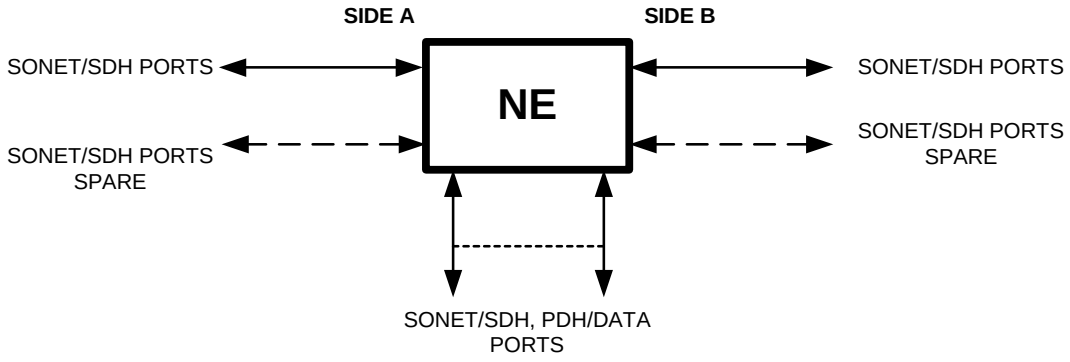


Figure 9. Add/Drop Multiplexer

– **"HUB" STM-N configuration** (see Figure 10. on page 36)

With HUB STM-N configurations, OC-N/STM-N tributaries are dropped/added into a multiple stream and then split off in HUB structures.

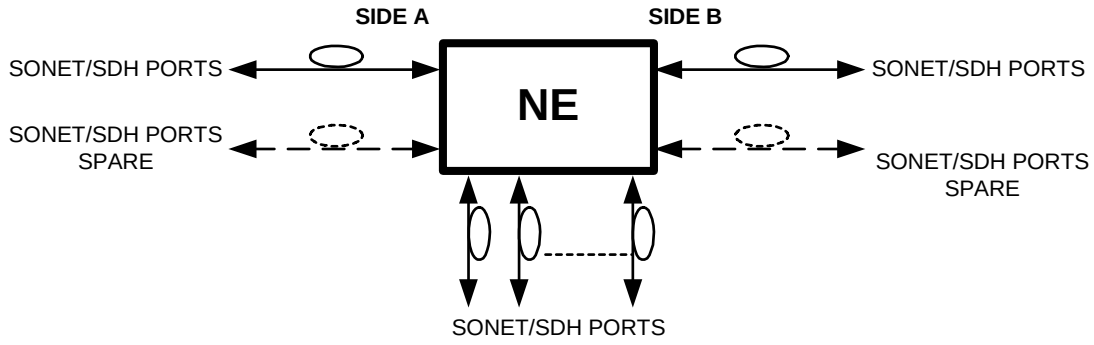


Figure 10. "HUB" STM-1

– **Mixed Configuration**

The NE handles all the previously-discussed configurations in one node simultaneously in mixed configurations.

1.6.1.1 Applications

For each of the SONET/SDH configuration supports a variety of network topologies incuding:

- Point to Point
- Linear
- Ring and multiring topology
- Meshed topology

– **Point-to-point link**

In this case, the NE is connected to another multiplexer through the line, as shown in Figure 11. on page 36.

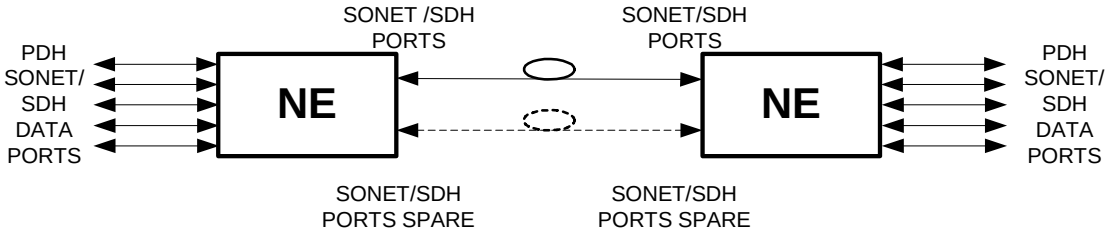


Figure 11. Point-to-point links

– **Linear Drop-insert** (see Figure 12. on page 37)

The NE is configured to drop (insert) PDH and SONET/SDH ports from (into) the OC-N (with N=3÷192) /STM-N (with N=1÷64) stream or terminate PDH ports, as shown in Figure 12. on page 37.

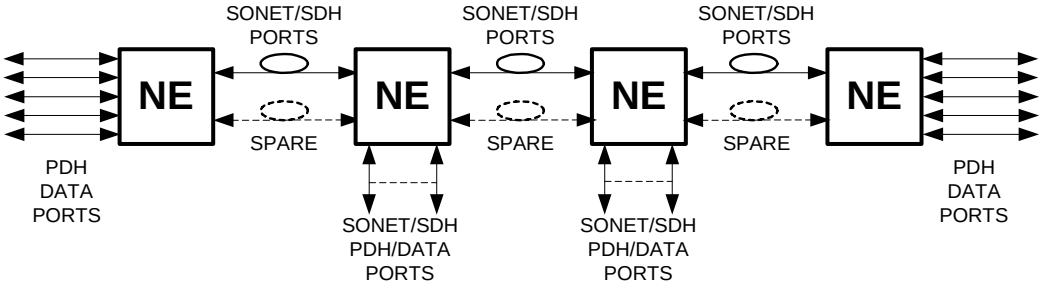


Figure 12. Linear drop-insert

– **Ring structure** (see Figure 13. on page 37)

Because of the drop-add function, large rings networks can be created in ring topologies. In this configuration, the VC is automatically rerouted in the event of a signal or node failure.

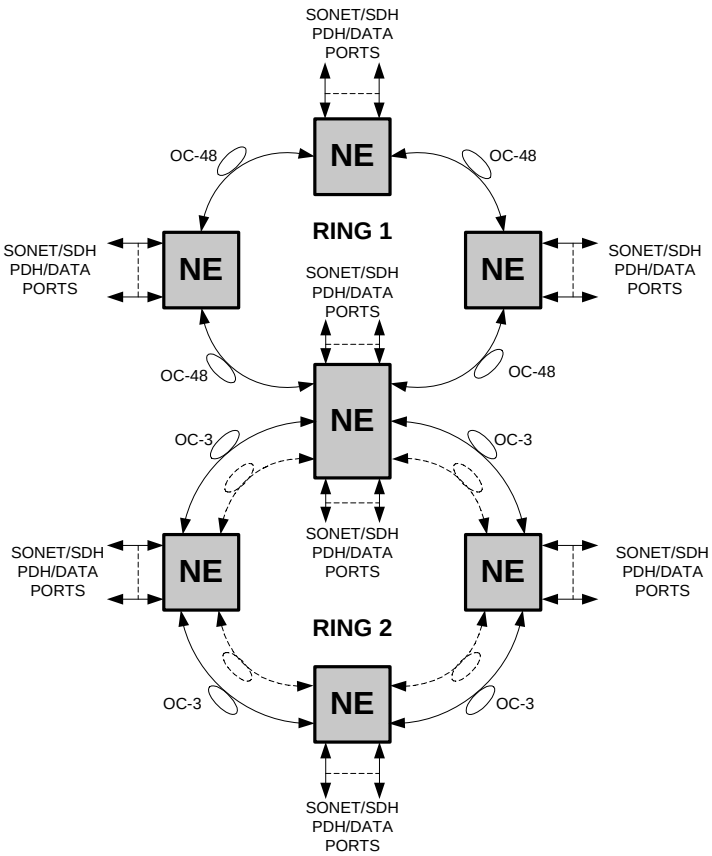


Figure 13. Example of Ring structure

– **Meshed Topology** (see Figure 14. on page 38)

Generally, meshed topology is used when there is a need to combine traffic from peripheral nodes or at customer sites. In this configuration, 1+1 line protection may be used to protect against line failure or node failure. Dual hub topology may also be used for protection. The mini digital cross-connect system is very useful in meshed technology; Subnetwork Connection Protection Inherent (SNCP/I) is also used.

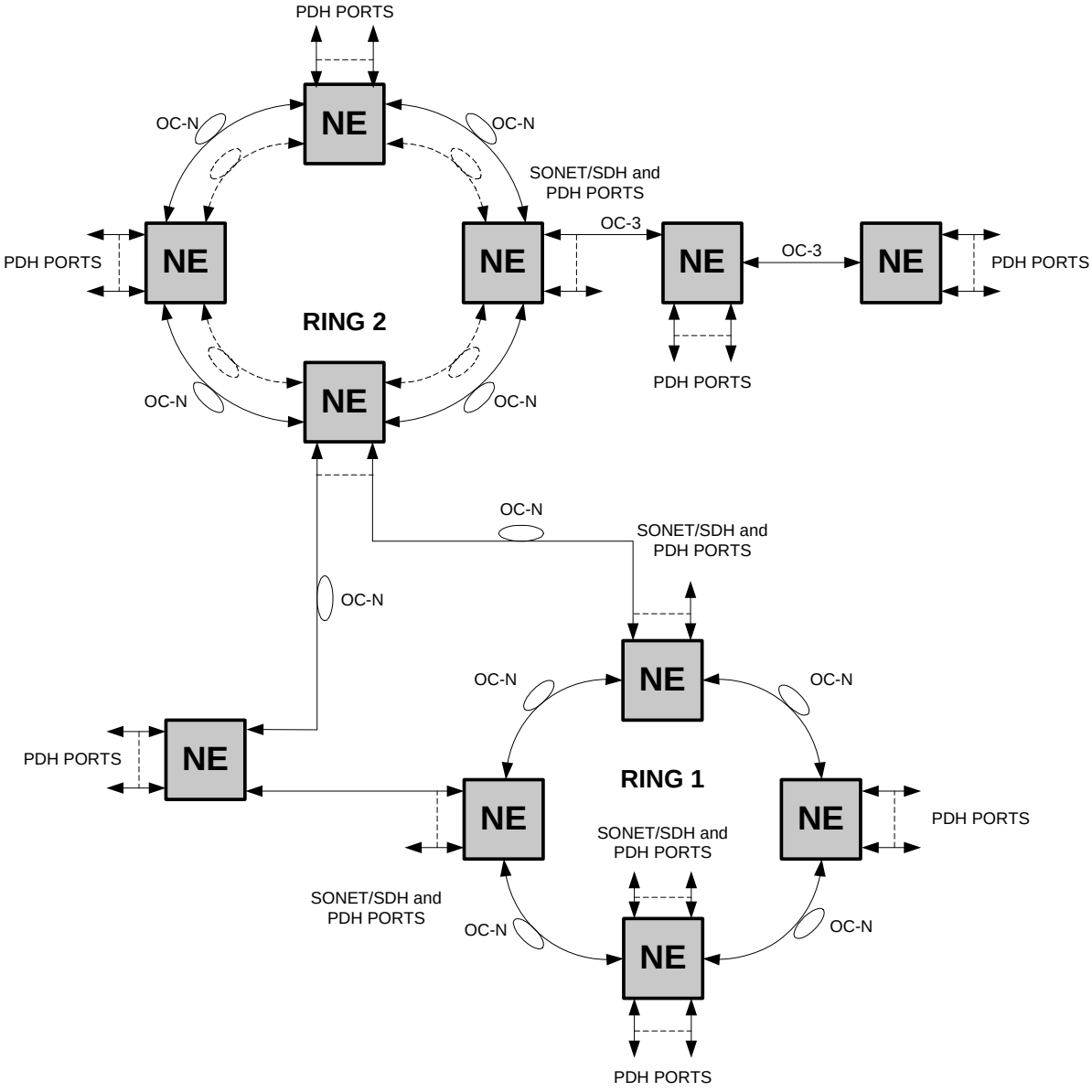


Figure 14. Example of Meshed topology

1.6.2 DATA network configuration

The 1850 TSS-320 DATA system is designed for METRO and Backbone networks applications with integrated Optical Transport (xWDM, OTH, SONET/SDH).
Note that the Data System includes the ETHERNET technology in this release.

1.6.2.1 Ethernet technique introduction

Ethernet operates at Layer 2 of the 7-layer ISO-OSI stack by means of the MAC protocol (Medium Access Control). The ISO-OSI protocol is an IEEE 802.3 standard.

The Ethernet Layer (also called MAC 802.3) transports data packets originated by the Network Layer (Level 3). These data packets are then encapsulated into the MAC frame and sent to the Physical Layer (Level 1), after conversion using the Manchester encoding procedure. It is based on the concept of “multiaccess channel" where a single channel is shared among many users that are connected on the same communication medium. MAC functions provide access to the physical channel and manage any access conflicts that may arise. The channel used to connect multiple users is called the LAN.

For more information about Ethernet/MAC refer to IEEE 802.3 standard.

Table 4 - Ethernet over SONET/SDH layer stack

3	**NETWORK**	**any network “packetized" data service**
2	**DATA LINK**	**ETHERNET**
1	**PHYSICAL**	**SONET/SDH**

1.6.2.2 Ethernet subsystem generalities

The 1850 TSS-320 Data/Ethernet system manages data packet streams transported over “local" Ethernet FE or GbE or 10Gbe (Fast Ethernet, Gigabit Ethernet) Ports (note: FE ports are not available in this release).

By virtue of the MAC layer processing, the 1850 TSS-320 Data/Ethernet system acts as an Ethernet Switch (or bridge) used to interconnect and route Ethernet data flows transiting on the LAN's (Local Area Network).

Data packets may also be transported over SONET/SDH networks by means of “remote" ethernet ports using GFP/SONET/SDH or LAPS/SONET/SDH framing or over WDM networks using “colored” Ethernet interfaces or “Transponder” boards (wavelength converters).

The maximum throughput for a data packet is 320 Gb/s for a mixed Data/SONET/SDH/WDM configuration, and 160 Gb/s for a “only-data” configuration, as a maximum of 8 data boards each with maxiumum access capacity of 20Gbps can be equipped. This means a local connectivity capacity of maximum 160 interfaces.

“Only-Data”, “Data+TDM” and “Data+TDM+WDM” configurations are illustrated in Figure 16., Figure 17. and Figure 18. on page 42.

The data packets are cross-connected by the Universal Matrix (or AgnosticMatrix) of the equipment to Local and Remote Ports.

The local Ethernet interfaces operate at rates of Optical 1 Gbps and 10 Gbps.

Data subsystem consists of the following units:

– 20G Packet Processor (also called “Data Aggregator”) (PP20G)
– 10x1 GE Plug-in-Module (PIM1GE)
– 1x10 GE Plug-in-Module (PIM10GE).
– MultiService Plug-in-Module (PIMMS).
– SFP, XFP pluggable connecting modules.

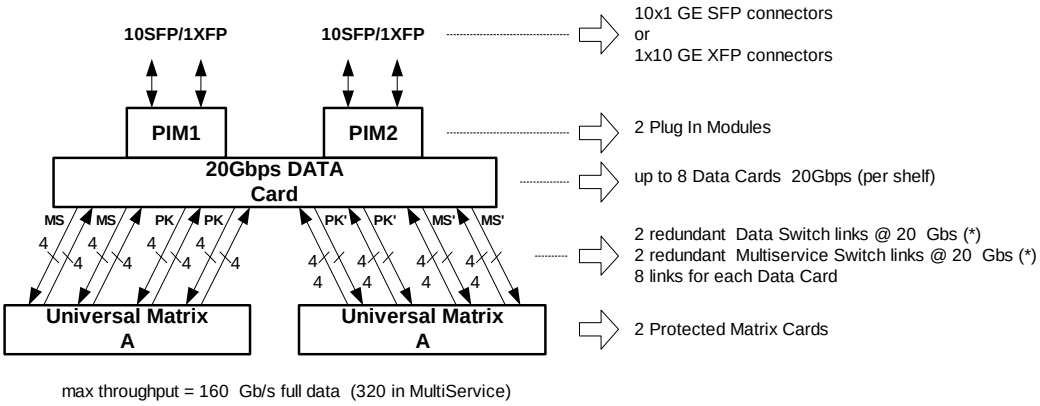
Note: A complete list of DATA units and associated codes is provided in Chapter 2 "Physical Configuration" on page 61.

The 1850TSS-320 Data SubSystem accomplishes the following functionality:

1) Ethernet 802.3 physical termination
2) MAC frame processing
3) Auto-Negotiation, Flow Control and Back-Pressure functions
4) VLAN/SVLAN (if present) tag processing
5) Ethernet flows Identification and Classification
6) Traffic Management including the following:
   a) Traffic Profile association
   b) Traffic Policing & Metering)
   c) Traffic Scheduling and queueing
   d) Data Buffering
7) Performance Monitoring
8) Ethernet switching/bridging using:
   a) Transparent port-to-port connection
   b) ETS Point-to-Point connection
   c) MAC Auto-learning & Aging (802.1d)
   d) Virtual Bridging (802.1q)
   e) Provider Bridging (802.1ad)
9) Spanning Tree Protocol management using:
   a) STP (802.1d)
   b) Rapid STP (RSTP, 802.1w)
   c) Multiple STP (MSTP, 802.1s)
10) MAC Frame to SONET/SDH Frame adaptation (GFP or LAPS mapping)
11) Matrix Interfacing

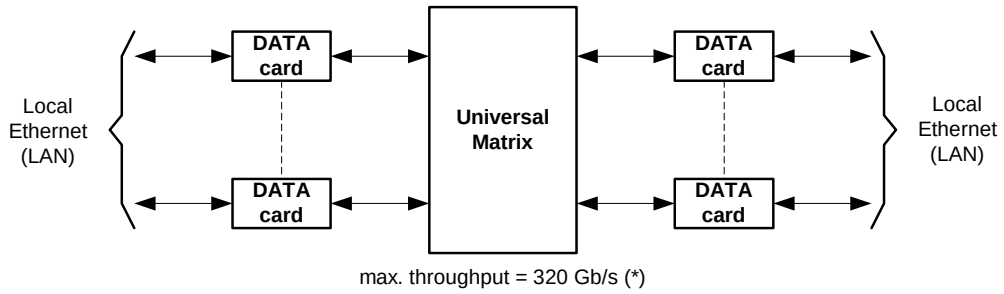
Additionally, the 1850TSS-320 supports the following features:

– Local Data Controller (LDC).
  The Control function of the equipment, which consists of three packs, as shown in Figure 22. on page 43:
  – The First Level Controller (FLC), located inside the central Equipment Controller
  – The Second Level Controller (SLC), located inside the Matrix Unit
  – The Local Data Controller (LDC) located inside each Data unit
– Power supply (PS)
– Remote Inventory (RI)
– Networking applications compliant with ITU-T G.8011x and MEF 10 (Metro Ethernet Forum)



NOTES:
(*): each link is bidirectional, @10Gbps (4x3.11Gb/s), 8 links for each DataCard
PK: Data Packet bidirectional link (@10Gbps)
MS: MultiService (Data over TDM) bidirectional link (@10Gbps)
PK': protecting Data Packet bidirectional link (@10Gbps)
MS': protecting MultiService bidirectional link (@10Gbps)

Figure 15. DATA subsystem, internal linkage



NOTES:
(*) in current release the access capacity is limited to 160 Gb/s, as a max. of 8 DATA boards can be equipped
(*) DATA card are units with a max. data access of 20 Gb/s

Figure 16. DATA subsystem, only-data configuration

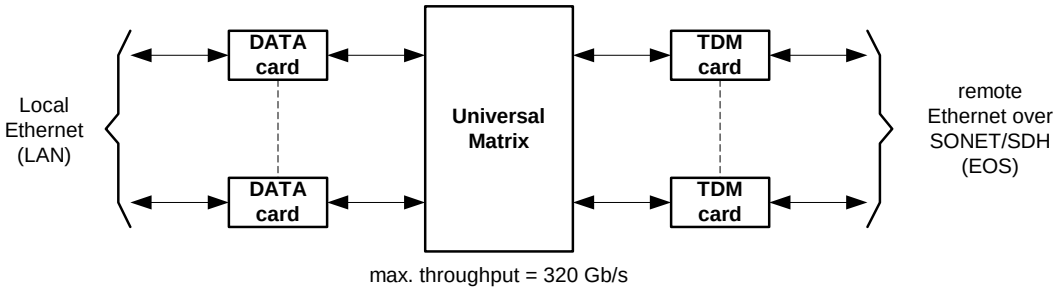


Figure 17. DATA subsystem, mixed DATA+TDM configuration

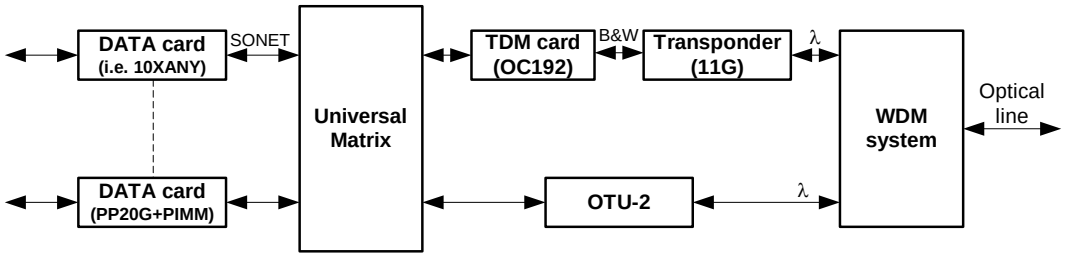


Figure 18. DATA subsystem, mixed DATA+TDM+WDM configuration

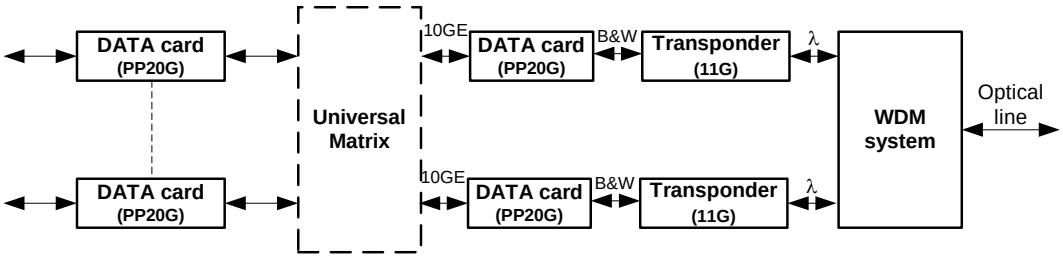
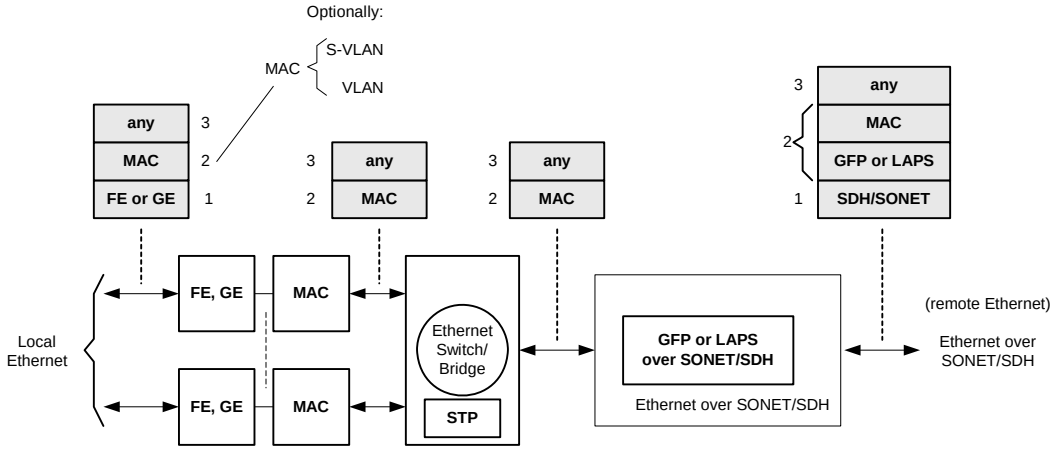
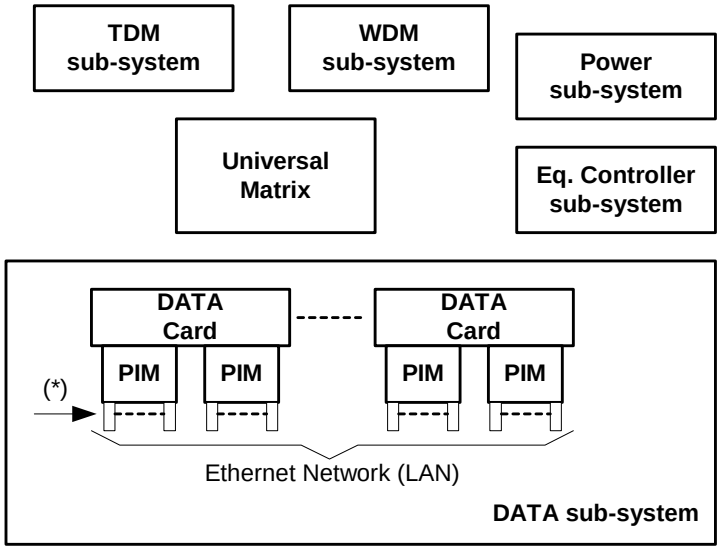


Figure 19. DATA subsystem, mixed DATA+WDM configuration



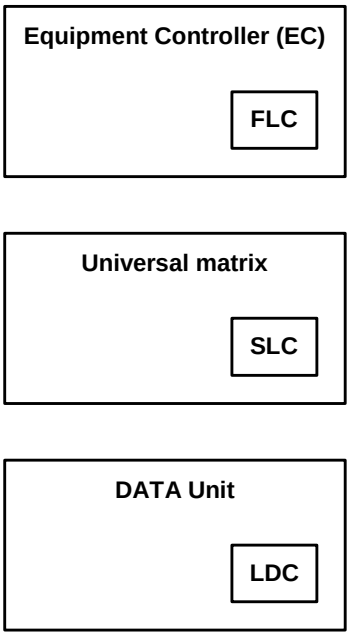
NOTES:
The MAC layer may optionally includes VLAN or S-VLAN sub-layers.
The Ethernet over SDH/SONET function is implemented in an optional sub-module (PIM-MS).

Figure 20. DATA Ethernet subsystem, protocol stacking



NOTES:
(*) SFP or XFP connectors

Figure 21. Data Subsystem overview



NOTES:
- FLC = First Level Controller
- SLC = Second Level Controller
- LDC = Local Data Controller

Figure 22. Control architecture overview

1.6.3 WDM network configuration

The 1850 TSS-320 is the new DWDM platform for ROADM systems in Metropolitan and Regional Networks.

The 1850 TSS-320 provides a modular transmission capacity on a single optical fiber by multiplexing:

– up to 44 x 10Gbps channels on a 100 GHz grid

– up to 88 x 10Gbps channels on a 50 GHz grid (future release).

The 100 GHz grid architecture can be equipped with up to 44 channels. Release 2.0 supports up to 8-degree ROADM (Reconfigurable OADM) configurations with single wavelength granularity capability, extending the flexibility to include the remote path configuration. It can access any wavelength in any site in point–to–point, ring or meshed networks..

Supported configurations in WDM networks are:

– In-Line Amplifier (ILA) and Upgradable In-Line Amplifier (UILA). An ILA consists of two LDRXA/B circuit packs. An UILA consists of two LDRXB circuit packs. The UILA is upgradeable to a 2-degree UROADM (see below). The UROADM my be further upgraded in-service to a maximum of 4 degree

– Line terminal (LT). It has a single optical line and is also referred to as a 1-degree ROADM

– Reconfigurable OADM (ROADM) and Upgradable ROADM (UROADM). The 1850 TSS-320 supports the following applications:
  - 1 to 4 degree ROADM that allows connections between up to 4 fiber directions. It is based on WR4 and LDRXA/B packs
  - 1 to 8 degree ROADM that allows connections between up to 8 fiber directions. It is based on WR8 and LDRXB packs
  - up to 4 degree UROADM that allows connections between up to 4 fiber directions. It is based on WR4 and LDRXB packs

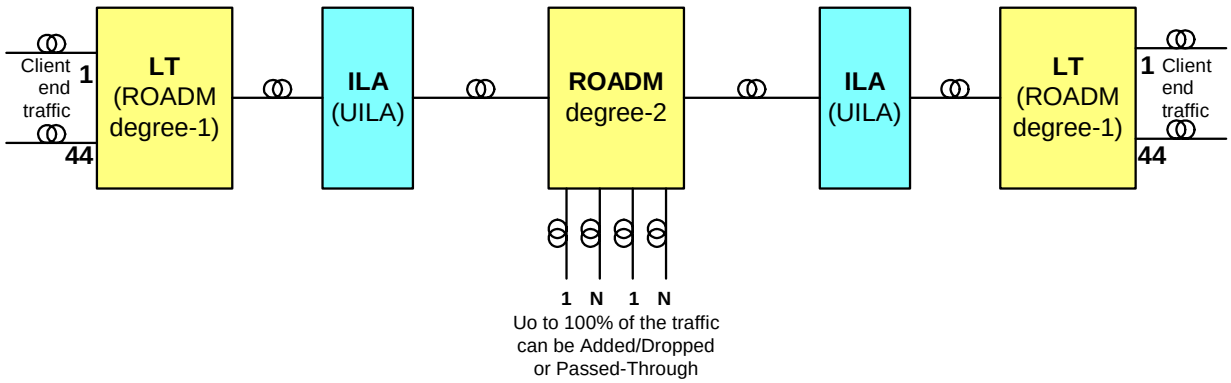


Figure 23. Example of 1850 TSS-320 configurations in a DWDM line

The Reconfigurable OADM (ROADM) functionality helps network planners to better plan customer networks and implement solutions.

When the network requirements depend on the traffic matrix and in those cases where the network evolution cannot be easily predicted, the reconfigurable OADM can bring added value.

ROADM brings to the network the following advantages:
– any node to any node support,
– gain equalization functionality
– reducing truck rolls.

Managing evolving networks: any node to any node support without planning constraints.

In fairly unpredictable conditions, the forecast errors have to be managed. In such situations, a DWDM with fixed OADM forces to define the plan in which a wavelength is dedicated to a given node. A ROADM system, on the other hand, allows each node to drop from 0 to 100% of the traffic without any planning.

When the DWDM system reaches full capacity, the transmission parameters need to be adapted. With a fixed OADM (FOADM) this requires manual intervention on the nodes, resulting in service interruption. With ROADM, the network automatically adapts to the new load conditions through the Telecommunication Management Network feature (TMN), thereby avoiding service interruptions.

Gain equalization functionality

The Software Control Of Transmission (SCOT) feature in this release supports the capability to automatically adjust per wavelength power at the network level to optimize system performance without disruption of existing channels.

Reducing truck rolls: ROADM as reconfigurable transit gate.

Whenever there is a need for a new connection between two ending points minimal field activity needs to be carried out.

1.6.3.1 DWDM ROADM network configuration

This section describes the ROADM and associated DWDM architecture for the 1850-TSS-320.

The following is a list of configurations supported in the 1850-TSS-320 DWDM ROADM networks:
– Support for point-to-point, linear, ring, and mesh topologies
– Operation on standard single mode fiber (SMF)
– 44-channel, mesh capable reconfigurable optical add/drop multiplexer (ROADM) network elements, with maximum mesh capability of 4-degree or 8-degree.
– In-service upgrades from from 1-degree up to the maximum allowable with ROADM.
– An in-line amplifier (ILA)
– An upgradeable ILA (UILA) that can be upgraded with minimal service downtime to an upgrade ROADM (UROADM)
– Upgrades of UROADM from 2 degree to the maximum 4 degree using adding standard ROADM transmission packs.
– Transmission rates of 10Gb/s
– 1+1 optical channel protection
– Optical drop and continue
– Optical translator units (OTs) with pluggable client side optics, G.709 forward error correction, enhanced forward error correction, and tunable line side transmitters. R2 supports two versions of the 11G “Anyrate” OT: a bidirectional version with transmit and receive capability and a unidirectional (receive only) version for receiving broadcast signals.
– Support for 33 dB spans
– Support for up to 24 spans between ROADMs without regeneration

Compared to previous metropolitan and long haul systems, the 1850-TSS-320 offers improved system performance and ease of use with features such as:

– Self-adjustment of channels for improved ease of installation
– Better engineering rules for systems with large numbers of optical add/drop multiplexers
– An ability to add new wavelengths to the system by installing equipment only at the add and drop points, without the need to visit intermediate add/drop sites
– Remote provisioning of channels to mesh/through or add/drop states
– Remote monitoring of the channel states (add/drop or mesh/through)
– Reduced fibering complexity for mesh/through channels

Future releases may include the following enhancements:

– Support for fiber types other than SSMF
– Colorless interfaces on add/drop packs
– Support for 88 wavelengths on a 50 GHz grid
– Optically transparent interworking of 44 and 88 channel systems for wavelengths that match the 44-channel wavelength plan
– Transmission of 40 Gb/s channels
– Support for alien optics carried over the DWDM system, without the use of an OT
– An option for 22-channel startup, for reduced startup cost
– Raman amplification for very long spans
– An ILA with a dynamic gain equalization filter for channel equalization
– An access end terminal for up to either 4 or 8 channels
– A 44-channel end terminal that does not upgrade to a ROADM, for reduced cost
– A low-cost ILA in a small shelf
– A 2.7G “Anyrate” OT
–

1.6.3.1.1 ROADM basics

Reconfigurable Optical Add-Drop Multiplexer (ROADM) is a new form of optical add-drop multiplexer that adds the ability to switch individual wavelenghts of light in a DWDM system. Its key differentiating features are:

– The use of Wavelength Selective Switching (WSS) or Wavelength Blocking architectures

– The ability to switch traffic at both wavelength and SONET/SDH layers

– The ability to multiplex non-SONET/SDH signals (Gigabit Ethernet, Fibre Channel) onto a wavelength

– The ability to statistically multiplex Ethernet signals prior to placing them onto a wavelength

ROADM functionality is not new but has been gaining traction since 2005 with the growing demand for larger metropolitan networks capable of meeting the needs of customers who provide a variety of services, such as: ILEC triple play services, MSO video transport services, and packet data services (as opposed to older ATM/frame/T1 services).

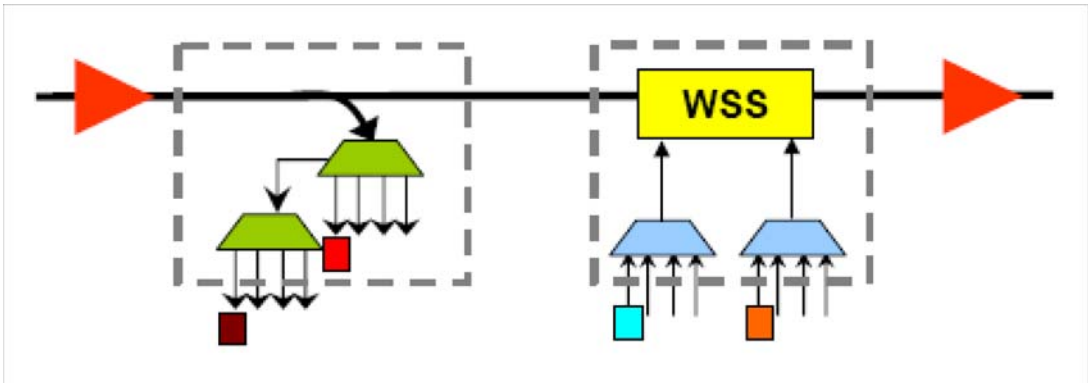
The main advantages of the ROADM are:

- Scalability
- Remote configuration and reconfiguration
- Automatic power balancing

WSS architecture

WSS architecture offers the following functionality on any or all (44) incoming wavelengths up to N colorless output ports:

– Add/Drop
– Attenuate
– Block
– Switch



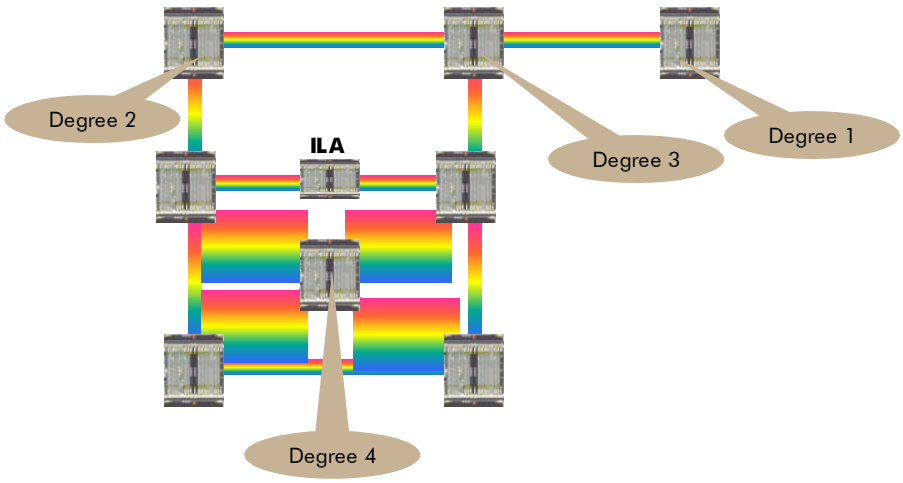
WSS functionality the 1850 TSS-320 is similar to that of the TDM matrix in SONET/SDH traffic connectivity. The only difference is that while VC4/3/12 is the “connection item” for theTDM matrix, for WSS, “connection item” is the Lambda (λ).

The 1850 TSS-320 addresses DWDM at the 10Gb rate.

Degree concept

The “level of degree” is the number of interfaces of the DWDM ROADM equipment that the user wants to add/ drop/pass-through lambdas.

Degrees can be 2, 4, 6, or 8, although odd configurations are also possible.



Network Elements

To build-up a ROADM node, it is necessary to handle the following basic functional blocks (i.e. cards per degree):

– Receiver amplifier (LDRX)

– Transmitter amplifier (LDTX) with OMON (Optical Spectrum analyzer) function that handles two degrees

– Wavelength router – WSS (WR4 and WR8)

– MUX/DEMUX

To handle λ "termination" consideration must be given to the following:

– Optical Transponder/Translator (OT)

– OTU card (OTU)

To handle λ "protection" consideration must be given to the following:

– Optical Protection Switch (OPS)

1.6.3.2 Line Terminal (LT)

n Line Terminal (LT) configurations, also known as "1 degree" for ROADM, the 1850 TSS-320 connects to an optical fibre DWDM line up to the following rates:

– 44 x 10Gbps channels on a 100 GHz grid

– 88 x 10Gbps channels on a 50 GHz grid (future release).

In LT configurations, the equipment is placed at both ends of point–to–point links, as depicted in Figure 24. on page 48. It consists of the following NEs:
– Line Driver (LDRXA and LDTXA), with the OSC
– Wavelength router (WR4)
– Optical Mux/Demux (OMD44) up to 44-channel

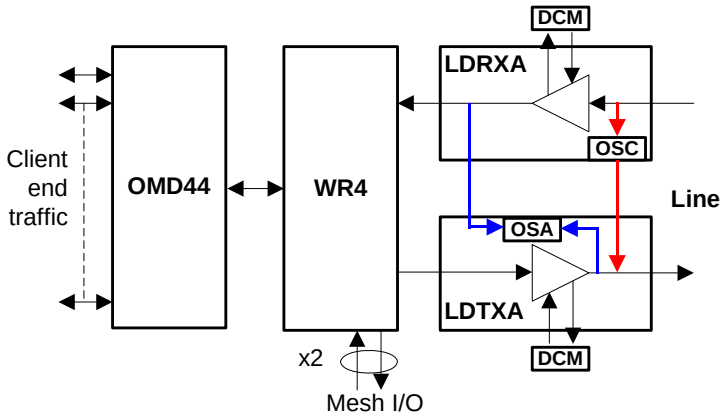


Figure 24. Line Terminal (1-degree ROADM) with LDRXA and WR4

1.6.3.3 In-Line Amplifier (ILA)

In In-Line Amplifier configuration (ILA), also known as “2-degree” for ROADM, the 1850 TSS-320 connects to an optical fibre DWDM line:
– Line Drivers (LDRXA and LDRXB), with the OSC

The In-Line Amplifier consists of two optical double–stage in–line amplifiers providing a bi–directional wide band amplification in order to boost the optical power of the aggregate DWDM signal avoiding any optical to electrical conversion.

The block diagram in Figure 25. on page 49 depicts the In-Line Amplifier configuration.

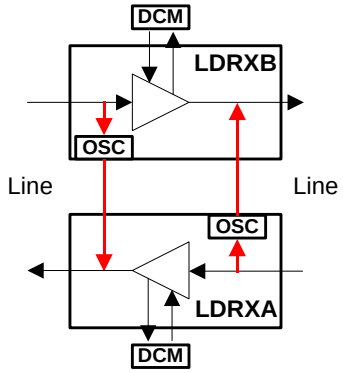


Figure 25. In-Line Amplifier ROADM with LDRXA and WR4

1.6.3.4 Optical Add/Drop Multiplexer (OADM)

The OADM feature permits the adding and dropping of one or more wavelengths to/from the aggregate signal in one or both directions in linear and ring based networks.

Up to 100% of the transit traffic may be added/dropped. All the bands that are not extracted are transparently transmitted without the need of any optical/electrical regeneration (bands are in optical pass–through).

Figure 26. on page 50 depicts an OADM system that consists of the following NEs:
– Line Drivers (LDRX_ and LDTX_), with the OSC for each side of the line
– Wavelength Router (WR4)
– Optical Mux/Demux (OMD44) up to 44-channel

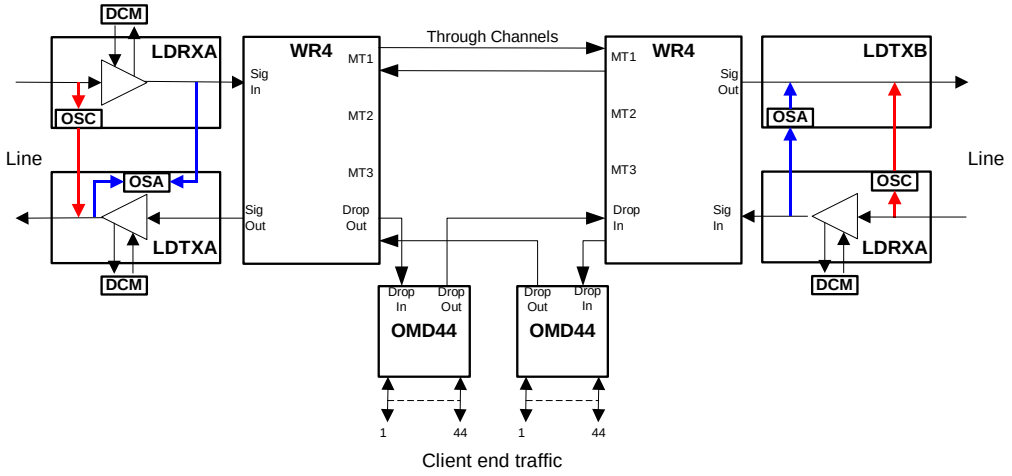


Figure 26. Optical Add/Drop Multiplexer ROADM 2-degree

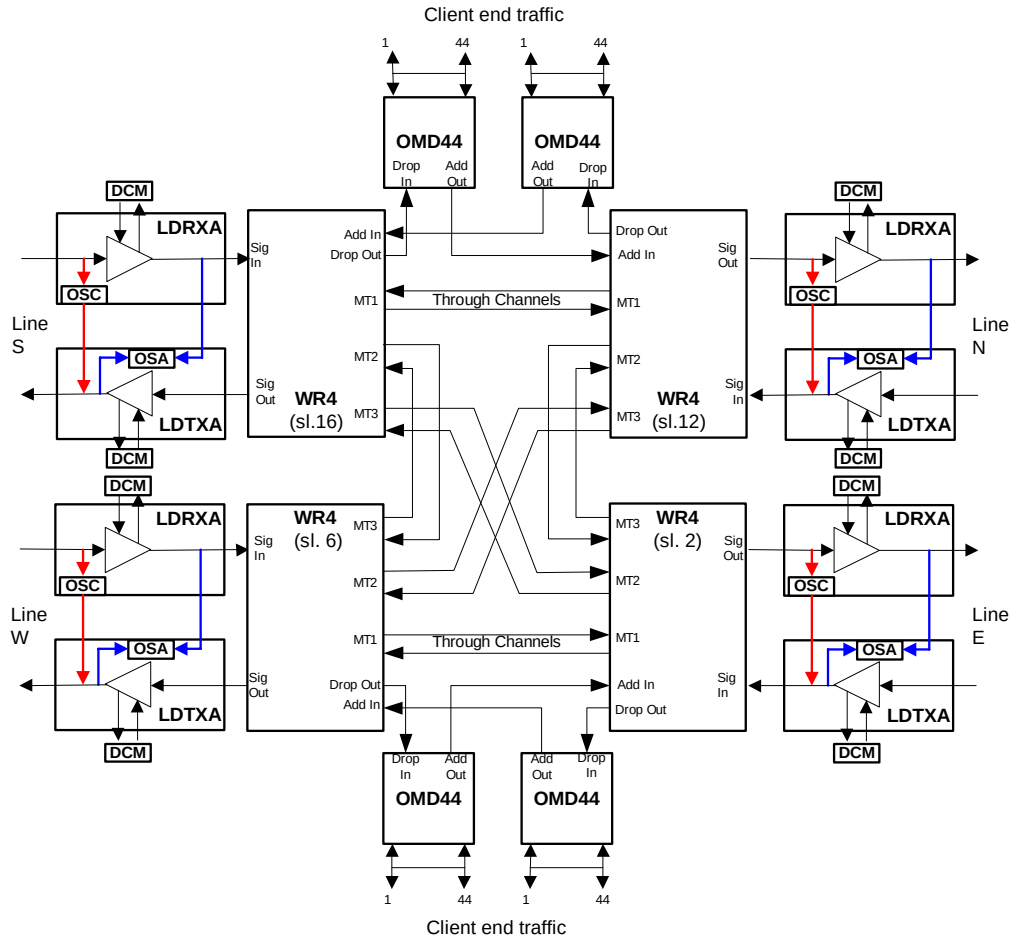


Figure 27. Optical Add/Drop Multiplexer ROADM 4-degree

1.7 Switching capacity subsystem

Table 5. on page 51 lists, by traffic type, the switch capacity reported on the 1850 TSS-320.

Because switching time is the same for HO SONET/SDH, OTN and packet based traffic, the values in the table refer to the maximum switching capacity that can be obtained with no technology mixing.

For LO SONET/SDH, LO switching is performed in a dedicated device. In this case, the management of OTN traffic and/or packets in the same equipment has no impact on the LO switching capacity.

Table 5. Reported switch capacity

HO SONET/SDH TDM traffic	LO SONET/SDH TDM traffic	OTN TDM traffic	Packet based traffic
320 Gb/s	40 Gb/s	320 Gb/s	160 Gb/s (note that the packets switching capacity is limited to 160Gb/s due to technology limitation of currently foreseen I/O data boards. Matrix device and backpanel capacity would allow up to 320Gb/s as well).
6144x6144 VC-3	21504x21504 VC-11	128x128 ODU1	
2048x2048 VC-4	16128x16128 VC-12	32x32 ODU2	
	768x768 VC-3		

1.8 Matrix connections

The 1850 TSS-320 can manage and configure several types of connections at different layers. Refer to the appropriate section(s) in the following list for more information on a given layer:

- SONET/SDH HO: refer to section C.1 on page 609
- SONET/SDH LO: refer to section C.2 on page 622
- OTN : refer to section C.5 on page 633
- Packet: refer to section C.6 on page 640

1.9 System Management

With the extensive introduction of SONET/SDH and WDM in the transport network, centralized and integrated network management is mandatory for Network Operators to realize the potential cost saving and required Quality of service.

Alcatel-Lucent provides a comprehensive range of Network Management Applications compliant with the ANSI/ITU-T Telecommunication management Network Principles.

The ZIC (Zero-Installation Craft terminal) is a project in charge of the **local** management of single network elements from different Alcatel-Lucent SONET/SDH and WDM products, providing ANSI/ITU compliant Information Model Interface to the Network Element.
The ZIC (Zero-Installation Craft terminal) manages all Gateway or Remore Network Elements in the Alcatel-Lucent Transmission catalogue, except for the Cross Connect (DXC).

The ZIC can be integrated to products in charge of the management of **networks** and network elements.

The ZIC uses a state-of-the-art platform for providing an advanced and integrated *Management*.

The 1850 TSS-320 control sub–system is based on a two level model :

– Equipment Controller (EC) implemented by the EC320 card.

– Shelf Controller (SC) implemented as part of the MATRIX card.

The EC provides the HW resources (physical interfaces) and the SW functionalities (protocol stack) required for the communication between NE and Management system (OS, craft terminal, etc).

It performs as well all the SW functions related to the control and management activities like info–model processing, event reporting and logging, equipment data base management, SW downloading and management, etc.

To support these activities, the EC function requires a non volatile mass storage device (flash card).

The SC provide the resources to support the SW functions related to the control and management operation of the boards.

As the SC is involved in critical activities (for instance EPS), is 1+1 protected.

Internal bus

For the controller sub–system the following buses are defined:

– ”Management bus” that allows:
  - connection between SC and boards for configuration data provisioning
  - remote inventory data acquisition
  - data collection (alarms) and commands handling (ex. loops)

– “ISSB bus” used for communication among the Equipment Controller, the Shelf Controllers and the Local Microprocessor (present for example on ISA board).

External interfaces toward Craft Terminal, OS and Mediation Device

F interface: available from the EC function for connection to a local Craft Terminal; the electrical interface and connector (both RJ45 and μUSB) are provided by the EC320 card.

M interface: is a TMN related communication interface based on the use of the Embedded Communication Channels. Through the QECC interface the system can exchange management messages with a remote OS. In the 1850 TSS-320 up to three full duplex ECC channels can be terminated from each SONET/SDH interface: one DCC_M at 576 kbit/s, one DCC_R at 192 kbit/s and one DCC_P 64 kbit/s.

RE / HK interface: this interface consists of parallel I/O signals used for remote alarms and for housekeeping signals.
The relevant electrical interfaces are placed on the 1850 TSS-320 interconnections panel and are controlled by the EC function through parallel I/O ports.

RA interface: it is dedicated to send commands toward the rack to light up the relevant lamps located on GEN-TRU unit.

Examples of network management architecture are reported in Figure 29. on page 57. and Figure 30. on page 58.
In these figures any generic SONET/SDH or WDM equipment (Add / Drop Multiplexer, Cross-connect, Regenerator, etc.) inserted in the network is indicated by the acronym NE (network element).

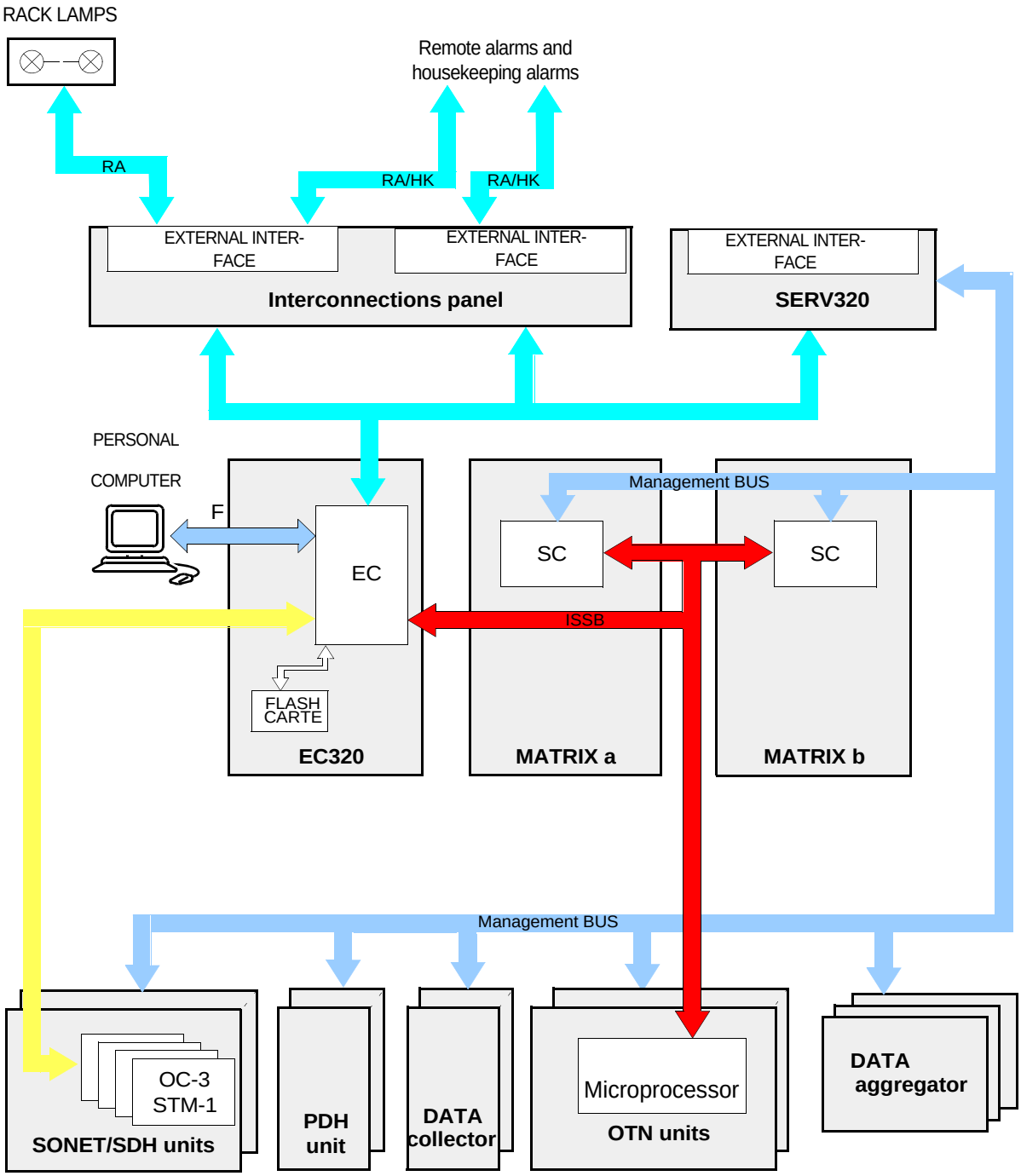


Figure 28. 1850 TSS-320 Control subsystem

1.9.1 Network management interfaces

The SONET/SDH/WDM Equipment provides two types of physical interfaces for management functions: the F interface and the M interface. To these interfaces can be connected the manager computer, that can be:

- a CRAFT TERMINAL (CT). It is generally a personal computer (PC) connected through the F interface for local management
- OPERATING SYSTEM (OS). Workstations utilized for the TMN (Telecommunications Management Network). They are connected through the M interface, for network management

This Operator's Guides deal with the management achieved by means of the first type of computer, i.e. the ZIC (Zero-Installation Craft terminal). For the Telecommunications Management Network description refer to the documents of the various Operation Systems.

The management can be realized in **local** or **remote** mode:

- in the **local mode** the managed equipment are directly connected to the computer via F interface
- in the **remote mode** (Type 1) the managed equipments are indirectly connected via the OSI Networking which can include both DCCM / DCCR protocol or Ethernet LAN (Local Area Network)
- in the **remote mode** (Type2) the managed equipments are indirectly connected via an IP network using a tunnel over IP.
- in the **remote mode** (Type3) the managed equipments are indirectly connected via external modem.

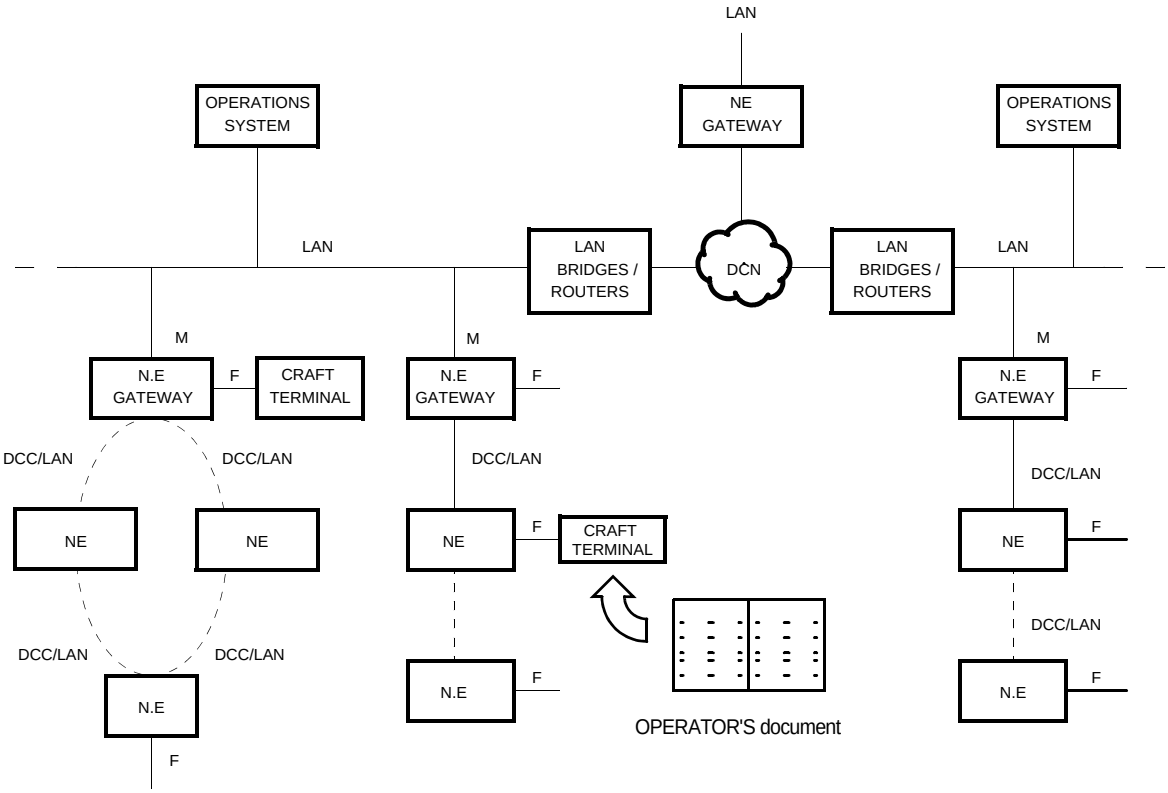
The software runs on the WINDOWS XP in a WINDOWS environment. User familiarity with this operating environment is, therefore, highly recommended.

1.9.1.1 Management

Management of the 1850 TSS-320 includes the following functions:g:

– Alarm (fault) management - for real time alarm reporting and subsequent fault localization and correction
– System management, for example:
  - Configuration management - for handling operational data of the Network Element
  - Performance Monitoring management - to set up, collect, log, and display performance data associated with the managed NE according to ANSI T1.105.05/ITU-T G.826 recommendations.
– NE access according to the user profile

The management functions on the 1850 TSS-320 are available for all the NEs - local or remote.



DCN : Data Communication Network

N.E. : Network Element (MSN, ADM, CROSS CONNECT; etc)

Figure 29. Example of network management architecture

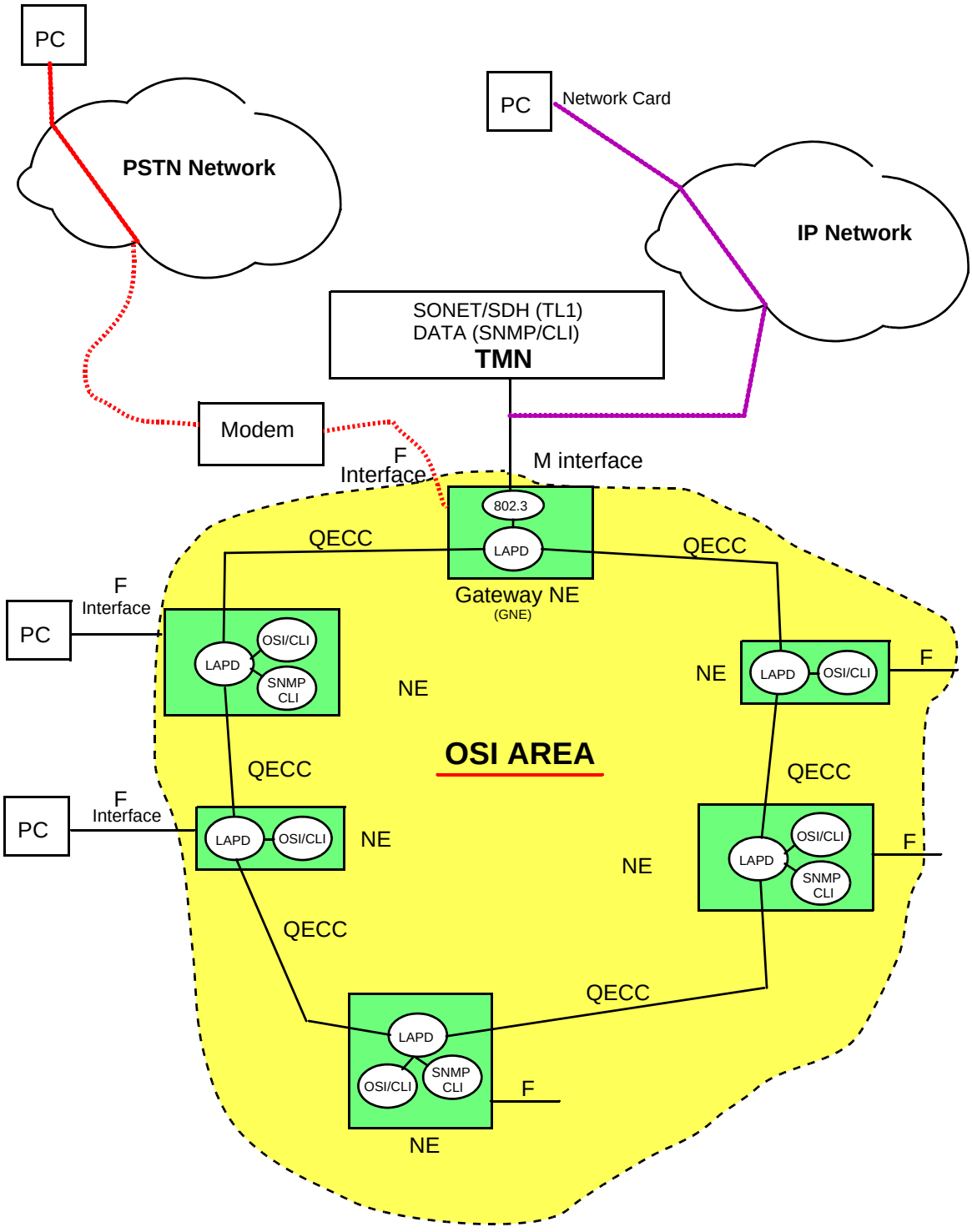


Figure 30. Example of management of a SONET/SDH, DATA and WDM network

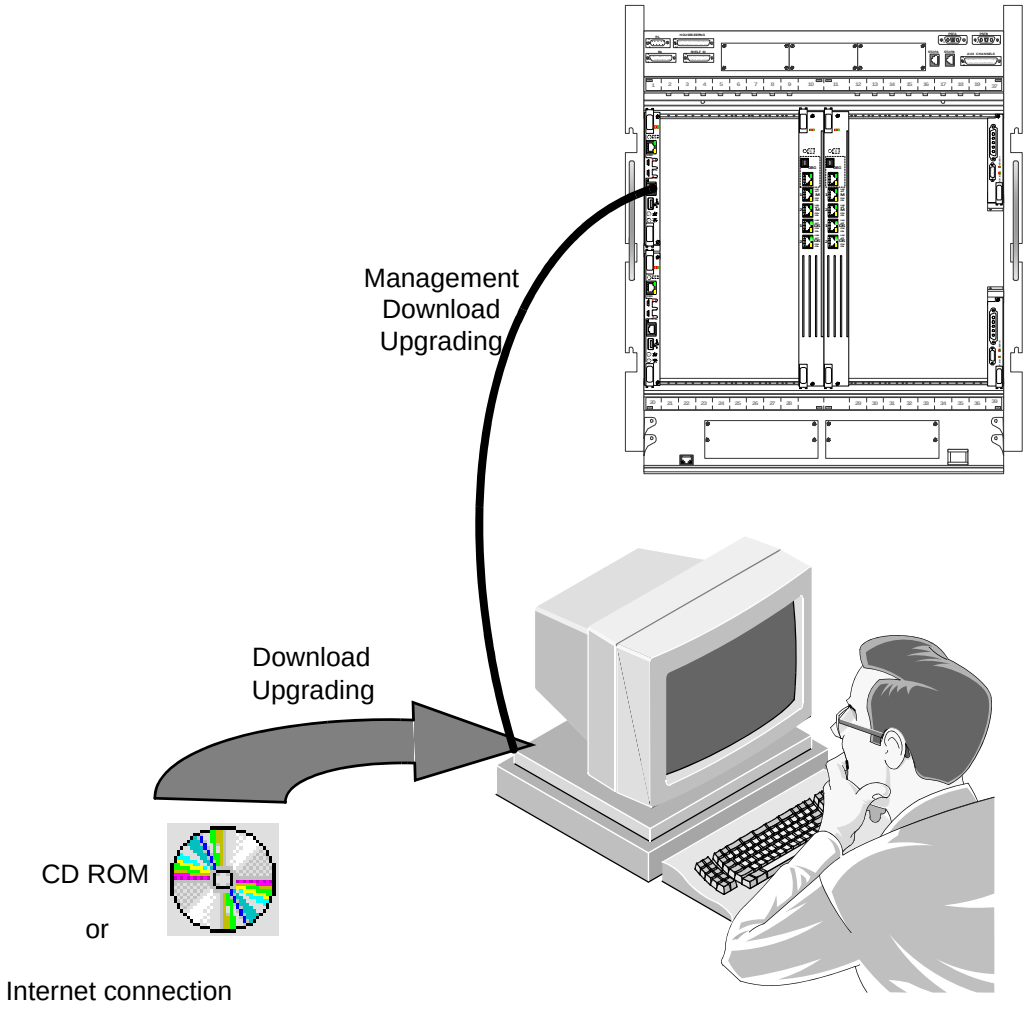
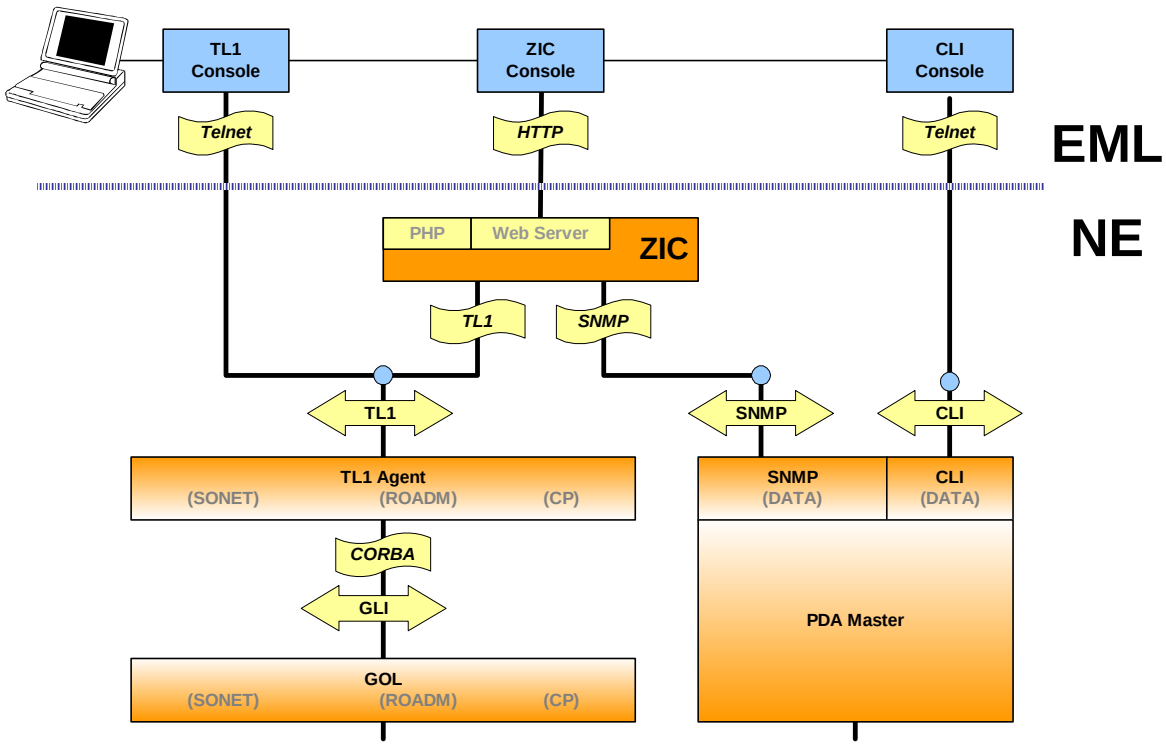


Figure 31. Management, dowloadin and upgrading

In the 1850 TSS-320, the management function is performed using one of three interfaces: CT, TL1, or CLI. Supported signals and interfaces are listed in Table 6. on page 59.

Table 6. 1850 TSS-320 interfaces

Managed Signals	ZIC (Zero-Installation Craft terminal)	TL1 (Translation Language level 1)	CLI (Command Line Inter-face)
SONET/SDH	X	X	
DATA	X		X
WDM		X	



The TL1 (Translation Language level 1) consists of input commands (TID, AID, CTAG, General Delayed Activation, Positional, Keyword Parameter Block, State Parameter Blocks), command output response (successful and unsuccessful) messages, acknowledgement output messages, and autonomous output messages.

It uses a Telnet session with TCP/IP connectivity between the host from which the Telnet session is opened, and the 1850TSS-320.

The CLI (Command Line Interface) performs most of the CT functionalities.

It uses a Telnet session with TCP/IP connectivity between the host from which the Telnet session is opened, and the 1850TSS-320.

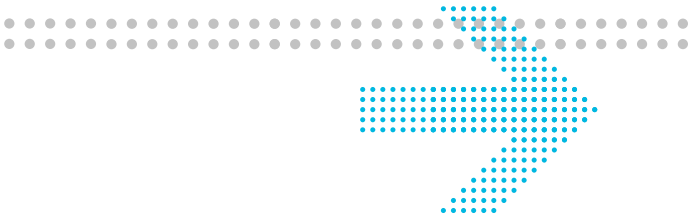
CLI is not required to manage the following functions:

– Support Domain
  - Event Reporting
  - PM Filtering
  - MIB Backup/Restore and SW download

– C&R domain:
  - Tunnel management:

Additionally, CLI does not cover the following management functions:

– Support Domain:
  - Condition of Configuration Mode
  - Inhibit/Allow Logging



2 Physical Configuration

This chapter describes the physical structure, layout and composition, coding, and partitioning of the equipment subrack. Specifically, this chapter covers the following:

– Bay Frame Composition in Table 7. on page 78.

  • 1850 TSS-320 Bay frame - Front view starting from Figure 48. on page 90.

– 1850 TSS-320 Shelf Composition in Table 8. on page 79.

  • 1850 TSS-320 SHELF - Front view (S320) starting from Figure 56. on page 96.

  Note: Explanatory notes are provided in Table 9. on page 88.

– UNITS FRONT VIEW:

  • For the units front view refer to para 2.4 on page 89.

  Note: Although the Personal Computer (Craft Terminal) used for Initial Turn-on and Maintenance operations is not shown as an item in the equipment list, it can be supplied by Alcatel-Lucent. See “Craft Terminal Operation Guide” for more information on PC hardware configuration..

2.1 Subrack overview

The main drivers guiding the mechanical design are summarized by the following statements:

– Transport (port) and Connection (electrical access) areas are physically split in two separate back panels, allowing electrical access components to be mounted as needed to save space. The subrack is designed to be configured as follows:

  • Traffic ports are always hosted in the basic shelf, along with all the common equipment

  • Optionally, the access panel can be used in place of one or more of the basic shelves to provide electrical access

– The basic shelf supporting traffic ports and common equipment is 21" wide; the access panel is also 21 inches wide.

– Dividable traffic slots can be used for a finer shelf equipping granularity (multisize slot concept) (refer to Figure 32. on page 63). An attempt has been made to standardize the boards the **WDM boards** and **full sized (data) boards** .

The five types of traffic card sizes available with the 1850 TSS-320 are listed in the table following table:

Size (abbreviation)	Used for	Dimensions
Double full (DF)	data applications (example “PP20G” Packet Processor)	PCB ~ 13.89 x 16.22 in. (353 x 412 mm)
Full (F)	data and several applications in general	PCB ~ 13.89 x 8.11 in. (353 x 206 mm)
Half (½ or H)	SONET/SDH/PDH applications	PCB ~ 6.26 x 8.11 in. (159 x 206 mm)
Normal (¾ or N)	WDM applications	PCB ~ 10.43 x 8.11 in. (265 x 206 mm)
Small (¼ or S)	WDM applications (not available in current release)	PCB ~ 2.87 x 8.11 in. (73 x 206 mm)

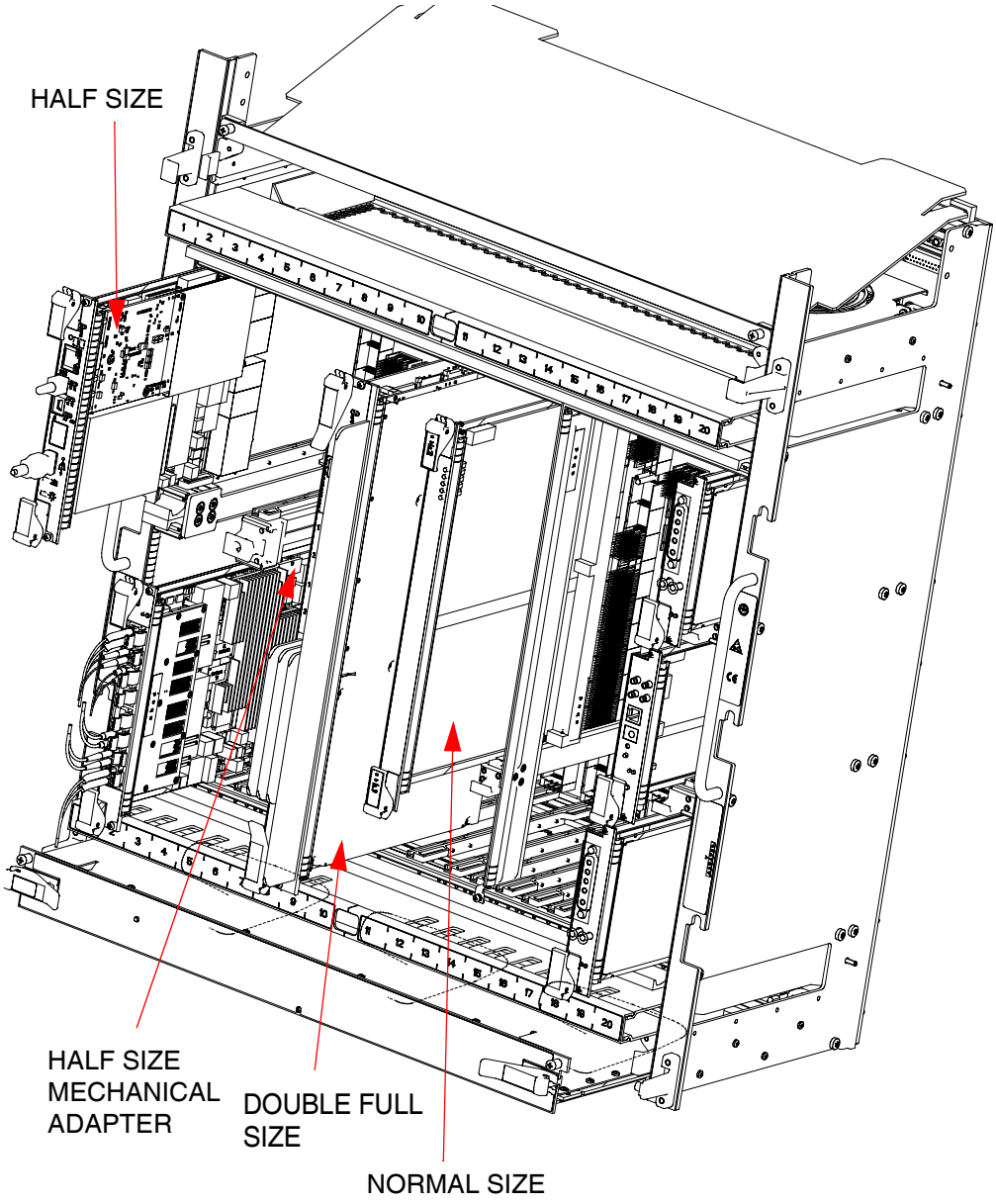


Figure 32. 1850 TSS-320 Subrack: example of boards size.



Figure 33. 1850 TSS-320: front cover plate

The basic shelf is partitioned for the following slot types, as shown in Figure 8.:

1) **Port slots:** **4,5TE wide**

   The port slot is compatible with full, half, normal, and small card sizes. Port slots are also compatible with double full and double normal card sizes.

2) **Matrix slots:** **7TE wide**

   Slot 7TE is a dedicated slot for the Matrix board.

3) **Control and common parts slots:** **5TE wide**

   Slot 5TE is the dedicated Equipment Controller (EC320) /First Level Controller (FLC) slot in this release.
   It is expected that Slot 5TE will also host Power Supply Filter (PSF320) and Service (SERV320) packs in a future release.

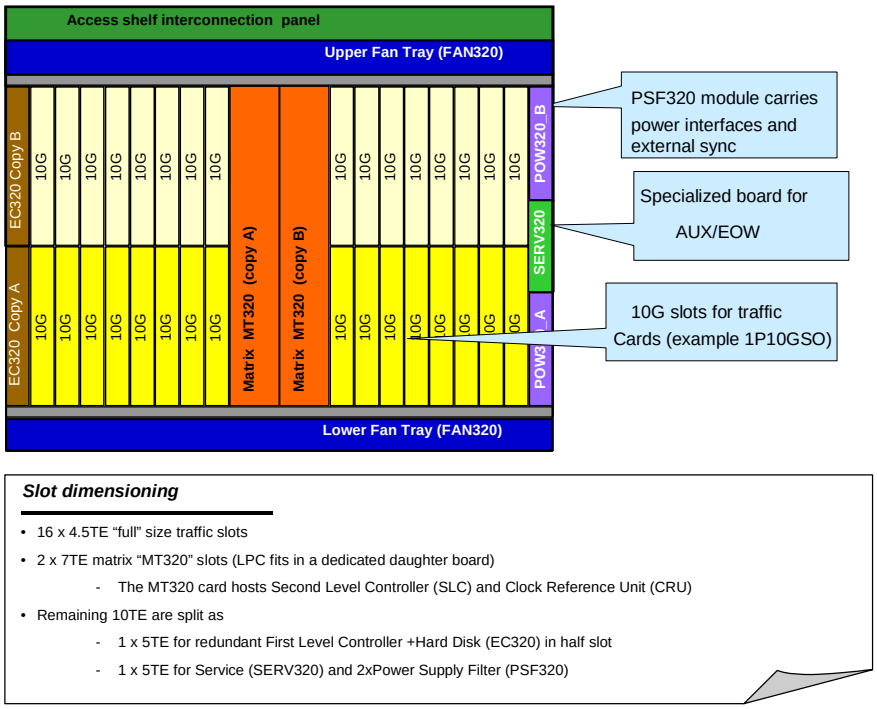


Figure 34. Slot dimensioning

– Each Port slot can be divided into two half slots.
In addition, the four slots adjacent to the Matrix slots can be divided into two to make one full slot and one half slot for WDM compatibility using the following special mechanical adapters:

1) Mechanical adapter without vertical fixing bar specific for 1850 TSS-320 half sized cards (4.5TE wide)

   – Both upper and lower cards are fixed with levers

2) Mechanical adapter with vertical fixing bar 2.5 mm thick for full sized cards 4.0TE wide

   – upper (normal) card fixed with levers

   – lower (small) card fixed by screws

– The upper part of the remaining four + four slots can also be used for PDH applications.

– Three of the remaining four half slots can also be used for lower order applications.

– Two adjacent port slots can also be combined for a double full slot (i.e. for 20G Full Rate Processor board "PP20G").

Side views of the shelf mechanics are shown in Figure 35. on page 66.

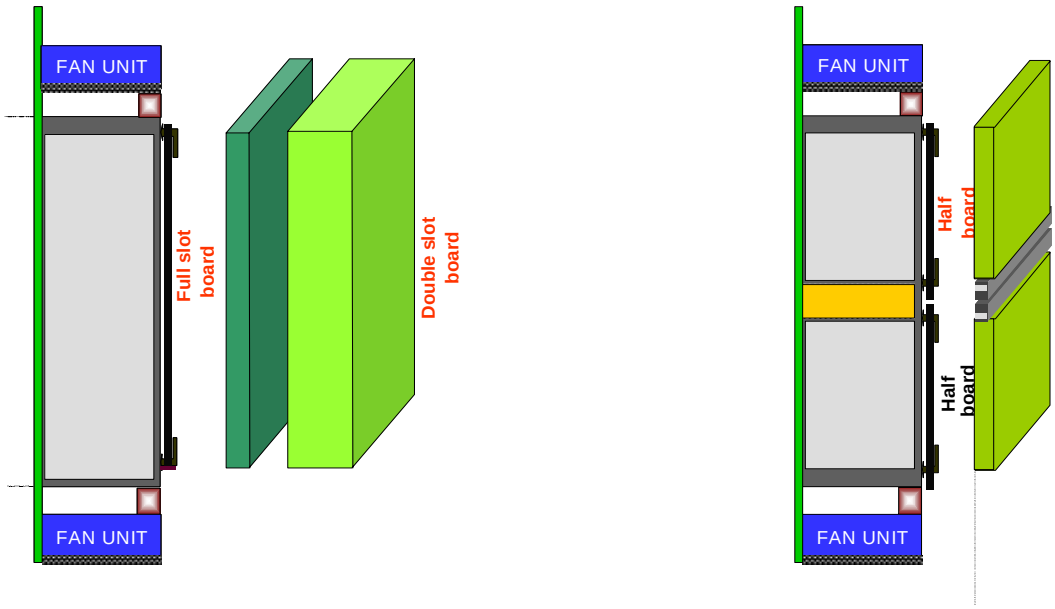


Figure 35. 1850 TSS-320: Side view of (N) card and (H) cards (4.5TE wide) with slot adapter

The 43 slots in a 1850 TSS-320 shelf are made up as follows:

– 32 are Port slots

– 2 are Matrix slots

– 5 are common part and control slots

– 2 are FANs and 2 are Bus Termination (hidden)

The shelf can be partitioned for up to 32 Port slots (achieved using slot adapters) plus 7 slots for common parts organized as follows:

a) 2x7TE **Matrix slots** (MT320) (a total of 14TE) dedicated to Matrix boards (copy A and copy B for redundancy).

Each Matrix board provides the following functionality:

- **Universal Matrix** with STS-1, STS-3c / AU3, AU4, ODUk and packet switching capability (overall maximum throughput of 320Gb/s)
- **LO switch Matrix** with VT/TU switching capability (maximim throughput of 40Gb/s) by means of a dedicated daughter board

- **SLC+CRU card** providing second level controller function and the reference clock generator by means of a dedicated daughter board

b) **16x4.5TE Port slots** (a total of 72TE are reserved to traffic ports) that can host the following cards:

- Transport optical cards like OC-N ports, G.709 UNI/NNI ports, GE/10GE ports etc.
  - Either up to 32 universal half slots (10Gb/s of max throughput each) or up to 16 universal full slots (20Gb/s of max throughput each) for different optical applications are available.
- Transport electrical cards like PDH ports, FE ports etc.
  - A subset of dedicated (colored) slots can be removed from the set of 32 universal half slots or 16 universal full slots and equipped with PDH and FE cards.
    Figure 35. on page 66 shows density and slot allocation of electrical cards.
- Lower order Adapter (LOA) card is needed to enable LO processing capabilities and for hosting LOA processing parts (4 LOA max. + 1 for protection)
  - A subset of up to 6 dedicated (colored) LO half slots can be removed from the set of 32 universal half slots and equipped with LOA cards.
    Figure 35. on page 66 shows slot allocation of LOA cards.
- Data cards
  - 20G Packet Processor cards (PP20G) take up double full slots
- ROADM cards

  Cards for ROADM application are generically known as "Circuit Packs" . These include:
  - Wavelength Routers (WR4 and WR8), which take up double full slots
  - Amplifiers (LDRXA. LDRXB, LDTXA and LDTXB), which take up a single full slots
  - Optical Protection Switching (OPS) packs, which take up single half slots
  - 11G Anyrate OTs (uni- and bidirectional) (11GBAR and 11GUAR), which take up single half slots
  - Optical mux/demux 44-ch. (OMD44) packs, which are housed in an external shelf (1 U)
  - Dispersation Compensation Modules (DCM)s. These are housed in a 9.65 in. wide (245 mm) x 9.45 in. (240 mm) deep package with additional depth for rear guide pins and a front handle. DCMs come in the following heights: 0.85 in. (21.5 mm), 1.77 in. (45 mm), and 2.66 in.(67.5 mm).

c) **Common parts**, such as those listed below, go in the remaining 10TEC slots.

- **FLC+HD card (Main and Spare)** provides the First Level controller function and has mass storage capabilities (Hard Disk)
  - Two half-sized slots on the left of the shelf are reserved to this function.

- **PSF320** and **SERV320** (A & B) cards go in the last slot on the right of the shelf. This slot is divided into three sections:
  - Two sections are symmetrical and reserved for (redundant) PSF320 functions of powering the whole shelf and providing ext sync interfaces.
  - The third section is reserved for the unprotected service functions (SERV320) of providing EOW and AUX channels.

2.2 Equipment front view

The 1850 TSS-320 is composed of one shelf with 43 slots as indicated in Figure 36. on page 69.

Examples of shelf configurations are shown in Figure 37. on page 70 through Figure 47. on page 76.

N.B. PDH and LOA boards are not available in this release.

2.2.1 1850 TSS-320 Shelf front view

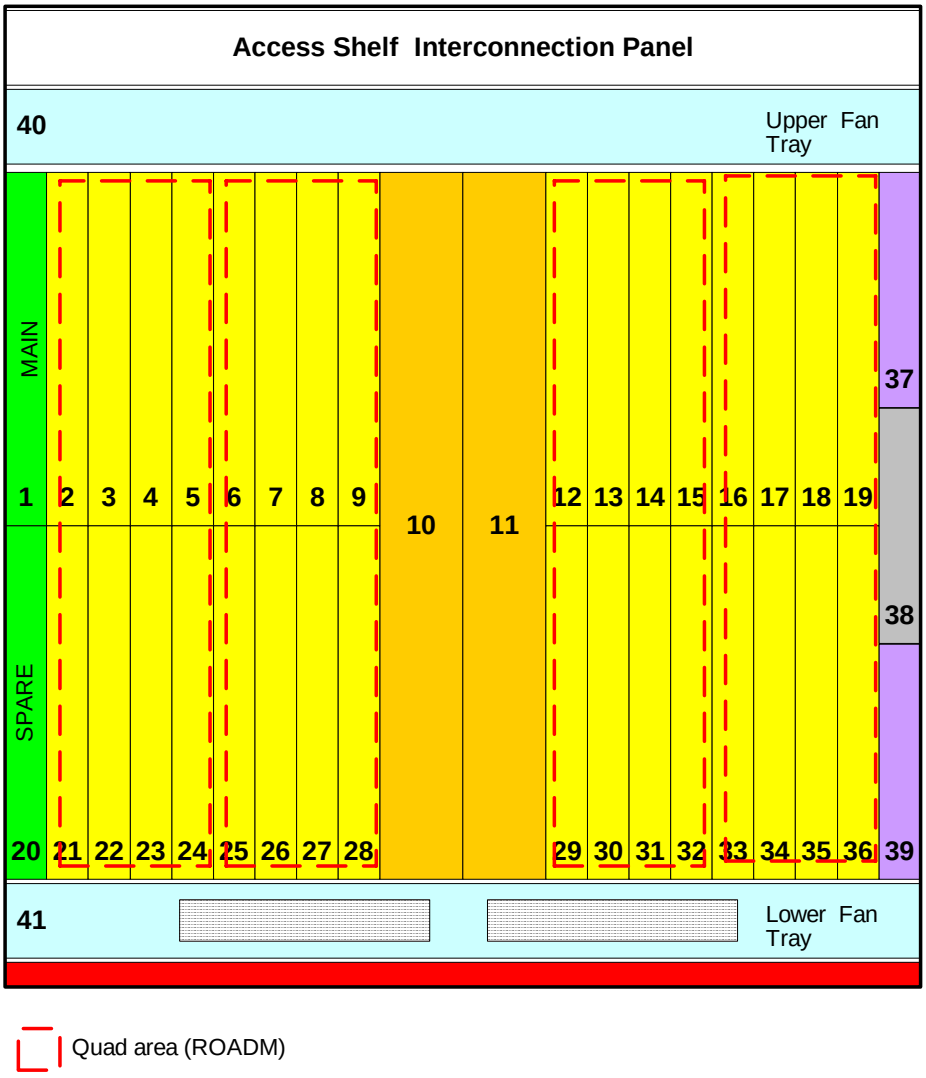


Figure 36. 1850 TSS-320 composition

2.2.2 Examples of Shelf Configuration

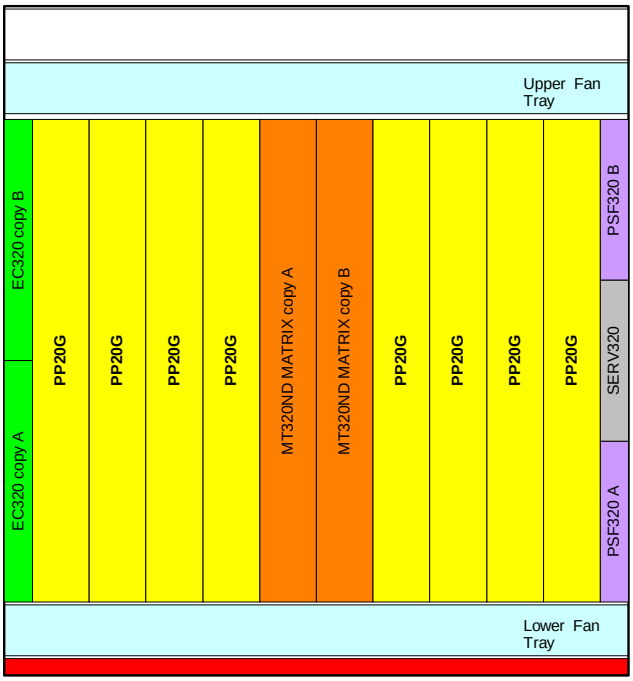


Figure 37. Shelf equipped with 20G Packet Processor "PP20G" boards

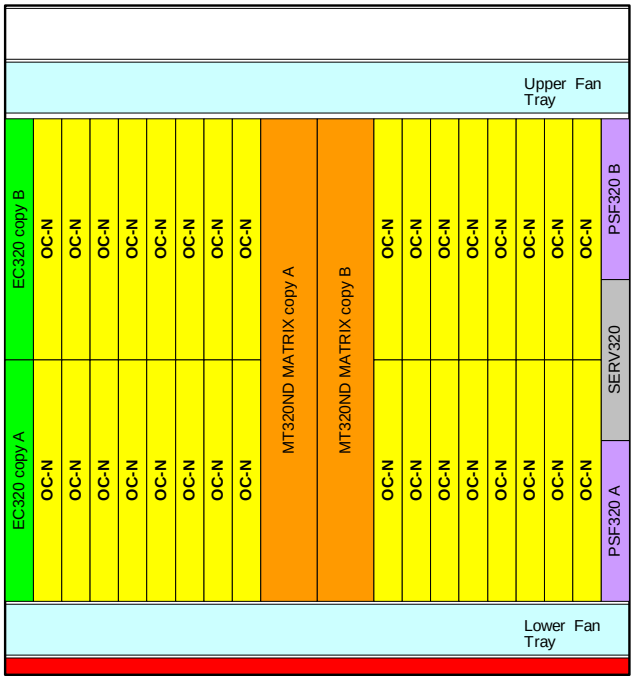


Figure 38. Shelf equipped with OC-N boards

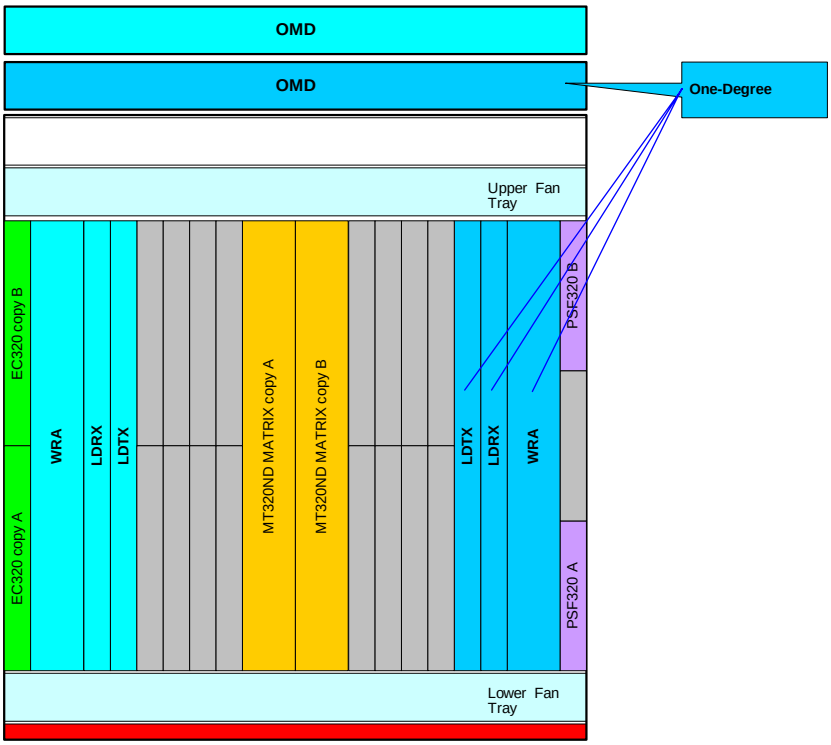


Figure 39. 1850 TSS-320: Degree-2 ROADM equipped in 1 shelf

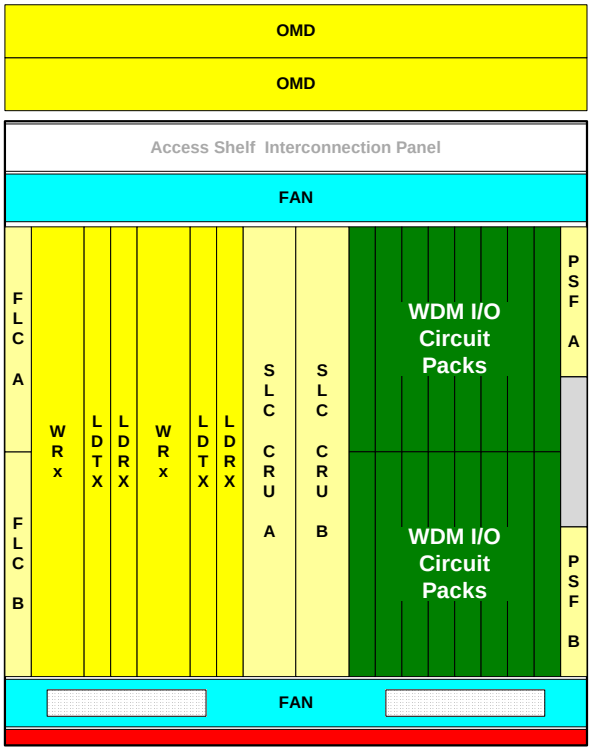


Figure 40. 2-degree UROADM equipped in 1 shelf - WDM-Only Node

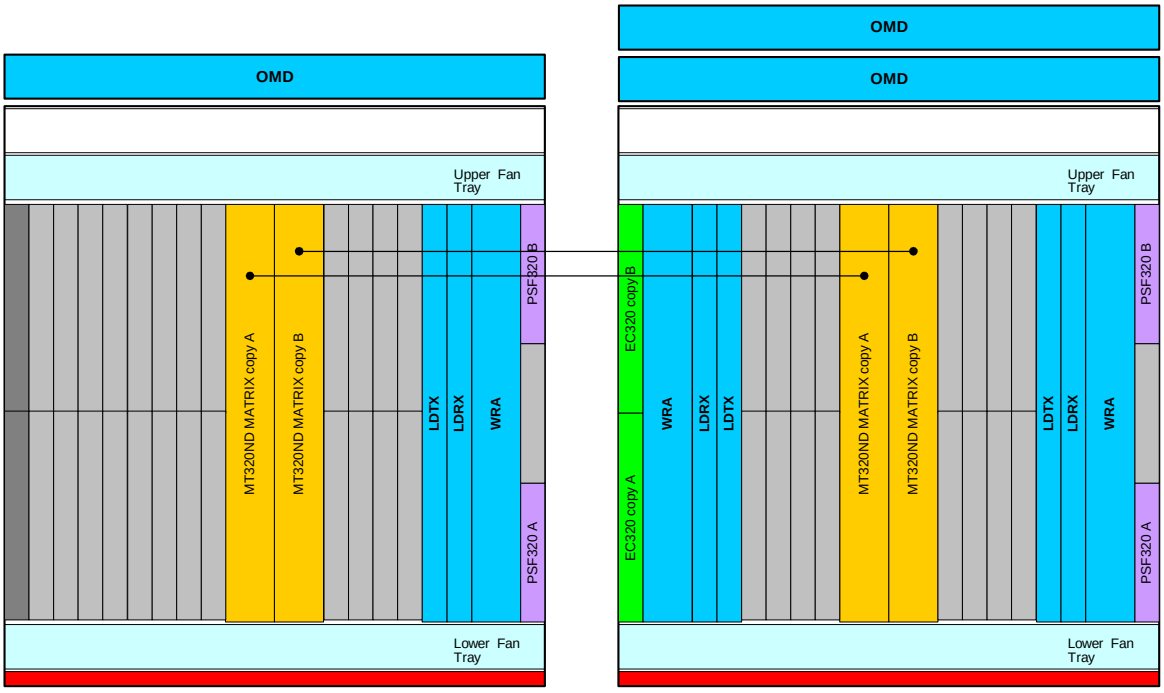


Figure 41. 3-degree ROADM equipped in 2 shelf

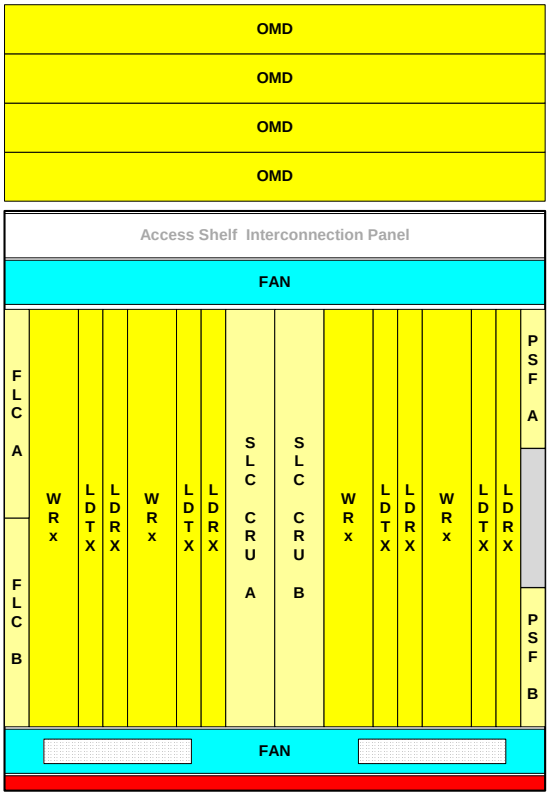


Figure 42. Degree-4 ROADM Shelf

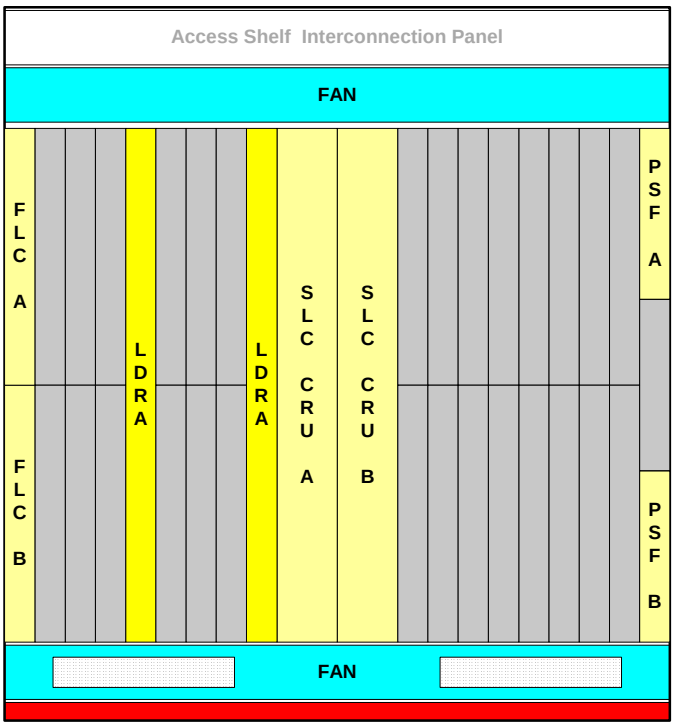


Figure 43. ILA Node (Single ILA Shelf)

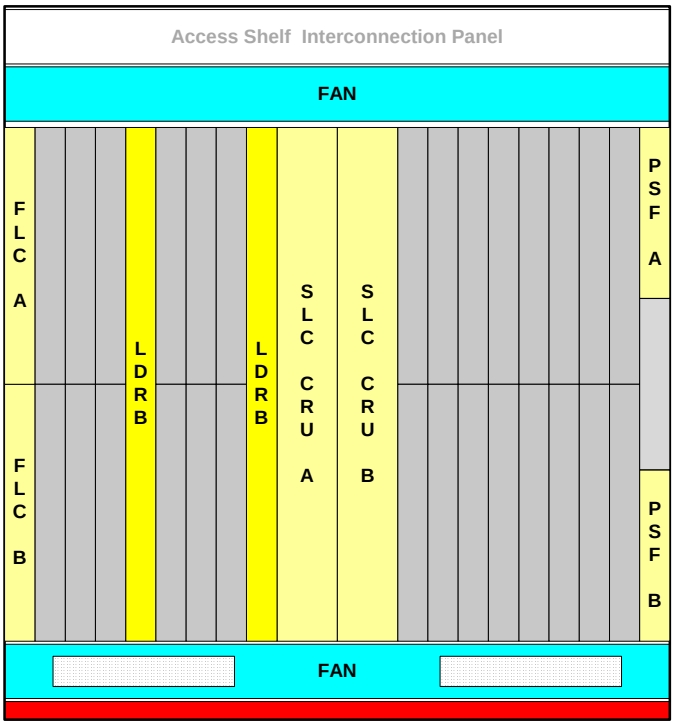


Figure 44. UILA Node (Single ILA Shelf)

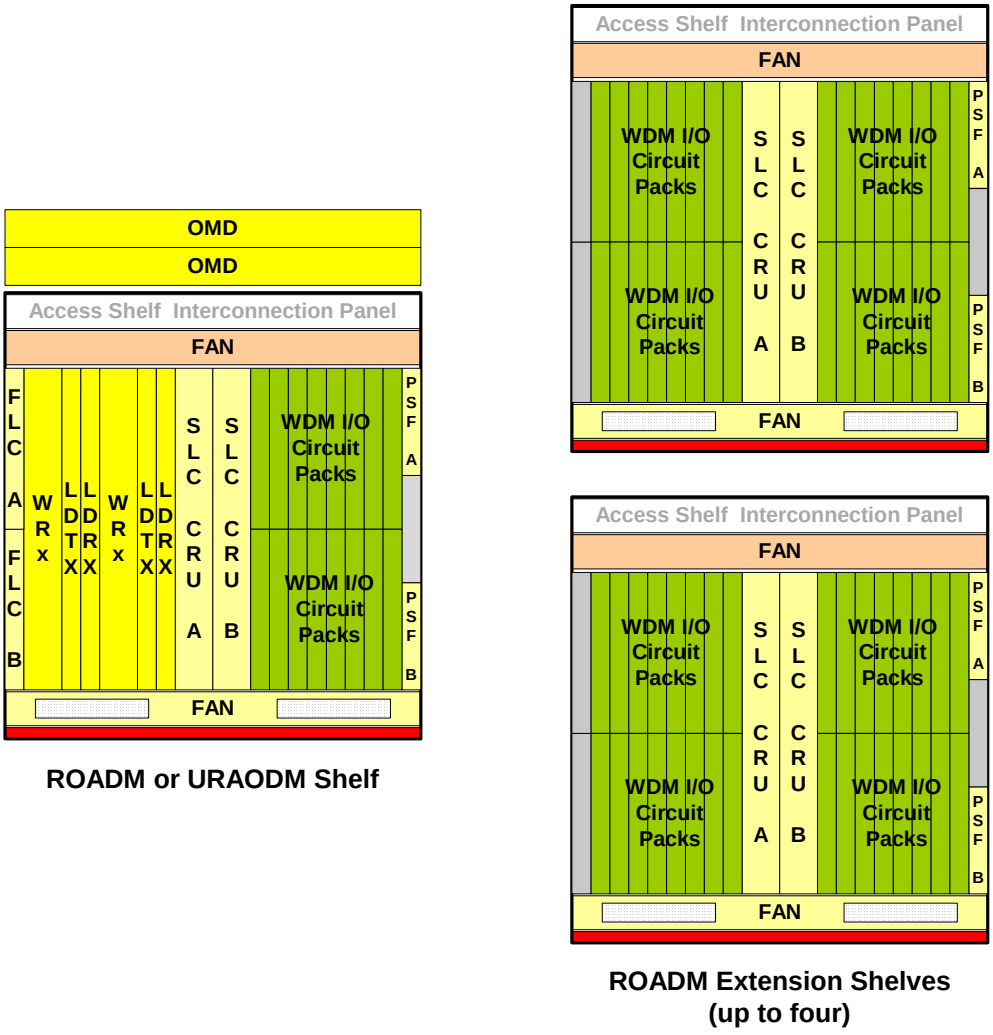


Figure 45. 2-degree ROADM (WDM Only) Node Configuration

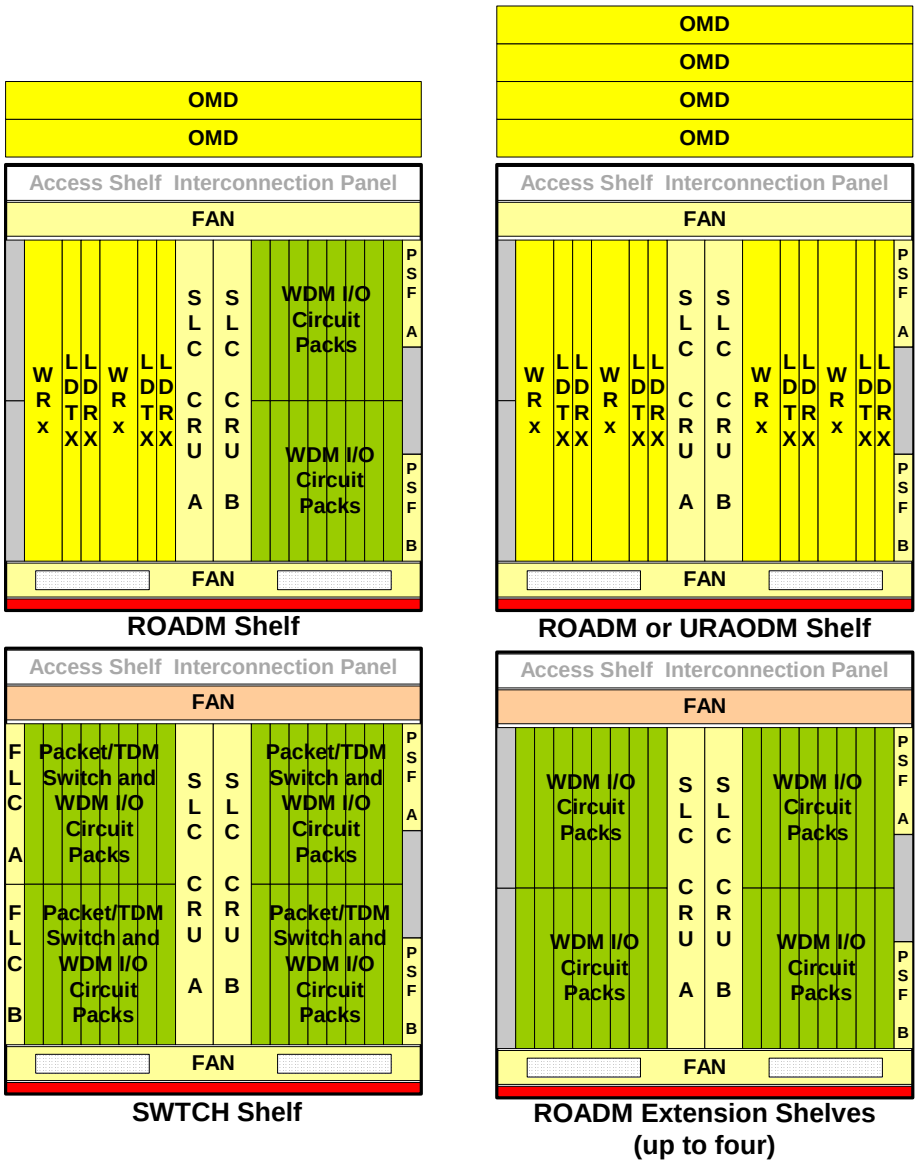


Figure 46. 6-degree ROADM Node Configuration

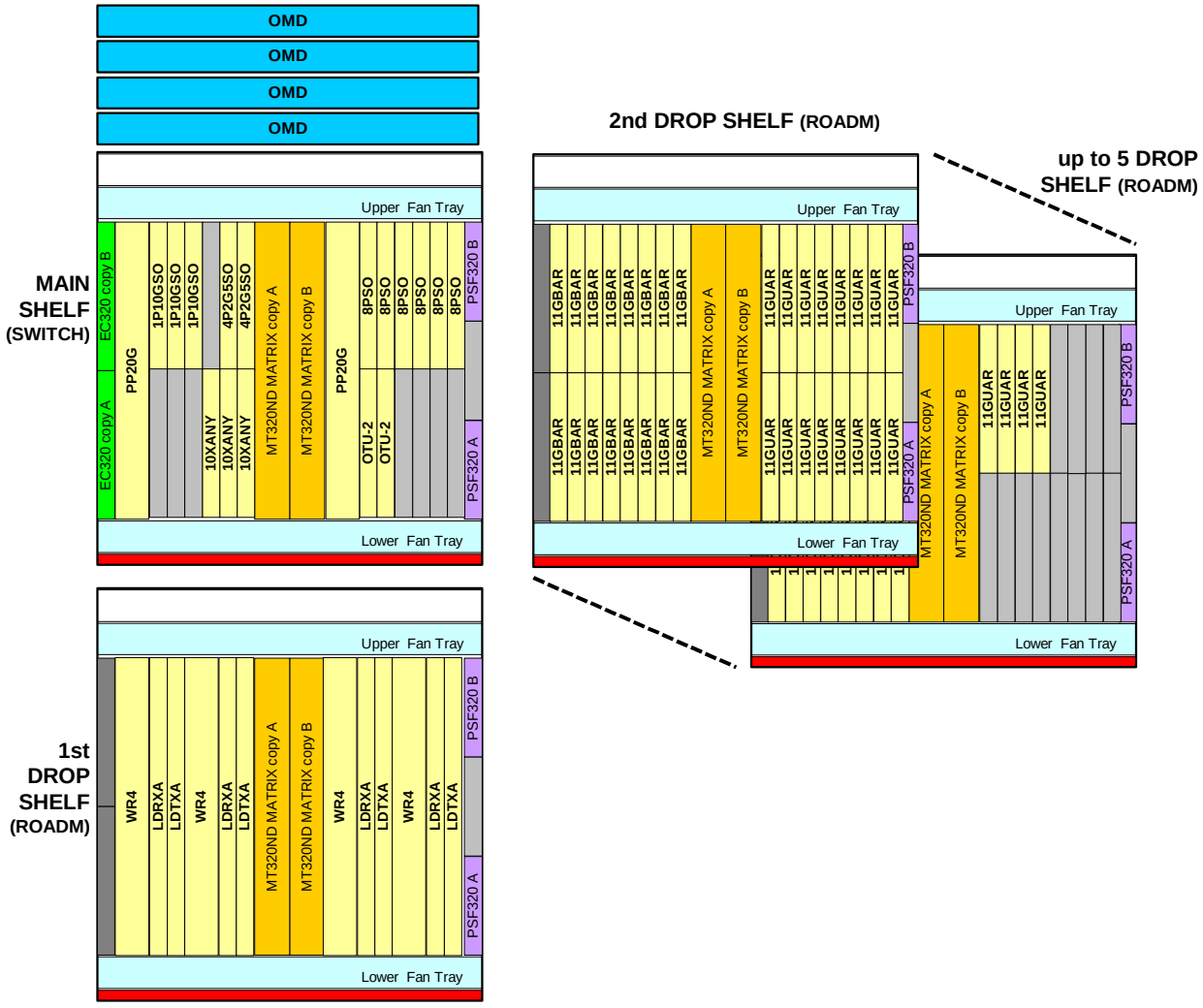


Figure 47. 4-degree ROADM equipped in multishelf

2.3 Part list

The following tables list the names and codes of components that make up the 1850 TSS-320 system. Slot positions and maximum qualities are also provided.

Specifically, the tables list the following:

- Name = the name of the component
- Acronym = the short name identifying the unit. This is printed on the front cover plate.
- Side = size of the boards.

  The following five card sizes are listed:

  – Double Full (DF): the board is two slots high and two slots wide

  – Full (F): the board is two slots high and one slot wide

  – Half (H): the board is one slot high and one slot wide

  – Normal (N): the board is 1.5 slots high and one slot wide

  – Double Normal (2N): the board is 1.5 slots high and two slots wide
- ANV part Numbers = component part numbers (shown as 3ALXXXXX XXXX)
- Maximum Quantity = maximum allowed in each shelf
- Position = component slot positions. Refer to Figure 36. on page 69 for slot numbering.
- Notes = Table notes. Explanatory notes are also provided in Table 9. on page 88.

2.3.1 Bay Frame equipment

Table 7. Bay Frame Composition

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	NOTES
BAY FRAME					
SINGLE NETWORK BAY FRAME (ANSI)	BAYFRAME		1AD 13937 0001	1	1
14” SINGLE NETWORK BAY FRAME (ANSI)	BAYFRAME		1AD 13937 0002	1	1
POWER DISTRIBUTION UNIT	GENTRU	--	8DG 08059 AA--	1	
STEPUP ETSI/ANSI 1850TSS	STEPUP	--	3AL 89590 AE--	2	
EXTENSION BYPASS	BYPASS	--	3AL 91622 AC--	2	
DCM SHELF	DCM	--	8DG 08255 AA--	1	
12" / ETSI DCM SHELF	DCM-SHF		8DG 08255 AB--		
FIBER STORAGE TRAY	--	--	8DG 08257 AA--	1	
12" / ETSI FIBER STORAGE TRAY	FST		8DG 08518 AB--	1	
14" FIBER STORAGE TRAY	FST		8DG 08518 AA--		
STILE STRIP SET	STILE STRIP		8DG 08283 AAAA	1	
12” STILE STRIP SET	STILE STRIP		8DG 08283 AB	2	
SPARE PARTS					
NAR LOWER BAFFLE UNIT	--/--		8DG 08260 AA--	1	
NAR UPPER BAFFLE UNIT	--/--		8DG 08259 AA--	1	

Notes:

1) It is supplied an Installation kit box

Table 8. 1850 TSS-320 Shelf Composition

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
COMMON PARTS						
SHELF (1850TSS-320) ANSI 12"	S320		8DG 08015 AB--	1	A	1
SHELF (1850TSS-320) ANSI 14"			8DG 08015 AA--			
POWER SUPPLY (TSS-320)	PSF320	--	8DG 07990 AA--	2	37 -39	2
FAN UNIT (TSS-320)	FAN320	--	8DG 90031 AA--	2	40 - 41	2
FAN UNIT PROTECTION	--/--	--	3AL 94613 AA--	1	B	
UNIVERSAL MATRIX (TSS-320)	MT320	DF	8DG 08044 AA--	2	10 -11	2
			3AL 92108 AB--			2
UNIVERSAL MATRIX (TSS-160)	MT160	DF	3AL 92108 AE--	2	10 -11	2
EQUIPMENT CONTROLLER (TSS-320)	EC320	H	3AL 92110 AA--	2	1 - 20	2
SERVICE (TSS-320)	SERV320	--	3AL 92170 AA--	1	38	
TIMING WIRE WRAP	--		8DG 08056 AA--	2		
SONET/SDH CARDS						
1x10G SYNC OPTICAL	1P10GSO	H	3AL 92111 AA--	32	02 to 09 12 to 19 21 to 28 29 to 36	3
4x2.5G SYNC OPTICAL	4P2G5SO	H	3AL 92112 AA--	32		4
8x155/622M SYNC OPTICAL	8PSO	H	3AL 92113 AA--	32		5
1xOTU-2 PORT SLIM	OTU-2	H	8DG 07955 AA--	32		
10XANY	10XANY	H	8DG 07931 AA--	32		
DATA CARDS and PIMs						
20G PACKET PROCESSOR	PP20G	DF	3AL 92114 AA--	8	2/3, 4/5, 6/7, 8/9, 12/13, 14/15, 16/17, 18/19	6
1x10GE PIM	PIM10GE	--	3AL 92116 AA-	16	read notes on right column	3 - 7
10 x 1GE PIM	PIM1GE	--	3AL 92117 AA--	16		7 - 8
MULTI-SERVICE PIM	PIMMS		3AL 92118 AA--	16		7
OPTICAL AMPLIFIER						
Ampl. 16 dBm + OSC	LDRXA	D	8DG08029 AA--	16	5 to 9 15 to 19	
Ampl. 20 dBm + OSC	LDRXB	D	8DG 08030 AA--	16	5 to 9 15 to 19	9
Ampl. 20 dBm + OSC	LDTXA	D	8DG 08031 AA--	16	4 to 8 14 to 18	
Ampl. + OSC	LDTXB	D	8DG 08032 AA--	16	4 to 8 14 to 18	

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
DWDM CARDS						
OPTICAL PROTECTION SWITCH	OPS	H	8DG 08036 AA--	32	02 to 09 12 to 19 21 to 28 29 to 36	
WAVELENGTH ROUTER 4 DEGREE	WR4	DF	8DG 08033 AA--	8	2/3, 6/7, 12/13, 16/17	10
WAVELENGTH ROUTER 8 DEGREE	WR8	DF	8DG 08034 AA--	8	2/3, 6/7, 12/13, 16/17	11
SINGLE PORT 11G BIDIR ANYRATE OT	11GBAR	H	8DG 08037 AA--	32	02 to 09 12 to 19 21 to 28 29 to 36	12
SINGLE PORT 11G UNIDIR ANYRATE OT	11GUAR	H	8DG 08038 AA--	32	02 to 09 12 to 19 21 to 28 29 to 36	12
OPTICAL MUX/DMUX 44CH	OMD44	--	8DG 08035 AA--	8	/	13
DISPERSION COMPENSATION MODULES						
DCM STD SMF 10 KM	DMSMF010		8DG08104AA	8	/	14
DCM STD SMF 20 KM	DMSMF020		8DG08105AA	8	/	
DCM STD SMF 30 KM	DMSMF030		8DG08106AA	8	/	
DCM STD SMF 40 KM	DMSMF040		8DG08107AA	8	/	
DCM STD SMF 50 KM	DMSMF050		8DG08108AA	8	/	
DCM STD SMF 60 KM	DMSMF060		8DG08109AA	8	/	
DCM STD SMF 70 KM	DMSMF070		8DG08110AA	8	/	
DCM STD SMF 80 KM	DMSMF080		8DG08111AA	8	/	
DCM STD SMF 90 KM	DMSMF090		8DG08112AA	8	/	
DCM STD SMF 100 KM	DMSMF100		8DG08113AA	8	/	
DCM STD SMF 110 KM	DMSMF110		8DG08114AA	8	/	
DCM STD SMF 120 KM	DMSMF120		8DG08115AA	8	/	14
DCM STD SMF 130 KM	DMSMF130		8DG08116AA	8	/	
DCM STD SMF 140 KM	DMSMF140		8DG08117AA	8	/	

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
SFP MODULES						
B&W SFP MODULES						
OPTO TRX SFP 1.25 GBE LX DDM	1000B	--	1AB 18728 0031	160	--	15 16
OPTO TRX SFP 1.25GBE LX DDM -40/+85		--	1AB 18728 0040	160		
OPTO TRX SFP 1.25 GBE SX DDM		--	1AB 18728 0033	160		15
OPTO TRX SFP 1.25GBE SX DDM -40/+85		--	1AB 18728 0045	160		
OPTO TRX 1.25 GBE SFP-ZX DDM		--	1AB 18728 0042	160		
OPTO TRX 1.25 GBE SFP-ZX DDM -40/+85		--	1AB 18728 0046	160		
OPTO TRX SFP DDM – IR-1 OC3 (ANSI market) – S-1.1 (ETSI market)	SS-11	--	1AB 19467 0004	256	--	17
OPTO TRX SFP DDM -40/+85 – IR-1 OC3 (ANSI market) – S-1.1 (ETSI market)			1AB 19467 0007	256		18
OPTO TRX SFP DDM -40/+85 – SR-1 OC3 (ANSI) – L-1.1 (ETSI)	SL-11	--	1AB 19467 0005	256		17
OPTO TRX SFP DDM – LR-2 OC3 (ANSI) – L-1.2 (ETSI)	SL-12	--	1AB 19467 0006	256		17
OPTO TRX SFP – IR-1 OC-12 (ANSI) – S-4.1 (ETSI)	SS-41	--	1AB 19636 0004	256	--	17
OPTO TRX SFP DDM -40/+85 – IR-1 OC-12 (ANSI) – S-4.1 (ETSI)			1AB 19636 0005	256		18
OPTO TRX SFP DDM ExTemp – LR-1 OC-12 (ANSI) – L-4.1 (ETSI)	SL-41	--	1AB 19636 0006	256	--	17
OPTO TRX SFP DDM ExTemp – LR-2 OC-12 (ANSI) – L-4.2 (ETSI)	SL-42	--	1AB 19636 0007	256	--	17

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
OPTO TRX SFP DDM – SR-1 OC48 (ANSI) – I-16.1 (ETSI)	SI-161	--	1AB 19637 0005	128	--	19
OPTO TRX SFP DDM -40/+85 – SR-1 OC48 (ANSI) – I-16.1 (ETSI)			1AB 19637 0013	128		18
OPTO TRX SFP DDM – IR-1 OC48 (ANSI) – S-16.1 (ETSI)	SS-161	--	1AB 19637 0006	128		19
OPTO TRX SFP DDM -5/+80 – LR-1 OC48 (ANSI) – L-16.1 (ETSI)	SL-161	--	1AB 19637 0008	128		19
OPTO TRX SFP DDM -5/+80 – LR-2 OC48 (ANSI) – L-16.2 (ETSI)	SL-162	--	1AB 19637 0009	128		
CWDM SFP MODULES						
CWDM 1470NM PIN SFP DDM	SS-162C	--	1AB 19634 0009	160	--	20
CWDM 1490NM PIN SFP DDM			1AB 19634 0010			
CWDM 1510NM PIN SFP DDM			1AB 19634 0011			
CWDM 1530NM PIN SFP DDM			1AB 19634 0012			
CWDM 1550NM PIN SFP DDM			1AB 19634 0013			
CWDM 1570NM PIN SFP DDM			1AB 19634 0014			
CWDM 1590NM PIN SFP DDM			1AB 19634 0015			
CWDM 1610NM PIN SFP DDM			1AB 19634 0016			
CWDM 1470NM APD SFP DDM	SL-162C	--	1AB 19635 0026	160	--	20
CWDM 1490NM APD SFP DDM			1AB 19635 0027			
CWDM 1510NM APD SFP DDM			1AB 19635 0028			
CWDM 1530NM APD SFP DDM			1AB 19635 0029			
CWDM 1550NM APD SFP DDM			1AB 19635 0030			
CWDM 1570NM APD SFP DDM			1AB 19635 0031			
CWDM 1590NM APD SFP DDM			1AB 19635 0032			
CWDM 1610NM APD SFP DDM			1AB 19635 0033			
XFP MODULES						
B&W XFP						
XFP-E ADAPTER	--/--	--	3AL 91721 AA--	32	--	21
XFP I-64.1/10GBE BASE L – SR-1 OC192 (ANSI) – I-64.1 (ETSI)	XI-641	--	1AB 21454 0001	32	--	22
XFP S64-2B/10GBE BASE E – S-64.2 (ETSI) – IR-2 OC192 (ANSI)	XS-642	--	1AB 21728 0001	32	--	22

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
XFP 10GBE BASE S	10GB	--	1AB 21454 0002	16	--	
XFP PIL1-2D2 – P1L1-2D2 (ETSI) – LR-2 OC192 (ANSI)	XP1L12D2	--	1AB 21728 0002	32	--	22
XFP-E PIL1-2D2 – P1L1-2D2 (ETSI) – LR-2 OC192 (ANSI)			1AB 25333 0001	32		23
DWDM XFP						
OE - TRX XFP DWDM CH20	XL-642C	--	1AB 35663 0041	32	--	24
OE - TRX XFP DWDM CH21			1AB 35663 0040			
OE - TRX XFP DWDM CH22			1AB 35663 0039			
OE - TRX XFP DWDM CH23			1AB 35663 0038			
OE - TRX XFP DWDM CH24			1AB 35663 0037			
OE - TRX XFP DWDM CH25			1AB 35663 0036			
OE - TRX XFP DWDM CH26			1AB 35663 0035			
OE - TRX XFP DWDM CH27			1AB 35663 0034			
OE - TRX XFP DWDM CH28			1AB 35663 0033			
OE - TRX XFP DWDM CH29			1AB 35663 0033			
OE - TRX XFP DWDM CH30	XL-642C	--	1AB 35663 0031	32	--	24
OE - TRX XFP DWDM CH31			1AB 35663 0030			
OE - TRX XFP DWDM CH32			1AB 35663 0029			
OE - TRX XFP DWDM CH33			1AB 35663 0028			
OE - TRX XFP DWDM CH34			1AB 35663 0027			
OE - TRX XFP DWDM CH35			1AB 35663 0026			
OE - TRX XFP DWDM CH36			1AB 35663 0025			
OE - TRX XFP DWDM CH37			1AB 35663 0024			
OE - TRX XFP DWDM CH38			1AB 35663 0023			
OE - TRX XFP DWDM CH39			1AB 35663 0022			
OE - TRX XFP DWDM CH40	XL-642C	--	1AB 35663 0021	32	--	24
OE - TRX XFP DWDM CH41			1AB 35663 0020			
OE - TRX XFP DWDM CH42			1AB 35663 0019			
OE - TRX XFP DWDM CH43			1AB 35663 0018			
OE - TRX XFP DWDM CH44			1AB 35663 0017			
OE - TRX XFP DWDM CH45			1AB 35663 0016			
OE - TRX XFP DWDM CH46			1AB 35663 0015			
OE - TRX XFP DWDM CH47			1AB 35663 0014			
OE - TRX XFP DWDM CH48			1AB 35663 0013			
OE - TRX XFP DWDM CH49			1AB 35663 0012			

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
OE - TRX XFP DWDM CH50	XL-642C	--	1AB 35663 0011	32	--	24
OE - TRX XFP DWDM CH51			1AB 35663 0010			
OE - TRX XFP DWDM CH52			1AB 35663 0009			
OE - TRX XFP DWDM CH53			1AB 35663 0008			
OE - TRX XFP DWDM CH54			1AB 35663 0007			
OE - TRX XFP DWDM CH55			1AB 35663 0006			
OE - TRX XFP DWDM CH56			1AB 35663 0005			
OE - TRX XFP DWDM CH57			1AB 35663 0004			
OE - TRX XFP DWDM CH58			1AB 35663 0003			
OE - TRX XFP DWDM CH59			1AB 35663 0002			
OE - TRX XFP DWDM CH60			1AB 35663 0001			
EQUIPMENT ACCESSORIES						
12” INSTALLATION KIT (NAR)	--/--	--	8DG 07989 AC--	1		
END GUARD (KIT)	--/--	--	1AD 13938 0001	1		
14" END GUARD (KIT)	--/--	--	1AD 13938 0002	1		
KIT-CRAFT TERMINAL CABLE KIT	--/--	--	3AL 89585 AA--	1		28
SFP DUMMY PLUG KIT	--/--	--	3AL 89857 AA--	16		
GENTRU INSTALLATION KIT (NAR)	--/--		8DG 08217 AA--	1		
INSTALLATION KIT (NAR)	--/--		8DG 07989 AB--	1		
14" OMD44 INSTALLATION KIT	--/--		8DG 08637 AA--	1		
NAR UPPER BAFFLE UNIT	--/--		8DG 08259 AA--	1		
FULL SLOT DUMMY PLATE	--/--	--	3AL 92154 AB--	8	--	25
GENTRU DUMMY COVER	--/--		3AN 51356 AB--	1		
MECHANICAL ADAPTER GUIDE	--/--	--	8DG 07796 AA--	1	--	29
12" OMD44 INSTALLATION KIT	--/--		8DG 08637 AB--	1		
EQUICO DUMMY PLATE	--/--	--	3AL 92159 AA--	2	--	
SERVICE DUMMY PLATE	--/--	--	3AL 92160 AA--	1		
1/2 SLOT MECHANICAL ADAPTER	HSLAD	--	3AL 92173 AA--	8	--	27
PIM DUMMY PLUG	--/--	--	3AL 92183 AA--	16	--	
1/2 SLOT DUMMY PLATE	--/--	--	3AL 92156 AB--	6		26
GENTRU INSTALLATION KIT NAR	--/--	--	8DG 08217 AA--	1		
OEM - FILTER MEDIA 21"	--/--	--	8DG 16609 AB--	1		

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
OFFICE SIDE ACCESSORIES						
DEGREE 4 UPGRADE FIBER KIT			8DG 08507 AE--			
DEGREE 5 UPGRADE FIBER KIT			8DG 08507 AF--			
DEGREE 6 UPGRADE FIBER KIT			8DG 08507 AG--			
CA-INVENTORY CABLE (7M), SHIELDED CAT5E, HAL-FREE			8DG 08361 AAAA			
ILA FIBER KIT			8DG 08507 AJ--			
UROADM UPGRADE FIBER KIT			8DG 08507 AL--			
DEGREE 8 UPGRADE FIBER KIT			8DG 08507 AM--			
DEGREE 3 UPGRADE FIBER KIT			8DG 08507 AD--			
DEGREE 7 UPGRADE FIBER KIT			8DG 08507 AH--			
LBO 10DB			1AB 25203 0001			
LBO 8DB			1AB 37124 0001			
LBO 4DB			1AB 37125 0001			
CA-AUX CH/HK CABLE (NAR), 45M, SHIELDED, 13 PR, 25 PIN D-SUB			8DG 08389 AAAA			
CA-MATRIX CABLE (NAR), 10M, SHIELDED CAT5, PVC			8DG 08352 AAAA			
CA-MATRIX CABLE (NAR), 20M, SHIELDED CAT5, PVC			8DG 08353 AAAA			
CA-MATRIX CABLE (NAR), 2M, SHIELDED CAT5, PVC			8DG 08368 AAAA			
UILA FIBER KIT			8DG 08507 AK--			
CA-MATRIX CABLE (NAR), 30M, SHIELDED CAT5, PVC			8DG 08354 AAAA			
DEGREE 2 UPGRADE FIBER KIT			8DG 08507 AC--			
CA-MATRIX CABLE (NAR), 40M, SHIELDED CAT5, PVC			8DG 08355 AAAA			
CA-MATRIX CABLE (NAR), 50M, SHIELDED CAT5, PVC			8DG 08356 AAAA			
CA-AUX CH/HK CABLE (NAR), 15M, SHIELDED, 13 PR, 25 PIN D-SUB			8DG 08387 AAAA			

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
CA-MATRIX CABLE (NAR), 60M, SHIELDED CAT5, PVC			8DG 08357 AAAA			
CA-AUX CH/HK CABLE (NAR), 30M, SHIELDED, 13 PR, 25 PIN D-SUB			8DG 08388 AAAA			
CA-MATRIX CABLE (NAR), 5M, SHIELDED CAT5, PVC			8DG 08351 AAAA			
CA-INVENTORY CABLE (2.3M), SHIELDED CAT5E, HAL-FREE			8DG 08359 AAAA			
CA-INVENTORY CABLE (5.5M), SHIELDED CAT5E, HAL-FREE			8DG 08360 AAAA			
CA-AUX CH/HK CABLE (NAR), 60M, SHIELDED, 13 PR, 25 PIN D-SUB			8DG 08390 AAAA			
CA-AUX CH/HK CABLE (NAR), 100M, SHIELDED, 13 PR, 25 PIN D-SUB			8DG 08391 AAAA			
CA-RACK ALM CABLE (NAR), 15M, SHLDED, 26AWG, 8 PR,15 PIN D-SUB			8DG 08400 AAAA			
CA-RACK ALM CABLE (NAR), 30M, SHLDED, 26AWG, 8 PR,15 PIN D-SUB			8DG 08400 ABAA			
CA-RACK ALM CABLE (NAR), 45M, SHLDED, 26AWG, 8 PR,15 PIN D-SUB			8DG 08400 ACAA			
CA-RACK ALM CABLE (NAR), 60M, SHLDED, 26AWG, 8 PR,15 PIN D-SUB			8DG 08400 ADAA			
CA-RACK ALM CABLE (NAR), 100M, SHLDED, 26AWG, 8 PR,15 PIN D-SUB			8DG 08400 AEAA			
DEGREE 1 FIBER KIT			8DG 08507 AB--			
SPARE PARTS						
1850 TSS-320 TBUS	TBUS320	--	3AL 92120 AA--	1	42-43	
SFP MODULE PLUGIN TOOL	--/--	--	3AL 81728 AA--	1	--	
14” AIR FILTER (ANSI)	--/--		8DG 16609 AAAA	1		
LAMP GROUP GENTRU	--		3AL 38426 AC--	1		
SHELF IDENTIFICATION	--		8DG 08508 AB--	1		
LABEL KIT B (DEG 1-5)	--		8DG 08508 AB--	1		
LABEL KIT A (DEG 1-4)	--		8DG 08508 AA--	1		

NAME	ACRONYM	SIZE	ANV Part Number	Max. Q.ty	SLOT	NOTES
SOFTWARE PACKAGES						
SWP-1850 TSS-320 R.2.0	--/--	--	8DG 07872 AA--	1	--	
SOFTWARE LICENCES						
SWL-1850 TSS METRO VERS. "B" ETH LP	--/--	--	3AL 92201 AFAA	1	--	
SWL-1850 TSS METRO VERS. "A" TDM LP	--/--	--	8DG 02690 ACAA	1	--	
SWL-1850 TSS METRO VERS. "B" WDM LP	--/--	--	8DG 05322 AEAA	1	--	

Table 9. Explanatory notes

Notes	Explanation
1	It is the main shelf of the equipment, also with back panel, TBUS units and SFP module plug-in tool.
2	Up to two items are required for shelf configuration (1+1 protection)
3	Require “XFP-E adapter” in order to host standard size XFP modules.
4	Up to four SFP modules can be supported by the card.
5	Only 8xOC3 / 8xOC12 is included in current release. Up to eight SFP modules can be supported by the card.
6	Either 2 PIMs or 1 PIM and PIM DUMMY plug are supported.
7	To be used on PP20G card.
8	Up to ten SFP modules can be supported by the PIM
9	To be used instead of LDRXA for upgradable ILA configuration
10	To be used for ROADM up to 4-degree
11	To be used for ROADM up to 8-degree
12	Requires XFP Modules on Client side
13	To be mounted in the Bay Frame
14	To be inserted in “DCM Shelf”
15	To be used in PIM1GE plug-in module
16	Can be used also for Long Reach/Long Haul application up to 10 km
17	To be used in 8PSO board
18	To be used in 10xANY only
19	To be used in 4P2G5SO board
20	CWDM PIN SFP and CWDM APD SFP optical modules (100Mbps->2.67Gbps) w/ DDM. They can be fitted in PIM1GE plug-in module and 4P2G5SO boards
21	To be used to insert XFP modules into 1P10GSO and PIM10GE boards (not used for XFP-extended)
22	It can be inserted on 1P10GSO and PIM10GE, using the XFP-Adapter. It can be inserted on 11GBAR and 11GUAR; these units don’t require XFP-Adapter
23	To be inserted on 1P10GSO and PIM10GE; it doesn’t require XFP-Adapter
24	DWDM APD XFP optical modules at 10 Gbps w/ DDM. They can be fitted in PIM10GE and 1P10GSO, using XFP-Adapter
25	To be used to cover two vertical slot empty space
26	To be used to cover one vertical slot empty space
27	Must be used in order to insert half board in the Equipment Shelf; It supplies two mechanical guide both for the upper and lower board.
28	Used to connect computer to EC320 board when Craft Terminal application is used.
29	It must be used to allow mounting the 1/2 and 3/4 mechanical adapters.

2.4 Units front view

The following section shows the access points (LEDs, switches, etc.) present on each unit with legends explaining the components:

– Section 2.4.1 on page 90 shows the Bay Frame front view

– Section 2.4.2 on page 91 shows the GENTRU unit front view

– Section 2.4.3 on page 96 shows the Common part view

– Section 2.4.4 on page 102 shows the Equipment accessories

– Section 2.4.5 on page 104 shows the SONET/SDH units front view

– Section 2.4.6 on page 109 shows the Data units front view

– Section 2.4.7 on page 115 shows the ROADM packs front view

2.4.1 Bay Frame front view



Figure 48. 1850 TSS-320 Bay frame - Front view

2.4.2 GENTRU unit front view

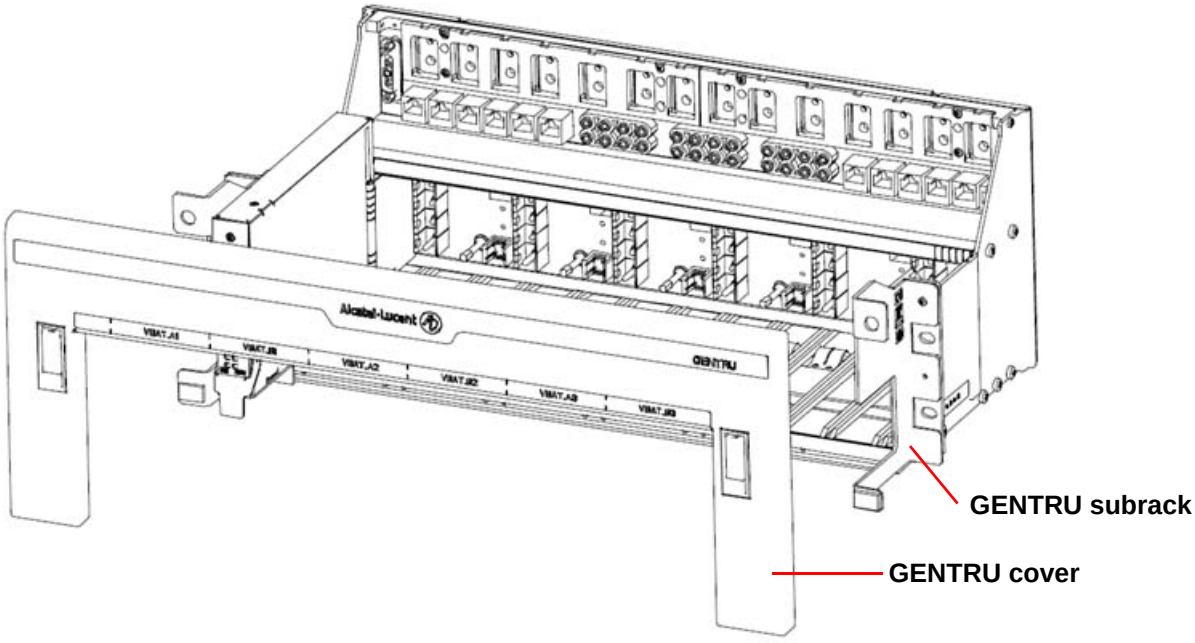


Figure 49. GENTRU unit detail

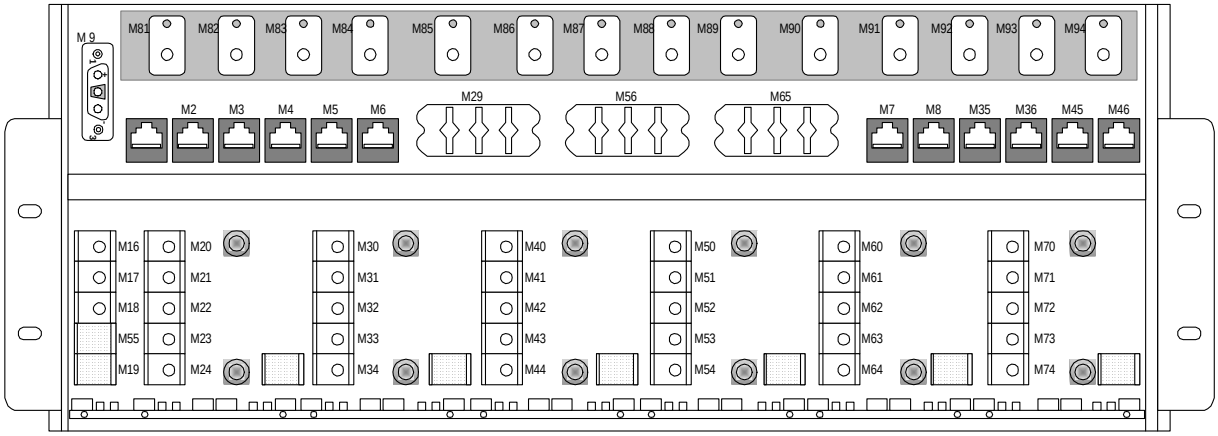
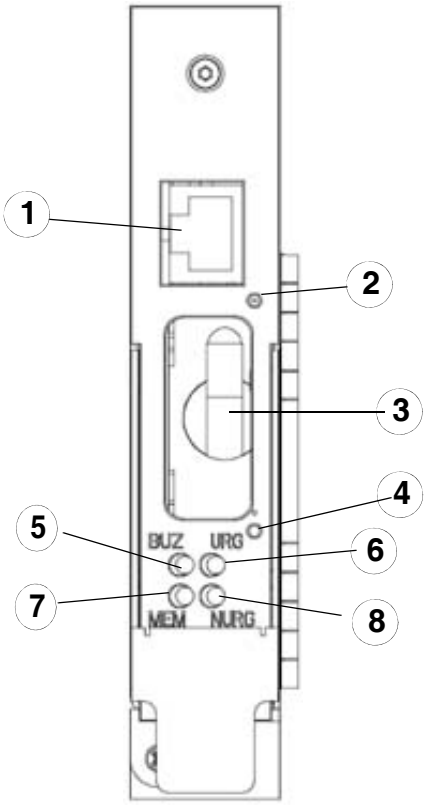


Figure 50. GENTRU unit - Front view (without units)

2.4.2.1 Rack lamp unit

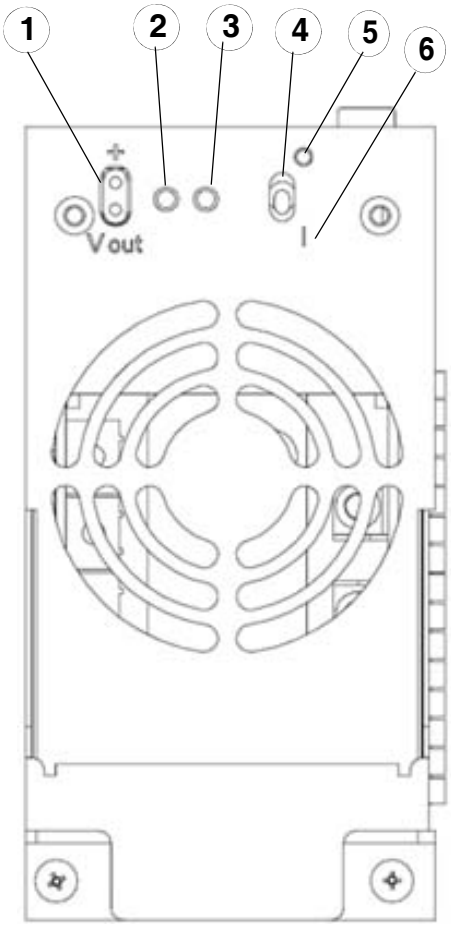


LEGEND:

(1) RJ45 connector for Extension Remote Alarm
(2) Turned OFF symbol
(3) ON/OFF manual switch - Fusebreaker
(4) Turned ON symbol
(5) Green LED - **BUZ:** indicates the presence of the Service Call or Service Battery
(6) Red LED - **URG:** indicates the presence of an Urgent Alarm
(7) yellow LED - **MEM:** indicates the storing of an alarm
(8) Red LED - **NURG:** indicates the presence of an Non Urgent Alarm

Figure 51. Rack lamp unit - Front view

2.4.2.2 3.5 kW STEPUP unit

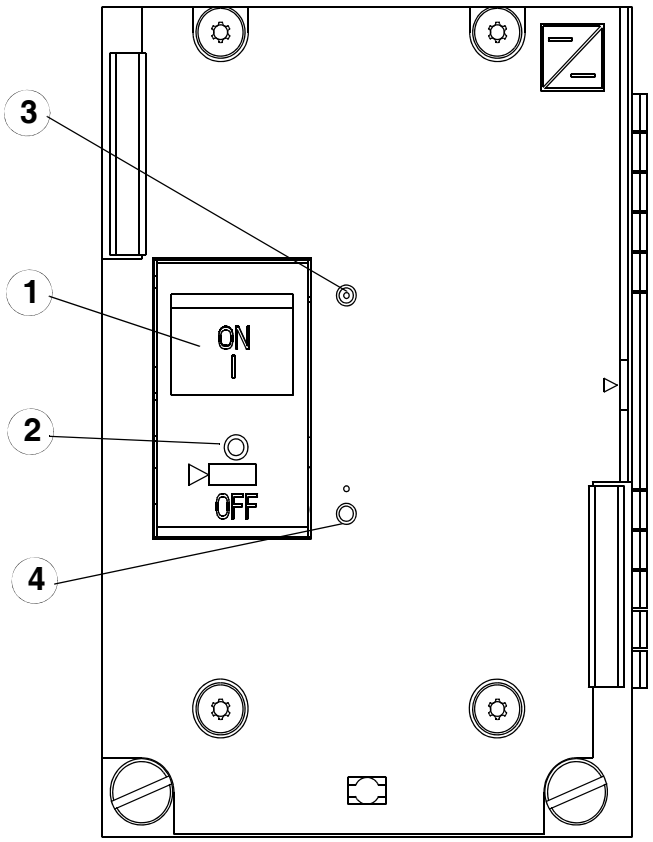


LEGEND:

(1) Output Voltage Test Point (-58/-65 VDC)
(2) Green LED: ON in Normal Output Voltage condition
(3) Red LED: ON in presence of an unit alarm
(4) ON/OFF manual switch
(5) Turned OFF symbol
(6) Turned ON symbol

Figure 52. 3.5 kW STEPUP unit - Front view

2.4.2.3 BYPASS unit - Front view



LEGEND:

(1) Manual Switch **ON/OFF** Fusebreaker
(2) Fusebreaker Switch **OFF** access
(3) Turned OFF symbol
(4) Turned ON symbol

Figure 53. BYPASS unit - Front view

2.4.2.4 DCM shelf front view

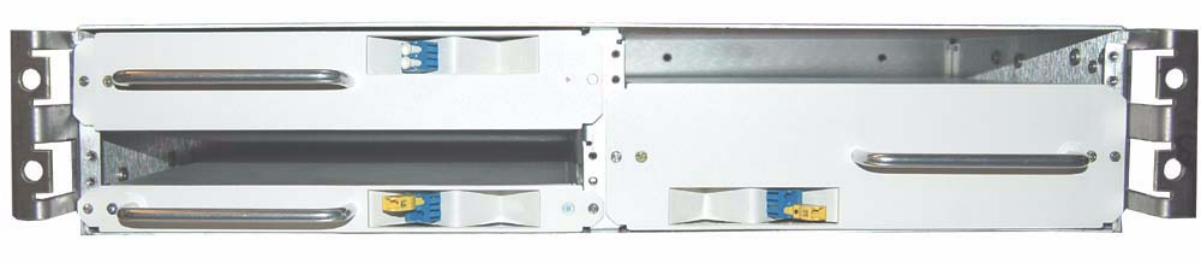


Figure 54. DCM shelf - Front view without front cover

2.4.2.5 Fiber storage Tray view

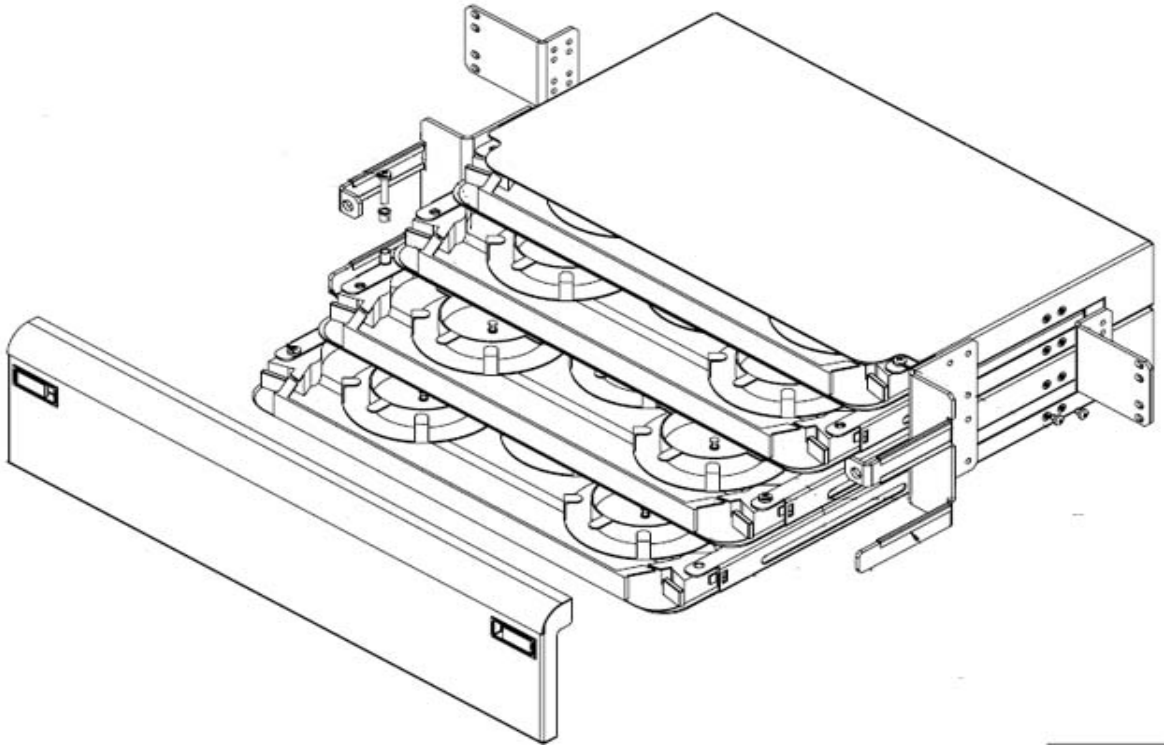
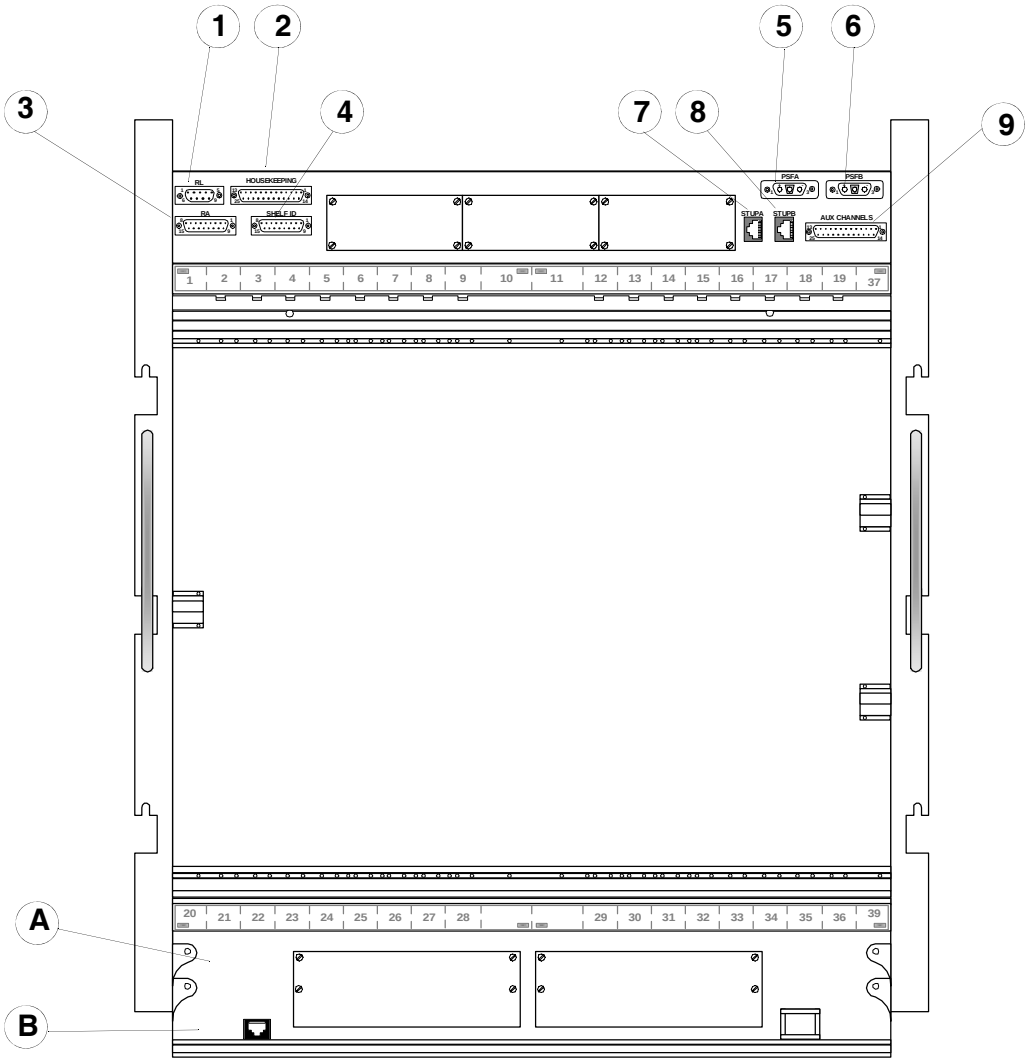


Figure 55. Fiber storage Tray

2.4.3 Common part view



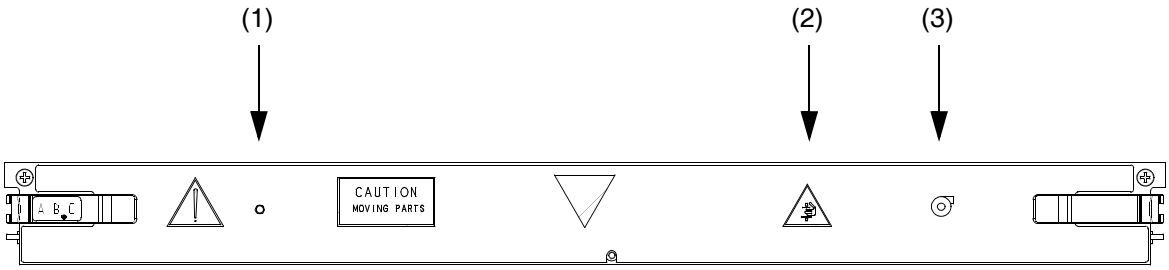
LEGEND:

(1) Rack lamps connector (RL)
(2) Housekeeping connector (HK)
(3) Remote alarms connector (RA)
(4) Shelf ID connector
(5) “Access panel” battery connector (BATT. A)
(6) “Access panel” battery connector (BATT. B)
(7) Alarms and Remote Inventory Step-Up “A” connector
(8) Alarms and Remote Inventory Step-Up “B” connector
(9) Auxiliary alarms connector
(A) Position of FAN320 shelf
(B) Position of AIR filter tray and Dust filter

Figure 56. 1850 TSS-320 SHELF - Front view (S320)

2.4.3.1 FAN320 - FAN unit

ACRONYM	SLOTS
FAN320	42, 43



LEGEND:

(1) Bicolor LED:
- Red LED - local unit alarm
- Green LED - in service unit

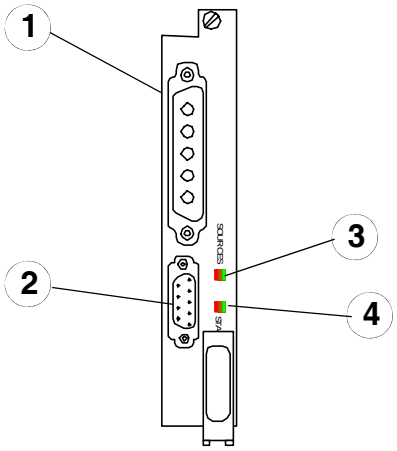
(2) WARNING LABEL: moving mechanical parts

(3) WARNING LABEL: windage (air sunction)

Figure 57. FAN320 - FAN unit - Front view

2.4.3.2 PSF320 - Power supply filter unit

ACRONYM	SLOTS
PSF320	37, 39



LEGEND:

(1) Input battery connector
(2) T3/T4 (1.5/2MHz) / T5/T6 (1.5/2Mbit/s) Input/Output synchronization signal
(3) “Sources” Status MULTICOLOR LED [Referred to point (2)]
(5) ”Status” MULTICOLOR LED
- GREEN: card In Service - Battery ON
- AMBER: card In Service Battery OFF
- RED: Card FailRED
- BLINK: Card Misconfigured or Card Mismatch

Figure 58. PSF320 - Power Supply Filter - Front view

2.4.3.3 EC320 - Equipment controller unit

ACRONYM	SLOTS
EC320	1, 20

LEGEND:

(1) BOARD STATUS MULTICOLOR LED:
- LED OFF: card inserted and not running
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: CARD provisioned and running
- RED: card fail
- RED BLINK: card miss-configured or card missmatch

(2) EPS MULTICOLOR LED:
- GREEN: eps configured - card active
- AMBER: eps configured - card stand- by
- AMBER LINK: eps configured but not available
- OFF: eps not configured

(3) RESET COMMAND KEY

(4) 10/100 ETH DEBUG RJ45 CONNECTOR - factory use only

(5) GREEN LED ON: full duplex
GREEN LED OFF: half duplex

(6) YELLOW LED ON: link/active (no activity)
YELLOW LED BLINK: link/active (with activity)
YELLOW LED OFF: no link

(7) RS232 on μUSB DEBUG CONNECTOR - factory use only

(8) LOCAL CRAFT TERMINAL μUSB CONNECTOR (F interface)

(9) LOCAL CRAFT TERMINAL CONNECTOR (RS232 F interface)

(10) USB INTERFACE for external memory device

(11) ALARM CUT-OFF KEY

(12) LAMP TEST KEY

(13) RED LED - critical alarm

(14) RED LED - major alarm

(15) ORANGE LED - minor alarm

(16) ORANGE LED - warning alarm

(17) RED LED - attended alarm

(18) ORANGE LED - abnormal condition

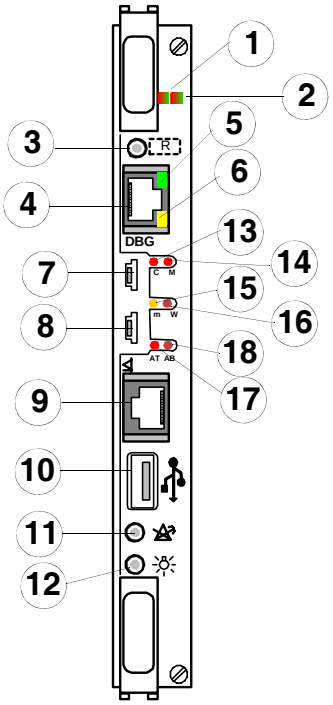
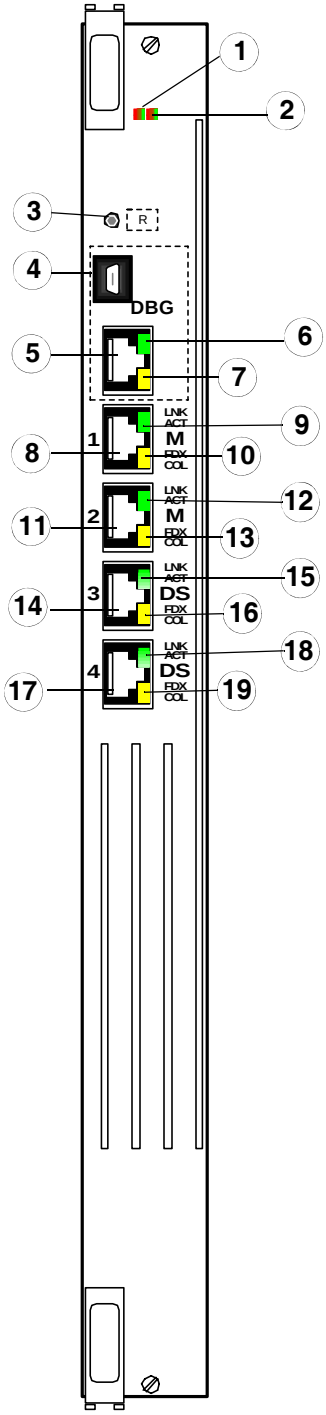


Figure 59. EC320 - Equipment Controller - Front view

2.4.3.4 MT320ND - Universal Matrix unit

ACRONYM	SLOTS
MT320ND	10, 11



LEGEND:

(1) EPS Multicolor LED:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

(2) BOARD STATUS Multicolor LED:
- LED OFF: card inserted and not running
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: CARD provisioned and running
- RED: card fail
- RED BLINK: card miss-configured or card mismatch

(3) Shelf Controller Restart Command Key
(4) mUSB DEBUG connector - Factory use only
(5) RJ45 DEBUG connector - Factory use only
(6) (9) (12) GREEN LED ON: link/active (no activity)
GREEN LED BLINK: link/active (with activity)
GREEN LED OFF: no link
(7) (10) (13) YELLOW LED ON: full duplex
YELLOW LED OFF: half duplex
YELLOW LED BLINKING: collision
(8) 10/100 Mbit/s Q3 interface
(11) 10/100 Mbit/s redundant Q3 interface
(14) (17) ETH/FETH/GETH interface for Drop Shelf connection
(15) (18) Multicolor LED:
LED OFF: no link
GREEN LED BLINK: 10/100 Mb/s link active (with activity)
ORANGE LED ON: 1000 Mb/s link active (no activity)
ORANGE LED BLINK: 1000 Mb/s link active (with activity)
GREEN LED ON: 10/100 Mb/s link active (no activity)
(16) (19) YELLOW LED ON: full duplex
YELLOW LED OFF: half duplex
YELLOW LED BLINKING: collision

Figure 60. MT320ND - Universal Matrix - Front view

2.4.3.5 Dust filter

ACRONYM	SLOTS

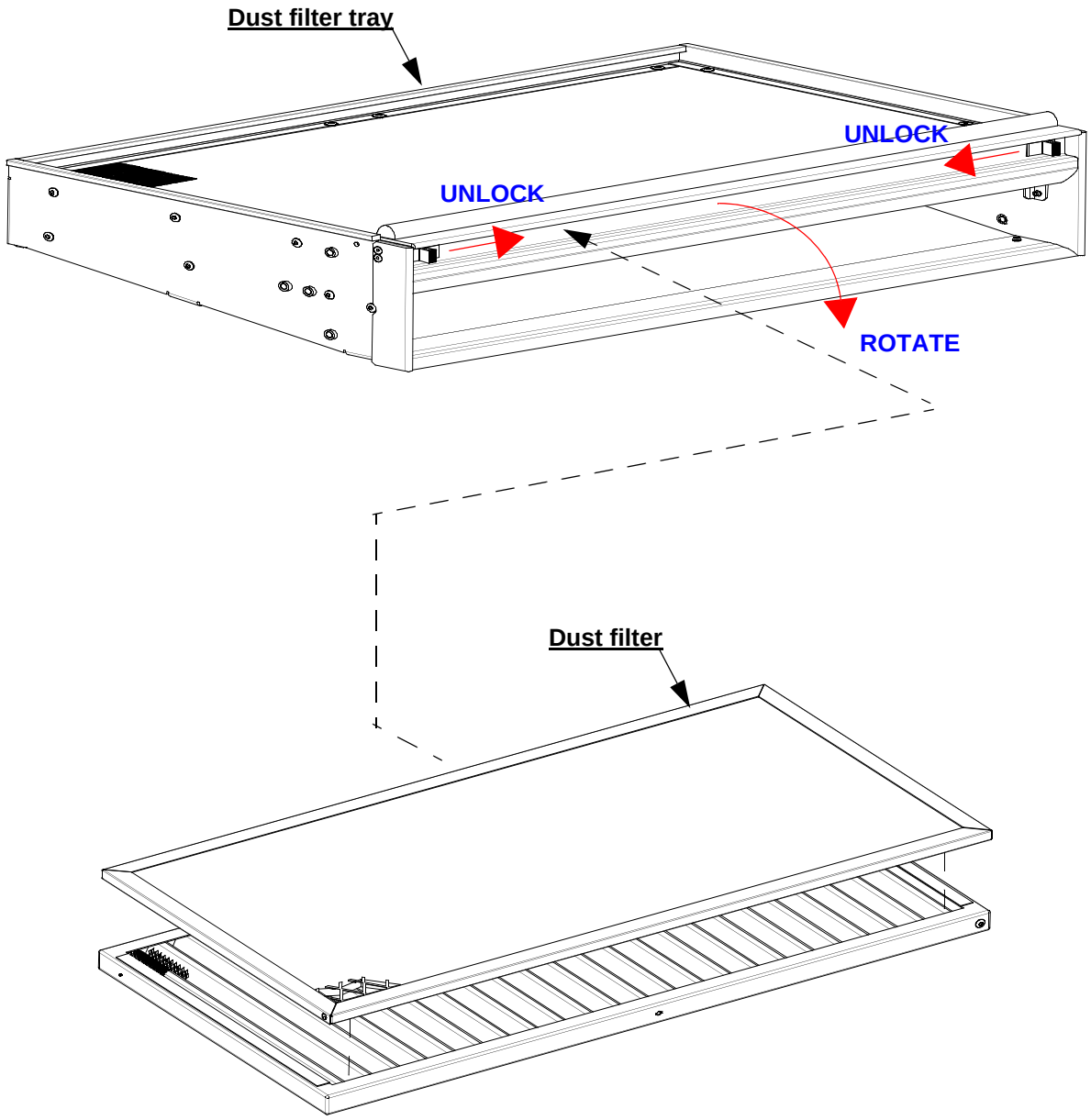


Figure 61. Air filter tray and Dust filter - View

2.4.4 Equipment accessories

ACRONYM	SLOTS
HSLAD	--

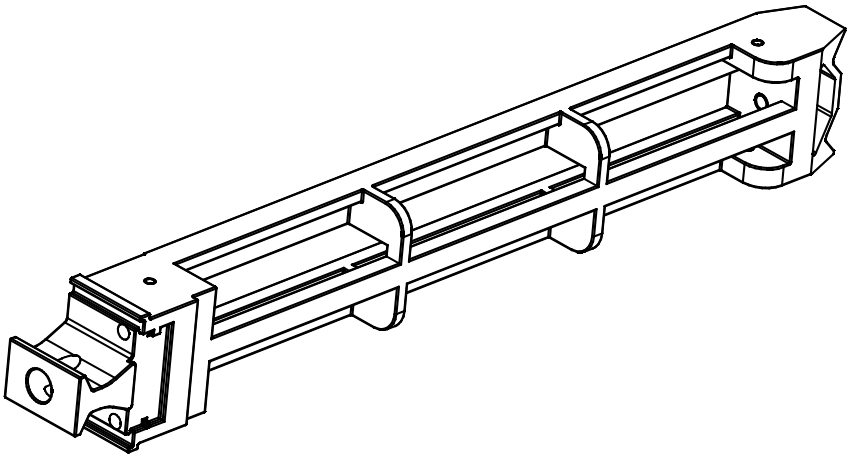


Figure 62. Half slot mechanical adapter (HSLAD) - View

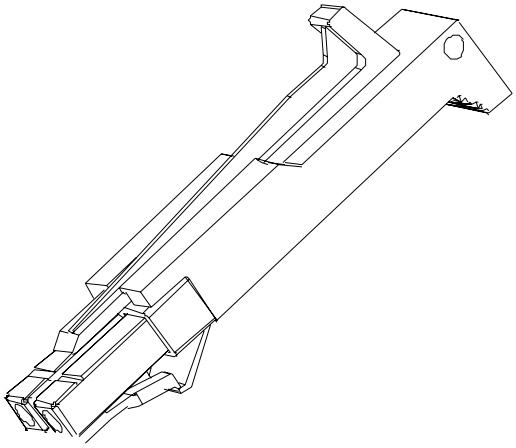


Figure 63. SFP Pug-in tool - View

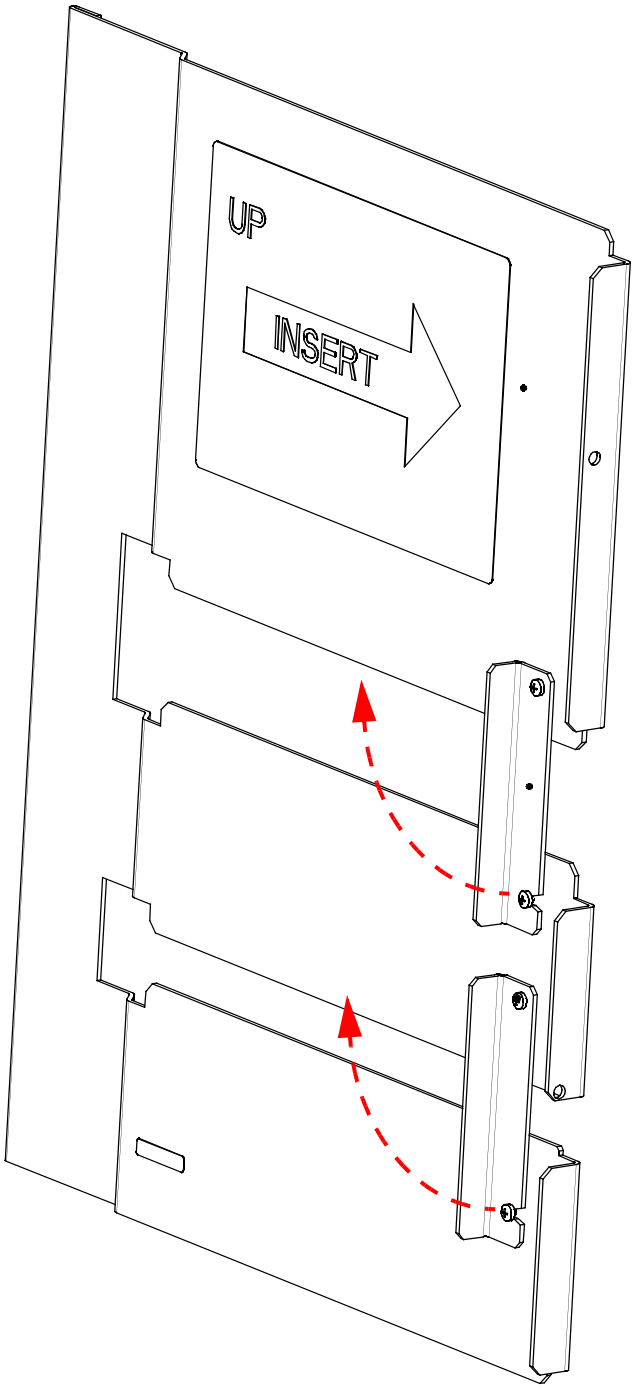
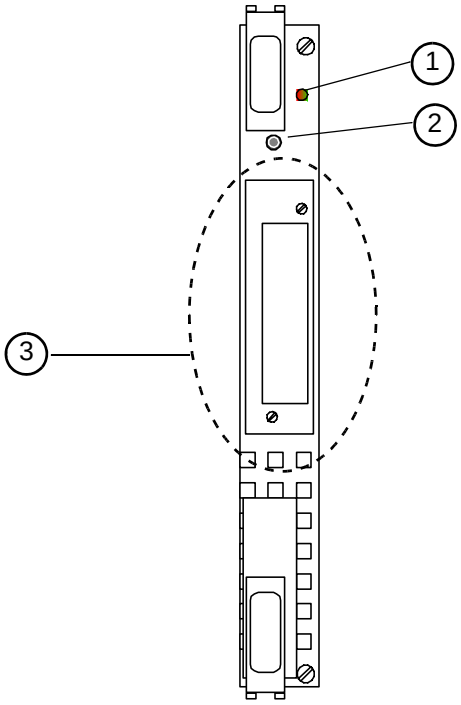


Figure 64. Mechanical adapter guide - View

2.4.5 SONET/SDH units front view

2.4.5.1 1P10GSO - 1x10G Synchronous Optical port card

ACRONYM	SLOTS
1P10GSO	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) Multicolor LED:
Red LED: Local unit alarm
Green LED: in service unit

(2) Laser restart Key

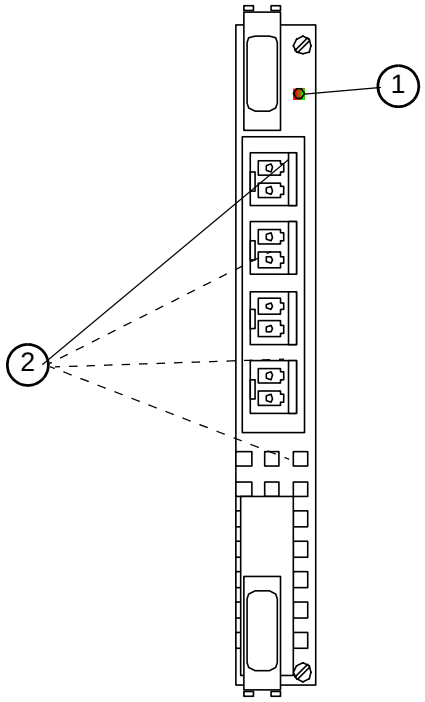
(3) Cavity for XFP module insertion (refer to **Note:**)

Note: For details on XFP front view refer to Figure 74. on page 113.

Figure 65. 1P10GSO - 1x10G Synchronous Optical port card - Front view

2.4.5.2 4P2G5SO - 4x2.5 G Synchronous Optical port card

ACRONYM	SLOTS
4P2G5SO	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) Multicolor LED:
Red LED: Local unit alarm
Green LED: in service unit

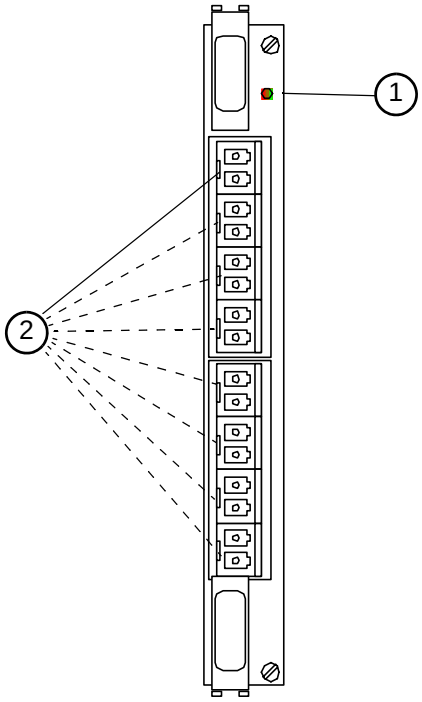
(2) Cavity for SFP module insertion (refer to **Note:**)

Note: For details on XFP front view refer to Figure 74. on page 113.

Figure 66. 4P2G5SO - 4x2.5 G Synchronous Optical port card - Front view

2.4.5.3 8PSO - 8x155/622 M Synchronous Optical port card - Front view

ACRONYM	SLOTS
8PSO	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) Multicolor LED:
Red LED: Local unit alarm
Green LED: in service unit

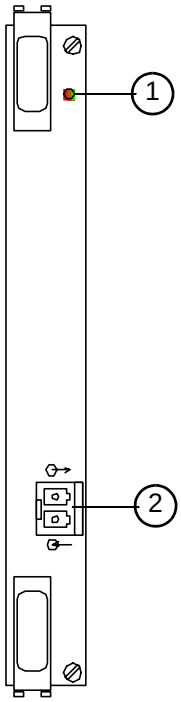
(2) Cavity for SFP module insertion (refer to **Note:**)

Note: For details on SFP front view refer to Figure 75. on page 114.

Figure 67. 8PSO - 8x155/622 M Synchronous Optical port card - Front view

2.4.5.4 OTU-2 - OTU-2 Port Slim port card - Front view

ACRONYM	SLOTS
OTU-2	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

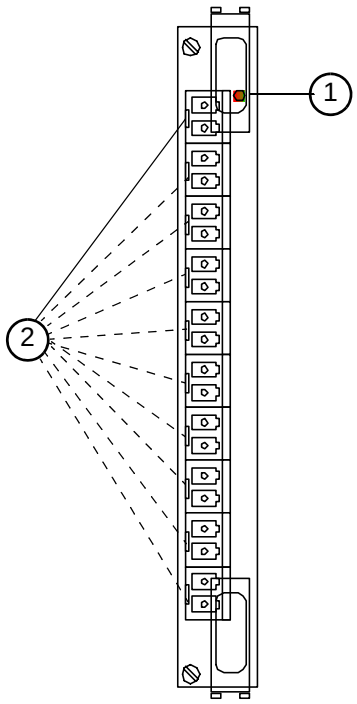
(1) Multicolor LED:
Red LED: Local unit alarm
Green LED: in service unit

(2) Duplex LC-type adapter for line optical access (RX + TX)

Figure 68. OTU-2 - OTU-2 Port Slim port card - Front view

2.4.5.5 10XANY - 10x ANY port card - Front view

ACRONYM	SLOTS
10xANY	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) Multicolor LED:
Red LED: Local unit alarm
Green LED: in service unit

(2) Cavity for SFP module insertion (refer to **Note:**)

Note: For details on SFP front view refer to Figure 75. on page 114.

Figure 69. 10XANY - 10 x ANY port card - Front view

2.4.6 Data units front view

2.4.6.1 PP10G - 20G Packet Processor

ACRONYM	SLOTS
PP20G	(2/3) - (3/4) - (4/5) - (5/6) - (6/7) - (7/8) - (8/9) - (12/13) - (13/14) - (14/15) - (1516) - (16/17) - (17/18) - (18/19)

LEGEND:

(1) Cavity Nr.1 for inserting PIM modules

(2) Cavity Nr.2 for inserting PIM modules

(3) RJ45 LAN connector to LocalController - Internal Use only

(4) USB RS232 connector

(5) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

(6) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for Local-Controller Debug - Internal Use only

(7) Push-Button for LocalController manual restart

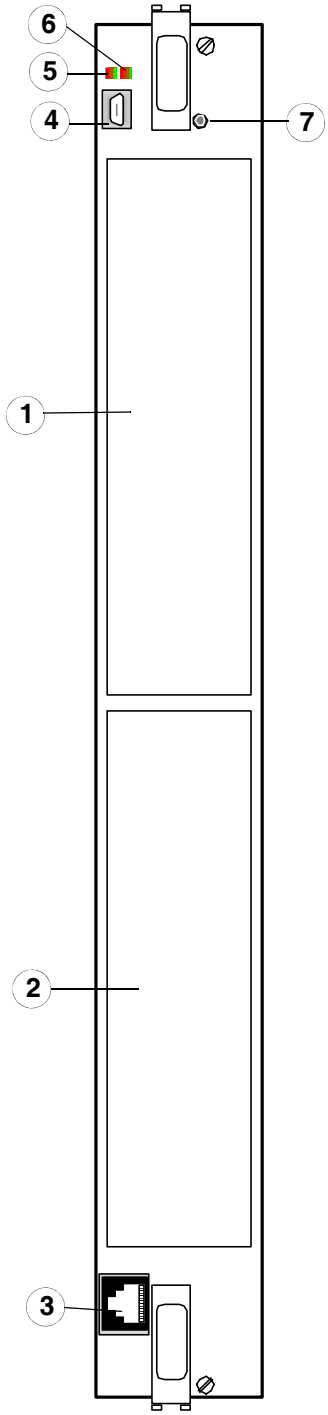


Figure 70. PP20G - 20G Packet Processor (Data Aggregator) - Front view

2.4.6.2 PIM1GE - 10x1GE Plug In Module

ACRONYM	SLOTS
PIM1GE	on PP20G

LEGEND:

(1) to (10): Ports Nr.1 to Nr.10 for inserting SFP 1Gbps modules (see 2.4.6.6 on page 114)

(12) and (13): 10 LEDs indicating the link status (up/down) of each SFP 1Gbps Port:
- OFF: link down
- GREEN: link up

(11) : multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch

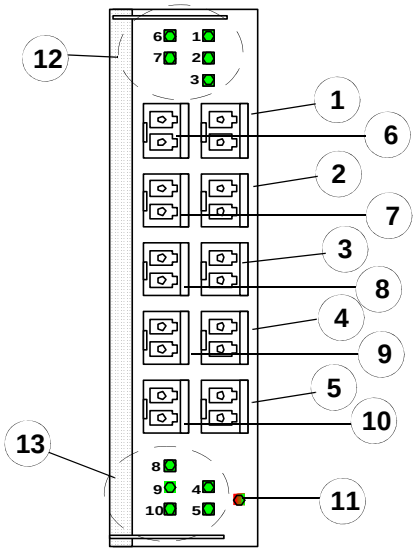


Figure 71. PIM1GE - 10x1GE Plug-in-Module - Front view

2.4.6.3 PIMMS - Multi-Service Plug-in-Module

ACRONYM	SLOTS
PIMMS	on PP20G

LEGEND:

(11 : multi-color LED indicating Unit status:

- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch

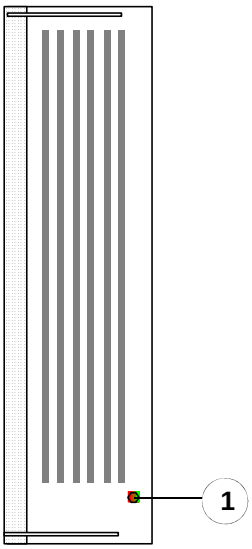


Figure 72. PIMMS - Multi-Service Plug-in-Module - Front view

2.4.6.4 PIM10GE - 1x10GE Plug-in-Module

ACRONYM	SLOTS
PIM10GE	on PP20G

LEGEND:

(1): Cavity for inserting XFP 10Gbps PIM modules (see 2.4.6.5 on page 113)

(2): LED indicating the link status (up/down) for XFP 1Gbps Port:
- OFF: link down
- GREEN: link up

(3) : multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch

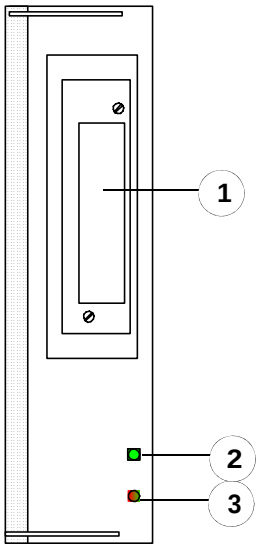


Figure 73. PIM10GE - 1x10GE Plug-in-Module - Front view

2.4.6.5 XFP modules

TYPE	ACRONYM	ANSI	ETHERNET	ETSI	EQUIPPED ON BOARD
B&W	10GB		10GBASE-S		PIM10GE
B&W	XI-641	SR-1OC192	10GBASE-L	I-64.1	PIM10GE, 1P10GSO
B&W	XS-642	IR-2 OC192	10GBASE-E	S-64.2	
B&W	XP1L1D2	LR-2 OC192		P1L1-2D2	
DWDM	XL-642C	APD - DWDM 10Gbps (DW100U-2AXC)			PIM10GE, 1P10GSO
	XFP ADAPTER				P10GSO, PIM10GE

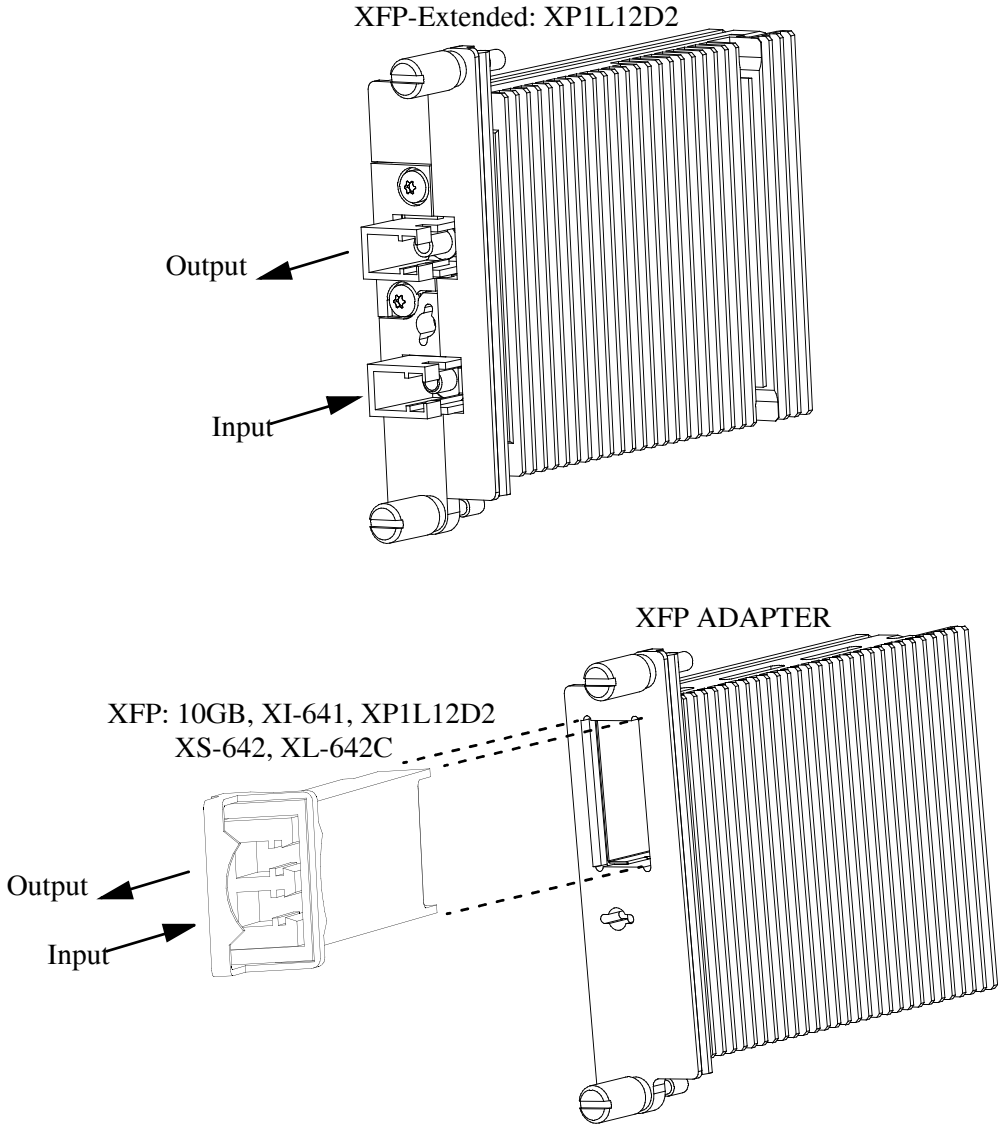
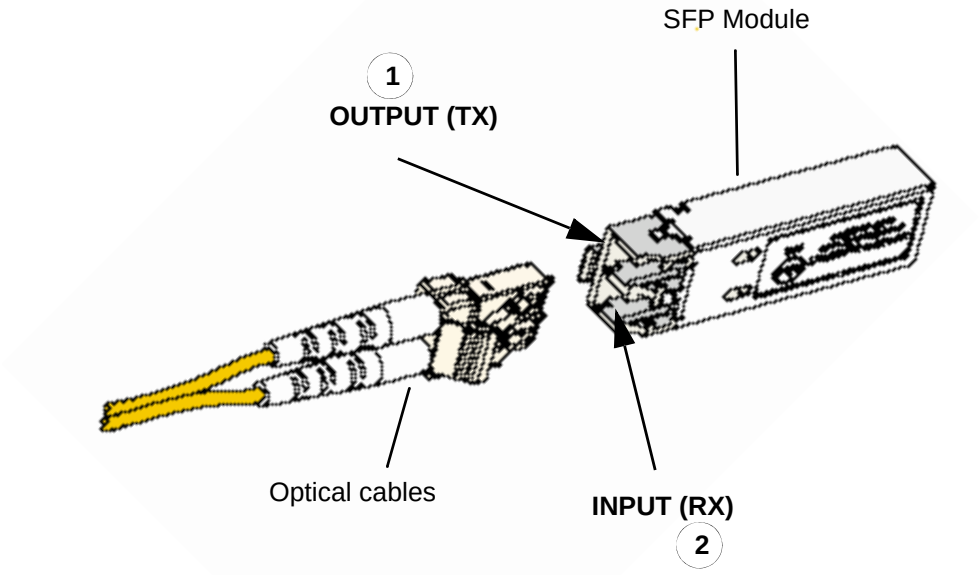


Figure 74. XFP modules and XFP adapter - View

2.4.6.6 SFP Modules

ACRONYM	ANSI	ETSI	SLOTS
SL-161 SI-161 SS-161 SL-162 SS-162C SL-162C	LR-1 OC48 SR-1 OC48 IR-1 OC48 LR-2 OC48 IR-2 OC48 LR-2 OC48	L-16.1 I-16.1 S-16.1 L-16.2 S-16.2 L-16.2	4P2G5SO
SS-11 SL-11 SL-12 SS-41 SL-41 SL 42	IR-1 OC3 LR-1 OC3 LR-1 OC3 IR-1 OC12 LR-1 OC12 LR-2 OC12	S-1.1 L-1.1 L-1.2 S-4.1 L-4.1 L-4.2	8PSO
1000B SS-162C SL-162C SS-161	- IR-2 OC48 LR-2 OC48 IR-1 OC48	- S-16.2 L-16.2 S-16.1	on PIM1GE



LEGEND:

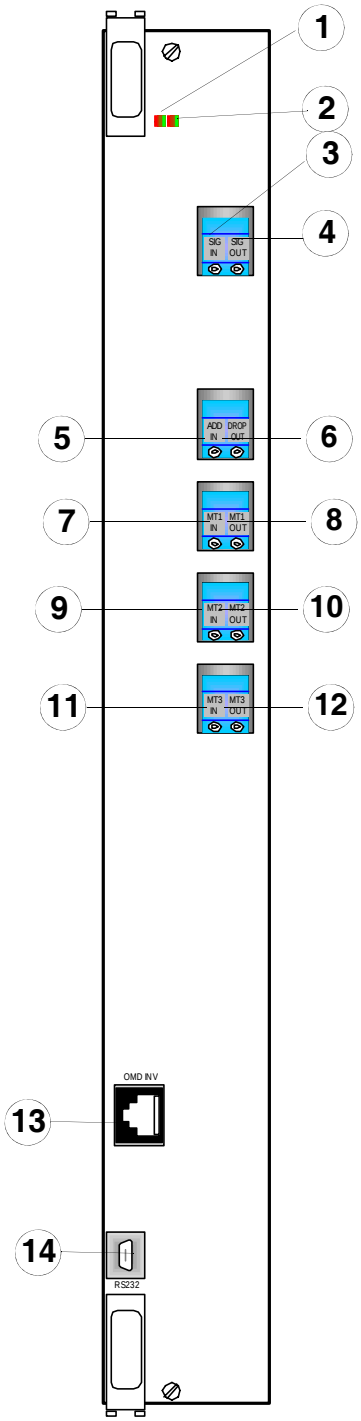
1) Output (TX) connector for optical fiber
2) Input (RX) connector for optical fiber

Figure 75. SFP Module - View

2.4.7 ROADM packs front view

2.4.7.1 WR4 - Wavelength Router 4 degree

ACRONYM	SLOTS
WR4	2/3 - 6/7 - 14/15 - 18/19



LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **SIG IN** Optical connector
(4) **SIG OUT** Optical connector
(5) **ADD IN** Optical connector
(6) **DROP OUT** Optical connector
(7) **MT1 IN** Optical connector
(8) **MT1 OUT** Optical connector
(9) **MT2 IN** Optical connector
(10) **MT2 OUT** Optical connector
(11) **MT3 IN** Optical connector
(12) **MT3 OUT** Optical connector
(13) **OMD INV** connector
(14) **DEBUG** connector
(15) **RS232** µUSB connector

Figure 76. WR4 - Wavelength Router 4 degree pack - Front view

2.4.7.2 WR8 - Wavelength Router 8 degree

ACRONYM	SLOTS
WR8	2/3 - 6/7 - 14/15 - 18/19

LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **SIG IN** Optical connector
(4) **SIG OUT** Optical connector
(5) **ADD IN** Optical connector
(6) **DROP OUT** Optical connector
(7) **MT1 IN** Optical connector
(8) **MT1 OUT** Optical connector
(9) **MT2 IN** Optical connector
(10) **MT2 OUT** Optical connector
(11) **MT3 IN** Optical connector
(12) **MT3 OUT** Optical connector
(13) **MT4 IN** Optical connector
(14) **MT4 OUT** Optical connector
(15) **MT5 IN** Optical connector
(16) **MT5 OUT** Optical connector
(17) **MT6 IN** Optical connector
(18) **MT6 OUT** Optical connector
(19) **MT7 IN** Optical connector
(20) **MT7 OUT** Optical connector
(21) **OMD INV** connector
(22) **RS232** µUSB connector

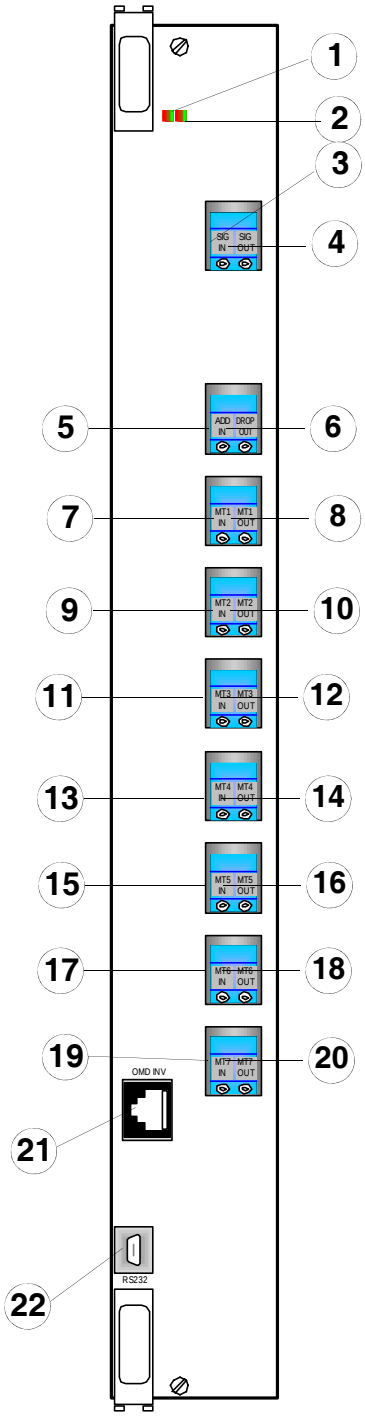


Figure 77. WR8 - Wavelength Router 8 degree pack - Front view

2.4.7.3 LDRXA - Amplifier 16 dBm + OSC

ACRONYM	SLOTS
LDRXA	4-5-8-9-12-13-16-17

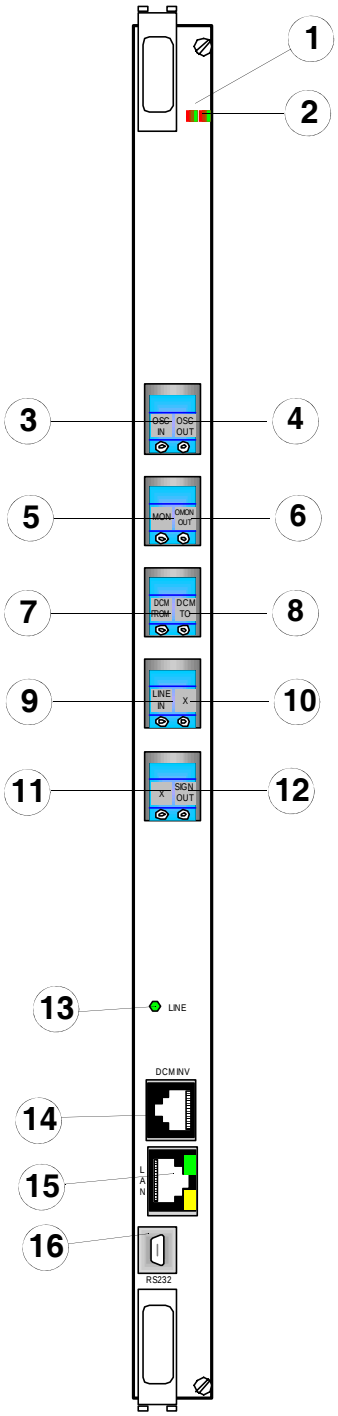


Figure 78. LDRXA - Amplifier 16 dBm + OSC pack - Front view

LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **OSC IN** Optical connector
(4) **OSC OUT** Optical connector
(5) **MON** Optical connector
(6) **OMON OUT** Optical connector
(7) **DCM FROM** Optical connector
(8) **DCM TO** Optical connector
(9) **LINE IN** Optical connector
(10) (11) Unused Optical connector
(12) **SIGN OUT** Optical connector
(15) **LINE** Line activity LED
(16) **DCM INV** connector
(17) **LAN** connector
(18) µUSB connector

2.4.7.4 LDRXB - Amplifier 20 dBm + OSC

ACRONYM	SLOTS
LDRXB	4-5-8-9-12-13-16-17

LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **ILA FROM** Optical connector
(4) **ILA TO** Optical connector
(5) **ROADM FROM** Optical connector
(6) **ROADM TO** Optical connector
(7) **OSC IN** Optical connector
(8) **OSC OUT** Optical connector
(9) **MON** Optical connector
(10) **OMON OUT** Optical connector
(11) **DCM FROM** Optical connector
(12) **DCM TO** Optical connector
(13) **LINE IN** Optical connector
(14) **LINE OUT** Optical connector
(15) **SIG IN** Optical connector
(16) **SIGN OUT** Optical connector
(17) **LINE** Line activity LED
(18) **DCM INV** connector
(19) **LAN** connector
(20) **RS232** µUSB connector

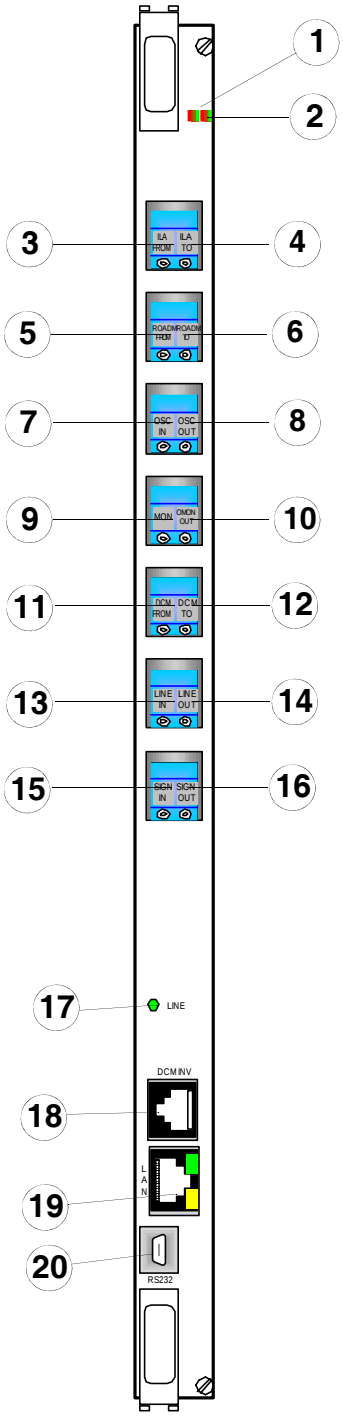
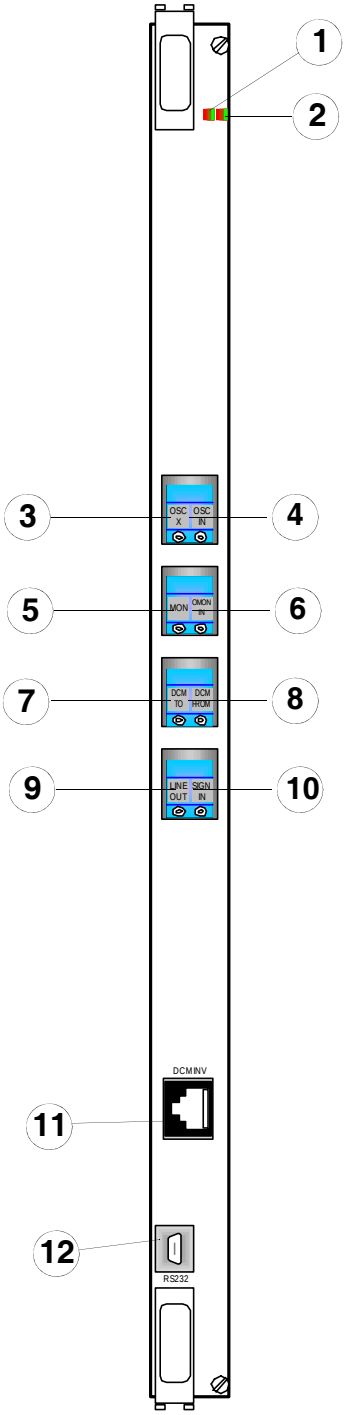


Figure 79. LDRXB - Amplifier 20 dBm + OSC pack - Front view

2.4.7.5 LDTXA - Amplifier 20 dBm + OSC

ACRONYM	SLOTS
LDTXA	4-5-8-9-12-13-16-17



LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

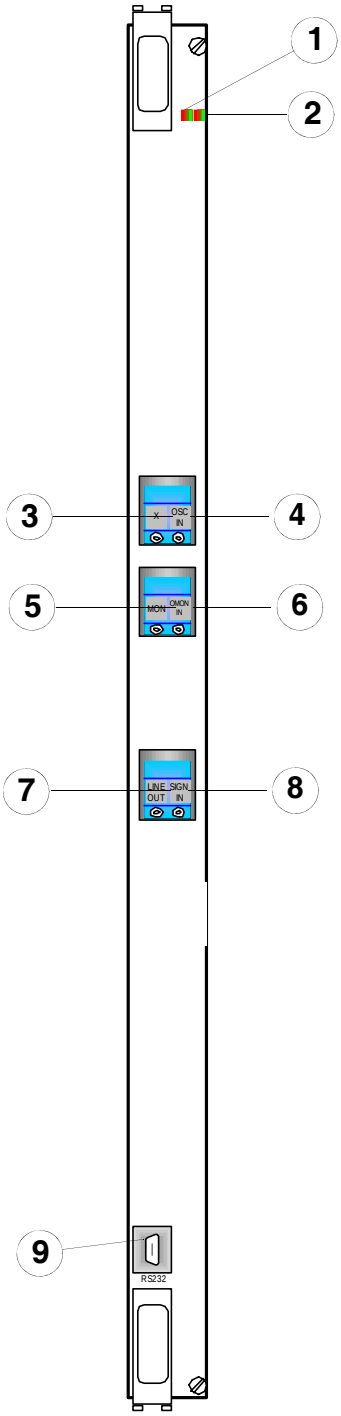
2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **OSC X** Optical connector
(4) **OSC IN** Optical connector
(5) **MON** Optical connector
(6) **OMON IN** Optical connector
(7) **DCM TO** Optical connector
(8) **DCM FROM** Optical connector
(9) **LINE OUT** Optical connector
(10) **SIG IN** Optical connector
(11) **DCM INV** connector
(12) **RS232** μUSB connector

Figure 80. LDTXA - Amplifier 20 dBm + OSC pack - Front view

2.4.7.6 LDTXB - OSC

ACRONYM	SLOTS
LDTXB	4-5-8-9-12-13-16-17



LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

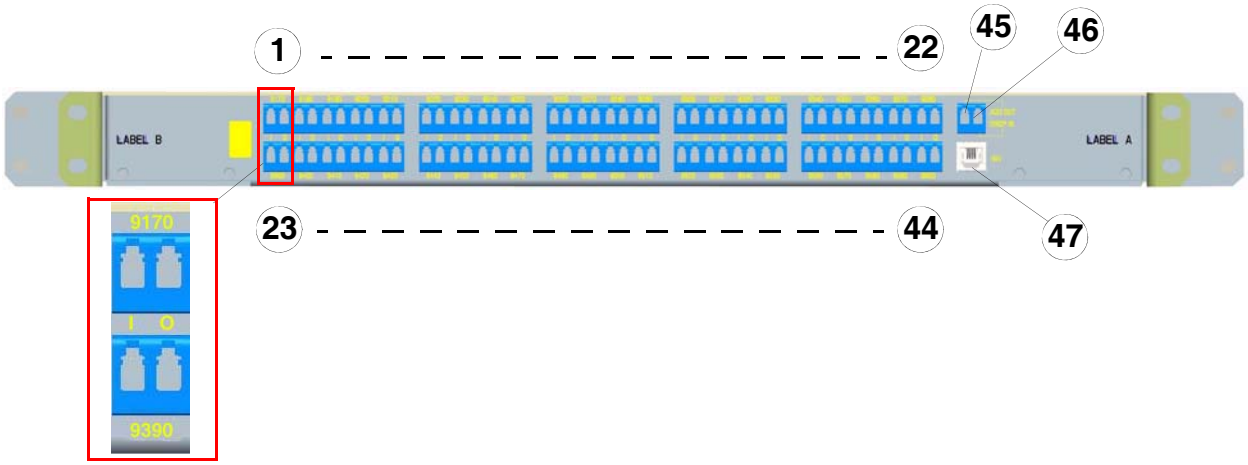
2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) Unused Optical connector
(4) **OSC IN** Optical connector
(5) **MON** Optical connector
(6) **OMON IN** Optical connector
(7) **LINE OUT** Optical connector
(8) **SIG IN** Optical connector
(10) **RS232** µUSB connector

Figure 81. LDTXB - OSC pack - Front view

2.4.7.7 OMD44 - Optical Mux/Demux 44 ch.

ACRONYM	SLOTS
OMD44	N/A



LEGEND:

(1) **9170**

I INPUT Optical connector @191.700 THz **O** OUTPUT optical connector @191.700 THz

(2) **9180**	(3) **9190**	(4) **9200**	(5) **9210**	(6) **9220**	(7) **9230**
(8) **9240**	(9) **9250**	(10) **9260**	(11) **9270**	(12) **9280**	(13) **9290**
(14) **9300**	(15) **9310**	(16) **9320**	(17) **9330**	(18) **9340**	(19) **9350**
(20) **9360**	(21) **9370**	(22) **9380**	(23) **9390**	(24) **9400**	(25) **9410**
(26) **9420**	(27) **9430**	(28) **9440**	(29) **9450**	(30) **9460**	(31) **9470**
(32) **9480**	(33) **9490**	(34) **9500**	(35) **9510**	(36) **9520**	(37) **9530**
(38) **9540**	(39) **9550**	(40) **9560**	(41) **9570**	(42) **9580**	(43) **9590**

(44) **9600**

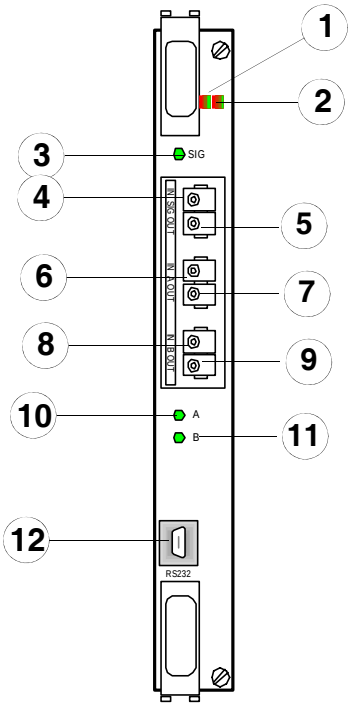
I INPUT Optical connector @196.000 THz **O** OUTPUT optical connector @196.000 THz

(45) **ADD OUT** Optical connector
(46) **DROP IN** Optical connector
(47) **INV** RJ45 connector

Figure 82. OMD44 - Optical Mux/Demux 44 ch. pack - Front view

2.4.7.8 OPS - Optical Protection Switch

ACRONYM	SLOTS
OPS	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

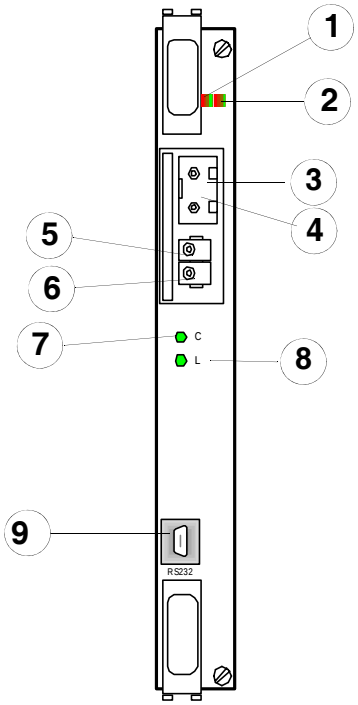
2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **SIG** LED
(4) **SIG IN** Optical connector
(5) **SIG OUT** Optical connector
(6) **A IN** Optical connector
(7) **A OUT** Optical connector
(8) **B IN** Optical connector
(9) **B OUT** Optical connector
(10) **A** LED - Presence of the signal when lit
(11) **B** LED - Presence of the signal when lit
(12) **RS232** μUSB connector

Figure 83. OPS - Optical Protection Switch pack - Front view

2.4.7.9 11GUAR - Single Port 11G unidirection anyrate OT (drop)

ACRONYM	SLOTS
11GUAR	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

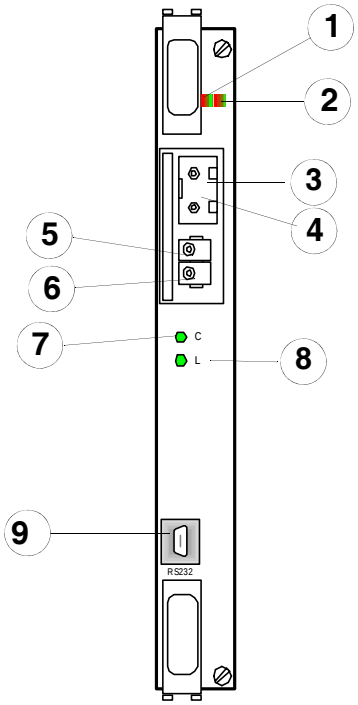
2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **C OUT** - Client side output optical connector (by XFP adapter)
(4) Unused Optical connector
(5) Unused Optical connector
(6) **L IN** - Line side optical connector
(7) **C** LED - Client side activity
(8) **L** LED - Line side activity
(9) **RS232** μUSB connector

Figure 84. 11GUAR - Single Port 11G unidirection anyrate OT (drop) pack - Front view

2.4.7.10 11GBAR - Single Port 11G bidirection anyrate OT

ACRONYM	SLOTS
11GBAR	from 02 to 09 from 12 to 19 from 21 to 28 from 29 to 36



LEGEND:

(1) multi-color LED indicating EPS status:
- GREEN: EPS configured - Card Active
- AMBER: EPS configured - Card Stand-by
- AMBER BLINK: EPS configured but not available
- SWITCHED OFF: EPS not configured

2) multi-color LED indicating Unit status:
- LED OFF: Card inserted but not working
- AMBER BLINK: FPGA download
- GREEN BLINK: SW boot/self test
- GREEN: Card provisioned and working
- RED: Card fail
- RED BLINK: Card mis-configured or Card mismatch for LocalController Debug - Internal Use only

(3) **C OUT** - Client side output optical connector (by XFP adapter)
(4) **C IN** - Client side input optical connector (by XFP adapter)
(5) **L OUT** - Line side output optical connector
(6) **L IN** - Line side input optical connector
(7) **C** LED - Client side activity
(8) **L** LED - Line side activity
(9) **RS232** µUSB connector

Figure 85. 11GBAR - Single Port 11G bidirection anyrate OT pack - Front view

3 Functional Description

3.1 General description

Figure 86. on page 128 is a block diagram illustrating the 1850 TSS-320 unit types and general operating functions.

- **EC320** card
  The unit provides the following functionality:
  - First-Level Controller (FLC) + HD (Hard Disk) function
  - DBG interface that supports application SW debug activities
  - F-interface that allows connection to a local craft terminal for operation and maintenance activities
  - HUSB interface that connects external USB v2.0 slave devices, such as “disk-on-key” or similar devices
  - LED Interface
  - Rack Lamp interface
  - Housekeeping interface
  - Remote alarm status reporting parallel output signals
  - LAN Interface
  - EPS Interface
  - Interface carrying data related to the Data Communication Channels mapped in the OH section of the SONET/SDH frame

- **MT320ND** Universal Matrix card
  The unit provides the following functionality:

  - Matrix that performs HPC, LPC, and protection functions; LPC is not available in current release
  - Synchronization functions
  - Shelf Controller (SC) function

  Note: As illustrated in the following figure, and as referred to throughout the Product Information document, the Universal Matrix board is subdivided in two blocks: TDM and Packet. This is a “logical“ subdivision only, not a physical subdivision.

Port cards manage the following signals:
- 56 x DS1 (T1)/63 x E1 PDH port card for balanced and unbalanced interfaces
- DS3/24xE3/EC-1 STS-1 and PDH traffic card for balanced and unbalanced interfaces
- 16 x E4 port card

– **SONET/SDH** port

The units provide the following functionality:
- Logical/Physical transport and adaptation
- POM
- TCT/TCM
- SUT/SUM
- OH add/drop
- DCC add/drop

Each unit can be configured by Craft Terminal in order to manage SONET/SDH signals.

The following boards are available:
- 1 x XFP(E) OC-192/STM-64 port card; needs to be equipped with an XFP adapter and the relevant XFP module
- 4 x SFP OC-48/STM-16 port card; requires SFP modules
- 8 x SFP OC-12(3)/STM-4(1) port card; requires SFP modules

– **SONET/SDH** adapter (LOA) (~~not available in current release~~)

Lower Order 10Gbit LPC Adapter Card providing connection to LPC and LOA support

– **20G PACKET PROCESSOR** port

The units provide the following functionality:
- Three Plug-in modules (PIM) with function of Logical/Physical Packet Transport adaptation
  - 1x10G, 10x1G, MultiService (MS)
- 20G Packet processing
- Traffic Manager
- Universal Matrix interfaces

– **SERVICE** card “SERV320” (not available in current release)

  The unit provides the following functionality:
  – Auxiliary channels
  – Engineering Order Wire (EOW)

– **“PSF320”** card

  This unit is considered an interface between the input battery coming from the GENTRU unit and the backlane in order to supply all the boards of the subrack. It also provides a 1.5-MHz to 1.5-Mb/s /2-MHz to 2-Mb/s input/output interface suitable for synchronization purpose.

The following chapters describe the Operations, Administration, Maintenance, and Provisioning (OAM&P) basic functions.

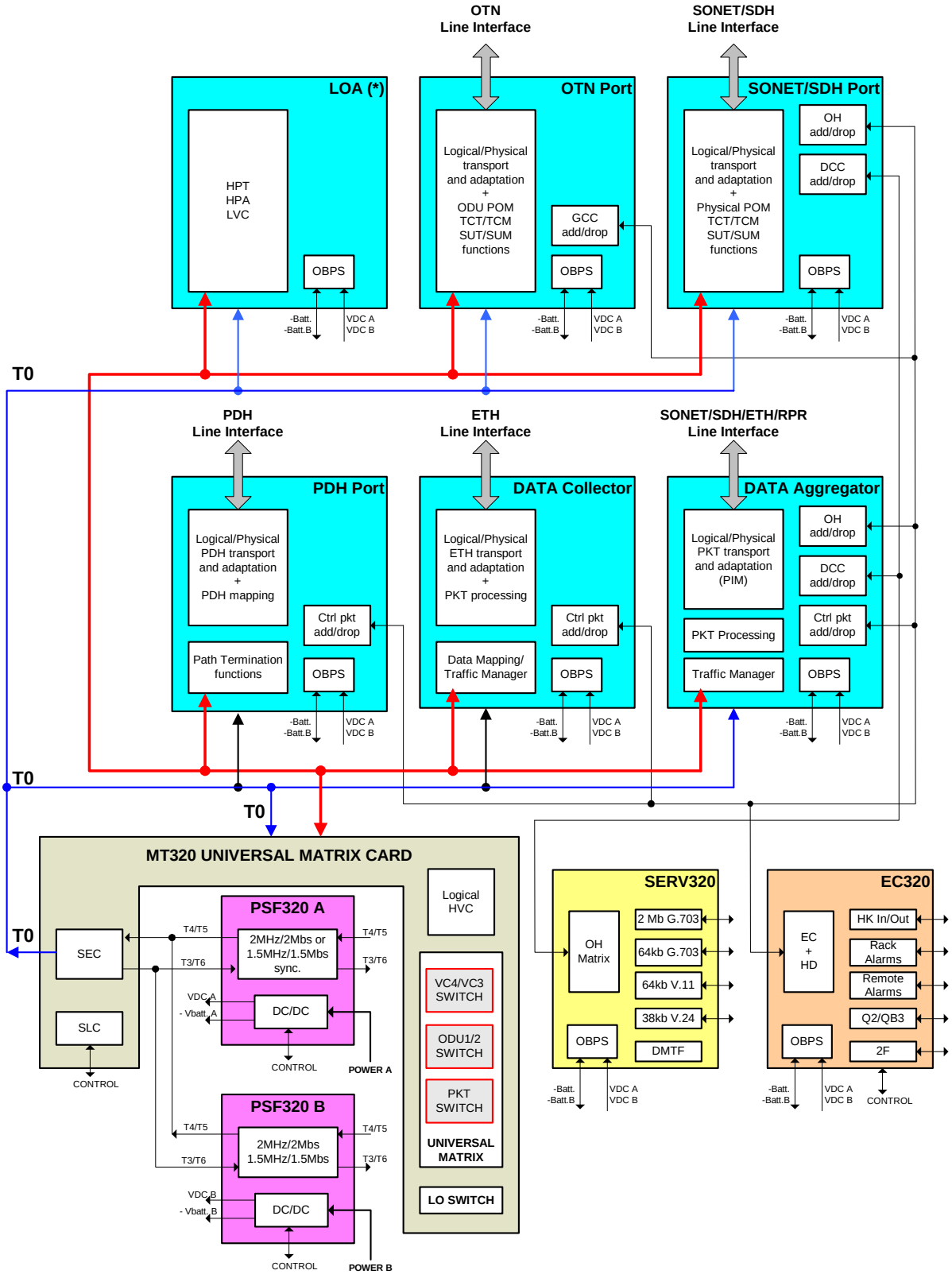


Figure 86. 1850 TSS-320 general block diagram

3.2 Operation

In the following are described the operation main features of the 1850 TSS-320 system.

The following parts are included in this paragraph:

– Signal architecture (chapter 3.2.1) on page 130
– OTN transmission architecture (chapter 3.2.2) on page 138
– Data transmission architecture (chapter 3.2.3) on page 139
– DWDM architecture (chapter 3.2.4) on page 190
– Equipment Protection Switching (EQPS) (chapter 3.2.5) on page 209
– Roll (chapter 3.2.6) on page 213
– Automatic Power Reduction (chapter 3.2.7) on page 217
– Facility Protection Switching (FPS) (chapter 3.2.8) on page 227
– GMPLS Architecture (chapter 3.2.9) on page 232
– TE Links (chapter 3.2.10) on page 246
– Optical Supervisory Channel (OSC) (chapter 3.2.12) on page 266
– Overhead (chapter 3.2.13) on page 268
– Power (chapter 3.2.14) on page 270
– Recovery (chapter 3.2.15) on page 272
– Synchronization (chapter 3.2.16) on page 273

3.2.1 Signal architecture

Signal management architecture is designed to be a flexible system that simultaneously handles TDM traffic (SONET/SDH) and data traffic.

This flexibility is obtained by means of a payload independent switching element.

Payload dependent functions are implemented dedicated cards (e.g,. I/O port cards for HO SONET/SDH processing).

The traffic management in 1850 TSS-320 is performed according to the functional architecture foreseen by the dedicated current reference standards.

In particular, the functional architecture includes:

- ITU-T G.783 for SDH traffic
- GR-253 for SONET traffic
- ITU-T G.8021/IEEE 802.3 for Ethernet traffic
- IEEE 802.17 for RPR traffic;
- IETF RFC 3031, RFC 3032 for MPLS traffic
- ITU-T G.798 characteristics of the Optical Transport Network (OTN) hierarchy equipment functional blocks

The overall functional architecture for traffic management of 1850 TSS-320 node is depicted in Figure 87. on page 131.

This system is based upon a payload switching element that combines both TDM and packet switching capabilities. Therefore, the same matrix element can be simultantously performed for ODUk, SONET/SDH MSP, SONET/SDH HO, MPLS, L2, RPR switches.

The SONET/SDH LO traffic is cross-connected in a dedicated LO Matrix device (not operative in current release).

In addition to matrices, the boards that can be housed in the equipment implement the payload specific processing functions (e.g., SONET/SDH port cards, as well as OTN cards, as well as data card).

The following sections describe the system on traffic base:

- SONET/SDH transmission architecture (chapter 3.2.1.1) on page 132
- OTN transmission architecture (chapter 3.2.2) on page 138
- Data transmission architecture (chapter 3.2.3) on page 139
- DWDM architecture (chapter 3.2.4) on page 190

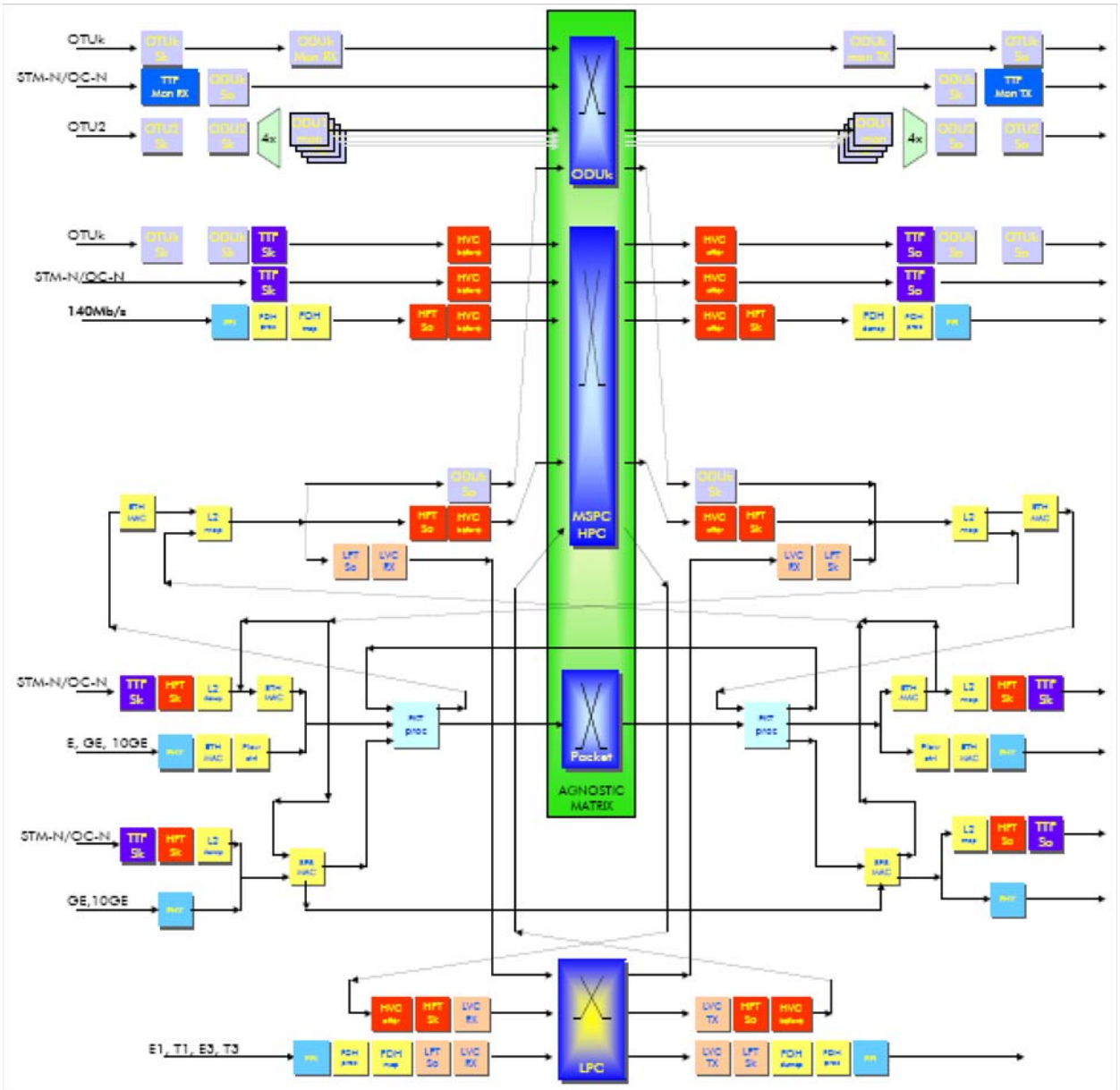


Figure 87. 1850 TSS-320 payload functional architecture

3.2.1.1 SONET/SDH transmission architecture

The overall functional architecture for SONET/SDH traffic is depicted in Figure 88. on page 132.

The description of SONET/SDH architecture is based on SONET/SDH terminologies, taking Telcordia/ITU-T standards (mainly GR-253/G.783) as a reference for the functional model description.

When dealing with SONET/SDH traffic, the functions of MSPC and HVC, foreseen by the standard functional model, collapse into one single entity implemented in the central switching element.

SONET/SDH LO traffic switching is managed in a different separated device (not available in current release).

SONET/SDH functional architecture can be further divided into different subsystems dedicated to the respective management of:

– *SONET/SDH HO traffic* (i.e., STS-1 SPE for SONET; VC-4 for SDH) (refer to Section 3.2.1.2 on page 133)

– *SONET/SDH LO traffic* (i.e., VT-1.5 SPE for SONET; VC-3, VC-12 for SDH) (refer to Section 3.2.1.3 on page 135)

– *PDH access and mapping* (refer to Section 3.2.1.4 on page 136)

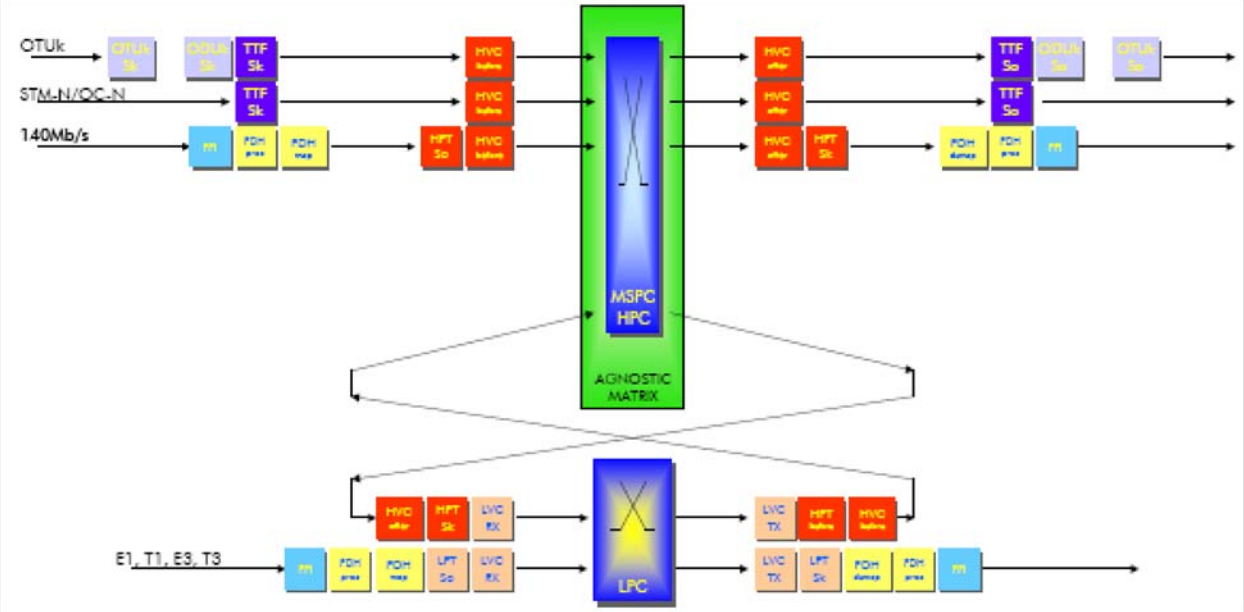


Figure 88. SONET/SDH payload functional architecture

3.2.1.2 SONET/SDH Higher Order part system

SONET/SDH Higher Order part system performs the processing of the Section and the Line of a SONET signal and Regenerator and the Multiplex of a SDH signal.

The adaptation to the path layer is also managed, with pointer regeneration, in RX side.

The HO path signals (STS-3c SPE for SONET / VC-4 for SDH) are processed as described in Section C.1 on page 609.

SONET/SDH Payload matrices, foreseen by ANSI and ITU-T standards for the management of Higher Order traffic (i.e., MSP_RX, HPC, MSP_TX matrices, using SONET/SDH terminologies) collapse into one single entity performing fully nonblocking STS-1/AU-3 and/or **STS-3c/**AU-4 switch, with respect to any broadcast type.

See Section C.1 on page 609 for the description of the SONET/SDH higher order switching capacity of the system.

Figure 89. on page 133 depicts the payload processing subsystem functional partitioning as far as HO traffic is concerned.

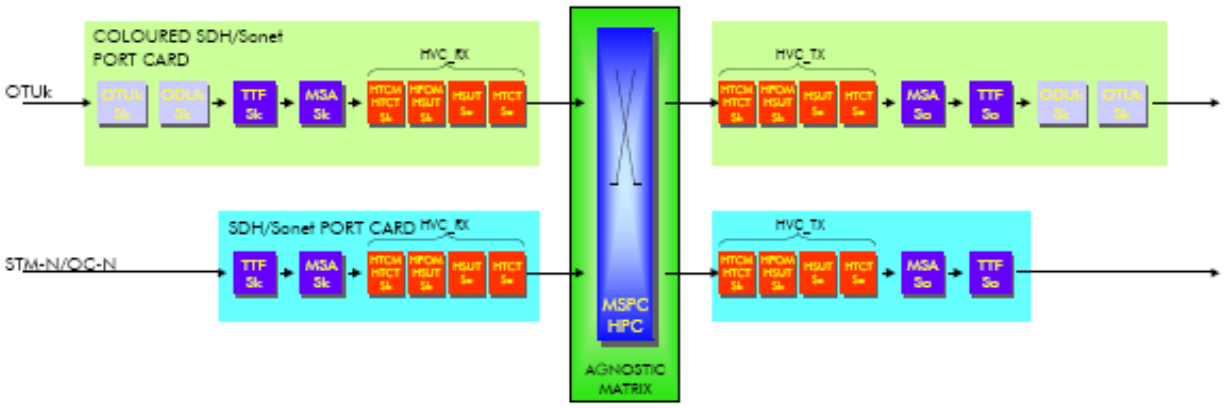


Figure 89. SONET/SDH HO payload subsystem

This implementation, however, causes a violation of the functional model defined in ITU-T G.783 standard. The adaptation function between multiplex section and path layer (MSA) and the path layer functions (HVC) are, in fact, placed before the MSP connection function. In order to override this issue, the information collected by MSA and HVC functions in I/O port card is carried via a dedicated channel, embedded in the payload back panel link (via in band signaling) to the Matrix board, where a vrtual image of MSA and HVC functions resides (see Figure 90. on page 134). The aim of the virtual functions is to manage alarm reporting, performance monitoring and remote criteria insertion. In addition to 1124 as MSA and HVC functions, MSP_RX and MSP_TX connection functions have a virtual image in Matrix card in order to condition the information, collected by the physical MSA and HVC functions, to the status of MSP switch.

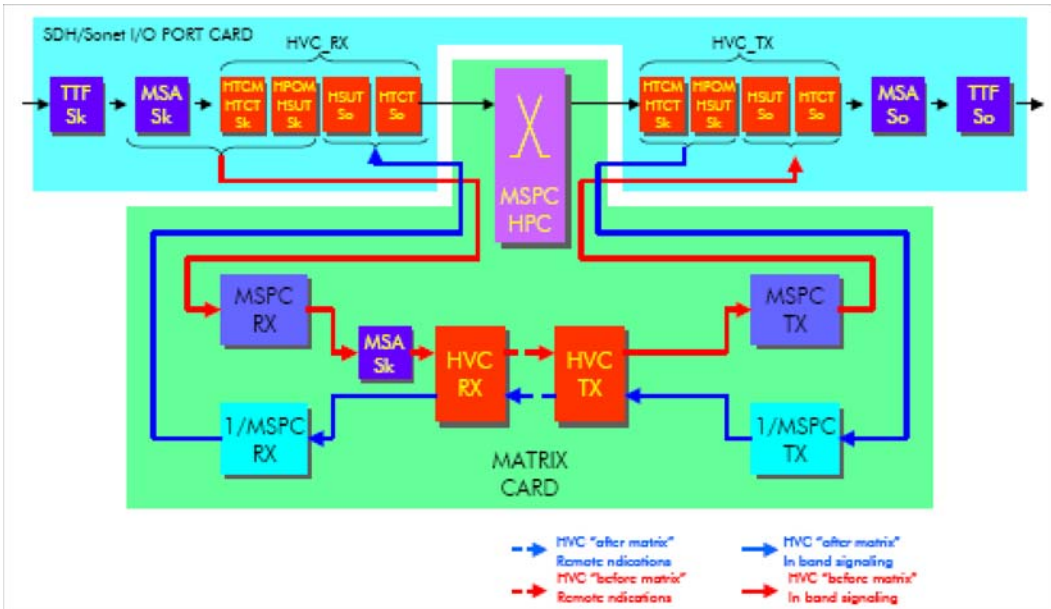


Figure 90. SONET/SDH HO payload subsystem Functional Model: in band mechanism.

Fullcompliancy to ANSI/ITU-T functional model is achieved. The equivalent functional model of the equipment is reported in Figure 91. on page 134

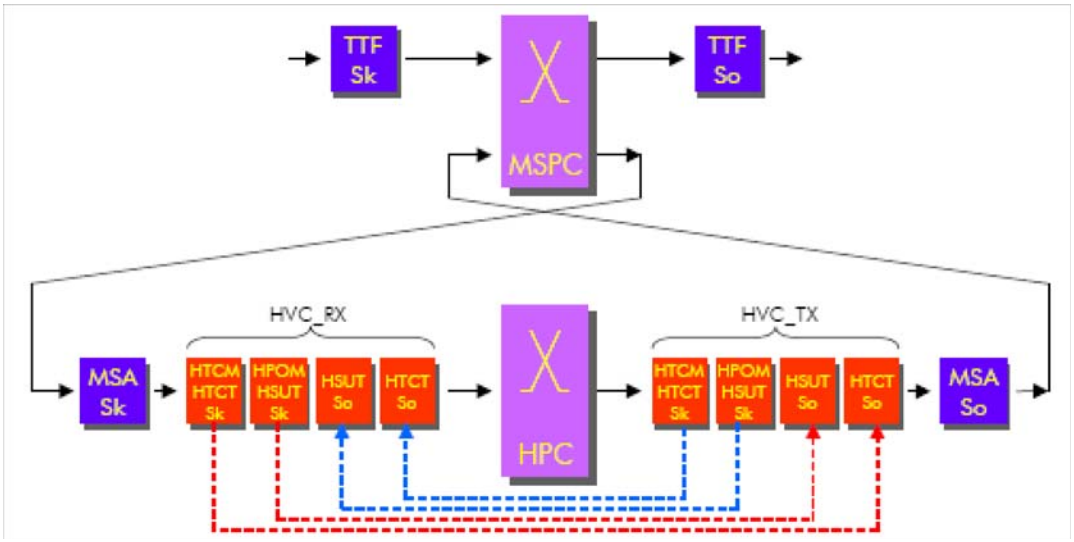


Figure 91. SONET/SDH HO payload subsystem equivalent logical functional model.

The described functional partitioning for the HO SONET/SDH signals introduces some slight difference in the equipment behavior, with respect to the expected one (i.e., described by G.783).

3.2.1.3 SONET/SDH Lower Order part system

SONET/SDH Lower Order part system provides processing capabilities of the LO tributaries part of an HO structured payload. Assembly and disassembly of the HO/LO payload is performed, by means of adaptation of the HO path to the LO path layer. TU pointer processing is also performed. The LO path signals (VT-1.5 SPE for SONET; VC-12 and VC-3 for SDH) are processed as described in Section C.2.1 on page 622
The implementation of the LO subsystem is fully compliant with the functional model described in the standard (G.783).

SONET/SDH Lower Order traffic is cross-connected in a dedicated device, placed in the Matrix board, able to switch VT-1.5 SPE - VT-2 SPE - VT-6 SPE for SONET and VC-11/VC12/VC-3 for SDH tributaries.
See Section C.1 on page 609 for the description of the SONET/SDH lower order switching capacity of the system.

Lower order payload processing (LOA: Lower Order Adaptation functionality) is performed in dedicated LOA cards, with 10G equivalent throughput each.

Figure 92. on page 135 shows the block diagram referred to in 1850 TSS-320.

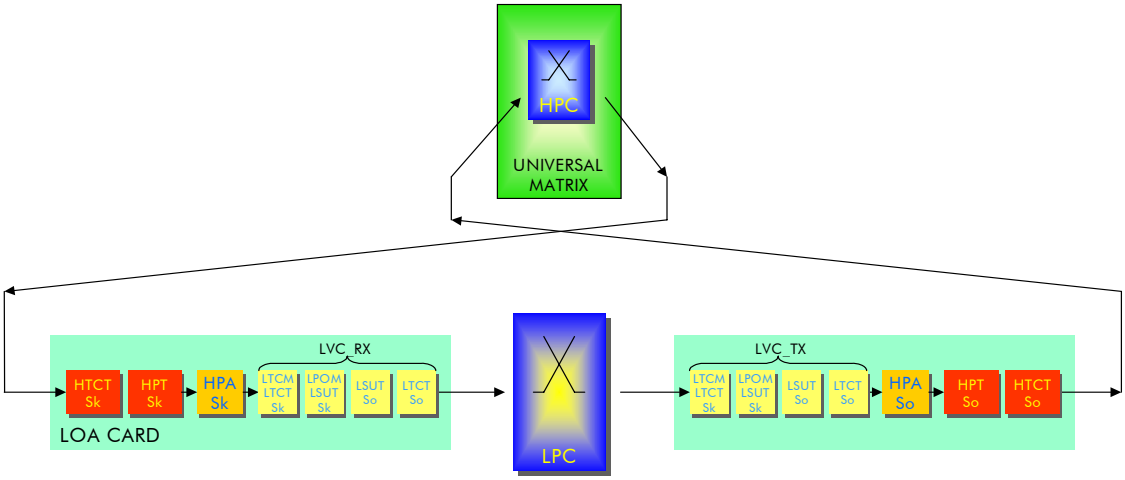


Figure 92. SONET/SDH LO payload subsystem

3.2.1.4 SONET/SDH PDH mapping part system

This section describes the portion of the system that manages PDH signals mapping into SONET/SDH frames. Both PDH into HO SONET/SDH and PDH into LO SONET/SDH mappings are supported, as depicted in Figure 93. on page 137.

PDH over HO SONET/SDH tributaries mapping is managed via HOI (Higher Order Interface) cards, which directly interface the Universal Matrix providing the functionalities of the standard Higher Order Path Connection (HPC) connection function.

The mapping of PDH over LO SONET/SDH tributaries mapping is managed in LOI (Lower Order Interface) cards, instead. LOI card manage the mapping of the PDH signals into Lower Order tributaries, managing a Virtual container with a meaningless path overhead: LO path termination, therefore, is not managed in LOI cards. The LO VC, carrying PDH clients, are mapped into a structured HO tributary (again, the HO VCs are created wih a meaningless path OH).

It is therefore necessary to interface the LOI cards to the Universal Matrix in order to manage the HO tributaries aggregation towards the LOA cards for SONET/SDH LO tributaries processing. This first passage into the LOA card is necessary not only for interfacing the LO SONET/SDH Matrix device (in order to provide LO cross connection), but also to provide the real LO path termination functionality: the meaningless HO tributaries are terminated and the LO containers are recovered, then the LO path OH is managed as foreseen by SONET/SDH standards.

The LO tributaries are then processed in the same way as described in Section 3.2.1.3 on page 135 with a second cross of the LOA card.

Note: With this particular architecture, the LOA resources physically implemented are doubled with respect to the total LO traffic coming from LOI cards processed in the equipment. HOI cards and LOI cards are described in Section C.3 on page 629.

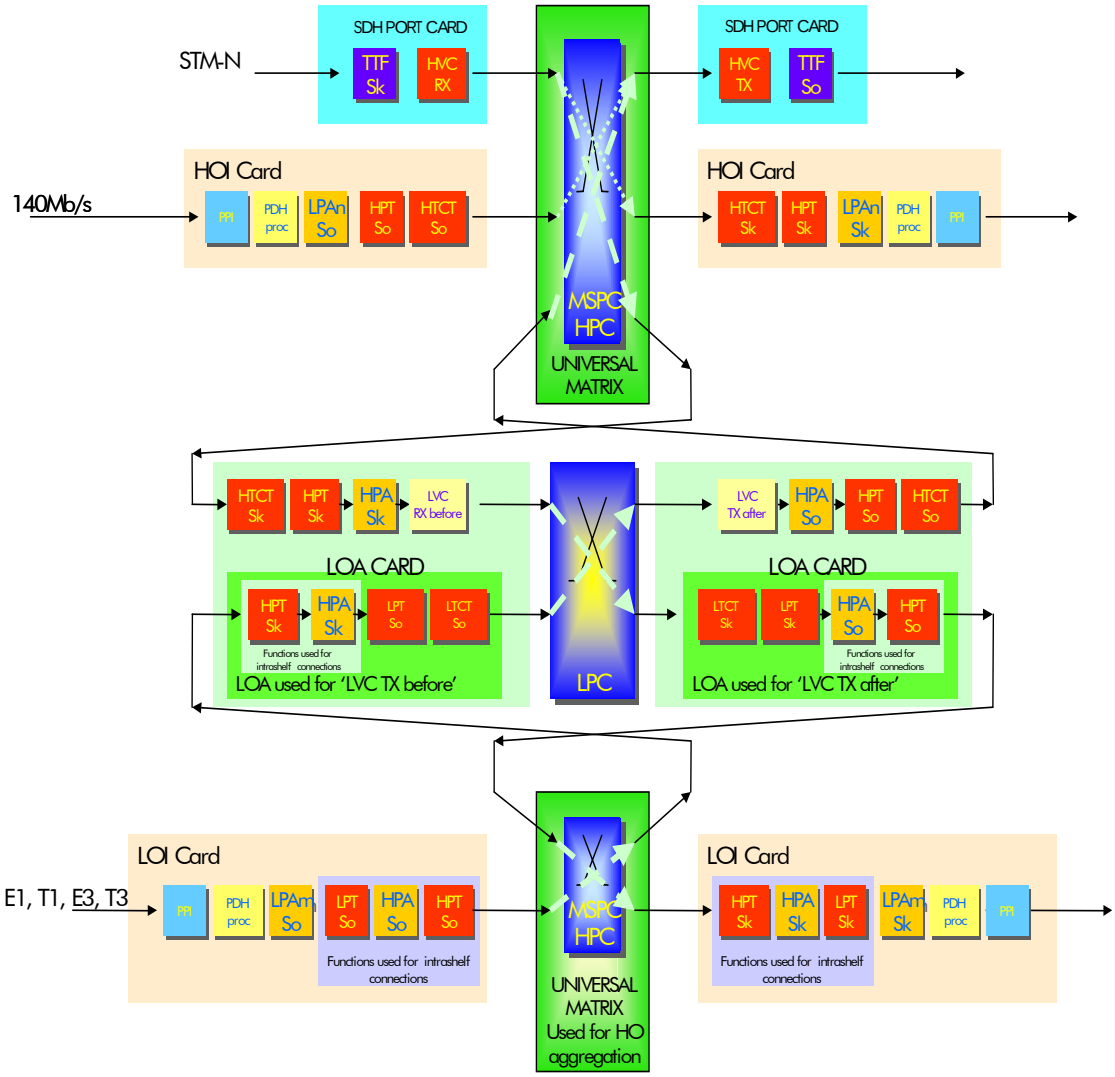


Figure 93. SONET/SDH PDH mapping subsystem

3.2.2 OTN transmission architecture

The overall functional architecture of 1850 TSS-320 equipment dealing with OTN traffic is depicted in Figure 94. on page 138.

OTN subsystem provides processing capabilities of the Optical Channel Transport Unit (OTUk) and of the Optical Channel Data Unit (ODUk). The capability to map CBR clients (e.g., SONET/SDH client signals) into ODUk frames is also supported, as well as the adaptation of ODU1 into ODU2 (Mux/Demux). The OTN signals are processed as described in Section C.5 on page 633.

The implementation of the OTN subsystem is fully compliant with the functional model described in the standard (GR-253/G.798). OTN traffic is cross-connected at ODUk level in the payload agnostic switching device, placed in the Matrix board, and able to switch ODU1/ODU2. See Section C.5 on page 633 for the description of the OTN switching capacity of the system. Payload processing is performed in dedicated cards.

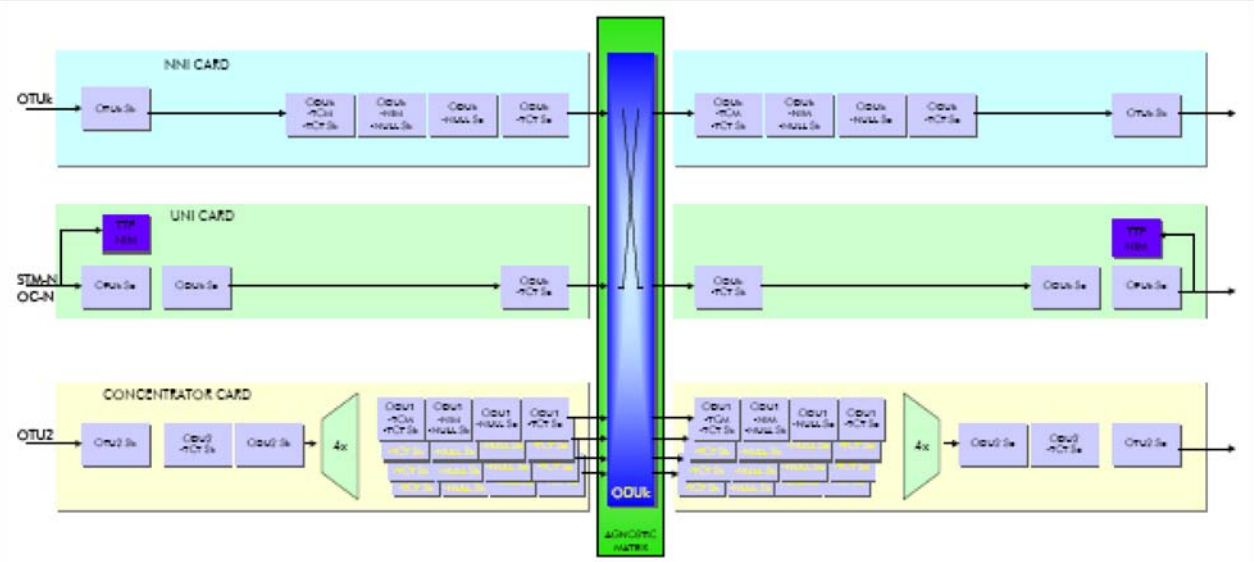


Figure 94. OTN payload functional architecture: physical position of functional blocks.

3.2.3 Data transmission architecture

This section describes the capabilities of the 1850 TSS-320 equipment to manage packet-based traffic.Pure packet based traffic and interworking between TDM and packets are also managed.

The overall functional architecture for packet based traffic management is reported in Figure 95. on page 139.

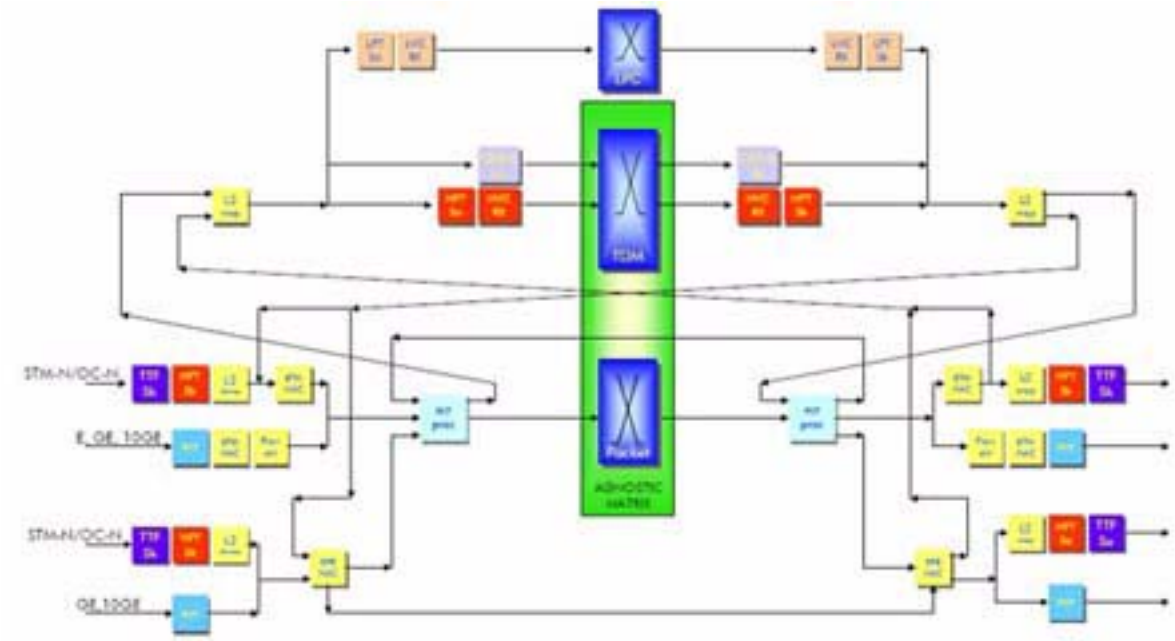


Figure 95. Data transmission functional architecture

Two different boards are foreseen in order to manage data traffic:

– PACKET PROCESSOR: Provides MPLS switching for customer or provider traffic aggregation. The board can host several interfaces by means of plug-in modules (PIM), thus reaching the best performances in terms of flexibility and modularity. PIMs control the termination and adaptation functions related to the specific layer.

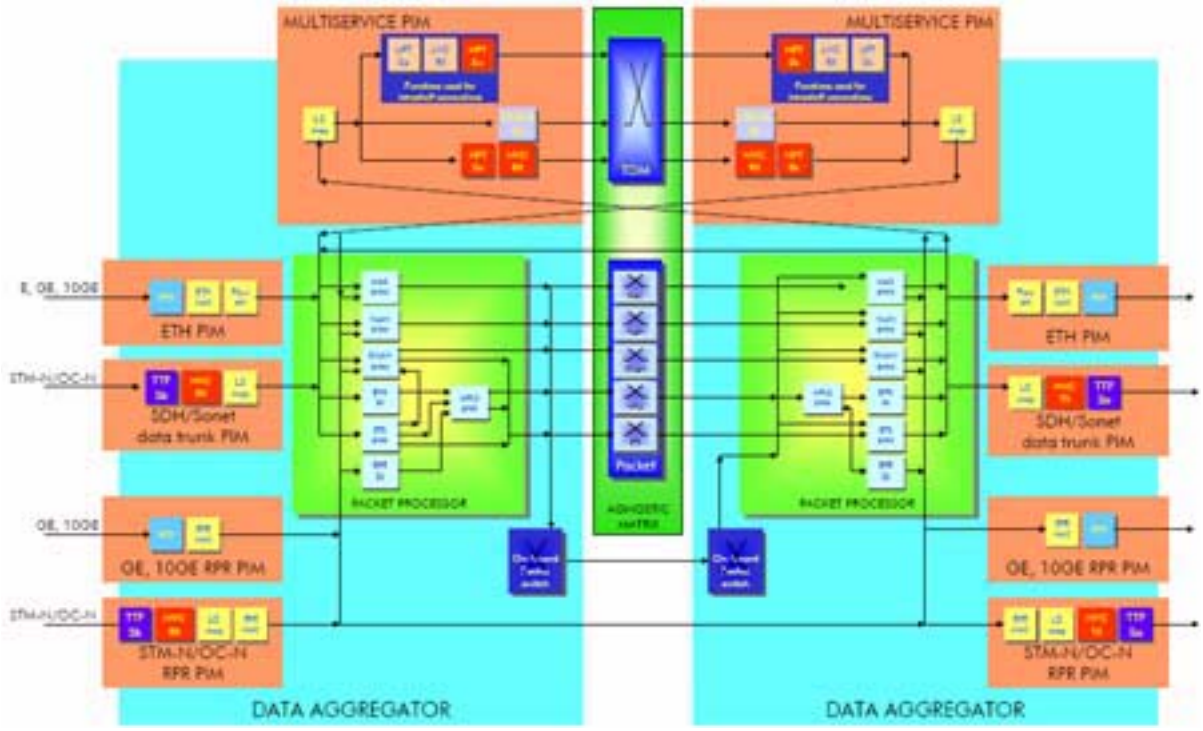


Figure 96. Packet Processor

Figure 97. on page 141 describes the simplified portion of the system dealing with the management of data traffic mapping into SONET/SDH frames.

Both data into HO SONET/SDH and into LO SONET/SDH mappings are supported and managed by PACKET PROCESSOR cards.

When data over HO SONET/SDH tributaries mapping is managed, 20G PACKET PROCESSOR cards are directly interfaced to the Universal Matrix in order to provide the functionalities of the standard HPC connection function. The mapping of data over LO SONET/SDH tributaries mapping is managed through another method.

Data cards manage the mapping of the data signals into Lower Order tributaries, managing a virtual container with a meaningless path overhead: LO path termination, therefore, is not managed in data cards. Due to the particular implementation, the LO SONET/SDH tributaries carrying data clients are mapped into a structured HO tributary (again, the HO VCs are created with a meaningless path OH)

It is therefore necessary to interface the data cards to the Universal Matrix to manage the HO tributaries aggregation towards the LOA cards for SONET/SDH LO tributaries processing.

This first passage into the LOA card is necessary not only for interfacing the LO SONET/SDH Matrix device, in order to provide LO cross connection, but also ito provide the real LO path termination functionality: the meaningless HO tributaries are terminated and the LO containers are recovered, then the LO path OH is managed as foreseen by SONET/SDH standards.

The LO tributaries are then processed in the same way as described in Section 3.2.1.2 on page 133, with a second cross of the LOA card.

Note: With this particular architecture, the LOA resources physically implemented are doubled with respect to the total LO traffic, coming from data cards, that has to be processed in the equipment.

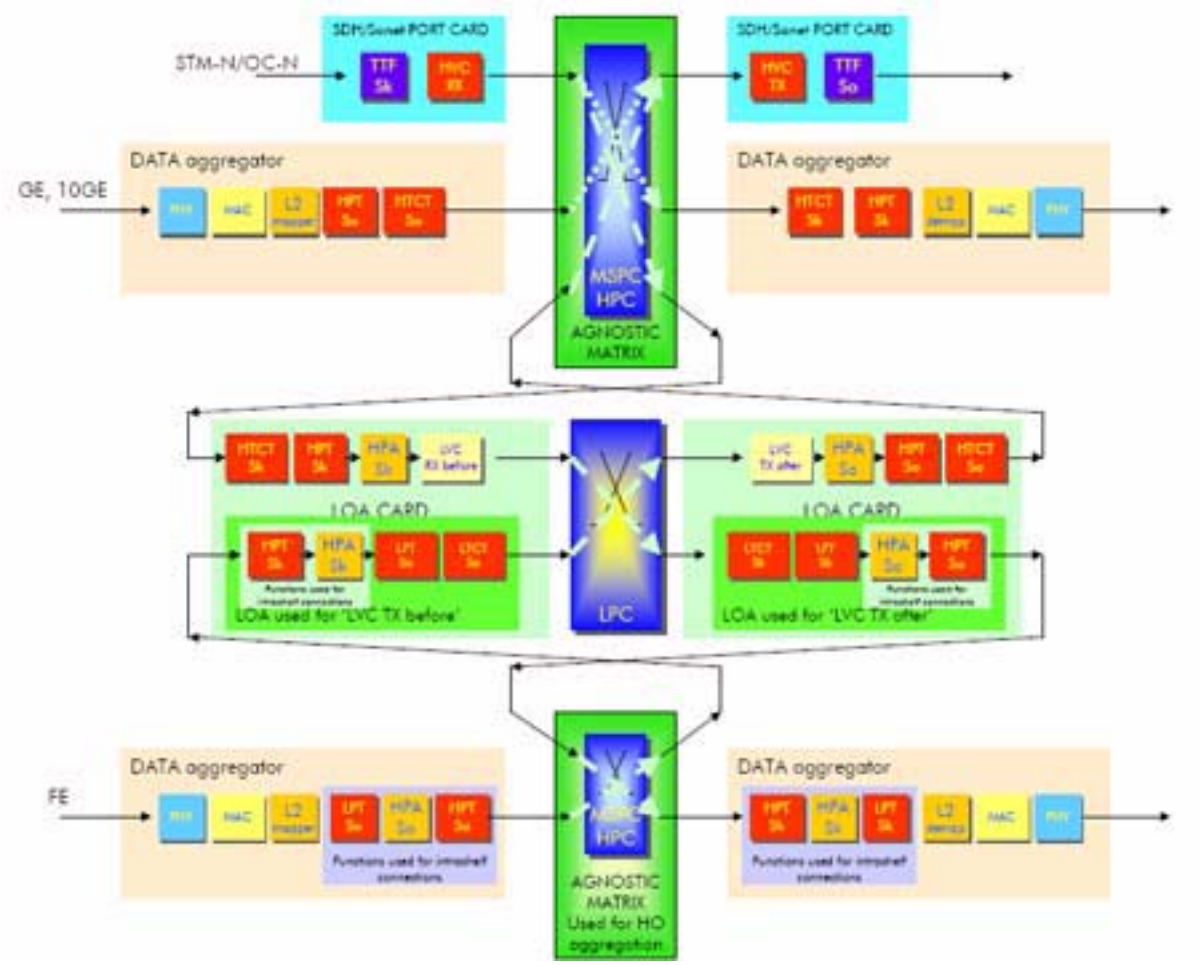


Figure 97. Data Mapping over SONET/SDH

3.2.3.1 Data features

The NE supports Virtual Concatenation paths per T1.105 at the STS-1 payload level.

Framing of data payloads into SONET is per GFP-F as defined in G.7041/Y.1303.

The bandwidth/capacity limitations as given in Table 10. are applicable to VCAT for each installed 10G Multiservice PIM module of the 20G Aggregator board:

Table 10. Maximum number of members for each type of VCG group in PIMMS module

Payload Level	Maximum interface bandwidth	Maximum Number of VCGs	Maximum Number of members within the VCG
STS-1	10 Gb/s	124	192

The bandwidth/capacity limitations as given in Table 11. are applicable to VCAT for each installed 10xANY board:

Table 11. Maximum number of members for each type of VCG group in 10xANY board

Payload Level	Maximum interface bandwidth	Maximum Number of VCGs + Physical Ports	Maximum Number of members within the VCG
STS-1	10 Gb/s	10	21 (Note)

Note: This is not actually a limit (it's the concatenation order which avoid client rate compression): it's possible to augment the concatenation order taking advange of the resiliency capability of LCAS protocol.

VCAT overhead functions is supported via SONET path bytes H4 (high order - STS-1)

The maximum differential delay supported by each VCG is 32 ms.

The following VCAT functionality is managed by TL1:
– Provisioning and de-provisioning of virtual concatenation groups
– Monitoring and reporting VCG alarms and conditions

The NE supports Link Capacity Adjustment Scheme (LCAS) per ITU-T G.7042. LCAS is used in conjunction with VCAT to allow a user to dynamically modify the number of channels in a Virtual concatenation group. The NE allows modification while the channels are in-service without impact to traffic.

The following LCAS management functions are available via TL1
– Allocation/De-allocation of members on a VCG, without traffic interruption
– Enable/Disable LCAS protocol on a VCG
– Activation/De-activation of generic members in a LCAS enabled VCG
– De-activation of specified members in a LCAS enabled VCG
– Retrieve LCAS parameters values for a LCAS enabled VCG
– Monitoring and reporting LCAS specific alarms and conditions

Virtual Concatenation (VCAT)

Virtual concatenation was developed so that the SONET/SDH network elements could more efficiently allocate bandwidth to client data signals. In the voice world, circuits were efficiently aggregated from DS0 to DS1 to DS3, which could be further aggregated into SONET containers for very efficient use of bandwidth.

In broadband data world, nearly the opposite holds true. Data network interfaces designed for the LAN or data center tend not to map efficiently into SONET/SDH. A 100 Mb/s Fast Ethernet signal, for example, must be mapped into a 155 Mb/s SONET STS-3c channel, leaving 55 Mb/s of transport capacity idle on both working and protect paths and unavailable to other services.

SONET/SDH historically dealt with large payloads through a process of contiguous concatenation, or the grouping of consecutive SPEs into one large container for transport through the network as a single unit. The challenges associated with contiguous concatenation are manifold when optimizing SONET/SDH for data services. First, contiguous concatenation is tied to SONET/SDH's fixed hierarchy of channel sizes, making it difficult to achieve transport efficiency when mapping Ethernet or storage protocols. Second, contiguous containers must travel along the same path, which requires all equipment along the path understand concatenation indication. This effectively eliminates the value of concatenation by requiring an upgrade of the entire SONET/SDH embedded core network. Lastly, there is no way to resize these in-service.

Virtual concatenation (VCAT) standardized as T1.105/G.707 by the ANSI/ITU-T, overcomes the limitations of contiguous concatenation by decoupling establishment of the path through the network from the physical network resources - hence the "virtual" nature of this scheme. All the members of the Virtual Concatenation group (VCG) travel through the network as individual SPEs and therefore may take different paths, although they are administered as a single group. The network sees only the individual STS1s or VT1.5s, relieving the operator of upgrading any equipment except those at the edges where the VCAT signal originates and terminates. Since members of a VCG need not be in contiguous time slots, an arbitrary number of VT1.5s (low order) or STS-1 (high order) can be grouped to form a VCG. This gets to the heart of right-sizing SONET/SDH channels for data services. With VCAT, pipes of nearly any size can be made by grouping the right number of VT1.5s, STS-1 or STS-3cs. The Table DATA-2 illustrates the bandwidth efficiency gains made possible by VCAT.

Table 12. Bandwidth utilization Efficiencies with Virtual Concatenation

Client Signal Protocols	Bitrate	Traditional SONET	Utilization	With VCAT	Utilization
Ethernet	10 Mbit/s	STS-1	20%	VT1.5-7v	89%
Fast Ethernet	100 Mbit/s	STS-3c	67%	STS1-2v	99%
Gigabit Ethernet	1,000 Mbit/s	STS-48c	42%	STS3c-7v	95%
Low-Speed ATM	25 Mbit/s	STS-1	50%	VT1.5-16v	98%
ESCON	200 Mbit/s	STS-12c	32%	STS1-4v	100%

VCAT also improves bandwidth management in some less obvious ways. For example, channels are more easily to network than with contiguous concatenation, since paths need not be engineered and reengineered through a network to account for a contiguous arrangement of channels. This provides an added benefit of load balancing a network by allowing operators to evenly distribute members of a VCG over their network as they fit.

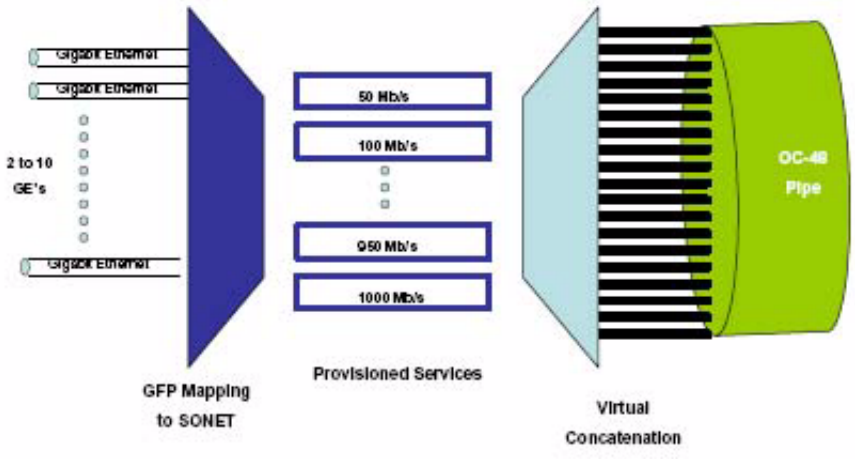


Figure 98. Ethernet Aggregation using High-Order (STS-1) Virtual Concatenation

VCAT isn't without its limitations, however. It certainly improves network utilization, but this comes at some cost and complexity. First, since the members of a VCG may be traveling along different paths, they may not arrive at the destination NE at the same time, which means local buffering is needed to compensate for this propagation delay. This adds cost and complexity to equipment interfaces and puts distance limits on the kind of paths operators can create for their services. Second it is important to note that VCAT only addresses the mismatch between a client interface data rate and SONET's channel rates. What it doesn't address is the bursty nature of that data traffic.

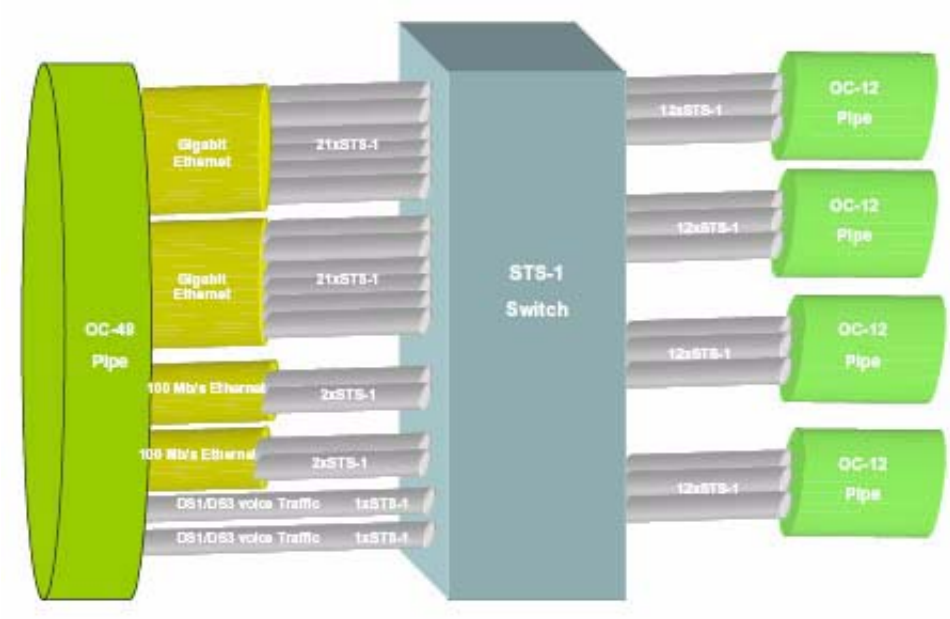


Figure 99. Multiservice Cross Connect using High Order Virtual Concatenation

As indicated earlier each member of a VCAT is transported individually through the network. The Sequence indicator (SQ) identifies the sequence/order in which the individual members of the VCAT are combined to form the contiguous VCAT payload capacity.

For the high order VCAT (STS-1) an 8-bit sequence number (which supports 256 VCAT members) is transported in the bits 1 to 4 of the H4 bytes, using frame 14 (SQ bits 1-4) and 15 (SQ bits 5-8) of the first multiframe stage. The STS-1/3c SPE transporting the first time slot of the STS-1/3c-Xc SPE has the sequence number 0, the STS-1/3c SPE transporting the second time slot the sequence number 1, and so on up to the STS-1/3c SPE transporting time slot X of the STS-1/3c-Xc SPE with the sequence number (X-1). The sequence number assigned is fixed and not configurable. It allows the service provider to check the correct constitution of the STS-1/3c-Xv SPE without using trace.

For the low order VCAT (VTs) bit 2 of the Z7 byte of the VTn POH is used to convey this information from the sending end to the receiving end of the VCAT signal where the alignment process is performed. A serial string of 32 bits (over 32 four-frame multiframe) is used to carry the Sequence Indicator. Each VTn SPE of an VTn-XV SPE has a fixed unique sequence number in the range of 0 to (X-1). The VTn SPE transporting the first time slot of the VTn-Xc SPE has the sequence number 0, the VTn SPE transporting the second time slot of the VTn-Xc SPE has the sequence number 1 and so on up to the X-1 sequence number carried by the Xth time slot.

Both high order and low order VCAT is standardized in ANSI T1.105-2001.

The 20G Aggregator (PP20G) module supports 2 PIMs (Plu-In Module) and is two slot hight and two slot wide.

Each PIM has a throughput of 10G. The supported PIMs are Mutiservice PIM supporting up to 124 VCGs, 10x1 Gigabit Ethernet PIM (PIM1GE) supporting up to 10 SFP (Small Form-factor Plug-in Module) and 1x10 Gigabit Ethernet PIM (PIM10GE) supporting 1 XFP (eXtended Form-factor Plug-in Module).

The 10xANY Clients (10XANY) module supports up to 10 SFPs (Small Form-factor Plug-in Module) and it is single slot hight and wide. It has a throughput of 10G, that is up to 192 STS1 which can be distributed between 10 VCGs; each VCGs is associated to a client port constituted by the SFP supporting a Gigabit Ethernet Signal.

The management of the Ethernet ports on the PIM1GE, PIM10GE modules, mapping of the Ethernet packets into GFP frame on the PIMMS module will be done by SNMP interface and is not included in this RRS. The management of Ethernet ports on the 10xANY board is specified in FM RRSs, while the management of GFP ports is described by the DATA ones.

Link Capacity Adjustment Scheme (LCAS)

Along with virtual concatenation, the capability to dynamically change the amount of bandwidth used for a virtual concatenated channel has been developed. This capability is the Link Capacity Adjustment Scheme (LCAS).

Signaling messages are exchanged within the SONET overhead in order to change the number of tributaries being used by a Virtually Concatenated Group (VCG). The number of tributaries may be either reduced or increased, and the resulting bandwidth change may be applied without loss of data in the absence of network errors. Remember since the VCAT is transported transparently in the core of the network and only the NEs at the edges need take any action, the LCAS protocol is between the edge NEs. The intermediate nodes do not participate in this protocol.

The ability to change the amount of bandwidth allows for further engineering of the data network and providing new services. Bandwidth can be adjusted based on time-of-day demands and seasonal fluctuations. For example, businesses can subscribe to higher bandwidth connections (for backup etc.) when the demand for bandwidth is low and hence the cost is lower.

LCAS can further provide “tuning” of the allocated bandwidth. If the initial bandwidth allocation is only for the average amount of traffic rather than the full peak bandwidth, and the average bandwidth usage changes over time, the allocation can be modified to reflect this change. This tunability can then be used to provide (and charge for) only as much bandwidth as the customer requires. Figure DATA-3 shows an example of dynamic bandwidth adjustment.

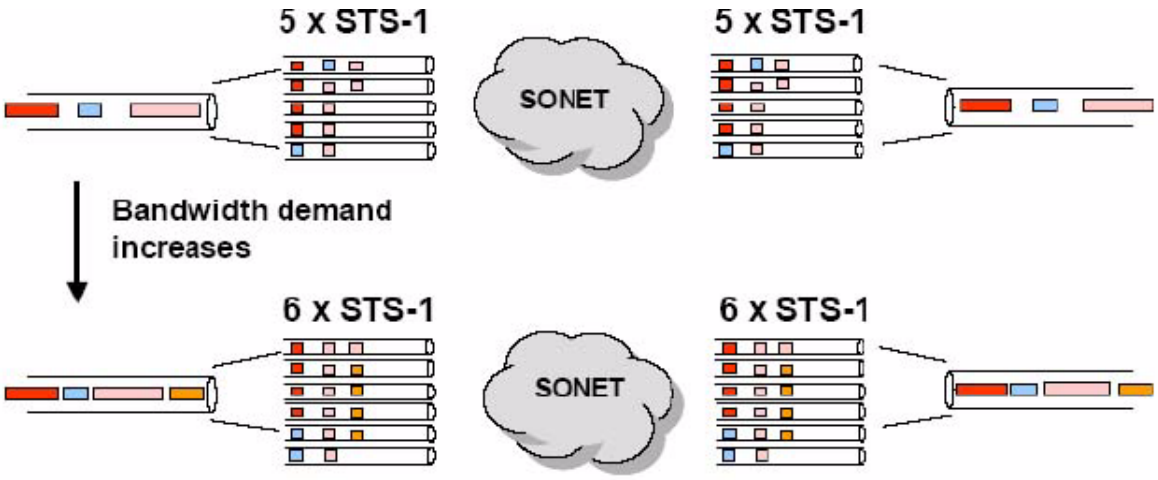


Figure 100. Dynamic bandwidth adjustment

LCAS is also useful for fault tolerance and protection since the protocol has the ability to remove failed links from the VCG. As the data stream is octet-striped across the tributaries in the virtual concatenation group, without such a mechanism if one of the tributaries has errors, the entire data stream has errors for the duration of the error within the tributary. The LCAS protocol provides a mechanism to detect the tributary in error and automatically remove it from the group. The VCG ends up operating at a reduced bandwidth, but the VCG still continues to carry data that is error free.

The LCAS is standardized in ITU G.7042/Y.1305.

3.2.3.2 DATA Ethernet Subsystem, functional description

The descriptions here reported are referred to the block-diagrams illustrated in Figure 15. on page 41. and Figure 16. on page 41.

The following functions are to be considered BIDIRECTIONAL, if not otherwise specified.

a) PHY: Ethernet 802.3 physical interface

It implements the Ehernet transceiver interface, compliant to IEEE 802.3 rec.; can be connected by front connectors to local Ethernet networks (LAN).
The interface type can be 1Gbps, or 10 Gbps, or 1Gb-CWDM, implemented on different modules.
Ethernet 802.3 also performs the following functions:

Auto-negotiation:

It adapts the speed rate of the port to the best rate offered by the far end connected port.

Flow Control:

It informs the far-end connected port about the congestion state of the receiver. If the receiver buffer is full, then the transmitter sends a “Pause” frame to the far end, in order to stop sending packets for a given time period.

Loop Back:

It reflects the received signal back to the far-end connected port, in order to check the integrity of a link.

CSF (Client Signal Failure):

the possibility to manage the CSF alarm, in order to indicate signal failures on ethernet line or on network link.

b) MAC1: frames checking

It checks that the received/transmitted frames are compliant with the supported technology. Also checks the FCS value (frame Check Sequence). In transmission direction, it recalculates the FCS and inserts it on the outgoing frame.

The Ethernet 802.3 packet structure is illustrated in Figure 106. on page 155. The MAC function is distributed over the local I/F block (MAC1) and the PP block (MAC2).

c) MAC2: frames processing

It removes the “Preamble” and “Start-of- Frame” fields from the ethernet packet. These fields are reinserted in transmit direction. Also inspects the MAC Destination/Source Addresses and the L/T field of the frame.

The Ethernet 802.3 frame format is illustrated in Figure 107. on page 155. The Ethernet Framing (on Local Ethernet Ports) is illustrated in Figure 114. on page 160.

d) VLAN

The afferent frames can be optionally VLAN and/or SVLAN tagged (Virtual LAN, Stacked Virtual LAN). Checks the 802.1Q field and the TCI (Tag Control Information). Manages the VLAN (user tag) and S-VLAN (provider tag) fields of the MAC frame (also called “VLAN-tagged MAC frames"). In this way it can further support the SLA (service Level Agreement) with differentiated CoS (Class of Service).The use of VLAN option permits the aggregation of many users over a single virtual circuit. Furthermore, if they are not physically tied to the same physical segment and can communicate each other as if they were on the same LAN. In this way, users may also move from a segment to another without changing their physical address.

If requested, it can insert (“Push”) or remove (“Pop”) the VLAN/SVLAN tags on/from the frames.

The VLAN and SVLAN tagged Ethernet frames structures are illustrated in Figure 108. on page 156, Figure 109. on page 156 and Figure 110. on page 157.

e) FIC: Flows Identification and Classification

It identifies and classifies the frames according to:

- **Traffic Description** (TD)
- **Policing method**
- **VLAN Identifier**
- **Priority** (the packet priority (802.1p) is contained in 3 bits of the TCI field)

f) TRAFM: Traffic Manager

This function is distributed and performed in coordinated mode on Data Units and Universal Matrix. It manages the afferent traffic, as performed by the following:

- **Traffic Profile** (traffic descriptor association)
- **Policing management** (packets checking, about their conformance to the traffic profile)
- **Queueing** (Packets are lined up on different queues, depending on the Traffic Profile, Priority, output port, etc.). This function is also called Scheduler.
- **Buffering** (Incoming packets are stored into a two-port buffer until they are transferred to the relevant output port).

g) Ethernet switching/bridging:

This function is distributed and performed in coordinated mode on Data Units and Universal Matrix. It connects the Ethernet ports and data flows between them and to forward packets. The function can be carried out in Connection mode (engineeered permanent link) or in Bridge (automatic dynamic packets forwarding) mode using the “Auto-Learning” and “Aging” mechanisms.

- **Auto-Learning mechanism**:
  Unknown incoming frames are flooded on all ports of the bridge, except the port where they arrived. When a far station responds back on a port, the bridge “learns" that frames having this received MAC-Addres (and, if existing, the associated VLAN/SVLAN-ID) have to be forwarded to that port. This connection is written on a table (FDB, Forwarding Data Base, reporting the associations between MAC-addresses, ports, and, if used, VLAN/SVLAN Id.), used to forward next incoming frames.
  Note: One VLAN/SVLAN identifier will be learned and forwarded, on a given port, only if registered on that port, otherwise it will be discarded
- **Aging**:
  After a settable period of time, a record of the FDB table can be deleted.

The **Bridge** representation is schematically illustrated in Figure 116. on page 162 and Figure 117. on page 163.

The **Switching/Bridging** different modalities are the followings:

a) Transparent port-to-port connection

This connection is done manually between two ports devoted to a single data flow. An example of port-to-port connection is schematically illustrated in Figure 123. on page 167.

b) ETS point-to-point connection

This connection is done manually between data flows where the port rate capacity can be subdivided among more data flows. In this case the use of VLAN or SVLAN is possible, see Figure 121. on page 166 and Figure 122. on page 167. An example of point-to-point connection is schematically illustrated in Figure 124. on page 168.

c) MAC Bridging (802.1D)

"Bridging" is automatically done on a packets basis using Auto-learning and Aging. The forwarding criteria for incoming packets is based on the association between MAC adresses and Ports, as written in the FDB. An application example of MACBridge is schematically illustrated in Figure 118. on page 164, see also Figure 116. on page 162.

d) Virtual Bridging (802.1Q)

"Bridging" is automatically done on a packets basis using Auto-learning and Aging. The forwarding criteria for incoming packets is based on the association between MAC adresses, Ports and VLAN, as written in the FDB. An application example of VirtualBridge is schematically illustrated in Figure 119. on page 164, see also Figure 117. on page 163.

e) Provider Bridging (802.1AD)

"Bridging" is automatically done on a packets basis using Auto-learning and Aging. The forwarding criteria for incoming packets is based on the association between MAC adresses, Ports, VLAN and/or SVLAN, as written in the FDB. An application example of ProviderBridge is schematically illustrated in Figure 120. on page 165, see also Figure 117. on page 163.

h) STP: Spanning Tree Protocol management

This function is distributed and performed in coordinated mode by the blocks LDC, "EthernetSwitch" and "TrafficManager." It accomplishes the functions requested by the **Spanning Tree Protocol** (STP). This procedure "breaks" all the loops of the network, permitting only one path from a Bridge to any other Bridge, in order to prevent "infinite loops" (i.e., infinite replaying of the frames) due to redundantly connected bridges networks.

Moreover, the STP procedure accomplishes the resilience of the network against STP failures. It provides,if the bridged network is redundantly protected, to recover the network connectivity (with respect to the STP topology). For instance by electing a new RootBridge (that is the root of the tree), if the actual one has failed; or by deactivating a failed link and activating a backup one, if existing. STP functions are compliant to 802.1d, 802.1w, 802.1s Rec. Some STP schemes examples are illustrated in Figure 126. up to Figure 129. on page 174.

The STP different modalities are the followings:

a) STP (802.1d)
b) Rapid STP (RSTP, 802.1w)
c) Multiple STP (MSTP, 802.1s)

i) EOS: Ethernet over SONET/SDH mapping

The function of this block is to map the Ethernet frames over the SONET/SDH transporting frames in order to connect, by means of the SONET/SDH network, remote Ethernet equipment. The Ethernet frame is encapsulated in an intermediate server frame that can be GFP type (Generic Framing Procedure) or LAPS (Link Access Procedure over SONET/SDH), and then accomodated into an SONET/SDH Virtual Container.
This Ethernet feature also implments, in coordination with UniversalMatrix and SONET/SDH boards, the Virtual Concatenation function, and LCAS (Link Capacity Adjustement Scheme), see Section 1.1.10 page 49. Furthermore, it supports the management of VC-AIS alarm: the possibility to insert AIS alarm into the SONET/SDH containers,in order to propagate Ethernet signal failure indications to the SONET/SDH systems.

The Ethernet and GFP frames matching are illustrated in Figure 111. on page 158 and Figure 112. on page 159.

The Ethernet and LAPS frames matching are illustrated in Figure 113. on page 159.
The Ethernet over SONET/SDH Framing (on Remote Ethernet Port) is illustrated in Figure 115. on page 161.

j) Matrix Interfacing

The function of this block is to adapt the Ethernet frames and the EOS frames to a proprietary inter-board framing, in order to form different frames that have to be elaborated by the central “Agnostic” Matrix.

k) Performance Monitoring

The function of this block is to check the state and the quality of the functions used on the system.
In particular it collects data relative to the existing links and resources, such as:

- number of total received/transmitted frames
- number of errored received frames
- number of correct received frames
- etc.

l) LDC: Local Data Controller

The control system of the 1850TSS-320 is split into three levels: FLC (First Level Controller. located inside the central Equipment Controller), SLC (Second Level Controller, located inside the Matrix Unit), LDC (Local Data Controller, located inside each Data unit), see Figure 112. on page 159.
The functions of this block are the followings:

- Management of control communications with the central equipment controller and the Matrix controller
- Unit software downloading
- Board monitoring
- Configuration of components and functions on board
- Board Data Base (MIB) management
- Aiding of special functions on board such as: STP, Bridging, Performance Monitoring, etc.

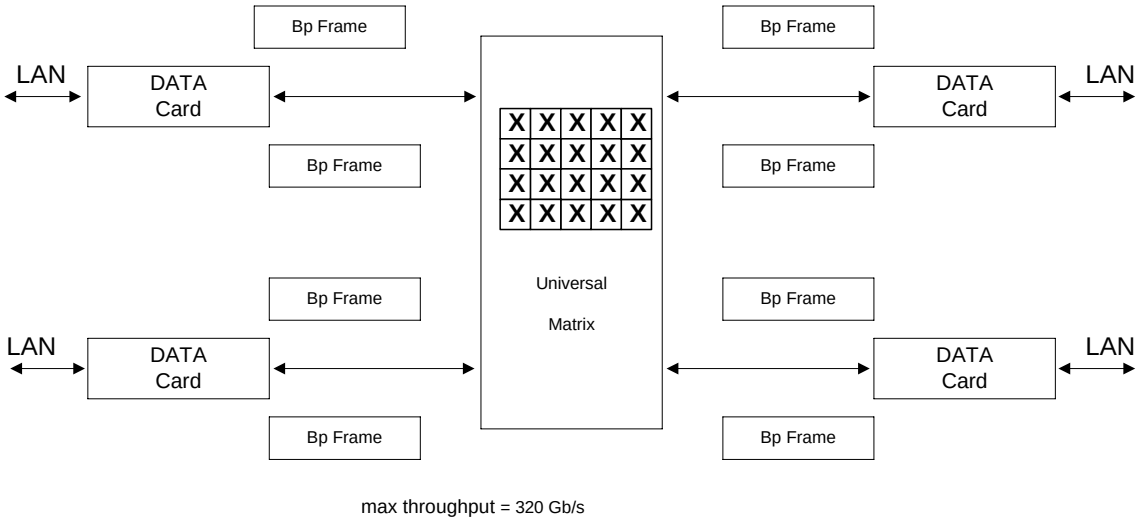
m) RI: Remote Inventory

The function of this block is to register board information for identification purposes.

n) PS: Power Supply

The function of this block is to provide the specific electrical power supply to the board and all the components on the board.

3.2.3.3 Internal Framing



Note:

– BpFrame: internal frame (or "agnostic" frame). A proprietary Back Panel frame is used, in order to convey payload data, traffic congestion information, transmission integrity check, channels protection information, etc.

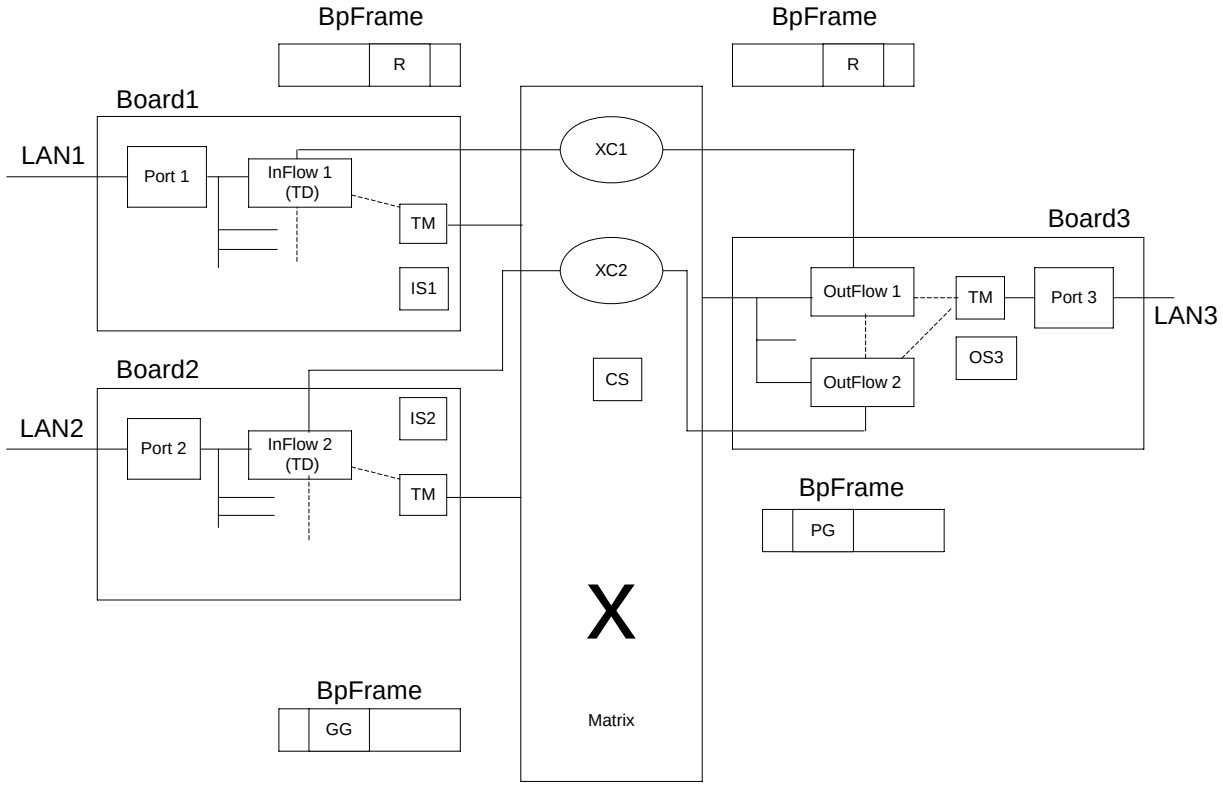
– A 10Gb/s payload data is accommodated into the internal frame to be exchanged among Matrix and Traffic Boards.

– 4 paralleled BpFrames are used to transport DATA payloads inside the equipment (link rate is about 4x3.11Gb/s).

Figure 101. DATA subsystem, internal framing

3.2.3.4 Packets Traffic Management, Scheduling

The DATA packets traffic inside the equipment is managed as depicted in the following figure.



Notes:
XC: Cross Connection
IS: Input Scheduler; OS: Output Scheduler ; CS: Central Scheduler;
TM: Traffic Manager; TD: Traffic Description; TD: Traffic Description;
R: Request; PG: Pre-Grant; GG: Global Grant;

Note:

– Two packets Cross Connections are established inside the Matrix: XC1 (from InFlow1 to OutFlow1) and XC2 (from InFlow2 to OutFlow2).

– The packets traffic is managed by exchanging, among Data boards and Matrix, some special information about traffic, inserted into the BpFrame. This information consists in: Requests to send packets and Grants to receive packets.
For instance, the Input Scheduler IS1 on board1 can send a Request (R) to Output Scheduler OS3 on Board3; contemporarily, the Input Scheduler IS2 on board2 may send a Request (R) to Output Scheduler OS3 on Board3.

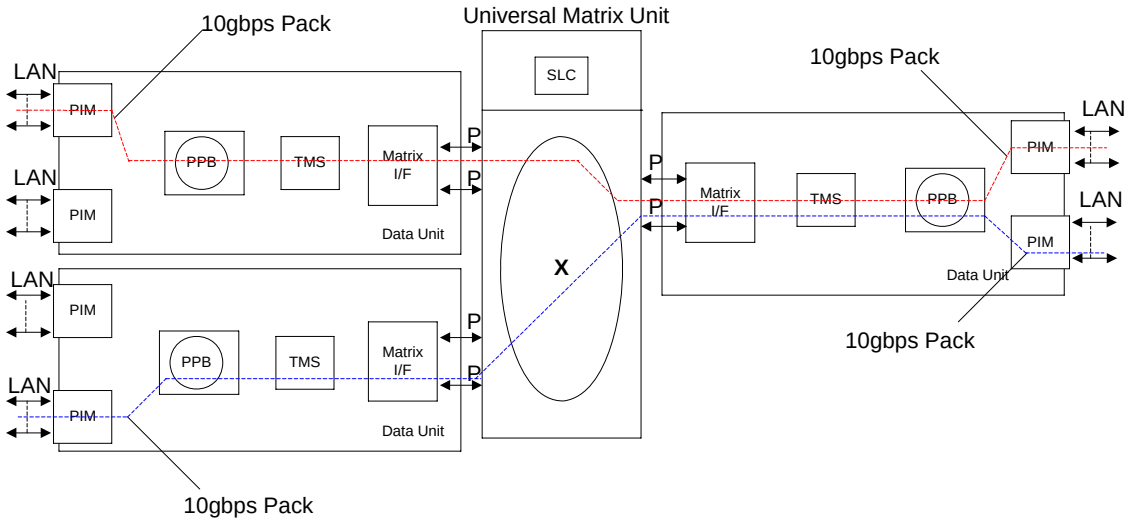
– Requests from IS's are Granted by OS's according to the available bandwidth. Grants from different OS's are mediated by the CS in order to optimize the Matrix usage.

– In case of congestion, Packets with low priority or red colored are discarded by the Input Traffic Manager.

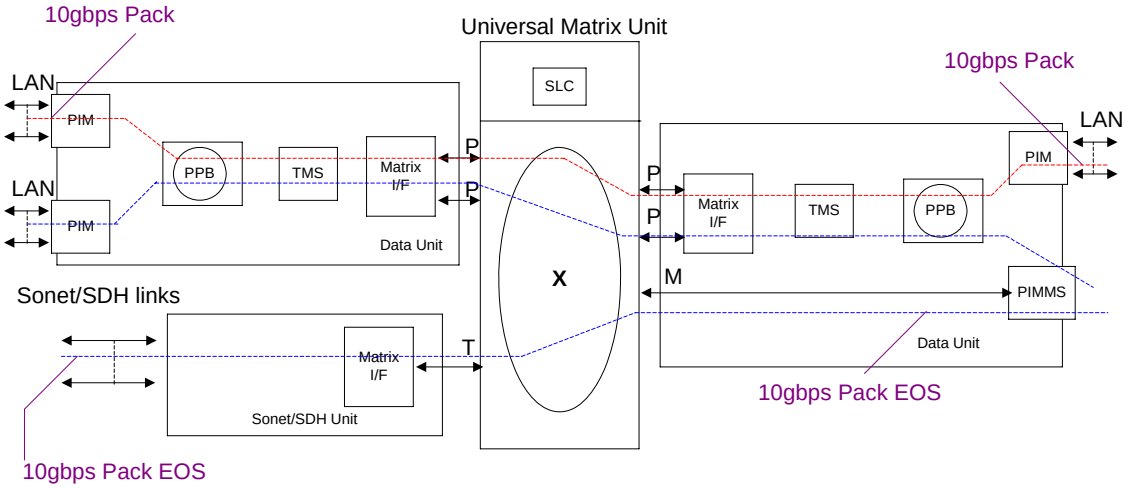
Figure 102. Packets Traffic Management

3.2.3.5 Packets Flows Distribution Management

The DATA packets distribution inside the equipment is managed as depicted by the following figures.
NOTE: one single flow is here considered, for simplicity, but in general one flow can be constituted or split up into many flows.

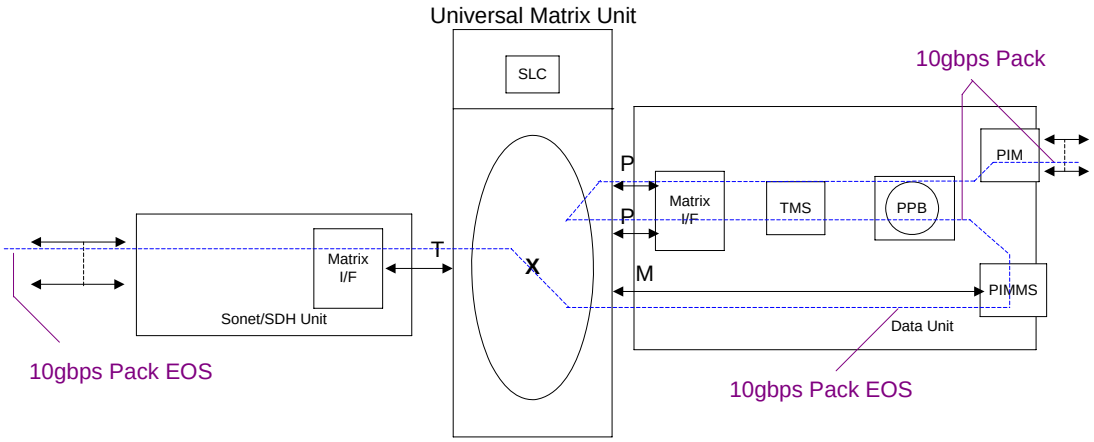


Example 1:
two 10 Gbps Packets link are distributed to two Data Units by means of two Flows



Example 2:
one 10 Gbps Packets links is a distributed to a Data Unit
another 10 Gbps EOS link is delivered a LAN port, after passing through a Data Unit equipped with PIMMS

Figure 103. Packets Flows distribution examples-1

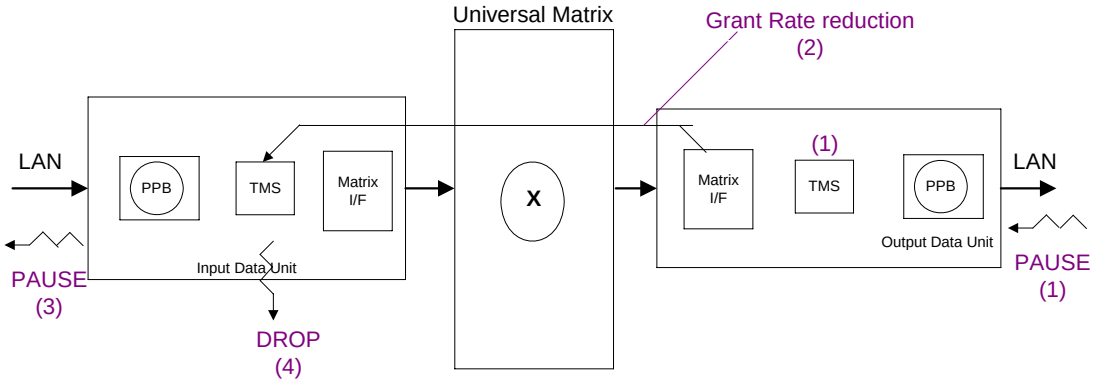


Example 3:
one 10 Gbps EOS link afferent to a TDM is ditributed to a one Data Unit
Equipped with one PIMMS and one 10GE-PIM

Figure 104. Packets Flows distribution examples-2

3.2.3.6 Flow Control Management

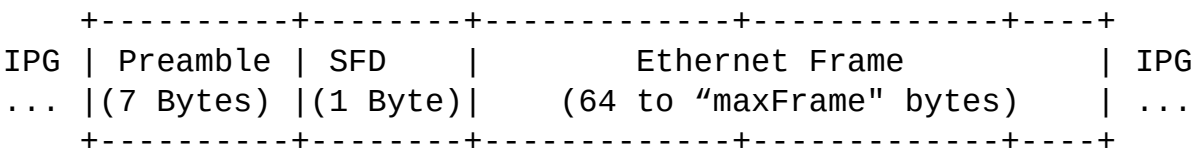
The rate of DATA packets transmission with other far end connected equipments can be decreased in case of congestion of the traffic queues, by means of the Flow Control feature, that is managed as depicted by the following figures.



Notes:
1) the output unit receiver a Pause from far end receiver, or the output buffer is near to full
2) the output unit allows less Grants to input unit (Grant Rate Reduction)
3) the Input unit can Pause request to the far end transmitter,or :
4) the Input Scheduler provides to discard if the Grant Rate cannot be sustained

Figure 105. Flow Control management example

3.2.3.7 Framing Procedures



IPG= Inter Packets Gap
Preamble= fixed pattern, used to lock the synchronization circuitry with the received frame's timing
SFD= Start of Frame Delimiter; it is fixed to 10101011
Frame Size :

Minimum frame size: 64 bytes

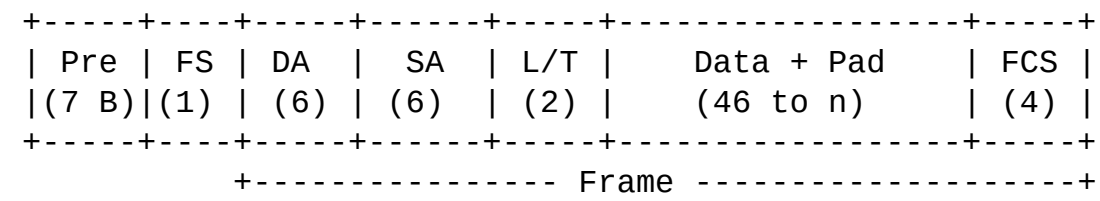
Maximum frame size, n (MTU= Maximum Transmit Unit, or MRU= Maximum Receive Unit):

- MTU/MRU = 1518 bytes if the frame is “untagged"
- MTU/MRU = 1600 bytes for NNI interface
- MTU/MRU = 1574 bytes for UNI interface

Jumbo Frame (JF): frames with length greater than 1574 (UNI) or 1600 (NNI):

- JF-MTU/MRU = 2008 bytes (tagged frames)
- JF-MTU/MRU = 2026 bytes (tagged&untagged frames)

Figure 106. Ethernet Packet format

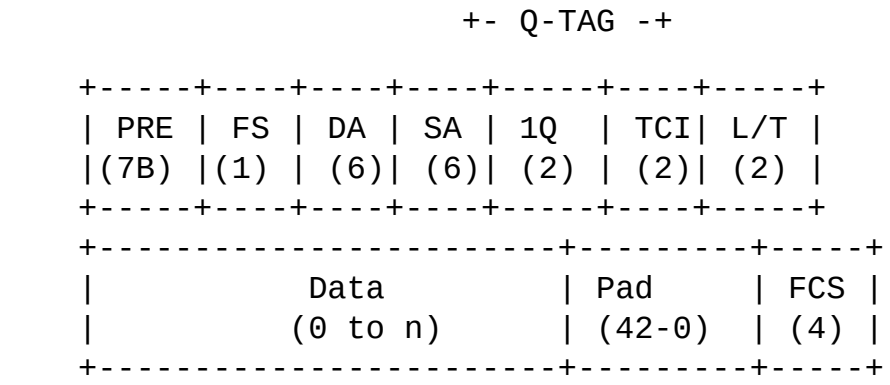


Pre= Preamble
FS= Frame Start, also called SFD: start of frame delimiter
DA: Destination Address
SA: Source Address
n: max number of bytes contained in the data field, depending on the MTU value (see Figure 106. on page 155) in this case n= MTU-18
L/T=Length (of-data-field) / Type; it indicates the Length or Type of the frame:

a) If its value is less than 1536 decimal, then L/T field indicates the number of MAC client data octets contained in the subsequent “Data" field of the frame.
b) If its value is greater than or equal to 1536 decimal, then L/T field indicates the nature of the MAC client protocol.

PAD = optional field, containing fixed stuff, to be added in case that the “Data" field is less or equal than 46 bytes, in order that the frame length (from DA to FCS) is at least 64 bytes.
FCS= Frame Check Sequence:
it contains a cyclic redundancy check (CRC), computed over all fields except Preamble, SFD, FCS

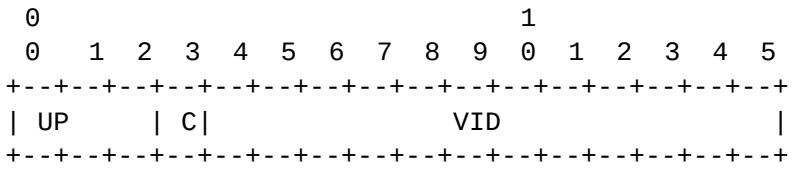
Figure 107. Ethernet packet and MAC frame format



PRE: preamble; FS: Frame Start; DA: Destination Addr.; SA: Source Addr.
1Q: “ProtocolType" 802.1Q field (a constant fixed value= hex“0x8100")
TCI : Tag Control Information = (3bits: user priority 802.1p)+(1bit: CFI)+(12bits: VLAN identifier 802.1q); [CFI: Canonical Field Id.]
L/T: MAC client Length/Type

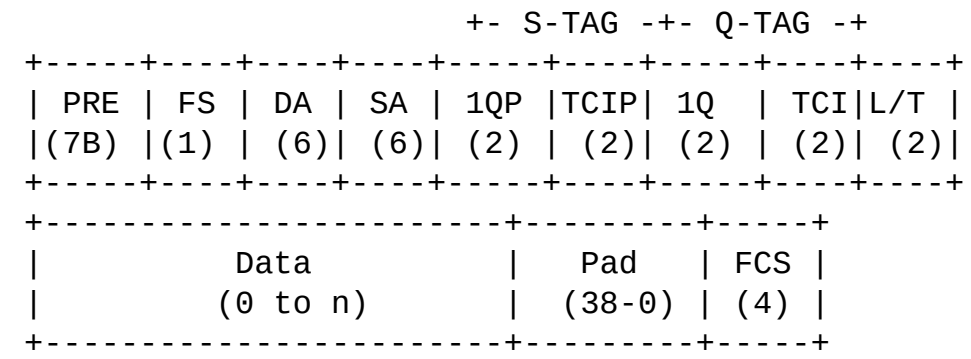
Note: The PAD is an optional field, containing fixed stuff, to be added in case that the data field is less or equal than 42 bytes, in order that the frame length (from DA to FCS) is at least 64 bytes.
n: max number of bytes contained in the data field, depending on the MTU value (see Figure 106. on page 155)

Figure 108. Ethernet “Q-Tagged" MAC 802.3 frame format



UP:User Priority (3 bits)
C:CFI, Canonical Field Identifier (1 bit)
VID:VLAN Identifier (12 bits)

Figure 109. TCI Field format (802.1Q VLAN Tag)



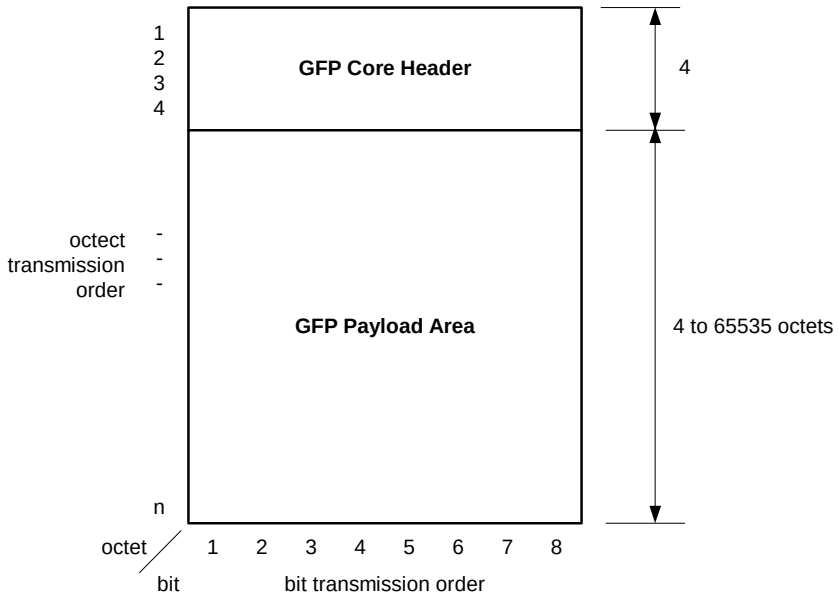
PRE: preamble; FS: Frame Start; DA: Destination Addr.; SA: Source Addr.
1Q: “ProtocolType" 802.1Q field (a constant fixed value= hex“0x8100")
TCI : “Tag Control Information" = (3bits: user priority 802.1p)+(1bit: CFI)+(12bits: VLAN identifier 802.1q); [CFI: Canonical Field Id.]
L/T: MAC client Length/Type
1QP: 2byte “provider-ProtocolType" , similar to the 1Q identifier, settable by the Service Provider
TCIP:2byte “provider-TagControl Information" , similar to the TCI bytes (3bits:provider-priority)+(1bit:CFI)+(12bits:provider-VLAN id.), settable by the Service Provider

Note: Q-TAG is also called C-TAG (Customer Tag, or User Tag); S-TAG is also called P-TAG

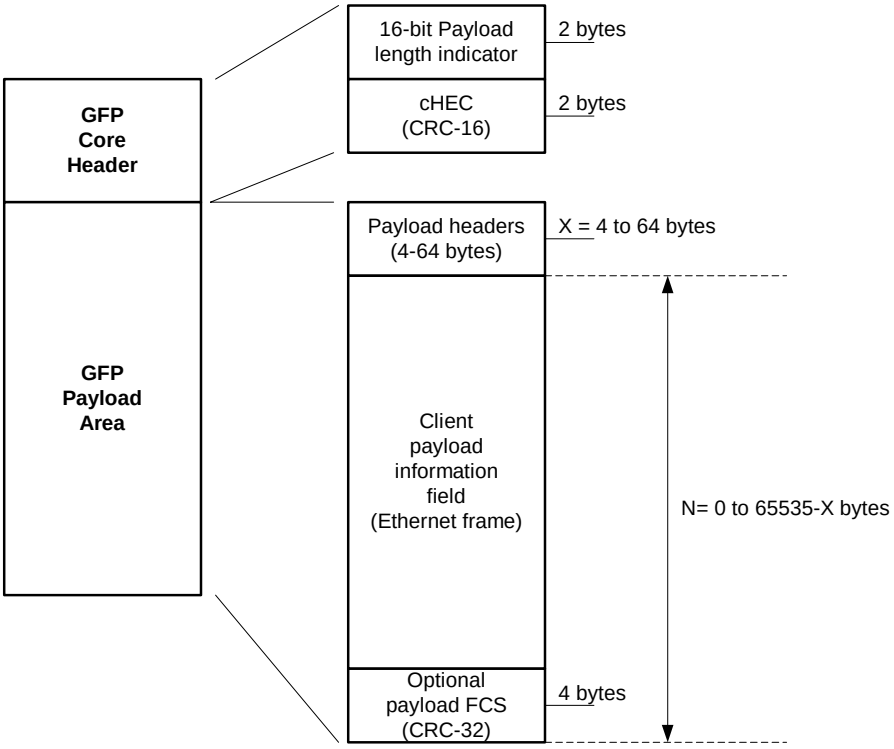
Note: the PAD is an optional field, containing fixed stuff, to be added in case that the data field is less or equal than 38 bytes, in order that the frame length (from DA to FCS) is at least 64 bytes.

n: max number of bytes contained in the data field, depending on the MTU value (see Figure 106. on page 155)

Figure 110. Ethernet “Stacked VLAN" frame format



GFP Frame size and transmission order



Fields constituting a GFP client frame

Figure 111. GFP Framing (from G.7041/Y.1303)

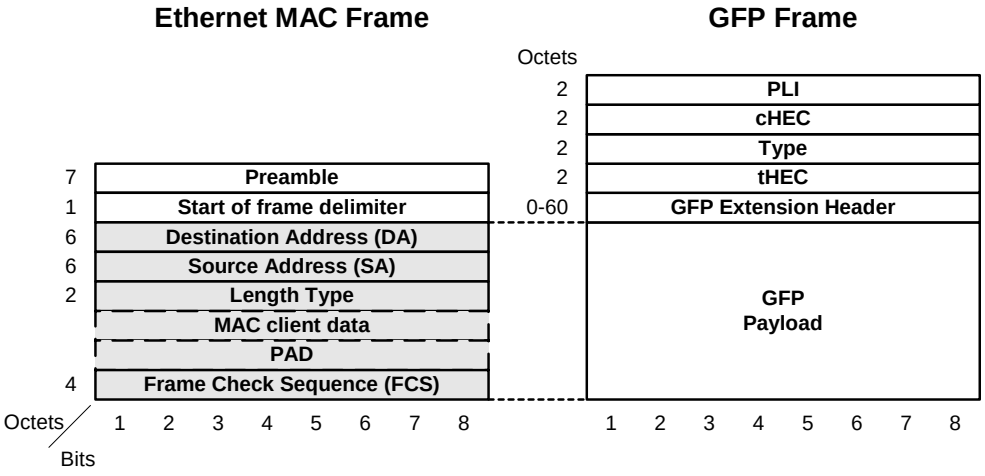


Figure 112. Ethernet encapsulation into GFP frame (from G.7041/Y.1303)

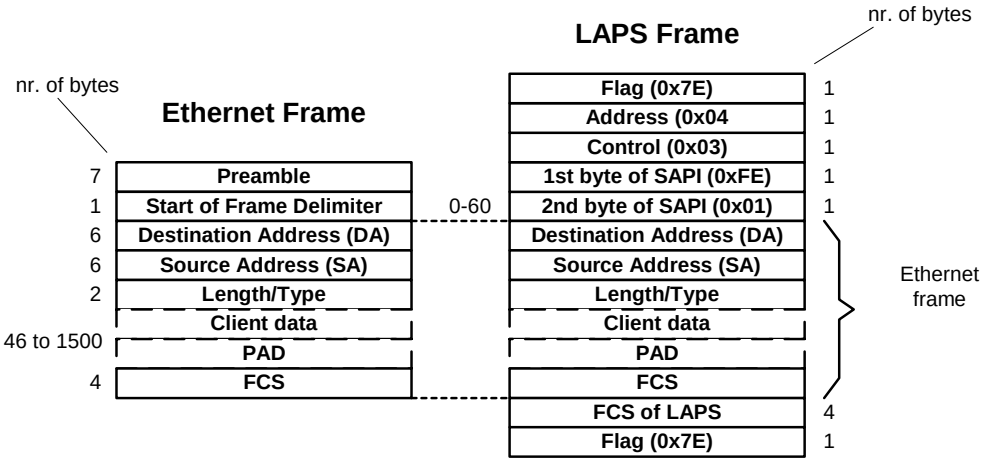
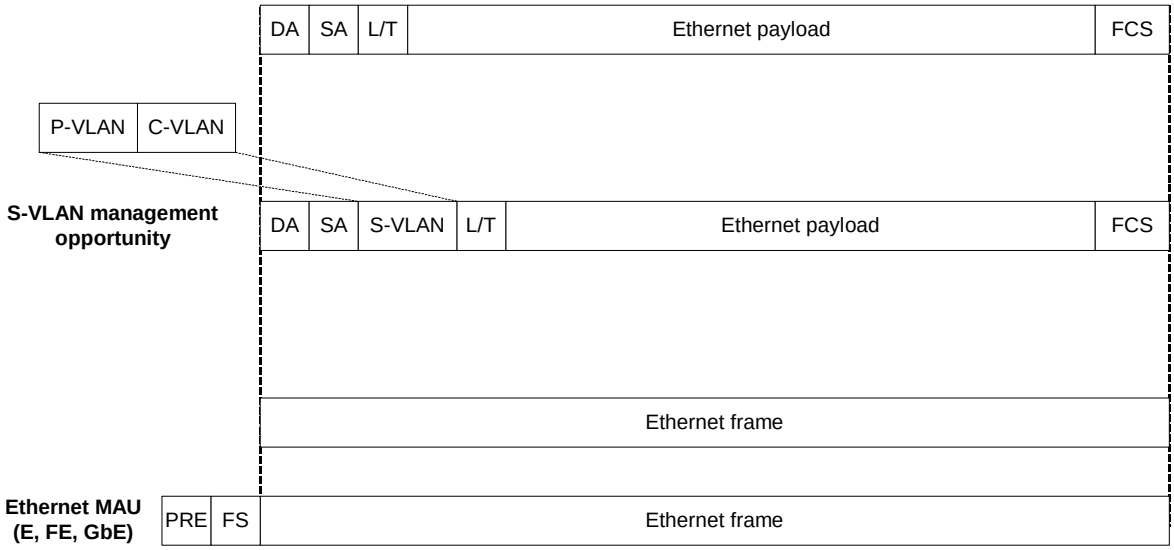


Figure 113. Ethernet/LAPS encapsulation (ITU-T X.86)

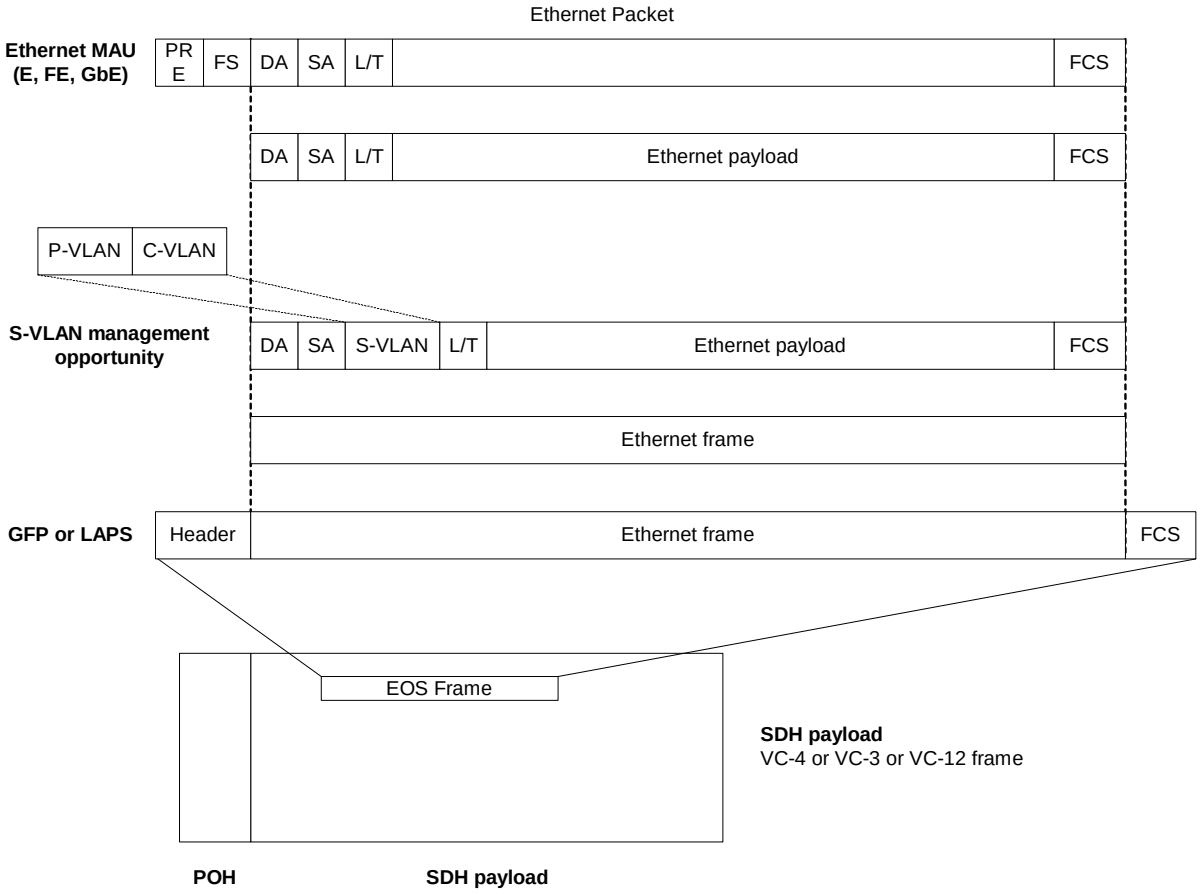


Ethernet Packet

Notes:

- P-VLAN = Provider VLAN
- C-VLAN = Customer VLAN

Figure 114. Ethernet Framing (on Local Ethernet Port)

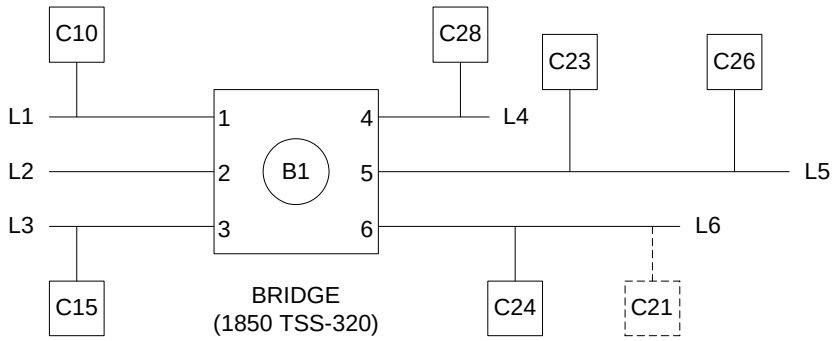


Note:

- The FCS on GFP or LAPS is optionally included
- P-VLAN = Provider VLAN
- C-VLAN = Customer VLAN

Figure 115. Ethernet over SONET/SDH Framing (Remote Ethernet Port)

3.2.3.8 Ethernet Connection and Bridging



NOTES:

- 1, 2, 3, 4, 5, 6 : ports of the bridge
- L1, L2, L3, L4, L5, L6: LANs

C24 : Computer with its own MAC address

C21 : new inserted computer

FDB table
(Filtering Data Base table)

Computer Address	Port
MAC-C10	1
MAC-C13	3
MAC-C23	5
MAC-C24	6
MAC-C26	5
MAC-C28	4

Bridge operations examples:
- C15 to C26 --> FORWARD to port5
- C26 to C23 --> DISCARD
- C10 to C21 --> LEARNING
- C21 to C28 --> LEARNING (adding C21 on FDB)

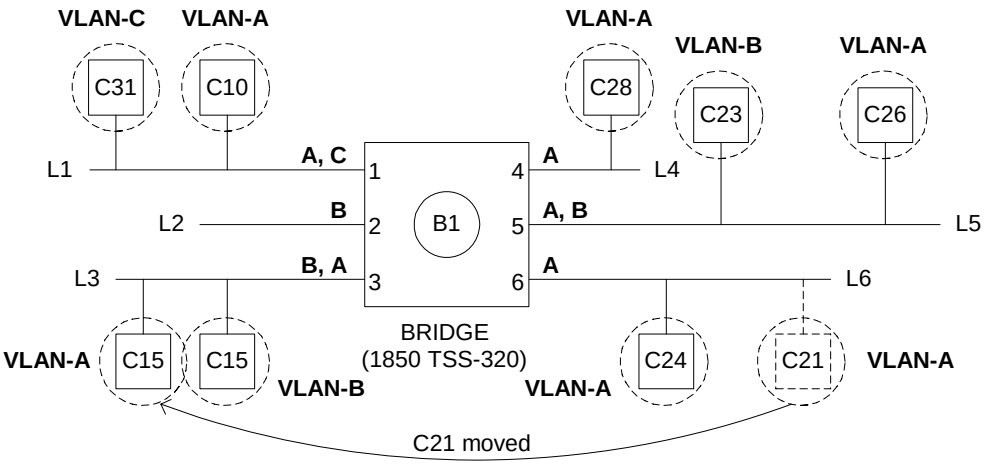
A “MAC Bridge" takes into account the MAC addresses.
A “Virtual Bridge" takes into account the MAC addresses and the VLAN identifiers (user tag), see next figure.
A “Provider Bridge" takes into account the MAC addresses and the S-VLAN identifiers (provider tag), see next figure.
The “Provider Bridge" can work in mixed mode, taking into account the VLAN and the S-VLAN identifiers.
In any of the above configurations, the Bridge ports work in “promiscuous" mode.

Auto-Learning mechanism:

Unknown incoming frames are flooded on all ports of the bridge, except the port where they arrived. When a far station responds back on a port, the bridge “learns" that frames having this received MAC-Address (and, if existing, the associated VLAN-ID) have to be forwarded to that port. This connection is written on the FDB table, used to forward next incoming frames.

Note: One VLAN will be learned and forwarded, on a given port, only if registered on that port, otherwise it will be discarded.

Figure 116. MAC-Bridge representation example and relevant FDB table



NOTES:

- 1, 2, 3, 4, 5, 6 : ports of the bridge
- L1, L2, L3, L4, L5, L6: LANs
- A, B, C: VLANs

C24 : Computer with its own MAC address

C21 : new inserted computer

FDB table
(Filtering Data Base table)

Computer Address	Port	VLAN
MAC-C10	1	A
MAC-C13	3	B
MAC-C23	5	B
MAC-C24	6	A
MAC-C26	5	A
MAC-C28	4	A
MAC-C31	1	C

Notes:

- The Bridge is configured in Virtual or Provider mode.
- The afferent VLAN's have to be registered on the relevant ports, otherwise they are discarded.
- In this way, incoming frames having a given VLAN-ID are distributed only to those ports registered on that VLAN (distribution domain “Member Set").
- Bundling examples are shown on ports 1,3,5 (more VLAN's are registered over one single port).

Frames Ingress Acceptance criteria on Bridge ports

The Data/Ethernet system permits to set the Frames Filtering criteria on ingress of Virtual or Provider Bridge ports (ETB), by means of the menu option “Transmission: BridgePort Management: Configure Bridge Port". The related parameters are the following:

Acceptable Frames : possible values: “AdmitAll"/“AdmitOnlyVlanTagged"

- if “AdmitAll": all types of MAC frames are accepted by the port
- if “AdmitOnlyVlanTagged": only VLAN tagged frames are accepted by the port

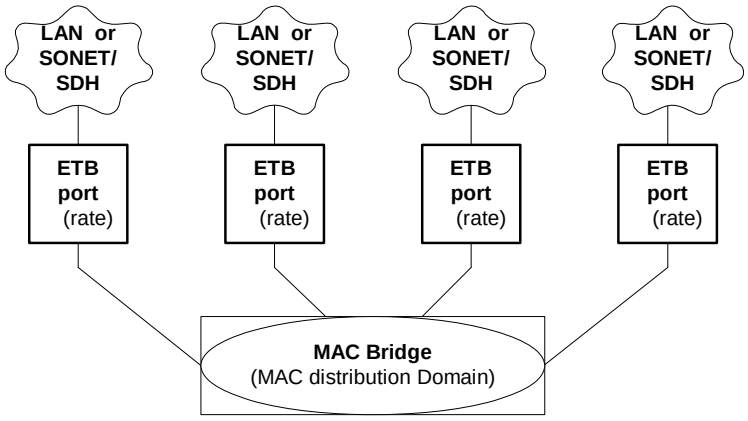
Ingress Filtering : possible values: True/False

- if True: only registered VLAN's are accepted by the port
- if False: all frames are accepted by the port

In case that untagged (or only-priority-tagged) frames are provisioned to be accepted, then they will be forwarded by attaching to them the PVID, i.e. the Port VLan Id. assigned by means of the menu option “Transmission: BridgePort: Modify Virtual/Provider Port PVID".

For details about the specific configurations here recalled, see the User Guides ([5], [6] and [7] on page 20..

Figure 117. LAN Bridge representation example and relevant FDB table

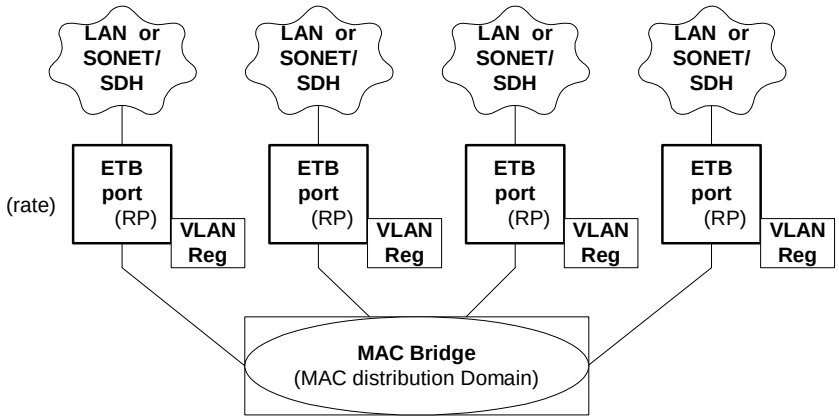


The frames are distributed to all the active ETB ports

Notes:

- ETB ports can be either Remote or Local
- The incoming frames are distributed to all the active ETB ports in MAC-learning modality (in case of VLAN Bridge, the frames are distributed only to the ports registered on the same VLAN).
- No XC is necessary, as the frames distribution is based upon the FDB table. The “Static Unicast Filtering" option of the FDB table can be used to create a “permanent" cross-connection
- This configuration is used for “Point-to-Multipoint", “Multipoint-to-Multipoint", or so called “E-Lan" applications

Figure 118. MAC Bridge distribution domain (example)

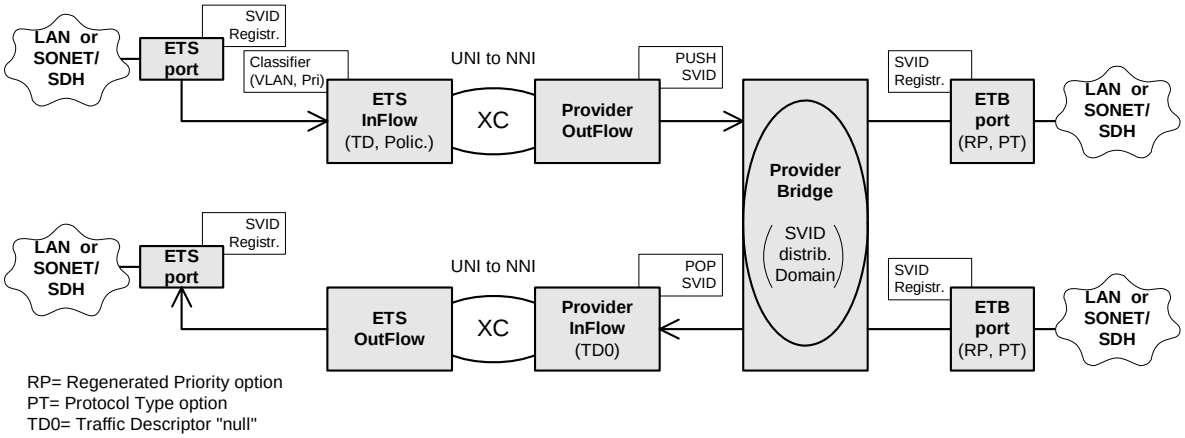


The frames are distributed only to the ports registered on the same VLAN.
Examples of VLAN registration:
VLAN-a = port1, port4, port5, port6 (Member-Set of VLAN-a)
VLAN-b = port2, port3, port5 (Member-Set of VLAN-b)
RP= Regenerated Priority option

Notes:

- E-VLAN type (see notes of previous figure)

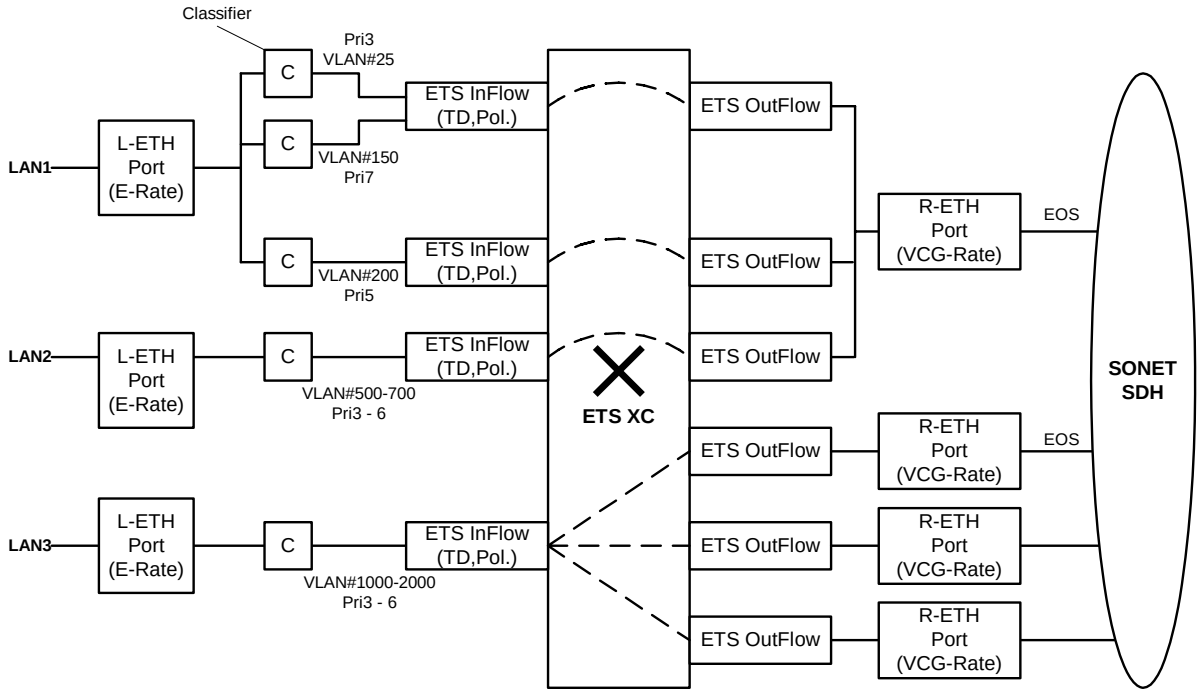
Figure 119. Virtual Bridge distribution domain (example)



Notes:

- ETS ports, as well as ETB ones, can be Remote or Local.
- The two XC's can also be created over the same ETS port.
- More data flows can be defined over one port (for Multiplexed and Differentiated Services).
- The incoming frames are distributed only to the ports registered over the relevant S-VLAN, i.e. parts of the “member set" distribution domain of that S-VLAN (SVID registration). In this way, ports registered
- on the same SVID can exchange ethernet frames.
- The Provider to Edge connection is accomplished by means of “One-Step" procedure.
- The UNI-UNI XC creates the two branches UNI-NNI and NNI-UNI in one single step.

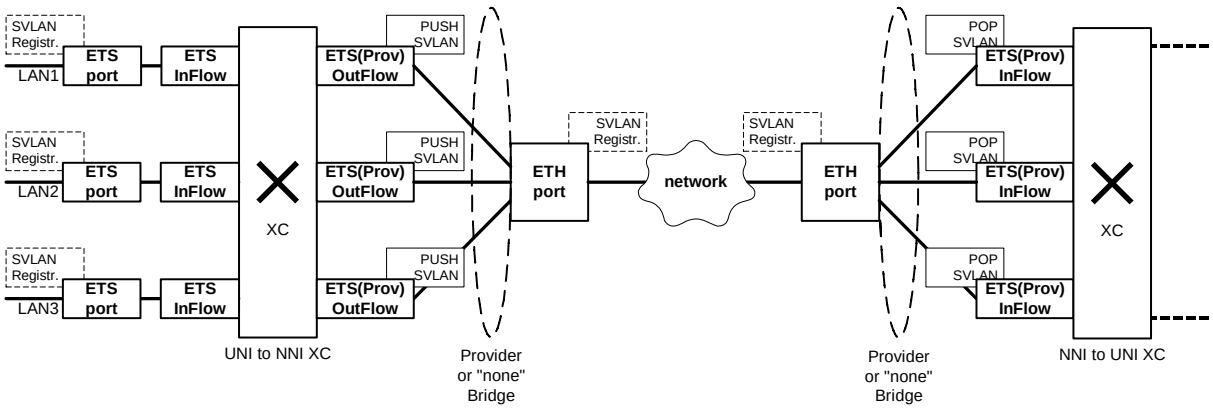
Figure 120. Provider Bridge using UNI ports (example)



Notes:

L-ETH = local ethernet; R-ETH = remote ethernet; EOS= Ethernet Over SONET/SDH
VCG= Virtual Concatenation Group; TD = Traffic Descriptor; Pol= Policing
C = classifier; Pri = priority; XC = Cross-Connection
E-Rate = rate of the ethernet port; VCG-rate= rate of the SONET/SDH Port
The involved ports can be either Remote or Local
Classifiers, InFlows and OutFlows are internal resources
A frame with VLAN tag that is not defined on Classifiers is discarded
More VLAN's and more Priorities can be defined by one classifier (Bundling)
More InFlows/OutFlows resources can be created over one Port (Multiplexing)
The VLAN usage is possible in “none" or Virtual or Provider Bridge configuration
The VLAN identifiers on LAN1 and LAN2 must be not-overlapping
Classification of more VLAN's and Service Multiplexing with differentiated CoS are possible only in “none" or Provider bridge Configuration
The E-Rate, sum of TD rates and VCG-Rate must be congruent
The VLAN's on LAN1 and LAN2 are aggregated on the same SONET/SDH resource
An example of multicast connection (Point-to-Multipoint) is shown in LAN3

Figure 121. Generic VLAN Classification-Identification-Aggregation (example)

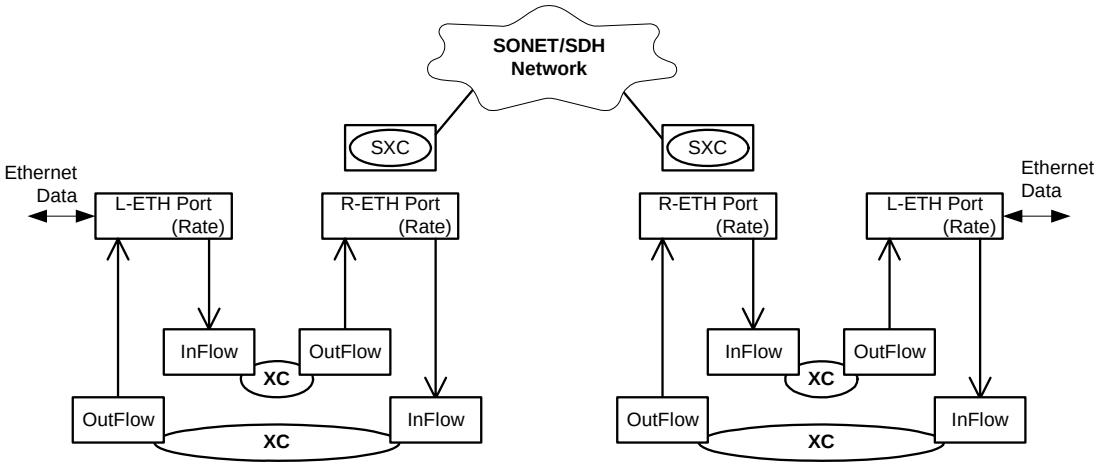


S-VLAN management example

Notes:

- Creation and Cross-Connections of S-VLAN are possible in Provider and “none" Bridge Config.
- PB= Provider Bridge domain.
- Classification and Identification of the single data flows is possible, as seen in Figure 121. on page 166.
- The involved ports must be registered on the relevant S-VLAN's (in case of “Provider" config.).
- SVLAN registration is not needed, in case of “none" Bridge config.
- VLAN's classification, Traffic Description, Policing and ColorProfile are also possible.

Figure 122. Stacked VLAN management (example)

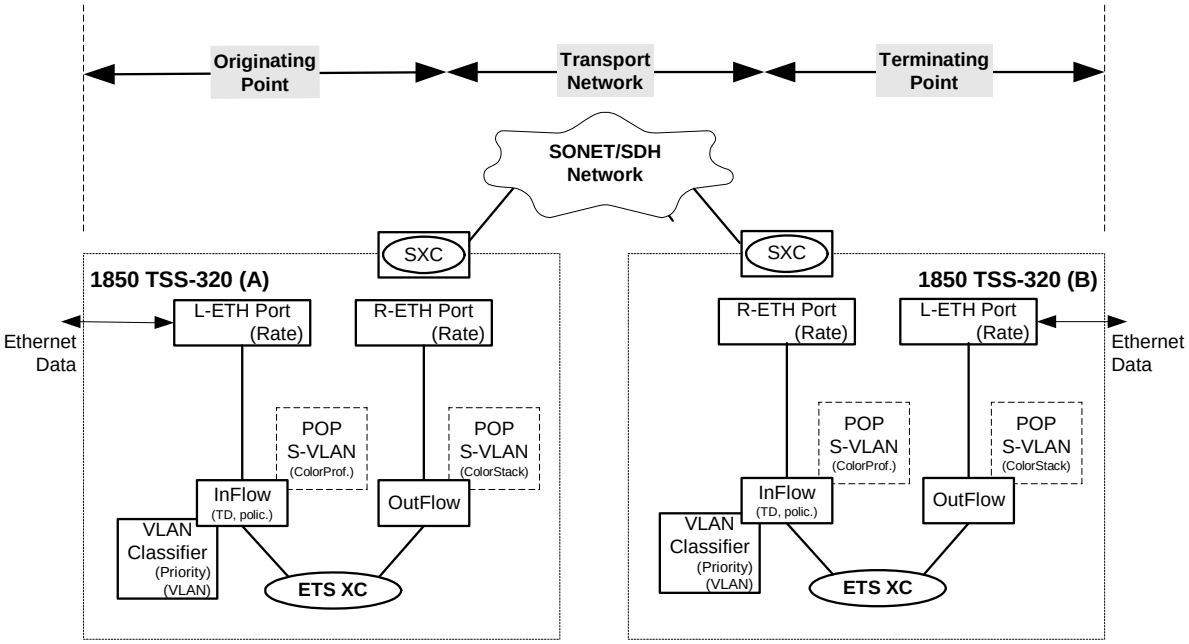


Transparent Port-to-Port (p2p) XC example bidirectional)

Notes:

- The ports are devoted to only one data flow, in transparent mode, without traffic classification nor policing.
- The two involved Ethernet ports may be either local or remote.

Figure 123. Transparent Mac/Virtual Port-to-Port XC “OneStep" (Example)



Notes:

- a BIDIRECTIONAL link can be accomplished by creating, under the same port, an InFlow and an OutFlow associated to the related data flow, and so on.
- VLAN, S-VLAN and TD are possible only in Provider configuration (and also in "none" bridge)
- More InFlows/OutFlows over a port are possible, in Provider config. (and also in "none" bridge")

Figure 124. Point-to-Point ETS Connection (end-to-end Example

3.2.3.9 STP (Spanning Tree Protocol)

The STP procedure is managed by means of special control frames BPDU (Bridge Protocol Data Unit), periodically sent, in band, as data payload, by the bridges into the network.

BPDU (Bridge Protocol Data Unit) Frame (from IEEE Std. 802.1w-2001):

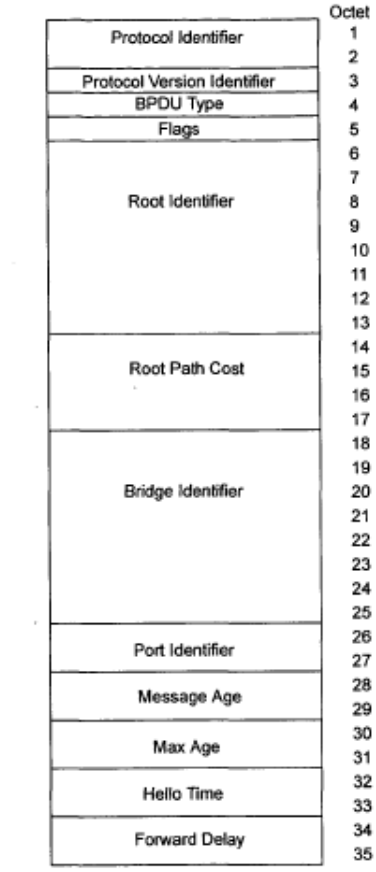
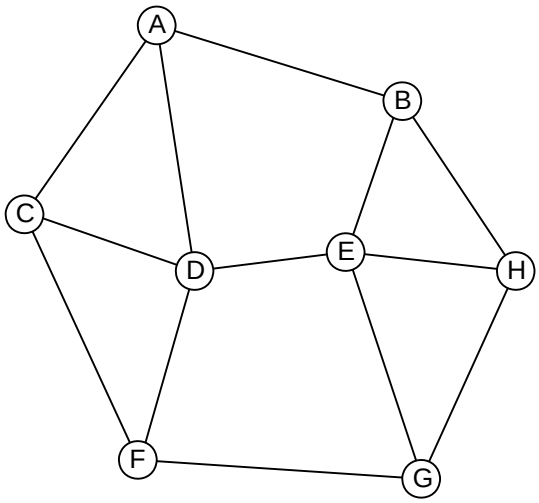
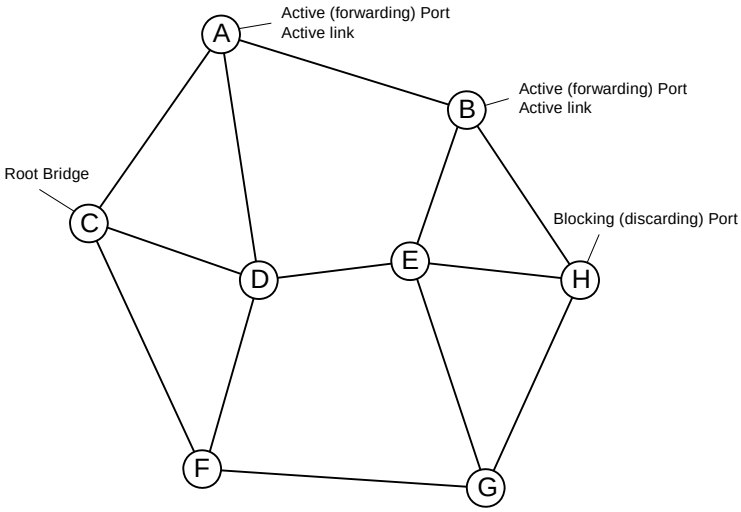


Figure 125. STP/RSTP BPDU Frame format

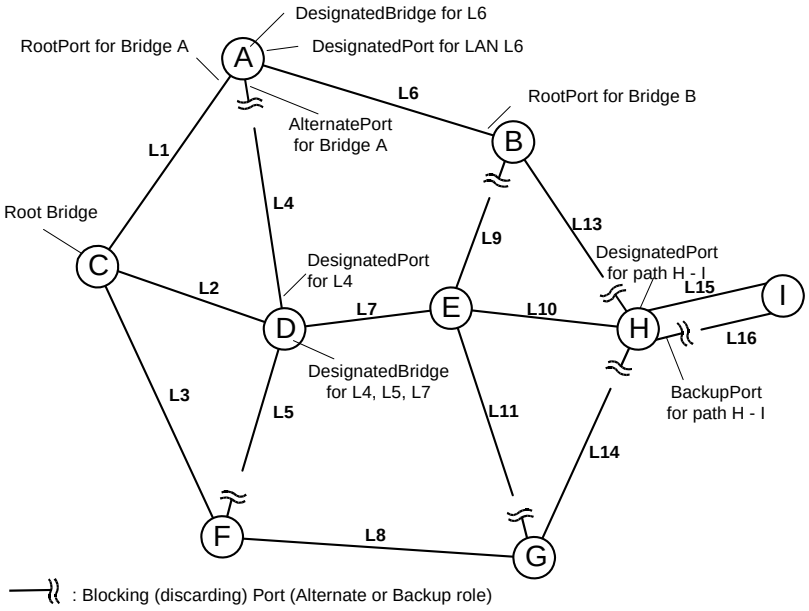


PHYSICAL TOPOLOGY (example)



ACTIVE SPANNING TREE TOPOLOGY (example)

Figure 126. Spanning Tree function (STP) example



BRIDGE and PORT ROLES (example)

Note:

- A, B,... : bridges
- L1, L2, ... : LAN's
- The STP procedure is managed by means of control frames BPDU (Bridge Protocol Data Unit)
- The active STP topology is dynamic, therefore it will change on occurrence of certain events/failures
- The RootBridge (i.e. the root of the tree) is the bridge having the highest priority, or, at priority equality, the identifier with lowest numerical value
- The “blocking" (or discarding) Ports can be configured to accept control BPDU frames
- Each Bridge and each Port has its own cost parameter and priority parameter
- The “RootPathCost" for a given bridge is the sum of the costs of all the RootPort encountered along the path to reach the RootBridge. If this value is zero, the selected bridge is the RootBridge.
- The best path from a bridge to the root is calculated taking into account the cost and, at costs equality, the priority parameters of ports and bridges along the path
- The parameters indicated will be detailed hereinafter in this document, where they will be used (see for instance, the paragraphs: “ConfigureNode” , “ConfigureBridgePort: STP-Per Bridge Management“, “BridgePort: STP-PerPort Management“, etc.).

Figure 127. Some examples of Bridges and Ports roles in xSTP network

RSTP

The **RSTP** (Rapid Spanning Tree Protocol) differs from STP in some parameters:

the convergence time is reduced to 5 sec (instead of 30 for STP) and in the possible States of the Ports: DataFrameDiscarding, Learning, Forwarding (STP PortStates are 5, including “Disabled” and “Listening”). The descriptions of these parameters are given in “Configure Bridge Port” .

BPDU (Bridge Protocol Data Unit) Frame for MSTP networks (from IEEE Std. 802.1Q-2003):

“MSTP (Multiple STP) provides simple and full connectivity for frames assigned to any given VLAN throughout a Bridged LAN comprising arbitrarily interconnected Bridges, each operating MSTP, STP or RSTP. MSTP allows frames assigned to different VLAN’s to follow separate paths, each based on an independent Multiple Spanning Tree Instance (MSTI), within Multiple Spanning Tree (MST) Regions composed of LAN’s and or MST Bridges. These Regions and the other Bridges and LAN’s are connected into a single Common Spanning Tree (CST)...” (from IEEE Std. 802.1Q-2003)

The MSTP-BPDU frame (see figure below) is compatible with the STP/RSTP BPDU, with the addition of fields conveying MST topology information and Regional Instances. Each MST Instance is represented by an additional field attached to the MSTP-BPDU, called MSTI Configuration Message. Up to a max of 64 “MSTI Configuration Messages” are allowed in a network.

	Octet
Protocol Identifier	1–2
Protocol Version Identifier	3
BPDU Type	4
CIST Flags	5
CIST Root Identifier	6–13
CIST External Path Cost	14–17
CIST Regional Root Identifier	18–25
CIST Port Identifier	26–27
Message Age	28–29
Max Age	30–31
Hello Time	32–33
Forward Delay	34–35
Version 1 Length = 0	36
Version 3 Length	37–38
MST Configuration Identifier	39–89
CIST Internal Root Path Cost	90–93
CIST Bridge Identifier	94–101
CIST Remaining Hops	102
MSTI Configuration Messages (may be absent)	103–*39 + Version 3 Length*

MST BPDU parameters and format

	Octet
MSTI Flags	1
MSTI Regional Root Identifier	2–9
MSTI Internal Root Path Cost	10–13
MSTI Bridge Priority	14
MSTI Port Priority	15
MSTI Remaining Hops	16

MSTI Configuration Message parameters and format

Figure 128. MSTP BPDU Frame format

In particular, the octets in the field “MST Configuration Identifier” of the frame contain the meaningful parameters defining a Region, i.e.:

– Configuration Identifier Format Selector (fixed by the standard to value 0)
– Configuration Name
– Revision Level
– Configuration Digest

Thus, by definition, Bridges having the same value of “MST Configuration Identifier” are considered to be part of the same Region, if they are connected between them by a LAN contained in the same Region, i.e. if the CIST designated Bridge for that LAN is in the same Region. (CIST=Common and Internal Spanning Tree).
In a same region, frames assigned to different VLAN’s can follow separate paths, each based on an independent Multiple Spanning Tree Instance (MSTI); in other words, the VLANs associated to an Instance of the Region are routed independently, as if there were as many independent networks as the VLAN-Instances are.
The parameters of one Port of an MSTP Bridge can be set in differentiated mode, for different MSTP Instances.
Furthermore, a Region of an MSTP network can be seen as a single Bridge whose Ports are those Ports that are connecting the Region with the other Region of the network.
An example of MSTP Bridge network and MSTID use is shown in Figure 131. on page 176.
The setting of the MSTP parameters is done by means of the option “Configure Bridge Port” and subsequent ones.

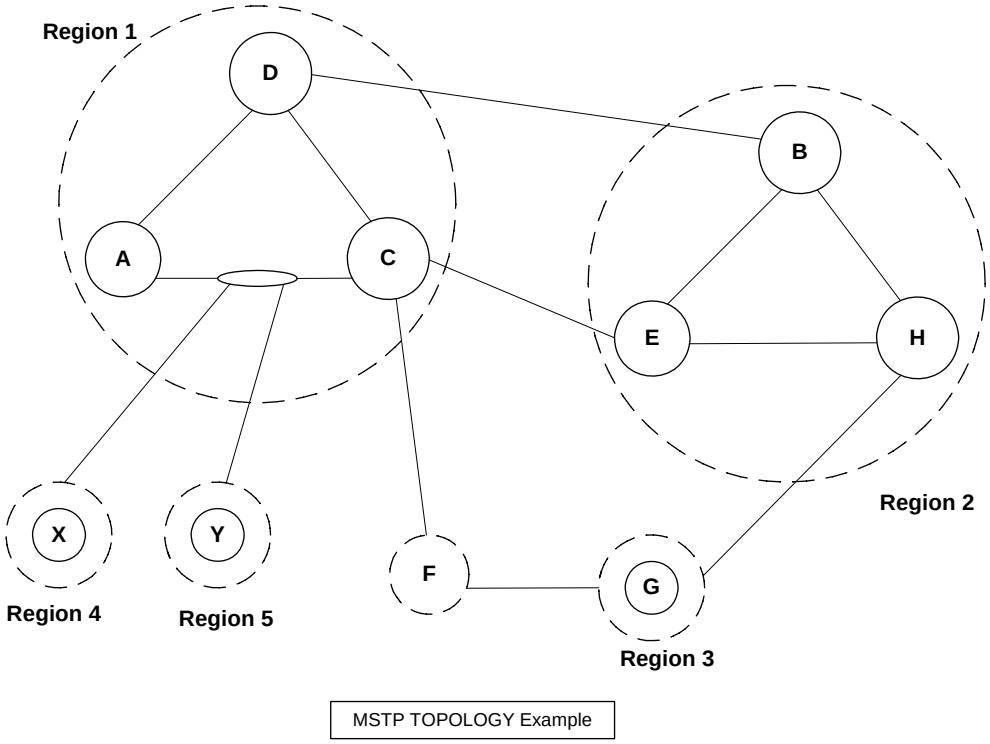


Figure 129. MSTP Network topology example

Note:

One Bridge in all the network is chosen as the CIST Root Bridge: that one having the lowest numerical Bridge Identifier of all the Bridges in the network.

One Bridge in each Region is chosen as the CIST Regional Root Bridge: that one having the lowest External Root Path Cost through a boundary Port.

Bridges A,C and D are in the same MST Region (Region1) because they have the same “MST Configuration Identifier”.

Bridges B,E and H belong to Region2 because they have the same “MST Configuration Identifier”, but different from those contained in Region1.

Bridge G is in Region3 because its “MST Configuration Identifier” is different from the Bridges contained in Region1 and Region2.

Bridge F is outside of any region, because it is not an MSTP Bridge (can be STP or RSTP).

Bridges X and Y are in different Regions, even though they had the same “MST Configuration Identifier”, because the LAN that connects them, e.g. by means of an hub, is in a different Region.

Region 1 and Region 2 can be seen, from the MSTP point of view, as “collapsed” single bridges, as illustrated in Figure 130. page 175.

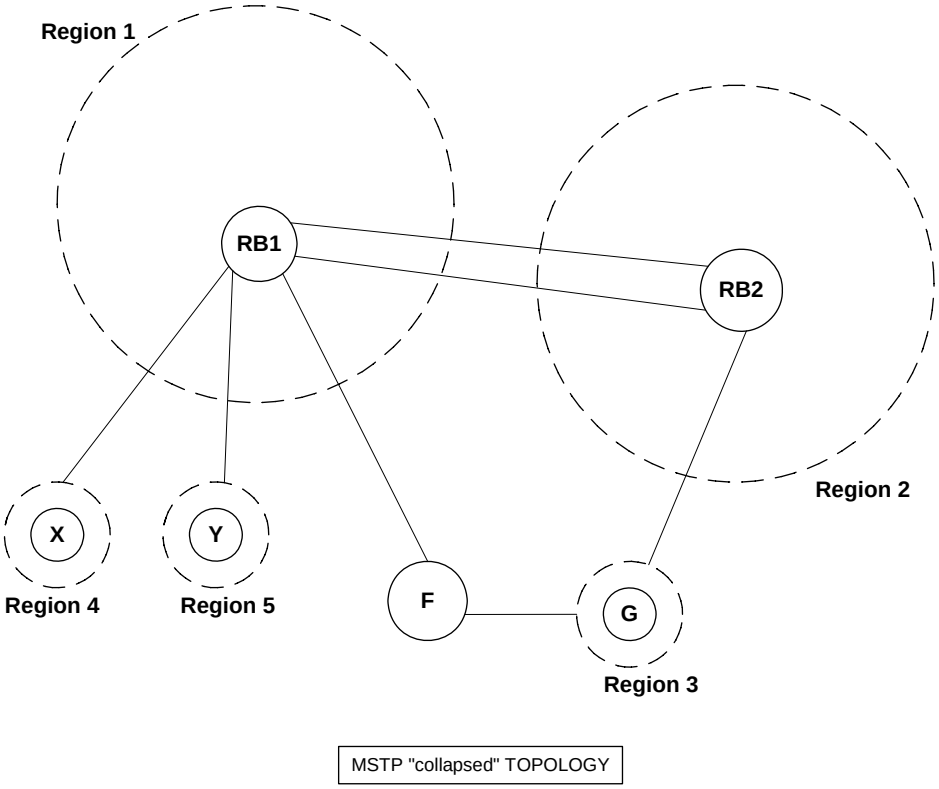


Figure 130. MSTP “collapsed” topology example

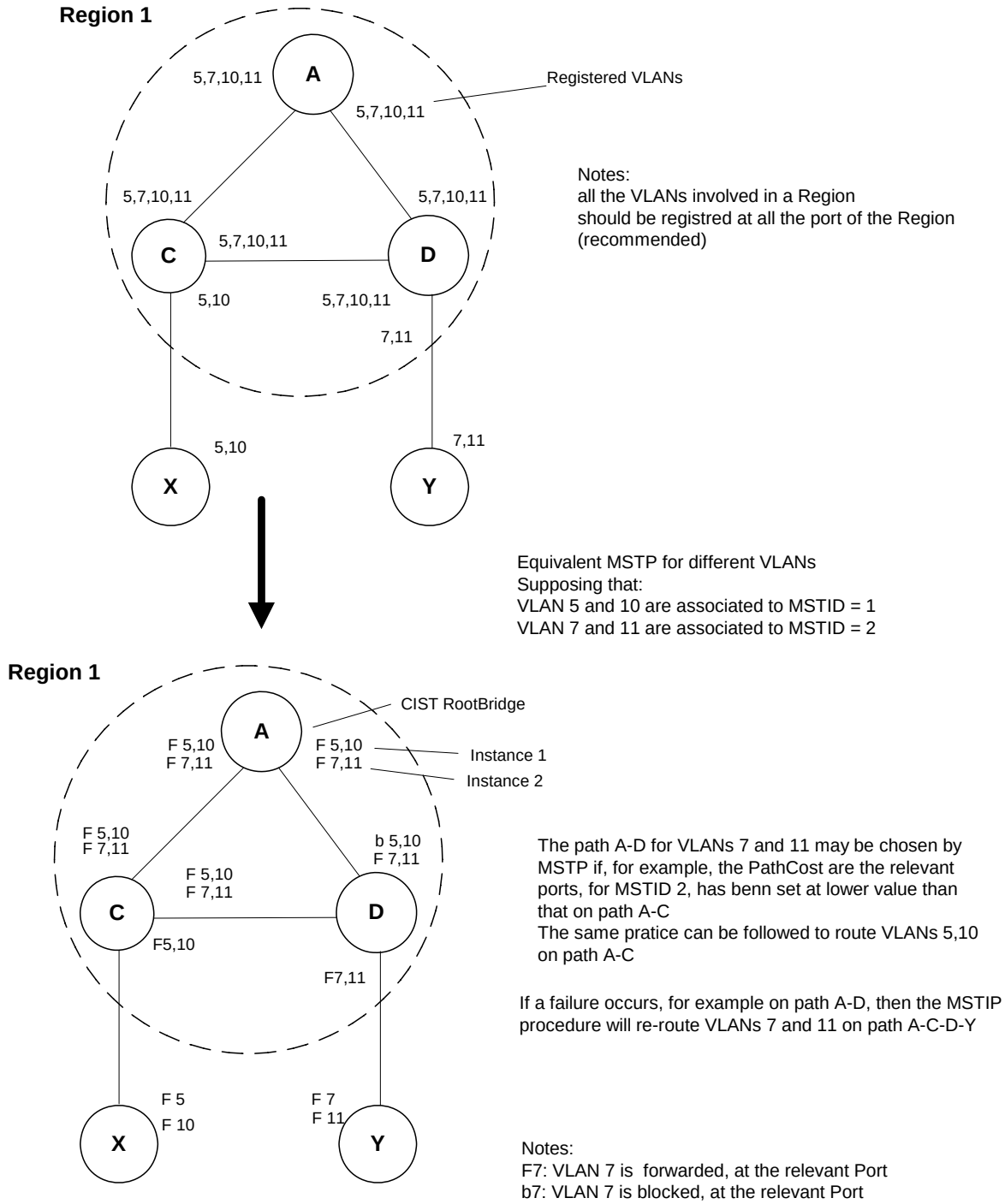


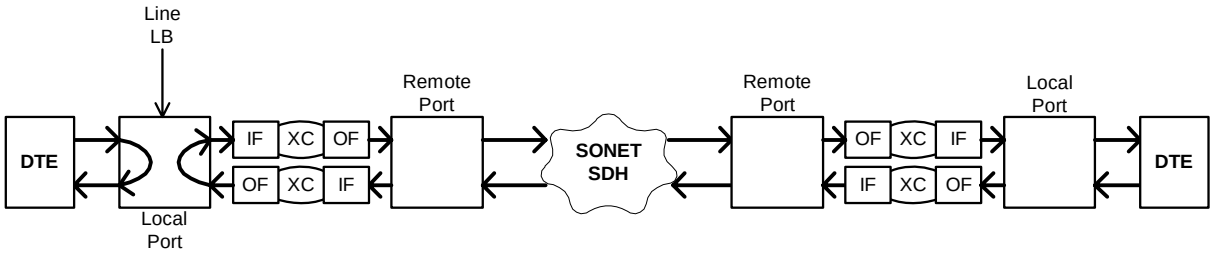
Figure 131. MSTP, VLAN differentiated routing example

3.2.3.10 Loop-Back management

The Data system supports Line and Internal Loop-Back feature, in order to check the network link integrity.

The loop-back scheme is illustrated in the Figure 132. below.

The “Line” LB is used to reflect back the signal towards the ethernet line. It is performed before the MAC processing.



Notes:

- LB = Loop Back
- IF = InFlow
- OF = OutFlow
- XC = Cross Connection
- DTE = Data Terminal Equipment

Figure 132. Line Loop Back scheme

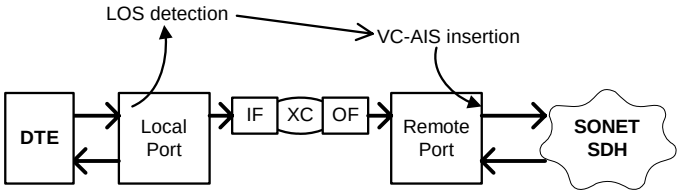
3.2.3.11 VC-AIS alarm management

The Data system supports the VC-AIS alarm management (VirtualContainer - Alarm Indication Signal), in order to propagate Ethernet signal failure indications to the SONET/SDH systems. This option is possible only in case of GFP framing on server layer, in “Port-to-Port" connection. The VC-AIS insertion is unidirectional.

The VC-AIS function is supported on 10/100 Mbps ports (not available in current release) as well as 1000 Mbps ports.

The AIS alarm will be inserted on the SONET/SDH transport containers, as a consequent action after local Ethernet Port failure (Ethernet LOS detection).

The VC-AIS mechanism scheme is illustrated in the Figure 133. below.



– The VC-AIS alarm is inserted on the SONET/SDH containers upon Ethernet LOS detection.
– The VC-AIS alarm insertion is uni-directional
– The ShutDown on local port must be disabled
– The FlowControl function on local port must be disabled

Notes:

- The management of VC-AIS alarm is possible only in case of GFP server layer
- The management of VC-AIS alarm is possible only in case of Port-to-Port connection (P2P)
- IF = InFlow
- OF = OutFlow
- XC = Cross Connection
- DTE = Data Terminal Equipment

Figure 133. VC-AIS alarm management

3.2.3.12 Virtual Concatenation and LCAS

The 1850TSS-320 DATA-system supports (at the SONET/SDH side) Virtual Concatenation and LCAS features.

The **Virtual Concatenation** consists in the fact that frames not fitting into a single SONET/SDH-container are transported over more individual containers, indicated with the symbol:

– **VTn-Xv** (e.g. VT15-3v indicates the virtual concatenation of 3 VT1.5),

– **VCn-Xv** (e.g. VC12-3v indicates the virtual concatenation of 3 VC12),

also called VCG (Virtual Concatenated Group).

The original frame is paralleled “TimeSlot-by-TimeSlot" and loaded over different payloads.
The individual containers can follow different paths in the network, with different delays, and they need to be reassembled at the end points, taking into account the different path delays.
This feature is compliant to T1.105.02-2001/ITU-T G.707 rec.
A schematic example is illustrated in the Figure 134. below (example with concatenation granularity=3).

The LCAS feature (Link Capacity Adjustement Scheme) permits the operator to “hitless" modify the bandwidth capacity of a virtual concatenated link (VCG), in order to meet the bandwidth needs of the service (by adding or removing virtual containers in all the involved nodes of the network). It can also temporarily remove failed links of the group, in automatic and hitless mode. In case of failure or addition of links, the traffic is automatically redistributed over the working links. Reference: ITU-T G.7042 rec.

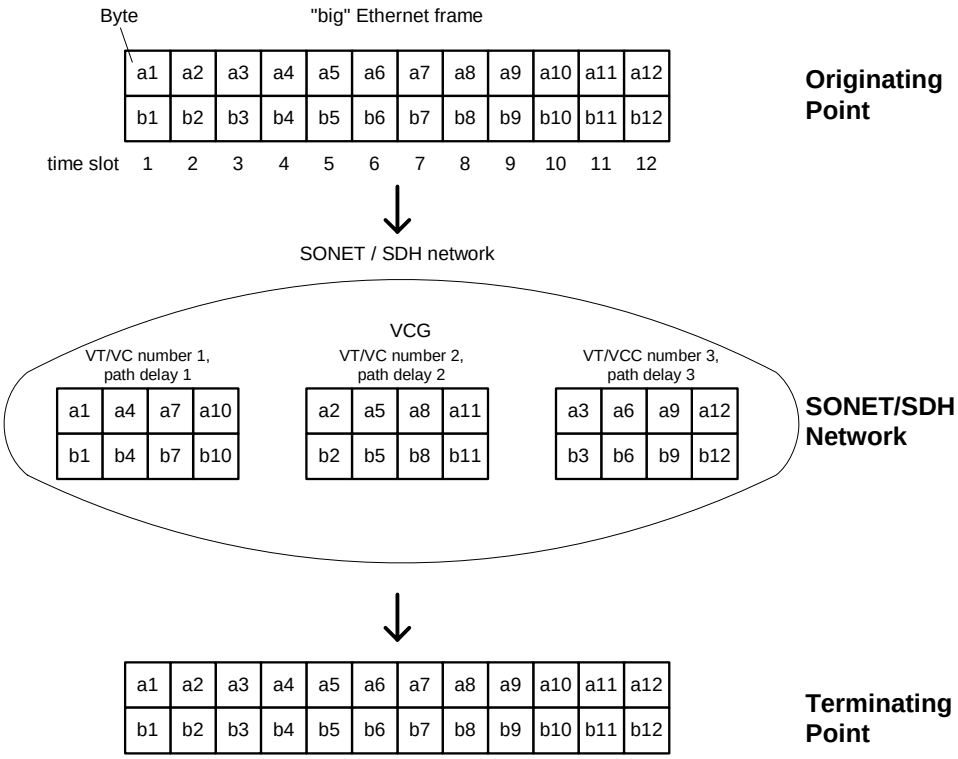


Figure 134. Virtual Concatenation (example)

3.2.3.13 Link Aggregation management

The DATA system supports the Link Aggregation at the Ethernet side, as specified in IEEE-802.3 rec.; it is a technique to aggregate many data streams into a single logical link. The resulting aggregate link will be treated by the system (with regard to instances about STP, IGMP, network protections, etc.), as a single link.
It permits to overcome the bandwidth limitation of the single ethernet interfaces, or to protect the traffic.
Permitted port rates to be aggregated are 1Gbps and 10Gbps (10Mbps and 100Mbps are for future release).
The max number of ports (LAG-size) to be aggregated is 16; (LAG stands for Link Aggregation Group).
Links may be anytime added or removed to/from the bundle.
Ports to be aggregated can be either located on the same board and also on different boards.
Its management in the network is based upon the communication, between the aggregate partner equipments, of LACP messages (Link Aggregation Control Protocol). The LACP packets transport information about set-up, aggregation capability, links failures, automatic reconfiguration after failure, etc.

The packets distribution over the constituting links is based upon classification of MAC SA and DA (Source Addresses and Destination Addresses), all packets belonging to the same conversation (i.e. same MAC-DA/SA) are transported over the same link.
The packets can not be fragmented, i.e. a packet is transmitted entirely on the same link.
More conversations (i.e. different MAC SA/DA) can be transported on the same link.
A fair load-balancing is not guaranteed, since conversations and packets can not be fragmented.

A priority value is associated to each port of the bundle, embedded in the Port Identifier. The Priority is coded on 16 bits (of which only 8 are used), lower values meaning higher priority.
A port of the aggregate is classified, by the system, in “Active” or “Stand-by” state, depending from the port-priority values and from the LAG-size. E.g.: if port-rate=1Gbps, LAG-size=5, number of ports=7, then 2 ports (those ones having lower priorities) are classified as “stand-by” by the system.
In case that the port-priorities between the two connected equipments do not match properly, then the Master system can change the port-priorities of the peer system; (Master system is the one having the lower System-Identifier value. System-Identifier is composed of 2 octets of System-Priority value and 6 octets of the System-MAC-Address).
The Port-priority is then used to manage the re-distribution of failed links, when Stand-By ports are configured for traffic protection.
In case of a protected traffic, if a link failure occurs, the traffic of the failed link will be switched to the Stand-By port having a priority value just lower than the failed one.
Both Actor (local) and Partner (far) systems must switch accordingly. The messages for link switch between connected aggregate systems are transported by means of slow-protocol packets called LAMP (Link Aggregation Marker Protocol).
If the traffic is not protected, i.e. no stand-by ports are configured, then the traffic of the failed link will be redistributed to all ports, if bandwidth is available. In this case frames discarding may occur.
The redistribution of the traffic after failures impacts all the involved links, therefore the transport is not hitless for all the conversations in operation.
The reconfiguration is triggered by the LOS on aggregate ports.
The reconfiguration is accomplished within 1 second.
In case that one or more links failed, the alarm LAG-DEG is arisen by the system.
In case that all links of the bundle fail, the alarm LAG-LOS is arisen by the system.

One “Primary” port is elected among the ports constituting the aggregate, for carrying special traffic (network control packets with multicast/broadcast address, such as xSTP-BPDU, IGMP, etc., and also packets with unknown address) . Primary port is the one that was first created in the group.

In case that the Primary port fails, the control protocol packets will be switched over the port created immediately after the first one, and so on. The flooding rate of unknown addressed packets can be limited, by the administrator.
Primary port selection is independent from the Priority values, depending only from the port creation date.

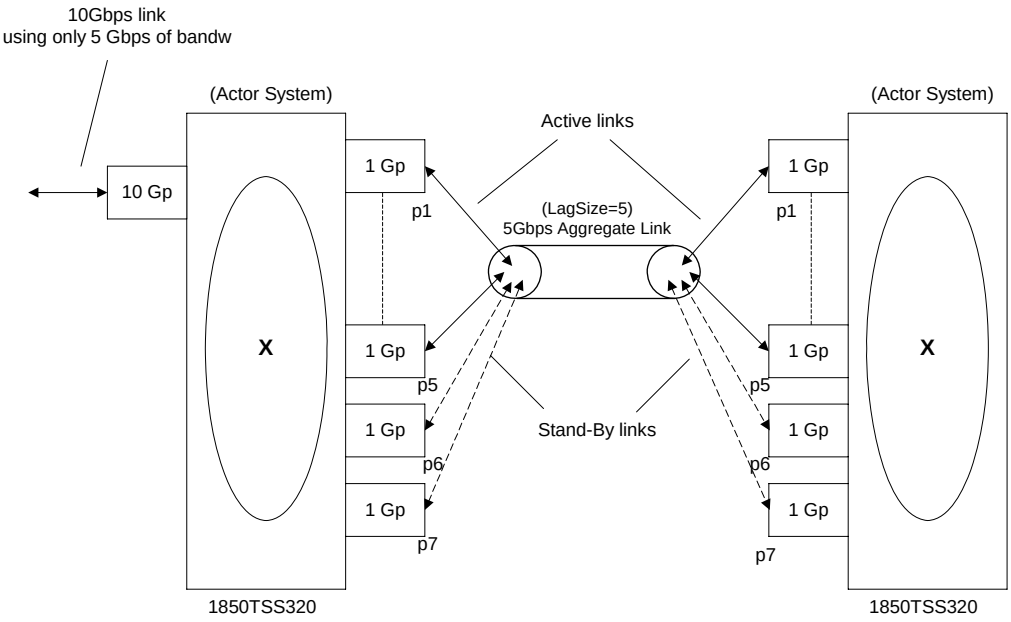
The benefits of Link Aggregation feature are:

- Bandwidth limitation overcoming.
- Load balancing (the traffic is distributed over the constituting links).
- Reliability increasing (in case that a link of the aggregate fails, its traffic will be automatically distributed over the other links of the aggregate).

The conditions for Link Aggregation option are the followings:

- All involved ports must work at the same rate.
- All involved ports must have the same configurations, regarding AutoNegotiation and FlowControl.
- All aggregated links must be point-to-point (Multicast is not allowed).
- All involved interfaces must work in full-duplex modality.
- All involved ports must be Local (Remote ports are not allowed).
- Actor and Partner ports (local and far sides) must be of the same type.

An example of Link Aggregation is illustrated in the Figure 135. below.



Each port (p1 to p7) is associated by the operator to a priority, in which lower value means higher priority.
Exaple of Port-Priority association:
p1: prior 6
p2: prior 5(highest priority)
p3: prior 12
p4: prior 87
p5: prior 21
p6: prior 252(lowestpriority)
p7: prior 251

With these values of priorities, having a LagSize=5 and PortRate=1Gbps, the ports p6 and p7 are set, by the system, to "StandBy" state.
In case of failure on a port, the traffic will be switched to port p7, that has priority higher than p6.
In case the priorities between the two connected equiments do not match properly, then the Master system can change the priorities of thr peer system.

Figure 135. Link Aggregation example

In this example, a 5Gbps packets stream, is transported on an incoming segment over a 10Gbps link, and the outgoing segment is implemented by means of the Link Aggegation feature, using 7 Ports at 1 Gbps, of which 2 are used for protection (Stand-By links).
In case of failure, the traffic of failed link is switched to the stand-by port having higher priority.

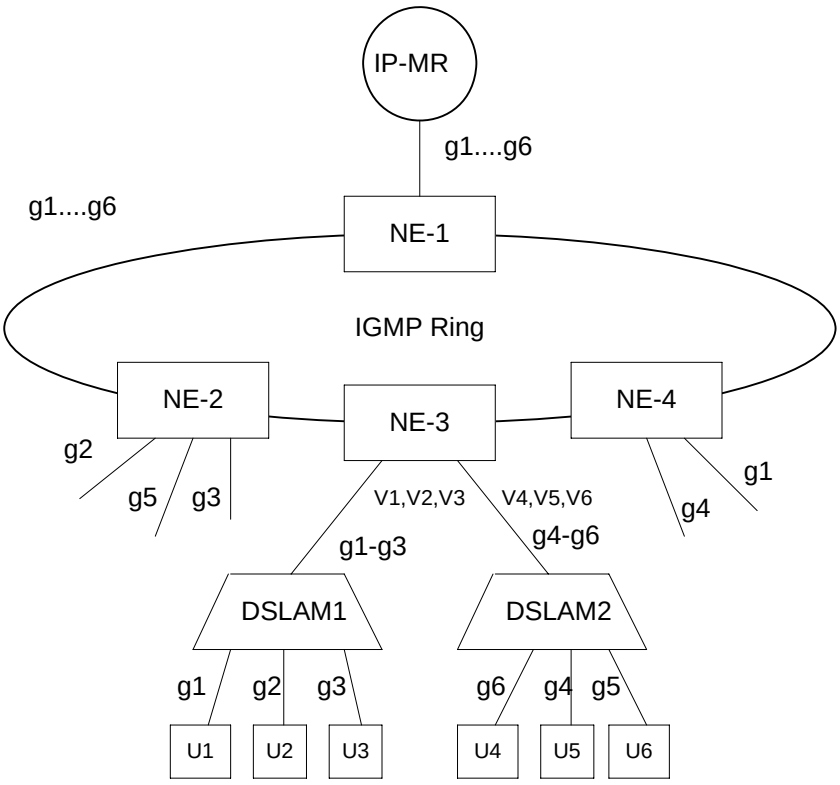
3.2.3.14 IGMP Snooping management

The 1850TSS320-Data system supports the IGMP function (Internet Group Multicast Protocol), as specified in international standard rec. IETF-RFC 1112, 2236, 3376.

It is configurable by means of the CraftTerminal menu; for details see Related Documents [5] on page 20 .

The function of this option is to configure the TSS320-Data equipment as a “Proxy” equipment, in order to intercept and inspect IP packets of level3 transporting IGMP information. In this way the TSS320-Data (that is a level2 Switch, L2) can check prospective requests of multicast traffic (using IGMP packets) between users and IP-Multicast Routers inserted into the network (i.e. IGMP Snooping activity). According to requests of “Multicast Join” or “Multicast Leave” received from users, the TSS320-Data system manages the forwarding or the shutting down of Multicast traffic on Ports towards the connected users, in order to save band resources. The Multicast packets are sent only to ports that are part of the IGMP group.
Further the IGMP system can provide to reduce the traffic of periodic packets between the Router and the users, by summarizing the individual Reports (“JoinReports” and “LeaveReports”) from users (called also **hosts**) in one single collective ProxyReport towards the Router.
The Leave and Join reports are dynamic events traced on the FDB table, as well as the Query messages periodically sent by the Router to discover its IGMP members.

An application example is reported in figure below.



g1,g2,...., g6 are Multicast Group packets flows
V1,V2,...,V6 are VLAN identifiers registered on given ports
u1 to u6 are users interested in Multicast trafic accessed by means of appropriate DSLAm equipments

IP-MR= IP Multicast Router equipment
NE-x=Tss320 equipped with Data Boards

Figure 136. IGMP application example

3.2.3.15 MEF (Metro Ethernet Forum) Network Applications

The MEF (Metro Ethernet Forum) specifies, in MEF-10-2004 and MEF-6-2004 recommendations, the basic models, services and applications for ethernet users.
This section illustrates some examples implementing MEF basic structures.

Network connections types (MEF terminology):

– EVC (Ethernet Virtual Connection) can be:

1) **Point-to-Point** (P2P), or **E-Line**. It can be:
   a) Ethernet Private Line (EPL)

   b) Ethernet Virtual Private Line (EVPL)

2) **MultiPoint-to-MultiPoint** (MP2MP), or **E-LAN**

MEF-Network connections accomplishment on 1850TSS-320 DATA system:

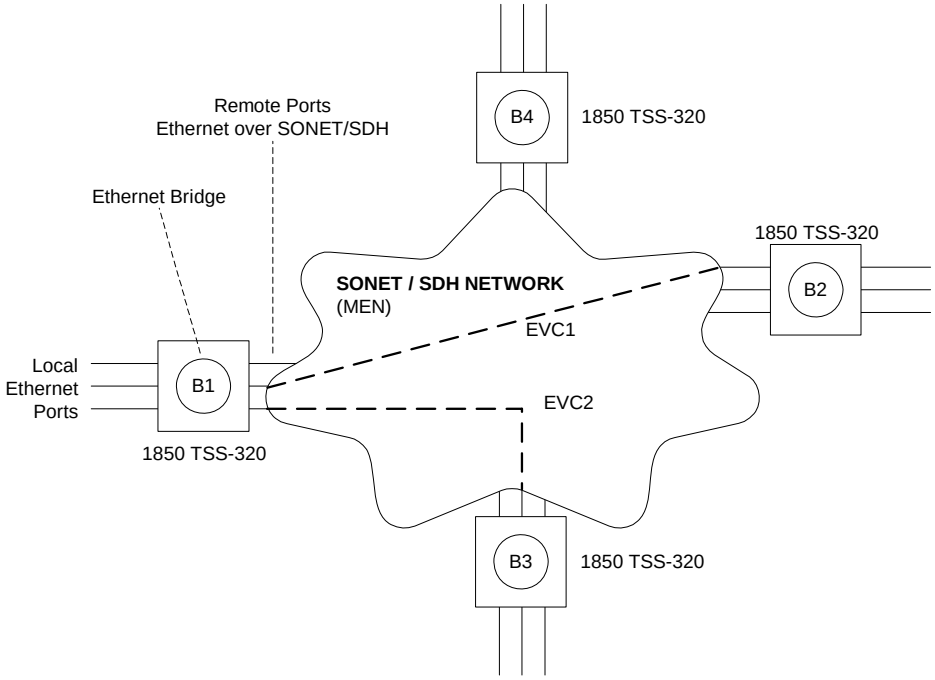
The EPL can be achieved using the transparent “Port-to-Port" connection (see Figure 138. on page 185).

The E-LAN can be achieved by means of the FDB function, either in MAC Bridge, or Virtual Bridge (also called E-VLAN), or Provider Bridge modality. See Figure 139. on page 186 (centralized LAN) and Figure 140. on page 187. (distributed LAN).

An example of EVPL with Services Multiplexing and differentiated CoS is shown in Figure 141. on page 188

The Bundling service can be achieved in Provider and Virtual Bridge configuration by registering more VLAN's over one EthernetPort. Either it can be achieved, in Provider bridge mode, by defining a range of customer VLAN's for a single Classifier associated to a data flow.

The Service Multiplexing can be achieved in Provider Bridge configuration, by creating more and different user data flows over one EthernetPort. See EVPL, Figure 141. on page 188.



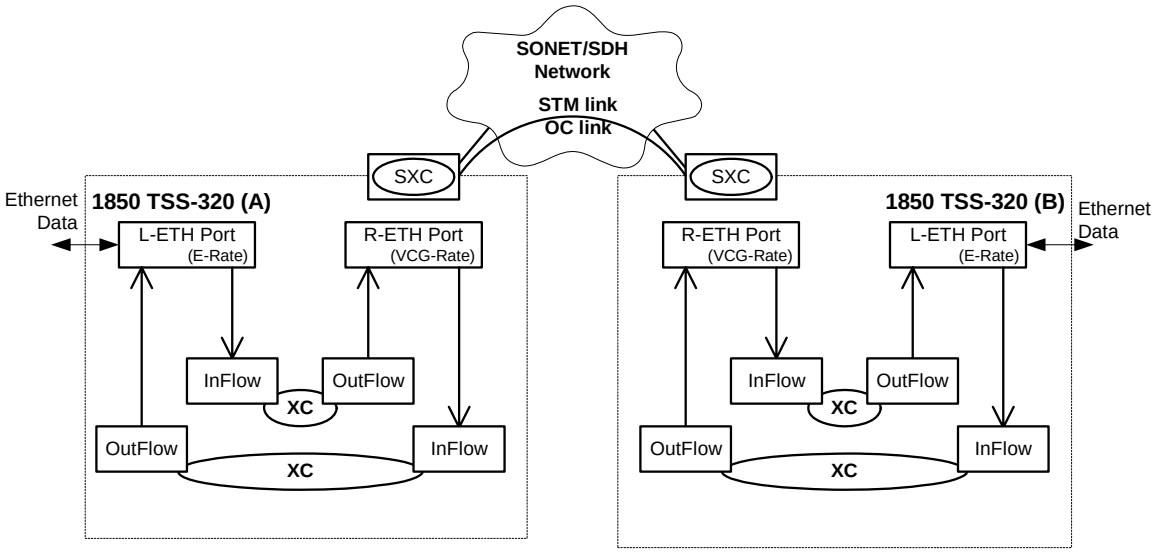
Notes:
– EVC (Ethernet Virtual Connection) is a connection between two or more Ethernet enabled Network Elements.
– MEN = Metro Ethernet Network

Figure 137. MEF-Network application for 1850TSS-320 DATA System

3.2.3.16 Ethernet Private Line (EPL), end to end implementation example

Refer to Figure 138. on page 185.

All involved ports are in ETS mode, concerning the client layer



Port-to-Port or EPL example

Notes:

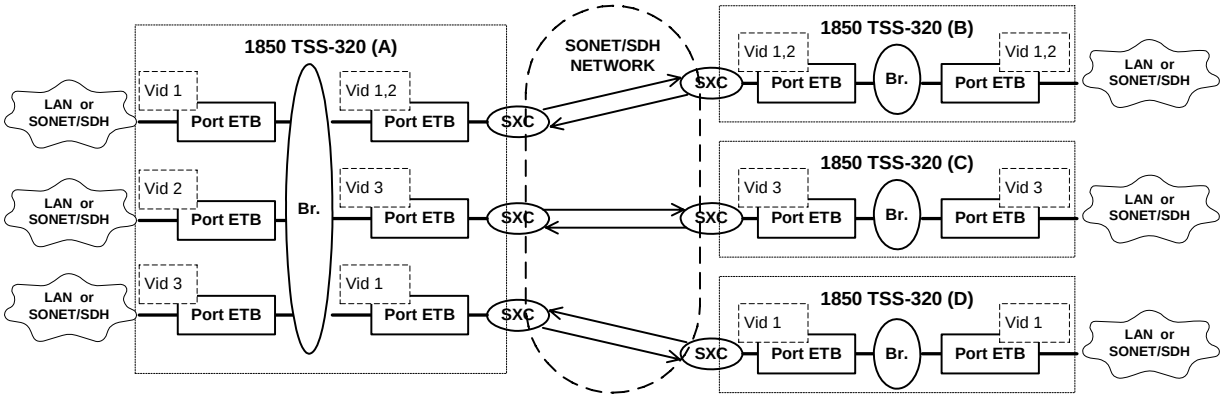
– E-Rate= rate of the Ethernet LAN link (1Gbps, 10Gbps)
– VCG-Rate= rate of the Ethernet over SONET/SDH link, that can also be concatenated over more SONET/SDH paths
– VCG= Virtual Concatenation Group
– The E-Rate and VCG-Rate must be congruent
– The STM link is bidirectional and LCAS option can be used
– Local (L-ETH) and Remote (R-ETH) Ethernet ports are ETS type
– The ports are devoted to only one flow, in transparent mode, without traffic classification nor policing.
– The two involved Ethernet ports may be either local or remote.
– The connection is done by means of the “OneStep Port-to-Port" procedure
– This link is EPL (Ethernet Private Line) type (also called point-to-point)

Figure 138. EPL application example

3.2.3.17 E-LAN / E-VLAN, end to end implementation example

Refer to Figure 139. on page 186 (centralized LAN) and Figure 140. on page 187 (distributed LAN).

All involved ports are in ETB mode (except if the Bridge is Provider). In case of Provider Bridge, see next section for more information.

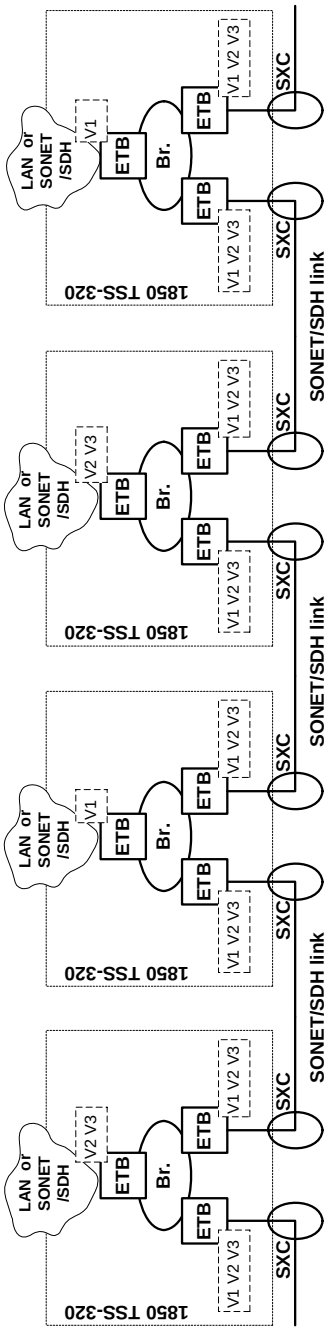


SXC = SONET/SDH XC
Vid X = VLAN ID X Registration
Br = Bridge

Note:

- The Bridges can be Mac or Virtual or Provider
- In case of MAC Bridge no registration is needed and the MAC frames are forwarded on all active ETB ports of the bridge (E-Lan implementation)
- In case of Virtual or Provider Bridge, the incoming frames are distributed only to the ports registered over the same VLAN, i.e. to those ports that are parts of the “member set" distribution domain (DD) of that VLAN
- More VLAN's can be registered on one port
- More ports can be part of the “member set" distribution domain (DD) of one VLAN
- The indicated links are bidirectional
- The frames distribution is based upon the FDB table
- ETB ports can be Remote (for SONET/SDH) or Local (for LAN).
- Where ETB ports are Remote, they need SONET/SDH XC (SXC) and eventual VCG association
- The LCAS feature can be used on the SONET/SDH-VCG links, in order to improve the band utilization
- The “Static Unicast Filtering" option of the FDB table can be used, in order to avoid the initial flooding of unknown frames destinations
- The E-VPLan structure can be implemented by using Provider bridge, for Differentiated and Multiplexed Services applications (see next example for some details about Provider Bridge configuration)
- This application is called “MultiPoint-to-MultiPoint" or “E-Lan/E-VLan"
- The Regenerated Priority option can be used, on the ETB ports

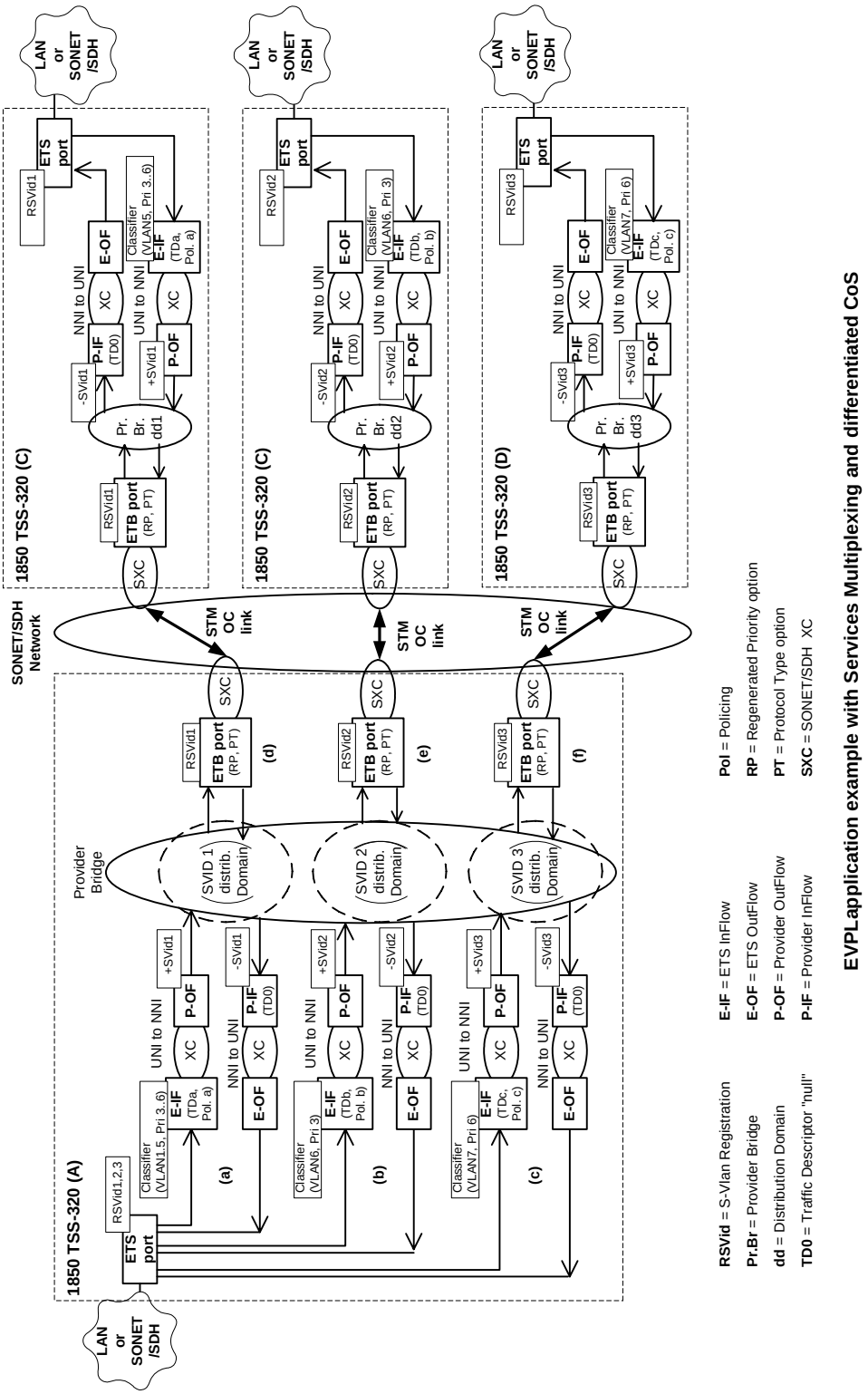
Figure 139. Example of E-Lan/E-VLan implementation (1: centralized LAN)



– SXC = SONET/SDH XC
– Vx = VLAN x Registration
– Br = Bridge
– The indicated links are bidirectional
– The SONET/SDH network emulates an E-VLAN for VLAN's ID 1,2,3

Figure 140. Example of E-Lan/E-VLan implementation (2: distributed LAN)

3.2.3.18 E-VPL, end to end implementation example



EVPLapplication example with Services Multiplexing and differentiated CoS

Figure 141. EVPL implementation example

Notes about Figure 141. on page 188:
the scheme illustrates an EVPL example with Service Multiplexing and Differentiated Class of Services.

- The links a to d, b to e, c to f are parts of three different EVC's, afferent to one single ETS port.
- (a), (b), (c): bidirectional links for different users; VLAN id, Priority (Pri), Traffic Descriptors (TD) and Policing (Pol) on these connections can be different.
- VLAN 1...5 means that VLAN's on range 1 to 5 are transported over this data flow (bundling).
- The priority (Pri) for a group of VLAN's can also be defined as a range, e.g. from Pri3 to Pri5.
- RSVID 1,2,3 means that S-VLAN 1,2 and 3 are registered on this port.
- (d), (e), (f): these ETB ports are used as Bridge Network Interfaces respectively for the data flows a,b,c.
- ETS ports, as well as ETB ones, can be Remote (for SONET/SDH) or Local (for LAN).
- Where ports are Remote, they need SONET/SDH XC and VCG association
- The frames are distributed only to the ports registered over the relevant S-VLAN, i.e. parts of the “member set" distribution domain of that S-VLAN (SVID registration).
- More data flows can be created under one ETS port.
- More S-VLAN Id can be registered on a single port.
- More ports can be headed to one S-VLAN.
- More (or a range of) customer VLAN's can be defined on one Classifier (user VLAN Bundling).
- The CoS of one traffic (Priority) may be changed at the ingress of the provider bridge network, in ETB port, RP option.
- The Protocol Type of one traffic (Protocol Type) may be changed at the ingress of the provider bridge network, in ETB port, PT option.
- The Provider UNI/NNI or NNI/UNI connections are accomplished by means of “One-Step" procedure.

3.2.4 DWDM architecture

1850TSS-320 is the new platform for Metro, Regional networks

The 1850 TSS-320 architecture is based on a single universal shelf that can be configured in different ways to support a variety of applications. The main building blocks (interfaces, mux/demux, optical amplifiers, protection boards, ...) can be allocated in the universal shelf in a very flexible way.

3.2.4.1 44-channel, 2-degree ROADMs (upgradable in service up to 4-degree).

3.2.4.1.1 ROADM with LDRXA

The 44-channel ROADM is capable of adding and dropping up to 44 channels per optical line. A view showing both directions of transmission circuit packs and optical connections in the 44-channel, 2-degree ROADM equipped with LDRXA is shown in Figure 142. on page 190 where the optical monitoring signals are shown in blue, and OSC add and drop paths are shown in red..

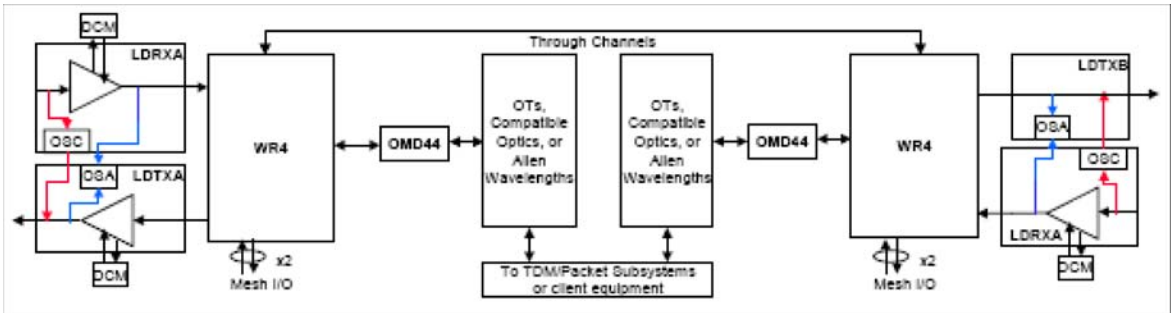


Figure 142. 2-degree ROADM equipped with LDRXA

A more detailed view showing one direction of transmission in a 44-channel, 2-degree ROADM (upgradable inservice to 4-degree) equipped with LDRXA is shown in Figure 143. on page 190.

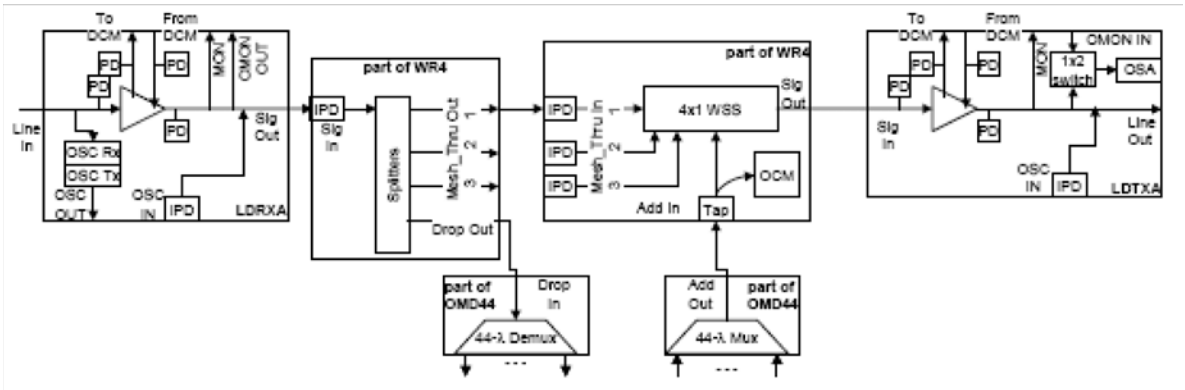


Figure 143. Detail of one direction of transmission for a 2-degree ROADM equipped with LDRXA

Startup packs include:

– Line Driver (LD) packs that terminate the optical supervisory channel (OSC) and, if necessary, amplify the incoming and outgoing signals. There are two LDs per optical line. The LDRX is on the incoming side of the line, and the LDTX is on the outgoing side. Figure 142. on page 190 illustrates the use of both LDTXA and LDTXB. LDTXA is used whenever amplification is needed on the outgoing channels, and LDTXB can be used for very short spans and in systems with limited reach.

– The incoming OSC and DWDM channels enter the node at the LINE IN port of LDRXA. The OSC channel and timing are recovered in this pack. The outgoing OSC channel is transmitted through the OSC OUT port to the OSC IN port of the LDTX on the same optical line. The OSC IN port of the LDRX is not used in this configuration. It is intended only for possible use in an ILA application.

– Optical monitoring is performed by the optical monitor (OMON) unit, consisting of a 1x2 switch and an optical spectrum analyzer (OSA) in each LDTX. The OMON monitors the power, wavelength, and OSNR of the DWDM channels at the outputs of the LDRX and LDTX packs for a single optical line. Note that OSNR monitoring will not be supported for 40Gb/s channels or for channels on a 50 GHz grid.

– Each LD also contains a MON port that can be connected to customer monitoring equipment.

– Dispersion Compensation Modules (DCMs). These are fibered to the mid-stage access ports of LDRXA and LDTXA.

– Wavelength Router (WR4) packs that broadcast incoming channels to drop, through, and mesh ports, and that route add, through, and mesh inputs of different wavelengths onto a single fiber to feed into the LDTX. The broadcasting of the incoming channels is accomplished through optical power splitting and the routing of the outgoing channels uses a 4x1 wavelength selective switch (WSS).

– The WSS has adjustable per-channel attenuation for equalizing add and thru channels. Drop channels are not equalized.

– WR4 also contains an optical channel monitor (OCM). The OCM monitors the channels that are added locally so that the loss of any of these added channels can be detected. The OCM provides reduced power and wavelength accuracy than the OSA, and the OCM does not provide OSNR readings.

– Optical multiplexer/demultiplexer (OMD) packs. These packs demultiplex DWDM signals for the local drops. They also multiplex the locally-added channels for transmission to WR4. These packs are passive, except for an EEPROM that is used for inventory purposes, and they are located outside of the shelf.

– Both OMDs and DCMs are passive units with EEPROMs. The OMD EEPROM is read by the WR to which it is fibered. Power is supplied by a cable from the WR, and communication is via a 1-wire interface. The DCM EEPROM uses the same arrangement with the associated LD.

– Channel loopback is available at OTs. Loopback is not available for the multiplexed DWDM channels.

3.2.4.1.2 ROADM with LDRXB

The optical amplifier in LDRXB has higher output power than the OA in LDRXA. LDRXB also has additional optical components that are used in some configurations. LDRXB may be substituted for LDRXA in the 2-degree ROADM that is upgradeable to degree 4. LDRXB is more expensive than LDRXA, but it can be used in a larger variety of nodes. Some customers might prefer to use LDRXB in this node in order to standardize on a single LDRX pack.

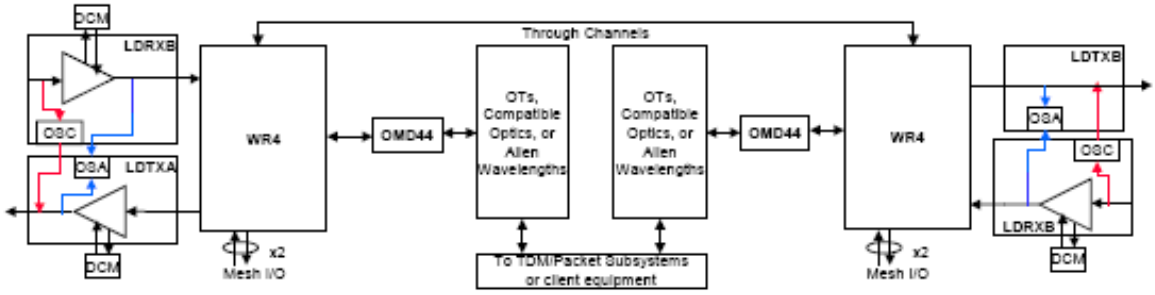


Figure 144. 2-degree ROADM equipped with LDRXB

Except for the use of LDRXB, the circuit packs in the ROADM are the same as those that are used with LDRXA (see Figure 144. on page 192) where the optical monitoring signals are shown in blue, and OSC add and drop paths are shown in red.. The extra optical components of LDRXB, and the proper fibering path, are shown in Figure 145. on page 192. An optical fiber jumper is used to connect the SIG OUT and SIG IN ports of LDRXB, and a connection is made from the TO ROADM port of LDRXB to the SIG IN port of WR4.

The purpose of the extra components in LDRXB will be explained in section 3.2.4.2.5 on page 198

The architecture will support mixing of LDRXA and LDRXB on different optical lines in these ROADMs.

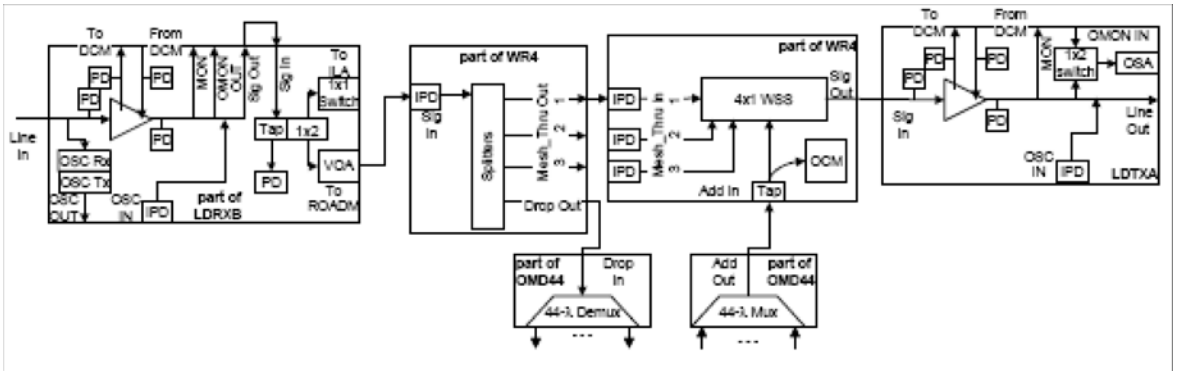


Figure 145. Detail of one direction of transmission for a 2-degree ROADM equipped with LDRXB

3.2.4.2 44-channel, 3- or 4-degree mesh ROADMs

The ROADMs shown in Sections 3.2.4.1.1 and 3.2.4.1.2 are designed to permit mesh connections up to 4-degree.

A 4-degree ROADM is illustrated in Figure 146. on page 193. The figure shows only LDRXA and LDTXA, but LDRXB and LDTXB may also be used. The solid colored lines show the mesh routing between WR4s, and dashed lines show the mesh routing within the WR4s. (Add and drop routing within the WR4s is omitted for clarity.) Connections are made between mesh_through outputs and inputs of different WR4s.

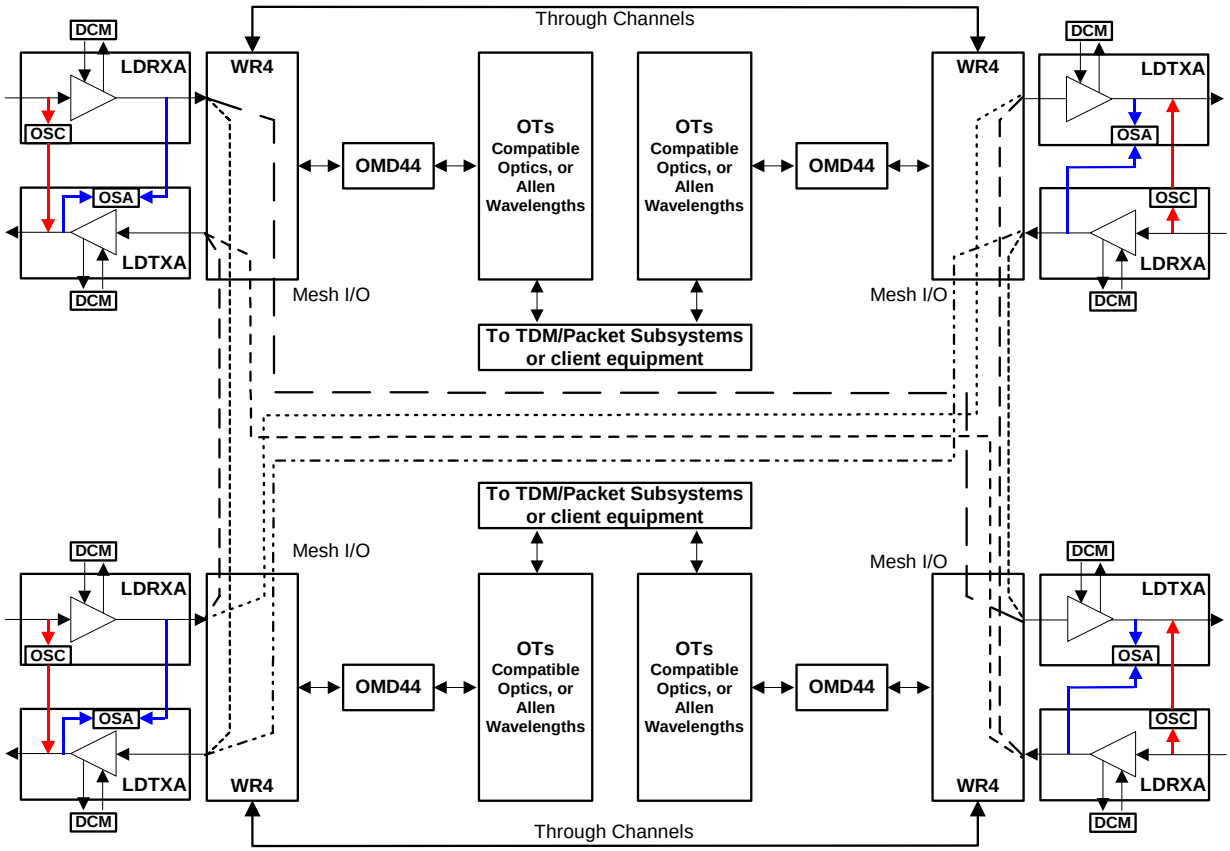


Figure 146. 4-degree, 44-channel ROADM.

The mesh connections establish additional through paths, so that a channel that enters on one optical line can exit on any of the remaining optical lines. Any channel from the LDRX may be routed by the WR4s to mesh ports, through ports, or drop ports.

Channels that are added and dropped must still be fibered to the correct optical line. This means that add/drop channels have connectivity to only a single optical line. Mesh connectivity applies only to through channels.

A 3-degree ROADM would have one set of optics removed from what is shown in Figure 146. on page 193.

An alternate depiction of the 4-degree ROADM is shown in Figure 147. on page 194. This figure emphasizes that the higher-degree ROADMs are constructed by replicating and interconnecting the core optical packs in the 2-degree ROADM.

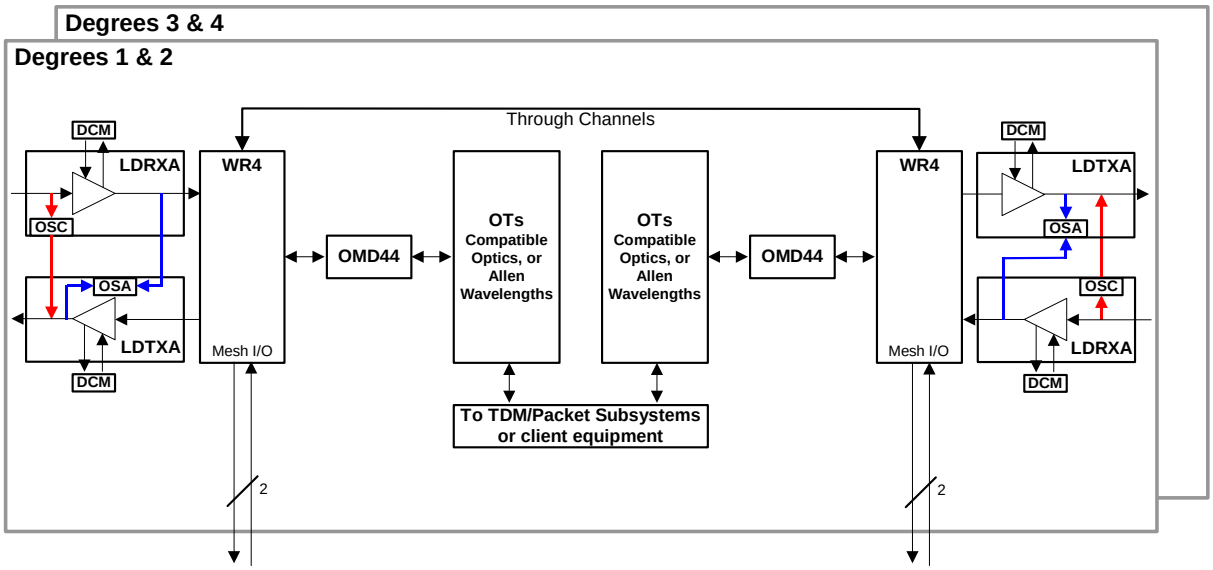


Figure 147. An alternative view of the 44-channel, 4-degree ROADM.

3.2.4.2.1 44-channel, 2-degree ROADMs (upgradable in service up to 8-degree).

The 44-channel, 2-degree ROADMs (Figure 148. on page 194) shown the transmission circuit packs and optical connections in the 44-channel, 2-degree ROADM (upgradeable inservice to 8-degree) equipped with LDRXB. Optical monitoring signals are shown in blue, and OSC add and drop paths are shown in red.

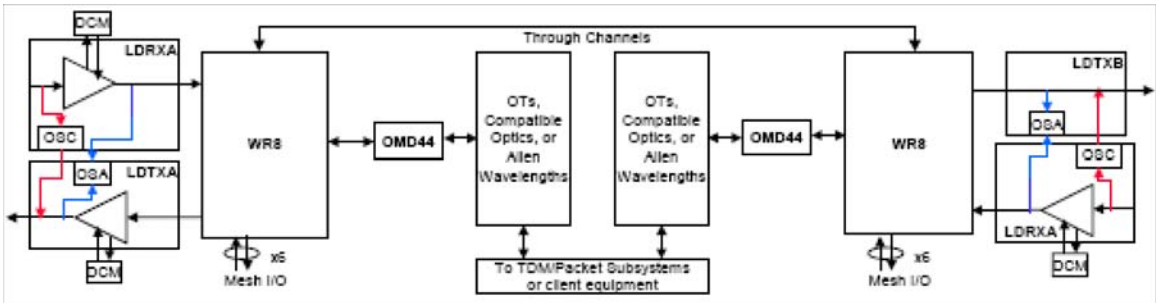


Figure 148. 44-channel, 2-degree ROADM (upgradeable to 8-degree) with LDRXB.

A 2-degree ROADM that may be upgraded in-service to as much as 8-degree is shown in Figure 7. WR4 has been replaced by WR8. The detailed view shown in Figure 149. on page 195 shows additional splitting of the incoming signal to achieve 7 mesh_thru outputs. An 8x1 WSS is used for 7 mesh_thru input ports and one port for locally-added channels.

LDRXA is never used for the incoming signal in a ROADM that is upgradeable to 8-degree. LDRXB, which has the higher output power that is needed to accommodate the splitting loss of WR8, is always required. For this application, the LDRXB output must be taken from the SIG OUT port, as shown in Figure 149. on page 195, in order to avoid the additional losses between the SIG IN and TO ROADM ports.

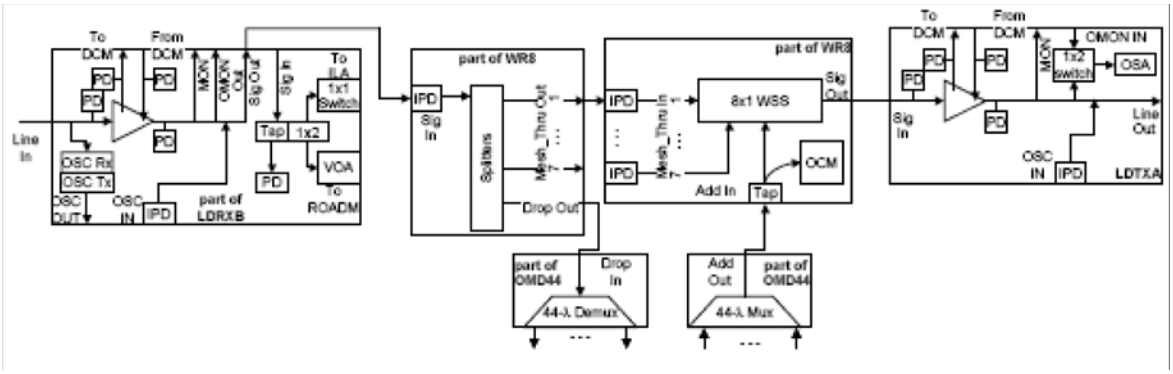


Figure 149. Detail of one direction of transmission in a 44-channel, 2-degree ROADM equipped with LDRXB.

Note that the fibering of the signal path differs for a maximum 4-degree ROADM and a maximum 8-degree ROADM (compare Figure 145. on page 192 and Figure 149. on page 195). If a connection were made directly from the SIG OUT port of LDRXB to the SIG IN port of WR4, the power at the DROP OUT port of WR4 would be too high, and receivers would be overloaded. WR8 has higher loss between the SIG IN and DROP OUT ports, so that receiver overload will not occur. A summary of how LDRXB is fibered for different ROADM variations is presented in section 3.2.4.2.6 on page 201.

3.2.4.2.2 44-channel ROADM up to 8-degree

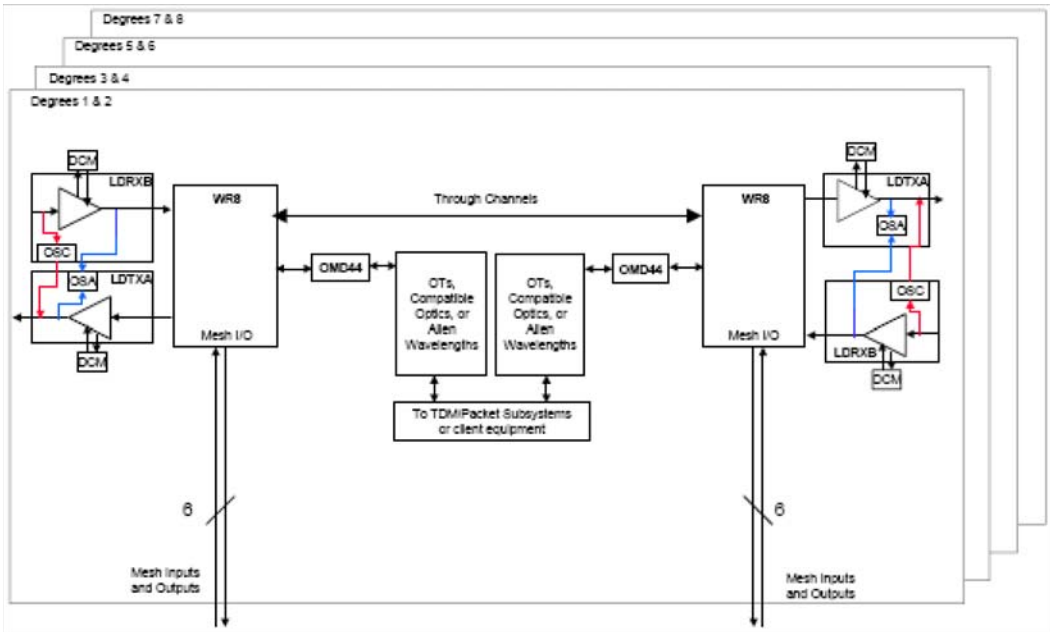


Figure 150. 8-degree ROADM.

The 8-degree ROADM is illustrated in Figure 150. on page 195. ROADMs up to 8-degree are constructed by replicating and interconnecting the core optics packs of the degree-2 ROADM that is described in 3.2.4.2.1 on page 194.

3.2.4.2.3 1-degree ROADM

A 1-degree ROADM can be made from any of the same core optics packs that are used in the different versions of the 2-degree ROADMs. An example is shown in Figure 151. on page 196. The ROADM can be upgraded in service to a higher degree.

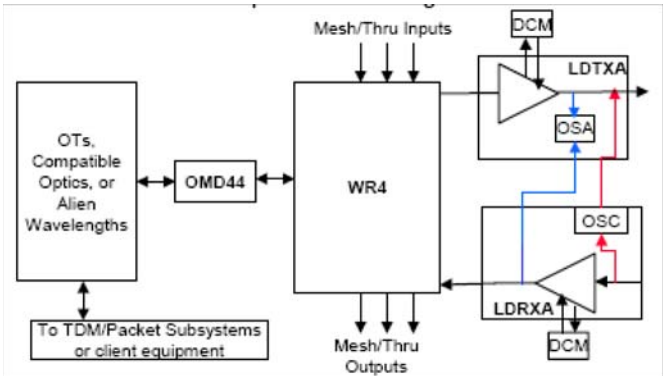


Figure 151. 1-degree ROADM with LDRXA and WR4.

3.2.4.2.4 In-Line Amplifier (ILA)

The ILA amplifies the optical channels and terminates the OSC for two optical lines. The ILA consists of two LDRXs and the necessary DCMs, power, and control packs in a standard shelf. The OMON is not used in the ILA.

Either of the two receive line drivers, LDRXA or LDRXB, may be used in an ILA. LDRXA can be used for span losses up to 29 dB. LDRXB provides 4 dB higher gain and output power than LDRXA, and can be used for span losses of up to 33 dB. An ILA can contain two LDRXAs, two LDRXBs, or one pack of each type. With its higher output power, the LDRXB provides better OSNR and worse optical nonlinearities. An engineering design tool will be used to optimize the choice of line drivers for the ILAs in a system.

An ILA with one LDRXA and one LDRXB is shown in Figure 152. on page 197 and, in more detail, in Figure 153. on page 197. The SIG OUT ports of both LDRXs are connected to the span. The extra components in LDRXB that follow the SIG IN port are bypassed. The OSC OUT port of one LDRX is connected to the OSC IN port of the other.

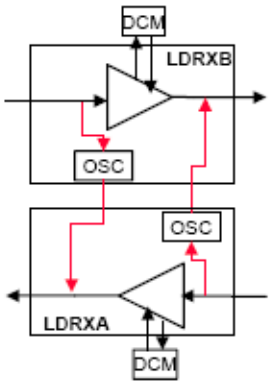


Figure 152. ILA with LDRXA for one direction of transmission and LDRXB for the other.

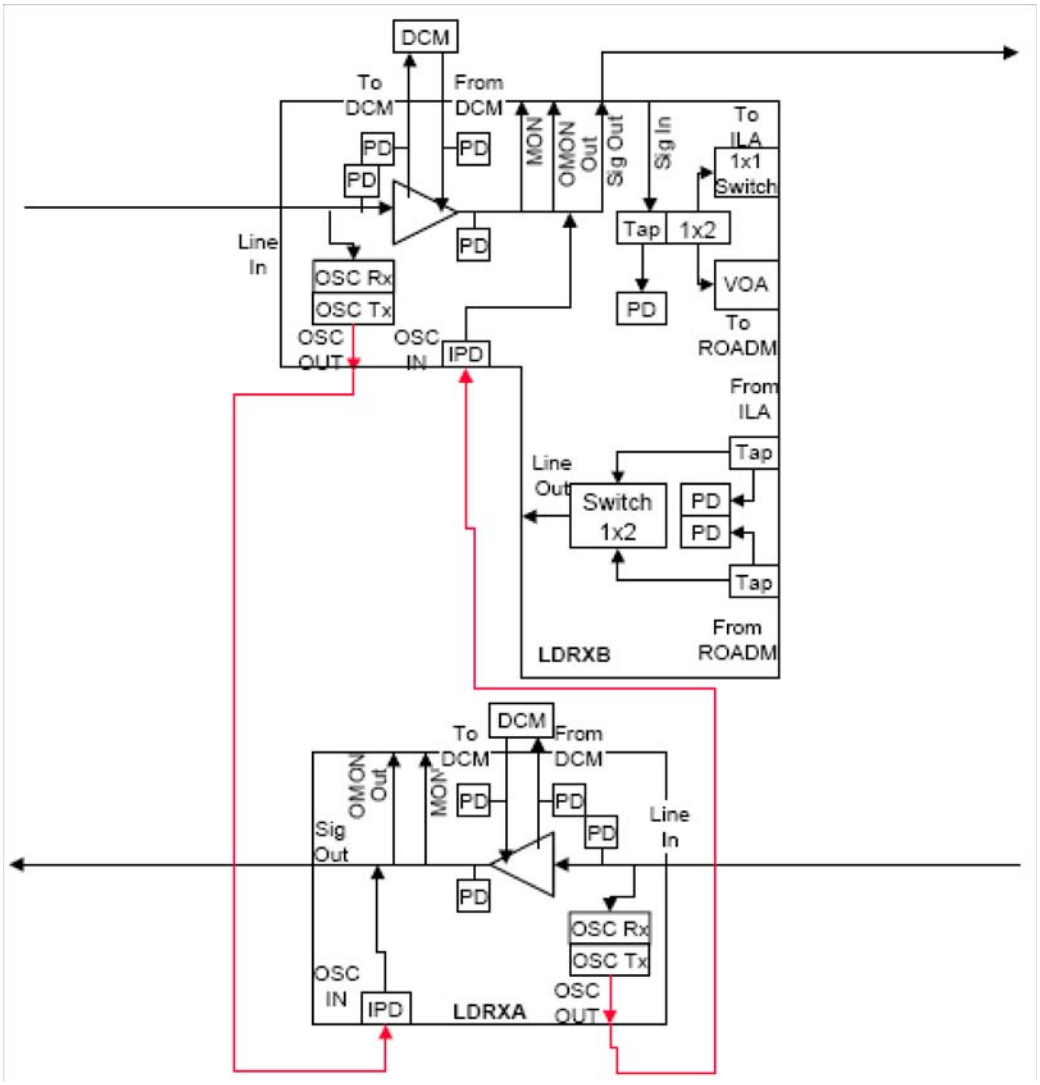


Figure 153. Detailed view of an ILA, showing the fibering between packs.

3.2.4.2.5 Upgradeable ILA (UILA) and Upgraded ROADM (UROADM)

The UILA is installed initially to function as an ILA. It is capable of being upgraded to a 2-degree ROADM with at most a short (a few ms) service interruption. After the upgrade it is referred to as a UROADM, to distinguish it from a standard ROADM. The startup installation consists of 2 LDRXBs, as shown in Figure 154. on page 198, where the OSC path is shown in red. LDRXA cannot be used in the UILA.



Figure 154. Startup packs for UILA.

A more detailed illustration of the startup configuration for the UILA is shown in Figure 155. on page 198. The fibering of the signal path is different from the fibering in a standard ILA. The SIG OUT port is fibered to the SIG IN port on the faceplate of the LDRXB. The TO ILA port of one LDRXB is fibered to the FROM ILA port of the other LDRXB. The signal is then directed through a fast (sub millisecond switching speed) 1x2 optical switch, and exits the node at the LINE OUT port. In the standard ILA, the signal is fibered directly from the SIG OUT port to the span in order to avoid the extra losses that are incurred in the UILA.

The fibering of the OSC is the same as in the standard ILA. This means that the OSC is transmitted from one LDRXB, added to the DWDM channels before the SIG OUT port of the other LDRXB, and is transmitted with the channels through the remaining path to the LINE OUT port of the first LDRXB.

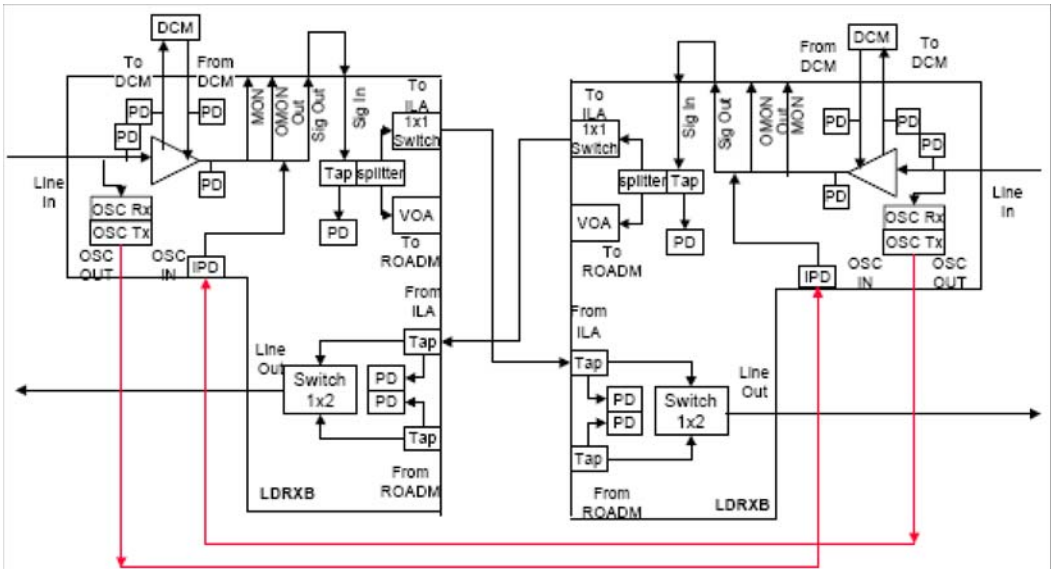


Figure 155. Detailed view of startup packs in the UILA.

The first step in upgrading the node to a 2-degree UROADM is to insert the ROADM circuit packs, as shown in blue in Figure 156. on page 199, where the UILA, operating as an ILA, but with ROADM core optics packs installed. The startup packs for ILA operation are shown in yellow, and the packs added for ROADM operation are shown in blue. The dashed black lines from the LDTXA output to the 1x2 switch on the LDRXB indicate that the connection has been fibered up, but the switch is still in the ILA position. LDTXB is never used in the UROADM because, with the extra loss at the output of the node, its usefulness would be quite limited. There is a 10 dB attenuator between the DCM ports of each LDTXA. The attenuator is in place of a DCM. In the standard ROADM, dispersion compensation is split between the LDTX and LDRX because this approach provides best system performance. In the UILA, full compensation is required at startup, so all dispersion compensation is placed on LDRXB.

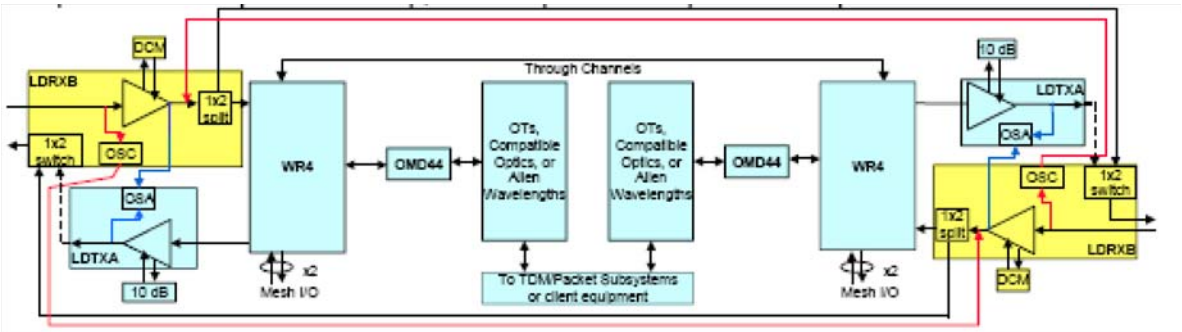


Figure 156. UILA, operating as an ILA

After the additional ROADM packs are added, adjustments must be made to the WSS in the WR4 and to the LDTXA for each direction. These adjustments will be described in the Software Control of Transmission (SCOT), which contains the optical transmission control algorithms. The adjustments will be performed automatically by SCOT software after a user indicates, through a provisioning command, that the packs are in place and are ready to be adjusted. After the adjustments have been completed, the switch can be made from the ILA branch to the UROADM branch. The OSC must then be manually refibered into the LDTXA. The OSC communication will be interrupted when the switch is made to the UROADM branch. It will be re-established when the OSC is refibered. If an alternate route is available for the OSC, it might be re-established over that alternate route before the OSC is refibered.

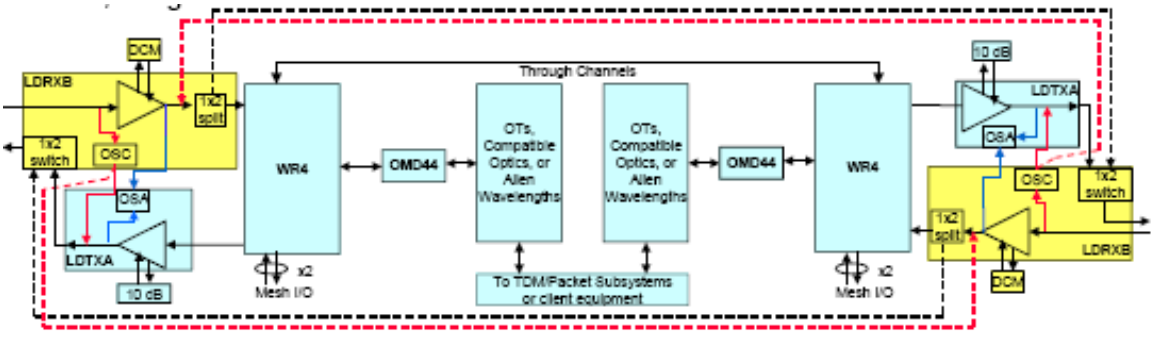


Figure 157. Final configuration for UILA after upgrade to 2-degree ROADM.

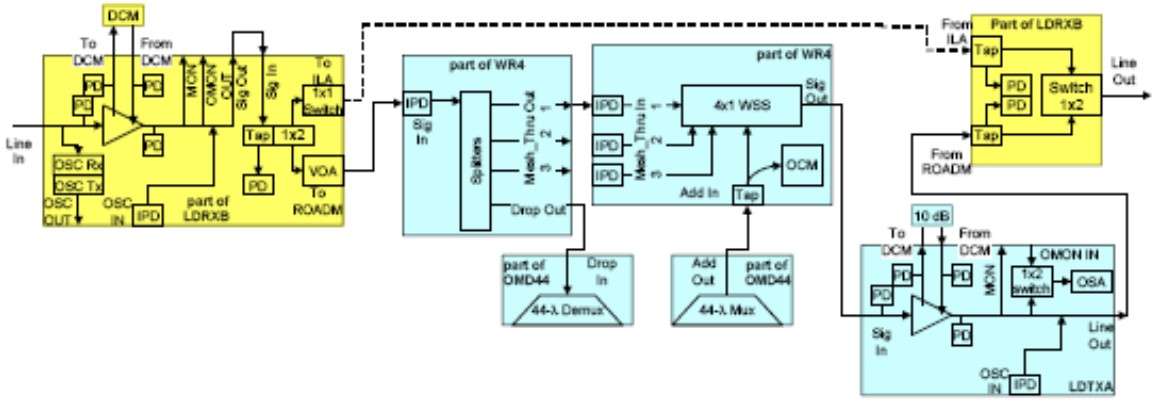


Figure 158. Detail of one direction of transmission for UILA after upgrade to 2-degree ROADM.

The final configuration is shown in Figure 157. on page 199 and Figure 158. on page 200. The black dashed lines indicate the ILA path that is disconnected after the 1x2 switch switches to the UROADM position. The red dashed lines indicate the OSC path that is manually disconnected after the change to UROADM operation.

Note that there is a VOA on the TO ROADM port of LDRXB. The VOA is used to limit the output power at that port when the port is not connected to a WR4. In the absence of the VOA, the power at the TO ROADM port could be high enough to cause connector damage when a user connects the port to WR4.

The TO ILA port has a 1x1 (on/off) optical switch. When the node is operating as an ILA, connector damage will be prevented by reducing the power of the variable gain optical amplifier module (VGOAM) in LDRXB when the connection to the FROM ILA port of the other LDRXB is open, and the switch will remain closed. Once the switch is made to transmission through the UROADM, the 1x1 switch will be opened in order to limit crosstalk between the UILA and UROADM paths. Calculations have shown that the crosstalk suppression from the 1x2 fast switch might not be sufficient on its own for avoiding penalties in large networks.

After the upgrade to 2-degree has been completed, the UROADM may be further upgraded to 3- or 4-degree using the configurations described in sections 3.2.4.1.1 on page 190 and 3.2.4.1.2 on page 192. It may not be upgraded to 8-degree.

The loss between the SIG IN and TO ROADM ports of LDRXB is too large for the higher loss of the WR8 pack.

3.2.4.2.6 Fibering summary for LDRXB

As discussed in the previous sections, LDRXB is fibered differently in different configurations. A summary is presented in Table 13..

Table 13. Fibering summary for LDRXB in different configurations.

Configuration	LDRXB Port Fibering						
	SIG OUT	SIG IN	TO ILA	TO ROADM	FROM ILA	FROM ROADM	LINE OUT
ILA	to span	-	-	-	-	-	-
ROADM – Max 4-degree	LDRXB SIG IN	LDRXB SIG OUT	-	WR4 SIG IN	-	-	-
ROADM – Max 8-degree	WR8 SIG IN	-	-	-	-	-	-
UILA	LDRXB SIG IN	LDRXB SIG OUT	Opposite LDRXB From ILA	-	Opposite LDRXB TO ILA	-	to span
UROADM	LDRXB SIG IN	LDRXB SIG OUT	Opposite LDRXB From ILA	Opposite LDRXB From ROADM	Opposite LDRXB TO ILA	Opposite LDRXB TO ROADM	to span

The table indicates how certain ports in LDRXB are fibered. For example, in an ILA, the SIG OUT port is fibered to the span, and none of the other ports in the table headings are used. For the UROADM, the SIG OUT and SIG IN ports on one LDRXB are fibered together, the TO ILA and TO ROADM ports of one LDRXB are fibered to the FROM ILA and FROM ROADM ports, respectively, of the other LDRXB, and so on. In the UROADM entries, the TO and FROM ILA boxes are grayed out to indicate that the fibering is left over from the UILA setup, and these connections are no longer used.

3.2.4.3 1+1 Optical Protection

The OPS circuit pack performs transmit bridging and receive switching for a single wavelength that is routed over diverse paths. A protection pack may be placed on the line side optical path of the OT, as shown in the left portion of Figure 159. on page 202. One OT is used per office. Protection is provided against a fiber cut, but not against OT failure. The working path is illustrated with solid lines. The protection path is indicated with broken lines.

Alternatively, a protection pack may be placed on the client side optical path, as shown in the right portion of Figure 159. on page 202. In this case, 2 OTs are used per office, and protection is provided against both fiber cuts and OT failure. Protection may also be performed with 2 OTs connected directly to separate client signals.

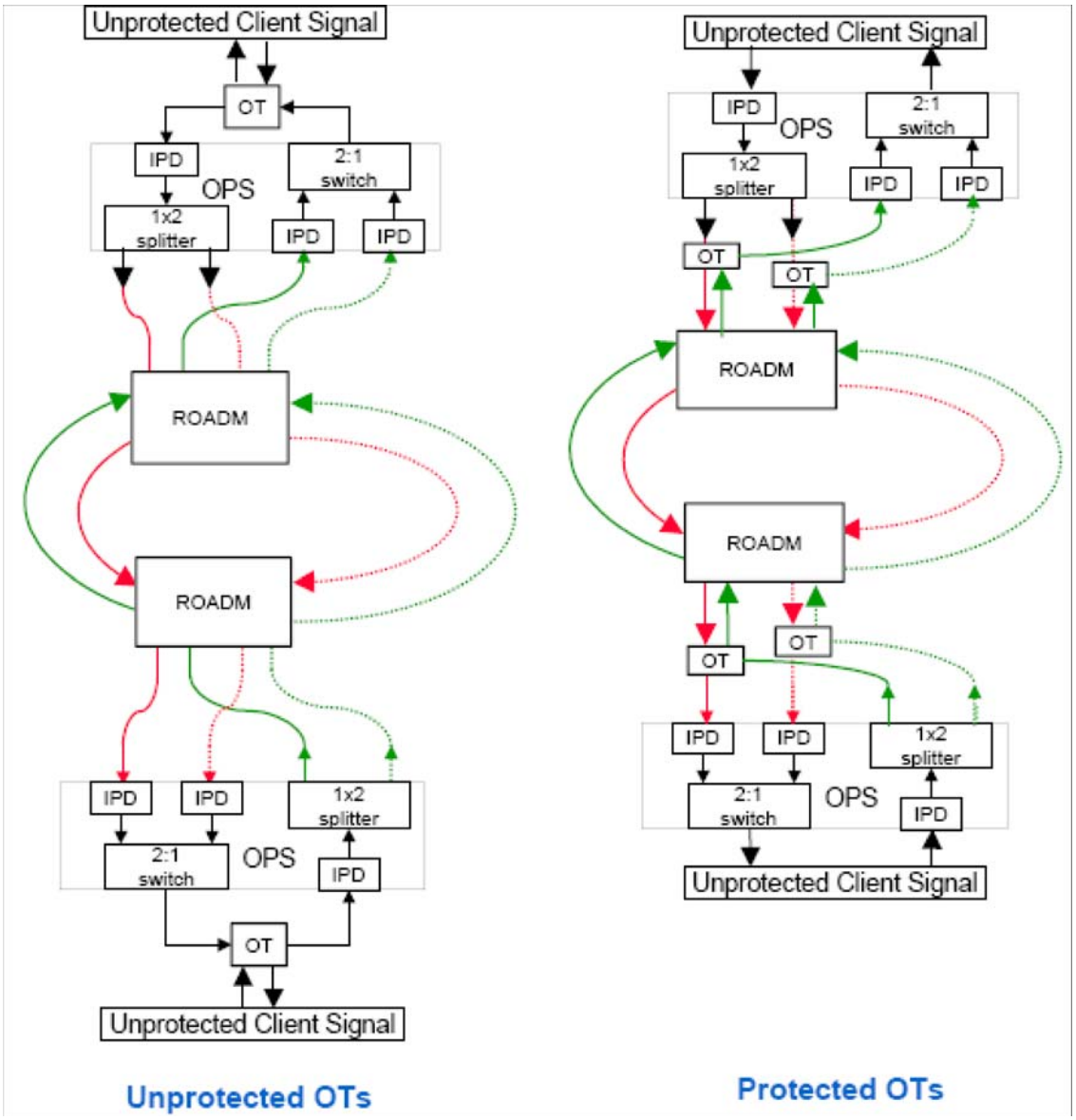


Figure 159. 1+1 Optical protection using OPS.

3.2.4.4 Drop and Continue

Channels that come into a node are broadcast. For example, a copy of a channel that is dropped on the west side of a node appears at the thru channel input port of the WR4 on the east side of the node.

Normally the east WR4 would be set to block the through path for this channel, but for a drop-andcontinue channel, the east WR4 passes this channel.

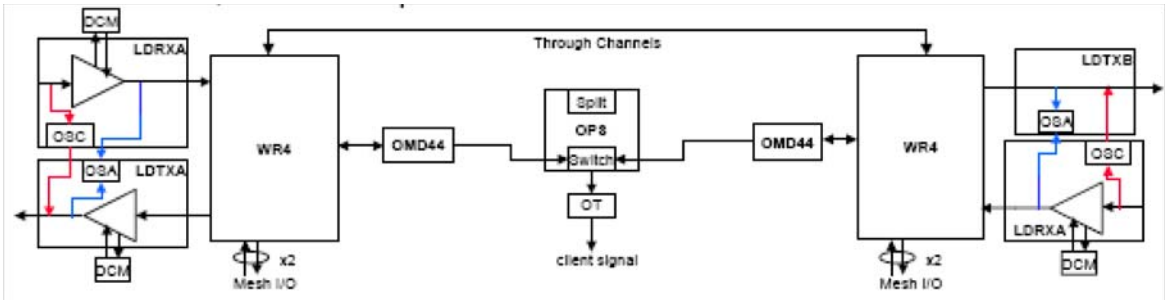


Figure 160. Drop and continue with 1+1 optical protection and unprotected OTs.

Figure 160. on page 203 shows drop and continue using the OPS optical protection switch pack, with an unprotected OT. The OT is operating may be a unidirectional OT because it serves only to drop the signal. The architecture supports unprotected drop-and-continue channels, as well as protection that is provided by a layer 2 switch and 1+1 client side optical protection. The actual protection options that are supported in each release are described in the feature list . Additional options for fibering of drop-and-continue channels are presented in Figure 161. on page 203 to Figure 169. on page 206.

When 1+1 line side optical protection is used, then the east-bound and west-bound copies of the signal are fibered to the selector switch of an OPS, and one copy of the signal is directed to the drop OT. The splitter ports of OPS are not used. Other options are allowed by the architecture: OPS could be used on the client side of two OTs; protection could be performed in the 1850 switch fabric; or, if protection is not required for the drop and continue signal, the OT may be fibered directly to OMD44.

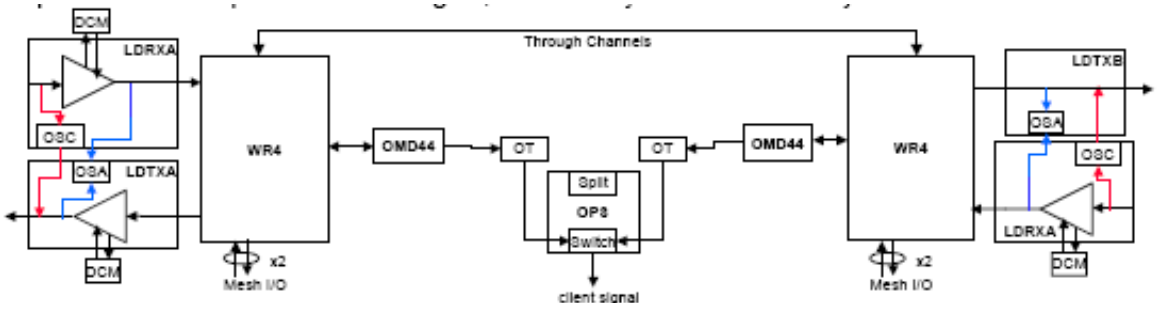


Figure 161. Drop and continue with 1+1 optical protection and protected OTs.

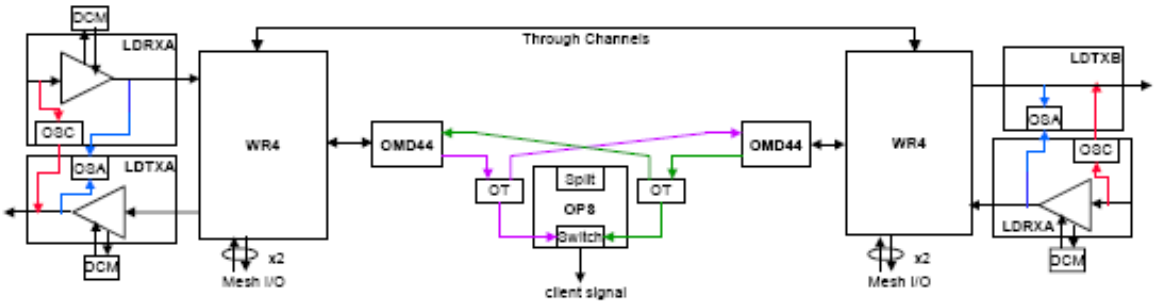


Figure 162. Drop and continue with protection and optical regeneration.

In a drop-and-continue node, the OT receives the channel from the optical line, but does not transmit to the optical line. The OT transmits, but does not receive, a client side signal. A unidirectional 10G OT that provides only the drop capability from the line side is available for drop and continue applications.

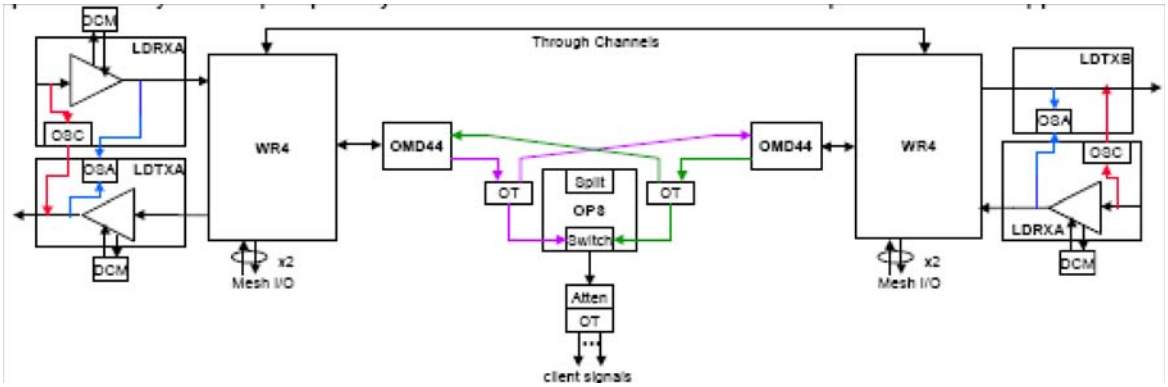


Figure 163. Drop and continue with regeneration when a multiplexing OT is used.

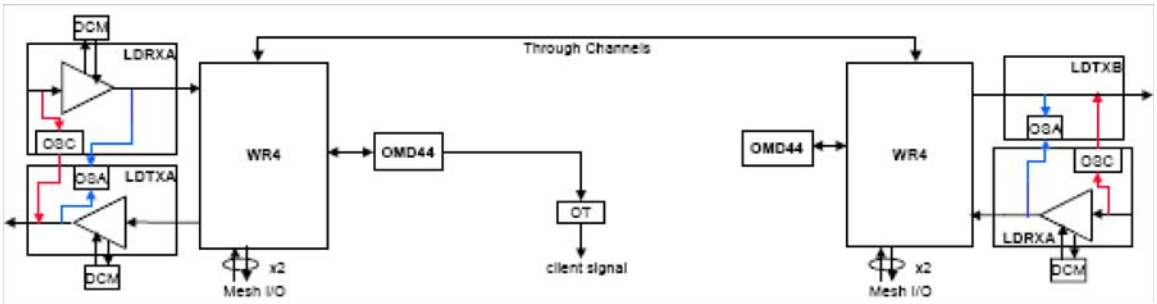


Figure 164. Unprotected drop and continue.

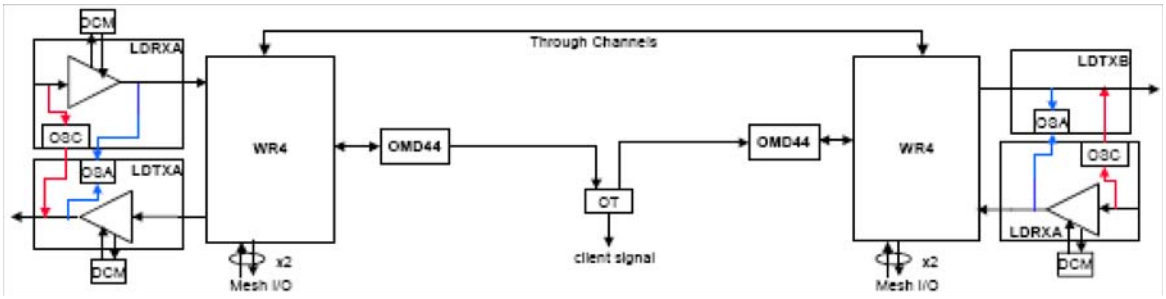


Figure 165. Unprotected drop and continue with regeneration.

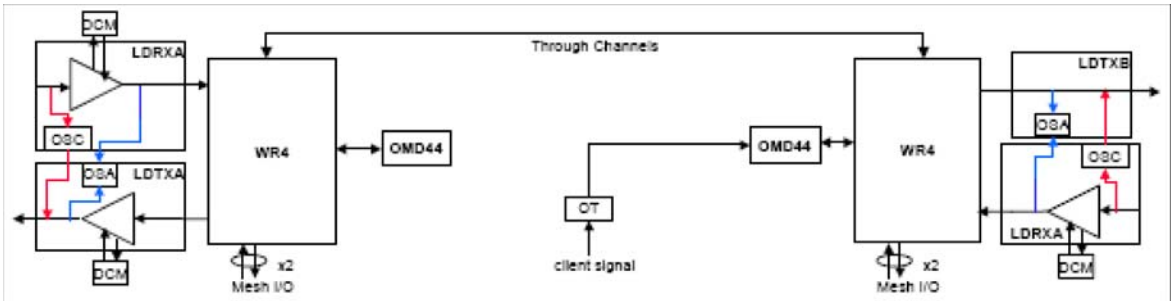


Figure 166. Headend for a unidirectional service without protection.

An additional copy of the channel is available on each mesh output port. This additional copy could be used, for example, for an access spur or for transmission on another ring. Protection would be provided by transmitting a copy of the signal from both the east side and west side WR4 mesh outputs.

A drop-and-continue channel will have an originating node with an OT that transmits the channel to the optical line, but does not receive from the optical line. On the client side, this OT receives, but does not transmit. If the signal is protected with OPS, then the splitting ports of OPS are used, but the switching ports are unused.

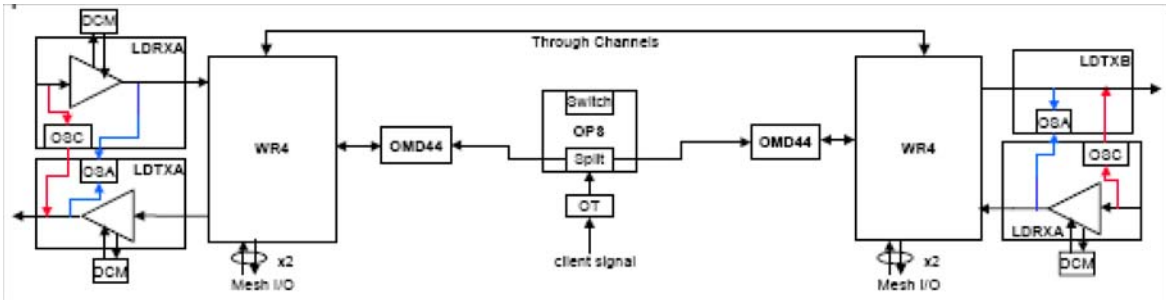


Figure 167. Head end for a unidirectional service, with optical protection (unprotected OT).

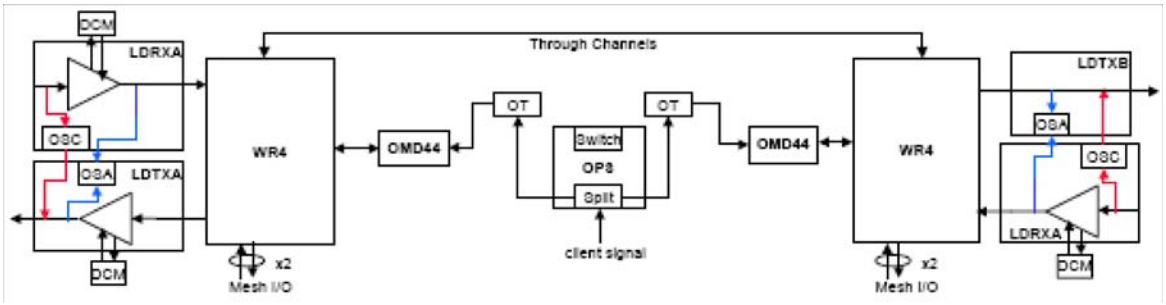


Figure 168. Head end for a unidirectional service, with optical protection (protected OT).

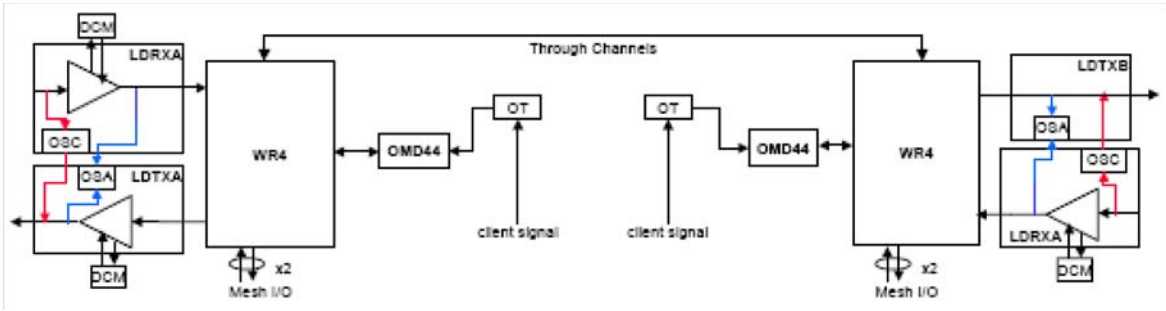


Figure 169. Head end for a unidirectional service, with optical protection (protected OT and client signal).

3.2.4.5 Protection Switching features of DWDM optical channel

The optical protection covers:

– **Protected Line Mode** - protection on the line side, with a single OT located after the switch.
In protected line mode, the working path has a dedicated OMD port and the protection path has a dedicated OMD port, in both the add and drop directions. The working path and the protection path shares a dedicated OT in both the add and drop directions. The client signals is directly attached to the OT circuit pack.
The protected line mode supports:
  - configurations using the single port bidirectional 11G "anyrate" OT packs (11GBAR).
  - onfigurations using the single port unidirectional 11G "anyrate" OT packs (11GUAR).
  - configurations using the OT2TDM (OTU-2) pack.
  - configurations in which all signals attached to the OPS are in the 1529-1610 nm range.

– **Protected OT Mode** - protection on the line side, with redundant protected OTs located before the switch
In protected OT mode, the working path has a dedicated OT and the protection path has a dedicated OT in both the add and drop directions. The client signals is directly attached to the OPS circuit pack.
The OT protected mode supports:
  - configurations using the single port bidirectional 11G "anyrate" OT packs (11GBAR).
  - configurations using the single port unidirectional 11G "anyrate" OT packs (11GUAR).
  - configurations in which both OT client modules and the attached client interface are equipped with 1310 nm modules.
  - configurations in which both OT client modules and the attached client interface are equipped with 1529-1610 nm modules.

Subnetwork Connection Protection
Subnetwork Connection Protection (SNCP) is a dedicated protection mechanism providing path-level protection for individual optical channels that are routed independently across any network (i.e. meshed, rings, or mixed). It may be applied at any path layer in a layered network. It can be used to protect a portion of a path between two Connection Points (CPs) or between a CP and a Termination Connection Point (TCP), or the full end-to-end path between two TCPs.
SNCP is a dedicated 1+1 protection architecture in which the traffic (an optical channel circuit) is permanently bridged onto two SNCs at the transmit end (head-end), carried through any number of facilities of any type, and selected from one of the two SNCs at the receive end (tail-end). One SNC is called the working SNC and the other, the protection SNC.
The path selection is based on purely local information: server layer information (SNC/I), client layer information (SNC/N) or TC monitoring information (SNC/S). For optical channels, only SNC/N will be used. No APS protocol is required since the switching type is uni-directional. SNCP for optical transport networks is defined in ITU G.872

SNC/I Protection
SNC/I protection, generically, protects against server failures. The protection process and the defect detection process are performed by two adjacent layers. The server layer performs the defect detection process, and forwards the status to the client layer by means of the Server Signal Fail (SSF) signal. Because the OPS pack also provides monitoring at the the optical channel layer as opposed to exclusively relying on failure detection at the OMS or OTS layer, SNC/I is not applicable.

SNC/N Protection

SNC/N protection, generically, protects against server failure and also monitors the integrity of the client signals in both the working and protection channels. This includes at least loss of optical power (LOS). Depending on OT confguration, it could include other Signal Fail (SF) and Signal Degrade (SD) conditions. The signal status information is evalutated and could result in a protection switch within the OPS pack.

The OPS function may be placed at the Optical Channel (OC) layer (between the Optical multiplexing layer and the Optical channel to Optical signal (OCh/OS) adaptation (i.e., the OT function). This is referred to as the protected line mode and can also be considered OC-SNC/N.

The OPS function may also be placed at the client or Optical Signal (OS) layer (between the client and the OCh/OS adaptation). This topology is referred to as the "protected OT" mode and can also be considered OS-SNC/N.

3.2.5 Equipment Protection Switching (EQPS)

The protection scheme used by the NE is based on the 1:1 and 1:n APS defined for the OC-n facilities in GR-253.

The system is designed so that no single failure in the switch fabric and control subsystem will impact service.

– Removing or reinserting an EC module doesn't cause a traffic interruption.

– The loss of a first level controller, or the loss of availability of the local NE database doesn't cause a traffic interruption, whether the controller is protected or not.

– Removal/replacement of a failed traffic bearing module following a protection switch doesn't cause any further traffic interruption or alarms, near end or far end.

Forced protection switch is allowed regardless of the state of the active module, if the non active module is provisioned.

In case of 1:1 protection, the forced protection switch is allowed as long as the standby duplex module is not UAS or UEQ (not assigned or not plugged) in case of EC and is not UEQ in case of SC.

All potentially protected modules is capable of operating normally in unprotected configurations (without a functional protecting module provisioned) in case of EC .

Any single failure in a protected module is detected and switch to the redundant copy within 60 ms (normally 10 ms for detection, 50 ms for switching).

A protection group is defined by provisioning a module in the protection slot (EC case only); in the SC case the protection group is automatically created on NE startup and undeletable.
– In 1:1 case, the protection group protects the module provisioned in the working slot only.

As far as the EC only is concerned, the deletion of the protection module results in the deletion of the protection group. This means that, the working EC module will move from protected mode of operation to unprotected mode of operation (i.e., any existing protection switching related states and conditions is cleared).

Deletion of the protection EC module is allowed only when it is locked out from being used by the working module (i.e., INH-SWTOPROTN-EQPT command is in effect for that module).

Deletion of a working module results in the clearing of any existing protection switch related operations, states, and conditions pertaining to that module. This statement doesn't apply to EC and SC group, since working EC and SC is not be able to be deleted.

The protection group doesn't require any particular order of module provisioning. This means that, for example, 1) the protection module can be provisioned after a working module is provisioned, and in this case the working module will move from unprotected mode of operation to protected mode of operation 2) it is not required to provision the working module in any particular sequence (except for working EC and SC, that are automatically preprovisioned and cannot be deleted).

The following secondary states is used to depict if a module involved in a protection scheme is providing service or not.

Module (1:1)	Active	Non active
duplex (1:1)	WRK	STBYH

The manual switch commands and the ALW/INH states is persistent through restarts for equipments.

1:1 Protection

The following common equipment modules are designed to permit 1:1 protection:

– EC320, Equipment Controller
– MT320, Second level controller + Clock functions + HO/LO Matrix

These modules supports the non-revertive switching mode only.

Module	Working Slot	Protection Slot
EC320	1	20
MT320	10	11

Automatically Initiated Switch

An event that causes a protected equipment to move to OOS-AU[MA] state is considered as an automatic switch request for that equipment.

– Only equipment alarm (all events mapped in HWFAIL condition, like equipment failure and voltage missing, and equipment extraction) causes an automatic switch request. Control bus failure doesn't cause an automatic switch request.
– If the non active module is in OOS-AU[MA] state, the automatic switch doesn't initiated, to prevent repeated automatic switches if both active and non active modules are in OOS-AU[MA] state.

For PSF320, that don't support a working/protection scheme but work in load sharing, if one of the two modules moves to OOS-AU[MA] state, the other takes 100% of the load.

When a working equipment is automatically switched to protection equipment, the WKSWPR condition is declared for that working equipment.

When a working equipment with WKSWPR condition moves out of the automatic switch state (due to restoration or preemption), the WKSWPR condition is cleared for that working equipment.

For the non revertive module, a switch to protection is mantained even after the working equipment has recovered from the failure that caused the switch.

Switch due to Logical Removal

When an attempt is made to logically remove the active SC, a forced removal is granted. No switching occurs as a result of a RMV. Both NORM and FRCD options is supported for RMV & ED:::OOS

It is up to the operator to use a SW-DX to change the active module to STBY before, or after, the RMV.

If a RMV NORM is attempted on a STBY module it is allowed .

If a RMV -NORM is attempted on an active module it is denied.

If a RMV -FRCD is attempted, it is always allowed regardless of the state of the module.

For PSF320, if one of the two modules moves to OOS-[AU]MA state, the other takes 100% of the load. Normal removal is allowed if the other PSF320 is in IS, forced removal is required only if the other module is out of service.

Because of the potential service impact, the user should switch traffic away from a module before performing a logical removal.

3.2.5.1 Externally Initiated Switch

1:1 Protection

The NE supports a command to disable (inhibit) an automatic and manual copy switching for the specified one-for-one redundant (duplex) equipment. Either copy of equipment can be specified; the command disables automatic and manual copy switching for both copies of equipment.

– The INH-SWDX-EQPT TL1 command with the active or standby entity provides this functionality.
– This command sets the SST of PSI and the condition type of INHSWDX on the specified entity and on its mate.

The NE supports a command to enable (allow) automatic and manual copy switching for the specified one-for-one redundant (duplex) equipment. Either copy of equipment can be specified; the command enables copy switching on both copies of equipment.

– The ALW-SWDX-EQPT TL1 command with the active or standby entity provides this functionality.
– This command clears the SST of PSI (previously set by FRCD SWDX-EQPT command) and the condition type of INHSWDX (previously set by INH-SWDX-EQPT command) on the specified entity and on its mate.

The NE supports a command to perform a copy switch for the specified redundant (duplexed) equipment. Either copy of equipment can be specified; the command performs a switch regardless of which copy of equipment is specified (the active copy becomes standby and the standby copy becomes active).

– The SW-DX-EQPT TL1 command with the active or standby entity provides this functionality.
– This command clears the SST of STBYH and sets the SST of WRK on the new active module and clears a SST of WRK and sets a SST of STBYH on the previously active module.

Forced SW-DX-EQPT is allowed regardless of the state of the active module, and regardless of the state of the standby duplex module as long as it is not UAS or UEQ (not assigned or not plugged).

Forced SW-DX-EQPT sets the PSI SST following the switch. Any further switching is inhibited just as if INH-SWDX-EQPT had been issued.
In order to clear a FRCD SW-DX and allow manual or automatic switching again, ALWSWDX-EQPT command must be executed

NORM SW-DX is allowed if the standby duplex module is IS (see notes below).

Note: 1. The IS status of the standby module is continuously evaluated by the appropriate controller. Any fault that could cause a service affecting failure after a switch MUST change the PST of the module to OOS-AU (and issue the appropriate alarm).

Note: 2. In case of the matrix/clock modules particularly, a state of IS is guarantee that all traffic bearing paths in the standby unit are failure free, and all clocks and database functions are completely aligned between with the working module. Switching must be accomplished without any traffic hits.

When a SW-DX-EQPT command is successfully completed, an autonomous "report switch" message is generated and issued to the user/OOS.

Switch Operation

All switch requests existing within the equipment protection group (i.e., equipment failure conditions, WTR or No Request switching states, or switch commands) are evaluated to determine the highest priority request based on the order of request priorities in the table below.

– The highest priority request is compared to the current request. If the highest priority request is of higher priority than the current request (based on the order of priorities) or if the current request is no longer a valid request (e.g., the condition or external request that caused it has been cleared) then the highest priority request replaces the current request (i.e., it becomes the new current request). In all other cases, the current request doesn't change.
– When a higher priority request preempts an external request, the preempted request doesn't retained (i.e., when the higher priority request is cleared, the preempted external switch request doesn't reinitiated).

Switch Request or State	TL1 Command or Event	Priority
Inhibit automatic or manual switch	INH-SWDX	1 (Highest)
Forced Switch	SW-DX-EQPT/MODE=FRCD	2
Automatic Switch	Occurrence of an event that causes the equipment to be in OOS-AU[MA] state (e.g., equipment failure/extraction).	3
Manual Switch	SW-DX-EQPT/MODE=NORM	4
No request	Normal Condition	5

Externally initiated switch requests at the same priority level doesn't be able to preempt each other (i.e., the existing request needs to be cleared explicitly).

A switch request (automatic switch, manual switch, switch request due to logical removal) doesn't be denied if the non-active module is not physically present or if it is not provisioned or if it is downloading SW.

When an externally initiated request is cleared, the No Request state is activated .

After any request for the protection equipment is cleared, the No Request state is activated.

When a working equipment is switched to the protection equipment, the provisioning data corresponding to the facilities supported by the affected working equipment is automatically transferred to the protection equipment

For a 1:1 protection equipment, when the switch request is one of the following and if that request is evaluated to be the current request, then a copy switch for the specified redundant (duplexed) equipment is executed (the standby entity becomes the active one, and the previously active one becomes the standby entity).

– Manual switch
– Auto switch

3.2.6 Roll

The NE provide the following Roll features:

– bridge and roll of all the following connectable paths:
  - STS192C
  - STS48C
  - STS12C
  - STS3C
  - STS1

– rolling mode(s).
  - Fully Manual
  - Automatic

– duplex rolling, simplex transmit side rolling and simplex receive side rolling.

In-service facility rolling allows a payload to be moved with minimal interruption from one path through the SONET / PDH network to a different path.

In-service rolling requires coordination with a far-end NE. The roll operation is started by temporarily bridging a payload that is already cross-connected to the desired new path at both the near-end and far-end NEs. After both ends are double fed or bridged, the signal incoming on the new path is verified at both NEs. When signal verification is complete the cross-connections are rearranged to connect the new path to the original tail. The remaining 1WAY connections to the old path are then deleted at both NEs.

A typical sequence of operations for rolling bidirectional traffic within a SONET network is shown in Figure 170..

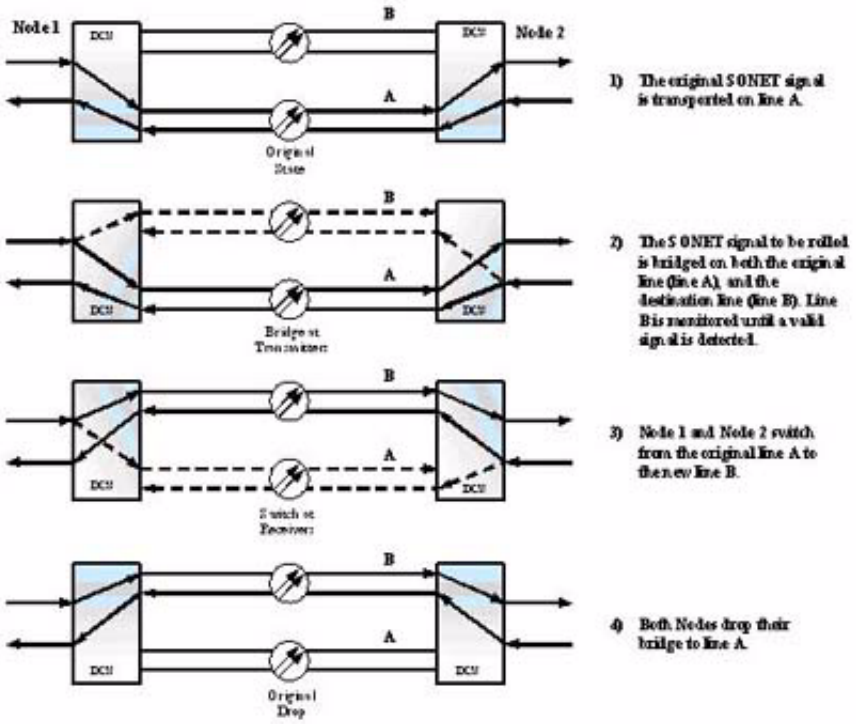


Figure 170. SONET Facility Rolling Procedure

Rolling of services from one facility to another doesn't affect service on any other facility terminating in the NE.

Facility rolling doesn't cause a transmission interruption of more than 2 ms (250 micro second SONET reframe time for STS-N rolling excluded).

The port being rolled to must be in a provisioned state (SST does not include UAS).

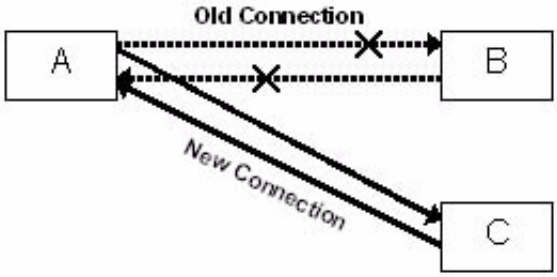


Figure 171. Full duplex rolling

A receive-end one-way roll is characterized by the transfer of a unidirectional receive-side path to a new unidirectional receive-side path, involving a break-connection of the original path and a make-connection to a new path.

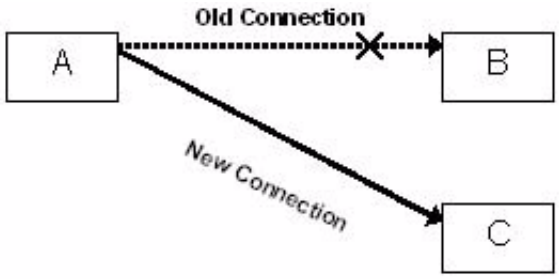


Figure 172. Simplex Transmit Side Roll

The break-make connection is made regardless of whether or not the original input, the new input, or both the original and new input port is connected to another port not involved in the roll as shown in the examples of figure Figure 174..

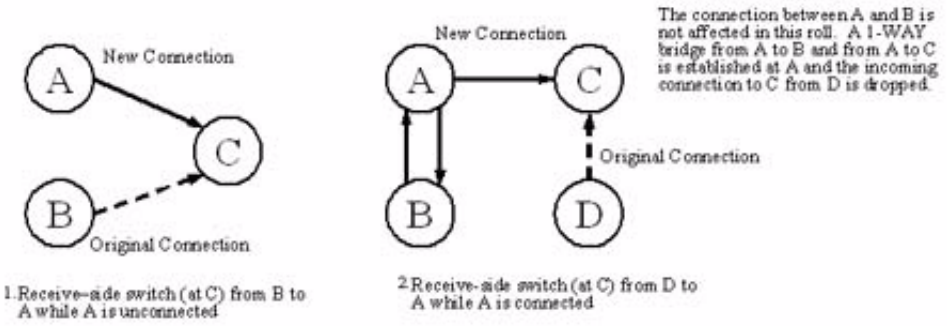


Figure 173. Receive End Roll

Roll commands is allowed on entities of a UPSR when the command is addressed (both Roll From and Roll To) to an Add / Drop port.
Transmit side roll of a UPSR 1WAYPR is allowed, when the command is addressed to an Add / Drop port.

The bridge portion of rolling functions performed at the Add / Drop of a Ring with a Selector establishes the broadcast bridge at the output of the Selector (in the drop direction).
Roll of a UPSR 2WAYPR is allowed, when the command is addressed to an Add / Drop port.
The bridge portion of rolling functions performed at the Add / Drop of a Ring with a Selector shall establish the broadcast bridge at the output of the Selector (in the drop direction).
An example of rolling a UPSR 2WAYPR connection from one Add / Drop port to another is depicted in Figure 174..

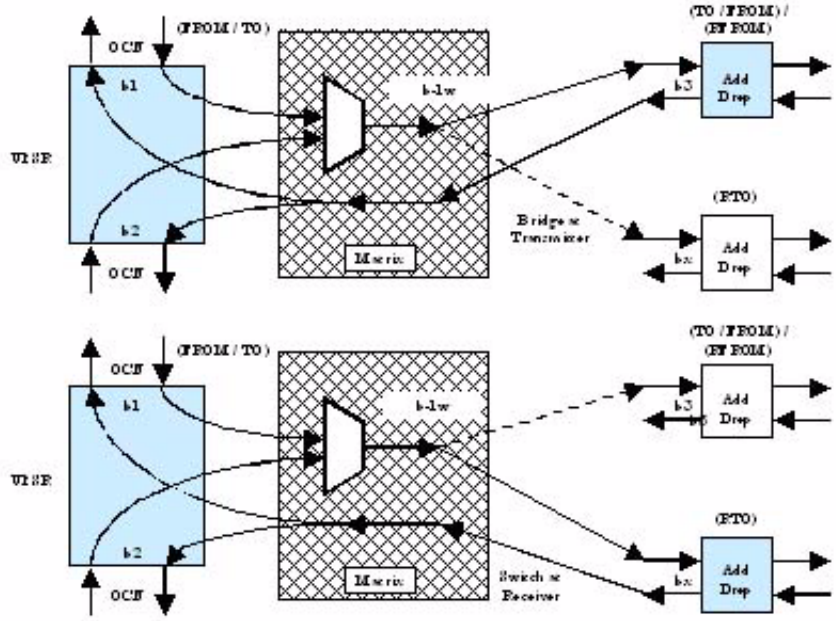


Figure 174. Roll a UPSR Drop

Roll Modes

At the NE level, the key operation in a roll is the movement of traffic from one path (A:B) to another path (A:C) without disruption of service. This is accomplished based on the Mode of the roll operation.

The system supports the following rolling mode(s).

– Fully Manual
  For fully manual mode, the original cross connection shall remain active until the step where the new connection is completely established (see Figure 175., step2b). At this step, the old cross connection shall be deactivated and the new cross connection shall be active instead.

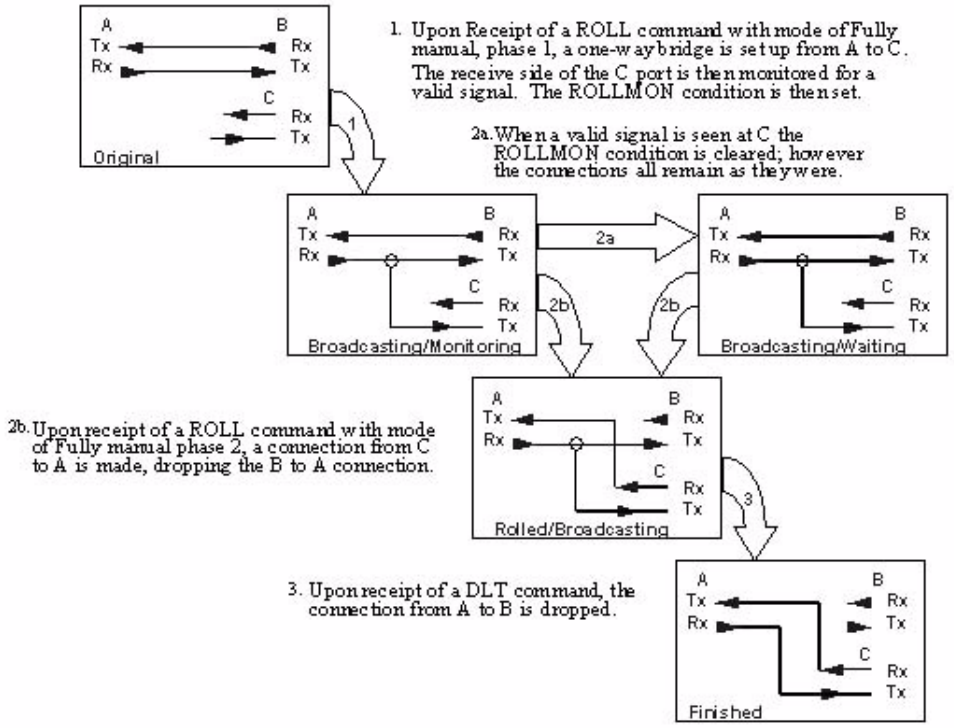


Figure 175. Fully Manual Mode Roll

– Automatic

For automatic mode, the original cross connection shall remain active until the step where the new connection is completely established (see e.g. Figure 176., step2). At this step, the old cross connection shall be deactivated and the new cross connection shall be active instead.

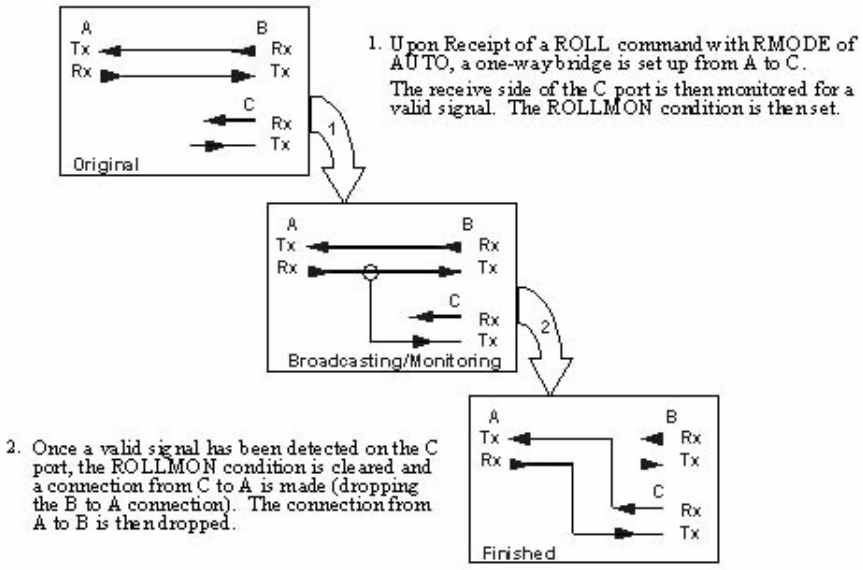


Figure 176. Duplex Automatic Mode Roll

3.2.7 Automatic Power Reduction

The packs involved in APR that must receive configuration information are:
– LDRXA
– LDRXB
– LDTXA
– LDTXB
– WR4
– WR8

During initial node startup or after a hard reset, the pumps on amplified line driver circuit packs remains shut down until configuration information is received from software.

During initial node startup or after a hard reset, the optical switch on LDTXB remains open until configuration information is received from software

Software downloads configuration information to packs that are involved in APR. This information is used to set the packs to monitor the proper defects and backplane traces. This configuration information is down-loaded to the packs during the initial startup of the node and whenever an involved pack has a hard reset. The configuration information includes the maximum channel count for each optical line.

The maximum channel count is always 44 channels. A future system that allows 88 channel transmission is anticipated. The 88-channel system will use higher power, and will require APR for safety reasons at some locations in the system.

For the UILA, additional software notification of configuration information is needed when the UILA makes its transition to a UROADM.

For a UILA, software provides updated configuration information to packs that are involved in APR when the UILA is put in the transition state to the UROADM and when the transition to the UROADM is completed.

Note that after the UILA has been upgraded to a degree-2 UROADM, there can be further in-service upgrades to a higher degree. These higher degrees are subject to the APR requirements of the ROADM, not of the UROADM.

3.2.7.1 Time Periods for APR and Restart

Automatic power reduction from an optical amplifier or a set of optical amplifiers begins if an APR - causing defect set has existed continuously for 10 +/- 2 milliseconds.
The term "defect set" is used to describe the defect or the combination of defects that triggers APR.
The time between determining that automatic power reduction is required for one or more amplifiers and the completion of APR for that set of amplifiers doesn’t exceed 2 seconds.
In some cases, when a shorter time limit is required, the specific APR scenario will specify a shorter response time. The above requirement is intended to provide margin relative to the 3 second time limit based on safety standards. Shorter times can be required if very high power levels are introduced in a future release.
Some APR cases are intended to remove high power from optical connectors before they are damaged by being disconnected or reconnected. Other APR cases are implemented to isolate transmission-affecting pack failures. The latter procedures have shorter time limits.
Release 2.0 includes cover protection on certain connectors in the amplified LD packs and on WR's. The cover must be removed before the fiber under the cover can be disconnected.
A set of amplifiers might include amplifiers in different network elements. This is true in particular if APR is required for a span cut.

Restart after an APR event is controlled by software. The restart is automatic, and will occur after the APR condition has cleared..
The APR itself is controlled by either hardware or software.
For APR that is initiated by hardware, hardware determines when the defect set that triggered APR has cleared, and indicates this clearing to software.
Restart of transmission begins no earlier than 100 seconds after detection of the defect set that triggers APR. This delay in restarting is for safety requirements. This reference is intended for APR that is required for safety purposes, but the 100 second requirement is adopted in this RRS for all APR events.
This part covers the response of circuit packs to removal and restoration of covers over optical connectors.

3.2.7.2 Cover Protection

This section describes the response of circuit packs to removal and restoration of covers over optical connectors.
If the response to the removal of a cover from a protected optical connector is to reduce the output power of a VGOAM to zero, then the VGOAM power remains at zero while the cover is off even if this power reduction causes APR conditions that have a different VGOAM response.
The response to removal of a cover from a protected optical connector is normally to reduce the output power of a VGOAM to zero. This reduction causes LOS at one or more input ports, which could trigger an APR condition that requires that the VGOAM output power be reduced to a nonzero level. This means that the VGOAM power must remain zero as long as the cover is off.

– **LDRXA**

  If the cover that protects the SIG OUT port of LDRXA is removed, hardware causes the VGOAM in LDRXA to shut off its output power.
  When the cover that protects the SIG OUT port of LDRXA is replaced, software causes the VGOAM output power to be set to its startup value.
  In a ROADM, when the VGOAM power is shut off, this causes an APR condition at the WR that follows. Recovery will begin when the cover is replaced and power is returned to the startup value.
  The Figure 177. shows the location of the cover-protected port on LDRXA.

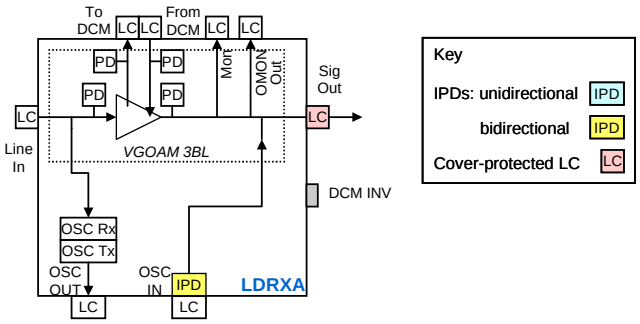


Figure 177. LDRXA

– **LDRXB**

  The Figure 178. shows the location of the cover-protected ports on LDRXB. The two ports share a single cover.

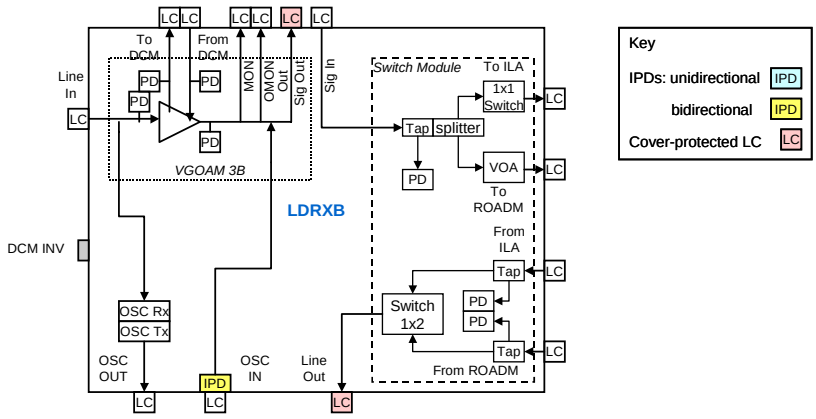


Figure 178. LDRXB

If the cover that protects the SIG OUT and LINE OUT ports of LDRXB is removed,

1) hardware causes the VGOAM in LDRXB to shut off its output power, and
2) if the LDRXB is part of a UILA, software causes the LDRX whose output is fibered to the FROM ILA port to shut off its output power, and
3) if the LDRXB is part of a UROADM, hardware causes the LDTXA whose output is fibered to the FROM ROADM port to shut off its output power, and
4) if the LDRXB is part of a node that is in the transition state between a UILA and a UROADM, software causes the LDRX whose output is fibered to the FROM ILA port and hardware causes the LDTXA whose output is fibered to the FROM ROADM port to shut off their output powers.

When the cover that protects the SIG OUT and LINE OUT ports of LDRXB is reattached, then

1) software causes the VGOAM output power to be set to its startup value, and
2) if the LDRXB is part of a UILA, software causes the LDRX whose output is fibered to the FROM ILA port to be set to its startup value, and
3) if the LDRXB is part of a UROADM, software causes the LDTXA whose output is fibered to the FROM ROADM port to be set to its startup value, and
4) if the LDRXB is part of a node that is in the transition state between a UILA and a UROADM, software causes both the LDRX whose output is fibered to the FROM ILA port and the LDTXA whose output is fibered to the FROM ROADM port to be set to their startup values.

The Figure 179. shows 1-direction of transmission for the UILA and UROADM. Removal of the cover from the LDRXB on the right side of the figure (shown in yellow) causes the VGOAM in that LDRXB to shut off. In addition, in the UILA, the removal of this cover causes a shutdown of the VGOAM in the LDRXB on the left side of the figure (shown in green). In the UROADM, removal of this same cover causes shutdown of the VGOAM in the LDTXA (shaded turquoise). For a shelf that is in transition between the UILA and UROADM, removal of the cover in the yellow LDRXB causes shutdowns of the VGOAMs in both the green LDRXB and the turquoise LDTXA.

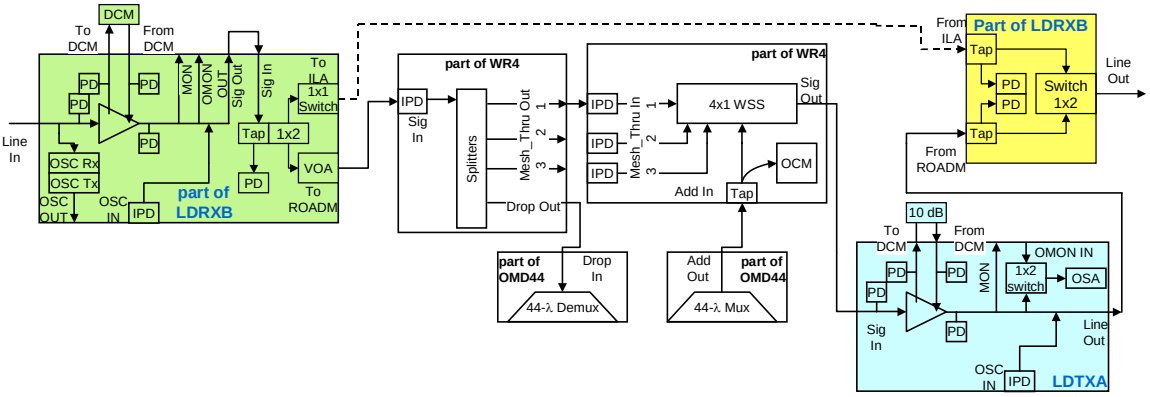


Figure 179. LDRXA for UILA

– **LDTXA**

If the cover that protects the LINE OUT port of LDTXA is removed, hardware causes the VGOAM in LDTXA to shut off its output power.

When the cover that protects the LINE OUT port of LDTXA is reattached, software causes the VGOAM output power to be set to its startup value.

– **WR4 and WR8**

The Figure 180. shows the location of the cover-protected SIG IN port on WR4 and WR8. The SIG OUT port might also be placed under the cover to satisfy physical design constraints, but the cover is intended to protect against damage to the SIG IN port if a fiber is disconnected.

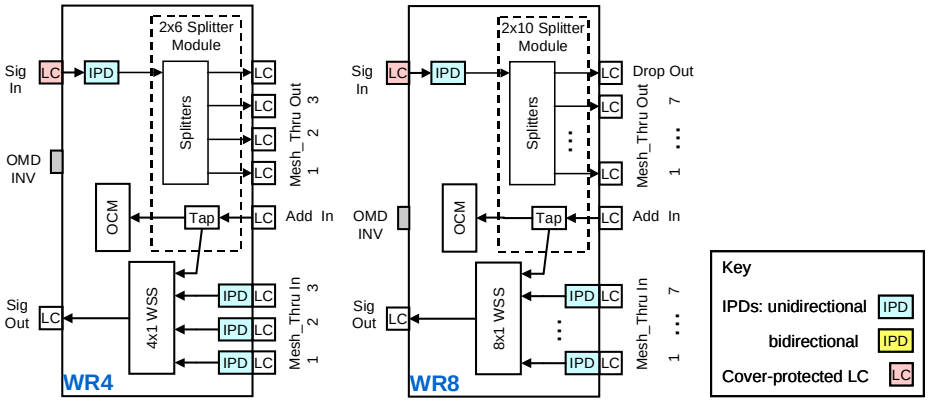


Figure 180. WR4 and WR8

If the cover that protects the SIG IN port of WR4 or WR8 is removed, software causes the VGOAM in the LDRX that is fibered to the WR SIG IN port to shut its power off.

When the cover that protects the SIG IN port of WR4 or WR8 is reattached, software causes the VGOAM in the LDRX that is fibered to the SIG IN port to be set to its startup value.

3.2.7.3 APR in 44-Channel ROADM, Maximum Degree 4

This section describes a ROADM of maximum degree 4. In addition, if a UROADM with maximum degree 4 is upgraded in service beyond degree 2, the requirements of this section are applyed to the optical lines other than lines 1 and 2.

The Figure 181. shows one direction of transmission in a 44-channel ROADM with maximum degree 4 equipped with LDRXA. Power from LDRXA is reduced when necessary to prevent connector damage due to possible disconnection of the fiber between LDRXA and WR4 (yellow packs). The LDTX is shut down if there is a transmission-affecting failure to the WSS in the preceding WR4 (blue packs).

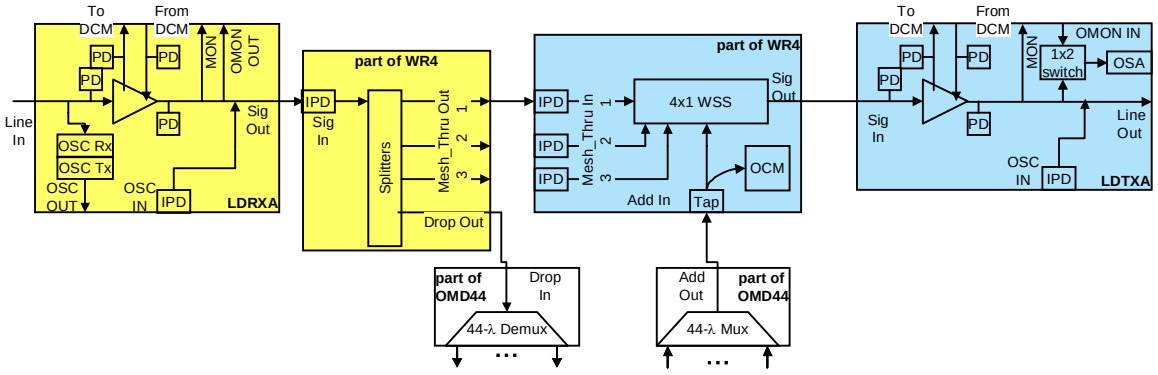


Figure 181. APR in 44-Channel ROADM, Maximum Degree 4

The Figure 182. shows one direction of transmission in a 44-channel, maximum-degree-4 ROADM equipped with LDRXB.

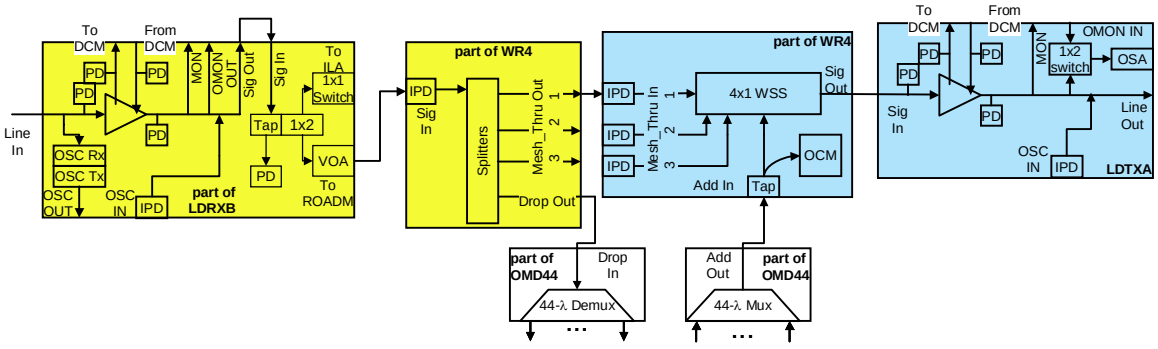


Figure 182. APR in 44-Channel ROADM, Maximum Degree 4 with LDRXB

APR for the LDRX

– Defects at the WR that Follows the LDRX

Detection of defects at the WR for triggering APR in the LDRX, and response to these defects, occurs in software.

APR occurs in the LDRX based on the following defect set at the WR: APR = LOP + LOV + dLOS, where LOP and LOV refer to WR defects, and dLOS is detected by the WR at the SIG IN port.

When APR occurs in the LDRX due to a defect at the WR, software causes the VGOAM to place its output at the eye-safe level.

The eye-safe level for the VGOAM is 10 dBm or less.

– Defects at the LDRX
  APR occurs when there is dLOS at the SIG IN port of LDRXB.
  Detection of dLOS at the SIG IN port of LDRXB, and response to this defect, occurs in hardware.
  When APR occurs due to dLOS at the SIG IN port, hardware causes the VGOAM to place its output at the eye-safe level.

APR for the LDTX

Detection of defects for triggering APR in the LDTX, and response to these defects, occurs in hardware.
APR occurs in the LDTX of a 44-channel ROADM based on the following defect set: APR = CRC + LOP + LOV. CRC and LOP are detected by the LDTX in its monitoring of the WR that precedes it, and LOV is detected by the WR and communicated to the LDTX that follows it.
When APR occurs in an LDTX that is equipped with a VGOAM, a hardware signal causes the VGOAM to disable its output. Hardware sends this instruction within 50 milliseconds from the time that the defect is first detected.
When APR occurs in an LDTX that is unamplified, a hardware signal causes the switch in the optical path to open. Hardware sends this instruction within 50 milliseconds from the time that the defect is first detected.

3.2.7.4 APR in 44-Channel ROADM, Maximum Degree 8

The Figure 183. shows one direction of transmission in a 44-channel ROADM with maximum degree 8 equipped with LDRXB. LDRXA cannot be used in a maximum degree-8 ROADM. The APR requirements are the same as in the maximum-degree-4 ROADM, except that the SIG IN port of LDRXB is not monitored for LOS.

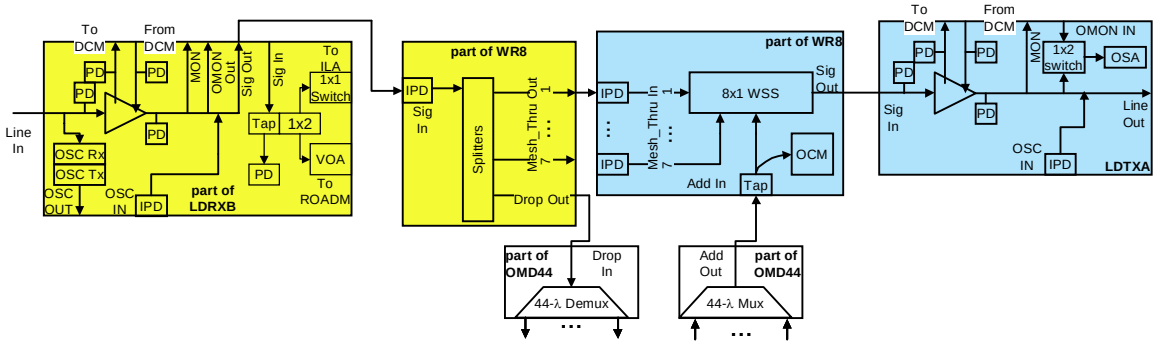


Figure 183. APR in 44-Channel ROADM, Maximum Degree 8

APR for the LDRX

Detection of defects at the WR for triggering APR in the LDRX, and response to these defects, occurs in software.
APR occurs in the LDRX based on the following defect set at the WR that follows the LDRX: APR = LOP + LOV + dLOS, where LOP and LOV refer to WR defects, and dLOS is detected by the WR at the SIG IN port.
When APR occurs in the LDRX due to a defect at the WR, software causes the VGOAM to place its output at the eye-safe level.

APR for the LDTX

Detection of defects for triggering APR in the LDTX, and response to these defects, occurs in hardware.
APR occurs in the LDTX of a 44-channel ROADM based on the following defect set: APR = CRC + LOP + LOV. CRC and LOP are detected by the LDTX in its monitoring of the WR that precedes it, and LOV is detected by the WR and communicated to the LDTX that follows it.

When APR occurs in an LDTX that is equipped with a VGOAM, the VGOAM is instructed through a hardware signal to disable its output. Hardware sends this instruction within 50 milliseconds from the time that the defect is first detected.
When APR occurs in an LDTX that is unamplified, the switch in the optical path is instructed through a hardware signal to open. Hardware sends this instruction within 50 milliseconds from the time that the defect is first detected.

3.2.7.5 UILA

The Figure 184. shows one direction of transmission in a 44-channel UILA. In this configuration, the 1x1 switch that precedes the TO ILA port is in the closed position, and the VOA that precedes the TO ROADM port is at the maximum attenuation setting.

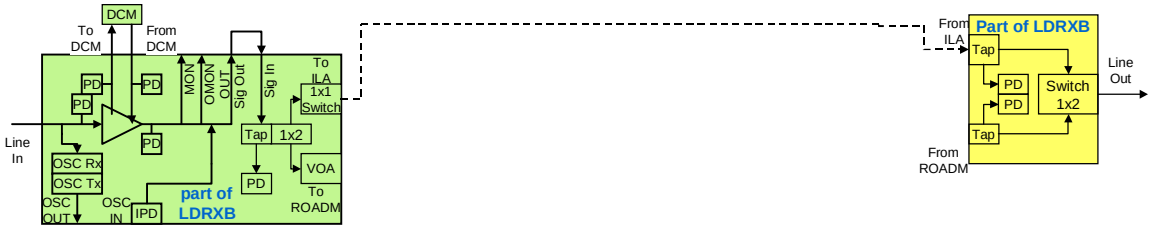


Figure 184. UILA

APR Due to LOS at the SIG IN Port of an LDRX

APR occurs when there is dLOS at the SIG IN port of LDRXB
Detection of dLOS at the SIG IN port of LDRXB, and response to this defect, occurs in hardware.
When APR occurs due to dLOS at the SIG IN port, hardware causes the VGOAM to place its output at the eye-safe level.
For this case, the defect and the APR are in the green-shaded LDRX.

APR at One LDRX Due to Defects at the Other LDRX

APR occurs in one LDRX based on the following defect set at the second LDRX: APR = dLOS (at the FROM ILA port) + dLOP + dLOV.
When APR occurs in the LDRX due to the defects in the second LDRX, software causes the VGOAM to place its output at the eye-safe level.
For this case, the defect is in the yellow-shaded LDRX and the APR occurs in the green-shaded LDRX.

3.2.7.6 UROADM for Maximum Degree 4

The figure shows one direction of transmission in a 44-channel UROADM. This version of the UROADM can be upgraded to a maximum degree of 4.

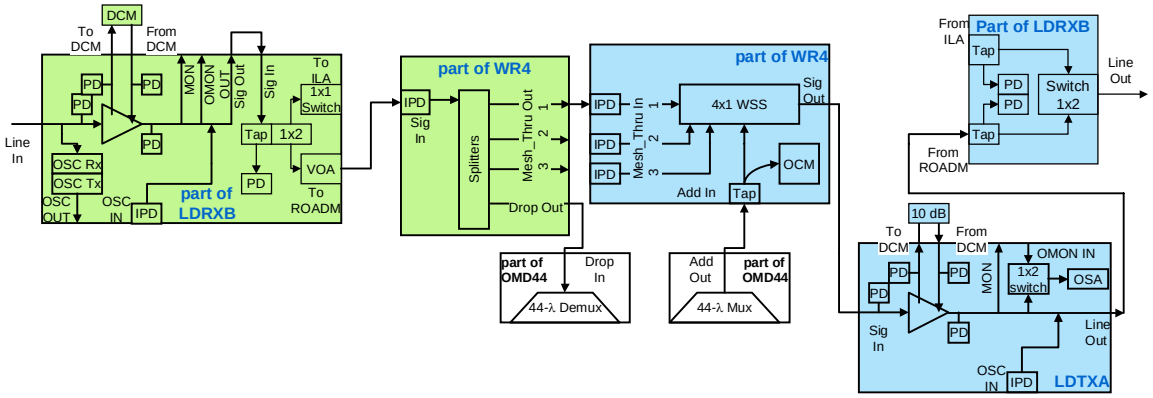


Figure 185. UROADM for Maximum Degree 4

APR at the LDRX

– APR Due to LOS at the SIG IN Port of an LDRX

APR occurs when there is dLOS at the SIG IN port of LDRXB

Detection of dLOS at the SIG IN port of LDRXB, and response to this defect, occurs in hardware.

When APR occurs due to dLOS at the SIG IN port, hardware causes the VGOAM to place its output at the eye-safe level.

For this case, the defect and the APR are in the green-shaded LDRX.

– Defects at the WR that Follows the LDRX

Detection of defects at the WR for triggering APR in the LDRX, and response to these defects, occurs in software.

APR occurs in the LDRX based on the following defect set at the WR: APR = LOP + LOV + dLOS, where LOP and LOV refer to WR defects, and dLOS is detected by the WR at the SIG IN port.

When APR occurs in the LDRX in response to a defect at the WR, software causes the VOA that precedes the TO ROADM port of the LDRX according to the following rules:

- If the output power of the VGOAM is less than or equal to 12.0 dBm, the VOA setting is unchanged from its normal operating value. The normal operating value is its minimum attenuation value.
- If the output power of the VGOAM is greater than 12.0 dBm, the VOA is set to a value 9 dB above its minimum attenuation value.

The above rules are set to ensure that the output power at the TO ROADM port is high enough to be detected at the SIG IN port of the WR, but low enough to make connector damage unlikely.

Comparing the low end of the power range to the LOS threshold at the WR: If the output power of the VGOAM is just above 12.0 dBm, the loss through the switch module path is at its maximum end-of-life value of 4.9 dB, and the added attenuation of the VOA is 9 dB, then the output power at the TO ROADM port is -1.9 dBm. The VOA setting uncertainty is +/- 2 dB, and there will be some additional optical connection loss. A likely minimum power level at the SIG IN port with this algorithm is thus approximately -4.5 dBm. For comparison, the thresholds for setting and clearing LOS occur at -8 and -7 dBm, respectively.

The upper limit of the power at the TO ROADM port is estimated as follows: The maximum output power of the VGOAM is 20.8 dBm. The minimum loss through the switch module is likely to be over 3 dB. For consistency with the ROADM TFS Annex, 3.2 dB, plus 0.1 dB connection loss, can be used. The minimum actual loss of the VOA is 7 dB when it is set to a nominal value of 9 dB. The resulting upper limit to the power at the TO ROADM port is 10.5 dBm. This value is within the range that is used elsewhere in the ROADM to reduce the likelihood of connector damage.

APR at the LDTX

– Defect at the WR that Precedes the LDTX
  Detection of defects at the WR for triggering APR in the LDTX, and response to these defects, occurs in hardware.
  The WR and LDTX that are involved in the APR are shaded blue in Figure 185..
  APR occurs in the LDTX based on the following defect set: APR = CRC + LOP + LOV. CRC and LOP are detected by the LDTX in its monitoring of the WR that precedes it, and LOV is detected by the WR and communicated to the LDTX that follows it.
  When APR occurs in the LDTX, a hardware signal causes the VGOAM to disable its output. Hardware sends this instruction within 50 milliseconds from the time that the defect is first detected.
  The unamplified LDTXB is not used in the UROADM.
  When APR occurs in an LDTX that is unamplified, a hardware signal causes the switch in the optical path to open. Hardware sends this instruction within 50 milliseconds from the time that the defect is first detected.

– Defect at the LDRX that Follows the LDTX
  Detection of defects at the LDRX for triggering APR in the LDTX, and response to these defects, occurs in hardware.
  The LDRX and LDTX that are involved in the APR are shaded blue in Figure 185..
  APR occurs in the LDTX based on the following defect set: APR = CRC + LOP + LOV + dLOS, where dLOS is monitored at the FROM ROADM port of the LDRX that follows the LDTX, and LOP and LOV are for this same LDRX, and CRC is monitored in hardware by the LDTX.
  When APR occurs in the LDTX, hardware causes the VGOAM to place its output at the eye-safe level.

3.2.7.7 Transitional State from UILA to UROADM

APR Due to LOS at the SIG IN port of an LDRX
When a node is in the transitional state from the UILA to the UROADM, all APR for the UILA and the UROADM for APR Due to LOS at the SIG IN port of an LDRX are applyed.

APR at One LDRX Due to Defects at the Other LDRX
When a node is in the transitional state from the UILA to the UROADM, all APR for the UILA at One LDRX Due to Defects at the Other LDRX are applyed.

APR at the LDTX
When a node is in the transitional state from the UILA to the UROADM, all APR for the UROADM at the LDTX, including Defect at the WR that Precedes the LDTX and Defect at the LDRX that Follows the LDTX, are applyed.

APR at the LDRX Due to Defects at the WR that Follows the LDRX
Detection of defects at the WR for triggering APR in the LDRX, and response to these defects, occurs in software.
APR doesn't occur in the LDRX based on the following defect set at the WR: APR = LOP + LOV + dLOS, where LOP and LOV refer to WR defects, and dLOS is detected by the WR at the SIG IN port (alarm dWRSIGINLOS).

When APR occurs in the LDRX in response to a defect at the WR, software causes the VOA that precedes the TO ROADM port of the LDRX according to the following rules:

1) If the output power of the VGOAM is less than or equal to 12.0 dBm, the VOA setting will be unchanged from its normal operating value. The normal operating value is its minimum attenuation value.
2) If the output power of the VGOAM is greater than 12.0 dBm, the VOA will be set to a value 9 dB above its minimum attenuation value.
3) During the APR condition, software reads the VGOAM output power and readjust the VOA setting if necessary once every 10 seconds. The rules for readjustment are:
    a) If the VOA is set to its minimum attenuation, and the output power of the VGOAM reaches a level greater than or equal to 13 dBm, then the VOA is set to 9 dB above its minimum attenuation value.
    b) If the VOA is set to 9 dB above its minimum attenuation value, and the output power of the VGOAM reaches a level less than or equal to 11 dBm, then the VOA is set to its minimum attenuation value.

The above rules are set to ensure that the output power at the TO ROADM port is high enough to be detected at the SIG IN port of the WR, but low enough to make connector damage unlikely.
Comparing the low end of the power range to the LOS threshold at the WR: If the output power of the VGOAM is just above 12.0 dBm, the loss through the switch module path is at its maximum end-of-life value of 4.9 dB, and the added attenuation of the VOA is 9 dB, then the output power at the TO ROADM port is –1.9 dBm. The VOA setting uncertainty is +/- 2 dB, and there will be some additional optical connection loss. A likely minimum power level at the SIG IN port with this algorithm is thus approximately –4.5 dBm. For comparison, the thresholds for setting and clearing LOS occur at –8 and –7 dBm, respectively.
The upper limit of the power at the TO ROADM port is estimated as follows: The maximum output power of the VGOAM is 20.8 dBm. The minimum loss through the switch module is likely to be over 3 dB. For consistency with the ROADM TFS Annex, 3.2 dB, plus 0.1 dB connection loss, can be used. The minimum actual loss of the VOA is 7 dB when it is set to a nominal value of 9 dB. The resulting upper limit to the power at the TO ROADM port is 10.5 dBm. This value is within the range that is used elsewhere in the ROADM to reduce the likelihood of connector damage.

The VGOAM output power must be monitored, and the VOA setting readjusted if necessary, in the course of an APR event. Otherwise, if the output power of the VGOAM changes – for example, due to a change in the number of incoming channels – it might no longer be possible to restart or to protect against connector damage. The readjustment has hysteresis and is performed only periodically in order to prevent excessive wear on the VOA.

3.2.8 Facility Protection Switching (FPS)

Path facility provisioning rules are different for each protection scheme and follows the schemas described below:

– **Linear 1+1 APS** path facilities may be created only on the Working/Preferred OCn.. Attempts to create path facilities on the Protecting/Alternate OCn is denied. Protection channel access is not allowed

– **UPSR** path facilities may be created on either OCn. If a path facility is created with UPSR connection enabled, then its companion path facility is automatically created with the same provisioning on the other OCn. After initial provisioning certain parameters can be independently edited the member path facilities. Deleting one path facility deletes them both.

– **BLSR** path facilities may be created on East or West OCn independently. The same time slot may be used for a different path rate signal on East and West. The protection path facilities cannot be created or addressed. Attempts to create path facilities in the Protecting timeslots is denied. Protection channel access is not allowed

The management state (IS, OOS-MA) of FFP members (OCn) or their embedded path facilities (STSn) doesn't have effect protection switching rules or operations. .
Automatic or Manual protection swithching is not inhibted if the Protecting entity is OOS-MA
Automatic proection switching is not initiated if the Working entity is placed OOS-MA
Protection Switching events doesn't directly affect the SA/NSA alarm escalation de-escalation evaluation, however the evaluation must be re-performed after each protection switching event or state change.
When a condition is defined as having the possibility to be either service-affecting (SA) or non-service affecting, the following requirements apply:

A facility condition is service-affecting (SA) if:
– the facility's secondary state is TRM or ACT or BUSY and the facility is either not protected or the facility is actively carrying traffic but protection is not available
– the facility's secondary state is TRM, and the facility itself is either not protected or the facility protection is not available, and any supported ACT or BUSY facilities are either not protected or their facility protection is not available

A facility condition is non-service-affecting (NSA) if:
– the facility's secondary state is neither TRM nor ACT nor BUSY
– the facility is a protecting facility not currently carrying the active traffic
– the facility's secondary state is TRM or ACT or BUSY and the facility is protected and the facility protection is available
– the facility's secondary state is ACT or BUSY and the facility is both protected and the facility protection is available
– the facility's secondary state is TRM and and all supported ACT or BUSY facilities are both protected and the facility protection is available

Note: "Facility protection not available" is defined when any protecting facility is OOS. "Facility protection available" is defined when all protecting facilities are IS.
"Facility protection not available" is defined when any protecting facility is OOS or when protecion switching is inhibited or locked out.
"Facility protection available" is defined when all protecting facilities are IS or OOS-MA and protection switching is enabled and not locked out.

Linear 1+1 APS

The NE supports uni-directional switching.

– A provisioned OC-n (n = 3, 12, 48, 192) port can be paired with another provisoned OC-n port of the same rate to form a 1+1 protection group.
– The port numbers on the OC-n modules paired in the 1+1 protection group must be the same.
– The modules and ports paired in a 1+1 protection group must be in adjacent slots.
– NE detects facility/APS failures requiring protection switching in 10 ms and complete switch in 50 ms.
– NE provides manual protection switching operation to support facility maintenance actions. Manual switch, Forced switch and Lockout modes are supported.
– The NE supports 1+1 switching on OC3, OC12, and OC48 facilities.
– Excessive switching lockout. The NE is designed to reduce the chance or number of rapid protection switching oscillations that could occur in multiple failure or degradation situations where one or more of the failures or degradations is intermittent.

BLSR

– 2F-BLSR is compliant with GR-1230 Issue 4 including:
– For a single failure, the 2FBLSR restores all traffic within 60 milliseconds (includes detection time).
– Ring switching in a non-clean ring, 2FBLSR restores all traffic within 110 milliseconds (includes detection time).
– The 2FBLSR services multiple failures while segmenting the ring into multiple rings.
– Adding, deleting and renaming of nodes from a 2FBLSR ring is supported.
– When multiple node isolation occurs from switch requests of equal priority, the BLSR ring recovers by segmenting into multiple rings.
– 2FBLSR ring maps and squelch maps is used to prevent misconnected traffic.
– Manual ring map and squelch map building is supported.
– K-Byte capture support to aid debugging switching related anomalies.
– Line Facility loopbacks are supported.
– BLSR map data is persistent during EC/MT controller restarts, warm restarts, cold restarts, power restarts, single module replacement and in-service upgrades.
– BLSR Performance monitoring support.

UPSR

The UPSR feature is designed to establish an interface with an OCn Unidirectional Path Switched Ring, and to cross-connect ring traffic between the ring and other facilities terminating at the NE. The feature also supports ring interconnection through the NE's matrices. The UPSR ring can support protected traffic and unprotected traffic. However, most customer applications demand protection of traffic. The NE supports cross connects that can be set up which are unprotected and cross connects that are protected.

One UPSR node is formed using two OCn modules that are located in adjacent slots of the NE. After a node is formed, UPSR path entities are provisioned either on the EAST or WEST OCn facility. When the ENT-STSn path command executes for a path in the EAST OCn facility, an identical path entity is automatically provisioned on the WEST OCn facility to match the path entered or when the ENT-STSn path command executes for a path in the WEST OCn facility, an identical path entity is automatically provisioned on the EAST OCn facility to match the path entered. The NE would insure sending out the autonomous database change message for the entity that is created by the system.

When traffic from the ring is to be dropped and cross-connected to another facility of the NE, a pair of path entities are normally connected as a 2WAYPR or 1WAYPR protected connections. When the ENT-CRS command executes for a protected connection, a path selector is created that selects ring traffic from the Preferred or Alternate path (Inner ring or outer ring) as provisioned. Path selection switching is controlled by path level defects and externally initiated switch commands.

When a cross connect is established, switching parameters are established.

Deletion of the UPSR protection group is supported by the NE. The UPSR protection group can is permitted to be deleted when all the cross connects are deleted including the THRU connections at the UPSR node.

The switch states of UPSR FFP are managed separately and reported separately at the path facility level for each UPSR connection implemented inside an OCn FFP.

UPSR nodes may co-exist with other BLSR, 1+1 protection groups or other unprotected OCn facilities in the same NE .

Each OCn (n = 3, 12, 48, 192) UPSR is provided with following features:

– STS-1, STS-3c, STS-12c, STS-48c and STS-192c path support.
– 1WAYPR Drop & Continue for Protected Broadcast applications.
– 2WAYPR protected path configurations.
– THRU connections (Pass Through) between path facilities embedded in UPSR OCn facilities.(Paths in East OCn facility to paths in WEST OCn facility). The incoming STSn on the EAST OCn will go out on the same STSn on the WEST outgoing path and incoming STSn on the WEST OCn will go out on the same STSn on the EAST facility.
– 1WAYTHRU connections (1WAY Pass Through) between path facilities embedded in UPSR OCn facilities.(Paths in East OCn facility to paths in WEST OCn facility). The incoming STSn on the EAST OCn will go out on the same STSn on the WEST outgoing path or incoming STSn on the WEST OCn will go out on the same STSn on the EAST facility.
– Unprotected 2WAY connections on the OCn EAST or OCn WEST facility.
– Support of path defects that initiate path switching are:
  • AIS-P, LOP-P, UNEQ-P, EBER-P,SDBER-P
– Support of externally initiated path switch commands LOCKOUT, FORCED SWITCH, MANUAL SWITCH and CLEAR
– Support for revertive and non-revertive switch provisioning.
– The switch initiation time for signal fail defects is 10 msec, and the switch completion time is 50 msec.

DRI (Dual Ring Inter-connection)

Various methods are available for interconnecting two rings. The rings may be two interconnected BLSR's, two interconnected UPSR's, a BLSR ring interconnected with a UPSR ring. The method used for interconnection may be varied based on the services of the provisioned circuits. For inter-ring customer traffic, the protection of traffic is based on the dual-node interconnections. The dual-node inter-connection is nothing but providing ring interconnections at two nodes at each ring which are referred to as primary and secondary nodes using the drop and continue type of connections. All of the inter-connected traffic is available at the primary node as well as the secondary node. This insures the protection of the traffic in case of node failures or facility failures using the dual homing of traffic at each node. GR-1230 provides a good primer on the ring inter working which includes the drop and continue method and dual transmit method

The NE uses the DRI feature to provide dual node interconnected rings Figure 186. illustrates interconnection between two BLSR rings. In this architecture, the primary node (node 4 and node 6) and secondary node (node 3 and node 7) for the dual node ring inter-working are identified for both rings via provisioning (note: the primary and the secondary nodes are provisioned on a per path basis). The primary node has a 2:1 service selector to select the service path (the path to the termination node) - it performs a selection switch based on comparison between the path coming from the other ring via the interconnection line (referred to as primary path) and the path coming from the secondary node (referred to as secondary path) by monitoring both paths. This switching must be performed for both failure and signal degrade conditions in accordance with standard switching times (60 milliseconds). The secondary path can be carried either on the working line or on the protection line (future). In the Dual Ring Interconnect on Working architecture, the secondary path is carried on the working line.

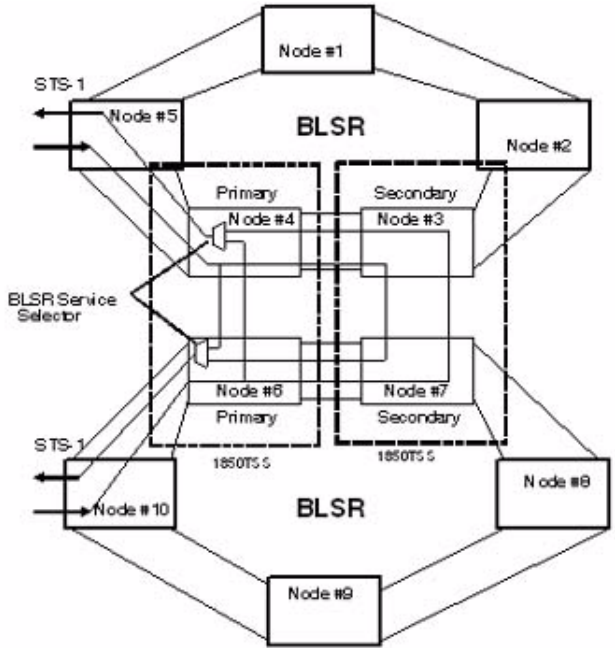


Figure 186. Two node BLSR to BLSR Ring Interconnection (Same Side Routing)

The following ring interconnections are supported:

- One Node BLSR to BLSR Ring Interconnections support.
- One Node UPSR to UPSR Ring Interconnections support.
- One Node BLSR to UPSR Ring Interconnections support.
- Two Node BLSR to BLSR Ring Interconnections support.
- BLSR Service Selector Switching.

In this release, fully protected Dual node Ring Interconnections may only be implemented in full 2-way manner. 1-way signals may use the two connections to traverse two rings in a protected fashion, but the opposite bandwidth is not available for other connections.

2WAYDCRR

2WAYDCRR, Two-Way Drop-and-Continue Ring-to-Ring, is a double bi-directional Drop and Continue cross-connection between the selected “FROM” on one ring and the selected “TO” on the second ring. It is used for dual node ring interconnection.

2WAYDC has to be applied to network scenarios with asymmetric ring speeds, for instance using TSS-320 to interconnect OC192 rings to OC12 and/or OC3/48 rings.

2WAYDCRR is used only for dual node interconnect. It applies to UPSR rings, as described in the following figures.

The following entities can be cross-connected: STS-1, STS-3c, STS-12c, STS-48c, STS-192c.

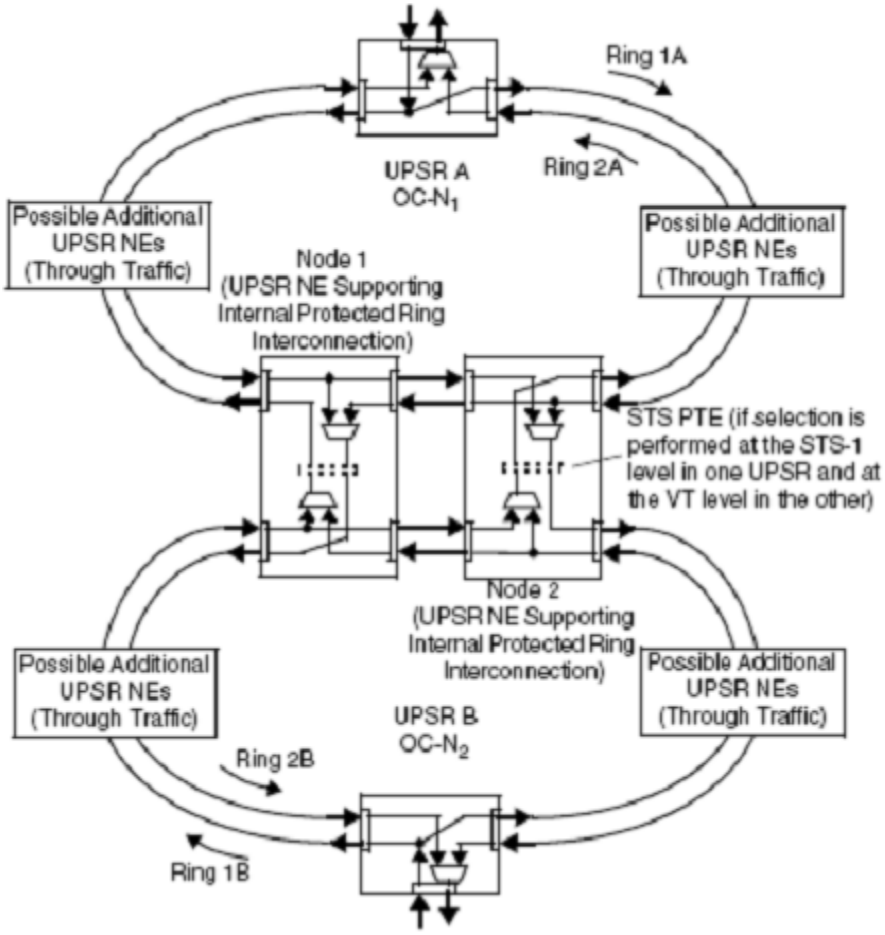


Figure 187. 2WAYDCRR: interconnection via internal protected rings interconnection nodes

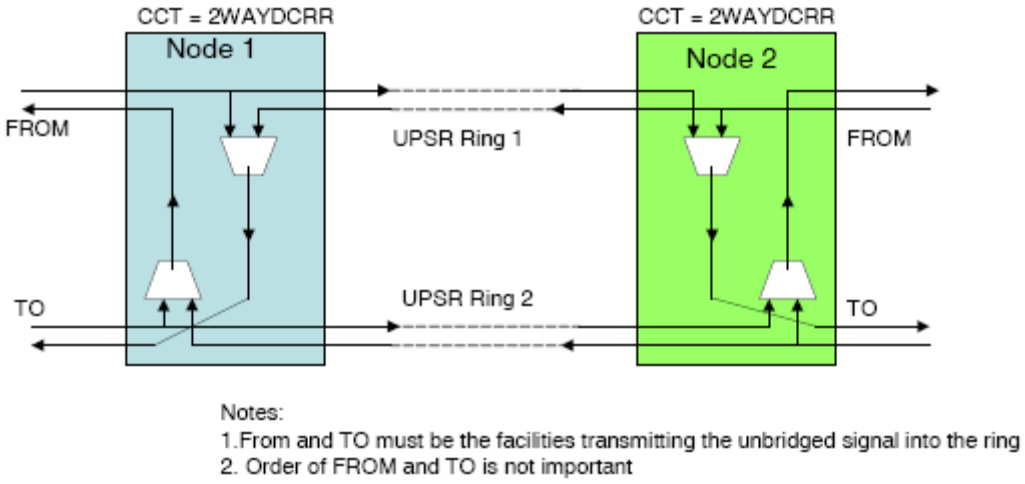


Figure 188. 2 Node UPSR Ring Interconnect using 2WAYDCRR

3.2.9 GMPLS Architecture

The following SONET entities can be provisioned: STS-1, STS-nc, STS-nv.

The following interfaces are supported:

I-NNI (with SPC [Soft Permanent Connections]: the request for path set-up is performed via management plane.

- E-NNI (inter-domain)
- E-NNI (intra-domain)
- UNI (not SC)

The system supports SC (Switched Connections) signaled via E-NNI interface (via either OIF or IETF UNI interface are not supported in current release).

The system supports:

– "Connection Admission Control" to be able to accept call/connection requests only if resources are available in the network to satisfy the requested call/connection.

– "RSVP-TE (RFC3209) and OSPF-TE (RFC3630) and their extensions for GMPLS.

– Unidirectional and Bidirectional LSPs.

– Label Suggestion by the Upstream and Label Restriction by the Upstream

– Protection (revertive and not revertive protection mechanisms) schemes:
  - unprotected
  - link protection (1+1 APS)
  - end-to-end path protection (1+1 SNCP)
  - full rerouting [CP392, CP391, CP327, CP250]

– single Node Identifier (Node ID) for representing Routing ID and Signaling ID. This represents also a valid IPv4 address to reach the node (it is a routable address)

Using the J0 mechanism, the system can perform neighbor discovery.

The following MPLS profile expressed in terms of MPLS features [RFC3031] applies to GMPLS:
– Downstream-on-demand label allocation and distribution.
– Ingress initiated ordered control.
– Control driven label allocation strategy.
– Explicit routing.

The Control Plane manages a single layer (Forwarding Adjacencies will be implemented in future release).

The system Is able to inter-work with system supporting different identifiers to represent Routing ID and Signaling ID.

– **Interaction between Control Plane and Management Plane**

  Resources are assigned to either Control Plane or Management Plane on port basis. For resources assigned to Control Plane the cross-connections are created by Control Plane and cannot be deleted by management plane.

The system supports the checks to avoid that management plane resources are used by control plane and vice-versa.
The system supports the option for the management plane to force the deletion of Control Plane resources (including cross-connections).

3.2.9.1 GMPLS Control Channels management

In GMPLS, the transport plane and the control channel topologies are independent, that is the control channels between two adjacent nodes are not required to use the same physical medium as the data links between those nodes. Moreover, the control channels that are used to exchange the GMPLS control-plane information exist independently of the links they manage (out-ofband control channel).

The system supports Signaling Communication Network according to ITU-T G.7712 [1] (Sec.6.2) based on the following options:
– IP SCN
– in-fiber / out-of-band: Line/Section DCC can be used for this purpose. Line and Section DCC channels shall be assigned either to Control Plane or management plane usage.
– out-of-fiber / out-of-band:
  • external local LAN
  • GRE
  • IP/IP [CP203, CP330]

The system supports also numbered and unnumbered control channels.
The system supports the following mapping for control channels used for control plane purposes [1]: -IP-only interfaces shall use PPP as per RFC 1661 -IP-only interfaces must use only PPPinHDLCframing/DCC as per RFC 1662.
The system supports LAN, IP/IP and "GRE-based" out-of-band control channel. In this case these are considered "virtual ports". The System may support several control channels between 2 adjacent nodes.

GMPLS signaling and routing protocols require at least one bi-directional control channel to communicate even if two adjacent nodes re connected by unidirectional links: GMPLS supports IP to transport the signaling and routing protocols over them.
Failure on Control Channels (DCC failures) are detected and reported.

Control Channels protection are supported via configuration of two diverse control channels (concurrent mode). Both active and backup control channels are active and in service. When active is going down the control traffic is automatically forwarded to the second active control channel.

The system supports a mechanism to manage congestion control setting up the maximum number of RSVP paths (LSPs) supported per socket. When the number exceeds the maximum, packet signaling messages are dropped.

Separated routing instances are provided for SCN (Signaling Communication Network) and MCN (Management Communication Network). This is obtained via DCC partitioning between SCN and MCN and different subnet configuration.

3.2.9.2 GMPLS TE Link Management

Unnumbered Interfaces

The System supports only Unnumbered Interfaces (RFC4202/RFC4203). The Unnumbered links are links without any assigned IP addresses. Unnumbered links are specified via extensions to both:
– signalling protocols (RSVP-TE extensions as in RFC3477) carrying local identifiers of Unnumbered Links where local identifiers may be provided from configuration, or via OSPF extensions; and
– routing protocols inside IGP extensions (OSPF extensions as in RFC 4202) [CP228, CP309]

A TE link is a logical construct that represents a way to group/map the information about certain physical resources (and their properties) that interconnects LSRs into the information that is used by Constrained SPF for GMPLS path computation, and GMPLS signaling.
A TE link populates TEDB (Traffic Engineering DataBase) and is identified as [local link_id, remote link_id].
TE Links do not necessarily determine a routing adjacency
– A TE link can include a single data link (= single component) or a set of data links (= multiple components -> bundle);
– A TE link can comprise a set of TE links (recursive), each of these TE links as defined inprevious step.

The System supports the TE link parameters as described in RFC3630 and its extensions for GMPLS (RFC4202/RFC4203) applicable for TDM Control Plane.

The System supports the following TE link parameters defined by:

– RFC3630:
  • Traffic Engineering Metric (TE metric): Link metric (e.g . delay, delay variation) that may be different from OSPF link metric
  • Resource Class/Color: Administrative group membership per TE link (bit mask)

– RFC4202/RFC4203:
  • Link Local/Remote Identifiers
  • Link Protection Type
  • Interface Switching Capability Descriptor
  • Shared Risk Link Group
  • Signal Type
  • Resource Color

– RFC4201:
  • Maximum Bandwidth: true TE link capacity (units: bytes/s)
  • Maximum Reservable Bandwidth: User configurable (by default = maximum link capacity but may be greater i.e. link over-subscription);
  • Unreserved Bandwidth (per priority): Bandwidth not yet reserved on the TE link (initial values correspond to the Maximum Reservable Bandwidth).

On E-NNI Routing Timeslots are advertised (instead of bandwidth) for TDM Control Plane.]
The System shall support automatic discovery of the following parameters (these parameters shall be discovered by Control Plane from Data Plane):
– Interface Switching Capability Descriptor
– Signal Type
– Maximum Bandwidth (or timeslots)
– Link Protection Type

The System is able to manage operational state for TE Link, associated with the alarm condition of the physical port. In case of failure or forced state down for the port, the corresponding TE Link is down.

Link Bundling

A link bundling is a logical link, consisting of multiple component links between a pair of LSRs:and advertised as a single link (e.g. for improved scalability) into routing protocols. The use of links bundling improves routing scalability reducing the information to be managed from Routing protocols (Link Bundle is advertised as a single link into OSPF):

– Component links inside the same Link Bundle are constrained to the same Link Type (point-to-point, multi-access) and Link Address (IPv4, IPv6, Unnnumbered). Proposed criteria (physical and admin features) in order to correlate component links are contained inside RFC3945
  Link bundle is explicitly configured by operator/NMS.

All component links in a bundle must begin and end on the same pair of LSRs; the parameters of a bundle like TE-Metric, Resource Color, SRLG shall be configurable via management interface independently from the corresponding parameters of the links belonging to the bundle itself.

The liveness and resource availability of the bundled link is determined by the liveness of each its component links. A bundled link is alive when at least one of its component links is alive.

The System supports:

– unnumbered link Bundle.
– unnumbered Bundle with manual configuration

Unnumbered Bundled link must be unique on a particular node via unnumbered identifier with a wide-node scope: in addition link local identifiers for all unnumbered links of a given LSR musdt be unique in the context of that LSR.

LSP Explicit Route object (ERO) carries information about unnumbered bundled link, where component link identifiers are carried inside RSVP message inside IF_ID RSVP_HOP object [as defined in RFC3945].

A Bundle link can group different port type, that it is possible to put inside a Bundle link an OC3 with an OC12 or with OC48 or with OC192 ports.

Neighbour discovery

The System is capable to automatically discover the physical links that connect a NE with its neighbors. The System shall support neighbour discovery using J0 mechanism.
It is possible to enable/disable the neighbour discovery using J0 mechanism. A parameter on a per node basis shall be available to enable/disable the automatic neighbour discovery. Consistent network domain configuration has to be performed by operator to insure the mechanism to properly work (J0 enabled on both sides of the link).

Discovery procedure is applicable to:

– I-NNI links.
– E-NNI inter-domain links

The discovery mechanism is based on definitions contained in ITU-T G.7714.1/Y.1705.1 recommendation. G.7714.1 describes a variety of different methods that can be applied in order to achieve layer adjacency discovery. TSS shall support the layer adjacency discovery process at the RS (section) layer and shall use the J0-based in-service discovery process

The 1850 TSS-320 uses J0 for discovery purpose only for ports assigned to Control Plane. This insures that J0 is not used by management plane for usual link connection verifications.

The system supports:
– Type 1 layer adjacency discovery method as described in ITU-T G.7714 [5] (Sec.8.1) [CP244]
– LAD (Link Adjacencies Discovery) in "Return-to-Service Triggered Mode" as described in ITU-T G.7714 [5] (Sec.8.2).

The following discovery message are implemented:
– the 16-byte J0-string (discovery message) is set on RS (section) source.
– if discovery is enabled, the discovery message (16-byte J0 string) is sent continuously
– First Byte of J0 is carrying CRC information, while other 15 bytes for discovery message is encoded as specified in ITU-T G.7714.1/Y.1705.1 (04/2003) [5] chapter 8, before it is inserted into the 16-byte J0-string of a port.
– discovery message format as defined in ITU-T G.7714.1/Y.1705.1, section 8.1 is used.
– DA DCN address format as defined in ITU-T G.7714.1/Y.1705.1, section 8.1.2 is used

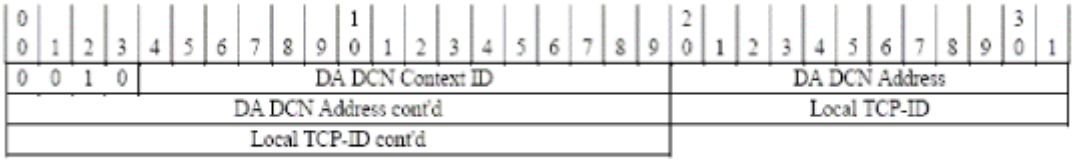


Figure 5/G.7714.1/Y.1705.1 – DA DCN Address Message format

Figure 189. DA DCN address message format

The message attribute values as hereafter defined are used:
– Message Attribute Field Width Attribute Value
– DA DCN Context ID 16 bits
– DA DCN Address 32 bits node IP address
– Local TCP-ID 32 bits Local ID (interface index) of physical port

The 16-byte J0-string (discovery message) is read by retrieving the received TTI (sink side).

Successful discovery of a link between two adjacent NEs (NE A and a NE B) requires that both discovery processes complete successfully: the discovery process initiated by NE A and the discovery process initiated by NE B. Both discovery processes can run independently which means that the reception of a message does not necessarily trigger the discovery process in the reverse direction. Due to the fact the interface index is used in the discovery message, automatically discovered links are always treated as unnumbered interfaces.

Discovery Triggers: If automatic discovery is enabled discovery processes can be triggered by one of the following events:
– when the link administrative state changes from 'down' to 'up'
– when new link has been configured (TE Link)
– when a loss of signal (LOS) alarm is cleared

3.2.9.3 GMPLS Routing

According to RFC 3630, the System supports extensions to OSPF protocol in order to announce bandwidth constraints associated to any optical link (physical or logical) and consisting of maximum bandwidth, maximum reservable bandwidth and unreserved bandwidth.

Enhancements of the OSPF routing protocol to advertise availability of optical resources in the network according to both RFC3630 and RFC 4202

According to RFC4202, the System supports Routing Enhancements:
– for Unnumbered links;
– for Dedicated 1+1 protection (1+1 APS)
– for shared Risk Link Group (to be applied over a set of links.)
– for TDM Interfaces. Interface Switching Capabilities and Labels as described in RFC4202 are supported for TDM.

The system supports also static Routes and the capabilities to redistribute static routes via OSPF and is able to perform in-service reconfiguration of the routing hierarchy.

OSPF

– OSPF-TE

According to RFC 3630, the System supports extensions to OSPF protocol in order to announce bandwidth constraints associated to any link (physical or logical) and consisting of maximum bandwidth, maximum reservable bandwidth and unreserved bandwidth.
The following parameters can be configurated:
- HelloInterval as periodic time (in seconds) of Hello packets transmission (Default is 10 sec.)
- RouterDeadInterval as the time (in seconds) before the router's neighbors will declare it down, when they stop hearing the router's Hello Packets (Default is 40 sec.)
- Area Identification (Default is area 0) [CP215]

– **Opaque LSA**

The System supports Opaque LSA. RFC2370 defines enhancements to the OSPF protocol to support a new class of Link-State Advertisements (LSA) called Opaque LSAs. Opaque LSAs provide a generalized mechanism to allow for the future extensibility of OSPF. Opaque LSAs consist of a standard LSA header followed by application-specific information. Traffic Engineering (TE) Extensions to OSPF Version 2 (RFC3630) relies on Opaque LSA.
TE Link information js flooded in Opaque LSAs (Type 10, area-wide scope)

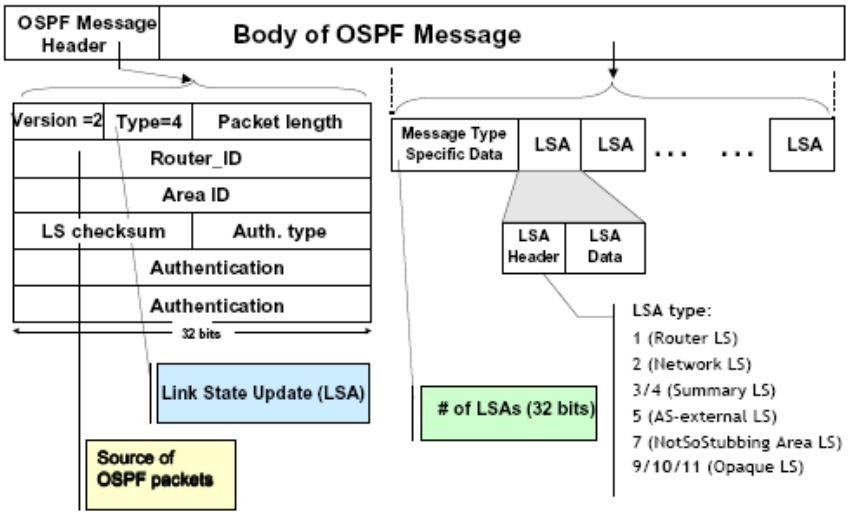


Figure 190. LSA Packet format

GMPLS-OSPF-TE

The System supports RFC4203 enhancements to the Traffic Engineering (TE) properties of GMPLS TE links that can be announced in OSPF TE LSAs in order to propagate:

- Link Protection Type
- Interface Switching Capability Descriptor
- Shared Risk Link Group.

Opaque LSAs (Type 10, area-wide scope) transports the following LSA packets:

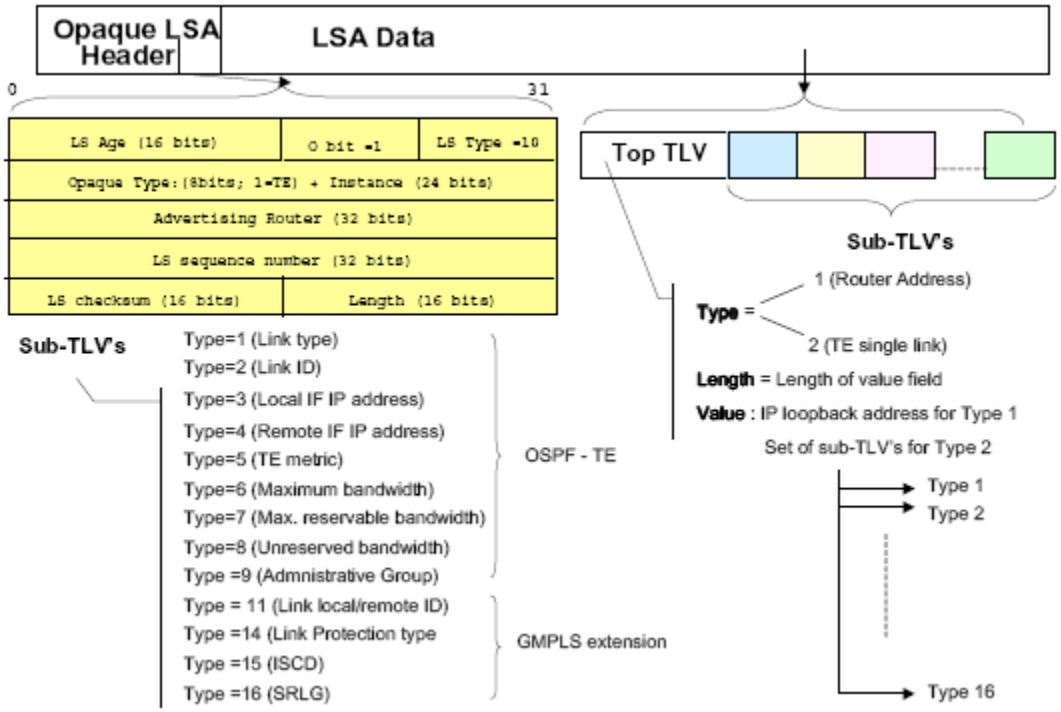


Figure 191. Opaque LSA TE link packet format

– **OSPF Graceful Restart**

The System supports OSPF Graceful Restart RFC3623 allows possibility ("graceful restart" or "non-stop forwarding") of maintaining a router's data forwarding capability while the router's control software is restarted/reloaded.

The OSPF protocol presents a problem to graceful restart whereby, under normal operation, OSPF intentionally routes around a restarting router while it rebuilds its link-state database. OSPF avoids the restarting router to minimize the possibility of routing loops and/or black holes caused by lack of data-base synchronization. Avoidance is accomplished by having the router's neighbors reissue their LSAs, omitting links to the restarting router. However, if (a) the network topology remains stable and (b) the restarting router is able to keep its forwarding table(s) across the restart, it would be safe to keep the restarting router on the forwarding path. RFC3623 documents an enhancement to OSPF that makes such graceful restart possible, and automatically reverts back to a standard OSPF restart for safety when network topology changes are detected.

OSPF Security

OSPF Authentication is supported by MD5 and can be enabled/disabled.

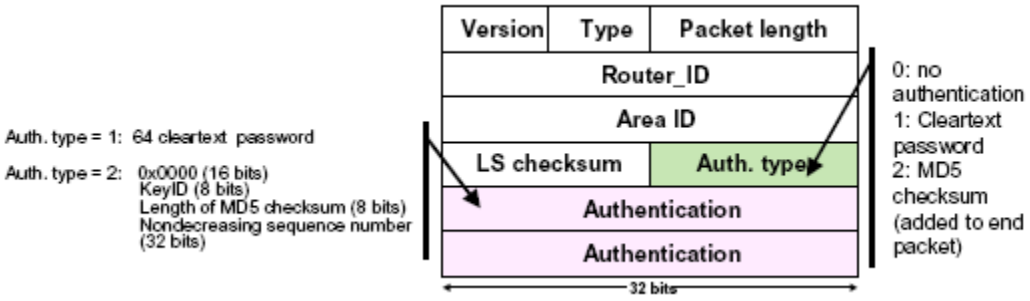


Figure 192. OSPF Authentication

3.2.9.4 GMPLS Signaling

The system shall support

– RSVP according to RFC2205 and TE extensions according to RFC3209.

– GMPLS signaling functional description RFC3471 and GMPLS RSVP-TE extensions RFC3473.

– GMPLS signaling extensions for SONET RFC4606.

RSVP

The system supports RSVP according to RFC2205.

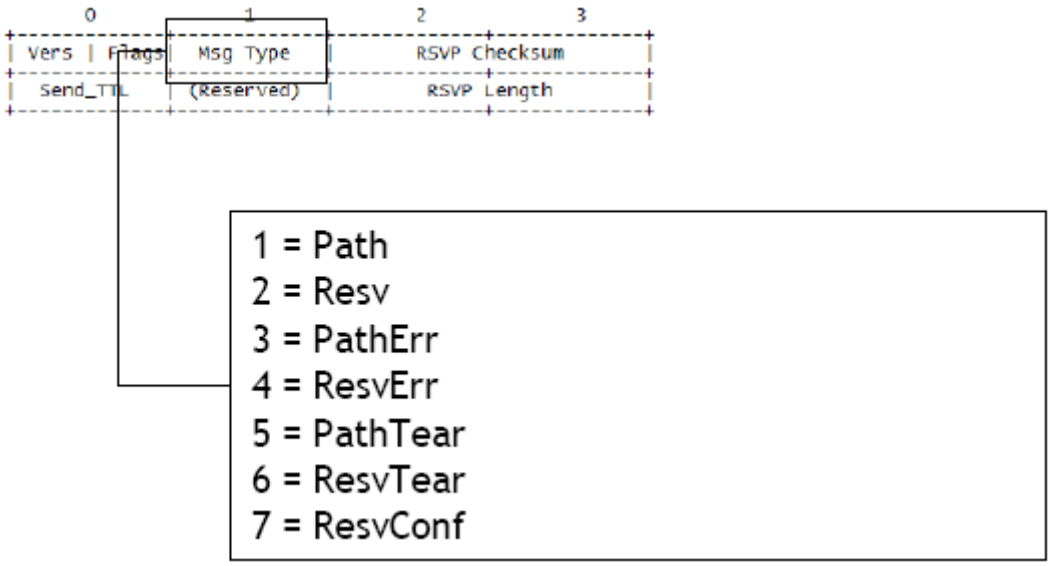


Figure 193. RSVP common header

Table 14. RSVP message types

Function	Message
LSP Set-up	1 = Path
LSP Accept	2 = Resv
LSP Upstream Error	3 = PathErr
LSP Downstream error	4 = ResvErr
LSP Downstream release	5 = PathTear
LSP Upstream release	6 = ResvTear
LSP Confirm	7 = ResvConf
LSP Notify	

RSVP-TE

The System supports below RFC3209 features:

– downstream-on-demand label distribution: A request to bind labels to a specific LSP tunnel is initiated by an ingress node through the RSVP Path message. For this purpose, the RSVP Path message is augmented with a LABEL_REQUEST object;
– explicit routing capability. This is accomplished by incorporating a simple EXPLICIT_ROUTE object into RSVP Path messages;
– the specification of an explicit path as a sequence of strict and loose routes;
– the reservation of bandwidth over an LSP tunnel using standard RSVP reservations and Integrated Services service classes: Bandwidth is encoded in the SENDER_TSPEC and FLOWSPEC objects.

The system supports "make-before-break" feature for re-routing of TE Tunnels.

Table 15. RSVP supported objects

	Class	1 = Path	2 = Resv	3 = PathErr	4 = ResvErr	5 = PathTear	6 = ResvTear	7 = ResvConf
Session	1	Y	Y	Y	Y	Y	Y	Y
RSVP_HOP	3	Y	Y		Y	Y	Y	
TIME_VALUE	5	Y	Y					
ERROR_SPEC	6			Y	Y			Y
STYLE	8		Y		Y		Y	Y
FLOWSPEC	9		Y		Y		Y	Y
FILTER_SPEC	10		Y		Y		Y	Y
SENDER_TEMPLATE	11	Y		Y		Y		
SENDER_TSPEC	12	Y		Y		Y		
ADSPEC	13	Y		Y		Y		
RESV_CONFIRM	15							Y
LABEL Object	16		Y		Y		Y	Y
LABEL_REQUEST	16	Y		Y		Y		
EXPLICIT_ROUTE	20	Y						
RECORD_ROUTE	21	Y		Y		Y		
SESSION_ATTRIBUTE	207	Y						
MESSAGE_ID	23	Y	Y	Y	Y	Y	Y	Y
MESSAGE_ID_ACK	24	Y	Y	Y	Y	Y	Y	Y
MESSAGE_ID_LIST	25							

GMPLS RSVP-TE

The System supports RFC3473 Generalized Label Request object:

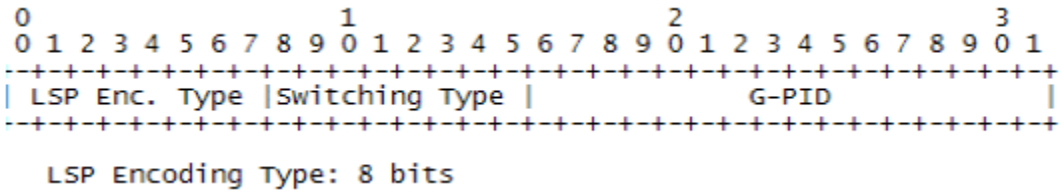


Figure 194. Label in the Path message

The System supports Encoding Type = SDH (5), Switching Time = TDM (100) and the following G-PID (Generalized PID):

- 27 STS SPE/HOVC SDH

The System supports bidirectional LSPs as defined in RFC3471 sec.4, including:

– content resolution (in case of concurrent labels requested in the two directions as specified in sec.4.2).
– explicit label control via egress routing object (ERO)
– protection (1+1)
– administrative status information

The System supports GMPLS RSVP-TE extensions according to RFC3473:

– Bidirectional LSP setup is indicated by the presence of an Upstream Label in the Path message;
– The Notify message as a mechanism to inform non-adjacent nodes (responsible for restoring failed LSPs) of LSP related events and failures.

TDM Signaling Extension

The system supports the extensions defined in RFC4606 for TDM (SONET). For RSVP-TE, the SONET/SDH traffic parameters are carried in the SONET/SDH SENDER_TSPEC and FLOWSPEC objects.

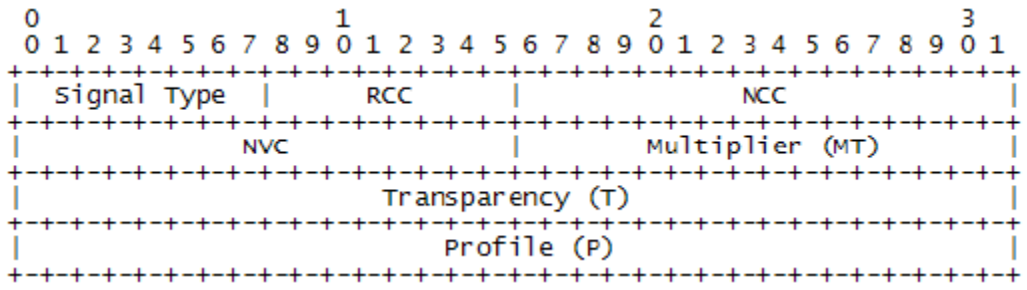


Figure 195. TDM Signaling Extension

The following codes are supported:

– signal Type indicates the type of elementary signal.
– RCC is used to indicate a request for contiguous concatenation.
– NCC is used to indicate the number of contiguous components.
– NVC is used to indicate the number of virtual concatenation group (in case of virtual concatenation).
– MT (multiplier) is used to indicate the number of identical signals requested for the LSP. This is used to manage Virtual Concatenation virtual components. Note: A usage of MT different from one and NVC = 0 for virtual concatenation is not compliant with RFC4606 that clearly states that NVC = 0 means that no virtual concatenation is requested. This is due to inter-work with other vendors.

Table 16. Signals and related codes

Signal	Type	RCC	NCC	NVC	MT
STS-1	5	0	0	0	1
STS-3c	6	1	1	0	1
STS-12c	6	1	4	0	1
STS-48c	6	1	16	0	1
STS-192c	6	1	64	0	1
STS-Nv (VCAT)	5	0	0	0	N

The System supports TDM Label indicated as five separated fields (S, U, K, L, M) in 32 bits to indicate the SONET hierarchy as per RFC4606.

LSP Path Computation

– **Automatic Control Plane Calculation**
The System supports the capability to automatically calculated the route.

– **Strict Explict Route option**
The path includes the only nodes included when provided the strict explicit route option.
According to RFC3209, the paths taken by MPLS LSP can be predetermined (either administratively specified or off-line computed taking into account TE requirements) independent of conventional IP Routing. RSVP-TE supports explicit routing capability incorporating a simple EXPLICIT_ROUTE object inside RSVP Path message (and null value of L bit inside EXPLICIT_ROUTE object). A node receiving a Path message containing an EXPLICIT_ROUTE object processes this message in order to determine the next hop for this path.
The system supports both outgoing and incoming interface to support the end-to-end path in ERO object.

– **Loose Explicit Route option**
The path includes the nodes included when provided the loose explicit route option, but may include additional nodes.
According to RFC3209, RSVP-TE may support the specification of an explicit path as a sequence of loose routes. This capability allows a significant amount of flexibility in satisfying a request for an explicit route. RSVP-TE supports loose routing capability incorporating a simple EXPLICIT_ROUTE object inside RSVP Path message setting L bit (value equal to 1). A node receiving a Path message containing an EXPLICIT_ROUTE object processes this message in order to determine the next hop for this path.

Crankback

When a signaling protocol attempting to setup a path on a calculated route encounters a problem the path setup attempt is rejected and the reason and location of the error are reported by the signaling protocol to the source node that tries to setup a NE.
When a failure occurs in call/connection set-up, the system shall automatically retry to establish the connection. The following parameters can be configured:
– The persistent tunnel retry interval. This is the interval between the first failure of a persistent tunnel and the first attempt to re-establish the tunnel. A value of 0 indicates retrying is not supported.
– The persistent tunnel delay rate. This is a percentage. Thus a value of 10 increases the retry interval by ten percent of the previous value. A value of 0 indicates a constant retry rate.
– The maximum number of retries attempts that will be before a persistent tunnel is deemed inoperable. A value of -1 indicates infinite retry, so a persistent tunnel will continue to be retried until it is successfully established.

Tear-down

The System supports
– explicit tear-down message to delete path configured via control plane.
– alarm suppression when tear-down is performed. This allows the network to avoid alarm generation caused by cross-connection deletions performed by control plane until tear-down is completed.
– the signaling of the administrative state (up/down) when path is requested or teared down
– a mechanism of "garbage collection" to be able to remove pending connections (remained present due to Control Plane issues).

Record Route

Capability to report and record the actual route of LSP (using RECORD_ROUTE object). This report shall be available to management plane via management interface (i.e. TL1).
Both outgoing and incoming interface to support the end-to-end path in RRO object.

Virtual Concatenation management

The possibility to manage virtually concatenated paths across SONET network (STS-1-nv) and co-routed virtually concatenated paths.
VCAT is supported by SONET Control Plane managing the "multiplier" capability of signaling protocol: TSS supports the possibility to signal a VCAT as single tunnel (one-call). When addition/removal of VCAT members is requested the tunnel is re-signaled with the updated "multiplier" parameter (in any case a single call for all VCAT group is provided). [CP353]
It is possible to automatically configure remote end when Virtually concatenated path is requested. In this way:
– STS/VCAT termination is automatically created remotely
– Path set-up is configured by Control Plane through the network
– "remote port" at Ethernet/MPLS layer are automatically created and can be than used for Ethernet/MPLS services.

RSVP-TE: Extension to RSVP for Graceful Restart

The system supports RSVP Graceful Restart according to RFC3473 RFC3473 defines Graceful Restart mechanisms, also called recovery from nodal faults, in order to permit recovery of signaling state from adjacent nodes when the data plane has retained the associated forwarding state across a restart.
RFC 5063 defines recovery all previously transmitted Path state including the Explicit Route Object and the downstream (outgoing) interface identifiers. The extensions can also be used to recover signaling state after the restart of an ingress node.

RSVP Scalability Enhancements

The RFC2961 extensions are collectively referred to as the "Refresh Overhead Reduction" or the "Refresh Reduction" extensions due to the use of Refresh messages for RSVP Signaling over multiple RSVP Sessions

3.2.9.5 GMPLS Interfaces

UNI interface
The system supports
– "edge" ports (UNI interfaces)
– TNA address identification for UNI edge interfaces
– the possibility to "attach" a tunnel to a configured "edge" port. Port can be :
  • OC-N port
  • Virtual Port (VCAT, GBE case)

It is possible to indicate as UNI destination port a virtual port: in this case the network element receiving the signaling message, automatically creates a VCG and associates it to the tunnel as destination.

I-NNI (Internal- NNI) interface
Internal NNI Interfaces (I-NNI) are based on OSPF-TE and RSVP-TE protocols.

E-NNI interface
When either SPC or SC services are supported across multiple control domains, E-NNI (according to OIF E-NNI 1.0) signaling.
The System supports RSVP-TE as signalling protocol for E-NNI interfaces.
For E-NNI control channel communication via DCC including PPP mapping with LCP is supported. The default LCP configuration options as defined in RFC1661 are supported.
The system allows:
– to configure DCCr and DCCm as control channels for ENNI.
– to create connections between two EDGE ports via oneor multiple ENNIs, terminated at supported SDH/ SONET EDGE ports.
– to create connections between two EDGE ports via one or multiple ENNIs, terminated at supported VCG EDGE
– to configure external LAN as control channels for ENNI.
– to provision neighbor information of E-NNI peers (remote link identifier and node identifier).
The limit of E-NNI domains a connection can pass is 4.
The system supports both an unprotected E-NNI link and an E-NNI links in an 1+1 APS/MSP protection.
Signalling Protocol Controller ID for TSS320 is not assigned explicitly but it is the same of Routing controller ID. Level 0 and Level 1 Addresses are the same for 1850 TSS-320.
Each SDH or SONET port in the NE can be configured to be an E-NNI port with E-NNI specific traffic engineering parameters.
The supported SONET/SDH EDGE ports can be configured with TNA/logical port identifier information.
The supported VCG EDGE ports can be configured with TNA/logical port identifier information.
The system supports the E-NNI Routing specification for the HO SDH/SONET layer. Inter-domain routing is implemented in 1850 TSS-320 ENNI CP routing solution based on modifications of OSPF protocol.
For the communication between RCs DDRP adjacencies using DDRP point-to-multipoint mode have to be configured. Between domains in the SCN manual routes towards the subnet of the neighbor domains must be created.
Abstract node model can be achieved if the call originator and the ENNI routing controller are the same.
The System supports Link Bundling for E-NNI inter-domain links.

– **Call/connection separation**
  ASON architecture requires for call/ connection separation. A call is an agreement between end points used to facilitate and manage a set of Connections that provide end to end data services.

– Call segments capabilities
  An end-to-end call is considered to consist of multiple connections, as the call traverses multiple control domains. The call segment approach allows for flexibility in choices of signaling across different domains specifically related to protection draft-ietf-ccamp-gmpls-rsvpte-ason-04.txt. G.7713.2

3.2.9.6 GMPLS Protection/Restoration

The system supports the possibility to configure
– both unprotected LSPs and LSPs over protected links (APS protection is supported)
– both revertive and not revertive protection options.
– Link protection for I-NNI and E-NNI interfaces (inter-domain/intra-domain).

Full re-routing

LSP re-routing is a control plane driven recovery mechanism applicable at path layer. LSP routing relies on establishment between the same pair of nodes of a working and protecting LSP that is link/node/SRLG disjoint from the working one.

LSP re-routing is allowed in not pre-planned way (Recovery LSP full provisioning after failure (dynamic re-routing)).

This feature refers to not pre-planned LSP re-routing where protecting LSP is neither pre-computed nor signalled or even allocated a priori. Recovery LSP is fully provisioned after failure (dynamic re-routing): this recovery mechanism is slower respect to preplanned LSP re-routing.

The System initiates (Full) LSP re-routing on the head-end node after this node has received a Notify message and consists of below ordered steps.

– Dynamic setup/ activation of recovery LSP
  - phase A.1 - path computation (or selection): identify potential resources e.g. segments/links for LSP recovery
  - phase A.2 - path activation: allocate recovery resources and perform cross-connections

Switch traffic to recovery LSP with Completion of Recovery procedure.

End-to-end Path Protection

It is the "Control Plane driven" protection without extra traffic of an entire LSP from its head-end to tail-end according to 1+1 protection model.

End-To-end Protection is a recovery mechanism fully provisioned before failure occurrence. One or more dedicated protection LSP(s)/link(s) are fully established to protect one ore more working LSP(s)/link(s): GMPLS capabilities are used for

– provisioning of the working and protection LSP/link (before failure)
– synchronizing end-points during protection switching.

After notification of the nodes responsible for protection switching actions (in front of Notify Message towards ingress/egress LER) and using protection resource from pre-defined link or LSP pool (pre-provisioning), both end-points perform protection switching actions and the traffic is switched to protection resource.

The Control Plane can:

– configure the protected path end-to-end
– report the protection status.
– Manage operator commands to force switch.

Control Plane is not requested to manage the switch action (switch is performed by Data Plane).

It is possible the end-to-end path protection internally to the area (I-NNI).

The System supports management inititated protections (forced commands from control plane).

3.2.9.7 Resilience

The following resilience capabilities are supported:

– Services undisruptive restarts of Ingress, Transits, Egress nodes.
– FLC, Node, Fiber, Card, Ports restarts/unplug.
– Graceful RSVP-TE Restarts, Hitless OSPF Restarts

3.2.10 TE Links

A Traffic Engineering (TE) link is a construct that represents a way to group/map information about certain physical resources (and their properties) into the information that is used by Constrained SPF (CSFP) for the purpose of path computation, and by GMPLS signalling.

This grouping/mapping must be done consistently at both ends of the link. LMP could be used to check/verify this consistency.

Depending on the nature of resources that form a particular TE link, for the purpose of GMPLS signalling, in some cases the combination of <TE link identifier, label> is sufficient to unambiguously identify the appropriate resource used by an LSP.

In other cases, the combination of <TE link identifier, label> is not sufficient; such cases are handled by using the link bundling construct that allows to identify the resource by <TE link identifier, Component link identifier, label>.

A TE link between a pair of LSRs doesn't imply the existence of a routing adjacency (e.g., an IGP adjacency) between these LSRs. As we mentioned above, in certain cases a TE link between a pair of LSRs could be advertised even if there is no Routing Adjacency (RA) at all between the LSRs (e.g., when the TE link is a Forwarding Adjacency (FA)). Forwarding Adjacency is not yet supported.

A TE link must have some means by which the advertising LSR can know of its liveness (this means may be routing "hellos", but is not limited to routing "hellos"). When an LSR knows that a TE link is up, and can determine its TE properties, then the LSR may advertise that link to its neighbors.

The liveness of a TE link can be determined by any of several means:

- IS-IS or OSPF hellos over the link,
- RSVP hello,
- LMP hellos,
- from layer 1 or layer 2 indications.

A TE link may be either numbered or unnumbered, but in this version can be only unnumbered.

– **TE Link Parameters**

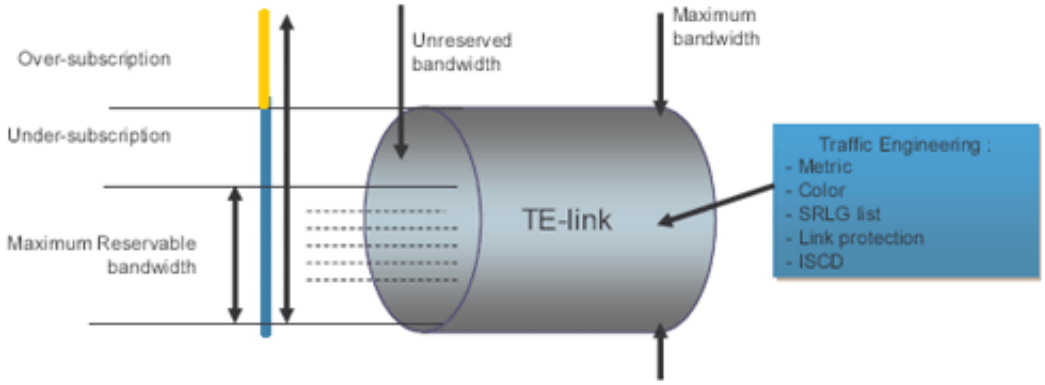


Figure 196. TE-Link parameters

TE Links can be described by several characteristics and parameters but the more important are:

- **Link Type**
  The Link Type defines the type of the link:
  – Point-to-point
  – Multi-access
  The System supports only Point-to-point links
- **Link class**
  The link class are:
  – UNI-C (Not supported)
  – UNI-N
  – I-NNI
  – E-NNI
  – Link ID
- **LinkID**
  The Link ID identifies the other end of the link. For point-to-point links, this is the Router IP address of the neighbour (i.e. Remote Router IP Address).
- **Numbered/ Unnumbered TE Link**
  The Control Plane port participating in a TE Link can be Numbered or Unnumbered
  A **numbered** link has to be a point-to-point link. An LSR at each end of an numbered link assigns an IP address to that link. Consider an numbered link between LSRs A and B. LSR A chooses an IP for that link. So does LSR B. From A's perspective we refer to the IP that A assigned to the link as the "link local IP address" and to the IP that B assigned to the link as the "link remote IP Address". Likewise, from B's perspective the IP that B assigned to the link is the local IP, and the IP that A assigned to the link is the remote IP.
  An **unnumbered** link has to be a point-to-point link. An LSR at each end of an unnumbered link assigns an identifier to that link. This identifier is a non-zero 32-bit number that is unique within the scope of the LSR that assigns it. Consider an (unnumbered) link between LSRs A and B. LSR A chooses an identifier for that link. So does LSR B. From A's perspective we refer to the identifier that A assigned to the link as the "link local identifier" (or just "local identifier"), and to the identifier that B assigned to the link as the "link remote identifier" (or just "remote identifier"). Likewise, from B's perspective the identifier that B assigned to the link is the local identifier, and the identifier that A assigned to the link is the remote identifier. For TE links, the Remote Identifier can be discovered by J0-discovery, if it is enabled.
  Support for unnumbered links in routing includes carrying information about the identifiers of that link.
  Specifically, when an LSR advertises an unnumbered TE link, the advertisement carries both the local and the remote identifiers of the link. If the LSR doesn't know the remote identifier of that link, the LSR should use a value of 0 as the remote identifier.
  In TL1 commands the Link Local ID and Link Remote ID are represented as AID of the corresponding port.
- **Local Interface IP Address**
  The Local Interface IP Address specifies the IP address of the interface corresponding to this link.
- **Remote Interface IP Address**
  The Remote Interface IP Address specifies the IP address of the neighbour's interface corresponding to this link. This and the Local Interface IP Address are used to discern links between systems. Discovered by OSPF for numbered link (see below)
- **Traffic Engineering Metric**
  The Traffic Engineering Metric specifies the link metric (e.g. delay, delay variation) for Traffic Engineering purposes. This metric may be different than the standard OSPF link metric. Typically, this metric is assigned by a network administrator.

- **Maximum Bandwidth**
  The Maximum Bandwidth specifies the maximum bandwidth that can be used on this link, in this direction (from the system originating the LSA to its neighbour). This is the true link capacity. The units are bytes per second.
- **Maximum Reservable Bandwidth**
  The Maximum Reservable Bandwidth specifies the maximum bandwidth that may be reserved on this link, in this direction. Note that this may be greater than the maximum bandwidth (in which case the link may be oversubscribed). This should be user-configurable; the default value should be the Maximum Bandwidth. The units are bytes per second.
- **Unreserved Bandwidth**
  The Unreserved Bandwidth specifies the amount of bandwidth not yet reserved at each of the eight priority levels. In this version only one level of priority is enabled. The values correspond to the bandwidth that can be reserved with a priority 0. The initial value (before any bandwidth is reserved) is set to the Maximum Reservable Bandwidth. The value will be less than or equal to the Maximum Reservable Bandwidth. The units are bytes per second.
- **Color**
  The Administrative Group (also called Resource Class or Color) contains a bit mask assigned by the network administrator. Each set bit corresponds to one administrative group assigned to the interface. A link may belong to multiple groups. By convention, the least significant bit is referred to as 'group 0', and the most significant bit is referred to as 'group 31'.
- **Interface Switching Capability Descriptor (ISCD)**
  In this context we say that a link is connected to a node by an interface. In the context of GMPLS interfaces may have different switching capabilities. For example an interface that connects a given link to a node may not be able to switch individual packets, but it may be able to switch channels within an SDH payload. Interfaces at each end of a link need not have the same switching capabilities. Interfaces on the same node need not have the same switching capabilities.
  The Interface Switching Capability Descriptor describes switching capability of an interface. For bi-directional links, the switching capabilities of an interface are defined to be the same in either direction. I.e., for data entering the node through that interface and for data leaving the node through that interface. ISCD values:
  – Packet-Switch Capable-1 (PSC-1)
  – Packet-Switch Capable-2 (PSC-2)
  – Packet-Switch Capable-3 (PSC-3)
  – Packet-Switch Capable-4 (PSC-4)
  – Layer-2 Switch Capable (L2SC)
  – Time-Division-Multiplex Capable (TDM)
  – Lambda-Switch Capable (LSC)
  – Fiber-Switch Capable (FSC)
- **Encoding Type**
  Link encoding type as specified in 'Generalized Multi-Protocol Label Switching (GMPLS) Signalling Functional Description' is an enumered value sdefined:
  – packet (1)
  – ethernet (2)
  – ansiEtsiPdh (3)
  – sdhItuSonetAnsi (5)
  – digitalWrapper (7)
  – lambda (8)
  – fiber (9)
  – fiberChannel (11)
- **Shared Risk Link Group (SRLG)**

A set of links may constitute a 'shared risk link group' (SRLG) if they share a resource whose failure may affect all links in the set. For example, two fibers in the same conduit would be in the same SRLG. A link may belong to multiple SRLGs. Thus the SRLG information describes an un-ordered list of SRLGs that the link belongs to.

An SRLG is identified by a 32 bit number that is unique within an IGP domain. The SRLG information may start with a configured value, in which case it does not change over time, unless reconfigured. The SRLG information is optional and if a Link State Advertisement doesn't carry the SRLG information, then it means that SRLG of that link is unknown.

- **Link Protection Type**

  The Link Protection Type represents the protection capability that exists for a link. It is desirable to carry this information so that it may be used by the path computation algorithm to set up LSPs with appropriate protection characteristics. This information is organized in a hierarchy where typically the minimum acceptable protection is specified at path instantiation and a path selection technique is used to find a path that satisfies at least the minimum acceptable protection. Values:

  – No Protection
  – Dedicated 1+1
  – Dedicated 1: 1
  – Signal Type

  For OCn ports are defined the following values for Signal Type:

Table 17. Signal Type vs OCn

SIGNAL-TYPE	OC-3	OC-12	OC-48	OC-192
VT1-5-SPE				
VT2-SPE				
VT3-SPE				
VT6-SPE				
STS-1-SPE	X	X	X	X
STS-3C-SPE	X	X	X	X
STS1	X	X	X	X
STS3c X X X X	X	X	X	X
STS12c X X X		X	X	X
STS48c X X			X	X
STS192c X				X
VC-11				
VC-12				
VC-2				
VC-3				
VC-4		X	X	X

3.2.10.1 Bundle Links

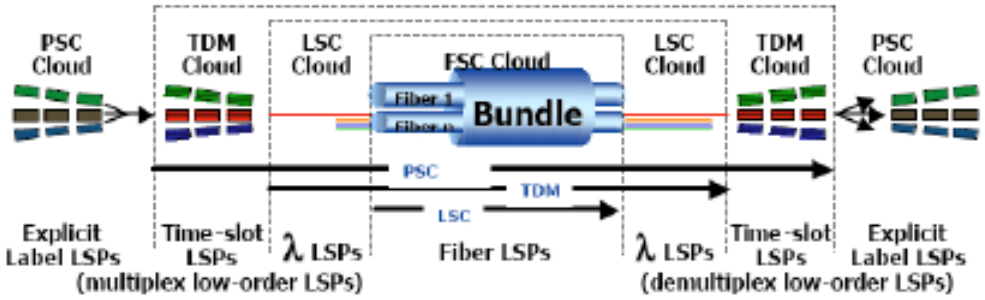


Figure 197. Bundle links

Consider a TE link, for the purpose of GMPLS signalling, a combination of <TE link identifier, labe l> is not sufficient to unambiguously identify the appropriate resources used by an LSP. In this situation, the link bundling construct assumes that the set of resources that form the TE link could be partitioned into disjoint subsets, such that (a) the partition is minimal, and (b) within each subset, a label is sufficient to unambiguously identify the appropriate resources used by an LSP. We refer to such subsets as "component links", and to the whole TE link as a "bundled link". Furthermore, we restrict the identifiers that can be used to identify component links such that they are unique for a given node. On a bundled link, a combination of <component link identifier, label> is sufficient to unambiguously identify the appropriate resources used by an LSP.
The partition of resources that form a bundled link into component links has to be done consistently at both ends of the bundled link. Both ends of the bundled link also have to understand the other end's component link identifiers. The purpose of link bundling is to improve routing scalability by reducing the amount of information that has to be handled by OSPF and/or IS-IS. This reduction is accomplished by performing information aggregation/abstraction. As with any other information aggregation/abstraction, this results in losing some of the information. To limit the amount of losses, one needs to restrict the type of information that can be aggregated/abstracted.

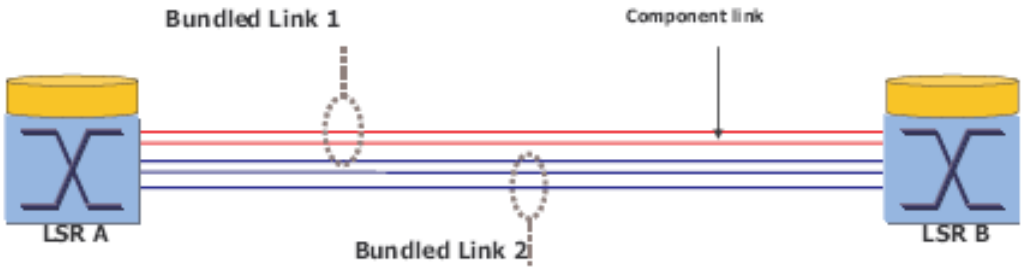


Figure 198. Bundle example

To set-up a bundle the most important information to be defined are:

- Local identifier;
- Remote identifier;
- Link ID;

TE links that form a bundled link must have compatible traffic engineering parameters (resource class, link metric and protection type). Bundling operation is performed by aggregating/abstracting TE link information and the rules for component links of the bundle are:

– must start and end on same node pair
– must have the same Link Protection Type, TE metric and color at each end of the links
– may be unnumbered

Bundle bandwidth accounting:
– Must be managed on a per component link basis
– Changes in link availability or unreserved Bandwidth affects bundled link Unreserved and maximum LSP Bandwidth

Link Bundling advantages:
– Routing scalability (TE link advertisement including set of component links)
– Deploy very high speed links (OC-768 or higher)
– Traffic engineering and management simplicity
– Add or delete link and take it in/out of service
– Reduces downtime and traffic disruption
– (1+1) or (1:1) protection

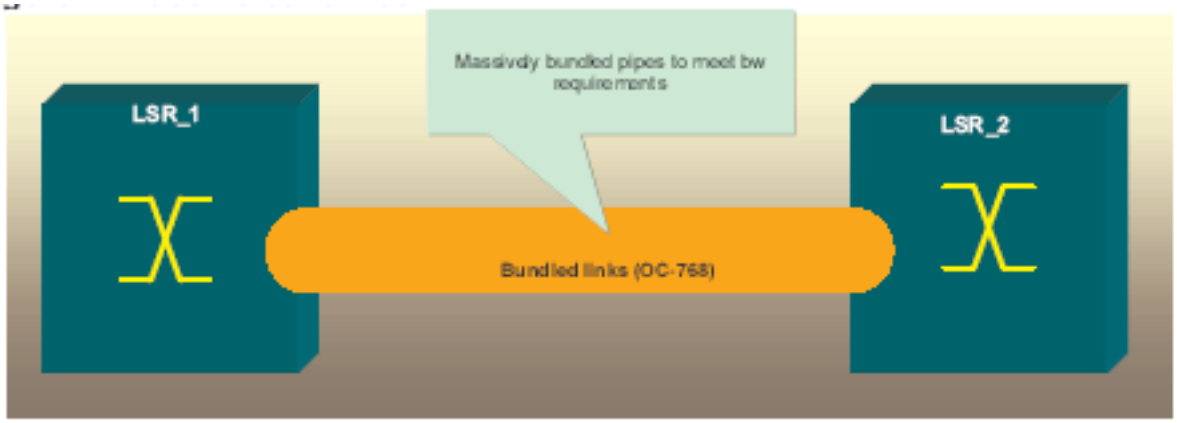


Figure 199. Massive bandwidth

Bundle link protection type is dynamically evaluated taking in account the protection of component links.

– **Restrictions on Bundling**
  All component links in a bundle have the same Link Type (i.e., point-to-point or multi-access), the same Traffic Engineering metric, the same set of resource color at each end of the links, and must begin and end on the same pair of LSRs.
  A bundle link inside another bundle can' t be defined.

– **Routing Considerations**
  A component link and Bundles may be only unnumbered.
  Handling identifiers for unnumbered component links, follows the same rules as those for an unnumbered NOT Component TE link. Furthermore, link local identifiers for all unnumbered links of a given LSR (whether component links, or bundled links) MUST be unique in the context of that LSR. (TL1 AIDs information are used in this case).
  The "liveness" of the bundled link is determined by the liveness of all the component links within the bundled link; a bundled link is alive when at least one of its component links is determined to be alive.
  The liveness of a component link can be determined by any of several means: IS-IS or OSPF hellos over the component link, RSVP Hello, LMP hellos, or from layer 1 or layer 2 indications.

Once a bundled link is determined to be alive, it can be advertised as a TE link and the TE information can be flooded. If IS-IS/OSPF hellos are run over the component links, IS-IS/OSPF flooding can be restricted to just one of the component links. Procedures for doing this are outside the scope of this document.

– **Bundle Link Parameters**
In this section, we define the Traffic Engineering parameters to be advertised for a bundled link, based on the configuration of the component links and of the bundled link.
  - **OSPF Link Type**
    The Link Type of a bundled link is the (unique) Link Type of the component links. The System shall support only Point-to-point Bundle link type.
  - **OSPF Link ID**
    For point-to-point links, the Link ID of a bundled link is the (unique) Router ID (IP address) of the neighbour.
  - **Local Interface IP Address**
    The Local Interface IP Address is known as the IPv4 Interface Address
    If the bundled link is numbered, the Local Interface IP Address is the local address of the bundled link
  - **Remote Interface IP Address**
    The Remote Interface IP Address is known as the IPv4 Interface Neighbour Address.
    If the bundled link is numbered, the Remote Interface IP Address is the neighbour address of the bundled link. OSPF protocol discovers this IP Address.
  - **Local Identifier**
    If the bundled link is unnumbered, the link local identifier is set to the identifier chosen for the bundle by the advertising LSR. Local Identifier will be assigned by the User and is related to "remote identifier" parameter.
  - **Remote Identifier**
    If the bundled link is unnumbered, the link remote identifier is set to the identifier chosen by the neighbour LSR for the reverse link corresponding to this bundle.
  - **Traffic Engineering Metric**
    The Traffic Engineering Metric for a bundled link specifies the link metric (e.g. delay, delay variation) for Traffic Engineering purposes. Typically, this metric is assigned by a network administrator.
  - **Link Protection Type**
    The bundle protection derives from all component protection type. This parameter can't be forced by operator.
  - **Maximum Bandwidth**
    The Maximum Bandwidth of a bundled link is evaluated as the sum of the Maximum Bandwidth of all component links.
  - **Unreserved Bandwidth**
    The Unreserved Bandwidth of a bundled link is the sum of the Unreserved Bandwidths of all component links associated with the bundled link.
  - **Administrative Group/ Resource Color**
    The Resource Color provisioned for a bundled link. Typically, this parameter is assigned by a network administrator.

3.2.10.2 Abstract Links

An Abstract link is an ENNI Intra-domain link defined between LSRs that belong to the same domain. It is a logical link and then it is necessary to bind a physical link (only INNI links can be bound) inside it to obtain a running Abstract-link. Abstract-Links are used to set-up level 1 CP domain. They connect LSRs on which are defined UNI links with RC on which are defined ENNI-Inter-Domain links.

3.2.10.3 UNI-ENNI-INNI Port

The LSR port class (or link class) is determinate by its role in the GMPLS domain.

- **UNI-C Port** A port that is providing end-points for SPC services, neither signalling nor routing protocol is running on such a port, it is located on the edge of a GMPLS domain.
- **UNI-N Port** A port that is connected to a UNI-C port of a corresponding client device providing SC services, only a signalling protocol is running on such a port, it is located on the edge of a GMPLS domain.
- **I-NNI Port** A port that is connected to a NNI port of a neighbour NE belonging to the same GMPLS domain providing SPC and SC services, signalling and routing protocols are running on such a port, it is a GMPLS domain internal interface.
- **E-NNI Port** A port that is connected to a NNI port of a neighbour NE belonging to the adjacent GMPLS domain providing SPC and SC services, signalling and routing protocols are running on such a port, it is located on the edge of a GMPLS domain. In TSS320 link-class topology foresees a further division in:
  - ENNI Intra Domain link class (Used for internal Abstract-Link)
  - ENNI Inter Domain link class (Used for external links between RC of different domains.)

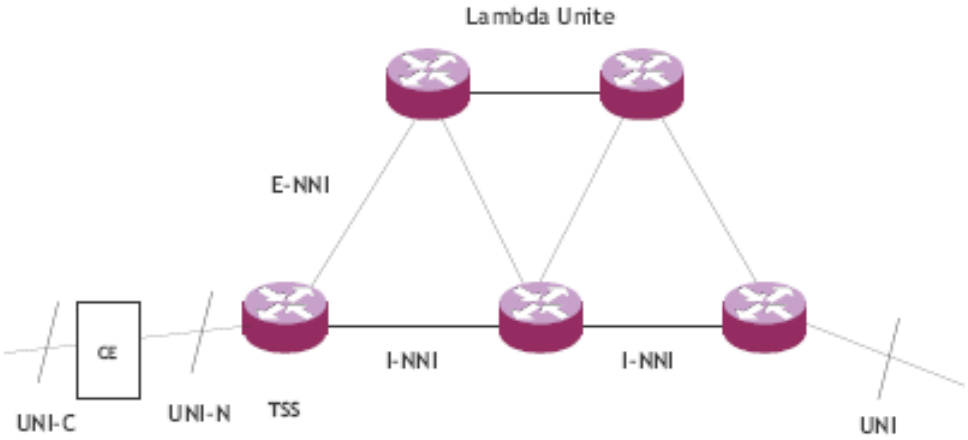


Figure 200. UNI, I-NNI and E-NNI Link class

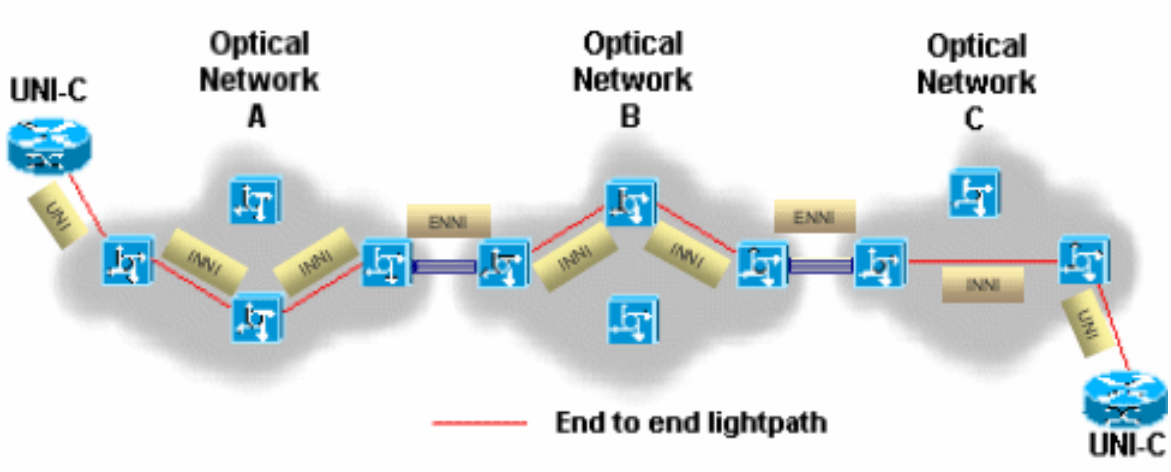


Figure 201. Figure 6: ENNI - Connecting Networks Together

Because UNI-C is not applicable to TSS these links are not supported. UNI-N are supported only as "termination" (or "drop") ports and the TNA IP address is provided as parameter to attach/detach them from to/from tunnel (see tunnel set-up).

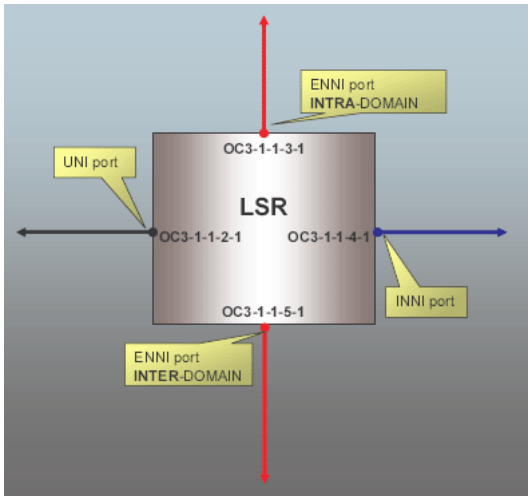


Figure 202. All the Port Class provisionable on LSR

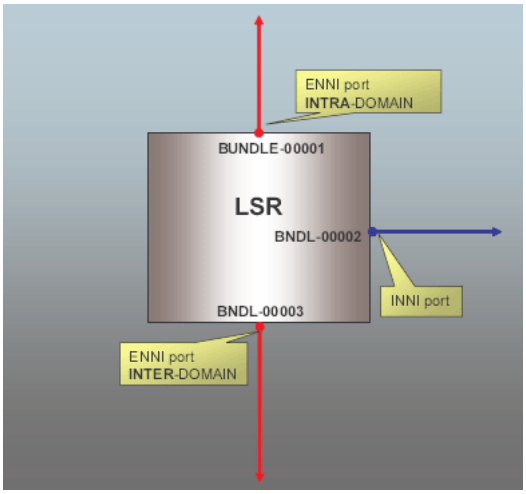


Figure 203. All the Port Class provisionable on LSR

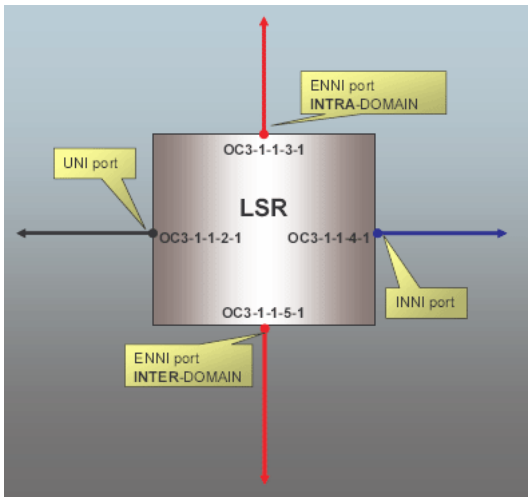


Figure 204. Port Class provisionable for Abstract-Links

UNI Functions	E-NNI Functions	I-NNI Functions
Discovery Adjacency (asymmetric or client/server) Neighbour (symmetric)	***Discovery*** Adjacency (asymmetric or client/server) Neighbour (symmetric)	***Discovery*** Adjacency (asymmetric or client/server) Neighbour (symmetric) - optional (may be replaced by routing)
Routing Reachability: no Topology: no Resources/Status: no Note: private UNI allows for Explicit Route and feedback using Record Route	***Routing*** Reachability: full Topology: limited (aggregation/summarization) Resources/Status: limited (aggregation/summarization)	***Routing*** Reachability: full Topology: full (aggregation/summarization for scalability) Resources/Status: full (aggregation/summarization for scalability)
Signalling GMPLS UNI (RFC 4208) OIF UNI 1.0	***Signalling*** Intra-carrier inter-domain referred to as intra-carrier GMPLS E-NNI signalling Note: Inter-carrier E-NNI not within current scope	***Signalling*** Intra-carrier intra-domain or INNI Typical GMPLS scope (peering allowed)

Figure 205. UNI, E-NNI and I-NNI functions

3.2.10.4 J0 Discovery

The user, during the provisioning of the CP Transport port, can obtain help enabling auto layer discovery protocol (J0) for discover neighbor port/router link info. The user, enabling J0 discovery mechanism, must not provide neighbor port AID and Remote Router IP address, so to speed-up network configuration.

3.2.10.5 RFC vs TL1 Parameters

Table 18. RFC vs TL1 Parameters

RFC Parameters Name	TL1 Parameters Name
Link type	[Not Used in TL1 commands]
UNI-ENNI-INNI Links	PORT-CLASS
Link ID	REMOTE-ROUTER-ADDR
Numbered/Unnumbered TE Link	[Not Used in TL1 commands]
Local interface IP address	TNA-IP-ADDR
Remote interface IP address	[Not Used in TL1 commands]
Local Identifiers	AID
Remote Identifiers	REMOTE-PORT-AID
Local Identifiers for bundle	BUNDLE-AID
Remote Identifiers for bundle	REMOTE-PORT-AID
Maximum bandwidth	MAX-TIMESLOTS
Maximum reservable bandwidth	[Not Used in TL1 commands]
Unreserved bandwidth	UNRESERVED-TIMESLOTS
Resource Color/ Administrative Group	COLOR
Traffic engineering metric	METRIC
Shared Risk Link Group	SRLG-LIST
Interface Switching Capability Descriptor (ISCD)	SWITCH-CAP
Link Encoding Type	ENCODING-TYPE
Link Protection Type	LINK-PROT-TYPE

3.2.10.6 Scenarios

– **Control Plane Port Configuration**

In this release CP will support only single hierarchy level and single abstraction topology model of level 1 hierarchy. Every domain will be represented by the one or more RC.

RCs within a domain are connected with internal LSRs by ENNI Intra-domain Abstract-Links. RCs belong to different domains are connected by ENNI Inter-domain Physical-Link. Edge RCs will advertise the TNA addresses towards all reachable LSRs within its domain.

Level 0 of TSS320 topology will require minimum provisioning of Node IP Address (ED-CP-GLOBAL), creating CP control channels (ENT-CP-COM), enabling CP transport ports (ENT-CP-TPORT) and building tunnels (ENTCP- CONN). Neighbour nodes IP address and port AIDs will be discovered dynamically if J0 DISCOVERY is enabled.

Then after level 1 abstract link creation, some level 0 ports might be bound (BIND-ABS-LINK param. of ENTCP-TPORT command) to abstract link. Abstract links only carry TE information that are used mainly by CP path computation.

Each domain expand incoming ENNI level 1 path request to the local domain level 0 path. On intra-domain links, physical resource allocation is performed always at level 0 ports. On inter-domain links, resource allocation is done directly at the level 1 port.

In the context of Transport Control Plane the following TL1 commands are used to configure a transport TE link:

- ENT-OCn Physical IFs
- ENT-CP-TPORT Using AID=OCn (component or not-component link)

- ENT-CP-TPORT Using AID=BNDL-nnnnn (Bundle link)
- ENT-CP-TPORT Using AID=ABSL-nnnnn (Abstract-link)

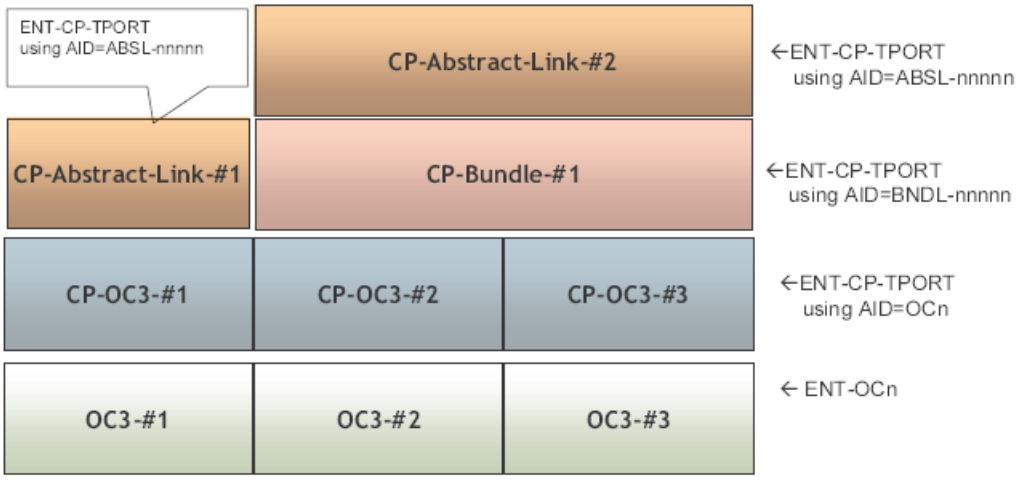


Figure 206. Facility layer

The steps to implement a TE link are:

Step 1: In Data Plane a port is characterized by a local interface_id; in Control Plane a link is characterized by a [local link id , remote link id]. The first step actions are:

- local interface_id -> local link id (associate a Data Plane port a data link identifier)
- define the remote link id (remote interface id & remote LSR IP Address).

This configuration is realized using ENT-CP-TPORT TL1 commands.

Step 2 (TE link bundling): This step is optional. A TE link can comprise a set of TE links, each of these component TE links are defined in Step 1.
This bundle configuration is realized using ENT-CP-TPORT TL1 commands.

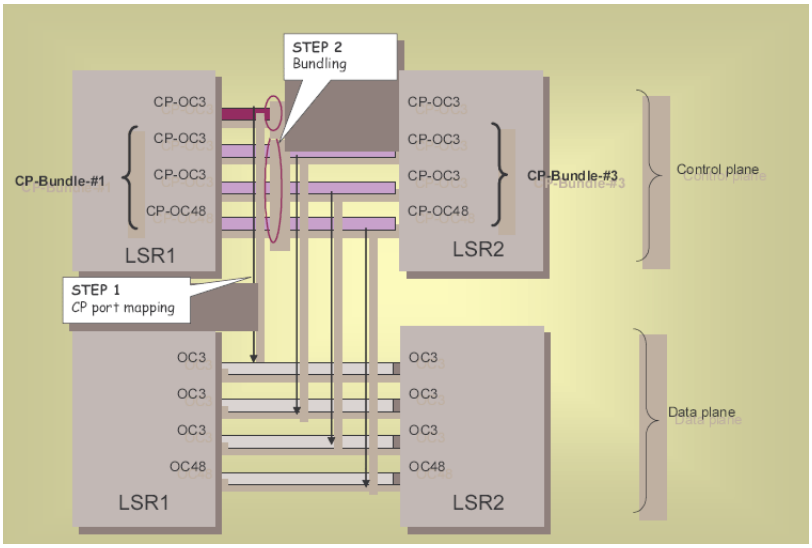


Figure 207. TE Link and Bundle creation scenario

The steps to implement an Abstract link are:

Step 1: In Data Plane a port is characterized by a local interface_id; in Control Plane a link is characterized by a [local link id , remote link id]. The first step actions are:

- local interface_id -> local link id (associate a Data Plane port a data link identifier)
- define the remote link id (remote interface id & remote LSR IP Address).

This configuration is realized using ENT-CP-TPORT TL1 commands.

Step 2 (TE link bundling): This step is optional. A TE link can comprise a set of TE links, each of these component TE links are defined in Step 1.
This bundle configuration is realized using ENT-CP-TPORT TL1 commands.

Step 3 (Abstract link definition): A logical link (useful for level 1 network set-up) can be defined using a proper AID
This logical Abstract-link configuration is realized using ENT-CP-TPORT TL1 commands.

Step 4 (Abstract link binding): A TE link can be bind inside a Abstract-Link to set-up a running ENNI link.
This Abstract configuration is realized using ENT-CP-TPORT TL1 commands.

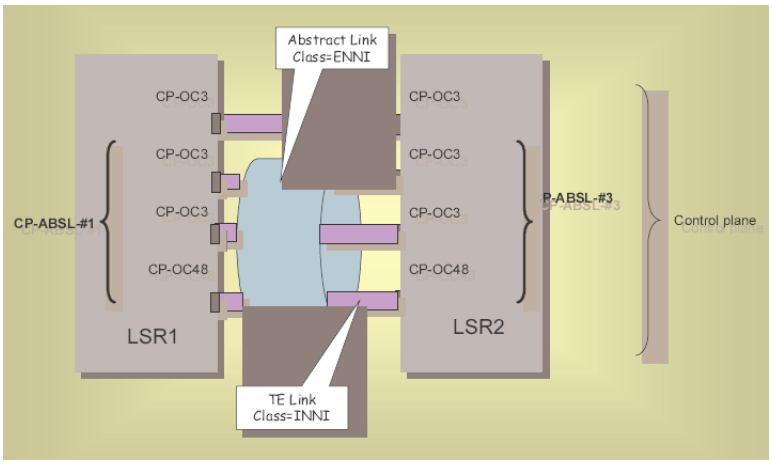


Figure 208. Abstract-Link creation scenario

– **Control Plane Not Component Port Configuration**

This paragraph describes the configuration parameters of a not component TE Link.

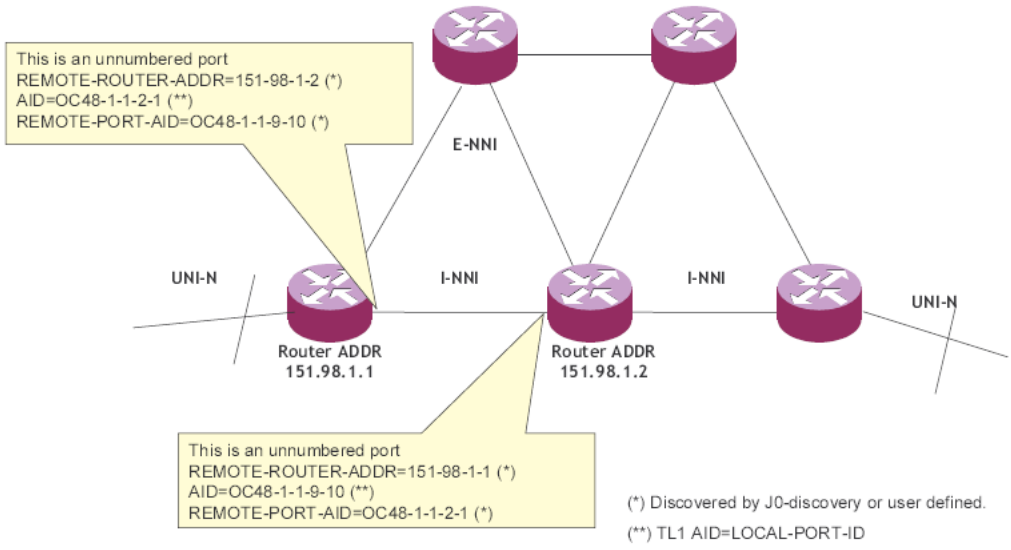


Figure 209. TE Link configuration

At the ends of TE link the user must define the same port type: (i.e. OC48 <--> OC48).

– **Control Plane Unnumbered Bundle Configuration**

For connect two LSRs with an unnumbered bundled link (OSPF is not able to discover neighbor information) the following steps are necessary:



Figure 210. LSRs to connect using a bundle link

Step 1 Lets create bundle BNDL-00001 on LSR 151.64.38.40 using mandatory parameters:
- AID=BNDL-00001
- REMOTE-ROUTER-ADDR=151-64-38-41
- REMOTE-PORT-AID=BNDL-00007

The REMOTE-ROUTER-ADDR parameter will be used for all UNNUMBERED port that will be afterwards inserted in this bundle. When the bundle is created, its Administrative status will be ON.

Step 2 Lets create bundle BNDL-00007 on LSR 151.64.38.41 using mandatory parameters:
- BUNDLE-AID= BNDL-00007
- REMOTE-ROUTER-ADDR=151-64-38-40
- REMOTE-PORT-AID=BNDL-00001

The REMOTE-ROUTER-ADDR parameter will be used for all unnumbered port that will be afterwards inserted in this bundle.
When the bundle is created its Administrative status will be ON.
After that a bundle is created between LSR 151.64.38.40 and LSR 151.64.38.41 with Administrative status will be ON.

From LSR 151.64.38.40 point of view the bundle is characterized by:

- BUNDLE-AID=BNDL-00001
- REMOTE-ROUTER-ADDR=151-64-38-41
- REMOTE-PORT-AID=BNDL-00007

From LSR 151.64.38.41 point of view the bundle is characterized by:

- BUNDLE-AID=BNDL-00007
- REMOTE-ROUTER-ADDR=151-64-38-40
- REMOTE-PORT-AID=BNDL-00001

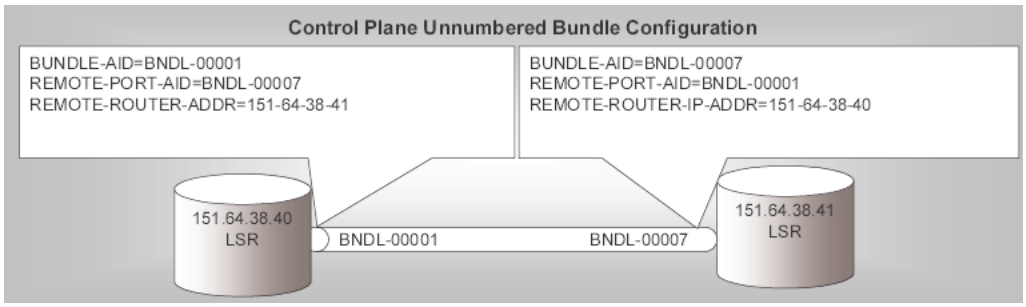


Figure 211. LSRs linked by a bundle

From single LSR point of view the bundle name can be different from neighbour LSR also if it is the same bundle. Nevertheless it is better to give the same name to the bundle on both LSR.

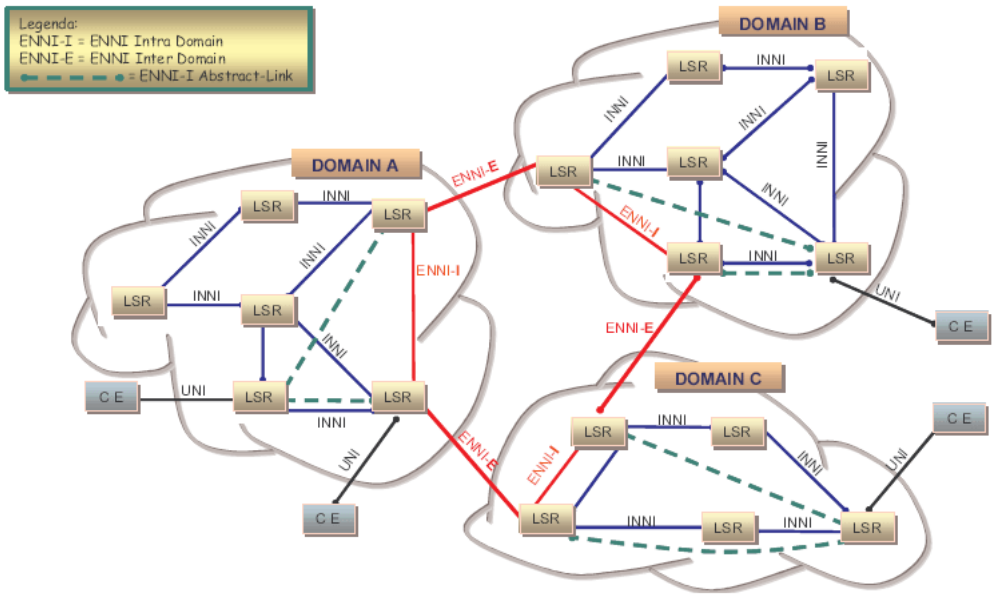


Figure 212. Complex Network

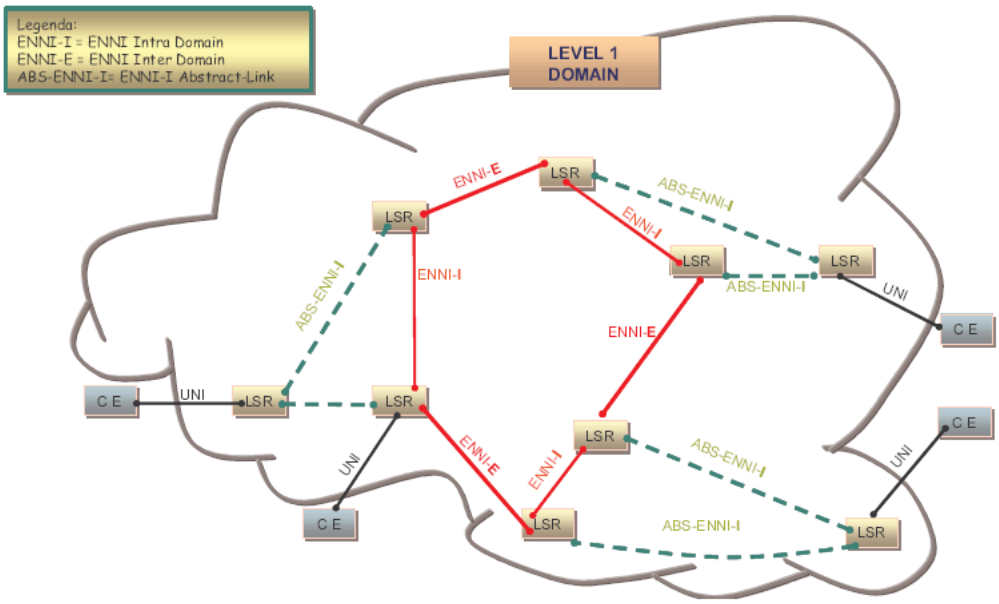


Figure 213. Level 1 Domain

The System support a maximum of:
– 500 CP Transport ports (OCn ports).
– 100 composite TE-link (Bundle link).
– 100 Abstract-Links.
– 100 component ports in the same Bundle link..
– 100 links inside the same Abstract-Link.

The System permits:
– to bind a Bundle link inside an Abstract-Link..

The System doesn't permit:
– to define a Bundle link inside another Bundle link.
– to define an Abstract-Link inside another Abstract-Link.
– to define an Abstract-Link inside a Bundle link.
– to define a OCn port inside different Bundle link.
– to bind a TE-Link inside different Abstract-Links.

If a failure happens on a component port, the bandwidth automatically reduced. No impact on Op Status for CP bundle port.

REMOTE-ROUTER-ADDR parameter is automatically discovered by J0-discovery for not component ports.

A component port can be assigned to a bundle only if the bundle LINK_ADMINSTATUS=ON.

3.2.11 Control Complex (CTLC)

The Control Complex (CTLC) consists of the processors needed to manage the system as a network element (NE). The control complex consists three types of processors at two levels, which are:

– **FLC**: Redundant OAM&P First Level Controller also known as Equipment Controller embedded in the 1850TSS-320 EC320, the NE interface to the external Network Management System, Operations Support System (OSS) and craftsperson. However, non-redundant FLC configuration is also supported.

– **SLC**:Redundant Second Level Controller also known as Shelf Controllers embedded in the 1850TSS-320 MT320 module. However, non-redundant SLC configuration is also supported.

– **LDC**:Optionally redundant Local Device Controller (also second level), which could be an FPGA, ASIC, or other programmable processor in 1850TSS-320 modules.

The following modules function as Local Device Controller.

- 1 x OC192 XFP card
- 4 x OC48 SFP card
- 8 x OC3/12 SFP card
- 20 Gigabit Aggregator card
- 10 x 1000 Ethernet PIM card
- 1 x 10G Ethernet PIM card
- 20G Multi-service TDM PIM card

The 1850TSS/320 provides a high availability control system (HA). It consists of the FLC (EC320) and the SLC (MT320). The 1850TSS is capable of running with duplex FLCs and SLCs as well as simplex FLCs and SLCs with no degradation of functionality. In addition, the 1850TSS is capable of passing existing traffic with no FLCs (i.e. when both are removed after traffic is passing).

When running with redundant FLCs, one of the FLCs is the active FLC and the other FLC is the backup FLC.

The same is true for SLCs. When a fully redundant node is powered on, the FLC is slot 1 is likely to become the active FLC, and the SLC is slot 10 is likely to become the active SLC. The backup FLC/SLC becomes active under the following circumstances:

1) When the active controller is reset through the use of the INIT-SYS command with the AID of the active controller.
2) When the SW-DX-EQPT, SW-TOPROTN-EQPT, or SW-TOWKG-EQPT command is issued.
3) When the reset button on the front of the active controller is pressed.
4) When the active controller is physically removed from the node.
5) When the active controller fails. Failure scenarios are discussed in a subsequent section.
6) When the whole node is reset, the same controllers will remain active unless it is a node power on reset. In this case, the FLC in slot 1 and the SLC in slot 10 will become active if they are not already.

Each FLC has its own disk (Flash Disk) system. When running with redundant FLCs, the active FLC controls both disks and runs them in a RAID configuration. If the disk hardware of one FLC has a failure, the FLC is has failed.

All protocols for the management plane and the data plane run on the FLC. Subsequently, a failure of the FLC, a reset of the FLC, or a change in the active FLC may effect the transmission of data traffic (not SONET traffic) as the protocols restart.

System Initialization

The 1850 TSS NE and its subsystems can be reinitialized through 5 mechanisms:

1) Power cycle: the complete node will be reset when power is removed and then restored.
2) Card replacement: a subsystem in the node will be reset when it is inserted into the 1850 TSS NE either for the first time or after being removed.
3) Pushing the reset button on the front of a card.
4) User command: through the use of the INIT-SYS command with is described in detail in the EM RRS.
    a) Command system initialization can be performed on a specific card or the whole node.
    b) Command system initialization can be performed at two levels
        1) Cold Restart -The software and database is reloaded. If an FPGA is not running a version compatible with the current software, it will be updated and reset. Otherwise, the FPGA will not be reset. All of the processor RAM is reinitialized. Data control protocols running on the card (FLCs) will be reset and may effect transmission on data cards. This has no effect on nonprocessor cards.
        2) Power Restart -The software and database is reloaded. If an FPGA is not running a version compatible with the current software, it will be updated. All of the processor memory is reinitialized. All subsystems, including transmission carrying hardware and all FPGAs, are reset. Transmission will be affected.

1) User command: through the SW-DX-EQPT, SW-TOPROTN-EQPT, and SW-TOWKG-EQPT commands which is described in the EM RRS.
    a) The SW-DX-EQPT, SW-TOPROTN-EQPT, and SW-TOWKG-EQPT commands is the same as performing an INIT-SYS command on the active FLC or SLC.

An INIT condition will be raised by the active processor as soon as possible in the restart sequence. The INIT condition will be cleared when all initialization activities are complete and the NE is fully capable of performing all management functions

Card Booting

All cards in the NE follow the same booting behavior with the exception of the active FLC. This section describes the booting procedure.

When the active FLC boots, it does the following:

1) Performs processor subsystem integrity checks.
    a) If this fails, the FLC will set its failure light, print a message providing information about the failure to the debug port (if it can), allow the make the other FLC (if it exists) be active, and stop booting.
    b) If this is a cold reset, all of RAM is reinitialized.
    c) If this is a power on reset, all of RAM is reinitialized and all other chips/subsystems are reset.
2) Mounts one or both disks and validates the disk subsystem.
    a) If the local disk has a hardware failure, this will be treated like a processor subsystem integrity check failure.
    b) If the disk subsystem is corrupted, the FLC will try to recover it. If this fails, the FLC will set its failure light, print a message providing information about the failure to the debug port, and stop booting. In this state, the administrator needs to fix both disks. Enough of a debug port/ console will be available to reconstruct the disk subsystem through commands. This includes FTPing files from a remote location.
3) The images and files pointing to the images are validated.

a) If image is corrupted, the FLC will set its failure light, print a message providing information about the failure to the debug port, and stop booting. In this state, the administrator needs download new images to the node.

4) The runtime image is booted.
5) The versions of all the FLC's FPGAs are checked
   a) Any FPGAs which are out of date will be upgraded to a version of code compatible with the runtime software.
6) The FLC will validate the persistent configuration
   a) If the configuration is corrupt, the FLC will set its failure light, print a message providing information about the failure to the debug port, and stop the booting process. In this state, the administrator needs to fix both disks. The software cannot boot other cards and needs to get into a state where the administrator can restore the database. This includes FTPing files from a remote location.
7) The FLC will load the persistent configuration to memory
   a) If the card is OOS-MA and the other FLC is in the system, the FLC will make the other FLC active and reset itself.
   b) Otherwise, the hardware will be programmed accordingly.
8) The FLC will reset all cards that are running versions of software not compatible with it.
9) The FLC will load other cards and pass persistent configuration to them. When other processor cards besides the active FLC boot, they do the following:
10) Performs processor subsystem integrity checks.
    a) If this fails, the card will set its failure light, print a message providing information about the failure to the debug port (if it can), and stop booting.
    b) If this is a cold reset, all of RAM is reinitialized.
    c) If this is a power on reset, all of RAM is reinitialized and all other chips/subsystems are reset.
11) Loads its image from the active FLC.
    a) If this fails, the card will set its failure light, print a message providing information about the failure to the debug port (if it can), and continue to attempt to get an image on a periodic basis.
    b) If this is the backup FLC and it becomes active, it will restart booting as the active FLC.
12) The runtime image is booted.
13) The versions of all its FPGAs are checked
    a) Any FPGAs which are out of date will be upgraded to a version of code compatible with the runtime software.
14) The persistent configuration will be loaded from the active FLC and the hardware will be programmed accordingly.

When other non-processor cards boot, the FLC does the following:

1) The versions of all the non-processor card's FPGAs are checked by the FLC
   a) Any FPGAs which are out of date will be upgraded to a version of code compatible with the runtime software.
2) From the persistent configuration, the non-processor card's hardware will be programmed accordingly.

Database Integrity

The control complex is responsible for maintaining the integrity of the database. A RAID system is used to maintain the integrity of the disk system on which the database is kept.

– When the active FLC receives a management command (SNMP, TL1, GUI, etc.), the whole command is either completed or none of the command is completed.
– If a command is positively acknowledged, the changes have been committed to the persistent database and cannot be lost due to any combination of card resets or power cycles.

– If a command is positively acknowledged, the changes will soon be committed to hardware. The hardware is guaranteed to be updated or the associated card will be failed.
– A single failure, set of card resets, set of switch duplexes, or set of power cycles cannot corrupt the persistent configuration.

Control System Failure Detection

The control complex is responsible for monitoring its own health. This includes processors, disk system, and communication paths between the cards. Specifically, the control complex will perform the following checks to determine if a controller card has failed:
– Each processor will have a watch dog timer. If the watch dog timer expires, the card will have failed.
– The software upon detecting a non-recoverable programming error or hardware failure declares itself as failed.

Control Alarm Status

The control complex is responsible for providing alarm and conditions about its state as follows:

1) INIT -a standing condition
   – This condition is raised by the active FLC after it has loaded its runtime software.
   – This condition is raised by the backup FLC after it has decided to become active and has loaded its runtime software.
   – This condition is cleared when all cards have either come up to the point that they are ready to handle configuration commands from the administrator or have gone into the failed state.
   – While this condition is raised, the system must only be able to handle retrieve commands. See the specific RRS for what is returned for retrieve commands to cards that are not capable of responding.
   – If a card fails to become active within 7 minutes, the card will be failed.

2) SYSTEM-READY -a transient condition
   – This condition is raised when INIT condition is cleared.
   – This condition is also raised when the back up FLC/SLC has become active and is ready to handle configuration commands from the administrator.

3) SWDWN -a standing condition

   – This condition is raised for all modules and controllers when a software or firmware download is in progress.

   – This condition is cleared when the card is ready to handle configuration commands from the administrator or has failed.

4) SWDL-PROG -a transient condition

This condition is generated after every 5 minutes while the SWDL condition is standing.

3.2.12 Optical Supervisory Channel (OSC)

ITU-T Recommendation G.872 defines the Optical Supervisory Channel (OSC) as an optical carrier, associated with the optical transmission section, that transfers overhead information between optical transmission section (OTS) termination point entities. The supervisory channel supports more than one type of overhead information. Overhead information is used by one or more transport network layers.

It is now accepted in the industry that the Optical Transmission Section trail overhead is carried by the OSC. Further, there is wide support for carrying at least some of the Optical Multiplex trail and the Optical Channel trail overhead information via the OSC.

As a result of this OSC implementation in 1850TSS-320 system follows standard recommendations but also is flexible to support the expected new overhead needs.

Current GR-2918 recommendation requires that the following Overhead types be supported in an OSC:
– OTS Trail, Interactive Management Channel & Network Operator channel(s).

Overhead types for future consideration are:
– OCh trail, OMS trail, Client specific, National Use.

All of the above channels may be either packet switched or dedicated connections. Packet switched routing means that a packet or cell routing protocol is used at the applicable network layer. A connection means that a dedicated real, or virtual circuit is used to connect communicating NEs.

In 1850TSS-320 OSC implementation we utilizes both packet switched and dedicated connections.

It should be noted that 1850TSS-320 OSC implementation is functionally compliant with standard recommendations. However some implementation aspects are 1850TSS proprietary to provide flexibility and provide some application specific functions. When OSC interworking with non-1850TSS NE becomes a requirement SW reconfiguration or firmware upgrade may be needed.

As a part of Interactive Management Channel function, OSC represents an Embedded Communication Channel (ECC) in a DCN model.

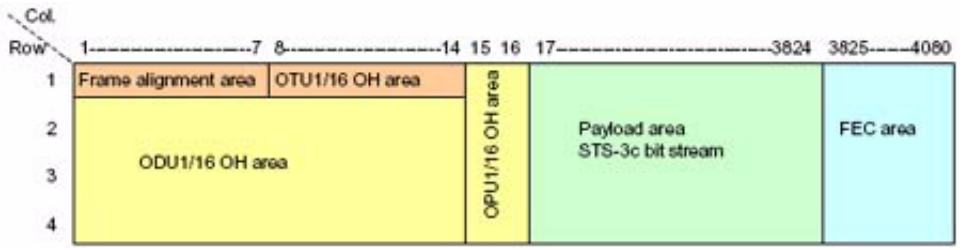
DCN is for distributed management communications related to the Telecommunication Management Network (TMN), distributed signaling communications related to the Automatic Switched Transport Network (ASTN), and other distributed communications (e.g., Customer LAN or Software Management applications).

DCN is defined as an entity that provides Layer 1 (physical), Layer 2 (Data Link) & Layer 3 (network) functionality consisting of switches/routers interconnected by links. Links can be WANs, LANs and ECCs.

OSC Frame structure

– OTU1/16 information structure

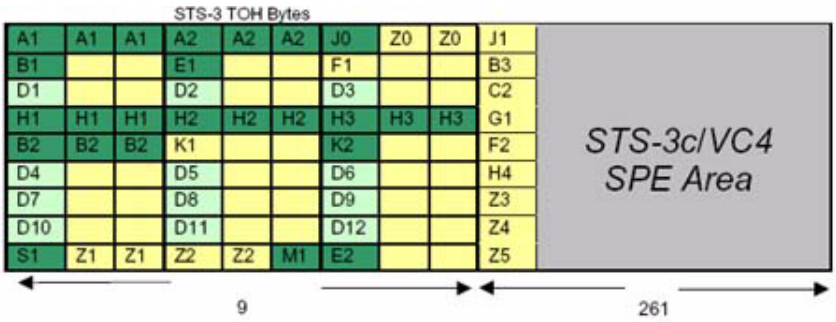
  Digital signal structure transmitted over an OSC carrier is a contiguous series of frames consisting of 4080 columns and 4 rows.



– STS-3c information structure specification

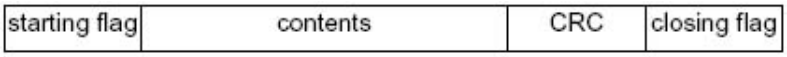
STS-3c structure is a reduced set of standard, defined OH functions is implemented to simplify design and avoid using resources for functions not necessary in OSC.

OH bytes indicated by green colored fields is used while yellow colored fields, whether standard defined or not, is set to 0x00 in source and ignored in sink direction. Light green colored fields (D1-D12) may be used in the future as ECC channel for interworking with legacy OTN systems.



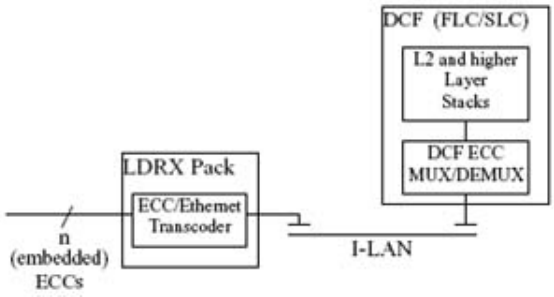
OSC interactive channel processing

ECC channels arrive multiplexed in their server signal on I/O packs of the system. An ECC channel contains HDLC frames with the following general layout:



The HDLC framing and HDLC-transparency (stuffing) is terminated and the contents of the HDLC frame is forwarded to the DCF function on an active FLC/SLC which performs all layer 2 and above processing of ECC channels.

When data from/to the ECC channels is transported via I-LAN, packets is transcoded to enable transport via Ethernet while preserving the ECC channel information (shelf, slot, port, location within the server signal (e.g. OSC payload area)).



3.2.13 Overhead

The NE generates the full complement of Section/Line/STSx Path overhead at each of its SONET interfaces. Active control is exercised over:

– A1, A2
– Z0
– B1
– J0 (on a 15 byte, printable-character basis)
– H1, H2, H3
– B2
– K1, K2
– M1
– S1
– J1 (on a 62 byte, printable-character basis)
– B3
– C2
– G1

The remaining Section/Line/ STSx Path overhead is generated with a default of all zeroes. All Section/Line/ STSx Path overhead is capable of being monitored at the SONET interfaces.



Figure 214. OTN Overhead bytes as defined in ITU G.709 for the OTUk/ODUk frame.

For the fully transparent transport of OC-192/10GE/10GFC/OTM0.2 signals only a reduced set of overhead bytes needs to be processed. See the applicability sections of the following requirements. For an overview refer to the following figure. The used overhead parts are shaded green.

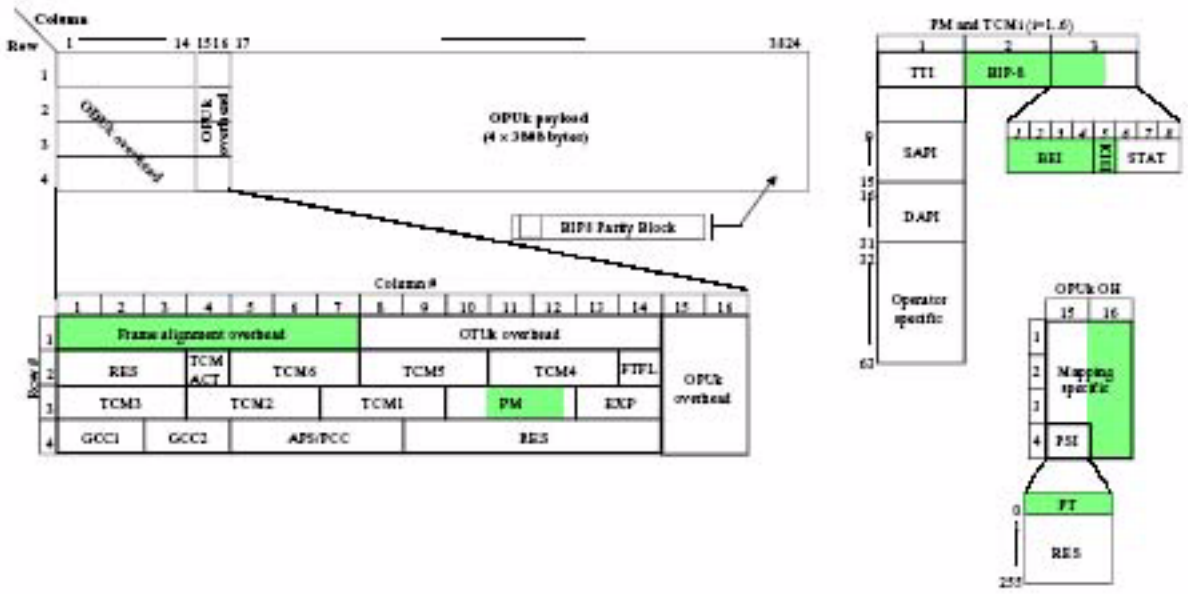


Figure 215. Overhead Details

3.2.14 Power

Each rack accepts redundant independent battery power plants providing - 40 VDC to -57.5 VDC with diversely routed dual bus.

Each rack that hosts a 1850TSS 320 has a device named GENTRU (Top Rack Unit) that has the main function to (re)generate, from each one of the (maximum) three incoming (plant) battery power inputs, a set of (A+B redunded) Battery cables for feeding the Shelves contained in the Rack through the plugged PSF boards (one PSF for Battery A access and one PSF for Battery B access): the power supply to the other Boards inside the Shelf and to the related two FAN trays is then distributed through the Back Panel.

The GENTRU (Top Rack Unit) provides fuse-protection between the multiple battery feeders cable from plant (available through the rack framework) and the shelves mounted within that rack.

The GENTRU (Top Rack Unit) accepts up to 3 independent inputs from the rack framework at nominal -48Vdc, with -38.4Vdc to -60Vdc range or -38.4Vdc to -57Vdc range; then each input is converted through a device inside TRU (step-up device) into a power interface outputs for shelves feeding with a minimum voltage of -65Vdc (recalibration of step-up is required in case of -38.4Vdc to -57Vdc input range).

The Maximum Power available from each step-up device output is 3.5 kW.

The GENTRU (Top Rack Unit) also accepts to by-pass each incoming plant Battery into two Battery connections for Standard

Feeding: the Maximum Power available from each By-Pass output is 1 kW.

The battery return of each feeder input and frame ground is isolated from the battery returns of the other feeder inputs.

The 1850 TSS-320 provide:
– low-impedance bond to the protective grounding system. Battery returns and chassis ground are isolated from each other.
– an electrical frame-grounding terminal at a place on the bay that is easily accessible to the installer.

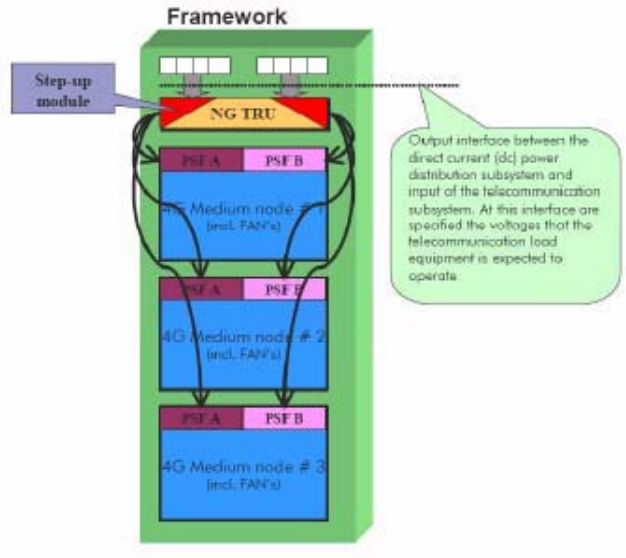


Figure 216. Battery Distribution

Failure of a single removable power supply module (e.g. PSF A) doesn't affect the traffic.

The power return cables from the DC to DC converters is completely independent.

The NE initiates a major alarm when a power sequence fault, an under-voltage fault, an over-voltage fault, or an over-current fault is detected on either of the power supplies.

The NE initiates a minor alarm when a fuse is blown or a breaker tripped

3.2.15 Recovery

The recovery time for the 1850 TSS 320 System is due to:
– a total power fail
– processor resets
– processor reboots

Different recovery time requirements apply, depending on the type of power recovery or resets/reboots that are being performed.

The 1850 TSS 320 supports the following recovery times:
– For recovery from a total power failure, alarms, status messages and full operational control is available within 10 minutes.
– All traffic connectivity is available within 10 minutes after restoration of power from total power failure.

The required system initializations complete to full operational control within the following time constraints:
– Initialization times for hardware resets, depending on level of processor:
  • Level 1 (L1 - FLC - First Level Controller): 5 minutes
  • Level 2 (L2 - SLC - Second Level Controller): 5 minutes
  • Level 3 (L3 - LDC - Local Data Controller): 5 minutes
– Initialization times for reboots (via INIT-SYS command):
  • Level 1+2+3: 10 minutes
  • Level 1: 5 minutes

Hardware Reset
A restart of any processor module, which includes a reloading of OS and applications (including databases), and possibly, self tests. Some processor levels perform self test on a cold restart, but not during hardware reset. This is also known as a cold restart.

Reboot
A restart of any processor module, which includes a reloading of OS and applications (including databases). Power-on self test is not done during reboot. This is also known as a warm restart.

Recovery from Power Failure
A restart of any processor module, which includes a reloading of OS and applications (including databases), and possibly, self tests after a restoration of power. This is also known as a power on restart.

3.2.16 Synchronization

SONET ports necessitate providing external synchronization from a network timing source to the system. Under normal conditions, all terminating and outgoing OC-Ns have identical average frequency derived from the network timing source. It is therefore necessary to ensure all clock modules of the system are synchronized to the same reference frequency as the terminating SONET facilities.

The NE utilizes external BITS (Building Integrated Timing Supply) timing to synchronize the system. The system is externally timed to either a Primary or Secondary BITS reference. The redundant synchronization subsystem act in a active/standby relationship. DS1 BITS timing enters the system either directly via the backplane (Rear Access Shelf) or via dedicated front plane integral - a panel just below the fan - (Front Access Shelf). The BITS interface is a DB9 connector with one DS1 input and output per connector. An optional wire wrap adaptor can be used to provide wire wrap connections. BITS timing is throughconnected to the redundant Clock Reference Unit (CRU). (refer also to Figure 217.).

The CRUs are resident on the Matrix boards "MT320"

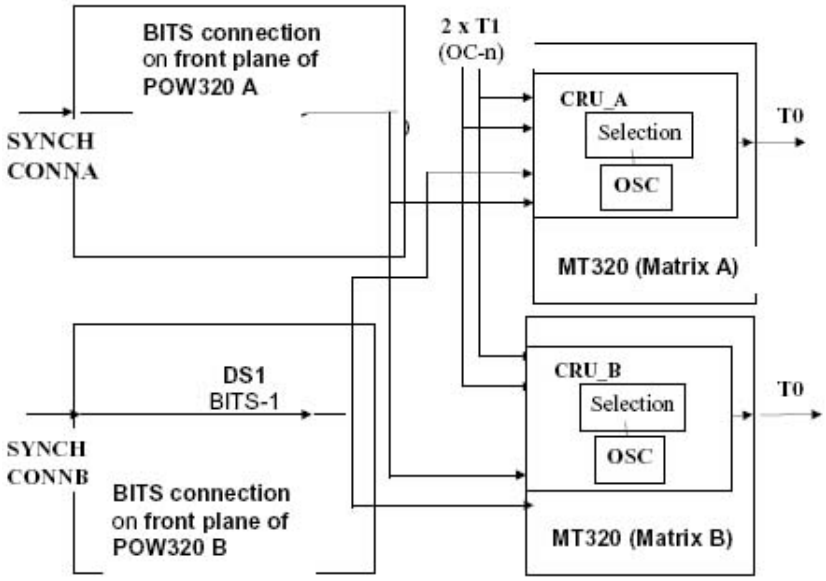


Figure 217. Block diagram for SONET clock architecture

The system additionally utilizes Line timing from OC-N ports to synchronize the system. In this case system is timed to either a Primary or Secondary Line time reference. Line timing enters via the OC-N boards the redundant Clock Reference Unit (CRU) on the matrix boards. The Clock Reference Generator (CRG) function of the CRU selects the appropriate source and distributes timing.

The Clock Reference Generator (CRG) function of the CRU selects the appropriate source out of up to two references (2 x BITS or 2 x Line timing or 1 x BITS and 1 x Line timing) and distributes timing. Refer to Figure SYNC-2

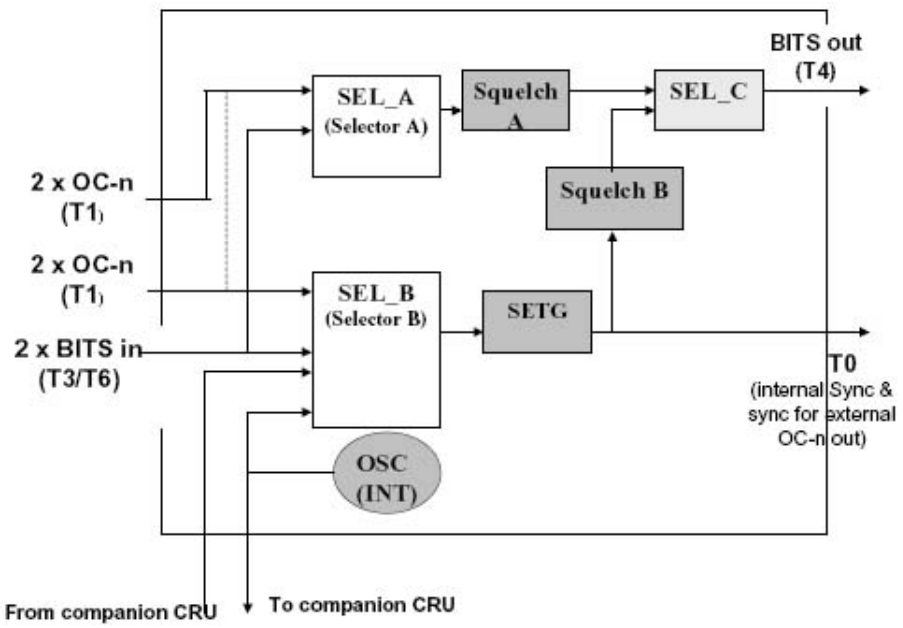


Figure 218. CRG functional view

The system supports the following synchronization capabilities:

– to synchronize the system to external timing reference from either of two DS1 BITS references.
– to support BITS output to DS1.
– to synchronize the system to Line timing reference from either of two OC-N references.
– to support Line timing output to OC-n.
– automatic switching of the CRUs on the matrix boards between timing references.
– manual switching between the BITS & Line timing references through the Operate Synchronization Switch command.
– switching between External and Internal timing through the Operate Synchronization Switch command.
– external BITS synchronization reference provisioning and maintenance states through the Edit BITS command.
– external BITS & Line timing reference source priority designation through the Edit Synchronization command.
– BITS & optical line sync messaging incoming and outgoing direction.
– The synchronization subsystem is duplicated and operated in an active/standby relationship.
– automatic switching between Active and Standby CRU.
– manual switching between Active and Standby CRU. Due to the fact, that a switch of the CRU always causes a complete switch of the hosting matrix board, this is provided by manual switching the matrix board. Therefore this is covered by EQPS-RRS.
– internal Oscillator of Stratum 3 quality as defined in GR-1244, with the objective of future compliance to Stratum 3E.
– A single BITS source shall be capable of timing up to 20 nodes in cascade.
– Autonomously report synchronization alarms with manual retrieval via command interface.

In the Multishelf configurations the main shelf is the only shelf where the synchronization selection process from external sources is performed and managed. There isn't any clock distribution from the main shelf CRU to the subtending shelf CRUs.

The CRUs of the subtending shelves are always in free running mode.

3.3 Administration

In the following are described the administration main features of the 1850 TSS-320 system.

The following parts are included in this paragraph:

– Network management (chapter 3.3.1) on page 276

– Network Management for Data/Ethernet system (chapter 3.3.2) on page 282

– Equipment Management (chapter 3.3.3) on page 286

– Security (chapter 3.3.4) on page 314

– Time of Day Synchronization (TODS) (chapter 3.3.5) on page 315

– Alarm Management (chapter 3.3.6) on page 317

– HouseKeeping (chapter 3.3.7) on page 319

– Installation and Upgrade (IAU) (chapter 3.3.8) on page 320

– Alarm Severity Assignement Profile (ASAP) (chapter 3.3.9) on page 322

– Database Management (chapter 3.3.10) on page 329

– Facility Management (chapter 3.3.11) on page 341

– Supervision (chapter 3.3.12) on page 366

3.3.1 Network management

The NE is provided with the following user service interfaces for connection from external management systems:

On MT320 unit (see Figure 60. on page 100)

– Two (2) “**M1**” (ref. 8) and “**M2**” (ref. 11) general purpose switched LAN ports (10/100BaseTX), for connection to EMS, craft terminal,

– Two (2) “**DS1**” (ref. 14) and “**DS2**” (ref. 17) independent switched LAN 1GE ports for connections to drop shelves.

On EC320 unit (Figure 59. on page 99)

– “**F**” (ref. 9) Local RS-232C Serial interface at 38400 baud for connection to craft terminal via serial link

– “**F**” (ref. 10) Local USB 2.0 serial interface at 2 Mb/s.

– “**DBG**” (ref. 4) a Debug port that can be used for a craft terminal interface

Separate debug LAN ports are available on each module that hosts a general processor. These LAN ports are connected directly to the processor LAN port and not switched

These interfaces provide an easy-to-use interface and security features to prevent unauthorized access. They support the following:

- Local access control based on login and password
- OSI neighbor discovery for easy access to the local NE(s)
- User provisioning of cross-connections, equipment, Ethernet services, software management, protection provisioning, and fault management
- Reports on NE equipage, cross-connections, alarms, and states

The interfaces can uses:

- Zero-Installation Craft (ZIC) terminal
- TL1 command
- CLI command

The customer and equipment sides of the Ethernet LAN User Interface, including the User Interface hardware itself is 1:1 redundant. It is up to the customer to suitably connect the NEs LAN interfaces to an appropriate customer provided LAN switch that can select LAN port(s) on the active MT320 module.

Tn the event of equipment protection switch of modules carrying LAN port does't necessarly switch. LAN port switch occurs when an unavailability state is detected on that interface.

The NE's MAC address is installed/assigned at the factory and isn't lost due to any single hardware failure or replacement of any normally field-replaceable module.

External IP address and MAC address remains fixed and follow the active LAN ports

A local craft terminal connected either through a serial or a LAN interface is able to establish TL1 connections to any NE reachable via DCC from the local NE.

The ports designated as the Craft terminal (LAN), EML (LAN) ports on the MT320 and the USB port 2 (ref. connector 10) on the EC320, are such that a user telnet to the 3082 and 3083 port should be able to access the TL1 commands.

The port designated as "RS232 Local Craft" Terminal needs PPP protocol.

In order to use USB port 2 (ref. connector 10) as a serial port, an hardware adapter is required that converts USB to 9 pin.

The MT320 Customer LAN, the MT320 Debug and the EC320 Debug terminal must run HCP protocol to function.

The NE has one (1) customer-provisionable IP address for all external IP communications via Ethernet.

On initial turn-up, the Customer LAN IP address is empty and the Customer LAN is disabled. An address is established by opening a TL1 session on the serial or craft Terminal port and provisioning the external IP address.

3.3.1.1 Communications Network Sizing

The basic communications network architecture for TL1 management is described in Figure 219. on page 277.

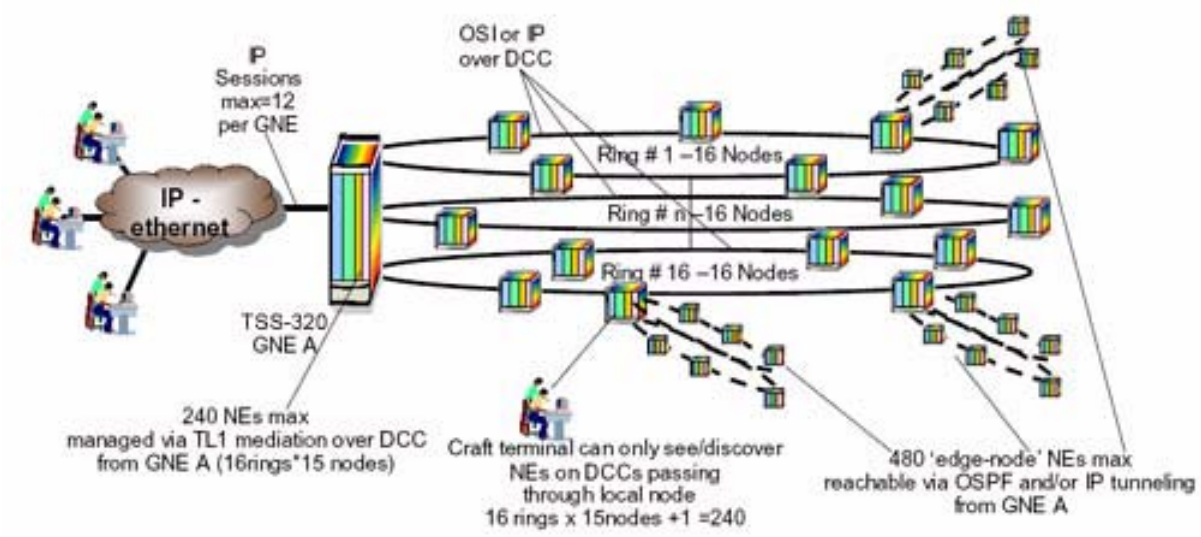


Figure 219. Communications network architecture example

The NE supports:

– Up to 12 simultaneous TCP connections to either of the L1 ports 3082 and 3083.

– Up to 32 section DCC and up to 32 line DCC channels, but they can be derived from up to 32 OC-n (3, 12, 48, 192).

– As a gateway network element (GNE), the NE supports DCC communications up to 240 nodes distributed over 16 separate DCC channels on 16 rings or APS subnetworks. The 16 rings may be all OSI over DCC, all IP over DCC, or mixed.

– A GNE is able to mediate up to 240 simultaneous TL1 user sessions logged into remote NEs. Normally, for large networks it is desirable to configure an additional GNE for every 30-40 managed nodes.

– Up to 128 as max number of IP tunnels.

The 7 layers of the OSI protocol stack as defined in Telcordia GR-253 are supported allowing interoperation with NEs not supporting TCP/IP over DCC. The OSI protocol stack supported is shown in Table 19..

Table 19. OSI over DCC protocol stack

Layer	Name	Service / Protocol
7	Application	TL1, ACSE
6	Presentation	ASN. 1 (ISO 8823)
5	Session	ISO 8327
4	Transport	TP4 (ISO 8073) and TARP (GR-253-CORE)
3	Network	CLNP (ISO 8473), ES-IS (ISO 9542) and IS-IS (ISO 10589), Integrated IS-IS (RFC 1195)
2	Data Link	SNDCF (ISO 8473) over LAPD (ITU Q.921) or PPP over HDLC (RFC 1662), LCP (RFC 1661), OSINLCP (RFC 1377)
1	Physical	DCC

The OSI protocol stack can be enabled or disabled on a specified DCC channel. The system guarantees that DCC channels are protected if the OC-n carrying them are involved in section protection schema.

The NE also supports the TARP protocol (ref. to GR-253 Section 8.7 and Appendix C.8)

The NE designates one NET or NSAP as the NET or NSAP to be used for mapping purposes of all TARP-related TID/NET mappings. Since only one Manual Area Address is allowed.

The TARP functionality (i. e., TARP origination, TARP propagation and TARP Data Cache) is always enabled. When the NE sends TARP PDUs (over CLNP), the Network Selector (N-SEL) portion of the NSAP DSP is set to an initial value of "AF" (hexadecimal).

The NE maintains a circular (First In First Out) TARP Loop Detection Buffer (LDB) in order to perform the Loop Detection Procedure.
The LDB needs to be populated only with the System Id portion of the tar-por (TARP Protocol Originator Address). The LDB can hold up to 240 tar-por, tar-seq (TARP Sequence Number) pairs.
The NE maintains a LDB entry timer for each LDB entry whose tar-seq number is being updated with the value of 0.
The "TID of Originator" is included in all TARP Type 1 and Type 2 PDUs generated from the NE.
The "TID of Target" field is set to NULL (i. e., having zero length) in generated Type 3 PDUs.
Whenever the "Sequence Number" field is reset to zero, a TARP Type 4 PDU are generated (even though the TID and / or the network address has not changed).

3.3.1.2 TCP/IP protocol stack

The TCP/IP protocol stack supported for an IP-based DCN will be as shown in Table 20..

Table 20. TCP/IP over DCC protocol stack

Layer	Name	Service / Protocol
7	Application	raw terminal TL1, telnet TL1
6	Presentation	
5	Session	
4	Transport	TCP
3	Network	IPv4, ICMP, Integrated IS-IS (RFC1377), ARP
2	Data Link	PPP over HDLC (RFC 1662) or SNDCF (ISO 8473) over LAPD (ITU Q.921), IPCP (RFC 1332), LCP (RFC 1661), IPv4 directly encapsulated over CLNP (proprietary solution)
1	Physical	DCC

The TCP/IP protocol stack can be enabled or disabled on a specified DCC channel, or the Customer LAN.

TL1 messages over the TCP/IP stack

TL1 message formats comply with the GR-831-CORE, so support:

– The raw encoding of TL1 over TCP.
  Raw terminal encoding provides to keep-alive probes. The character sequence used in keep alive probes consists of the character ASCII 255 immediately followed by the character ASCII 241.
  Both of these characters are outside of the TL1 character set. This character pair was chosen because in the Telnet protocol the command IAC NOP is encoded as ASCII 255 241, and it is desirable that the same keep-alive probe encoding is used for the raw encoding and the Telnet encoding.
  TL1 responders uses the port number 3082 to listen for incoming TL1 connections using the raw terminal encoding.

– The Telnet encoding of TL1 over TCP.
  The Telnet encoding is provided for human-machine interactions.
  The TL1 responders use port number 3083 to listen for incoming TL1 connections using the telnet encoding.
  Only the support for the ECHO and the SUPPRESS-GO-AHEAD Telnet options is required.
  These options are supplied by Telnet commands. A Telnet command consists of an escape byte - the Interpreter As Command escaping character (IAC) - followed by a command code of at least one byte.
  When a TCP connection is in urgent mode (signaling the presence of urgent data on the TCP connection) incoming data are processed in the same way as when the TCP connection is in normal mode (i.e. not in urgent mode). Specifically, when the TCP connection is in urgent mode, incoming user data (i.e. TL1 messages carried over normal mode) must not be discarded.
  TL1 Responder function supports prompts on a Telnet encoded connection, in order to make more user-friendly the interface between network elements and users.
  Whenever the TL1 responder is ready to begin reading the next TL1 command it should send a prompt string.

3.3.1.3 SNMP messages over the IP stack

SNMP message format complies the RFC3417.

The SNMP messages are carried by DCN over UDP/IP stack.

Table 21. UDP/IP over DCC protocol stack

Layer	Name	Service / Protocol
5	Application	SNMP
4	Transport	UDP
3	Network	IPv4, ICMP, Integrated IS-IS
2	Data Link	PPP over HDLC (RFC 1662) or SNDCF (ISO 8473) over LAPD (ITU Q.921), IPCP (RFC 1332), LCP (RFC 1661)
1	Physical	DCC

The SNMP messages can be also carried by IP over OSI tunnels (see 3.3.1.7).

3.3.1.4 Gateway mapping table

The NE maintains a Gateway mapping table, which contains the mappings between TIDs and IP addresses belonging to neighboring NEs.
Only static mappings between TIDs and IP is supported in this release. Along with the TID/IP association, each entry in the Gateway mapping table contains the corresponding IP port number used for raw terminal encoding and the status of the mapping (i.e., if the mapping is a static or dynamic one).

3.3.1.5 IP routing

The NE supports Integrated IS-IS.
It is possible for the operator to select Integrated IS-IS protocol for the layer 3 routing.

3.3.1.6 IP-MAC resolution.

To allow correct IP routing over an Ethernet interface, the ARP (Address Resolution Protocol) is used to map IP addresses with the corresponding MAC (Medium Access Control) addresses.
The IP-MAC associations established by ARP software are collected in the ARP Cache.
The ARP Cache entries is filled automatically by ARP protocol's software.

3.3.1.7 IP tunneling

Note: The IP tunnels are basically uni-directional and they have to be created from each side to get a bidi-rectional tunnel. The translation from Remote TID to NSAP is done at the ENT-NE-IPT command time and is never dynamically updated.

The NE shall provide the capability to establish IP Tunnels (IPT) between NEs on the same DCC subnetwork. This function allows NEs with existing OSI connectivity to be able to establish an IP tunnel over CLNP.
The NE shall support direct IP in CLNP encapsulation according to the Alcatel-Lucent proprietary method used by OMSN systems.
The loopback IP address that represents the local IP address for all the tunnels is configured first, before any tunnel is configured.

3.3.1.8 Ping

Remote ping operations is performed in compliance with RFC 2925. Ping capability is provided by means of ICMP (Internet Control Message Protocol) ECHO facility.
The NE is able to answer to remote ping tests which have been started by a Network Manager through a Ping Request. In particular, this Ping Request shall be an ICMP Echo Message, as described in RFC 792.
The NE answers to a ping request sending its own IP address in a Ping Response. In particular, this Ping Response is an ICMP Echo Reply Message.

3.3.1.9 PPP protocol

The Data Link Layer protocol for the SONET Section and Line DCC channel is based on the following RFCs, when the DCC channel is provisioned for IP applications:

– RFC 1661 (The Point-To-Point Protocol)
– RFC 1662 (PPP in HDLC-like framing)
– RFC 1332 (PPP Internet Protocol Control Protocol)
– RFC 1377 - The PPP OSI Network Layer Control Protocol (OSINLCP)

The PPP interface meets the specifications listed in Table 22..

Table 22. PPP interface's specifications

Physical Layer Characteristics	Setting	References
Transmission	Full Duplex	RFC 1662, Section 1, paragraph 1
Framing	Bit-Synchronous	RFC 1662, Section 2, paragraph 1
Interface Format	Octet Format	RFC 1662, Section 2, paragraph 2

The bit-synchronous PPP framing format shall be as defined in RFC 1662 and is depicted in Figure XCOM-6.

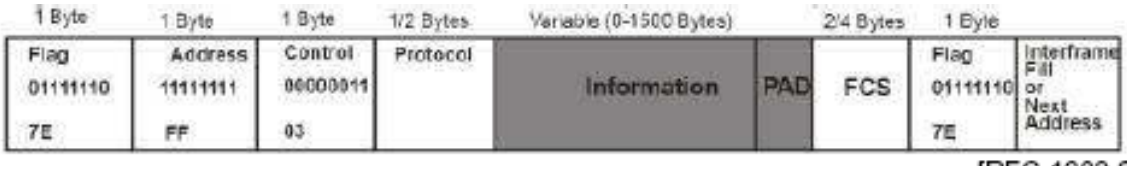


Figure 220. PPP framing format

The bits in the HDLC frame signal is inserted into the DCC channel on the STM-N facility in the same order that they were received from the HDLC frame signal generator.

Frames which are too short (less than 4 octets) are silently discarded and not counted as an FCS error.

3.3.2 Network Management for Data/Ethernet system

3.3.2.1 Mixed Ethernet and SONET/SDH Network

The management of SONET/SDH/WDM equipment is organized as required by the 7-layers ISO/OSI protocol stack, while the Ethernet system is managed by means of SNMP (Simple Network Management Protocol), that is an application of the 5-layers TCP/IP reference model.

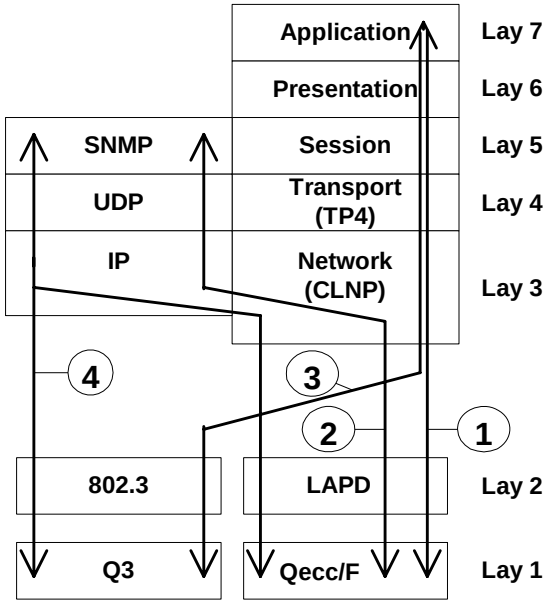
In networks with Ethernet over SONET/SDH there is the need to manage together and contemporarily SONET/SDH and Ethernet systems; this task is accomplished by means of the encapsulation of SNMP messages inside the OSI layers ("IP over OSI tunneling"). In this way the Ethernet management information is transported together with the SONET/SDH control messages.

For Ethernet and SONET/SDH networks, the protocols relationships are illustrated in Figure 221. on page 282.

An example of Ethernet and SONET/SDH network management is shown in Figure 222. on page 283.
In this example, the OS enters the network management messaging over an Ethernet link (IEEE-802.3 protocol) of a Gateway NE (GNE); here the messagges are transported over the optical Qecc links by means of the LAPD protocol; at the remote managed nodes, the messages are acknowledged as belonging to:

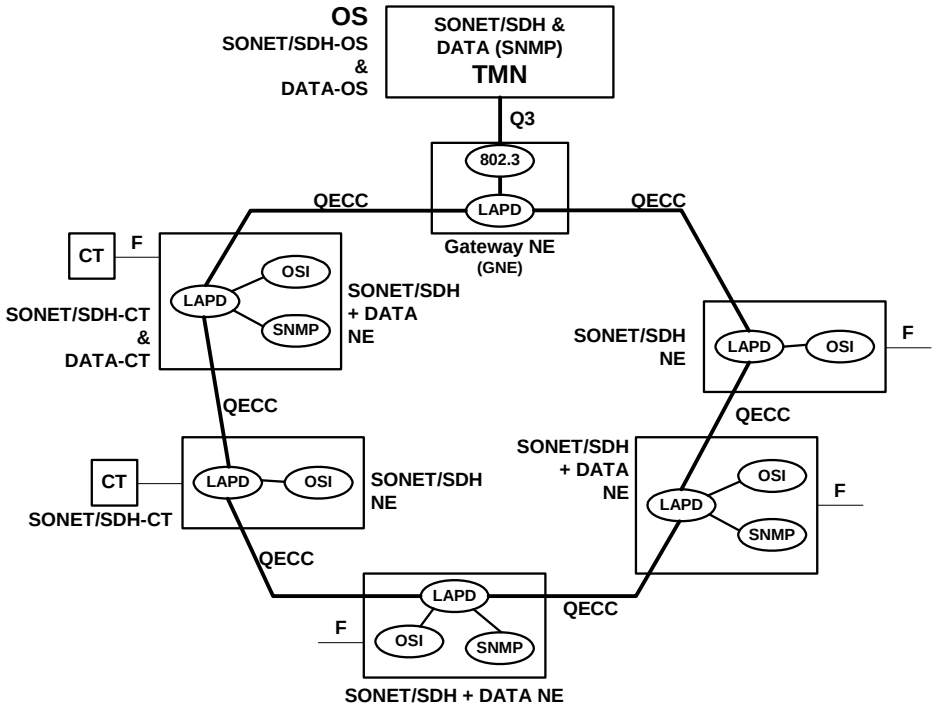
– OSI reference model, for SONET/SDH management

– TCP/IP (SNMP) reference model, for Ethernet, or MPLS management.

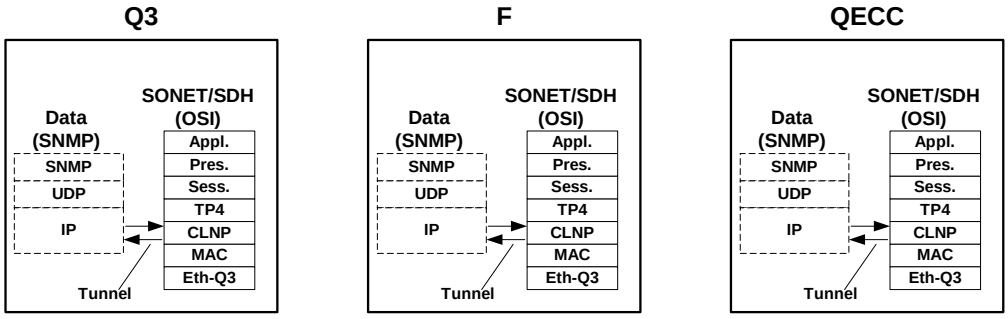


1) OSI stack for SONET/SDH management (F/Qecc Interface)
2) IP over CLNP tunneling for DATA Management (F/Qecc Interface)
3) OSI stack for SONET/SDH management (Q3/Qecc Interface)
4) IP over CLNP tunneling for DATA management (GNE entry from OS, IEEE-802.3)

Figure 221. Protocol stack for Ethernet and SONET/SDH management



Protocol stack at different interfaces:



Note:

– The tunnel IP over CLNP is initiated inside the Manager (CT or OS) and terminated at the destination NE, in order to carry SNMP management messages into the SONET/SDH network

– The SNMP messages are tunneled in the NE's where the message is not to be opened

Figure 222. Example of management of SONET/SDH network with Ethernet traffic

Note:

In order to transfer the management information, the involved entities need an OSI address (for the ISO/OSI information messages) and an IP address (for the SNMP information messages). In case of “full-data” network, the only IP addressing is sufficient. In case of “pure-TDM” (SONET/SDH/WDM) network, the OSI addressing is sufficient.

1) CT (personal computer, local manager or craft terminal) addressing. The OSI address is assigned by means of the Alcatel-Lucent Lower Layers Manager (ALL) application; the IP address assignment is done in the WINDOWS environment by means of the “Network" application of the “ControlPanel". Refer to the [5], [6] and [7] on page 20 document for these operations.

2) CLI

3) EC (Equipment Controller board of the NE) addressing. The OSI address and IP address are assigned by means of the SONET/SDH-CT application (“Configuration:Comm/Routing:..." options). Refer to the [5], [6] and [7] on page 20 documents for these operations.

An illustrative example is reported in next Figure 223..

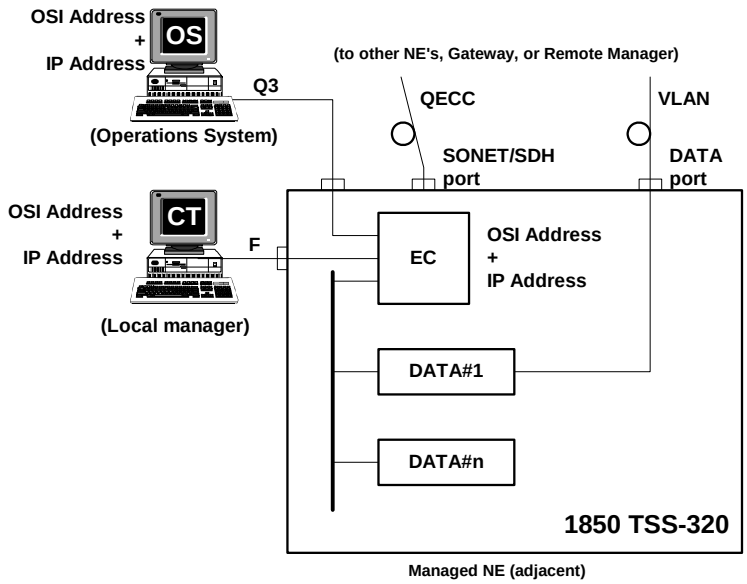
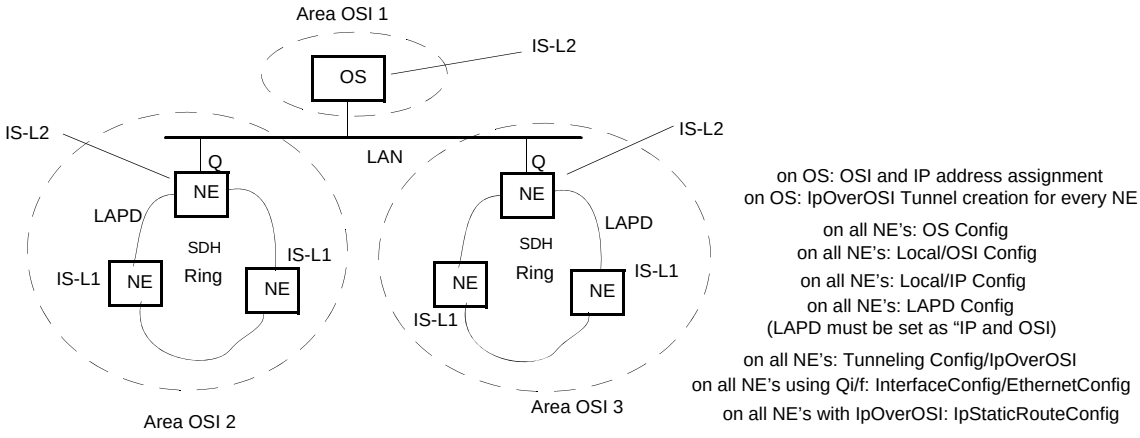


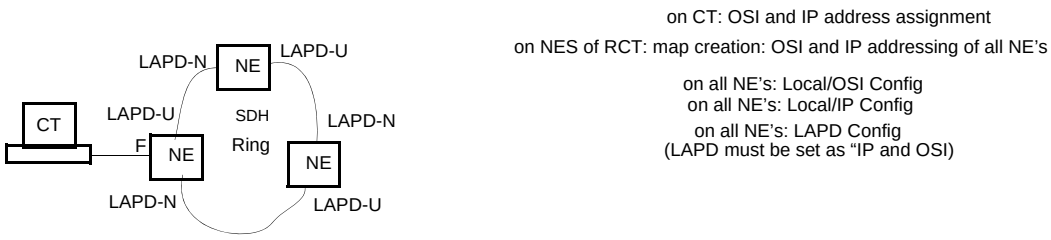
Figure 223. OSI and IP addressing example

3.3.2.2 Examples of Management Networks

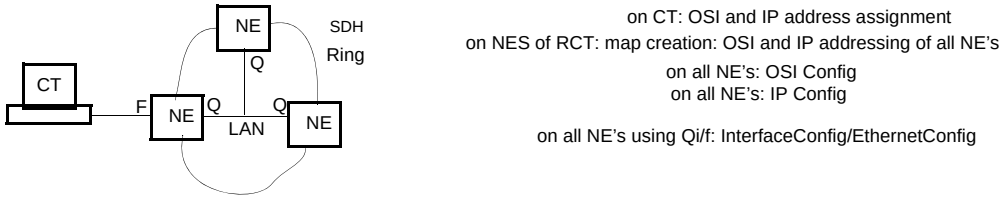
The following figure illustrates some examples of network management. Each NE is supposed to be equipped with DataBoards.



1 - Example of Network Management by OS and different OSI areas



2 - Example of Network Management by RCT over LAPD



3 - Example of Network Management by RCT over LAN Q-Eth

Note:

IS: Intermediate System. IS-L1 is a Level1 (Intra-Area) system; IS-L2 is a Level2 (Inter-Area) system. The IS function performs the routing of control messages inside the OSI network. See Related Documents [5] on page 20 for more details.

LAPD: (also called Q-ECC), protocol for transporting network control messages over DCC bytes of the SONET/SDH frame. LAPD-N (Network role) is used when source convention is used at the interface; LAPD-U (User role) is used when sink convention is used at the interface; the two conventions must be alternated. Refer to the See Related Documents [5] on page 20 for details about these operations.

Figure 224. Examples of Network Management

3.3.3 Equipment Management

This part contains the details for Equipment Management feature for the 1850 TSS-320 node .

The NE provides to the initialization, preprovisioning, autoprovisioning, postprovisioning and deprovisioning functionality of all the modules.
Postprovisioning is the capacity to explicitly provision by management an IO card which cannot be automatically configured via plug and play due to some characteristics which cannot be determined without system management intervention. This type of IO cards is not automatically entered and provisioned when plugged in an unassigned slot, until explicitly provisioned by the management system.

The NE support both Modify Equipment Expected. and Multi Shelf configurations.

The EC320 (main), MT320 (a+b), PSF320 (a+b), TBUS320 (a+b), FAN320 (a+b) units are automatically preprovisioned on each provisioned Main Shelf/not-Main Shelf and cannot be able to be deleted.
The PP20G (aggregator) unit and WRx (wavelenght DWDM router) circuit pack reside in four (two upper + two lower) slots, all the other modules reside in two (one upper + one lower) slots or one slot.

Provisioning/deprovisioning procedures on an entity doesn't cause errors on other entities.

Modification of states and parameters, pertaining to the modules is provided. Modifications will take effect immediately. The NE provides retrieval of states and parameters pertaining to the modules.

The NE detects insertion and extraction of all modules in the system.

The NE supports:
– The Equipment Primary States (PST) and Secondary States (SST) based on GR-1093.
– The logical removal and restore of modules.
– The restart functionality both at pack level, at shelf level and at NE level.

Slot Assignment
The shelf layout is reported in chapter 2, where it is described which boards can go into which slots in the shelf, which boards are working and protection modules, and which modules are single-slot or two-slot or four-slot.

- Two slot (vertical) modules are addressed with the number of the top slot
- Two slot (horizontal) modules are addressed with the number of the leftmost slot
- Four slot modules are addressed with the number of the top leftmost slot

As far as the IOC boards pluggable in shelf position(s) is concerned:
– PP20G (Aggregator) and WRx (wavelenght DWDM router) Card reside in four (two upper + two lower) slots;
– 11GUAR, 11GBAR, OPS, 10GSO , 2G5SO, 8XSO, OTU2 and 10XANY resides in one slot;
– The other modules reside in two (vertical) slots: they are LDTx (DWDM Transmit Amplifier) and LDRx (DWDM Receive Amplifier).
– MT320 (SC) physically resides in two vertical slots but logically, that is at AID naming level, is managed as a single slot unit.

Equipment Discovery
The active SC performs the detection of port cards, other matrix/sync cards and EC.
Card missing signals are reported from SC to the EC320 by PSF320 units using a dedicated 3-wire serial link in addition to a "card missing" (CMISS) signal of the PSF320 unit. Additionally, EC provides each PSF320 unit with its "card missing" output signal.

Card detection is supported for the following equipment entities:

– EC320
– MT320
– IOC
– FAN320
– PSF320
– PIMMS
– LDTXA
– LDTXB
– LDRXA
– LDRXB
– WR4
– WR8
– OPS
– DCM
– 11GBAR
– 10XANY
– OTU2

As far as OMD44 and DCM discovery/missing and Inventory retrieving, XFP and SFP modules are detected by SC polling their relative IO boards. For PIMs, XFP and SFP the active SC retrieves the remote inventory data from the card that hosts the module. For these modules, the system performs the following minimum set of operations after PIM/SFP/XFP insertion:

– SC is not able to collect directly its RI data via SPI bus: PIM/XFP/SFP's RI data are retrieved by the card which hosts the module.
– SC makes a periodic check of hw setting: at the first check made after PIM/XFP/SFP insertion, SC collects RI data from the main card which retrieves and send to SC also PIM/XFP/SFP data.

The "not present" indication causes the equipment entities to follow the indicated state transitions that are associated with the UEQ SST.
Physical insertion and removal of a module causes REPT^DBCHG autonomous message
Physical removal of a module raises an Alarm Condition.
Insertion or extraction of a module doesn’t cause errors to occur on other entities.

For the core optics the “Quad” term is defined; it means a set of four contiguous slots holding core optics circuit packs in a ROADM or UROADM Shelf: The quads are slots 2-5, 6-9, 12-15 and 16-19

Manual Restart

It is possible to reset a specified equipment entity or the entire NE via TL1 command (INIT-SYS).
Different possible level of restart are defined:

- *WARM*: reload of dynamic data only (DB in RAM). It is supported by MT320 without traffic affecting if the current configuration is in line with the one to be reloaded.
- *COLD*: reload of dynamic and static data (SW and DB if present). Processor is restarted. It is supported by all the Processor-based Card without traffic affecting if the current configuration is in line with the one to be reloaded.
- *POWER-ON*: full restart (as if unplugged and plugged), including processor restart and reloading of sw and db. It is supported only by MT320.

Here below Table 23. shows the type of Restart allowed for each Board.

Table 23. Restart allowed for each Board

	POWER-ON	COLD	WARM
Network Element	a) Reboot MT320 WDM standby Processor with code and data reloading b) Reboot MT320 WDM active Processor with code and data reloading c) Reboot MT320 TDM standby Processor with code and data reloading d) Reboot MT320 TDM active Processor with code and data reloading e) Reboot EC320 with code reloading and with data reloading (if changed)	a) Reboot MT320 WDM standby Processor with code reloading (if changed) and data reloading (if changed) b) Reboot MT320 WDM active Processor with code reloading (if changed) and data reloading (if changed) c) Reboot MT320 TDM standby Processor with code reloading (if changed) and data reloading (if changed) d) Reboot MT320 TDM active Processor with code reloading (if changed) and data reloading (if changed) e) Reboot EC320 with code reloading (if changed) and with data reloading (if changed)	--
Shelf (not OMD)	--	a) Reboot MT320 standby Processor with code reloading (if changed) and data reloading (if changed) b) Reboot MT320 active Processor with code reloading (if changed) and data reloading (if changed) c) Reboot EC320 (if present) with code reloading (if changed) and with data reloading (if changed)	--
EC320	--	Reboot EC320 Processor with code reloading (if changed) and with data reloading (if changed)	--
MT320	Reboot MT320 Processor with code and data reloading	Reboot MT320 Processor with code reloading (if changed) and with data reloading (if changed)	Restart MT320 Processor w/o code reloading
PIMMS PIM1GE PIM10GE 10GSO 2G5SO 8XSO OTU2 10XANY	--	Reload the relevant data (if changed)	--
PP20G LDTXA LDTXB LDRXA LDRXB WR4 WR8 11GBAR 11GUAR OPS	--	Reboot the relevant Processor with code reloading (if changed) and with data reloading (if changed)	Restart the relevant Processor w/o code reloading

Control Mode

– Simplex Control Mode
  In simplex control mode, there is a single First Level Controller (FLC = EC320) in slot 1 of the node's main shelf. Simplex control is the default mode of operation.

– Duplex Control Mode
  A node operates in duplex control mode with FLCs placed in slots 1 and 20 of the node's main shelf . The EC320 controller in slot 1 is initially the active one; the EC320 controller in slot 20 is initially the standby one: if the slot 1 EC320 fails, the slot 20 EC320 becomes active.
  The Duplex mode is automatically set when the EC320 is provisioned in slot 20 (spare).
  A switch of a node's active FLC yields a switch notification.
  The user is also be able to effect a manual switch of a node's active FLC.

Provisioning

Mandatory equipment are automatically provisioned whether present or not.

For non-mandatory equipment (incl. XFP and SFP modules), the following modes are defined for provisioning:
– Auto-provisioning also referred to as Plug & Play, where the SC discovers and provisions any legal card in a formerly empty and unprovisioned slot and places it in service
– Pre-provisioning, where the slot is provisioned in advance of a card being inserted

Autoprovisioned modules are automatically placed in service (IS), if no alarm conditions are detected during insertion or power-on diagnostics.
It is possible to provision a protection EC by:
– Pre-provisioning
– Auto-provisioning
Modules inserted in a preprovisioned slot, if no alarm conditions are detected during insertion or power-on diagnostics, are automatically placed in service (IS) or in OOS-MA depending by the operator intended PST for the equipment being provisioned (IS or OOS) .
Factory default values for equipment provisioning parameters referred in “**TL1 Operation Details**” manual. Factory default values cannot be changed via TL1.

Provisioning procedures on an entity doesn’t cause errors on other entities.

Provisioning Hierarchy
There is a provisioning hierarchy in the WDM portion of an 1850 TSS-320 node such that objects must be provisioned in order from higher level to lower level in accordance with these constraints:
- Shelves before the circuit packs they contain
- Circuit packs before the ports they contain
- Circuit packs before the optical connections that connect fixed ports
- Circuit packs before optical or electrical plug-in modules
- Optical plug-in modules before optical connections to those modules

DCM Existence Provisioning
Both DCMs and OMDs are passive devices that are not slot-resident. They provide optical line-level signals to the circuit packs to which they are connected (LD and WR_ circuit packs, respectively). When the modules exist, absence of an optical line-level signal implies a fiber failure.

Absence of an optical line-level signal does not always imply a fiber failure. Mis-fibering is always a possibility and there can be instances in which a DCM or an OMD do not exist. OMDs are provisioned - and have AIDs, but DCMs are not provisioned and thus do not have AIDs. Because of this, DCM existence or absence is provisioned via the Primary State (PST) of the LDRXA, LDRXB or LDTXA circuit pack port to which the DCM is connected.

- Setting the Primary State of the LD_ cirucit pack DCMINV port to IS (in-service) means that a DCM is equipped.
- Setting the Primary State of the LD_ cirucit pack DCMINV port to OOS (out-of-service) means that there is no DCM equipped.

Note: The expected TL1 commands for provisioning DCM existence and retrieving DCM EEPROM transmision data are, respectively, *ED-OPORT-OTS* and *RTRV-OPORT-OTS*.

Below we consider as related modules:
– PP20G and PIMMS
– XFP/SFP and IOC

It is NOT allowed to preprovision or autoprovision an entity (e.g. XFP) with its related hosting module (e.g. IOC) not provisioned.

The NE complies with the following constraints between related modules:

- **Provisioning of main card first**: If a main IOC card is provisioned in slot X with no other possible related PIM IOC card already provisioned, it is not allowed to provision a PIM IOC card, different from the one compatible with the provisioned main IOC board, that points to the slot X.

If a single-slot card is inserted in a slot provisioned for a many-slot card, the following changes happens in the related slots (see Figure 225. and Figure 226.):
– If the single-slot card is inserted in the slot acting as reference for the many-slot card, a mismatch is detected and the module goes to OOS-AU, MEA
– If the single-slot card is inserted in the slot different from the one acting as reference for the many-slot card, an abnormal is detected and the module goes to OOSMA, UAS
– If more than one single-slot card is inserted in slots provisioned for the many-slot card, the result in terms of Condition Types event and state changes is a pure "sum" of the related one only plugging.

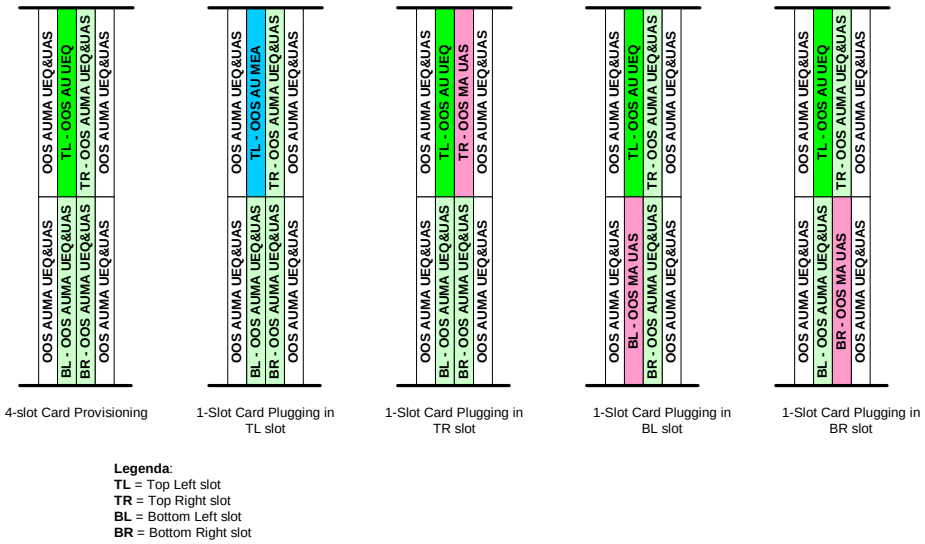


Figure 225. Single-Slot Board plugged in Four-Slot provisioned domain

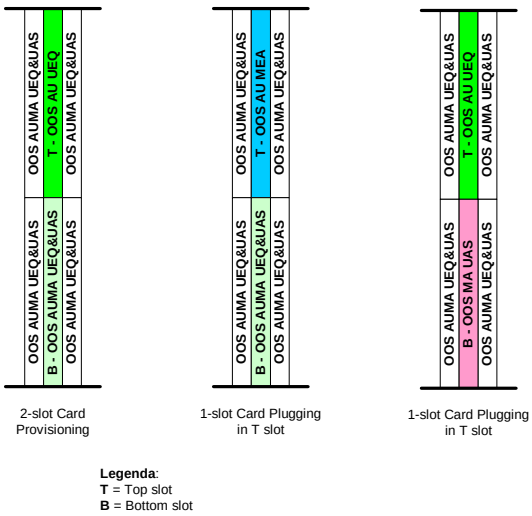


Figure 226. Single-Slot Board plugged in Two-Slot provisioned domain

If a two-slot (vertical) card is inserted in a slot provisioned for a four-slot card, the following changes will happen in the related slots (see Figure 227.):

– If the two-slot (vertical) card is inserted in the slot acting as reference for the four-slot card, a mismatch is detected and the module goes to OOS-AU, MEA
– If the two-slot (vertical) card is inserted in the slot different from the one acting as reference for the four-slot card, an abnormal is detected and the module goes to OOS-MA, UAS
– If more than one two-slot card is inserted in slots provisioned for the four-slot card, the result in terms of Condition Types event and state changes is a pure "sum" of the related one only plugging.

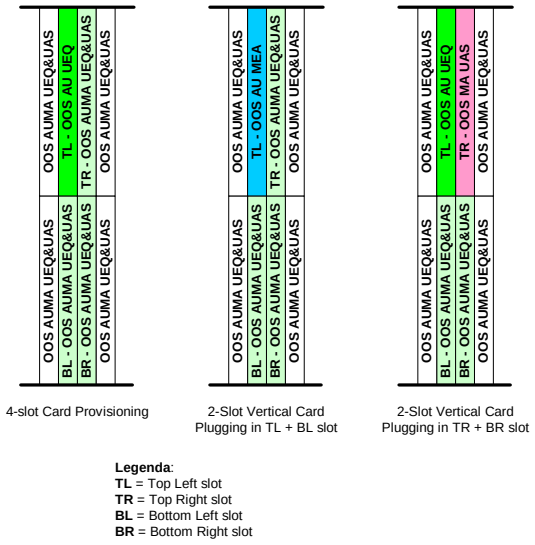


Figure 227. Two-Slot Board plugged in Four-Slot provisioned domain

If a many-slot card is inserted into the NE and at least one of the related slots is already provisioned for a one-slot card, the following changes happens in the related slots (see Figure 228.):

– If the slot acting as reference for the plugged many-slot card is the same one of the provisioned one-slot card, a mismatch is detected and the module goes to OOS-AU, MEA
– If the slot acting as reference for the plugged many-slot card is not the same one of the provisioned one-slot card, a abnormal is detected and the module goes to OOS-MA, UAS
– If more than one single-slot card is provisioned in slots where a many-slot card is then plugged, the result in terms of Condition Types event and state changes is a pure "sum" of the related one only provisioning.

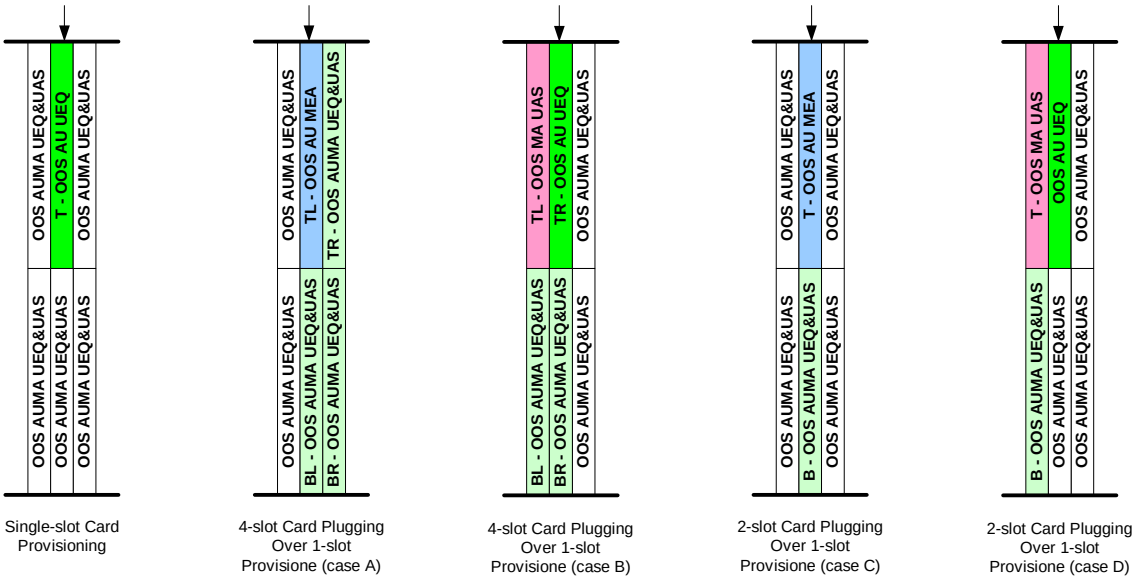


Figure 228. Four/Two-Slot Board plugged over One-Slot provisioned domain

If a four-slot card is inserted into the NE and at least one of the related slots is already provisioned for a two-slot card, the following changes happens in the related slots (see the Figure EM-34):

– If the slot acting as reference for the plugged many-slot card is the same one of the provisioned one-slot card, a mismatch is detected and the module goes to OOS-AU, MEA
– If the slot acting as reference for the plugged many-slot card is not the same one of the provisioned one-slot card, a abnormal is detected and the module goes to OOS-MA, UAS
– If more than two-slot card is provisioned in slots where a four-slot card is then plugged, the result in terms of Condition Types event and state changes is a pure "sum" of the related one only provisioning.

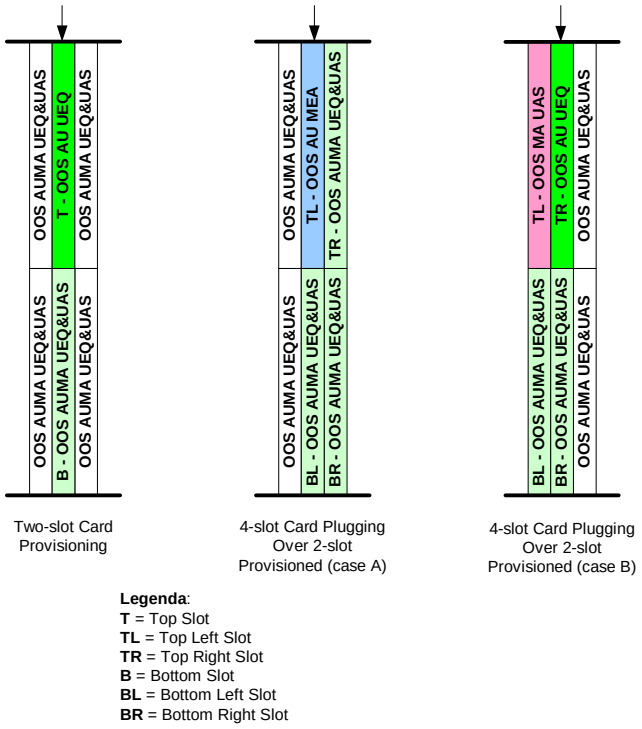


Figure 229. Four-Slot Board plugged over Two-Slot provisioned domain

Pre-provisioning

An Enter Equipment TL1 command is supported to create a provisionable equipment.
– The ENT-EQPT TL1 command is used to provide this functionality
– The command supports a AID parameter to specify the type of equipment being provisioned
– The command supports a PST parameter to specify the operator intended primary state for the equipment being provisioned (IS or OOS)
– The command doesn't require the equipment entity to be physically present in the system.
– The ENT-EQPTcommand supports a parameter to specify if card missing alarm has to be generated after the ENT-EQPT command or not. The AINSMODE parameter is used to provide this functionality. We consider only two possible values of AINSMODE:
  • AINS: no alarm is generated after preprovisioning until a board is plugged in the slot for the first time
  • NOWAIT: card missing alarm is generated immediately after the ENT-EQPT command
– AINSMODE is implemented without using a timer

It is possible to pre-provision an equipment by downloading and activating a previously stored database (see paragraph 3.3.10 on page 329 for details.

The Enter Equipment command allows the following equipment entities to be provisioned:
– protection EC320
– IOC
– XFP/SFP

Auto-provisioning

Auto-provisioning, also referred to as Plug & Play, means that the equipment is detected and configured automatically upon insertion and is placed In Service (IS) if no alarm conditions are detected during insertion or power-on diagnostics.

If a plug&play module is inserted in a slot which cannot be provisioned with that entity, the provisioning attempt fails, a PRCDERR condition is raised on the generic module AID (MDL), and its state moves to OOS-MA,UAS. No data is provisioned for the inserted module.
– After a full restart of the NE, all the modules are automatically autoprovisioned.
– After a cold restart of the active SC in unprotected configuration (non-active SC not present), SC downloads DB from EC and autoprovisions only the modules that have no provisioned data in the DB.
– After a power-on restart of the active SC in unprotected configuration, SC autoprovisions all modules except ECs.

If a module is placed in the system during a restart or a power down of the NE, as soon as the active SC is up and running, the module is autoprovisioned because in the DB restored from EC there is nothing related to this module

The following equipment entities can be auto-provisioned
– protection EC320
– IOC
– XFP/SFP

– Auto-provisioning in Restart Scenarios
  When a board is (logically) deleted by DLT command and not physically removed, it doesn't be automatically reprovisioned if the FLC (EC320) undergoes a restart.
  This is obtained by defining a new parameter (AUTPROV) that is recorded in the FLC database for each slot.

AUTOPROV behavior is the following:

- When it is ON the FLC accepts and automatically provisions any module found in the slot.
- When it is OFF, the FLC doesn't automatically provision any module in this slot.
- When a module is present the state of the slot is OOS-MA, UAS
- When a module is not present the state of the slot is OOS-AUMA, UAS&UEQ
  - AUTOPROV parameter is managed transparently by the FLC and not by the user.
  - AUTOPROV default value is ON (autoprovisioning enabled) for every slot: when a module is logically deleted, AUTOPROV is automatically set to OFF by the FLC.
  - Once turned to OFF, AUTOPROV will remain in this status (OFF) until either:
- An unplug event is received from the SLC, or the slot is otherwise reported as empty by the SLC
- The slot is manually re-provisioned using the ENT-EQPT command

The state of the AUTOPROV parameter is reported by RTRV-EQPT whenever the reported slot is UAS.

Logical Removal and Restoration

A Remove Equipment command is supported to perform logical removal (forced or normal) on a provisioned equipment entity. The RMV-EQPT TL1 command is used to provide this functionality. The effect of logical removal is to change the service state of the module to OOS-[AU]MA.

When an equipment entity is in an OOS-MA or OOS-AUMA state, any equipment specific condition types is cleared and a MAN condition type is set for the specified entity.

A Restore Equipment command is supported to perform logical restore (forced or normal) on a provisioned equipment entity. The effect of logical restoral is to change the service state of the module from OOS-[AU]MA to IS or OOS-AU.

When an equipment is restored (PST moves to IS or OOS-AU,FLT), the MAN condition for the specified equipment clears and any other detected conditions can now be able to be declared.

Default RST-EQPT (MODE=NORM) is not able to move PST value from OOSAUMA to OOS-AU if an entity is in fault condition (as a result the entity remains in OOSAUMA, FLT), forced restoration (MODE=FRCD) instead moves PST to OOS-AU,FLT.

Below the basic rules to logical removal an IOC or a SFP/XFP modules are listed:

– removal of non protected IOC or SFP/XFP is traffic affecting for unprotected facilities
– normal removal of IOC/SFP/XFP is allowed if no OCn below is terminated, or if all the working line/path are switched off of the affected OC
– forced removal of IOC/SFP/XFP is always allowed

a successful removal of IOC/SFP/XFP turns off the laser(s) of the affected OCn

When an equipment entity is logically removed, it allows the operator to manually move all the facility traffic to protecting ports on another module before (or after) placing the module OOS-MA.
The logical removal of an active equipment is allowed only if forced (FRCD).
Until the operator does not manually execute the SW-DX, the operations of the logically removed module has not be affected, except for the suppression of autonomous alarm/event messages pertaining to that equipment entity.

– the traffic/service functions currently provided is continued
– monitoring of conditions and performance is continued
– current conditions is retrievable

When an equipment entity is logically restored, its operations has not be affected, except for enabling of autonomous alarm/event messages pertaining to that equipment entity.

The Remove Equipment and the Restore Equipment commands applies to the following equipment entities:
– EC320 and MT320 (both forced and normal mode allowed - see Note)
– FAN320 and PSF320 (forced/normal - see Note)
– IOC (forced/normal)
– XFP/SFP (forced/normal)

Note: The forced mode is only required on the currently working module, while the normal mode is successfully for any STBY module.

Logical removal and restoration of WDM-related circuit packs:

1) It is possible to logically remove (put out of service) and logically restore (return to service) WDM-related circuit packs
2) The state transitions that the two commands effect are
   – **Remove** puts the circuit pack in the OOS (out-of-service) primary equipment state.
   – **Restore** puts the circuit pack in either the IS (in-service) or OOS-AU (out-of-service automatic) primary equipment state.

Note: The expected syntax for circuit pack logical removal and restoral are: *RMVEQPT:: AID_circuitPack;* and *RST-EQPT::AID_circuitPack;*

Equipment Provisioning Changes

An Edit Equipment command is supported to modify the data associated with a provisioned equipment entity. The modifications takes effect immediately.
The state parameter PST is editable.

The Edit Equipment command allows the PST parameter to be modified for all equipment entities.

Using the Edit Equipment command to change an equipment entity's PST to OOS is equivalent to logically removing that equipment entity using a Remove Equipment command.

Using the Edit Equipment command to change an equipment entity's PST to IS is equivalent to logically restoring that equipment entity using a Restore Equipment command.

A Shelf Equipment Entity couldn’t be managed by the Edit Equipment command.

Modify Equipment

The NE supports Modify Equipment Expected via PROVISIONEDTYPE parameter in EDIT command. It is used in two different cases:
– replacement of an active module with a "compatible" one but not the same card, that is:
  • use ED-EQPT:OOS to put in management state a working card (IS -> OOS-MA)
  • unplug a working card (OOS-MA -> OOS-AUMA, UEQ)
  • plug a different (but compatible) card (OOS-AUMA,UEQ -> OOS-AUMA, MEA)
  • modify equipment provisioned with ED-EQPT:PROVISIONEDTYPE command. If IS parameter is specified, the transitions are: OOS-AUMA,MEA -> OOS-AU,SWDL (if necessary) -> IS. If OOS parameter is used, the sequence is: OOS-AUMA,MEA -> OOS-AUMA, SWDL (if necessary) -> OOS-MA
– upgrade a compatible board with another firmware/sw allowing new features or modify SFP/XFP with different optical performance. The sequence is:
  • use ED-EQPT:OOS to put in management state a working module (IS -> OOS-MA)
  • modify equipment provisioned with ED-EQPT:PROVISIONEDTYPE command. If IS parameter is specified, the transitions are: OOS-MA-> OOS-AU,SWDL (if necessary) -> IS. If OOS parameter is specified, the transitions are: OOS-MA -> OOS-AUMA,SWDL (if necessary) -> OOS-MA

Modify Equipment Expected is allowed for all equipment entities: its domain is the set of parameter (included PROVISIONEDTYPE) associated to the addressed AID.

Retrieve Equipment

A Retrieve Equipment command is supported to retrieve the data associated with an equipment entity.

The RTRV-EQPT and RTRV-RI TL1 commands are used to provide this functionality.

– RTRV-EQPT is used to retrieve data and state parameters associated with provisioned equipment (i.e. AID, provisioned module type, PST, SST, etc).
– RTRV-RI is used to retrieve Remote Inventory Data (serial number, CLEI code, identifier of board manufacturer, firmware version, etc)

The Retrieve Equipment and the Retrierve Remote Inventory commands applies to any plugged modules (MT320, EC320, FAN320, PSF320, IOC, XFP, SFP, TBUS320).

The Retrieve Inventory command is able to retrieve an equipped module's remote inventory information (including the module type) regardless of whether the module is provisioned or not.

It is possible, by means of a single TL1 command:

– to read the Equipment parameters of all the plugged modules at once.
– to read the Equipment parameters of all the modules plugged inside a Shelf at once
– to read the Remote Inventory of all the plugged modules at once (Auto-Inventory).
– to read the Remote Inventory of all the modules plugged inside a Shelf at once.

A Retrieve Firmware Version command is supported to retrieve the actual running firmware version for the equipment entities supporting a downloadable firmware.

It is possible, by means of a single TL1 command, to retrieve the firmware version for all the processor based modules present both in the NE at once and in a Shelf at once.

A Retrieve Software Version command is supported to retrieve the actual running software version for the equipment entities supporting a downloadable software.

It is possible, by means of a single TL1 command, to retrieve the Software version for all the processor based modules present both in the NE at once and in a Shelf at once.

Retrieval of Optical Line OMD and WR_ Circuit Pack Information

Optical line OMD and WR_ circuit pack information is outputted via a TL1 retrieval command for a specified optical line. The data reported are:

- The optical line number
- The AID of the OMD for the optical line (if equipped)
- The AID of the WR_ circuit pack for the optical line
- The AIDs of the transmit and receive LD_ circuit packs that support the optical line

The expected syntax for such a command is: *RTRV-OTS::AID_oline;*

Retrieval of DCM Transmission Information

DCM EEPROM transmission parameter data are retrievable by the user as part of the data associated with the LDRXA, LDRXB or LDTXA circuit pack to which a DCM is connected.

Note: It is expected that DCM transmission parameter data will be retrieved via the RTRV-OPORT-OTS TL1 command with an AID that is the DCMINV LD_ circuit pack port to which a DCM is connected.

Deprovisioning
A Delete Equipment command is supported to delete a provisioned equipment.
Deletion of an equipment entity is not allowed if that entity is not logically removed.
The Delete Equipment command allows the following equipment entities to be deleted:
– protection EC320
– IOC
– XFP/SFP

Deletion of FAN320, PSF320, EC320 in Mandatory slot (that is slot 1), working EC320 (whatever is the slot) and working/spare MT320 is not allowed.

Deprovisioning procedures on an entity doesn't cause errors on other entities.

Deprovisioning Hierarchy
There is a deprovisioning hierarchy in the WDM portion of an 1850 TSS-320 node such that objects must be deprovisioned in order from lower level to higher level in accordance with these constraints:
- Connections (optical or electrical) before the ports on which the connections terminate
- Ports before the circuit packs and/or optical or electrical plug-in modules that contain the ports
- Circuit packs(equipped slots) before the shelves that contain them.

OMD Deprovisioning

An OMD can be deprovisioned via the standard deprovisioning equipment command - using the AID of the OMD that is to be deprovisioned. The expected syntax is: *DLT-EQPT::AID_OMD*;

3.3.3.1 Shelf Management

General Shelf Provisioning
At each Shelf of an NE, hosting Common Cards (e.g. EC320, MT320, etc.) and IOCs, a unique shelf number (independent from the hosting Rack) is settable via a physical mechanism at the shelf.
The same physical preset value is also be provisioned as a parameter, named SHELFNUM, with the purpose to have a greater control on Shelf Cascade configuration.

For one NE, one and only one Shelf can be provisioned to have the Role of Main Shelf: the parameter for defining it is named SHELFROLE.

The Role of Main Shelf is also to be an HW preset to which the provisioned value should be according to.

The Shelves cannot be Auto-provisioned.

The Not-Main Shelves can be pre-provisioned.

The Type of the Shelf is provisioned through the PROVISIONEDTYPE parameter with the values: SWTCH, ROADM, ILA, UILA and OMD.

For one NE containing DWDM parts, one and only one (WDM) Shelf can be provisioned to have the Role of Master DWDM Shelf through the parameter SHELFROLEWDM.

Here below is a Table that summarize the association of Parameters and their management to the Shelves.

	SHELFNUM	SHELFROLE	SHELFWDMROLE
MAIN Shelf	Mandatory / Check	Mandatory / Check	Optional (WDMMASTER or WDMSLAVE automatically according to Shelf Type)
Other Shelves	Mandatory	Optional (NOMAIN)	Optional (WDMMASTER or WDMSLAVE automatically according to Shelf Type and Currently assigned WDM Roles)

OMD Shelf Provisioning

As far as OMD Shelf is concerned, the parameter SHELFNUM, SHELFROLE and SHELFROLEWDM are meaningless.

The OMD Shelf cannot be Auto-provisioned.

The OMD Shelf can be pre-provisioned.

The OMD Shelf is viewed as a Shelf whose type is OMD, with one only slot, that c0an host a card whose type is OMD44: two ENT command are required to provision it: one for Shelf and another for Card (even if they are one only physical entity).

Shelf AID Assignment

The Main Shelf is the first Shelf for which the AID is to be assigned.

The Main Shelf is physically present with what is minimum for accept TL1 command for AID assignment (EC320, PSF320, TBUS, FAN320): no default configuration is required to be present inside EC320.

The AID of the Shelves is proposed to be assigned according to the following procedure (Figure 230.)

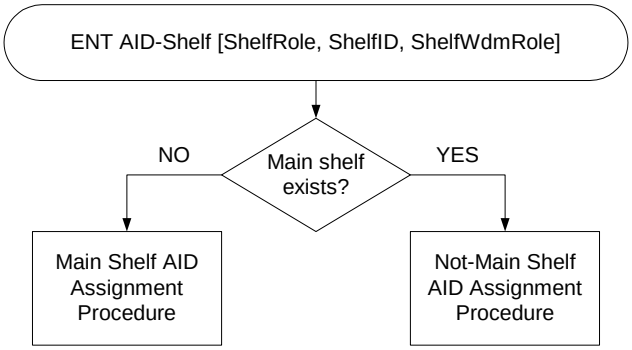


Figure 230. Shelf AID Assignment Procedure

The AID of the Main Shelf, really composed by rack and shelf addressing, is assigned according to the following procedure (Figure 231.) before the AID assignment of the other Shelves.

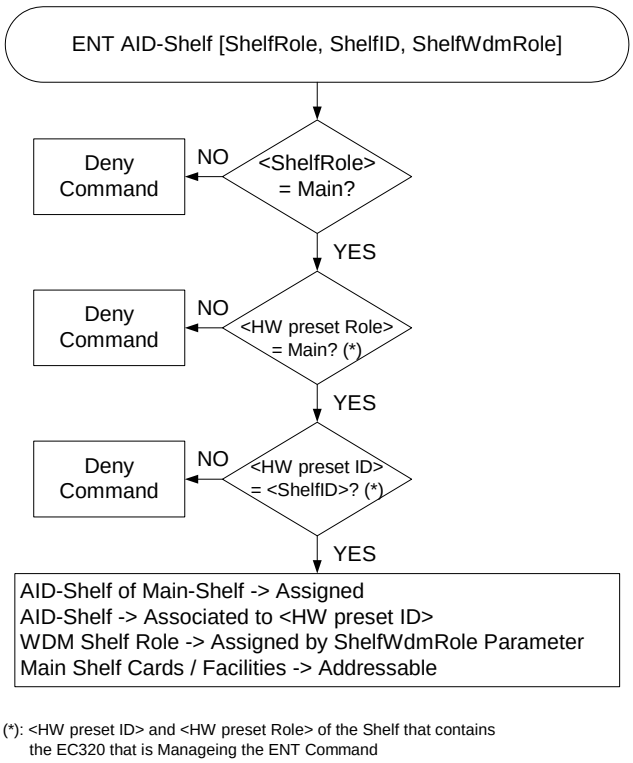


Figure 231. Main Shelf AID Assignment Procedure

The AID of other Shelves (not OMD ones) is assigned according to the following procedure (Figure EM-3) after the AID assignment of the Main Shelf.

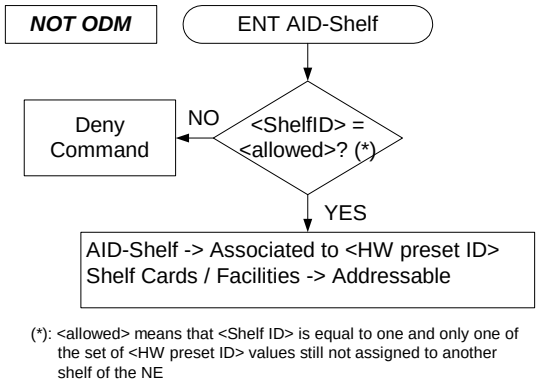


Figure 232. Other Shelves AID Assignment Procedure

The Shelf AID follows the rule to increase according to physical position (from bottom to top) inside the Rack that hosts it.
The EC320 in slot 1 is a mandatory Card only in the Shelf set as Main Shelf.
As far as an OMD Shelf, the AID is automatically assigned with the ENT in the same way as for other shelves without any test (apart from the check on already used AIDs).

Shelf Configuration and Adding (not OMD)

The following table explains which (WDM) shelf type can be sequentially added to various node configurations:

If Node configuration is comprised of or contains this shelf type …	… this shelf type can be added
SWTCH	ROADM
ROADM	ROADM
UROADM	ROADM
ILA	nothing (single shelf node)
UILA	nothing (single shelf node)

Note: No shelf can be added to a UILA node, but a UILA shelf/node is upgradeable to a Degree 2 ROADM node consisting of a UROADM Shelf.

When a Shelf is provisioned, there are automatically created some Mandatory Equipment Entity, according to the following list:

– Main Shelf Role: EC320 (slot 1), MT320 (slot 10 and 11), PSF320 (slot 37 and 39), TBUS320 (slot 42 and 43), FAN320 (slot 40 and 41)
– Not-Main Shelf Role: MT320 (slot 10 and 11), PSF320 (slot 37 and 39), TBUS320 (slot 42 and 43), FAN320 (slot 40 and 41)

The following Shelf Cascades can be configured:

– *Packet/TDM-only ONE SHELF*
  • Single SWTCH Main, WDM Slave Shelf
– *In-Line Amplifier Only ONE SHELF*
  • Single ILA Main, WDM Master Shelf
– *In-Line Amplifier Only ONE SHELF UPGRADEABLE*
  • Single UILA Main, WDM Master Shelf
– *WDM-only ONE SHELF*
  • Single ROADM Main, WDM Master Shelf
– *WDM-only UPGRADED ONE SHELF*
  • Single UROADM Main, WDM Master Shelf
– *Packet/TDM and WDM - CASCADE*
  • One SWTCH Main, WDM Slave Shelf
  • One up to Six ROADM Not-Main Shelf

  One among ROADM must have the WDM Master Role
– *WDM-only - CASCADE*
  • One ROADM Main Shelf
  • One up to Six ROADM Not-Main Shelf

  One among all ROADMs must have the WDM Master Role
– *WDM-only - CASCADE WITH UPGRADE*
  • One UROADM Main Shelf
  • One up to Six ROADM Not-Main Shelf

  One among all ROADMs/UROADM must have the WDM Master Role

Shelf Changes (not OMD)

The following Parameters can be changed onto a Shelf:

– Provisioned Type : It is possible, through an Edit command, only the Upgrade from UILA to UROADM: during this change of Shelf Type, no change occurs in SHELFNUM, SHELFROLE and WDMSHELFROLE
– WDM Role : It is possible to change it through an Edit-like command starting from the In Service State: some rules apply on this change:
  1) One and only one WDM Master should be present in a WDM Configuration
  2) A SWTCH Shelf cannot have the WDM Master Role

The Other Shelf Parameters (e.g. SHELFNUM associated to HW ShelfID) can be changed only after a Deletion (Deprovisioning) of the same Shelf.

Shelf Management: Provisioning/Deprovisioning and Data Retrieval
A Shelf can be Provisioned (ENT command) and Deprovisioned (DLT command).
Edit command on a Shelf is only allowed in In Service State for Provisioned type Change from UILA to UROADM.
Removal / Restoration command are not allowed on Shelves.
The Retrieve Equipment command addressed to a Shelf retrieves all the provisioned equipment information related to the same shelf (e.g. the Shelf Type) and to the Equipment Entities provisioned in it.
The Retrieve Inventory command addressed to a Shelf retrieves all the provisioned inventory information related to the Equipment Entities provisioned in it.

3.3.3.2 Specific Equipment Provisioning/Deprovisioning Characteristics

In this paragraph, we provide additional information pertaining to provisioning/deprovisioning and to logical removal/restoration, specific for any equipment entities.

EC320
Main features:
– Mandatory modules (slot 1)
– Mandatory Module automatically preprovisioned whether present or not
– Auto-provisioning allowed only for protection module
– ENT-EQPT command allowed only for protection module (slot 20)
– DLT-EQPT command allowed only for protection module (slot 20)
– Modify equipment expected allowed
– Logical Removal/Restoration allowed for standby cards
– Forced restoration allowed (transition by forced RST-EQPT from OOS-AUMA,FLT to OOS-AU,FLT. See state diagram)
– No Possibility to plug in a "wrong" module
– EC320 isdesigned to permit 1:1 protection.
– Default behaviour is Simplex mode of operation.
– Duplex mode is set by provisioning of the EC320 in slot 20.
– EC320 Switching operation is Non-revertive
– Possibility to automatically or manually switch to and from working/protection module (see EQPS RRS)
– Possibility to work in unprotected mode deleting the protection module
– If forced switch is specified, the switch occurs regardless of the state of the active module (if non-active module is provisioned). If NORM mode is specified, the switch is allowed only if non active module's state is IS NR,STBYH.
– Power-on diagnostics
– SW download support required
– Fault detection

The EC320 mother board provides a flash disk for non volatile program and data storage.
– EC320 disk is not managed as a separate entity, it is simply considered a part of EC320. A disk failure implies an EC320 failure (HWFAIL condition).
– EC320 disks can't run out of space, disk space is controlled and managed with opportune mechanism to avoid this situation. No "disk full" event is generated by disk or managed by EC320, so there is no condition related to this case.

When a new backup EC320 is plugged in an active NE:
– the working EC320 mirrors its disk contents to the new standby EC320
– a SWDL SST and a SWDN condition are set on the standby EC320 for the duration of the initial mirroring and are cleared when the standby EC320 is ready

MT320

Main features:
– Mandatory modules (slot 10 and 11)
– Both Modules Automatically preprovisioned whether present or not
– Modify equipment expected allowed
– Logical Removal/Restoration allowed for standby cards
– Forced restoration allowed (transition by forced RST-EQPT from OOS-AUMA,FLT to OOS-AU,FLT. See state diagram)
– No Possibility to plug in a "wrong" module
– MT320 is designed to permit 1:1 protection.
– Possibility to automatically or manually switch to and from working/protection module (see EQPS RRS)
– Power-on diagnostics
– SW download support required
– Fault detection

PSF320 and FAN320

Main features:
– Mandatory modules
– Automatically preprovisioned
– Auto-provisioning not allowed
– Modify equipment expected not allowed
– ENT-EQPT command not allowed
– DLT-EQPT command not allowed
– Logical Removal/Restoration not allowed
– No possibility to manage equipment mismatch (see State Diagram)
– No SW download required
– PSF320 modules work in load sharing. When one of the two modules is physically removed or fails in Power supplying, the other one takes 100% of the load.
– Fault detection

IOC

Main features:
– Pre-provisioning and auto-provisioning allowed
– Modify equipment expected allowed
– ENT-EQPT command supports a PST parameter to specify the operator intended primary state for the equipment being provisioned (IS or OOS)
– AINSMODE parameter is used in ENT-EQPT command to specify if card missing alarm has to be generated after the ENT-EQPT command or not. (See Pre-provisioning section)
– DLT-EQPT command allowed. Deletion is allowed only after logical removal.

- When an IOC is deleted, also every SFP/XFP is deleted together with it, also if the SFP/XFPs are not logically removed. When an IOC is removed, the XFP/SFPs below go to OOS-AU[MA], SGEO state.
- When a facility supported by IOC is provisioned, NE sets SDEE on the IOC
- Deletion is not allowed if IOC is supporting a facility
- Forced restoration allowed (transition by forced RST-EQPT from OOS-AUMA,FLT to OOS-AU,FLT. See state diagram)
- Logical Removal/Restoration allowed
- Possibility to plug in a "wrong" module (mismatch of equipment) and to manage this situation (see State Diagram).
- If forced switch is specified, the switch occurs regardless of the state of the active module (if non-active module is provisioned). If normal mode is specified, the switch is allowed only if non active module's state is IS NR,STBYH.
- Power-on diagnostics
- SW download support required
- Fault detection

List of IO modules supported by the NE:

- 10GSO (OC-192) card 10G Synchronous Optical
- 2G5SO (OC-48) module 4x2.5G Synchronous Optical
- 8XSO Port OC-3/OC-12 Card 8 x Synchronous Optical
- OTU2 G.709 OTU 10GB
- 10XANY 10GB 10 x GBE/Sonet
- PP20G 20G Layer 2 Aggregator card
- PIM1GE PIM 10x1GE optical
- PIM10GE PIM 1x10GE optical
- See DWDM Addendum for other IO packs

PIMMS

Main features:

- Non-mandatory modules
- No supporting/supported relationships is considered between PIMMS and PP20G
- Preprovisioning allowed
- Auto-provisioning allowed
- Modify equipment expected allowed
- AINSMODE parameter is used in ENT-EQPT command to specify if card missing alarm has to be generated after the ENT-EQPT command or not. (See Pre-provisioning section)
- ENT-EQPT command supports a PST parameter to specify the operator intended primary state for the equipment being provisioned (IS or OOS)
- DLT-EQPT command allowed. Deletion is allowed only after logical removal
- When a facility is supported by PIMMS, SDEE is set on this PIMMS
- Deletion is not allowed if SDEE is set on PIMMS.
- PIMMS supports SGEO as SST to model the relationship with PP20G hosting module (see State Diagram)
- Logical Removal/Restoration allowed
- Possibility to plug in a "wrong" module (mismatch of equipment) and to manage this situation (see State Diagram)
- Power-on diagnostics
- SW download required
- Fault detection

XFP/SFP

Main features:

– Non-mandatory modules
– Pre-provisioning allowed (PROVISIONEDTYPE parameter, corresponding to RI Alcatel mnemonic, or ANY for a generic Alcatel or non Alcatel module, mandatory, see below)
– Auto-provisioning allowed:
– For TDM XFP/SFP, autoprovisioning is allowed only if the RI data corresponds to one of the allowed Alcatel-Lucent mnemonics (see complete list in EM TL1 RRS, PROVISIONEDTYPE field for ENT-EQPT and ED-EQPT). Plug and play is not supported for unrecognized XFP/SFPs.
– For DATA XFP/SFP any XFP/SFP (both Alcatel or non Alcatel) supports autoprovisioning since no mismatch check is implemented on it.
– Modify equipment expected allowed
– Provisioning attempt fails if the corresponding IOC is not provisioned
– When a facility supported by IOC is provisioned, NE sets SDEE on the related XFP/SFP.
– Deletion is not allowed if SDEE is set on XFP/SFP.
– XFP/SFP supports SGEO as SST to model the relationship between IOC and the related XFP/SFP modules (see State Diagram)
– XFP/SFP is automatically deleted if the related IOC is deleted, also if the XFP/SFP is not logically removed.
– AINSMODE parameter is used in ENT-EQPT command to specify if card missing alarm has to be generated after the ENT-EQPT command or not. (See Pre-provisioning section)
– ENT-EQPT command supports a PST parameter to specify the operator intended primary state for the equipment being provisioned (IS or OOS)

It is mandatory to specify PROVISIONEDTYPE parameter (corresponding to RI data) when XFP/SFP is provisioned, to distinguish XFP/SFP optical features (short/long/intraoffice haul,...). It is allowed to specify PROVISIONEDTYPE = ANY-<type> (ANY-OC3, ANY-OC12, ANY-OC48, ANY-OC192, ANY-DATA) as generic value for XFP/SFP to allow a generic MSA-compliant XFP/SFP compatible with the supporting board to work without mismatch alarms. ANY-DATAS and ANY-DATAX is the standard mode of provisioning a DATA XFP/SFP (e.g: to provision a generic MSA SFP on a 2G5SO board we need to specify PROVISIONEDTYPE=ANY-OC48, for a 8XSO that may support OC3 and OC12, we need to specify or ANY-OC3 or ANY-OC12, for a data XFP ANY-DATAX, etc).
Non-MSA SFP/XFPs generate a mismatch in Ethernet and Sonet slot also if they are provisioned with PROVISIONEDTYPE equal to ANY-<type>

– Forced restoration allowed (transition by forced RST-EQPT from OOS-AUMA,FLT to OOS-AU,FLT. See state diagram)
– Logical Removal/Restoration allowed
– No power-on diagnostics
– Fault detection (XFP/SFP may fail separate than their relative IOC)

For the NE, there are two different types of XFP/SFP: TDM (Sonet) and DATA (Ethernet).

– For TDM modules, SC makes a comparison between the detected module and a list of all possible compatible ones, in this way it is possible to know if a correct card is plugged in or not. So we can consider MEA as one of the allowed SST in the state diagram. It is also allowed to specify PROVISIONEDTYPE=ANY-<type> to provision a generic MSA SFP/XFP module, without mismatch alarm on it.
– For DATA modules, since a great and not predictable number of module exists, SC doesn't perform any check, this means that SC is not able to find an equipment mismatch (MEA doesn't appear as a valid SST for these modules). These modules are provisioned by default with PROVISIONEDTYPE=ANY-DATA.
– Non MSA SFP/XFPs generate a mismatch alarm also in DATA case.

TBUS320

Main features:

– ISPB Termination bus (TBUS320) are placed in slot 42 and 43. Both modules are mandatory and are necessary to have the internal communication bus working.
– If one of the two TBUS320 fails or is unlugged, the ISPB bus doesn't work.
– The TBUS320 are preprovisioned and cannot be edited, logically removed or deleted.
– It is allowed to retrieve the provisioned data (in terms of PST and SST) and the remote inventory data.
– The only conditions allowed on TBUS320 are HWFAIL and IMPROPRMVL

OMD

Each OMD multiplexes and de-multiplexes optical channel signals. The OMD provides an optical line-level signal to (and receives an optical line-level signal from) the Wavelength Router (WR_) circuit pack to which the OMD is connected. Each OMD, which is associated with a specific optical line, is addressable, contains retrievable inventory data, and must be provisioned.

For installation and operations purposes, OMDs are identified by their position within a rack. In this regard, they are treated as if they were shelves.

OMDs are passive rack-mounted devices that are not slot-resident. An OMD is monitored via a serial electrical interface to the WR_ circuit pack to which it is connected; inventory data is collected over this interface.

OMD AID Provisioning

An OMD is provisioned via the standard equipment provisioning command (ENTEQPT) using this AID:
AID_OMD = OMD -rack# - shelf# - 1 with rack# = {1-7} and shelf# = {1-9}

In terms of equipment hierarchy, and for installation and operations purposes, an OMD can be thought of as a “one-slot” shelf. That is, each OMD has a “shelf number” corresponding to its physical position in a rack (or frame – or bay) sequenced from the bottom of the rack upward.

It is expected that either one or two physical 4G Medium shelves are mounted in a rack. If two ROADM shelves (or one ROADM and one UROADM shelf) are mounted in a rack, there might be as many as four OMDs in the rack. In a Degree 8 ROADM, there could be a rack that contains only one ROADM shelf and all eight OMDs. To accommodate this configuration, the maximum number of shelves allowed in a rack is 9 (nine).

Associating an OMD with an Optical Line

Association Done as Part of Optical Line Provisioning

An OMD (or lack thereof) is associated with an optical line when the optical line is provisioned. This is done vi an OMD_identifier parameter of the ENT-OTS TL1 command.

The allowed values for OMD_identifier are:

- OMD_identifier = {1-7}-{1-9}-1 when an OMD exists for an optical line
- OMD_identifier = NONE when there is no OMD for an optical line.

Note: The expected syntax for the ENT-OTS command is *ENT-OTS:TID]:AID_oline::QUAD=quad-value, OMD=OMD_identifier;*

Provisioning or installing core optics circuit packs in a ROADM Shelf:

If no circuit pack has been installed or provisioned in any slot of a quad and if an allowed core optics circuit pack is then installed or provisioned in a quad slot, the system allows only core optics circuit packs to be installed or provisioned in all of the quad’s slots. (The affected quads are slots 2-5, 6-9, 12-15 and 16-19.)

The plugging of WDM I/O (one-slot) circuit pack in a quad area of a ROADM after an allowed core optics circuit pack is installed or provisioned in an allowed slot of the same quad, generates the transition to OOS MA, UAS state of the related slot with generation of an ABNORMAL event.

Provisioning or installing core optics circuit packs in a UROADM Shelf

If no circuit pack has been installed or provisioned in any slot of a quad and if an allowed core optics circuit pack is then installed or provisioned in any slot of quads 12-15 or 16-19, the system allows only core optics circuit packs to be installed or provisioned in all of the quad's slots.
The plugging of WDM I/O (one-slot) circuit pack in a quad area of a UROADM after an allowed core optics circuit pack is installed or provisioned in an allowed slot of the same quad, generates the transition to OOS MA, UAS state of the related slot with generation of an ABNORMAL event.

Provisioning or installing WDM I/O circuit packs in ROADM or UROADM shelves
For both ROADM and UROADM shelves, if no circuit pack has been installed or provisioned in any slot of a quad and if a WDM I/O circuit pack is then installed or provisioned in a quad slot, the system allows only WDM I/O circuit packs to be installed or provisioned in all of that quad's slots.
The plugging of a core optics circuit pack in a quad area of a ROADM / UROADM after a WDM I/O circuit pack is installed or provisioned in a slot of the same quad, generates the transition to OOS MA, UAS state of the related reference slot with generation of an ABNORMAL event.

Provisioning or installing WDM I/O circuit packs in SWTCH shelves
WDM IO circuit packs (IOCs) - meaning OTs and OPSs (Optical Protection Switch packs) are allowed in slots 2-9, 12-19 and 21-36 of SWTCH shelves.

Fixed Assignment of Optical Lines 1 and 2 in UROADM Shelves
In UROADM shelves, optical lines 1 and 2 (separately), optical line assignment is fixed and automatic once a valid core optics circuit pack is inserted into a slot for a particular quad. The assignment is that
– Insertion of an allowable core optics circuit pack into any of slots 2-5 yields optical line 1.
– Insertion of an allowable core optics circuit pack into any of slots 6-9 yields optical line 2.
This is shown in the Table 24 -.

Table 24 - UROADM Shelf: Association of Slots with Fixed Optical Line Numbers

Quad of Slots	Associated Optical Line Number
2-5	1
6-9	2

Flexible Optical Line Number Assignments in ROADM Shelves (all quads) and UROADM Shelves (quads 12-15 and 16-19)
a) In ROADM shelves, any and all quads can be used for support of optical lines. It is therefore possible for a user to assign any line number - in the range [1-8] - to the optical line that a quad supports.

b) In quads 12-15 and 16-19 (separately) of UROADM shelves, it is possible for a user to assign optical line values of 3 or 4 to each quad of slots.

Note: The above (a. and b.) is implemented via an ENT-OTS TL1 command. Changing an optical line number is done via an ED-OTS TL1 command.

Provisioning an Optical Line Number for a Quad of Core Optics Circuit Pack Slots
For ROADM and UROADM shelf types, a QUAD spec block parameter of the ENTOTS command sets the optical line number that the specified quad of core optics circuit packs supports. The optical line number is set implicitly - as part of the AID.
The allowed optical line number AID is OTS-{1-8} for ROADM shelves and OTS-{3-4} for UROADM shelves.
QUAD is the identifier of a WR circuit pack:
– QUAD = {1-7}-{1-9}-{2, 6, 12, 16} for ROADM shelves
– QUAD = {1-7}-{1-9}-{12, 16} for UROADM shelves

Note: The expected TL1 command syntax is: ENT-OTS:TID]:AID_oline::QUAD=quad-value,OMD=OMD_identifier.

Core Optics Circuit Packs Must Be Provisioned or Installed Before an Optical Lines Provisioned
It is only possible to provision an optical line value for a quad of core optics circuit pack slots after the quad has been either completely pre-provisioned or autoprovisioned (allowed circuit packs installed).
In other words, an attempt to provision an optical line value is denied if the WR, LDRX_ and LDTX_ circuit packs for the quad have not yet been either pre-provisioned or installed.

Optical Line Number Provisioning in ILA and UILA Shelves
In ILA and UILA shelves:
– oline = 1 is automatically assigned by software to the optical line supported by the LDRX_ in slot 5
– oline = 2 is automatically assigned by software to the optical line supported by the LDRX_ in slot 9

3.3.3.3 Supported Equipment State

The NE supports equipment PST values as described below.
– IS to indicate that the provisioned equipment entity is in in-service state (no autonomous/management events).
– OOS-AU to indicate that the provisioned equipment entity is in out-of-service state caused solely by an autonomous event.
– OOS-MA to indicate that the equipment entity is in out-of-service state caused solely by a management event.
– OOS-AUMA to indicate that the equipment entity is in out-of-service state caused by both an autonomous event and a management event.

The NE supports equipment SST values as described below to indicate the cause for being in a particular PST.
– FLT to indicate that a failure is detected pertaining to the equipment entity.
– UEQ to indicate that the equipment entity is not present in the system.
– MEA to indicate that the equipment entity physically present in the system is invalid (the inserted module is inconsistent with slot provisioning data or the inserted module is of incompatible revision).
– SWDL to indicate that the equipment entity is undergoing necessary initialization procedures to become operational (e.g., running diagnostics, downloading, configuring hardware devices as applicable/supported).
– UAS to indicate that the equipment entity is not provisioned.
– AINS to indicate that the equipment is waiting for the correction of the off-normal condition (UEQ). Alarms will not be generated for the entity if AINS is present.

The NE supports SST values as described below to provide additional state information.
– In a duplex equipment protection scheme, WRK indicates that a module is currently acting as protected module, whether it is able to carry out its service or not.
– In a duplex equipment protection scheme, STBYH indicates that a module is currently acting as protecting module, whether it is able to carry out its service or not.
– SDEE to indicate that the entity is currently supporting other entities
– SGEO to indicate that the associated supported entity has outage, it is used for qualifying the OOS-AU[MA] state of an entity when its supporting entity is OOS-AU, OOS-MA, or OOS-AUMA.
– PSI to indicate that the working module is inhibited from protection switching operations, if it is set on the working module, or that the protection module in a group is inhibited to become an active unit, if it is set on the protection module.

Equipment State Transitions

In this part, we report the state diagram and the state values of the following equipment entities:

– EC320
– MT320
– IO Card
– PSF320
– FAN320
– XFP/SFP
– TBUS320

The acronyms used in the state diagram figures here reported are:

– IPF Initialization Procedure Failure
– IPP Initialization Procedure Pass
– SWDL SW download + Diagnostic
– P&P Plug & Play
– CC Correct Card
– WC Wrong Card
– IOCOOS IOC Out Of Service
– IOCREC IOC Recovery (IOC goes in Service)
– IOCREC & FLT IOC Recovery & SFP/XFP module is in FLT
– IOCREC & MEA IOC Recovery and SFP/XFP module is in MEA
– PLUG & CC & MIS Correct Card and Mismatch with the related module

LED Management

All pluggable modules have LED indicators to provide visual indication of module status; excluded the SFP interface modules and electrical interface modules that are hosted in the access panel that no LED are required.

The same functionality must show the same LED color on any module on which it is implemented

LEDs of the same function appears in the same physical location on the face plate of each module type. They are vertical alignedt to permit the operator a rapid scan and interpret all LEDs on a shelf.

Recognizing that the normal error-free state of a module may result in no LEDs being on, upon board plugin, there is a positive indication by LED that the board is properly powered. This indication persists for at least 4 seconds, then the board may assume it's otherwise normal LED state.

LED color assignment comply with GR-474-CORE, especially R2-36 and 2- 37:

– Red indicates a critical or major failure, error, or danger.
– Yellow or amber indicates a minor failure, caution, warning, or temporary malfunction, or state for which the craftsperson should use caution.
– Green indicates satisfactory operation, active condition, or completion of a process or procedure.

In the following tables (from Table 25 - to Table 31 -) the LED organization is referred.

Table 25 - First Level Controller LEDs

LED	Meaning	Color
LED 1	Card Not Equipped or Card Equipped and not provisioned or Card out of service (if applicable)	Switched OFF
	FPGA download	Amber Blink
	SW in boot/Autotesting	Green Blink
	Card Properly Equipped and Provisioned and In Service	Green
	Card Fail	Red
	Card Misconfigured or Card Mismatch	Red Blink
	At least 1 port carrying service is alarmed	Amber
LED 2	EPS Configured – Card Active	Green
	EPS Configured – Card Stand-by	Amber
	EPS Configured but not available	Amber Blink
	EPS not configured	Switched OFF
LED 3	Critical Alarm	Red
LED 4	Major Alarm	Red
LED 5	Minor Alarm	Amber
LED 6	Not Used	Switched OFF
LED 7	Not Used	Switched OFF
LED 8	Not Used	Switched OFF

Table 26 - Matrix/SLC Controller LEDs

LED	Meaning	Color
LED 1	Card Not Equipped or Card Equipped and not provisioned or Card out of service (if applicable)	Switched OFF
	FPGA download	Amber Blink
	SW in boot/Autotesting	Green Blink
	Card Properly Equipped and Provisioned and In Service	Green
	Card Fail	Red
	Card Misconfigured or Card Mismatch	Red Blink
LED 2	EPS Configured – Card Active	Green
	EPS Configured – Card Stand-by	Amber
	EPS Configured but not available	Amber Blink
	EPS not configured	Switched OFF

Table 27 - SONET/PDH IO module LEDs

LED	Meaning	Color
LED 1	Card Not Equipped or Card Equipped and not provisioned or Card out of service (if applicable)	Switched OFF
	FPGA download	Amber Blink
	SW in boot/Autotesting	Green Blink
	Card Properly Equipped and Provisioned and In Service	Green
	Card Fail	Red
	Card Misconfigured or Card Mismatch	Red Blink
	At least 1 port carrying service is alarmed	Amber
LED 2	EPS Configured – Card Active	Green
	EPS Configured – Card Stand-by	Amber
	EPS Configured but not available	Amber Blink
	EPS not configured	Switched OFF

Table 28 - Power Supply Module LEDs

LED	Meaning	Color
LED 1	Card in service - Battery on	Green
	Card In Service - Battery off	Amber
	Card Fail	Red
	Card Misconfigured or Card Mismatch	Red Blink
LED 2	No source configured	Switched OFF
	Either or both sources configured. All sources configured have no errors	Green
	Both sources configured. One source has errors	Amber
	All sources configured have errors	Red

Table 29 - ROADM modules LEDs

Pack Name	Meaning	Color
LDRX (A/B)	1x Pack status LED	
	1x Port status LED	
LDTX (A/B)	1x Pack status LED	Input signal failure may be indicated by amber color on pack status LED
WR (4/8)	1x Pack status LED	Input signal failure may be indicated by amber color on pack status LED
OMD	No LEDs	
OPS	1x Pack status LED	
	3x Port status LED	
11GBAR	1x Pack status LED	
	2x Port status LED	
11GUAR	1x Pack status LED	
	2x Port status LED	

Table 30 - WR and LDTX modules LED.

Pack Status LED	Color	Controlled by (board ANSI)	Controlled by (board ANSI)
Card Not Equipped or Card Equipped and not provisioned or Card out of service	Switched OFF	SC, LDC	TBD
FPGA download	Amber Blink	LDC	TBD
SW in boot/Autotesting	Green Blink	LDC, SC Autotest only	TBD
Card Properly Equipped and Provisioned and In Service	Green	LDC	TBD
Card Fail	Red	SC	TBD
Card Misconfigured or Card Mismatch	Red Blink	SC	TBD
Fault detected on an interface to another ROADM sub-system	Amber	LDC	TBD

Table 31 - LDRX, OPS, 11GBAR & 11GUAR modules LED

Pack Status LED	Color	Controlled by (board ANSI)	Controlled by (board ANSI)
Status LED behaviour			
Card Not Equipped or Card Equipped and not provisioned or Card out of service	Switched OFF	SC, LDC	TBD
FPGA download	Amber Blink	LDC	TBD
SW in boot/Autotesting	Green Blink	LDC, SC Autotest only	TBD
Card Properly Equipped and Provisioned and In Service	Green	LDC	TBD
Card Fail	Red	SC	TBD
Card Misconfigured or Card Mismatch	Red Blink	SC	TBD
Individual Port/Pluggable module status LED summary			
Pluggable module Not Equipped or Equipped and not provisioned or Port out of service	Switched OFF	LDC	TBD
Port Module Equipped and Provisioned and Port In Service	Green	LDC	TBD
Pluggable module Fail	Red	LDC	TBD
Pluggable module Mismatch	Red Blink	LDC	TBD
Port Facility failure	Amber	LDC	TBD

3.3.3.4 Remote Inventory

1850 TSS-320 WDM circuit pack, OMD, DCM and XFP data (remote inventory and other) formats and layouts and equipment identifiers are considered.

Remote Inventory Data Retrieval (General)

1) Remote Inventory data is retrieved via a TL1 command.
2) Allowed AIDs for this command includes:
   – Specific slot - for WDM circuit pack inventory data - and for both transmit and receive fiber DCM inventory data

- Specific shelf - for OMD module inventory data
- Specific circuit pack port - for XFP module inventory data

Note: The syntax for remote inventory data retrieval is: *RTRV-RI::AID;*

OMD Remote Inventory Data Retrieval

Remote Inventory data is retrieved via a Remote Inventory Retrieval TL1 command.

Note: The syntax for remote inventory data retrieval from an OMD is: *RTRVRI::AID_OMD;*

Using the provisioned data parameters and the relationships described earlier, system software knows the WR_ circuit pack to which a specified OMD is connected. System software then commands the WR_ circuit pack to collect the OMD remote inventory data via means of the serial electrical interface between the OMD and the WR_ circuit pack.

DCM Remote Inventory Data Retrieval

1) DCM inventory data are collected as part of the inventory data for the LD_ circuit pack to which a DCM is connected.
2) DCM inventory data are reported (beginning on a new line - separate from the circuit pack data) using an output AID with this format:
   DCM-LD_circuitpack_rack#-LD_circuitpack_shelf#-LD_circuitpack_slot#

Note: The syntax for the command to collect LD_ circuit pack remoteinventory data is: *RTRV-RI::AID_LD_circuitpack;*

OT10G XFP Module Remote Inventory Data Retrieval

The TSS320 Rel 2.0 OT circuit packs (11GBAR and 11GUAR) can accept any of three client-side XFP modules.
These modules are therefore called OT10G XFP Modules - or DWDM XFP Modules.
XFP Remote Inventory data is retrieved via a Remote Inventory Retrieval TL1 command.

Note: The syntax for remote inventory data retrieval from an XFP is : *RTRV-RI::AID_XFP-Module;*

1850 EEPROM Remote Inventory Data Segments

Circuit pack remote inventory and other data reside on a 32 kByte serial EPROM (SEEPROM). OMD and DCM data reside on 512 byte OMD and DCM SEEPROMs.
XFP module remote inventory data is created by the NE - on the basis of vendor-generated XFP module EEPROM data.

Sequence of Remote Inventory Data on WDM Circuit Packs

WDM Circuit Pack Remote Inventory Data Sequence

1) On WDM circuit packs, remote inventory data is in four segments:
   a) the standard Alcatel-Lucent Remote Inventory "Format 22" data (128 bytes in a 256 byte data block)
   b) a copy of the standard Alcatel-Lucent Remote Inventory data segment
   c) factory data
   d) applications-specific data
2) The first data segment, which is not stored on the SEEPROM, is retrieved in standard Alcatel-Lucent fashion over a Serial Peripheral and Inventory (SPI) interface.
3) The second and subsequent data segments are stored, non-volatile, on an SEEPROM.

Note: The copy of the Alcatel-Lucent Remote Inventory data segment (second data segment) simplifies booting of the circuit pack.

Sequence of Remote Inventory Data on OMDs

The passive OMD inventory data is in two parts on an SEEPROM:

1) “Format 22” remote inventory data for the OMD (128 bytes)
2) OMD insertion loss data
3) factory data

Sequence of Remote Inventory Data on DCMs

The passive DCM inventory data is in two parts on an SEEPROM:

1) “Format 22” remote inventory data for the DCM (128 bytes)
2) DCM transmission parameter data

Sequence of Remote Inventory Data for OT10G XFP Modules

The remote inventory data retrievable from OT10G XFP modules is the standard "Format 22" remote inventory data block (128 bytes in a 256 byte data block).

3) It is expected that the fields of the Format 22 data block is populated by a DWDM SLC.
4) Many of these fields are extracted from the XFP EEPROM (the format of which adheres to the XFP-MSA specification).

The value of the Mnemonic field results from a "mapping" of XFP EEPROM module data.

3.3.4 Security

The NE supports the following features:

– Trusted path by SSH: any interactions with the NE shall be secured by a trusted path. A trusted path is an encrypted pathway accomplished by means of Secure Shell (SSH).
– Security Report Events as transient condition on excessive login attempts, security log buffer overflow and 90% of its max size.
– Security Report Information on login from DEBUG and CLI.

Note: A login from DEBUG (the same as 'DEBUG session') means a login accomplished on one of the debug ports of the NE, without TL1 security authentication, but with LINUX security authentication.

– Security Report Event as transient condition on users going to be dormant (inactivity without login).
– User identification and authentication based upon a user-id with password.
– Access control including definition and aging of passwords, login failure actions, inactivity time-outs for users, both for input TL1 commands and for dormant users, user accounts and passwords, disconnect actions, and advisory messages.
– User privilege partitioning with super user and common user classes.

The NE supports default users as created by the customer during the initial installation.
A remote maintenance user is included in the default users. This user allows an Alcatel-Lucent technician to log-in to the NE. The User Access Privilege of this user includes all of the privilege tokens values (CONF, NETADMIN, PROV, READ, SEC, DEBUG and NOTMOUT), as well any security administrator user, but with also the DEBUG token.
Default users cannot be deleted.

– Security audit trail (Security Log for real time logging of all those messages, transactions, recent commands and responses to the EMS/NMS, that are related to security, access privileges and login/logout issues) also containing Security alarms Reports and Contents.
– A Security Log in non-volatile memory contains this audit trail.
– Provide retrieval of security log

– Administration of security functions from the EMS or CIT.
– No undocumented access mechanism and no access mechanism without a login/password is allowed.
– The NE supports a maximum of 512 unique userIDs.
– The number of users allowed to be logged into an NE is limited only by the number of separate communications sessions permitted by the NE.
– The NE supports the capability of detecting and deleting TCP half open connections. A "half open TCP connection" is a TCP connection for which the remote TCP host has shut down without closing the TCP connection (e.g. when the OS crashes).
  The NE maintains a timer to detect inactivity on TCP connections. In case of inactivity the NE sends an empty message (KEEP^ALIVE^MESSAGE) that causes the TCP stack will detect the half-open condition and abort the TCP connection.

The NE provides security capability at the user, LAN channel, and NE level. A super user (i.e., System Administrator with security administration privileges, that means with UAP including SEC) is able to:
– add users to the NE,
– delete users from the NE,
– edit the security information of any user,
– retrieve security information about users (not password),
– change the password of other users without entering the old password,
– logoff a particular user (included a User with security administration privileges and users that are logged with DEBUG and CLI sessions),
– obtain user info about the user currently logged on to the NE (included users that are logged with DEBUG and CLI sessions),
– inhibit and allow users,
– set system wide user security attributes,
– retrieve security information about authenticated (logged on) and unauthenticated (not logged on) sessions,
– set command privilege partitioning, and
– do anything that a normal user can do (see below).

A normal user (i.e., a user without security administration privileges, that means with UAP not including SEC) is able to:
– establish a session with the NE (logon),
– change own user password,
– obtain own user info,
– retrieve system wide user security attributes,
– retrieve command privilege partitioning,
– terminate the session (logoff),
– execute accessible/privileged NE command language requests.

Note: The term "Security Level" is used with its generic meaning. That is, the terms "Access Privilege" and "Security Level" are used in the same way.

3.3.5 Time of Day Synchronization (TODS)

The NE supports the following features:
– Providing time of day setting (including both time and date) by TL1 command.
– Ability to provide time stamping accurate to within +/- 500 msec. per day.
– Synchronize the NE clock from an NTP server
– Support customer provisionable time offset from UTC for all system time displays and event time stamps

3.3.6 Alarm Management

The operation and maintenance of the NE is accomplished through the built-in monitoring features and the interpretation of this information to operational support system interfaces.

Equipment and incoming signal failures are autonomously detected by the NE.

The system supports the following condition severities (notification codes) which are reported to Maintenance and Operations personnel responsible for the equipment:
– Critical
– Major
– Minor
– Non-Alarmed

The NE supports a Not-Reported notification code for conditions that are declared but not autonomously reported.

The NTFCNCDE code (i.e., CR | MJ | MN | NA | NR) is separately provisioned for each Condition Types (SA and NSA) on a per profile basis.

The NE supports one profile type for each generic entity type that is able to arise alarms, events or not-reported conditions. That is, there is one profile type for each transmission facility type, one for all the equipments entities, one for the all common entities and one for the synchronization entities.

The NE supports the capability to report the Condition Code and the Condition Type for each entity alarm, depending on the state of the protection. It is able to:

a) provision and retrieve two levels of Condition Code, one for SA and another for NSA, for each Condition Type in each profile.

b) report the alarms with different severities based on whether they are SA/NSA

There are two meanings for “service-affecting.” One is that the failure affects a service that was being provided when the failure occurred. The other is that the failure will affect the ability of the network to provide service. A failure can be service-affecting according to one definition but not the other. For example, a loss of a single trunk that is in use would meet the first definition but not the second (if there were enough other trunks available for use). Loss of a single facility that was not in use, but contained half the circuits between two COs, would meet the second definition but not the first. Which definition is intended should be determined from the context.
– All SA failures default to a notification code of CR.
– All NSA failures default to a notification code of MN.

The system supports autonomous reporting and logging of alarms and conditions for equipment and facilities. Management.

All currently existing alarmed, not alarmed, and not reported events are retrievable.

When an entity is deleted, all of its associated alarms and conditions are cleared.

When an entity is not provisioned no alarms or conditions are set against that entity.

If a condition error has to be set against a non provisioned entity, then it is set against the generic non provisioned MDL module with the same instance of the non provisioned entity. An example is the condition PRCDRERR, that is raised when a non compatible module is inserted in an unprovisioned slot and no auto provisioning is possible: PRCDRERR raises by MDL in the unprovisioned slot.

When an entity is logically removed (placed in OOS-[AU]MA state), clear messages is sent for all the outstanding conditions on that entity that were autonomously reported, except for the off-normal conditions; however, the outstanding conditions on that entity is still be retrievable

The example below illustrates the system behavior.

1) An unprotected fiber (say OC48-x) is pulled (LOS is detected).
2) System declares LOS/SA/CR for OC48-x and sends a message of REPT^ALM^OC48 / alarm-set for OC48-x.
3) OC48-x is logically removed (OC48-x moves to OOS-AUMA state due to RMV-OC48/OC48-x command or ED-OC48/OOS/OC48-x command).
4) The system does not clear the LOS/SA/CR condition for OC48-x internally but it sends a message of REPT^ALM^OC48/alarm-clear for OC48-x.
5) When RTRV-COND-OC48/OC48-x is issued, the system returns LOS/SA/CR.
6) When RTRV-ALM-OC48/OC48-x is issued, the system doesn't return LOS/SA/CR.

The conditions severity is managed by means of profiles ASAP (ref to _____).

3.3.7 HouseKeeping

The NE is able to receive and process eight (8) separate customer-defined inputs for fault conditions arising externally to the NE. The fault conditions is processed and reported as for internally detected fault conditions. It is possible to disable the reporting from any input if not used.

The inputs is capable of interfacing to a dry relay contact, i.e. an input comprises two wire interface capable of detecting an open or closed circuit condition between the two connections. Each user alarm input is separately configurable to accept either a closed circuit or open circuit state as the active alarm condition. The inputs from the dry contacts are normally used for "site specific" alarms such as open door, high temperature, high water level, etc. The polarity of an external input control determines the relationship between the declaration of an environmental condition and the physical signal.

The NE drives 4 separate output station controls for customer defined site specific facilities external to the NE, such as air conditioning, generators, etc. Operating an external control means that a relay is activated to control some external device. Releasing an external control means deactivating the relay. The polarity of an external output control determines the relationship between the control state (CONTSTATE) value and the physical signal.

It is possible to configure user labels for each alarm input and control output to be used for TL1 command and message purposes on all user interfaces (via the local terminal and element manager). The labels consist of free (ASCII) text fields of up top 30 characters. It is possible to reconfigure each label at any time. Provisioning of housekeeping alarms and controls is persistent Housekeeping functionality is provided by the active FLC board. Customer access to the HKP connections is via 25 pin D-Sub connector on the NE Front-top of the Main Shelf.

3.3.8 Installation and Upgrade (IAU)

The Installation and Upgrade feature consists of these areas:

– Initial Software Installation
For initial download of system software to the NE, a network boot approach is used. The process used to perform an initial software installation and turn-up on the NE system is documented for customers and customer service personnel. However the exact details of these procedures are described in the system operation documents and are not subject to this RRS.

– Software Download
The Software Download feature provides a mechanism to load a software from an remote file server onto a NE system without impact to service.
The software to be downloaded is identified by a build identifier.
The NE is supposed to logically provide two independent storage areas on its DSK. One storage area holds the active system and application software, the other storage area holds the standby system and application software.
Software download from a remote file server to the NE modifies the standby storage area only, i.e., the downloaded software release files are stored on the standby storage area. Any previous content of the standby storage area may be overwritten by the remote file transfer operation.

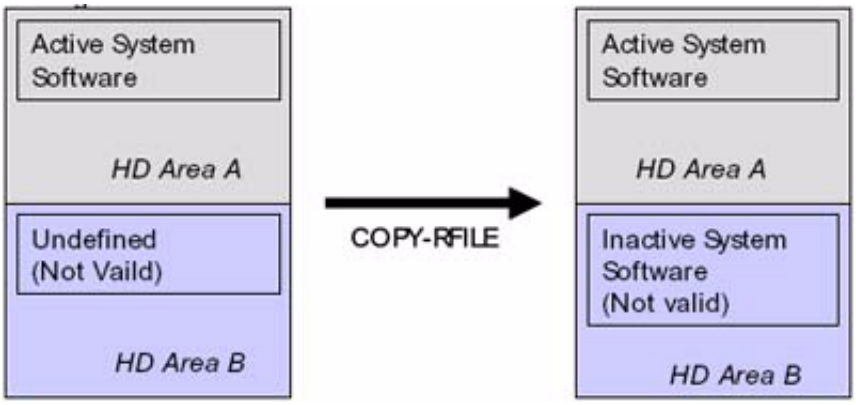


Figure 233. Software Download

The NE downloads programs and databases for local Network Element (NE) use. The following functions are supported:

- ability to receive a set of files containing the software for all FLC, SLC and LDC processors in the control hierarchy.
- download function via TL1 request.
- download function from a remote file server.
- capability of being stored on the DSK.

Commands are provided to retrieve the firmware version and software version (release ID) of the software being run on the NE.
The download completion time is a maximum of 15 minutes for download via an ethernet LAN connection (10 Mb/s).
The download completion time is a maximum of 4 hours for download via an DCC connection (576 kbs).
System performance doesn't be adversely affected by the download process.

– In-Service Upgrade

The In-Service Upgrade process converts the existing system database to the new release database and upgrades the existing release software to a new release software while in service, without impact to existing traffic.

The new SW packages is installed by the appropriate TL1 command directly on the active FLC (FLC A). The standby FLC (FLC B) is updated automatically, by means of an internal mechanism (RAID).

While the In-Service Upgrade process is performed, the system is in a restriced TL1 command execution mode. Any TL1 command that does not change the NE configuration (RTRV-XXX) can be executed during an ongoing In Service Upgrade. TL1 commands that modifies the NE configuration are denied during an ongoing In Service Upgrade. This ensures that the NE starts operation in the new release with the same provisioned database as when the upgrade was started in the old release.

The whole content of the database, including all provisioning, but excluding historical performance monitoring data, alarm data and the event log, are preserved during an In-Service Upgrade.

The NE provides the capability to perform an ISU to a release max. two release steps newer, compared to the currently active release.

The NE supports to fall back to the previously active release after an successfully performed ISU to a new release, until the new release is explicitly commited by the operator.

3.3.9 Alarm Severity Assignement Profile (ASAP)

Managed entities yield alarms when they have some malfunctions. An ASAP is a list of Alarm probable causes to which Severities Profiles are assigned, predefined or settable by the operator. This option permits to configure (create, modify, etc.) the ASAPs.

An ASAP indicates, for each condition, the SA and NSA severity (notification code).

The reference document which contains the list of conditions for each ASAP is the “Maintenance and Troubleclearing” manual (ref. to [4] on page 20).

The system supports:
– one ASAP type for each transmission entity (OC3, OC12, STS1, etc.),
– one for all equipment entities (EQPT),
– one for common entity (COM),
– one for synchronization entity (BITS)
– one for Security entity (SECU).

Each ASAP type contains only those conditions that apply to the related entity, i.e. an equipment ASAP shall not contain conditions that are specific for OC3 and vice versa.

The system supports one factory default ASAP for each ASAP type.

The factory default ASAP is identified:
– by an AID with the indication of the related entity and the index 1, e.g. ASAPEQPT-1, ASAPOC3-1.
– by a USERLABEL with the prefix =LBL-", the indication of the related entity and the suffix "-SYSDFLT", e.g. LBL-ASAPEQPTSYSDFLT, LBL-ASAPOC3-SYSDFLT.

The system supports one null ASAP for each ASAP type, where all conditions severity is equal to NR (Not Reported).

Null ASAP is identified:
– by an AID with the indication of the related entity and the index 0, e.g. ASAPEQPT-0, ASAPOC3-0 (see AID RRS for details).
– by a USERLABEL with the prefix "LBL-", the indication of the related entity and the suffix "-NULL", e.g. LBL-ASAPEQPT-NULL, LBLASAPOC3- NULL.

Both factory default and null ASAP profiles are part of the NE database and are not created by means of a TL1 command.
Users with appropriate privileges are able to create new ASAP instances (profiles) for each ASAP type.
A new created ASAP profile is a clone of the factory default ASAP for the specified entity.
A new created ASAP profile is identified by an AID, which is assigned by the NE, with the indication of the related entity and the index number that shall be a sequence number starting from 2, e.g. ASAPEQPT-2, ASAPEQPT-3, ASAPOC3-2, ASAPOC3-3.
When creating a new ASAP profile by means of ENT-ASAP-PROF, the user can optionally input a user label (USERLABEL parameter).
If USERLABEL is missed, and the command is successfully completed, the NE shall assign a USERLABEL value to the created ASAP instance.

The system assigned USERLABEL consists of the prefix "LBL-", the indication of the related entity and a suffix indicating the ASAP AID assigned index, e.g. LBLASAPEQPT-2, LBL-ASAPOC3-4.

The maximun number of ASAP profiles instances that are allowed to be created for the NE is 256, included null and factory default ASAP instances. Besides that limit, no specific limit shall be applied to each ASAP type.

It is possible to set a new ASAP profile as the current default profile for the related entity type. This means that all the future instances of the related entity type shall use that ASAP profile as the default profile.

Users with appropriate privileges is able

– to edit a user defined ASAP profile. It is denied to edit factory-default and null ASAP profiles. For each condition code it is possible to edit the SA and NSA severity (notification code). It is denied to add and/ or delete condition codes.
– to delete an ASAP profile. It is denied to delete factory-default and null ASAP profiles. It is denied to delete an ASAP profile that is currently in use, i.e. an ASAP that is associated to at least one entity instance.
  If a default ASAP is successfully deleted, i.e. it is not in use and it is not the factory default, the NE is automatically set the factory default as the default for that ASAP type.

It is possible to retrieve:

– the information stored into an ASAP profile.
– the list of the entity instances (identifiers) associated to an ASAP profile.

When an entity is created in the database, by means of the TL1 ENT-<entity> command, it shall be associated with an existing ASAP profile for that entity. By default an entity instance is associated with the default ASAP profile for that entity.

3.3.9.1 DWDM sub-system faults

The faults based on analog power measurements are:

– declared when the threshold has been exceeded for 20 milliseconds.

– cleared when the measured power level is within the threshold range for greater than 125 microseconds or 2.5T containing no transition free intervals of length T, where T is greater than or equal to 2.3 microseconds and less than or equal to 100 microseconds.

3.3.9.1.1 Continuity supervision (loss of continuity defect)

Defect	Meaning
Loss of Signal Payload	– Loss of Signal Payload (LOS-P) defect is monitored at the OTS layer. The dLOS-P takes on the value "incoming payload LOS" when the incoming power level of the payload signal at the receiver has dropped to a level that corresponds to a high error condition. The purpose of monitoring this parameter is to indicate an optical path break at the OCh, OMS, OTS or OPS layer. An additional hold-off time of 500 milliseconds is defined for the dLOS-P activation in the OTSn_TT_Sk function. This time is introduced in order to avoid false dLOS-P activation in case the payload signal is already missing at the related trail termination source. The PMI signal is used to signal this information from the trail termination source to the sink. The hold-off time covers the propagation, processing and detection delay of the PMI signal between the source and sink. The hold-off time is not configurable, it depends on the specific implementation of the PMI signalling and LOS-P detection.
Line Driver High Input Power	– Line Driver High Input Power defect is monitored at the OMS layer for the transmit direction (dLDTXHIPWR) and at the OTS layer for the receive direction(dLDRXHIPWR).
Loss of Signal Overhead	– Loss of Signal Overhead defect (dLOS-O) is monitored at the OTS layer. LOS-O corresponds to loss of the Optical Supervisory Channel (OSC) signal. The dLOS-O takes on the value "SUPVY Channel LOS" when the incoming power level of the OSC at the receiver has dropped to a level that corresponds to a high error condition. The purpose of monitoring this parameter is to indicate either: OSC transmitter failure at the OTS layer; OSC optical path break at the OTS layer.
Loss of Frame Overhead	– Loss of Frame Overhead defect (dLOF-O) is monitored at the OTS layer. LOF-O corresponds to a frame loss of the Optical Supervisory Channel (OSC) signal.
Loss of Lock Overhead	– Loss of Lock Overhead defect (dLOL-O) is monitored at the OTS layer. LOL-O corresponds to a receiver loss of lock of the Optical Supervisory Channel (OSC) signal.
Signal Degrade of Overhead	– The Overhead signal degrade defect (dSDEG-O) is monitored at the OTS layer. SDEG-O corresponds to a high received error rate of the Optical Supervisory Channel (OSC) signal.

From DCM Input LOS – The From DCM Input LOS defect (dLOSDCM) is monitored at the OTSn/OMSn_A layer. LOSDCM corresponds to a input LOS at the From DCM fiber connector on the LD_ circuit pack.

DCM Loss Out-of-Range – The DCM Loss Out-of-Range defect (dOORDCM) is monitored at the OTSn/OMSn_A layer. LOSDCM corresponds to an excessive loss through the DCM.

LDTX Sig In LOS – The LDTX Sig In LOS defect (dLDTXSIGINLOS) is monitored at the OMSn_TT_Sk layer. LDTXSIGINLOS corresponds to a loss of input signal at the LDTX SIG IN port.

LDRX Sig In LOS – The LDRX Sig In LOS defect (dLDXSIGINLOS) is monitored at the OMSn_TT_Sk layer. LDRXSIGINLOS corresponds to a loss of input signal at the LDRXB SIG IN port.

From ROADM LOS – The From ROADM LOS defect (dLOSFROADM) is monitored at the OTSn_TT_So layer. LDFROADMLOS corresponds to a loss of input signal at the LDRXB From ROADM IN port.

From ILA LOS – The From ILA LOS defect (dLDFILALOS) is monitored at the OTSn_TT_So layer. LDFILALOS corresponds to a loss of input signal at the LDRXB From ILA IN port.

Transmitting SCOT Suspended – The Transmitting SCOT Suspended defect (dSCOTSUSTX) is monitored at the OTSn/OMSn_A layer. SCOTSUSTX corresponds to a failure of the SCOT software to make successful adjustments.

Receiving SCOT Suspended – The Receiving SCOT Suspended defect (dSCOTSUSRX) is monitored at the OTSn/OMSn_A layer. SCOTSUSRX corresponds to a failure of the SCOT software to make successful adjustments.

SCOT Span Measurement Failure – The SCOT Span Measurement Failure defect (dSPANMEAS) is monitored at the OTSn/OMSn_A layer. SPANMEAS corresponds to a failure of the SCOT software to calculate the span loss.

Optical Channel LOS – The Optical Channel LOS defect (dLOS-OCh) is monitored at the OMSn_TT_Sk and OTSn_TT_So layers. LOS-OCh corresponds to a failure of the OSA to detect an optical channel that the SCOT software says should be present.

OMON Input LOS – The OMON IN LOS defect (dLOS-OMON) is monitored at the OTSn_TT layer. LOS3 OMON corresponds to a loss of input signal at an OMON input.

WR Add In LOS – The WR Add In LOS defect (dLOSADDIN) is monitored at the OMSn_TT layer. LOSADDIN corresponds to a loss of input signal at the WR ADD IN port.

WR Mesh_Thru In [1-7] LOS – The WR Mesh_Thru In [1-7] LOS defect (dLOSMTIN[1-7]) is monitored at the OMSn_TT layer. LOSMTIN[1-7] corresponds to a loss of input signal at the WR MESH_THRU IN [1-7] port.

WR Sig In LOS – The WR Sig In LOS defect (dWRSIGINLOS) is monitored at the OMSn_TT layer. WRSIGINLOS corresponds to a loss of input signal at the WR SIG IN port.

Optical Channel Input LOS – The Optical Channel Input LOS defect (dLOSOCHIN) is monitored at the OMSn_TT_So layer. LOSOCHIN corresponds to a loss of input signal detected by the WR channel monitor.

APR Active LDRX Node – The APR Active LDRX Node defect (dAPR-RX) is monitored at the OMSn_TT_Sk layer. A failure condition detected by the WR_ or a failed WR_ creates an APR condition for the LDRX_ amplifier that connects to the WR_ Sig In port.

APR Active LDTX Node – The APR Active LDTX Node defect (dAPR-TX) is monitored at the OMSn_TT_So layer. A failure condition detected by the WR_ or a failed WR_ creates an APR condition for the LDTX_ amplifier that connects to the WR_ Sig Out port.

Supervisory Transmit LOS – The Supervisory Transmit LOS defect (dSUPVYTXLOS) is monitored at the OTSn_TT_So layer. SUPVYTXLOS corresponds to a loss of input signal at the LDTX OSC IN port.

3.3.9.1.2 Maintenance signal supervision

Defect	Meaning
Backward Defect Indication Payload	– Backward Defect Indication Payload defect (dBDI-P) is monitored at the OTS layer. The purpose of monitoring this parameter is to allow for single ended supervision of the trail. BDI-P (dBDI-P) defect is: • declared at the trail termination sink function within 500 ms of detecting the far-end defect causing the insertion of BDI-P into the OSC overhead signal. • cleared at the trail termination sink function within 500 ms of detecting that the far-end defect, which caused the insertion of BDI-P into the OSC overhead signal, has cleared.
Backward Defect Indication Overhead	– Backward Defect Indication Overhead defect (dBDI-O) is monitored at the OTS layer. The purpose of monitoring this parameter is to allow for single ended supervision of the trail. BDI-O (dBDI-O) defect is: • declared at the trail termination sink function within 500 ms of detecting the far-end defect causing the insertion of BDI-O into the OSC overhead signal. • cleared at the trail termination sink function within 500 ms of detecting that the far-end defect, which caused the insertion of BDI-O into the OSC overhead signal, has cleared.
Payload Missing Indication	– Payload Missing Indication (PMI) defect is monitored at the OTS layer. The purpose of monitoring this parameter is to suppress downstream loss of signal alarms at the trail termination sink due to upstream defects causing missing payload at the start of the trail. **Note:** The defect PMI doesn't result in a fault cause. It is used to suppress LOS-P defects related consequent actions, defect correlations and performance monitoring data at the OTS and OMS trail termination sink in case of an already missing payload at the trail termination source. PMI defect (dPMI) is: • declared at the trail termination sink function within 500 ms of detecting the missing payload condition causing the insertion of PMI into the OSC overhead signal. • cleared at the trail termination sink function within 500 ms of detecting that the missing payload condition, which caused the insertion of PMI into the OSC overhead signal, has cleared.
Overhead Missing Indication	– Overhead Missing Indication (OMI) defect is monitored at the OTS layer. The purpose of monitoring this parameter is to suppress downstream loss of signal alarms at the trail termination sink due to upstream defects causing missing overhead signal at the start of the trail. OMI defect (dOMI) is: • declared at the trail termination sink function within 500 ms of detecting the missing payload condition causing the insertion of OMI into the OSC overhead signal. • cleared at the trail termination sink function within 500 ms of detecting that the missing payload condition, which caused the insertion of OMI into the OSC overhead signal, has cleared.

3.3.9.1.3 Generic Defect detection

Trace Identifier Mismatch Defect

– Trace Identifier Mismatch Defect dTIM for 16 Byte Specific String
  The dTIM defect is detected when the received trace identifier differs from the expected trace identifier for 5 - 9 consecutive multiframes. It is cleared when the received trace identifier is identical with the expected trace identifier for three consecutive multiframes.
  The defect is suppressed during the receipt of a SSF.
  The value 5 - 9 is coming from the ASIC implemenation.
– Trace Identifier Mismatch Detection Time
  dTIM is detected within a maximum period of 100 ms in the absence of bit errors.
– Trace Identifier Mismatch Clearing Time
  dTIM is cleared within a maximum period of 100 ms in the absence of bit errors.

GBASE-R Fault signalling

10GBASE-R link fault signaling operates between the remote Reconciliation Sub layer and the local Reconciliation Sub layer. Faults detected between the remote RS and the local RS are received by the local RS as Local Fault. Only an RS originates Remote Fault signals.
Upon recognition of a fault condition PCS sublayer indicates Local Fault status on the data path. When this Local Fault status reaches an RS, the RS stops sending MAC data, and continuously generates a Remote Fault status on the transmit data path (possibly truncating a MAC frame being transmitted). When Remote Fault status is received by an RS, the RS stops sending MAC data, and continuously generates Idle control characters.
When the RS no longer receives fault status messages, it returns to normal operation, sending MAC data.
Link status signaling is accomplished using transmission/reception of ordered sets.
Ordered sets consist of a control character followed by three data characters.
Ordered sets always begin on the first octet of the XGMII.10 Gigabit Ethernet uses one kind of ordered_set: the sequence ordered_set. The sequence ordered_set control character is denoted /Q/ in 64B/66B. An additional ordered_set, the signal ordered_set, has been reserved and it begins with another control code. The 4-bit O field encodes the control code.
Status is signalled in a four byte Sequence ordered set as shown in following table - "Sequence Ordered set definition". The PHY indicates Local Fault with a Sequence control character in the first byte and data characters of 0x00 in the following 2 bytes plus a data character of 0x01 in byte 4.The RS indicates a Remote Fault with a Sequence control character in the first byte and data characters of 0x00 in the following 2 bytes plus a data character of 0x02 in byte 4. Although most fault detection is on the receive data path of a PHY, in some specific sub layers, faults can be detected on the transmit side of the PHY. This is also indicated by the PHY with a Local Fault status.

Control Char.	Data Char. #1	Data Char. #2	Data Char. #3	Description
Sequence, /Q/	0x00	0x00	0x00	Reserved
Sequence, /Q/	0x00	0x00	0x01	Local Fault
Sequence, /Q/	0x00	0x00	0x02	Remote Fault
Sequence, /Q/	≥ 0x00	≥ 0x00	≥ 0x03	Reserved

Link status may be an important parameter to ensure protection performance in certain Ethernet configurations. Ethernet port status may be used as an input to protection switch or Link aggregation state machine. Based on link status state machine will declare the Ethernet port entity failed and perform appropriate action (re-direct the traffic to the protection entity or perform a load sharing among the remaining working entities).

3.3.10 Database Management

An NE maintains all its configuration in a volatile memory database. Non-volatile disk backup databases are maintained implicitly by the NE, and explicitly by operator commands. The NE is able to restore its memory database from the contents of a disk backup database at restart time or triggered by an operator command.

The NE provides mechanisms to transfer a locally stored disk database backup to an RFS and vice versa.

The NE allows operator to reset its memory and primary backup database to a factory installed default configuration.

The NE supports autonomous messages to report all changes to the provisioning database, all primary state changes, equipment insatllation or removal, equipment or facility failure or recovery.

Database Overview
The volatile memory database (ACTV CPU DB) is maintained by the NE and reflects the NE configuration, its alarm states and conditions. Two non-volatile disk database types exist for the NE: the primary backup database (ACT DSK DB) and the secondary backup data base (STDBY DB).
The primary backup database is maintained implicitly by the NE during its normal operation. At any time, it reflects the state of the NE's volatile memory database. Updating the primary backup database occurs online without interrupting the NE's normal service operation.
The primary backup database can be copied to the secondary backup database by an operator command (backup).
The secondary backup database can be copied to the primary backup database. After an FLC restart (or FLC switch) the memory database is reloaded from the restored disk database.
The secondary backup database can be copied to/from a remote file server (RFS) by operator commands (remote backup and remote restore).
The NE supports autonomous reporting of memory database changes, in particular, changes to provisioning state of the equipment and the facilities.
The NE meets the DB requirements from GR-472-CORE and other applicable standards.

Disk Redundancy
The NE disk is considered to be part of the L1 controller board. In case of a redundant L1 controller configuration, the system assures consistency of disk contents between active and standby L1 controller. IIt is therefore assumed that all locally stored backup databases are consistent between the redundant L1 controllers of the NE without need for specific operator action.
All database operations described on this part refer to the disk on the active L1 controller unless explicitly mentioned otherwise. The system is responsible to replicate any change to disk databases on the active L1 controller to the corresponding disk database on standby L1 controller (if available).
In particular, the implementation of the operations for creation of a database backup and download of a database backup to the disk on the active L1 controller is expected to have the corresponding effects on the disk of the standby L1 controller.
After a reboot or insertion of a standby FLC, the FLC status LED inidicates a status of Software Download (SWDL, flashing green) until the standby database image is synchronized with the primary.

Local Database Operations
Any failures in updating the database is reported by the NE.
The system is capable of being automatically restored after a power failure or severe faults from the primary backup database to the latest stable and consistent configuration before the failure occured.
The system restores the memory database from the primary backup database when initializing the NE.
The system provides the ability to restore the memory database and enable "normal operations" via a standard interface (e.g. TL1). These operations are to be provided on any USI port.

Restoration of the memoy database from the primary backup database, once initiated, is completed within the time the system is required to achieve full operational control, under normal operating conditions.
A method of verifying the valid state of locally stored disk databases is provided.
The NE prevents inadvertent restoration of an obsolete, corrupt or empty database or database from another system. By default the NE only allows to restore the most recent backup. The system incorporates timestamp checks, system ID comparisons, etc., but allow a forced override by a sufficiently privileged user.
The NE supports the ability to cancel active backup operations.
No more than one backup, restore, or software download operation are allowed at a time on the NE.

Remote Database Operations
The NE supports the ability to transfer the secondary backup database to and from a Remote File Server (upload and download).
The % completion of the file transfer is reported via an autonomous message.
The NE supports the ability to retrieve information on a backed up database currently existing on an RFS. Information includes the SID, NE type, and release of the NE on which the backup took place, and the date and time at which the backup occurred.
The correct file size of a remotely stored disk databases is verified before downloading the database to the NE.
The file transfer functionality works with any RFS supporting an IP connection, a standard ftp file server.
The system is not required to resume automatically a previously started remote file transfer operation (either direction) that was interrupted by an NE restart or FLC protection switch.

Database Types
The following database types are provided for the NE:

- **ACTV CPU DB** Database in volatile memory (e.g. RAM on the L1 controller). At FLC (re-)start time the contents of the ACTV DSK DB is copied into the ACTV CPU DB.
- **ACTV DSK DB** Primary backup database on the NE's disk. This database is also used to automatically restore the ACTV CPU DB on system initialization.
- **STDBY DB** Secondary backup database on the NE's disk. This database is created during a successful backup operation. It can be copied to the ACTV DSK DB and ACT CPU DB during a successful restoration operation. The STDBY DB can also be copied to/from the RFS.
- **DFLT DB** Factory default configuration provided for the NE during system installation time. The factory default configuration is not necessarily a database in the strict sense but may be a fixed set of configuration values.
- **RFS DB** Remote File Server Database. This database can be copied to the STDBY DB during a successful file transfer operation.

Figure 234.depicts the memory database (ACTV CPU DB), the primary backup database (ACTV DSK DB), the secondary backup database (STDBY DB), the factory default database, and the remote file server (RFS).

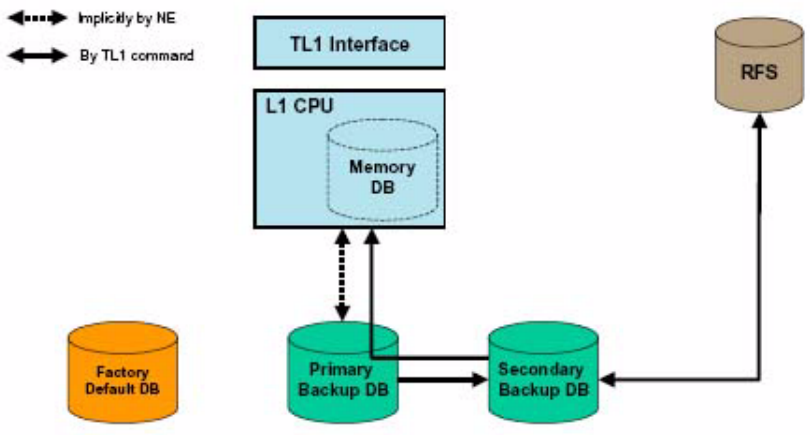


Figure 234. Database Types and Transitions

Database Label

A database label is maintained for the ACT DSK DB, the STDBY DB and all RFS DBs to aid in recovery for database backups.

The database label contains the following parameters:

- **SYSTYPE** {1850TSS/40, 1678MCC,1850TSS/15,1850TSS-320} System Type on which the database was created.
- **RLSID** <1-20 CHARACTER> Software Release identifier of the system software the database was created with.
- **SID** <1-20 CHARACTER SID> Site Identification, identifies the provisioned system identification.
- **BACKUP-DATE** {YY-MM-DD:{05-99}-{1-12}-{1-31}} Backup Date
  For the ACT DSK DB, identifies the date of the last successfull database backup from ACTV DSK DB to STBY DB. If a backup has not occurred for the database currently operating in the NE, this date is the same as the date of NE installation date.
  For the STDBY DB, identifies the date when the database backup was created.
- **BACKUP-TIME** {HH:MM:SS:{0-23}:{0-59}:{0-59}} Backup Time
  For the ACT DSK DB, identifies the time of the last database backup for the database currently operating in the NE. If a backup has not occurred for the database currently operating in the NE, this time is the same as the date of NE installation time.
  For the STDBY DSK DB, identifies the time when the database backup was created.
- **CRC** <8 UPPER CASE HEXADECIMAL CRC CHARACTERS> 32-bit Cyclic Redundancy Code calculated over the backed-up data.

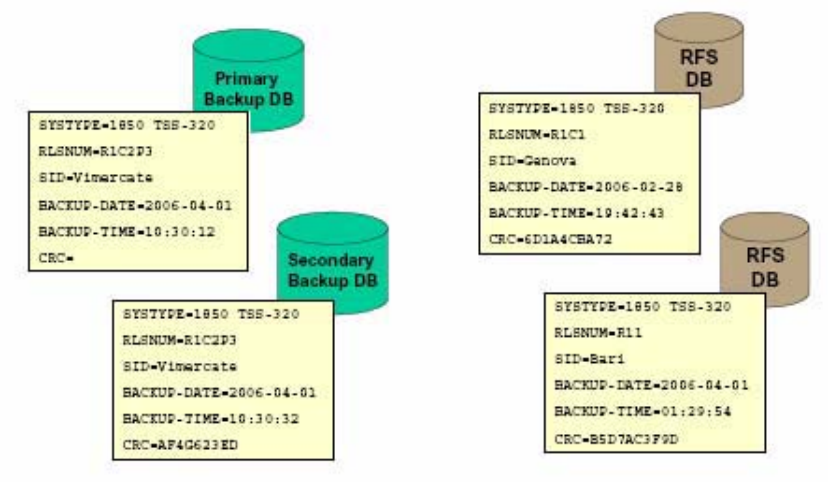


Figure 235. Relationship between databases and their labels.

Disk/Partition Full

The NE assures that:

– a download of database backups from RFS does not exceed the free disk space on the FLCs' disks. The file transfer command is denied if the free FLC disk space is not sufficient to store the remote database backup.
– the creation of a local database backup on the FLC does not exceed the free disk space on the FLCs' disks. The backup creation command is denied if the free FLC disk space is not sufficient to create a local datbase backup.

Database Change Report

The NE system generates a Report Database Change message when any of the following provisioning changes occur:

– Provisioning change to the SID
– Provisioning changes to equipment and/or facility entities
– Any equipment and/or facility entity state provisioning transitions.
– Cross Connection Provisioning changes
– Loopback Connection provisioning changes
– Rolling Provisioning Changes
– Building Integrated Timing Supply (BITS) state provisioning transitions
– Synchronization reference provisioning transitions
– LAN Port state provisioning transitions
– Date and Time provisioning transitions
– Protection Group Provisioning changes

The NE system generates a Report Database Change message when any of the following autonomous events occur:

– Installation (physical insertion) of an equipment entity
– Removal (physical extraction) of an equipment entity
– Failure of an equipment and/or facility entity
– Failure recovery of an equipment and/or facility entity
– Autonomous change in the primary state of any equipment, facility, and/or cross connect entity.
– Clearing of Automatic In Service

The NE system generates a Report Database Change autonomous message only for those AIDs specified directly by an entity provisioning command. Implicit changes of dependent resources are not be notified by subsequent Report Database Change autonomous messages.
For TL1 commands issued with AID ranging and grouping, a separate REPT^DBCHG message is issued for each entity specified in the AID for which a reportable change has occured.
When a single event, such as a TL1 provisioning command or entity failure, causes multiple reportable database changes to an entity, the REPT^DBCHG message is issued only once, and reports the final current value of the primary and secondary states of the entity.
On a change due to an automomous event, (facility falure, pst change, etc), a DBCHG message could be issued only on the top level facility. In other words, for any facility entering or leaving the SGEO secondary state, the DBCHG should be supressed. (SGEO, supporting entity outage, is set./cleared on a child facility upon an outage/recovery of the parent.)
A DBCHG report triggered by a user command is not sent to the originating user's session(s).

If at any point the ACTV CPU DB or ACT DSK DB incurs a failure of any type, the L1 equipment entity experiencing the failure is placed into a OOS AU state and is reset.

Database Backup
The ACTV DSK DB is updated after configuration affecting commands have been processed, and after any autonomous volatile configuration changes have been performed by the NE, in such a way as to guarantee that no configuration changes of the memory database changes are lost.
The NE does not maintain the current alarm situation of the system in the non-volatile database. The actual alarm situation is recovered from the NE at restart time.
Memory backup activities (ACTV CPU DB to ACTV DSK DB) occurs on-line with minimal impact to normal service operations. In particular, it doesn’t interrupt or interfere with traffic carried by the NE, protection switch time is not impacted, response times is not impacted enough to cause investigation by the casual user.
Disk Database backup activities (ACTV DSK DB to STDBY DB) - also called database backups in the following - occurs on-line with minimal impact to normal service operations. In particular, it doesn’t interrupt or interfere with traffic carried by the NE, facility protection switch time is not impacted, response times is not impacted enough to cause investigation by the casual user. Unless explicitly specified otherwise, no TL1 command is rejected due to an ongoing backup activity.
The following non-DBM related commands are rejected during an ongoing backup activity:
– FLC restart with INIT-SYS command
– FLC duplex switching with SW-DX-EQPT command
If L1 controller equipment protection is available, the NE remains fully operational at the TL1 interface during on ongoing database backup operation. However L1 controller redundancy becomes unavailable and no L1 protection switch event can occur during backup creation.
If L1 controller equipment protection is not available, a forced command mode is required to create a database backup. During database backup creation, all TL1 connections are closed and the NE is not manageable by TL1.
Excluding historical performance monitoring data and the event log file, the database backup operation backups the whole database content. Active alarms and conditions aren’t be backed up or restored
The database backup operation also writes the backup date and time stamp to the ACT DSK DB label. This information is used in a database restore scenario to make sure that by default only the most recent database backup can be restored.
The database backup operation also writes the system type, the software release number, the site identity, a CRC, and the backup date and time stamp to the STDBY DB label.
The CRC validity of the SDTBY DB and/or the ability to read the data back is checked, and if a failure is detected, a failure of a database backup condition type is set against the AID COM.
The NE denies the Activate Database Backup request:
– When a database backup event is currently in progress.

– When a database restore event is currently in progress.
– When a remote database backup is currently in progress.
– When a remote database restore is currently in progress.
– When an in-service upgrade event is in progress (via a Start In-Service Upgrade request).
– CRC/Database Read Error validation of the backup fails for the STDBY DB.
– When an Initialize System event is in progress (via an Initialize System request)

Failure of a database backup to the STDBY DB causes the setting (resetting with a new time stamp if a Failure of a database backup condition preexisted) of a Database Backup Failure condition type.
The Database Backup Failure condition type is a standing condition declared agains the COM AID. It is cleared upon successful completion of a subsequent Active Backup Database or Restore Database command.
The presence of the Database Backup Failure notifications doesn't cause a change in state of L1 controllers nor other equipment.
The database backup operation performs a subsequent data integrity verification. Specifically, a robust 16 or 32 bit Cyclic Redundancy Check algorithm is applied to the STDBY DB and the resulting checksum is stored within the database's label.
The NE accomplishe the generation of database backups in 15 minutes or less.
The completion of the database backup creation is notified by an autonomous message.

Database Restore

The NE supports the ability to restore the STDBY DB to the ACTV DSK DB and subsequently reinitialize the system via a Restore Database request.
Disk database restoration will restore the complete contents of the STDBY database to the ACTV DSK DB. Any site specific configuration (e.g., SID, NE network addresses, routing configuration) doesn't be preserved. Database restoration doesn't interrupt or interfere with traffic on connections that are not altered by the restoration.
When reinitializing the NE to activate the restored database, the NE performs an alarm resynchronization to update the alarm database with the actual NE's alarm situation.
The NE system denies the Restore Database request for the following reasons:

– When an in-service upgrade event is in progress (via a Start In-Service Upgrade request).
– When a system initialization event is in progress (via a INIT-SYST request).
– The database to be restored has a database read error or the CRC does not match the calculated CRC on the media.
– A database restore event is presently in progress.
– A database backup event is currently in progress.
– The system type on the database to be restored does not match the system type on the system to be restored.
– The system identifier on the database to be restored do not match the system identifier on the system to be restored. The NE provides a forced variant of the request that can override this condition.
– The release number on the database to be restored do not match the release number on the system to be restored. The NE provides a forced variant of the request that can override this condition.
– The Database Label BACKUP-DATE and BACKUP-TIME stamp on the ACTV DSK DB is more recent than the Database Label BACKUP-DATE and BACKUP-TIME stamp on the STDBY DB to be restored. The NE provides a forced variant of the request that can override this condition.

The NE system completes the Restore Database event from the STDBY DB in less than 30 minutes, under normal operating conditions.

Database Backup Cancellation

The NE supports the ability to cancel (abort) a database backup currently in progress via a Cancel Database Backup request.
The CANC-DB-BACKUP command deletes any inconsistent or invalid backup database left over from an cancelled backup operation in a way that it cannot be restored and activated by the operator.
The NE denies the Cancel Database Backup request for any of the following reasons:
– A database backup event is not in-progress.
– A Cancel Database Backup event is already in-progress.

Database Label Retrieval
The NE supports the ability to retrieve the database label information associated with the ACT DSK DB and the STDBY DB via a Retrieve Database Label request.
The NE denies the Retrieve Database Label request for any of the following reasons:
– The read operation from the database cannot be performed.
– Any Database backup event is currently in progress.
– Any Database restore event is presently in progress.
– Any In Service Upgrade is presently in progress.

Remote File Transfer
The NE provides for transfer database files from the local storage area on the disk to a remote storage area on a RFS and vice-versa. Using this capability, operators can perform remote database backup and remote database restore.

File Transfer
The remote file transfer process is performed with minimal impact to system performance (e.g., protection switch times, response times doesn't impact enough to cause investigation by the casual user).
The remote file transfer functionality works with any RFS supporting an IP connection and the FTP protocol as defined in RFC-959 and the RSYNC protocol for differential file transfer.
Only one originating remote file transfer is allowed on a system at any given time.
The system reports to the managing system the percentage and remote file transfer status of the file transfer every 30 seconds after file transfer initiation and during file transfers to/from an RFS.
The NE provides an operator with the capability to interrupt an in-progress file transfer that was previously initiated.
In case a remote download file transfer is autonomously or manually canceled, all files already transferred on the NE are removed.
In case a remote upload file transfer is autonomously or manually canceled, partially transferred files might exist on the RFS after an upload gets canceled. The system doesn't take care of these remote files. It is the responsibility of the RFS maintainer in this case to do the clean up, or to reuse the same storage location for future backups by using the overwrite option.
In case a file transfer is canceled (whether it is autonomously or through an operator request), the NE provides the reason for the cancellation.
The NE relies on the underlying file transfer interruption mechanism to stop a transfer. It is able to detect and report the interruption.
In case of a file transfer failure or manual cancellation, the REPT^COPY^RFILE indicates the file transfer did not complete, the reason why the file transfer did not complete, and the reason is indicated as clearly as possible in the free format text.
Figure 236. depicts a typical scenario of file transfer. The IP network is used for OS management communication.

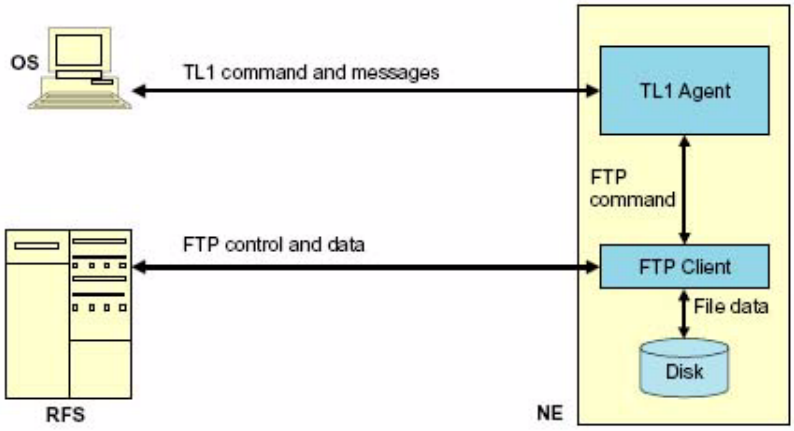


Figure 236. Reference architecture for file transfers

The file transfer protocol used in an IP-based DCN is the FTP as specified in RFC 959.
It is possible to specify the port number on which the file transfer client will connect to the server on the RFS, in case the server was not started with the default listening port.
All FTP file transfers uses the passive mode and the binary type as specified in RFC 959.
No user intervention is necessary for the file transfer to complete after the file transfer command has been issued.
In all file transfer transactions, the system that receives the file transfer request is always the initiator of the transfer, whether it uploads or downloads files. In the currently defined configurations, it is an FTP client.
The NE doesn't store in any form of non-volatile memory (including log files) any information related to the userid or password of the file server account, nor about the file location of the file to transfer.
The NE hides the password value when using a raw mode form of input where command entry character echoing is under NE control.
The NE hides the password value in all command responses and log files.
Universal Resource Locator (URL) notation is used to address remote target devices. In general, URLs are written as follows:

<scheme>:<scheme-specific-part>

A URL contains the name of the scheme being used (e.g. FTP) followed by a colon and then a string representing the specific part of it, whose interpretation depends on the scheme. For instance:

ftp://user01:pwd01@123.124.125.126//backups/NE3/December_25_2006/

File locations in commands related to file transfers is expressed in the form of URLs.
The file transfer mechanism provides a way, for file transfers to/from an RFS, to specify the directory in/from which the files will be put/taken.
When an upload on an RFS occurs, the file transfer mechanism checks that the directory path indicating where the file should be transferred, to the exclusion of the last directory, exists. If not, it denies the command.
For instance, if the "LOCATION" designator is set to:

ftp://user01:pwd01@123.124.125.126//etc/backups/20020411

the system checks that the directory /etc/backups exists on the system.

If the last directory specified in the directory path for an upload on an RFS does not exist, the system attempts to create that directory on the RFS.
From the previous example, if the directory 20020411 does not exist, it get created automatically in the directory /etc/backups.

Every file or group of files (i.e. database file) to be downloadable to a NE from a RFS requires a descriptor file which describes the files present in the same directory location as the descriptor file.
During a download (potentially involving multiple files), the system performs the checks listed below and if any of the checks do not pass, the file transfer is canceled, and the system provides the reason for the failure:

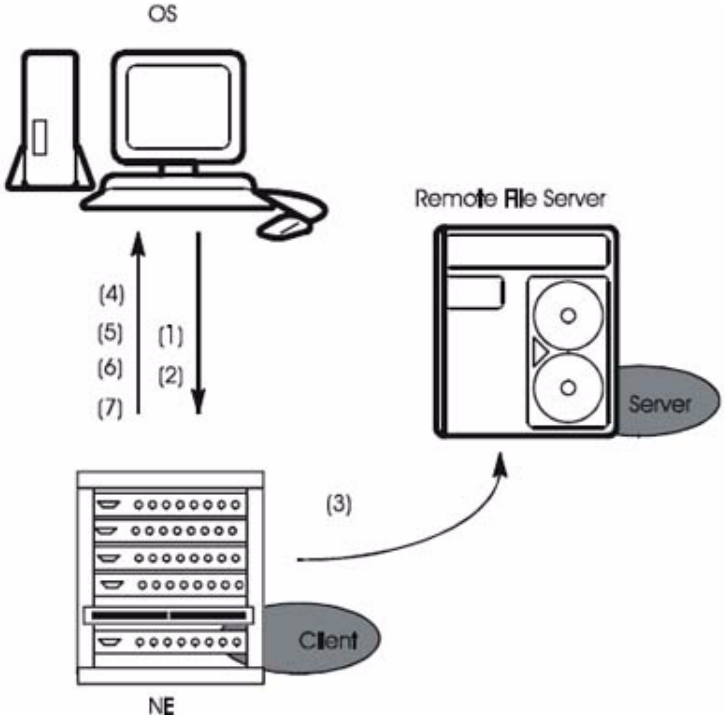
– A CRC check for each file transferred (including the descriptor file) and compare the CRC in the descriptor file with a recomputed CRC.
– A file size check for each file transferred (including the descriptor file) and compare the descriptor file size with predefined size and file unit size with stored file size in the descriptor file.
– A check to ensure that the files described in the descriptor file exist in the same Location as the descriptor file.
– REPT^COPY^RFILE autonomous message provides this functionality. File Transfer Failures found DURING the transfer operation (after COPY-RFILE completes and initiates the file transfer) on the data files is reported by the REPT^COPY^RFILE autonomous message and a reason why the file transfer did not complete in the free format text.
– COPY-RFILE TL1 command provides this functionality. If the COPY-RFILE fails, the request to initiate a file transfer doesn't completed successfully, and the reason for the failure is indicated as clearly as possible in the free format text.

During or after 'download/upload completion' from/to an RFS, the NE sends a positive or negative (i.e., upload or download FTP failure, CRC and/or file size check failure on files to download not including the descriptor file, files described in descriptor file do not exist in the same location as the descriptor file when downloading) acknowledgment to the managing system indicating the success or failure, respectively, of the file transfer. REPT^COPY^RFILE autonomous message provides this functionality. File Transfer Failures found DURING the transfer operation (after COPY-RFILE completes and initiates the file transfer) on the data files and successful completions is reported by the REPT^COPY^RFILE autonomous message. If the file transfer fails, a reason why the file transfer did not complete in the free format text is also included in the message.
During or after 'download/upload initiation' from/to an RFS, the NE sends a positive or negative (i.e., CRC and/or file size check failure for the descriptor file, CRC and/or file size check failure on files to upload, files described in descriptor file do not exist in the same location as the descriptor file when uploading) acknowledgment to the managing system indicating the success or failure, respectively, of the file transfer request. COPY-RFILE TL1 command provides this functionality. If the COPY-RFILE fails, the request to initiate a file transfer is not complete successfully, and the reason for the failure is indicated as clearly as possible in the free format text; otherwise the command completes successfully.

Remote Database Backup

The process of backing up can be split in two different phases: first, create a backup database on the NE; second, send this backup database to its remote storage destination.

Figure 237. depicts the general principle for the backup of an NE database on a Remote File Server:



(1) The OS sends a command to setup the database backup image in the backup partition (i.e. ACT-DB-BACKUP).
(2) The OS sends a command to the NE to trigger the backup to the RFS (i.e. COPY-RFILE).
(3) The NE sends a message to the RFS initiating the file transfer.
(4) The NE sends a message to the OS, indicating that the file transfer is on its way (COPY-RFILE command completion).
(5) The NE sends a message to the OS, indicating that the file transfer is on its way (i.e. REPT^COPY^RFILE).
(6) During the transfer process, messages are sent to the OS to keep it informed of the progress (i.e. REPT^COPY^RFILE).
(7) When the transfer is completed, the NE sends a completion message to the OS (i.e. REPT^COPY^RFILE).

Figure 237. General backup mechanism to an RFS

Upon receipt of a Copy Remote File Database Backup Request, an NE validates the file transfer, initiate a file transfer connection and transfer the database to the remote location (COPY-RFILE TL1 command provides this functionality with the AIDs FROM=STDBYDB and TO=RFSDB).

In order to check, during the restoration process, if the backup is compatible with the NE on which it is restored, without first having to do a complete download of the database, the database label information is stored in a separate descriptor file for each database backup stored on the NE or on the RFS. The descriptor file is kept in the same path as the database backup.

The system, by default, doesn't allow the transfer of a database to a remote location where a backup with the same location/database name already exists.

However, an option exists to force the overwriting of the existing files at the remote location (COPY-RFILE TL1 command provides this functionality with the setting of the parameter OVWRT to YES.

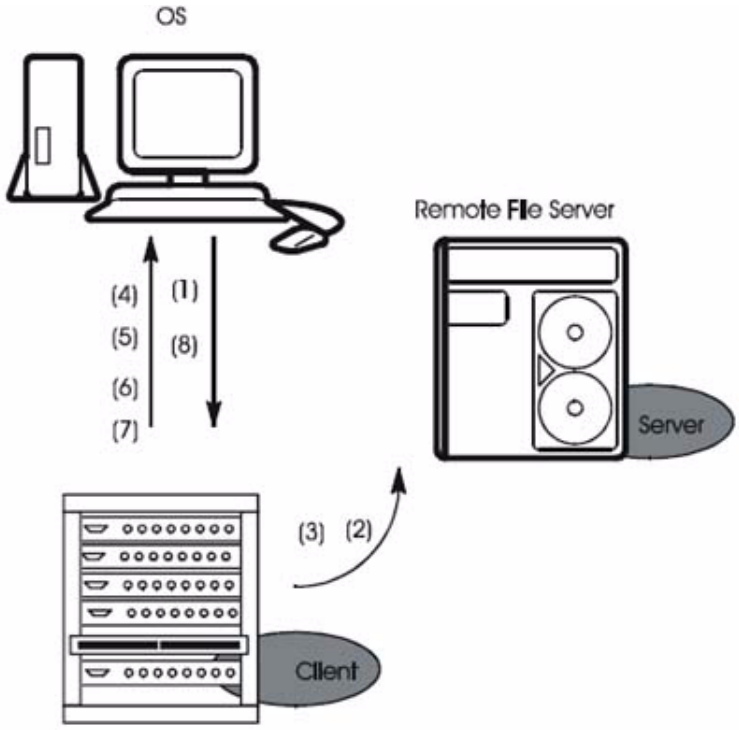
The system provides a way to retrieve the database label information for a database backup located on an RFS (RTRV-RFILE TL1 command provides this functionality. The AID RFSDB is used to retrieve information on a database backup stored on an RFS).

Remote Database Restoration

The process of restoring an NE's working database is two fold:

– first, download a backup from a remote location onto a target NE;
– second, restart the NE with the downloaded database.

Figure 238. depicts the general principle for the restoration of an NE working memory from a Remote File Server:



(1) The OS sends a command to the NE to trigger the remote transfer from the RFS (i.e. COPYRFILE).
(2) The NE sends a message to the RFS to retrieve the descriptor file (containing the database label) from the RFS.
(3) The NE requests the backup from the RFS and begins storing it on the hard disk.
(4) The NE sends a message to the OS, indicating that the file transfer is on its way (COPY-RFILE command completion).
(5) The NE sends a message to the OS, indicating that the file transfer is on its way (i.e. REPT^COPY^RFILE).
(6) During the transfer process, messages are sent to the OS to keep it informed of the progress (i.e. REPT^COPY^RFILE).
(7) When the transfer is completed, the NE sends a completion message to the OS (i.e. REPT^COPY^RFILE).
(8) The OS sends commands to the NE to trigger the activation of the restored database (i.e. RESTORE-DB).

Figure 238. General restore mechanism from an RFS

The system provides a command to download and restore a previously backed up database from a Remote File Server to an NE (COPY-RFILE TL1 command provides the download functionality with the AIDs FROM=RFS DB and TO=STDBY DB).

Prior to downloading a backup, the restore procedure downloads first the database descriptor file and perform the following checks:

– Validation of the descriptor file itself by an CRC check.
– If the system type of the NE is not identical to the one of the RFS database being restored, the transfer fails.
– If the software release of the NE is not identical to the one of the RFS database being restored, the transfer fails, unless an option is used to force the transfer.
– If the SID of the NE is not identical to the one of the RFS database being restored, the transfer fails, unless an option is used to force the transfer.

– If the date/time stamp of the RFSDB is older/prior to the date/time stamp of the primary backup database on the system, the transfer fails, unless an option is used to force the transfer. (Note: data/time stamp of primary backup database refers to last successful creation of a database backup, but not to last update of primary backup database from memory database.)

After a database restoration has been successfully downloaded, it is possible to tell if it is present in the system.

Retrieval of NE Parameters

A command allows to retrieves some system level parameters from the NE:

– System type
– Software release identifier
– Software release date,
– Matrix size,
– System restart status

Setting Site Identifier

A command allows to provision the NE Site Identifier (SID).

The factory default SID is the following:

On initial turnup, the NE automatically generates an unique SID, using the last 5 hexadecimal characters of the NE's MAC address and appending them to the PLEASESET-SID name. This SID will be updated (by reading the MAC address from the appropriate NE hardware module) and stored in the NE's database during any cold restart of the NE, as long as the SID is already set to PLEASE-SET-SID- xxxxx, or a default database is created.

3.3.11 Facility Management

3.3.11.1 Default Signals

After a power-on condition and before provisioning of its database is complete, the lasers on optical IO modules remains off.

After a power-on condition and software downloading of the provisioning database, if the OC-n facility is provisioned but the embedded facilities are not provisioned, a default SONET signal is transmitted with valid Framing in the A1 and A2 bytes, valid B1 and B2 values and 'n' valid pointer values in the H1, H2 and H3 bytes. All other bytes in the TOH is set to Hex 00.

The IDLE signals generated when a entity is provisioned but not cross connected is referred in per Table FM-1. Idle signals is the default signal transmission during intermediate stages of provisioning or recovery after database restoration or power on reset.

Table 32. IDLE SIgnals

Entity	STSMAP	VTMAP	DS3 FMT	DS1 FMT	Outgoing Payload Signal
IO Module with TYPE=10GSO, 2G5SO, 8PSO					No output signa
Ethernet Module PP20G and associated PIMs, XFPs, SFPs					No output signa
OC3, OC12, OC48, OC192 (with no embedded facilities)					All STS1 with C2=00h, J1 = 00h, STS1 Payload = 00hex, valid H1/H2 pointers
STS1	any STS-MAP value				STS1 with C2=00h, STS1 Payload = 00h, valid H1/H2 pointers, J1 as provisioned
STS3C	any STS-MAP value				STS3C with C2=00h, STS3C Payload = 00h, valid H1/H2 pointers, J1 as provisioned
STS12C	any STS-MAP value				STS12C with C2=00h, STS12C Payload = 00h, valid H1/H2 pointers, J1 as provisioned
STS48C	any STS-MAP value				STS48C with C2=00h, STS48C Payload = 00h, valid H1/H2 pointers, J1 as provisioned
STS192C	any STS-MAP value				STS192C with C2=00h, STS192C Payload = 00h, valid H1/H2 pointers, J1 as provisioned

Concatenated STS3C, STS12C, STS48C, STS192C , STS1 signals pass the incoming path overhead bytes when cross connected.

The system doesn’t originate transmission of invalid overhead byte values at any time.

3.3.11.2 Factory Defaults

Factory defaults for provisionable parameters, shipped with the software load, is specified in "**TL1 Operations Details**" manual where are also described the command defaults .

3.3.11.3 Facility Provisioning

The paths embedded within the OC-n are addressed using the AID of the working OC-n facility for all OC-n that are in 1+1 line protection relationship.

Only one set of path objects exists in the system per OC-192, OC-48, OC-12, OC-3 working/protect pair that are in 1+1 APS protection relationship, as only one path is selected and passed through the matrix at any given time.
This applies to STSnC, STS-1 path objects
The system supports only one set of path alarms per OC-192, OC-48, OC-12, OC-3 working/protect pair that are in 1+1 protection relationship.

When a hardware port can support SFP/XFP modules at different signal rates without generating a hardware mismatch condition, the system verifies that an OCn to be entered is compatible with the SFP/XFP signal rate of the provisioned hardware. In the case of incompatibility, the ENT-OCn command is denied.

Automatic Laser Shutdown and Restart

The NE optical IO Modules supports transmitter automatic laser shutdown (ALS) in the event of LOS on the corresponding receive signal.
It is possible
– to enable or disable this feature on a per port basis. The default is "disabled".
– to retrieve the current state of ALS provisioning on a per port basis.

When ALS is enabled, following a laser shutdown, the IOC emits periodic laser pulses to attempt to restart the circuit.
The duration and interval of the restart pulses is specified in the hardware design
The maximum duty cycle of the restart pulses is 15%

Manual restart capability is accomplished by disabling ALS. Whenever ALS is disabled, laser power is always transmitted.

10xAny Module Provisioning Rules

The NE supports management of port facilities for the 10xAny module. This module has 10 ports that can be provisioned for OC3, OC12, OC48, or GBE. Port usage can be mixed with the following restrictions.
– Only the first 8 ports can be provisioned for OC-n
– Any port (1-10) may be provisioned for GBE, but limited to a total of 8 GBE ports per module
– No more than 10G of total bandwidth (192 STS1 equivalents) can be allocated to all ports (GBE and OCn)
– OC48 can be assigned only to odd numbered ports
– If an OC48 is provisioned on an odd numbered port, the next even numbered port cannot be used for OC3 or OC12

Any facility that cannot be provisioned because of these rules reports a state of OOS-AUMA, UAS&DSBLD.

An attempt to enter (ENT) a facility that cannot be provisioned because of these rules is denied.

OTU2 Provisioning Rules

The NE supports management of port facilities on an OTU2 module. This module has a single 10 Gig port that supports a colored optical input in an OCH format. This signal includes a transparently embedded OC192 (section, line, and path)

The port is managed as an OTPE Line facility.

At the OTPE level only FEC management, and LOS and FEC related alams is supported.

The embedded OC192 and its payload are managed in the same manner as an OC192 on a 10GSO module, except that the physical LOS defect is not present.

The OC192 is considered a supported facility of the OTPE, and all of the rules and states associated with a supported-supporting facilities are applied.

OC-n (n = 3, 12, 48, 192) Line and Section entity

The OC-n (n = 3, 12, 48, 192) object entity which is for the SONET Section and Line level overhead on an OC-n is maintained and managed within the system, one for working and the other for protect. The following attributes are maintained for each OC-n entity:

– **AINSTH**Automatic in-service threshold. Determines how long a customer signal must be present on the OC-n facility without a failure condition before the system puts the OC-n in IS-NR or IS-ANR state.
– **AINSTIMER**Automatic In-Service Timer value, specifies how much time is currently remaining on the AINS timer before the facility is placed in service. (Retrieve Only)
– **SDTH**Signal Degrade Threshold for SD protection switching.
– **SFTH**Signal Fail Threshold for SD protection switching.
– **TRC** Section Trace, specifies the contents of the section trace message to be transmitted in the J0 byte.
– **S1TRANS**S1 byte to be transmitted, determines if the S1 byte transmitted of the specified OCn will have the "DUS" message or will have the actual traceability of the signal.
– **ALSENB**ALS Enable, determines if the laser will be shut down on the occurence of an LOS on the receive side.
– **PST** Primary State. Specifies the primary state of the OC-n entity.
– **SST** Secondary State. Specifies the secondary state of the OC-n entity.

OC-n entities are uniquely identified in the system with an AID.

The NE allows:

– OC-n object entity to be created and provisioned. Attribute values identified as "[default]" is set initially unless they are explicitly defined in the provisioning command.
– creating and provisioning of both working and protecting OC-n.
– a modification of the provisioned parameters of a OC-n object entity.

Using the Edit OC-n command to change a facility's primary state:

– to out of service is equivalent to logically removing the facility using a Remove OC-n command.
– to in service is equivalent to logically restoring the facility using a Restore OC-n command

The NE allows deprovisioning of a provisioned OC-n entity.
The OC-n that is part of a protection group, doesn’t allow to be deprovisioned (deleted).
The OC-n that has embedded facilities provisioned, i.e. it is in SDEE secondary state, doesn’t allow to be deprovisioned (deleted).
The NE allows retrieving the provisioned parameters and the state of an OC-n object entity.
The retrieve OC-n command doesn’t be denied because of the OC-n's state.

For OC-12:
An attempt to provision an OC-12 on a port on an 8PSO module that is equipped with an OC-3 SFP will be denied.

For OC-3:
An attempt to provision an OC-3 on a port on an 8PSO module that is equipped with an OC-12 SFP will be denied.

GBE Entity

Gigabit ethernet facilities associated with the 10xAny module are managed in TL1 in port-to-port applications. Each GBE facility is mapped via GFP to a dedicated VCG (GBEVCG). The VCG contains STS1 carriers (GBESTS1) that are separately cross connected into the SONET network.

The following attributes will be maintained for each GBE entity:
- **AINSTH**Automatic in-service threshold. Determines how long a customer signal must be present on the facility without a failure condition before the system puts the facility in IS-NR or IS-ANR state.
- **AINSTIMER**:Automatic In-Service Timer value, specifies how much time is currently remaining on the AINS timer before the facility is placed in service. (Retrieve Only)
- **ECHECK**Ethernet frame check, specifies whether the ethernet frame check is enabled or disabled. The default is N (No).
- **IPG** Interpacket Gap, specifies the maximum interpacket gap. Valid values are 64-456 nanoseconds. The default is 96.
- **JUMBO**Jumbo frame support, specifies whether or not to accept Jumbo frames. If set to Y (Yes), jumbo frame up to 9600 bytes will be accepted. Otherwise, a maximum 1522 byte frame size will be accepted. The default is Y (Yes).
- **NEGOTN**Negotiation mode, specifies the negotiation mode. Valid values are Auto, Disabled. The default is Auto
- **PST** Primary State . Specifies the primary state of the GBE entity. The valid values for PST are described in Section "Facility States".
- **SST** Secondary State. Specifies the secondary state of the GBE entity. The valid values for SST are described in Section "Facility States".

The NE allows GBE object entity to be created and provisioned. Attribute values identified as "[default]" are set initially unless they are explicitly defined in the provisioning command.

The NE allows modification of the provisioned values and the primary and/or secondary state for each GBE object entity.

Using the Edit GBE command to change a facility's primary state
- to out of service is equivalent to logically removing the facility using a Remove GBE command.
- to in-service is equivalent to logically restoring the facility using a Restore GBE command.

The NE allows deprovisioning of a provisioned GBE entity.
The GBE that has embedded facilities provisioned, i.e. it is in SDEE secondary state doesn't allow to be deprovisioned.
The NE provides a method for retrieving provisioned parameters and the present state of the GBE entity.

Section Trace Messages

The following capabilities are provided:

– to provision transmitting a 15 byte API section trace message on a per OC-n facility basis.The section trace messages is formatted according to the API format provided by ITU-T G.707.
– to provision a 15 byte API section trace message independently on protected and protecting optical facility.
– to retrieve the received 15 byte API section trace message on each OC-n line.
– to retrieve and display the received section trace message in either alphanumeric format or hexadecimal format
– to retrieve the provisioned 15 byte API transmitted section trace message.

All OCn facilities support these capabilities.

If the user does not provision a section trace message or specifies a TRC value of "", the transmitted section trace message is 01 hex (Section Trace unspecified) on the J0 byte, for all 15 bytes.

If the user specifies a TRC section trace message (other than TRC=""), the following sequence for transmitting the 16 byte section trace message occurs.

If value of the TRC parameter contains less than 15 ASCII printable characters, the existing character string is padded by appending NULL characters to it to produce a 15 character API message. Otherwise, the 15 characters in the TRC parameter is the entire API message.

The 15 character (possibly NULL padded) API message derived from the TRC parameter is appended to a framing byte that has a value of 80 hex (i.e., its MSbit is assigned a value of `1' - this is the API frame sync byte. Note that it is the first byte of the API frame).

The 16-Byte outgoing section trace bit-wise format complying with the following table (ITU G.707).

Byte#	Values (bits 1-8)							
1	1	C1	C2	C3	C4	C5	C6	C7
2	0	X	X	X	X	X	X	X
3	0	X	X	X	X	X	X	X
....	0	X	X	X	X	X	X	X
16	0	X	X	X	X	X	X	X

A CRC-7 value for the API message is then be calculated across the entire 16 byte API message frame and its value placed into the 7 LSbits of the API frame sync byte of the next message frame. Calculation of the CRC-7 value that is stored in the 7 LSbits of the API frame sync byte is as follows:

– The Generator Polynomial for the CRC-7 calculation is X7+X3+1 This corresponds to a value of 10001001 binary.
– The Frame Polynomial to be divided by the Generator Polynomial is the 16 byte API frame defined above. The MS bit of the first byte of the API frame is the MS (i.e., first) bit of the frame polynomial. The LS bit of the sixteenth byte is the LS (i.e., the 128th) bit of the frame polynomial.
– After the full frame polynomial has been divided by the generator polynomial, the 7 bit remainder is stored in (i.e., replaces) the last 7 bits of the frame polynomial (i.e., the 7 LS bits of the API frame sync byte (bits 2-8 of the first byte of the trace message: C1 (MSB of the remainder operation) to C7 (LSB of the remainder operation)).
– The choice of algorithm used to calculate the CRC-7 (e.g., serial, parallel, or table driven) is up to development as long as it does not delay provisioning of the facility more than 2 seconds.

To retrieve a section trace message, a search of the incoming 16 byte section trace is made for the first instance of a byte with its MS bit set to 1. The first character following this byte is considered the first character of the trace message. If the signal can not be framed or contains invalid CRC, the trace is considered invalid.

When a section trace message retrieval is requested in standard printable format, using RTRV-SECTRC, the actual incoming 15 byte section trace message (without CRC) that has been received may contain some non-printing and control type characters which are undesirable in the TL1 response to this command, after retrieval and just prior to transmitting the 15 byte message (as the frame marker is not printed), each of the non-printing, control, and special characters in that message is replaced with either a period (.) or a question mark (?) character. This is as follows:

– All NULL characters (00 hex) are replaced with a period (.) character (2E hex).
– All double quote ("), semicolon (;), left angle bracket (<), right angle bracket (>), and back slash (\) characters (22 hex, 3B hex, 3C hex, 3E hex, and 5C hex respectively) are replaced with a question mark (?) character (3F hex).
– All control characters (i.e., 01 hex to 1F hex and the value 7F hex) are replaced with a question mark (?) character (3F hex).
– All 8 bit characters (i.e., 80 hex to FF hex) are replaced with a question mark (?) character (3F hex).
– All other characters are left unchanged.

When a section trace message retrieval is requested in hexadecimal format, using RTRV-SECTRC, after retrieval and just prior to transmitting the message, each of the 15 message bytes (as the frame marker is not printed) are converted into a two byte text string representing the hexadecimal value of the byte. The notation "X" is prepended to the message.

STSn (n= 1, 3c, 12c, 48c, 192c) path entity provisioning

The following attributes is maintained for each STSn entity.

– **AINSTH**Automatic in-service threshold. Determines how long a customer signal must be present on the STS1 facility without a failure condition before the system puts the STSn in IS state.
– **AINSTIMER**:Automatic In-Service Timer value, specifies how much time is currently remaining on the AINS timer before the facility is placed in service. (Retrieve Only)
– **RDITYPE**RDI-P type. Applies to monitoring and generation.
– **STSMAP**STS Payload Mapping. Specifies the expected payload type and the value of the expected path Signal Label (C2). Used for comparison for the Payload Label Mismatch function. The default is <ALL>. Additional values are defined in the following requirement. This parameter is only effective for path terminated facilities. Although a value is accepted when the facility is provisioned, the parameter will have no effect on through-connected facilities.
– **TACC**Test Access, specifies that this AID will be provisioned as a test access port. If TACC=Y, the AID in the command is the FADA port.
– **FADB**Optional parameter that explicitly defines the FADA port AID. By default if not entered, The FADA port is automatically assigned to this facility's AID plus one. (FADA port is only valid if TACC=Y)
– **UPSR**Flag to indicate whether an STS entity in a UPSR FFP can be provisioned for protected (Y) or unprotected (N) connections. Parameter is valid only if the OCn parent is part of a UPSR FFP
– **SDTH**Signal degrade (SDBER) threshold for UPSR SD protection switching.
– **SFTH**Signal Failure Threshold for UPSR SF protection switching.
– **VCGSEQ**Virtual Concatenation Group Sequence, returns the received sequence number in the output response if the facility is in VCGSEQ alarm condition.
– **LCASSTAT**Status of this facility in the LCAS management of the VCG (retrieve only and only for VCG embedded facilities)
– **PST** Primary State . Specifies the primary state of the STSn entity.
– **SST** Secondary State. Specifies the secondary state of the STSn entity.

STSMAP values allowed for STS1 facilities are defined as:

- **ALL** Only provisionable STSMAP value since no provisionable path facilities are terminated on this NE.

STSMAP values allowed for STS3c facilities are defined as:

- **ALL** Any signal label, the system will accept any incoming signal labels without creating a PLM-P condition. Incoming idle (unequipped) signal labels will continue to produce UNEQ-P condition type. If the facility is terminated, the facility transmits the Non-Specific Equipped (0x01) code.

Provisioning and terminating states of OCn and its STS1, STSnC embedded facilities

Figure 239. shows the effect of provisioning STS3c on the STS1s that lie in the same time slot and the effect of provisioning of STS1 on the STS3c that lie in the same time slot. When an OC-3/12/OC48/OC192 is provisioned, then both the STS1s and the STSNc that can reside in it have their DSBLD state cleared. However once a STS1 is provisioned in the time slot 1 say, then the STS3c that occupies the time slots 1, 2, and 3 enters into DSBLD state indicating that the STS3c cannot be provisioned in the same time slot. Similarly if a STS3c gets provisioned first, then all the STS1s belonging to the time slot enters DSBLD state. Similar relationship exists between STS192C, STS48c, STS12c, STS3c and STS1s within OC-12, OC48, OC192 facilities.

The secondary states such as those relating to Loopback and Test Access are not shown in Figure 239.. Only the basic provisioning and connection states for the facilities are shown.

The relationships between facility provisioning states for SONET path entities (STS1, STSnC provisioned inside a GBE VCG port) behave as illustrated in Figure 240..

Note: VCG supports STS1 only in this release

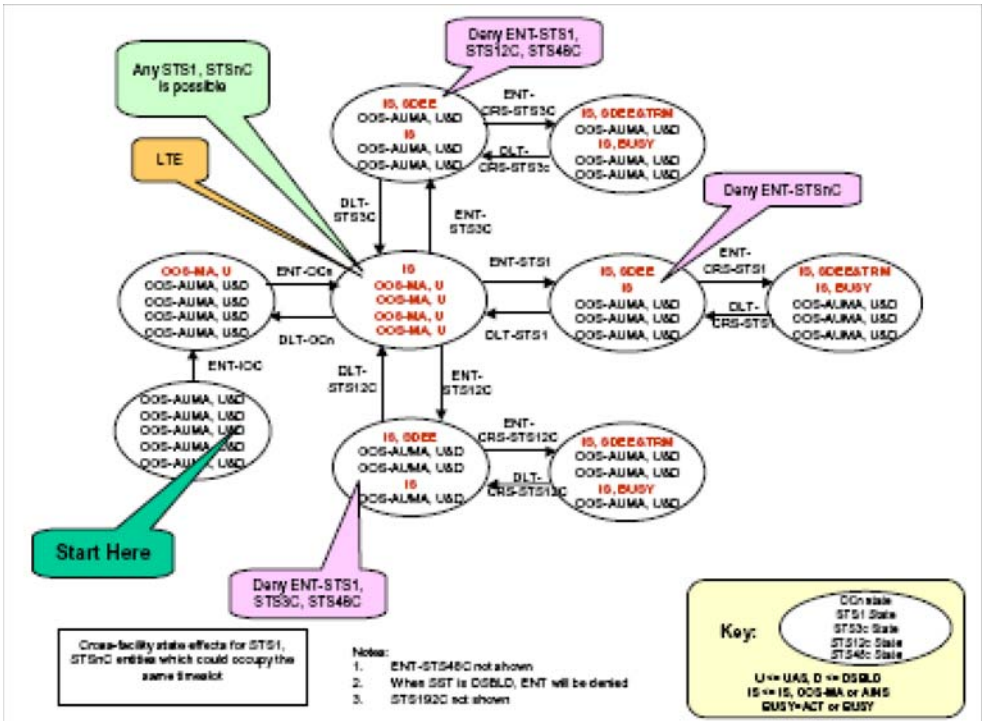


Figure 239. Provisioning and terminating states of OCn and its STS1, STSnC embedded facilities

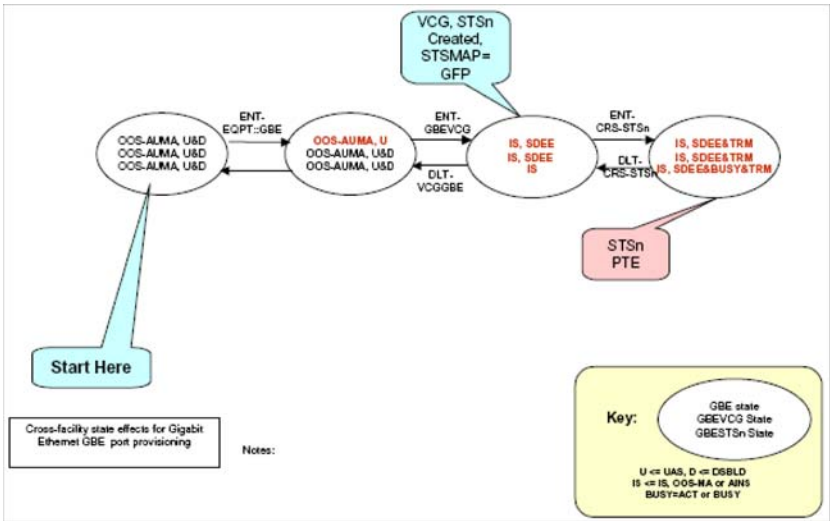


Figure 240. Provisioning and terminating states of STS1, STSnC inside a GBE port VCG

Detailed State Management

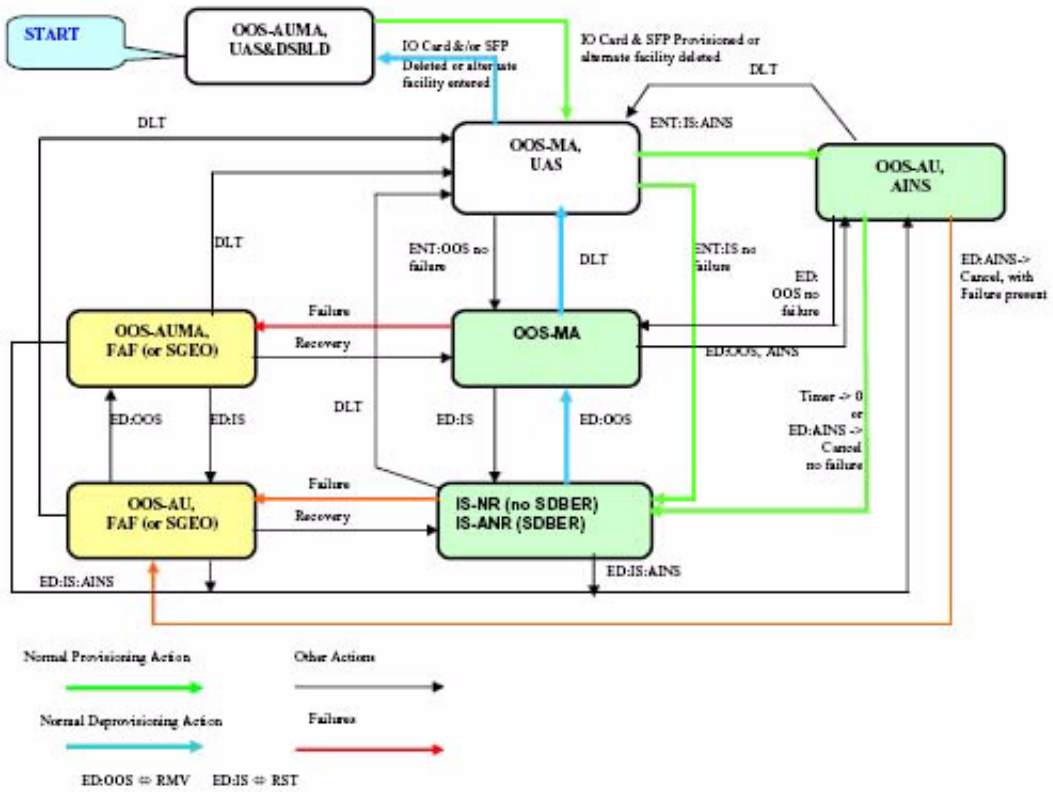
- All primary service state changes to any provisioned facility is reported via REPT^DBCHG. The DBCHG report issued on PST change also includes the current value of the SST.
- All path facilities is in the OOS-AUMA, UAS&DSBLD state when the supporting entity is not yet provisioned.
- When a facility is not yet provisioned but the supporting entity is provisioned, then that facility is in OOS-MA, UAS state.
- When a supporting entity has the MAN condition set, indicating it is OOS-MA, the supported facility enters a state depending on its present state as follows:
  - IS to OOS-AU, SGEO
  - OOS-AU, FAF to OOS-AU, FAF&SGEO
  - OOS-MA to OOS-AUMA, SGEO
  - OOS-AUMA, FAF to OOS-AUMA, FAF&SGEO
- On an incoming signal failure a SST of FAF is set on the facility unless it is already in AINS secondary state, in which case FAF is not be set.
- On a signal failure of a supporting entity (FAF is set) , the facility enters a state depending on its present state as follows:
  - IS to OOS-AU, SGEO
  - OOS-AU, FAF to OOS-AU, SGEO
  - OOS-MA to OOS-AUMA, SGEO
  - OOS-AUMA, FAF to OOS-AUMA, SGEO
- On an incoming signal failure, in the absence of SGEO, the facility enters a state depending on its present state as follows:
  - IS to OOS-AU, FAF
  - OOS-MA to OOS-AUMA, FAF
- When SGEO or FAF SSTs or the MAN condition is set on a facility, SGEO is set on all of it's supported facilities.
- On an incoming signal degradation, an OC-n or STSnC facility enters a state depending on its present state as follows:
  - IS-NR to IS-ANR

- Conditions causing an in-service abnormal facility on an OCn includes defects declared on Signal Degrade Bit Error Rates (SDBER)
- For entities under path protection, conditions causing an in-service abnormal facility on STS1/STS3C/ STS12C/STS48C includes defects declared on
  - Signal Degrade Bit Error Rates (SDBER)
- Conditions causing an out of service facility on an OCn (n = 3, 12, 48, 192) includes defects declared on:
  - Loss of Signal (LOS)
  - Loss of Frame (LOF)
  - Alarm Indication Signal (AIS-L)
  - Excessive BER (EBER)
- Conditions causing an out of service facility on GBE includes defects declared on
  - Gigabit Ethernet Loss of Signal (LOS)
  - Gigabit Ethernet Loss of Link (LOL)
- Conditions causing an out of service facility on STSn (n = 1, 3c, 12c, 48c, 192c) includes defects declared on
  - Loss of Pointer (LOP-P)
  - Alarm Indication Signal Path (AIS-P)
  - STS path Idle (UNEQ-P)
- When an incoming signal failure clears, if SST of FAF is set, it is cleared.
- When an incoming signal failure clears, the facility enters a state depending on its present state as follows:
  - OOS-AU, FAF to IS
  - OOS-AU, SGEO&FAF to OOS-AU, SGEO
  - OOS-AUMA,FAF to OOS-MA
  - OOS-AUMA, SGEO&FAF to OOS-AUMA, SGEO
- When a facility is logically removed, it enters a state depending on its present state as follows:
  - IS to OOS-MA
  - OOS-AU to OOS-AUMA
- A facility in the OOS-AU, AINS state, it goes into the OOS-AUMA state when AINS is deactivated and the facility is placed in the OOS state.
- A facility in the OOS-AU, AINS state, it goes into the OOS-AU, FAF state if AINS is deactivated while a failure still exists on the facility
- While a facility is in OOS-MA or OOS-AUMA state, the NE monitors the facility for failures, continues to collect PM if enabled to do so, however, it doesn't send any autonomous message regarding the failure setting or clearing and the Threshold Cross Alerts.
- If the associated supporting facility has a failure (i.e. goes into OOS-AU state), the FAF if set on the supported facility is cleared and SGEO is set.
- If the associated supporting facility has an outage due to it being logically removed (i.e. goes into OOS-MA state), then the FAF on the supported facility, is cleared and SGEO is set.
- While a facility is in OOS-MA or OOS-AUMA state, any failure/abnormal condition present on the facility is retrievable.
- When a facility is logically restored, it enters a primary state depending on its present state as follows:
  - OOS-MA to IS
  - OOS-AUMA to OOS-AU
- When an outage (i.e. OOS-AU) on the facility clears, the embedded entity has its SGEO cleared, if set. If the embedded entity has a facility failure, then a FAF is set on the embedded facility.
- When a facility is logically restored and there is no failure on this facility (OOS-MA => IS), then SGEO on the embedded facilities is cleared. If the embedded entity has a facility failure, then a FAF is set on the embedded facility.

- When a facility transitions from OOS-AUMA to OOS-AU or OOS-MA, then SGEO remains set and FAF is not be set
- A facility carries a SDEE secondary state, when an embedded facility (within the parent facility) is provisioned.
- When the last embedded facility is de-provisioned, then the SDEE secondary state carried by the facility is cleared.
- ACT, BUSY and TRM secondary states are set and cleared according to the rules provided in the CONN RRS.
- LPBK secondary states is set and cleared according to the rules provided in the LPBK RRS.
- Facilities doesn't allow to be deleted while the entity is under loopback operation.
- A facility under loopback operation doesn't allow to be provisionable in-service (IS or OOS-AU) state.
- The PMI SST state is set and cleared according to rules provided in the PM RRS.
- The ROLL SST state is set and cleared according to rules provided in the ROLL RRS.
- Facilities doesn't allow to be deleted while the entity is under a bridge and roll operation.
- The TS SST state is set and cleared according to rules provided in the TACC RRS.
- Facilities doesn't allow to be deleted while the entity is under test access operation.
- Secondary states associated with FFP protection (i.e., PSI, WRK, STBYS, STBYH) is set and cleared according to the rules provided in the FPS RRS.
- When an entity is deleted, all associated condition types are cleared, and performance monitoring functionality disabled (if PM is supported on the entity).
- When an entity is successfully entered, the following actions take place:
  - the system's default provisioning parameter default values are automatically provisioned for the specified entity (if the provisioning parameter is not specified in the ENT command).
  - alarm attributes are set to the factory defaults.
  - all PM data collection registers for the entity are automatically reset to zero.
  - if PM is supported on the entity, PM mode are set to the default values (refer to the PM RRS). PM threshold level is set to the default values (refer to PM RRS).

OCn Facilities

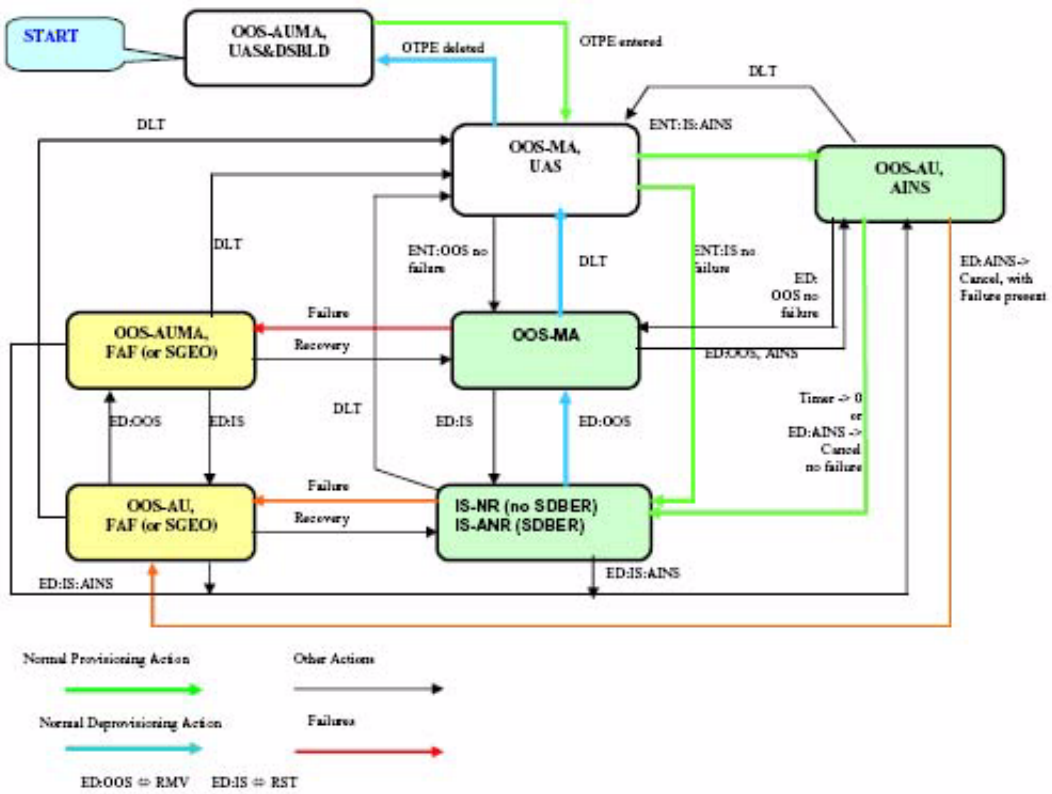
The facility state transition of OC-n is defined in Figure 241..



Other Secondary States

1) SDEE is set when supported facilities are created.
2) SGEO is set when the supporting IOC is OOS for any reason; SGEO clears FAF while set
3) TRM is set if a supported facility is connected
4) LPBK is set if a loopback is present on this facility
5) PMI is set if performance monitoring is inhibited on this facility
6) PSI is set if protection switching is locked out
7) STBYH is set if this is the alternate facility in a Linear FFP and not currently active
8) STBYS is set if this is standby preferred facility in a linear FFP and not currently active
9) WRK is set if this facility is a member of a UPSR FFP or if it is the working side of a Linear FFP
10) When a port that can be provisioned for more than one OC rate is provisioned for one rate, the facilities for the other rates return to DSBLD state.
11) A facility that is entered with failure will first pass to OOS-MA or IS, then to OOSAU, FAF after the failure integration period, normally 2.5 seconds

Figure 241. State Transition of OC-n



Other Secondary States

1) SDEE is set when supported facilities are created.
2) SGEO is set when the supporting IOC is OOS for any reason; SGEO clears FAF while set
3) TRM is set if a supported facility is connected
4) LPBK is set if a loopback is present on this facility
5) PMI is set if performance monitoring is inhibited on this facility
6) When a port that can be provisioned for more than one OC rate is provisioned for one rate, the facilities for the other rates return to DSBLD state.
7) A facility that is entered with failure first passes to OOS-MA or IS, then to OOSAU, FAF after the failure integration period, normally 2.5 seconds

Figure 242. Special Case: State Transition of OC192 on an OTU2 module

Follows the definition for the OOS state relationship between a supporting equipment (IOC or PIM or SFP/XFP) and the supported OCn

1) OOS-AU, SGEO is set on the OCn/GBE if the underlying equipment is OOS for any reason, except AINS
2) OCn/GBE alarms are not cleared or supressed. The alarm hierarchy does not cross the facility-equipment boundary

In the event of 2), facilities supported by the OCn/GBE with SGEO, will have alarms supressed or cleared and state set to OOS-AU, SGEO as if the supported OCn was OOS-AU

Follows the definition for the OOS state relationship between a supporting OTPE and the supported OC-192

1) OOS-AU, SGEO is set on the OC192 if the underlying OTPE is OOS for any reason, except AINS
2) OC192 alarms are supressed when OTPE is OOS for any reason.
3) Facilities supported by an OC-192 with SGEO will have alarms supressed or cleared and state set to OOS-AU, SGEO.

The valid PST, SST combinations and applicable state values for OC-n are shown in Table 33..

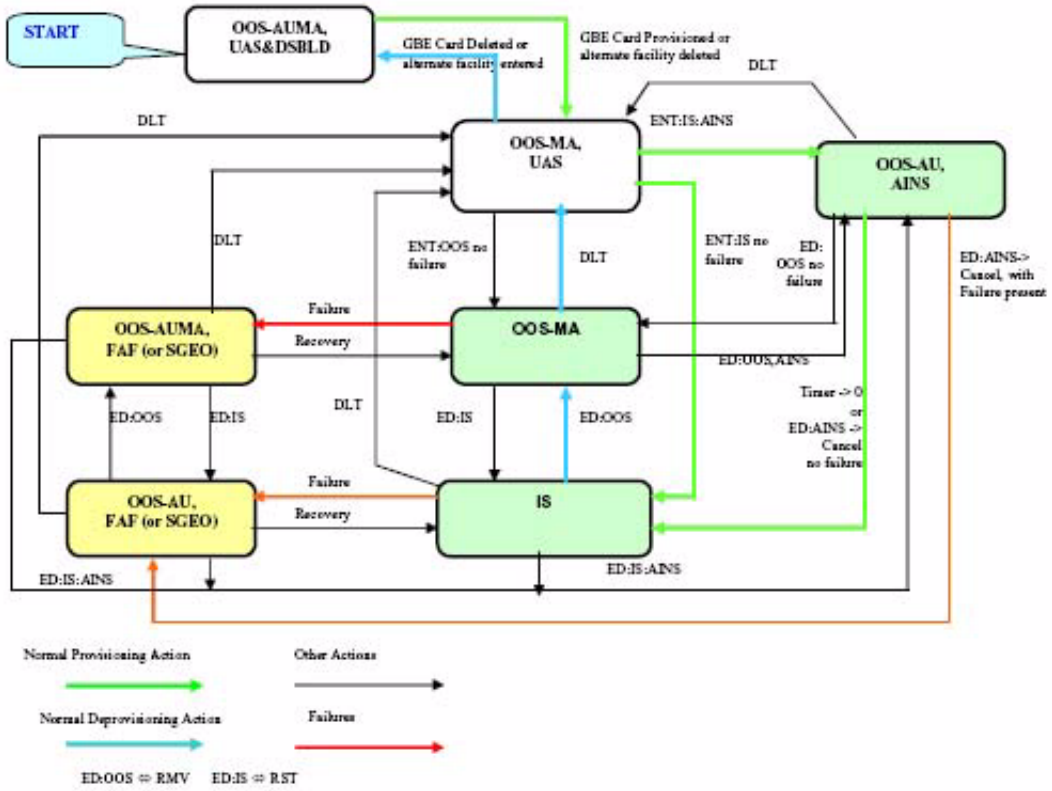
Table 33. OCn PST/SST

PST Value	Possible Cause of PST Change	Possible Additional SST Information
IS-NR | IS-ANR		[{STBYH|WRK}, PMI, PSI, SDEE, TRM]
OOS-AU	FAF | SGEO	[{|WRK|STBYS},PMI,PSI,SDEE, TRM]
OOS-AUMA	[UAS] | [UAS&DSBLD] | [FAF]	[{WRK|STBYS}, LPBK, PMI, PSI, SDEE, SGEO TRM]
OOS-MA	[UAS]	[{WRK|STBYS},LPBK, PMI, PSI, SDEE, TRM]

A DSBLD SST is added to an OC-n facility (n =3,12,48) when that port has been assigned to be an OC-m facility (n <>m). This applies to ports on the 8PSO and 10xANY modules

GBE Facilities

The state transition of GBE is defined in Figure 243.



Other Secondary States

1) SDEE is set when supported facilities are created.
2) SGEO is set when the supporting GBE card\ is OOS for any reason; SGEO clears FAF while set
3) TRM is set if a supported facility is cross connected
4) PMI is set if performance monitoring is inhibited on this facility
5) A facility that is entered with failure first passes to OOS-MA or IS, then to OOSAU, FAF after the failure integration period, normally 2.5 seconds

Figure 243. State Transition of GBE (GIGE)

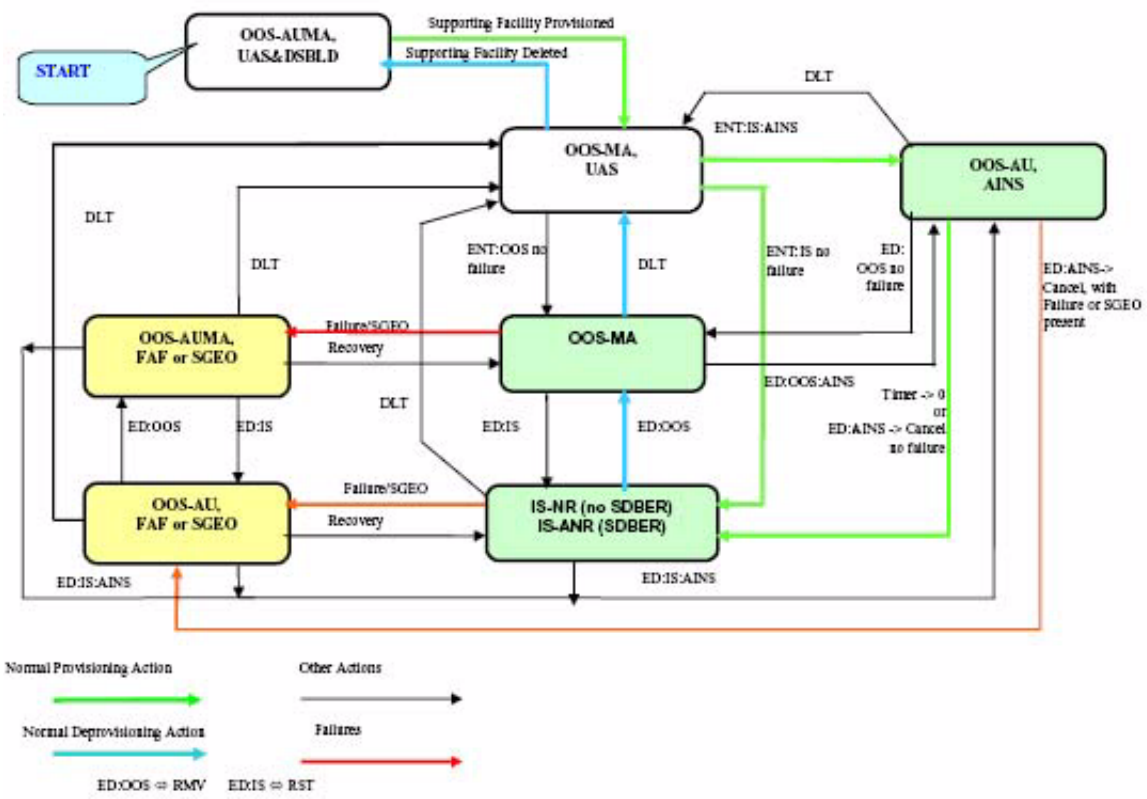
The valid PST, SST combinations and applicable state values for GBE is shown in Table 34..

Table 34. GBE PST/SST

PST Value	Possible Cause of PST Change	Possible Additional SST Information
IS-NR		[TRM, PMI, SDEE, SGEO]
OOS-AU	[AINS, SGEO] | [FAF | SGEO]	[TRM, PMI,SDEE, SGEO]
OOS-AUMA	[UAS&DSBLD] | [FAF|SGEO]	[TRM, PMI,SDEE, SGEO]
OOS-MA	[UAS]	[TRM, PMI,SDEE, SGEO]

STS Facilities

The facility state transition of STS1 and STSnC is defined in Figure 244..



Other Secondary States

1) SDEE is set when supported facilities are created.
2) SGEO is set when the supporting IOC is OOS for any reason; SGEO clears FAF while set
3) ACT or BUSY is set when this facility is cross connected
4) TRM is set if a supported facility is cross connected
5) LPBK is set if a loopback is present on this facility
6) PMI is set if performance monitoring is inhibited on this facility
7) PSI is set if protection switching is locked out
8) ROLL is set when a facility is engaged in a bridge and roll operation
9) WRK is set if this is the working facility of a UPSR pair
10) STBYH or STBYS is set if this is the standby facility in a UPSR or BLSR pair
11) Once a time slot (STS1) is provisioned) for STS1 or STSnC, all other potential possible facilities (which are now non provisionable) are marked UAS&DSBLD.
12) A facility that is entered with failure first passes to OOS-MA or IS, then to OOS-AU, FAF after the failure integration period, normally 2.5 seconds

Figure 244. State Transition of STS1, STSnC

The valid PST, SST combinations and applicable state values for STS1, and STSnC is shown in Table 35..

Table 35. STS1, STSnC State Values

PST Value	Possible Cause of PST Change	Possible Additional SST Information
IS		[{STBYH|WRK},{ACT |BUSY}, PMI, ROLL, SDEE, TRM, TS]
OOS-AU	[AINS, SGEO] | [FAF | SGEO]	[{WRK|STBYS},{ACT |BUSY}, PMI, ROLL, SDEE, SGEO, TRM, TS]
OOS-AUMA	[UAS&DSBLD] | [FAF|SGEO]	[{WRK|STBYS},{ACT |BUSY}, LPBK, TS, PMI, ROLL, SDEE, SGEO, TRM]
OOS-MA	[UAS]	[{WRK|STBYS}, LPBK, TS, PMI, ROLL, SDEE, TRM, {ACT | BUSY}]
Note: TRM applies to STS1 facilities only.		

VCG Facilities

The state transition of VCG is defined in Figure 245..

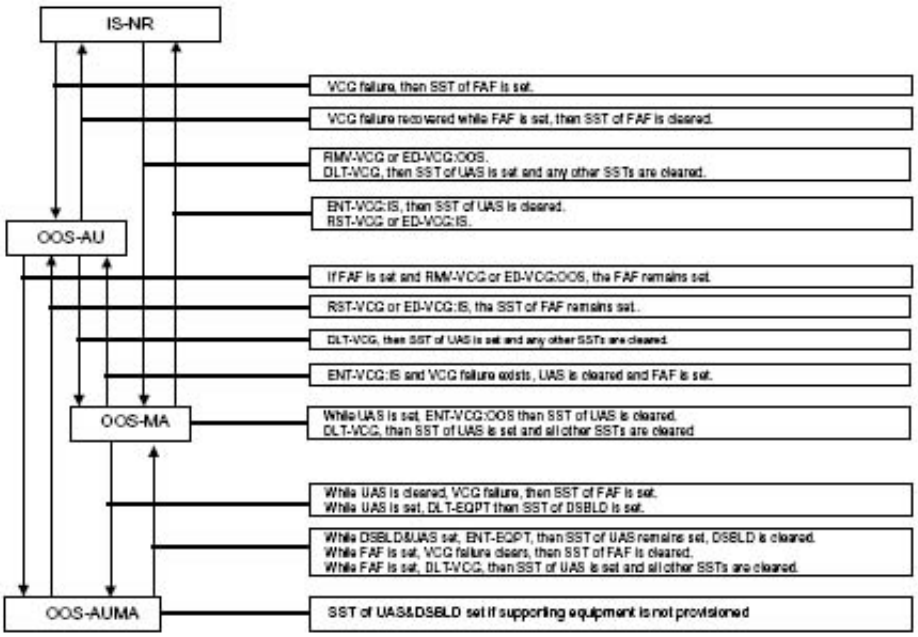


Figure 245. State Transition of a VCG

The valid PST, SST combinations and applicable state values for VCG are shown in Table 36..

Table 36. VCG state values

PST Value	Possible Cause of PST Change	Possible Additional SST Information
IS-NR		SDEE, TRM
OOS-AU	FAF, SGEO without MAN	SDEE, TRM
OOS-AUMA	UAS	
OOS-MA	[UAS&DSBLD] | FAF, SGEO with MAN	SDEE, TRM

- The VCG object entities are in the OOS-AUMA,UAS&DSBLD state when the supporting entity (PIMMS module) is not yet provisioned.
- When a VCG is not yet provisioned, however the supporting module is provisioned, then all VCG supported by the module is in OOS-MA, UAS state.
- On a failure on the VCG, the VCG enters a state depending on its present state as follows:
  - IS-NR to OOS-AU, FAF
  - OOS-AU, SGEO to OOS-AU, SGEO&FAF
  - OOS-MA to OOS-AUMA, FAF
  - OOS-AUMA, SGEO to OOS-AUMA, SGEO&FAF
- Conditions causing an out of service on VCG includes defects declared on:
  - **VCGLOA** Loss Of Alignment. Raised when the differential delay cannot be compensated and the LCAS is disabled.
  - **VCGSSF** Server Signal Failure. Raised when at least one member of the VCG is failed or has UNEQ-P (for STS-1), TIM-P, VCLOM, VCSQM, LOP-P, AIS raised on it, or SST is equal to SGEO (if there is a failure on its superior object, for example LOS on the OC-48 in which STS-1 is embedded) and LCAS is disabled. When LCAS is enabled, all members of the VCG have to fail or have UNEQ-P (for STS-1), TIM-P, VCLOM, VCSQM, LOP-P, AIS raised on them. The individual members of the VCG is considered failed; if their SST is equal to SGEO (there is a failure on its superior object, for example LOS on the OC-48 in which STS-1 is embedded).
  - **VCGPLM** Payload Mismatch. Raised when a the received payload type indication does not match the expected (GFP mapping)
  - **VCGLOF** Loss of Frame. Raised when the GFP frame cannot be recoverd
  - **VCGCSF** Client Signal Failure. Raised when the GFP indicates a severe problem (e.g. LOS) at the remote side of the network
  - **VCGUPM** User Payload Mismatch. Raised when the received GFP user payload type does not match the expected.
  - **VCGEXM** Extension Header Mismatch. Raised when the received GFP extension header type does not match the expected.

  VCGPLM, VCGLOF, VCGCSF, VCGUPM, VCGEXM alarms can be raised by 10xANY board and not by PIMMS
- Conditions causing an out of service facility on STS-1that are defined as a member of a VCG includes defects declared on:
  - **VCLOM** Loss Of Multiframe: raised when it is not possible to align with the multiframed structure of the byte H4 for STS-1.
  - **VCMND** Member Not Deskewable: The differential delay on the member cannot be compensated.
  - **VCSQM** Sequence Number Mismatch: raised when the received sequence Number is different from the expected one.

  Note: These conditions are in addition to those that are specific to STS-1 as defined in the FM RRS.
- The retrieve of the members in a VCG returns the received sequence number in the output response if the facility is in VCGSQM alarm condition.
- When the failure clears, if SST of FAF is set, it is cleared.
- When the failure clears, the VCG entity enters a state depending on its present state as follows:
  - OOS-AU, FAF to IS-NR
  - OOS-AU, SGEO&FAF to OOS-AU, SGEO
  - OOS-AUMA, FAF to OOS-MA
  - OOS-AUMA, SGEO&FAF to OOS-AUMA, SGEO
- When a VCG is logically removed, it enters a state depending on its present state as follows:
  - IS-NR to OOS-MA
  - OOS-AU to OOS-AUMA

- When a VCG enters an OOS-MA or OOS-AUMA state, the NE clears all the facility failure conditions on it and set a MAN condition on the VCG.
  If the VCG that entered an OOS-MA or OOS-AUMA state has subordinate VCs assigned, then any alarm existing on the subordinate VC object entity is cleared and any subsequent alarm on the subordinate VC object entity is inhibited.
- While a VCG is in OOS-MA or OOS-AUMA state, the NE monitors the VCG for failures, however, doesn't send any autonomous message regarding the failure setting or clearing.
- The VCG carries a secondary state of SGEO, if the PIMMS module that supports the VCG or the hosting PP20G module is either faulty or is taken out of service; i.e. the PIMMS module is in OOS-AU state or OOS-MA state.
- The VCG carries a secondary state of SGEO, if the 10XANY board that supports the VCG is either faulty or is taken out of service; i.e. the 10XANY module is in OOS-AU state or OOS-MA state.
- While a VCG is in OOS-MA or OOS-AUMA state, the present failure/abnormal condition on the VCG is retrievable.
- When a VCG is logically restored, it enters a state depending on its present state as follows:
  - OOS-MA to IS-NR
  - OOS-AUMA to OOS-AU
- When an outage (i.e. OOS-AU, OOS-MA) on the PIMMS or PP20G clears, all the VCG entities supported by it has their SGEO cleared, if set.
- When an outage (i.e. OOS-AU, OOS-MA) on the 10XANY clears, all the VCG entities supported by it has their SGEO cleared, if set.
- When a VCG transits from OOS-AUMA to OOS-AU state , the NE clears the MAN condition on the VCG and raises any failure condition that was suppressed due to the MAN condition.
  If the VCG that has been logically restored has VC members assigned, then any VC alarm existing on the member object, that was suppressed while the VCG was in OOSMA state entity, is re-declared.
- If the VCG that entered an OOS-AU state has member objects assigned, then any alarm existing on the member object, that was suppressed while the VCG was in OOSAUMA state, it is re-declared.
- A VCG carries a TRM secondary state, when a member facility is cross connected.
- When the cross connect on the last member facility is disconnected, then the TRM secondary state carried by the VCG is cleared.
- When a PIMMS module is logically restored, then only the SGEO on the supported VCG is cleared and FAF on the embedded VCG if set, remains set.
- When a 10XANY module is logically restored, then only the SGEO on the supported VCG is cleared and FAF on the embedded VCG if set, remains set.
- When a failure on a VCG clears, and if the member facility has a facility failure, then a FAF is set on the embedded facility.

State transition of VCAT members

The state transition of VC is defined in Figure 246.

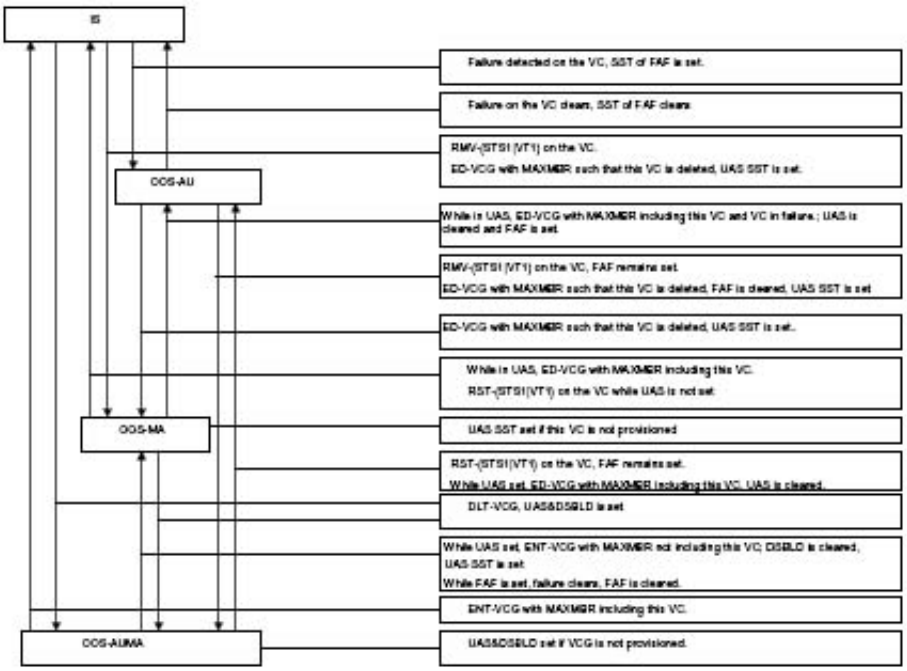


Figure 246. State transition of the VCG members

The STS-1 entities that are members of a VCG supports the following secondary states in addition to those previously defined:

- **VCACT** - Virtual Concatenation Path is Active. This means the entity is part of VCG and is allowed to carry traffic.
- **VCIDLE** - Virtual Concatenation Path is Idle. This means the entity is part of VCG and is not allowed to carry traffic.

3.3.11.4 Automatic In-service (AINS) Feature

Capability to enter and edit the OC3, OC12, OC48, OC192, STS1, STSnC, OTU2, ODU2, 10FC, 10GE facilities to 'AINS' secondary state is provided but it is not provided for GFP Ethernet payload facilities (VCGSTS1)

Upon successful placing of the line/path entity in AINS secondary state, the entity transits into a state depending on its present state, and the value of the AINS threshold as follows:

Current State	AINS Threshold = 0	AINS Threshold > 0
IS-NR or IS-ANR	IS-NR or IS-ANR	OOS-AU, AINS
OOS-AU	OOS-AU, AINS	OOS-AU, AINS
OOS-MA, w/o	UAS IS-NR or IS-ANR	OOS-AU, AINS
OOS-AUMA w/o UAS	OOS-AU, AINS	OOS-AU, AINS
OOS-MA, UAS w/o facility failure	IS-NR or IS-ANR	OOS-AU, AINS
OOS-MA, UAS with facility failure	OOS-AU, AINS	OOS-AU, AINS

Upon successful placing a line/path entity in AINS secondary state an autonomous message with Clear Condition is sent if a Standing Condition has been previously set.

While in the OOS-AU, AINS state a facility doesn't transit out of the OOS-AU, AINS state as long as a failure condition is present. Absence of a failure condition causes the AINS timer to start counting; the facility remains in AINS state until the timer reaches 0. Presence of any of these conditions causes the AINS timer to reset to AINSTH and hold until the failure clears. This behavior applies to all line and path facilities.
AINS timer state change occurs following the normal integration time of a defect or its absence.
A failure condition is defined as any condition that would normally result in OOS-AU, FAF on the facility.
Far-end failure conditions (e.g., RFI) and conditions causing in service anbnormal operation (e.g., SDBER) doesn't interrupt AINS timer count down or cause it to reset.
The timer doesn't start counting if SGEO is set on the facility. If the timer is already counting when SGEO is raised, the timer resets to threshold

While in the SST=AINS state:
– the current state of line/path is monitored and for each onset or clearing of the failure condition, no autonomous report is sent for the Near End and Far End conditions.
– when so provisioned, PM data is collected and is retrievable.
– reporting of TCAs is suppressed.
– the current Near End and Far End Standing failure condition is retrievable.

While in OOS-AU:
– AINS state and the facility is still failed, then all other functions perform in the same way as it would perform when the entity is in OOS-AU, FAF state.
– AINS state and the port is in count down state, then all other functions perform in the same way as it would perform when the entity is in IS-NR state.
– AINS state exists on a supporting equipment or facility, it doesn't of itself affect the behavior of any supported facility. No special states is set, no functions inhibited, no effects on failure or switching behavior of the supported facility result.

AINS Threshold

When maintenance technicians perform pre-service provisioning of terminating ports on Digital Cross Connect Systems (DCSs) or SONET Network Elements (NEs), Alarm, Performance Monitoring (PM) and Threshold Crossing Alert (TCA) messages are often turned OFF (inhibited) to prevent false messages from being sent to Operations Service (OS) centers and various OS monitoring systems. However, this action requires the technician to remember to turn-on the Alarm, PM and TCA before ending the session. This situation is particularly acute when user initiates the inhibit command from Network Monitoring and Administration (NMA) centers, given NMA's importance to monitoring and troubleshooting faults that occur in the network.

To solve the above problem, an AINS timer feature is used. Once a good customer signal is detected, the system starts a timer, which measures the duration of the presence of the customer signal. This is referred to as ' Start-up State'. In the start-up state, the customer begins to send a signal, but may still be conducting various start-up activities. During this start-up interval, the system monitors the input signal for an uninterrupted or continuous customer signal with the autonomous reporting of Alarms and TCAs still turned OFF. If the customer signal is interrupted or lost (i.e., LOS, LOF or AIS-L etc. occurs) before reaching the provisioned or default start-up interval, the timer is automatically reset to its initial value and the process starts over again.

Capability to set the AINSTH Threshold value for each facility is provided. The range of the AINSTH is 0 minute to 48 hours in 1 minute increments.

The factory default value for AINSTH is 8 hours.

While the AINS timer is active, if the AINSTH value is modified, the AINS timer is restarted.

If the AINSTH value is explicitly specified as 0 while the AINS timer is held reset, then the entity transits from OOS-AU, AINS to IS-NR or IS-ANR state as soon as all the failures on the facility have cleared.

If the AINSTH value is explicitly specified as 0 while the AINS timer is active, then the AINS timer is immediately terminated and the entity transits out of the AINS secondary state.

AINS Timer (AINSTIMER):

- it is assigned to each entity that is in SST=AINS state.
- it is set equal to the AINSTH time.
- It is reset and held reset while the entity is in the SST=AINS state and a failure (not defect) is present on the facility.
- it is released and decremented while the entity is in the SST=AINS state and a failure (not defect) is not present on the facility.
- It is set/reset to a value equal to the AINSTH whenever the timer is initialized.

The NE allows the operator to retrieve the currently remaining time until expiration of the AINSTIMER via a command.

Exiting AINS State

When the AINSTIMER is equal to zero, the SST=AINS is exited automatically.
Capability to manually exit the 'AINS' secondary state is provided.
Capability to retrieve the AINSTH value is provided.
Once the failure on the facility clears and the facility enters the AINSTIMER mode (i.e. when AINSTIMER is decrementing), the facility remains in OOS-AU, AINS state.
While the line entity is in AINSTIMER mode, if the failure appears, then the entity remains in OOS-AU, AINS state. In such a case, the AINSTIMER is reset to the AINSTH and held reset till failure clears.

If an AINSTIMER is assigned to both the parent and the child entities, then the AINSTIMER on the parent entity counts to zero before an AINSTIMER on the child is released and decremented.

3.3.11.5 Failure Detection & Alarm Generation

Once a Facility entity is provisioned, the entity can be monitored for near-end and far-end failure conditions for OC-n, STS1, and STSnC facilities

When a line or path facility becomes out of service (OOS) for any reason, an SGEO SST is applied to all of its supported facilities.

When a line or path facility enters a failure condition, AIS is generated and transmitted on all supported facilites that are cross connected

When an equipment module supporting a provisioned line facility (IOC or SFP or XFP) becomes out of service (OOS) for any reason, an SGEO SST is applied to all of the supported line facilities.

OC-n failures:

For the OC-n, a **LOS** (Loss of Signal) defect is entered and exited as follows: LOS is detected by looking for an "all zeros pattern" on the incoming facility.
An "all zeros pattern" is considered if it lasts longer than 100 micro seconds. The LOS defect state occurs at the 100 micro second point.
Once the LOS defect state is entered, it doesn't exit until the incoming signal and no pulse-free intervals of length T occur during a time period equal to the greater of 125 microseconds, and 2.5*T, where 2.3<T'<100 microseconds.

Note: LOS is not detected or reported for an OC192 embedded in a colored Optical Transport (OTPE) facility

The OC-n performs the SONET framing algorithm as follows: Framing is based on the A1 and A2 overhead bytes in the SONET signal.
While in-frame, an SEF (Severely Errored Frame) condition on occurs when a minimum of 4 consecutive errored framing patterns have been received. The maximum SEF detection time is 625 micro seconds for a random signal. The framing algorithm used to check the alignment is such that 10E-3 BER (Poisson distribution of bit errors is assumed) does not cause an SEF more than once every 6 minutes.
When in an SEF condition, the NE assumes the frame has been recovered and declared an in-frame condition, on detecting 2 successive error-free framing patterns. Any implementation of the frame recovery circuitry that achieves realignment following a declared SEF within the 250 micro seconds interval implied by this definition is acceptable.

For OC-n a **LOF** (Loss of Frame) defect state is entered and exited as follows: When an SEF condition on the incoming signal persists for more than 3 msec, the LOF defect state is entered.
Once in the LOF state, the state is exited within 3 msec of a continuous in-frame signal condition, if the SEF is not redetected before the LOF defect is terminated.

For OC-n an **AIS-L** (Alarm Indication Signal-Line) defect state is entered or exited as follows: Line AIS on an incoming signal is detected by an LTE as all ones in bits 6, 7, and 8 of the K2 byte in five consecutive frames, at which point the LTE enters a Line AIS defect state.
The Line AIS defect state is exited when the LTE detects any pattern other than the code `111' in bits 6, 7, and 8 of the K2 byte in five consecutive frames.

For OC-n a **RDI-L** defect state is generated and cleared as follows: RDI-L on an incoming signal is detected by an LTE when a `110' pattern is observed in bits 6, 7, and 8 of the K2 byte in five consecutive frames, at which point the LTE enters a RDI-L defect state.
The RDI-L defect state is exited when the LTE detects any pattern other than the code `110' in bits 6, 7, and 8 of the K2 byte in five consecutive frames.

For the OC-n entity, the **EBER** (Excessive BER) Line defect state is activated when excessive Line BIP-8 (B2) BER > SFTH (Signal Fail Threshold) is detected. The BER of a line is derived from the sum of Line BIP-8 violation counts of the individual STS-1s in the OC-n.
The EBER condition is suppressed in the presence of LOS, LOF or AIS-L on the entity.

For the OC-n entity, the SDBER (Signal Degrade Bit Error ratio) defect state is activated when Line BIP-8 (B2) BER > SDTH (Signal Degrade threshold) is detected. SDBER defect state is cleared when the line BER The SDBER condition is suppressed in the presence of LOS, LOF, AIS-L, EBER on the entity.

STS Failures

For the failed STS input signal, a **LOP-P** (Loss of Pointer) defect state is entered and exited as follows: An STS facility enters the LOP-P state if a valid pointer is not found in N consecutive frames, or if N consecutive NDFs (New Data Flags) are detected (other than in a concatenation indicator), where 8 N 10 (N=8 Nominal). Incoming STS path AIS doesn't result in that STS entering the LOP-P state.
The STS exits the LOP-P state when a valid pointer with normal NDF, or a concatenation indicator, is detected in three consecutive frames.
The STS exits the LOP-P state when an all 1's pointer (AIS-P) is detected in three consecutive frames and should enter the STS path AIS state.

For the STS entity that is path terminated, the incoming C2 overhead bytes is compared with the STSMAP attribute of the STS. If the expected C2 value is not present as defined by the STSMAP attribute, a defect state can occur. An STS Payload Label Mismatch (**PLM-P**) defect state is entered and exited as follows: Incoming STS path AIS or LOP doesn't result in an STS entering the STS Payload Label Mismatch defect state.
Incoming C2 overhead bytes with a value of 01 hex (equipped-unspecified) doesn't result in an STS entering the STS Payload Label Mismatch defect state (i.e. a C2 value of 01 hex is considered to always be matched).
An STS detects Payload Label Mismatch defect within 250 msecs of the onset of at least 5 consecutive samples (which may or may not be consecutive frames) of mismatched STS Signal Labels (C2 bytes). Any received all zero signal label (i.e unequipped) doesn't cause Payload Label Mismatch state but is treated differently.
Having entered the STS Payload Label Mismatch defect state, an STS exist the STS Payload Label Mismatch defect state within 250 msecs of detecting the onset of at least 5 consecutive samples (which may or may not be consecutive frames) of matched STS Signal Labels.

Table 37. UNEQ-P and PLM-P Defect Conditions

Provisioned STS Payload Label (STSMAP)	Received STS Payload label (C2 byte in Hex format)	Defect Type
None (Not Provisioned - OOS-MA, UAS)	Any (00h C2 FFh)	None
{ALL}	Unequipped (C2=00h)	UNEQ-P
	All remaining values (01h v C2 v FFh)	None (Matched)

Provisioned STS Payload Label (STSMAP)	Received STS Payload label (C2 byte in Hex format)	Defect Type
GFP	Unequipped (C2=00h)	UNEQ-P
	Mapping for GFP (C2=1Bh)	None (Matched)
	All other Codes (except FFh)	PLM-P
	Reserved(C2=FFh)	No Change
Note: Detection of C2=FFh will not cause a new UNEQ-P, PLM-P defect to be detected, or cause an existing UNEQ-P or PLM-P defect to be terminated.		

STS PTE terminates a PLM-P defect upon detecting an UNEQ-P defect.

For the STS entity, an STS Path Idle (**UNEQ-P**) defect condition is activated and cleared. In this case, path idle is detected based on a value of C2=00.
An STS detects STS Idle defect, within 10 msecs of the onset of at least 5 consecutive samples (which may or may not be consecutive frames) of zero in STS Signal Labels (C2 bytes), with valid pointer.
Having entered the STS idle defect state, an STS exits the STS Idle defect state within 10 msecs of detecting the onset of at least 5 consecutive samples (which may or may not be consecutive frames) of non-zero STS Signal Labels.

For the STS entity, an STS **AIS-P** (Path Alarm Indication Signal) defect state is entered and exited as follows: Any provisioned STS detects an STS Path AIS on an incoming signal by observing an all-ones pattern in bytes H1 and H2 in three consecutive frames, at which point the STS shall enter an STS Path AIS defect state.
Removal of STS Path AIS isdetected on an incoming signal by an STS when a valid STS Pointer is observed with the New Data Flag (NDF) set to `1001,' or when a valid STS Pointer with normal NDF is observed in three consecutive frames. The detection of the removal of STS Path AIS causes the STS to exit the STS Path AIS defect state.

For the STS entity, an STS **RDI-P** (Path Remote Defect Indication) state is entered and exited as follows: The precise G1 bit configuration for entering and exiting RDI-P depends on the RDITYPE of the facility according to the table below.

Table 38. Table FM-10: RDI-P Definitions

G1 Bits 5,6,7	Priority of ERDI-P Codes	Trigger	Interpretation
0xx	NA	No Defects	No RDI-P defect
1xx	NA	AIS-P, LOP-P	One-bit RDI-P

Any provisioned STS isdetect RDI-P on an incoming signal by observing one of the defined conditions in bits 5-7 of the G1 byte for ten consecutive frames, at which point the STS enters a RDI-P defect state.
Removal of RDI-P is detected on an incoming signal by an STS when bits 5-7 of the G1 byte indicate a "no-defects" configuration for ten consecutive frames. The detection of the removal of RDI-P causes the STS to exit the STS RDI-P defect state.
While in the RDI-P state, an RFI (Remote Failure Indication) condition is raised on the facility, subject to the standard alarm integration time of 2.5 seconds on raise and 10 seconds on clear .

For an STS entity in a path protection group, the **EBER** (Excessive BER) Line defect state is activated when Path BIP-8 (B3) BER > SFTH (Signal Fail Threshold) is detected.

For an STS entity in a path protection group, the **SDBER** (Signal Degrade BER) Line defect state is activated when Path BIP-8 (B3) BER > SDTH (Signal Degrade Threshold) is detected.

For an STS entity that is part of a Virtual Concatenation Group, the **VCLOM** (Virtual Concatenation - Loss of Multiframe) defect state is activated when it is not possible to align with the multi-framed structure of the byte H4 of STS-1 (see DATA RRS for additional details)

For an STS entity that is part of a Virtual Concatenation Group, the **VCSQM** (Virtual Concatenation -Sequence Number Mismatch) defect state is activated when the received sequence Number is different from the expected one.

For an STS entity that is part of a Virtual Concatenation Group, the **VCMND** (Virtual Concatenation - Member not deskewable) defect state is activated when the differential delay on the member cannot be compensated. This condition only applies to STS1s in an LCAS controlled VCG.

3.3.11.6 Alarm Hierarchy

The alarm hierarchy affects the issuance of alarm reports and alarm clear reports in the following manner:
– When a condition is raised that is higher than any existing condition, an alarm report is issued for the new condition and alarm clear reports for any previously reported lower level alarms.
– While the higher level alarm condition is present, lower level alarm reports is suppressed. When the highest level condition is cleared, an alarm report is issued for the next highest level condition, if any.
– When an entity is placed OOS-MA and the MAN condition is raised the highest level condition then present on the entity, if any, is cleared.
– When an entity is restored from OOS-MA to IS or OOS-AU and the MAN condition is cleared, the alarm hierarchy is reevaluated and the appropriate highest level alarm is raised.

The alarm hierarchy is reevaluated whenever one of the following events occur:
– A standing condition is declared
– A standing condition is cleared
– A protection switching event occurs
– Protection becomes available or unavailable for any reason
– A PST or other traffic affecting state change occurs

The TL1 command RTRV-ALM retrieves all standing non-suppressed conditions with severity of CR, MJ, MN, including the MAN condition

The TL1 command RTRV-COND retrieves all standing conditions with severity of CR, MJ, MN, NA, and NR including the MAN condition and any alarm that would otherwise be reported if MAN were not present.

To prevent false alarm transitions due to transients, the integration period of the new alarm condition is performed as specified in the chapter 3.3.6 on page 317 before clearing any existing alarm and activating the new alarm condition when transitions from a lower level alarm to a higher level occur. Transitions to lower level alarms requires the high level alarm integration time to expire before it is cleared and any low level alarm is activated. The alarm delays are always measured from the entering and exiting of their related failure states.

The near-end and far-end alarms are independent of each other in the sense that both near-end and far-end alarms on a line port could exist at the same time with both near-end and far-end alarm being reported.

MAN condition

The MAN condition, which results when a facility is placed OOS-MA:

– is not suppressed by higher level conditions.
– supresses all lower level alarms.

3.3.12 Supervision

The elementary building blocks of any telecommunication network are the Network Elements (NEs).

Operating with the Craft Terminal the NE can present different management states according to the condition of the connection (supervision, local access, connection state, etc).
All the information referred to the management states are inserted in the Operator's document Common.

Any disruption in the communication link between the CT and the NE results in an update of the management states when the CT has detected the communication failure.

3.4 Maintenance

Maintenance consists of a set of operations which maintain or bring back the assembly to optimum operating conditions in a very short time, with the aim of obtaining maximum operational availability.

The maintenance activities have been subdivided in the following topics:

- **routine maintenance**:
- **corrective maintenance** (**troubleshooting**):

Routine maintenance

Routine maintenance is a periodic set of measurements and checks.

This maintenance discovers those devices whose function has deteriorated with time and therefore need adjustment or replacement.

Typically, digital equipment requires no routine maintenance.

The equipment allows to assess the quality of the connection links for SECTION and PATH o counting the errored events and obtaining performance data.

The Performance Monitoring application, described in the relevant **Operator's document**, allows this function.

Corrective maintenance (troubleshooting)

Corrective Maintenance (or **Troubleshooting**) involves the detection, location and correction of failures in the equipment and the replacement of the defective parts.

The troubleshooting procedure is carried out with the help of some flow-charts and tables, reported hereinafter. Anyway this method does not deal with the following aspects (which are to be deduced in other ways):

– faulty electronic alarm indication, processing and detection circuits
– faulty wiring (back-panel, connectors, etc.)

The following **interfaces** are present to troubleshoot the equipment:

– **M** interface for NE (Network Element) management.

– **F** interface for Craft Terminal (Local or Remote);

– Remote Alarm for Supervisory Center;

– LEDs on the units of the NE:
  Each unit and PIMs equipped in the 1850TSS-320 are provided with a bicolor LED (green/red) and/or a multi color LED (green/red/orange) indicating the **status** of the unit.
  Bicolor LED generally indicates:
  - when **red**, internal failure (indicates that the unit concerned must be replaced)
  - when **green**, in service unit

  Multi color LED generally indicates:
  - when **red**, indicates a critical failure, error, or danger; it means an “internal failure” (indicates that the unit concerned must be replaced)
  - when **green**, indicates satisfactory operation, active condition, or completion of a processor procedure; it means “in-service” unit

- when **orange** or **amber**, indicates a minor failure, caution, warning, or temporary malfunction, or state for which the operator should use caution; it also means that the unit is part of an EPS schema and its status is “stand-by"

Usually maintenance is firstly done via software (TMN or Remote Craft Terminal) to locate the faulty equipment and the faulty unit or the faulty path and then on site to physically solve the trouble.

The Maintenance can be done:

– from a **TMN network management center**;
By means of the TMN the maintenance technician can see the alarms sent by each equipment of the managed network

– from a **Remote Craft Terminal (RCT) management center**;
The operator, connected to a local NE, can remotely manage and troubleshooting a network composed of max. 32 NEs including itself.

– from a **Station Supervisory center**;
The maintenance technician refers to the **Remote Alarms** received from the equipment in a centralized office of the station i.e.:
  - T URGENT (MAJOR and CRITICAL), T NOT URGENT (MINOR): remote alarms pertaining to the urgent, not urgent alarm type;
  - TOR, TAND: remote alarms respectively due to the decrease or loss of one or both station power supply DC voltages;
  - INT: Remote alarm pertaining to the local (internal) alarm type

  When a second PSF320 unit is used the following remote alarms are added:
  - TORC, TANC: remote alarms respectively due to the loss of +3,3V generated by the on board converter in of one or both the PSF320 units;
  - IND: indeterminate alarm synthesis; indicates synthesis of alarms not associated to others severities;
  - TUP: remote alarm due to microprocessor fault in the EC320 unit.

  Depending on the supervisory center organization, it is possible to locate the equipment in troubles and to detect the failure type and source.

– **on site**.
The operator is on site in case:
  1) the equipment is not managed by a TMN or by a Remote Craft terminal (RCT);
  2) the equipment is not reachable by the remote manager (TMN or RCT) and is therefore isolated;
  3) link problems are present;
  4) the trouble has been located and a substitution is necessary.

  In case 1), 2), and 3) the alarmed equipment is checked by means of the local CT and of TSS-320 Rack LED indications and station buzzers.

Alarm Reporting

After an autonomously reported standing condition has been cleared, an automatic output message shall be generated by an NE indicating that the alarmed condition has been cleared.

The automatic output message has the same priority as that reported in the original alarm.

This indicates that the clear indication isn’t be dropped from an NE buffer in favor of lower priority alarms.

The colors red, yellow or amber, and green indicating the severity of the trouble, are used on an NE's physical control/status display panel to visually represent various alarm levels and status conditions at the NE's equipment location.

Color assignments for physical control/status display panels are the following:
– Red indicates a critical failure, error, or danger.
– Red indicates a major failure, error, or danger.
– Yellow or amber indicates a minor failure, caution, warning, or temporary malfunction, or state for which the operator should use caution.
– Green indicates satisfactory operation, active condition, or completion of a processor procedure.

The alarm LEDs either on the PDU or on the NE are lit according to the alarm level(s) being asserted by the NE where the following levels are supported:
– Critical alarm
  A critical alarm is used to indicate that a severe, service-affecting condition has occurred and that immediate corrective action is imperative, regardless of the time of day or day of the week. Notification code for this alarmed condition is CR.
– Major alarm
  A major alarm is used to indicate a serious disruption of service or the malfunctioning or failure of an important NE entity. This alarm requires the immediate attention and response of a operator to restore or maintain system capability. The urgency is less than in critical situations because of a lesser immediate or impending effect on service or system performance. Notification code for this alarmed condition is MJ.
– Minor alarm
  A minor alarm is used to indicate a condition that does not have a serious effect on service or for a condition that is not essential to NE operation. Notification code for this alarmed condition is MN.

Also are managed some conditions. The term "condition" is a generic term used to refer to a trouble/status detected/existing at the NE. When the NE declares a condition, it determines the service-effect of the condition using internal rules and gets the corresponding notification-level from the provisioning data. If the notification-level is one of CR, MJ, or MN, the condition is called an "alarm". If the notification-level is NA, the condition is called an "event". If the notification-level is NR, the condition is a "not-reported condition" and as such it is not reported via an autonomous message.
– Not-Alarmed Condition:
  A not-alarmed condition is one that does not require operator action. It is reported via an autonomous message. A not-alarmed condition can be either standing or transient. Visual and audible indications are not triggered. Notification code for this not-alarmed condition is NA..
– Not-Reported Condition:
  A not-reported condition is one that is detected by the system but not reported by autonomous message or any visual or audible indication to the CO alarm interface. However, it is logged by the system and then retrievable. Notification code for this not-reported condition is NR.
– Off-Normal Condition:
  A condition designated as off-normal is not cleared when the associated entity is logically removed (OOS-[AU]MA state). It is only cleared when the original triggering-event that caused declaring the condition clears. In general, an off-normal condition is triggered by an operator action (e.g., loopback, command-driven protection switching action).
– Standing Condition:
  A standing condition is an alarmed, not-alarmed, or not-reported condition that can be obtained by interrogating the NE. A standing condition is a persistent state that must be cleared.
– Transient Condition:

A transient condition is a not-alarmed condition. Like the standing condition it is reported; but unlike the standing condition it does not require clearing.

– Visual Alarm:
  A visual alarm is an alarm condition that is triggered to a visual indication on the NE's physical control/ status display panel. Not-alarmed and not-reported conditions are not triggered to visual indications.

The PDU and the shelf provides the capability to activate a CO visual alarm for each Critical, Major and Minor alarm severity.

Alarm Integration and Time Stamp

Internal equipment failures are reported with no built-in delays. In other words, the equipment failures are not integrated and they are immediately reported to the OS with no additional delay.
To avoid possible bouncing alarms, however, an integration time period of 10 secs (+/- .5) is applied on the clearing of the equipment failures.
Unless otherwise noted, facility alarms are integrated for 2.5 seconds (± 0.5 s) before reporting and are integrated for 10 seconds (± 0.5 s) before clearing.
During normal operation, internal critical, major and minor alarms shall be reported within 2 minutes of the initial determination of the failure.
Normal operation is when the NE is not experiencing any other autonomous messaging (e.g., PM reports, no other alarms occurring, etc.).
Audible and visual alarms are initiated when the output message reports the failure.
An NE time stamps the actual time that the triggering event (alarm detection set or clear) occurred (at the source) and not the time when the notification was transmitted. That is, the Event Header message displays the actual reporting time, while the contents of the response, displays the alarm's time stamp.
Integrated alarms are time stamped at the source at the completion of the integration period.
If a triggering or a provisioning event causes an alarm to be re-reported with a different service affecting code, then the old alarm are reported as cleared using the time stamp of the new alarm.
After a reset, all standing alarms and conditions that were declared prior to the reset is re-descovered with a new timestamp when the reset has completed.

Alarm Hierarchy

Any reference to the term 'level' in this paragraph has to be intended as 'hierarchical level', not to be confused with the severity level of the alarm.
Whenever a higher level alarm occurs while a lower level alarm is already declared on the same entity, then the lower level alarm shall be cleared and the higher level alarm shall be declared.
Time stamping, described in this section, is governed by the time stamping and integration time previously described.
When the higher level alarm clears, if the lower level alarm still persists, then the following rules shall be applied:

– the lower level alarm is re-declared with the time stamp of when it is re-declared,
– the higher level alarm is cleared with the time stamp of when it is cleared.

When a lower level alarm is cleared due to a higher level one, then it can be retrieved (by a suitable TL1 command), and its time stamp is the time stamp before the clearing, and only when it is re-raised its time stamp is updated.

In the context of hierarchy, currently declared alarms on an entity is cleared before declaring another alarm, within the same hierarchy chain, against that entity.

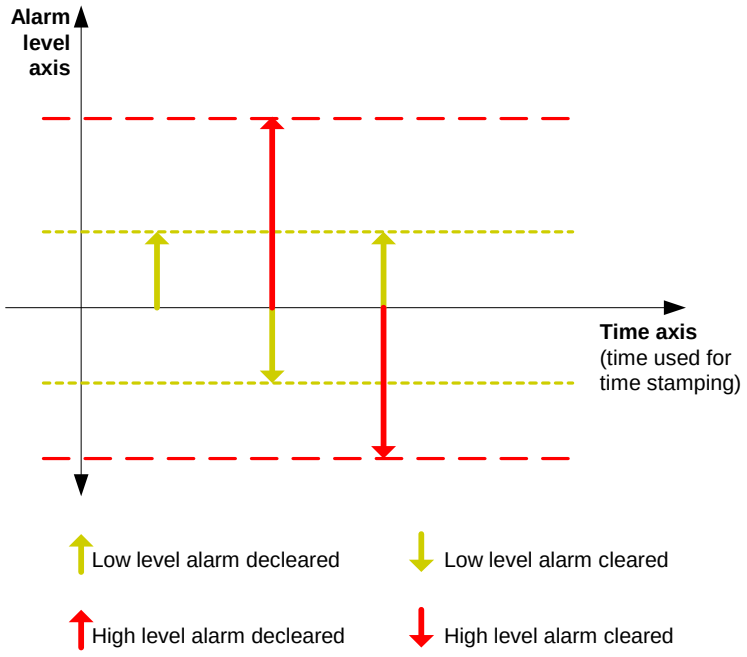


Figure 247. Management of Alarm hierarchy

The declaration of a ”new” (unrelated) failure by an NE not automatically causes that NE to clear any previously declared, independent failures.

Central Office Alarm Subsystem

An NE provides the capability to activate the Central Office (CO) alarm subsystem for the local distribution of alarm signals by means of an isolated relay closure.
A Central Office NE is mounted in a rack hosting a PDU: the PDU includes lamp displays to indicate the summary alarm status of all the shelves in the rack.
The Central Office alarm subsystem visual functions is carried out by the PDU, when it is present, and by the shelf itself.
The ACO capability retires CO audible alarms for an NE and it doesn’t inhibit (mask) subsequent CO audible indications, which indicate additional failures.
The ACO capability doesn’t extinguish any visual CO subsystem or NE alarm indications.
One local control is provided at a Central Office NE for CO audible Alarm Cut-Off (ACO); it is carried out by means of a push button on the face plate of the equipment controller. This button is defined as Alarm Cut Off or ACO button.
The NE also provides the capability to remotely invoke the audible ACO.
The ACO LED is turned on either when the ACO button is depressed or when suitable TL1 command is issued.
When the ACO LED is turned on and a new alarm arrives, it is presented to the audible closures and the ACO LED turns off.
Alarms silenced by the ACO button or suitable TL1 command doesn’t be presented to the Audible closures even if they are still present (only new alarms).

Equipment Alarms

The equipment failures are classified as either Service-Affecting (SA) or Non-Service-Affecting (NSA), depending on whether they affect the services that the equipment transports.
Because hardware designs vary, the report of the equipment failure describes the failure condition. Unique condition types with AIDs localizing a failure will describe what has failed in the system and what needs to be remedied.
Detectable faults on a module that affect the working of that module results in an alarm generated against the failed module.
An error detected between two pieces of equipment is blamed on the receiving/detecting equipment
The facility failures are classified as either Service-Affecting (SA) or Non-Service- Affecting (NSA).

Commands and Autonomous Messages

Other than failures that were not cleared prior to a system reset, the NE individually clears (and send a clear message to the OS) any failure that is individually reported to an OS; the following commands are supported:
- "Retrieve Alarm All"
- "Retrieve Alarm Common"
- "Retrieve Alarm Equipment"
- "Retrieve Alarm Facility"
- "Retrieve Condition - All"
- "Retrieve Condition Common"
- "Retrieve Condition Equipment"
- "Retrieve Condition Facility"
- "Enter ASAP Profile"
- "Delete ASAP Profile"
- "Edit ASAP Profile"
- "Retrieve ASAP Profile"
- "Retrieve Profile"
- "Report Equipment Alarm"
- "Report Facility Alarm"
- "Report Equipment Event"
- "Report Facility Event"
- "Report Common Event"
- "Report Common Alarm"

Alarm Escalation and Deescalation

The process for equipment alarm escalation is:
1) Failure(s) occur(s) on an equipment and mate is available
   - Set non service-affecting alarm on detecting equipment
2) Failure(s) occur(s) on the mate equipment or the mate is no longer available for use
   - Clear non service-affecting alarm(s) for the first equipment failure(s)
   - Set any alarms to service-affecting for both equipment.

The process for equipment alarm deescalation is:
1) All failures clear on one of the mated equipment pair or one becomes available if not alarmed
   - Clear any service-affecting alarms on both equipment
   - Set non service-affecting alarm on any remaining equipment failure(s)
2) Last failure(s) clear(s)
   - Clear remaining non service-affecting alarm(s).

For protected facilities meeting the state conditions for alarm escalation is:

1) Failure(s) occur(s) on a facility and protection is available
   – Set non service-affecting alarm on detecting facility
2) Failure(s) occur(s) on the mate facility or it is no longer available for use
   – Clear non service-affecting alarm(s) for the first facility's failure(s)
   – Set any alarms to service-affecting on both facilities.

For protected facilities meeting the conditions for alarm deescalation is:

1) All failures clear on one of the facilities supported by the protection group or one becomes available if not alarmed.
   – Clear service-affecting alarms on both facilities
   – Set non service-affecting alarms on any remaining facility failure(s)
2) The last failure(s) clear(s)
   – Clear remaining non service-affecting alarm(s).

For unprotected facilities that have transitioned into the conditions for meeting alarm escalation criteria is:

1) Failure(s) occur(s) on the facility
   – Set non service-affecting alarm on the detecting facility
2) The facility undergoes the appropriate conditions for alarm escalation
   – Clear non service-affecting alarm(s) for the facility's failure(s)
   – Set service-affecting alarm(s) on the facility.

For protected facilities that have transitioned into the conditions for meeting alarm escalation criteria is:

1) Failure(s) occur(s) on one or both members of any of the paired facilities (including embedded ones) that are supported by a protection group.
   Set non service-affecting alarms on the detecting facility(ies)
2) The facilities undergo the conditions for alarm escalation
   a) If failures are on both members of any of the paired facilities (including embedded ones) or only on one with the other not available,
      • Clear non service-affecting alarms for the failures
      • Set any alarms to service-affecting for both facilities.
   b) If failures are on only one facility
      • Retain existing NSA status on the alarms.

For facilities that have transitioned into the conditions for meeting alarm deescalation, the deescalation process is the following:

1) Clear service-affecting alarm(s) on the facility

Set non service-affecting alarm(s) on the facility.

In the following are described the maintenance main features of the 1850 TSS-320 system.

The following parts are included in this paragraph:

– Loopbacks and Tests (chapter 3.4.1) on page 375

– Performance Monitoring (chapter 3.4.2) on page 377

3.4.1 Loopbacks and Tests

In order to control and monitor the equipment during test operation, several kinds of signal loopbacks are implementaed in the system, for the different kind of interfaces (SONET/SDH, PDH, Data interfaces).

SONET/SDH interfaces

A line and an internal loopbaccks are implemented for SDH/Sonet interfaces. Line loopback is performedafter multiplex section processing, while the internal loopback acts before the multiplex section processing (see Figure 248.). Both loopback and AIS and Loopback and continue are supported.

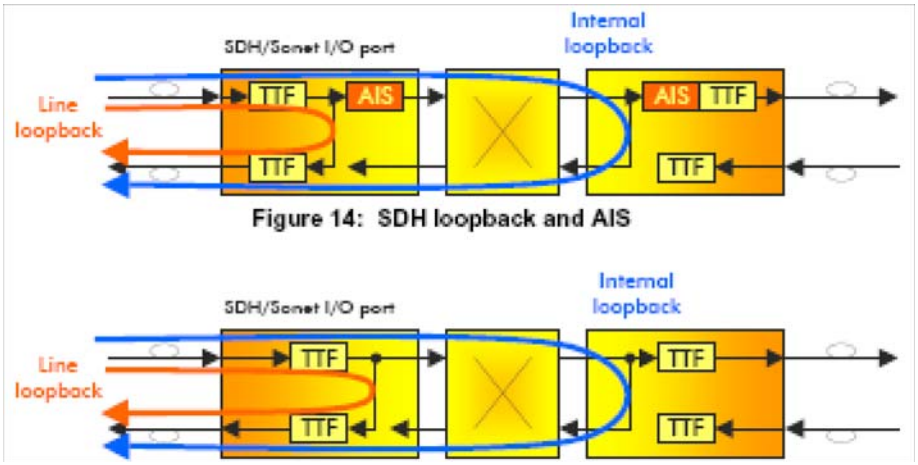


Figure 248. SDH loopback and continue

PDH interfaces

A line and an internal loopbacks are implemented for PDH interfaces. Line loopback is performed before the PDH signal is processed, while the internal loopback acts after the PDH signal is demapped (see Figure 249. on page 375). Both loopback and AIS and Loopback and continue aresupported.

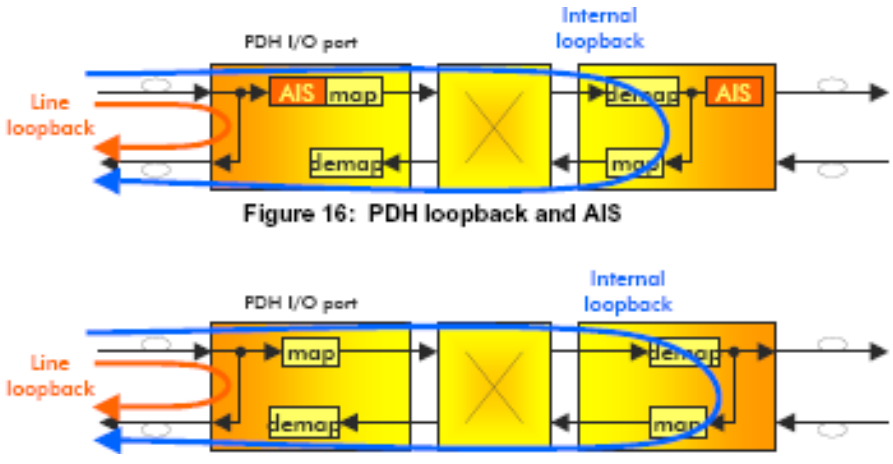


Figure 249. PDH loopback and continue

Data interfaces

A line and an internal loopbacks are implemented for Data interfaces. Line loopback is performed before MAC is processed, while the internal loopback acts after MAC processing (see Figure 250.). Both loopback and "AIS" (AIS is used in the meaning of 'downstream alarm' since no AIS is currently defined for Ethernet signals) and simple Loopback are supported:

– in line loopback and "AIS" a Client Signal Fail (CSF) indication is forwarded in case the physical interface on which the loopback is enabled is involved in port-to-port application and the CSF propagation is enabled, while in internal loopbacks and "AIS", in forward direction, the tranmitter is32 shut down;
– in simple loopback operation the signal is not forwarded (i.e. no traffic is continued).

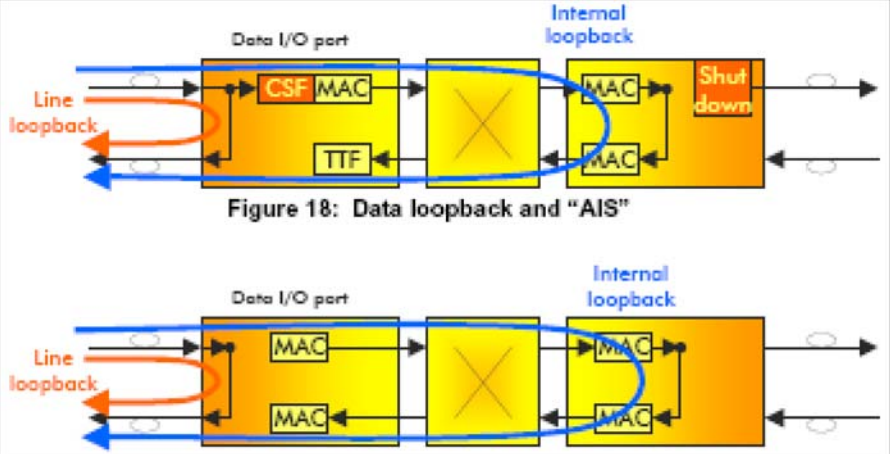


Figure 250. Data simple loopback

Manual optical loopbacks

Front access to the optical connectors on the optical line interface unit allows easy manual optical loopback. This loopback is performed by connecting a fiber jumper from the unit output to its input. In some cases a light-guide buildout assembly is required to prevent receiver overload when performing loopbacks.

3.4.1.1 Test Access

For the use of these test access points please refer to the "Turn-on & Commissioning Guide" and Maintenance & Troubleclearing Guide" manuals referred as [3] and [4] in the chapter "**Preface**".

3.4.2 Performance Monitoring

The system provides the following type and number of storage registers for each PM parameter monitored as per GR-253 and T1.231:
– One (1) Current 15-Minute register,
– One (1) Current Day Register,
– One (1) Previous 15-Minute register,
– One (1) Previous Day register,
– Thirty-one (31) Recent 15-Minute registers,
– Six (6) Recent Day registers.

The system is able to reset the current registers.

Each register has an associated validity (VLDTY) flag. This flag indicates the status of the collected register.

Performance data can be reportable to the OS interface under following conditions:
– Upon request by the operator.

The system provides a means of disabling/enabling the PM collection per facility.
– The disabling of the PM in no way affects the ability of the system to report alarms on the facility (except threshold crossing alerts).

15-minute and 1-day accumulation periods is accurate to within +/- 5 seconds.

The start of 15-minute and 1-day counts is accurate to within +/-5 seconds with respect to the NE clock.

Inhibition of the performance monitoring when under defect conforms to the requirements in T1.231.

Provide both Near-End and Far-End PM counters for OC-N, embedded STS-1 and embedded STS-nC. The PM collection are compliant with GR-253-CORE and T1.231.

The NE supports threshold crossing registers and TCA for the 15 minute and 1 day registers.

The NE support Optical Layer Performance Monitoring for OTS, OCh, OPS and OSn layers.

The Performance Monitoring domain on the NE covers the monitoring of counter values for trail termination points and connection termination points.
Examples of these counters on the SONET/SDH PORT are Errored Seconds (ES) and Severely Errored Seconds (SES).
The Performance Monitoring domain counts these errors during specified granularity periods (15 min, 24h) and stores the values in history data logs.
For the purpose of quality supervision, the values of the error counters can be compared to user–defined threshold levels. If a counter value has crossed a threshold level, a notification (threshold crossing alarm) is issued.
The principle performance management functions are:
– Configuration of the counting interval for each performance measurement point.
– Collection of the performance data.

Configuration of the quality thresholds that generate alarms and log records when predefined values are exceeded.

Performance Monitoring on SONET/SDH port

Performance Monitoring functionalities, are described in the following paragraph in addition to general information concerning performance monitoring on the NE.

– Configuration (SONET/SDH port) deals with the configuration of performance monitoring
– Display Current Data (SONET/SDH port) deals with displaying current performance data
– Display History Data (SONET/SDH port) deals with displaying history performance data
– PM Threshold Table Selection (SONET/SDH port) deals with the selection of threshold tables
– PM Threshold Table Modification/Display (SONET/SDH port) deals with the modification of threshold tables and permits to display the same

Supported Performance Counters

The NE uses performance counters to count transmission errors.
A set of performance counters is provided according to the Termination Point (TP), where performance measurement occurs.
The user can start performance monitoring on one or more subsets of counters for each TP; it is not possible to start individual performance counters.

Near end performance monitoring events are:

– **Background Block Error (BBE)**: A BBE counter measures the number of errored blocks which do not occur as part of an SES.
– **Errored Second (ES)**: A one second period with one or more errored blocks or with a defect.
– **Severely Errored Second (SES)**: A one second period which contains ≥ 30% of errored blocks, or at least one Severely Disturbed Period (SDP). An SES is also counted as an ES.
– **Near End Unavailable Second (NEUAS)**: An Unavailable Second is a second which is part of the Unavailable Time.

The corresponding Far End (FE) performance monitoring events are:

– **Far End Background Block Error (FEBBE)**: A far end errored block which does not occur as part of an FESES.
– **Far End Errored Second (FEES)**: Identifies, at a terminal, a one second period with one or more errored blocks or with a defect which were received by the Far End Terminal.
– **Far End Severely Errored Second (FESES)**: Identifies, at a terminal, a one second period which contains ≥ 30% of errored blocks, or at least one Severely Disturbed Period (SDP) which was received/ detected by the Far End Terminal. An FESES is counted as an FEES.
– **Far End Unavailable Second (FEUAS)**: An Unavailable Second is a second which is part of the Unavailable Time at the far end.

The Termination Point (TP) type determines which performance monitoring events can be counted:

– SONET/SDH TPs
  Both near end and far end counters are supported in receive direction of the signal for all SONET/SDH path layers and for the line/multiplex section layer. For the regenerator section, no far end information is transmitted and, therefore, only near end counting is supported.
– PDH TPs
  Only near end counters are supported in receive direction for all PDH path layers.

Further definitions:

– **Errored Block (EB)**: A block in which one or more bits associated with the block are erroneous.
– **Remote Error Indicator (REI) [formerly Far End Block Error (FEBE)]** : Identifies, at a terminal, the count of errored blocks that were received by the far end terminal.
– **Remote Defect Indicator (RDI) [formerly Far End Receive Failure (FERF)]**: indicates to a terminal that the far end terminal has detected an incoming failure.

– **Unavailable Time (UAT)**: A period of unavailable time begins at the onset of 10 consecutive SES events. These 10 seconds are considered to be part of unavailable time. A new period of available time begins at the onset of 10 consecutive non–SES events.
– **Pointer Justification Event (PJE)**: A PJE is an inversion of I- or D- bits of the pointer , together with an increment or decrement of the pointer value to signify a frequency justification.
– **Out of Frame Second (OFS))**: An OFS is defined as a second in which one or more out of frame events have occurred. This event is identified by the A1/A2 byte of the SDH Frame.

The counting of OFS is only supported for the regenerator section termination. Please note that this counter is deprecated by ETSI and will be removed from international standards.

Far End (FE) and Near End (NE) Performance Counting

Far end performance monitoring parameters are derived from Remote Defect Indicators (RDI) and Remote Error Indicators (REI) (refer to Figure 251.).

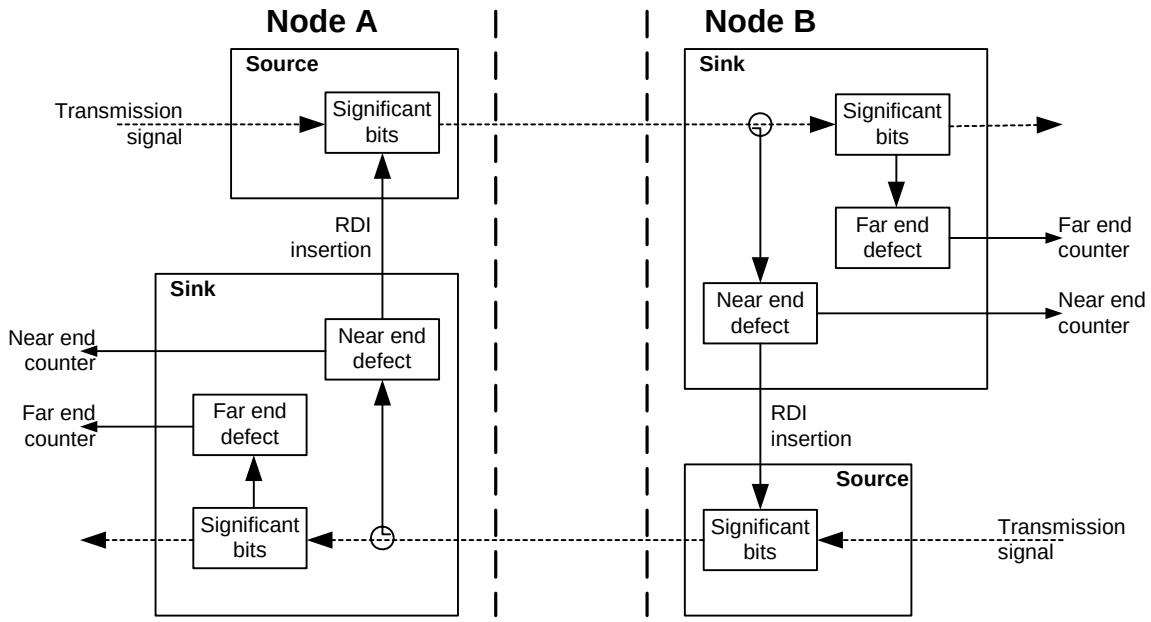


Figure 251. Far End Performance Monitoring Principles

– At Node A, the near end information represents the performance of the unidirectional section/path from B to A, while the far end information represents the performance of the unidirectional section/path from A to B.

– At Node B, the near end information represents the performance of the unidirectional section/path from A to B, while the far end information represents the performance of the unidirectional section/path from B to A.

Near end performance data at Node A and far end performance data at Node B correspond as long as neither direction is disturbed, and vice versa.

In compliance with ANSI and ITU–T standards, far end errors cannot be counted in the case of near end failures.

Bidirectional counting (24 h Bi) for QoS

As specified in G.826, G.784 and ETSI 300417, the bidirectional PM collection for Quality of Service has been supported by combining the information on each direction of transport to assess a single unavailability state: the bidirectional path is in the unavailable state if either one or both directions are in the unavailable state.
PM data are collected by a single UAS plus two sets of three event counters (BBE,ES,SES) for NE-PM and FE-PM respectively. When the path transports unidirectional payload just the four counters for the NE-PM are activated (BBE, ES, SES and UAS).
Data collection is performed only on 24 hours registers and the NE maintains a buffer of two registers: the 24hours current registers and the historical one.

End to End (e-e 24h) Performance Counting

VCn trails can be monitored in intermediate node through the activation of performance monitoring process on Monitoring function.
As the trails are often responsible of the end-to-end customer service, the end to-end monitoring can be requested to provide monitoring for Quality of Service purposes and , in addition, for network Maintenance applications.
If SNCP is configured the Quality of Service collection have to be enable in the monitoring functions after the matrix .
End to end monitoring is achieved by activation of Performance monitoring on the two direction of path and using far-end primitives. This process can be unidirectional (for Monitoring) or bidirectional process (for QoS).
In case of unidirectional process one direction can be monitored end to end and both 15minute and 24 h collection can be activated 15min./ 24H FE_BBE, FE-ES, FE-SES, FE-UAS on incoming or egress signal depending of the POM is enable. The TCA are also evaluated in both 15 minute and 24 H counters.
The bidirectional process needs the presence on the two Monitoring functions in the two directions in one NE and among the two monitoring function a 24 hour collection can be activated with the collection of incFE_BBE, incFE-ES, IncFE-SES, UAS, eFE-BBE, eFE-es, eFE-SES.

Performance Data Collection

Near end and far end performance monitoring events are counted over fixed monitoring periods of 15 minutes and 24 hours.
The 24–hour monitoring periods start at 00 : 00 (UTC) and the 15–minute monitoring periods start at xx : 00, xx : 15, xx : 30 and xx : 45.
Performance monitoring can be enabled and disabled at any time during a monitoring period. An entity of all near end or far end performance monitoring events is always counted, it is not possible to start individual performance counters (e.g. SES only). BBE, ES and SES counting is stopped during Unavailable Time.

Event Counting
The performance events (e.g. SES) are counted in a counter per event. These counters are called the current registers. At the end of the monitoring period, the contents of the current registers are transferred to the first of the recent registers, together with a time stamp to identify the period (including the day). Time stamping is performed using UTC (as for all alarms). After that, the current register is reset. It is also possible to reset an individual current register manually.

Suspect Flag
A suspect interval flag is set as an indication that the data of the corresponding register may be either incomplete or invalid.

Zero Suppression

Zero suppression is a basic mechanism to remove irrelevant PM information and to reduce the amount of PM reports in the system. A PM report is suppressed and hence no history record is created by the entity which is responsible for PM reporting when **all of** the following conditions are true for the monitoring period:

- an interval is error–free (all PM counter values are zero)
- PM was enabled during the entire monitoring interval (the elapsed time equals its nominal value, i.e. 900 for 15 min. and 86400 for 24 h)
- PM was running properly (the suspect interval flag is not set)

By default, zero suppression is active for all PM enabled TPs. The number of suppressed intervals is indicated.

Data Collection

Note: PM data is not counted on boards that were plugged out at the moment of enabling data collection (see **PM Configuration** dialog). Nevertheless, PM data is counted on boards that were plugged in at the moment of enabling data collection, but were plugged out and back in some time during data collection.

Performance Monitoring can be started at any time.
As soon as Performance Monitoring is started on the Craft Terminal, current PM data is collected on the I/O boards, incrementing the performance counters each time an error is detected.
The performance data counted is evaluated every quarter of an hour or every 24 hours and stored there in a history record.
When the user disables the monitoring of a TP within the first 10 minutes of a 15–minute period, it is possible that have still not been received the PM data of the previous monitoring interval.
Since PM data is not stored after monitoring is disabled, the PM data of the previous interval is lost in this case.
If equipment or line protection switching occurs during a counting interval, the NE does not provide complete performance measurement for the protected TPs.
Only the period between the last switch and the end of the counting window is counted.
The interval is marked for suspect data and the elapsed time indicates the length of the measured period.

Performance Monitoring History

Performance Monitoring history data is necessary to assess the recent performance of transmission systems. Such information can be used to sectionalize faults and to locate the source of intermittent errors. History data, in the form of performance monitoring event counts, is stored in registers in the NE. All the history registers are time stamped.
In compliance with ANSI and ITU–T standards, the history registers operate as follows:
The history data is contained in a stack of registers. There are sixteen 15–minute period registers and one 24–hour period registers per monitored event. These registers are called the recent registers. At the end of each monitoring period, the contents of the current registers are moved to the first of the recent registers. When all recent registers are full, the oldest information is discarded.

Thresholds

For quality supervision purposes, the recorded errors through the performance counters can be compared to threshold levels. If a counter value has crossed a threshold level, a Threshold Crossing Alarm (TCA) is transmitted to the alarm manager.
The threshold values are defined in threshold tables together with a severity and a flag indicating whether crossing this value should be notified by an alarm and logged or only stored in the current problem list. The user can modify and delete such tables.
Different thresholds can be assigned for near end and far end and for granularity of 15 minutes and 24 hours.

The TCA only reports the value of the counter which has crossed the threshold, it does not provide a complete set of all counters. Therefore, the user has to explicitly retrieve all current performance data after receiving the alarm. The user can retrieve this information from the Current Performance Management Data Dialog.
Two thresholds mechanism are supported:

– For 24-hour (implicit clearance) monitoring periods, one threshold value is defined: if the event count reaches or exceeds the threshold value during the monitoring period, a TCA is generated. To clear a TCA, the alarm must be manually acknowledged by the user.
– For 15-minute (explicit clearance) monitoring periods, two threshold values (set, reset) are defined:
– a TCA is generated during the monitoring period when the event count reaches or exceeds the set threshold value the first time. This TCA is automatically cleared by the system at the end of the following monitoring period in which the event count is less than or equal to the reset threshold value and there was neither an unavailable nor a suspect period during this monitoring period

The following limitations apply for explicit clearance:

– The value of the low threshold is fixed to “0" (only a single threshold is provided by a threshold table).
– An SES threshold crossing is cleared at the end of the interval if no unavailability was detected and SES had not reached the low threshold (low threshold equal to 0).
– Even in case of a suspect interval the TCA is cleared if no unavailability was detected and the low threshold had not been reached.

Additionally an explicit clearance of TCAs for all granularity periods is executed if one of the following events occurs during the current interval:

– deletion of the current data instance (TP),
– resetting of counters (only for 24 h), increased thresholds (higher than current value of counters) (only for 24 h).

3.5 Provisioning

This section describes the many types of provisionable parameters available in 1850 TSS-320 equipment.

1850 TSS-320 allows the user to customize many system characteristics through provisioning features. Provisioning parameters are set by software controls.

As example, in the following the basic provisioning features referred to the Local Craft Terminal are described.

Equipment Management
This section deals mainly with the setting and changing of the boards present on the Equipment and undertaking board protection operations.
Using the menu options, the *first level* of the “Equipment Overview" representation will be displayed .The Equipment Overview enables a fast navigation through all levels of the equipment hierarchy. Navigation is done from higher to lower levels.

The NEs hierarchy is different organized as follow:

Rack > Subrack > Slot > port > TP

- the first level shows the *subrack level* of the Equipment view;
- the *board level* of the Equipment view can be reached.
- the *port level* of the Equipment view can be reached. .

3.5.0.1 Board

The Board View permits to ***show the physical port*** available in a specific board and to access the Port view.
The “Board view" is reached selecting a pull down menu, then double clicking on the selected board to show the relevant **Board view,** presenting the ports.
In case of board containing “sub-boards", another view permits to see the contained item, named “daughter" or “sub-board".
Alarms and Status indications referred to the board level are present at the bottom of the view, as indicated in the example (Administrative State and Board Alarms/Status).
This information are “In/Out of service" of the board (Administrative State) and board alarms and status like “missing" (RUM) or “mismatch" (RUTM), EPS condition if supported and other indications typical of each unit
A port type is described with a board rectangular view and a port identification.
The port identification is usually internal to the rectangular board.
The following information is available:

- type of port (name)
- state of port (alarm status synthesis)
- symbol of the port

The operator is provided with a representation of the port alarm synthesis on each port.

Port
The Port View permits to set and show the transmission resources (i.e. the Termination Point, TP) referred to the specific Port; it permits to ***check the detailed alarms*** presented by each TP of the Port, and the available menu permits to ***configure the port***, (many setting options listed in the port menu are common with the “Transmission" view). In these views are presented only the TP specific of the port.
The menu differs according the port type (SDH, PDH, HOA port).
The Port View can be accessed from the Equipment or Transmission Views.

Transmission

The generic ***Transmission*** View, described in this chapter, offers the possibility of displaying a single TP or a set of all kinds of TPs (or collected functionality which is represented by one/several TPs).
To display the termination points in the Transmission View, either select specific TPs from a TP search dialog or access the view directly from another view, e.g. by navigating from the Port View.
The Transmission View provides the following features:

– Brief overview regarding transmission resources.
  - An overview concerning all TPs belonging to a port can be called in by activating the function to expand the selected TP. TP names are listed in an additional information area if the mouse pointer is positioned over it. The following states are indicated:
    – the alarm state is indicated by the ***alarm synthesis*** icon
    – the ***cross–connection state*** is indicated by a cross
    – whether a TP can be ***structured*** is indicated by a circle
    – whether a TP is under Performance Monitoring indicated by a blue “P" letter
    – whether a TP is involved in a loop action, it is indicated by a back-folded arrow
  - An overview concerning ***signal flow*** can be requested by a user action. The result is that the objects related to the TP are displayed and lines indicate the connections. Expanding and hiding TPs that are related to the currently selected TP (e.g. show all TPs that are above the TU–12 CTP) enables all related TPs to be added to the view, thus providing a representation of the entire signal flow.

– Display of single or multiple termination points.
  - Search for and select a termination point in a TP search dialog and display it in the Transmission View.
  - Pop–up the Transmission View from the board view. All TPs/compound TPs associated with the physical port are displayed (i.e. TPs down to AU–4).

– Provide the functionality to create/show cross–connections.

– Provide the functionality to create/show Multiplex Section Protection

Equipment Protection management (EPS)

It is unthinkable to launch a telecommunications system, handling millions of communications, without the possibility of replacing equipment in a real time way, consequent to equipment failure. Everything must be done so that the communications can continue smoothly and so that the equipment failure remains transparent to the users. Protection management deals with this aspect of the EML-USM.
The protection is performed by switching the board supporting the protected service when this board fails to a protecting board capable of supporting the same service. This protection is realized according to a protection scheme.

An equipment protection scheme is composed of the following parameters which can be configured:
- Group type: 1+1 or 1+n
  the group type specifies if one or more unreliable resources for protection can be assigned to one or more reliables resources. 1+1 group type means that a working element is protected by one protecting unit. 1+n group type means that n working elements are protected by only one protecting unit.
- Protection priority:
  A priority can be assigned to protected units in 1+n protection schemes. This priority can be be 1, 2, ... or n, 1 being the highest priority.
- Configuration type: revertive or non revertive

In revertive mode, a protected service will be switched back to its protected element when it has recovered from its failure.
In non revertive mode, the switch to the protecting element is maintained even after a recovery from failure.

- Protection wait to restore time:
  Used when revertive mode is active, the protection wait to restore time prevents several protection switches due to an intermittent failure. A protected element must be fault free during this fixed period of time before a protected service is switched back to it.

Board duplication remains the easiest way to ensure equipment protection in a system.
The actions that can be undertaken are of the following type:

– Consult and modify an Equipment Protection Scheme (EPS),
– Force Switch EPS,

In Board view, the board whose contents is represented is considered as implicitly selected.
EPS protection states are displayed by the functional state message area of the boards involved in an equipment protection scheme.

Cross–Connection

A cross–connection represents the logical connection between the input and output of the matrix, called the matrix port.

The NE supports unidirectional, bidirectional and broadcast connections unprotected as well as protected.

– Unidirectional Connection
  Information is transmitted exclusively from the input port to the output port (point–to–point); there is no routing in reverse direction.



Figure 252. Unidirectional Connection

– Bidirectional Connection
  Information is transmitted between input port and output port in both directions (point–to–point).

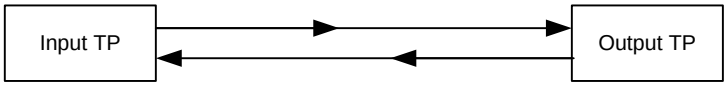


Figure 253. Bidirectional Connection

– Broadcast Connection (Multi–leg / Multipoint)
In contrast to a cross–connection between just two points (point–to–point), one source and one sink, a broadcast connection consist of one source and several sinks, different `legs' that share the same source TP.
In the example below, information is broadcast from one input to outputs A, B and C on three legs.

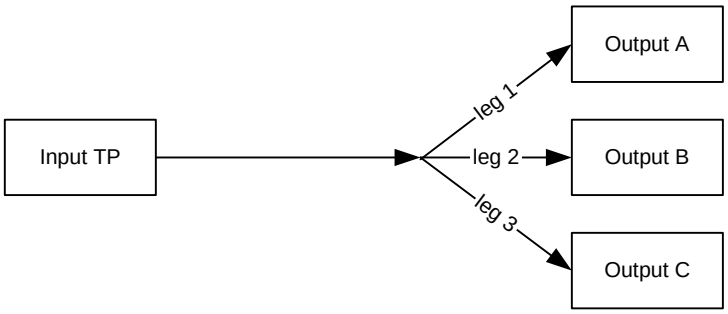


Figure 254. Example of Broadcast Connection with Three Legs

A warning box indicates when the resources available for broadcast connections are exhausted.

Note: Non–intrusive Monitoring
Adding a protection leg to a unidirectional cross–connection offers the ability to perform non–intrusive monitoring on this cross–connection. No errors are introduced to the original cross–connection with applying or removing the protection leg.

Cross–Connection Protection

– Protected Unidirectional Connection
A unidirectional connection is routed from Input A to the Output (primary route). In the case of a failure, the system automatically switches to the protection path from protection Input B to the Output. This second connection is permanently kept in hot standby operation.

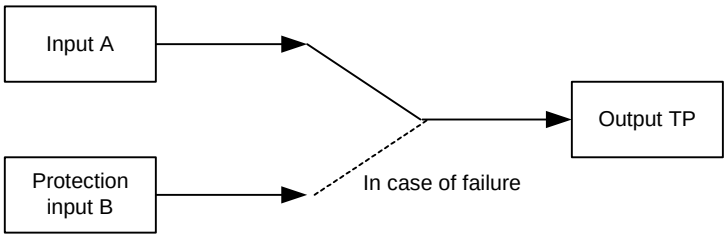


Figure 255. Protected Unidirectional Connection

– Protected Bidirectional Connection
A bidirectional connection is routed from Input A to the Output C (primary route). Input A (input protected) can be protected:

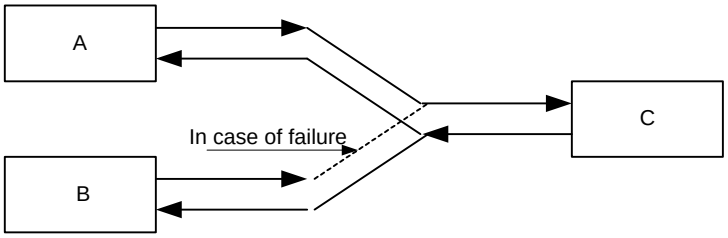


Figure 256. Bidirectional Connection - Input Protected

Note: By means of this connection are created links with **SNCP** protection.

– Protected Broadcast Connection
The protected broadcast is realized as a set of independent, protected, unidirectional connections using the same pair of input termination points. Each protection can be forced, locked out or switched independently. Therefore, if a failure occurs at a certain input, it is possible that only some of the protections of the protected broadcast actually switch to the protection input.

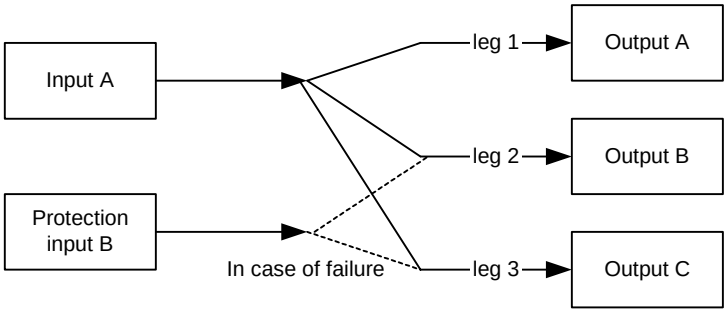


Figure 257. Protected Broadcast

The above figure shows a broadcast connection from input A to outputs A, B and C. Leg 2 and 3 are protected via input B, whereas leg 1 is not protected.
In current release only one out of N legs can be protected.

– Drop and Continue Connection
A Drop and Continue connection is a composed by: (see Figure 258.)
- a unidirectional connection routed from Input A to the Output C and also to Input protecting B.
- a unidirectional connection from Input protecting B to Output C.
- a unidirectional connection from Output C to Input A.
  Output C is protected; when receive from Input main the connection is defined ***normal***, when receive from Input Protecting main the connection is defined ***inverse***.

All the connections are created in a single step of configuration.

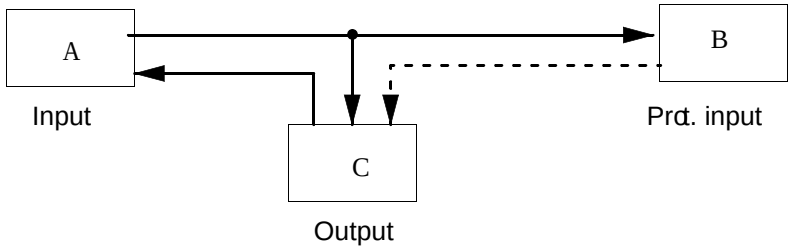


Figure 258. Drop and Continue - Normal

Synchronization

All SDH NEs require timing in order to generate the necessary synchronization and frame phase reference information. The timing can be provided by a source external to the NE or an internal timing generator. The derived timing shall be used for all signals and interfaces in the NE that are related to the SDH frame structure. Follows a brief description of the heart of the NE clock known as the Synchronization Equipment Timing Source (SETS).

It can be divided into 2 parts:
– **OSC:** the internal oscillator.
– **SETG:** the Synchronization Equipment Timing Generator.

The SETG is responsible for the generation of the external timing source for the Frame structure and the clock, whilst the internal oscillator (OSC) is useful only in the abnormal functioning "Free-running" mode that will be explained later.
The simplified figure that follows represents the internal organization of the SETS.

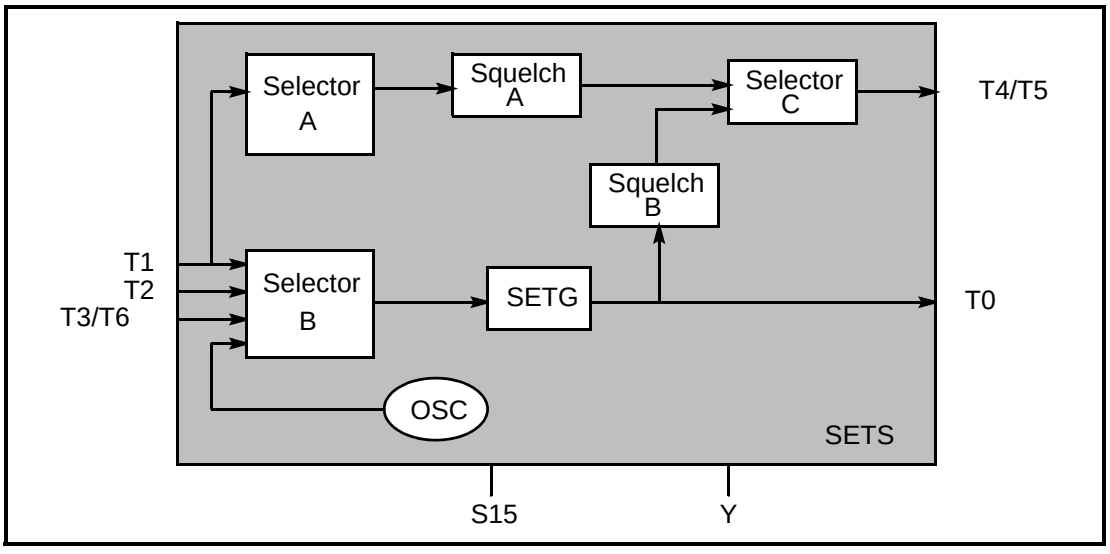


Figure 259. Internal organization of the SETS.

The internal sources (inputs) are:
– **T1:** Reference obtained from incoming STS-N/STM-N signals,
– **T2:** Reference obtained from incoming 1.5/2 Mbits signals (not available in current release),
– **T3/T6:** Reference obtained from an external incoming 1.544/2.048 MHz (T3) or 1.544/2.048 Mbit/s (T6) signal.
– **OSC:** the internal oscillator.

The number of timing reference inputs depends on the configuration of the NE.
The external sources (outputs) are:
– **T0:** is the reference output signal for the clock and signal frames,
– **T4:** is the 1.5/2 MHz reference output for the external equipment synchronization.
– **T5:** is the 1.5/2 Mbit/s reference output for the external equipment synchronization.

Other reference points:
– **Y:** is used for communication of Synchronization Status Message (SSM) between SETS and MST functional blocks.
– **S15:** is used to provide notifications and loss of incoming timing reference reporting to the Synchronous Equipment Management Function (SEMF).

Selector A provides the capability to select timing reference from available T1 inputs, either automatically based on the priority and quality level of the candidate sources (SSM algorithm), or manual as a result of commands issued from the managing system.
Selector B is capable of selecting timing reference from T1, T2, or T3/T6 inputs, according to the SSM algorithm. The capability for manual selection of the timing source is also provided.
Selector C is only operated in manual mode, to switch between SETG output signal (T0) and a T1 timing reference.

The **squelch** functions **A** and **B** mute the relevant timing references in the presence of failure condition, or SSM threshold violation.
The choice of the timing reference is done in two ways:
– **Automatically:**
Following a particular algorithm based on the quality and the priority of the incoming timing signals. The automatic selection is based either on the priority of the incoming timing source (Priority algorithm) or on the priority and the quality level of the incoming sources (SSM algorithm).
– **Manually:**
Following an order from the Operator.

Note: The **priority level** is determined by the Operator for each candidate timing source. It is static information. On the other hand, the **quality** of the source is dynamic information, dependant of the quality of the reference clock generating the timing.
In an SDH signal frame, the quality of the timing source is located in the Section Overhead.

The SETG has 3 modes of operation:
– **Locked mode:**
The SETG output is fully controlled by the external timing references (T1, T2 and T3/T6).
– **Hold-Over mode:**
The external timing reference is malfunctioning. The SETG during normal functioning stores regularly the value of the external timing reference. In this case the SETG output is controlled by this memorized value.
– **Free running mode:**

This is not a normal operating mode. The external timing reference and the memorized timing reference are malfunctioning. In this case the SETG output is controlled by the internal clock source.

ALS

Automatic laser shutdown (ALS) is useful in case of a loss of communication between two NEs due to optical fiber breakdown. For safety reasons it may be necessary to shutdown the laser to enable the fixing of the communication link.

The automatic laser shutdown function can only be configured from the optical ports of the equipment.

The dialogue box enables the ALS Management and the Restart parameters. The following actions are available:

– Allow Automatic Laser Shutdown.
To allow the automatic laser shutdown functionality, .

– Forcing the Laser to start or stop.
When the laser is forced to ON or OFF, it is restarted or stopped and the Automatic Laser Shutdown is disabled, if it was not already so.

– Delete : for deactivates the ALS function. By this action it is only possible to create the ALS function .

– Enabling or Disabling Automatic / Manual Laser Restart.
The laser will be ON for 2 secs and OFF for 70 secs, in periodic mode. The same procedure is applicable for the ***ALS Manual restart*** : while the ALS auto Restart is disabled,the manual restart permits to perform a laser restart for a single time period.

– Wait to restart time
The ***Wait To Restart Time*** is the delay period in seconds, occurring before an automatic laser restart is launched (following an automatic shutdown). The restart time period for this equipment is fixed to 70 secs.

– ALS Manual restart
When the ALS Manual Restart is Enable it is possible to enter two different commands: ***Manual*** or ***Test*** Restart. The Manual command immediately activates a single laser restart: this command overrides the wait to restart time. The Test restart is similar to the manual restart but the laser remains “ON" for a longer time in order to make a measurement of the received optical power.

Note that the ALS procedure is activated (if enable) only when the fiber has been interrupted and the ALS state has not to be confused with the laser state.

ALS states, displayed by the functional state message area of the optical port, are:

- ALS states:
  - Inactive = No ALS has been activated (Off) or the laser has been Forced ON/OFF.
  - In test = The laser restart has been automatically activated .
  - Active = The ALS has been activated (On).
  - Undefined = The ALS is not present (not created).
- Laser state:
  - On = all OK or ALS not present (not created).
  - Off = Laser off (when ALS is created).
  - Forced on = ALS forced on by operator command.
  - Forced off = ALS forced off by operator command.

Diagnosis (report)

Alarms are always present on the operator's workspace. The different types of alarms, their number and their severity level, are represented in all Equipment views. An icon representation is used, which change color when the relevant alarm is active. Thus, at all times, you know the number of alarms and their severity relating to the equipment.
Access to the Alarm Surveillance to show the alarm condition is detailed in the following.
Than is presented the abnormal condition list (as result of operator's command such us loop, laser forced on etc.).
Information about the significance of equipment alarms and status is given in the Maintenance document.

Alarms surveillance

IIt is possible to show all the Alarms or filter the alarms report.

– ***NE Alarms***:
  all the NE alarms are listed in the Alarm Surveillance report which is activated

– ***Object Alarms***:
  only the alarms of the selected object are listed in the Alarm Surveillance report

– ***Subtrees Alarm***:
  only the alarms of the selected object and of the relevant subtrees are listed in the Alarm Surveillance report

– ***Equipment Alarms***:
  only the alarms of the equipment management are listed in the Alarm Surveillance report

– ***Transmission Alarms***:
  only the alarms of the transmission management are listed in the Alarm Surveillance report

– ***External Points Alarms***:
  only the alarms of the input external point management are listed in the Alarm Surveillance report

Selecting any of the previously options, the Alarm surveillance report is displayed.

This view shows first a synthesis of the NE alarms (Counter Summary) with the sum of all alarms, then a detailed list of alarms of the selected filter (Alarms Sublist).

Detailed information for each alarm is supplied.
For example the board in which the alarm is detected, the status of the alarm, the alarm type, the probable cause.
The information supplied help the operator, typically during troubleshooting operation, presented in the Maintenance documentn.

Abnormal Condition List

The abnormal condition provides the synthesis of NE “not normal conditions" listinig the events that contribute to abnormal condition.

The abnormal condition are the following:
– Loopback
– ALS is disable and the laser is forced on or off
– Protection units (in case of EPS, SNCP and MSP) are in lockout or in forced status
– Board (or sub-board) is placed in a not configured slot

Internal Link Monitor

This function improves, at the user interface level, the diagnostic associated to the hardware failure.
The presence of a failure on RX or TX side for the signal incoming/outgoing from/to the active/standby MT320ND is detected.
Internal Link Monitor displays a detailed localization of the link failure: a graphical representation of the status of the link among the active and stand-by MT320ND is shown.

In detail, each page contains the following functional blocks and graphical objects:

- the tab of the page displays the user label of the MT320 board;
- the left side of the page displays the block representing the MT320 board;
- the right side of the page displays the list of blocks representing the equipped boards; each block displays a string contained the user label of the associated board;
- two arrows are displayed between the MT320ND block and each board block; the two arrows represent the link status in Rx and Tx side:
  – a **red** arrow indicates a "link failure"
  – a **green** arrow indicates a "working link"
- the ***Refresh*** button allows to perform an explicit refresh of all the displayed information.

In order to indicate all the possible roots of the "link failure", all boards that detect the link failure are represented by a red block in the page of the MT320ND main:
- a "port" board is represented by a red block if a link problem is detected in the NGI Rx from the active MT320ND;
- the MT320ND is represented by a red block if a link problem is detected in one of the NGI Tx from one of the possible "port" board.

Remote Inventory
In the Remote Inventory are stored information of identification, construction data ect.
The options used are:
– ***Upload Remote Inventory***: store the Remote Inventory data in the Craft Terminal.
– ***View Remote Inventory***: display the remote inventory data, previously stored in the Craft Terminal by means the “upload remote inventory" performed in the “Supervision" menu.

Data is displayed in specific fields:
- **Company**
  It indicates the Company's (Alcatel-Lucent's branch) which designs the unit.
- **Unit Type**
  It indicates the units' acronym
- **Unit Part Number**

It indicates Alcatel-Lucent or Factory product's Part No.. The number indicated is that printed on the labels or on the units' front coverplate.

- **Software Part Number**
  It indicates the id. of the unit's resident software
- **CLEI Code**
  It indicates the CLEI code according to Bellecore specs. TR-ISD-325
- **Manufacturing plant**
  It indicates the Company's manufacturing plant id. within the company, producing the unit. Refer to Alcatel for the abbreviation's meaning (four characters).
- **Serial Number**
  It indicates the product's serial number as specified by the NR 130 Norm.
- **Date identifier**
  It indicates the meaning of the date that follow. It is a two-digit code
- **Date** (YYMMDD)

The identification of the date depends on the indications stated in the previous field. When only the year is displayed, the format must be "YY- - - “

3.5.1 Cross Connections

The following cross connection types are supported:

– by the higher order matrices for STS-1, STS-3c, STS12c, STS-48c and STS-192c facilities:
  - 1WAY and 2WAY cross connects
  - Head-End bridge
  - Broadcast implementation by multiple 1WAY legs from the same head end
  - Special cases of broadcast include one way drop and continue and bridge connections
  - One way connection to the same facility is permitted (matrix loopback).
  - Back direction of a one-way connection may be used for an additional one way connection at the same signal rate.
– by the higher order matrices for add/drop cross connections between UPSR line and trib facilities
  - 2WAYPR (UPSR - two way bridge and select)
  - 1WAYPR (UPSR - protected broadcast)
– by the higher order matrices for dual-node add/drop cross connections between UPSR line and trib facilities
  - 2WAYBR (UPSR -one-way add + two way select & continue) also represented as 2WAYDC
– for dual-node add/drop cross connections between BLSR line and trib facilities
  - 2WAYBLSRPRI (add with line-side select, drop and continue) also represented as 2WAYBLSR
  - 2WAYBLSRSEC (same as a 2WAY)
– for BLSR and UPSR through connections
  - 2WAYTHRU (high speed line to line connection)
  - 1WAYTHRU (high speed line to line connection- 1 way - UPSR only)
– by the wavelength selective switch for all photonic layer facilities:
  - 1WAY and 2WAY cross connects
  - Bridges
  - Multicast by multiple 1WAY links
  - Regenerator
  - Special cases
    – Drop and continue
    – Regen
    – Wavelength Change
  - No matrix loopback (no hairpinning)
  - Upstream direction of one-way connections can support independent service
– by the higher order matrices for add/drop cross connections between DWDM line and trib facilities:
  - 2WAY
  - 1WAY

  All complex combinations of 1WAY and 2WAY connections that support multicast applications and protection scenarios is composed of combinations of 1WAY and 2WAY connections.

Full grooming, non blocking connections are possible for any and all STS1s, and STSnCs across all I/Os, including hairpinning. (Haripinning refers to a one way connection from/to the same facility, like a matrix loopback.

This part also contains the OCONN constructs that are used to support cross-connections. Some OCONNs are implicit, like the connections between LD packs and WR packs, or among WR packs. These connections are fixed by convention and can not be provisioned or retrieved by the user.
Other OCONNs depend upon the deployment order of wavelengths and other equipment and must be explicitly provisioned by the user. For example the connection between a particular wavelength port on an OMD and the line-side port of an OT will depend upon the bay-shelf-slot-port of the newly deployed OT and the wavelength chosen on one of eight optical lines.

Photonic cross-connects and optical protection groups depend upon the previous provisioning of OCONNs. OCONNs provide the supporting structure for PXCs and protection groups. Drop and Add connections can only be made to OMDPORTS that have been connected to OPS or OT packs with OCONNs. OCONNs are also used to move ports carrying OCH signals from a non-existent state to an OOS state at OMDPORTS, OPS ports, and OT ports.

UPSR Connections:

It is possible to declare 2 OC-N port pairs of the same rate to be East and West sides of a UPSR ring.

This defines a UPSR Line pair

- Multiple UPSR ring line pairs is defined on the NE.
- Signals can be added/dropped from the EW pair to any other available facility on the NE of the same rate and format. 2WAYPR and 1WAY PR cross connections are used to implement this function
- Assignment of ports from the same port module to the same protection group is denied at the TL1 level

The NE universally supports non-terminated ADD/Drop connections for all STS1s, STS3Cs, STS12Cs, and STS48Cs. It is possible to monitor and report intermediate path PM on non-terminated add-drop and through connections

The NE universally supports non-terminated ADD/Drop connections for all STS-192c It is possible to inter-connect an STS signal between 2 UPSR line pairs belonging to different rings, using back to back 2WAYPR as a single 4-way connection. Dual hub ring-to-ring protected connections is possible

BLSR Connections:

It is possible to declare 2 OC-N port pairs of the same rate to be East and West sides of a 2 Fiber BLSR ring

- For OC-48 ports
- For OC-192 ports
- The first N/2 STS1 time slots is the protected channels
- The 2nd N/2 STS1 time slots is the protecting channels
- Assignment of ports from the same port module to the same E-W protection group isn't permitted for BLSR configurations
- The NE supports multiple BLSR rings
- Attempts to make connections to protecting channels is denied (no PCA)
- Dual Ring Interconnect; Provide Working path Dual node interconnect for connecting the 2FBLSR to another 2FBLSR via an optical tributary drop for OC48, OC192
- The system accommodates a cross-connection time for a single normal cross-connection on a quiet system in less than 1 second. This time is interpreted as the time from issuance of the TL1 command at a local craft terminal, to the availability of signal on the connected paths

3.5.1.1 Connection Circuit Identification

The NE provides for an operator:

– to specify up to 45 characters to identify uniquely each leg of a cross connect.
– to modify/change the connection Circuit ID (Identification) of an existing cross connect.
– to retrieve the connection circuit identification of a provisioned cross connect.

3.5.1.2 Signal Delay

The system accommodates a cross-connection time for a single cross connection on a quiet system in less than 1 second. This time is considered from the time the command is received by the system until the cross-connection becomes active (i.e. traffic may be transported between the connection facility endpoints).
The time interval to establish a multipoint broadcast starts at the time a cross connect command is entered into the system and ends when service stabilizes through the new path. The time to establish a X port bridge connect has not exceed the time to establish the X 1-way connections.
Connection time is measured on a quiet system which is defined as one with:

– No autonomous messaging active (e.g., PM reports, Alarms occurring, etc.).
– The system is only operating those commands specifically needed for testing a connection time.

The NE is capable of executing a minimum of 20 connection commands per second at the TL1 interface
The NE is able to process one-time burst of 100 cross connect commands in 1 second on a quiet system without loosing any commands.
If the capacity of the NE to accept commands is exceeded, new commands may be dropped without processing, without notice or reply. Excessive command rate not causes the NE processor to lock up.
New cross-connections and/or disconnections not causes any bit errors on other existing connections.
Optical Transmitter Lasers is turned off when there are no logical cross-connections to a transmit port. Current wavelength router technology does not provide sufficient isolation to block the signal from leaking into other ports of the device when the add port switch is in the blocked state.
A request to enter a cross-connection is:

– denied if any of the ports has all its bandwidth utilized by other existing cross-connections.
– allowed if the required equipment is provisioned but not equipped.

The provisioned cross-connection is persistent in the NE (i.e., it survives system restart and in-service upgrade and it is included in database backup).
Cross connection TL1 commands is atomic. Typically a cross connect is implemented with multiple physical matrix connections. If any part of the connection specified by a command cannot be made/broken for any reason, then the system must be restored to the state just preceding the command.

3.5.1.3 Cross Connect Level

The NE provides cross connections at STS-1, STS-3c, STS12c, STS-48c, STS-192c and at the photonic layer for all wavelengths defined by the channel plan levels.

– A STS-1 cross connection cross connects any incoming embedded STS-1 to any outgoing embedded STS-1 unaltered. A STS-1 to STS-1 cross connect terminates the OC-n in which STS-1 path is embedded and hence all the maintenance signals prescribed for a LTE sis detected and generated as defined in the FM RRS. A a STS-1 that belongs to a VCG cross connected to a STS-1 embedded within a OCn, is an exception to the above rule of unaltered cross connect as it terminates the STS-1 and hence all the maintenance signals prescribed for a STS-1 PTE is detected and generated.
– A STS-3c cross connection cross connects any incoming embedded STS-3c to any outgoing embedded STS-3c unaltered. A STS-3c to STS-3c cross connect terminates the OC-n in which STS-3c path is embedded and hence all the maintenance signals prescribed for a LTE is detected and generated.
– A STS-12c cross connection cross connects any incoming embedded STS-12c to any outgoing embedded STS-12c unaltered. A STS-12c to STS-12c cross connect terminates the OC-n in which STS-12c path is embedded and hence all the maintenance signals prescribed for a LTE is detected and generated as defined in the FM RRS.
– A STS-48c cross connection cross connects any incoming embedded STS-48c to any outgoing embedded STS-48c unaltered. A STS-48c to STS-48c cross connect terminates the OC-n in which STS-48c path is embedded and hence all the maintenance signals prescribed for a LTE is detected and generated.

– A STS-192c cross connection cross connects any incoming embedded STS-192c to any outgoing embedded STS-192c unaltered. A STS-192c to STS-192c cross connect terminates the OC-n in which STS-192c path is embedded and hence all the maintenance signals prescribed for a LTE is detected and generated.
– A photonic cross connection cross connects any incoming embedded wavelength to the same outgoing embedded wavelength on any line except for the line on which the signal entered the system.

3.5.1.4 Cross connect types

One-Way/Two-way Cross Connect

A single input command establishes a unidirectional/bidirectional path between one STS-1 or STSnC input and any other one at the same rate .

A 1-way/2-way cross connect between any two STS1 or STSnC is able to be disconnected with a single input command.

Two 1-way cross connects that form a bi-directional connection (i.e. going between the same ports) is able to be disconnected by either separate 1-way disconnect commands, or by a single 2-way disconnect command

The NE supports self connected ports i.e. allow a port to be one way connected to itself.

Head-END Bridge Cross Connect

A head-end bridge connection involves connecting a STS1, STS-3c, STS-12c, STS-48c or a STS-192c input, whether or not it is already 1-way or 2-way cross connected, on a unidirectional head-end bridge basis to any other unused STS1, STS-3c, STS-12c, STS-48c or a STS-192c output. I.e. if port A is 1way or 2way cross connected to port B, then the system should allow an head end bridge from port A to port C as long as port C is idle or has a 1WAY connection to another port D as shown in Figure 260..

Once the bridge is established, any 1-way cross connect that is formed is able to be disconnected by a 1-way disconnect command; any 2-way cross connect that is formed is able to be disconnected by either separate 1-way disconnect commands or by a 2-way disconnect command.

Once a Head-End bridge is established, deletion of any cross connect leaves any remaining cross connections intact.

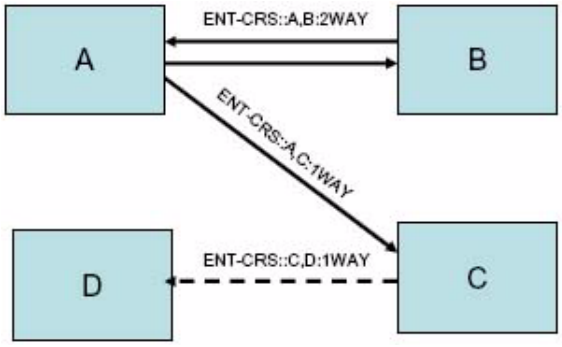


Figure 260. Head End Bridge Example (Head end is A)

Broadcast/Conference Cross Connect

A broadcast/conference connection involves connecting a STS-1, STS-3c, STS-12c, STS-48c or a STS-192c input, called broadcast/conference head, on a unidirectional head-end bridge basis to a number of other unused STS-1, STS-3c, STS-12c, STS-48c or a STS-192c output, called broadcast tail; that is the system should allow an broadcast/conference connection from port A to port B,C,E..Z as long as port B,C,,E..Z are idle or one of them is 1WAY cross conneted to the head A as shown in Figure 261..

The maximum number of broadcast leg connections from the same head end are as follows:

- STS-1/STS-3c/STS-12c/STS-48c/STS-192c - 8

Once a broadcast head with a number of broadcast legs has been established, the system allows more legs to be added or deleted.

The system allows one and only one of the legs to be one-way

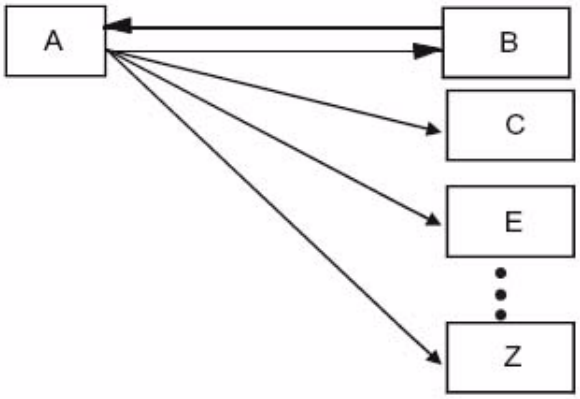


Figure 261. Broadcast/Conference Connections

Cross connections related to UPSR

Note: Only the various cross connect types necessary for implementing a UPSR are covered.

The NE supports UPSR path at STS-1, STS-3c, STS-12c, STS-48c and STS192C levels.

The OC-n interfaces that have been configured as UPSR supports passthrough connections from one ring fiber to other ring fiber as shown in Figure 262..

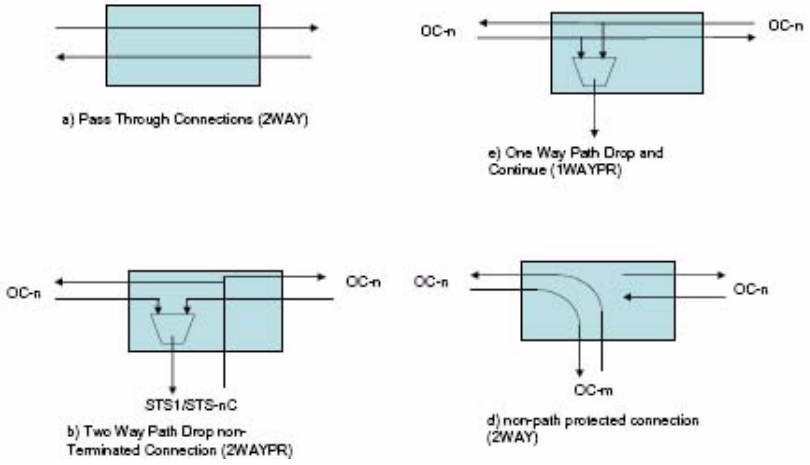


Figure 262. UPSR Connections

The OC-n interfaces that have been configured as UPSR supports two-way non-terminated paths (2WAYPR) connections as shown in Figure 262. b. A Drop-nonterminated is a path selected from the ring without having its path terminated at the exit node. For example a STS-1 signal could be dropped to another STS-1 embedded within an OC-n.

The 2WAYPR and 1WAYPR and THRU, UPSR protected connections are supported for STS1, STCnC facilities that a) belong to a UPSR FFP, and b) have been individually provisioned to participate in UPSR connections

The 2WAY and 1WAY unprotected connections are supported for STS1, STCnC facilities belong ing to a UPSR FFP, but have not been provisioned to participate in UPSR connections

Once a path pair is defined to be two-way drop terminated/non-terminated path, the system provides bridging functions to add a signal to the ring by transmitting the same low speed signal (STSnC, STS1) on both fiber rings in the same time slot.

Once a path pair is defined to be a two-way drop terminated/non-terminated path, the system provides a selector function to drop a signal from the ring by determining which of the two received signals is better. The determination of the better signal is done.

The OC-n interfaces that have been configured as UPSR supports 2WAY cross connect from the ring OC-n to to any other available facility on the NE of the same rate and format. (i.e. unprotected path from the Ring OC-n to the drop side or another Ring OC-n) as shown in Figure 262.d

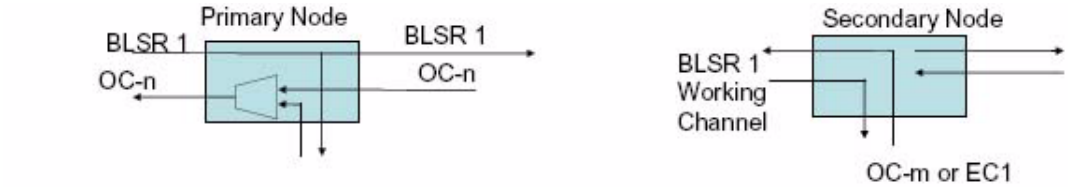
The OC-n interfaces that have been configured as UPSR supports 1WAY cross connect from the ring OC-n to to any other available facility on the NE of the same rate and format. (i.e. unprotected path from the Ring OC-n to the drop side or another Ring OC-n).

The OC-n interfaces that have been configured as UPSR supports 1WAY drop and continue path protected cross connect (1WAYPR) as shown in Figure 262.e.

Cross connections related to BLSR

Note: Only the various cross connect types necessary for implementing a BLSR are covered.

The NE supports a Two way Drop and Continue cross connection between a OC-n defined to be part of a BLSR and a drop connection as shown in Figure 263. a. These connections are used to support dual node ring interconnect.



a) Two Way drop and Continue (2WAYBLSR) **b**) 2Way Connection (2WAY)

Figure 263. BLSR cross connections for Dual Node Ring Interconnect

The NE supports a two way cross connect from the Secondary Ring node Interconnect to Working OCn in 2 fiber BLSR (2WAY) as shown in Figure 263. b.

Ring Interconnect connections

The NE allows a path facility that is used as a drop connection of either an UPSR or a BLSR ring to be defined as a drop connection of another UPSR or a BLSR ring.

Connection Circuit Identification

The NE provides for an operator to specify up to 45 characters to identify uniquely each leg of a cross connect, to modify/change the connection Circuit ID (Identification) of an existing cross connect., to retrieve the connection circuit identification of a provisioned cross connect and to retrieve all cross-connections that contains a specified circuit ID.

The Connection Circuit Identification isn't allow any semicolon, double quote, asterisk, greater-than, less-than, or backslash characters.

Non-blocking cross connects

Full grooming, non blocking connections is possible for any and all STS1s, and STSnCs across all I/Os, including hairpinning.

Retrieval of Connections

A method is available to retrieve cross connect information for existing connections. These cross connects include pass through connection.

State Transitions

The transition of the cross connect object entity between two facility entities is described in Figure 264. and Table 39. describes the possible primary and secondary state values for a cross connect entity. The pass through connections conform to this state transition.

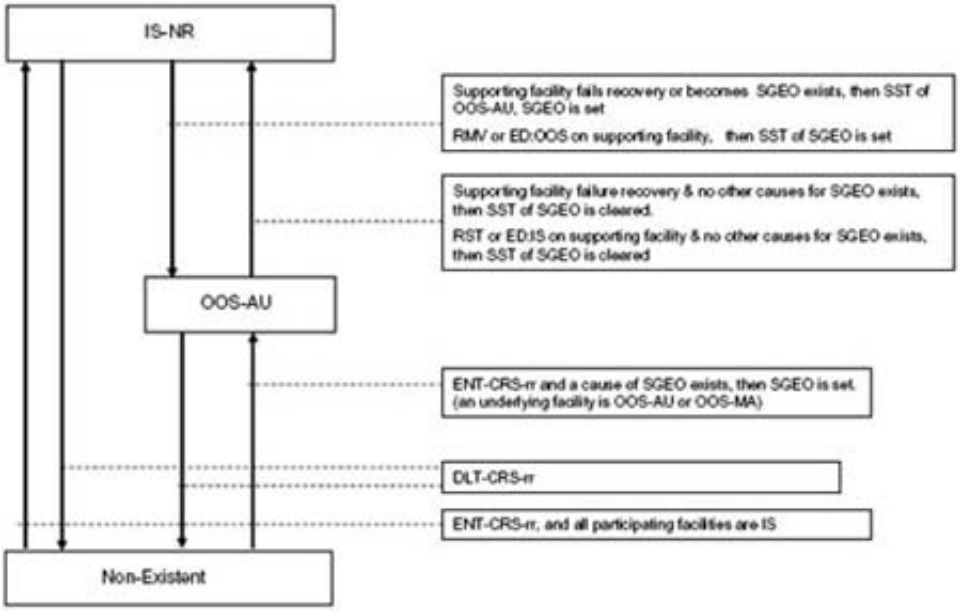


Figure 264. Cross Connect State Transitions

Table 39. State Values of a Cross Connect

PST Value	Possible Cause of PST Change
IS-NR	
OOS-AU	SGEO

When a cross connection is made between two facilities, then the cross connect entity transits from a non-existing state to either IS-NR or OOS-AU primary state depending on the primary state of the facilities as Table 40. shows:

Table 40. Cross connect states with respect to the facility states

Primary state of either/both Facility	State of the Cross Connect
IS-NR (Both)	IS-NR
OOS-AU (either)	OOS-AU, SGEO
OOS-MA (either)	OOS-AU, SGEO
OOS-AUMA (either)	OOS-AU, SGEO

For facilities that are embedded within the 1+1 OC-n or that are path protected, the cross connect transits into OOS-AU, SGEO state only if the selected path is in OOS state.

When a facility is cross connected, that entity carries an ACT secondary state if more cross connects can be made to that facility as illustrated in Figure 265.

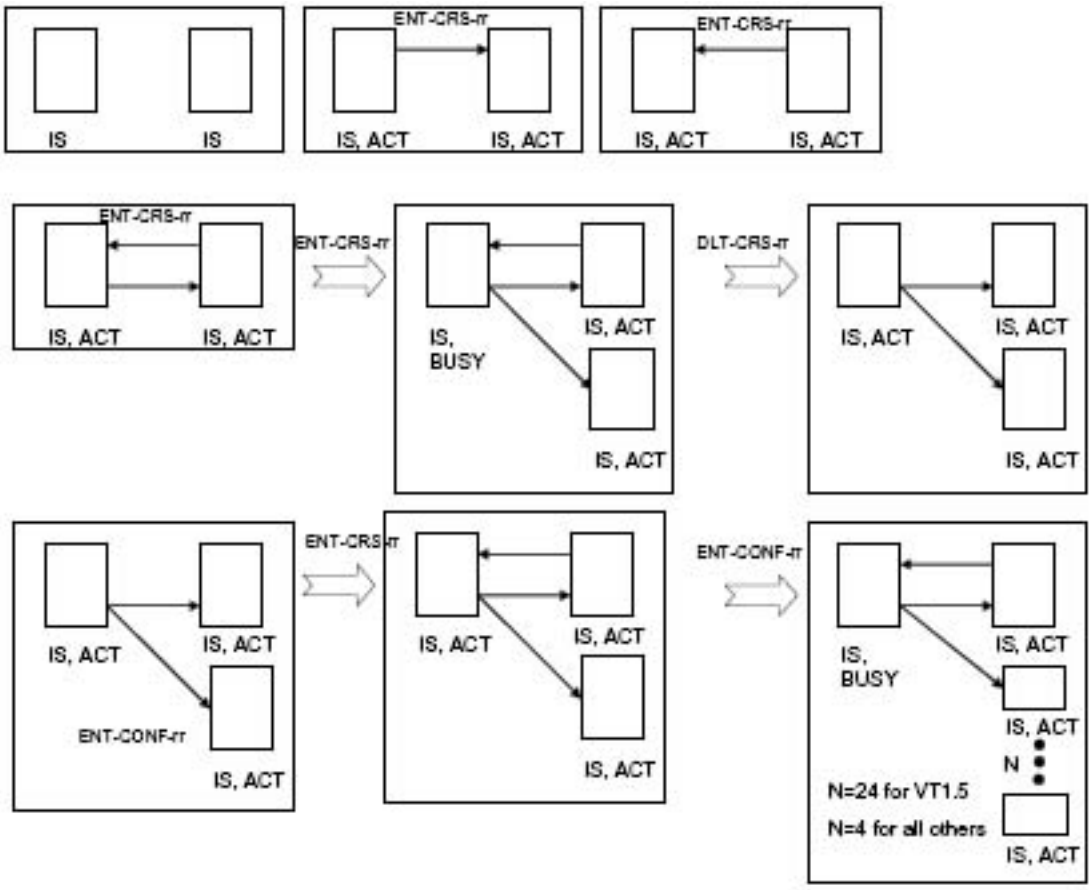


Figure 265. Cross Connect Facility States

When a facility is cross connected, that entity carries a BUSY secondary state if no more cross connects can be made to that facility as illustrated in Figure 265..

When a 2WAYPR, 1WAYPR, 2WAYDC cross connect is made on a path facility within an OC-n that is defined to be in a UPSR relationship, the entity that is the defined as the preferred path carries WRK secondary state. The facility that is defined to be alternate path carries STBYH secondary state.

The deletion of a cross connection is allowed regardless of the state of the facility entities (i.e., a connection may be disconnected when the facility entity is in the IS-NR state, failed, or logically removed).

If after deletion of the cross connect, if a cross connect still exists on the facility, then the facility carries an ACT secondary state.

If after deletion of the cross connect, the facility is not cross connected to any other facility, then the ACT secondary state on the facility is cleared.

The system allows cross connecting a port that is under loopback and not when its supporting line entity is under loopback.

On a STS-1 to STS-1 cross connect, all the higher level facility objects in which the STS-1 is embedded, carries a TRM secondary state.

On a STS-nC to STS-nC cross connect, all the higher level facility objects in which the STS-nC is embedded, carries a TRM secondary state.

3.5.1.5 Optical Cross Connections (OCONN)

In TDM systems there are certain implicit connections that exist by virtue of the backplane interconnect. For instance most of the field replaceable units have backplane connections that give them access to some of the switch fabric bandwidth. In DWDM systems, these connections among facilities and between facilities and add/drop access points are made by connecting optical fiber jumper cables between the connection points. The system software is provisioned with information about the placement of these optical fiber jumper cables in order to assess whether the system can support the connections requested by an operator. Furthermore, the information about the placement of the optical fiber jumpers allows the system to account for the consequent actions of establishing a connection and to correlate the messages about faults and trace the messages to the source of the problem so that it can be reported to the management system.

OCONN structures are treated as equipment. They can be pre-provisioned in a network element

To reduce the amount of provisioning that is required some of the OCONNs have been fixed by convention. These OCONNs comes into existence with the provisioning of a DWDM optical facility. The placement of circuit packs and fibering is fixed by the configuration rules, and therefore there is no need to place that burden on the craft worker. Consequently the only AIDs that are provisionable as OCONN endpoints are the OMD-PORT, the OT port, and the OPS port. OCONNs that are implicitly provisioned are those between Line Driver (LD) ports and Wavelength Router (WR) ports, WR ports and Optical Mux-Demux (OMD) ports, and among WR ports. Photonic cross-connects are denied to OMDPORTS that do not have an OCONN provisioned.

The rest of the OCONN connections depend upon the growth order of the system and are explicitly provisioned. OCONNs that need explicit provisioning are those between OMD ports and OT ports, OMD ports and OPS ports, and those between OPS ports and OT ports. Optical ports that are exposed as user connections (except client ports of OTs used as external ports) are connected to a special AID to demonstrate intentional connection and to assist checking of higher layer structures like protection groups and photonic cross-connections.

An optical connection or OCONN connects two optical ports in a network element.

The equipment containing both ports specified as endpoints for the OCONN must have been provisioned before the OCONN can be provisioned.

Entering an OCONN on an OPORT, it moves the OPORT out of its initial state, to a state that allows the provisioning of an optical path

Deleting an OCONN from an OPORT, it moves the OPORT back to its initial state.

An OCONN that is supporting higher level structures or services can’t be deleted until the structures that it supports have first been deleted.

Note: In release 2 optical protection groups and photonic cross-connects are the two higher level structures that depend upon the pre-existence of OCONNs at OPORTS.

It is illegal:
– to connect two transmit ports with an OCONN.
– to connect two receive ports with an OCONN.

An OCONN is either type 1WAY or type 2WAY. A 1WAY OCONN connects a transmit port to a receive port. A 2WAY OCONN connects two bi-directional ports as follows: from the transmitter of the first port to the receiver of the second port, and from the transmitter of the second port to the receiver of the first port.

Each port (transmit or receive) has at most one OCONN attached. A bi-directional port can have either two 1WAY OCONNs or one 2WAY OCONN attached.
Each OCONN bears an arbitrary label.
The OCONN that connects an OT with an OMD sets the tuning frequency of the laser transmitter.
The first OCONN that connects one of the two splitter ports of an OPS pack to an OMD sets the required frequency for the other splitter port and the SIG port to the frequency of the OMD port. Subsequent connections to the ports on the OPS pack matches the frequency of the first OCONN.
An OT line port that is connected to the SIG port of an OT inherits the frequency of the ASPLIT port or BSPLIT port (which must be the same) whenever the OCONN on the ASPLIT or BSPLIT port is provisioned.
Optical channel ports that are exposed to the user for connection is provisioned with an OCONN that connects them to a special AID named EXTERNAL.
Client ports of OTs do not require the OCONN to the special AID named EXTERNAL. Requiring that OCONN would result in extra provisioning for little or no gain in functionality.

Note: Applying the OCONN to the SIG port of an OPS pack, for instance, raises the state of the facility at that port out of the disconnected state, simplifying the mechanism for creating and checking protection groups.

3.5.1.6 Optical Cross connect types

One-Way/Two-way

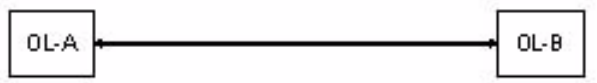


Figure 266. Simple Through

A single input command establishes:

- a unidirectional optical path between a wavelength on a DWDM facility port and the same wavelength on any outgoing DWDM facility except the one on which it entered the network element.
- a bidirectional optical path between a wavelength on DWDM facility port and the same wavelength on any outgoing optical line except the one on which it entered the network element.
- a unidirectional optical path between a wavelength on a DWDM facility port and the corresponding wavelength on the drop port of that facility's OMD.
- a unidirectional optical path between a wavelength on a DWDM facility port and the corresponding wavelength on the add port of that facility's OMD.

Any photonic 1WAY or 2WAY cross connect is able to be disconnected with a single input command.

Two 1-way cross connects that form a bi-directional connection (i.e. going between the same ports) is only be able to be disconnected by separate 1-way disconnect commands.

Add/Drop Configuration

The add/drop configuration is created by fibering an OT to an OMD and entering the OCONN and the OT circuit pack, then adding a cross connect on the optical line to which the OMD is attached at the appropriate frequency

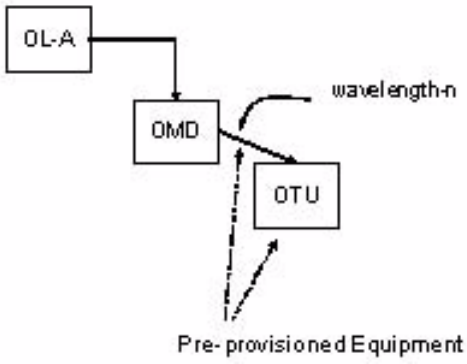


Figure 267. Add/Drop

A single input command establishes a bidirectional optical path between a wavelength on an OMD add/drop port to the same wavelength on the physically attached optical line.
The NE doesn't support self connected ports i.e. allow a port to be one way connected to itself.

Optically Protected 1WAY

The protected facility is created by constructing separate 1WAY connections along two different paths through the network, beginning at the head end and terminating at the tail end.
An optical protected 1WAY configuration consists of a head end where an optical protection group splits the signal before adding it to two separate outgoing optical lines, and a tail end where an optical protection group selects one of two signals from the two separate optical lines before dropping it. An OT protection group has been previously provisioned in ADD mode at the head end and another optical protection group provisioned in DROP mode at the tail end and their respective ports previously provisioned with OCONN objects to the corresponding internal ports.
The protection group of an optically protected 1Way configuration can be either a protected line configuration or a protected OT configuration.

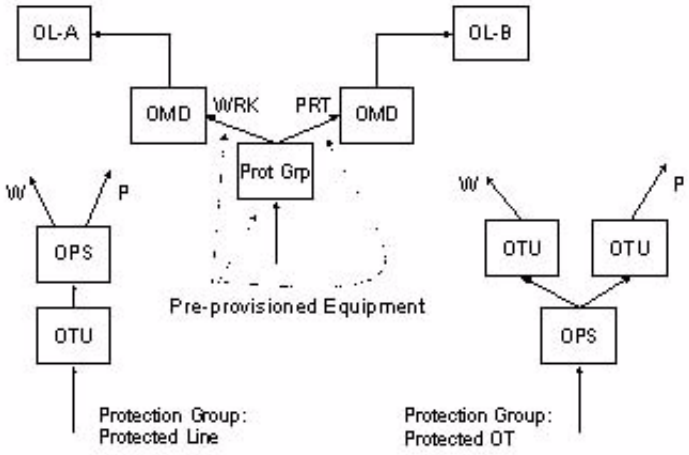


Figure 268. Optically Protected Head End

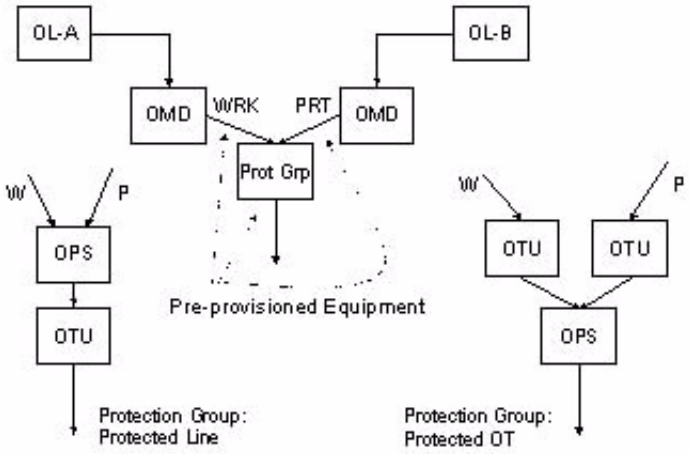


Figure 269. Optically Protected Tail End

Optically Protected 2WAY

An optically protected 2WAY configuration consists of a head end and a tail end co-located in each terminating network element. At each head end an optical protection group splits the source of the signal into two branches before adding it to two separate outgoing optical lines. At each tail end, an optical protection group selects one of two signals from the two separate optical lines before dropping it to a receiver at both terminating network elements.

The protection group of an optically protected 2WAY configuration can be either a protected line configuration or a protected OT configuration.

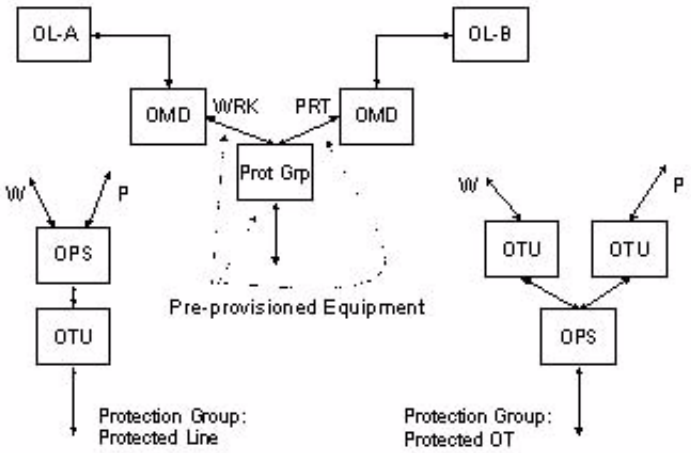


Figure 270. Optical Protected

Regenerate

A regenerate configuration consists of a 1WAY connection to a Drop Port from an incoming optical multiplex and a 1WAY connection from an add port on a different optical line to an out going optical multiplex on the same wavelength. An OT has been previously provisioned in REGEN mode and its ports previously provisioned with OCONN objects to the corresponding internal ports.

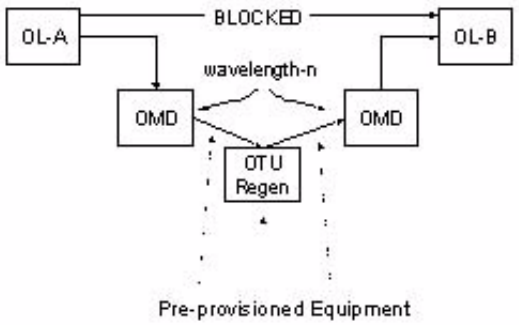


Figure 271. Regenerate

Drop and Regenerate

A drop and regenerate configuration consists of a 1WAY connection to a Drop Port from an incoming optical multiplex and a 1WAY connection from an add port on a different optical line to an out going optical multiplex on the same wavelength. An OT has been previously provisioned in DROP_AND_REGEN mode and its ports previously provisioned with OCONN objects to the corresponding internal ports.

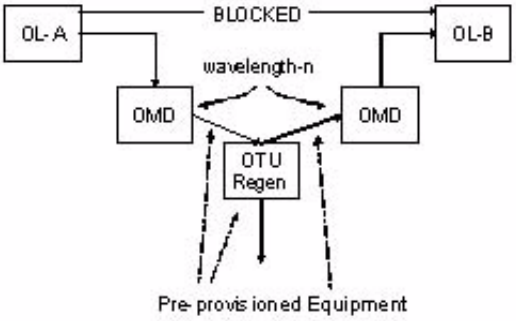


Figure 272. Drop and Regenerate

Drop and Continue

A drop and continue configuration consists of a 1WAY connection to a Drop Port from an incoming optical multiplex and a 1WAY connection from an incoming optical line to an outgoing optical line. A bidirectional OT has been previously provisioned in DROP mode or a unidirectional OT used and its ports previously provisioned with OCONN objects to the corresponding internal ports.

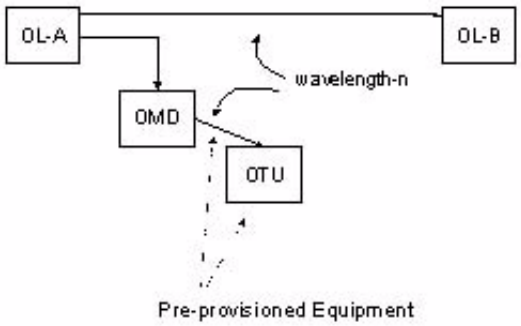


Figure 273. Drop and Continue

Drop and Continue Protected

A drop and continue protected configuration consists of a 1WAY connection to a Drop Port from an incoming optical multiplex, and a second 1WAY connection to a Drop Port from a different incoming optical multiplex, and a 1WAY connection from both the incoming optical lines to outgoing optical lines. An OT protection group has been previously provisioned in DROP mode and its ports previously provisioned with OCONN objects to the corresponding internal ports.

The protection group of a drop and continue cross connection can be either a protected line configuration or a protected OT configuration.

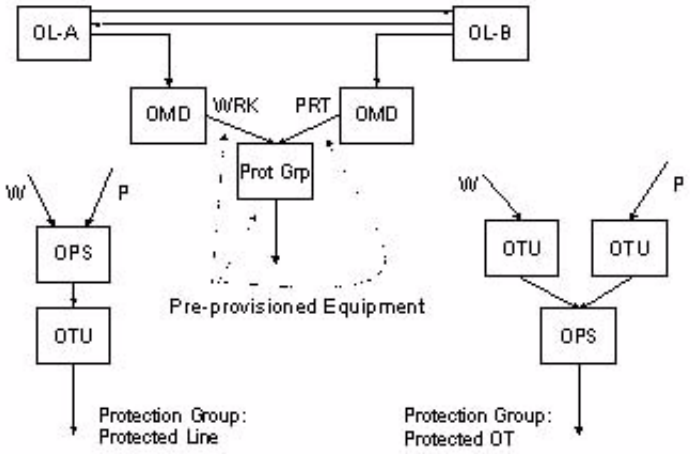


Figure 274. Drop and Continue Protected

Drop and Continue Protected w/Regeneration

A drop and continue protected cross connection with regeneration consists of a 1WAY connection to a Drop Port from an incoming optical multiplex and a 1WAY connection from the regen OT to the add port of an outgoing optical line, and a 1WAY connection from the same optical line as the previously mentioned outgoing signal to the drop port and a 1WAY connection from a second regen OT to the Add port of the original incoming signal. The two regen OT packs each drops a signal to an OPS pack one to the WRK port and one to the PRT port. An OT protection group has been previously provisioned in DROP-REGEN mode and its ports previously provisioned with OCONN objects to the corresponding internal ports.

The protection group of a drop and continue cross connection must be a protected OT configuration.

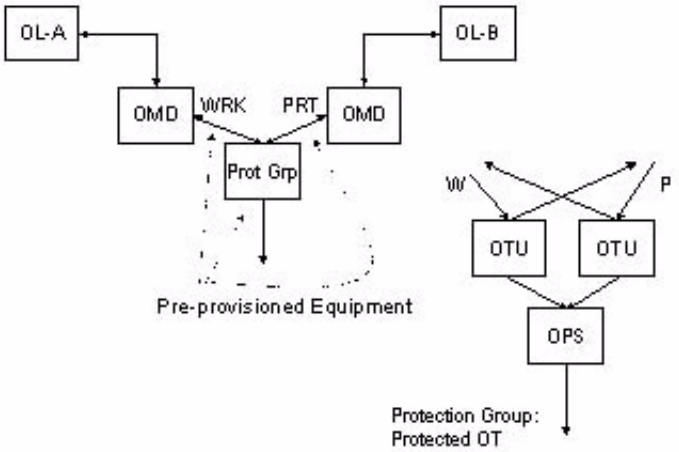


Figure 275. Drop and Continue Protected w/Regeneration

Wavelength Change

A wavelength change cross connection consists of a 1WAY connection to a Drop Port from an incoming optical multiplex and a 1WAY connection from an add port to an out going optical multiplex on a different wavelength. An OT has been previously provisioned in REGEN mode and its ports previously provisioned with OCONN objects to the corresponding internal ports.

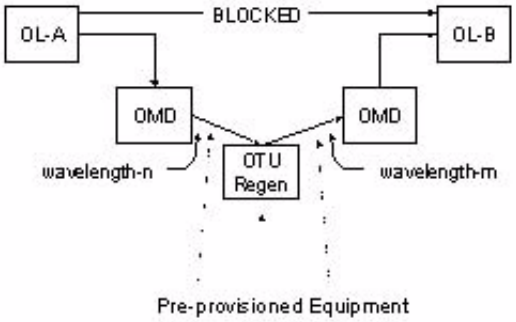


Figure 276. Wavelength Change

Multicast

Additional 1WAY bridge connections can be established from a wavelength on a line input port to the same wavelength on any other output line or a drop port.

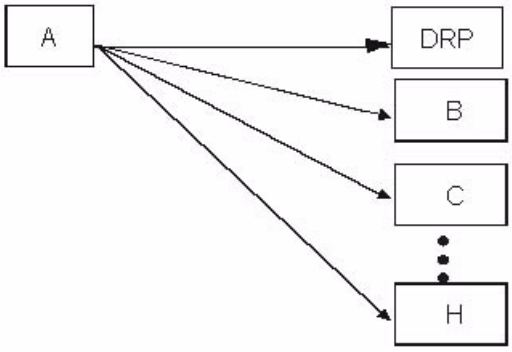


Figure 277. Multicast

The maximum number of multicast leg connections from the same head end is limited to the maximum number allowed by the provisioned equipment. WR4 allows four-way multicast, WR8 allows eight-way multicast.

Once a multicast head with a number of legs has been established, the system allows more legs to be added/deleted.

The system allows one and only one of the legs to be one-way back connected to the head. This can be established by any 1WAY cross connect with port A as its destination or by the initial set up of a 2Way cross connect on any of the ports DRP (ADD) or B through H, or by adding a 2WAY cross connect to an initial 1WAY cross connect or set of 1WAY cross connects.

In general any destination AID can have one and only one source.

Bridge

A bridge configuration involves connecting a wavelength input, that is already 1WAY or 2WAY cross connected, on a unidirectional head-end bridge basis to any other unused wavelength output of the same wavelength as the input.

This is a special case of the multi-cast construct: i.e. if OTSOCH port A is either 1way or 2way cross connected to port B, then the system allows a head end bridge from port A to port C as long as the receiver on port C is not participating in another connection see Figure PCONN-1.

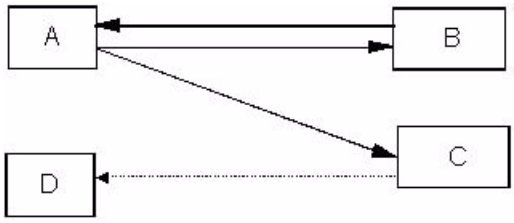


Figure 278. Head End Bridge

Once the bridge is established, any 1-way cross connect that is formed is able to be disconnected by a 1-way disconnect command; any 2-way cross connect that is formed is able to be disconnected only by a 2-way disconnect command.
Once a Head-End bridge is established, deletion of any cross connect leaves any remaining cross connections intact.

Non-blocking cross connects

Full grooming, non blocking connections are possible for any and all photonic cross connects, as long as the necessary hardware is equipped and the proper jumper connections are made and provisioned. Hair pinning of photonic layer signals is explicitly not allowed.

Retrieval of Connections

Photonic cross connect information for existing connections can be retrieved by means of the suitable commands.

State Transitions

The transition of the cross connect object entity between two facility entities is described in Figure 279. and Table 41. describes the possible primary and secondary state values for a cross connect entity.

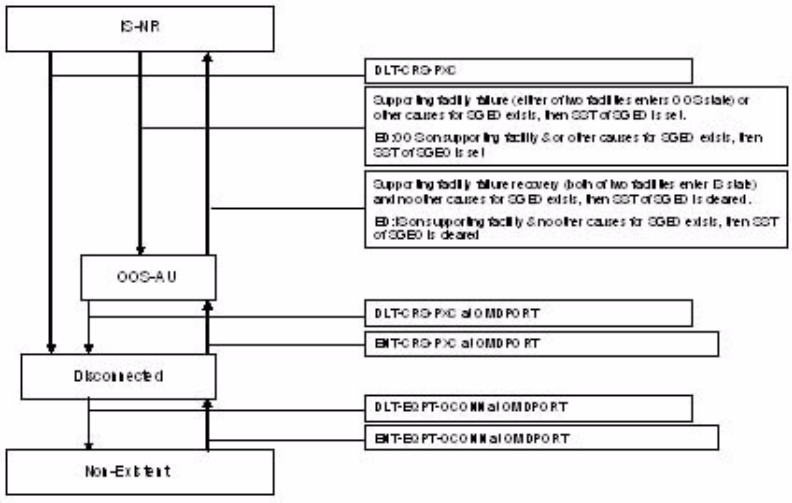


Figure 279. Cross Connect State Transitions

Table 41. State Values of a Cross Connect

PST Value	SST Values	
	Possible Cause of PST Change	Possible Additional SST Information
NON-EXISTENT	Initial State	
DISCONNECTED	ENT-EQPT-OCONN	
OOS-AU	ENT-CRS-PXC	
IS-NR	Arrival of Light Signal, Both Facilities exit OOS	
OOS-AU	At least one facility enters OOS	
DISCONNECTED	DLT-CRS-PXC	
NON-EXISTENT	DLT-EQPT-OCONN	
Note: SGEO- Supporting Entity Outage		

When a cross connection is made between two facilities, then the cross connect entity transits from a disconnected state to either IS-NR or OOS-AU primary state depending on the primary state of the facilities as shows in Table 42.:

Table 42. Cross connect states with respect to the facility states

Primary state of either/both	FacilityState of the Cross Connect
IS-NR (Both)	IS-NR
OOS-AU (either)	OOS-AU, SGEO
OOS-MA (either)	OOS-AU, SGEO
OOS-AUMA (either)	OOS-AU, SGEO

When a facility is cross connected, that entity carries an ACT secondary state as shown in Figure 280..

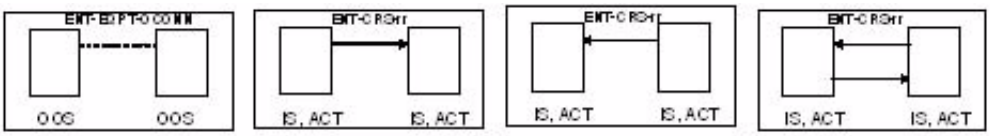


Figure 280. Cross Connect Facility States

The deletion of a cross connection is allowed regardless of the state of the facility entities (i.e., a connection may be disconnected when the facility entity is in the IS-NR state, failed, or logically removed).
If after deletion of a branch cross connect, a cross connect still exists on the facility, then the facility carries an ACT secondary state.

If after deletion of the cross connect, the facility is not cross connected to any other facility, then the ACT secondary state on the facility is cleared.

3.5.2 Loopbacks

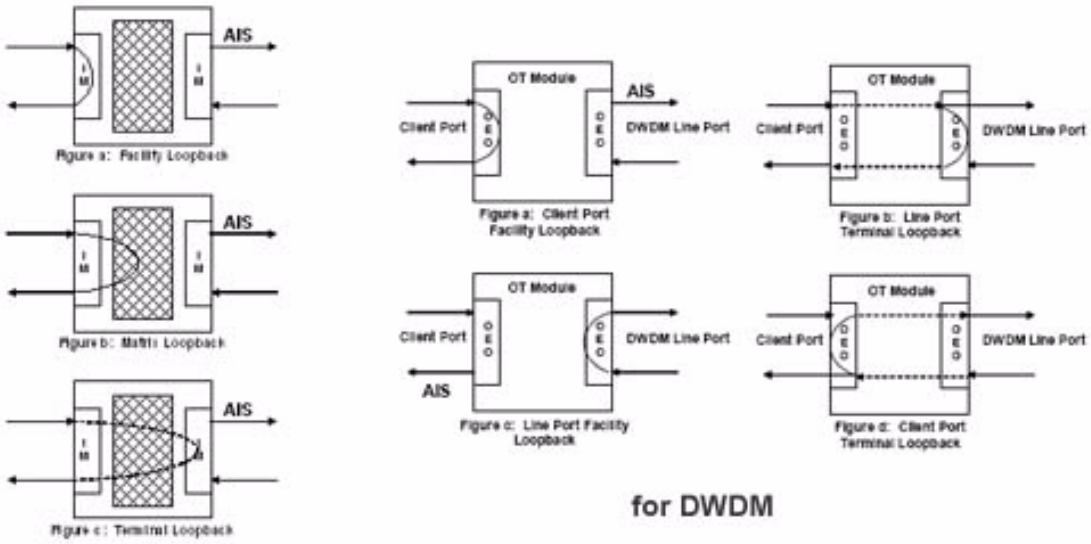
The Network Element supports the following types of near end loopbacks:

Table 43. Supported loopback types

Signal Level	Loopback Location		
	Near End	DWDM	
OC-192	Supported	Supported	Facility
OC-48	Supported		Facility
OC-12	Supported		Facility
OC-3	Supported		Facility
OTU2		Supported	Facility
10GBE		Supported	Facility
10GFC		Supported	Facility
OC-192	Supported	Supported	Terminal
OC-48	Supported		Terminal
OC-12	Supported		Terminal
OC-3	Supported		Terminal
OTU2		Supported	Terminal
10GBE		Supported	Terminal
10GFC		Supported	Terminal
STS-192c	Supported		Cross Connect (or Matrix)
STS-48c	Supported		Cross Connect (or Matrix)
STS-12c	Supported		Cross Connect (or Matrix)
STS-3c	Supported		Cross Connect (or Matrix)
STS-1	Supported		Cross Connect (or Matrix)

Capability to loopback working and protect OC-n facilities independent of each other is provided.

Figure 281. summarizes the loopbacks supported on the Network Element.



IM = Interface Module

Figure 281. Loopback Access Point

Facility Loopbacks

In a Facility loopback, the incoming received signal is connected to the associated transmitter in the return direction. Figure 282. depicts Facility loopback.

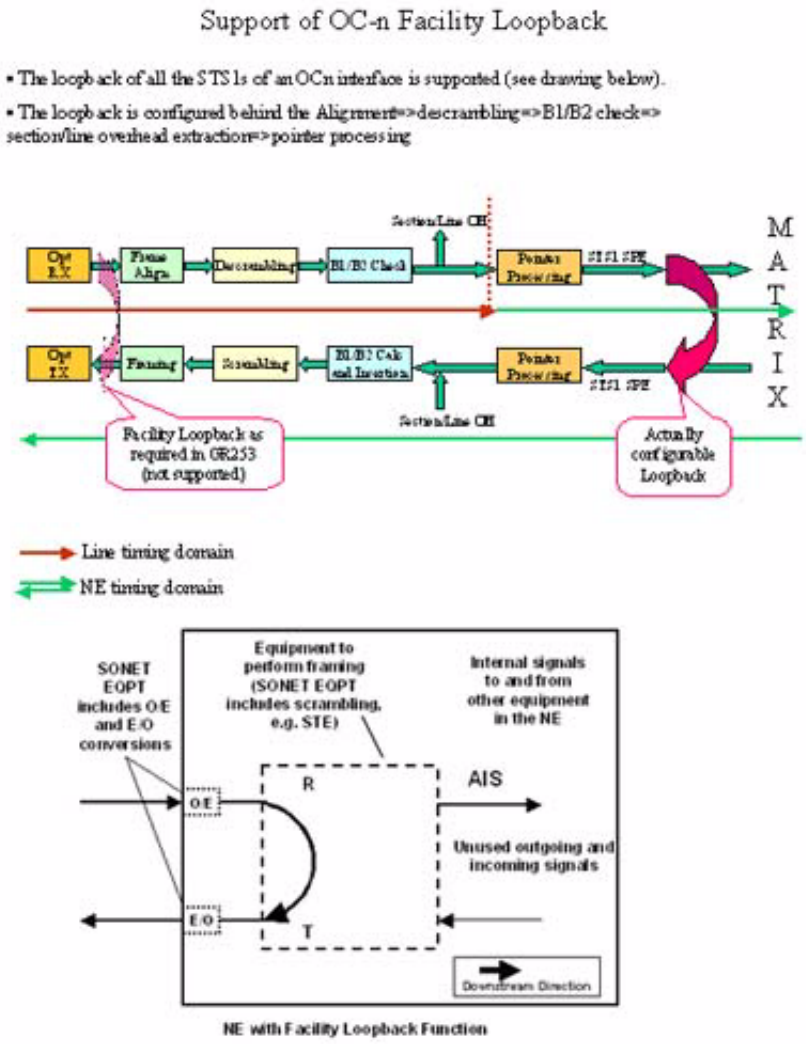


Figure 282. Facility Loopback

Terminal Loopbacks

In a Terminal loopback, the signal that is about to be transmitted is connected to the associated incoming receiver. Figure 283.depicts Terminal loopback.

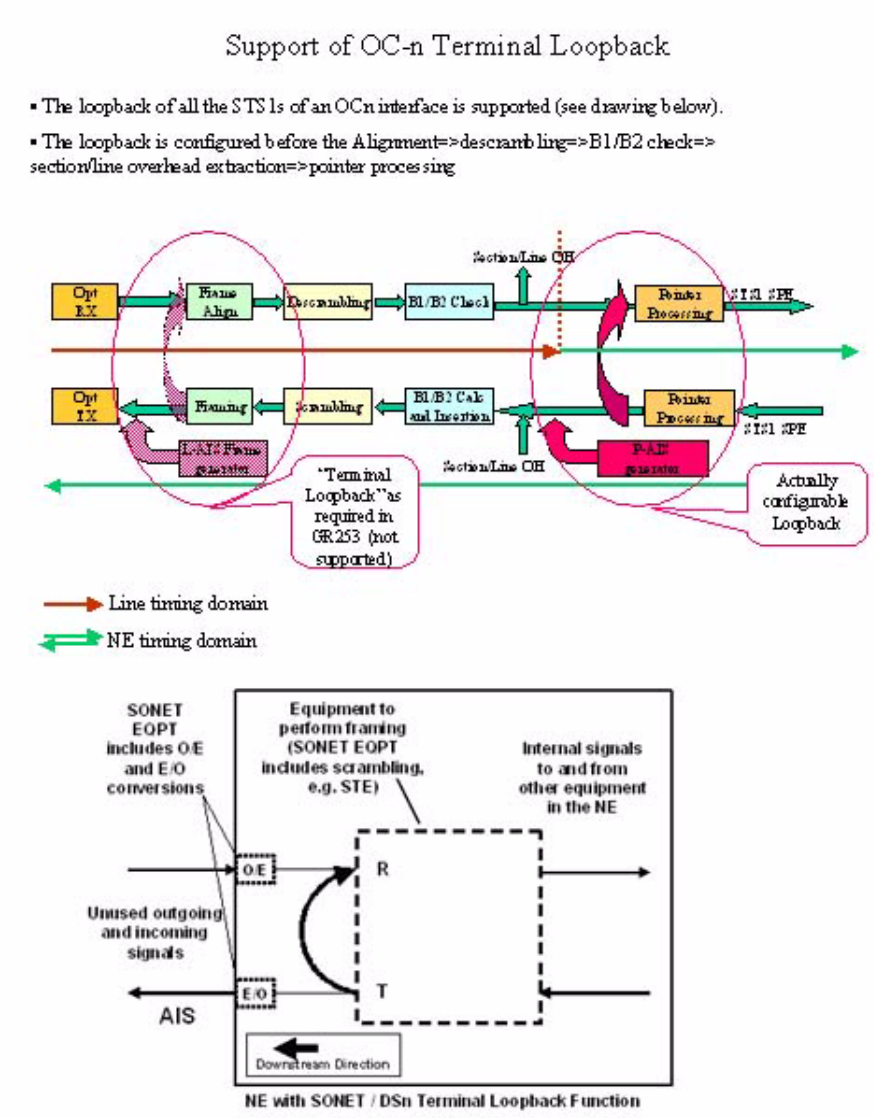


Figure 283. Terminal Loopback

Matrix Loopbacks

A basic Matrix Loopback is established by cross-connecting a port to itself through the fabric. A special type of Matrix loopback is established where path selectors are involved. Figure LPBK-4 depicts a Matrix loopback at the Drop of a 2-Way Protected connection.

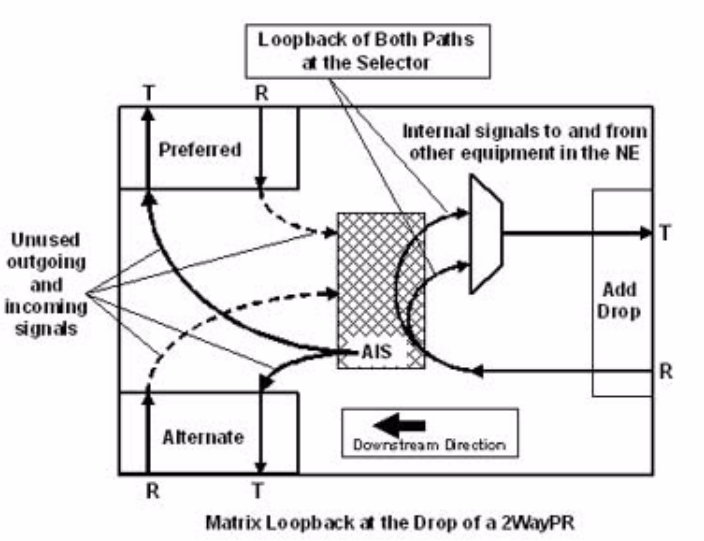


Figure 284. Matrix Loopback at the Drop of a 2WayPR

4 Unit Descriptions

The following sections provide information on the 1850 TSS-320 unit, sub-unit and pack.

Contents

– GENTRU (please ref ere to 4.1 on page 416)

– Common parts (please ref ere to 4.1 on page 416)

– SONET/SDH units (please ref ere to 4.3 on page 444)

– DATA units (please ref ere to 4.4 on page 483)

– ROADM packs (please ref ere to 4.5 on page 507)

4.1 GENTRU unit

This chapter describes the General Top Rack Unit, the part of the 1850 TSS-320 that terminates the two station batteries.

The GENTRU performs the following functions:

– Delivers power to the housed equipment by means of a DC/DC converter called “STEPUP”. The power output is as follows:
  - The distributed voltage is:.
    – 58 VDC for ANSI standard/market.
    – 65 VDC for ETSI standard/market.
    The selection is done by means of the switch on the back of the STEPUP converter
  - The distributed voltage can be either 48V or 60V by means of the Bypass or Extension Bypass.

– Delivers the service battery (VSERV+ and VSERV-) to the housed equipment (for future release)

– Collects commands received from the equipment and then generates optical indications and transmits remote alarms as necessary

– Connects the assemblies equipment to the supervisory network through connectors within the GENTRU.

The optical indications are generated by the "Rack Lamps UNIT" inserted into the GENTRU.

The GENTRU can be equipped with:

– LAMP GROUP:
  The LAMP GROUP manages the alarms of the installed system.

– STEP-UP 3500W:
  The 3.5 kW STEPUP is a DC/DC converter. It behaves as follows depending on whether ANSI or ETSI standard is selected:
  - ANSI standard: regulates the output voltage at 58 VDC with the input voltage in the range between 38.4 VDC and 58VDC. When input voltage is greater than 58 VDC and less (or equal) than 72VDC, the device works like a pass through (the internal switching circuit turns off and the output wires are connected directly with the input side).
  - ETSI standard: when the input voltage is between 38.4 VDC and 65 VDC, it is able to adjust the output voltage at 65 VDC (the internal switching circuit works as a step-up converter to generate the 65 V at the output side). When the input voltage is greater than 65 VDC and less (or equal) than 72 VDC, the device works like a pass through (the internal switching circuit turns off work and the output wires are connected directly with the input side);

– EXTENSION BYPASS:
  The Extension-Bypass works like a pass through in the range from 38.4 V to 72 V but with two breaker fuses, not one, installed inside the group. The two distributed lines are protected by two fuse-breaker that have a maximum capacity of 40 A.
  The power delivered at the output side is 3.5 kW and the stand-by state (output side) is available when the output is not connected to the load.

– GENTRU DUMMY COVER:
  The GENTRU DUMMY COVER is a cover that is used the in absence of extension bypass or step-up modules.

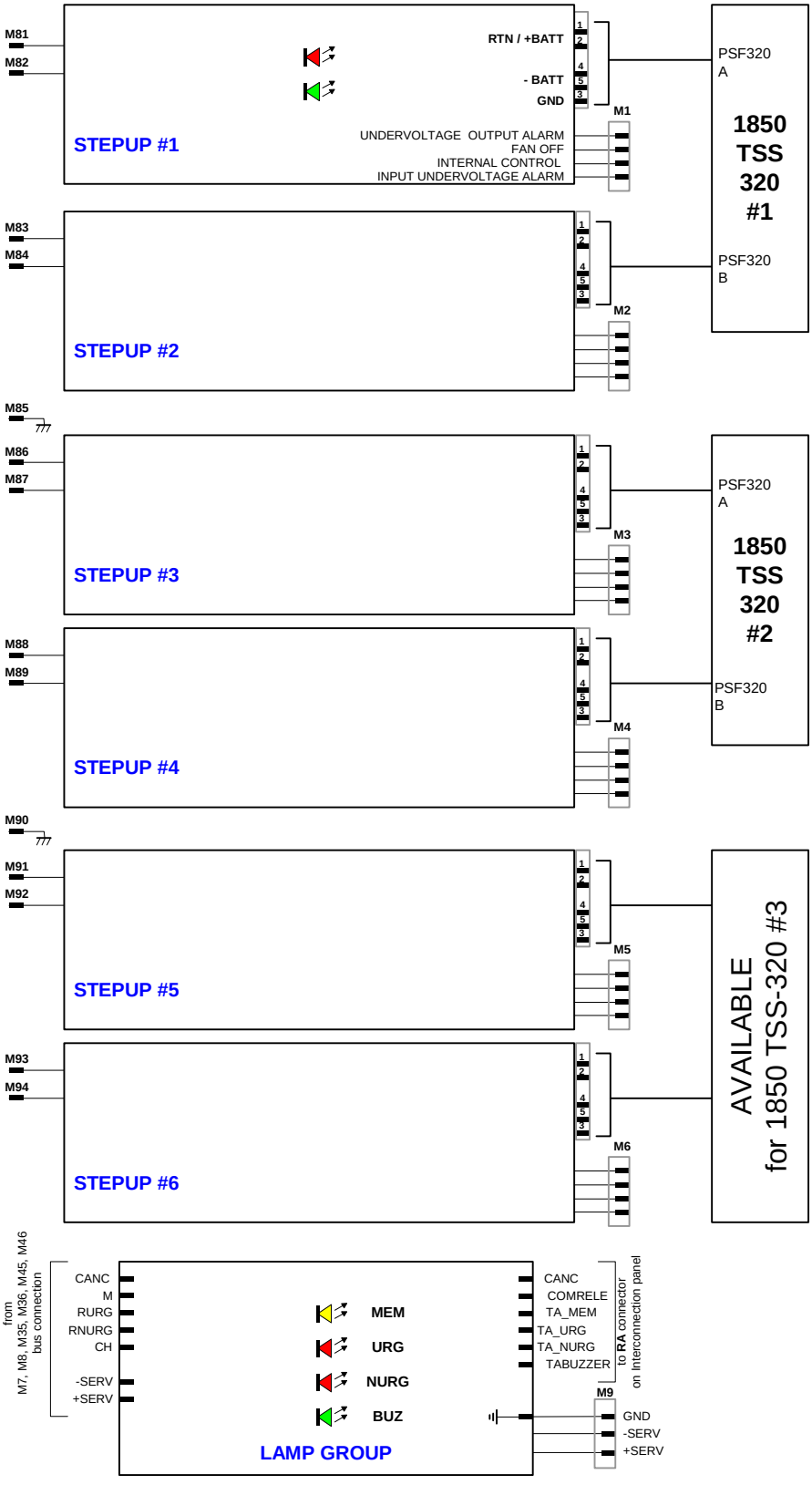


Figure 285. GENTRU unit - Block diagram

4.1.1 Back panel

In a telecommunication center, the unit receives a direct voltage at each of its three input lines, in compliance with the American standard AT&T 802-010-100 and European standard ETS 300 132-2 .

Three input battery voltages can be distributed through the back panel, to a maximum of three units housed in the bay frame/rack:

- L1 (A and B) on connectors M81÷M84
- L2 (A and B) on connectors M86÷M89
- L3 (A and B) on connectors M91÷M94

to maximum three equipments housed in the bayframe/rack.

All the inputs are protected from short-circuit by automatic breaker (40 A) placed on extension bypasses or by an electronic short-circuit protection placed on the step-ups.

4.1.2 Extension ByPass

The Extension ByPass is supplied by the telecom station power supplies and acts as an interface between the station power supply and the equipment. Because it delivers a distributed voltage of either 48 VDC or 60 VDC from power supply to the equipment, the extension bypass can be considered a pass through. The two distributed battery lines are protected by two fuse breakers that have a maximum capacity of 40 A.

It is important to note that the extension bypass always works in pairs (one powered from battery A and the other from battery B); it is not possible to have only one extension bypass.

The following are the components and symbols found on the front cover panel:
– Two manual vertical lever type ON/OFF fuse breakers located on the negative line. The switch is ON when the switch lever is up.
– A DC/DC symbol in the top right corner
– An ON/OFF symbol near the switches

Two connectors on the upper cover panel deliver the main power supply voltage (48V/60V) to the housed assemblies/equipment.

4.1.3 Lamp group

This unit can be considered an interface between signals coming from the apparatus in the bayframe/rack and the LED lighting/outgoing alarms.

The following are the components and symbols that are visible on the front cover panel of the 1850 TSS-320:

a) One green LED that indicates the presence of the service call or service battery
b) One red LED that indicates the presence of an urgent alarm (Major)
c) One red LED that indicates the presence of a not urgent alarm (Minor)
d) One yellow LED that indicates the storing of an alarm

e) A manual vertical lever type ON/OFF fuse-breaker located on the negative input. The switch is ON when the lever is on.
f) An Interface connector for extension alarm.
g) An ON/OFF symbol near the switch.

The unit may be supplied in any case by the service battery (VSERV) or via presetting (default internal configuration of TC is closed) one of the three lines (L1, L2 and L3) of the input power bus.

Voltage can be delivered to the housed assemblies/equipment to manage the "tele-alarms".

The conversion frequency is 300 kHz.

Protections

a) Protection against transients
Input protection is provided with a transil. It is possible for transients or spikes to occur on the voltage bus that is carried and distributed inside the equipment. The cause varies; the most probable being the result of a sudden load change that could occur when a fuse is blown, for example. The parasitic inductances present in the distribution mains of the input voltage may generate spikes with a discrete power (up to 70W).

b) Start-up and inrush current limiting circuit
When a board is inserted in the equipment connector, all its capacitors are discharged and a pseudo short-circuit occurs. The fuses are present on both the lines to provide the maximum protection in case of battery floating (not connected to ground).
The inrush current generated is limited to a low value because the MOSFET is open, thus presenting a high in-series resistance.
When the threshold is reached:
1) The MOSFET gate capacity progressively charges itself by setting the MOSFET Rdson value to a very low value in the mW range.
2) The hysteresis cycle (during the shutdown phase) opening at approximately 29V

c) Input protection

F1 = 5A
F2 = Fusebreaker = INT. UNIP. 1A 80V

A circuit (diode) that is able to prevent reverse polarity voltage

Alarms

Rack alarms are processed through the "group lamp". The group lamp receives information on the alarm condition of the housed assemblies/equipment through the bus.

The group lamp is equipped with LEDs which detect the following alarm conditions:

1) Red LED "URG" - urgent alarm (MAJOR)
2) Red LED "NURG" - non-urgent alarm (MINOR)
3) Yellow LED "M" - storing alarm

The detected alarm can be stored, red LED goes OFF and yellow LED goes ON, by an external command (CANC).

The alarm system is ready to detect new alarm conditions.

A green LED is used (through a presetting) to indicate the reception of the service call or the presence of the service battery.

The TA_NURG, TA_URG, TA_MEM and TA_BUZZER remote alarms can be accessed .

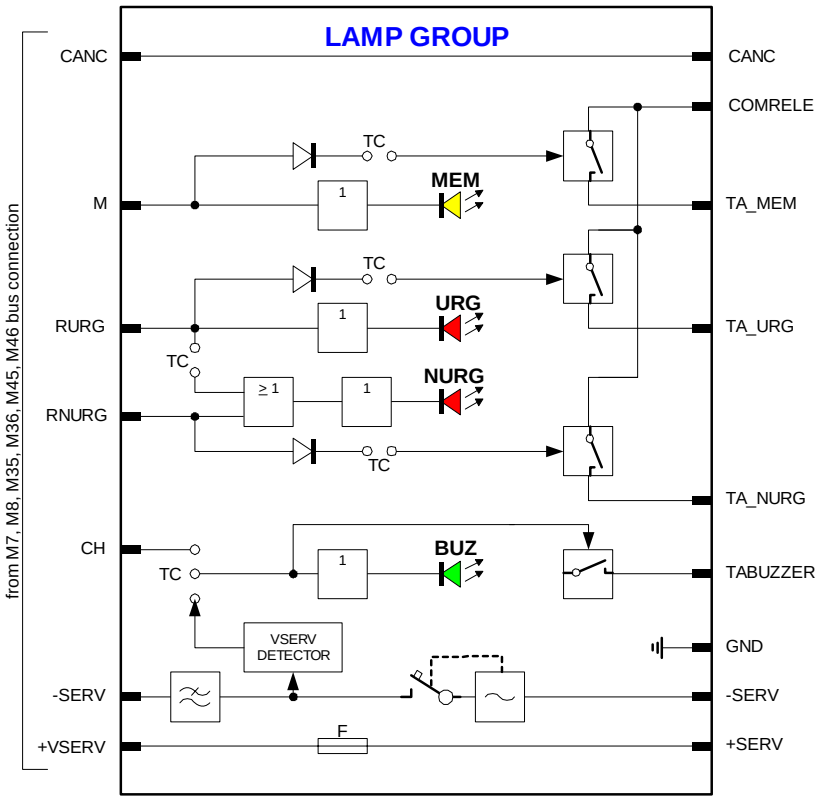


Figure 286. Rack lamp - Block diagram

4.1.4 STEPUP unit

Figure 50. on page 91, Figure 52. on page 93, and Figure 287. on page 421, show views of the SETUP unit.

This unit (maximum 6) is mounted on the GENTRU subrack.

It is important to note that the **STEPUP** unit always works in pairs (one powered from battery **A** and the other one powered from battery **B**); it is not possible to have only one STEPUP unit.

Each STEPUP unit distributes the Power Supply voltage (**A** and **B**) to a maximum of **3** shelves in the bayframe/ rack.

The power is supplied to the unit by means of a Manual ON/OFF Switch when the lever is down.

Input circuits protect against reverse voltage, undervoltage, and overvoltage (reversible type).
A fuse on the negative input protects against overload protection.

The STEPUP unit provides an output voltage test point marked “Vout” and is also protected against output short circuits.

LEDs on the STEPUP unit are as follows:

- green LED ON in normal output voltage condition
- red LED ON when the unit is in alarm

The STEPUP unit is equipped with an internal fan for air flow from the front to top of the unit.

The correctly remove the STEPUP unit from the GENTRU subrack, insert the appropriate extractor tool into the appropriate access point.

The following unit alarms are detected and reported by the SETUP unit:

- **FANOFF** = detection of faulty fan.
  Both green and red LEDs are ON.

- **UNDERVOLTAGE OUTPUT ALARM** = detection of output voltage of less than 65V. This is referred to as Vnom and is from -10% to -20% less than the expected voltage. This alarm is not active when the input undervoltage alarm is present.
  Green LED is off; red LED is ON.

- **INTERNAL ALARM** = detection of an overvoltage or overtemperature.
  Green LED is off; red LED is ON.

- **INPUT UNDERVOLTAGE ALARM** = detection of an undervoltage threshold of the incoming voltage that is incompliant with European and American standards.
  Green LED is off; red LED is ON.

The four alarms are also connected to and are available on the tagblock of the GENTRU subrack.

Remote Inventory circuit is present on the unit for internal use.

Refer to 5.4.3 on page 555 for electrical characteristics.

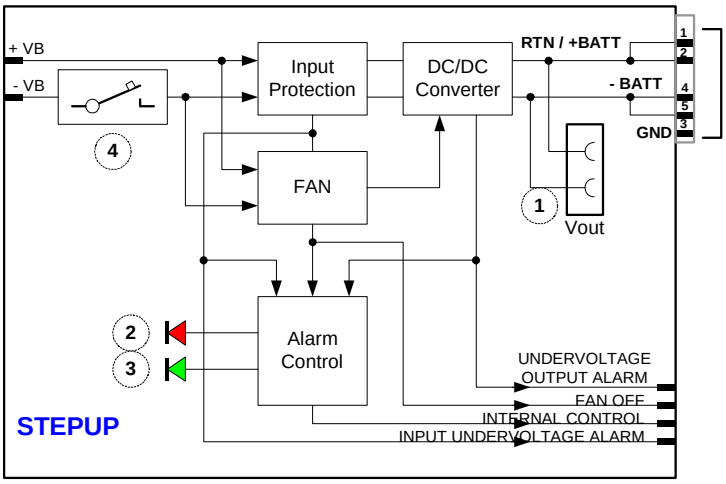


Figure 287. STEPUP unit block diagram

4.2 Common units

4.2.1 EC320 - Equipment controller card

The board provides the HW resources to support the Equipment Controller (EC), Operation and Maintenance (OAM), and Control and General Interface (CGI) functions.

The EC is in charge of the processing following activities of the Virtual Equipment Control Element (VECE) function:

- Virtual Machine Management Function (VMMF)
- Message Communication Function (MCF)

The OAM function is in charge of providing the hardware support for the GMPLS Routing Engine (GMRE). This is a software engine capable of automatically setting up and tearing down cross-connections according to signaling and routing standards defined by OIF, IETF, and ITU organizations.

The CGI function is tailored primarily to EC activity and manages several physical interfaces related to station alarms collection and signaling, which are available on the front panel of the unit.

The EC320 unit is consists of a main board and a daughter board.

The main board provides the circuits for the following components:

– Physical layer interface – a related serial communication channels supported by the EC function

– Station alarm signaling interfaces (Rack lamps, Remote Alarms and Housekeeping)

– Mass storage device for NE data base (Hard Disk Drive)

– Board and System Identification function (support to EC daughter board).

– Unit's power supply

– Multi-High Level Data Link Control (HDLC) controller for Embedded Communication Channel (ECC) termination (that is, DCC_M, DCC_R, and DCC_P)

– Remote Inventory function

The daughter board is the PQ3/MC1-B module, a processor that provides all the basic hardware components required by the following EC processing functions:

– Microprocessor (CPU)

– System memory (Boot Flash EPROM, RAM)

– I/O parallel bus (PCI interface)

– Serial communication channels

– General Purpose Parallel I/O

– Real Time Clock (RTC)

4.2.1.1 Physical Interfaces

Front panel interfaces

– **DBG Interface**: the DBG interface supports application SW debug activities.
The following two DBG interfaces are available with the 1850 TSS-320:
  - The first port is a twisted-pair 10/100 Mbit Ethernet on a standard RJ45 connector
  - The second port is a point-to-point low speed UART-based RS-232 serial channel operating at up to 38400 bit/sec. It is compatible with the COM port of a PC and is accessible through a USB mini-B type connector on the front panel.

– **F interface**: the F interface allows for connection to a Local Craft Terminal for OAM activity.
The interface is supported through the following two serial channels:

  - The first channel is a point-to-point serial link with a standard RS232 electrical interface, suitable for asynchronous communications at speed up to 38400 bit/sec on a RJ45 connector.
  - The second channel is a serial interface compliant with the Universal Serial Bus specification 1.1, able to support both the 12 Mb/s (full speed) and the 1.5Mb/s (low speed) modes on a standard USB mini–B connector.

– **HUSB Interface**: is a USB V2.0 host port accessible at the front panel of the EC320 unit. It connects to external USB slave devices such as “disk-on-key”.

– **LED Interface**: there are eight LEDs on the front panel of the EC320 board. Six are related to NE alarms and are typically associated to an alarm category (critical, urgent/major, not urgent/minor, abnormal, warning, and attended) and the remaining two are for “board status” indication and “Equipment Protection Switching (EPS)” status.

Back Panel Interfaces

– **RL Interface**: the Rack Lamp interface drives the visual and audible alarm indicators on a shelf.
The interface consists of a set of four parallel output signals with dry-contact interface through which galvanic isolation is obtained. Under control of the active EC processor, the dry-contacts can be left open (no alarm) or closed (active alarm condition) toward a common, isolated RL ground.
At system level, the physical access to this interface is provided through one connector, located on the shelf back panel, as shown inFigure 56. on page 96.
An alarm cut-off push button is also available as part of this interface, as shown in Figure 59. on page 99 and Figure 288. on page 426.

  The EC320 unit provides support for the following Rack Lamps (RL) interfaces:
  - RL_URG: Urgent alarm lamp command.
  - RL_NURG: Not urgent alarm lamp command.
  - RL_ATTD: Attended alarm lamp command: previous RL_URG or RL_NURG alarm attended.
  - Driven closed (lamp on) when the front–panel Alarm Cut-Off push–button on one of the EC320 units is pressed and a RL_URG and/or RL_NURG alarm is active. This action clears only the RL_NURG alarm when the original fault that generated the RL_URG or RL_NURG alarms disappears.

- **HK Interface**: the Housekeeping interface is a set of **eight input** and **four output** signals.
  Input signals collect site-specific fault or alarm conditions external to the NE, such as open door, high temperature, and high water level.
  Output signals drive site-specific actuators external to the NE, such as generators and air conditioning.
  All the signals have dry-contact interfaces through which galvanic isolation is obtained.
  Under control of the EC software, an output dry-contact interface can be left open or closed on an independent HKO ground (one each interface). Similarly, the input dry-contact interfaces can sense the open or close status on a common, isolated HKI ground.
  The EC processor can either control the status of the HK output interfaces or read the status of the HK input interfaces. At system level, the physical access to the signals of the HK interface is provided through a female connector located on the shelf back panel, as shown in Figure 56. on page 96.

- **RA Interface**: is a set of seven parallel output signals suitable for remote alarm status reporting.
  Each signal is associated with an alarm category and reports the summary of the alarm status of the NE for a given category.
  The following alarm categories are available in the 1850 TSS-320: urgent (RA_URG), not urgent (RA_NURG), internal (RA_INT), indeterminate (RA_IND), Service power OR (RA_ORC).
  All the signals have dry-contact interfaces through which galvanic isolation is obtained.
  Under control of the active EC processor, the dry-contacts can be left open (no alarm) or closed (active alarm condition) on an RA ground.

- **LAN Interface**: provides access to the NEs internal LAN for communication with other processors in the NE and with external Operation System (OS) station.
  The interface consists of a pair of high speed communication channels supporting the Ethernet protocol IEEE 802.3. The channels can be configured to support either 10BaseT, 100BaseT or 1000BaseT connections. The layer 2 protocol functions (MAC controller) together with the PHY transceiver device for these channels are available. Both channels can be connected to an external redundant LAN switch through the back panel.

- **SYS_ID Interface**: consists of a set of parallel input signals from the back panel interface connectors and is generally used to collect data for the equipment identification (Equipment ID, Shelf ID and Slot ID).

- **SPI bus Interface**: allows access to the unit's remote inventory memory and other resources connected downstream or directly controlled. This interface is normally controlled by the SC processor on MT320ND board; the EC320 board is designated as slave. The interface consists of two SPI compatible serial ports, for redundant SC processing.

- **EPS Interface**: supports systems in which the EC and OAM functions provided by the EC320 unit are protected through a 1+1 redundant architecture.
  The interface consists of a high speed point-to-point Ethernet serial channel (Inter Processor Link) with some I/O status signals that are used for active / stand–by role arbitration.

- **Local Configuration Memory (LCI) interface**: is an SPI-compatible serial link dedicated to the LCM located on one of the Bus Termination boards where data related to the MAC address of the NE and other parameters are stored.

- **HDDUSB Interface**: consists of two USB V2.0 ports, one operating in host mode and one in function mode. It is used to support redundant Hard Disk Drive (HDD) solutions, regardless the redundancy of the EC board.

The host port is used to access a remote HDD device usually located on the redundant EC board or on a dedicated HDD redundancy board. The function port is used to give the remote EC board (when present in the system) access to the local HDD. Host and function ports of the redundant EC boards are cross-connected to each other through the back panel.

– **Card Missing (CMISS) Interface**: gets information on port and Matrix cards in the subrack. Card missing bits are reported to the EC320 board by the PSF320 [A, B].

– **PIO Interface**: consists of general purpose I/O signals that are available to exchange status information with other boards in the system through the back panel.
Signals related to the following functions are typically part of the PIO interface:
  • Card Presence notification
  • Alarm status notification

– **GENTRU link interface**: is an extension of the local SPI bus interface. It is used to access a pair of remote inventory memories and some alarm signals related to circuitry physically located on board of the external GENTRU module. The interface is not controlled by the local EC processor.

4.2.1.2 Power Supply

The unit is powered from two completely independent main battery supplies (BATT_A and BATT_B) that have a nominal voltage of -48V.

A single main voltage is generated from the input batteries by means of a +5V/10A DC/DC converter and has a voltage of VC5V. It is used as a Hard Disk Drive and is an alternate source of power to the board.

An isolated 9V/100mA DC/DC converter is used to generate the VC9VN (-9V) for housekeeping interfaces.

A 3.3V/16A step down DC/DC converter is used to generate the VC3V3 voltage. It is used for LV devices on the mother board and the daughter board.

Additional power can be generated from the VC3V3 voltage by means of DC/DC step down converters or Low Drop Out (LDO): VC2V5 (+2.5V) and VC1V2 (+1.2V).

A Low Drop Out device also generates an additional VC3V6 voltage (3.6V), used to power devices on-board external modules (GENTRU) related to their remote inventory and alarm interface.

An additional duplicated 3.3VS service power supply received through the back panel is used together with the VC3V3 for powering the circuitry related to the SPI bus interface.

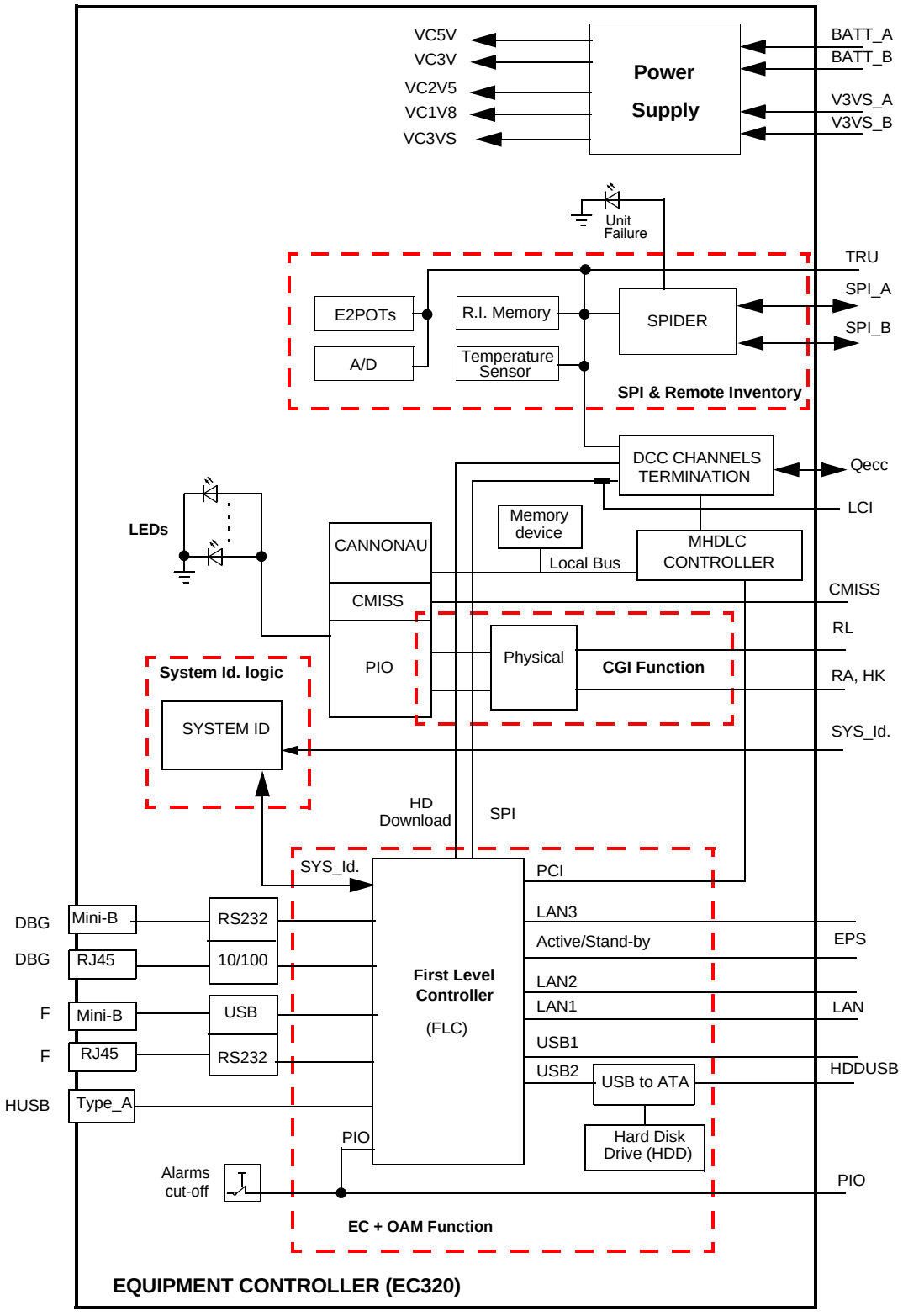


Figure 288. EC320 - Block diagram

4.2.2 MT320ND - Universal matrix

The Universal Matrix unit provides SONET/SDH and agnostic data flows switching capabilities on the 1850 TSS-15 shelf.

The unit performs the following functions:

- Management of 128 bi-directional links @3.1Gb/s (for an overall capacity of 320Gb/s) in Hmatrix
- Management of 24 bi-directional links @2.5Gbit/s (for lower order cross connection) in Lmatrix
- FEC protection of the links through the back panel
- Payload Performance Monitoring (PM)
- Traffic Sub Network Connection Protection (SNCP)
- Unidirectional Path Switched Ring (UPSR) or Bidirectional Line Switched Ring (BLSR)
- Central Scheduler for data switch management
- Synchronous clock management

The functions of the Universal Matrix unit can be grouped into the following five categories:

- **Shelf Controller (SC)**: the configuration manager that monitors the activities of all the boards in the system.
- **Clock Reference Unit:** the circuit that provides the reference clock used in all SDH units and back panel interfaces.
- **HO Matrix:** provides Multiplex Section Protection Connection (MSPC) and Higher Order Path Connection (HPC) switching functions. It supports SNCP protection and takes part in the protection of LOA units.
- **LO Matrix:** implements LPC (Lower Order Path Connection) switch function and takes part in the protection of LOA units.
- Unit **Power Supply**

4.2.2.1 SC and control architecture

Embedded in the Matrix unit, The Shelf Controller manages the control bus links in all peripheral units to monitor the following activities:

– ASIC/FPGA configuration (for example, provisioning, sync source selection, Port EPS, MSP switch functions)
– FPGA update
– Collection of alarms
– Collection of performance monitor data
– Reporting of collected data to Equipment Controller

Figure 291. on page 430 depicts, in detail, the structure of the Controller function. The physical components of this unit are:

[1] *Second Level Controller (SLC)*: hosts the Microprocessor and the related memories/devices. Two debug interfaces (one RS232 on mini USB connector and one E/FE on RJ45 connector) are provided in the front of the Matrix unit.

[2] Slot Id. and FPGA downloading block: sends the SHELF_ID, SLOT_ID and BOARD_ID information to the SLC. It also sends the “HW config. bus” from SLC to the FPGAs on board and to the backplane to allow the download of the FPGAs located on Port units.

[3] *ISPB master and Performance Monitoring Block*: the master ISPB bus that has been divided into three different and independent stripes: two stripes for Matrix-to-port connections (red and blue lines in Figure 289. on page 428) and one stripe for Matrix-to-Matrix connections (yellow line in Figure 289. on page 428).
This device also collects Performance Monitoring (PM) data.

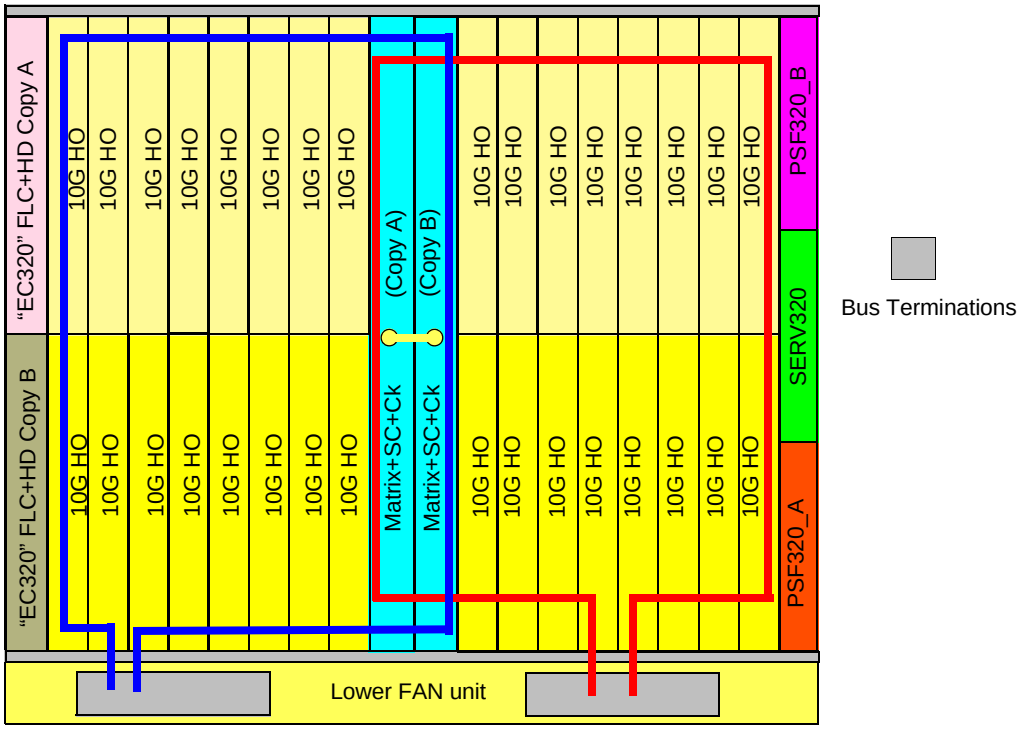


Figure 289. ISPB bus connections

[4] *SPI bus and SPIDER block*: three SPI connections go to all the other units of the equipment:

- one for the main shelf (with the exception of WDM boards)
- one for the WDM boards
- one for the access shelf (not available in current release)

SPIDER blocks collect basic failure alarms of the unit and collect remote inventory information. The block is the power from service voltage coming from central unit (PSF320)

SPI BUS EXTENSION block is used to extend the SPI bus to other slave devices and also drives the bicolor LED present on the front cover of the unit.

[5] *Internal LAN bus:* the 1850 TSS-320 provides 5 LAN swtiches. These connect the two SLCs, the two ECs, and all the ports. The two LAN switches named "LAN Switch" and "GE Switch" in Figure 291. are the "core" of this function. The switches allow the Equipment Controllers to be connected to the two Q3 interfaces and the two Drop Shelf interfaces.
Figure 290. on page 429 depicts control LAN subsystem connections.

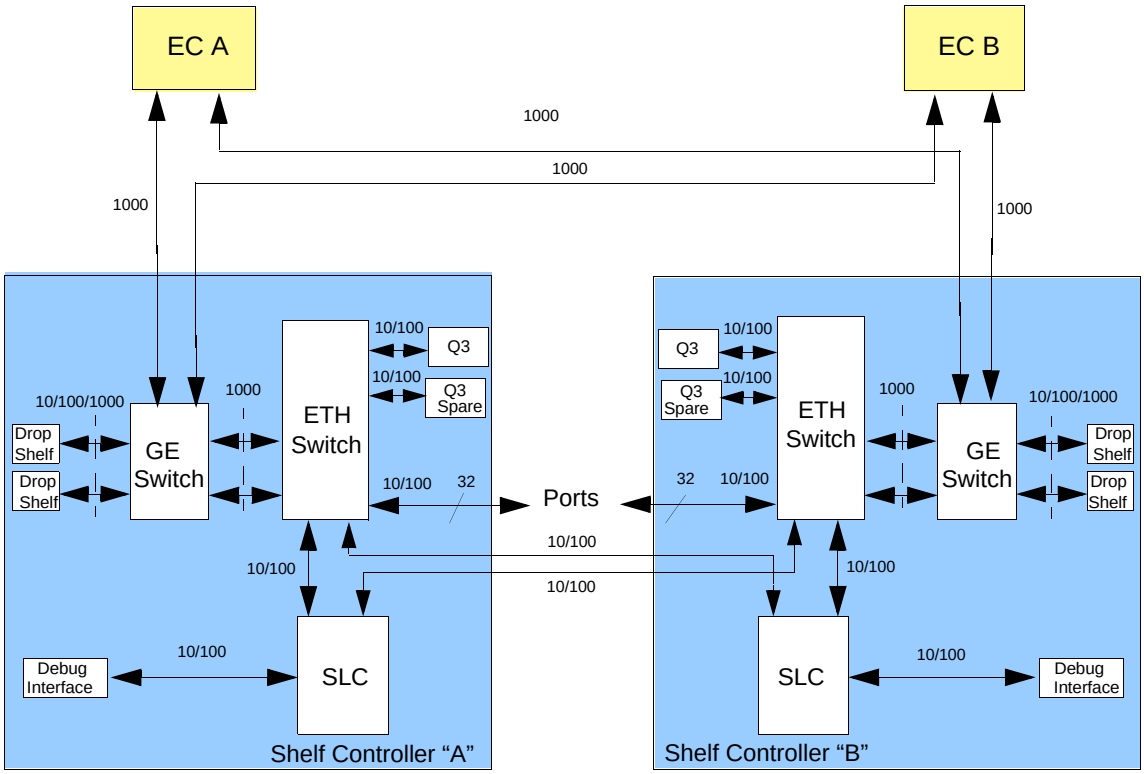


Figure 290. Control LAN subsystem

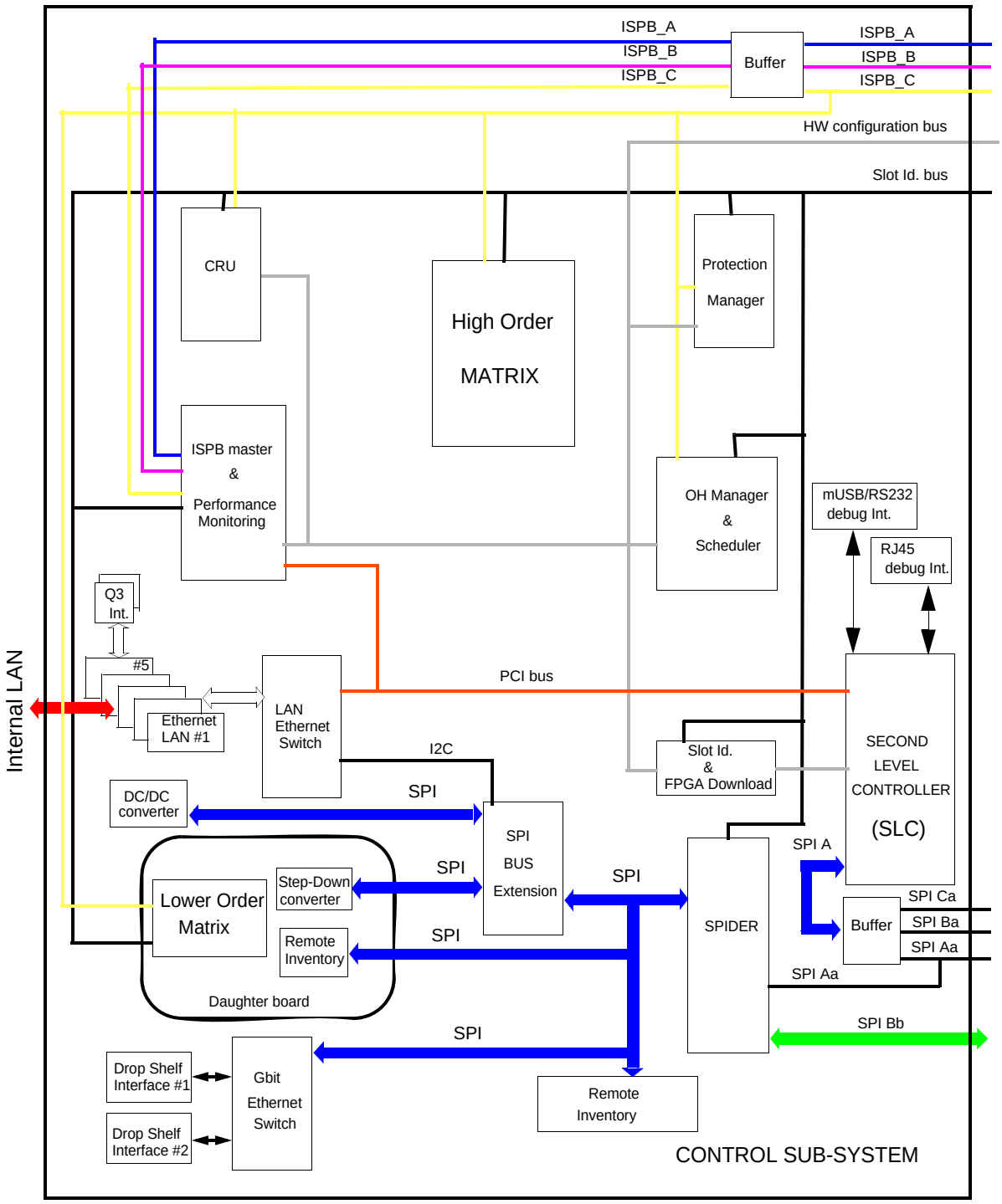


Figure 291. MT320ND - Control subsystem block diagram

4.2.2.2 CRU - Clock Reference Unit

The Clock Reference Unit (CRU) is the core of the synchronous equipment.
It locks the local oscillator to the network reference and provides synchronization reference to other network elements.
For all boards, the CRU distributes synchronization for back panel interfaces. It also provides synchronization to all SDH boards on the shelf, in compliance with ANSI T1.105.03-1994 / ITU-T G813 regulations.

The CRU supports the following functions:

- Capability to manage the external reference: till 6 T1/T2 and 2 T3/T6:
  - timing reference signals coming from the SDH ports **(T1)**
  - 2 MHz signal coming from the PDH ports **(T2) (not operative in current release)**
  - two 2 MHz clocks **(T3)** or 2 Mbit/s signals **(T6)**
- Capability to provide:
  - two 2 MHz clock **T4** or a 2 Mbit/s signal **T5** used as synchronization clock
  - a system clock **T0** (at 622.08 MHz) locked to the selected reference (T1, T2, T3/T6) and distributed to the equipment
  - **CK38Mhz:** is derived from the system clock (T0) and is distributed to all the ports. Its frequency is 38.88 MHz
  - **MFSY:** is the multiframe synchronism at 500 Hz, obtained from the ck38MHz. It is distributed to all the ports
- Free-running and hold-over operational modes
- 1+1 EPS protection scheme when two Matrix units are present in the shelf

For T6 and T5 interfaces, the adding/dropping of the SSM field is also supported.

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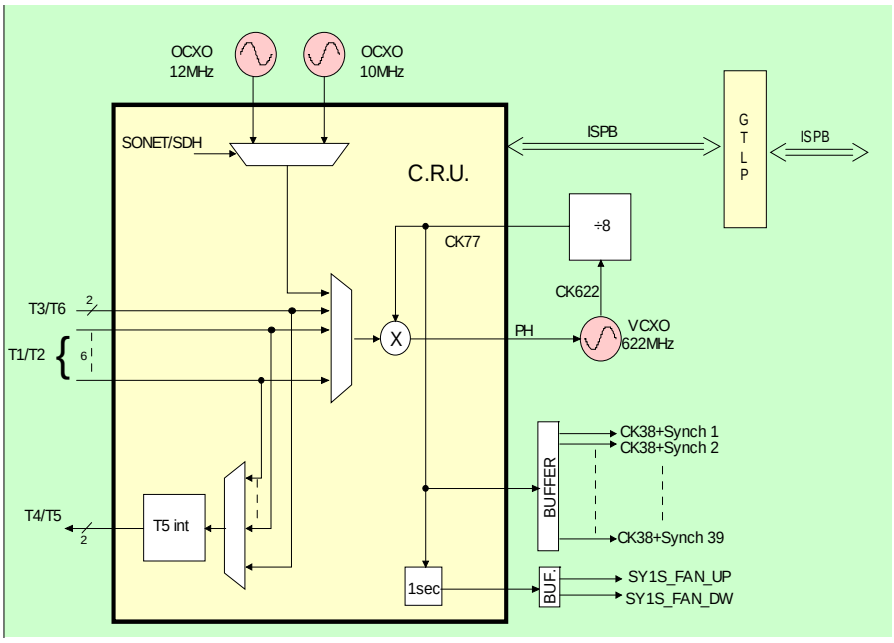


Figure 292. Functional block diagram of Clock Reference Unit

4.2.2.3 Hmatrix

The main function of the unit is the management of the Higher Order cross connection interfacing 128 bi-directional high-frequency links.
All 32 Port slots are connected to Hmatrix by means of 4 bi-directional links NGI3 at 3.1Gbit/s

Hmatrix links can be connected to SONET/SDH/Data ports for cross-connection of Higher Order Virtual Containers (structured or not structured) or data packets.

Hmatrix links can be connected to LOA boards when cross-connections of Lower Order Virtual Containers have to be performed.

It performs fully non-blocking STS-1/STS-3c (AU-3/AU-4) switch. The switching element combines both TDM and packet switching capabilities. When used as TDM matrix, the full capacity of 320Gbit/s must be used. With data packets, the capacity is reduced to 160Gbit/s due to port size limitations.

The unit supports the following functions:

- cross-connection with STS-1 granularity of up to 2048 STM-1 signals (6144 signals at AU3 level), non blocking
- 1+1 EPS protection scheme, when two Matrix Units are present in the system
- alarm reporting
- performance monitoring
- performs central scheduler and protection switch manager functions to route the payload stream in Matrix.
  Packet switching functionality is implemented in the Matrix board of the equipment by means of the payload universal switching device, which can switch both TDM and data traffic.
  The device provides switching capabilities with packet granularity, fully non blocking with respect to any broadcast type.
  See 1.7 on page 51 for the maximum switching capacity allowed in the system.
  When dealing with packet based traffic, the Universal Matrix device receives from the data boards (PACKET PROCESSOR MODULE) data traffic to be cross connected and the information needed to manage the schedulers.

  Traffic managers on data boards regulate traffic by means of scheduling algorithms, which determine the amount of traffic to be transmitted first to the Matrix device and then to the egress board, depending on the quality of service. Traffic managers use a mechanism called “requests” and “credits” to exchange information between the ingress and egress through the Matrix to efficiently manage the scheduling algorithm. The schedule algorithm is divided into three components: input scheduler, central scheduler', and output scheduler, as depicted in Figure 293. on page 433.

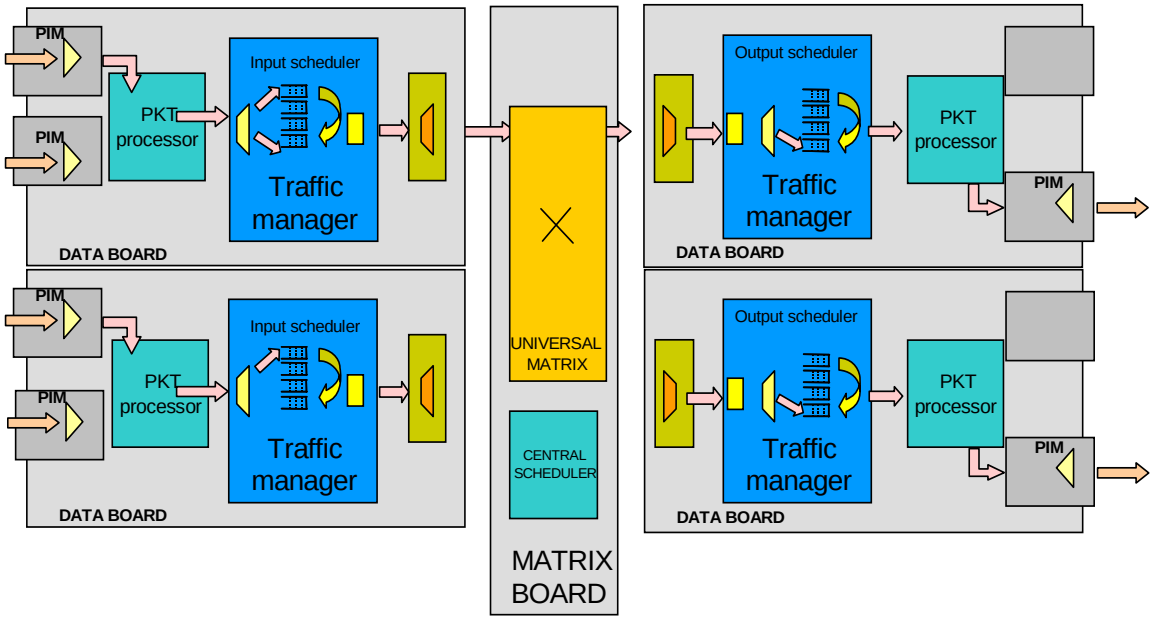


Figure 293. Scheduler implementation

The exchange of information for scheduling management can be divided into three precise steps: Request, Credit, and Transmission phases.

During the Request phase, the status of all the input queues is sent to the egress boards. The red arrows in Figure 294. on page 434 represent this phase.

In the Credit phase, the egress board determines how many cells are sent by each of the ingress boards and sends information (the “credits”) to the ingress boards.
During this phase, the central scheduler collects the credits from the egress boards in order to coordinate the requests towards the input boards, thus avoiding collisions. The green arrows in Figure 294. on page 434 represent this phase.

Each ingress board sends the amount of traffic that has been granted in the Creation phase to the Matrix in the Transmission phase. The yellow arrows in Figure 294. on page 434 represent this phase.

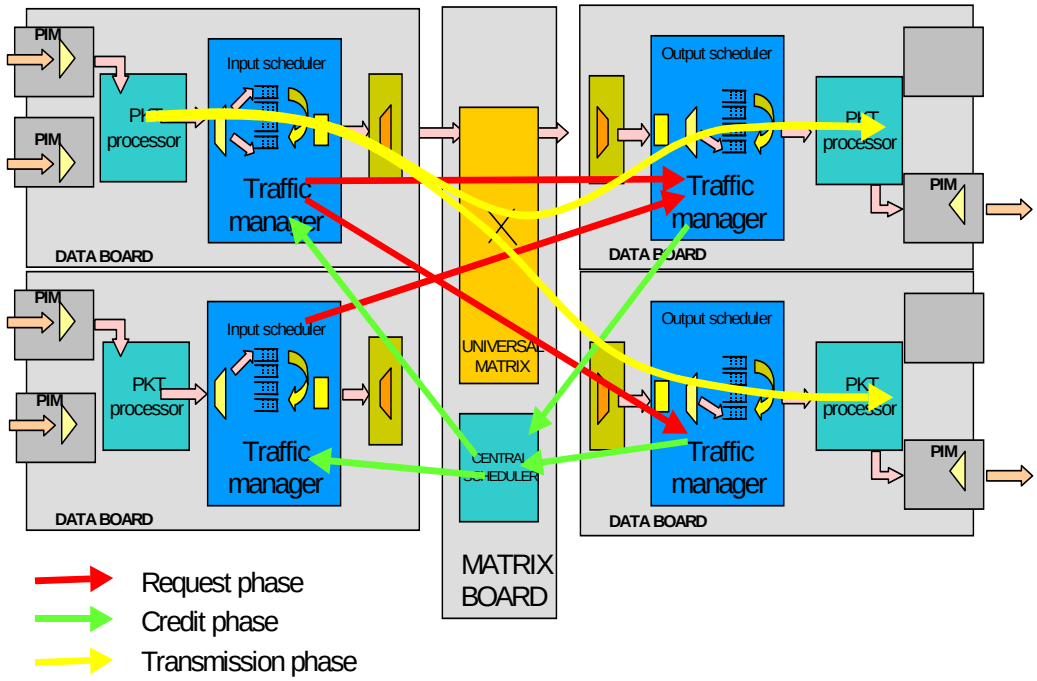


Figure 294. Three steps for scheduling

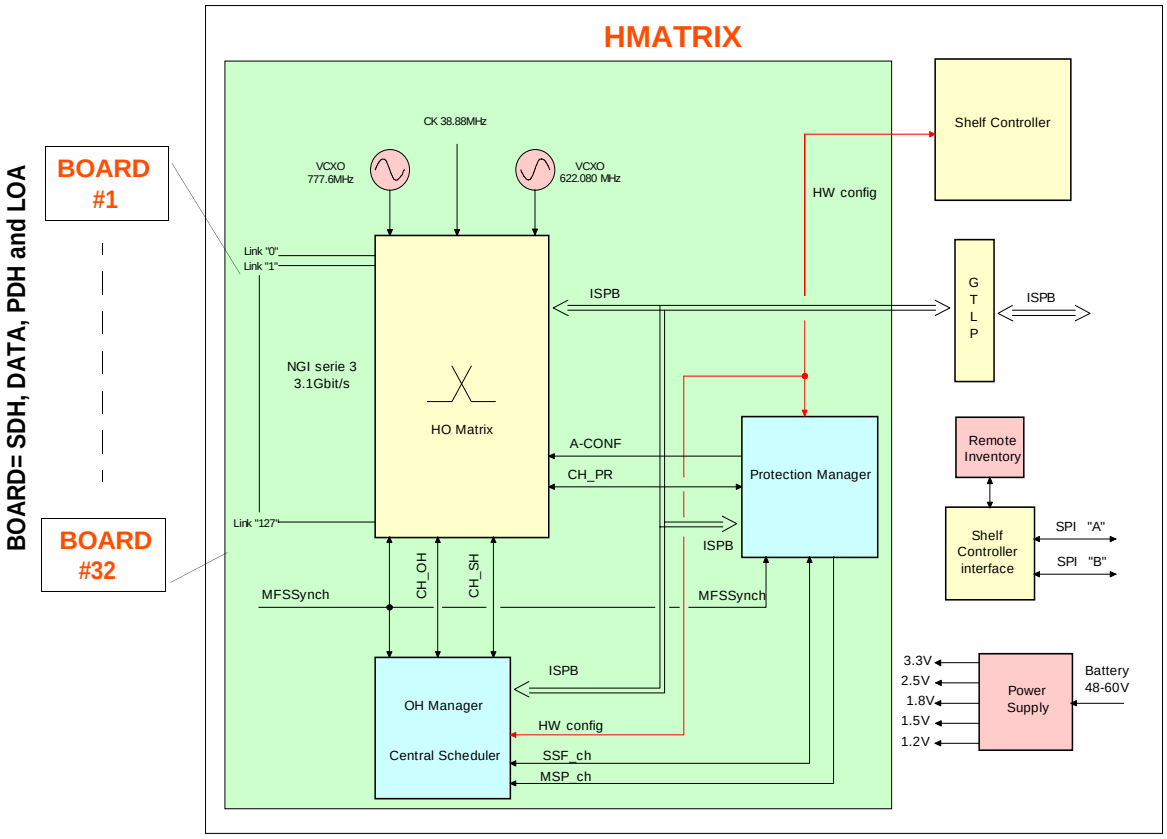


Figure 295. Functional block diagram of Hmatrix

4.2.2.4 Lmatrix

This function is not available in current release, It's accomplished with a subassembly that can be plugged on a devoted connector.
The Lower Order cross connection performs fully non-blocking STS-1/VC3 (lower order), VT 2/VC12 and/or VT 1.5/VC11 switch.

The TDM matrix has a whole capacity of 40 Gbit/s. A cross over circuit connects all input/output links (24 at 2.5G Bit/s) and allows performing of LOA EPS protection in 4+2 configuration.

The unit supports the following functionalities:

- Cross-connection with STS-1, VT 2, VT 1.5 / VC3, VC12, VC11 granularity of up to 256 OC-3/STM-1 signals, non blocking
- SNCP protection
- alarm reporting

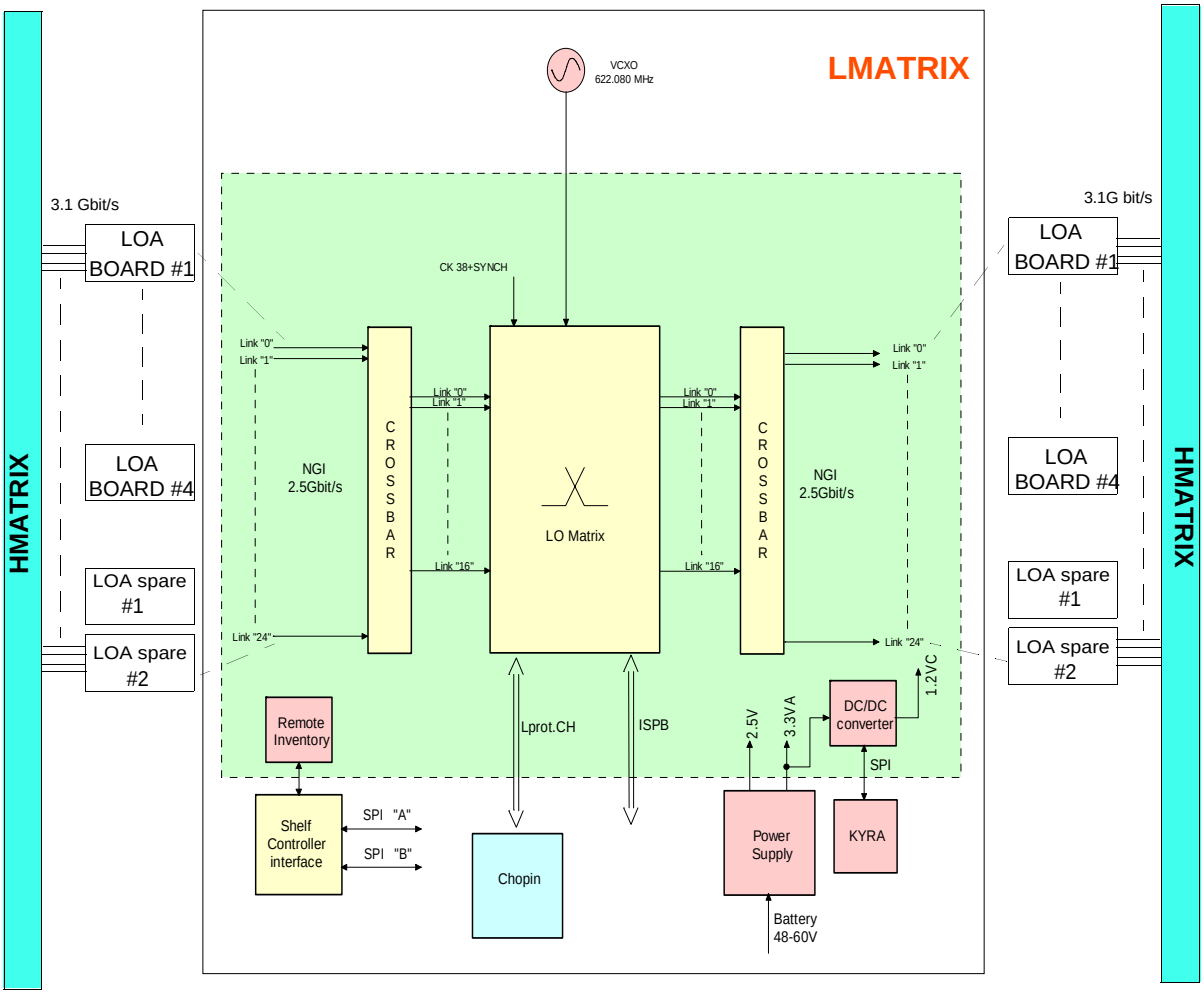


Figure 296. Functional block diagram of Lmatrix

4.2.2.5 Unit Power Supply

Starting from station battery, power levels generated by the main power supply is as follows:

– 1.2Vdc
– 1.5Vdc
– 1.8Vdc
– 3.3Vdc
– 2.5Vdc

The block diagram of the Matrix unit power supply is reported in Figure 297. on page 436)

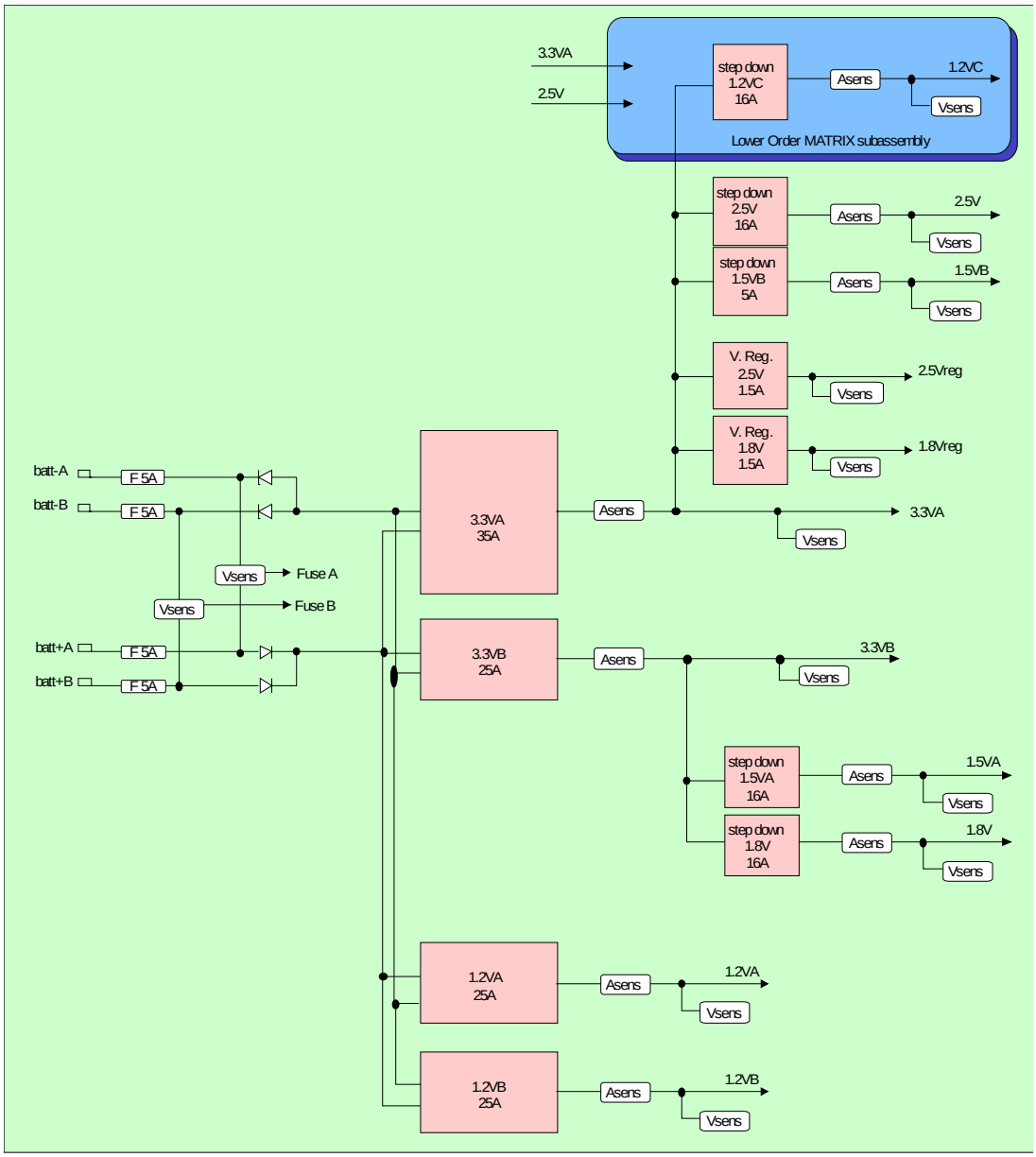


Figure 297. MT320ND - Unit power supply block diagram

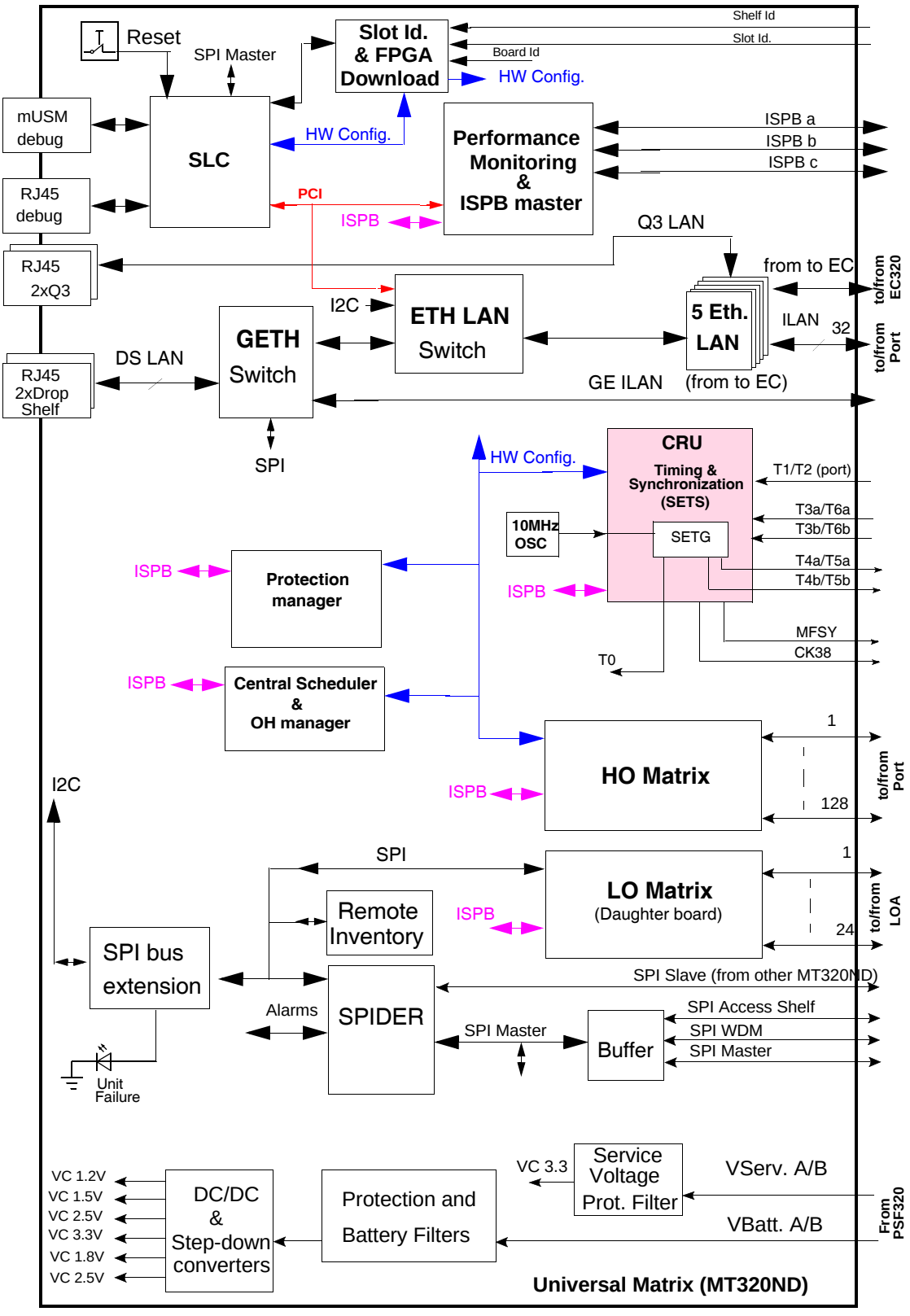


Figure 298. MT320ND - Universal Matrix unit block diagram

4.2.3 PSF320 - Power supply filter unit

This unit can be considered an interface between the input battery coming from the TOP RACK UNIT (GENTRU) and the backplane to supply power to all the boards in the subrack.

It outputs two "Auxiliary voltages": 3.6V and 5.3V, as shown in Figure 299. on page 441.

The main board of the sub-unit power supply (PSF320) performs the following fuctions:

- Input filter
- Battery distribution
- Battery alarms (battery missing and failure of batteries [*And*])
- Presence sensors
- Card missing
- By-pass for Access battery
- Power monitoring
- 2M/bit terminations
- Spider

The daughter board of the sub-unit power supply (PSF320) performs the following fuctions:

- Input power stage for DC/DC converters
- DC/DC converters
- Step-down

4.2.3.1 Input filter

The EMI filter (shown in Figure 299. on page 441) is a low pass filter on the power line that performs the following functions:

- Prevents the entry of high frequency interference carried by the DC power line into the equipment
- Prevents the exit of interference energy generated within the protected equipment into the DC power line

4.2.3.2 Battery alarm

The Battery alarm is connected before fuses are installed to monitor the presence or absence of the input battery.

The relative alarm is managed by SPIDER and the “Battery alarms management block”.

4.2.3.3 Battery distribution and presence sensors

The main board distributes battery input to the back panel and all the boards. Each line goes to a fuse (“over-voltage and over-current protection” block in Figure 299. on page 441) on both the positive and the negative lines.

Fuses are fitted on each line to prevent a failed back panel from shorting the input bus; each line monitor its own fuses.

4.2.3.4 Card missing

Through ground contact, this component detects and reports the presence of any board on the shelf.

4.2.3.5 By-pass for Access battery

This component delivers battery input to the Access boards through a female sub D connector located on the upper part of the back panel shelf (refer to Figure 299. on page 441).

4.2.3.6 Power monitoring

This block is able to monitor the input voltage and the input current in order to check the input power.

4.2.3.7 1.5/2 Mbit/s and MHz Sync. terminations

Two external reference signals are provided at 1.544/2.048 MHz or 1.544/2.048 Mb/s.

Function performed:

- the unit can receives up to one 1.5/2 MHz clock (T3) or up to one 1.5/2 Mbit/s signals (T6) that could be used to synchronize the N.E. The unit provide software programmability to switch between the two mode.
- the unit provides up to one 1.5/2 MHz clock (T4) or up to one 1.5/2 Mbit/s signals (T5) that can be used by another N.E. for synchronism purpose. The unit provide software programmability to switch between the two mode.

The correspondent physical interfaces are located on the front panel of the PSF320_A and PSF320_B units, guaranteeing in this way the required redundancy of this functionality(T3a, T3b or T6a, T6b / T4a,T4b or T5a,T5b).

In the 1850 TSS-320 equipment, the physical accesses and terminations of the synchronization signals are implemented on the PSF320_A and PSF320_B units, while the frame processing (significant in case of E1) with SSM management is realized on the Matrix units (MT320ND).

4.2.3.8 Input power stage for DC/DC converter

This block is able to guarantee a start-up and an inrush current limiting system in order to provide controlled charge-up for the input hold-up capacitor and therefore prevent a current surge at the input to the module when the board is plugged in.

4.2.3.9 DC/DC converters

On the unit there are two DC/DC converters that supply the following two voltage:

– 3.6V is the service voltage for all the boards of the system.

– 5.3V is the voltage for WDM boards.

Besides in order to supply the internal circuit of the board a step-down 3.3V/5A is connected on the output of the 5.3V/10A DC/DC converter.

The output of the step-down is used in double with the equivalent of the PSF320 B.

At last, always connected on the output of the 5.3V/10A there is another DC/DC converter 5.3V/9V that is able to supply the “Power monitoring” circuit connected on input battery lines.

4.2.3.10 Spider block

Spider block drives the two LED present on the front of the unit, collects the alarm detected on the board, and reads the Remote inventory information on the board.

Through the SPI bus A and B it communicates with the Shelf Controller preset on the Matrix board (MT320ND).

4.2.3.11 Power capability

The two centralized boards (PSF320-A and PSF320-B) provide adaptation to the central telecom power bus and the internal system power bus. They work in a 1+1 configuration.

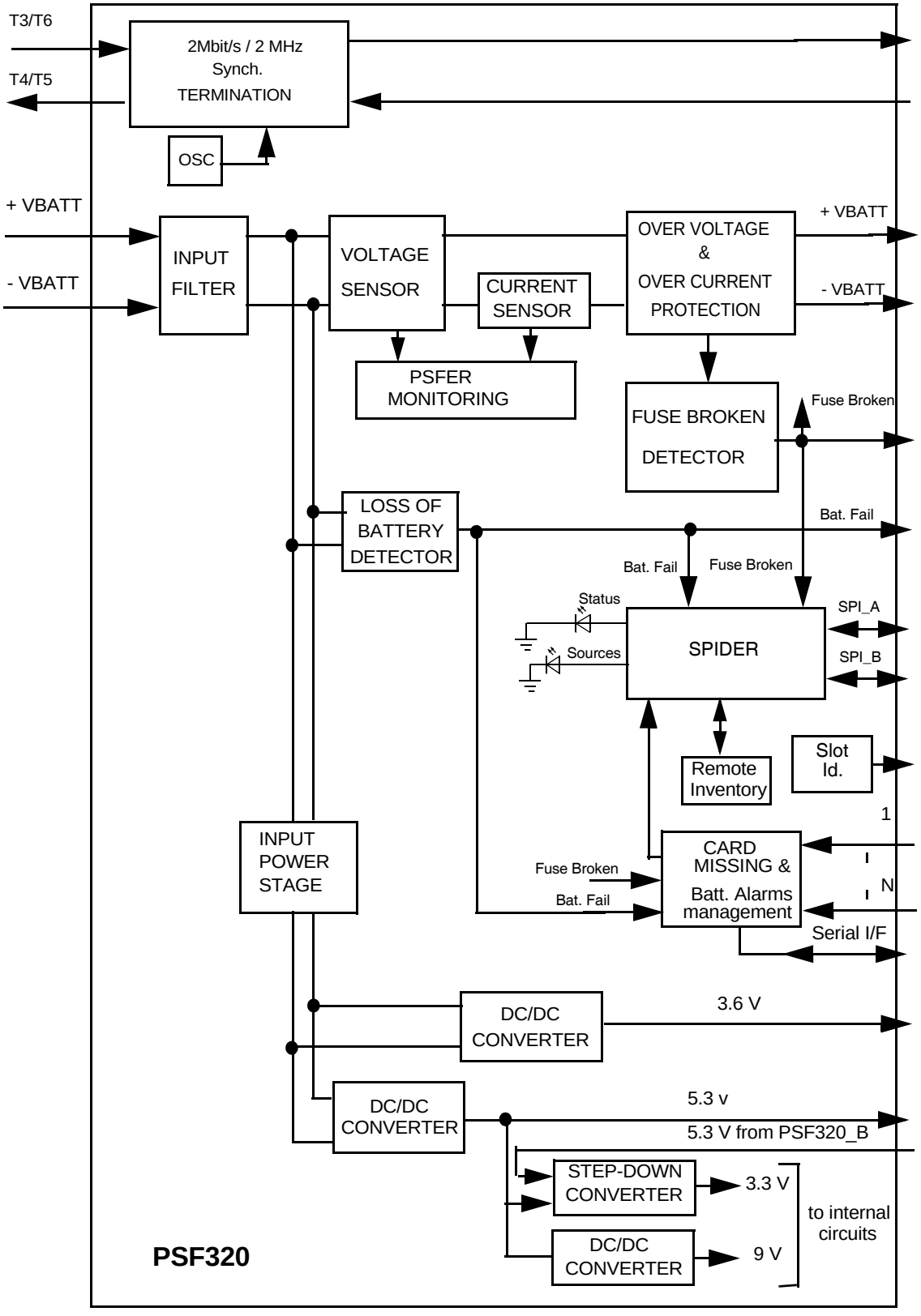


Figure 299. PSF320 - Power Supply Filter Unit block diagram

4.2.4 FAN320 - Fan unit

The 1850 TSS-320 shelf must have two FAN units installed.

As with other 1850 TSS-320 boards, this unit can be plugged in to the back panel in one of the two designated slots at the top and at the bottom of the shelf.

Fan speeds are monitored through the Spider block, which raises an alarm when the fans revolve below 30% of their maximum allowable speed.

The fan unit is set up with a basic assembled pcb on which fans and the fan controller are housed.

4.2.4.1 Functional description

The fan controller is the pcb dedicated to providing fans with power, managing the speed of each of them and monitoring speeds through Spider block. It also raises an alarm when the fans revolve below 30% of their maximum allowable speed.

Each fan is powered by 48Vdc voltage supplied through a 38V-75V input acceptable range DC/DC converter.

On the power supply of each fan a fuse has been inserted, so that if a rotor had to be blocked for any reason, the current absorbed from it would rise and then the fuse would blow, protecting the motor from damages.

In reality, this caution is not strictly necessary, since fans mounted on the unit have themselves a locked rotor protection. if the rotor is prevented from rotating and power is applied to the unit, the motor will self-protect. When the locked rotor condition is removed the fan will automatically restart. The motor can sustain locked rotor conditions indefinitely throughout the full specification range of voltage and temperature.

Figure 300. on page 443 shows the block diagram of the unit.

As we can see, Spider can individually interrupt the 48V power supply of each fan, detects temperatures from three sensors spread across the controller board and can adjust fan speeds by means of three potentiometers, which provide variable voltages to fan speed control pins through potential dividers.

A bicolor LED on a board shows:

– green: unit in service

– red: internal fault (unit out of service)

The FAN unit front panel is shown on Figure 57. on page 97.

4.2.4.2 Performance

Each fan provides a flow of 167 m^3/hr against a pressure of 82 Pa when running at maximum speed and with 1.2 kg/m^3 inlet air density.

The life limiting feature of the fan design is the life of the lubrificant in the motor bearings.

In a 40ºC environment at full speed, the grease in the bearings has an L10 life of 100,000 hours. In 75ºC environment, the grease in the bearings has an L10 life of 40,000 hours.

4.2.4.3 Power Supply

The maximum current drawn by one single fan is 0.35A at full speed on 48VDC supply, corresponding to 16.8W of power consumption.

With all fans at full speed, the board absorbs 0.9A when powered through battery A by a voltage of 65V. that it, it has a total power consumption of 58.2W.

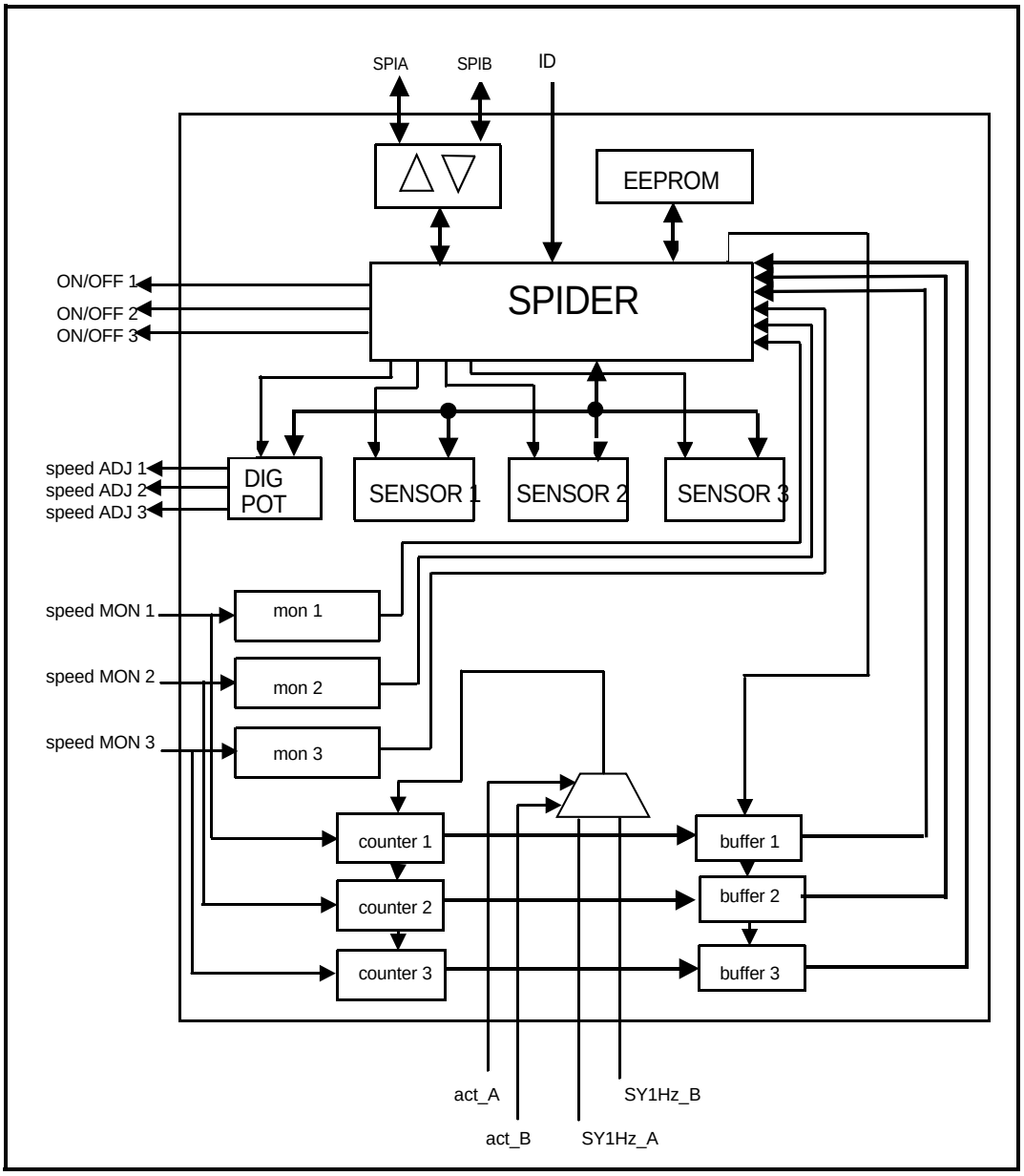


Figure 300. FAN320 - Functional block diagram

4.3 SONET/SDH units

4.3.1 1P10GSO - “1x10 G Synchronous Optical” unit

(Refer to Figure 302. on page 452)

General:

1P10GSO Port provides bi-directional processing of one OC-192/STM64 signal, such as:

- regenerator and multiplexer section transport overhead insertion/extraction
- payload assembly/disassembly at VC4 level
- DCC access and Auxiliary OverHead Channels insertion/extraction
- Loopback testing capability

The Unit is used in conjunction with either an “XS-642" Optical Transceiver or an “XFP-E ADAPTER + Optical Transceiver (example XI-641)" as an Optical Line Interface Card at the OC-192/STM64 Level.

From an intra-equipment functional viewpoint, unit assembly carries out its tasks working in conjunction with other equipment parts, such as:

- Matrix subsystem (two MT320ND cards) for payload exchange
- Synchronization subsystem (SETS functions) for reference timings (on MT320ND cards)
- Second Level Controller (SLC) for provisioning and alarm management (on MT320ND cards)
- SERV320 card for Auxiliary OverHead channels processing
- EC320 cards for DCC termination

Based on ITU-G.783 recommendations, the 1P10GSO Port card performs the Transport Terminal Function (TTF) (sink on RX side, source on TX side) on an OC-192/STM64 data stream.

The TTF Function conects two MT320ND boards (1+1 configuration) for cross connection [Higher Order Path Connection (HPC)] processing.
The unit also provides Optical Safety support by means of an Automatic Laser Shutdown (ALS) procedure (refer to ITU-T G.664).

Physical description

The 1P10GSO Port is a half slot unit consisting of: a Front Panel and a Printed-Circuit Board assembly.

The following is available on the Front Panel:

- an embedded slot for XFP optical transceiver (for line optical access)
- a Multicolour LED as visual card status indicator (card failure, in-service, updating, etc.)
- a push button for Manual Laser Restart

The printed circuit board assembly houses:

- SONET/SDH, synchronization and control circuitries
- DC/DC converters

Details of different subsystems implementation are provided in the following sections:

4.3.1.1 Hardware partitioning

Unit functions are essentially distributed among the following main building blocks, as shown in the Figure 302. on page 452:

- XFP Optical Module (this is a separate plug-in item)
- SerDes XFI/SFI4.1
- EUCLIDE Asic
- FERMAT FPGA
- Two GTLP bi-directional translators for the ISPB control bus
- GTLP bi-directional translator for the HW_CFG bus
- GOBLIN_4G Cpld for the SPI control bus
- Remote Inventory E2PROM
- KYRA Cpld for the SPI / I2C bridge
- QDR-II SRAM 2Mx18
- FLASH memory (to store the FERMAT FPGA code)

4.3.1.2 Payload subsystem description

Figure 301. on page 446 shows the flow of traffic signals on the Sink side (from Optical Line to HPC Matrix) and on the Source side (from HPC Matrix to Optical Line).

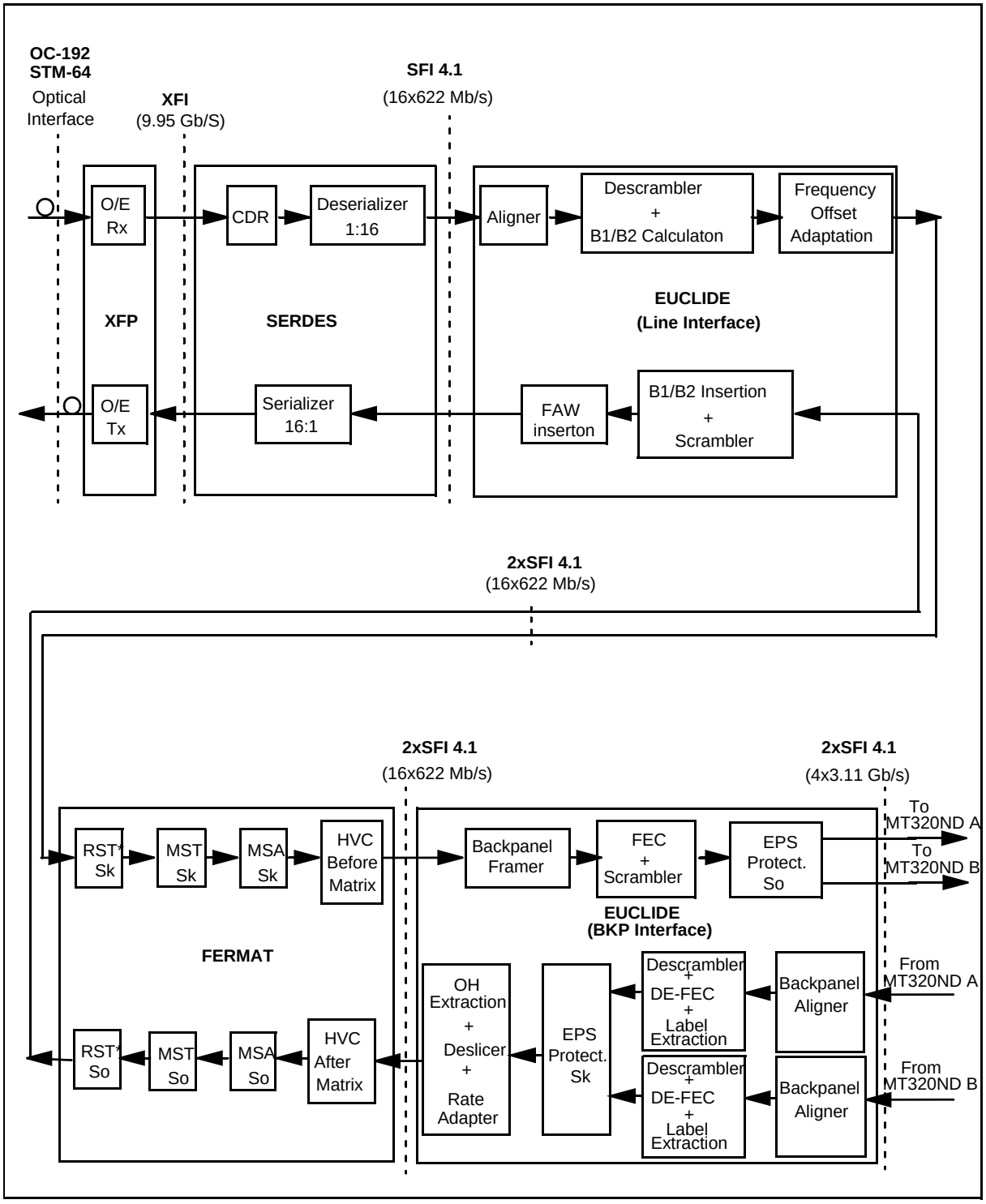


Figure 301. 1P10GSO - Payload subsystem block diagram

4.3.1.2.1 Sink side (Signal flow from Optical Line to HPC Matrix)

O/E RX:

It performs the conversion from an optical OC-192/STM-64 signal to an electrical XFI signal. The receive also performs LOS detection and 3R regeneration by means of a CDR circuit.

CDR:

This function is integrated in the SERDES device and performs 3R-regeneration on the incoming serial data signal.

Deserializer 1:16:

It performs the serial-to-parallel conversion on the data signal.

Aligner:

This function is integrated in EUCLIDE Asic. It recovers frame alignment and detects OOF events.

Descrambler + B1/B2 Calculation:

It descrambles the incoming signal and performs BIP-8 (B1) and BIP-1536 (B2) calculations.

Frequency Offset Adaptation:

It eliminates the frame alignment word from the incoming signal, performs rate adaptation on the on-board local clock, and provides the data together with control and synchronisms bytes to the FERMAT FPGA via a double SFI4.1-like interface.

RST*Sk (partial RSn_TT_Sk):

- it recovers frame alignment by detecting the synchronism of J0 (inserted by EUCLIDE)
- it extracts OOF events (detected by EUCLIDE) and detects the LOF alarm
- it performs regenerator section trace recovery and mismatch detection (J0), BIP-8 (B1) errored blocks count, and TSF insertion (on LOS, LOF or TIM detection)
- it provides RS data communication (DCCR) extraction (D1-D3)
- it provides RS OverHead bytes extraction (E1, F1, ...)

MST Sk (MSn_TT_Sk):

Performs BIP-1536 (B2) errored blocks count, MS-REI recovery, K1 and K2 extraction and MS-RDI/MS-AIS detection, as well as MS data communication (DCCM) extraction (D4-D12) and MS OverHead auxiliary bytes extraction (E2, ...)

MSA Sk (MSn/Sn_A_Sk):

Performs STS-3c/AU4's pointer processing, LOP and AIS detection, and pointer justification (including STS-3c/AU4 Concatenation handling capability)

HVC Before Matrix (HTCM/HTCTsk, HPOM/HSUTsk, HSUTso, HTCTso):

Performs path overhead processing such as J1 and G1 recovery, C2 signal label monitoring, UNEQ and VT-AIS/VC-AIS detection, BIP-8 (B3) violation count, N1 extraction, and BIP-8 (B3) compensation.

Back panel Framer:

Receives the incoming data stream on a 16-bit differential LVDS interface, performs frame alignment, and generates a proprietary frame for back panel links (Rate Adaptation, Slicing, insertion of OverHead and Protection channels generated by Fermat, FAW and J0Link Label insertion).

FEC+Scrambler:

Performs the Forward Error Correction (FEC) redundancy calculation and insertion (The FEC code used is a Reed-Solomon code: RS (243, 241)), and the scrambling.

EPS Protection So:

Provides proprietary signals at 3.11 Gb/s to HPC Matrix A and B (for EPS protection purposes).

4.3.1.2.2 Source side (Signal flow from HPC Matrix to Optical Line)

Back panel Aligner:

Performs Alignment processing on proprietary signals at 3.11 Gb/s coming from HPC Matrix A and B

Descrambler+DEFEC+Label extraction:

Performs descrambling: FEC decoding, error detection, corrected/uncorrected errored blocks count, and J0Link extraction.

EPS Protection Sk:

Performs the selection (for EPS protection purposes) between the link from HPC Matrix A and the link from HPC Matrix B.

OverHead extraction+Deslicer+Rate Adapter:

Overhead and Protection channels extraction and transmission to FERMAT; adaptation from back panel rate to SONET/SDH rate.

HVC After Matrix (HTCM/HTCTsk, HPOM/HSUTsk, HSUTso, HTCTso):

Performs path overhead handling: N1 insertion, BIP-8 (B3) compensation, C2 "unequipped" insertion, J1 and G1 insertion, BIP-8 (B3) calculation and insertion.

MSA So (MSn/Sn_A_So):

Performs STS-n/AUG assembly, STS-3c/AU4 pointer generation and processing, STS-AIS/AU-AIS generation, and PJE count.

MST So (MSn_TT_So):

MS-REI and MS-RDI insertion, D4-D12, K1-K2 and MSOH OverHead bytes insertion.

RST*So (partial RSn_TT_So):

Performs regenerator section trace (J0) insertion, D1-D3 and RSOH OverHead bytes insertion, and provides the data together with control bits on two 16-bit differential LVDS interfaces to EUCLIDE.

B1/B2 Insertion + Scrambler:

Performs errored blocks BIP-8 (B1) and BIP-1536 (B2) computing and insertion, and scrambling.

FAW Insertion:

Performs frame alignment word insertion and provides a 16-bit differential LVDS interface (SFI4.1) to the SERDES device.

Serializer 16:1:

Performs the parallel-to-serial conversion on the data signal and provides a serial data output.

O/E TX:

Performs 3R regeneration by means of a CDR circuit and the conversion from an electrical XFI signal to an optical OC-192/STM-64 signal.

4.3.1.2.3 Loopbacks

For Test and maintenance purposes, Loopback capabilities are located on the BCM8152 SerDes and the FERMAT FPGA.

– BCM8152 provides both “Line" side and “Equipment" side Loopback with granularity at Section level (i.e. on the whole OC-192/STM-64). These Loopbacks are controlled via SPI bus and GOBLIN_4G parallel I/O.

  • In “Line side Loopback“, the following two operating modes are allowed:

    – “Loop and continue“
    – “Loop and send AIS" (note: AIS insertion towards backplane must be forced via FERMAT FPGA)

  • In “Equipment side Loopback" only “Loop and continue" operating mode is supported.

– FERMAT FPGA provides both “Line" side and “Equipment" side Loopbacks with 64xSTS-3c/VC4 granularity (i.e. on the whole payload). These Loopbacks are controlled via ISPB bus.
  In both “Line side Loopback“ and “Equipment side Loopback“, the following operating modes are supported:

  • “Loop and continue"
  • “Loop and send AIS"

4.3.1.2.4 Power subsystem description

Distributed power supply architecture on card is consists of an input power stage and a set of compact DC/DC converters.

The input power stage provides circuitry to:

- monitor the presence of the battery A/B voltages after the input fuses
- perform the OR-ing of the batteries
- perform over-voltage and under-voltage protection on the 48V power bus
- control the inrush current at the start-up, plus the EMI filtering

The main unit power supply voltages are generated as follows:

- 2 isolated DC/DC converters to derive +5.0V and +1.2V operating voltage from the 48V back-plane bus
- 1 isolated DC/DC converter to derive -5.2V operating voltage from the 48V backplane bus
- 3 small non-isolated Step Down (5A) to obtain +2.5V, +1.8V, +1.5V from the +5V
- 1 small non-isolated Step Down (16A) to obtain +3.3V from +5V

An additional service voltage at 3.3VS, obtained from a duplicated 3.6V (V3A, V3B) coming from back panel, is used for on-board SPI circuitry: Remote Inventory device, status Leds, Goblin_4G, and Kyra Cpld.

4.3.1.3 Timing subsystem description

The clock management is carried out by EUCLIDE Asic, which performs the following main tasks:

- synchronization to reference SONET/SDH Equipment Clock (SEC) T0 and selecting between two clocks at 38.88 MHz (coming from SLC/CRU cards)
- feeding of the selected T0 clock (CK38) and related synchronism (MFSY) to the FERMAT
- phase comparison to lock the on-board local 622.08 MHz VCXO to the selected T0 timing reference (PLL at 622 MHz)
- phase comparison to derive the timing reference at 777.6 MHz for the NGI3 back panel Links (PLL at 777.6 MHz)
- feeding of T1 timing reference from the Rx Optical Line signal to the SECs

FERMAT FPGA presents the following synchronization structure:

- timing signal at 77.76 MHz, coming from EUCLIDE and related to the overhead channels, is used as core logic reference
- clock signals at 311.04 MHz, coming from EUCLIDE and related to SFI-4.1-like interfaces (operating in DDR mode), are used to synchronize both input and output SFI-4.1-like sides.
- T0 timing signals coming from SECs are used as reference on DCC channels

4.3.1.4 Control subsystem description

There are three types of interfaces for communication between the Second Level Controller Cards and the 1P10GSO Port:

- ISPB: Intra Shelf Parallel Bus
- SPI: Serial Peripheral and Inventory Bus
- HW_CFG: Hardware Configuration Bus

4.3.1.4.1 Intra Shelf Parallel Bus (ISPB) Bus

ISPB provides a backplane communication channel between Second Level Controller (SLC) and every Transport card in the same shelf.

By means of the ISPB, the Second Level Controller loads proper configuration settings on to the internal registers of the EUCLIDE and FERMAT, monitors the current status, and collects data for performance monitoring.

4.3.1.4.2 Serial Peripheral and Inventory (SPI) Bus

By means of the SPI bus and GOBLIN_4G housed on Port card, the Second Level Controller is able to perform the following tasks:

- gathering of Port card power supply failure alarms
- gathering of Optical LOS alarm
- detection of XFP optical module presence
- controling of SERDES testing loopbacks (Line and Equipment Loop-backs)
- centering of SERDES elastic store (to carry out during board activation and after every loop-back activation/deactivation)
- access to/from onboard EEPROM for Remote Inventory data via local SPI Bus
- access to/from a dedicated A/D converter to collect electric data (voltage levels, current values)
- moreover, via KYRA Cpld, the unit is able to:
  - control card status LED
  - gain access (via SPI-I2C bridge integrated within the KYRA) of the XFP Remote Inventory data (serial ID, digital diagnostics)
  - monitor the FERMAT junction temperature and card temperature values

4.3.1.4.3 Hardware Configuration Bus (HW_CFG) Bus

By means of the HW_CFG, the Second Level Controller can access to the HW_CFG bridge function located inside the GOBLIN_4G device.

This function grants both read and write access modes to the Flash Memory and also transfer the downloaded Configuration Data from the Flash memory to the FERMAT via the FPGA's parallel configuration interface. This download procedure can also to be done remotely.

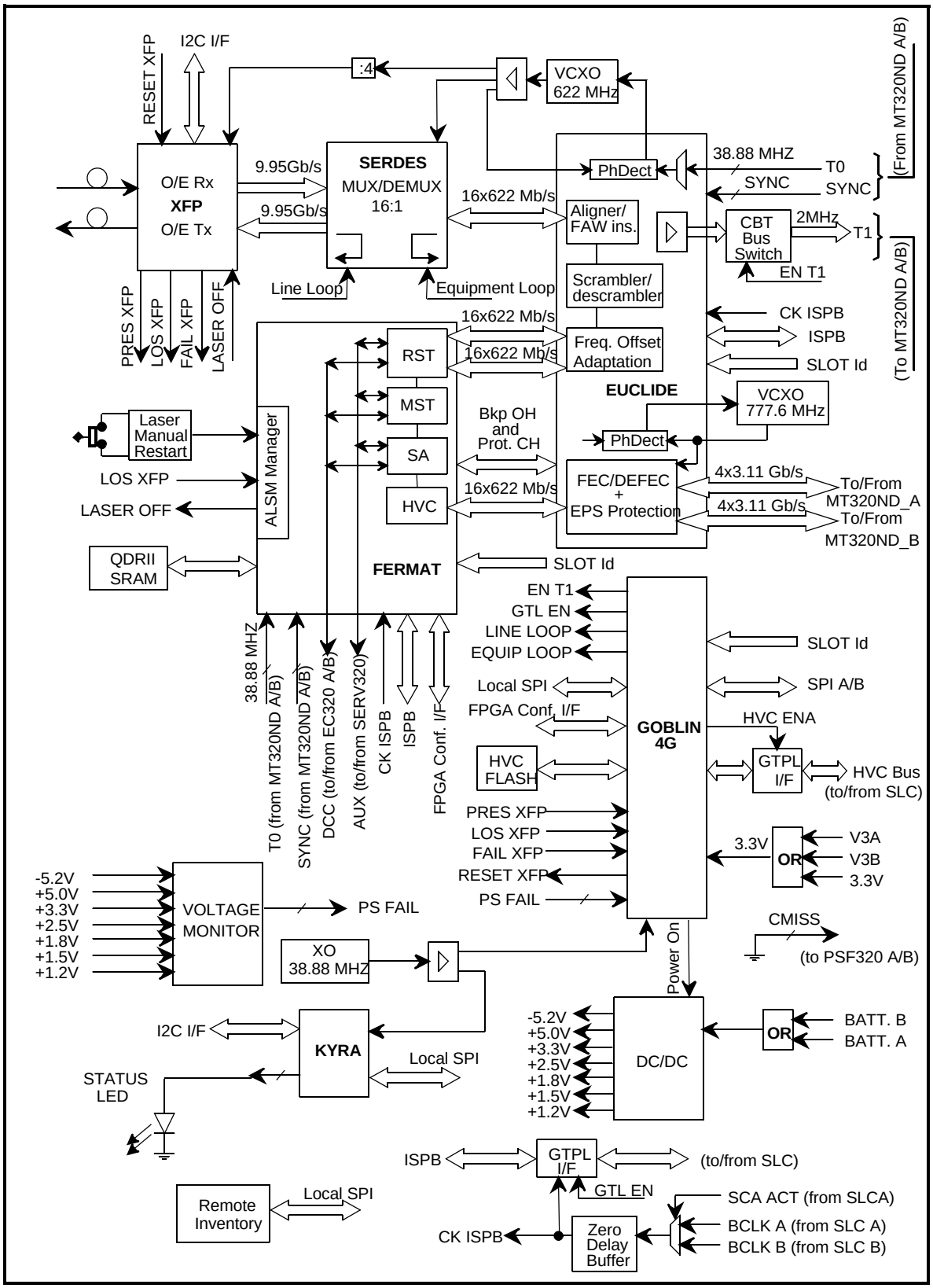


Figure 302. 1P10GSO - Functional block diagram

4.3.2 XFP Modules and XFP Adapters

(Refer to Figure 303. on page 454)

Different XFP modules type are available in the 1850 TSS-320, as reported in Chapter 2. Some require a XFP mechanical adapter (XFP-E ADAPTER) to be inserted in to the board (example 1P10GSO). The functional description that follows can be applied to all XFPs:

The module is a 10Gbit/s serial-to-serial transceiver, made of two independent components: an optical transmitter and receiver.

The transmitter gets the electrical data input through the 30-position pluggable edge connector, performs 3R regeneration via a CDR, and converts the regenerated signal into an optical data output using a Laser.

The receiver detects the optical data input via a Photo Detector, performs 3R regeneration via a CDR, and sends the regenerated signal through the 30-position pluggable edge connector.

Input and output signals are in NRZ format, as depicted in the block diagram Figure 303. on page 454.

The module is equipped with an I_2C bus interface to access the following features implemented in the module:

- Monitor signals
- Alarms signals
- Control signals
- Remote inventory (EEPROM)

The following are alarms and commands associated with XFPs:

- LOS XFP: Loss Of Signal
- FAIL XFP: XFP fault
- RESET XFP: module reset
- LASER OFF: the laser source is turned off
- PRES XFP: module physically present

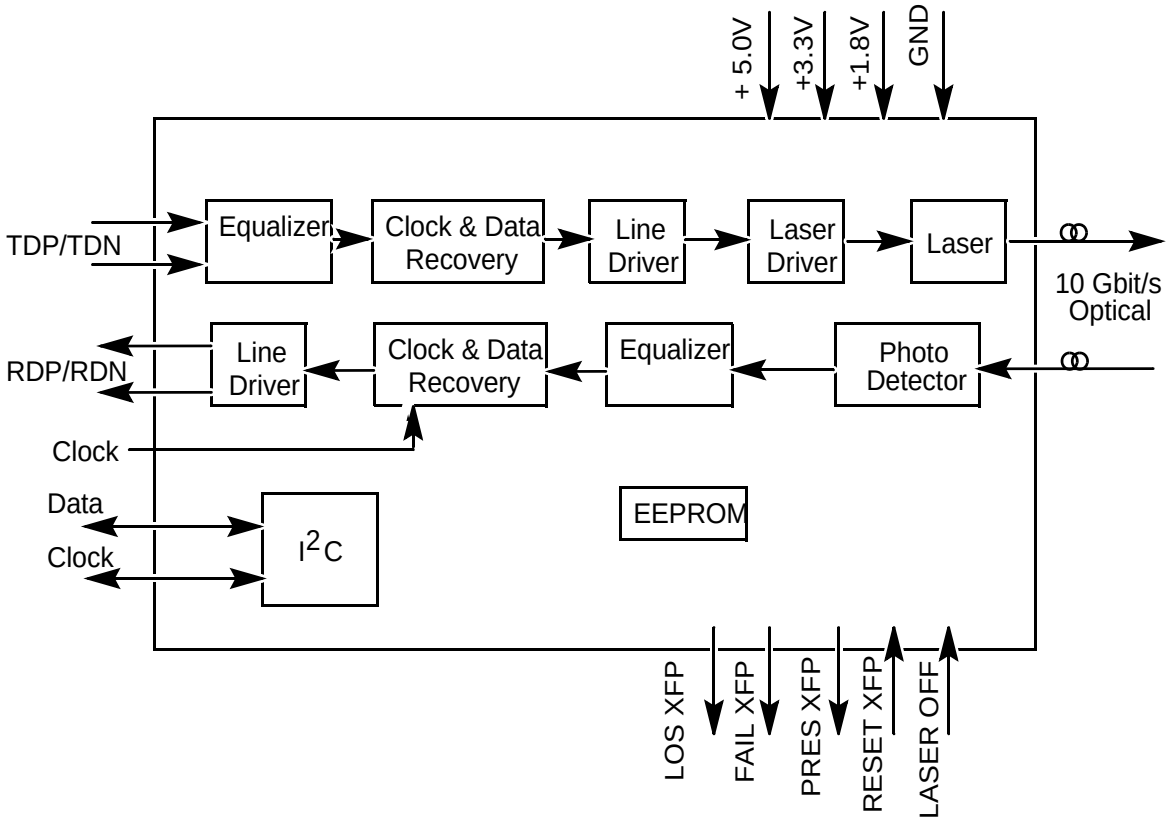


Figure 303. XFP module block diagram

4.3.3 4P2G5S0 - 4x2.5 G Sync Optical unit

(Refer to Figure 305. on page 463)

General:

4P2G5SO Port provides bi-directional processing of (up to) four independent OC-48/STM-16 signals, such as:

- regenerator and multiplexer section transport overhead insertion/extraction
- payload assembly/disassembly at STS-3c/VC4 level
- DCC access and Auxiliary OverHead Channels insertion/extraction
- Loopback testing capability

The Unit will be used in conjunction with four SFP optical transceivers as a Line Interface Card at OC-48/STM-16 Level.

From an intra-equipment functional viewpoint, unit assembly carries out its tasks working in conjunction with other equipment parts, such as:

- Matrix subsystem (two MT320ND cards) for payload exchange
- Synchronization subsystem (SETS functions) for reference timings
- Second Level Controller (SLC) for provisioning and alarm management
- SERV320 card for Auxiliary OverHead channels processing
- EC320 cards for DCC termination

Based on ITU-G.783 recommendations, the 4P2G5SO Port card performs the Transport Terminal Function (TTF) (sink on RX side, source on TX side) on up to four independent OC-48/STM-16 data streams.
The TTF Function connects two MT320ND boards (1+1 configuration) for cross connection (HPC) processing.

The Unit provides Optical Safety support by means of an Automatic Laser Shutdown (ALS) procedure [see ITU-T G.664].

Physical description:

4P2G5SO is an half slot unit consisting of: a Front Panel and a Printed-Circuit Board assembly.

Available on the Front Panel are:
- four embedded slots for optical line access via SFP optical transceivers
- a Multicolour LED as visual card status indicator (card failure, in-service, updating, etc.)

The pcb assembly houses:
- SONET/SDH, synchronization and control circuitries
- DC/DC converters

Details of different subsystem implementations are provided in the following sections:

4.3.3.1 Hardware Partitioning

Unit functions are essentially distributed among the following main building blocks, as shown in the Figure 305. on page 463:

- four SFP Optical Modules (these are independent plug-in items)
- four CDR devices
- four SerDes devices
- EUCLIDE Asic
- FERMAT FPGA
- Two GTLP bi-directional translators for ISPB control bus
- GTLP bi-directional translator for HW_CFG bus
- GOBLIN_4G Cpld for SPI control bus
- KYRA Cpld for SPI/I2C bridge
- Remote Inventory E2PROM
- QDRII SRAM
- FLASH memory (to store FERMAT FPGA code)

4.3.3.2 Payload subsystem description

Figure 304. on page 457 shows the flow of traffic signals on the Sink side (from Optical Line to HPC Matrix) and on the Source side (from HPC Matrix to Optical Line).

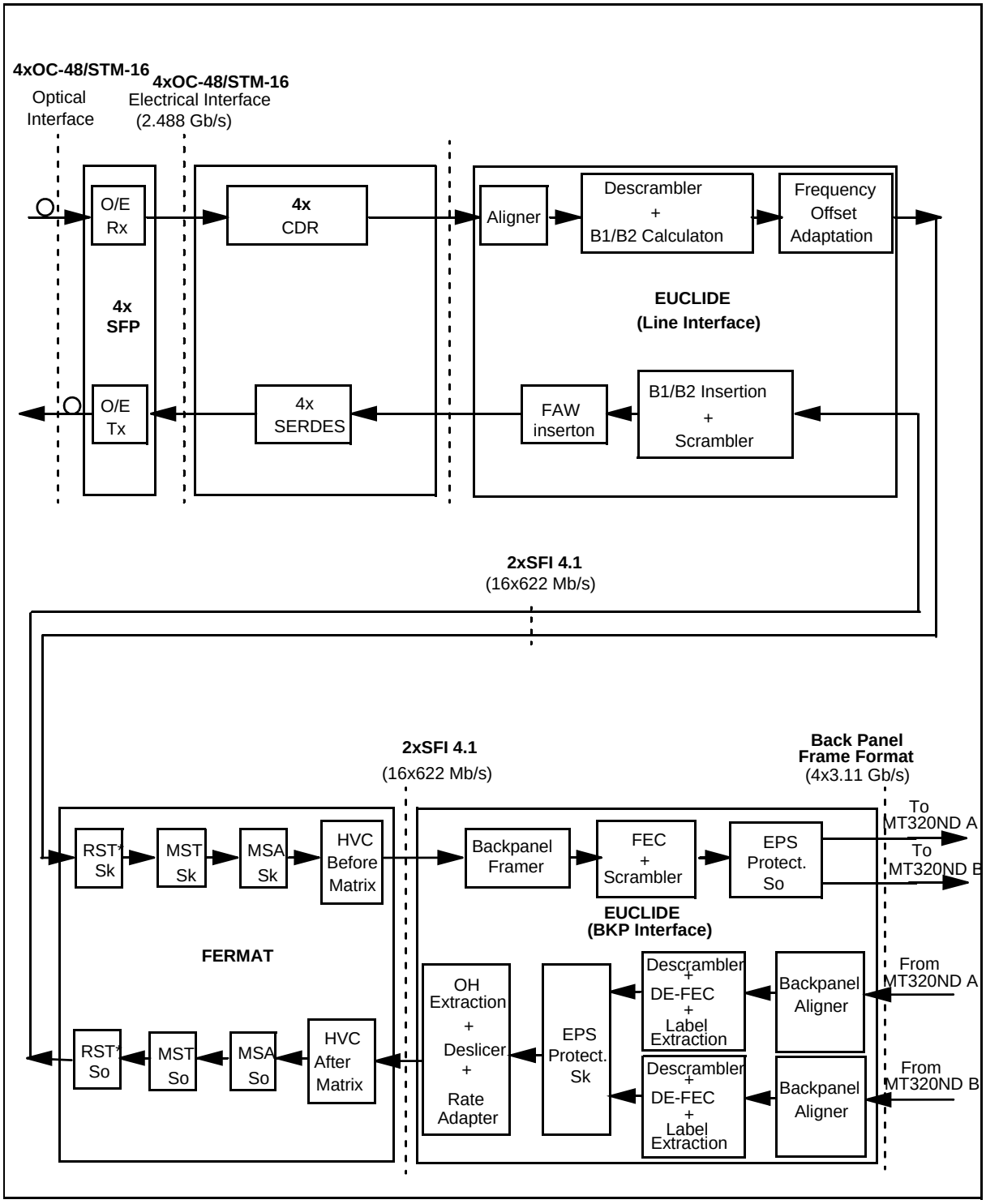


Figure 304. 4P2G5SO - Payload subsystem block diagram

4.3.3.2.1 Sink Side (Signal flow from Optical Line to HPC Matrix)

O/E RX:

Performs the conversion from an optical OC-48/STM-16 signal to an equivalent electrical stream by using differential signaling, as defined by SFP MSA specifications.

CDR:

A Clock and Data recovery device that performs 3R-regeneration on the incoming serial data stream.

Aligner:

This function is integrated in EUCLIDE Asic. It recovers frame alignment and detects OOF events.

Descrambler + B1/B2 Calculation:

It descrambles the incoming signal and performs BIP-8 (B1) and BIP-384 (B2) calculations.

Frequency Offset Adaptation:

It eliminates the frame alignment word from the incoming signal, performs rate adaptation to the on-board local clock by means of negative stuffing, and provides the data together with control and synchronism bytes via a double SFI4.1-like interface, to FERMAT FPGA.

RST*Sk (partial **RSn_TT_Sk):**

- it recovers frame alignment by detecting the synchronization of J0 (inserted by EUCLIDE)
- it extracts OOF events (detected by EUCLIDE) and detects LOF alarm.
- it performs regenerator section trace recovery and mismatch detection (J0), BIP-8 (B1) errored blocks count, and TSF insertion (on LOS, LOF or TIM detection)
- it provides RS data communication (DCCR) extraction (D1-D3).
- it provides RS OverHead bytes extraction (E1, F1...)

MST Sk (MSn_TT_Sk):

Performs BIP-384 (B2) errored blocks count, MS-REI recovery, K1 and K2 extraction and MS-RDI/MS-AIS detection, MS data communication (DCCM) extraction (D4-D12), and MS OverHead auxiliary bytes extraction (E2,....)

MSA Sk (MSn/Sn_A_Sk):

Performs AU4's pointer processing, LOP and AIS detection, and pointer justification (including AU4 Concatenation handling capability)

HVC Before Matrix (HTCM/HTCTsk, HPOM/HSUTsk, HSUTso, HTCTso):

Performs path overhead processing such as J1 and G1 recovery, C2 signal label monitoring, UNEQ and VC-AIS detection, BIP-8 (B3) errored block count, N1 extraction, and BIP-8 (B3) compensation.

Back panel Framer:

Receives the incoming data stream on a 16-bit differential LVDS interface, performs frame alignment, and generates a proprietary frame (Backplane Frame Format) for back panel links (Rate Adaptation, Slicing, insertion of OverHead and Protection channels generated by Fermat, FAW and J0Link Label insertion).

Forward Error Correction (FEC)+Scrambler:

Performs the FEC redundancy calculation and insertion (The FEC code used is a Reed-Solomon code: RS (243, 241)) and scrambling.

EPS Protection So:

Provides proprietary 4G Backplane Frame Format signals at 3.11 Gb/s to HPC Matrix A and B (for EPS protection purposes).

4.3.3.2.2 Source Side (Signal flow from HPC Matrix to Optical line)

Back panel Aligner:

Performs alignment processing on proprietary Backplane Frame Format signals at 3.11 Gb/s coming from HPC Matrix A and B

Descrambler+DEFEC+Label extraction:

Performs descrambling, FEC decoding, error detection, corrected/uncorrected errored blocks count, J0Link extraction.

EPS Protection Sk:

Performs the selection (for EPS protection purposes) between link from HPC Matrix A and link from HPC Matrix B.

OverHead extraction+Deslicer+Rate Adapter:

Performs Overhead and Protection channel extraction and transmission to FERMAT and adaptation from back panel rate to SDH rate.

HVC After Matrix (HTCM/HTCTsk, HPOM/HSUTsk, HSUTso, HTCTso):

Performs path overhead handling: N1 insertion, BIP-8 (B3) compensation, C2 “unequipped" insertion, J1 and G1 insertion, and BIP-8 (B3) calculation and insertion.

MSA So (MSn/Sn_A_So):

Performs AUG assembly, AU4 pointer generation and processing, AU-AIS generation, and PJE count.

MST So (MSn_TT_So):

Performs MS-REI and MS-RDI insertion, D4-D12, K1-K2, and MSOH OverHead bytes insertion.

RST*So (partial RSn_TT_So):

Performs regenerator section trace (J0) insertion, D1-D3 and RSOH OverHead bytes insertion, and provides the data together with control bits on two 16-bit differential LVDS interfaces to EUCLIDE.

B1/B2 Insertion + Scrambler:

Performs errored blocks BIP-8 (B1) and BIP-384 (B2) computing and insertion as well as scrambling.

FAW Insertion:

Performs frame alignment and word insertion.

SerDes :

Cleans up the intrinsic jitter present on data stream coming from EUCLIDE. An internal FIFO allows it to decouple the serial data stream to the SFP optical transmitter from Euclide timing domain, by retiming data with a clean synchronous reference clock

O/E TX:

Performs the conversion from an electrical OC-48/STM-16 signal to an equivalent optical stream.

4.3.3.2.3 Loopbacks

For Test and maintenance purposes, Loopback capabilities are supported on the 1850 TSS-320 and are located on the FERMAT FPGA.

For each STM16 Channel, the FERMAT FPGA provides both “Line" side and “Equipment" side Loopbacks with 16xVC4 granularity (i.e. on the whole payload).
In both “Line side Loopback" and “Equipment side Loopback", the following operating modes are supported:

- “Loop and continue"
- “Loop and send AIS“

These Loopbacks are controlled via ISPB bus.

4.3.3.3 Power subsystem description

Distributed power supply architecture on card consists of an input power stage and a set of compact DC/DC converters.

The input power stage provides circuitry to:

- monitor the presence of the battery A/B voltages after the input fuses
- perform the OR-ing of the batteries
- perform over-voltage and under-voltage protection on 48V power bus
- control the inrush current at the start-up, plus EMI filtering

The main unit power supply voltage that can be obtained are as follows:

- 2 isolated DC/DC converters (1/8 brick) to derive 3.3V and 1.2V operating voltages from the 48V back-plane bus
- 2 small non-isolated Step Down to obtain +2.5V, +1.8V from the +3.3V

An additional service voltage at 3.3VS, obtained from a duplicated 3.6V (V3A, V3B) coming from back panel, is used for on-board SPI circuitry: Remote Inventory device, status Leds, Goblin_4G and Kyra Cpld.

4.3.3.4 Timing subsystem description

The clock management is carried out by EUCLIDE Asic, which performs the following main tasks:

- synchronization to reference SDH Equipment Clock (SEC) T0 and selecting between two clocks at 38.88 MHz (coming from SLC/CRU cards)
- feeding of the selected T0 clock (CK38) and related synchronism (MFSY) to the FERMAT phase comparison to lock the on-board local 622.08 MHz VCXO to the selected T0 timing reference (PLL at 622 MHz)
- phase comparison, to derive the timing reference at 777.6 MHz for the 4G Backplane Frame Format back panel Links (PLL at 777.6 MHz)
- feeding of T1 timing reference, derived by Rx Optical Line signal, towards SECs

FERMAT FPGA presents the following synchronization structure:

- timing signal at 77.76 MHz, coming from the EUCLIDE and related to the overhead channels, is used as core logic reference:
- clock signals at 311.04 MHz, coming from EUCLIDE and related to SFI-4.1-like interfaces (operating in DDR mode), are used to synchronize both input and output SFI-4.1-like sides.
- T0 timing signals coming from SECs are used as reference on DCC channels.

4.3.3.5 Control subsystem description

There are three types of interfaces for communication between the Second Level Controller Cards and the 4P2G5SO:

- ISPB: Intra Shelf Parallel Bus
- SPI: Serial Peripheral and Inventory Bus
- HW_CFG: Hardware Configuration Bus

4.3.3.6 Intra Shelf Parallel Bus (ISPB) Bus

The ISPB Bus provides backplane communication channel between the Second Level Controller (SLC) and every Transport card in the same shelf.

By means of ISPB, the Second Level Controller loads proper configuration settings in to the internal registers of the EUCLIDE and FERMAT, monitors the current status, and collects data for performance monitoring.

4.3.3.7 Serial Peripheral and Inventory (SPI) Bus

By means of the SPI bus and GOBLIN_4G Cpld housed on Port card, the Second Level Controller can perform the following task:

- gathering of Port card power supply failure alarms
- gathering of alarms of SERDES
- controlling of settings for CDR and SERDES
- gathering of Optical LOS alarm
- detection of SFP optical module presence
- access to/from onboard EEPROM for Remote Inventory data via local SPI Bus
- access to/from a dedicated A/D converter to collect electric data (voltage levels, current values)
- moreover, via KYRA Cpld, it is possible to:
  - control card status LED on front-panel
  - gain access (via SPI-I2C bridge integrated within KYRA) of the SFP Remote Inventory data (serial ID, digital diagnostics)
  - monitor the FERMAT junction temperature and card temperature values

4.3.3.7.1 Hardware Configuration (HW_CFG) Bus

By means of the HW_CFG Bus, the Second Level Controller accesses the HW_CFG bridge function implemented inside the GOBLIN_4G device.

This function grants both read and write access modes to the Flash Memory and also transfer the downloaded Configuration Data from the Flash memory to the FERMAT via the FPGA's parallel configuration interface. This download procedure can also to be done remotely.

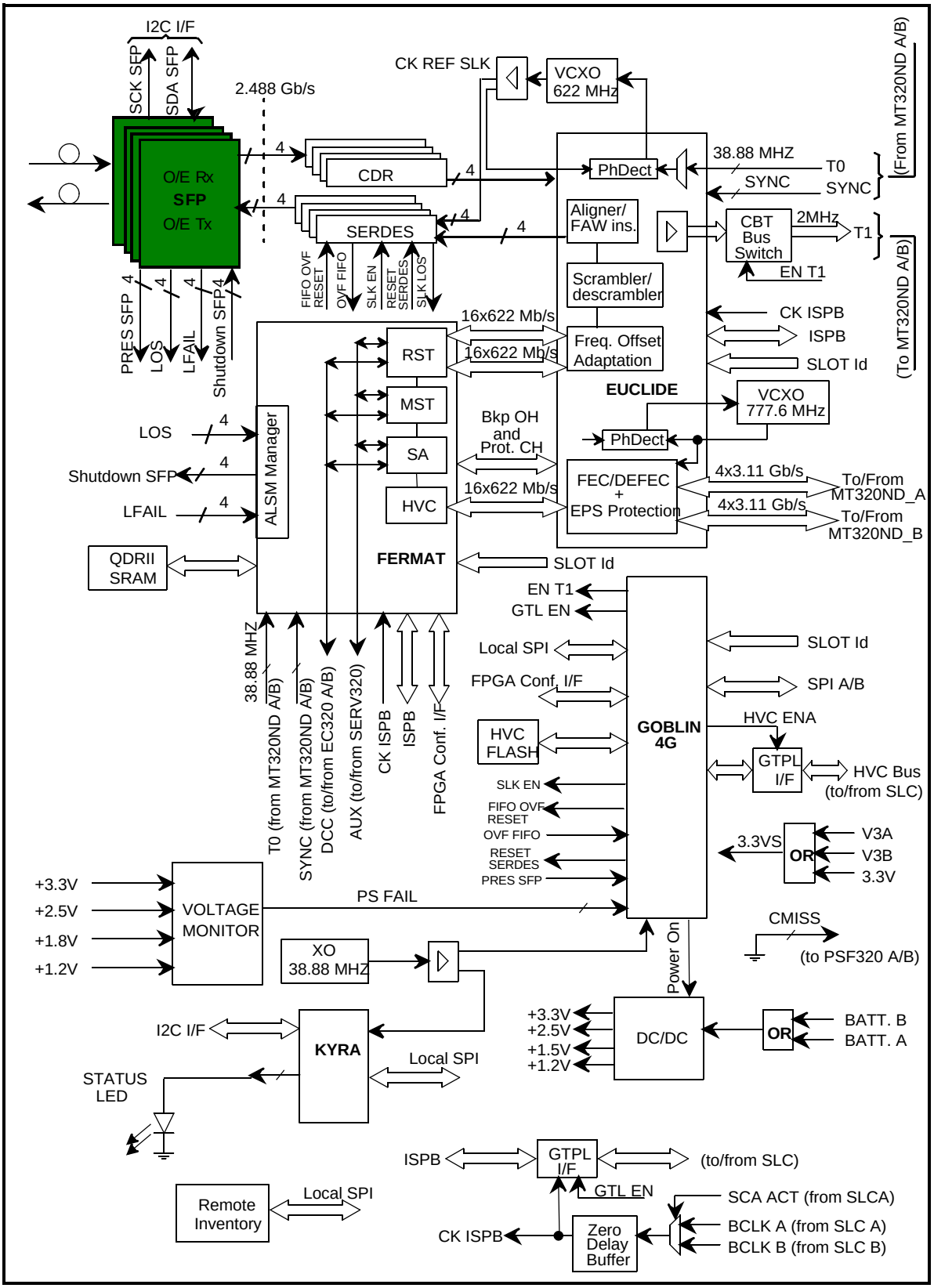


Figure 305. 4P2G5SO - Functional block diagram

4.3.4 8PSO - 8x155/622 M Synch Optical unit

(Refer to Figure 307. on page 471)

General:

8PSO Port provides bi-directional processing of (up to) eight OC-3/STM-1 or OC-12/STM-4 signals such as:

- regenerator and multiplex section transport overhead insertion/extraction
- payload assembly/disassembly at VC4 level
- DCC access and Auxiliary OverHead Channels insertion/extraction
- Loopback testing capability

The Unit is used in conjunction with eight SFP optical transceivers as a Line Interface Card at OC-12/STM-4 Level.

From an intra-equipment functional viewpoint, this unit assembly carries out its tasks by working in conjunction with other equipment parts such as:

- Matrix subsystem (two Matrix cards) for payload exchange
- Synchronization subsystem (SETS functions) for reference timings
- Second Level Controller (SLC) for provisioning and alarm management
- SERV320 card for overhead channels processing
- EQUICO cards for DCC termination

Based on ITU-G.783 recommendations, the 8PSO Port card performs the Transport Terminal Function (TTF) (sink on RX side, source on TX side) on up to eight independent OC-3/STM-1 or OC-12/STM-4 data streams.

The TTF Function connects two Matrix boards (1+1 configuration) for cross connection (HPC) processing.

The unit provides Optical Safety support by means of an Automatic Laser Shutdown (ALS) procedure (refer to ITU-T G.664).

Physical description

8PSO Port is a half slot unit consisting of: a Front Panel and a Printed-Circuit Board assembly.

Available on the Front Panel are:

- eight embedded slots for optical line access via SFP optical transceivers
- a Multicolour LED as visual card status indicator (card failure, in-service, updating,...)

The printed circuit board assembly houses:

- SONET/SDH, synchronization and control circuitries
- DC/DC converters

Details of different subsystems implementation are provided in the following sections:

4.3.4.1 Hardware Partitioning

Unit functions are essentially distributed among the following main building blocks, as shown in the Figure 307. on page 471:

- eight SFP Optical Modules (these are independent plug-in items)
- EUCLIDE Asic
- FERMAT FPGA
- Two GTLP bi-directional translators for ISPB control bus
- GTLP bi-directional translator for HW_CFG bus
- GOBLIN_4G Cpld for SPI control bus
- KYRA Cpld for SPI/I2C bridge
- Remote Inventory E2PROM
- QDRII SRAM
- FLASH memory (to store FERMAT FPGA code)

4.3.4.2 Payload subsystem description

Figure 306. on page 466 shows the flow of traffic signals on the Sink side (from Optical Line to HPC Matrix) and on the Source side (from HPC Matrix to Optical Line).

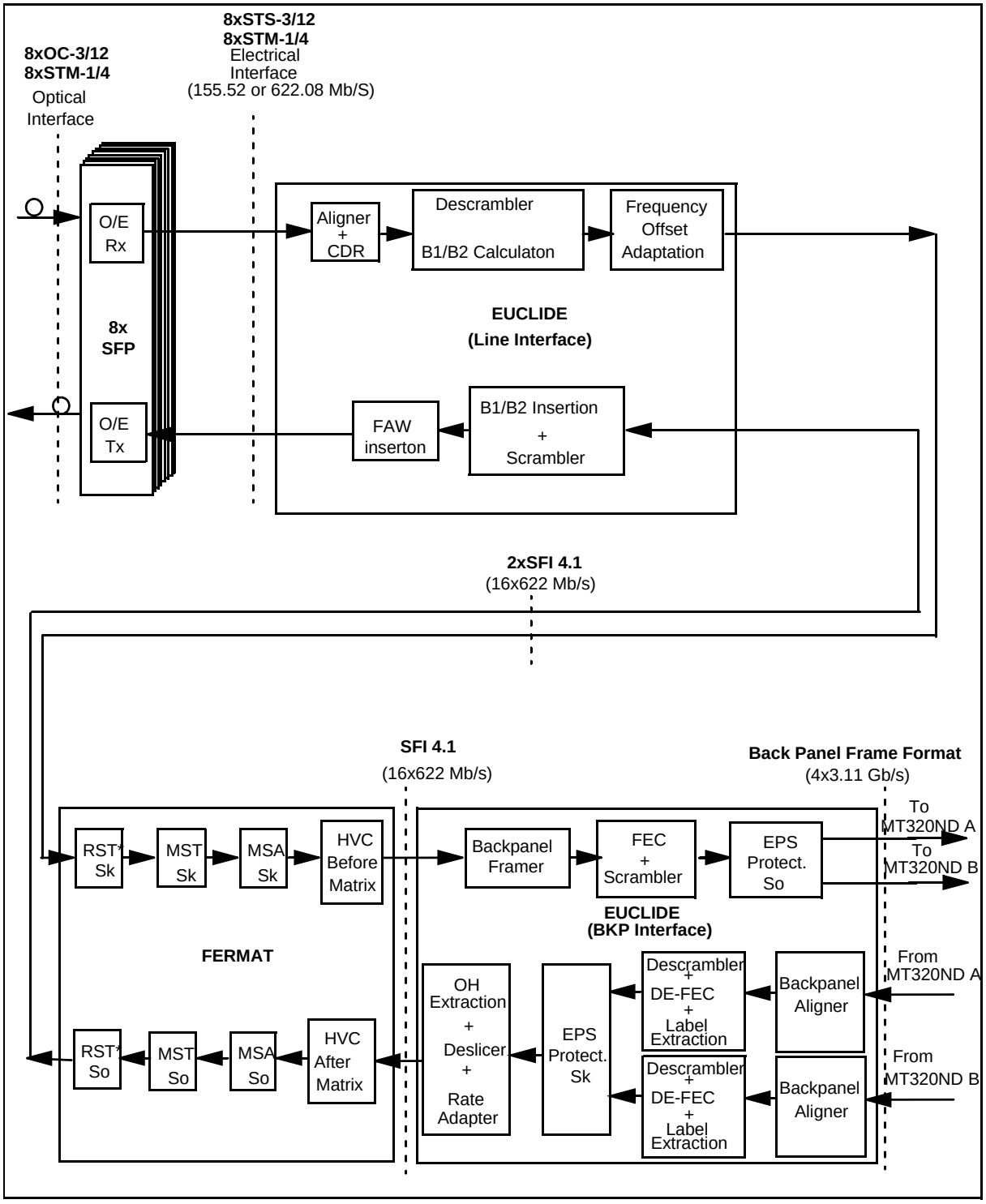


Figure 306. 8PSO - Payload subsystem block diagram

4.3.4.3 Sink Side (Signal flow from Optical Line to HPC Matrix)

O/E RX:

It performs the conversion from an optical OC-3/STM-1 (or OC-12/STM-4) signal to an equivalent electrical stream (STS-n per SONET), by using differential signaling, as defined by SFP MSA specifications.

CDR+Aligner:

These functions are integrated in EUCLIDE Asic. CDR performs 3R-regeneration on the incoming data stream; the Aligner recovers frame alignment and detects OOF events.

Descrambler + B1/B2 Calculation:

It descrambles the incoming signal and performs BIP-8 (B1) and BIP-24 (or BIP-96) (B2) calculations.

Frequency Offset Adaptation:

It eliminates the frame alignment word from the incoming signal, performs rate adaptation to the on-board local clock by means of negative stuffing, and provides the data together with control and synchronism bytes, via a double SFI4.1-like interface, to FERMAT FPGA.

RST*Sk (partial RSn_TT_Sk):

- it recovers frame alignment, by detecting the synchronism of J0 (inserted by EUCLIDE)
- it extracts OOF events (detected by EUCLIDE) and detects LOF alarm
- it performs regenerator section trace recovery and mismatch detection (J0), BIP-8 (B1) errored blocks count, and TSF insertion (on LOS, LOF or TIM detection)
- it provides RS data communication (DCCR) extraction (D1-D3)
- It provides RS OverHead bytes extraction (E1, F1....)

MST Sk (MSn_TT_Sk):

Performs BIP-24 (or BIP-96) (B2) errored blocks count, MS-REI recovery, K1 and K2 extraction and MS-RDI/MS-AIS detection, MS data communication (DCCM) extraction (D4-D12), and MS OverHead auxiliary bytes extraction (E2,.....)

MSA Sk (MSn/Sn_A_Sk):

Performs AU4's pointer processing, LOP and AIS detection, and pointer justification (including AU4 Concatenation handling capability).

HVC Before Matrix (HTCM/HTCTsk, HPOM/HSUTsk, HSUTso, HTCTso):

Performs path overhead processing such as J1 and G1 recovery, C2 signal label monitoring, UNEQ and VC-AIS detection, BIP-8 (B3) errored block count, N1 extraction, and BIP-8 (B3) compensation.

Back panel Framer:

Receives the incoming data stream on a 16-bit differential LVDS interface, performs frame alignment, and generates a proprietary frame (4G Backplane Frame Format) for back panel links (Rate Adaptation, Slicing, insertion of OverHead and Protection channels generated by FERMAT, FAW and J0Link Label insertion).

Forward Error Correction (FEC)+Scrambler:

Performs the FEC redundancy calculation and insertion (The FEC code used is a Reed-Solomon code: RS (243, 241)), and scrambling.

EPS Protection So:

Provides proprietary 4G Backplane Frame Format signals at 3.11 Gb/s to HPC Matrix A and B (for EPS protection purposes).

4.3.4.3.1 Source Side (Signal flow from HPC Matrix to Optical line)

Back panel Aligner:

Performs alignment processing on proprietary 4G Backplane Frame Format signals at 3.11 Gb/s coming from HPC Matrix A and B

Descrambler+DEFEC+Label extraction:

Performs descrambling; FEC decoding, error detection, corrected/uncorrected errored blocks count; and J0Link extraction.

EPS Protection Sk:

Performs the selection (for EPS protection purposes) between the link from the HPC Matrix A and the link from the HPC Matrix B.

OverHead extraction+Deslicer+Rate Adapter:

Performs Overhead and Protection channel extraction and transmission to FERMAT and adaptation from back panel rate to SDH rate

HVC After Matrix (HTCM/HTCTsk, HPOM/HSUTsk, HSUTso, HTCTso):

Performs path overhead handling: N1 insertion, BIP-8 (B3) compensation, C2 “unequipped“ insertion, J1 and G1 insertion, and BIP-8 (B3) calculation and insertion

MSA So (MSn/Sn_A_So):

Performs AUG assembly, AU4 pointer generation and processing, AU-AIS generation, and PJE count.

MST So (MSn_TT_So):

Performs MS-REI and MS-RDI insertion, D4-D12, K1-K2, and MSOH OverHead bytes insertion.

RST*So (partial **RSn_TT_So)**:

Performs regenerator section trace (J0) insertion, D1-D3 and RSOH OverHead bytes insertion, and provides the data together with control bits on two 16-bit differential LVDS interfaces to EUCLIDE.

B1/B2 Insertion + Scrambler:

Performs errored blocks BIP-8 (B1) and BIP-24 (or BIP-96) (B2) computing and insertion, as well as scrambling.

FAW Insertion:

Performs frame alignment and word insertion.

O/E TX:

Performs the conversion from an electrical STS-3c/STM-1 (or STS-12c/STM-4) signal to an equivalent OC-3/STM-1 (or OC-12/STM-4) optical stream.

4.3.4.3.2 Loopbacks

For Test and maintenance purposes, Loopback capabilities are supported on the 1850 TSS-320 and are located on the FERMAT FPGA.

For each OC-3/STM-1 (or OC-12/STM-4) Channel, the FERMAT FPGA provides both “Line" side and “Equipment" side Loopbacks with STS-3c/VC4 granularity (or 4xSTS-3c/VC4 granularity for OC-12/STM4).

In both “Line side Loopback" and “Equipment side Loopback", the following operating modes are supported:

- “Loop and continue"
- “Loop and send AIS"

These Loopbacks are controlled via ISPB bus.

4.3.4.4 Power subsystem description

Distributed power supply architecture on card consists of an input power stage and a set of compact DC/DC converters.

The input power stage provides circuitry to:

– monitor the presence of the battery A/B voltages after the input fuses

– perform the OR-ing of the batteries

– perform over-voltage and under-voltage protection on 48V power bus

– control the inrush current at the start-up, plus the EMI filtering

The main unit power supply voltage is obtained as follows:

– 2 isolated DC/DC converters (1/8 brick) to derive 3.3V and 1.2V operating voltages from the 48V back-plane bus

– 2 small non-isolated Step Down to obtain +2.5V, +1.8V from the +3.3V

An additional service voltage at 3.3VS, obtained from a duplicated 3.6V (V3A, V3B) coming from back panel, is used for on-board SPI circuitry: Remote Inventory device, status Leds, Goblin_4G and Kyra Cpld.

4.3.4.5 Timing subsystem description

The clock management is carried out by EUCLIDE Asic, which performs the following main tasks:

– synchronization to reference SONET/SDH Equipment Clock (SEC) T0 and selecting between two clocks at 38.88 MHz (coming from SLC/CRU cards)

– feeding of the selected T0 clock (CK38) and related synchronism (MFSY) to the FERMAT

– phase comparison to lock the on-board local 622.08 MHz VCXO to the selected T0 timing reference (PLL at 622 MHz)

– phase comparison, to derive the timing reference at 777.6 MHz for the 4G Backplane Frame Format back panel Links (PLL at 777.6 MHz)

– feeding of T1 timing reference, derived by Rx Optical Line signal, towards SECs

FERMAT FPGA presents the following synchronization structure:

– timing signal at 77.76 MHz, coming from EUCLIDE and related to the overhead channels, is used as core logic reference

– clock signals at 311.04 MHz, coming from EUCLIDE and related to SFI-4.1-like interfaces (operating in DDR mode), are used to synchronize both input and output SFI-4.1-like sides.

– T0 timing signals coming from SECs are used as reference on DCC channels

4.3.4.6 Control subsystem description

There are three types of interfaces for communication between the Second Level Controller Cards and the 8PSO Port:

– ISPB: Intra Shelf Parallel Bus

– SPI: Serial Peripheral and Inventory Bus

– HW_CFG: Hardware Configuration Bus

4.3.4.6.1 Intra Shelf Parallel (ISPB) Bus

The ISPB Bus provides a backplane communication channel between Second Level Controller (SLC) and every Transport card in the same shelf.

By means of ISPB, the Second Level Controller loads proper configuration settings in to the internal registers of the EUCLIDE and the FERMAT, monitors the current status, and collects data for performance monitoring.

4.3.4.6.2 Serial Peripheral and Inventory (SPI) Bus

By means of SPI bus and GOBLIN_4G Cpld housed on Port card, the Second Level Controller performs the following task:

– gathering of Port card power supply failure alarms

– gathering of Optical LOS alarms

– detection of SFP optical modules presence

– access to/from onboard EEPROM for Remote Inventory data via local SPI Bus

– access to/from a dedicated A/D converter to collect electric data (voltage levels, current values)

– moreover, via KYRA Cpld, it is possible to:
  - control card status LED on front-panel
  - gain access (via SPI-I2C bridge integrated within the KYRA) of SFP Remote Inventory data (serial ID, digital diagnostics)
  - monitor the FERMAT junction temperature and card temperature values

4.3.4.6.3 Hardware Configuration (HW_CFG) Bus

By means of the HW_CFG Bus, the Second Level Controller can access the HW_CFG bridge function implemented inside the GOBLIN_4G device.

This function grants both read and write access modes to the Flash Memory and also transfer the downloaded Configuration Data from the Flash memory to the FERMAT via the FPGA's parallel configuration interface. This download procedure can also to be done remotely.

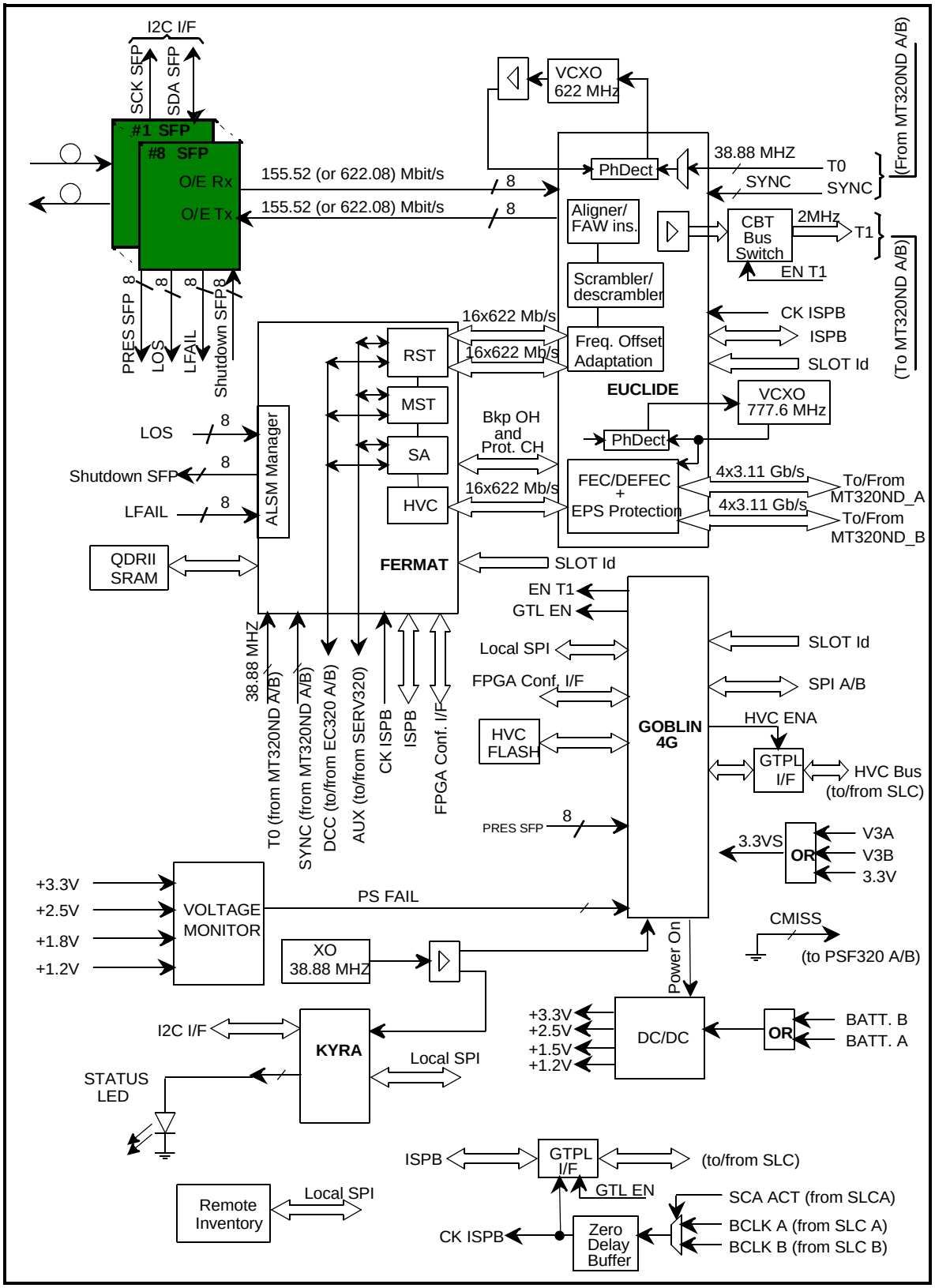


Figure 307. 8PSO - Functional block diagram

4.3.5 SFP Modules

(Refer to Figure 308. on page 473)

The SFP modules provide the optical physical access necessary to operate the SONET/SDH unit (example 4P2G5SO, 8PSO...).

The following types of optical modules can be used:

- Black and White application:

ANSI	ETSI
IR-1 OC3, LR-1 OC3, LR-2 OC3	S-1.1,L-1.1, L-1.2
IR-1 OC48, SR-1 OC48, LR-1 OC48, LR-2 OC48	S-16.1 w/DDM, I-16.1 w/DDM, L-16.1, L-16.2 w/DDM
OC-12 multirate/multiformat OC-12 ANY w/DDM	STM-16 multirate/multiformat STM-16 ANY w/DDM

- CWDM application:

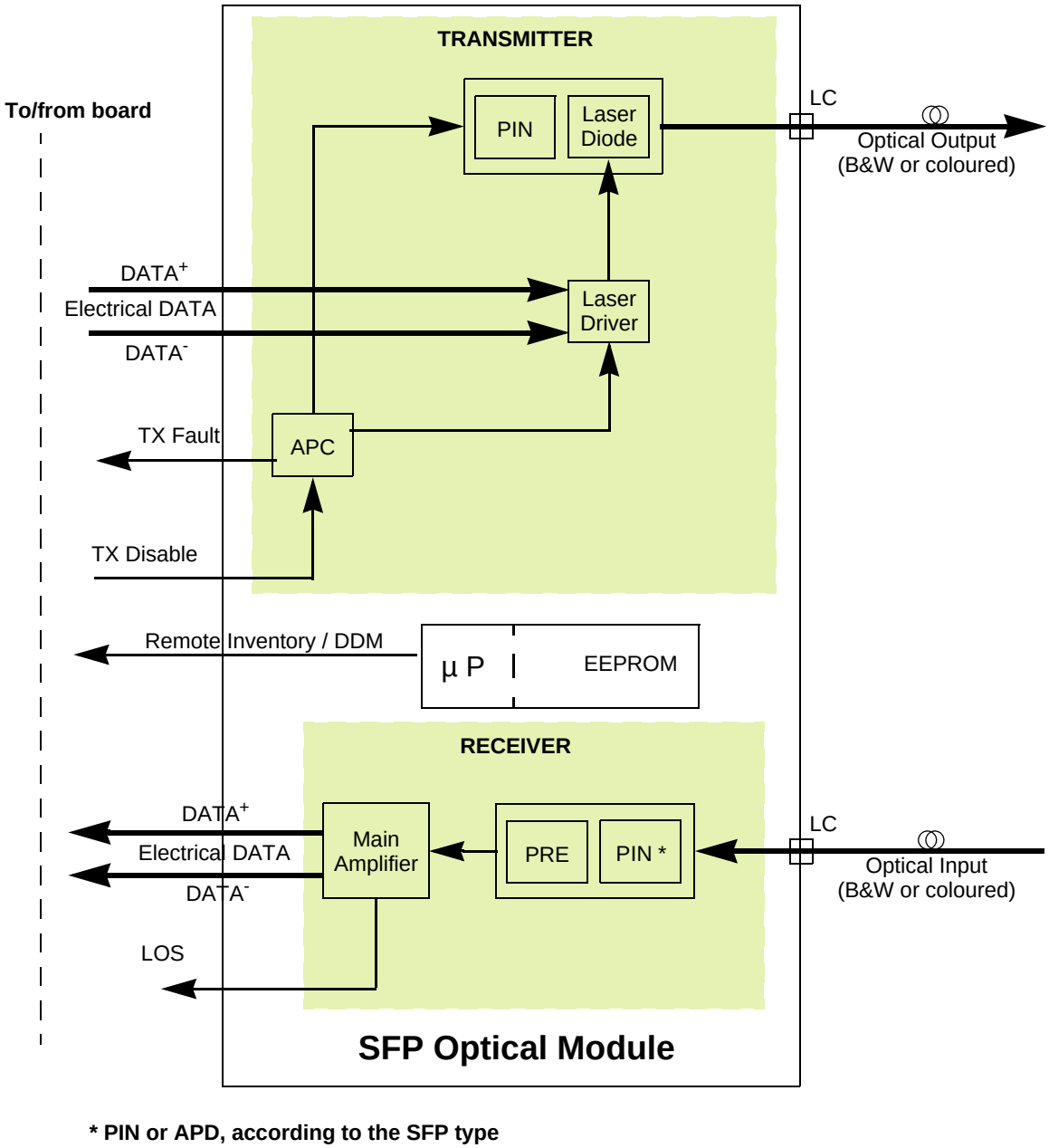
ANSI	ETSI
OC-12 PIN (bronze): IR-2 OC48 (1470 nm -> 1610 nm)	STM-16 PIN (bronze): S-16.2 (1470 nm -> 1610 nm)
OC-12 APD (silver): LR-2 OC48 (1470 nm -> 1610 nm)	STM-16 APD (silver): L-16.2 (1470 nm -> 1610 nm)

Each module is equipped with an automatic optical output power control circuit, a laser driver, and a laser diode module on the transmission side.

The transmitter is based on an uncooled DFB laser.
The laser safety class for the complete integrated module is CLASS 1, in accordance with CDRH 1040.10/ IEC 60825 2001. It can manage command for TX disable and reports TX Fault alarms.
Depending on the SFP type, the optical access is compatible with:
– single mode fibre (9/125 µm) or
– multi mode fibre (50/125 µm or 62.5/125 µm)
with standard LC optical connector.
TX Fault reports laser faults. The Transmitter is not disabled when TX Fault signal is active.
TX Disable is an input that is used to shut down the transmitter optical output.

On receiver side, each module has a PIN or APD photodetector for light to electrical current conversion and a limiting amplifier.
The photo detector current is amplified by an electrical circuit which delivers two complementary data signals. The module reports LOS alarms (LOS on an input Power Signal). This output signal indicates the received optical power is below the worst case receiver sensitivity (as defined by the standard in use).
Depending on the SFP type, the optical access is compatible with:
– single mode fibre (9/125 µm) or
– multi mode fibre (50/125 µm or 62.5/125 µm)
with standard LC optical connector.

The Transceiver is eqiuipped with an EEPROM to provide Remote Inventory, which contains information such as transceiver's capabilities, standard interfaces, the manufacturer. The serial interface uses the 2-wire serial CMOS EEPROM protocol defined for the ATMEL AT24C01A/02/04 family of components.
The Digital Diagnostic Monitoring (DDM) is an SFP function supporting analog parameters measurements such as temperature, laser bias, and laser power. This optional feature displays availability information on the SFP Remote Inventory.



*** PIN or APD, according to the SFP type**

Figure 308. SFP modules general block diagram

4.3.6 1XOTU-2 - OTU-2 Port Slim port card

The OTU-2 card is a 10 Gbps bidirectional unit that supports one DWDM optical interface (one optical channel) in the 1529 nm –> 1563 nm range on a 100 GHz grid, per G.709 requirements .

The board performs an optical to electrical conversion. The optical interface is the line interface and the electrical interface is the back panel interface to the client unit (that is, 10xANY) through the Matrix, by means a cross-connection.

The **Line/WDM** bidirectional optical interface is the connection to the network and it is accomplished by a single coloured wavelength. Each wavelength is multiplexed into a single fiber and sent to the G.709 network. The WDM interface is a Network to Network Interface (NNI) and the bit rate is 10.709225 Gbps. It manages NRZ coded signals.

The driver amplifier with AGC adjusts the electrical signal amplitude to achieve the required output optical extinction ratio. The WDM emitter is a Mach Zenhder Modulator, able to modulate the 10.709Gbps signal on the wavelength generated by the tuneable CW Laser.
Variable Optical Attenuator (VOA) and CDR functions are integrated into the optical module**.** The VOA attenuates the optical signalto obtain the desired optical output power. The target attenuation level is obtained by applying an appropriate voltage to the VOA. The CDR performs 3R-regeneration (with adjustable decision threshold) on the incoming serial data signal. The decision threshold level is set externally by an analog signal to optimize the Bit Error Rate (BER).
The Channel Tap Detector monitors the optical output power of the VOA by coupling about the 5% of the power launched into the input fiber to the tap port and converting it into electrical current with a photo-detector.
On the Line side, the unit supports the following selectable FEC types:

– Standard G.709 Reed Solomon FEC (RSFEC) based on RS(255,239) algorithm (5.8dB Net Coding Gain on OSNR @BER=10-13)
– Proprietary Enhanced FEC (EFEC) based on BCH algorithm (8.5dB Theoretical Net Coding Gain on OSNR @BER=10-13).

The **Client** interface is a bidirectional back panel electrical interface on a black and white wavelength, providing the connection to the client unit (i.e. 10xANY) via a Matrix cross-connection.
The supported bit rate is 9.95320 Gbps in UNI mode (STM–64, OC–192, 10 GB Ethernet WAN).

1xOTU2 Port provides bi-directional processing of one OTU2 signal, such as:

– FEC coding/decoding
– OTU2 and ODU2 overhead insertion/extraction
– mapping/demapping of an OC-192/STM64 client signal into/from an OTU2 frame structure
– bi-directional processing of the OC-192/STM64 client signal, such as:
  • regenerator and multiplex section transport overhead insertion/extraction
  • payload assembly/dissasembly at STS-3c SPE/VC4 level
– Loopback testing capability

From an intra-equipment functional viewpoint, the unit assembly carries out its tasks by working in conjuction with other equipment parts, such as:

– Matrix subsystem (two MATRIX cards) for payload exchange at STS-3c SPE/VC4 level
– Synchronization subsystem (SETS functions) for reference timings
– Second Level Controller (SLC) for provisioning and alarm management
– SERVICE card for Auxiliary OverHead channels processing
– First Level Controller (FLC) cards for DCC termination

Based on ITU-G.798 and ITU-G.783 recommendations, the 1xOTU2 Port card performs the Transport Terminal Functions (sink on RX side, source on TX side) such as:

a) OCh to OTU2 Adaptation Function (OCh/OTU2_A)
b) OTU2 Trail Termination Function (OTU2_TT)
c) ODU2P (Path) Trail Termination Function (ODU2P_TT)
d) ODU2T (Tandem Connection) Trail Termination Function (ODU2T_TT)
e) ODU2P to CBR10G Adaptation Function (ODU2P/CBR10G_A)
f) OC-192/STM64 Section Layer Functions (RSn_TT, MSn_TT, MSn/Sn_A)
g) STS-3c SPE/VC4 Path Layer Functions (HTCM/HTCT, HPOM/HSUT, HSUT, HTCT)

1xOTU2 Port card is connected to two Matrix boards (1+1 configuration) for cross connection (HPC) processing.

The unit provides Optical Safety support by means of a protection procedure, which is based on the trigger signals when alarrms/defects are detected and when the Automatic Laser Shutdown (ALS) command is issued.

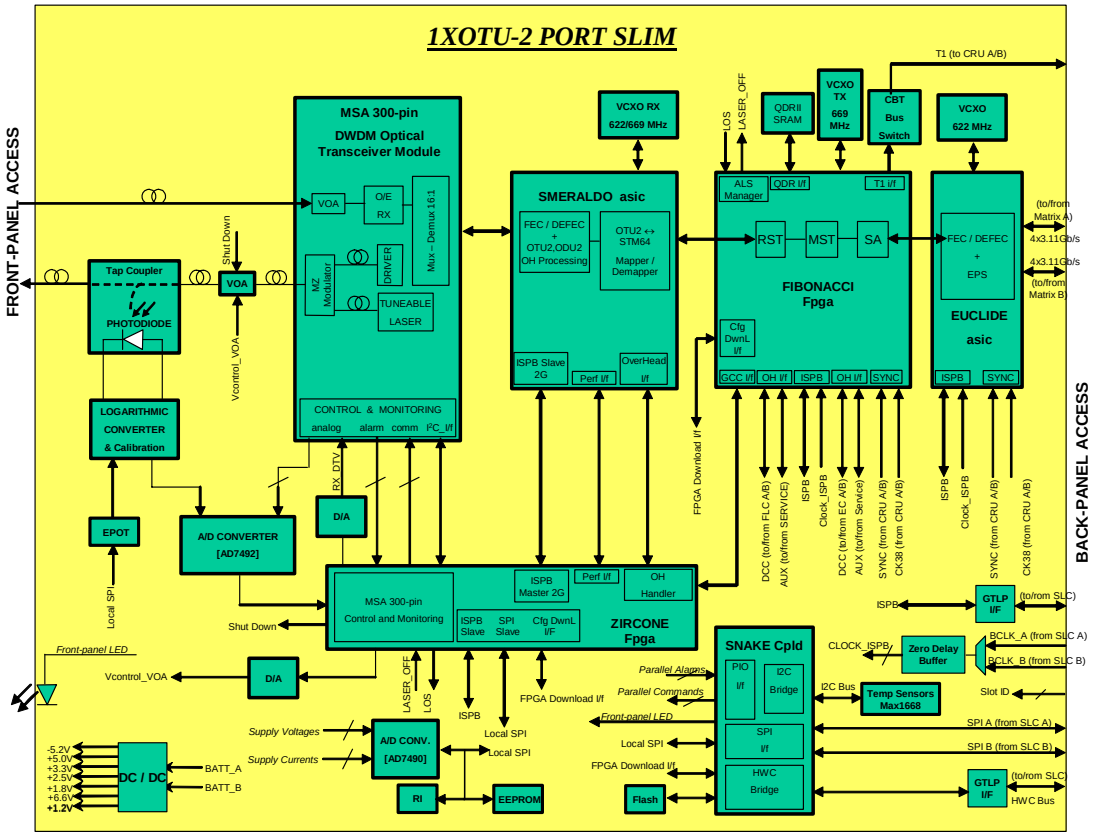


Figure 309. Functional and physical block diagram

Available on the Front Panel are:
– a duplex LC-type adapter for line optical access (RX + TX)
– a Multicolour LED as visual card status indicator (card failure, in-service, updating, etc.

4.3.6.1 Payload subsystem description

Figure 310. on page 476 the flow of traffic signals on the Sink side (from Optical Line to HPC Matrix) and onthe Source side (from HPC Matrix to Optical Line).

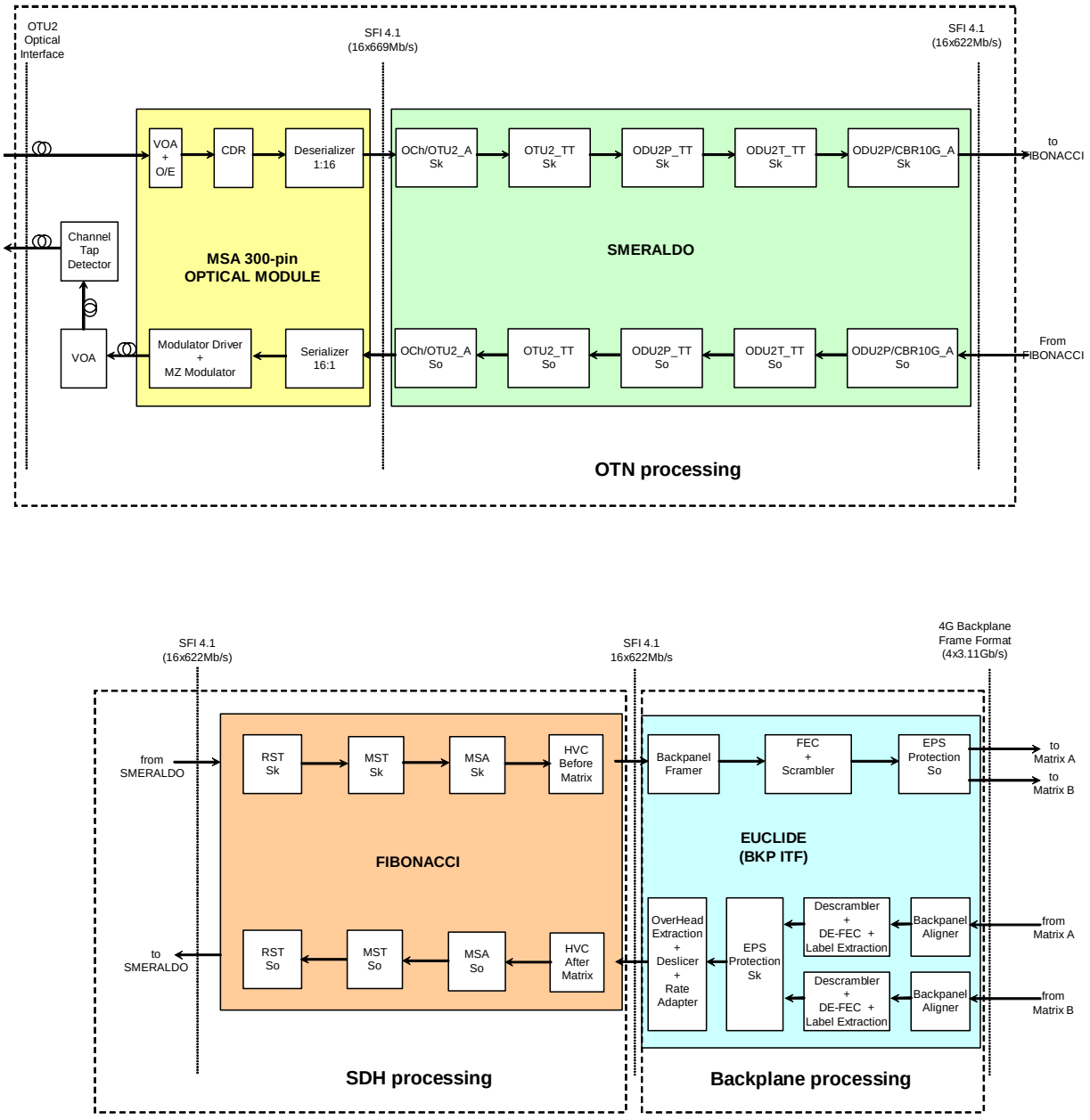


Figure 310. Payload subsystem block diagram

4.3.6.2 Loopbacks

For Test and maintenance purposes, the following Loopback capabilities are supported:

– both "Line" side Loopback and "Equipment" side Loopback
  - In "Line side Loopback", the following two operating modes are allowed:
    – "Loop and continue"
    – "Loop and send client AIS"
  - In "Equipment side Loopback", the following two operating modes are allowed:
    – "Loop and continue"
    – "Loop and send OTU2-AIS"

4.3.6.3 Performance Monitoring

10Gbps PM FEC, based on FEC decoder info (Corrected Errors, Uncorrected Blocks) are available line side.
FEC **Near End** performance monitoring:
– Corrected Errors: bits corrected over one second
– Uncorrected blocks: blocks not corrected over one second.

FEC **Near End** and **Far End** performance monitoring:
– Errored Block Count: frames with at least one code violation.

4.3.6.4 Power subsystem description

Distributed power supply architecture on the OTU-2 Port Slim port card card consists of an input power stage and a set of compact DC/DC converters.

The main unit power supply voltage generated on the daughterboard is as follows:
– 3 isolated DC/DC converters to derive +5.0V, -5.2V and +1.2V operating voltages from the 48V back-plane bus
– 2 small non-isolated Step Down (5A) to obtain +2.5V, +1.8V from the +5V
– 1 small non-isolated Step Down (16A) to obtain +3.3V from +5V

One additional power supply voltage is generated on motherboard as follows:
– 2 small non-isolated switched-capacitor voltage converters (50mA) connected in parallel to obtain +6.6V from the +3.3V

The service voltage at 3.3VS, obtained from a duplicated 3.6V (V3A, V3B) coming from back-panel is used for on-board SPI circuitry: Remote Inventory device, Status Led, Flash memory and Snake Cpld.

4.3.7 10 x ANY port card

The 10xANY unit is a Data/TDM concentrator which aggregates up to ten client signals (GE, 1/2/4 Fibre Channel, OC-3/12/48 SONET, STM-1/4/16 SDH) into a VC4-nv (n= 1 .. 64) electrical frame, supporting VCAT/LCAS.
The client signals on the front panel (GE, STMn) can be mapped to VCAT groups or extracted to single VC4 and cross-connected to other TDM units (e.g. OTU-2, 1P10GSO). The client signals on the same 10xANY can be cross-connected to multiple TDM units via Matrix.

Fibre Channel support is planned for a future release.

The board performs an optical to electrical conversion. The optical interfaces are the client interfaces and the electrical interface is the back panel aggregate/multiplexed interface to any TDM card (OTU-2, another 10xANY, 1P10GSO, 4P2.5GSO, etc.) via the Matrix, by means a cross-connection.

The card manages any combination of the client signals satisfying the total processing power that is limited to 10 Gb/s by backplane links.

All the client interfaces are external SFP pluggable modules (0 to 9 on the front plate).

The **Aggregate** interface is a bidirectional back panel electrical interface on a B&W wavelength. It can be cross-connected via the Matrix to the electrical B&W interface of a WDM unit (i.e. OTU-2), that is launched on the WDM line.
The supported bit rate is 9.95320 Gbps in UNI mode (10 GB Ethernet WAN).

Each **Client** interface (0 to 9 on the front plate) provides the connection to the clients by up to ten SFPs.
SFPs are optical transceivers enabling the building of a unit with a client-oriented User Interface.
B&W GbE, FC (1/2/4 FC), OC-3/12/48, STM-1/4/16 interfaces are supported according to the SFP plugged.
The following SFP optical modules are supported on the client side:
– B&W FC/2FC/4FC: 1/2/4 Fiber Channel (1.065Gbps/2.125Gbps/4.25Gbps) at 850nm and 1310nm
– B&W GbE–SX, GbE–LX, GbE–ZX, supporting 1.25Gbps bit rate at 850nm, 1310nm, 1550nm
– B&W S-1.1/L-1.1/L-1.2: OC-3/STM–1 (155Mbps) Short/Long reach at 1310nm and (L-1.2) 1550nm
– B&W S-4.1/L-4.1/L-4.2: OC-12/STM–4 (622Mbps) Short/Long reach at 1310nm and (L-4.2) 1550nm
– B&W I–16.1/S–16.1: OC-48/STM–16 (2.488Gbps) Inter–office/Short reach at 1310nm
– B&W L–16.1/L–16.2: OC-48/STM–16 Long reach at 1310nm and 1550nm.

GbE SFP electrical modules are also be supported.
The client interfaces/ports are LC/PC connectors. The SFP modules can be extracted/inserted via the front panel without removing the board.

Performance monitoring is performed on the client side by:
– B1 PM are available on SONET/SDH signals, compliant with GR-253 and T1.231
– 8B/10B PM, also called PM Ethernet layer 1, are available on FC signals
– Layer 2 GbE PM are available on GbE signals.

Measurements
SFP measurements (Tx Fault, Rx Loss, Tx Disable, Rx rate..) are accessible by the controller through the board.

DCC/AUX management
The unit supports DCC signalling communications with the FLC via backplane links. Furthermore, it processes Auxiliary Overhead Channels to/from Service.

4.3.7.1 Functional description

A functional block diagram showing the main interfaces is shown in Figure 311. on page 479.

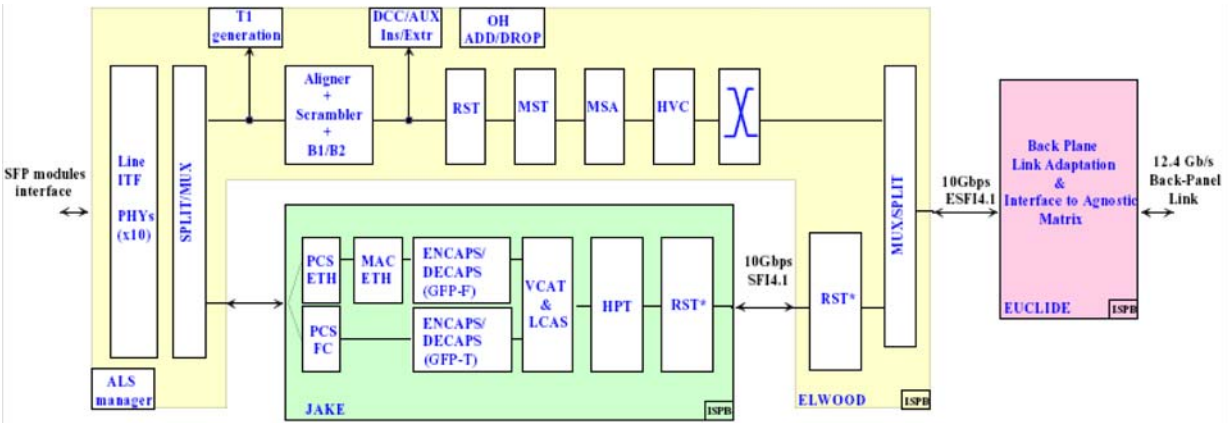


Figure 311. Functional block diagram

Each traffic type follows a different path inside the card (see Figure 312. on page 480). The bi-directional processing phases performed on the 10xANY unit are:

– Line Interface and PHYs management

– TDM/Data path processing:
  - TDM path
    – SDH/SONET processing
    – DCC management and Auxiliary Overhead Channels insertion/extraction
    – TOH transparency
    – Performance monitoring
  - Data path
    – Ethernet
      - ETH processing (PCS and MAC)
      - SDH-like Ethernet synchronization source and sink
      - GFP-F mapping
      - VCAT/LCAS management (differential path delay compensation up to 32 ms, with 576 Mb external RLDRAMII)
      - L2 performance monitoring
      - Support for Jumbo Packets up to 9 KB in both ingress and egress directions
      - Flow control
      - Auto-Negotiation
    – Fibre Channel (future release)
      - FC processing (FC-1)
      - GFP-T mapping
      - VCAT management (differential path delay compensation up to 32 ms, with 576 Mb external RLDRAMII)
      - L1 performance monitoring
  - 10Gb/s backplane processing power

The following features are also provided:

– T1 timing reference (six signals) from RX line interface generation (both SDH/SONET and Ethernet traffic)
– Loopback for debug
– Database supporting cost reduction strategies, without SLC software upgrade
– Protection by the Matrix

The 10xANY unit also provides Optical Safety support by means of an Automatic Laser Shutdown (ALS).

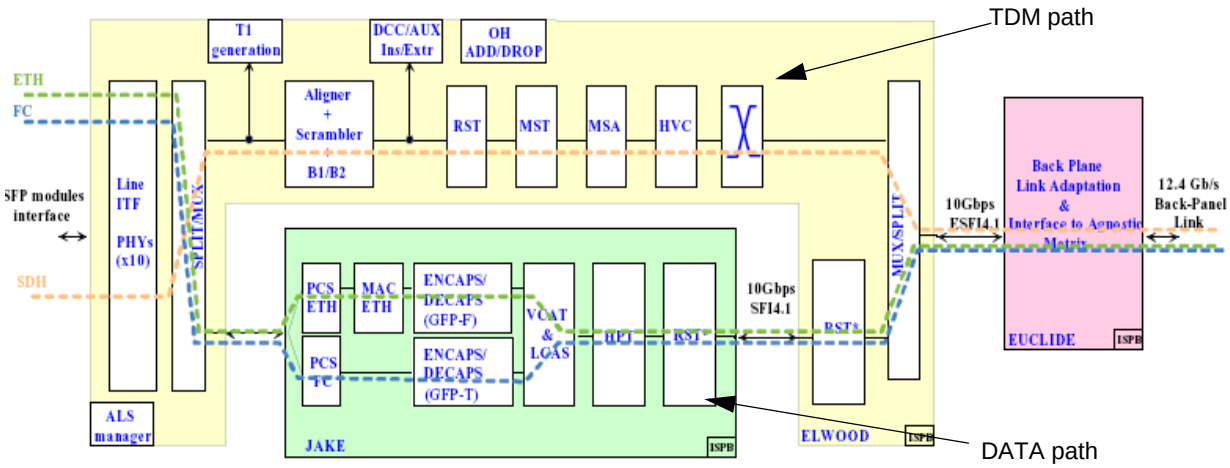


Figure 312. Traffic flow paths

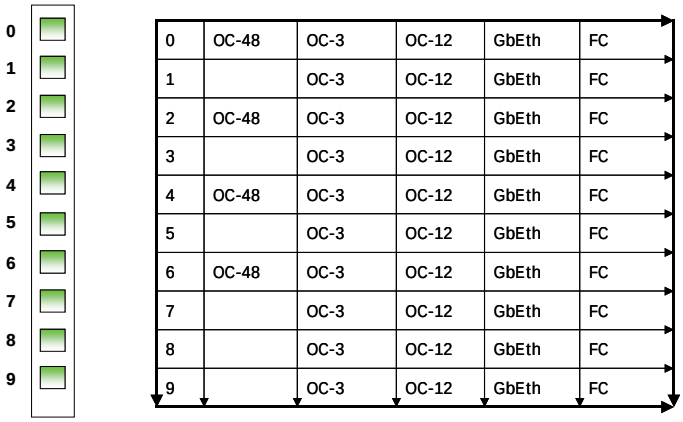
The front panel integrates two bi-colour LEDs to indicate the unit status and the EPS status.

4.3.7.2 Equipping rules

Each board can manage the following maximum quantities of client signals (SFPs):

– up to 10 x OC-3 (STM-1) / OC-12 (STM-4) / GbE / FC (future release)
– up to 4 OC-48 / STM-16

Mixed configurations are allowed, but with the following restrictions: only two types of clients can be installed in each group of four clients (0 -> 3, 4 -> 8 on the front plate). This means only SONET and GbE or SONET and FC or GbE and FC can be plugged in each group, but not SONET and GbE and FC together.



0	OC-48	OC-3	OC-12	GbEth	FC
1		OC-3	OC-12	GbEth	FC
2	OC-48	OC-3	OC-12	GbEth	FC
3		OC-3	OC-12	GbEth	FC
4	OC-48	OC-3	OC-12	GbEth	FC
5		OC-3	OC-12	GbEth	FC
6	OC-48	OC-3	OC-12	GbEth	FC
7		OC-3	OC-12	GbEth	FC
8		OC-3	OC-12	GbEth	FC
9		OC-3	OC-12	GbEth	FC

4.3.7.3 Payload management description

The logical flow of traffic signals is shown in Figure 313. on page 481.

The ten clients (SFPs optical), with no restrictions on optical SFP modules (up to 10 for each 10xANY, according to the bit rate)

SONET/SDH traffic coming from SFPs has to be sent to the TDM path. Other types of traffic must be sent to the Data path. This functionality is carryed out with a split in the ingress direction and a MUX in egress: Figure 313. on page 481 shows the block for SFP#0.

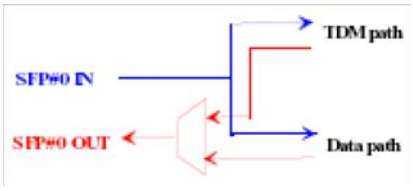


Figure 313. Split/MUX block

TDM path

The frame format is compliant with ITU-T G.707.

This function supports dynamic VC/VT allocation and TOH transparency.

Data path

It performs PCS and MAC management for Ethernet traffic and PCS for Fibre Channel traffic. It also performs the data mapper functions and allows interworking between packet based traffic and TDM traffic, providing data encapsulation functionalities and technology specific path monitoring and termination.

Packet-based traffic is encapsulated in different ways, depending on its nature. GFP-F and GPF-T mapping is performed. Encapsulated traffic is then mapped into virtually concatenated or contiguous virtual containers (STS-1/3c - VC4/3). The Virtual Concatenation core provides path delay compensation and is complemented with a link capacity adjustment scheme (LCAS).

The frame sent/received to/on TDM side is a 4xOC-48/STM-16 structure.

MUX/SPLIT

Generated and transmitted TDM frames are multiplexed with frame coming from TDM path to get a proprietary SDH-like structure. In the other direction, proprietary signal is send both to the TDM path and to the Data path.

The SDH-like structure signal is adapted to the backplane links frame format, suitable for processing by the Matrix.

4.3.7.4 Loopbacks

Figure 314. on page 482 shows "Line loopback" in red and "Equipment loopbacks" in blue. There is also an internal loop-back function (violet in the figure).

All these loop-backs are controlled via ISPB bus.

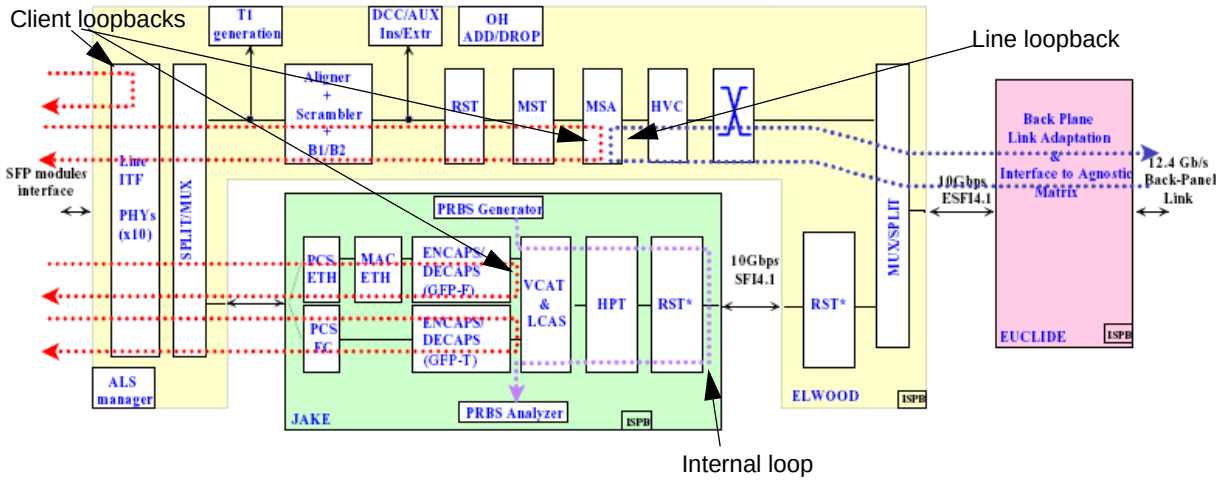


Figure 314. Loopbacks for debug purpose

4.3.7.5 Power Subsystem description

The unit gets the 48V main power and the 3.3V Service power from backplane connectors.
The backplane 48V is filtered and converted by two DC/DC converters in low voltage board main power supply.
Some secondary power supplies with lower current consumption are generated using 3.3V by small DC/DC step down converters.
1.5V voltage manages 4GFC. It is derived from 1.8V by a LDO.

4.4 DATA units

4.4.1 PP20G - 20G Packet Processor

This unit allows the transportation and management of packet data services over Ethernet physical layer or over SDH physical layer.
Refer to the block-diagram illustrated in Figure 315. on page 490.
The functions are to be considered BIDIRECTIONAL, if not otherwise specified.
The funcionalities of this board can be subdivided into 4 main parts:

- **a) Data Engine**
- **b) Local Controller**
- **c) Inventory and Peripherals (P&I)**
- **d) Power Supply**

a) Data Engine

It contains the functions to process the data packets:
(the blocks PacketProcessor and NetworkProcessor are physically located on the same component PPB or X10Q)

PIM1 and PIM2:

Plug-in Modules to be inserted into the front openings of the unit. A max of two PIM's can be equipped on a board.
The following PIM's are allowed:

PIM1GE: capable of ten local ethernet accesses at a rate of 1Gbps. Described in Section 4.4.2 on page 491.

PIM10GE : capable of one local ethernet access at a rate of 10Gbps. Described in Section 4.4.3 on page 495.

PIMMS : performs the mapping of Ethernet frames over SDH/SONET (EOS). Described in Section 4.4.4 on page 499.

Packet Process:

This block consists of the functions **MAC2**, **VLAN**, **FIC**, **TPROF** and **POL**, described below.
The control messages relative to this block are communicated to/from the LDC by means of the XCM bus.

System Packet Interface (SPKI) level 4 phase 2 bus:

This bus transports ethernet data stream at a rate of 10 Gb/s from the PIM modules to the Packet Processor (paralleled 16x700+16x700Mbps data +350Mhz ddr clock). It implements a standard interface compliant with OIF-SPI-4-02.1 recommendations.
Two SPKI buses to interface the PPB device with the two PIM modules. Two other SPKI buses transport the data between the PPB and TM1 and TM2 blocks of the TMS.

MAC2:

It receives the ethernet packets from the PIM modules over the SPKI bus at the rate of about 10Gbps. SPKI is a standard bus type SPI4.2: System Packet Interface level 4.2.
It inspects the MAC frame fields for Destination and Source Addresses, L/T, FCS, etc.
The Ethernet 802.3 frame format is illustrated in Figure 107. on page 155.
The Ethernet Framing (on Local Ethernet Ports) is illustrated in Figure 110. on page 157.

VLAN:
The afferent frames can be optionally VLAN and/or SVLAN tagged (Virtual LAN, Stacked Virtual LAN). In these cases, they check the 802.1Q field and the TCI (Tag Control Information).
It manages the VLAN (user tag) and S-VLAN (provider tag) fields of the MAC frame (also called “VLAN-tagged MAC frames"); in this way it can further support the SLA (Service Level Agreement) with differentiated CoS (Class of Service).
The use of VLAN option permits the aggregation of many users over a single virtual circuit, allowing them to communicate with each other as if they were on the same LAN even if they are not physically connected. In this way, users may also move from one segment to another without changing their physical address.

If requested, it can insert (“Push”) or remove (“Pop”) the VLAN/SVLAN tags on/from the frames.
The VLAN and SVLAN tagged Ethernet frames structures are illustrated in Figure 108. on page 156, Figure 109. on page 156, Figure 110. on page 157.

Flows Identification and Classification (FIC):
This function identifies and classifies the frames, according to the following parameters configured by the operator:

- **Traffic Description** (TD)
- **Policing method**
- **VLAN Identifier**
- **Priority** (the packet priority (802.1p) is contained in 3 bits of the TCI field)

Traffic Profile (TPROF): traffic descriptor association.

Policing (POL) : traffic parameters checking, to verify their conformance to the traffic profile.

Network Process:
This block consists of two functions, **STP** and **EthernetSwitch**, described below.
The control messages associated with this block are communicated by means of the XCM bus.

Ethernet switching/bridging:
This function is coordinated on the unit and Universal Matrix. It associates the ethernet ports and data flows and forwards packets. The function can be carried out either in Connection mode (engineeered permanent link) or in Bridge mode (automatic dynamic packets forwarding), using the “Auto-Learning” and “Aging” mechanisms, and the FDB (Forwarding Data Base) information. The following FDB components are stored in a memory (M).

Auto-Learning mechanism:
Unknown incoming frames are flooded on all ports of the bridge, except the port where they arrived. When a far station responds back on a port, the bridge “learns" that frames having this received MAC-Addresss (and, if existing, the associated VLAN/SVLAN-ID) have to be forwarded to that port. This connection is written on a table (FDB, Forwarding Data Base, reporting the associations between MAC-addresses, ports, and, if used, VLAN/SVLAN Id.), used to forward next incoming frames.
Note: A VLAN/SVLAN identifier is learned and forwarded on a given port only if it is registered on that port; otherwise it will be discarded

Aging:
After a settable period of time, a record of the FDB table can be deleted.

The following are the different Switching/Bridging modes:

a) **Transparent port-to-port connection**
This is a manual connection between two ports devoted to a single data flow.

b) **ETS point-to-point connection**
This is a manual connection between data flows, where the port rate capacity can be subdivided among more data flows. In this case, VLAN or SVLAN can be used.

c) **MAC Bridging (802.1D)**
This “Bridging” is done on a per packets basis and done automatically using Auto-learning & Aging. The forwarding criteria for incoming packets is based on the association between MAC adresses and Ports, as written in the FDB.

d) **Virtual Bridging (802.1Q)**
This “Bridging” is done on a per packets basis and done automatically using Auto-learning & Aging. The forwarding criteria for incoming packets is based on the association between MAC adresses, Ports, and VLAN, as written in the FDB.

e) **Provider Bridging (802.1AD)**
This “Bridging” is done on a per packets basis and done automatically using Auto-learning & Aging. The forwarding criteria for incoming packets is based on the association between MAC adresses, Ports, VLAN and/or SVLAN, as written in the FDB.

Spanning Tree Protocol (STP) management:
The STP process “breaks" all the loops of the network, permitting only one path from a Bridge to any other Bridge, to prevent “infinite loops" (that is, infinite replaying of the frames) due to redundantly connected bridges networks. The STP information is recorded inside memory blocks (M). The STP process also protects the network STP failures. It provides, if the bridged network is redundantly protected, to recover the network connectivity (with respect to the STP topology). For instance by electing a new RootBridge (that is the root of the tree), if the actual one has failed; or by deactivating a failed link and activating a backup one, if existing. STP functions are compliant to 802.1d, 802.1w, 802.1s Rec.
The following are the STP modes:

a) **STP (802.1d)**
b) **Rapid STP (RSTP, 802.1w)**
c) **Multiple STP (MSTP, 802.1s)**
d) **Per-VLAN STP**

TMS : Traffic Manager and Scheduling (Eulero)
This function is distributed and performed in coordinated on the unit and Universal Matrix (and other data dnits involved in packet distribution). The control messages associated with this block are communicated to/from the LDC by means of the PCI bus.
There are two identical Traffic Manager and Scheduling blocks (**TM1** and **TM2**) in the TMS device, each of which process one data stream up to 10Gbps.
One TM block manages the afferent traffic, as performed by the following:
Input Buffering : the packets are stored until they are transferred to the relevant queue/port, according to the scheduling mechanism.

Queueing : the packets are lined up on different queues, depending on the TrafficProfile, Priority, output port, etc. This function is also called the Scheduler.
Output Driver : the packets are directed to relevant queues/port, according to the scheduling mechanism.
Input and Output Scheduling (IS, OS): the afferent data packets are transferred from the input ports to output ports, according to their priorities and traffic parameters. This function is accomplished by means of the IS (Input Scheduler, associated with the input port) and OS (Output Scheduler, associated with the output port) functions. The CS (Central Scheduler) block inside the Matrix is involved in this process. This mechanism is illustrated in Section 3.3.1.1 on page 277.
PM: performance monitoring of traffic management.
The Memory device (**M**) is used to store information about traffic scheduling and PM.

SERDES Framer Interface (SFI) bus:
This bus connects the EUCLIDE component (Matrix I/F) to the TMS, by means of standard SERDES (Serializer/Deserializer) interfaces contained in the associated components. Its maximum rate is about 10 Gbps, which is suitable for 10Gb Ethernet and STM64/OC192 rates. It implements a standard bus (paralleled 16x622+16x622Mbps data +311Mhz ddr clock) compliant to OIF-SFI-4-01 recommendations).

EEthernet over SDH/SONET OS mapping:
The mapping of Ethernet frames over the SDH (or SONET) transport frames is performed on the “MultiService” PIM (called “PIMMS”), described in Section 4.4.4 page 499. The **PIMMS** performs the mapping of ethernet frames over SDH/SONET and then allows the exchange of ethernet frames mapped over SDH/SONET between the NetworkProcessor of the MotherBoard and the Universal Matrices of the equipment. Its external buses are: SPKI (towards the MotherBoard) and MS-NGI (to the Matrix). The EOS-NGI data bus is active only if the PIM equipped on board is the MultiService type (PIMMS).
MS-NGI bus is used to transport Multi-Service or Ethernet-Over-SDH (MS or EOS) traffic between the Data Units and the two Matrices A and B of the equipment. It is a parallel link over 4 wires at 3.11 Gbps (4x3.11Gb/s). Each link is bidirectional and doubled, to connect Matrix A and Matrix B. The internal framing is illustrated in Section 3.2.3.3 on page 151.
MS-NGI1_A bidirectional link transports 10Gbps EOS traffic to/from Matrix A.
MS-NGI1_B bidirectional link transports 10Gbps EOS traffic to/from Matrix B.
MS-NGI2_A bidirectional link transports 10Gbps EOS traffic to/from Matrix A.
MS-NGI2_B bidirectional link transports 10Gbps EOS traffic to/from Matrix B.

Matrix Interfacing (Euclide):
The function of this block is to adapt Ethernet frames to a proprietary inter-board framing, in order to standardize different frames that have to be combined by the central “Agnostic” Matrix.
It also performs the Equipment Protection Switch (EPS) function, to switch from Matrix A to B, in case of Matrix failure.
The control messages associated with this block are communicated to/from the LDC by means of the Intra Shelf Parallel Bus- BP (ISPB) bus.
It contains the CKR, U-Framer, FEC, and EPS blocks. These latter three ones are duplicated in order to process two separated data streams up to 10 Gb/s.

U- Framer
The function of this block is to adapt Ethernet Packet frames to a proprietary inter-board framing, in order to standardize different frames that have to be combined by the central “Agnostic” Matrix.
The internal framing is illustrated in Section 3.2.3.3 on page 151.

Forward Error Correction (FEC):
In the receive direction, it recovers prospective errors that have occurred over the link pathway. FEC is an error correction technique in which redundant bits are transmitted along with the payload, permitting the receiving station the detection of errors and the correction of the relevant frame. The extra bits are removed on the receive side (de-FEC). To limit the impact of lost packets, FEC can be used to repair frames damaged by packet loss.

Equipment Protection Switching (EPS):
In case of failure of the main Matrix, it switches the link to the other Matrix thus permitting the restoration of the communication link.

Clock Recovery (CKR):
It performs the recovery of the clock for timing the Matrix I/F in the receive direction.

Pkt-NGI (1&2, A&B) : BackPanel bidirectional links:
Each link is bidirectional, paralleled at 4x3.11Gb/s, to convey payload data, traffic congestion information, transmission integrity check, channels protection information, etc. Used to transport the internal frames (or “agnostic” frames, rated about 10Gbps) to and from the Universal Matrices A and B.
The internal framing is illustrated in Section 3.2.3.3 on page 151.
PKT-NGI1_A bidirectional link transports 10Gbps Packets traffic to/from Matrix A.
PKT-NGI1_B bidirectional link transports 10Gbps Packets traffic to/from Matrix B.
PKT-NGI2_A bidirectional link transports 10Gbps Packets traffic to/from Matrix A.
PKT-NGI2_B bidirectional link transports 10Gbps Packets traffic to/from Matrix B.

Performance Monitoring (PM):
The function of this block observes the state and the quality of the functions used on the system. The collected monitoring data is stored inside the memory block **M**.
In particular, it collects data on existing links and resources, such as:
- number of total received/transmitted frames
- number of errored received frames
- number of correct received frames

b) Local Data Controller (LDC):

This block performs the following main functions:

- Management of control communications with the central equipment controller (EC or FLC) and the Matrix Controller (SLC, Second Level Controller)
- Unit software downloading
- Board states and alarm monitoring
- Configuration of components and functions on board
- Board Data Base (MIB) management
- Aiding of special functions on board such as STP, Bridging, PerformanceMonitoring, etc.

It is composed by a micro-controller (MICROP) and other components to adapt and distribute the various control and communication buses and also to resolve prospective conflicts arising from contemporary requests for access to the control from the other control entities of the equipment. The control of the unit (or a part of it) must be accessible on the part of the local micro-controller, on the part of the SLC (resident on the Matrix), and on the part of the FLC. The bus-management functions are represented in the block-diagram by TESLA and LANSW.

MICROP- local micro-controller:

The function of this block is the controlling, monitoring and provisioning of components dedicated to process the payload data afferent to the unit.

Its main functions are listed below:

– It communicates with the FLC by means of the LAN-x bus, arriving from LANSW block.
– Access to the board building blocks is gaind by means of the PCI bus.
– Control and monitoring of local peripherals, local alarms, local inventory, etc. is possible using the SPI-m bus.
– Communication with the SLC is also (optionally) possible using the PCI bus.
– It also allows download the FPGA components present on board.

Control Lan switch (LANSW)

This switch connects the communication LANs linked to the EC (LANa and LANb) with the LAN-x linked to the MICROP and with the LAN-dbg linked to the TESLA component. These LANs are the 10/100 Mbps FastEthernet type. It permits the communication between FLC and MICROP, and allows the FLC access to the control of the Network Processor.

TESLA:

The function of this block is:

– To adapt the different control buses present on board so that messages can be transported by different protocols
– To bridge the afferent control buses (ISPB: Intra Shelf Parallel Bus, from the SLC; PCI: Peripheral Components Interconnect, MICROP; LANy, and FLC).
– To recognize the different incoming messages and to forward them to the appropriate bus using a suitable protocol
– To arbitrate buses access conflicts. Each control entity of the equipment can request the control access to a given function. However, in case of contemporary requests, an arbitration function present on this building block is deputed to resolve the conflict. This arbitration function is indicated by “**X**” in the schema.

The blocks in this part perform the following main functions:

- Management of static or low frequency configurations and alarms, such as static switches, static alarms of the unit (power fail, lower voltages, etc.), temperature, voltages and currents monitoring, management of front LEDs, reset of the board, registers reset, components reset, etc. This unit can also be restarted by the operator, using the approrpriate push button on the front of the board.
- PIM's and components presence monitoring.
- Management of the "Remote Inventory" function (RI).

X SPI bus arbiter (**SPIDER1 and SPIDER2**):

The two Matrices of the equipment (SLCa and SLCb) can request the control access to the SPI bus of the board. In case of contemporary requests, an arbitration function on this building block (Spider1) is deputed to resolve the conflict.

Another "**X**" arbiter (Spider2) is present, between the SPI-i buses of the SLC and the bus SPI-µ from the micro-processor. The resulting SPI-x bus is used to manage all the other P&I functions of the board.

The "hand-shake" for SPI Bus is managed using control signals driven by the Microprocessor (SPI-Request, SPI-Grant), indicated in the block diagram in Figure 315. on page 490 with the SPI-HS arrow.

Remote Inventory (RI):

Provides memory for storage of the MAC address of the unit, logical and physical type, denomination and code of the board, and other information for remote identification. This function must be accessible from the Second Level Controllers (SLC a and b).

SPI2PIM - SPI bus adapter (KYRA device):

The function of this block drives the SPI access to the PIMs on board, adapting and, if necessary, converting the buses protocols (e.g. from SPI to I2C bus) in order to access the different PIMs that can be equipped on the board.

It also generates the Power-ON command for the components on board.

Furthermore, it arbitrates the potential access conflicts between the SPI-µ from the micro-processor and the SPI-i from the Matrices.

Additionally, the SPI2PIM drives the **front LEDs** of the boards, indicating the working or faulty state of the unit.

The front LEDs and their locations are shown in Chapter 2 - "Physical Configuration", where the front view of the unit is illustrated.

c) Power Supply

This function provides the electrical power supply to the board and all the components on the board.

The unit gets the -48V power voltage and a 3.3V service voltage from the power units of the equipment (PSF320 a and b, in redundant mode), by means of the back panel connectors.

The -48V power voltage is connected using fuses to prevent overcurrent, then filtered and passed across voltages and currents circuitries to protect against inrush of overcurrents and overvoltages.
The appropriate voltages (3.3, 2.5, 1.8, 1.5, 1.2, etc.), needed by the various components on board, are obtained using specific DC/DC voltage converters.
The presence and correctness of the various voltage levels are monitored by voltage/current sensors and then communicated to the control system by means of the SPI function.

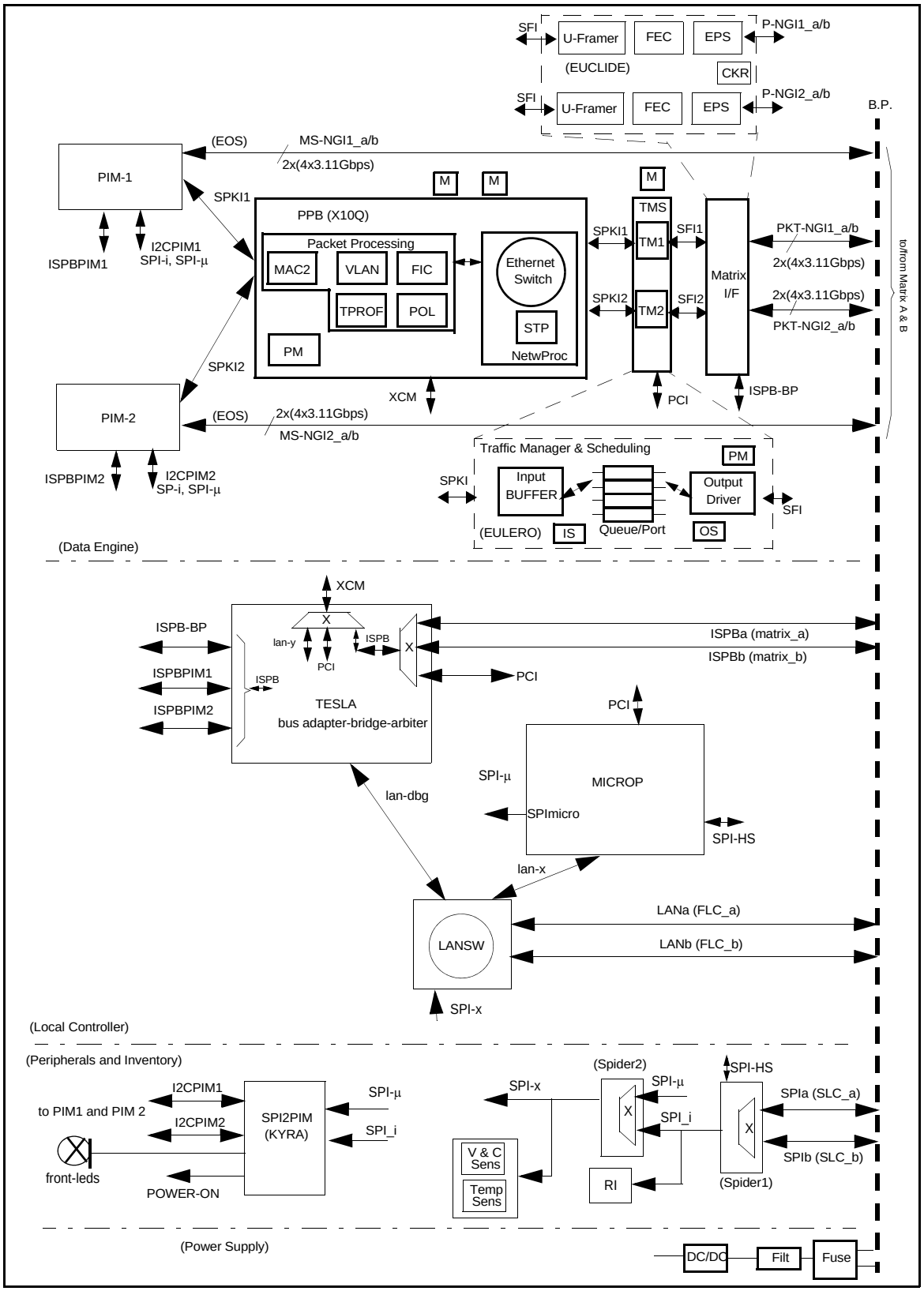


Figure 315. PP20G Unit, block diagram

4.4.2 PIM1GE - 10x1GE Plug-In Module

This Module allows the physical access to Ethernet LAN over optical fiber at a rate of 1Gb/s, compliant with IEEE 802.3x standards.
Refer to the block-diagram illustrated in Figure 316. page 494.
The functions are to be considered BIDIRECTIONAL, if not otherwise specified.
The funcionalities of this unit can be subdivided into 4 main parts:

- **a) Payload Processing**
- **b) Control Bus Bridge**
- **c) Peripherals and Inventory (P&I)**
- **d) Power Supply**

a) Payload Processing

It contains the functions to process the following payload data packets:

Small Form Factor (SFP) 1 to 10:

Up to 10 Small Form Factor Plug-in Modules at a maximum rate of 1Gb/s can be inserted into the front openings of this unit. The SFP performs the optical to electrical conversion (transceiver multisource) and the Physical Medium Dependent (PMD) function (per the IEEE 802.3x requirement). SFPs are discussed in greater detail in Section 4.4.5 on page 503.

BAGIRA (Ethernet Payload Process):

This component consists of 10 **ETHF** blocks and one **SPK42I**, described below.
The control messages associated with this block are communicated by means of the **MOTB** bus.

ETHF1 to ETHF10:

10 of these blocks are contained in BAGIRA device. Each block is dedicated to process an ethernet stream afferent to the corresponding SFP port at 1GbE. ETHF performs the functions as specified by IEEE802.3x standard to interface the Ethernet LAN at 1000 Mb/s : **PMA**, **PCS** and **MAC1**.
Each ETHF block drives one LED on the front of the module, indicating the “Link-Up” or the “Link-Physical Medium AttachmentDown” state of the LAN connected.

Physical Medium Attachment (PMA)

It receives/transmits from SFP one data flow at about 1.25 Gb/s (here named S1G), and receives /transmits from PCS a signal coded at ten-bit code-groups (dc-balanced octet-oriented data encoding, “8b/10b”). It mainly performs the following functions:

Clock recovery (CKR)
Preamble field removing/inserting
Start of Frame acknowledgement
Packets streams acknowledgement and their serialization/deserialization to PCS.
Line LoopBack: the ability to loop back the received signal to the far end connected port to check the integrity of a link, for example.

Physical Coding Sublayer (PCS)

It codes/decodes the ten-bit code-groups to 8-bit data-groups (8b/10b) to the PMA and interfaces the MAC1 component. Further, it performs the following main functions:

Carrier Sensing (CSMA), in case of half-duplex link
Collision Detection (CD), in case of half-duplex link
Auto Negotiation: the ability to adapt the technology and speed rate of the local port to the best technology and rate offered by the far end connected port.

MAC1 - frames checking:

It checks that the received/transmitted frames are compliant with the supported technology, performing the following functions:

Check of the incoming FCS value (Frame Check Sequence). In the transmit direction, it recalculates the FCS and inserts it on the outgoing frame.

Frame Length and type acknowledgement, by inspecting the L/T field.

Normal or Jumbo Frame (JF) identification.

Flow Control: the ability to inform the far end connected port about the congestion state of the receiver. If the receiver buffer is full, then the transmitter sends a “Pause” frame to the far end to stop it from sending packets for a given time period.

Performance Monitoring (PM):

The function of this block is to observe the state and the quality of the functions used on the system. The collected monitoring data is stored inside the memory block **M**.

In particular, it collects data associated with existing links and resources such as:

number of total received/transmitted frames

number of errored received frames

number of correct received frames

SPK42I I/F - Interface for System Packet Interface level 4 phase 2:

It multiplexesdemultiplexes the 10 ethernet data flows associated with the 10 SFP ports into a single data stream at a rate of 10 Gb/s to the PacketProcessor of the mother board (paralleled 16x700+16x700Mbps data +350Mhz ddr clock). It implements a standard interface compliant to OIF-SPI-4-02.1 regulations.

b) Control Bus Bridge (MAZINGA)

It contains the functions to adapt the control and communication buses and distribute them to the components of the module. The control of the unit is driven by the ISPB bus.

The MAZINGA macroblock interfaces the following buses:

Intra Shelf Parallel Bus (ISPB): control and communication bus originating from the mother board. This bus is passed into the Adaptation block **A**, to convert its protocol into a MOTB bus protocol.

MOTB: it is a “motorola-like” bus that controls the BAGIRA components. It is used to manage: the communications with the controllers of the equipment (FLC, SLC and LDC), the configuration of components and functions on board, Data Base (MIB) management, Performance Monitoring (PM), module states, and alarms monitoring.

Serial Peripheral and Inventory (SPI): bus originating from the Peripheral and Inventory components (described below). This bus is passed into the Adaptation block **A**, to derive 10 I2C buses and 10 SFP-C command signals afferent to the 10 SFP modules.

Inter Integrated Circuit (I2C) bus: There are 10 I2C buses, used to drive the SPI (Remote Inventory) functions inside the SFP modules.

Small Form Factor (SFP) -C: 10 command signals afferent to the 10 SFP modules, used to communicate alarms or commands such as TX-failure, RX-LOS, SFP-presence, and Laser-ShutDown.

c) Peripherals and Inventory (P&I)

This part performs the following main functions:

- Management of static or low frequency configurations and alarms, such as static switches, static alarms of the unit (power fail, lower voltages, etc.), temperature, voltages and currents monitoring, management of front LEDs, reset of the board, registers reset, components reset, etc.
- Components presence monitoring.
- Management of the “Remote Inventory” function (RI).

X SPI bus arbiter (**SPIDER**):

The SLC (via the SPI-i bus) and the LDC (via the SPI-m bus) can request the control access to the P&I functions of the module. In case of contemporary requests, the arbitration function “**X**” is deputed to resolve the conflict.

The resulting SPI-x bus is used to manage all the other P&I functions of the module.

Remote Inventory (RI):

Provided memory for storage of the MAC address of the unit, logical and physical type, denomination and code of the board, and other information for remote identification.

Diagnosis (DIAG) block:

it contains the V&C-SENS block that monitors the correctness of the voltages and currents running on board, and the TEMP-SENS to monitor the temperature of the unit.

Front LED:

The SPI function also drives the **front LEDs**, indicating the working or faulty state of the module. The front LEDs and their locations are described in Chapter 2 - "Physical Configuration", where the front view of this unit is illustrated.

d) Power Supply

This function provides the specific electrical power supply to all the components on the board.
The unit gets a 3.3Vcc power voltage and a 3.3Vs service voltage from the mother board.
The 3.3Vcc power voltage is connected using fuses to prevent overcurrent, then filtered and passed across voltages and currents circuitries to protect against inrush of overcurrents and overvoltages.
The appropriate voltages needed by the various components on the board are obtained by means of specific DC/DC voltage converters.
The 3.3Vs service voltage is used to supply the functions related to P&I (Peripheral and Inventory).
The presence and correctness of the various voltage levels are monitored by voltage/current sensors and then communicated to the control system by means of the SPI function.

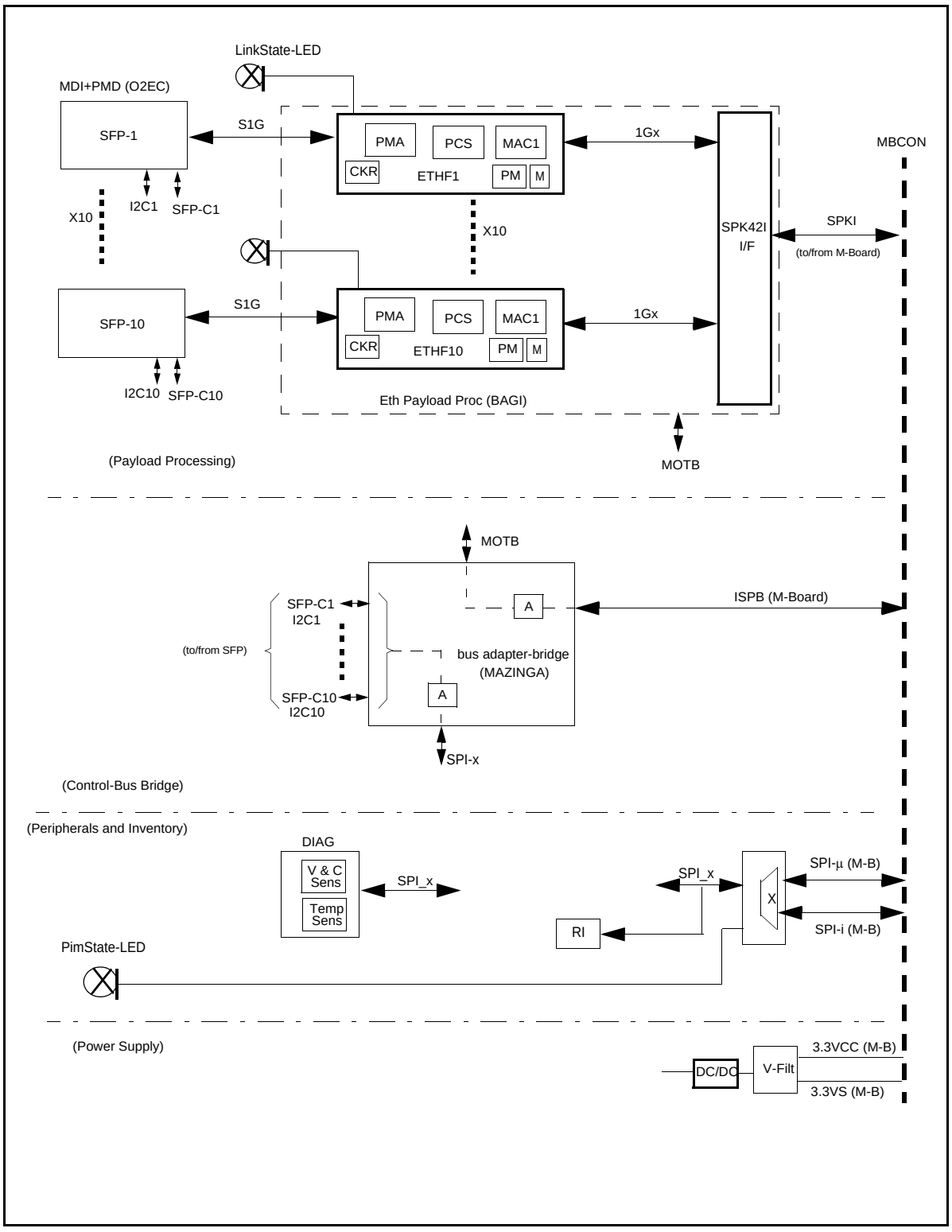


Figure 316. PIM1GE Unit, block diagram

4.4.3 PIM10GE - 1x10GE Plug-In Module

This Module allows the physical access to Ethernet LAN over optical fiber at a rate of 10Gb/s, compliant to IEEE 802.3ae standards.
Refer to the block diagram illustrated in Figure 317. on page 498.
The functions are to be considered BIDIRECTIONAL, if not otherwise specified.
The funcionalities of this unit can be subdivided into 4 main parts:

- **a) Payload Processing**
- **b) Control Bus Bridge**
- **c) Peripherals and Inventory (P&I)**
- **d) Power Supply**

a) Payload Processing

It contains the functions to process the following payload data packets:

Extra Small Form Factor (XFP):

10GE-ExtraSmall Form Factor Plug-in Modules at a maximim rate of 10Gb/s that can be inserted into the front opening of this unit. The XFP performs the optical to electrical conversion (transceiver multisource) and the PMD function (Physical Medium Dependent, per IEEE 802.3ae requirements). It is described in Section . 4.4.6 page 505.

Ethernet Payload Process (ETHP):

This macro-block consists of two components: **SERDES** and **BAGIRA**, described below.
The control messages associated with this block are communicated by means of the **MOTB** bus.

SERDES:

It performs interface functions specified by IEEE802.3ae standards for an Ethernet LAN at 10 Gb/s : **PMA**, **WIS** and **PCS**.
It drives one LED on the front of the module, indicating the “Link-Up” or the “Link-Down” state of the LAN connected.

Physical Medium Attachment (PMA):

It receives/transmits one data flow from the XFP at about 10 Gb/s (here named S10G), and receives/transmits a signal 64B/66B coded (dc-balanced multi-octet-oriented data encoding, “64b/66b”) from the PCS. It mainly performs the following functions:

Clock recovery (CKR)
Preamble field removing/inserting
Start of Frame acknowledgement
Packets streams acknowledgement and their serialization/deserialization towards PCS.
Line Loopback: The ability to loop back the received signal to the far end connected port to check the integrity of a link, for example.

WAN Interface Sublayer (WIS):

This block manages the transport of ethernet data as:

LAN flow: the data stream is viewed as passing through an “only-ethernet” network at a rate of 10.3125 Gbps;
or **WAN flow**: the data stream is viewed as passing through a mixed “ethernet and SDH/SONET” network at a rate of 9.953 Gbps (STM64 or STS192), thus adapting the channel rate at the SDH/SONET containers capacity.

Physical Coding Sublayer (PCS):

It codes/decodes the 66-bit code-groups to 64-bit data-groups (64b/66b) to the PMA and interfeces the BAGIRA component through the 10Gx signal per XAUI specifications (see below). Further, it performs the following main functions:

Carrier Sensing (CSMA), in case of half-duplex link

Collision Detection (CD), in case of half-duplex link

Auto Negotiation: the ability to adapt the technology and speed rate of the local port to the best technology and rate offered by the far end connected port.

XAUI Bus: a10Gigabit Attachment Unit Interface at the rate of about 10Gbps, paralleled over 4x3.125 Gb/s links. XAUI is a standard bus used to transport packet data streams up to about 12 Gbps.

BAGIRA:

It contains the following sub-blocks : **MAC1**, **SPK42I** and **PM**.

MAC1: frames checking

It checks that the received/transmitted frames are compliant with the supported technology by performing the following functions:

Check of the incoming Frame Check Sequence (FCS) value. In transmit direction, it recalculates the FCS and inserts it on the outgoing frame.

Frame Length and type acknowledgement, by inspection of the L/T field.

Normal or Jumbo Frame (JF) identification.

Flow Control: the ability to inform the far end connected port about the congestion state of the receiver. If the receiver buffer is full, then the transmitter sends a “Pause” frame to the far end to stop it from sending packets for a given time period.

Performance Monitoring (PM):

The function of this block observes the state and quality of the functions used on the system. The collected monitoring data is stored inside the memory block **M**.

In particular, it collects data associated with existing links and resources, such as:

number of total received/transmitted frames

number of errored received frames

number of correct received frames

System Packet Interface (SPK42I) level 4 phase 2:

It interfaces the 10Gbps ethernet data flow associated with the XFP port in to a data stream at a rate of 10Gbps to the Packet Processor of the mother board (paralleled 16x700+16x700Mbps data +350Mhz ddr clock). It implements a standard interface compliant to OIF-SPI-4-02.1 requirements.

b) Control Bus Bridge (MAZINGA)

It adapts the control and communication buses and distribute them to the components of the module. The control of the unit is driven by the ISPB bus.

The MAZINGA macroblock interfaces the following buses:

Intra Shelf Parallel Bus (ISPB): control and communication bus coming in from the mother board. This bus is passed into the Adaptation block **A** to convert its protocol in to a MOTB bus protocol.

MOTB: it is a “motorola-like” bus that controls the BAGIRA component. It is used to manage:communications with the controllers of the equipment (FLC, SLC and LDC), the configuration of components and functions on board, Data Base (MIB) management, Performance Monitoring (PM), module states, and alarms monitoring.

Serial Peripheral and Inventory (SPI): the Serial Peripheral and Inventory bus comes in from the Peripheral and Inventory components (described below). This bus is passed into the Adaptation block **A** to derive the I2C bus and the XFP-C command signals afferent to the XFP module.
Inter Integrated Circuit (**I2C)** bus: It drives the SPI (Remote Inventory) functions inside the XFP module.
XFP-C: the command signals afferent to the XFP module, used to communicate alarms or commands such as TX-failure, RX-LOS, SFP-presence, Laser-ShutDown, etc.

c) Peripherals and Inventory (P&I)

This part performs the following main functions:

- Management of static or low frequency configurations and alarms such as static switches, static alarms of the unit (power fail, lower voltages, etc.), temperature, voltages and currents monitoring, management of front LEDs, reset of the board, registers reset, components reset.
- Components presence monitoring.
- Management of the “Remote Inventory” function (RI).

X: SPIDER (SPI) bus arbiter

The SLC (through the SPI-i bus) and the LDC (through the SPI-m bus), can request the control access to the P&I functions of the module. In case of contemporary requests, the arbitration function “**X**” is deputed to resolve the conflict.
The resulting SPI-x bus is used to manage all the other P&I functions of the module.

Remote Inventory (RI):

Provides memory for storage of the MAC address of the unit, logical and physical type, denomination and code of the board, and other information for remote identification.

Diagnosis (DIAG) block:

It contains the V&C-SENS block that monitors the correctness of the voltages and currents running on board, and the TEMP-SENS to monitor the temperature of the unit.

Front LED:

The SPI function drives the **front LEDs**, indicating the working or faulty state of the module. The front LEDs and their locations are shown in Chapter 2 - "Physical Configuration", where the front view of this unit is illustrated.

d) Power Supply

This function provides the specific electrical power supply to all the components on the board.
The unit gets the battery -48V and a 3.3Vcc power voltages and a 3.3Vs service voltage from the mother board (MB).
The power voltages are connected using fuses to prevent overcurrent, then filtered and passed across voltage and current circuitries that protect against inrush of overcurrents and overvoltages.
The appropriate voltages needed by the various components on the board are obtained by means of specific DC/DC voltage converters.
The 3.3Vs service voltage is used to supply the functions related to P&I (Peripheral and Inventory).
The presence and correctness of the various voltage levels are monitored by voltage/current sensors and then communicated to the control system by means of the SPI function.

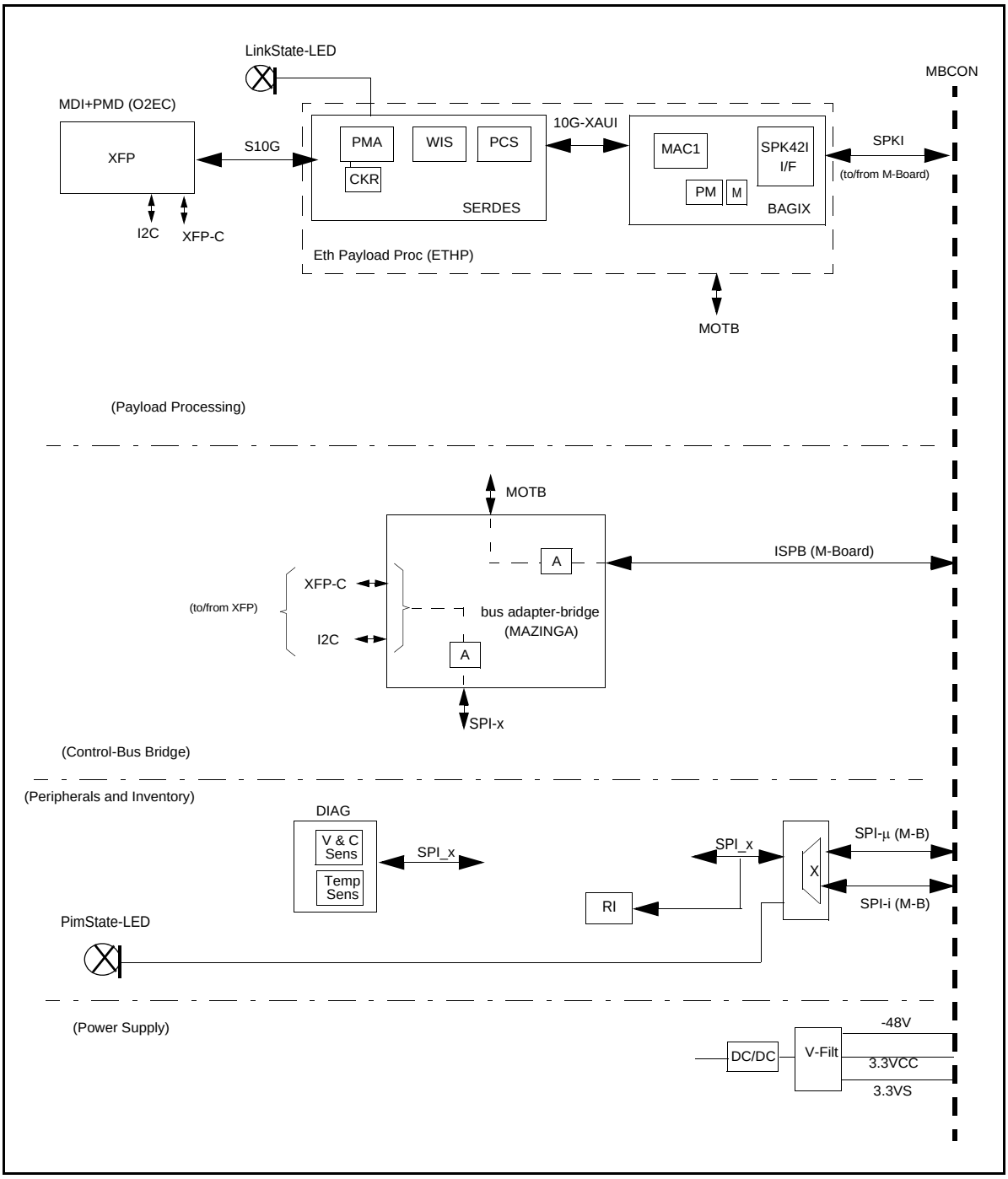


Figure 317. PIM10GE Unit, block diagram

4.4.4 PIMMS - Multi Service Plug-In Module

This module performs the mapping of Ethernet frames over SDH/SONET to exchange Ethernet frames between the Ethernet Network Pocessor of the mother board and the Universal Matrices of the equipment. It allows the “remotization” of ethernet flows, transporting them through the SDH/SONET network, to reach remote ethernet equipments. Its maximum throughput is 10Gbps, equivalent to STM64 or OC192 SDH/ SONET rate.
It does not support local ethernet data access.
Refer to the block-diagram illustrated in Figure 318. page 502.
The functions are to be considered BIDIRECTIONAL, if not otherwise specified.
The funcionalities of this unit can be subdivided into 3 main parts:

- **a) Payload Processing**
- **b) Peripherals and Inventory (P&I)**
- **c) Power Supply**

a) Payload Processing

It contains the functions to process the payload.
The macroblocks are: **GAUSS** and **EUCLIDE**, as described below.

GAUSS: contains the functions to map the Ethernet frames over the SDH/sonet containers in the blocks **SPK42I**, **GFP/LAPS**, **VCONC/LCAS**, **HPT**, **PM**.

System Packet Interface level 4 phase 2 (SPK42I)
It provides to interface the ethernet data flow (SPKI bus, at a max rate of 10 Gbps) to the Network Processor of the mother board. It implements a standard interface (paralleled 16x700+16x700Mbps data +350Mhz ddr clock) compliant to OIF-SPI-4-02.1 requirements.

GFP or LAPS: Ethernet over SDH mapping
The function of this block is to map the Ethernet frames over the SDH/SONET transporting frames. The ethernet frame is encapsulated in an intermediate server frame that can be GFP type (Generic Framing Procedure) or LAPS (Link Access Procedure over SDH), and then housed in an SDH Virtual Container.
The mapping function is aided by the memory block (**M**).
Further, it supports the management of VC-AIS alarm by inserting AIS alarms into the SDH containersto propagate Ethernet signal failure indications to SDH systems (see details in Section 3.2.1 on page 130).
Matching Ethernet and GFP frames are illustrated in Figure 111. on page 158 and Figure 112. on page 159.
Matching Ethernet and LAPS frames are illustrated in Figure 113. on page 159.
Ethernet over SDH Framing (on Remote Ethernet Port) is illustrated in Figure 115. on page 161.

VCONC/LCAS:
It implements the Virtual Concatenation function (VCONC), and LCAS (Link Capacity Adjustement Scheme) by coordinating with Universal Matrix and SDH boards. Refer to Section 3.2.3.8 on page 162.
VCONC: frames not fitting into a single SDH-container are transported over more individual containers identified with the symbol VCn-Xv (e.g. VC12-3v indicates the virtual concatenation of 3 VC12), also called VCG (Virtual Concatenated Group).
The original frame is paralleled “TimeSlot-by-TimeSlot" and loaded over different payloads.

The individual containers can follow different paths in the network, with different delays, and they need to be reassembled at the end points, taking into account the different path delays. To adjust the path delays (max 32 ms), the received data is stored inside the memory block (**M**). This feature is compliant with ITU-T G.707 requirements.
The **LCAS** feature permits the operator to “hitlessly" modify the bandwidth capacity of a virtual concatenated link (VCG), in order to meet the bandwidth needs of the service (by adding or removing virtual containers in all the involved nodes of the network). It can also temporarily remove failed links of the group automatically and hitlessly. In case of failure or addition of links, the traffic is automatically redistributed over the working links. Reference: ITU-T G.7042 requirements.

Higher order Path Termination (HPT) - SDH
It inserts/extracts the POH (payload overhead) bytes (J1,B3, C2, G1, F2, F3, etc.) to/from the SDH VC (Virtual Container) payload used to transport the ethernet data frames over the SDH network. The container used in this release is VC4.

Performance Monitoring (PM):
The function of this block is to observe the state and the quality of the functions used on the system. The collected monitoring data is stored inside the memory block **M**.
In particular, it collects data associated with existing links and resources such as:
- number of total received/transmitted frames
- number of errored received frames
- number of correct received frames

SERDES Framer Interface (SFI) bus:
This bus connects the GAUSS and EUCLIDE components by means of standard SERDES (Serializer/Deserializer) interfaces contained inside these components at a max rate of about 10 Gbps, suitable for STM64/OC192 rates. It implements a standard bus (paralleled 16x622+16x622Mbps data +311Mhz ddr clock) compliant with OIF-SFI-4-01 requirements

EUCLIDE: It contains the functions to interface with the Universal Matrixes through the back panel of the equipment in the **Matrix Framer**, **FEC**, **EPS**, and **CKR** blocks.

Matrix I/F Framer
The function of this block is to adapt Ethernet Packet frames to a proprietary inter-board framing, in order to standardize different frames that have to be combined by the central “Agnostic” Matrix. In this case, it maps the EOS frames over the “agnostic” frames running over the back panel.

Forward Error Correction (FEC):
In the receive direction, it recovers prospective errors that have occurred over the link pathway. FEC is an error correction technique in which redundant bits are transmitted along with the payload, permitting the receiving station the detection of errors and the correction of the relevant frame. The extra bits are removed on the receive side (de-FEC). To limit the impact of lost packets, FEC can be used to repair frames damaged by packet loss.

Equipment Protection Switching (EPS):
In case of failure of the main Matrix, it switches the link to the other Matrix thus permitting the restoration of the communication link.

CKR (Clock Recovery):
In the receive direction, it recovers the clock for the timing of the Matrix I/F.

Intra Shelf Parallel Bus (ISPB) Control Bus:
The control of the PIMMS module is driven by the ISPB from the mother board.

MS-NGI bus is used to transport Multi-Service or Ethernet-Over-Sdh (MS or EOS) traffic between the PIMMS equipped on Data Units and the two Matrixes A and B of the equipment. It is a parallel link over 4 wires at 3.11 Gbps (4x3.11Gb/s). Each link is bidirectional and doubled, in order to connect Matrix A and Matrix B. The internal framing is illustrated in Section 3.2.3.3 on page 151.
MS-NGI_A bidirectional link transports 10Gbps EOS traffic to/from Matrix A.
MS-NGI_B bidirectional link transports 10Gbps EOS traffic to/from Matrix B.

b) Peripherals and Inventory (P&I)

This part performs the following main functions:

- Management of static or low frequency configurations and alarms such as static switches, static alarms of the unit (power fail, lower voltages, etc.), temperature, voltages and currents monitoring, management of front LEDs, reset of the board, registers reset, components reset.
- Components presence monitoring.
- Management of the “Remote Inventory” function (RI).

X: **Serial Peripheral and Inventory (SPI) bus arbiter (SPIDER)**

The SLC (through the SPI-i bus) and the LDC (through the SPI-m bus) can request the control access to the P&I functions of the module. In case of contemporary requests, the arbitration function “**X**” is deputed to resolve the conflict.
The derived SPI-x bus is used to manage all the other P&I functions of the module.

Remote Inventory (RI):

It provides memory for storage of the MAC address of the unit, logical and physical type, denomination and code of the board, and other information for remote identification.

Diagnosis (DIAG) block:

It contains the V&C-SENS block that monitors the correctness of the voltages and currents running on board, and the TEMP-SENS to monitor the temperature of the unit. The temperature is sensed by using the **I2C-PIM** (Inter Integrated Circuit bus) from the mother board.

Front LED:

The SPI function comprises also the driving of a **front LED**, indicating the working or faulty state of the module. The front LEDs meanings and locations are shown in chapter 2 - "Physical Configuration", where the front view of this unit is illustrated.

c) Power Supply

This function provides the specific electrical power supply to all the components on the board.
The unit gets a 3.3Vcc power voltages and a 3.3Vs service voltage from the mother board (MB).
The power voltages are connected using fuses to prevent overcurrent, then filtered and passed across voltage and current circuitries that protect against inrush of overcurrents and overvoltages.
The appropriate voltages needed by the various components on the board are obtained by means of specific DC/DC voltage converters.
The 3.3Vs service voltage is used to supply the functions related to P&I (Peripheral and Inventory).
The presence and correctness of the various voltage levels are monitored by voltage/current sensors and then communicated to the control system by means of the SPI function.

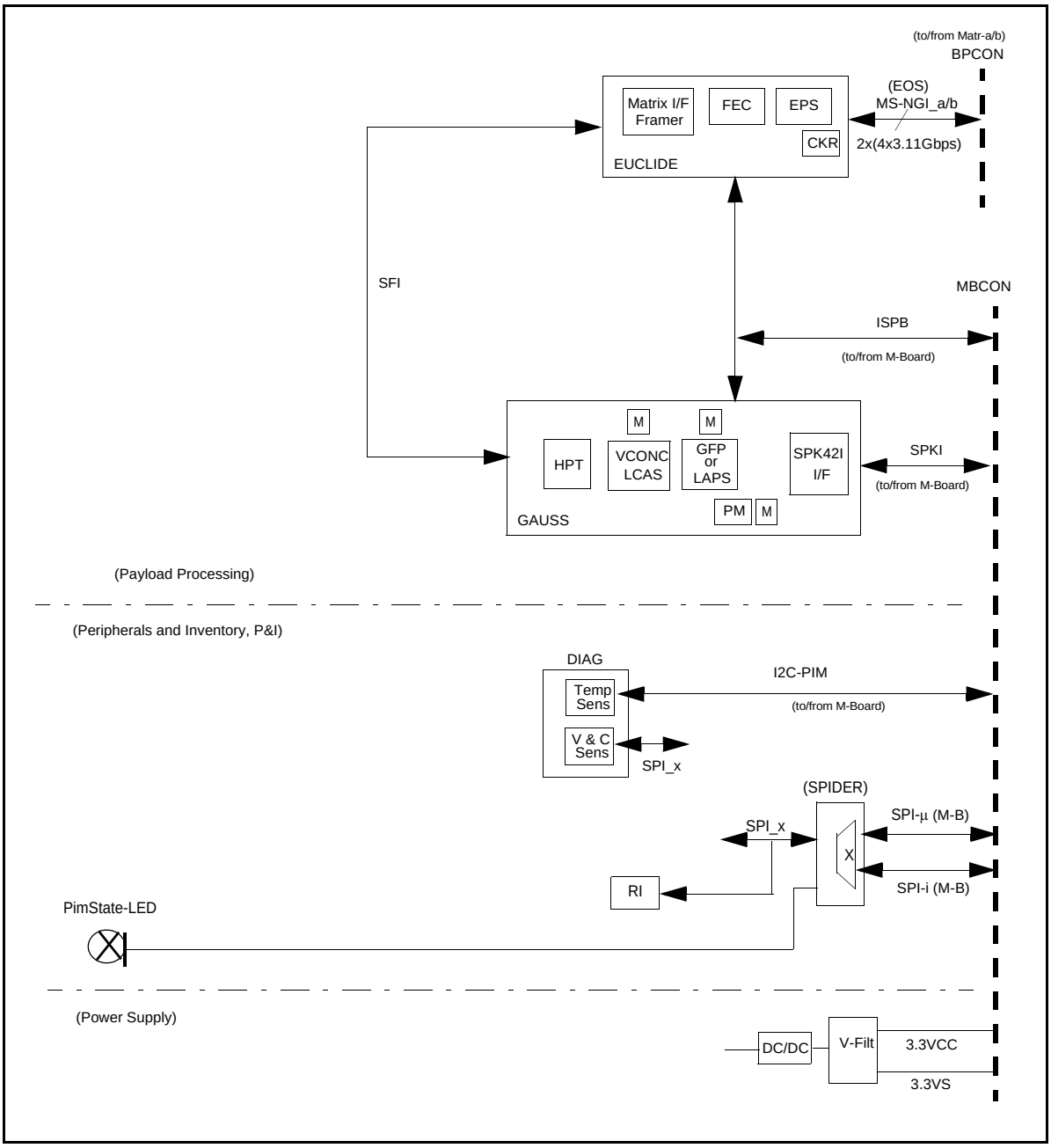


Figure 318. PIMMS Unit, block diagram

4.4.5 1000B, SS-162C , SL-162C - SFP Modules

(Refer to Figure 308. on page 473)

The description below applies to the following SFP modules: **1000B** , **SS-161**, **SS-162C** , **SL-162C** .

The SFP modules are the optical physical accesses for local Ethernet data that have to be equipped on Ethernet Units as described in Chapter 2 - "Physical Configuration".
They operate (in the DATA context), at a nominal bit rate of 1250 Mb/s.
Various types of SFP modules are designed to satisfy different optical hauls (SX, LX, ZX, etc.).

The following types of optical modules can be used:

- Black and White application:
  - 1Gb-Ethernet SFP: 1000B-SX,1000B-LX,1000B-ZX.
  - “Any Rate” Ethernet and SDH SFP, from 100Mbps to 2.7 Gbps: SS-161
- CWDM application:
  - 1GbE/STM16/OC48 PIN (bronze) SFP (SS-162C): IR-2 OC48/S-16.2 (1470 nm -> 1610 nm)
  - 1GbE/STM16/OC48 APD (silver) SFP (SL-162C): LR-2 OC48/L-16.2 (1470 nm -> 1610 nm)

SS-162C and **SL-162C** modules are 2.5Gps-STM16 SFP Optical Transceivers operating in “Coarse WDM”. They are used to transport 1.25Gb Ethernet Data to the WDM network. They are “coloured”; that is, operating on different wavelengths from 1470 nm to 1610 nm (1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 nm). They can work in **PIN** (SS-162C) or **APD** (SL-162C) optical modes (short-hauls and long-hauls).

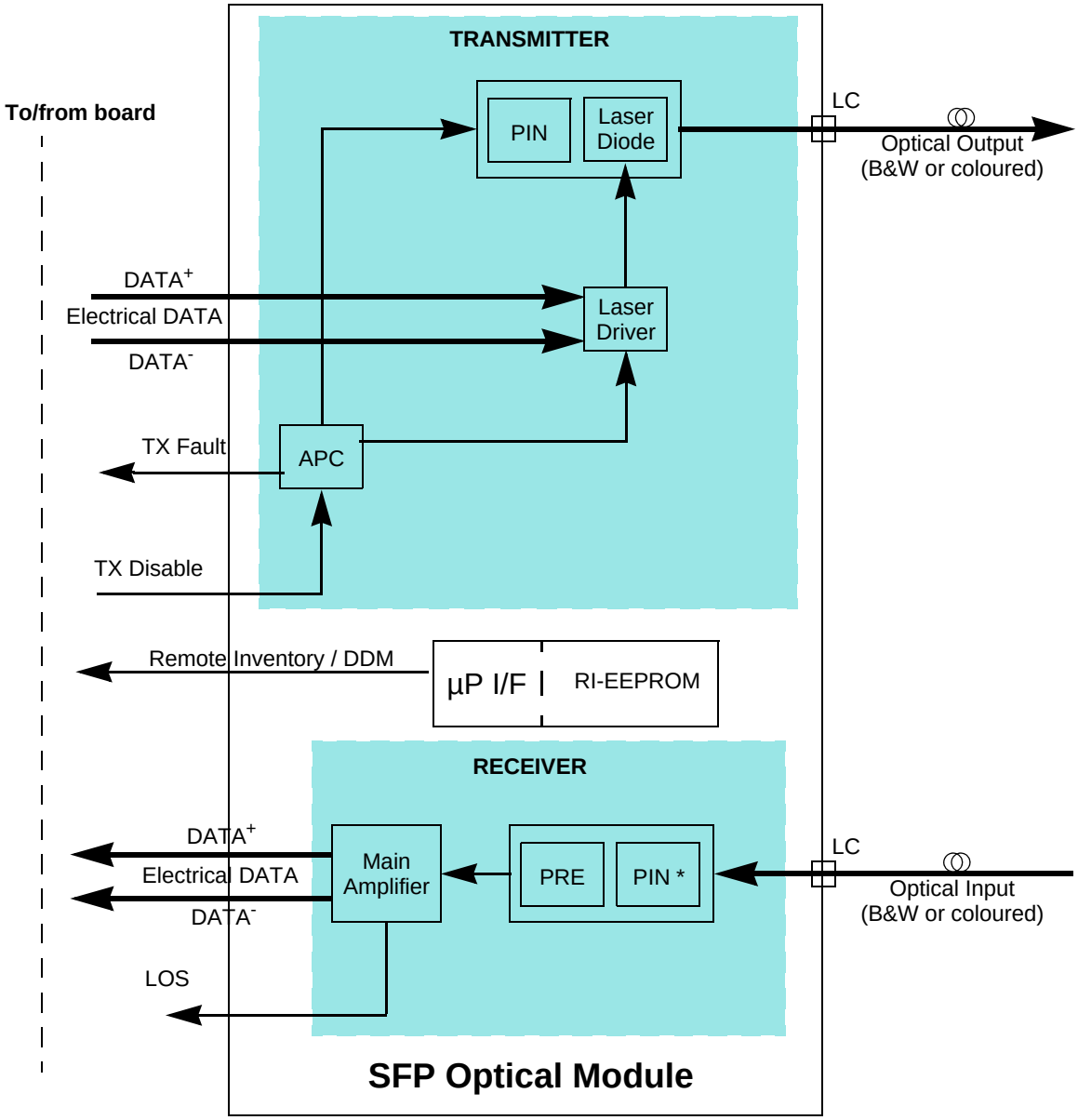
The optical parameters are specified in Chapter 5 - "Technical Specifications".

Each module is equipped with an automatic optical output power control circuit, a laser driver, and a laser diode module on the transmission side.

The **transmitter** is based on an uncooled DFB laser.
The laser safety class for the complete integrated module is CLASS 1, in accordance with IEC 60825 2001.
It can manage commands for TX disable (laser Shut Down) and reports Tx Fault alarms.
Depending on the SFP type, the optical access is compatible with:
– single mode fibre (9/125 µm) or
– multi mode fibre (50/125 µm or 62.5/125 µm)
with standard LC optical connector.
TX Fault indicates a laser fault of some kind. The Transmitter is not disabled when TX Fault signal is active.
TX Disable is an input that is used to shut down the transmitter optical output.

On **receiver** side each module has a PIN or APD photodetector for light to electrical current conversion and a limiting amplifier.
The photo detector current is amplified by an electrical circuit, which delivers two complementary data signals.
The module reports LOS alarms (LOS of input Power Signal). This output signal indicates that the received optical power is below the worst case receiver sensitivity (as defined by the standard in use).
Depending on the SFP type, the optical access is compatible with:
– single mode fibre (9/125 µm) or
– multi mode fibre (50/125 µm or 62.5/125 µm)
with standard LC optical connector.

The Transceiver is equipped with EEPROM to provide Remote Inventory (RI), which contains information about transceiver's capabilities, standard interfaces, manufacturer and others. The serial interface uses the 2-wire serial CMOS EEPROM protocol defined for the ATMEL AT24C01A/02/04 family of components. This optional feature displays availability information on the SFP Remote Inventory.



*** PIN or APD, according to the SFP type**

Figure 319. SFP modules general block diagram

4.4.6 XS-642E, XS-642, XI-641 - XFP Modules and XFP Adapters

(Refer to Figure 303. on page 454)

The description below applies to the following XFP modules: **XS-642E, XS-642, XI-641, 10GB, XP1L12D2**.

Different XFP modules type are available, as reported in Chapter 2 - "Physical Configuration". Some, for example, (XI-641 and XS-642), also require an XFP mechanical adapter (XFP-E ADAPTER) and the PIM10GE to be inserted into the boards (for example, PP20G).
The XS-642E (Extended XFP Module) can be directly inserted into the PIM10GE.

The functional description that follows can be applied to all mentioned XFPs in this section.

The module is a 10Gbit/s serial-to-serial transceiver made up of two independent optical transmitter and receiver.

The transmitter gets the electrical data input through the 30-position pluggable edge connector, performs 3R regeneration via a CDR and converts the regenerated signal in the optical data output using a Laser.

The receiver detects the optical data input via a Photo Detector, performs 3R regeneration via a CDR, and sends the regenerated signal through the 30-position pluggable edge connector.

Input and output signals are in NRZ format, as depicted in the block diagram in Figure 303. on page 454.

The module is equipped with an I_2C bus interface to access the following features implemented in the module:

- Monitor signals
- Alarms signals
- Control signals
- Remote inventory (EEPROM)

Alarms and commands:

- LOS XFP: Loss Of Signal
- FAIL XFP: XFP fault
- RESET XFP: module reset
- LASER OFF: the laser source is turned off
- PRES XFP: module physically present

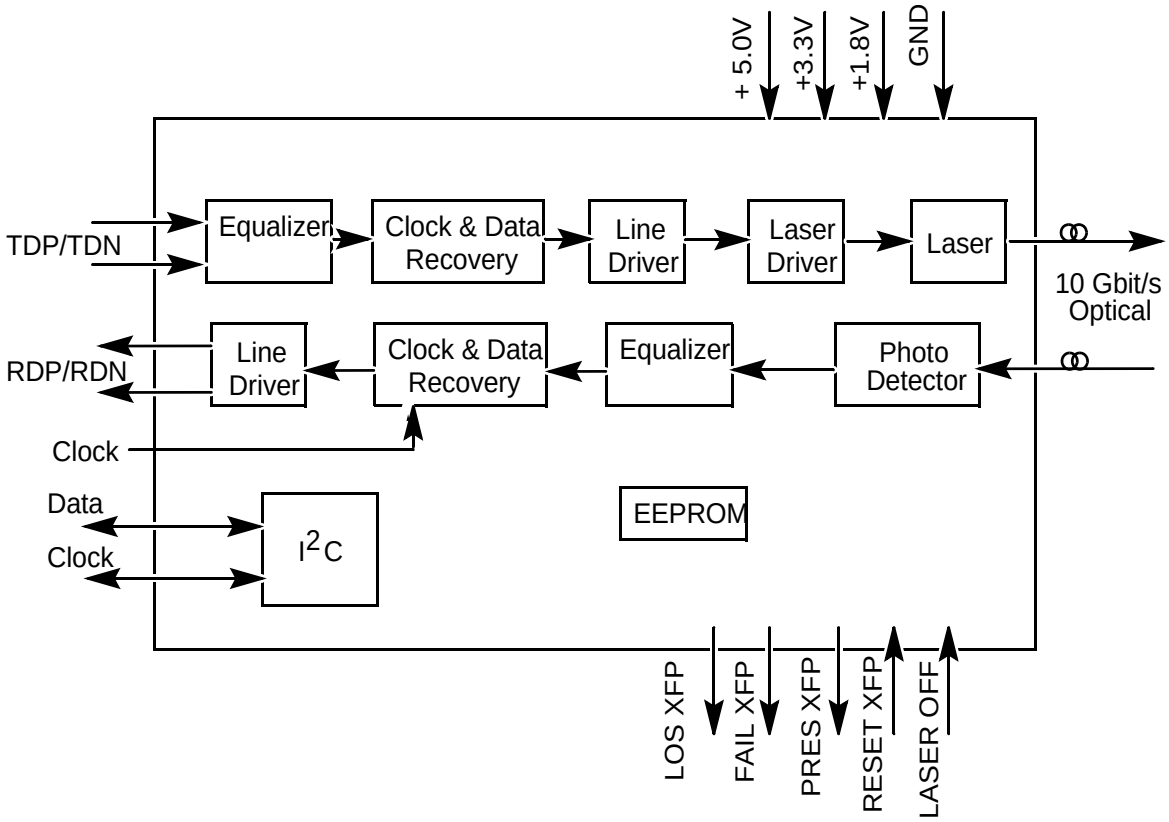


Figure 320. XFP module block diagram

4.5 ROADM packs

4.5.1 WR4 - Wavelength Router 4-degree

WR4 is a bidirectional pack for handling up to 44 channels on a 100 GHz grid. Incoming channels from the line that have been amplified in the LDRX enter the pack at the SIG IN port. The signals are broadcast to the DROP and MESH_THRU output ports through a series of optical splitters, as shown in Figure 321. on page 507. Loss specifications are shown in Table 44. on page 507.

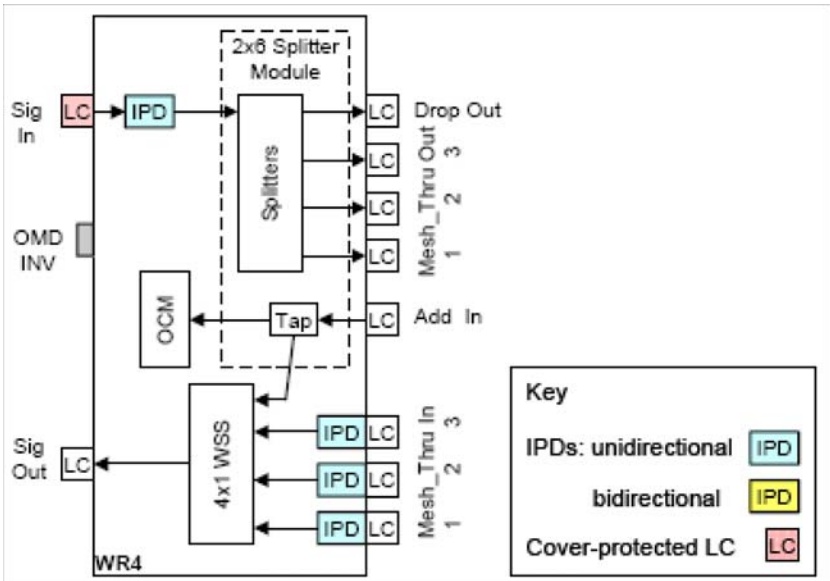


Figure 321. WR4 - Optical components diagram

Table 44. WR4 losses (including one optical connection).

Location	Loss (dB)		
	Typical	Min.	Max.
Sig In Mesh Thru Out	6.5	5.7	7.2
Sig In to Drop Out	10.3	9.4	11.1
Mesh Thru In to Sig Out	5.0	2.3	7.6
Add In to Sig Out	5.0	2.3	7.6
Add In to CCM	13.8	12.5	15.0

Channels entering the pack at the ADD and MESH_THRU input ports are directed to a 4x1 Wavelength Service Switch (WSS). The WSS equalizes channels that are intended for the outgoing line and blocks other channels.

All inputs, except the ADD IN port, are equipped with Integrated Photo Detectors (IPDs) for loss of signal detection. LOS thresholds are defined in Ref 11. IPDs can be either bidirectional (that is, they monitor power equally well in either the forward or backward direction) or unidirectional. Unidirectional IPDs provide at least 20 dB of directivity to the monitor. Unidirectional IPDs are used in WR4 because some designs for WSS's can have high levels of coupling of channels backwards through the device. This coupling occurs for channels that are blocked from the output port, and if bidirectional IPDs were used, it would not be possible to detect LOS on the inputs.

An optical channel monitor determines which channels are present at the ADD IN port. The OCM is expected to be able to provide accurate power readings over the range of –10 to –35 dBm. A 5% tap coupler should provide levels of approximately –11.5 to –24 dBm to the OCM. Accurate power readings are not needed in Release 2, as software relies on the OCM to only detect which channels are present. Since there is no IPD on the ADD IN port, software decides that an LOS condition exists at the ADD IN port when all channels at the port are found by the OCM to be in LOS.

When the WSS is switched to allow a channel from any input port to be transmitted to the SIG OUT port, there can be no transient connection made between any other input port and the SIG OUT port.

An electrical connection is made through the faceplate (shown in Figure 321. on page 507 as the OMD INV port) to the OMD so that software can track the OMD inventory.

Cover protection is used on the SIG IN port of WR4. The cover must be removed before the fiber can be accessed on this port. Removal is detected by a switch in the pack; the response must be to turn the output power of the LDRX that transmits to the WR4. This procedure prevents connector damage at the SIG IN port that could result from connecting and disconnecting fibers that carry high power.

4.5.2 WR8 - Wavelength Router 8-degree

WR8 has similar functions to WR4 except for larger numbers of inputs and outputs. There are 7 mesh_thru inputs and outputs. The 4x1 WSS of WR4 is replaced with an 8x1 WSS, and the 2x6 splitter module of WR4 is replaced by a 2x10 splitter module. The pack is illustrated in Figure 322. on page 509, and the losses are shown in Table 45. on page 509. Cover protection is used in the same manner as in WR4.

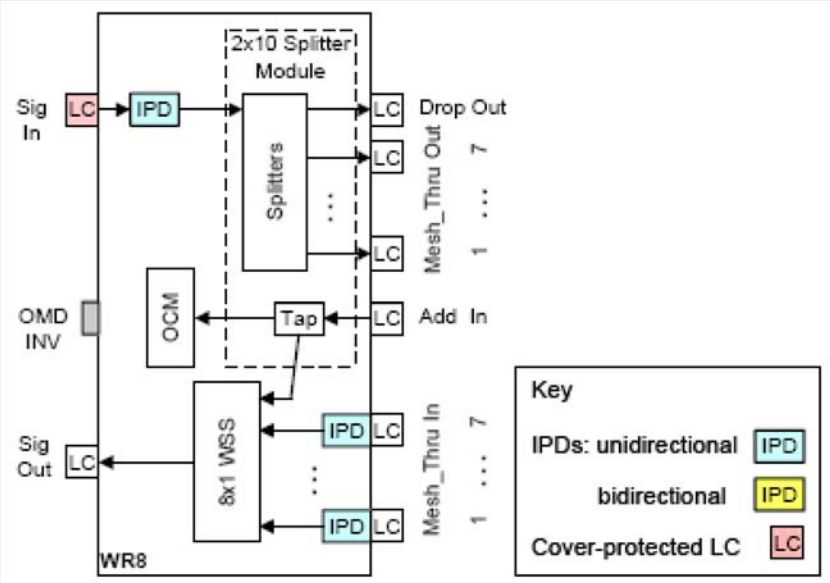


Figure 322. WR8 - Optical components diagram

Table 45. WR8 losses (including one optical connection).

Location	Loss (dB)		
	Typical	Min.	Max.
Sig In Mesh Thru Out	10.6	9.5	11.6
Sig In to Drop Out	14.1	12.8	15.4
Mesh Thru In to Sig Out	5.0	2.3	7.6
Add In to Sig Out	5.0	2.3	7.6
Add In to CCM	13.8	12.5	15.0

4.5.3 LDRXA - Amplifier 16 dBm + OSC

The LDRXA is equipped with a VGOAM3BL optical amplifier module with specifications as provided in the VGOAM specification, including:

– A filter for dropping the 1510 nm supervisory signal that is received from the line
– A filter for adding the 1510 nm supervisory signal to the outgoing channels (not used in the ROADM)
– 9 to 29 dB of gain, with flat (tilt within the range +/- 0.5 dB) outputs available over a gain range of 9 - 22 dB.
– A total output power of 16 dBm
– Mid-stage access for 10 dB DCM loss
– Gain tilt that is adjustable from 0 to -3 dB
– Transient response circuitry

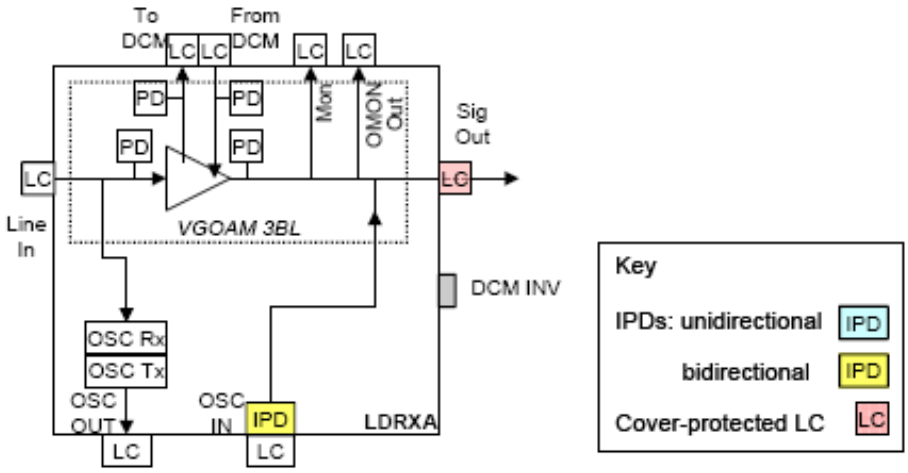


Figure 323. LDRXA - Optical components diagram

The LDRXA is also equipped the OSC optics, as well as electrical processing related to the OSC. The OSC in an LDRX might have to be disabled in some configurations in a future release.

The OSC IN port is monitored for LOS, but the alarm is suppressed in the ROADM configuration.

A bidirectional IPD is used on this port. The loss in the supervisory band for the OSC IN to SIG OUT port is stored in EEPROM so that the supervisory transmitted power can be calibrated to the output of the pack.

LOS monitoring is performed at the input to LDRXA by the VGOAM. The LOS threshold is -32 dBm. The minimum input power for clearing an LOS is -30 dBm. The path between the DCM ports is also monitored for LOS.

The maximum input power to the LDRXA is +7 dBm.

System software sends commands to the VGOAM firmware to adjust the gain or output power per channel and the amplifier gain tilt.

The OMON OUT port is connected to the OMON IN port on the LDTX that serves the same optical line.

The output power of the amplifier is read by software and correlated with the total power that is read by the OMON in order to calibrate channel power readings in the OMON. This calibration is needed by the software transmission control algorithms.

Cover protection is used on the SIG OUT port. When the cover is removed, the output power of the VGOAM must be shut down to prevent connector damage.

An electrical connection is made via the faceplate (shown in Figure 323. on page 510 as the DCM INV port) to the DCM so that software can inventory the DCM and check certain parameters that are useful for transmission control algorithms.

4.5.4 LDRXB - Amplifier 20 dBm + OSC

The LDRXB uses a VGOAM3B optical amplifier module instead of the VGOAM3BL that is used in the LDRXA.

The VGOAM3B has 4 dB higher gain and output power than the VGOAM3BL. The total output power is 20 dBm, the gain range is 13 to 33 dB, and the flat gain range is 13 to 26 dB. Other amplifier features are the same as in the LDRXA.

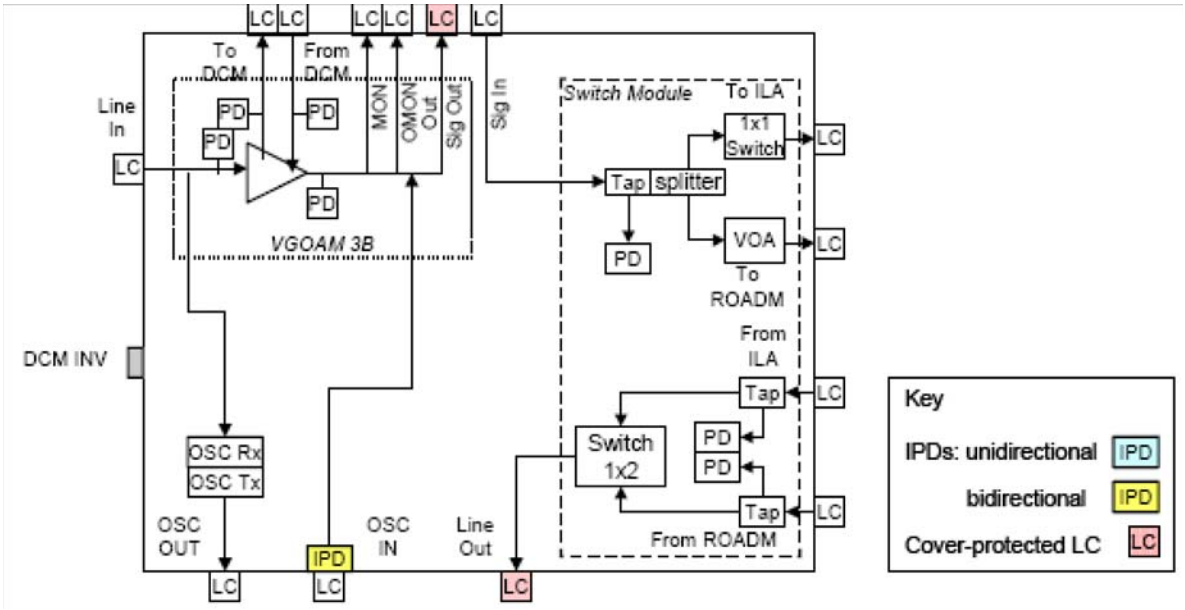


Figure 324. LDRXB - Optical components diagram

The LDRXB (ref. Figure 324. on page 512) contains a switch module that is designed for use in the Upgrade-able In-Line Amplifier (UILA). After amplification, the signal at the SIG OUT port can be fibered to the SIG IN port in order to access the TO ILA and TO ROADM ports or directly to the span or to the WR pack. The proper fibering depends on the configuration.

Embedded in the SIG IN port is a tap and photodetector for monitoring LOS, a 50/50 power splitter, and a 1x1 switch and a VOA on the TO ILA and TO ROADM ports, respectively. The 1x1 switch is not required to be a fast switch, but it must provide at least 20 dB of crosstalk suppression when LDRXB is operating as a UILA that has been upgraded to a ROADM. The VOA limits the output power on the TO ROADM port. Without a VOA, in a fully-loaded system, there could be 15 – 16 dBm of power on that port. If a connection is made to that port to upgrade the UILA to a ROADM when this level of power is present, connector damage could result. The VOA is used to reduce the power until the connection to the WR4 has been established. See the APR requirements for details.

The portion of the switch module extending from the FROM ILA and FROM ROADM ports to the LINE OUT port is used only in the UILA. The FROM ILA and FROM ROADM ports are equipped with photodetectors to monitor for LOS. The FROM ILA port is only monitored when the node is operating as an ILA. The FROM ROADM port is monitored when the node is operating as a ROADM and during the transition period when the LDTXA is operating but the node is still serving as an ILA. The switch from ILA to ROADM operation is made with a 1x2 switch with a maximum of 1 ms switching time and at least 40 dB crosstalk suppression.

Losses for the switch module are presented in Table 46. on page 513.

As in LDRXA, the loss in the supervisory band for the OSC IN to SIG OUT port is stored in EEPROM so that the supervisory transmitted power can be calibrated to the output of the pack. This loss is sufficient for calibrating the transmitted supervisory power in an ILA. Additional calibrations may be required for the UILA.

Table 46. LDRXB losses (including one optical connection).

The maximum losses are specified values; the minimum and typical losses are values that are assumed for loss budget calculations.

Location	Loss (dB)		
	Typical	Min.	Max.
Sig In to To ROADM	4.0	3.2	4.8
Sig In to To ILA	3.8	3.2	4.4
From ROADM to Line Out	1.4	0.9	1.9
From ILA to Line Out	1.4	0.9	1.9

A single cover is used to provide cover protection at the SIG OUT and LINE OUT ports. Removal of this cover triggers the VGOAM to shut down.

4.5.5 LDTXA - Amplifier 20 dBm + OSC

The LDTXA is equipped with a VGOAM3C optical amplifier module with specifications as provided in the VGOAM specification, including:

– A filter for adding the 1510 nm supervisory signal to the outgoing channels
– 13 to 26 dB of gain, with flat outputs available over a gain range of 13 - 20 dB.
– A total output power of at least 20 dBm, not to exceed 20.8 dBm
– Mid-stage access for 10 dB DCM loss
– Gain tilt that is adjustable from 0 to -3 dB
– Transient response circuitry

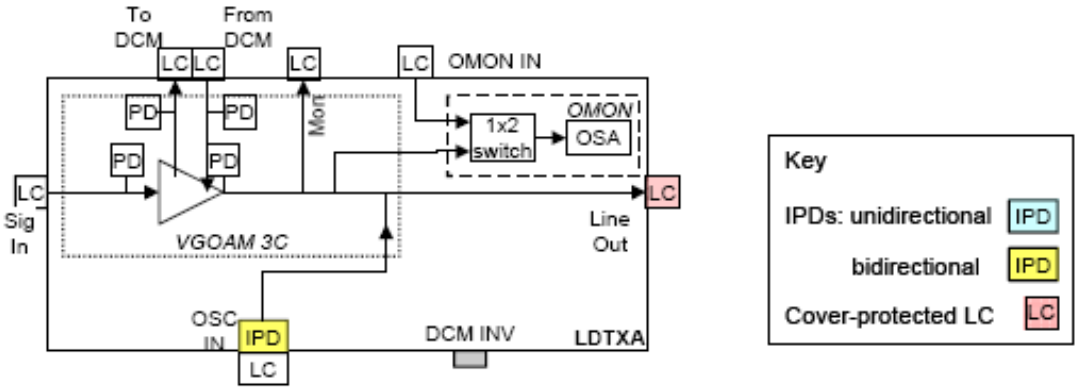


Figure 325. LDTXA - Optical components diagram

The OSC IN port is monitored for LOS. The loss in the supervisory band for the OSC IN to SIG OUT port at the supervisory wavelength is stored in EEPROM so that the supervisory transmitted power can be calibrated to the output of the pack.

LOS monitoring is performed at the input to LDTXA. The LOS threshold is -32 dBm. The minimum input power for clearing LOS is -30 dBm. The path between the DCM ports is also monitored for LOS.

LDTX packs detect loss of power to the WSS in the WR pack that serves the same optical line. The monitored signal is carried through a trace in the backplane. A loss of power can put a WSS into a state that can harm transmission, so the LDTXA amplifier shuts down when the WSS loses power.

The maximum input power to the LDTXA is +7 dBm.

System software sends commands to the VGOAM firmware to adjust the gain or output power per channel and the amplifier gain tilt.

An OMON module, consisting of a 1x2 switch and an Optical Spectrum Analyzer (OSA), is located in the pack. One input to the switch is connected internally to the VGOAM. The other input is connected to the faceplate, so that the LDRX can be monitored as well.

Optical Monitoring (OMON) determines per-channel power levels and wavelength. It provides OSNR values for channels on a 100 GHz grid at bit rates below 40 Gb/s. It also monitors channels with all bit rates that are intended for use in this system, including 40 Gb/s. Additionally, OMON monitors the total band power that it receives. The OMON hardware is capable of supporting 50 and 100 GHz channel spacing.

The OSA is designed for an input power range of -10 to -40 dBm per channel. The switch will have additional loss, so the input power to the switch should be greater than -40 dBm.

OMON is not used for any time-critical processes, so switching speed and scan time are not critical.

Optical spectrum analysis is not used for monitoring for disconnected or broken optical fibers. Input power photodetectors are placed at key points in the nodes to monitor for LOS as well as to control various transmission parameters. See the optical fault isolation pages for details.

OMON readings may be used to determine whether the wavelengths detected at a location match the wavelengths expected. This provides a check that channels are being properly routed.

Failure of the OMON module by itself does not cause any service interruption in an otherwise working system. However, failure of the OMON does prevent updates of certain transmission-affecting parameters.

The result could be some degradation of system performance until the LDTX is replaced. Addition of new channels without a functioning OMON is, therefore, not advised.

Cover protection is used so that the amplifier power can be turned off before the output connector at the SIG OUT port is removed. This procedure prevents connector damage.

An electrical connection is made via the faceplate DCM INV port to the DCM so that software can inventory the DCM and check certain parameters that are useful for transmission control algorithms.

4.5.6 LDTXB - Optical Supervisory Channel (OSC)

The LDTXB is used at the output of a ROADM when spans are short enough that no amplification is required. It is expected to be used with all spans that have up to 3 dB of loss, and some spans with greater loss.

The LDTXB is be connected through the span to an LDRX at the next ROADM site. The amplifier in the LDRX can provide enough gain to support a moderate-loss span with LDTXB. However, since the OSNR is degraded from channels launched at low powers into the span, the LDTXB most commonly used for span losses of 6 dB or less.

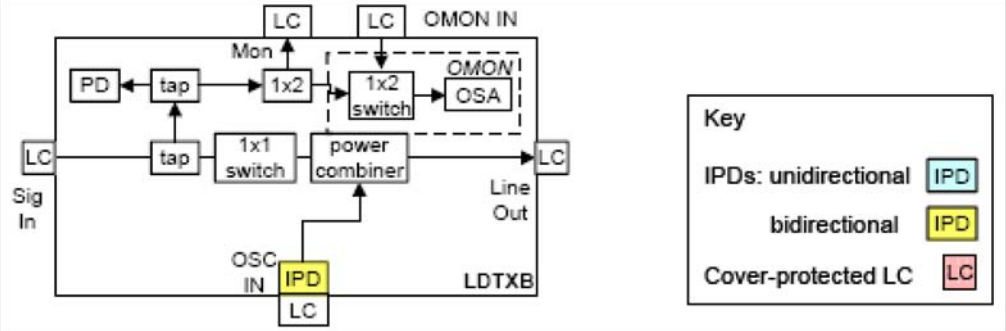


Figure 326. LDTXB - Optical components diagram

LDTX packs detect loss of power to the WSS in the WR pack that serves the same optical line. The monitored signal is carried through a trace in the backplane. A loss of power can put a WSS into a state that can harm transmission, so the LDTXB 1x1 (on/off) switch must open when the WSS loses power.

The LDTXB taps off a portion of the signal power to detect the signal power and to provide a MON output port. The tap is placed before the 1x1 optical switch so that the detector can act as an input power detector, even when the switch is open. The behavior is similar to that of LDTXA, which has an input power monitor that detects the input power when the amplifier is shut down.

The photodetector is used to monitor for LOS. The actual power level at the photodetector is in the range of -40 dBm at the LOS threshold. A low dark-current photodetector is required at this position.

The photodetector power reading is calibrated against both the input and the output power of the LDTXB when the pack is manufactured. The calibration is stored in nonvolatile memory. The associated receiver circuit must provide accurate readings for performance monitoring and transmission control.

An OMON module, consisting of a 1x2 switch and an OSA, is located in the pack. One input to the switch is connected internally to the VGOAM. The other input is connected to the faceplate, so that the LDRX can be monitored as well.

The LDTXB also provides an optical path for adding the supervisory channel. An asymmetric power combiner is used to minimize losses on the channels and prevent the OSC receiver from overloading. No attenuation is needed at the input to LDRX at the receiving ROADM when LDTXB is used, even for short spans. The loss in the supervisory band for the OSC IN to SIG OUT port at the supervisory wavelength is stored in EEPROM so that the supervisory transmitted power can be calibrated to the output of the pack.

Table 47. on page 517 shows specified losses through the pack. The “High” loss entries include allowance for aging.

Table 47. LDTXB losses (including one optical connection).

- **Signal Channels**

Location	Loss (dB)		
	Typical	Min.	Max.
Sig In to Line Out	1.4	0.6	2.1
Sig In to Mon	14.2	12.8	15.8
Sig In to internal OMON	14.2	12.8	15.8
Sig In to internal PD	20.5	19.1	22.1

- **Supervisory Path**

Location	Loss (dB)		
	Typical	Min.	Max.
OSC In to Line Out	17.8	16.8	19.1

4.5.7 OMD44 - Optical Mux/Demux 44 ch.

The OMD44 pack is used to multiplex and demultiplex 44 channels on a 100 GHz grid. The channels for OMD44 are specified in the Optical Spectrum section. Both minimum and maximum losses through the pack must be specified.

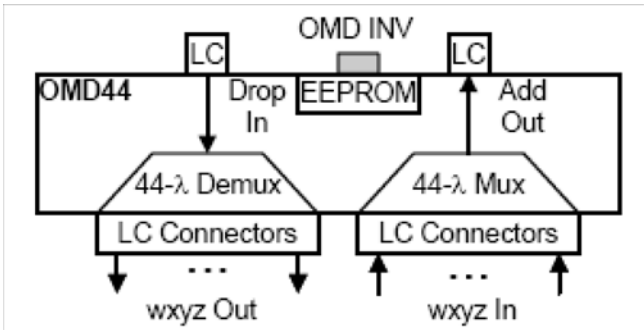


Figure 327. OMD44 - Optical components diagram

The pack is fully passive. It has a 1-wire EEPROM that contains inventory data. The EEPROM is accessed through a connector on the faceplate. The EEPROM is connected through a cable to the faceplate of the corresponding WR pack.

Because the pack is passive, there is no monitoring for optical LOS at any inputs. Input LOS monitoring for add channels takes place in the corresponding WR, whose ADD IN port is monitored with an OCM.

There is no way to determine that LOS has occurred at the DROP IN port of the OMD. LOS is detected by the individual channels that are dropped at the node.

Table 48. OMD44 losses (including one optical connection).

- **MUX - includes 1 connection**

Location	Loss (dB)		
	Typical	Min.	Max.
wxyz In to Add Out	17.8	16.8	19.1

- **DMUX - includes 1 connection**

Location	Loss (dB)		
	Typical	Min.	Max.
Drop to wxyz Out	17.8	16.8	19.1

4.5.8 OPS - Optical Protection Switch

OPS is used for 1+1 protection and protected optical drop and continue applications. OPS may be used on the line side or the client side of an OT, so the pack must be able to operate in the 1.5 mm and 1.3 mm wavelength bands.

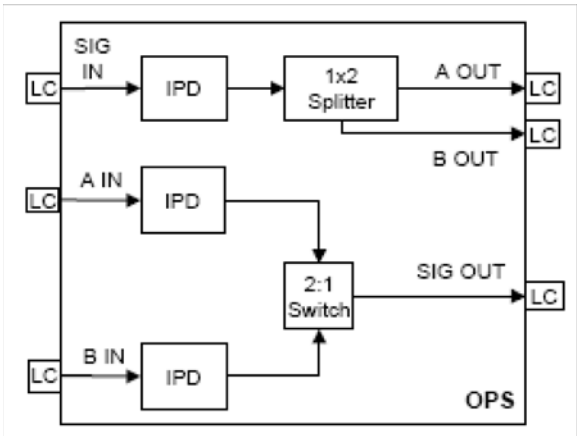


Figure 328. OPS - Optical components diagram

For 1+1 protection, the channel is added at the SIG IN port. The channel is split and sent on two separate paths from the A OUT and B OUT ports. The maximum loss through this path is 4.4 dB. Two diversely-routed copies of the channel are received at the pack at the A IN and B IN ports. A working channel is selected by the 2:1 optical switch and sent to the optical receiver via the SIG OUT port. The maximum loss through this path is 1.7 dB.

For protected drop and continue with OPS, the originating node uses the splitter to send the channels on two separate paths from the A OUT and B OUT ports, but does not use the switch. The drop and continue nodes receive two diversely-routed copies of the channel at the A IN and B IN ports and selects a working channel with the 2:1 optical switch. In the drop-and-continue nodes, the splitter is not used.

4.5.9 OT - Optical Translator Unit

The traditional function of Optical Translator units (OTs) is to provide O-E-O signal processing and adaptation of a colorless signal to a specific Optical channel wavelength within a DWDM domain.

Besides O-E-O signal regeneration, OTs may perform various other functions in electrical domain such as: adaptation of client information structure to a carrier information structure, multiplexing of client signals onto a carrier, cross-connection or protection function, maintenance/monitoring function, data communication function.

In the generic OT model, this function is achieved through an interaction with other subsystems (through a backplane electrical connections) and external world (through a front face plate access).

Typical OT function provides O-E-O conversion and all transmission interface is through a front access via optical transceivers (see Figure 38). Some OT applications such as “ADM on a blade” may require switching sub-function and transmission interface in the back-plane to a mate ADM OT. Also, hybrid OT/TDM I/O implementation may require transmission interfaces on the backplane side. Besides transmission interfaces, ADM on a blade may require protection control signals between the ADM mate OTs.

The front of the OT also provides status indication using a set of LEDs and other indicators.

The OT function uses the system’s the control, power, DCN, OH, and in some applications, timing interfaces in the backplane. Note that DCN/OH indicates communication interface to internal OH, ECC or I-LAN infrastructure.

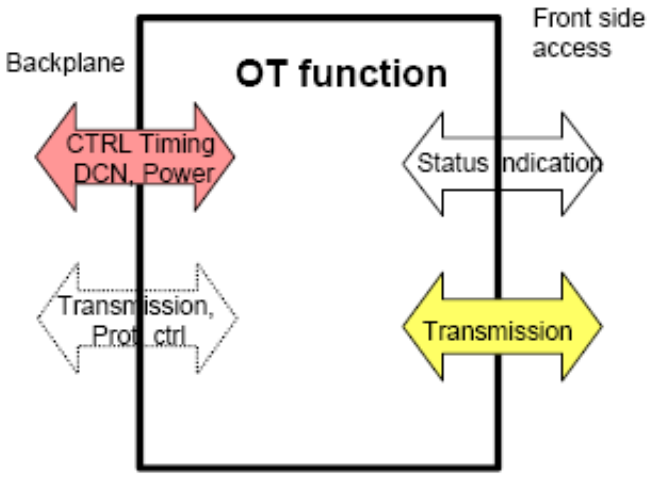


Figure 329. Generic OT model

4.5.10 11G AnyRate OT

Two types of AnyRate 11G OTs are supported in the 1850 TSS-350: Bidirectional AnyRate pack and Unidirectional AnyRate pack.

Single Port Bidirectional AnyRate OT consists of a single AnyRate 11G function.

Unidirectional 11G AnyRate OTs provide a cost optimized version of 11G AnyRate OT targeting video broadcasting applications (which inherently require unidirectional transport services). From a hardware standpoint, the pack design is the same as in bidirectional version with exception of tunable laser module and PLL circuits required for the add transmission direction.

Unidirectional OTs always process transmission in the Drop direction (egress in the DWDM domain).

4.5.10.1 Functional description of a Bidirectional AnyRate 11G OT

The AnyRate 11G function provides a building block for multipurpose 11G tunable transponders. The following high level features are upported as part of the AnyRate 11G function:

- Full 44/88 channel C-band tunability
- Enhanced line side receiver, for improved reach
- Pluggable XFP client interface
- Operation as add/drop and unidirectional through mode
- Full compliance with G.709 bit rate, frame structure, fault processing, and signal monitoring
- Enhanced FEC with 8.5dB OSNR gain on a DWDM line side (ITU-T G.709 OTU2V, EFEC compliant with ITU-T G.975.1, Annex I.4)
- Client side fully compliant with appropriate physical layer specifications and provisionable as:
  - 10G Ethernet LAN PHY [IEEE 802.3ae],
  - 10G Ethernet WAN PHY [IEEE 802.3ae],
  - 10G Fibre Channel [ANSI INCITS 364-2003],
  - OC-192/STM-64 [SONET/SDH],
  - OTM-0.2 [G.709].

CBR10G transport is supported in both Bit-Synchronous and Asynchronous mapping modes.

SONET/SDH non-intrusive monitoring, 10GbE LAN & 10GFC PCS layer monitoring, as well as 10GbE LAN RMON statistics, are supported.

The nominal bit rate of the OTU2 is 255/237 x 9.953280 Gb/s or approximately 10.709225316 Gb/s, with a bit-rate tolerance of +/-20 ppm.

The 10GbE LAN PHY is transported in a standard OTU2 structured signal with 10.709 Gb/s rate. It also uses CBR mode, in which case the bit rate of the line becomes 11.049 or 11.096 Gb/s.

10G Fibre Channel is transported as a CBR signal with a line bit rate of 11.27Gb/s.

The AnyRate 11G OT pack is used in unprotected, single, and dual OT protected configurations. To support some protection configurations, the NE provides configurable consequent action of Laser OFF, Generic-AIS and Framed-AIS on client port triggered by signal fail conditions that are detected on DWDM line side.

4.5.10.2 AnyRate 11G architecture description

AnyRate 11G functional block diagrams are shown on Figure 330. on page 524 (bidirectional model) and Figure 331. on page 524 (unidirectional model).

The “XFP & SER/DES” module is responsible for:

– In the ADD direction: receiving the client signal, recovering its clock, and taking its signals to the parallel data path on the next module
– In the DROP direction: taking signals from the parallel data path and transmitting them to the clientside fiber, using timing reference from PLL for the transmitted signal

The “RS FEC encode/decode” module is responsible for:

In the ADD direction:
- Terminating RS FEC field of an incoming OTU2 client stream
- Correcting errors using Reed Solomon error correction algorithm
- Providing PM statistics for FEC Correctable and Uncorrectable errors
- Transparently passing parallel data/clock lines to the next module in the case of non-OTU2 client signal provisioning

In the DROP direction:
- Generating the FEC field of an OTU2 information structure for an OTM-0.2 provisioned client interface type, if FEC is enabled.
- Transparently passing parallel data/clock lines to the next module (SERDES) in the case of non-OTU2 client signal provisioning

The “SONET/SDH, G.709 and 10GbE LAN processing” module is responsible for:

In the ADD direction:
- Mapping incoming OC192/STM64 signals in to an ODU2 information structure using asynchronous or bit-synchronous methods
- Mapping 10GbE-LAN or 10GFC signal in to an extended ODU2 information structure using bit-synchronous method
- Encapsulation of incoming 10GbE LAN signal into a standard or extended OPU2 information structure using GFP method and mapping
- Generating ODU2 and OTU2 OH fields, except in OTM-0.2 client signal provisioning
- Providing non-intrusive monitoring of incoming OC192/STM64 10GbE LAN or ODU2 streams
- Performing fault processing per G.798 requirements

In the DROP direction:
- Terminating OTU2 OH fields
- Terminating ODU2 OH fields, except when client signal is provisioned to OTM-0.2
- Bit synchronously or asynchronously de-mapping CBR10G signals from an ODU2 information structure
- Providing PCS layer monitoring for CBR mapped 10GbE LAN or 10GFC signals
- Extracting 10GbE LAN bit PDUs from GFP stream and generating PCS layer IEEE802.3ae requirements
- Generating OTU2 OH for outgoing OTM-0.2 provisioned signals
- Performing fault processing per G.798 requirements
- Providing non-intrusive monitoring of incoming OC192/STM64 or ODU2 streams
- Providing RMON statistics for 10GbE LAN traffic in egress direction

The “RSFEC/ EFEC” module is responsible for:

In the ADD direction:

- Generating the FEC field of an OTU2 formatted signal based on either Reed Solomon or EFEC algorithm (user provisioning determines which of the two will be used)

In the drop direction:

- Terminating FEC field of an incoming OTU2 signal
- Correcting errors using Reed Solomon or EFEC error correction algorithm
- Providing PM statistics for FEC Correctable and Uncorrectable errors.

The “Tunable Tx & Rcvr.” modules are responsible for:

- Implementing the 1850TSS-320 (tunable)/(44/88 channel tunable) line side interface
- Dispersion tolerance of at least +1000ps/nm at BER = 6x10-5 for 3.0dB OSNR penalty at 10.7GBit/s
- Line transceiver dynamic range of equal or better then:
  - RX: Pmin= -21dBm, Pmax= -11 dBm
  - Tx: Pmin= 0 dBm, Pmax= +4 dBm
- In the ADD direction: taking the signals from the parallel data path and transmitting them on to the line side fiber
- In the DROP direction: receiving the line signal, recovering its clock, and taking its signals on to the parallel data path on the next module

The “XO” module is an oscillator which provides a clock signal with an accuracy of +/- 20 ppm.

The “MISC FPGA” module performs the function necessary for utilizing Electronic Dispersion Compensation capability of a Multiprotocol ASIC (feedback from the RSFEC/EFEC block is processed and receiver sampling point adjusted to the optimal position). The “OH processing FPGA” allows OH access, if necessary, for ECC termination and processing function.

The Phase Locked Loops (PLL) are modules which are used to condition the clock to be used as a reference in appropriate module.

The “DC/DC” module represents DC/DC converter.

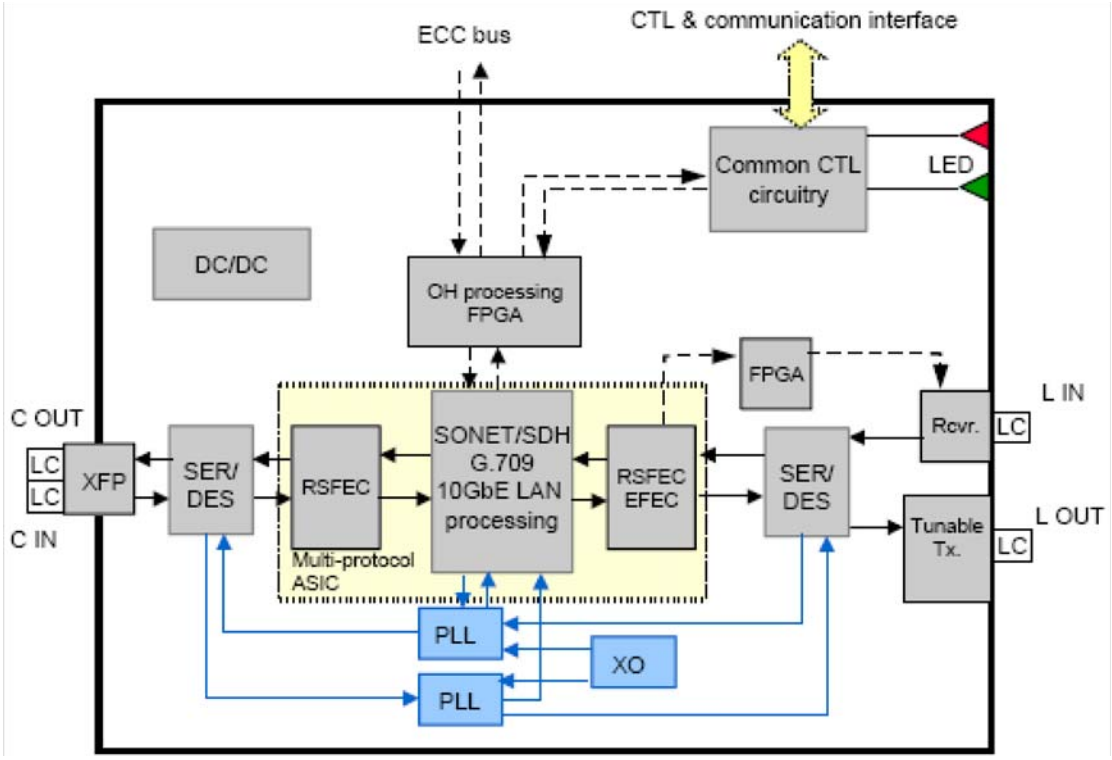


Figure 330. Bidirectional 11G AnyRate OT pack block diagram

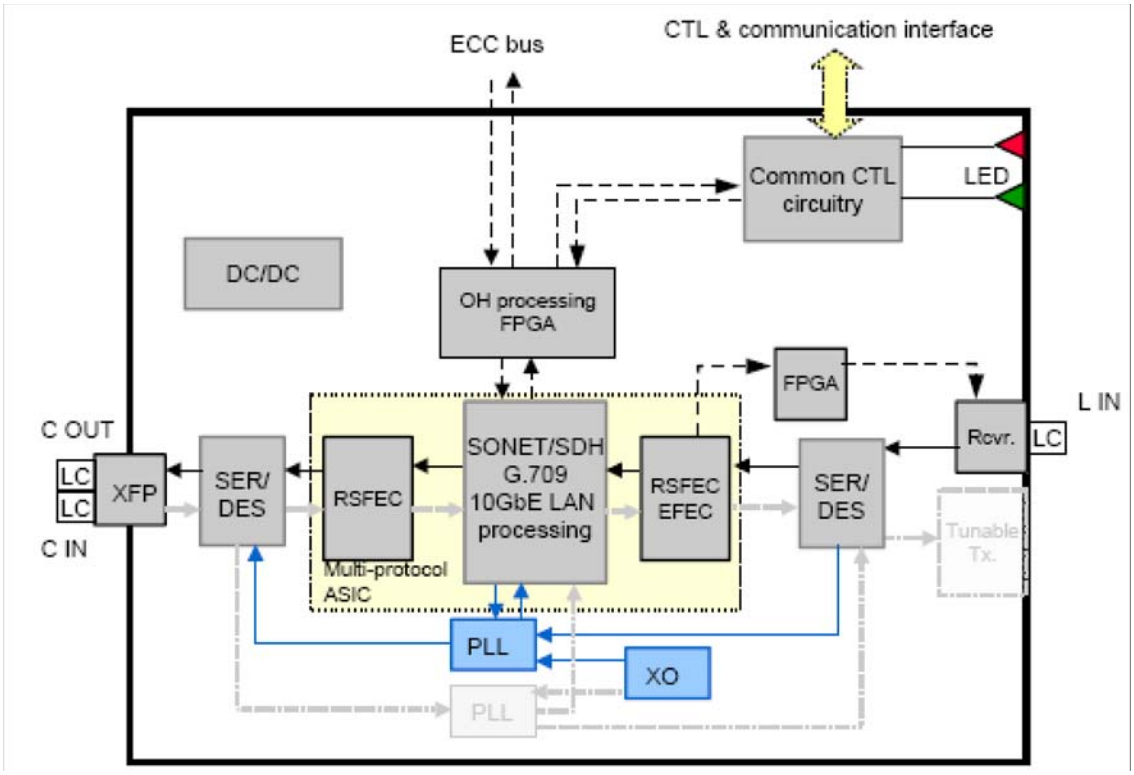


Figure 331. Unidirectional DROP 11G AnyRate OT block diagram

4.5.10.3 11G AnyRate OT operational modes

11G AnyRate OT supports the following operational modes:

a) ADD_DROP mode. In this mode, the pack is processing the signal in both transmission directions (ingress, from client port to the DWDM line port, and egress, from DWDM line port to client port)

b) DROP mode. In this mode, the pack is processing the signal in the egress direction

c) ADD mode. In this mode, the pack is processing the signal in the ingress direction

d) DROP_&_CONTINUE mode. In this mode, the pack is processing the signal in the egress direction and looping the signal from the DWDM line port input to the DWDM line port output

e) THROUGH mode. In this mode, the DWDM line port input is looped to the DWDM line port output.

The greyed out arrows and blocks (shown in Figure 332. on page 526) indicate that those transmission signals and functional blocks would not be processed in a particular mode of operation. This means the associated maintenance and monitoring functions would be disabled, and where physical layer source function is not being used, the associated transmitter would be permanently turned off.

In the THROUGH mode of operation, where client port is not being used, the associated XFP module should not be equipped.

Bidirectional 11G AnyRate OT can support all of the modes described in this section while unidirectional AnyRate OT supports only the DROP mode.

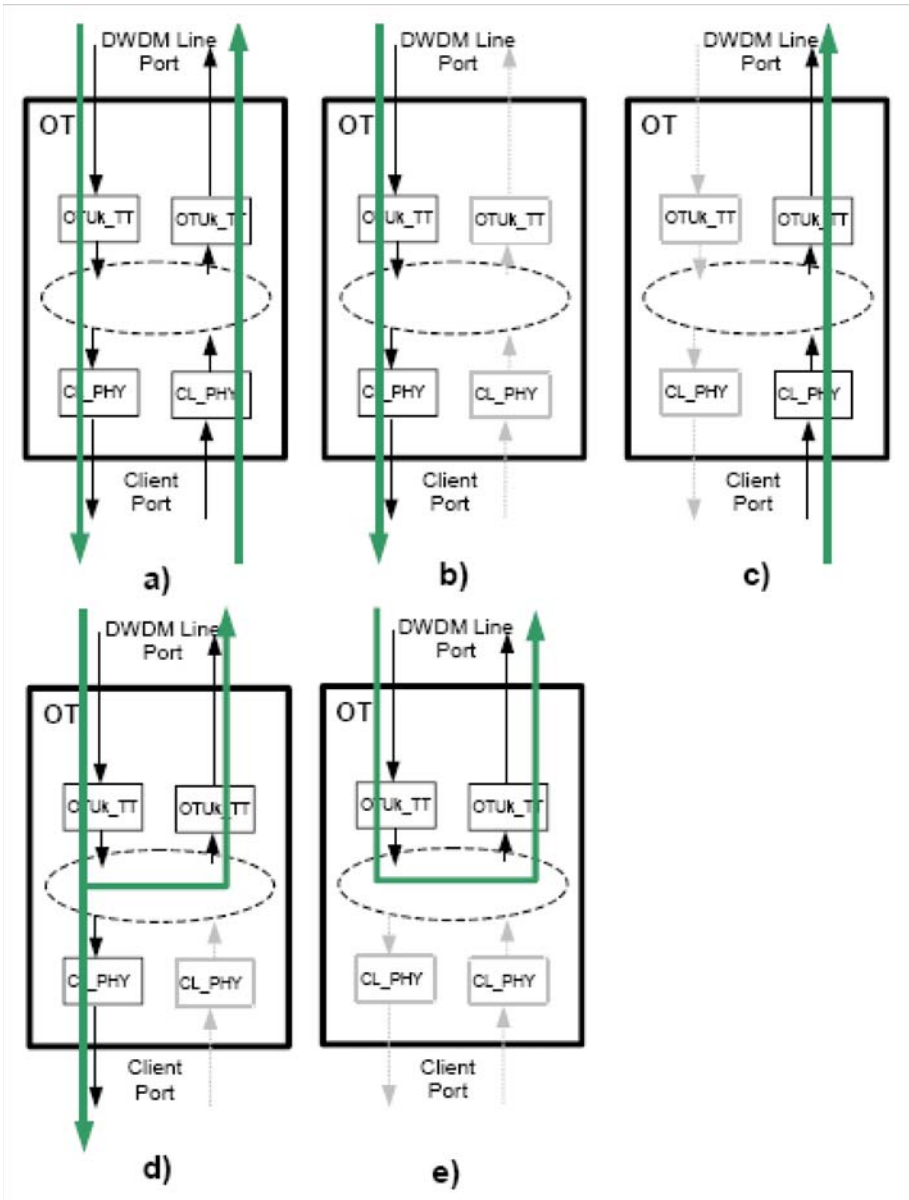
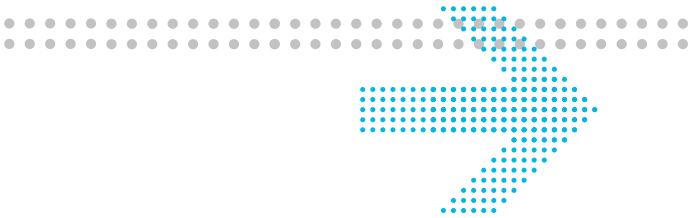


Figure 332. OT Pack operational modes



5 Technical Specifications

Data provided in the document must be considered **standard values**.
Data provided in the contract must be considered **guaranteed values**.

5.1 General characteristics

Application types		
Any combination of: – Terminal Multiplexer (TM) – ADM in protected and unprotected linear links and rings – Digital Cross Connect (DXC) – Regenerative back to back terminal (HUB) – Optical Add and Drop Multiplexer (OADM) – Ethernet switch		
WDM subsystem Optical bit rate, client side		
– 155.520 Mbps	OC-3 / STM-1	10xANY, 8PSO
– 622.080 Mbps	OC-12 / STM-4	10xANY, 8PSO
– 1.250 Gbps	Gigabit Ethernet	10xANY, PIM1GE
– 2.488.320 Gbps	OC-48 / STM-16	10xANY, 4P2G5SO
– 9.95328 Gbps	OC-192/STM-64/10GbE WAN	OTU-2, 11GBAR, 11GUAR, PIM10GE, 1P10GSO
– 10.3125 Gbps	10 GBE LAN	11GBAR, 11GUAR
– 10.519 Gbps	10G FC	11GBAR, 11GUAR
WDM subsystem Optical bit rate, line side		
– 10.709225 Gbps	OC-192/STM-64/10GbE WAN with FEC	OTU-2, 11GBAR, 11GUAR
– 11.095728 Gbps	10GbE LAN with FEC	11GBAR, 11GUAR
– 11.319 Gbps	10G Fiber Channel with FEC	11GBAR, 11GUAR
SONET / SDH subsystem Optical bit rate		
– 155.520 Mbps	OC-3 / STM-1	10xANY, 8PSO
– 622.080 Mbps	OC-12 / STM-4	10xANY, 8PSO
– 2.488.320 Gbps	OC-48 / STM-16	10xANY, 4P2G5SO
– 9.95328 Gbps	OC-192 / STM-64 / 10GbE WAN	1P10GSO
DATA subsystem Optical bit rate		
– 1.250 Gbps	1 Gigabit Ethernet	10xANY, PIM1GE
– 9.95328 Gbps	OC-192 / STM-64/10GbE WAN	1P10GSO, PIM10GE

Type of optical fiber		
– 9/125 µm SMF – 50/125 µm MMF – 62.5/125 µm MMF according to ITU-T G.652, G.653, G.654, G.655		
Applied standards		
SDH	ITU-T G.703 for electrical interfaces ITU-T G.707 for SDH frame and multiplexing structure ITU-T G.957, G.958, G.691, G.693, G.959.1 for optical interfaces ITU-T G.821 and G.826 for transmission quality ITU-T G813 for synchronization ITU-T G.783 and G.841 for network protection architectures ITU-T G.784 and G.774 for system management functions ITU-T G.662 and G.663 for optical amplification	
DATA	IEEE 802.3 IEEE 802.1D, 802.1Q, 802.1AD IEEE 802.1s, 802.1w ITU-T 8011x MEF 6, MEF 10	
WDM	ITU-T G.709 interface for the Optical Transport Network (OTN) ITU-T G.798 Characteristics of the Optical Transport Network (OTN) hierarchy equipment functional blocks ITU-T G.692 Optical interfaces for multichannel system with optical amplifier ITU-T G.694.1 Spectral grid for WDM applications: DWDM wavelength grid ITU-T G.652 Characteristics of a single-mode optical fibre and cable ITU-T G.872 Architecture of the Optical Transport Network (OTN) ITU-T G.693 Optical interfaces for Intra-office system ITU-T G.959.1 Optical Transport Network (OTN) physical layer interfaces ITU-T G.958 Digital line system based on the synchronous digital hierarchy for use on optical fibre cables	
Max quantity of each interface per shelf		
– 256 x OC-3/OC-12 - STM-1/STM-4 optical interfaces; – 128 x OC-48 / STM-16 optical interfaces; – 32 x OC-192 / STM-64 optical interfaces; – 256 x Fast Ethernet optical interfaces; – 256 x GEthernet optical interfaces; – 32 x 10GEthernet optical interfaces;		
Add-Drop and Cross connect features		
Cross-Connections capacity	*320 Gbit/s*	2048x2048 VC-4 (SDH-HO)
	40 Gbit/s	16128x16128 at VC-12 (SDH-LO) 768x768 at VC-3 (SDH-LO)
	160 Gbit/s	Packet based traffic
Transmission delay		
125 µs maximum for any traffic pathway		

Protections	
Network protection	***WDM protection***: – O-SNCP ***SONET protection***: – APS 1+1 – BLSR – ULSR – Collapsed single-node interconnection??? – Collapsed dual-node interconnection??? ***DATA protection***: – Link aggregation – Ethernet protection through STP protocols
Equipment protection	1+1 Matrix (MT320ND) EPS 1+1 Equipment Controller (EC320) EPS 1+1 Power (PSF320) EPS

Management interface		
Local:	Craft Interface/CLI (Personal Computer)	– RS232 PC compatible SUB-D 9 pins at 38 kbit/s – µUSB
Remote:	Craft Interface (Personal Computer)	– RS232 PC compatible SUB-D 9 pins at 38 kbit/s; it handles up to 31 NEs via DCC (D4 - D12 and/or D1-D3) – µUSB; it handles up to 31 NEs via DCC (D4 - D12 and/or D1-D3)
Remote:	Transmission Management Network (TMN) interface	Q3 CMISE, SNMP for data
	Information Model	According to ITU-T (G.774) and ETSI specification
Protocol Stack/Information Model messages	According to ITU-T G.774 and ETSI rec. ISO-OSI 7-layers reference model. Data functions are organized according to the TCP/IP reference model. They are managed by means of SNMP protocol tunneling over OSI layers.	
Dual addressing to O.S.	Allows O.S. redundancy	

Operation processes	
SDH and WDM configuration and provisioning	Equipment, ports, add-drop, cross-connect, synchronization, protection, Message Communications Function (MCF), Synchronous Equipment Management Function (SEMF), OH connection.
Data configuration and provisioning	Equipment, ports, flow provisioning, SLA provisioning, classification and policing.
Software download	Locally as well as remotely on non volatile memories without traffic interruption.
SONET/SDH performance monitoring	According to GR-253 and T1.231 requirements.
Data performance monitoring	According to RFC 2863, 2665, 2668, 1471 requirements.
Unit and Equipment acknowledgement	Through Remote Inventory (Company id, Unit Type, Unit Part Number, Serial Part Number, Software Part Number etc.). For detail refer to the Operator's Guide.
Security	Password, operator profile, back-up for programs and data
Output Housekeeping signals (CPO) and Remote Alarms	
By electronic relay contact connected to external negative voltage:	
– Max. guaranteed current with closed condition	50 mA
– Voltage drops vs. ground with closed condition	-2 V ÷ 0 V
– Max. allowed voltage with open condition	-72 V
Input Housekeeping signals (CPI)	
– Max. guaranteed current with closed condition	3 mA
– Voltage drops vs. ground with closed condition	-2 V ÷ 0 V
– Max. allowed voltage with open condition	-72 V
Clock characteristics	
Selectable input clock	– 1544/2048 kHz from 2 Mbit/s port (T2) – 1544/2048 kHz external sync clock (2 input, T3a and T3b) or 1544/2048 Mbit/s external sync (2 input, T6a and T6b) – STM-N ports (T1)
No. of selected clock (normal mode)	6 max.
Synchronization output	– 1544/2048 kHz G.703 (2 output, T4a and T4b) or – 1544/2048 Mbit/s (2 output T5a and T5b)
Operational modes	– Locked to reference – Free-run mode ±4.6 ppm (PLL without reference) – Holdover mode drift 0.37 ppm max./day (PLL with stored frequency for more than half an hour, with no selected input frequency)
Synchronization selection	Priority and SSM algorithm
Protection against lighting surges	
Not applicable	
Additional features	
– VCi Signal Label management – Programmable alarms severity – J0 - Section Trace Management	

5.1.1 Optical Safety

5.1.1.1 Optical Safety compliance with American and European Norms

The 1850 TSS-320 meetings the following optical safety standards:

– ANSI standard
  - FDA/CDRH - 21 CFR 1010 and 1040

– ETSI standards
  - IEC 60825-1 Edition 2.0 (2007)
  - IEC 60825-2 Edition 3.1 (2007)

	Due to the inconsistency between the new 60825-1 and the current 60825-2, the previous edition of IEC 60825 Part 1 (IEC 60825-1:1993 and its amendment 1 (1997) and amendment 2 (2001) should be used for calculating or measuring hazard levels of optical fibre communication systems using IEC 60825-2:2004 incorporating amendment 1: 2006. This instruction will remain valid until a new version of IEC 60825-2 is published.

5.1.1.2 Hazard Level classification

The HAZARD LEVEL classification for the different optical interfaces supported in the 1850 TSS-320 is listed in Table 49. on page 531.

Hazard levels are assigned in accordance with the requirements of the following ANSI standards:
– FDA/CDRH - 21 CFR 1010 and 1040

Hazard levels are also assigned in accordance with the following ETSI standards:
  - IEC 60825-1 Edition 2.0 (2007) and IEC 60825-2 Edition 3.1 (2007)

Table 49. Hazard level classification of different optical interfaces

Signal type	Acronym	Optical Interface (GR-253-CORE)	Hazard Level
OC-3 (STM-1)	SS-11	IR-1 OC3 (intermediate reach)	1
	SL-11	LR-1 OC3 (long reach)	1
	SL-12	LR-2 OC3 (long reach)	1
OC-12 (STM-4)	SS-41	IR-1 OC12 (intermediate reach)	1
	SL-41	LR-1 OC12 (long reach)	1
	SL-42	LR-2 OC12 (long reach)	1
OC-48 (STM-16)	SI-161	SR-1 OC48 (short reach)	1
	SS-161	IR-1 OC48 (intermediate reach)	1
	SL-161	LR-1 OC48 (long reach)	1
	SL-162	LR-2 OC48 (long reach)	1
	SS-161AR	IR-1 OC48 Anyrate	1
OPTO TRX 1.25GBE SFP-SX	1000B	1000B-SX	1
OPTO TRX 1.25GBE SFP-LX	1000B	1000B-LX	1

Signal type	Acronym	Optical Interface (GR-253-CORE)	Hazard Level
OPTO TRX 1.25GBE SFP-ZX	1000B	1000B-ZX	1
OPTO TRX 10G BASE S	10GB	10G BASE-S	1
OPTO TRX 10G BASE L/I-64.1	XI641	10G BASE-L / SR-1 OC192 (short reach)	1
OPTO TRX 10G BASE E/S-64.2b	XS642	10G BASE-E / IR-2 OC192 (intermediate reach)	1
OPTO TRX 10G P1L1-2D2 (L-64.2)	XP1L12D2	P1L1-2D2 (LR-2 OC192) (long reach)	1

5.1.1.3 Location type

The 1850 TSS-320 equipment must be installed in “restricted locations" (industrial and commercial premises) or “controlled locations" (optical cable ducts and switching centers).

5.1.1.4 Incorporated laser sources characteristics

Output optical interfaces data: the wavelength and the maximum optical power at the output connector of incorporated laser sources is given in the specific documents (refer to "Related Documents" on page 20).

5.1.1.5 Optical Safety Labelling

The label shown below comes in a plastic bag.

The customer is required to use the label corresponding to the highest Hazard level of all the modules equipped on the shelf.

The optical interfaces which have HAZARD LEVEL 1 (see Table 49. on page 531) carry the following explanatory label:



5.1.1.6 Openings and fiber connectors

The locations of openings and fibre connectors can be seen in the graphics starting in Section 2.4 on page 89.

5.1.1.7 Engineering design features

In normal operating conditions, unless intentional manumission, the laser radiation is never accessible.

The laser beam is launched in optical fibre through an appropriate connector that totally shuts up the laser radiation.

In case of cable fibre break, to minimize exposure times, Automatic Laser Shutdown (ALS) procedure according to ITU-T G.958 Rec. is implemented on the STM-1, STM-4, or on the STM-16 ports.

ALS meets G.958 requirements.

5.1.1.8 Optical Safety instruction

The safety instructions for proper assembly, maintenance, and safe use including warnings and precautions to avoid possible exposure to hazardous laser radiation are reported in [8] on page 20.

5.1.2 Electrical Safety

Electrical Safety	
Safety status of the connections with other equipment	– TNV2 (Telecommunication Network Voltage) for Remote Alarms, Housekeeping Alarms (CPO, CPI), Rack Lamp (RM) – SELV (Safety Extra Low Voltage) for all the other

5.1.2.1 Electrical Safety compliance with European Norms

The 1850 TSS-320 meets the following electrical safety standards:

- IEC 60950-1 ed.2001
- EN 60950-1 ed.2001

5.1.2.2 Electrical Safety Labelling

The labels reproduced in Appendix A on page 593 are affixed at the factory.

5.1.2.3 Electrical Safety instructions

The safety instructions for proper assembly, maintenance, and safe use including warnings and precautions to avoid possible exposure to hazardous voltage are reported in Appendix A on page 593 .

5.2 Electrical interface characteristics

2 Mb/s G.703 /G.704 AUX channel interface	
Electrical	According to ITU-T Rec. G.703 (75 Ohm or 120 Ohm using a special cable)
Attenuation	0 to 6 dB
Return loss	– w12 dB 51-102 kHz – w18 dB 102-2048 kHz – w14 dB 2048-3072 kHz
Pulse shape	See ITU-T Rec. G.703

5.3 Optical units interface characteristics

5.3.1 OTU-2 optical interfaces characteristics

Optical interface specification - WDM interface	
Type of optical fiber	9/125 µm SMF, according to ITU-T G.652, G.653, G.654, G.655
Connector type	LC
Optical bit rate	10.709225 Gbps (OC-192 / STM-64 / 10 GbE WAN with FEC)
Optical interface type	DWDM interface for long haul (APD detector)
Wavelength range	3rd window (1529.553 –> 1563.863 nm)
Channels grid	Refer to Table 54. on page 549, 100 GHz grid (44 channels)
WDM interface - Receiver specification	
Input Optical Power	-22 -> +8dBm
WDM interface - Transmitter specification	
Output Optical Power	-13dBm -> +2dBm
Extinction Ratio (ER)	+13 dB

5.3.2 10xANY optical interfaces characteristics

Optical interface specification - client interfaces		
Type of optical fiber	9/125 µm SMF 50/125 µm MMF 62.5/125 µm MMF according to ITU-T G.652, G.653, G.654, G.655	
Connector type	LC (on XFP module)	
Optical bit rate	155.520 Mbps 622.080 Mbps 1.250 Gbps 2.488.320 Gbps	OC-3 / STM-1 OC-12 / STM-4 Gigabit Ethernet OC-48 / STM-16
Optical interface type (according to the SFP module plugged on)	Telcordia GR-253-CORE SR-1 OC3, LR-1 OC3, LR-2 OC3, SR-1 OC12, LR-1 OC12, LR-2 OC12 , IR-1 OC48, SR-1 OC48, LR-1 OC48, LR-2 OC48	ITU–T G.957 S–1.1, L-1.1, L-1.2, S-4.1, L-4.1, L-4.2, I–16.1, S-16.1, L–16.1, L–16.2 IEEE 802.3 Gigabit Ethernet
Wavelength range	1st window for GbE-SX (1000B-SX) 2nd window for: – Telcordia SR-1 OC3, LR-1 OC3, SR-1 OC12, LR-1 OC12, SR-1 OC48, IR-1 OC48, LR-1 OC48, GbE-LX – ITU-T S–1.1, L-1.1, S-4.1, L-4.1, I–16.1, S-16.1, L–16.1, GbE-LX 3rd window for Telcordia LR-2 OC3, LR-2 OC12, LR-2 OC48, GbE-ZX and ITU-T L-1.2, L-4.2, L-16.2, GbE-ZX	
Other interfaces characteristics	Refer to para 5.3.9 on page 543 for SFP details	

5.3.3 11GBAR optical interfaces characteristics

Optical characteristics of the Client/B&W interface of the 11GBAR unit	
Fiber type	9/125 μm Single-mode (SMF) 50/125 μm Multi-mode (MMF) 62.5/125 μm Multi-mode (MMF)
Connector type	LC on XFP module; the client interface is an XFP module
Bit rate, client side (according to the B&W XFP module plugged on user side)	9.9532 Gbps ±20ppm - UNI: OC-192/STM-64/10GBE WAN 10.709225 Gbps ±20ppm - OTM-02 (G.709) - NNI 10.3125 Gbps ± 100ppm - UNI: 10 GBE LAN (IEEE 802.3ae)
User interface type (according to the B&W XFP module plugged on user side)	Telcordia GR-253-CORE SR-1 OC192, ITU–T G.691 I-64.1; ITU–T G.693 VSR 2000 Telcordia GR-253-CORE IR-2 OC192, ITU–T G.691 S-64.2b ITU–T G.959.1 P1L1-2D2 (L-64.2) IEE 802.3ae 10GBASE-SR (LAN), 10GBASE-SW (WAN) IEE 802.3ae 10GBASE-LR (LAN), 10GBASE-LW (WAN) IEE 802.3ae 10GBASE-ER (LAN), 10GBASE-EW (WAN)
Wavelength range	1st window for 10GBASE-S 2nd window for SR-1 OC 192, I-64.1 and 10GBASE-L 3rd window for IR-2 OC192, S-64.2b, P1L1-2D2 (LR-2 OC192/ L-64.2),10GBASE-E Refer to Section 5.3.11 on page 547 for XFP details
Other user interface characteristics	Refer to Section 5.3.11 on page 547
Optical characteristics of the WDM interface of the 11GBAR unit	
WDM interface - Common specification	
Wavelength specification	ITU-T G.694.1, 100 GHz channel spacing
Modulation format	NRZ
Wavelength tunability	Over the whole extended C-band
Wavelength range	1529.553nm -> 1563.863nm
Frequency range	196,000 THz -> 191,700 THz
WDM interface bit rate (IN/OUT)	11.095728 Gbps ± 20 ppm for 10 GbE LAN client signals 10.709225Gbps ±20ppm for 9.95Gb and G.709 client signals
Fiber type	Single-mode (SMF)
Connector type	LC
WDM interface - Transmitter specification	
Output power	0 dBm -> +4.0 dBm
WDM interface - Receiver specification	
Input power	-21 dBm -> -11.0 dBm

5.3.4 11GUAR optical interfaces characteristics

Optical characteristics of the Client/B&W interface of the 11GUAR unit		
Fiber type	9/125 μm Single-mode (SMF) 50/125 μm Multi-mode (MMF) 62.5/125 μm Multi-mode (MMF)	
Connector type	LC on XFP module; the client interface is an XFP module	
Bit rate, client side (according to the B&W XFP module plugged on user side)	9.9532 Gbps - UNI: OC-192/STM-64/10GBE WAN 10.709225 Gbps - OTM-02 (G.709) - NNI 10.3125 Gbps - UNI: 10 GBE LAN	
User interface type (according to the B&W XFP module plugged on user side)	Telcordia GR-253-CORE SR-1 OC192, ITU–T G.691 I-64.1; ITU–T G.693 VSR 2000 Telcordia GR-253-CORE IR-2 OC192, ITU–T G.691 S-64.2b ITU–T G.959.1 P1L1-2D2 (L-64.2) IEE 802.3ae 10GBASE-SR (LAN), 10GBASE-SW (WAN) IEE 802.3ae 10GBASE-LR (LAN), 10GBASE-LW (WAN) IEE 802.3ae 10GBASE-ER (LAN), 10GBASE-EW (WAN)	
Wavelength range	1st window for 10GBASE-S 2nd window for SR-1 OC192, I-64.1 and 10GBASE-L 3rd window for IR-1 OC192, S-64.2b, P1L1-2D2 (L-64.2), 10GBASE-E Refer to Section 5.3.11 on page 547 for XFP details	
Other user interface characteristics	Refer to Section 5.3.11 on page 547. Only Tx and common values have to be considered (Rx from client is not supported)	
Optical characteristics of the WDM interface of the 11GUAR unit		
WDM interface - Common specification		
Wavelength specification	ITU-T G.694.1, 100 GHz channel spacing	
Modulation format	NRZ	
Wavelength tunability	Over the whole extended C-band	
Wavelength range	1529.553nm -> 1563.863nm	
Frequency range	196,000 THz -> 191,700 THz	
WDM interface bit rate (IN/OUT)	11.095728 Gbps ± 20 ppm for 10 GbE LAN client signals 10.709225Gbps ±20ppm for 9.95Gb and G.709 client signals	
Fiber type	Single-mode (SMF)	
Connector type	LC	
WDM interface - Transmitter specification - functionality not supported		
WDM interface - Receiver specification		
Input power	-21 dBm -> -11.0 dBm	

5.3.5 1P10GSO (OC-192/STM-64) optical interfaces characteristics

Optical interface specification	
Type of optical fiber	9/125 µm SMF, according to ITU-T G.652, G.653, G.654, G.655
Connector type	LC (on XFP module)
Optical bit rate	9.95328 Gbps (OC-192 / STM-64)
Optical interface type (according to the XFP module plugged on)	Telcordia GR-253-CORE SR-1 OC192, IR-2 OC192 and ITU–T G.691 I–64.1, S–64.2b ITU–T G.693 VSR 2000 ITU–T G.959.1 P1L1-2D2 (LR-2 OC192 / L-64.2)
Wavelength range	2nd window for SR-1 OC192, I–64.1 and VSR 2000 3rd window for IR-2 OC192, S–64.2b and P1L1-2D2 Refer to Section 5.3.11 on page 547 for XFP details

5.3.6 4P2G5SO (OC-48/STM-16) optical interfaces characteristics

Optical interfaces specification	
Type of optical fiber	9/125 µm SMF, according to ITU-T G.652, G.653, G.654, G.655
Connector type	LC (on SFP module)
Optical bit rate	2.488 Gbps (OC-48 / STM-16)
Optical interface type (according to the SFP module plugged on)	Telcordia GR-253-CORE SR-1 OC48, IR-1 OC48, LR-1 OC48, LR-2 OC48 ITU–T G.957 I–16.1, S-16.1, L–16.1, L–16.2
Wavelength range	2nd window for SR-1 OC48/I–16.1, IR-1 OC48/S-16.1, LR-1 OC48/L-16.1 3rd window for LR-2 OC48/L-16.2 Refer to Section 5.3.9 on page 543 for SFP details

5.3.7 8PSO (OC-3/12 / STM-1/4) optical interfaces characteristics

Optical interfaces specification	
Type of optical fiber	9/125 µm SMF, according to ITU-T G.652, G.653, G.654, G.655
Connector type	LC (on SFP module)
Optical bit rate	155.520 Gbps (OC-3 / STM-1) 622.080 Gbps (OC-12 / STM-4)
Optical interface type (according to the SFP module plugged on)	Telcordia GR-253-CORE IR-1 OC3, LR-1 OC3, LR-2 OC3, IR-1 OC12, LR-1 OC12, LR-2 OC12 ITU–T G.957 S–1.1, L-1.1, L-1.2, S-4.1, L-4.1, L-4.2
Wavelength range	2nd window for IR-1 OC3/S–1.1, LR-1 OC3/L-1.1, IR-1 OC12/S-4.1, LR-1 OC12/L-4.1 3rd window for LR-2 OC3/L-1.2 and LR-2 OC12/L-4.2 Refer to Section 5.3.9 on page 543 for SFP details

5.3.8 PP20G (20 GB packet processor) optical interfaces characteristics

Note: 1: Not all DATA function characteristics are reported by this pack.

Note: 2: The codes and denominations of the Units and Interfaces mentioned in the following tables are reported in Section 2.3 on page 77.

GigaBit Ethernet Optical characteristics (1GbE)	
Interface type	– 1000B-SX – 1000B-LX – 1000B-ZX – SS-161 (anyrate), Refer to 5.3.9 on page 543
Optical connectors	LC/PC on SFP (Small Formfactor Pluggable) module
Pulse shape	See IEEE 802.3

10 GigaBit Ethernet Optical characteristics (10GbE)	
Interface type:	– 10GBase-SW, 10GBase-SR (10GB) – 10GBase-LW, 10GBase-LR (XI-641) – 10GBase-EW, 10GBase-ER (XS-642) Refer to 5.3.11 on page 547
Optical connectors	Optical connectors: LC/PC on XFP (eXtra Form factor Pluggable) module
Pulse shape	See IEEE 802.3

Table 50. 20G Packet Processor (PP20G), main features

CHARACTERISTICS	VALUES
Physical interface	Types of insertable PIM's: – PIM1GE (see Table 51. on page 541) – PIM10GE (see Table 52. on page 541) – PIMMS (see Table 53. on page 542)
Local Ethernet ports number	See PIM's characteristics (Table 51. on page 541 and Table 52. on page 541)
Remote Ethernet ports number	See PIMMS characteristics (Table 53. on page 542)
Ethernet over SDH features	See PIMMS characteristics (Table 53. on page 542)
Bridging/Connection	– ETH permanent cross-connection – MAC Bridge (802.1d) – Virtual Bridge (802.1q) – Provider Bridge (802.1ad)
Traffic Classification criteria	– per Port – VLAN Id – CoS (VLAN priority bits) – Port and MAC address (802.1d) – Port, MAC and VLAN (802.1q) – Port, MAC, VLAN and/or SVLAN (802.1ad)
Forwarding Data Base management	– per Port – MAC auto-learning and aging – MAC static configuration – MAC ACL configuration
Look up table size	– number of VLAN-id = 4 K – number of MAC addresses = 128K
Traffic delivery	– Unicast – Multicast – Broadcast
VLAN capabilities	– Push, Pop, Swap – cVLAN (802.1 Q) – pVLAN (SVLAN, 802.1AD)
CoS	– Regulated (PIR>CIR>0) – Guaranteed (PIR=CIR>0) – Best Effort (PIR>0, CIR=0)
CAC (Connection Admission Control)	Yes
Policing	– Single rate token-bucket Metering – Dual rate token-bucket Metering – MEF Marking (for future release) – MEF Policing (for future release) – Color Blind policing – Color Aware policing – Marking -> 3 colors – Dropping -> out of profile

CHARACTERISTICS	VALUES
Scheduler	– Strict priority – Traffic shaping per port – Traffic shaping per port per service – Head of line (HOL) -> 4 priorities (for future release) – Deficit Round Robin (DRR)
Congestion Avoidance	W-RED per queue
Spanning tree	– STP, 802.1d – RSTP, 802.1 w – MSTP, 802.1s – Per-VLAN STP
Multicast	– IGMP snooping – IGMP proxy – IGMP fast leave
Performance ethernet counters	Yes
Redundancy management	– EPS 1+1 (for future release) – Dual Homing via BPDU tunnelling – Dual Homing via STP – Dual Attachment
Networking	– MEF linkage services – ITU-T linkage services – IETF linkage services
Link Aggregation	On Local Ethernet Ports 1Gbps and 10Gbps. Max Aggregate-Size = 16 ports

Table 51. 10x1 GE Plug-In Module (PIM1GE) main features

CHARACTERISTICS	VALUES
Type of interface	Optical, on SFP modules: – ETH 1000B SX – ETH 1000B LX – ETH 1000B ZX – “AnyRate” SS-161AR. For details, refer to 5.3.9 on page 543
Local Ethernet ports number	10 ports at 1 Gb/s on SFP connectors (LC type)
Auto-negotiationì	Configurable
Flow Control	Configurable
Line Loopback	Configurable
Network Loopback	Configurable
CSF alarm propagation	Configurable
Jumbo Frames supporting	Baby JF up to 2k bytes (2026)

Table 52. 1x10 GE Plug-In Module (PIM10GE) main features

CHARACTERISTICS	VALUES
Type of interface	Optical, on XFP modules: – 10GBase-S (10GB) – 10GBase-L (XI-641) – 10GBase E (XS-642) – P1L1-2D2 / L-64.2 (XP1L12D2) For details, refer to 5.3.11 on page 547 and 5.3.13 on page 549
Local Ethernet ports number	1 port at 10 Gb/s on XFP connectors (LC type)
Auto-negotiationì	Configurable
Flow Control	Configurable
Line Loopback	Configurable
Network Loopback	Configurable
CSF alarm propagation	Configurable
Jumbo Frames supporting	Baby JF up to 2k bytes (2026)

Table 53. Multi-Service Plug-In Module (PIMMS) main features

CHARACTERISTICS	VALUES
Type of interface	No local i/f
Remote Ethernet ports number	Up to 64
VC-AIS alarm propagation	Configurable
VC termination max.	VC-12 = not available VC-3 = not available VC-4 = 64 per PIMMS unit
Virtual Concatenation	Configurable
Rate Limiting	Configurable per VCG port
Number of VCGs ETH over SDH	VC-12 = not available VC-3 = not available VC-4 = 64
VCs per VCG max.	VC-12 = not available VC -3 = not available VC - 4 = 64 per PIMMS
VC composite delay	Max 32 ms
Mapping to SDH	GFP LAPS
LCAS	Configurable on SDH side

5.3.9 B&W SFPs Optical Characteristics

SFP module type		ETSI / ANSI	STM-1 S.1.1 IR-1 OC3	STM-1 L.1.1 LR-1 OC3	STM-1 L.1.2 LR-2 OC3	Unit
Addressed wavelength			1261 -> 1360	1270 -> 1360	1480 -> 1580	nm
Min. launched power			-15	-5	-5	dBm
Max. launched power			-8	0	0	dBm
Allowed bit rates			155.520	155.520	155.520	Mbps
Min. extinction ratio (dB)			8.2	10	10	dB
Spectral width	Max. -20dB bandwidth (nm)		NA	1 **nb1**	1	nm
	Max. RMS width (nm)		7.7	3 **nb2**	NA	nm
Minimum SMSR			NA	30 if SLM laser	30	
Max. chromatic dispersion			-100 -> +100	-250 -> +250	1900	ps/nm
Min. sensitivity, @ BER=$1E^{-10}$			-28	-34	-34	dBm
Min. overload			-8	-10	-10	dBm
Max. optical path penalty			1	1	1	dB
Max. receiver reflectance			-14	-14	-25	dB
Optical connector (Tx/Rx) / Fibre type			LC / SMF	LC / SMF	LC / SMF	
Acronym			SS-11	SL-11	SL-12	

nb1: if SLM laser
nb2: if MLM laser

SFP module type		ETSI / ANSI	STM-4 S.4.1 IR-1 OC12	STM-4 L.4.1 LR-1 OC12	STM-4 L.4.2 LR-2 OC12	Unit
Addressed wavelength			1274 -> 1355	1280 -> 1335	1480 -> 1580	nm
Min. launched power			-15	-3	-3	dBm
Max. launched power			-8	+2	+2	dBm
Allowed bit rates			622.080	622.080	622.080	Mbps
Min. extintion ratio (dB)			8.2	10	10	dB
Spectral width	Max. -20dB bandwidth (nm)		NA	1	1	nm
	Max. RMS width (nm)		2.5	NA	NA	nm
Minimum SMSR			NA	30	30	
Max. chromatic dispersion			-100 -> +100	-250 -> +250	1900	ps/nm
Min. sensitivity, @ BER=$1E^{-10}$			-28	-28	-28	dBm
Min. overload			-8	-8	-8	dBm
Max. optical path penalty			1	1	1	dB
Max. receiver reflectance			-14	-14	-27	dB
Optical connector (Tx/Rx)			LC	LC	LC	
Fiber type			SMF	SMF	SMF	
Acronym			SS-41	SL-41	SL-42	

SFP module type	ETSI / ANSI	STM-16 I.16.1 / SR-1 OC48	STM-16 S.16.1 / IR-1 OC48	Unit
Addressed wavelength		1270 -> 1360	1270 -> 1360	nm
Min. launched power		-10	-5	dBm
Max. launched power		-3	0	dBm
Allowed bit rates		2.48832	2.125; 2.48832	Gbps
Min. extinction ratio (dB)		8.2	8.2	dB
Spectral width	Max. -20dB bandwidth (nm)	NA	1	nm
	Max. RMS width (nm)	4	NA	nm
Minimum SMSR		NA	30	
Max. chromatic dispersion		-12 -> +12	-100 -> +100	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-18	-18	dBm
Min. overload		-3	0	dBm
Max. optical path penalty		1	1	dB
Max. receiver reflectance		-27	-27	dB
Optical connector (Tx/Rx) / Fibre type		LC / SMF		
Acronym		SI-161	SS-161	

SFP module type	ETSI / ANSI	STM-16 L.16.1 / LR-1 OC48	STM-16 L.16.2 / LR-2 OC48	Unit
Addressed wavelength		1280 -> 1335	1500 -> 1580	nm
Min. launched power		-2	-2	dBm
Max. launched power		+2	+2	dBm
Allowed bit rates		2.48832	2.48832	Gbps
Min. extinction ratio (dB)		8.2	8.2	dB
Spectral width	Max. -20dB bandwidth (nm)	1	1	nm
	Max. RMS width (nm)	NA	NA	nm
Minimum SMSR		30	30	
Max. chromatic dispersion		-250 -> +250	+1600	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-27	-28	dBm
Min. overload		-8	-8	dBm
Max. optical path penalty		1	2	dB
Max. receiver reflectance		-27	-27	dB
Optical connector (Tx/Rx) / Fibre type		LC / SMF		
Acronym		SL-161	SL-162	

SFP module type		ETSI	S.16.1 Multirate Multiformat	Unit
		ANSI	IR-1 OC48 Multirate Multiformat	
Addressed wavelength			1290 -> 1330	nm
Min. launched power			-5	dBm
Max. launched power			0	dBm
Allowed bit rates			100 -> 2700	Mbps
Min. extinction ratio (dB)			For bit rates > 2.125Gbps = 8.2 For bit rates < 2.125Gbps = 9	dB
Spectral width	Max. -20dB bandwidth (nm)		1	nm
	Max. RMS width (nm)		NA	nm
Minimum SMSR			30	
Max. chromatic dispersion			-100 -> +100	ps/nm
Min. sensitivity, @ BER=1E^{-10}			-18	dBm
Min. overload			0	dBm
Max. optical path penalty			1	dB
Max. receiver reflectance			-27	dB
Optical connector (Tx/Rx) / Fibre type			LC / SMF	
Acronym			SS-161AR	

SFP module type		1.25GbE GbE1000SX	1.25GbE GbE1000LX (10)	1.25GbE GbE1000ZX	Unit
Addressed wavelength		820 –> 860	1270 -> 1355	1540 –> 1570	nm
Min. launched power		-9.5	-11	0	dBm
Max. launched power		-4	-3	+5	dBm
Allowed bit rates		1.250	1.250	1.250	Mbps
Min. extinction ratio (dB)		9.0	9.0	9.0	dB
Spectral width	Max. -20dB bandwidth (nm)	NA	NA	1	nm
	Max. RMS width (nm)	0.85	4	NA	nm
Minimum SMSR		NA	NA	30	
Max. chromatic dispersion		-	-	1200	ps/nm
Min. sensitivity, @ BER=1E^{-10}		-17	-19	-24	dBm
Min. overload		0	-3	0	dBm
Max. optical path penalty		-	-	2	dB
Max. receiver reflectance		-12	-12	-12	dB
Optical connector (Tx/Rx)		LC	LC	LC	

Fiber type	50/125 µm MMF - 550m 62.5/125 µm MMF - 275m	10km 9/125 µm SMF 50/125 µm MMF - 550m 62.5/125 µm MMF - 550m	9/125 µm SMF	
Acronym	1000B	1000B	1000B	
Interface type	1000Base-S	1000Base-L	1000Base-Z	

5.3.10 CWDM SFPs Optical Characteristics

	CWDM SFP module type		
CHARACTERISTICS	**APD CWDM - long haul**	**PIN CWDM - short haul**	**Unit**
Addressed wavelength	1471, 1491, 1511, 1531, 1551, 1571, 1591, 1611, according to ITU-T G.694.2		nm
Min. launched power	0	0	dBm
Max. launched power	+5.0	+5.0	dBm
Allowed bit rates	0.002 -> 2700	0.002 -> 2700	Mbps
Min. extintion ratio	8.2	8.2	dB
Max. -20dB bandwidth	1	1	nm
Minimum SMSR	30	30	dB
Max. chromatic dispersion	1600 @ 1611nm 1600 @ 1591nm 1500 @ 1571nm 1400 @ 1551nm 1400 @ 1531nm 1300 @ 1511nm 1200 @ 1491nm 1100 @ 1471nm	1000 @ 1611nm 900 @ 1591nm 900 @ 1571nm 900 @ 1551nm 800 @ 1531nm 800 @ 1511nm 700 @ 1491nm 700 @ 1471nm	ps/nm
Min. sensitivity, @ BER=$1E^{-10}$	-28	-18	dBm
Min. overload	-9	0	dBm
Max. optical path penalty	2	1	dB
Max. receiver reflectance	-27	-27	dB
Optical connector (Tx/Rx)	LC	LC	
Fiber type	SMF	SMF	
Acronym	SL-162C	SS-162C	
Interface type	APD - CWDM interface for long haul (C8L1-1D2)	PIN - CWDM interface for short haul (C8S1-1D2)	

5.3.11 B&W XFPs Optical Characteristics

10 G XFP module type	ETSI / ANSI	10GBE Base-S / 10GBE Base-S	I-64.1 / 10GBE Base-L / SR-1 OC192 / 10GBE Base-L	Unit
Addressed wavelength		840 -> 860	1290 -> 1330	nm
Min. launched power		-7.3	-6.0	dBm
Max. launched power		-1.0	-1.0	dBm
Allowed bit rates		9.95328; 10.3125	9.95328; 10.3125; 10.709225	Gbps
Min. extinction ratio		3.0	6.0	dB
Spectral width Max. -20dB bandwidth		See IEEE 802.3ae Triple Tradeoff Curves (TTC)	1.0	nm
Minimum SMSR		-	30	dB
Max. chromatic dispersion		-	60	ps/nm
Min. sensitivity, @ BER=1E^{-12}		-9.9	-11	dBm
Stressed sensitivity		-7.5	-	dBm
Min. overload		-1.0	0.5	dBm
Max. optical path penalty		-	1.0	dB
Max. receiver reflectance		-12	-14	dB
Optical connector (Tx/Rx) / Fibre type		LC / MMF	LC / SMF	
Acronym		XS-642	XI-641	

10 G XFP module type	ETSI / ANSI	S-64.2b / 10GBE Base-E / IR-2 OC192 / 10GBE Base-E	P1L1-2D2 (L-64.2) / P1L1-2D2 (LR-2 OC192)	Unit
Addressed wavelength		1530 -> 1565	1530 -> 1565	nm
Min. launched power		-1.0	0	dBm
Max. launched power		+2.0	+4.0	dBm
Allowed bit rates		9.95328; 10.3125; 10.709225		Gbps
Min. extinction ratio		8.2	9.0	dB
Spectral width Max. -20dB bandwidth		0.25	0.25	nm
Minimum SMSR		30	30	dB
Max. chromatic dispersion		800	1600	ps/nm
Min. sensitivity, @ BER=1E^{-12}		-14	-24	dBm
Min. overload		-1	-7	dBm
Max. optical path penalty		2	2	dB
Max. receiver reflectance		-27	-27	dB
Optical connector (Tx/Rx) / Fibre type		LC / SMF	LC / SMF	
Acronym		XS-642	XP1L12D2	

5.3.12 DWDM XFPs Optical Characteristics

CHARACTERISTICS	DWDM XFP module type	Unit
	APD DWDM - long haul	
Addressed wavelengths	1529,55nm (196.00 THz) -> 1561,42nm (192.00 THz) 100 GHz grid, compliant with ITU-T G.694.1	
Min. launched power	-2.0	dBm
Max. launched power	+3.0	dBm
Maximum wavelength deviation EOL	+/- 100	pm
Allowed bit rates	9.95328; 10.3125; 10.709; 11.095728	Gbps
Min. extintion ratio	9.0	dB
Max. -15dB bandwidth	+/- 8	GHz
Minimum SMSR	30	dB
Max. chromatic dispersion	1600	ps/nm
Min. sensitivity, @ BER=$1E^{-4}$ – (w/o ASE noise)	-25 @ 1300 ps/nm (-23 @ 1600 ps/nm)	dBm
Min. OSNR (dB), @ BER=$1E^{-4}$	17 @ 1300 ps/nm 19 @ 1600 ps/nm	dB/0.1 nm
Min. sensitivity, @ BER=$1E^{-12}$ up to 10.3125 Gbps	-22 @ 1300 ps/nm	dBm
Min. OSNR (dB), @ BER=$1E^{-12}$ up to 10.3125 Gbps	25 @ 1600 ps/nm	dB/0.1 nm
Min. overload	-8	dBm
Max. receiver reflectance	-27	dB
Optical connector (Tx/Rx)	LC	
Fiber type	SMF	
Acronym	XL-642C	
Interface type	APD DWDM	

nb1 Application with FEC @ 1300 ps/nm

nb2 Application without FEC @ 1300 ps/nm

nb3 Application without FEC @ 1600 ps/nm

5.3.13 ROADM packs characteristics

The 44-channel 100-GHz-spaced optical frequencies and wavelengths are shown in Table 54. on page 549. The frequency range of 191.7 – 196.0 THz selected to meet the capabilities of suppliers for the DWDM optical components. Preparation is also being made for an eventual 88-channel system with 50-GHz channel spacing. The 88-channel set of frequencies and wavelengths is shown in Table 55. on page 550.

Table 54. Optical frequencies and wavelengths for a 44-channel, 100-GHz system

Frequency (THz)	Wave-length (nm)	Frequency (THz)	Wave-length (nm)	Frequency (THz)	Wave-length (nm)	Frequency (THz)	Wave-length (nm)
191.70	1563.863	192.80	1554.940	193.90	1546.119	195.00	1537.397
191.80	1563.047	192.90	1554.134	194.00	1545.322	195.10	1536.609
191.90	1562.233	193.00	1553.329	194.10	1544.526	195.20	1535.822
192.00	1561.419	193.10	1552.524	194.20	1543.730	195.30	1535.036
192.10	1560.606	193.20	1551.721	194.30	1542.936	195.40	1534.250
192.20	1559.794	193.30	1550.918	194.40	1542.142	195.50	1533.465
192.30	1558.983	193.40	1550.116	194.50	1541.349	195.60	1532.681
192.40	1558.173	193.50	1549.315	194.60	1540.557	195.70	1531.898
192.50	1557.363	193.60	1548.515	194.70	1539.766	195.80	1531.116
192.60	1556.555	193.70	1547.715	194.80	1538.976	195.90	1530.334
192.70	1555.747	193.80	1546.917	194.90	1538.186	196.00	1529.553

Table 55. Optical frequencies and wavelengths for a 88-channel, 50-GHz system

Frequency (THz)	Wave-length (nm)	Frequency (THz)	Wave-length (nm)	Frequency (THz)	Wave-length (nm)	Frequency (THz)	Wave-length (nm)
191.700	1563.863	192.800	1554.940	193.900	1546.119	195.000	1537.397
191.750	1563.455	192.850	1554.537	193.950	1545.720	195.050	1537.003
191.800	1563.047	192.900	1554.134	194.000	1545.322	195.100	1536.609
191.850	1562.640	192.950	1553.731	194.050	1544.924	195.150	1536.216
191.900	1562.233	193.000	1553.329	194.100	1544.526	195.200	1535.822
191.950	1561.826	193.050	1552.926	194.150	1544.128	195.250	1535.429
192.000	1561.419	193.100	1552.524	194.200	1543.730	195.300	1535.036
192.050	1561.013	193.150	1552.122	194.250	1543.333	195.350	1534.643
192.100	1560.606	193.200	1551.721	194.300	1542.936	195.400	1534.250
192.150	1560.200	193.250	1551.319	194.350	1542.539	195.450	1533.858
192.200	1559.794	193.300	1550.918	194.400	1542.142	195.500	1533.465
192.250	1559.389	193.350	1550.517	194.450	1541.746	195.550	1533.073
192.300	1558.983	193.400	1550.116	194.500	1541.349	195.600	1532.681
192.350	1558.578	193.450	1549.715	194.550	1540.953	195.650	1532.290
192.400	1558.173	193.500	1549.315	194.600	1540.557	195.700	1531.898
192.450	1557.768	193.550	1548.915	194.650	1540.162	195.750	1531.507
192.500	1557.363	193.600	1548.515	194.700	1539.766	195.800	1531.116
192.550	1556.959	193.650	1548.115	194.750	1539.371	195.850	1530.725
192.600	1556.555	193.700	1547.715	194.800	1538.976	195.900	1530.334
192.650	1556.151	193.750	1547.316	194.850	1538.581	195.950	1529.944
192.700	1555.747	193.800	1546.917	194.900	1538.186	196.000	1529.553
192.750	1555.343	193.850	1546.518	194.950	1537.792	196.050	1529.163

Table 56. Loss budget for 2-degree – 4 ROADM with LDRXA

Location		Power Level (dBm)			Comment
Pack Port	Port	Typical	High	Low	
LDRX	Sig Out	-0.4	1.6	-2.4	
Mesh/Thru Channels					
WR4	Mesh_Thru Out	-7.1	-4.2	-9.8	
WR4	Sig Out	-12.2	-6.6	-17.7	WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels without 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OMD	Add Out	-3.3	0.9	-5.5	
WR4	Sig Out	-8.4	-1.5	-13.3	Add WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels with 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OPS	Line side output	-3.1	0.5	-4.7	
OMD	Add Out	-7.3	-2.6	-10.1	
WR4	Sig Out	-12.4	-4.9	-18.0	Add WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Drop Channels without 1+1 Protection Pack					
WR4	Drop Out	-10.9	-7.9	-13.8	
OMD	Channel Out	-15.3	-11.0	-19.5	
Drop Channels with 1+1 Protection Pack					
WR4	Drop Out	-10.9	-7.9	-13.8	
OMD	Channel Out	-15.3	-11.0	-19.5	
OPS	Line side output	-16.6	-11.1	-21.5	

VOA Levels in WSSs			
Pack	Channels	VOA Atten (dB)	
		Min	Max
WR4	Add	0.0	14.5
WR4	Thru	0.0	9.4

Table 57. Loss budget for 2-degree – 4 ROADM with LDRXB

Location		Power Level (dBm)			Comment
Pack Port	**Port**	**Typical**	**High**	**Low**	
LDRX	Sig Out	-3.6	5.6	1.6	
LDRX	TO ROADM	-0.6	2.3	-3.5	
Mesh/Thru Channels					
WR4	Mesh_Thru Out	-7.2	-3.5	-10.9	
WR4	Sig Out	-12.4	-5.9	-18.7	WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels without 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OMD	Add Out	-3.3	0.9	-5.5	
WR4	Sig Out	-8.4	-1.5	-13.3	Add WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels with 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OPS	Line side output	-3.1	0.5	-4.7	
OMD	Add Out	-7.3	-2.6	-10.1	
WR4	Sig Out	-12.4	-4.9	-18.0	Add WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Drop Channels without 1+1 Protection Pack					
WR4	Drop Out	-11.0	-7.2	-14.8	
OMD	Channel Out	-15.4	-10.3	-20.6	
Drop Channels with 1+1 Protection Pack					
WR4	Drop Out	-11.0	-7.2	-14.8	
OMD	Channel Out	-15.4	-10.3	-20.6	
OPS	Line side output	-16.7	-11.0	-22.5	

VOA Levels in WSSs			
Pack	**Channels**	**VOA Atten (dB)**	
		Min	**Max**
WR4	Add	0.0	14.5
WR4	Thru	0.0	10.1

Table 58. Loss budget for 2-degree – 8 ROADM

Location		Power Level (dBm)			Comment
Pack Port	Port	Typical	High	Low	
LDRXB	Sig Out	-3.6	5.6	1.6	
Mesh/Thru Channels					
WR8	Mesh_Thru Out	-7.2	-4.0	-10.3	
WR8	Sig Out	-12.3	-6.4	-18.1	WSS attenuators at minimum
WR8	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels without 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OMD	Add Out	-3.3	0.9	-5.5	
WR8	Sig Out	-8.4	-1.5	-13.3	Add WSS attenuators at minimum
WR8	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels with 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OPS	Line side output	-3.1	0.5	-4.7	
OMD	Add Out	-7.3	-2.6	-10.1	
WR8	Sig Out	-12.5	-4.9	-18.0	Add WSS attenuators at minimum
WR8	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Drop Channels without 1+1 Protection Pack					
WR8	Drop Out	-10.7	-7.3	-14.1	
OMD	Channel Out	-15.1	-10.4	-19.8	
Drop Channels with 1+1 Protection Pack					
WR8	Drop Out	-10.7	-7.3	-14.1	
OMD	Channel Out	-15.1	-10.4	-19.8	
OPS	Line side output	-16.4	-11.1	-21.8	

VOA Levels in WSSs			
Pack	Channels	VOA Atten (dB)	
		Min	Max
WR8	Add	0.0	14.5
WR8	Thru	0.0	9.6

Table 59. Loss budget for UILA and UROADM.

Location		Power Level (dBm)			Comment
Pack Port	**Port**	**Typical**	**High**	**Low**	
LDRXB	Sig Out	-3.6	5.1	2.1	Use LDRXB
LDRXB	TO ROADM	-0.6	1.8	-3.0	VOA in switch module at min loss
LDRXB	TO ILA	-0.4	1.8	-2.6	
ILA Power Levels					
LDRXB	LINE OUT	-1.9	0.8	-4.7	
Through Channels					
WR4	Mesh_Thru Out	-7.2	-4.0	-10.4	
WR4	Sig Out	-12.4	-6.4	-18.2	WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels without 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OMD	Add Out	-3.3	0.9	-5.5	
WR4	Sig Out	-8.4	-1.5	-13.3	Add WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Add Channels with 1+1 Protection Pack					
OT	Line side output	1.0	4.0	0.0	
OPS	Line side output	-3.1	0.5	-4.7	
OMD	Add Out	-7.3	-2.6	-10.1	
WR4	Sig Out	-12.5	-4.9	-18.0	Add WSS attenuators at minimum
WR4	Sig Out	-16.0	-16.0	-16.0	Attenuators adjusted for proper P_out
Drop Channels without 1+1 Protection Pack					
WR4	Drop Out	-11.0	-7.7	-14.3	
OMD	Channel Out	-15.4	-10.8	-20.1	
Drop Channels with 1+1 Protection Pack					
OMD	Channel Out	-15.4	-10.8	-20.1	
OPS	Line side output	-16.7	-11.5	-22.0	
Drop Channels with 1+1 Protection Pack					
LDTXA	SIG IN	-16.0			
LDTXA Gain		16.0			
LDTXA	LINE OUT	0.0			
ESWA	**LINE OUT**	**-1.5**			

Typical power level into span

VOA Levels in WSSs			
Pack	**Channels**	**VOA Atten (dB)**	
		Min	**Max**
WR8	Add	0.0	14.5
WR8	Thru	0.0	9.6

5.4 Power Supply characteristics

Note: The Service Battery (VSERV) is forecast for future relese.

5.4.1 GENTRU unit and Input Service Battery

The main power supply characteristics are:

Input Voltage (VSERV)	-48 VDC ± 20%
Max. Input Current	70 mA
Fusebreaker Protection	1A (on GENTRU unit)
Max. current on the VSERV	200 mA

5.4.2 BYPASS units

The main power supply characteristics are:

Input voltage	**-48 VDC ± 20%**
Fusebreaker protection	40A

5.4.3 STEPUP unit

The main power supply characteristics are as follows:

Input Voltage	-48 VDC ± 20%
Output short-circuit protection	33A to 37A
Output Voltage	– **For ANSI standard**: regulates the output voltage at 58 VDC with the input voltage in the range between 38.4 VDC and 58VDC. When input voltage is greater than 58 VDC and less (or equal) than 72VDC, the device works like a pass through (the internal switching circuit does not work and the output wires are connected directly with the input side). – **For ETSI standard**: when the input voltage is between 38.4 VDC and 65 VDC, it adjusts the output voltage at 65 VDC (the internal switching circuit works as a step-up converter to generate the 65 V at the output side). When the input voltage is greater than 65 VDC and less (or equal) than 72 VDC, the device works like a pass through (the internal switching circuit doesn't work and the output wires are connected directly with the input side).

5.4.4 Power consumption

The Alcatel-Lucent 1850 TSS-320 is designed for low power consumption. Developing new components with very high integration density and low voltage supply leads to a significant reduction in power consumption.

Max. power consumption per each board	
STEPUP ETSI/ANSI 1850TSS	100
SHELF (1850TSS-320) ANSI 14"	16
PSF320	28
MT320	140
EC320	25
OTU-2	75
10xANY	83
11GBAR	52
11GUAR	46
1P10GSO	38
4P2G5SO	37
8PSO	31
PP20G	90
PIM1GE	30
PIM10GE	15
PIMMS	35
WR4	46
WR8	46
LDRXA	52
LDRXB	52
LDTXA	52
LDTXB	26
OPS	14
SFP (SX &LX)	0.85
SFP (S & L fom 1.1 to 4.2)	1
SFP (S, I & L 16)	1.3
XFP I-64.1/10GBE BASE L	2.5
XFP S64-2B/10GBE BASE E	3.5
XFP-E P1L1-2D2	7

5.5 Alarm characteristics

Units alarms:

Each 1850 TSS-320 port card or access card has a bicolor LED (green/red) on the front coverplate.

The LED indicates the following:

– when red, internal failure
– when green, in service unit

Centralized equipment alarms:

All the alarms detected on the units are collected by the EC320 unit, which sends out the following indications through LEDs on the front coverplate:

- Red LED (13): detection of an CRITICAL alarm
- Red LED (14): detection of an MAJOR (URGENT) alarm
- Orange LED (15): detection of a MINOR (NOT URGENT) alarm
- Orange LED (16): detection of an WARNING (INDICATIVE) alarm
- Red LED (17): alarm condition ATTENDED
- Orange LED (18): detection of an ABNORMAL operative condition. Examples of when this alarm occurs are: during active loopbacks, when forcing the unit into service, when laser is forced ON or OFF, when attempting to restore after an ALS

Refer to Figure 59. on page 99, where the front view of each unit and the LED locations are illustrated.

Rack lamps and remote alarms:

Rack alarm and Remote Alarm are physically available on connectors placed at the top of the subrack back panel (refer to Figure 56. on page 96).

The available alarms are the following:

Rack lamps alarms:

- RL_RURG: urgent alarm
- RL_RNURG: not urgent alarm
- RL_RATTD: alarm storing

Remote alarms:

- RA_URG: detection of an urgent alarm (from EC320)
- RA_NURG: detection of a non-urgent alarm (from EC320)
- RA_INT: detection of an Internal alarm (from EC320)
- RA_ORC : fault or loss of service battery (OR) (from EC320)
- RA_IND: Indeterminate alarm. It indicates synthesis of alarms not associated to the other severity (from EC320)
- RA_ORBATT: fault or loss of one battery station (from POW320)
- RA_ANDBATT: loss of both battery station (from POW320)

Housekeeping alarms/commands:

Four output (CPO) and 8 input (CPI) contacts for housekeeping alarms or commands are physically available on connectors placed at the top of the subrack back panel (refer to Figure 16. on page 44).

The available housekeeping contacts are the following:

- HK-OUT 1 to 4: outgoing contacts
- HK-IN 1 to 8: Incoming contacts

Alarm attending:

Detected SDH units alarm condition are stored through a push button (11) on the EC320 unit (Attended).

This operation turns OFF the general red LED (14) and lights up the yellow LED (17) on the EC320 unit (Attended). The attended command is also sent to the rack lamps (if present).

Troubleshooting:

The 1850 TSS-320 equipment is designed to communicate with a Personal Computer (PC) in order to service, activate, and trouble-shoot the equipment.

Troubleshooting procedures for the equipment and details of the alarms for each card and relevant indications are described in the relevant documents.

The PC connects with the unit by means of a connector (8) or (9) available on the EC320 board.

The unit can also be directly connected to an operation system associated to the Transmission Management Network to execute operations similar to those carried out by the PC.

Characteristics of the reported remote alarms and details of the housekeeping contacts interface (EM type) are provided in Section 5.1 on page 527 in this chapter.

5.6 Mechanical characteristics

5.6.1 Bay frame

Mechanical compatibility	ANSI
Bay frame size	21” Wide x 7’-0” High x 12” Deep
1” mounting spaces	78
Bay frame weight	30 kg
Back-to-back installation	Yes
Bay frame colour	heavy dark gray

5.6.2 GENTRU unit

Mechanical compatibility	ANSI / ETSI ETS300 119-3
Unit size	21” Wide x 5” High x 12” Deep
Unit weight	53 kg

5.6.2.1 STEPUP unit technical characteristics

The main structural characteristics are:

- mechanical size: 99x67x200 mm (HxLxD)
- weight: about 2 kg
- class protection: IP20
- isolation, earth leakage current and earth bondage are compliance to EN6095 and GR-1089

5.6.3 Subrack

Mechanical compatibility	ANSI / ETSI ETS300 119-3;1850 TSS Rack
Subrack size	532 mm Wide x 624 mm High x 290 Deep
Board size	– 353.6 mm High x 22.5 mm Wide. – 265 mm High x 20 mm Wide – 265 mm High x 40 mm Wide – 159 mm High x 22.5 mm Wide – 73 mm High x 20 mm Wide
Subrack weight	15 kg
Rack cabling	Vertical between rack and subrack front access
Back-to-back installation	Yes

5.7 Environmental conditions

Alcatel-Lucent products offer the following environmental benefits:

– reduced energy consumption during manufacturing and use

– materials harmfulness and recyclability

– reduced emissions to air, water or soil during the manufacturing and use of the product

– reduced electromagnetic (EM) emissions

– value recovery at the product end of life

5.7.1 Electromagnetic Compatibility (EMC) norms

The CE markings on the product denote compliance with the following Directives:

- 89/336/EEC of May 3rd, 1989 (EMC Directives), amended:
  - by the 92/31/EEC Directive issued on April 28th, 1992
  - by the 93/68/EEC Directive issued on July 22nd, 1993

A product is compliant with the above Directed when the equipment is installed per manufacturer instructions, as stated in their installation guide and according to the following European Norms:

- EN 300 386 (V1.3.1), environment “Telecommunication Center"

WARNING

This is a class A product EN55022. In domestic, residentia,l and light industry environments, this product may cause radio interference, in which case the user may be required to take appropriate measures.

5.7.1.1 EMC condition

Information on EMC condition see Safety Guide document.

5.7.2 Waste from Electrical and Electronic Equipment (WEEE)

The marking printed on the subrack (refer to Appendix A on page 593) indicates compliance with the Directive 2002/96/EC On Waste of Electrical and Electronic Equipment.



This European Union directive outlines the manufacturers’ reponsibility for the collection and disposal of products at the end of the product life cycle. This directive applies to products put on the market after 13th August 2005.

All Alcatel-Lucent products also fall under in Category 3 of Annex 1A of the WEEE directive (Directive 2002/96/ EC) titled "IT and Telecommunication equipment" under item "other products transmitting sound, images or other information by telecommunications."

Alcatel-Lucent products fall under the WEEE directive in Annex 1B that states: "Other product or equipment of transmitting sound, images or other information by telecommunications".

This mark will not cause any responsibility as all responsibilities will be defined by contract.

5.7.3 Acoustical noise

The acoustical noise level of the product complies with the following standard:

- ETS 300 753 Environmental Class 3.1 for attended telecommunication equipment rooms (maximum sound level 7.2 bels)

5.7.4 Climatic for operating conditions

The equipment meets the requirements of ETSI Standards on the use of fans housed in an external subrack.

The 1850 TSS-320 supports temperature levels specified by the following standard:

ETS 300 019-1-3 :1992 , class 3.2.

Class 3.2:Partly temperature-controlled locations.
(see climatogram on Figure 333 - on page 562)

5.7.4.1 Class 3.2: partly temperature controlled locations

The following are the characteristics of partial temperature controlled locations:

– where installed equipment is exposed to solar radiation and heat radiation, or to movements of the surrounding air due to draughts in buildings; for example, through open windows. Partial temperature controlled locations also include areas where equipment may be subjected to condensation or to water from sources other than rain and ice

– where mould growth or attacks by animals, except termites, may occur

– industrial areas, heavy traffic areas and/or in areas with normal levels of contaminants such as in urban areas

– in close proximity to sources of sand or dust

– with vibration of low significance, e.g. for products fastened to light supporting structures subjected to negligible vibrations.

Class 3.2 conditions may be present in the following locations:

– entrances and staircases of buildings

– garages

- cellars
- workshops
- buildings in factories and industrial process plants
- unattended equipment stations
- telecommunication buildings
- storage rooms for frost-resistant products, and farm buildings

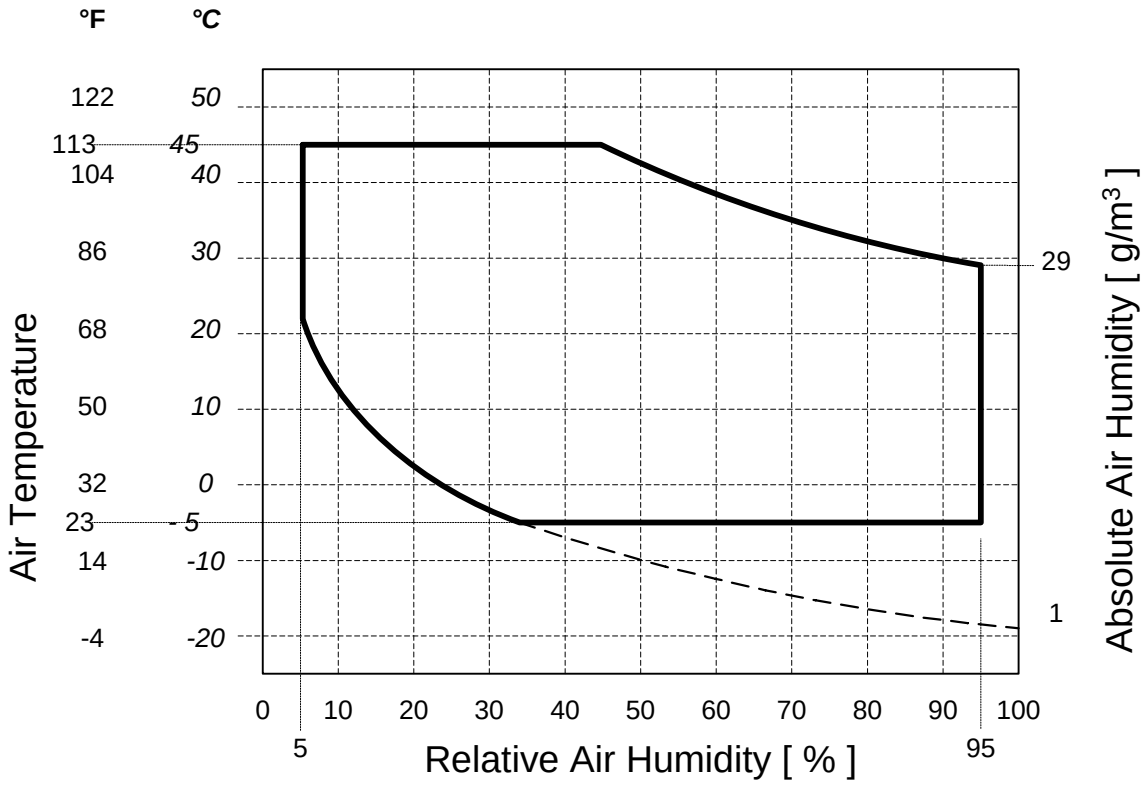


Figure 333 - Climatogram for Class 3.2: Partly temperature controlled locations

5.7.5 Storage

The 1850 TSS-320 equipment meet the following requirements for storage:

ETS 300 019-1-1: 1992, class 1.2

Class 1.2: weatherprotected, not temper. controlled storage location.

This class applies to weather protected storage having neither temperature nor humidity control. The location may have openings directly to the open air; i.e., it may be only partly weatherproofed. The climatogram is shown on Figure 334 - on page 564.

The following are the characteristics of partial storage controlled locations:

– where installed equipment is exposed to solar radiation and heat radiation, or to movements of the surrounding air due to draughts in buildings; for example, through open windows. Partial storage controlled locations also include areas where equipment may be subjected to condensation, snow, or water from sources other than rain and ice

– where mould growth or attacks by animals, except termites, may occur

– industrial areas, heavy traffic areas and/or in areas with normal levels of contaminants such as in urban areas

– in areas with sources of sand or dust, including urban areas

– with vibration of low significance and insignificant shock

Class 1.2 conditions may be present in the following locations:

– unattended buildings

– entrances of buildings

– garages and shacks

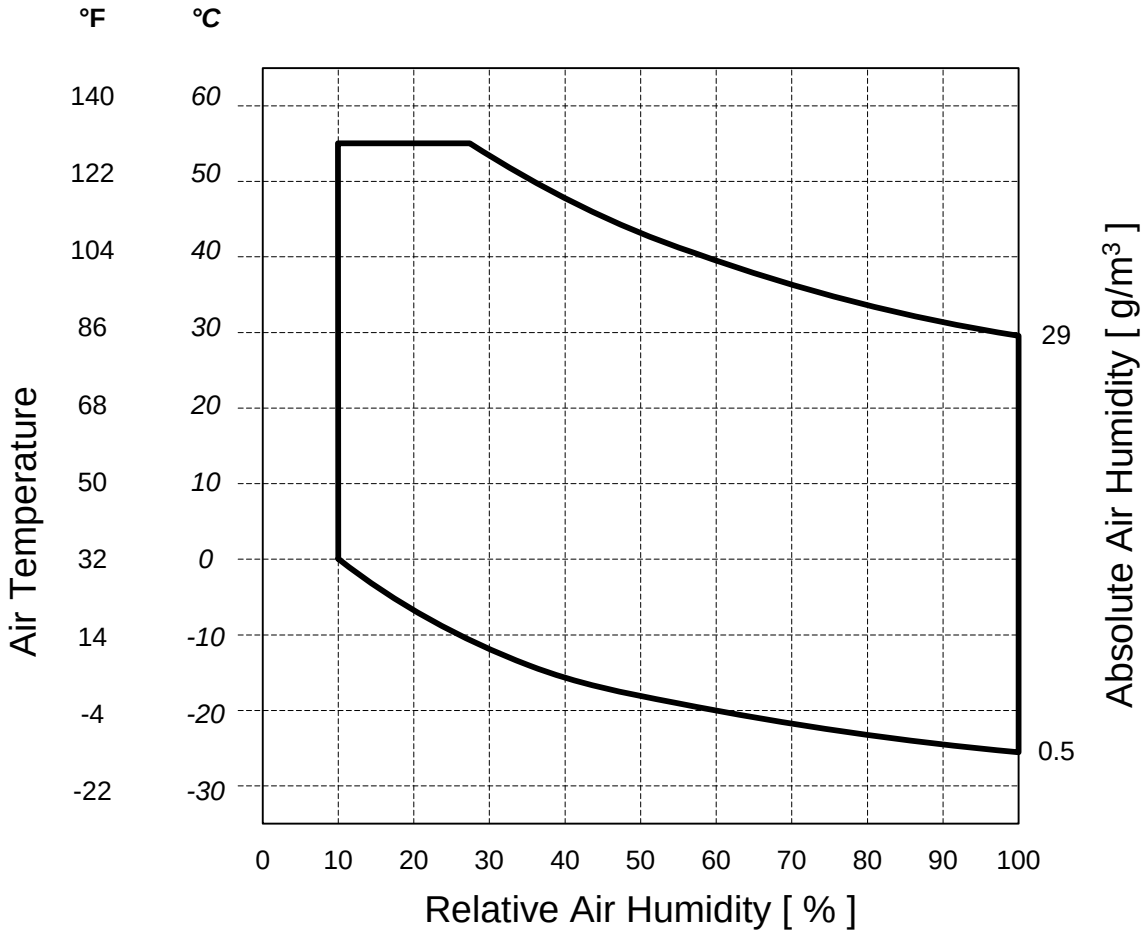


Figure 334 - Climatogram for Class 1.2: not temperature controlled storage location

5.7.6 Transportation

The 1850 TSS-320 equipment meets the following requirements for transportation:

ETS 300 019-1-2 : 1992, class 2.2

Class 2.2 : Careful transportation (see Table 60. on page 565).

This class applies to transportation where special care has been taken e.g. with respect to low temperature and handling.

Class 2.2 includes all the conditions of Class 2.1. In addition, Class 2.2 includes transportation in all types of lorries and trailers as well as transportation by ship and by train, with a manual loading and unloading limit of 20 kg.

In its standard packing, the 1850 TSS-320 equipment can be transported under the following conditions without damange to optical interfaces:

AT -40 °C for a maximum of 72 Hours

Table 60. Transportation climatic

Environmental parameter		Unit	2.1 and 2.2	2.3
(A)	Low temperature air	F (°C)	-13 (-25)	-40 (-40)
(B)	High temperature, air in unventilated enclosures (Note 1)	F (°C)	+158 (+70)	+158 (+70)
(C)	High temperature, air in ventilated enclosures or outdoor air (Note 2)	F (°C)	+104 (+40)	+104 (+40)
(D)	Change of temperature air/air (Note 3)	F (°C)	-13/+86 (-25/+30)	-40/+86 (-40/+30)
(E)	Change of temperature air/water (Note 3)	F (°C)	+104/+41(+40/+5)	+104/+41(+40/+5)
(F)	Relative humidity, not combined with rapid temperature changes	% F (°C)	95 +104 (+40)	95 +45
(G)	Relative humidity, combined with rapid temperature changes air/air, at high relative humidity (Note 3 and Note 6)	% °C	95 -13/+86 (-25/+30)	95 -40/+86 (-40/+30)
(H)	Absolute humidity, combined with rapid temperature changes : air/air at high water content (Note 4)	g/m^3 °C	60 +158/+59(+70/+15)	60 +158/+59(+70/+15)
(I)	Low air pressure	kPa	70	70
(J)	Change of air pressure	kPa/min	no	no
(K)	Movement of the surrounding medium, air	m/s	20	20
(L)	Precipitation rain	mm/min	6 (Note 7)	6
(M)	Radiation, solar	W/m^2	1120	1120
(N)	Radiation, heat	W/m^2	600	600
(O)	Water from sources other than rain (Note 5)	m/s	1 (Note 7)	1
(P)	Wetness	none	conditions of wet surfaces	

Note:

1 The high temperature of the surfaces of a product may be influenced by both the surrounding air temperature specified here, and the solar radiation through a window or another opening.

2 The high temperature of the surface of a product is influenced by the surrounding air temperature specified here, and the solar radiation defined below.

3 Direct transfer of the product between the two differing temperatures is presumed.

4 The product is assumed to be subjected to a rapid decrease of temperature only (no rapid increase). The values for water content apply to temperatures down to the dew-point. At lower temperatures, the relative humidity is assumed to be approximately 100 %.

5 This value pertains to the velocity of water, not to the amount of water accumulated.

6 Occurrence of condensation.

7 For short duration only.

6 Hardware settings

This chapter discusses the document sheets to reference for unit/sub-unit/pack hardware setting options.

Each section is dedicated to a single unit/sub-unit or to a group of unit/sub-unit with the same hardware setting.

Each section contains the following:

- one or more tables defining the relationship between the functions achievable and the setting options to make
- the unit layout drawing which shows the exact location of all the setting options

In case of hardware setting modification in the same unit, all of the different options are provided in the section.

Unit Identification Part Number and Change Status information is provided in the following section.

The **HARDWARE SETTINGS can be executed** after having checked all the sub-units belonging to a unit, and by using the presetting indication presented in this chapter.

Note:



Note: When necessary to make strap switch (TC) Hardware Settings fitted on the rear side of the board, remove the protective cover plate present on the same rear side and replace it at the end of the operation

The setting options described in this chapter must be used according to 3AL377470001 (962.000.022 F) MSxxx document, inserted in section ...., which shows the 'ON' (closed) position of microswitches.

The setting options with the caption “**For factory use only”** should never be modified.

6.1 Part Number and Change Status identification

Each unit or sub–unit is distinguished by the following:

- a Part Number: ANV–P/N (xxx.xxxxx xxyy)

  The last two ANV–P/N letters (yy, in the following stated as **'suffix'**) stand for a "feasible alternative". These differentiate functionally compatible units.

  For example: The **hardware settings** for units P/Ns "3AL 34065 AA AA" and "3AL 34065 AA BA" are compatible. Consequently, the hardware settings described later in this chapter for the two units apply for both.

- a design & production series (change status): **ICS**

The following table shows an example of evolution of **"ANV P/N + ICS"**

Table 61. Example of ANV Part Number + ICS' evolution!

ANV CODE	
Part Number	ICS
3AL 34422 AA AA	01
3AL 34422 AA AB	01
3AL 34422 AA AC	01

Note: The P/Ns used in this example have no correspondence with those of the actual equipment part list.

In this example, the production series is identified by the 'suffix + ICS' in the ANV code.

Some of the possible positions of the label indicating the unit's P/Ns and ICS are illustrated in Appendix B on page 605.

As the customer may have to manage many units of the same type (same Part Number) but with different ICS's, each hardware setting section describes with possible parts and the different setting options, for all the possible P/N+ICSs. For this purpose, **when more than one setting versions are present,** a table at the beginning of the section indicates the part to be used by 'suffix + ICS', taking into account the following:

- a change of the production series does not necessarily imply a change in the setting options; a change of the ANV P/N suffix does not imply an document change
- the SUFFIX and ICS must be meant as:
  - **from** specified SUFFIX or ICS (**included**)
  - **to** next SUFFIX or ICS (**excluded**) if listed

EXAMPLE

Note: The P/Ns used in this example have no correspondence with those of the actual equipment part list!

Taking into account the same unit of Table 61. on page 568.

Supposing that the setting options valid for suffix --AA+01+ ICS 01 are equal to those for --AB + ICS 01, but change for --AB + ICS 02, the table at the beginning of the section dedicated to 3AL 34422 AAAA will be:

part in the paragraph	ANV P/N	
	FROM SUFFIX	FROM ICS
1	--AA	01
2	--AB	02

If you have the unit identified by one of this identification data:

ANV CODE	
P/N	ICS
3AL 34422 AAAA	01
3AL 34422 AAAB	01

you will use **Part 1** of section for **3AL 34422 AAAA**

If you have the unit identified by one of this identification data:

ANV CODE	
P/N	ICS
3AL 34422 AAAB	02
3AL 34422 AAAD	03

you will use **Part 2** of section for **3AL 34422 AAAA**

6.2 General safety rules and warning

ATTENTION	EMC NORMS

WHEN CARRYING OUT THE GIVEN OPERATIONS OBSERVE THE NORMS STATED IN
Appendix A on page 593



SAFETY RULES

Carefully observe the front-panel warning labels prior to working on optical connections while the equipment is in-service.

Should it be necessary to cut off power during the operative phase, switch off the power supply units and cut off the power station upstream (rack or station distribution frame).



SAFETY RULES

A TNV-2 (battery) voltage could be present on “R/M interface connector" (cable side); do not touch the pins when unplugged.

DANGER: Possibility of personal injury. Short circuiting, low–voltage, low–impedance, DC circuits can cause severe arcing that can result in burns and/or eye damage. Remove rings, watches, and other metal jewelry before working with primary circuits. Exercise caution to avoid shorting power input terminals.



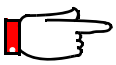
SAFETY RULES

DANGER: Possibility of eyes damage: read carefully and strictly observe the rules pointed out in Appendix A on page 593

GENERAL RULES

- Check that the equipment is operating with all the shields properly positioned (dummy covers, ESD connector protections, etc.).
- In order to reduce the risk of damage the electrostatic sensitive devices, it is mandatory to put on the elasticized band (around the wrist) and the coiled cord connected to the ground rack before touching the equipment.

INSERTING UNITS (AND CIRCUIT PACKS) INTO THE subrack
(caution to avoid equipment damage)



The screw tightening torque for fixing the units (and modules, if any and if fixed by screws) into the subrack must be

0.28 Nm (2.48 in-lb) ± 10 %

Exceeding this value may result in the broken screws or subrack damage.

For other screw size torque values, please refer to "*Installation Guide*"

6.3 Microswitches “ON” position (3AL 37747 0001)

The following figure shows all the available switch type front view and their positions.

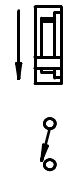
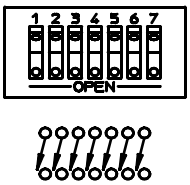
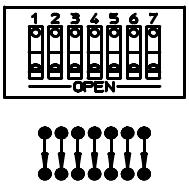
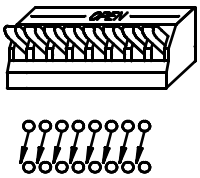
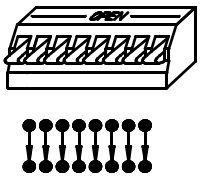
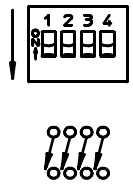
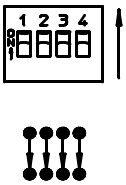
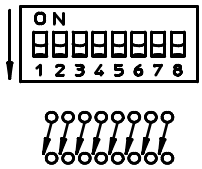
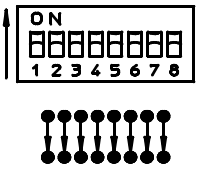
	Position "OFF"	Position "ON"	Circuit closed (ON) condiction
Figure "A"			visible dot
Figure "B"			Press on the opposite side of "OPEN" inscription
Figure "C"			Switch lever shifted towards the lower side.
Figure "D"			Switch lever shifted towardsw the "ON" position marked by numbers.
Figure "E"			Switch lever shifted towards the "ON" position whithout numbers.

Figure 335. Microswitch front view and position

6.4 Equipment HW settings

6.4.1 STEPUP unit hardware setting

This unit contains Hardware Settings. The switch position on the board and their meanings are provided in Figure 336. on page 573 and Table 62. on page 573 .

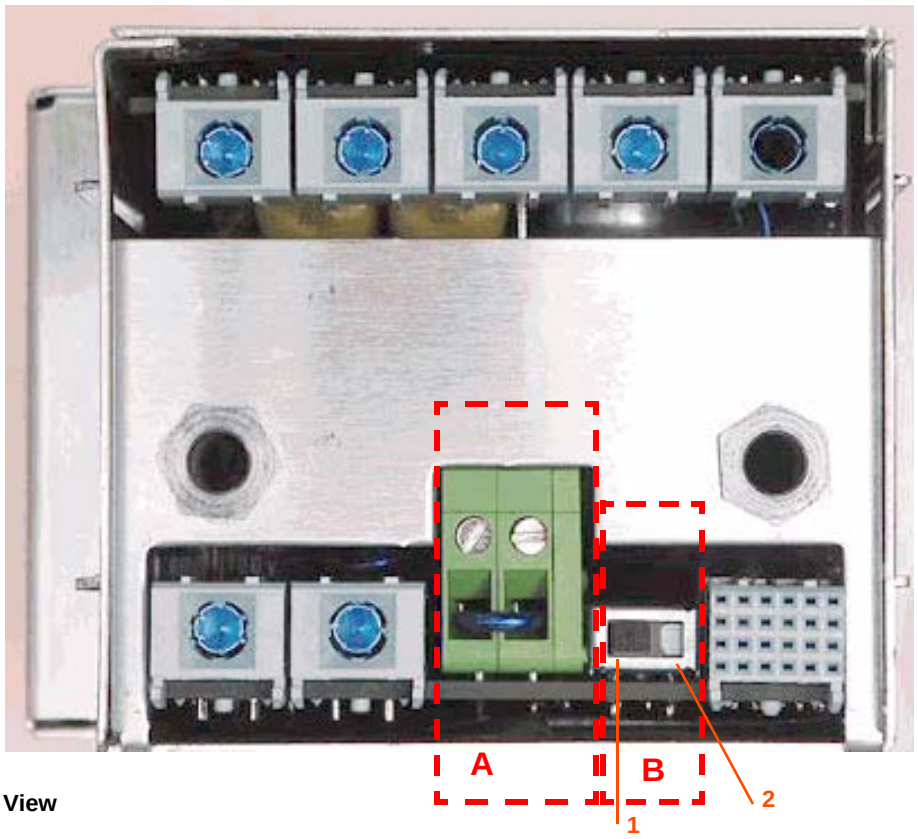


Figure 336. STEPUP unit hardware settings

Table 62. Presetting table of STEPUP-E unit

Nr.	SWITCH	FACTORY PRESET.	REFERENCE	OPERATION
1	Closed	*	**A**	+BATT **connected** to Mechanical Ground
2	Open		**A**	+BATT not connected to Mechanical Ground
3	Position **1**	*	**B**	For **ETSI** standard
4	Position **2**		**B**	For ANSI standard

Note: **T**he asterisk denotes factory presetting; the B switch is provisioned in two ways, but position 1 and position 2 are the same.

6.4.2 Group Lamp unit hardware setting

This unit is a part of GENTRU unit (3AL 38426 AB--).

This sub-unit contains Hardware Settings. The strap switch (**TC**) position on the board and their meanings are provided in Figure 337. on page 574 and in Table 63. on page 575.

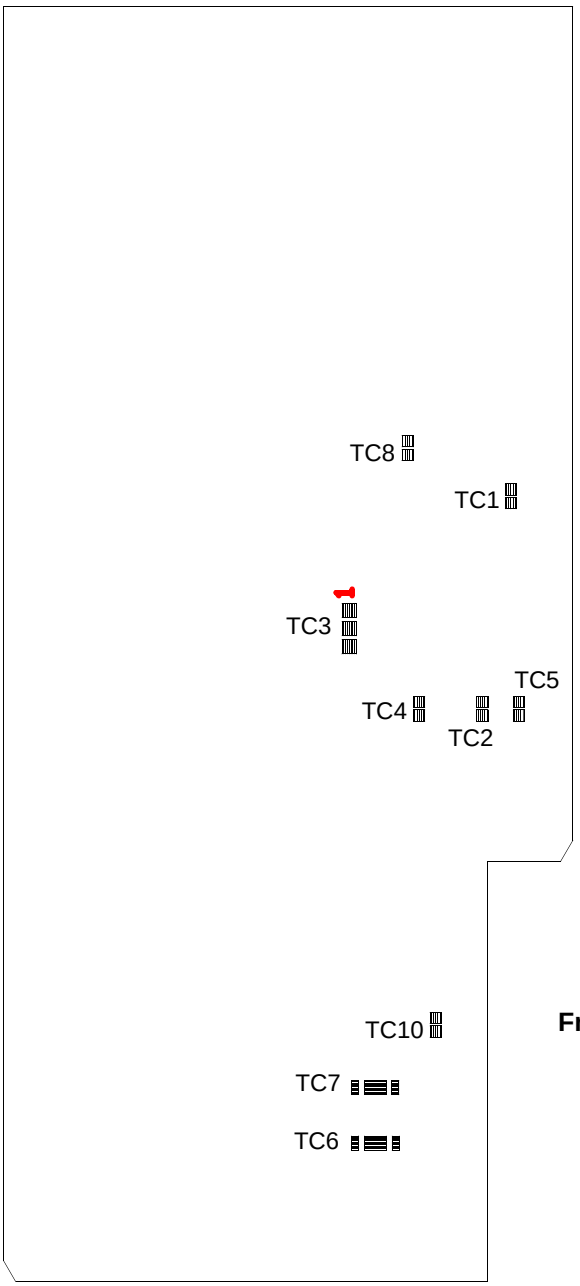


Figure 337. Group Lamp unit hardware settings

Table 63. Presetting table of Group Lamp unit

Nr.	REFERENCE	FACTORY PRESET.	STRAP SWITCH	OPERATION
1	TC1	*	1 - 2 closed	URGENT Tele-alarm Output **Enabled**
2	TC1		1 - 2 open	URGENT Tele-alarm Output Disabled
3	TC2	*	1 - 2 closed	NOT URGENT Tele-alarm Output **Enabled**
4	TC2		1 - 2 open	NOT URGENT Tele-alarm Output Disabled
5	TC3	*	1 - 2 closed 2 - 3 open	Green LED On by **Buzzer**
6	TC3		1 - 2 open 2 - 3 closed	Green LED On by Service Battery Voltage
7	TC4	*	1 - 2 closed	Memorization Tele-alarm Output **Enabled**
8	TC4		1 - 2 open	Memorization Tele-alarm Output Disabled
9	TC5	*	1 - 2 open	Red LED (for Not Urgent Alarm) **OFF** by Urgent Alarms
10	TC5		1 - 2 closed	Red LED (for Not Urgent Alarm) ON by Urgent Alarms
11	TC6		1 - 2 - 3 closed	+BATT connected to Mechanical Ground (GNDM)
12	TC6	*	1 - 2 - 3 open	+BATT **not** connected to Mechanical Ground (GNDM)
13	TC7	*	1 - 2 - 3 closed	Mechanical Ground **connected** to Electrical Ground
14	TC7		1 - 2 - 3 open	Mechanical Ground not connected to Electrical Ground
15	TC8	*	1 - 2 closed	OR Battery **connected**
16	TC8		1 - 2 open	OR Battery not connected
17	TC10	*	1 - 2 closed	OR Battery **connected**
18	TC10		1 - 2 open	OR Battery not connected

Note: The asterisk denotes factory presetting; TC9 is not used.

6.5 Subrack HW settings

6.5.1 Shelf identification

This setting establishes the correct shelf number in a multi-shelf architecture.

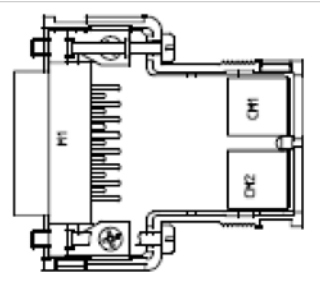


Figure 338 - Subrack ID module



Figure 339 - Subrack ID module rotating switches

Table 64. Meaning of the setting

SWITCH "I1"	MEANING
0	Basic shelf
1	Expansion shelf #1
2	Expansion shelf #2
3	Expansion shelf #3
n	Expansion shelf #n

6.6 Common Parts HW settings

6.6.1 EC320 card hardware setting (3AL 92110 AA--)

This unit contains Hardware Settings. The switch position on the board and their meanings are reported in Figure 340. on page 577 and Table 65. on page 578.

For details on the use of these Hardware Settings, refer to the Maintenance document.

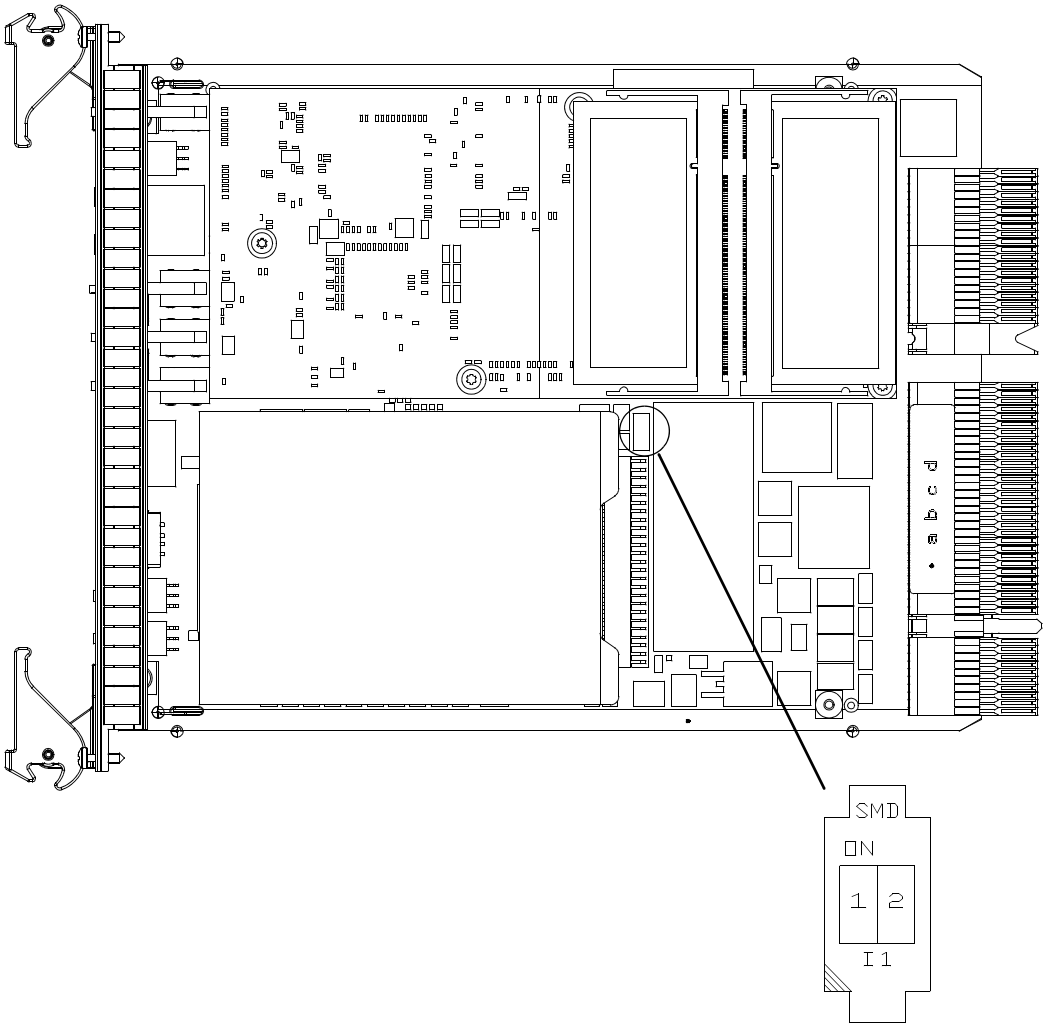


Figure 340. EC320 board hardware settings

Table 65. EC320 Presetting table

SWITCH "I1"		MEANING
1 = OFF	**2** = OFF	Normal Operation
1 = OFF	**2** = ON	Reset Data Base
1 = ON	**2** = OFF	Reset Data Base and up-load from back up copy (if available)
1 = ON	**2** = ON	Raw loader FW waiting for commands from console: application not started.

7 Dismantling and Recycling

7.1 WEEE general information

According to the European directive (2002/96/EC) **Waste Electric** and **Electronic Equipment (WEEE)**, from August 13th, 2005 the "producer" of the equipment being sold, unless otherwise specified in the contract with the Customer, is responsible for collecting and treating Electrical and Electronic Equipment.

Equipment put on the market after August 13th, 2005 have a label affixed on the product (refer to **Appendix A** on page 593 and Figure 362. on page 604).



The use of the crossed-out wheeled bin symbol indicates that this product is subject to separate collection and is not to be treated as general household waste.
The separate collection of this equipment at the end of its lifetime is organized and managed by the producer. Please contact the producer or his authorized representative for information concerning the disposal of your equipment.
The separate collection and recycling of waste equipment at the time of disposal contribute to avoid possible negative effects on the environment and on human health.

In next paragraphs is given a description example of how to disassemble the Optinex Rack; the same principles can be applied to all the subracks and units composing the rack.

The para. 7.2 on page 580 describes the rack disassembly; in detail:

- para. 7.2.1 on page 580 lists the **tools** necessary for disassembly;
- para. 7.2.2 on page 580 describes the **bay frame** disassembly;
- para. 7.2.3 on page 583 describes the **GENTRU subrack** disassembly;
- para. 7.2.4 on page 585 describes an example of **unit** disassembly;
- para. 7.2.5 on page 588 describes the procedure to apply in order to manage **hazardous materials and components** (example battery).

The para. 7.3 on page 590 reports the **ECO declaration** information.

7.2 How to disassembly the bay frame

This bay frame is designed for easy disassembly, by using screws and rivets for mechanical assembly of bay frame, subracks and units. The variety of screw types is minimized.

The tools necessary to disassemble are reported in para. 7.2.1 on page 580.

The disassembly process depends on the respective recycling methods and can be derived from the delivered assembly instructions of the product.

These guidelines are NOT mandatory.
They are given in order to optimize the disassembling process and material recovery as whole.

7.2.1 Tools necessary for disassembly

The following tools are necessary for disassembly:

- # T9 TORX screwdriver
- # T20 TORX screwdriver
- crosshead screwdriver
- wrenches
- scissors
- protection gloves

7.2.2 Bay frame disassembly

In the **TSS ANSI Bay Frame** (ED-8C800-50) are hosted the following:

- **1850 TSS-320** subrack(s)
- **GENTRU** subrack
- **Fiber** tray(s)
- **Fiber** ducts
- **DCM** subrack
- **OMD44** module(s)
- **Stile strips**
- Cable crossover

In Figure 341. on page 581 and Figure 342. on page 582 are shown the complete TSS ANSI bay frame.

In order to disassemble the bay frame first remove the subracks and the other devices eventually present, then proceed as described in the following:

- unscrew all the screws present and remove the main mechanical parts of the rack:
- remove all flanges, adapters, bulkheads and hub cross members;
- disassemble in more little parts again, if it is necessary;
- separate all disassembled materials (aluminium from steel, for example) in order to obtain a correct dismantling.

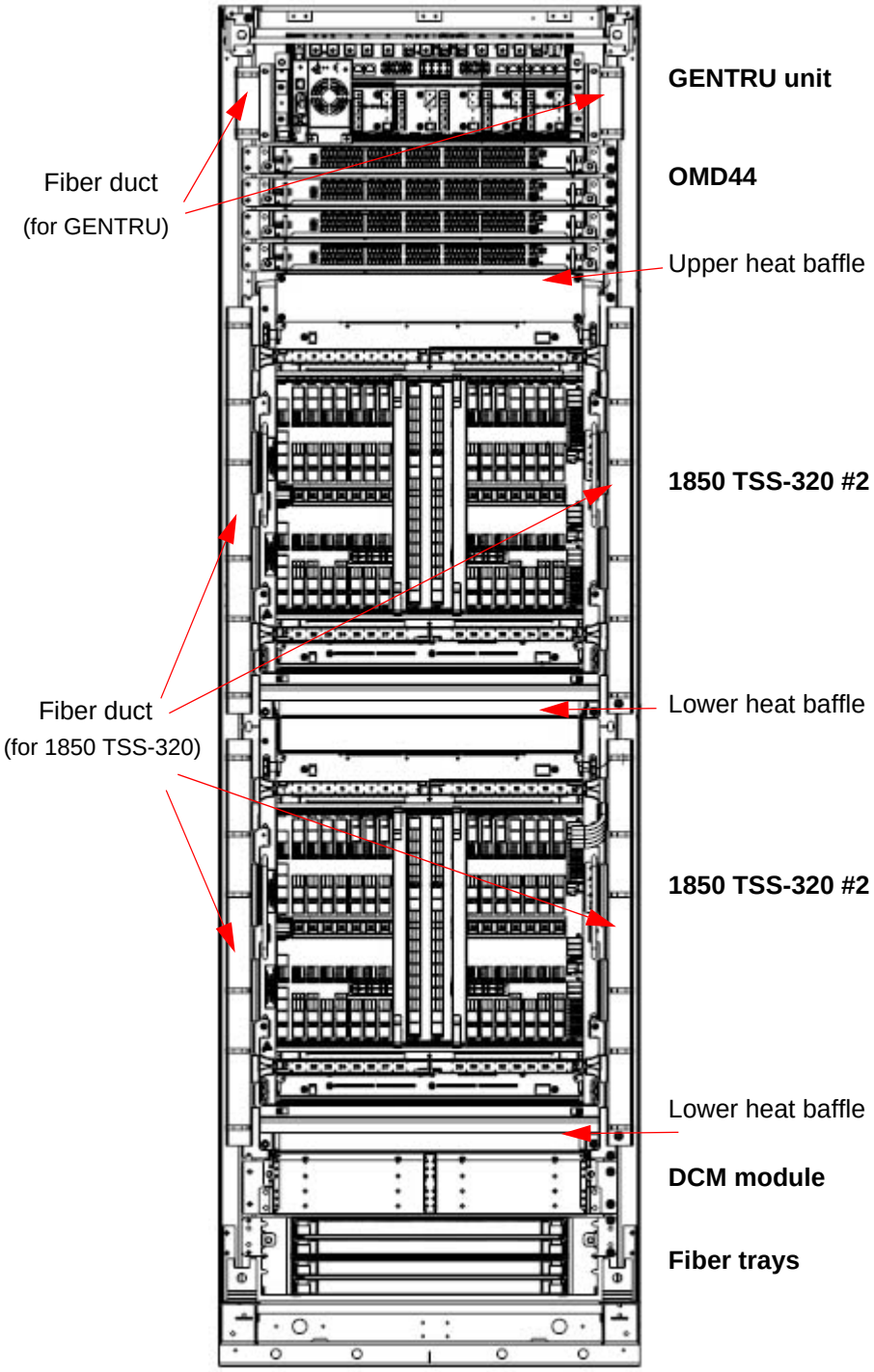


Figure 341. ANSI bayframe

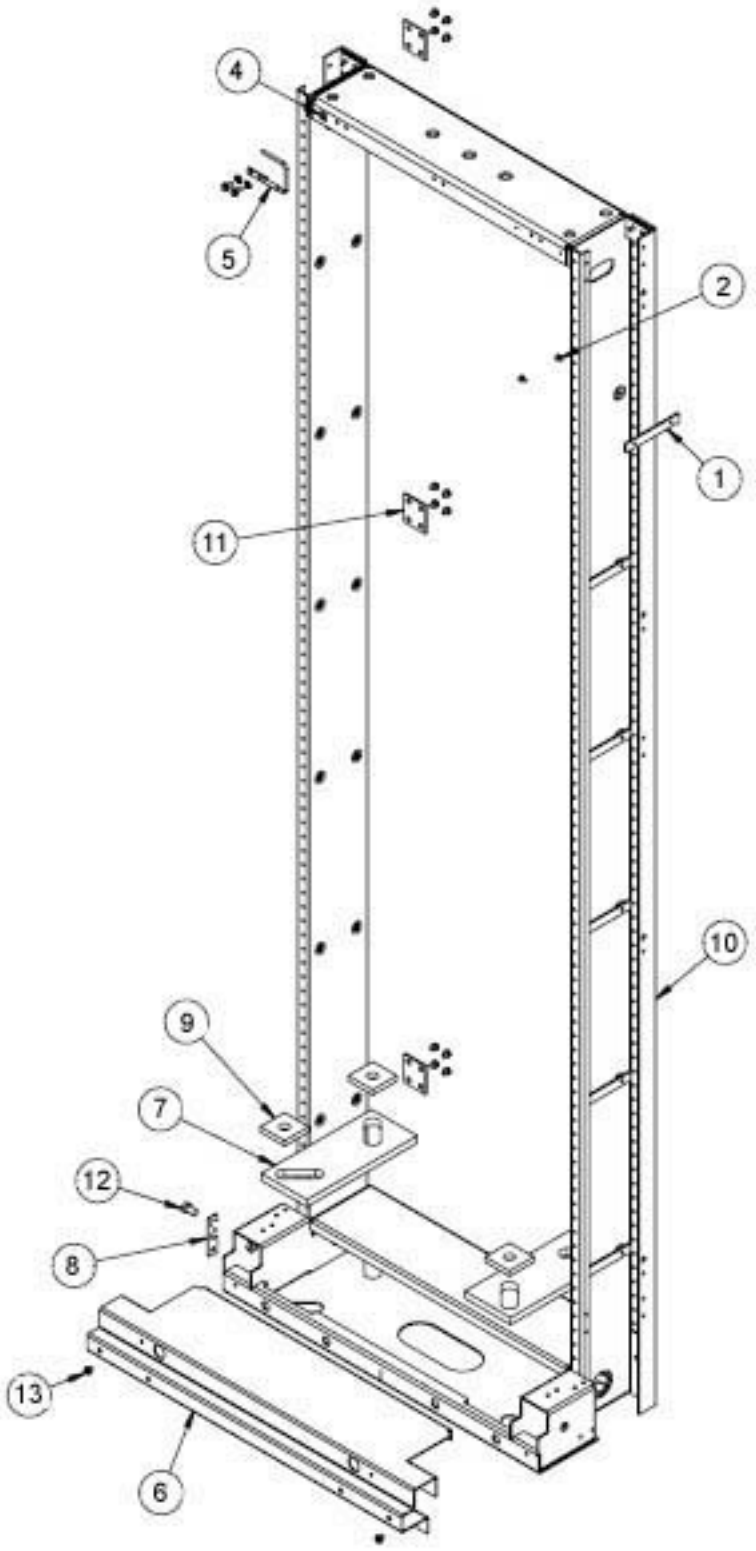


Figure 342. ANSI Rack dismantling parts

7.2.3 GENTRU subrack disassembly

In Figure 343. on page 584 is shown the complete GENTRU subrack parts.

In order to disassemble this subrack first remove the boards **(2)** eventually present, then proceed as described in the following:

- unscrew all the screws present on rear cover **(21)**;
- remove the rear cover **(21)** and **(20)** in order to access the subrack Back Panel **(1)**;
- unscrew all the screws fastening the Back Panel **(1)** to the mechanical structure of the subrack and remove it;
- remove the unit support guide **(12)**;
- remove the side walls **(3)(4)** of the subrack;
- remove the plastic guides **(8)** and subsequently pull them out from the mechanical structure;
- remove the hub cross members **(5)(6)(7)(9)**;
- remove the contact springs **(14)(15)(17)(18)**: refer to para. 7.2.5 on page 588 for information about **hazardous** parts dismantling; these parts are highlighted in Figure 343. on page 584;
- disassemble in more little parts again, if it is necessary;
- separate all disassembled materials (aluminium from steel or plastic, for example) in order to obtain a correct dismantling.

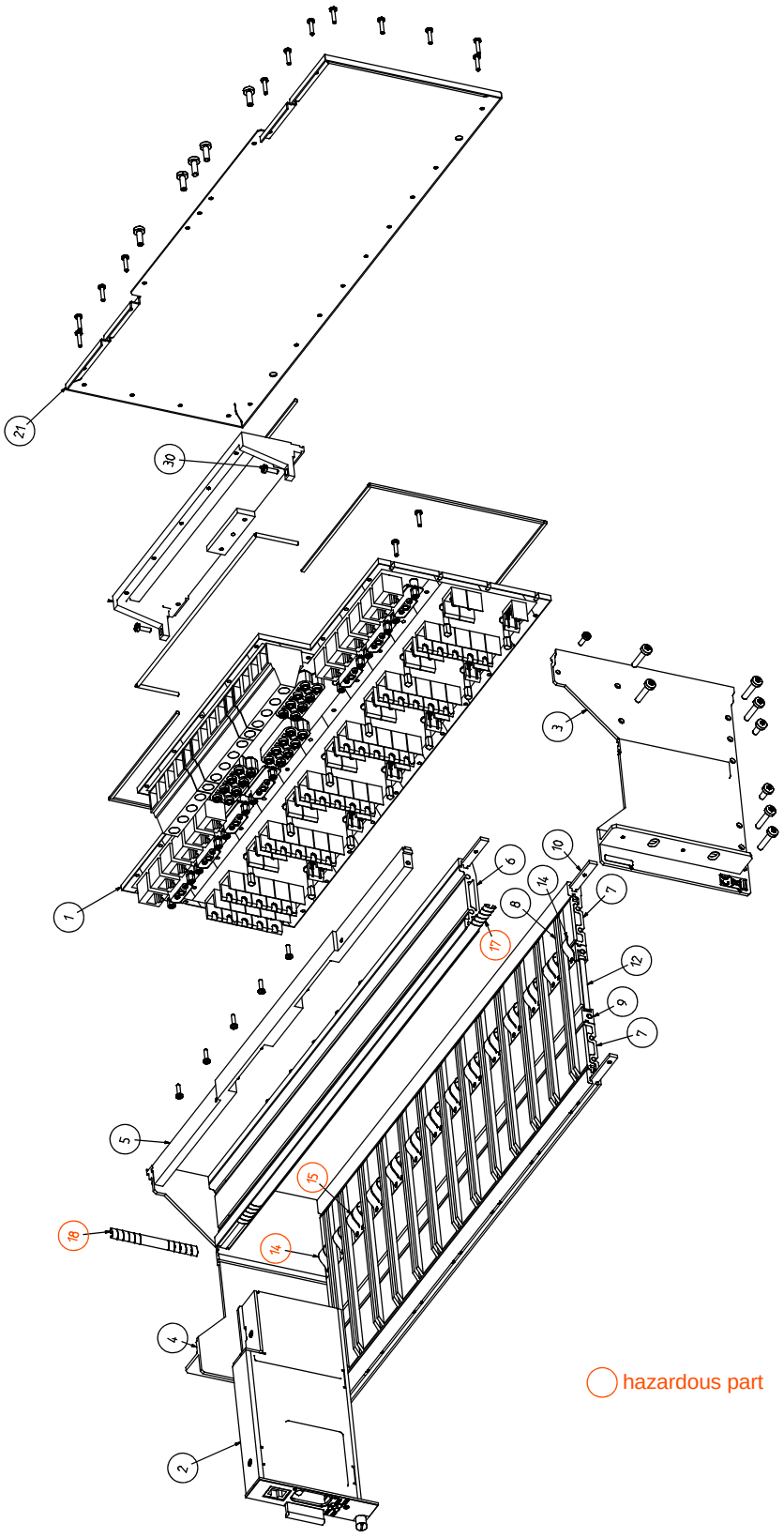


Figure 343. GENTRU subrack dismantling parts

7.2.4 Unit disassembly and dismantling

In the following figures is shown an **example** of unit.

The same rules can be applied to the specific units to be dismantled.

Proceed as described in the following:

- remove the screws **(A)** from the side coverplate as indicated in Figure 344.on page 586;
- remove the screws **(B)** that fix the two levers and subsequently pull out them from the front plate as indicated in Figure 345. on page 587;
- remove the front plate from the PCB (refer to Figure 345. on page 587);
- extract from the top the contact spring **(C)** as indicated in Figure 345. on page 587: refer to para. 7.2.5 on page 588 for information about **hazardous** parts dismantling;
- remove the plastic light conductor and cutaway the rear connector as reported in Figure 346. on page 588.



Figure 344. Side coverplate removal

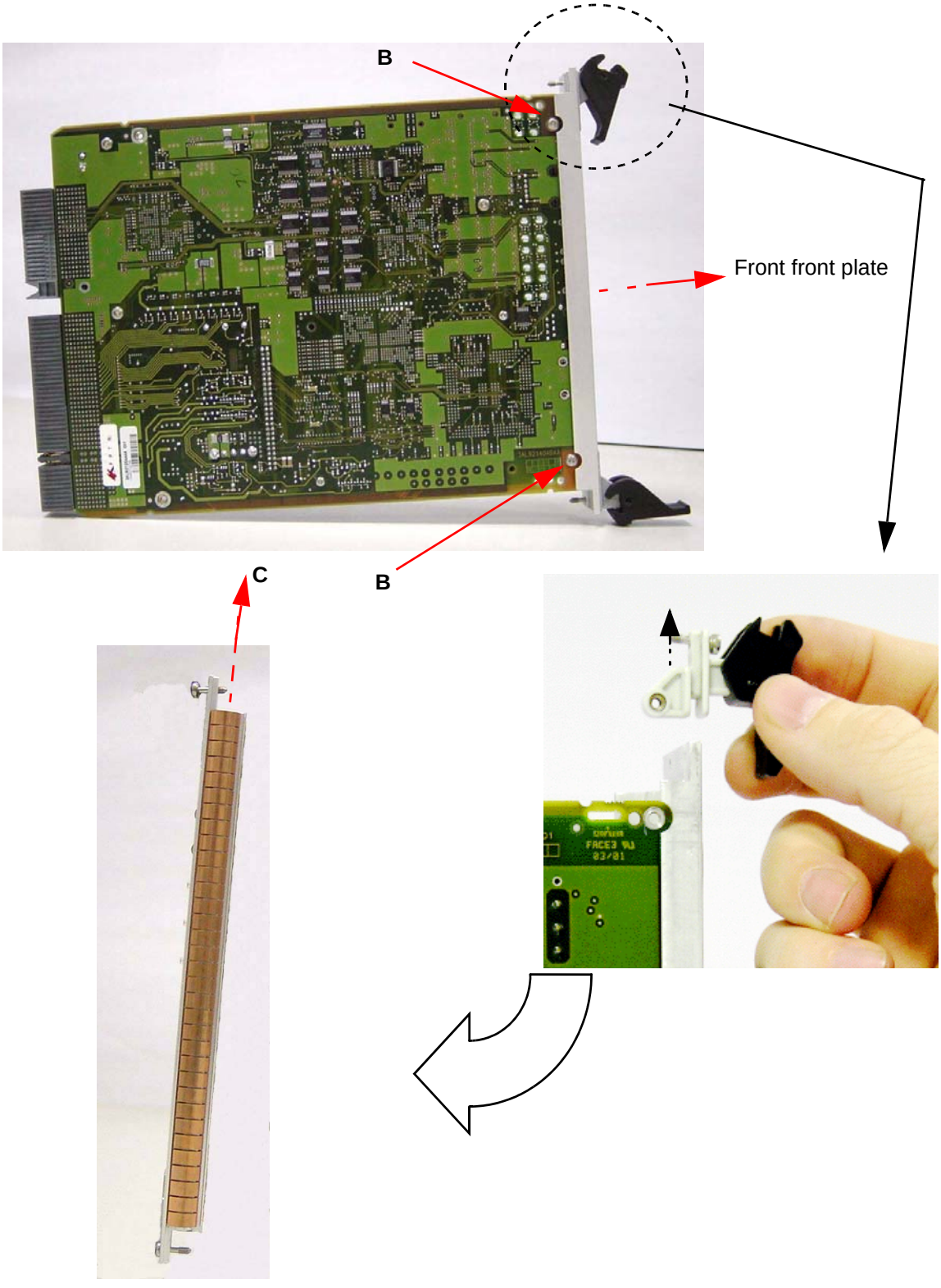


Figure 345. Levers, front plate and contact spring removal

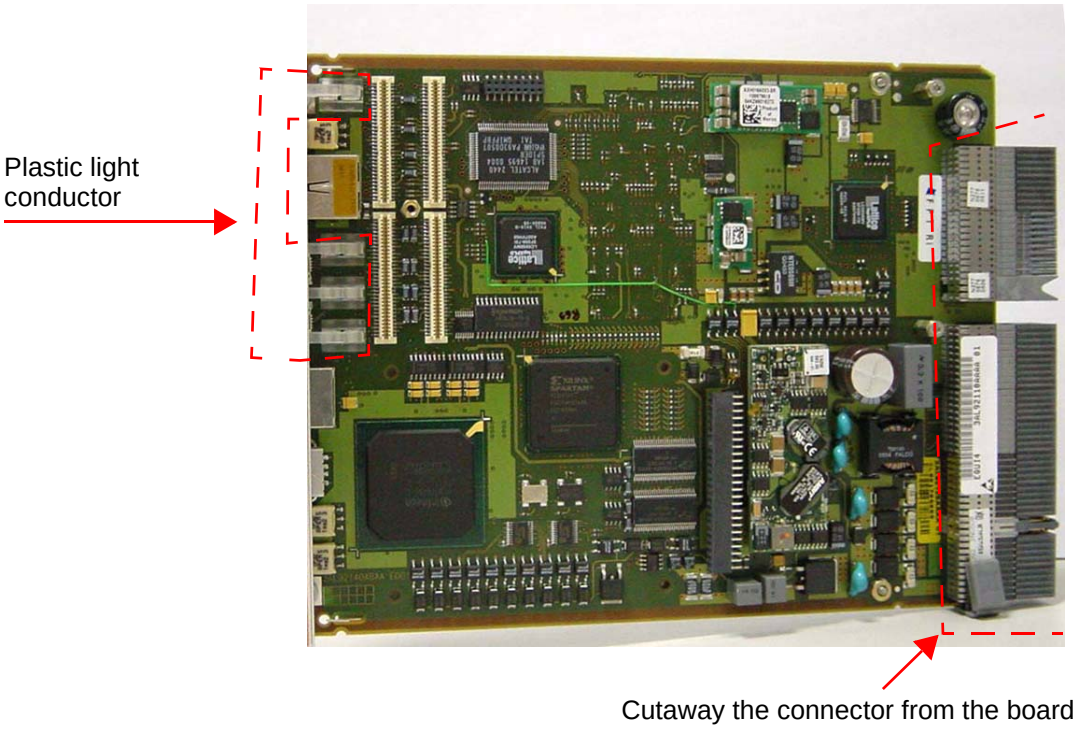


Figure 346. Connector removal

7.2.5 Hazardous materials and components

Table 66. on page 589 lists the presence or not of hazardous substance/components.

The system cabling is designed for reduced halogen content; all the traffic cabling is fully PVC free.

Table 66. List of hazardous materials and components

Materials or substances	Presence	Where
Materials or substances of interest for Dismantling & Recycling (end of life information for treatment facilities)		
Batteries (Mercury/NiCad/Lithium/Other)	NO	---
Parts containing Mercury (if above specified level)	NO	---
Parts containing Cadmium (if above specified level)	NO	---
Capacitors with PCB's	NO	---
Capacitors with substances of concern + height >25 mm, diameter >25 mm or proportionately similar volume	NO	---
Gas discharge lamps	NO	---
Mercury containing Backlighting lamps	NO	---
Plastic containing brominated flame retardants other than in Printed Circuit Assemblies	NO	---
Liquid Crystal Displays with a surface greater than 100 cm^2	NO	---
Asbestos	NO	---
Refractory ceramic fibres	NO	---
Radio-active substances	NO	---
Beryllium Oxide	NO	---
Other forms of Beryllium	**YES**	Refer to Figure 343. on page 584 and Figure 345. on page 587. Note: copper-beryllium contact spring must be separated from other material and must be fused in a specific regulated environment.
Parts containing elements under pressure	NO	--
Parts containing Liquids	NO	---
Parts containing Gas	NO	---
Mechanical springs (springs used for fixation of mechanical parts under force)	NO	---
Gasses which fall under specific regulation (CFCs, HCFCs, ...)	NO	---
Polychlorinated biphenyls (PCB), polychlorinated terphenyls (PCT) or PCN	NO	---
Other materials or substances		
Ago colorants	NO	---
Short chain Chloroparaffins	NO	---
Lead or lead compounds	NO	---
Hexavalent chromium compounds	NO	---
TBT and TBTO	NO	---

7.3 Eco declaration

The Optinex Rack is a new type of rack used for the new generation of OSMN equipment family (MultiService Node for transmission and cross-connection).
Has be designed for high power comsuption equipment and to facilitate the installation and cabling phases.

7.3.1 Weight and Dimensional Characteristics

Refer to para. 5.6 on page 559.

7.3.2 Extension of System Lifetime

The product is designed to ensure an outstanding quality of services through very high traffic transmission, connection and protection performances and minimum service interruption.

The life utility is at least **20** years. This means that maintenance will be assured for at least **20** years.

The system architecture facilitates future extensibility and upgradability.

The terms and conditions of warranty, service availability and spare parts availability are individually agreed between Alcatel-Lucent and the Customer and are part of the relevant contractual commitments.

7.3.3 Power Consumption

Refer to para. 5.4.4 on page 556.

7.3.4 Radio Frequency Emission

Regarding compliance with radio frequency emission requirements refer to para. 5.7.1 on page 560.

7.3.5 Acoustical Noise

Refer to para. 5.7.3 on page 561.

7.3.6 Materials

Refer to Table 66. on page 589 for details.

7.3.7 Disassembly

Refer to para. 7.2 on page 580.

7.3.8 Batteries

The product requires no backup batteries.

7.3.9 Packaging

The packaging of this Alcatel-Lucent equiment complies with the directive 94/62/EEC concerning packaging and packaging waste. Depending on the means of transportation the racks are packed in a cardboard or wooden box, which can easily be recycled after use.

Environmentally harmful materials are not used for packaging.

The packaging materials are marked according to ISO 11 469. If required by the Customer and agreed by both parties, Alcatel-Lucent can take care of the proper disposal of all packaging materials.

For details refer to para. 5.7.5 on page 563.

7.3.10 Take-back Information

On request of customers, Alcatel-Lucent can take care of the take back of depreciated equipment and of the ecological safe and appropriate disposal under conditions to be agreed.

For that purpose Alcatel-Lucent co-operates with qualified companies.

7.3.11 Documentation

In order to reduce paper consumption for Customer Documentation, Alcatel-Lucent delivers the Generic Customer Documentation on a CD-ROM. The CD-ROM contains interactive HW Descriptions, SW Descriptions, Functional Descriptions, Maintenance Manuals and User Guides.

This allows the operator to put the documentation on a server accessible by all relevant people in the organization without any additional paper copies.

Appendix A Labels affixed to the equipment

This chapter covers the **positions** and the **information contained** on the identification and serial labels affixed to the equipment.

Figure 347. through Figure 351. illustrate the most common positions of the labels on the units, modules and subracks.

Figure 352. through Figure 362. illustrate the **information** (for example, Identification and Serial No.) printed on the labels.

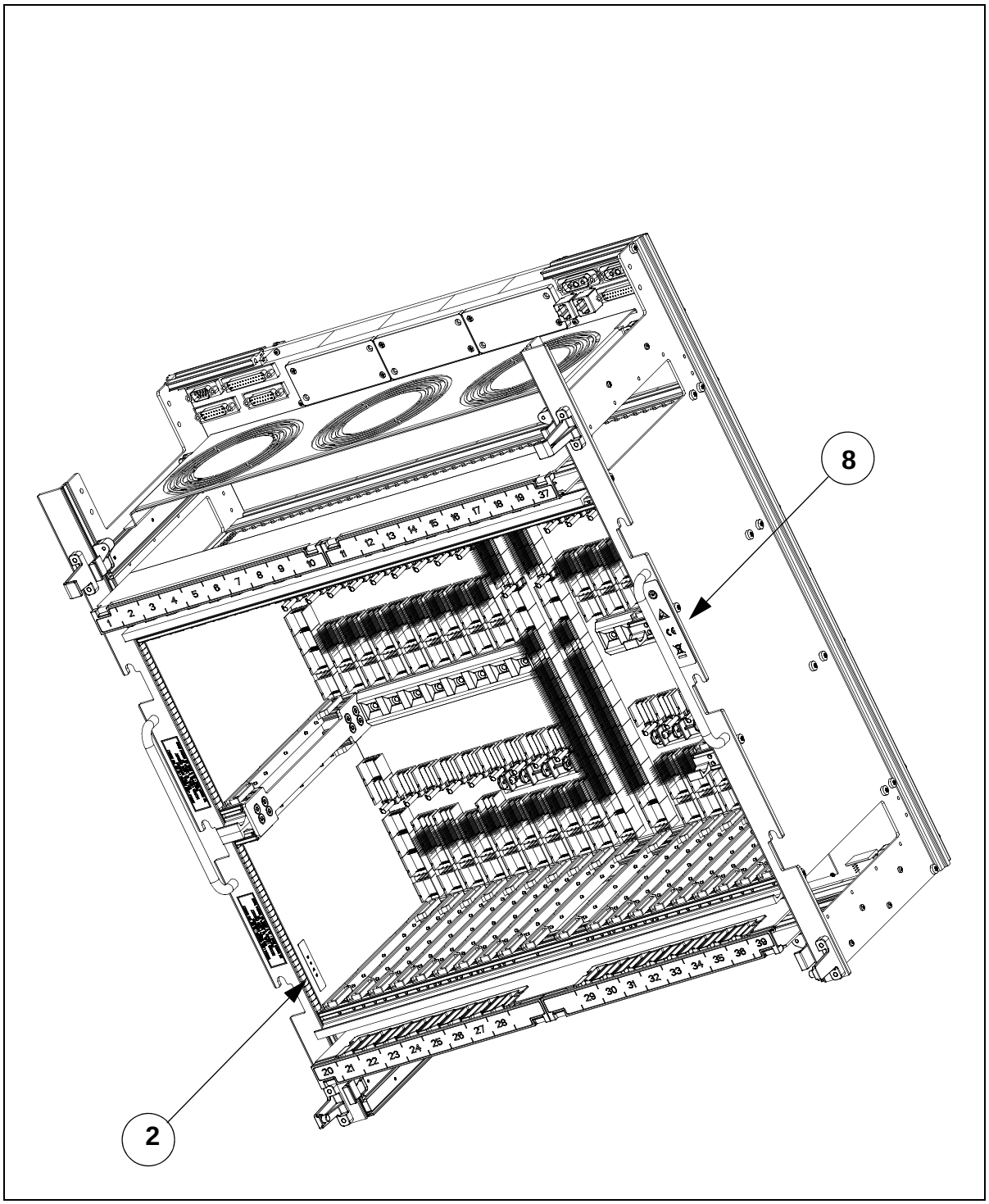
The table below maps reference numbers to the labels used in the figures in this appendix.

Labelling depicted here is for information and could be changed without noticee.

Table 67. Label references

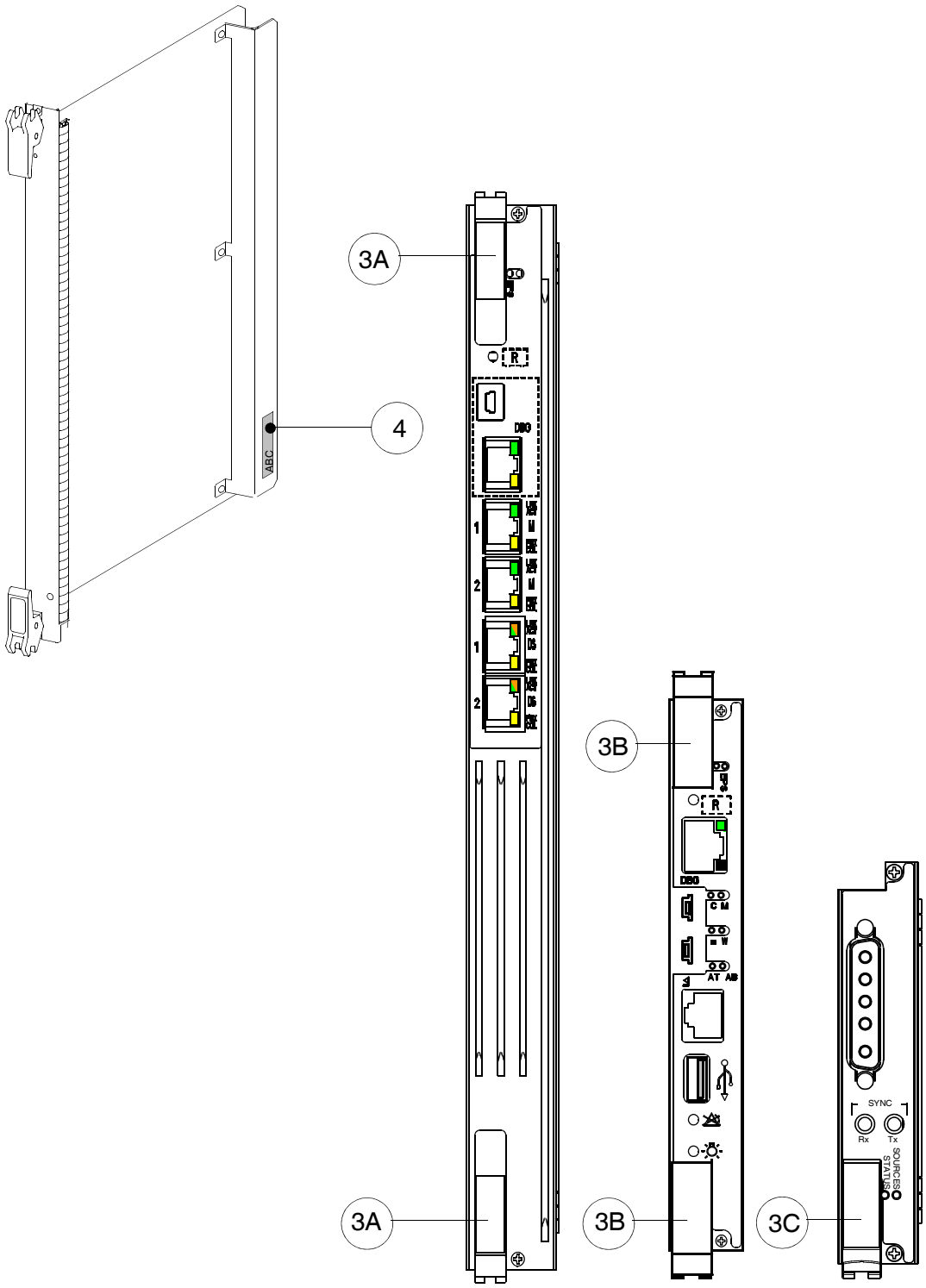
Ref. No.	Name of Label
1	Label identifying PBA (Printed Board Assembly) - Internal labelling. Refer to Figure 352. on page 599.
2	Label identifying Optical Assembly/Shelf/Back Panels. Refer to Figure 353. on page 599
	External Unit identification (End Item):
3A	Standard label external identification. Refer to Figure 354. on page 600
3B	Non-standard external unit identification. Refer to Figure 355. on page 601
3C	Labelling for unit with only one handle. Refer to Figure 356. on page 602
4	Label used inside the unit. Refer to Figure 357. on page 602
5	Optical module XFP EXTENDED label. Refer to Figure 358. on page 603
6	XFP optical module label. Refer to Figure 359. on page 603
7	SFP Optical module label. Refer to Figure 360. on page 603
8	Label indicating compliancy with CE and WEE directives. Refer to Figure 361. on page 604 and Figure 362. on page 604

On a per-contract basis, customized labels can be affixed to the equipment.
Standard labels can be affixed anywhere on the equipment, as required by the customer.



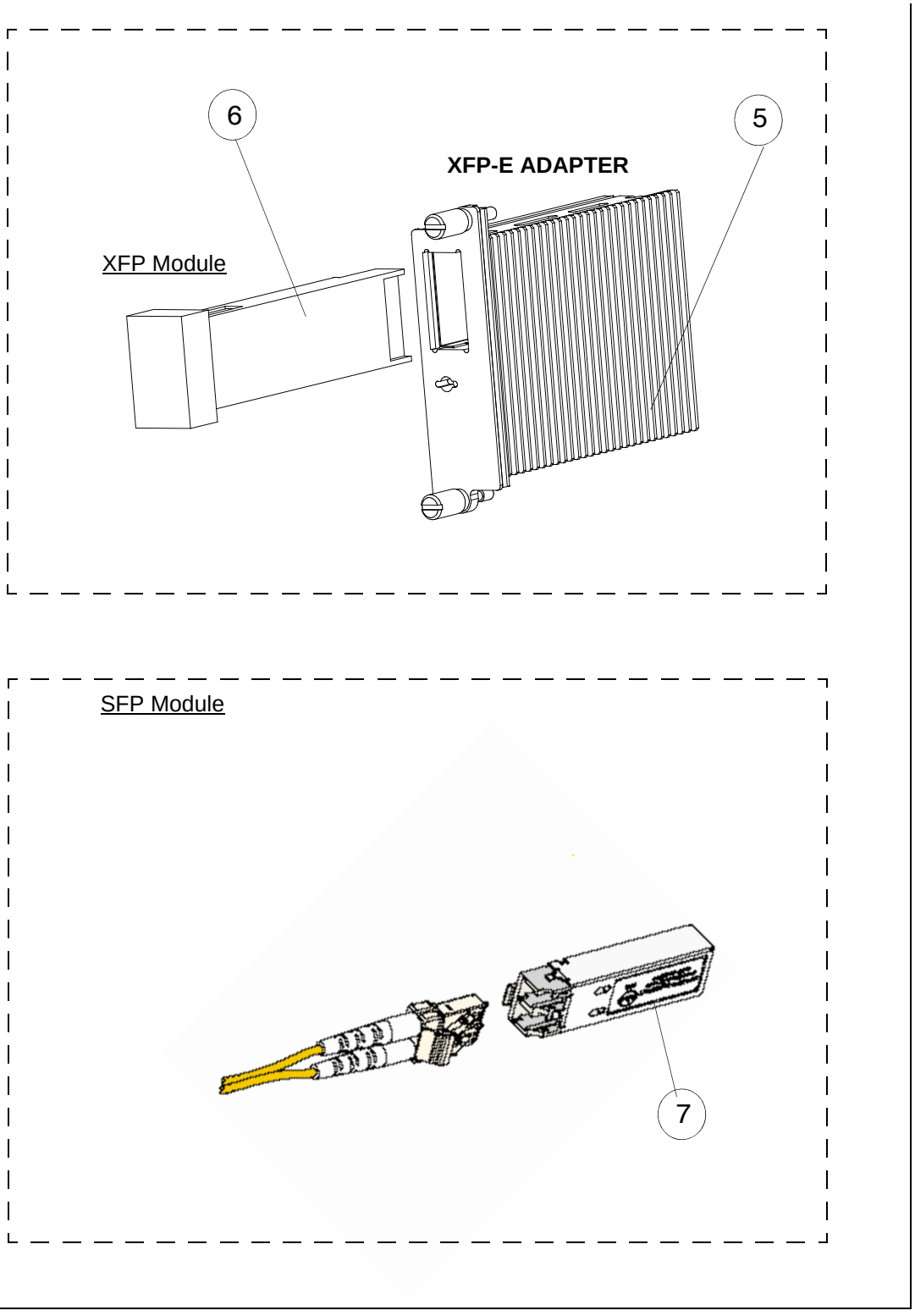
Note: The above reference numbers are detailed on on page 593

Figure 347. Subrack label



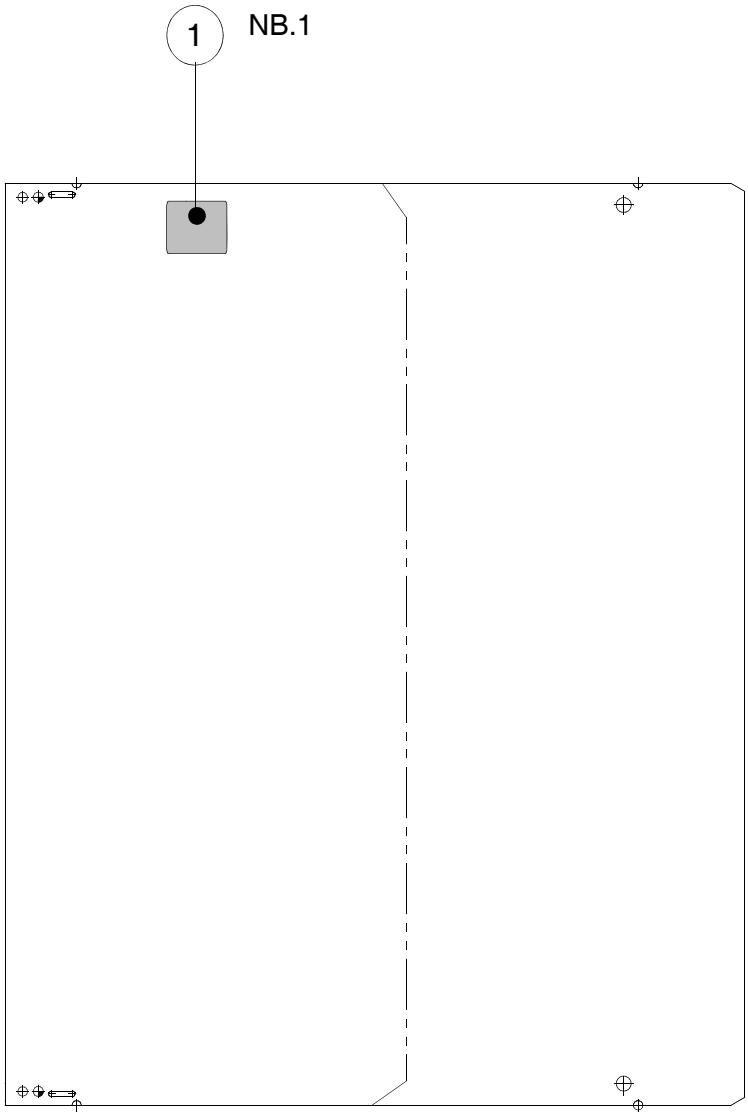
Note: The above reference numbers are detailed on on page 593

Figure 348. Labels on units with standard cover plate



Note: The above reference numbers are detailed on on page 593

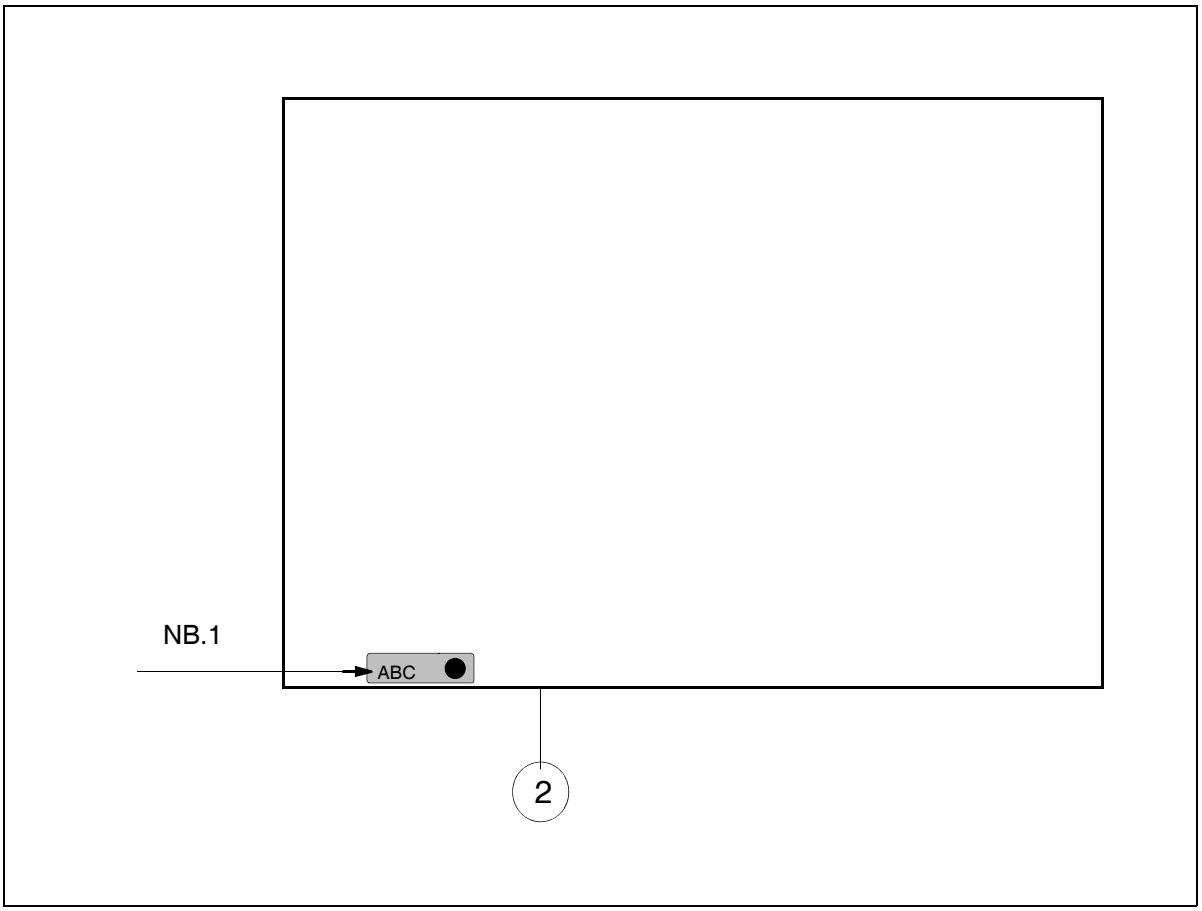
Figure 349. Labelling for modules



Note: NB.1 = The label is present on the p.c.s. component side

Note: The above reference numbers are detailed on on page 593

Figure 350. Internal label for Printed Board Assembly



Note: N.B. 1 = The label is present on p.c.s. components side or rear side on the empty spaces.

Note: The above reference numbers are detailed on on page 593

Figure 351. Back panel's internal label

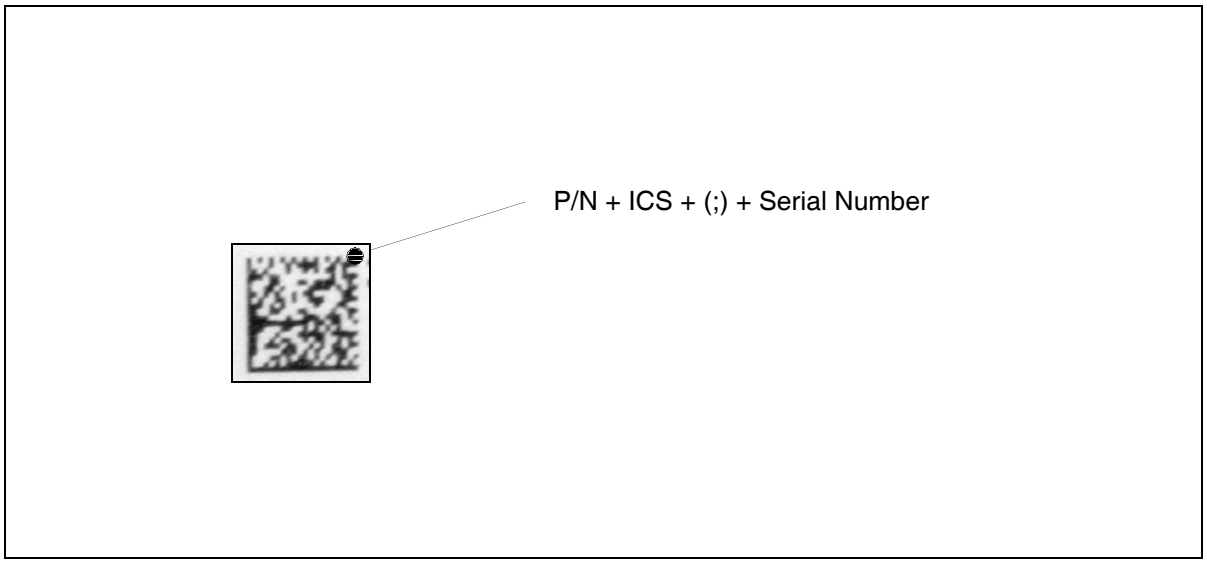


Figure 352. PBA identification label (internal labelling)

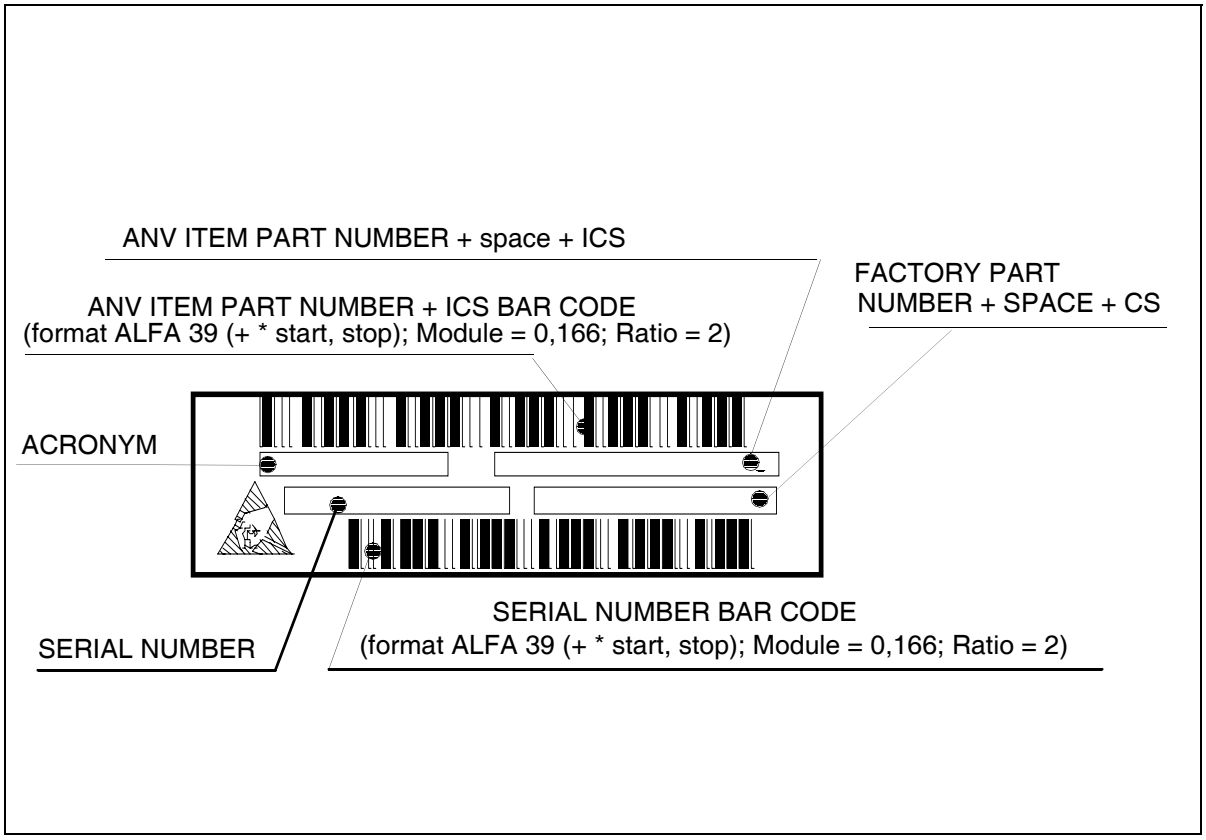
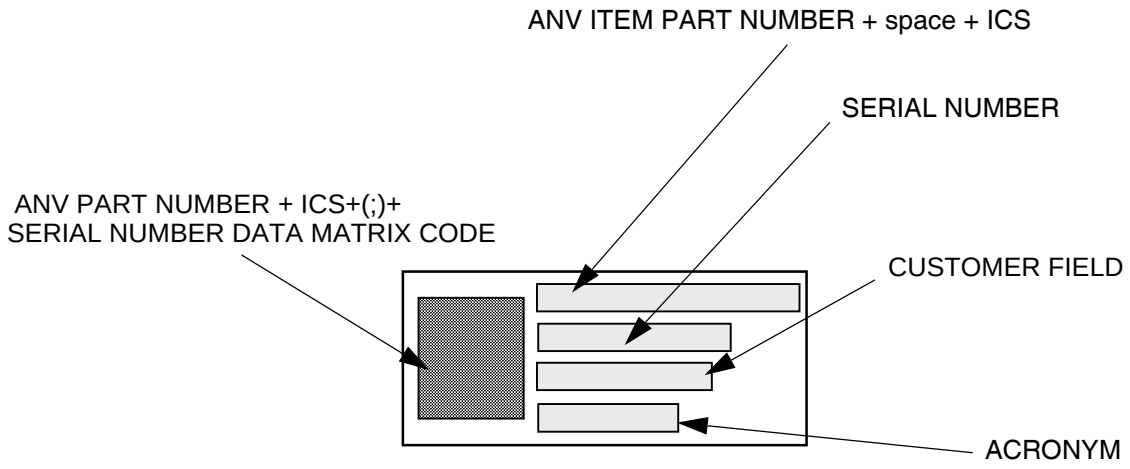
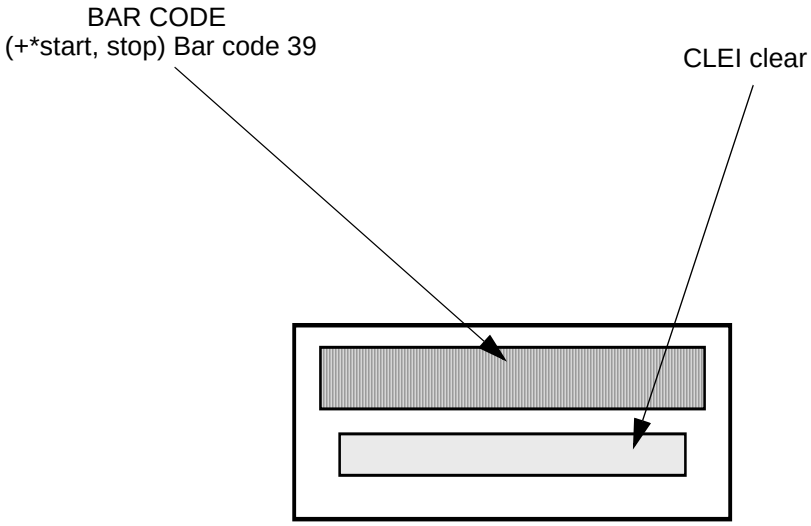


Figure 353. Optical assembly identification/shelf/back panels

The labels below are applied when there are two handles on the unit



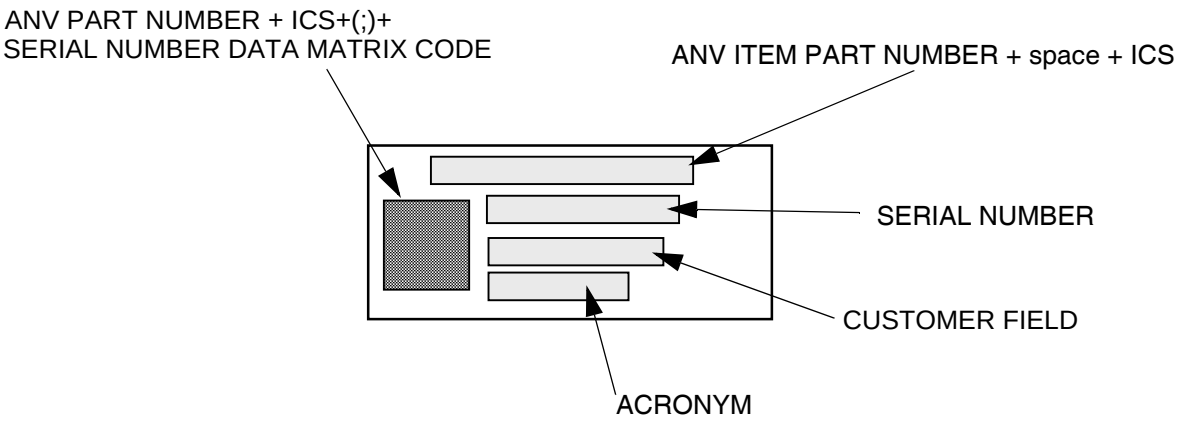
Note: the label is put on the Bottom handle for the vertical unit or Left handle for the horizontal unit



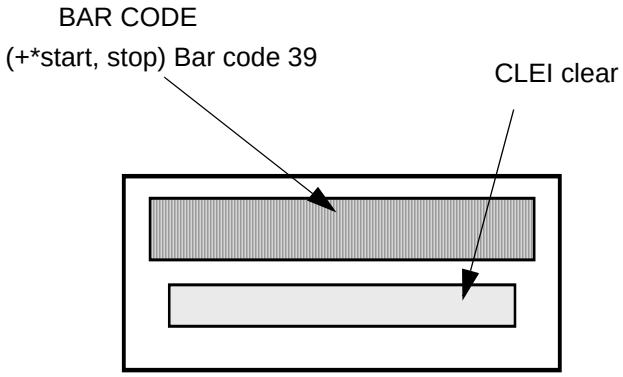
Note: the label is put on the Top handle for the vertical unit or right handle for the horizontal unit

Figure 354. External unit identification: standard label

The labels below are applied when there are two handles on the unit



Note: the label is put on the Bottom handle for the vertical unit or Left handle for the horizontal unit



Note: the label is put on the Top handle for the vertical unit or right handle for the horizontal unit

Figure 355. External unit identification: not standard label

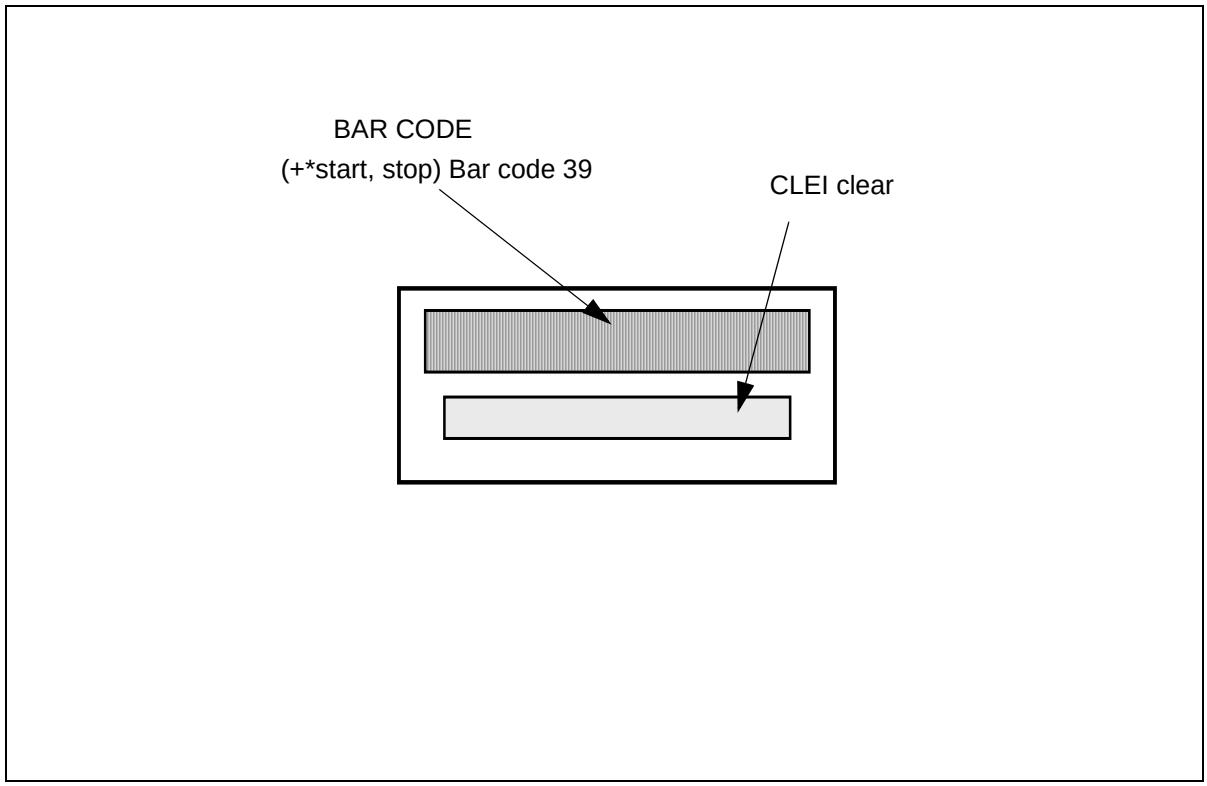


Figure 356. External unit identification: unit with only one handle

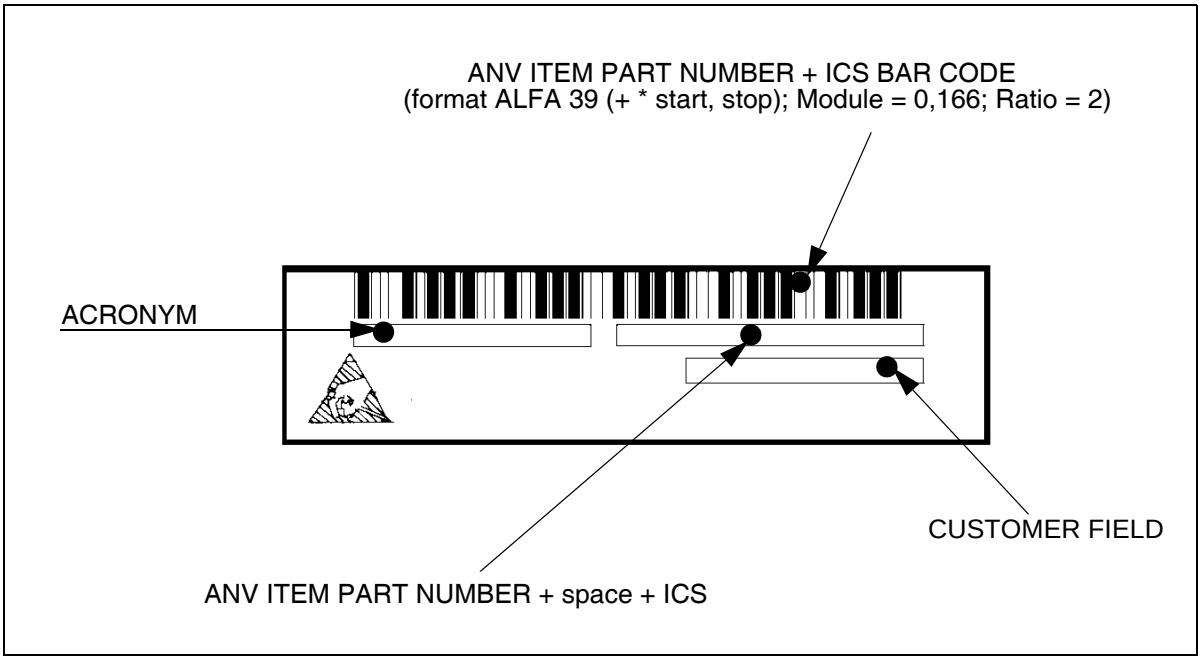


Figure 357. Internal unit label

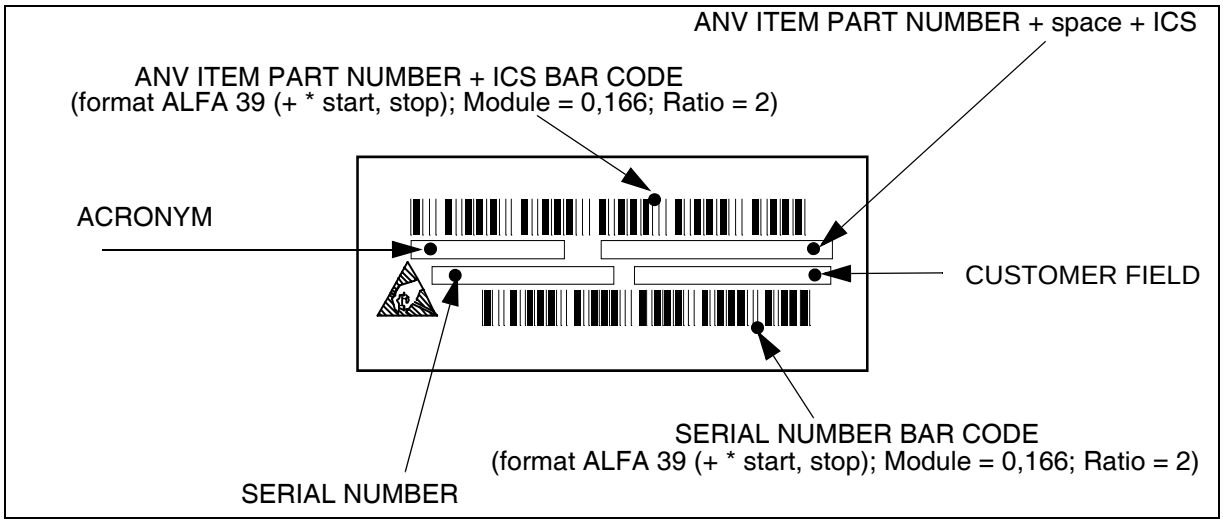


Figure 358. label for Optical module XFP extended

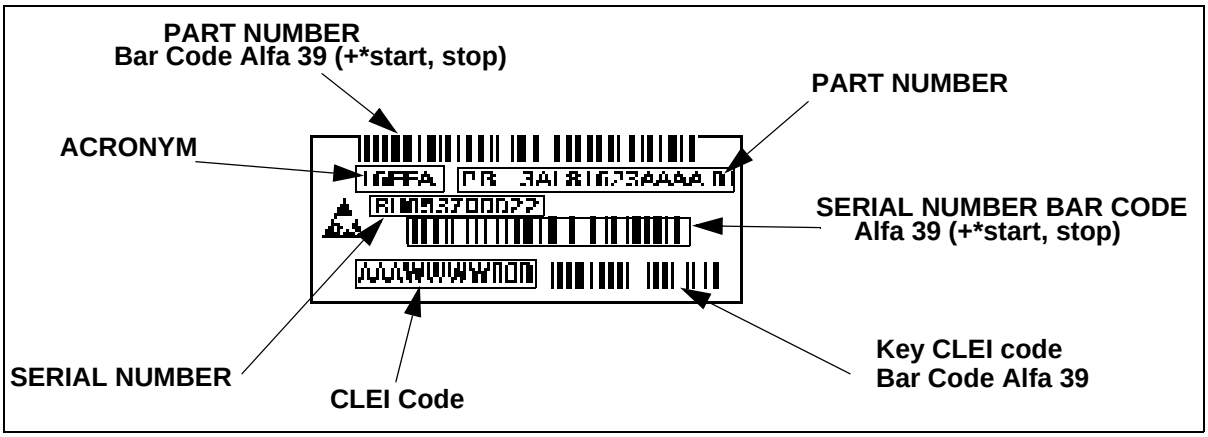


Figure 359. XFP module label

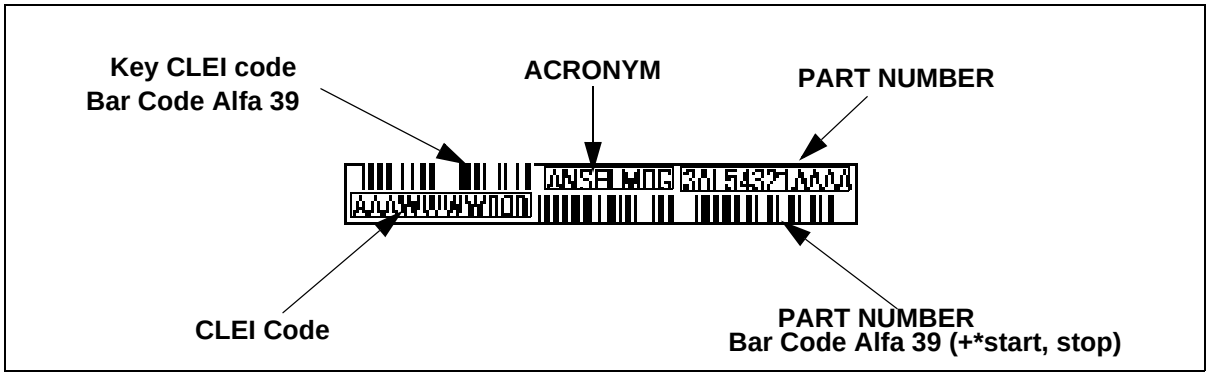


Figure 360. SFP module label

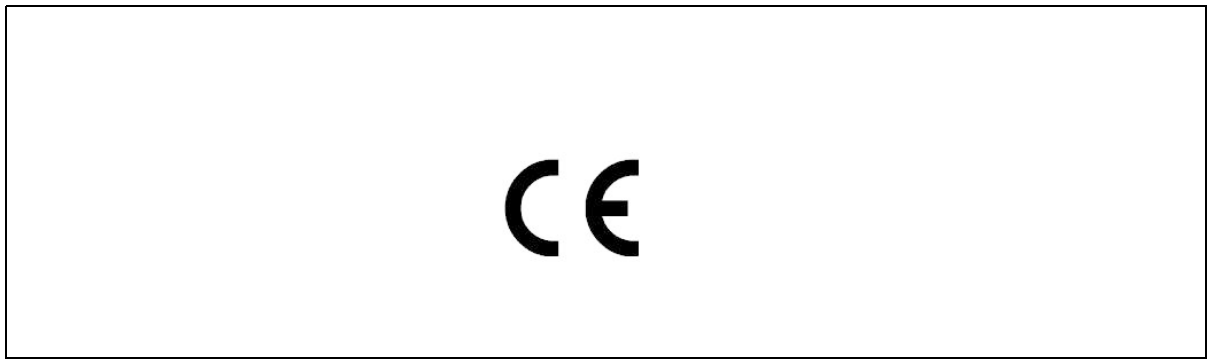


Figure 361. CE label

WEEE General Information

According to the European directive (2002/96/EC) Waste Electric and Electronic Equipment (WEEE), from August 13th, 2005 the "producer" of the equipment being sold, unless otherwise specified in the contract with the Customer, is responsible for collecting and treating electrical and electronic equipment.

Equipment put on the market after August 13th, 2005 must have a label affixed on the product.

The use of the crossed-out wheeled bin symbol indicates that this product is subject to separate collection and is not to be treated as general household waste.
The separate collection of this equipment at the end of its lifecycle is organized and managed by the producer. Please contact the producer or his authorized representative for information concerning the disposal of your equipment.
The separate collection and recycling of waste equipment at the time of disposal contribute to avoiding possible negative effects on the environment and on human health.

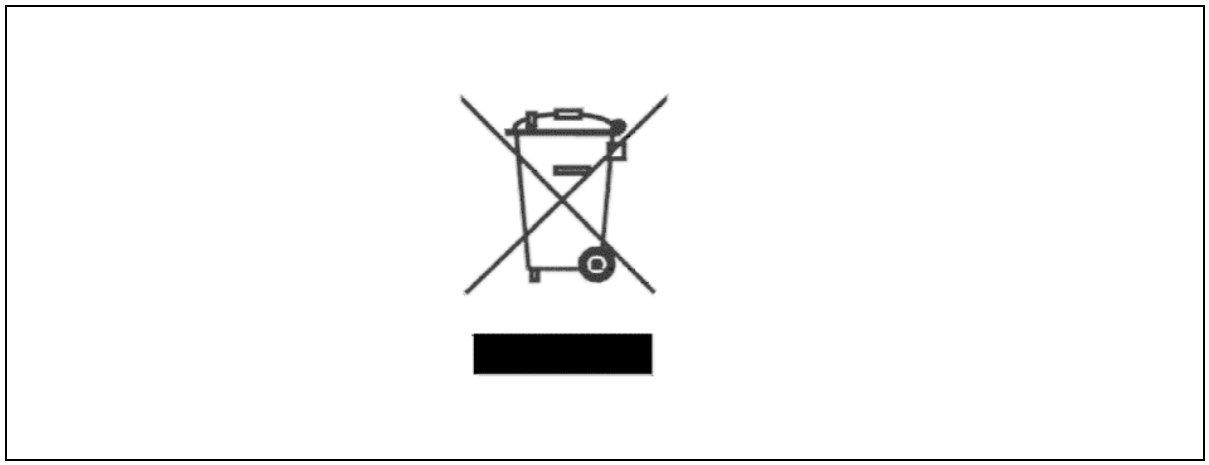


Figure 362. WEEE label

Appendix B General on Customer Documentation

B.1 Products, product-releases, versions and Customer Documentation

A product is defined by the network hierarchical level at which it is used and by the whole of performance and services for which it is meant.

A product evolves through successive product releases, which are the real products marketed for their delivery at a certain release availability date. So, a product release defines a set of hardware components and a software package which, as a whole, identify the possible network applications and the equipment performance for which the specific product release has been designed, engineered, and marketed.

In some cases, a product release has further development steps, named versions, that are introduced to improve or add some functionality (mainly software) over to the previous version, or for bug fixing purposes.

A product release has its own standard Customer Documentation, composed by one or more documents.

A new version of a product release may or may not produce a change in the status of the Customer Documentation set, as described in Section B.4 on page 606.

B.2 Document supply to Customers

Documents are not automatically delivered with equipment with which they apply. The number of documents per unit to be supplied must be decided at the contract level.

B.3 Aims of standard Customer Documentation

Standard Customer Documentation, referred to hereafter, is always meant as plant–independent.

Plant–dependent documentation, if specified by the contract, is subject to commercial criteria based on content, format, and supply conditions. Plant–dependent documentation is not discussed in this document.

Standard hardware and software documentation is meant to provide customers with the information necessary to install, commission, operate, and maintain the equipment according to ALCATEL-LUCENT Laboratory design choices.

In particular, the content of documents associated with software applications focus on the explanation of the man–machine interface and the operating procedures allowed. Maintenance is covered to the faulty PCB location and replacement level.

Consequently, design documentation (like PCB hardware design and production documents and files, software source programs, programming tools, etc.) is not supplied to customers.

Hardware-specific documents (usually the "Technical Document") and software-specific documents (usually the "Operator's Guide") are not part of the standard documentation set because they are not necessarily impacted by product changes.

For example, only the Technical Document might be revised because of hardware configuration changes (for example, replacing one unit with another that performs the same function but has a different P/N).

On the other hand, the Operator's Guide may be updated because of a new software version. Changes in software versions do not impact the Technical Document as long as it does not imply hardware modifications.

Both document types can be updated to improve content, correct errors, etc.

B.4 Updating document

The documents associated with this product release are listed in Related Documents on page 20.

Each document is identified by:

– the name of the product–release (and version when the document is applicable to the versions starting from it, but not to the previous ones)

– the document name

– the document Part Number (P/N)

– the document edition (usually first edition=01)

– the document issue date. This date on the document does not refer to the date of print but to the date on which the document source file was finalized and released for the production.

B.4.1 Changes introduced in the same product-release (same document P/N)

The edition and date of issue might change on future document versions for the following reasons:

– only the date changes (pointed out in the Table of Contents) when modifications are of an editorial nature and do not change the technical content of the document.

– the edition, hence the date, is changed because modifications impact the technical content. In this case:

  • the changes from the previous edition are listed in History on page 19

  • revision bars on the left of the page in updated chapters indicate modifications in text and drawings

Changes that impact the technical content of the document cause the edition number to increase (for exmaple, from Ed.01 to Ed.02). For minor updates (for example, for corrections), documents retain thier edition but an extra letter is appended to the version (for example, from Ed.02 to Ed.02A). Version character/letters can also be used for draft or proposal editions.



NOTES ON DOCUMENTS RELEVANT TO SOFTWARE APPLICATIONS

Documents relevant to software applications (typically the Operator's Guide) are not updated when the new software version distributed to customers implies man-machine interface changes or in case of slight modifications to procedures.

Moreover, screenshots and figures in documents do not run with releases; they are not updated to reflect current product release versions if the screens or figures are unchanged.

B.4.2 Supplying updated documents to customers

Supplying updated documents to customers who have already received previous issues is submitted to commercial criteria.

By updated document delivery, it is meant the supply of a complete copy of the document new issue (supplying errata-corrige sheets is not envisaged).

B.4.3 Changes due to new product version

A new product version changes the document P/N and the edition starts from 01.

In this case, the modified sections of the document are not listed.

B.5 Customer documentation on CD-ROM

In the following sections, 'CD-ROM' is used to refer to the 'Customer Documentation on CD-ROM'

B.5.1 Contents, creation and production of a CD-ROM

In most cases, a CD-ROM contains, in read-only electronic format, the documents for one product release (or version) for a particular language.

In other cases, a CD-ROM can contain documentation for different product releases (or versions) for a particular language.

As a general rule:

– CD-ROMs for Network Management products do not contain:

  • Installation Guides

  • documentation of system optional features and related software that are not available for purchase from ALCATEL-LUCENT

– CD-ROMs for Network Elements products do not contain:

  • documentation of system optional features (for example, System Installation Guides for racks and related hardware) that are not available for purchase from ALCATEL-LUCENT

A CD-ROM contains guides and documents for a particular product/release in .pdf format. Bookmarks and hyperlinks are included to aid navigation. The resulting master CD-ROM is electronically transferred to the appropriate department for distribution to customers.

The information contained on CD-ROMs and in paper documents for a given product/release is identical.

Suitable checks are made to ensure a virus-free product.

B.5.2 Use of the CD-ROM

The CD-ROM can be used both in PC and UNIX WS environments.

The CD-ROM starts up automatically with autorun; the Index and other hyperlinks help navigate the documents. ReadMe notes are also included on the CD-ROM.

In order to open the .pdf documents, Adobe Acrobat Reader Version 4.0 (minimum) must be installed on your system. The customer is responsible for obtaining and installing the correct version of Adobe Acrobat Reader.

Once the correct version of Reader is installed, users have the option of reading the documents on their PC/WS, installing documents to their PC/WS, or printing all documents or selected documents/sections to a local printer.

B.5.3 CD-ROM identification

Each CD-ROM is identified by the following:

1) external identifiers (imprinted on the CD-ROM):
   - the name of the "product release(s)" (and "version" if applicable)
   - text indicating the language(s)
   - the CD-ROM Part Number)
   - the CD-ROM edition (usually first edition=01)
2) internal identifiers - a list of files and documents (with P/Ns and editions) included on the CD-ROM

B.5.4 CD-ROM updating

The list of source document P/Ns-editions indicated in the previous section (C.5.3 point 2), in association with the CD-ROM's own P/N-edition, is also loaded in the ALCATEL/LUCENT-INFORMATION-SYSTEM as a structured list.
Whenever a new edition of any document is released in the ALCATEL-LUCENT archive system, a check in the ALCATEL/LUCENT-INFORMATION-SYSTEM is made to identify the list of CD-ROMs that must be updated to include the new editions of these guides/documents.
This causes the planning and creation of a new edition of the CD-ROM.
Updating of CD-ROMs always follows, with a certain delay, the updating of the single documents composing the collection.

Appendix C Signal management

C.1 SONET/SDH High Order processing block

C.1.1 SONET/SDH port card

The SONET/SDH port card provides processing capabilities of STM-1/OC-3 up to STM-64/OC-192 signals. The HO payload processing is performed at port card level, while connection functions are collapsed into one single entity, placed in the Matrix board.
The functional block diagram of a generic STM-N board of 1850 TSS-320 equipment is shown in Figure 363. on page 609.

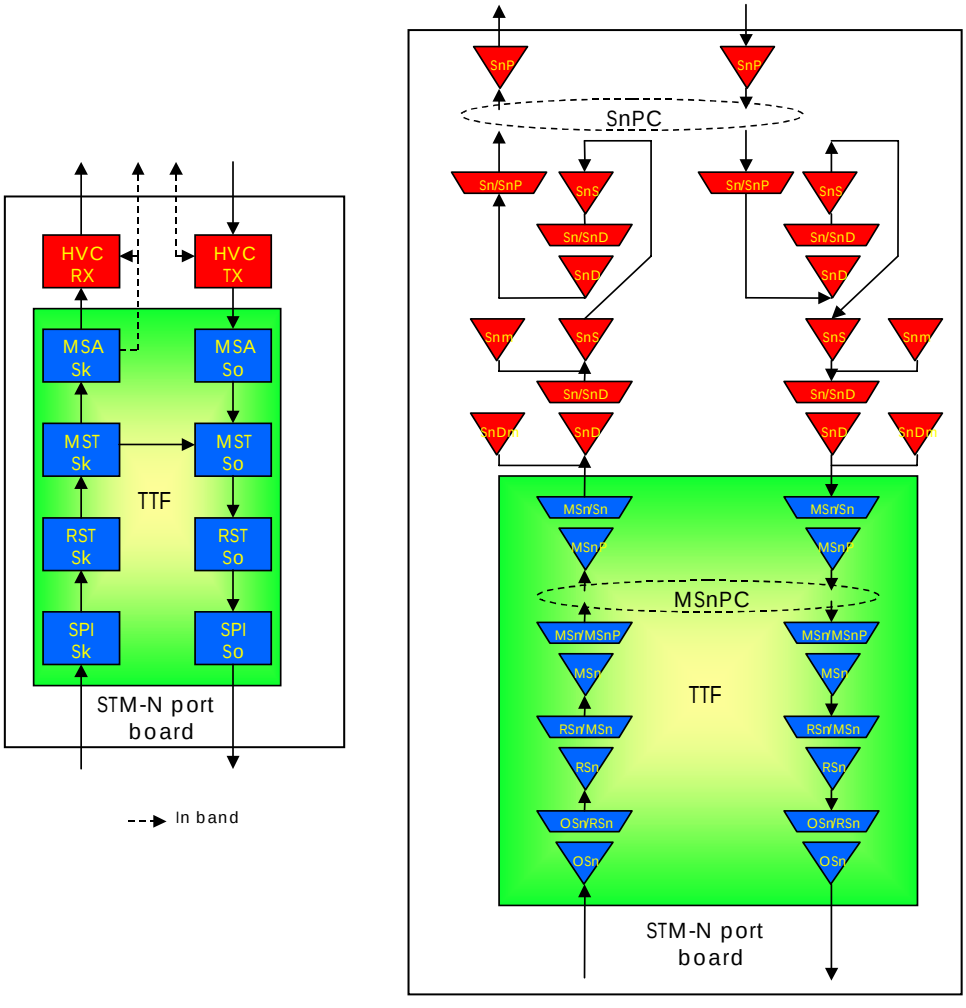


Figure 363. SONET/SDH Port board implementation and corresponding ITU-T G.783 functional model

Note that MSn switching (MSnPC block) is performed in the Matrix board: the dotted MSnPC block in Figure 363. on page 609 shows the correct placement for that block.
The criteria detected by MSn/MSnP function are in band signaled to the Matrix.
Moreover, the HVC functions are implemented before MSn switches, per the ITU-T standard functional model. The information collected by HVC functions are in band signaled to the Matrix board where a virtual image of the HVC functions resides (see Sec. C.1.3.2 on page 620 for details).

The received/transmitted line signal is optical STM-N with N=1, 4, 16, 64, 256 (ITU-T G.957 Rec. and ITU-T G.691 Requirements).

The SONET/SDH frame format is compliant with ITU-T G.707 Requirements.

f) SONET/SDH Physical Layer

- **Optical Section Layer Trail Termination: OSn_TT**

  OSn_TT_Sk
  input LOS detection
  TSF insertion on LOS detection

  OSn_TT_So
  signal conditioning for transmission medium

- Optical Section Layer Adaptation to Regenerator Section Layer: OSn/RSn_A

  OSn/RSn_A_Sk
  descrambler
  OOF count and LOF detection
  SSF insertion (on LOF detection)

  OSn/RSn_A_So
  scrambler

g) Regenerator Section Layer

- **Regenerator Section Layer Trail Termination: RSn_TT**

  RS_TT_Sk
  A1, A2: frame alignment detection
  J0: regenerator section trace recovery and mismatch detection
  B1: BIP-8 Errored Block count: even bit parity is computed and compared with B1 recovered from the current frame
  D1-D3: RS data communication (DCCR) extraction
  SSF detection
  TSF insertion (on SSF or TIM detection)

  RS_TT_So
  A1, A2: frame alignment insertion
  J0: regenerator section trace insertion
  B1: BIP-8 calculation and insertion
  D1-D3: RS data communication (DCCR) insertion

- **Regenerator Section Layer Adaptation to Multiplex Section Layer: RSn/MSn_A**

  RSn/MSn_A_Sk
  TSF detection
  SSF insertion (on TSF detection)

  RSn/MSn_A_So
  no information is inserted

h) Multiplex Section Layer

- **Multiplex Section Layer Trail Termination: MSn_TT**

  MSn_TT_Sk
  B2: BIP-24N Errored Block count
  M1, M0: MS-REI recovery (M0 significant for STM-64 only)
  K2[6-8]: MS-RDI detection
  K2[6-8]: MS-AIS detection
  D4-D12: MS data communication (DCCM) extraction
  S1: SSM message extraction
  TSD insertion on MS-DEG (Signal Degrade) detection
  TSF insertion (on MS-AIS detection)

  MSn_TT_So
  B2: BIP-24N calculation and insertion
  M1, M0: MS-REI insertion (M0 significant for STM-64 only)
  K2[6-8]: MS-RDI insertion
  K2[6-8]: MS-AIS insertion
  D4-D12: MS data communication (DCCM) insertion
  S1: SSM message insertion

- **Multiplex Section Sub-layer protection function:**

  – Multiplex Section Layer Adaptation to the Multiplex Section Protection Sub-layer: MSn/MSnP_A

  MSn/MSnP_A_Sk
  the K1-K2 (extended to K0) information (APS protocol) is recovered
  SSF insertion (on TSF detection)
  SSD insertion (on TSD detection)

  MSn/MSnP_A_So
  generation of K1-K2 information (APS protocol - extended to K0).

  – Multiplex Section Protection Sub-layer Termination: MSnP_TT

  MSnP_TT_Sk
  SSF detection
  TSF insertion (on SSF detection)

  MSnP_TT_So
  no information is inserted

- **Multiplex Section Layer Adaptation to the high Order Path Layer: MSn/Sn_A**

MSn/Sn_A_Sk

AU-3/4 Pointer interpreter
Standard concatenation management (AU4-4c/AU3-12C; AU4-16c/AU3-48C; AU4-64c/AU3-192C)
SSF insertion (on LOP and AU-AIS detection)

MSn/Sn_A_So

AUG assembly and byte interleaving
AU-3/4 Pointer generator
AU-AIS generator
PJE (Pointer Justification Events) generated count (SDH only)

i) Path Layer

- **High Order Path Overhead Monitoring Function (POM): Snm_TT**

Snm_TT_Sk

J1: Path Trace information is recovered.
G1[1-4]: The REI information is recovered.
G1[5-7]: Path Status monitoring detection --> G1[5] is used for HP-RDI detection;
G1[6-7]: is optionally used for HP-RDI coding enhancement.
C2: Signal Label Monitoring --> UNEQ and VC-AIS detection.
B3: VC-4 BIP-8 Errored Block Count.
TSF insertion (on SSF or UNEQ or TIM or AIS detection).
TSD insertion (on a condition of degraded signal detection).

- **High Order Supervisory Unequipped Termination (HSUT): Sns_TT**

Sns_TT_Sk

J1: Path Trace information is recovered.
G1[1-4]: The REI information is recovered.
G1[5]: Path Status monitoring detection --> G1[5] is used for HP-RDI detection;
G1[6-7]: is optionally used for HP-RDI coding enhancement.
C2: Signal Label Monitoring --> UNEQ and VC-AIS detection.
B3: VC-4 BIP-8 Errored Block Count.

Sns_TT_So

Generation of an unequipped container and frame offset.
C2: "unequipped" insertion.
J1: trail trace identifier is generated.
G1: insertion of RDI and/or REI information.
B3: VC-4 Bip-8 calculation and insertion.

- **VC-4 Tandem Connection Trail Termination: SnD_TT**
  For SONET tributaries the function is not applied.
  For SDH VC-4 tributaries, the following applies, according to G.707 Annex D requirements; (G.707 Annex C option is not supported):

  SnD_TT_Sk

  N1[1-4]: VC-4 BIP-8 extraction and EDC calculation.
  N1[8][73]: RDI extraction.
  N1[5]: REI extraction.
  N1[7][74]: ODI extraction (Outgoing Defect Indication).
  N1[6]: OEI extraction (Outgoing Error Indication).
  N1[7-8]: extraction from the multiframed channel N1[7-8] of:
  FAS (Frame Alignment Signal) in frames 1 to 8.
  trace identifier in frames 9 to 72.
  TC RDI and ODI in frames 73 to 76.
  B3: BIP-8 compensation.

  SnD_TT_So

  N1[8][73]: RDI insertion.
  N1[5]: REI insertion.
  N1[7][74]: ODI insertion (Outgoing Defect Indication).
  N1[6]: OEI insertion (Outgoing Error Indication).
  N1[7-8]: insertion in the multiframed channel N1[7-8] of:
  FAS (Frame Alignment Signal) in frames 1 to 8.
  trace identifier in frames 9 to 72.
  TC RDI and ODI in frames 73 to 76.
  N1[1-4]: BIP-8 calculation and insertion.
  B3: BIP-8 compensation.

- **VC-4 Tandem Connection Adaptation: Sn/SnD_A**
  For SONET tributaries the function is not applied.
  For SDH VC-4 tributaries, the following applies, according to G.707 requirements.

  Sn/SnD_A_Sk

  this function restores the invalid Frame Start condition if that existed at the ingress of the tandem connection.
  AIS insertion.

  Sn/SnD_A_So

  this function replaces the incoming Frame Start signal by a local generated one if all-ONEs VC is received.

- **VC-4 Tandem Connection non-intrusive monitoring: SnDm_TT**
  For SONET tributaries the function is not applied.
  For SDH VC-4 tributaries, the following applies, according to G.707 Annex D Requirements; (Annex C option is not supported):

  SnDm_TT_Sk
  N1[1-4]: VC-4 BIP-8 extraction and EDC calculation.
  N1[8][73]: RDI extraction.
  N1[5]: REI extraction.
  N1[7][74]: ODI extraction (Outgoing Defect Indication).
  N1[6]: OEI extraction (Outgoing Error Indication).
  N1[7-8]: extraction from the multiframed channel N1[7-8] of:
  FAS (Frame Alignment Signal) in frames 1 to 8.
  trace identifier in frames 9 to 72.
  TC RDI and ODI in frames 73 to 76.

- **Path Sub-layer protection function**

  – Path Layer Adaptation to the Path Protection Sub-layer: Sn/SnP_A

  Sn/SnP_A_Sk
  SSF insertion (on TSF detection)
  SSD insertion (on TSD detection)
  F2, F3: path user channel insertion

  Sn/SnP_A_So
  F2, F3: path user channel extraction

  – Path Protection Sub-layer Termination: SnP_TT

  SnP_TT_Sk
  SSF detection
  TSF insertion (on SSF detection)

  SnP_TT_So
  no information is inserted

C.1.2 SONET/SDH port card with OTN interface

The card provides the capability to encapsulate an OC-n/STM-n signal into ODUk frame in order to transmit an OTUk frame protected with FEC code, for transmission performance enhancement.

SONET/SDH processing capabilities are as described in section C.1.1 on page 609. The functional block diagram is shown in Figure 364. on page 615.

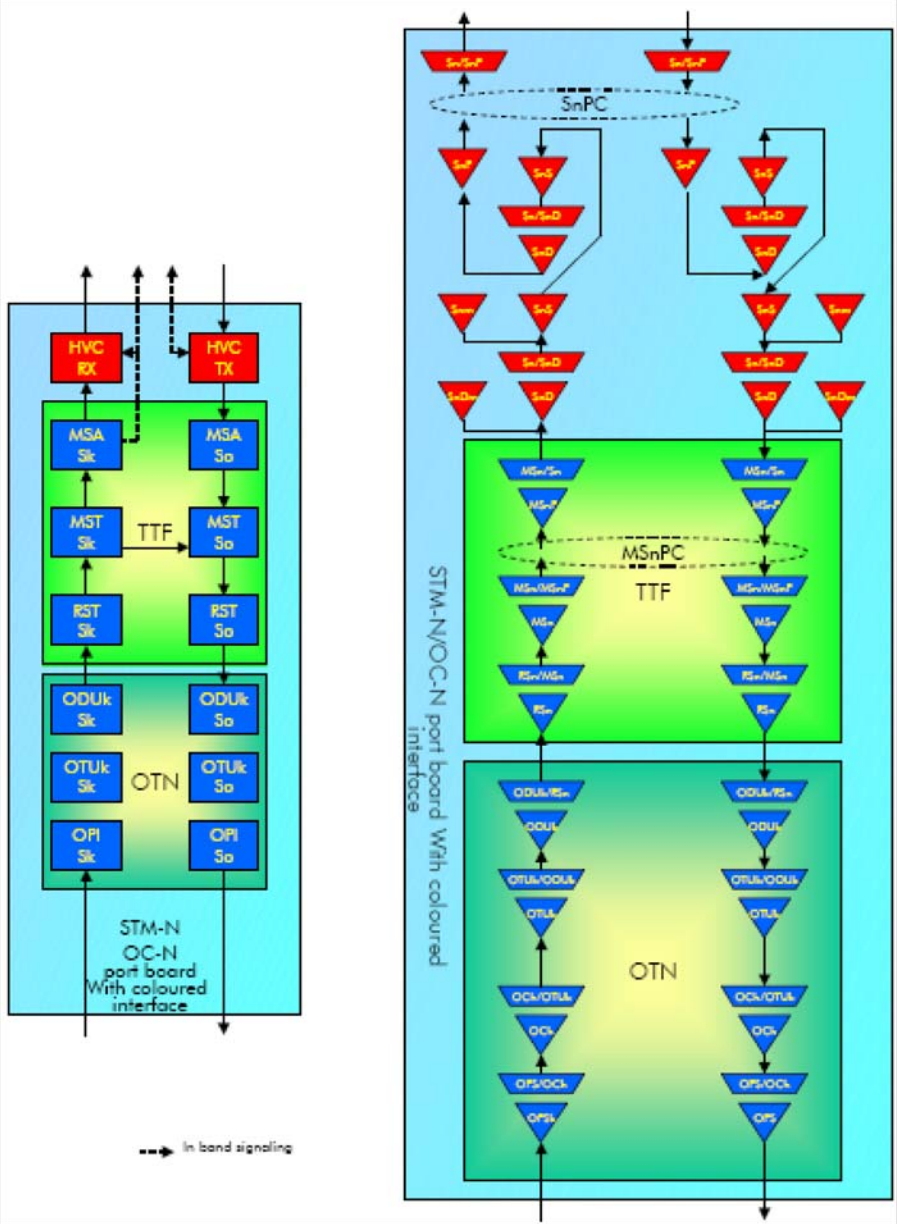


Figure 364. SONET/SDH Port board with OTN interfaces implementation and corresponding ITU-T G.783/G.798 functional model.

a) OTN Physical Layer

- **Optical Physical Section Layer Trail Termination: OPS_TT**

  OPS_TT_Sk
  input LOS detection
  TSF insertion on LOS detection

  OPS_TT_So
  signal conditioning for transmission medium

- **Optical Section Layer Adaptation to Optical Channel Layer: OPSn/OCh_A**

  OPS/OCh_A_Sk
  demodulation of optical signal

  OPS/OCh_A_So
  modulation of optical signal

b) Optical Channel Layer

- **Optical Channel Trail Termination: OCh_TT**

  OCh_TT_Sk
  Termination of the OCH payload as baseband signal
  LOS detection
  TSF insertion on LOS detection

  OCh_TT_So
  Generation of the OCH payload as baseband signal

- **Optical Channel Adaptation to Optical Channel Transport Unit: OCh/OTUk_A**

  OCh/OTUk_Sk
  Clock recovery
  Frame alignment
  FEC decoding with corrected errors count
  Descrambler
  LOF detection
  LOM detection
  SSF insertion (on LOF detection)

  OCh/OTUk_So
  Frame alignment word insertion
  FEC encoding
  Scrambler

c) Optical Channel Transport Unit Layer

- **Optical Channel Transport Unit trail termination: OTUk_TT**

OTUk_TT_Sk

SM_TTI:	Trail Trace Identifier recovery and mismatch detection
SM_BDI:	Backward Defect Indication detection
SM_BEI/BIAE:	Backward Error Indication or Remote Incoming Alignment Error detection
SM_BIP8:	BIP8 errors detection and errored blocks count
SM_IAE:	Incoming Alignment Error detection

OTUk_TT_So

SM_TTI:	Trail Trace Identifier insertion
SM_BDI:	Backward Defect Indication insertion
SM_BEI/BIAE:	Backward Error Indication or Remote Incoming Alignment Error insertion
SM_BIP8:	Calculation and insertion of BIP-8 parity code
SM_IAE:	Incoming Alignment Error insertion

- **Optical Channel Transport Unit Adaptation to Optical Channel Data Unit: OTUk/ODUk_A**

OTUk/ODUk_Sk

Extraction of ODUk signal from incoming OTUk signal

OTUk/ODUk_So

Mapping of incoming ODUk signal into OTUk signal

d) Optical Channel Data Unit Layer

- **Optical Channel Data Unit trail termination: ODUk_TT**

ODUk_TT_Sk

PM_TTI:	Trail Trace Identifier recovery and 1495 mismatch detection
PM_BDI:	Backward Defect Indication detection
PM_BEI:	Backward Error Indication detection
PM_BIP8:	BIP8 errors detection and errored blocks count
PM_STAT:	AIS, OCI and LCK defect detection

ODUk_TT_So

PM_TTI:	Trail Trace Identifier insertion
PM_BDI:	Backward Defect Indication insertion
PM_BEI:	Backward Error Indication insertion
PM_BIP8:	Calculation and insertion of BIP-8 parity code

- **Optical Channel Data Unit Adaptation to Regenerator Section Layer: ODUk/RSn_A**

ODUk/RSn_Sk

Asynchronous demapping of RSn signal from ODUk frame
PT: payload type extraction for PLM detection
Frame alignment of STM-n signal

ODUk/RSn_So

Asynchronous mapping of RSn signal into ODUk frame

PT: insertion of the payload type

e) Regenerator Section Layer

As described in C.1.1 on page 609.

f) Multiplex Section Layer

As described in C.1.1 on page 609.

g) Path Layer

As described in C.1.1 on page 609.

C.1.3 SONET/SDH Higher Order Matrix board

The SONET/SDH Higher Order Matrix is implemented in the Matrix board of the equipment, by means of the payload agnostic switching device, able to switch both TDM and data traffic.

The device provides switching capabilities at MSP and VC-n level: Both MSPC (Multiplex Section Protection Connection) and HPC (Higher Order Path Connection) switching functions are in fact collapsed in the device. See section 1.7 on page 51 for maximum switching capability of HO matrix.

C.1.3.1 SONET/SDH HO Matrix physical representation

The corresponding functional model of the Matrix board is depicted in Figure 365. on page 619.

The status of MSPC and HPC connection functions are individually calculated as if they were two physical entities..

The switching command is then derived correlating MSPC status and HPC status.

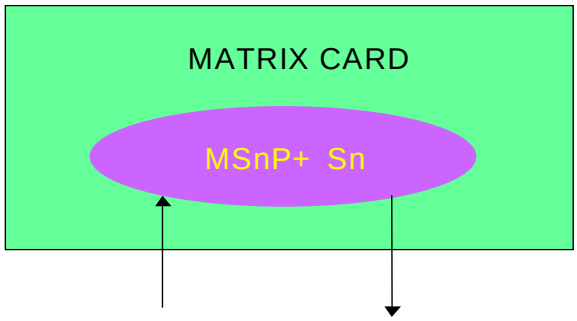


Figure 365. SONET/SDH HO Matrix board implementation

- **MSPC** (not operative in current release) connection function status is determined in order to provide protection for the STM-N signal against channel-associated failures within a multiplex section, by using the bit-oriented protocol defined for the MSP bytes K1, K2 and optionally K0. Under failure conditions, in Rx direction, valid data is no longer taken from the working line termination but from the spare one; the required switch operation for MSP protection does not involve HPC.
  Similarly in Tx direction, the MSPC status guarantees data forking to both working and spare lines.

  – Type of connection:

    - unprotected,
    - 1+1 protected by means of linear MSP protection
    - 1:N protected by means of linear MSP protection
    - protected by means of MS-SPRING

- **HPC** connection function status is generated in order to provide VC-ns connectivity among input and output ports. The assignment of incoming VC-ns to outgoing VC-ns is defined as the “connection pattern”, which can be described as a uni-directional connection matrix and characterized by:

  – Type of connection:

    - unprotected,
    - 1+1 protected by means of SNCP/I, SNCP/N, SNCP/S protection (the last two are not operative in current release)
    - protected by means of Label Based Restoration using the label protocol defined in K3 byte

  – Traffic direction (unidirectional, bi-directional).

  – Input and output connection points.

C.1.3.2 SONET/SDH HO Matrix logical implementation

From the logical point of view, the functions implemented in the Matrix board aim to the fulfillment ITU-T G.783 requirements.

Such functions are the so called "virtual images" of MSPC and HVC functions, described as follows.

- MSPC "virtual image" function: according to the MSPC switch status, this function conditions the information, carried via in band signaling, collected by physical MSA Sk and HVC functions located in the port board, in "before Matrix" configurations. The MSA Sk and HVC "before Matrix" report the results as if they were performed after the MSPC switch, as defined by the ITU-T G.783 functional model

- 1/MSPC "virtual image" function: according to the MSPC switch status, this function conditions the information, carried via in band signaling, collected by physical HVC functions located in the port board, in "after Matrix" configurations. The HVC "after Matrix" report the results as if they were performed after the MSPC switch, as defined by the ITU-T G.783 functional model. The notation 1/MSPC means that the performed action is the corresponding inverse operation with respect to MSPC

- HVC "virtual image" function: this function performs alarm F4 filtering and reporting, 1 second performance monitoring, reporting, and remote indications management. Note that the physical insertion of the remote indications in SONET/SDH POH is performed in the port board by HVC "physical functions"

Figure 366. on page 621 shows the virtual images functions integrated in the Matrix board. The characteristic information processed by each atomic function is composed of the information collected by the physical HVC functions. It should be noted that no payload processing is performed by "virtual image" functions.

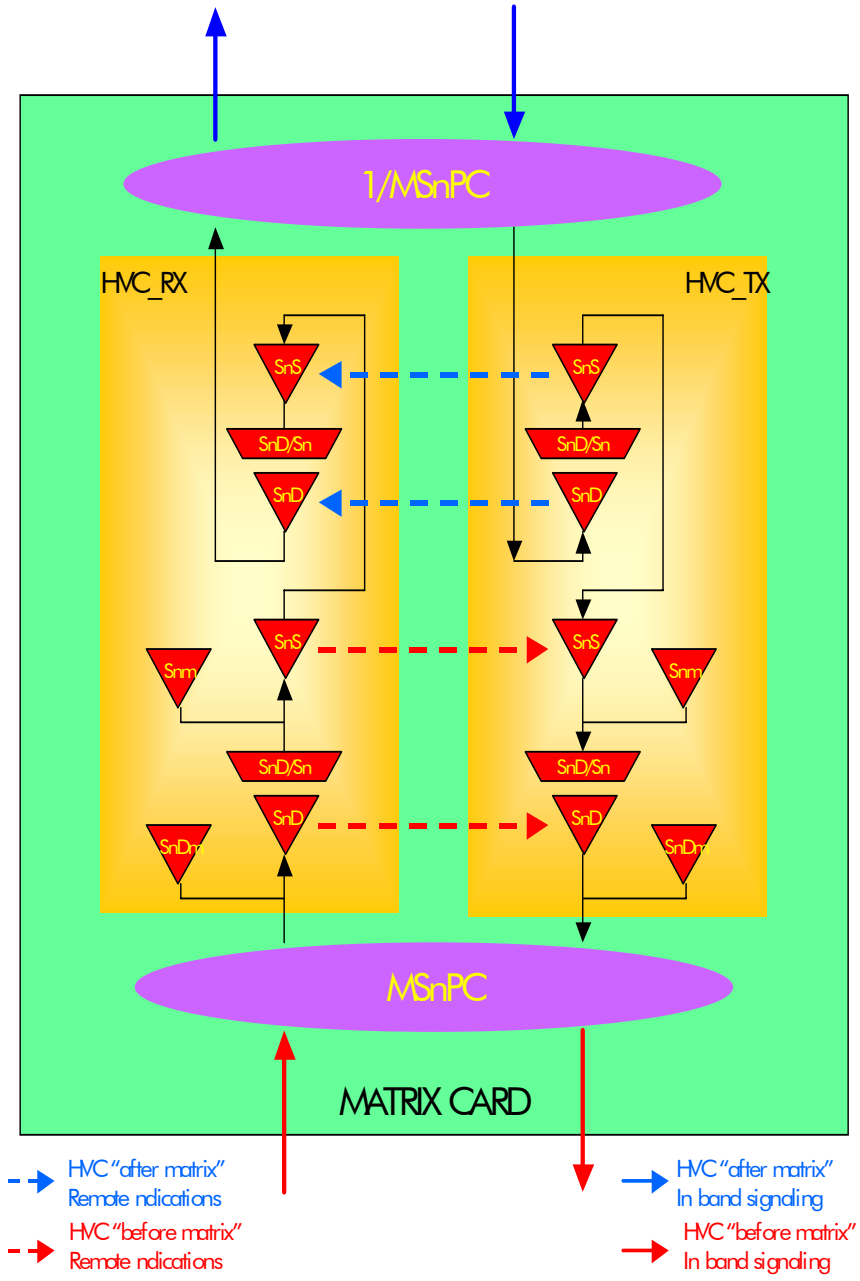


Figure 366. SONET/SDH MSPC/HPC Matrix board logical implementation

C.2 SONET/SDH Lower Order payload processing blocks

C.2.1 Lower Order tributaries processing (LOA)

The processing of the LO tributaries is performed in a dedicated card receiving/sending structured HO traffic from/to the HPC connection function.
After processing, the LO tributaries are carried to the LPC connection function for cross connection. This is obtained by means of a dedicated backplane in band signalling.

The generic LOA board for 1850 TSS-320 is depicted in Figure 367. on page 622 with its corresponding atomic functions representation, fully compliant with the G.783 functional model.
It should be noted that LOA card also provides the LO path termination functionalities needed for PDH and Data mapping over LO SONET/SDH.
For this application, the LPT functionality is performed between the HPT and HPA functionalities (needed to manage the "meaningless" HO tributaries used to carry the LO VCs from PDH and data cards to the LOA card) and the LTCT functionality.

The information collected from the LO tributaries processing is then transported to the LO switching element via a dedicated in-band signalling through the backplane frame format.

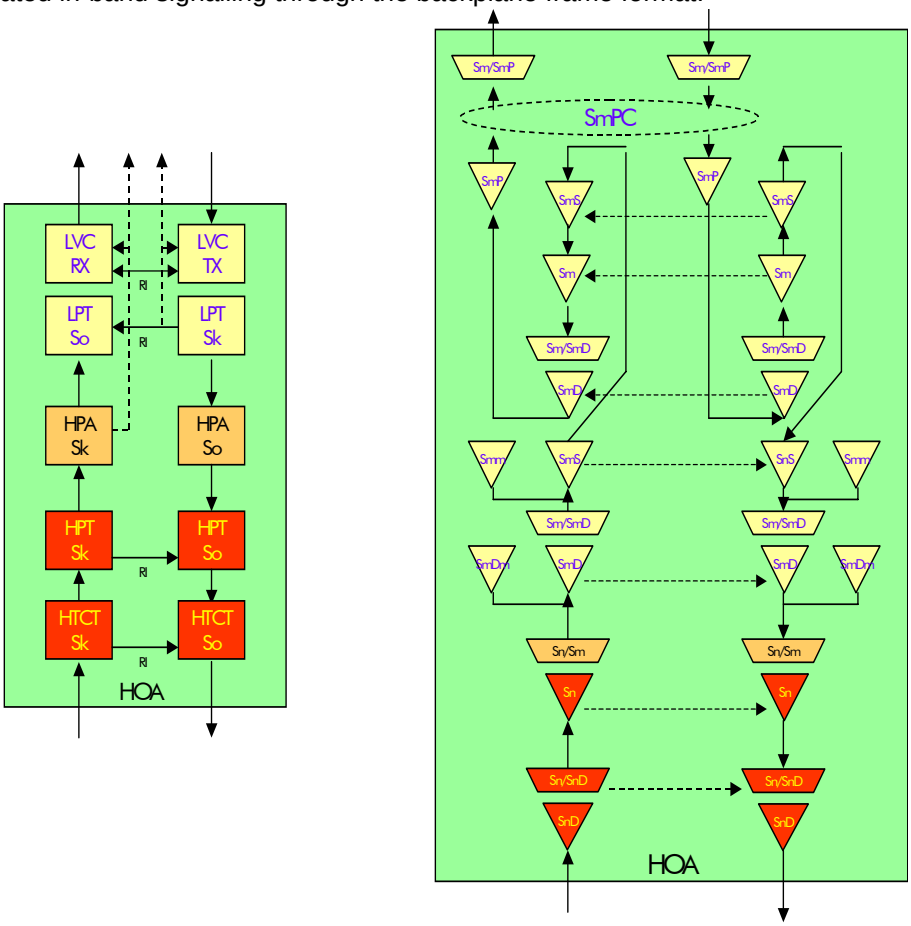


Figure 367. SONET/SDH LO processing (LOA) board implementation and ITU-T G.783 functional model

a) HO Path Layer

- **VC-4 Tandem Connection Trail Termination: SnD_TT**

  For SONET tributaries the function is not applied.

  For SDH VC-4 tributaries, see C.1.1 on page 609 for details.

- **High Order Path trail termination Function (HPT): Sn_TT**

  Sn_TT_Sk

  J1: Path Trace information is recovered.
  G1[1-4]: The REI information is recovered.
  G1[5-7]: Path Status monitoring detection --> G1[5] is used for HP-RDI detection; G1[6-7] is optionally used for HP-RDI coding enhancement.
  C2: Signal Label Monitoring --> UNEQ and VC-AIS detection.
  B3: VC-n BIP-8 Errored Block Count.
  TSF insertion (on SSF or UNEQ or TIM or AIS detection).
  TSD insertion (on a condition of degraded signal detection).

  Sn_TT_So

  J1: Path Trace information insertion.
  G1[1-4]: The REI information insertion on B3 errors detection.
  G1[5-7]: Path Status monitoring insertion --> G1[5] is used for HP-RDI; G1[6-7] is optionally used for RDI enhancement.
  B3: VC-n BIP-8 calculation and insertion

- **High Order Path adaptation to Lower Order Path layer (HPA): Sn/Sm_A**

  Sn/Sm_A_Sk

  TU pointer interpretation
  Multiframe alignment recovery (not significant for VC-3)
  HO payload deassembly into LO tributaries

  Sn/Sm_A_So

  TU pointer generation
  PJE events count
  Multiframe alignment generation (not significant for VC-3)
  HO payload assembly from LO tributaries

b) LO Path Layer

- **Lower Order Path non intrusive monitoring Function (LPOM): Smm**
  For VC-3 LO tributaries (m=3), refer to Snm_TT functions described in section C.1.1 on page 609.
  For other LO tributaries:

  Smm_TT_Sk

  J2: Path Trace information is recovered.
  V5[3]: The REI information is recovered.
  V5[8]: Path Status monitoring detection.
  V5[5-7]: Signal Label Monitoring --> UNEQ and VC-AIS detection.
  V5[1-2]: VC-m BIP-2 Errored Block Count.

- **Lower Order Supervisory Unequipped Termination (LSUT): Sms_TT**
  For VC-3 LO tributaries (m=3), refer to Sns_TT functions described in section C.1.1 on page 609.
  For other LO tributaries:

  Sms_TT_Sk

  J2: Path Trace information is recovered.
  V5[3]: The REI information is recovered.
  V5[8]: Path Status monitoring detection.
  V5[5-7]: Signal Label Monitoring --> UNEQ and VC-AIS detection.
  V5[1-2]: VC-m BIP-2 Errored Block Count.

  Sms_TT_So

  Generation of an unequipped container and frame offset.
  V5[5-7]: "unequipped" insertion.
  J2: trail trace identifier is generated.
  V5[3]: insertion of REI information.
  V5[8]: insertion of RDI information.
  V5[1-2]: VC-4 Bip-8 calculation and insertion.

- **Lower Order Tandem Connection Trail Termination: SmD_TT**
  For SONET tributaries the functions is not applied.
  For SDH VC-3 LO tributaries (m=3), refer to SnD_TT functions described in section C.1.1 on page 609.
  For SDH VC-12 tributaries, the following applies:

  SmD_TT_Sk

  N2[1-2]: VC-12 BIP-2 extraction and EDC calculation.
  N2[8][73]: RDI extraction.
  N2[5]: REI extraction.
  N2[7][74]: ODI extraction (Outgoing Defect Indication).
  N2[6]: OEI extraction (Outgoing Error Indication).
  N2[7-8]: extraction from the multiframed channel N2[7-8] of:
    - FAS (Frame Alignment Signal) in frames 1 to 8.
    - trace identifier in frames 9 to 72.
    - TC RDI and ODI in frames 73 to 76.

  V5[1-2]: BIP-2 compensation.

  SmD_TT_So

  N2[8][73]: RDI insertion.
  N2[5]: REI insertion.
  N2[7][74]: ODI insertion (Outgoing Defect Indication).
  N2[6]: OEI insertion (Outgoing Error Indication).
  N2[7-8]: insertion in the multiframed channel N2[7-8] of:
    - FAS (Frame Alignment Signal) in frames 1 to 8.
    - trace identifier in frames 9 to 72.
    - TC RDI and ODI in frames 73 to 76.

  N2[1-2]: BIP-2 calculation and insertion.
  V5[1-2]: BIP-2 compensation

.

- **Lower Order Tandem Connection Adaptation: Sm/SmD_A**
  For SONET tributaries the functions is not applied.
  For SDH VC-3 LO tributaries (m=3), refer to Sn/SnD_A functions described in section C.1.1 on page 609
  For SDH VC-12 tributaries, the following applies:

  Sm/SmD_A_Sk

  This function restores the invalid Frame Start condition if that existed at the ingress of the tandem connection.
  AIS insertion.

  Sn/SmD_A_So

  This function replaces the incoming Frame Start signal by a local generated one if all-ONEs VC is received.

- **Lower Order Tandem Connection non-intrusive monitoring: SmDm_TT**
  For SONET tributaries the functions is not applied.
  For SDH VC-3 LO tributaries (m=3), refer to SnD_TT functions described in section C.1.1 on page 609. For SDH VC-12 tributaries, the following applies:

  SmD_TT_Sk

  N2[1-2]: VC-12 BIP-2 extraction and EDC calculation.
  N2[8][73]: RDI extraction.
  N2[5]: REI extraction.
  N2[7][74]: ODI extraction (Outgoing Defect Indication).
  N2[6]: OEI extraction (Outgoing Error Indication).
  N2[7-8]: extraction from the multiframed channel N2[7-8] of:
  - FAS (Frame Alignment Signal) in frames 1 to 8.
  - trace identifier in frames 9 to 72.
  - TC RDI and ODI in frames 73 to 76.

- **Lower Order Path trail termination (LPT): Sm_TT**
  Note that the Lower Order path termination function is needed for PDH or data mapping applications over LO tributaries. For Lower Order processing applications, only non intrusive path monitoring should be performed.

  Sm_TT_Sk

  J2: trail trace identifier recovery
  V5[1, 2]: BIP-2 errored blocks count
  V5[3]: REI information extraction
  V5[8]: RDI detection
  K4[5-7]: optional use of enhanced-RDI (E-RDI)

  Sm_TT_So

  J2: trail trace identifier insertion
  V5[1, 2]: BIP-2 calculation and insertion
  V5[3]: REI insertion on BIP-2 errors detection
  V5[8]: RDI insertion
  K4[5-7]: optional use of enhanced-RDI (E-RDI)

- **Path Sub-layer protection function:**
  For VC-3 LO tributaries (m=3), refer to Sub layer protection functions described in section C.1.1 on page 609.
  For other LO tributaries:

  – **Path Layer Adaptation to the Path Protection Sub-layer: Sm/SmP_A**

    Sm/SmP_A_Sk
    SSF insertion (on TSF detection)
    SSD insertion (on TSD detection)

    Sm/SmP_A_So
    No information is inserted

  – **Path Protection Sub-layer Termination: SmP_TT**

    SmP_TT_Sk
    SSF detection
    TSF insertion (on SSF detection)

    SmP_TT_So
    no information is inserted

C.2.1.1 AU3/TU3 conversion function

The Lower Order processing subsystem, in addition, provides the capability to convert AU3 into TU3 and vice versa to convert VC3 HO tributaries carried over a OC-N signal, and map them into a structured HO VC4 tributary carried over an STM-N signal to allow SONET/SDH conversion.

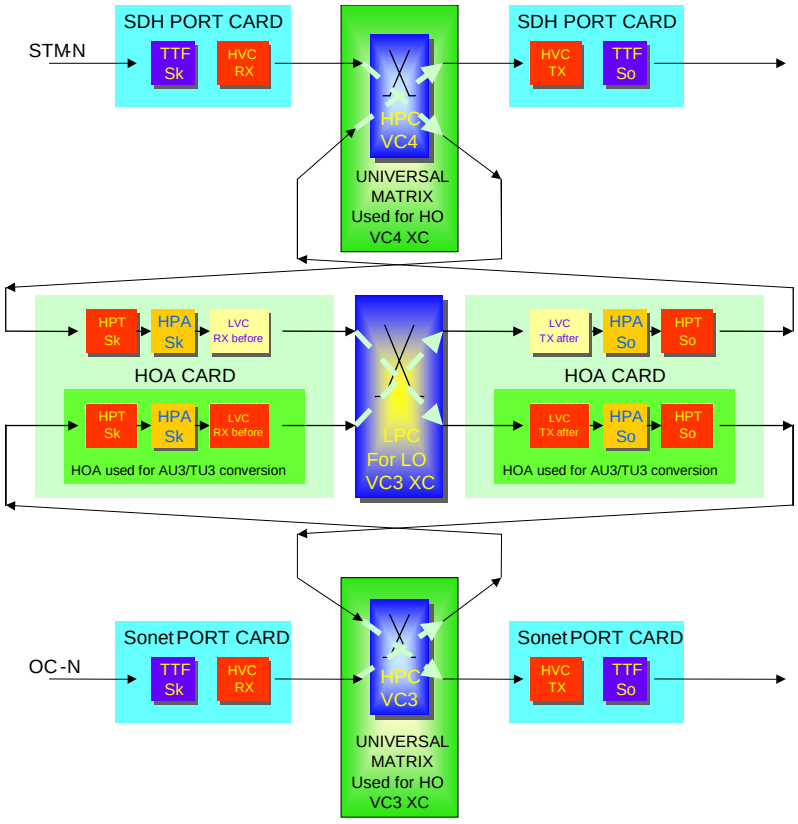


Figure 368. LOA utilization for AU3/TU3 conversion.

Figure 368. on page 627 shows the use of the system to achieve AU3/TU3 conversion. As depicted, the HO Universal Matrix has to aggregate the traffic coming from both SONET and SDH side to the LOA card, providing VC-4 and VC-3 cross-connection capabilities at the same time.

The LOA card then provides two different functionalities: one devoted to the processing of the VC-3 LO tributaries carried over structured VC-4s, the other devoted to the conversion of AU-3 containers into TU-3. In this way, SONET HO VC-3s are converted into SDH LO VC-3.

C.2.2 LO Matrix

The LO Matrix is implemented in the Matrix board of the equipment by means of a dedicated device that provides switching capabilities with VC-3/VC-12/VC-11 granularity, thereby providing full applicability to both SDH and SONET. The switching capability is fully non blocking with respect to any broadcast type.

The Matrix receives LO tributaries from the LOA board together with the information, carried via in band signalling, representing the status of each LO tributary. Such information are processed in the LO Matrix device in order to calculate the state of the LPC connection function and then perform the switching command. The corresponding functional model of the Matrix board is depicted in Figure 369. on page 628.

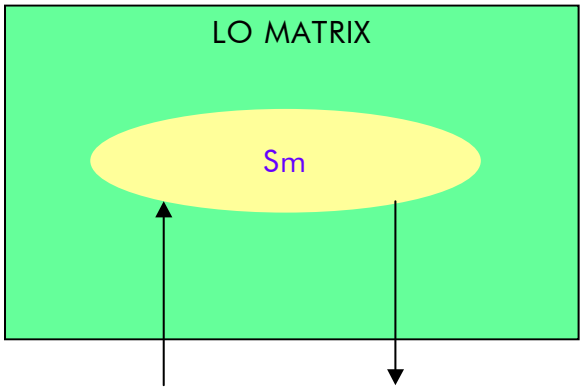


Figure 369. SONET / SDH LO Matrix functional model

- **Sm_CF (LPC):** LO connection function status is generated in order to provide VC-m (m= 3, 12, 11) connectivity among input and output ports. The assignment of incoming VC-m to outgoing VC-m is defined as the 'connection pattern', which can be described as a uni-directional connection Matrix and characterized by:
  - **Type of connection** (unprotected, 1+1 protected by means of SNCP/I, SNCP/N, SNCP/S protection).
    Note: SNCP/N, SNCP/S protection are not operative in current release
  - **Traffic direction** (unidirectional, bi-directional)
  - Input and output connection points

C.3 SONET/SDH PDH mapping processing blocks

C.3.1 HOI card

The Higher Order Interface card manages the mapping of PDH clients into Higher Order SONET/SDH tributaries (for example, E4 over VC-4 or DS3 over VC-3).

The card is interfaced with the payload Universal Matrix device for HPC functionalities implementation. HVC functionalities managed in the HOI card are limited, according to G.783 specifications, to the HTCT (that is, the card implements a 'before Matrix' TCT). Non-intrusive monitoring of the PDH signals is performed before their mapping into SONET/SDH payload in one direction, and after the demapping in the other direction.

The generic card block diagram, with its atomic functions representation, is depicted in Figure 370. on page 629.

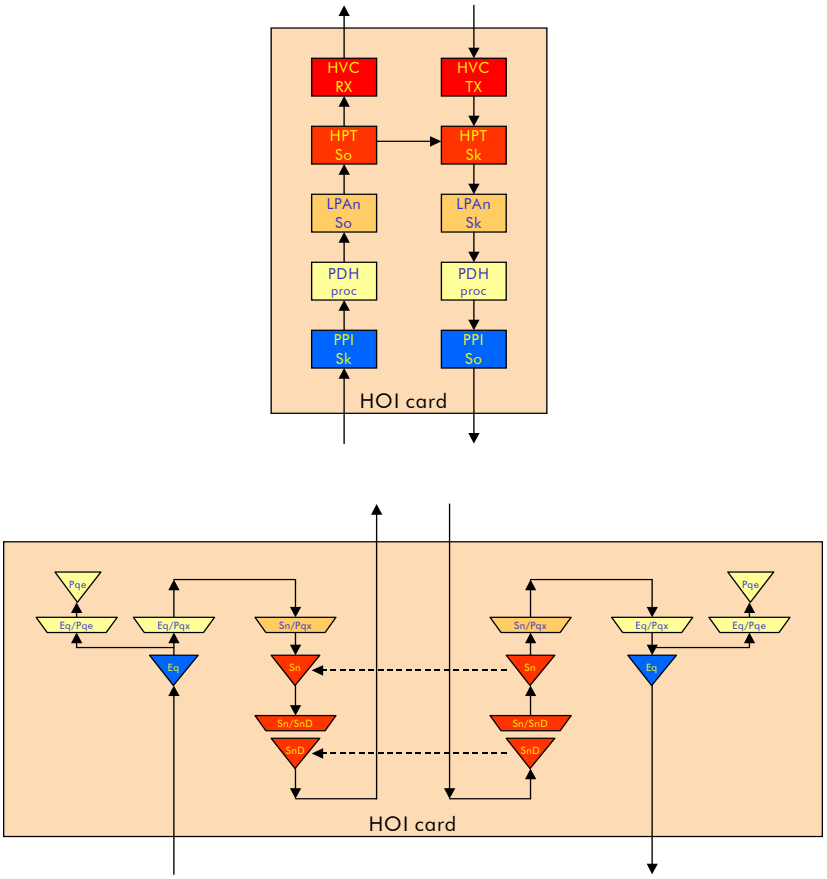


Figure 370. PDH mapping into HO SONET/SDH (HOI) card implementation and ITU-T functional model

a) Plesiochronous Physical layer

Note that *q* = 4,3.

- **Physical Trail Termination (PPI): Eq_TT**
  Eq_TT_Sk
  Electrical signal recovery
  LOS detection
  Eq_TT_So
  Generation of the electrical signal

- **Physical Layer adaptation to PDH client: Eq/Pqx_A**
  Eq/Pqx_A_Sk
  Clock recovery
  Signal decoding
  Eq/Pqx_A_So
  Signal encoding

- **Physical Layer adaptation to framed PDH client: Eq/Pqe_A**
  Eq/Pqe_A_Sk
  Clock recovery
  Signal decoding
  Frame alignment with LOF detection
  Eq/Pqe_A_So
  Signal encoding

- **Framed PDH client monitoring: Pqem**
  Pqem_Sk
  RDI detection
  Near End errored block count

b) HO Path Layer

- **High Order Path adaptation to PDH client layer (LPAn): Sn/Pqx_A**
  Sn/Pqx_A_Sk
  C2 byte extraction for PLM detection
  Client signal de-mapping
  Sn/Pqx_A_So
  C2 byte insertion
  Client signal mapping

- **High Order Path trail termination (HPT): Sn_TT**
  As described in section C.2.1 on page 622.

- **VC-4 Tandem Connection Trail Termination: SnD_TT**
  As described in section C.1.1 on page 609.

- **VC-4 Tandem Connection Adaptation: SnD_A**
  As described in section C.1.1 on page 609.

C.3.2 LOI card

The Lower Order Interface card manages the mapping of PDH clients into Lower Order SONET/SDH tributaries (for exampl, E2 over VC-12 or DS1 over VC-11).

The card is interfaced with the payload Universal Matrix device, but differently from HOI. Here, the Matrix is only used for HO tributaries aggregation to present traffic to the LOA boards, as above described.
The generic card block diagram, with its atomic functions representation, is depicted in Figure 371. on page 631.

In the LOI card representation, the LPT and LVC functional blocks are depicted with a dotted box, due to the fact that the physical implementation is not in the LOI card, but in the LOA cards managing the LPC interfacing (the diagrams shows the logical implementation of the LOI card). The LOI cards generate a LO VC with a meaningless path OH, mapped into an HO VC needed for intrashelf interconnection.

The LO tributaries are then processed as described in section C.2.1 on page 622.
Non-intrusive monitoring of the PDH signals is performed before their mapping into SONET/SDH payload in one direction, and after their demapping in the other direction.

For E2 client signals, it is also possible to terminate the PDH frames managing PRA functionalities.

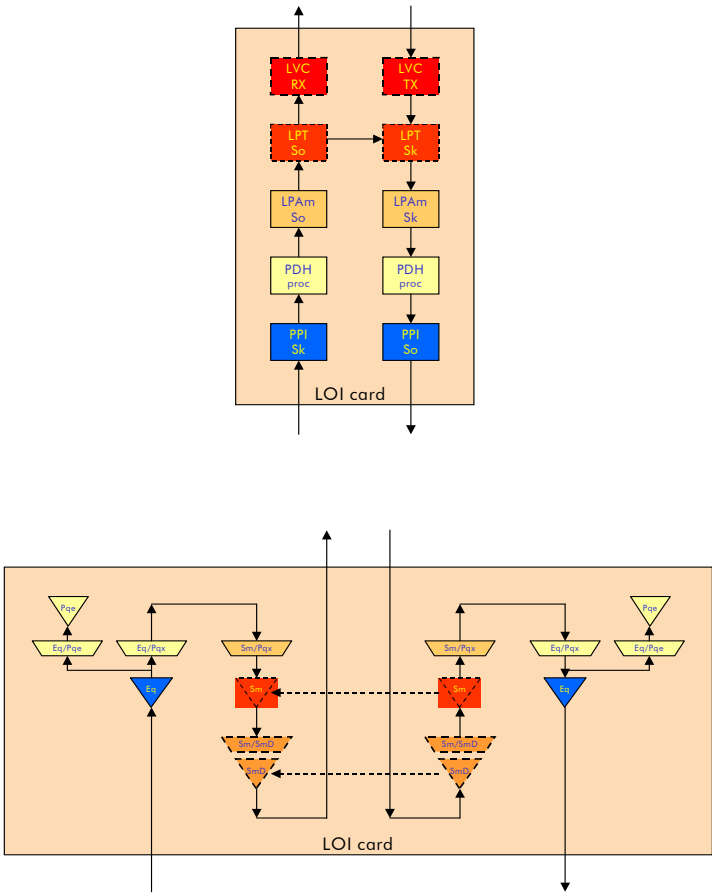


Figure 371. PDH mapping into LO SONET/SDH (LOI) card implementation and ITU-T functional model

a) Plesiochronous Physical layer

Note that q = 12,11.

- **Physical Trail Termination (PPI): Eq_TT**

  Eq_TT_Sk
  Electrical signal recovery
  LOS detection

  Eq_TT_So
  Generation of the electrical signal

- **Physical Layer adaptation to PDH client: Eq/Pqx_A**

  Eq/Pqx_A_Sk
  Clock recovery
  Signal decoding

  Eq/Pqx_A_So
  Signal encoding

- **Physical Layer adaptation to framed PDH client: Eq/Pqe_A**

  Eq/Pqe_A_Sk
  Clock recovery
  Signal decoding
  Frame alignment with LOF detection

  Eq/Pqe_A_So
  Signal encoding

- **Framed PDH client monitoring: Pqem**

  Pqem_Sk
  RDI detection
  Near End errored block count

b) LO Path Layer

- **Lower Order Path adaptation to PDH client layer (LPAm): Sm/Pqx_A**

  Sm/Pqx_A_Sk
  K4 byte extraction for PLM detection
  Client signal demapping

  Sm/Pqx_A_So
  K4 byte insertion
  Client signal mapping

C.4 TMUX

TBA

C.5 OTN Processing Blocks

C.5.1 NNI card

The OTN NNI card processes OTN signals received from the line. ODUk information recovered from OTUk signals are processed as well, in order to provide path monitoring or TCT functionalities.

Different from SONET/SDH cards, alarms and performance monitoring are managed in the OTN port board with no need for a process to be completion in the Matrix board. As far as the switching criteria collection, for protection mechanisms, the information collected from the OTUk and ODUk processing is transported to the ODUk switching element via a dedicated in band signalling through the backplane frame format.

The generic OTN NNI card for 1850 TSS-320 equipment is depicted in Figure 372. on page 633 with its corresponding atomic functions representation; it is fully compliant with the G.798 functional model.

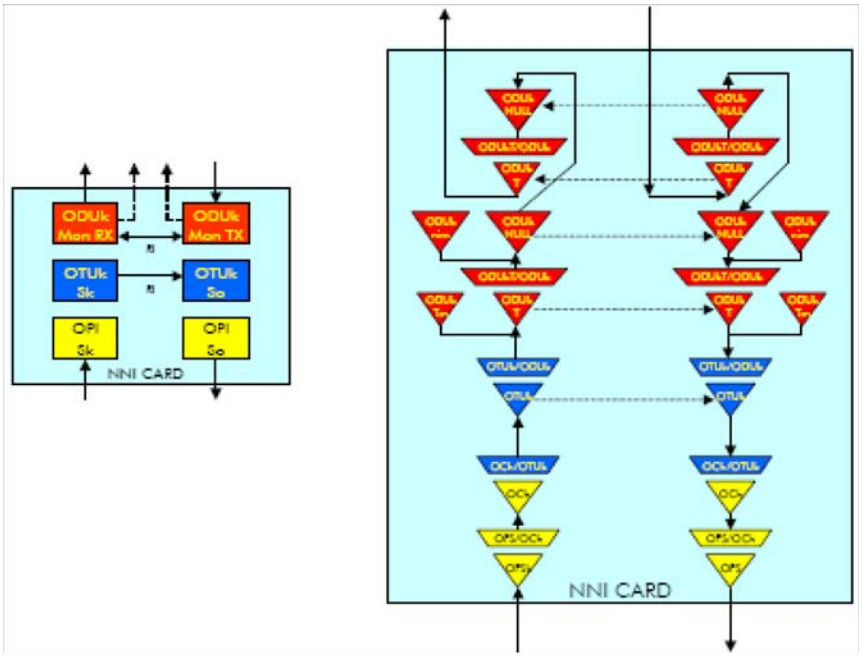


Figure 372. OTN processing NNI board implementation and corresponding ITU-T G.798 functional model

a) OTN Physical Layer

As described in C.1.2 on page 615.

b) Optical Channel Layer

As described in C.1.2 on page 615.

c) Optical Channel Transport Unit Layer

As described in C.1.2 on page 615.

In addition:

GCC0: embedded communication channel insertion and extraction.
Generation of ODUk-AIS and ODUk-LCK

d) Optical Channel Data Unit Layer

- **Optical Channel Data Unit Tandem connection trail termination: ODUkT_TT**

  ODUkT_TT_Sk
  To be added

  ODUkT_TT_So
  To be added

- **Optical Channel Data Unit Adaptation to Tandem connection sublayer: ODUk/ODUkT_A**

  ODUk/ODUkT_Sk
  To be added

  ODUk/ODUkT_So
  To be added

- **Optical Channel Data NULL termination: 1901 ODUk_NULL_TT**

  ODUk_NULL_Sk
  To be added

  ODUk_NULL_So
  To be added

- **Optical Channel Data Unit trail termination monitoring: ODUk_TT_mon**
  As the ODUk_TT_Sk function described in C.1.2 on page 615, but without consequent actions activation.

C.5.2 UNI card

The OTN UNI card provides the capability to map a generic CBR signal (2.48Mb/s into ODU1 or 9.95Mb/s into ODU2) into ODUk frames. The capability to non-intrusively monitor the client signal is also provided.

Different from SONET/SDH cards, alarms and performance monitoring are managed in the OTN port board with no need for a process to be completed in the Matrix board. The generic OTN UNI card for 1850 TSS-320 equipment is depicted in Figure 373. on page 635 with its corresponding atomic functions representation, fully compliant with G.783/G.798 functional model.

The OTN NNI card processes OTN signals received from the line. ODUk information recovered from OTUk signals are processed as well, in order to provide path monitoring or TCT functionalities.

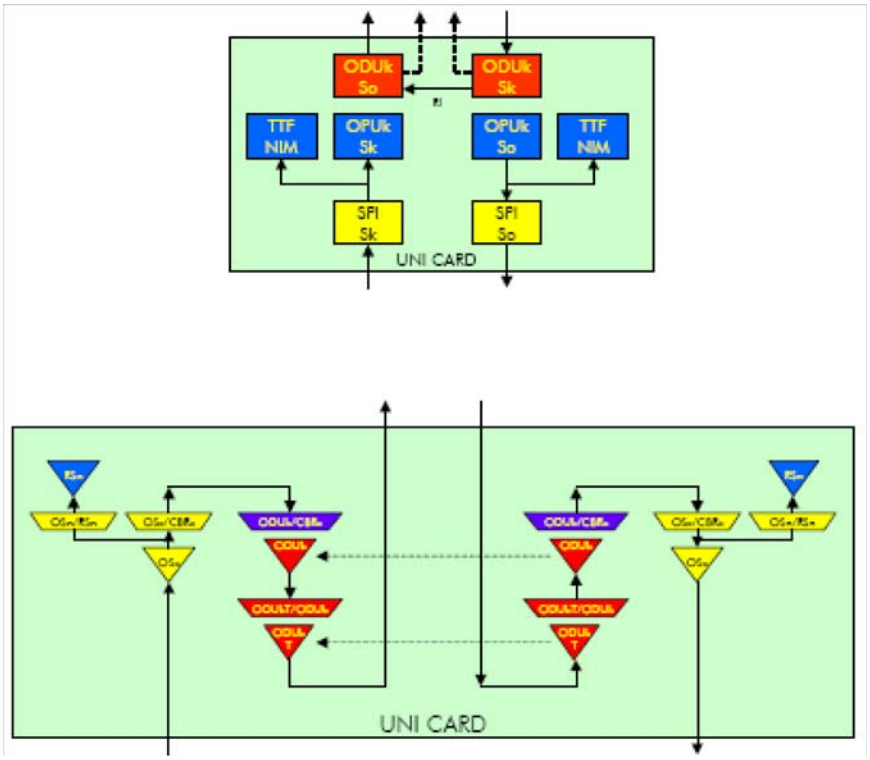


Figure 373. OTN processing UNI board implementation and corresponding ITU-T G.798 functional model

a) SONET/SDH Physical Layer

- **Optical Channel Data Unit Tandem connection trail termination: ODUkT_TT**

  As described in C.1.1 on page 609.

- **Optical Section Layer Adaptation to CBR: Osn/CBR_A**

  Osn/CBR_Sk

  Demodulation of optical signal
  AIS insertion (tbc)

Osn/CBR_So
Modulation of optical signal

b) Regenerator Section Layer monitoring

- **Optical Section Layer Adaptation to Regenerator Section Layer: OSn/RSn_A**

  As described in C.1.1 on page 609.

- **Regenerator Section Layer Trail Termination: RSn_TT**

  As described in C.1.1 on page 609, but without consequent action activation.

c) Optical Channel Data Unit Layer

- **Optical Channel Data unit Adaptation to CBR: ODUk/CBR_A**

  ODUk/CBR_Sk
  Asynchronous demapping of CBR signal from ODUk frame

  ODUk/CBR_So
  Asynchronous mapping of CBR signal into ODUk frame

- **Optical Channel Data Unit trail termination: ODUk_TT**

  As described in C.1.2 on page 615.
  In addition:
  GCC1, 2: embedded communication channel insertion and extraction.

- **Optical Channel Data Unit Tandem connection trail termination: ODUkT_TT**

  As described in C.5.1 on page 633.

- **Optical Channel Data Unit Adaptation to Tandem connection subayer: ODUk/ODUkT_A**

  As described in C.5.1 on page 633.

C.5.3 OTN concentrator (4xODU1) card

The OTN concentrator card provides the capability to map into ODU2 frames four ODU1 tributary signals. ODU1 signals are also processed to provide path monitoring or TCT functionalities.

Different from SONET/SDH cards, performance monitoring is managed in the OTN port board with need need for process to be completed in the Matrix board. As far as the switching criteria collection, for protection mechanisms, the information collected from the ODU1 processing is then used for generation of the switching criteria for ODU1 protection triggering. The criteria is transported to the ODU1 switching element via a dedicated in band signalling through the backplane frame format.

Note: Management of ODU protections is still under assesment when ODUk multiplexing is being performed.

The generic OTN concentrator card for 1850 TSS-320 equipment is depicted in Figure 374. on page 637 with its corresponding atomic functions representation, fully compliant with G.798 functional model.

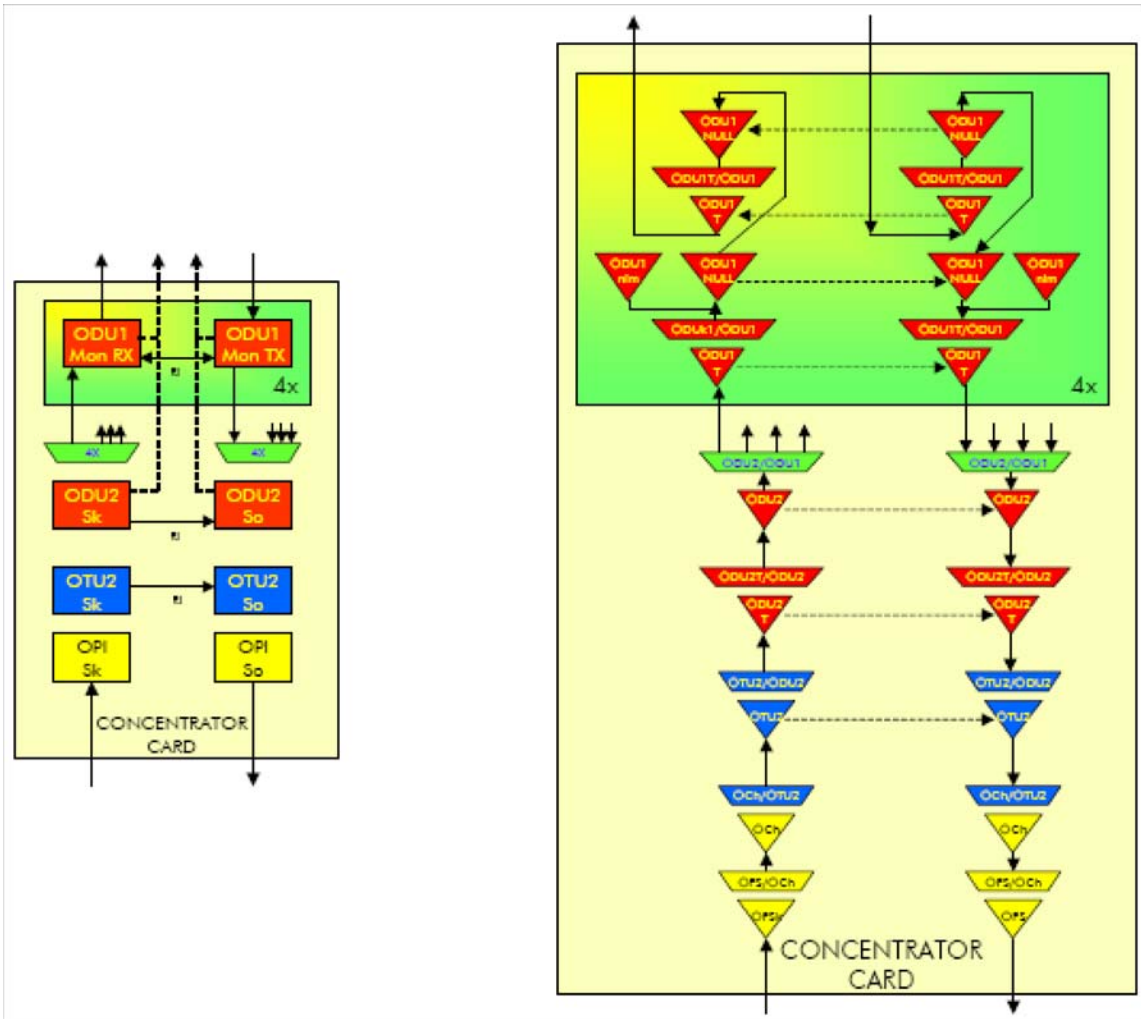


Figure 374. OTN concentrator board implementation and corresponding ITU-T G.798 functional model

a) OTN Physical Layer

As described in C.1.2 on page 615.

b) Optical Channel Layer

As described in C.1.2 on page 615.

c) Optical Channel Transport Unit Layer

As described in C.1.2 on page 615 with k=2.
In addition:
GCC0: embedded communication channel insertion and extraction.

d) Optical Channel Data Unit Layer

- **Optical Channel Data Unit trail termination: ODU2_TT**
  As described in C.1.2 on page 615.
  In addition:
  GCC1, 2: embedded communication channel insertion and extraction.

- **Optical Channel Data Unit multiplexing: ODU2/ODU1_A**

  ODU2/ODU1_Sk
  Demultiplies 4xODU1 frames from ODU2 payload area
  Extract ODU1 individual clocks

  ODU2/ODU1_So
  Multiplies 4xODU1 frames into one 1981 ODU2 payload area

- **Optical Channel Data Unit Tandem connection trail termination: ODU1T_TT**
  As described in C.5.1 on page 633 with k=1.

- **Optical Channel Data Unit Adaptation to Tandem connection sublayer: ODU1/ODU1T_A**
  As described in C.5.1 on page 633 with k=1.

- **Optical Channel Data NULL termination: ODU1_NULL_TT**
  As described in C.5.1 on page 633 with k=1.

- **Optical Channel Data Unit trail termination monitoring: ODU1_TT_mon**
  As ODUk_TT_Sk function described in C.5.2 on page 635, but without consequent actions activation, with k=1.

C.5.4 ODUk matrix

The ODUk matrix is implemented in the Matrix board of the equipment, by means of the payload agnostic switching device, able to switch both TDM and data traffic. The device is able to provide switching capabilities with ODU1 and ODU2 granularity, fully non blocking with respect to any broadcast type. See section 1.7 on page 51 for the maximum switching capacity.

The Matrix receives ODUk traffic from the OTN port boards together with the information, carried via in band signalling, representing the status of each processed ODUk. Such information are processed in the Matrix board in order to calculate the state of the ODUk connection function and perform then the switching command. The corresponding functional model of the Matrix board is depicted in Figure 375. on page 639.

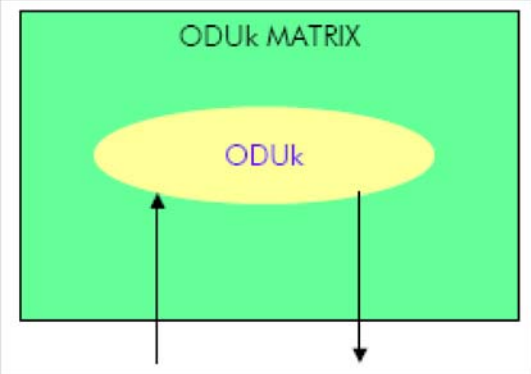


Figure 375. ODUk matrix functional model

– **ODUk_CF**: ODUk connection function status is generated in order to provide ODUk (k= 1,2) connectivity among input and output ports. The assignment of incoming ODUk to outgoing ODUk is defined as the “connection pattern” which can be described as a uni-directional connection matrix and characterized by:
  - **Type of connection** (unprotected, 1+1 protected by means of SNC/I, SNC/N, SNC/S protection or 1:n SNCP by using the bit oriented protocol defined in APS bytes of the ODUk OH).
  - **ODUk ring protections**
  - **Traffic direction** (unidirectional, bi-directional).
  - Input and output connection points.

  The OCI generation (tbc).

C.6 Data processing blocks

C.6.1 Data collector card

Data collector boards manage incoming Ethernet traffic (either GE or FE) providing collection of customer traffic.

Packet processing is performed on SVLAN base, thus providing Ethernet 2017 provider bridging functionalities, in the so called ‘promisquous’ mode, with no frame discarding. Input/output scheduling functionalities are also implemented, for RX and TX client signals respectively, to effectively manage the packet switching. In addition, data collector boards manage access/collection of customer traffic (UNI interfaces) aggregated in MPLS pipes (PW LSPs or TUNNELs) in cooperation with aggregator boards.

Figure 376. on page 640 represents the block diagram for data collector board.

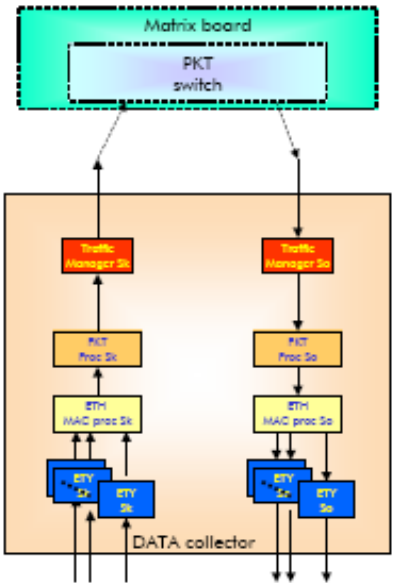


Figure 376. Data collector block diagram.

- **ETY Sk**
  Recovers data from line encoded signal
  Detects LOS:

- **ETY So**
  Condition data for line transmission
  ALS management

- **ETH MAC processing Sk**
  MAC validity check
  Pause frame reception
  Metering on port base
  Flow control
  According to IEEE standard 802.3

- **ETH MAC processing SO**
  MAC generation
  Pause frames generation
  Back pressure So process
  Metering on port base
  According to IEEE standard 802.3

Packet processor

Packet processing in data collector boards manage the following ports:

– MAC 2047 port
– Virtual bridge port
– Provider bridge port
– ETS port
– MPLS port

Interworking between ETS/MPLS and Provider Bridge/ETS is also managed.

Figure 377. on page 641 is the functional block diagram of the packet processor.

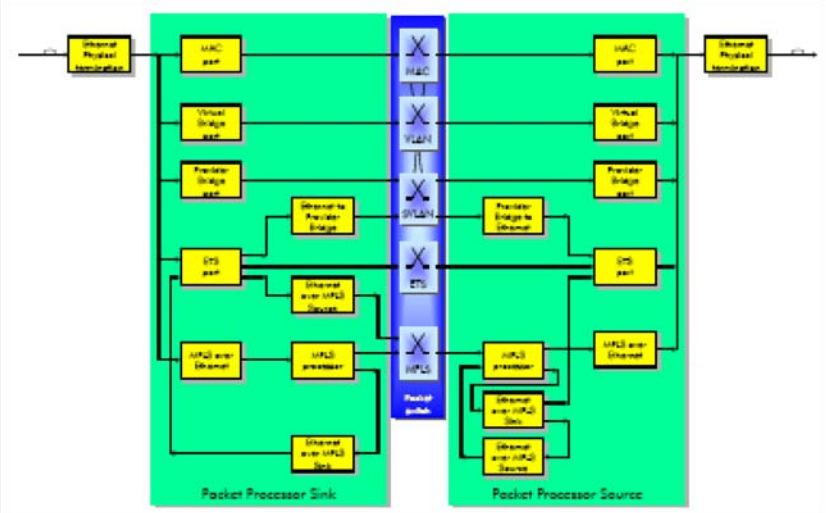


Figure 377. Packet processor block diagram.

– **MAC Port**
  Classification on the MAC DA base
  Snooping
  Control and signaling packet drop
  Data packets forwarding on the MAC DA base
  Metering on port base

– **Virtual Bridge Port**
  Classification on VLAN ID MAC DA and priority base
  Snooping
  User priority regeneration
  Ingress rule checking

VLAN popping (tbc)
MAC Learning
Control and signaling packet drop
Data packets forwarding on the VLAN MAC DA base
Metering on the VLAN base

– **Provider Bridge Port**
  Classification on the VLAN ID MAC DA and priority base with configurable ETH type
  Snooping
  User priority regeneration
  Ingress rule checking
  VLAN popping (tbc)
  MAC Learning
  Control and signaling packet drop
  Data packets forwarding on the VLAN MAC DA base
  Metering on the VLAN base

– **ETS Port**
  • ***ETS processing***
    Classification on the VLAN ID MAC DA and priority base with configurable ETH type
    Optional VLAN popping
    MAC Learning
    Control frames filtering
    Metering on the flow base
    Policing
    Forwarding to:
    – ETS switch
    – ETS_So (point to point applications)
    – Ethernet over MPLS adaptation function
    – ETS to Provider bridge adaptation

Ethernet over MPLS (EOM) Source	ETS to provider Bridge adaptation
Metering on the flow base Martini encapsulation Forwarding (to MPLS switch)	Counting on the flow base MAC Learning Forwarding on MAC DA and SVLAN Metering on the SVLAN base

– **MPLS Port**
  • ***MPLS over Ethernet (MOE) Sink***
    Frames discarding on MAC DA base
    Dropping of frames with type different from the expected ones
    Metering of dropped frames
    Control and signaling packet forwarding to Host CPU
    MPLS frames decaspulation from ETH
    MPLS processing
    OAM label processing
    Activation of protection process
    Classification on top label base and EXP bits

Dropping of packets with unknown label
Metering on tunnel base
Depending on the received label:

Lower TE tunnel forwarding	***Lower TE tunnel termination***	
TTL management Forwarding	Metering on tunnel base Check end-of-stack bit	
	if = '0' Upper TE tunnel forwarding	*if = '1' Pseudo Wire*
	Top label popping Classification on new top label Dropping of packets with unknown label Policing Metering TTL management Forwarding	Depending on provisioning the following can be either applied: 1) Forward to Host CPU 2) Discard 3) ETS in flow processing (EoM Sk: function: see ETS port processing for details)

– **Paket processor So**
  - ***MAC Port***
    MAC Learning
    Packet transmisison
  - **MAC Port**
    VLAN tagging
    Metering on VLAN base
  - **Provider Bridge Port**
    VLAN tagging
    Metering on VLAN base

– **ETS Port**
  - ***ETS processing***
    Optional VLAN popping with configurable Eth type
    Metering

Ethernet over MPLS (EOM) Sink	Provider Bridgeto ETS adaptation
Martini decapsulation Classification on the MAC DA (for VPLS only) MAC Learning (for VPLS only) Policing Metering on flow base	Metering on SVLAN base Counting on flow base

– **MPLS Port**
  - ***MPLS processing***
    Depending on the application (forwarding/termination) determined at the MPLS Sk port, the following should be applied:

<table>
<tr><td rowspan="3"><u>Lower TE tunnel forwarding</u>
Label swap or swap and push
Packet length check
Discard of long packets
Metering on LSP base
Metering on MPLS port base</td><td colspan="2"><u>Lower TE tunnel termination</u>
Check end-of-stack bit</td></tr>
<tr><td>if = ‘1’ Pseudo Wire</td><td>if = ‘0’</td></tr>
<tr><td>ETS in flow processing (EoM Sk: function: see ETS port processing for details)</td><td>Frames discard</td></tr>
</table>

  - **MPLS over Ethernet (MOE) Source**
    Address resolution
    MPLS frames encapsulation in Ethernet
    Control frames insertion from host CPU

– **Traffic manager Sk**
  QoS
  Input Scheduling
  Out-of-profile packet dropping
  Metering at following levels: ETS flow, port, MPLS pw, MPLS tunnel
  WRED buffering
  Back pressure to Packet Processor
  Multicasting at board level

– **Traffic manager So**
  Output scheduling
  Output shaping
  Multicasting at port or tunnel level (tbc)
  Back-pressure Sk from Data Mapper and MACl

C.6.2 Data aggregator card

Data aggregator boards manage data traffic (that is, FE, GE, RPR) to allow aggregation of customer or provider traffic. Packet processing is performed on the MPLS/VPLS base rather than on the ETH or RPR MAC. Input/output scheduling functionalities are also implemented, for RX and TX client signals respectively, to efficiently manage the packet switching (see C.6.3.4 on page 650).

The generic functionalities needed to perform packet processing and traffic management reside in the board. Other functionalities related to the particular technology are managed in dedicated plug-in modules.

Figure 378. on page 645 shows the functional block diagram for the data aggregator board: as an example, the board is equipped with an ETH PIM and a multi-service PIM. PIMs may vary depending on the application.

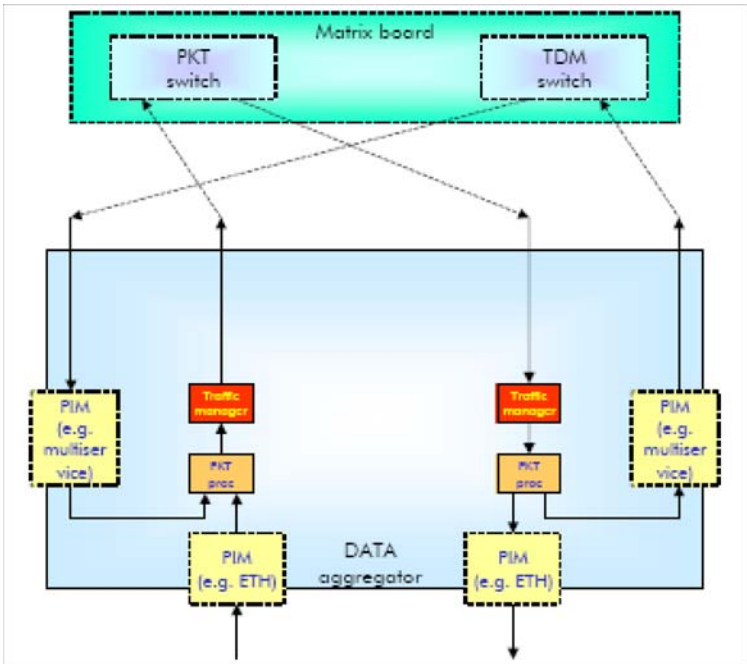


Figure 378. Data aggregator block diagram

– **Packet processor Sk**
  See C.6.1 on page 640 for detailed process description.
  RPR processing still tba.

– **Packet processor So**
  See C.6.1 on page 640 for detailed process description.
  RPR processing still tba.

– **Traffic manager Sk**
  See C.6.1 on page 640 for detailed process description.

– **Traffic manager So**
  See C.6.1 on page 640 for detailed process description.

C.6.3 Plug-in Modules (PIM)

As previously discussed, Plug-In Modules allow data aggregator cards to host several interfaces, providing the dedicated termination and adaptation functionalities.

C.6.3.1 Ethernet (FE/GE/10GE) PIM

Ethernet PIMs allow data aggregator boards to host ethernet interfaces to provide both bridging functionalities (promisquous mode: frames are not discarded) and switching functionalities (non-promisquous mode: depending on MAC address, frames can be discarded).

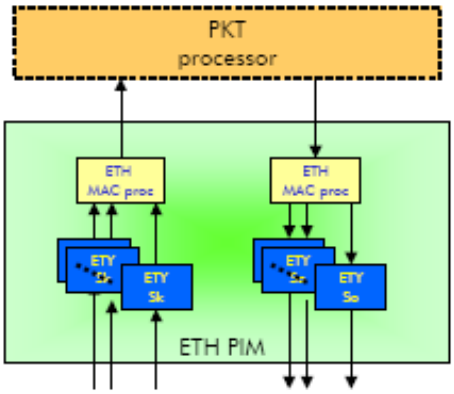


Figure 379. Ethernet PIM block diagram.

– **ETY Sk**
  See C.6.1 on page 640 for detailed process description.

– **ETY So**
  See C.6.1 on page 640 for detailed process description.

– **ETH MAC processing Sk**
  See C.6.1 on page 640 for detailed process description.

– **ETH MAC processing So**
  See C.6.1 on page 640 for detailed process description.

C.6.3.2 Multi-service PIM

The multi-service PIM allows interworking between TDM traffic and packet based traffic, providing data encapsulation functionalities and technology specific path monitoring and termination (i.e. SONET/SDH HO and LO, ODUk).

Packet based traffic can be encapsulated in different ways depending on its nature: ETH is transported using GFP encapsulation, while IP/MPLS traffic can be mapped over HDLC (via POS encapsulation). Encapsulated traffic is then mapped into virtually or contiguously concatenated tecnology specific virtual containers (e.g virtually or contiguously concatenated HO STS-3c/1 - VC-4/3, virtually concatenated LO STS-1/2/1.5 - VC3/12/11 or virtually concatenated ODU1).

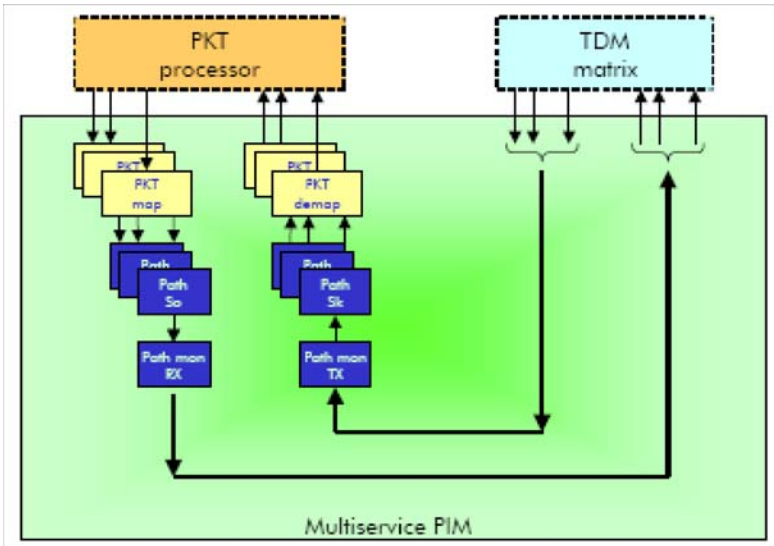


Figure 380. Multi-service PIM block diagram.

– **Path monitoring TX**

Provides tandem connection termination capabilities for the particular path to be terminated. For a detailed description, refer to the following:

SONET HO (STS-3c) SDH HO (VC-4)	SONET LO (STS-1/VT-2) SDH LO (VC3/12)	ODU 1/2
SnD_TT_Sk (see C.1.1 on page 609)	SmD_TT_Sk LO path monitoring is provided by LOA card, as described in C.2.1 on page 622	ODUkT_TT_Sk (see C.5.1 on page 633)

Note: For SONET tributaries (HO and LO) the Tandem connection functionalities are not applied.

– **Path monitoring RX**

Provides tandem connection generation capabilities for the particular path to be transmitted. For a detailed description, refer to the following:

SONET HO (STS-3c) SDH HO (VC-4)	SONET LO (STS-1/VT-2) SDH LO (VC3/12)	ODU 1/2
SnD_TT_So (see C.1.1 on page 609)	SmD_TT_So LO path monitoring is provided by LOA card, as described in C.2.1 on page 622	ODUkT_TT_So (see C.5.1 on page 633)

Note: For SONET tributaries (HO and LO) the Tandem connection functionalities are not applied.

– **Path processing Sk**

Provides path termination functionalities for the particular transport technology.
For a detailed description, refer to the following:

SONET HO (STS-3c/1) SDH HO (VC-4/3)	SONET LO (STS-1/VT-2/1.5) SDH LO (VC3/12/11)	ODU 1/2
Sn_TT_Sk see C.2.1 on page 622	Sm_TT_Sk LO path termination is provided by LOA card, as described in C.3.2 on page 631: the data card provides a simplified VC	ODUk_TT_Sk see C.1.2 on page 615

– **Path processing So**

Provides path termination functionalities for the particular transport technology.
For detailed description refer to the following:

SONET HO (STS-3c/1) SDH HO (VC-4/3)	SONET LO (STS-1/VT-2/1.5) SDH LO (VC3/12/11)	ODU 1/2
Sn_TT_So see C.2.1 on page 622	Sm_TT_So LO path termination is provided by LOA card as described in C.3.2 on page 631: data card provides a simplified VC	ODUk_TT_So see C.1.2 on page 615

– **Packet demapper**

Virtual Concatenated Group termination with LCAS management for SDH, SONET (both LO and HO) or OTN based traffic). For HO SDH/SONET traffic, standard contiguous concatenation (i.e. AU4-4c/AU3/12c and AU4-16c/AU3-48c – AU4-64c/AU3-192c tbc) is also supported.
Each card manages Virtual Concatenated Groups for SDH and SONET traffic with the characteristics described below:

		Max number of VCG per card	Max number of VC in a VCG
SDH	HO	64	64
	LO VC12/VC3	128	21
SONET	HO	192	192
	LO VT1.5/VC11	128	21

Extraction of GFP/LAPS/HDLC (standard PPP/HDLC and Cisco proprietary HDLC) frames from the specific transport technology (SDH/OTN).
Depending on the transported packet traffic different functionalities are provided:

ETH based traffic	MPLS/IP based traffic
GFP/LAPS frames termination Detection of CFS (for GFP only) FCS check (GFP/LAPS only) Packet discarding in case of FCS error Metering (GFP/LAPS frames) ETH decapsulation from GFP/LAPS frames MAC validity check Metering on port base Support of Ethernet over Cisco proprietary HDLC in transparent way	GFP/Cisco proprietary HDLC/ standard PPP HDLC (LAPS tbc) frames termination Traffic and payload type decapsulation from GFP/ Cisco proprietary HDLC/ standard PPP HDLC frames (LAPS tbc) FCS check (n.b. for GFP the check is mandatory) Metering (GFP/LAPS/HDLC frames)

– **Packet mapper**

Virtual Concatenated Group generation with LCAS management for SDH, SONET (both LO and HO) or OTN based traffic. For HO SDH/SONET traffic, standard contiguous concatenation (that is, AU4-4c/AU3/12c and AU4-16c/AU3-48c – AU4-64c/AU3-192c tbc) is also supported.
VCG management characteristics are defined in demapper functionality.
The mapping of GFP/LAPS/HDLC frames into the specific transport technology (SDH/OTN).
Depending on the transported packet traffic different functionalities are provided:

ETH based traffic	MPLS/IP based traffic
MAC generation ETH encapsulation into GFP/LAPS frames GFP/LAPS frames generation Metering (GFP/LAPS frames)	MPLS/IP traffic encapsulation into Cisco proprietary HDLC/GFP/ standard PPP HDLC frames (LAPS tbc) GFP/Cisco proprietary HDLC/ standard PPP HDLC frames generation (LAPS tbc) Metering (GFP/LAPS/HDLC frames)

C.6.3.3 Trunk SONET/SDH PIM

To be added - detailed functional description. Block diagram showing the application is reported below.

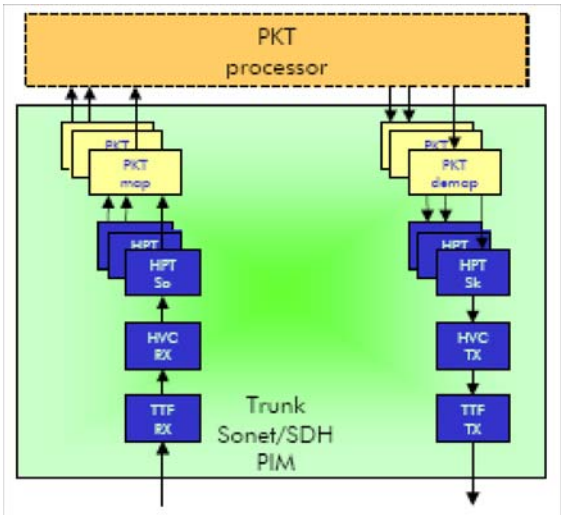


Figure 381. Trunk SONET/SDH PIM block diagram.

C.6.3.4 10GE RPR PIM

To be added - detailed functional description. Block diagram showing the application is reported below.

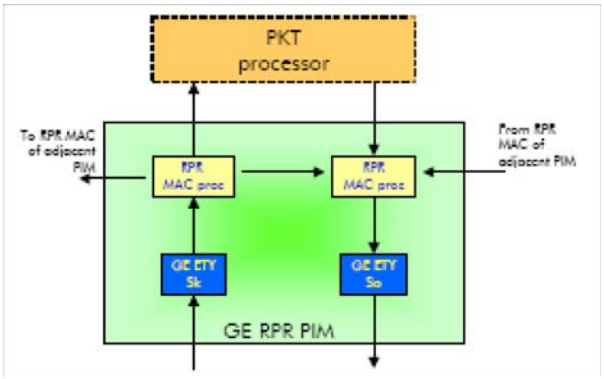


Figure 382. 10GE RPR PIM block diagram.

C.6.3.5 OC-192/48 (STM-64/STM16) RPR PIM

To be added - detailed functional description. Block diagram showing the application is reported below.

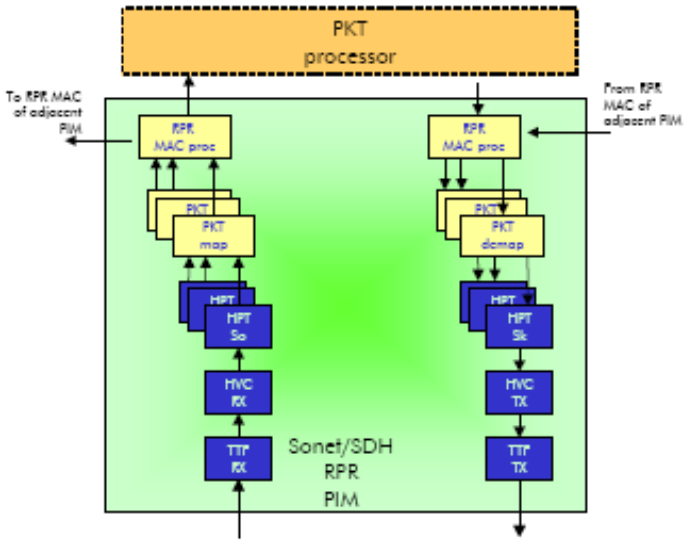


Figure 383. STM-64/STM-16 (OC-192/48)RPR PIM block diagram.

C.6.3.6 N x RPR Multi-service PIM

To be added - detailed functional description. Block diagram showing the application is reported below.

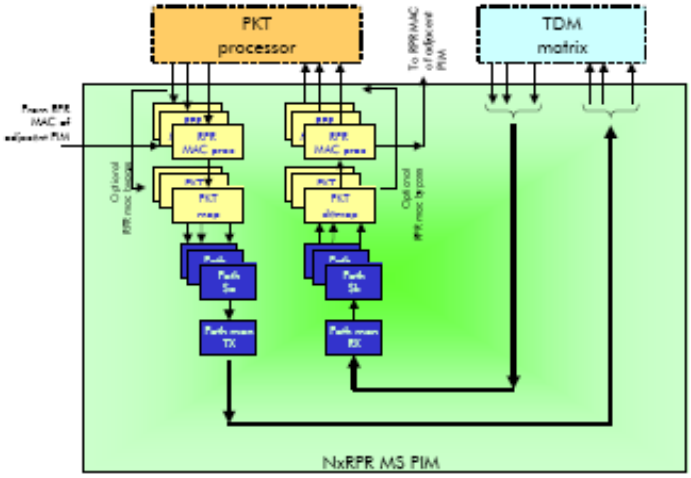


Figure 384. N x RPR Multi-service PIM block diagram.

C.7 Equipment functional models supported in 11G AnyRate implementation

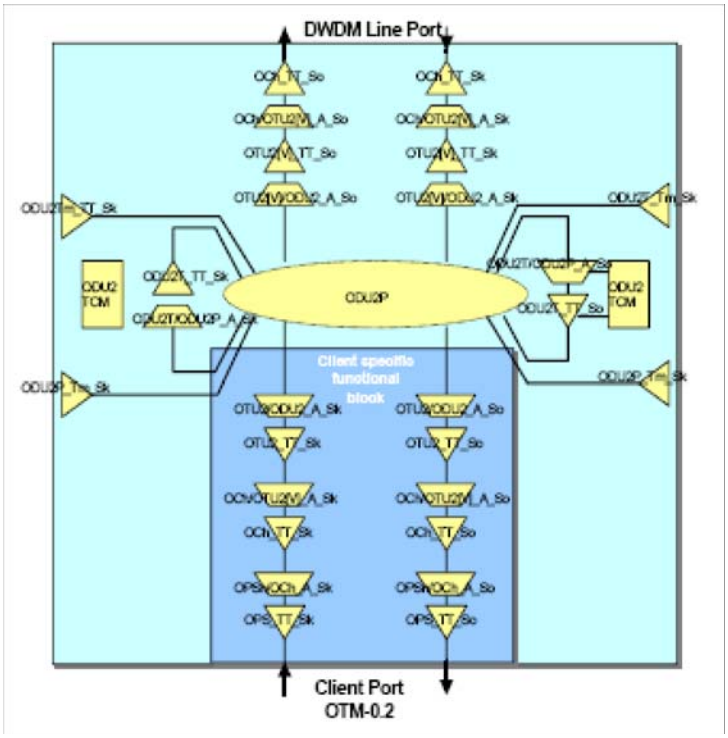
This section provides a description of 11G AnyRate OT implementation using a standard equipment functional model representation. Since the 11G AnyRate pack supports various client signal processing models, one sub-section is dedicated to describing client side of the OT functional model while the line side of the functional model, which is common for all the client signal types, is shown only in the first subsection.

Note that although some functions appear in multiple models, appropriate processing function is described only at the first occurrence to avoid repetition.

It should be noted that OTUk[V] or ODUk[V] indicates functionally standardized structure while actual digital structure may not fully comply with G.709 specifications. This was used to indicate, for example, EFEC implementation as well as overclocked rates for CBRLAN transport.

The ODUkP connection function is trivial in OT implementation as there is only one input and one output and no ODUk protection implementation is possible. It is shown in the model only to provide clear separation between the client port specific and common line port section of the model.

C.7.1 Functional model pertinent to OTM-0.2 client signal configuration



a) OTN Physical Layer

- **Optical Physical Section Layer Trail Termination: OPS_TT**

  OPS_TT_Sk

Input LOS detection
TSF insertion on LOS detection

OPS_TT_So
Signal conditioning for transmission to the medium

- **Optical Section Layer Adaptation to Optical Channel Layer: OPSn/OCh_A**

OPS/OCh_A_Sk
Demodulation of the optical signal

OPS/OCh_A_So
Modulation of the optical signal

b) Optical Channel Layer

- **Optical Channel Trail Termination: OCh_TT**

OCh_TT_Sk
Termination of the OCH payload as baseband signal
LOS-P detection
TSF insertion on LOS-P detection

OCh_TT_So
Generation of the OCH payload as baseband signal

- **Optical Channel Adaptation to Optical Channel Transport Unit: OCh/OTUk_A**

OCh/OTUk_Sk
Clock recovery
Frame alignment
FEC decoding with corrected errors count
Descrambler
LOF, LOM detection
SSF insertion (on dLOF or dLOM detection)

OCh/OTUk_So
Frame/Multiframe alignment word insertion
FEC encoding
Scrambler

c) Optical Channel Transport Unit Layer

- **Optical Channel Transport Unit trail termination: OTUk_TT**

OTUk_TT_Sk
SM_TTI: Trail Trace Identifier recovery and mismatch detection
SM_BDI: Backward Defect Indication detection
SM_BEI/BIAE: Backward Error Indication or Remote Incoming Alignment Error detection
SM_BIP8: BIP8 errors detection and errored blocks count
SM_IAE: Incoming Alignment Error detection

OTUk_TT_So
SM_TTI: Trail Trace Identifier insertion

SM_BDI: Backward Defect Indication insertion
SM_BEI/BIAE: Backward Error Indication or Remote Incoming Alignment Error insertion
SM_BIP8: Calculation and insertion of BIP-8 parity code
SM_IAE: Incoming Alignment Error insertion

- **Optical Channel Transport Unit Adaptation to Optical Channel Data Unit: OTUk/ODUk_A**

OTUk/ODUk_Sk
Extraction of ODUk signal from the incoming OTUk signal

OTUk/ODUk_So
Mapping of incoming ODUk signal into the OTUk signal

d) Optical Channel Data Unit Layer

- **Optical Channel Data Unit trail termination, trail monitoring: ODUk_TT, ODUk_Tm**

ODUk_TT_Sk, ODUkP_Tm
ODUk_TT_Sk, ODUkP_Tm
PM_TTI: Trail Trace Identifier recovery and mismatch detection
PM _BDI: Backward Defect Indication detection
PM _BEI: Backward Error Indication detection
PM _BIP8: BIP8 errors detection and errored blocks count
PM _STAT: AIS, OCI and LCK defect detection

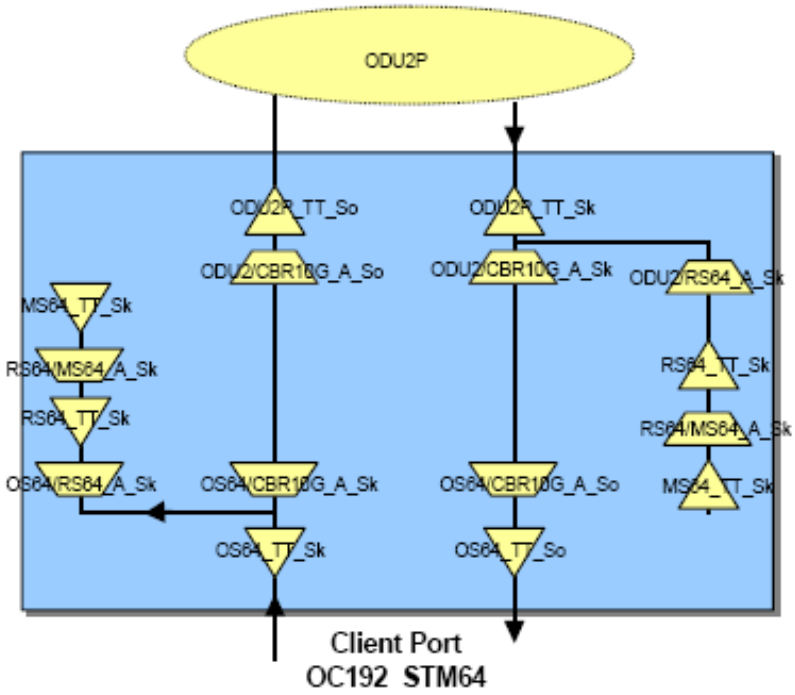
ODUk_TT_So
PM_TTI: Trail Trace Identifier insertion
PM_BDI: Backward Defect Indication insertion
PM_BEI: Backward Error Indication insertion
PM_BIP8: Calculation and insertion of BIP-8 parity code

- **ODUk Tandem Connection Sub-Layer trail termination: ODUkT_TT, ODUkT_Tm**

ODUkT_TT_Sk, ODUkT_Tm
TCMOH _TTI: Trail Trace Identifier recovery and mismatch detection
TCMOH _BDI: Backward Defect Indication detection
TCMOH _BEI: Backward Error Indication detection
TCMOH _BIP8: BIP8 errors detection and errored blocks count
TCMOH _STAT: AIS, OCI and LCK defect detection
Detection of dDEG, dLTC, dIAE, dBIAE

ODUk_TT_So
TCMOH _TTI: Trail Trace Identifier insertion
TCMOH _BDI: Backward Defect Indication insertion
TCMOH _BEI: Backward Error Indication insertion
TCMOH _BIP8: Calculation and insertion of BIP-8 parity code

C.7.2 Functional model pertinent to client port configured to OC-192_STM64



a) SDH Physical Layer

- **Optical Section Layer Trail Termination: OSn_TT**

  OSn_TT_Sk
  Input LOS detection
  TSF insertion on LOS detection

  OSn_TT_So
  Signal conditioning for transmission medium

- **Optical Section Layer Adaptation to Regenerator Section Layer: OSn/RSn_A**

  OSn/RSn_A_Sk
  Descrambler
  OOF count and LOF detection
  SSF insertion (on LOF detection)

  OSn/RSn_A_So
  Scrambler

b) Regenerator Section Layer

- **Regenerator Section Layer Trail Termination: RSn_TT**

RS_TT_Sk

A1, A2: Frame alignment detection
J0: Regenerator section trace recovery and mismatch detection
B1: BIP-8 Errored Block count: even bit parity is computed and compared with B1 recovered from the current frame

- **Regenerator Section Layer Adaptation to Multiplex Section Layer: RSn/MSn_A**

RSn/MSn_A_Sk

TSF detection
SSF insertion (on TSF detection)

c) Regenerator Section Layer

- **Multiplex Section Layer Trail Termination: MSn_TT**

MSn_TT_Sk

B2: BIP-24N Errored Block count
M1, M0: MS-REI recovery (M0 significant for STM-64 only)
K2[6-8]: MS-RDI detection
K2[6-8]: MS-AIS detection
MS-DEG (Signal Degrade), MS-EXC (Excessive BER) detection

d) Optical Channel Data Unit Adaptation to Regenerator Section Layer: ODUk/RSn_A

ODUk/RSn_Sk

Bit-synchronous or asynchronous demapping of RSn signal from ODUk frame
Frame alignment of STM-n signal (dLOF detection)

e) Optical Channel Data Unit Adaptation to Constant Bit Rate signal: ODUk/CBRx_A

ODUk/CBRx_Sk

Bit-synchronous or asynchronous demapping of CBRx signal from ODUk frame
Detection of Payload Type Mismatch
Insertion of SSF and AIS

ODUk/CBRx_So

Bit-synchronous or asynchronous mapping of CBRx signal to ODUk frame
Generation of PT field

f) Optical SDH Section Adaptation to Constant Bit Rate signal: OSn/CBRx_A

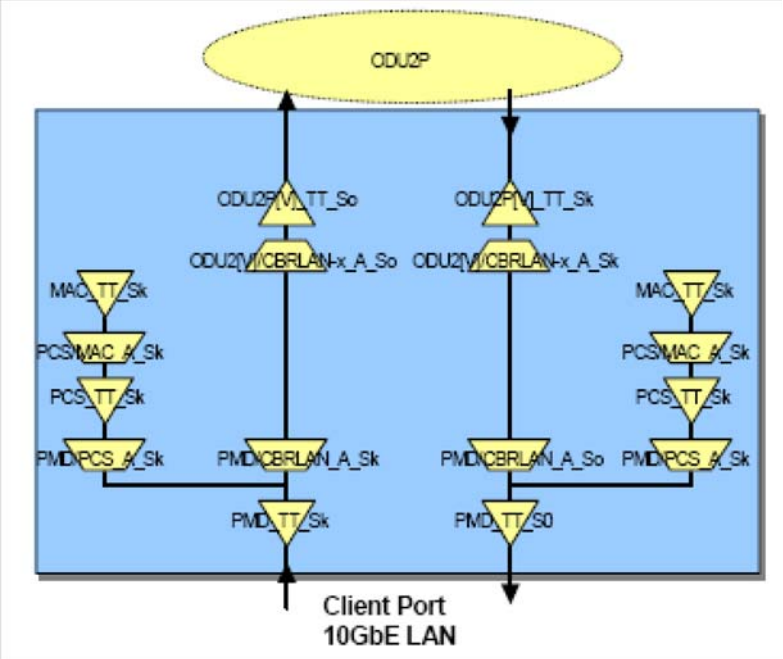
OSn/CBRx_Sk

Optical signal post conditioning, demodulation, and clock recovery
Insertion of SSF and Generic AIS

OSn/CBRx_So

Optical carrier modulation, and optical signal preconditioning

C.7.3 Functional model pertinent to client port configured as 10GbE LAN transport as Constant Bit Rate (overclocking at 11.049Gb/s or 11.096Gb/s)



a) Physical Media Dependent Layer (PMD)

- **PMD Trail Termination: PMD_T**T

  PMD_TT_Sk
  Input LOS detection
  TSF insertion on LOS detection

  PMD_TT_So
  Signal conditioning for transmission over the medium

- **PMD to Constant Bit Rate LAN adaptation: PMD/CBRLAN_A**

  PMD/CBRLAN_A_Sk
  Optical signal post conditioning, demodulation & clock recovery
  Insertion of SSF and generic AIS

  PMD/CBRLAN_A_So
  Optical signal post conditioning and modulation

- **PMD to Physical Coding Sublayer adaptation: PMD/PCS**_A

  PMD/PCS_A_Sk
  Optical signal post conditioning, demodulation, and clock recovery

b) Physical Coding Sub-Layer (PCS)

- **PCS Trail Termination: PCS_TT**

  PCS_TT_Sk
  Termination of 64B/66B encoding and block synchronization
  Detection of coding errors and loss of block code synchronization
  Detection of Local and Remote Failure Indication

- **PCS to MAC Adaptation: PCS/MAC_A**

  PCS/MAC_A_Sk
  Extraction of MAC PDUs and forwarding PDUs to MAC layer

c) Media Access Control Layer (MAC)

- **MAC Trail Termination: MAC_TT**

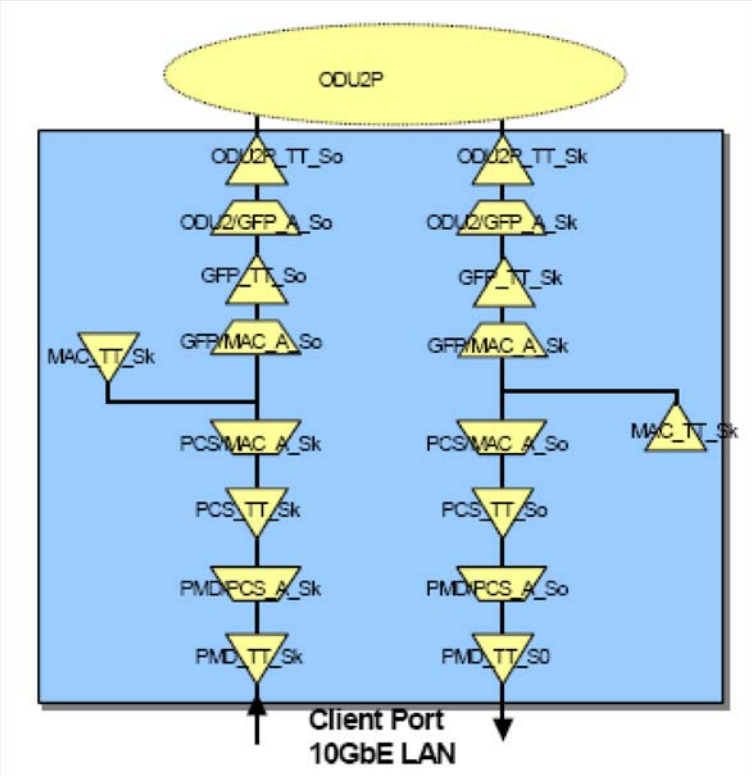
  MAC_TT_Sk
  RMON statistics accumulation

d) Optical Channel Data Unit Adaptation to Constant Bit Rate LAN signal: ODUk/CBRLAN_A

ODUk/CBRLAN_Sk
Bit-synchronous demapping of CBRLAN signal from ODUk frame
Detection of Payload Type Mismatch
Insertion of SSF and AIS

ODUk/CBRLAN_So
Bit-synchronous mapping of CBRLAN signal to ODUk frame
Generation of PT field

C.7.4 Functional model pertinent to client port configured as 10GbE LAN transport using GFP encapsulation



a) Physical Media Dependent Layer (PMD)

- **PMD Trail Termination: PMD_TT**

  PMD_TT_Sk
  Input LOS detection
  TSF insertion on LOS detection

  PMD_TT_So
  Signal conditioning for transmission medium

- **PMD to Physical Coding Sub-Layer adaptation: PMD/PCS_A**

  PMD/PCS_A_Sk
  Optical signal post conditioning, demodulation & clock recovery
  Insertion of SSF and generic AIS

  PMD/PCS_A_So
  Optical signal post conditioning and modulation

b) Physical Coding Sub-Layer (PCS)

- **PCS Trail Termination: PCS_TT**

  PCS_TT_Sk
  Termination of 64B/66B encoding and block synchronization
  Detection of coding errors and loss of block code synchronization
  Detection of Local and Remote Failure Indication

  PCS_TT_So
  Generation of 64B/66B coded bit stream
  Generation of Local and Remote Failure Indication

- **PCS to MAC Adaptation: PCS/MAC_A**

  PCS/MAC_A_Sk
  Extraction of MAC PDUs and forwarding PDUs to MAC layer

  PCS/MAC_A_So
  Forwarding MAC PDUs to PCS_TT_So layer

c) Generic Framing Procedure encapsulation Layer (GFP)

- **GFP Trail Termination: GFP_TT**

  GFP_TT_Sk
  Delineation of GFP frames
  Detection of Packet Delineation loss (dLPD), GFP Payload Type mismatch (dPLM), Remote Client Failure Loss of signal, Loss of Synchronization, Local Failure Indication and Remote Failure Indication (dCSF_LOS, dSCF_LSS, dCSF_LFI, dCSF_RFI)

  GFP_TT_So
  Generation of GFP PDUs, Encoding Payload Type, GFP_Idle and GFP_CMF

- **GFP to MAC Adaptation: GFP/MAC_A**

  GFP/MAC_A_Sk
  Extraction of MAC PDUs from the GFP payload area

  GFP/MAC_A_So
  Mapping of the MAC PDUs into the GFP payload. Depending on whether provisioned encapsulation mode is GFP-F or proprietary GFP-P (preamble transparency), the MAC preamble is included or discarded in the process of encapsulation.

d) Optical Channel Data Unit Adaptation to GFP: ODUk/GFP_A

This function implements both G.709 compliant ODUk/GFP_A, as defined in section 17.3 of ITU-T G.709, and a non-standard mapping that includes 7 OH positions from the OPU2 overhead in the payload area for additional bandwidth needed for preamble transparency in the GFP-P encapsulation method. The PT field code for the proprietary mapping is 0x80.

ODUk/GFP_Sk

Extraction of the GFP PDU stream into an ODUk payload area
Detection of the ODUk Payload Type Mismatch
Insertion of the SSF

ODUk/GFP_So

Mapping of the GFP PDU stream into an ODUk payload area
Generation of the PT field

Appendix D SONET to SDH COMPARISON

This appendix provides an overview of the differencies and commonalities between SDH and SONET overhead bytes processing.

D.1 Section Overhead (SONET) / Regenerator Section Overhead (SDH)

OH Byte	Direction	Process	SDH	SONET
			Regenerator Section	Section
			RS 1/4/16/64/256	STS 1/3/12/48/192/768
A1A2: frame alignment signal	Source	Insertion		
	Sink	defect detection/reporting	OOF: 5 frames LOF: 3ms	OOF: 4 frames LOF: 3ms
		PM - OFS	y	y
		PM - N_DS	y	y
		consec actions: AIS inj	250 µs	125 µs
		consec actions: RDI	n/a	n/a
		protection switching: SF	y	y
B1: BIP8	Source	calculation		
	Sink	defect detection/reporting	y	y
		PM - N_EBC	y (blocks)	y BIP violation
		TCA (10e-x x=5..9)	n	y (x=6)
J0: section trace identifier	Source	insertion	y - 16 bytes string	y - 1 byte (optional)
	Sink	defect detection/reporting	y - TIM	n
		PM - N_DS y n	y	n
		consec actions: AIS inj	250 µs	n
		consec actions: RDI n/a n/a	n/a	n/a
		acceptance & reporting	y - acceptance under study	y
E1: Order wire	Source	insertion	y	y
	Sink	extraction	y	y
F1: user channel	Source	insertion	y	n
	Sink	extraction	y	n
D1 .. D3: RS DCC	Source	insertion	y	y
	Sink	extraction	y	y

D.2 Line Overhead (SONET) / Multiplex Section Overhead (SDH)

OH Byte	Direction	Process	SDH	SONET
			Multiplex Section	Line
			MS 1/4/16/64/256	STS 1/3/12/48/192/768
B2: BIP24N	Source	calculation	y	y
	Sink	defect detection/reporting	y EXC/DEG	y EXC/DEG
		protection switching: SF	y on EXC	y on EXC
		protection switching: SD	Y on DEG	Y on DEG
		PM - N_EBC	y BIP violation	y BIP violation
		TCA (10e-x x=5..9)	n	y (x=6)
E2: Order wire	Source	insertion	y	y
	Sink	extraction	y	y
D4 .. D12: MS DCC	Source	insertion	y	y
	Sink	extraction	y	y
K1[1-8] K2[1-5]: APS protocol	Source	insertion	y	y
	Sink	extraction/validation	y 3 times persistency check	y 3 times persistency check
		defects FOP	y	y
S(9,9,1): K0 (proprietary use): enhanced APS	Source	insertion	n. Prop: y	n
	Sink	extraction/validation	n. Prop: y 3 times persistency check	n
		defects FOP	n. Prop: y	n
K2[6-8]: RDI	Source	insertion	y	y
	Sink	defect detection/reporting	y 3-5 times persistency check	y 5-10 times persistency check
		PM - N_DS	y	y
K2[6-8]: MS-AIS	Source	insertion	y	y
	Sink	defect detection/reporting	y 3 times persistency check	y 5 times persistency check
		consequent actions: AIS inj	250 µs	125 µs
		consequent actions: RDI	y	y
		protection switching: SF	y	y
		PM - N_DS	y	y
M1: REI	Source	inserts det. BIP violations	y	y
	Sink	PM_FEB	y violation count	y violation count
M0: optional enhanced REI	Source	inserts det. BIP violations	y (MS 64/256)	y (STS-192/768)
	Sink	PM_FEB	y (MS 64/256) violation count	y (STS-192/768) violation count
S1: Sync. Status Msg	Source	insertion	y	y
	Sink	extraction/validation	y 3 times persistency check	y 8 times persistency check

D.3 Administrative Unit Overhead

OH Byte	Direction	Process	SDH	SONET
			Administrative unit	
			AU-3/4/4-4c/4-16c/4-64c/4-256c	STS 1/3c/12c/48c/192c/768c
H1H2: AU-3/4 TU-3 pointer	Source	pointer generation	y (ss bits set at "10")	y (ss bits set at "10"- old ss="00")
		consequent actions: AIS inj	250 µs	125 µs
		PM_PJE+/PJE-	y	n
		PM_PPJCgen, NPJCgen, PJC-Sgen, PJCdiff	y	n
	Sink	SS-bits	ignore	ignore
		pointer interpretation	y	y
		increment detection	majority of D bits	majority of 8 out of 10 D bits
		decrement detection	majority of I bits	majority of 8 out of 10 I bits
		NDF enabled detection	y	y
		defect detection: AIS	y (3 frames with H1H2="11..11")	y (3 frames with H1H2="11..11")
		defect detection: LOP	y (8 frames with invalid ptr)	y (8 frames with invalid ptr)
		PM_PPJCdet, NPJCdet, PJCS-det	n	y
		PM_NDS	n/a	n/a
		consequent actions: AIS inj	250 µs	125 µs
		consequent actions: RDI	n/a	n/a
		consequent actions: ERDI	n/a	n/a
		protection switching: SF	y	y
H3: justification opportunity	Source	insertion of data during justification action, fixed stuff otherwise.	y	y
	Sink	extraction of data during justification action, ignore otherwise.	y	y

D.4 Higher Order Path Overhead

D.4.1 Path termination and monitoring

OH Byte	Direction	Process	SDH	SONET
			Path	Path
			VC-3/4/4-Xc	STS 1/3c/12c/48c/192c SPE
B3: BIP8	Sink	defect detection - reporting	y dDEG/dEXC	y dDEG/dEXC
		PM-N_EBC	y (block count)	y (violations count)
		protection switching SF	y dEXC	y dEXC
		protection switching SD	y dDEG	y dDEG
C2: UNEQ	Sink	defect detection	y 5 times persistency check	y 5 times persistency check
		PM-N_DS: option 1	y	n
		PM-N_DS: option 2	y if also J1 = "0"s	n
		protection switching: SF option 1	y	y
		protection switching: SF option 2	y if also J1 = "0"s	n
		reporting: option 1	y	y
		reporting:option 2	y if also J1 = "0"s	n
C2: VC-AIS	Sink	defect detection - reporting	y 5 times persistency check	n
		PM-N_DS	y	n
		protection switching: SF	y	n
C2: payload type	Sink	defect detection - reporting	n	y
		protection switching: SF	n	n
		acceptance	n	y
C2: payload defect indication	Sink	defect detection - reporting	n	y
		protection switching: SF	n	y
		acceptance	n	y
G1[1-4]: REI	Sink	PM-F_EBC	y (block count)	y (violations count; block count if ERDI supported)
G1[5]: RDI	Sink	defect detection - reporting	y 5 times persistency check	y 10 times persistency check
		PM-F_DS	y	y
G1[5-7]: ERDI	Sink	defect detection - reporting	n	y
		PM-F_DS	n	y
J1: path trace identifier	Sink	defect detection: TIM	y - 16 bytes string expected	y - 64 bytes string expected
		PM-N_DS	y	n
		protections: SF	y	n
		acceptance & reporting	y - acceptance under study	y

D.4.2 Path Supervisory Unequipped termination and monitoring

OH Byte	Direction	Process	SDH	SONET
			Path	HSUT functionality is not defined
			VC-3/4/4-Xc	
B3: BIP8	Source	calculate	y	n
	Sink	defect detection - reporting	y dDEG/dEXC	n
		PM-N_EBC	y (block count)	n
		consequent actions: REI	y number of detected violations	n
		Protection switching SF	y on dEXC	n
		Protection switching SD	y on dDEG	n
C2: UNEQ	Source	insertion - all "0"	y	n
	Sink	defect detection	y 5 times persistency check	n
		consequent actions: RDI	y if also J1 = '0'	n
		PM-N_DS	y if also J1 = "0"	n
		reporting	y if also J1 = "0"	n
G1[1-4]: REI	Source	insertion	y	n
	Sink	PM-F_EBC	y (block count)	n
G1[5]: RDI	Source	insertion	y	n
	Sink	defect detection - reporting	y 5 times persistency check	n
		PM-F_DS	y	n
G1[5-7]: ERDI	Source	insertion	n	n
	Sink	defect detection - reporting	n	n
		PM-F_DS	n	n
J1: path trace identifier	Sink	defect detection: TIM	y - 16 bytes string expected	n
		PM-N_DS	y	n
		consequent actions: RDI	y	n
		protections: SF	y	n
		acceptance & reporting	y - acceptance under study	n

D.4.3 Path Tandem Connection Trail termination and monitoring

OH Byte	Direction	Process	SDH	SONET
			Path	HSUT functionality is not defined
			VC-3/4/4-Xc	
B3: BIP8	Source	compensate value for parity continuity	y	n
	Sink	violations detection	y	n
		consequent actions: IEC	y	n
		PM-ON_EBC	y	n
N1: UNEQ	Source	insertion - all "0"	y	n
	Sink	defect detection - reporting	y 5 times persistency check	n
		consequent actions: RDI, ODI	y	n
		consequent actions: OSF	y	n
		consequent actions: SF	y	n
		PM-N_DS	y	n
N1[7-8][1-8]: frame alignment signal	Source	insertion	y	n
	Sink	defect detection: LTC	y OOF detected in 2 frames	n
		consequent actions: RDI, ODI	y	n
		consequent actions: OSF	y	n
		consequent actions: SF	y	n
		PM-ON_DS	y	n
G1[5]: RDI	Source	insertion	y	n
	Sink	defect detection - reporting	y 5 times persistency check	n
		PM-F_DS	y	n
N1[7-8][9-72]: Trail Trace Identifier	Source	insertion	y	n
	Sink	defect detection: TIM	y	n
		consequent actions: RDI, ODI	y	n
		consequent actions: OSF	y	n
		PM-ON_DS	y	n
		consequent actions: SF	y	n
		acceptance/reporting	y (acceptance process under study)	n
N1[1-4]	Source	insertion	y	n
	Sink	defect detection: DEG	y	n
		protection switching: SD	y	n
		consequent actions: REI	y	n
		PM-N_EBC	y	n
N1[5]: REI	Source	insertion	y	n
	Sink	PM-F_EBC	y	n
N1[8][73]: RDI	Source	insertion	y	n
	Sink	defect detection	y	n
		PM-F_DS	y 5 times persistency check	n
N1[6]: OEI	Source	insertion	y	n
	Sink	PM-OF_EBC	y	n
N1[7][74]: ODI	Source	insertion	y	n
	Sink	defect detection	y 5 times persistency check	n
		PM-OF_DS	y	n

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ABBREVIATIONS

ABBREVIATION	MEANING
ABIL	Enabling
ABN	Abnormal
ACD	Access Control Domain
ACL	Access Control List
ACSE	Access Control Service Element
ADM	Add/Drop Multiplexer
AGC	Automatic Gain Control
AIM	Alarm Indication Message
AIS	Alarm indication Signal
ALS	Automatic Laser Shutdown
APD	Avalanche Photodiode
APS	Automatic Protection Switching
AND	Alarm on both station batteries
ANSI	American National Standards International
APD	Avalanche Photodiode
APS	Automatic Protection Switching
ARP	Address Resolution Protocol
AS	Alarm Surveillance
ASAP	Alarm Severity Assignment Profile
ASIC	Application Specific Integrated Circuit
ASN	Abstract Syntax Notation
ATM	Asynchronous Transfer Module
ATTD	Attended (alarm storing)
AU	Administrative Unit
AUG	Administrative Unit Group
AUOH	AU Pointer
AUI	Attachment Unit Interface
AUX	Auxiliary
AU4	Administrative unit - level 4
B&W	Black and White
BATT	Battery

ABBREVIATION	MEANING
BE	Best Effort
BER	Bit Error Rate
BGP	Border Gateway Protocol
BIP	Bit Interleaved Parity
BM	Bandwidth Manager
BNC	Bayonet Not Coupling
BOL	Beginning Of Life
BW	BandWidth
C	Storing command
C&I	Classification and Identification
C12/C3/C4	1st, 3rd and 4th level Container
CAC	Connection Admission Control
CBR	Constant Bit Rate
CD	Current Data
CD-ROM	Compact Disc Read Only Memory
CDR	Common Data Representation
CE	European Conformity
CE	Customer Edge (device)
CFI	Canonical Field Identifier
Ch	Channel
CID	Card Identifier
CIR	Committed Information Rate
CLNP	ConnectionLess Network Protocol
CMI	Code Mark Inversion
CO	Central Office
COAX	Coaxial
COMD	Colorless Optical Mux/Demux circuit pack.
CoS	Class of Service
CPE	Customer premises equipment
CPI	Incoming parallel contacts
CPO	Outgoing parallel contacts
CPU	Central Processing Unit (referred to Controller equipment unit or Microprocessor)
CRC	Cyclic Redundancy Check
CR-LDP	Constraint based Routing Label Distribution Protocol
CSF	Client Signal Failure
CT	Craft Terminal
CWDM	Coarse Wavelength Division Multiplexing
DC	Direct Current
DCC	Data Communication Channel

ABBREVIATION	MEANING
DCCM	Data Communication Channels Multiplex
DCCR	Data Communication Channels Regeneration
DCE	Data Circuit Terminating Equipment
DCF	Data Communication Function
DCM	Dispersion Compensation Module
DCN	Data Communication Network
DDM	Digital Diagnostic Monitoring
DEMUX	Demultiplexer
DHCP	Dynamic Host Configuration Protocol
DiffServ	Differentiated Service
DPLL	Digital Phase Locked Loop
DS	Differentiated Service
DSC	Different Speed Connection
DSP	Domain Specific Part
DTE	Data Terminal Equipment
DTE	Data Terminal Equipment
DTL	Designed Transit List
DVB	Digital Video Broadcast
DVB-ASI	Digital Video Broadcast - Asynchronous Serial Interface
DWDM	Dense Wavelength Division Multiplexing
EC	Equipment Controller
ECC	Embedded Communication Channel
ECID	Enhanced Card IDentifier
ECT	Equipment Craft Terminal
EDC	Error Detection Code
EDFA	Erbium Doped Fiber Amplifier
EFCI	Explicit Forwarding Congestion Indication
EFEC	Enhanced FEC algorithm
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
EML	Element Management Layer
EMLIM	Element Management Layer Information Manager
EMS	Element Management System
ENE	External Network Element
EOL	End Of Life
EOS	Ethernet Over SONET/SDH
EOW	Engineering Order Wire
EOM	Ethernet over MPLS
EPD	Early Packets Discarding
EPS	Equipment Protection Switching

ABBREVIATION	MEANING
ES	Ethernet Switch
ESCON	Enterprise System Connection
ESD	Electrostatic discharges
ESI	End System Identifier
E-SNCP	Electrical Sub-Network Connection Protection
ETB	Ethernet Bridge
ETP	External Termination Point
ETS	Ethernet Transparent Service (or Ethernet Transport Service)
ETSI	European Telecommunication Standards Institute
EVC	Ethernet Virtual Connection
EXP	MPLS Experimental field
E2PROM	Electrically erasable programmable read only memory
F	Interface F (for Craft Terminal) or Fuse
FAD	Functional Access Domain
FCS	Frame Check-Sum
FDB	Filtering Data Base
FDDI	Fiber Data Digital Interface
FE	Fast Ethernet
FEBE	Far End Block Error
FEC	Forward Error Correction
FEC	Forwarding Equivalence Class
FEPROM	Flesh Electrically erasable programmable read only memory
FERF	Far End Receive Failure
FICON	Fiber Connection
FLC	First Level Controller
FOADM	Fixed Optical Add/Drop Multiplexer
FPGA	Field Programmable Gate Array
FTN	FEC to NHLFE
GA	Gate Array
GCC	General Communication Channel
GE	Gigabit Ethernet
GFC	Generic Flow Control
GFP	Generic Framing Procedure
GND	Ground
GNE	Gateway Network Element
GOSIP	Government Open System Interconnection Profile
GUI	Graphical User Interface
HD	Hard Disk
HDBK	document
HDB3	High Density Bipolar Code

ABBREVIATION	MEANING
HDLC	High-level Data Link Control
HIGHREFL	High Optical reflections
HK	Housekeeping
HO	Higher Order
HOA	High Order Adaptation
HOI	High Order Interface
HOL	Head Of Line
HPA	High order Path Adaptation
HPC	High order Path Connection
HPT	Higher Order Path Termination
HPOM	High order Path Overhead Monitoring
HS	High Speed
HSUT	High order Supervisory Unequipped Termination
HTCA	High Order Tandem Connection Adaptation
HTCM	High Order Tandem Connection Monitoring
HTCT	High Order Tandem Connection Termination
HVC	HEC violation count
HW	Hardware
ICI	Inter Carrier Interface
ICMP	Internet Control Message Protocol
ICS	Item Change Status
ID	Identification signals
ID	Identifier
IF	InFlow
I/F	Interface
I/O	Input/Output
ICS	Item Change Status
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronic Engineering
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
ILA	In Line Amplifier
I-LAN	Intra-subsystem Local Area Network
ILOS	Input Loss Of ignal
IM	Information Manager
IN	Input
IND	Indicative alarm
INT	Internal Local Alarms
IP	Internet Protocol
IPCP	IP Control Protocol

ABBREVIATION	MEANING
ISA	Integrated Service Adapter (or IP, SDH, ATM)
ISDN	Integrated Services Digital Network
IPD	An optical power tap with an Integrated PhotoDetector
ISO	International Organism for standardization
ISPB	Intra Shelf Parallel Bus
ITU-T (*)	International Telecommunication Union-Telecommunication Sector
JE1	Joint Engineering
JF	Jumbo Frame
JRE	Java Runtime Environment
L3	Layer 3
LAN	Local Area Network
LAPD	Link Access Protocol D-channel
LAPS	Link Access Procedure over SONET/SDH
LB	Loop Back
LCAS	Link Capacity Adjustment Scheme
LCP	Link Control Protocol
LD	Line Driver
LDB	Loop Detection Buffer
LDP	Label Distribution Protocol
LDRX	Line Driver circuit pack for use at the receive (incoming) side of ROADMs and at repeaters.
LDSSHUT	Command for ALS
LDTX	Line Driver circuit pack for use at the transmit (outgoing) side of ROADMs.
LDC	Local Data Controller
LEAF	Large Effective Area Fiber
LED	Light emitting diode
LER	Label Edge Router
LO	Lower Order
LOA	Lower Order Assembler
LOF	Loss of alignment
LOI	Low Order Interface
LOM	Loss Of Multiframe
LOP	Loss Of Pointer
LOS	Loss of signal
LPA	Lower order path adaption
LPC	Lower order path connection
LPOM	Lower Order Path Monitoring
LPT	Lower order path termination or Loopback equipment side (local)

ABBREVIATION	MEANING
LSB	Least Significant Bit
LSP	Label Switched Path
LSR	Label Switch Router
LSUT	Lower order Supervisory Unequipped Termination
LTCA	Lower Order Tandem Connection Adaptaiton
LTCM	Lower Order Tandem Connection Monitoring
LTCT	Lower Order Tandem Connection Termination
LVC	Lower Order Virtual Container
M	Tagblock or Alarm storing
MAC	Media Acces Control
MAU	Medium Access Unit
MCF	Message Communication Function
MEF	Metro Ethernet Forum
MEN	Metro Ethernet Network
MIB	Management Information Base
MLM	Multi Longitudinal mode
MMF	Multi Mode Fibre
MPLS	MultiProtocol label Switching
MRU	Maximum Receive Unit
MS	Multiplex Section
MSA	Multiplex section adaptation
MSB	Most Significant Bit
MSN	Multi Service Node
MSOH	Multiplex Section Overhead
MSP	Multiplex section protection
MSPP	Multi Service Provisionable Platform
MST	Multiplex section termination
MTU	Maximum Transmit Unit
MUX	Multiplexer
NAD	Network Access Domain
NAP	Network Access Point
NAT	Network Address Translation
NCP	Network Control Protocol
NE	Network Element
NES	Network Element Synthesis
NET	Network Entity Title
NHLFE	Next Hop Label Forwarding Entry
NIM	Non Intrusive Monitoring
NML	Network Management Layer
NMS	Network Management System

ABBREVIATION	MEANING
NNI	Network to Network Interface
NRZ	No return to zero
NSAP	Network Service Access Point
NURG	Not urgent alarm
OA	Optical Amplifier
OADM	Optical Add and Drop Multiplexer
OAM	Operation, Administration and Maintenance
OBPS	On Board Power Supply
OCH	Optical Channel
OC-x	Optical Carrier level x
OCM	Optical Channel Monitor
ODUk	Optical channel Data Unit, capacity k=1, 2, 3
O-E-O	Optical to Electrical to Optical
OF	OutFlow
OH	Overhead
OH-BUS	Dedicated housekeeping stream
OID	Object Identifier
OMD	Optical Mux/Demux circuit pack
OMON	Optical MONitor
OMP	OSPF Optimized Multi Path
OMS	Optical Multiplex Section
OMSN	Optinex MultiService Node
OMSP	Optical Multiplex Section Protection
OOF	Out Of Frame
OPS	Optical Protection Switch circuit pack.
OPUk	Optical Channel Payload Unit, capacity k=1, 2, 3
OR	Logic sum/Loss of only one station battery
OS	Operating system
OS	Operations System
OSA	Optical Spectrum Analyzer
OSC	Optical Supervisory Channel
OSI	Open System Interconnection
O-SNCP	Optical - Sub-Network Connection Protection
OSNR	Optical Signal to Noise Ratio
OSPF	Open Shortest Path First
OT	Optical Transponder/Translator
OTH	Optical Transport Hierarchy
OTM-0.n	Optical Transport Module, single color, capacity n=1,2,3
OTN	Optical channel Transport Network
OTS	Optical Transmission Section

ABBREVIATION	MEANING
OTUk	Optical Channel Transport Unit, capacity k=1, 2, 3
OUT	Output
P/S	Parallel/Serial converter
P2MP	Point To Multi-Point
P2P	Point To Point
PC	Personal Computer
PCI	Peripheral Components Interface
PCS	Physical Coding Sub-layer
PD	PhotoDetector. Several figures use PD to indicate photodetectors that are provided in optical amplifier modules
PDH	Plesiochronous Digital Hierarchy
PDU	Protocol Data Unit
PFAIL	Power supply failure
PHY	Physical layer interface
PI	Physical interface
PIM	Plug In Module
PIR	Peak Information Rate
PJE	Pointer Justification Event
PLL	Phase Locked Loop
PLM	PayLoad Mismatch
PPI	Plesiochronous Physical interface
PPP / P2P	Point-to-Point
POH	Path Overhead
PM	Performance Monitoring
PMA	Physical Medium Attachment
PMD	Physical Medium Dependent
PMMF	Physical Machine Management Function
PMV	Performance Monitoring View
POH	Path Overhead
POS	Packet Over Sonet/SDH
PPI	Plesiochronous Physical interface
PPP	Point to Point Protocol
PPS	Path Protection Switching
PR_EA (or PREA)	Packet Ring, Edge Aggregator
PRBS	Pseudo Random Binary Signal
PSTN	Public Switched Telephone Network
PWALM	Power supply alarm
PWANDOR	ANDOR/3 failure
Q2/QB2	TMN Interface with B2 protocol. Interface towards plesiochronous equipment

ABBREVIATION	MEANING
Q3/QB3	TMN Interface with B3 protocol. Interface towards TMN
QoS	Quality of Service
R	Reset command /General alarm
RA	Received Aggregate
RAI	Remote Alarm Indication
RAM	Random Access Memory
RAS	Remote Access Service
RCC	Routing Control Channel
RCK	Received clock
RDI	Remote Defect Indication
RDI	Remote Defect Indication
RDPS	Residual Dispersion Per Span.
RECC	Recommendation
RED	Random Early Discarding
REF	Reference
REI	Remote Error Indication
REL	Release
RFC	Request For Comment
RI	Remote Inventory
RIBUS	Remote Inventory BUS
RIP	Routing Information Protocol
RMS	Root Mean Square
RNE	Remore Network Element
RNURG	Not urgent Alarm command. Lights up the relative rack red LED
ROADM	Reconfigurable Optical Add/Drop Multiplexer
RPR	Resilient Packet Ring
RS FEC	Reed-Solomon Forward Error Correction
RSOH	Regenerator Section Overhead
RST	Regenerator Section Termination
RSTP	Rapid Spanning Tree Protocol
RSVP	Resource Reservation Protocol
RURG	Urgent Alarm command. Lights up the relative rack red LED
Rx	Reception
SC	Shelf Controller
SCOT	Software Control Of Transmission
SCSI	Small Computer Serial Interface
SD	Signal Degrade
SDH	Synchronous Digital Hierarchy
SDI	Serial Digital Interface (for Video transmission)
SEC	SDH Equipment Clock

ABBREVIATION	MEANING
SETG	Synchronous Equipment Timing Generation function
SF	Signal Fail
SFI	SERDES Framer Interface
SFP	Small Form Factor Pluggable module
SL	Signal Label
SLA	Service Level Agreement
SLC	Second Level Controller
SLM	Single Longitudinal Mode
SM	Single Mode/Synchronous Mux
SMF	Single Mode Fibre
SNCP	Sub-Network Connection Protection
SNCP/I	Subnetwork Connection Protection Inherent
SOH	Section Overhead
SONET	Sinchronous Optical Network
S/P	Serial/Parallel Converter
SP	Service Provider
SPE	Synchronous Payload Envelope
SPI	Synchronous Physical Interface
SPI	Serial Peripheral Interface
SPI	System Packet Interface
SSF	Server Signal Fail
SSMF	Standard Single Mode Fiber
SPV	Supervision
SQ	Squelch
SSF	Server Signal Fail
STM-n	Synchronous Transport Module, level n
STP	Spanning Tree Protocol
SVID	Stacked Virtual LAN Identifier
STS-nc	Synchronous Transport Signal level n concatenation
SVLAN	Stacked VLAN
SW	Software
TA	Transmitted Aggregate
TANC	Remote alarm due to failure of all power supply units
TARP	TID Address Resolution Protocol
TBD	To Be Defined
TCA	Threshold Crossing Alarm
TCI	Tag Control Information
TCP/IP	Transmission Control Protocol / Internet Protocol
TD	Layout drawing
TDM	Time Division Multiplexing

ABBREVIATION	MEANING
TIM	Trace Identifier Mismatch
TLS	Transparent LAN Service
TL1	Translation Language level 1
TMN	Telecommunication Management Network
TN	Telecommunications Network
TOR	Remote alarm indicating loss of one of the station batteries
TORC	Remote alarm due to a faulty/missing power supply unit
TP	Termination Point
TP/VP_A	Transmission Path/Virtual Path Adaptation
TP_T	Transmission Path Termination
TPD	Transponder
TPD	Tail Packets Discarding
TRU	Top Rack Unit
TSD	Trail Signal Degrade
TSF	Trail Signal Fail
TSS	Transpor Service Switch
TTF	Transport Terminal Function
TTL	Time To Live
TU	Tributary Unit
TUG2/3	Tributary unit group, level 2,3
TUOH	Tributary Unit Overhead
TUP/UP	Equipment Controller remote alarm
TU12/TU3	Tributary unit level 12, 3
TX	Transmission
TW-RS	True Wave Reduced Slope fiber
UDP	User Datagram Protocol
UILA	Upgradeable In-Line Amplifier
UNI	User to Network Interface
URG	Urgent
UROADM	Upgraded Reconfigurable Optical Add Drop Multiplexer.
USM	User Services Manager
VC	Virtual Container/Virtual Concatenation
VCAT	Virtual Concatenation
VCG	Virtual Concatenation Group
VCXO/VCO	Voltage controlled oscillator
VC12/VC3/VC4	Virtual Container, levels 12,3,4
VGOAM	Variable Gain Optical Amplifier Module
VID	Virtual LAN Identifier
VLAN	Virtual LAN
VMMF	Virtual Machine Management Function

ABBREVIATION	MEANING
VOA	Variable Optical Attenuator
VoIP	Voice over IP
VPN	Virtual Private Network
VR	Virtual Router
VT	Virtual Tributary
WAN	Wide Access Network
WC-WFQ	Work-Conservative WFQ
WDM	Wavelength Division Multipleing
WEEE	Waste Electric and Electronic Equipment
WFQ	Weighed Fair Queuing
WL	Wavelength
WLA	Wavelength Adapter
WNC-WFQ	Work-Non-Conservative WFQ
WR	Wavelength Router circuit packs.
WR4, WR8	4- and 8-port WR packs, respectively
WSS	Wavelength Selective Switch.
W-RED	Weighed - Random Early Discarding
XC	Cross-Connection
XFP	10 Gigabit Small Form Factor Pluggable module

DEFINITION	MEANING
ACT	Active: the entity is currently in use and has spare operating capacity for further usage demand. When applied to a facility entity, this value means that the entity is cross-connected (the entity is a constituent leg of a cross-connect) and additional cross-connect capacity can be applied, e.g., a 1-way cross-connect, a 2-way cross-connect but not with a 1-way bridge, a 56-leg conference connection but not with a 1-way bridge.
AINS	Automatic In-Service: the entity is allowed to transition to the in-service state if it is operationally capable, e.g., a OC-3 transitions from OOS-AU,AINS to IS when all OC-3 alarm conditions have cleared.
BUSY	Busy: the entity is currently in use and has no spare operating capacity for further usage demand. When applied to a facility entity, this value means that the entity is cross-connected (the entity is a constituent leg of a cross-connect) and no additional capacity can be applied, e.g., a Test Access port is connected to another entity for test access
DCM	The Dispersion Compensation Modules (DCM) are fibered to the mid-stage access ports of LDRX and LDTX to compensate for the dispersion present in the outside plant fiber.
DSBLD	Disabled: the facility entity is prohibited from carrying traffic , e.g., the required supporting equipment is not provisioned.
DWDM Channel	A service that is to be carried by the DWDM network.
DWDM Link	A contiguous series of spans terminated by a ROADM at each end. A DWDM link can be a single span or series of spans joined by ILA's or UILA's.
FAF	Facility Failure: the associated facility entity has failed, e.g., a LOS, LOF, AIS condition for OC-3 entities.
ILA	An In-Line Amplifier (ILA) shelf. Two LDRX are used at a non-upgradeable ILA, one for each direction of transmission.
IS, IS-NR	In_Service, Normal: the entity is capable and allowed to provide its provisioned functions. (IS and IS-NR are interchangeable)
IS-ANR	In_Service_Abnormal: the entity is capable of most functions, is allowed to provide its provisioned functions, but is operating in a degraded or abnormal state (e.g., non-alarmed BER Signal Degrade threshold crossing on an OCn or STS)
LD	A circuit pack used to terminate a DWDM span at a ROADM, UROADM, ILA, or UILA. The line drive may contain an OA to amplify the DWDM line signal, or it may be unamplified. LD CP's are unidirectional and may be for either receive terminations (LDRX) or transmit sources (LDTX).
LPBK	Loopback: loopback activity is currently being performed on the entity.
NE	A configuration of 1850 equipment at a single site that is addressed as a single entity and is under the control of a single controller.
OMD	The Optical Multiplexer/Demultiplexer (OMD) is a shelf that mounts in the frame. The OMD is a passive device that combines the individual optical channels (OCh) and creates the OMS signal that is fibered into the WR in the transmit direction. In the receive direction, the OMD takes the dropped OMS signal from the WR and splits it into the individual OCh. OMD inventory information is retrieved via an electrical connection to the WR circuit pack.

DEFINITION	MEANING
OOS-AU	Out_Of_Service-Autonomous: the entity is not available for providing its provisioned functions but the entity is not intentionally suspended by external management command (from an OS or craft interface) from performing these functions. In general, the cause of the incapability is due to an unsolicited autonomous event detected in the system or in the associated network (e.g., OC-3 LOS detected).
OOS-AUMA	Out_Of_Service-Autonomous_and_Management: the entity is not available for providing its provisioned functions because an OOS-AU state transition has occurred and the entity is intentionally suspended by external management command (from an OS or craft interface) from performing its provisioned functions.
OOS-MA	Out_Of_Service-Management: the entity is intentionally suspended by external management command (from an OS or craft interface) from performing its provisioned functions, but the entity may still be operationally capable of performing its provisioned functions.
OPS	The Optical Protection Switch (OPS) provides the bridging and switching functions required for various optical protection applications.
OSC	The Optical Supervisory Channel (OSC) provides communications between adjacent pairs of WDM network elements. The OSC hardware is contained in the LDRX circuit pack. For more information refer to OSC_DWDM_RRS.
OSP	Outside Plant, the fiber optic cables connecting sites in the network.
OT or OTU-2	The Optical Translator Unit (OT) provides the O-E-O signal conditioning and monitoring functions required for connection to the OMD. The OT can be tuned to any of the channel frequencies defined within the sytem. For more information refer to FM_DWDM_RRS. The OTU-2 board has the same line side functions as an OT but the client side connects to the switch matrix of the TSS320 shelf.
PMI	Performance Monitoring Inhibited: the performance monitoring function performed by the entity has been temporarily suspended.
PSI	Protection Switching Inhibited: the working entity is inhibited from automatic switching to protection, i.e., it is locked out from automatic protection.
ROADM	A Reconfigurable Optical Add Drop Multiplex (ROADM) shelf. The ROADM shelf can have 1 to 8 degrees or optical lines. The addition of an OMD to a "through node" - a 2-degree ROADM shelf with no add/drop signals -is hitless. There are two LDs per optical line in a ROADM. The LDRX is on the incoming side of the line, and the LDTX is on the outgoing side of a ROADM's optical line.
ROLL	Roll: the entity is currently under a roll operation. This state is a transitory state unless Manual rolling mode is being used.
SDEE	Supported Entity Exists: the entity is currently supporting other entities; deletion or state change of this entity will have impact on the service condition of the supported entities.
SGEO	Supporting Entity Outage: the associated supporting entity has failed or is out-of-service due to management action (OOS-MA or OOS-AUMA).
Span	NE to NE bidirectional link; one or more segments terminated by a NE at each end.

DEFINITION	MEANING
STBYH	Standby-Hot: the entity is to back-up another entity and is synchronized with the backed-up entity. An entity with a hot standby status will be immediately able to take over the role of the backed-up entity without the need for initialization activity. An entity shall carry a STBYH SST when the protection switching state is no request (NR)
STBYS	Standby-Switched: the entity is normally STBYH but a switching state exists than will prohibit a protection switch. This is any other state besides NR, no request.
Transparent DWDM Link	A single channel within a contiguous series of one or more DWDM links terminated by OT's.
TRM	Terminated: the facility entity has been given termination parameters, i.e., the entity has been connected and its path has been terminated (as a result of the connection) or the parent entity has been terminated as a result of its subentities being connected. For SONET line entities, this state indicates that the entity is supporting cross-connections.
TS	Test: a Test Access activity is currently being performed on or by this entity.
UAS	Unassigned: the entity has not been assigned with the necessary provisioning data. No service activity or maintenance activity (including monitoring, testing, or service recovery) is permitted in this state since the necessary data has not been assigned.
UILA	An Upgradeable In-Line Amplifier (UILA) shelf. A UILA shelf can be upgraded to a UROADM shelf with a single switch hit in each direction. Two LDRXB are used at an UILA, one for each direction of transmission.
UROADM	An Upgradeable Reconfigurable Optical Add Drop Multiplex (UROADM) shelf. The UROADM shelf can have 1 to 4 degrees or optical lines. The UROADM network element is created by upgrading from an UILA. There are two LDs per optical line in a UROADM. The LDRX is on the incoming side of the line, and the LDTX is on the outgoing side of a ROADM's optical line. The LDTX outgoing signal connects to the LDRXB to pass through the optical switch used for the UILA to UROADM upgrade.
VCACT	Virtual Concatenation Path is Active. This means the entity is part of VCG and is allowed to carry traffic.
VCIDLE	Virtual Concatenation Path is Idle. This means the entity is part of VCG and is not allowed to carry traffic.
WDM Core Optics	The circuit packs that transport or process the OMS and OTS. Within this document the acronym OMS is defined as Optical Multiplex Section and the OTS is defined as Optical Transport Section as defined in ITU-T Recommendation G.798. The OMS function combines the individual optical channels (OCH) into a common fiber signal. The OTS function combines the OMS signal with the OSC signal for transport onto the outside plant fiber.

DEFINITION	MEANING
WRK	Working: the entity is currently providing service as part of a protection group (e.g., selector is selecting this entity in a UPSR configuration).
WRx	The Wavelength Router (WR) circuit packs propagate the OMS signal received from their optical lines to all other transmit optical lines, and switch individual OCh signals from all received optical lines onto their transmit optical line signal. This will allow the adding or dropping of individual OCh signals to or from an optical line (OTS/OMS) as it passes through a ROADM or UROADM shelf. One WRx is required for each DWDM line. WR4 CP's are used in ROADMS that support up to 4 DWDM lines. WR8 CP's are used in ROADM's that support up to 8 DWDM lines.

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8DG 08136 AAAA Ed. 03 - Change Note: ECR-0000065555

Unit: Wireline Optics OMSN Vimercate June 2009

Author: C. Gianni

Appraisal: E.Di Lorenzo - M.Lenti