Lucent Technologies
Bell Labs Innovations

Metropolis® ADM (Universal shelf)

Release 5.2

Applications and Planning Guide

365-312-841R5.2
CC109640607
Issue 1
December 2006

Trademarks

Notice

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Additional information about Hart Hat Linux can be obtained at www.mvista.com/products/pro.

Declaration of Conformity

The Declaration of Conformity (DoC) for this product can be found in this document at "Conformity statements" (p. 9-5), or at: http://www.lucent.de/ecl.

WEEE directive

The *Waste from Electrical and Electronic Equipment (WEEE) directive* for this product can be found in this document at "Eco-environmental statements" (p. 9-8).

Overview EMC/ESD Safety

The EMC/ESD boundary has been defined at rack/subrack level. The principle is based on the "Faraday Cage" theory. If there are doors, then the doors must be closed. With every rack/subrack an ESD (electrostatic discharge) earth socket and an ESD sticker are supplied. On the Rack frame ETSI an ESD bonding point for an ESD wrist strap is present. It is mounted in a way that it's always accessible for installation, normal operation and maintenance activity.

Wrist strap

The wrist strap must be worn when opening the subrack doors.

Electrostatic sensitive devices

The equipment described in this guide contains static sensitive devices. Electrostatic discharge precautions should be taken when operating or working on this equipment.

Special handling precautions apply whenever installing or removing parts of the equipment include:

- leaving components or equipment in original packaging until required for use.
- removing plug-in units with previously discharged hands (e.g. using grounded wrist straps connected to the ESD bonding point on the cabinet).
- returning items for repair in suitable antistatic packaging.

Ordering information

The order number of this document is 365-312-841R5.2 (Issue 1).

Technical support

Please contact your Lucent Technologies Local Customer Support Team (LCS) for technical questions about the information in this document.

Information product support

To comment on this information product online, go to *http://www.lucent-info.com/comments* or email your comments to *comments@lucent.com*.

Contents

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About this information product

Purpose

This Application and Planning Guide (APG) provides the following information about the *Metropolis®* ADM (Universal shelf), Release 5.2:

- System overview
- Features and benefits
- Applications
- Product description
- System planning and engineering
- OAM&P
- Product support
- Quality and reliability
- Technical specifications.

Reason for reissue

This is the first issue of this guide for *Metropolis®* ADM (Universal shelf) Release 5.2.

A new version of this document was needed to address all features supported by *Metropolis®* ADM (Universal shelf) Release 5.2. The most important feature added to the previous release is that so-called Alarm Severity Assignment Profiles ASAPs can now be assigned to *Metropolis®* ADM (Universal shelf) functional system components (a circuit pack or a specific port for example) during provisioning.

ASAPs allow the user to control alarm reporting with more flexibility, and to create multiple alarm profiles for each alarm category and to assign these profiles to entities within the system.

Safety information

This information product contains hazard statements for your safety. Hazard statements are given at points where safety consequences to personnel, equipment, and operation may exist. Failure to follow these statements may result in serious consequences.

Intended audience

The *Metropolis*® ADM (Universal shelf) Applications and Planning Guide is primarily intended for network planners and engineers. In addition, others (e.g. Lucent sales people and customers) who need specific information about the features, applications, operation, and engineering of *Metropolis*® ADM (Universal shelf) may find the information in this manual useful.

How to use this information product

Each chapter of this manual treats a specific aspect of the system and can be regarded as an independent description. This ensures that readers can inform themselves according to their special needs. This also means that the manual provides more information than needed by many of the readers. Before you start reading the manual, it is therefore necessary to assess which aspects or chapters will cover the individual area of interest.

The following table briefly describes the type of information found in each chapter.

Chapter	Title	Description
About this information product		This chapter • describes the guide's purpose, intended audience, and organization • lists related documentation • explains how to comment on this document
1	Introduction	This chapter • presents network application solutions • provides a high-level product overview • describes the product family • lists features
2	Features	Describes the features of *Metropolis*® ADM (Universal shelf)
3	Network topologies	Describes some of the main network topologies possible with *Metropolis*® ADM (Universal shelf)
4	Product description	This chapter • provides a functional overview of the system • describes the hardware and configurations available for the product
5	Operations, administration, maintenance, and provisioning	Describes OAM&P features (such as alarms, operation interfaces, security, and performance monitoring)
6	System planning and engineering	Provides planning information necessary to deploy the system

Chapter	Title	Description
7	Ordering	Describes how to order *Metropolis*® ADM (Universal shelf).
8	Product support	This chapter • describes engineering and installation services • explains documentation and technical support • lists training courses
9	Quality and reliability	This chapter • provides the Lucent Technologies quality policy • lists the reliability specifications
10	Technical specifications	Lists the technical specifications
Glossary	Defines telecommunication terms and explains abbreviations and acronyms	
Index	Lists specific subjects and their corresponding page numbers	

Conventions used

These conventions are used in this document:

Numbering

The chapters of this document are numbered consecutively. The page numbering restarts at "1" in each chapter. To facilitate identifying pages in different chapters, the page numbers are prefixed with the chapter number. For example, page 2-3 is the third page in chapter 2.

Cross-references

Cross-reference conventions are identical with those used for numbering, i.e. the first number in a reference to a particular page refers to the corresponding chapter.

Keyword blocks

This document contains so-called keyword blocks to facilitate the location of specific text passages. The keyword blocks are placed to the left of the main text and indicate the contents of a paragraph or group of paragraphs.

Typographical conventions

Special typographical conventions apply to elements of the graphical user interface (GUI), file names and system path information, keyboard entries, alarm messages etc.

- Elements of the graphical user interface (GUI)
  These are examples of text that appears on a graphical user interface (GUI), such as menu options, window titles or push buttons:
  - **Provision…**, **Delete**, **Apply**, **Close**, **OK** (push-button)
  - **Provision Timing/Sync** (window title)

- **View Equipment Details...** (menu option)
- **Administration** → **Security** → **User Provisioning...** (path for invoking a window)

- File names and system path information

  These are examples of file names and system path information:
  - *setup.exe*
  - *C:\Program Files\Lucent Technologies*
- Keyboard entries

  These are examples of keyboard entries:
  - **F1**, **Esc X**, **Alt-F**, **Ctrl-D**, **Ctrl-Alt-Del** (simple keyboard entries)

    A hyphen between two keys means that both keys have to be pressed simultaneously. Otherwise, a single key has to be pressed, or several keys have to be pressed in sequence.
  - `copy abc xyz` (command)

    A complete command has to be entered.
- Alarms and error messages

  These are examples of alarms and error messages:
  - `Loss of Signal`
  - `Circuit Pack Failure`
  - `HP-UNEQ`, `MS-AIS`, `LOS`, `LOF`
  - `Not enough disk space available`

Abbreviations

Abbreviations used in this document can be found in the "Glossary" unless it can be assumed that the reader is familiar with the abbreviation.

Related documentation

This section briefly describes the documents that are included in the *Metropolis*® ADM (Universal shelf) documentation set.

- Installation Guide

  The *Metropolis*® ADM (Universal shelf) Installation Guide (IG) is a step-by-step guide to system installation and setup. It also includes information needed for pre-installation site planning and post-installation acceptance testing.
- Applications and Planning Guide

  The *Metropolis*® ADM (Universal shelf) Applications and Planning Guide (APG) is for use by network planners, analysts and managers. It is also for use by the Lucent Account Team. It presents a detailed overview of the system, describes its applications, gives planning requirements, engineering rules, ordering information, and technical specifications.
- User Operations Guide

  The *Metropolis*® ADM (Universal shelf) User Operations Guide (UOG) provides step-by-step information for use in daily system operations. The manual demonstrates how to perform system provisioning, operations, and administrative tasks by use of ITM Craft Interface Terminal (ITM-CIT).

- Alarm Messages and Trouble Clearing Guide
  The *Metropolis®* ADM (Universal shelf) Alarm Messages and Trouble Clearing Guide (AMTCG) gives detailed information on each possible alarm message. Furthermore, it provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement.
- The Lucent OMS Provisioning Guide (Application *Metropolis®* ADM (Universal shelf))
  The Lucent OMS Provisioning Guide (Application *Metropolis®* ADM (Universal shelf)) gives instructions on how to perform system provisioning, operations, and administrative tasks by use of Lucent OMS.

The following table lists the documents included in the *Metropolis®* ADM (Universal shelf) documentation set.

Document title	Document code
Metropolis® ADM (Universal shelf) Release 5.2 Applications and Planning Guide	109640607 (365-312-841R5.2)
Metropolis® ADM (Universal shelf) Release 5.2 User Operations Guide	109640623 (365-312-842R5.2)
Metropolis® ADM (Universal shelf) Release 5.2 Alarm Messages and Trouble Clearing Guide	109640599 (365-312-843R5.2)
Metropolis® ADM (Universal shelf) Release 5.2 Installation Guide	109640581 (365-312-844R5.2)
Lucent OMS Provisioning Guide (Application *Metropolis®* ADM (Universal shelf))	109640649 (365-312-875R5.2)
Metropolis® ADM (Universal shelf) Safety Guide	109640631 (365-312-879)
CD-ROM Documentation *Metropolis®* ADM (Universal shelf) Release 5.2 (all manuals on a CD-ROM)	109640615 (365-312-845R5.2)

These documents can be ordered at or downloaded from the Customer Information Center (CIC) at http://www.cic.lucent.com/documents.html, or via your Local Customer Support.

Related training

For detailed information about the *Metropolis®* ADM (Universal shelf) training courses and how to register please refer to "Training support" (p. 8-11) in this document.

Customer Documentation Subnetwork Controller Related

The documentation set related to Lucent OMS is shown in the following table:

Document title	Document code
Lucent OMS Getting Started Guide Instructs new users how to use Lucent OMS. This document contains a glossary of terms.	365-315-145R5.1
Lucent OMS Connection Management Guide Instructs users how to use Lucent OMS to provision and manage network connections.	365-315-150R5.1
Lucent OMS Network Element Management Guide Instructs users how to use Lucent OMS to provision and manage network elements.	365-315-146R5.1
Lucent OMS Ethernet Management Guide Instructs users on how to use the Ethernet Management feature to provision and manage Ethernet connections in a network.	365-315-147R5.1
Lucent OMS Service Assurance Guide Instructs users on how to manage and interpret fault information collected from the network.	365-315-148R5.1
Lucent OMS Administration Guide Instructs users on how to administer and maintain Lucent OMS and the network.	365-315-149R5.1

Documented feature set

This manual describes *Metropolis*® ADM (Universal shelf) Release 5.2. For technical reasons some of the documented features might not be available until later software versions. For precise information about the availability of features, please consult the Software Release Description (SRD) that is distributed with the network element software. This provides details of the status at the time of software delivery.

Intended use

This equipment shall be used only in accordance with intended use, corresponding installation and maintenance statements as specified in this documentation. Any other use or modification is prohibited.

Optical safety

IEC Customer Laser Safety Guidelines

Lucent Technologies declares that this product is compliant with all essential safety requirements as stated in IEC 60825-Part 1 and 2 “Safety of laser products” and “Safety of optical fibre telecommunication systems”. Futhermore Lucent Technologies declares that the warning statements on labels on this equipment are in accordance with the specified laser radiation class.

Optical Safety Declaration (if laser modules used)

Lucent Technologies declares that this product is compliant with all essential safety requirements as stated in IEC 60825-Part 1 and 2 “Safety of Laser Products” and “Safety of Optical Fiber Telecommunication Systems”. Furthermore Lucent Technologies declares that the warning statements on labels on this equipment are in accordance with the specified laser radiation class.

Optical Fiber Communications

This equipment contains an Optical Fiber Communications semiconductor laser/LED transmitter. The following Laser Safety Guidelines are provided for this product.

General Laser Information

Optical fiber telecommunication systems, their associated test sets, and similar operating systems use semiconductor laser transmitters that emit infrared (IR) light at wavelengths between approximately 800 nanometers (nm) and 1600 nm. The emitted light is above the red end of the visible spectrum, which is normally not visible to the human eye. Although radiant en at near-IR wavelengths is officially designated invisible, some people can see the shorter wavelength energy even at power levels several orders of magnitude below any that have been shown to cause injury to the eye.

Conventional lasers can produce an intense beam of monochromatic light. The term “monochromaticity” means a single wavelength output of pure color that may be visible or invisible to the eye. A conventional laser produces a small-size beam of light, and because the beam size is small the power density (also called irradiance) is very high. Consequently, lasers and laser products are subject to federal and applicable state regulations, as well as international standards, for their safe operation.

A conventional laser beam expands very little over distance, or is said to be very well collimated. Thus, conventional laser irradiance remains relatively constant over distance. However, lasers used in lightwave systems have a large beam divergence, typically 10 to 20 degrees. Here, irradiance obeys the inverse square law (doubling the distance reduces the irradiance by a factor of 4) and rapidly decreases over distance.

Lasers and Eye Damage

The optical energy emitted by laser and high-radiance LEDs in the 400-1400 nm range may cause eye damage if absorbed by the retina. When a beam of light enters the eye, the eye magnifies and focuses the energy on the retina magnifying the irradiance. The irradiance of the energy that reaches the retina is approximately 105, or 100,000 times more than at the cornea and, if sufficiently intense, may cause a retinal burn.

The damage mechanism at the wavelengths used in an optical fiber telecommunications is thermal in origin, i.e., damage caused by heating. Therefore, a specific amount of energy is required for a definite time to heat an area of retinal tissue. Damage to the retina occurs only when one looks at the light long enough that the product of the retinal irradiance and the viewing time exceeds the damage threshold. Optical energies above 1400 nm cause corneal and skin burns, but do not affect the retina. The thresholds for injury at wavelengths greater than 1400 nm are significantly higher than for wavelengths in the retinal hazard region.

Classification of Lasers

Manufacturers of lasers and laser products in the U.S. are regulated by the Food and Drug Administration's Center for Devices and Radiological Health (FDA/CDRH) under 21 CFR 1040. These regulations require manufacturers to certify each laser or laser product as belonging to one of four major Classes: I, II, lla, IlIa, lllb, or IV. The International Electro-technical Commission is an international standards body that writes laser safety standards under IEC-60825. Classification schemes are similar with Classes divided into Classes 1, 1M, 2, 2M, 3R, 3B, and 4. Lasers are classified according to the accessible emission limits and their potential for causing injury. Optical fiber telecommunication systems are generally classified as Class I/1 because, under normal operating conditions, all energized laser transmitting circuit packs are terminated on optical fibers which enclose the laser energy with the fiber sheath forming a protective housing. Also, a protective housing/access panel is typically installed in front of the laser circuit pack shelves The circuit packs themselves, however, may be FDA/CDRH Class I, IIIb, or IV or IEC Class 1, 1M, 3R, 3B, or 4.

Laser Safety Precautions for Optical Fiber Telecommunication Systems

In its normal operating mode, an optical fiber telecommunication system is totally enclosed and presents no risk of eye injury. It is a Class I/1 system under the FDA and IEC classifications.

The fiber optic cables that interconnect various components of an optical fiber telecommunication system can disconnect or break, and may expose people to laser emissions. Also, certain measures and maintenance procedures may expose the technician to emission from the semiconductor laser during installation and servicing. Unlike more familiar laser devices such as solid-state and gas lasers, the emission pattern of a semiconductor laser results in a highly divergent beam. In a divergent beam, the irradiance (power density) decreases rapidly with distance. The greater the distance, the less energy will enter the eye, and the less potential risk for eye injury. Inadvertently viewing an un-terminated fiber or damaged fiber with the unaided eye at distances greater than 5 to 6 inches normally will not cause eye injury, provided the power in the fiber is less than a few milliwatts at the near IR wavelengths and a few tens of milliwatts at the far IR wavelengths. However, damage may occur if an optical instrument such as a microscope, magnifying glass, or eye loupe is used to stare at the energized fiber end.

CAUTION

Laser hazard

Use of controls, adjustments, and procedures other than those specified herein may result in hazardous laser radiation exposure.

Laser Safety Precautions for Enclosed Systems

Under normal operating conditions, optical fiber telecommunication systems are completely enclosed; nonetheless, the following precautions shall be observed:

1. Because of the potential for eye damage, technicians should not stare into optical connectors or broken fibers
2. Under no circumstance shall laser/fiber optic operations be performed by a technician before satisfactorily completing an approved training course
3. Since viewing laser emissions directly in excess of Class I/1 limits with an optical instrument such as an eye loupe greatly increases the risk of eye damage, appropriate labels must appear in plain view, in close proximity to the optical port on the protective housing/access panel of the terminal equipment.

Laser Safety Precautions for Unenclosed Systems

During service, maintenance, or restoration, an optical fiber telecommunication system is considered unenclosed. Under these conditions, follow these practices:

1. Only authorized, trained personnel shall be permitted to do service, maintenance and restoration. Avoid exposing the eye to emissions from un-terminated, energized optical connectors at close distances. Laser modules associated with the optical ports of laser circuit packs are typically recessed, which limits the exposure distance. Optical port shutters, Automatic Power Reduction (APR), and Automatic Power Shut Down (APSD) are engineering controls that are also used to limit emissions. However, technicians removing or replacing laser circuit packs should not stare or look directly into the optical port with optical instruments or magnifying lenses. (Normal eye wear or indirect viewing instruments such as Find-R-Scopes are not considered magnifying lenses or optical instruments.)
2. Only authorized, trained personnel shall use optical test equipment during installation or servicing since this equipment contains semiconductor lasers (Some examples of optical test equipment are Optical Time Domain Reflectometers (OTDR's), Hand-Held Loss Test Sets.)
3. Under no circumstances shall any personnel scan a fiber with an optical test set without verifying that all laser sources on the fiber are turned off
4. All unauthorized personnel shall be excluded from the immediate area of the optical fiber telecommunication systems during installation and service.

Consult ANSI Z136.2, American National Standard for Safe Use of Lasers in the U.S.; or, outside the U.S., IEC-60825, Part 2 for guidance on the safe use of optical fiber optic communication in the workplace.

Technical Documentation

The technical documentation as required by the Conformity Assessment procedure is kept at Lucent Technologies location which is responsible for this product. For more information please contact your local Lucent Technologies representative.

How to order

This information product can be ordered with the order number 365-312-841R5.2 at the Customer Information Center (CIC), see http://www.cic.lucent.com/.

An overview of the ordering process and the latest software & licences information is given in Chapter 7, “Ordering” of this manual.

For a complete and up-to-date list of the orderable hw items with the respective comcodes please refer to the Engineering Drawing ED8C937-10-A4, that you can

- find appended at the end of this document, as available on the date of printing (if ordered at the Customer Information Center (CIC))
- order in the latest version at CIC under http://www.cic.lucent.com/drawings.html with the order code ED8C937-10-A4.

How to comment

To comment on this information product, go to the Online Comment Form (http://www.lucent-info.com/comments/enus/) or e-mail your comments to the Comments Hotline (comments@lucent.com).

As customer satisfaction is extremely important to Lucent Technologies, every attempt is made to encourage feedback from customers about our information products. Thank you for your feedback.

1 Introduction

Overview

Purpose

This chapter introduces the *Metropolis*® ADM (Universal shelf).

Contents

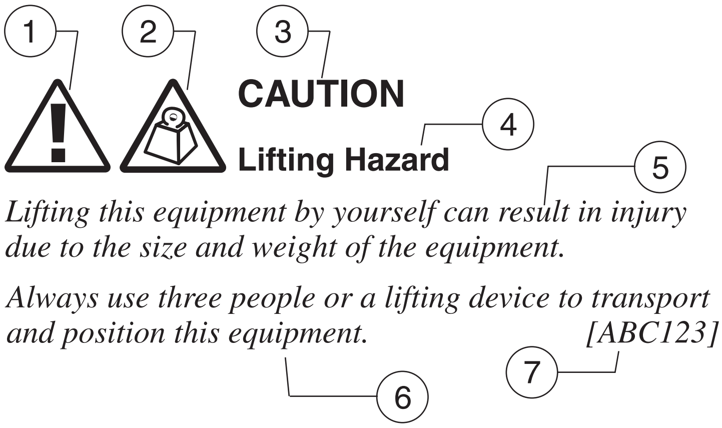
Structure of hazard statements

Overview

Hazard statements describe the safety risks relevant while performing tasks on Lucent Technologies products during deployment and/or use. Failure to avoid the hazards may have serious consequences.

General structure

Hazard statements include the following structural elements:



Item	Structure element	Purpose
1	Personal-injury symbol	Indicates the potential for personal injury (optional)
2	Hazard-type symbol	Indicates hazard type (optional)
3	Signal word	Indicates the severity of the hazard
4	Hazard type	Describes the source of the risk of damage or injury
5	Damage statement	Consequences if protective measures fail
6	Avoidance message	Protective measures to take to avoid the hazard
7	Identifier	The reference ID of the hazard statement (optional)

Signal words

The signal words identify the hazard severity levels as follows:

Signal word	Meaning
DANGER	Indicates an imminently hazardous situation (high risk) which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation (medium risk) which, if not avoided, could result in death or serious injury.
CAUTION	*When used with the personal injury symbol:* Indicates a potentially hazardous situation (low risk) which, if not avoided, may result in personal injury. *When used without the personal injury symbol:* Indicates a potentially hazardous situation (low risk) which, if not avoided, may result in property damage, such as service interruption or damage to equipment or other materials.

Metropolis® ADM (Universal shelf) network solutions

The *Metropolis*® ADM (Universal shelf) is a high capacity, flexible, cost-effective wideband multiplexer and transport system that can multiplex standard PDH and SDH bit rates as well as Ethernet signals to line-transport rates that can be selected at 2.5 Gbit/s (STM-16) or 10 Gbit/s (STM-64). This system is a useful element in building efficient and flexible networks because of its wide-ranging in capacity in addition to a compact and flexible design.

References

A more detailed product description can be found in Chapter 4, “Product description”.

Key features

One of the main features of the *Metropolis*® ADM (Universal shelf) is its ability to add/drop and flexibly cross-connect 1,5 Mbit/s and/or 2 Mbit/s directly from the STM-16 or the STM-64. Another attractive feature is that the Ethernet can be connected directly to the SDH layer.

Other signals that can be add/dropped are:

- 34 Mbit/s,
- 45 Mbit/s,
- 155 Mbit/s (STM-1),
- 622 Mbit/s (STM-4),
- 2.5 Gbit/s (STM-16),
- 10/100BASE-T and
- 1000 Base-X Ethernet.

Key features of *Metropolis*® ADM (Universal shelf) include:

- 1 + 1 equipment protection
- 1:N equipment protection
- multiplex section protection (MSP) for STM-1o, STM-4, STM-16, and STM-64.
- subnetwork connection protection with non intrusive monitoring (SNCP/N) as path protection or for higher and lower order VCs
- 2-fiber multiplex section shared protection ring (MS-SPRing) at STM-16 and STM-64 level (on 10-Gbit/s and 2.5-Gbit/s interfaces).
- dual node interconnection (DNI) with drop and continue.
- synchronization and timing
- Remote maintenance and management by Lucent Technologies management solutions (*Navis*® NMS, and Lucent OMS)
- tunneling of TCP/IP over DCN
- hardware family with the *Metropolis*® ADM (Compact Shelf)
- Ethernet LAN connection supporting generic framing procedure (GFP/EOS) and link capacity adjustment scheme (LCAS)

- multi-service product for circuit- and packet based services
- compact design
- front access for all optical and electrical interfaces
- easy installation and maintenance
- low power dissipation
- flexibility in applications and protection capabilities.
- manageable by Craft Interface Terminal (ITM-CIT).

These features make the *Metropolis®* ADM (Universal shelf) one of the most cost-effective, future-proof and flexible network elements available on the market today.

Applications

The *Metropolis®* ADM (Universal shelf) supports a large variety of configurations for various network applications:

- Ethernet services - Packets over SDH
- Metro/Access Multi-ring Node with LXC functionality
- Dual node interworking (DNI)
- Access/metro/core networking

Main applications of the system:

- grooming of lower order traffic in a ring
- path-protected rings
- ring closure
- ADM in MS-SPRing protected STM-16 and STM-64 rings.

Management

Like most of the network elements of the Lucent Technologies Optical Networking Group (ONG) product portfolio, *Metropolis®* ADM (Universal shelf) is managed by Lucent Technologies *Navis®* NMS. This user-friendly management system provides information and management of *Metropolis®* ADM (Universal shelf) network elements on a subnetwork-level and a network level. A local craft terminal, the ITM Craft Interface Terminal (ITM-CIT), is available for on-site, but also for remote operations and maintenance activities.

Interworking

The *Metropolis®* ADM (Universal shelf) can be included in 2 fiber MS-SPRing protected ring networks that also contain *LambdaUnite®* MultiService Switch (MSS), *WaveStar®* TDM 10G, *WaveStar®* BWM, *WaveStar®* ADM 16/1, or *Metropolis®* ADM (Compact Shelf) network elements. Provisioning commands and protocol operation between the different NEs does interwork.

The following feature and mechanism are specifically needed to support this interworking:

- ring communication server: a special communication feature for nodes in a ring to support functions like automatic ring discovery, cross-connect distribution, selection of channels for MS-SPRing etc. This ring communication server is common across the Lucent Technologiesproducts.
- enhanced auto ring discovery: a mechanism to discover automatically the nodes that participate in an MS-SPRing consisting of different Lucent Technologies products and to detect addition/deletion of ring nodes.
- circuit audit and auto squelch map interworking: a mechanism to exchange cross-connect distribution information between the nodes of the MS-SPRing using the ring communication server.

If necessary, you can coordinate with Lucent Technologies what products are able to interwork with *Metropolis*® ADM (Universal shelf).

□

The optical networking products family

Lucent Technologies offers the industry’s widest range of high-quality transport systems and related services designed to provide total network solutions. Included in this offering is the optical networking product family. The optical networking product family offers telecommunications service providers advanced services and revenue-generating capabilities.

Family members

The optical networking products family includes products designed to bring your networks forward.

The following table lists optical networking products that are currently available or under development.

Optical networking product	**SONET**	**SDH**
FT-2000	Yes	No
LambdaUnite® MultiService Switch (MSS)	Yes	Yes
LambdaXtreme™ Transport	Yes	Yes
Metropolis® ADM (Universal shelf)	No	Yes
Metropolis® AM	No	Yes
Metropolis® AMS	No	Yes
Metropolis® DMX Access Multiplexer	Yes	No
Metropolis® DMXpress Access Multiplexer	Yes	No
Metropolis® Enhanced Optical Networking (EON)	Yes	Yes
Navis® Optical Capacity Analyzer (CA)	Yes	Yes
Navis® Optical Customer Service Manager (CSM)	Yes	Yes
Navis® Optical Management System (OMS)	Yes	Yes
Navis® Optical Fault Manager	Yes	Yes
Navis® Optical Integrated Network Controller (INC)	Yes	Yes
Navis® Optical Network Management System (NMS)	Yes	Yes
Navis® Optical Performance Analyzer (PA)	Yes	Yes
Navis® Optical Provisioning Manager (PM)	Yes	Yes
OptiGate™ OC-192 Transponder	Yes	No
OptiStar™ EdgeSwitch	Yes	No
OptiStar™ IP Encryption Gateway (IPEG)	Yes	No
OptiStar™ MediaServe	Yes	No
OptiStar™ Network Adapters	Yes	No
Radio OEM	No	Yes

Optical networking product	**SONET**	**SDH**
Synchronization OEM	Yes	Yes
TransLAN™ Ethernet SDH Transport Solution	No	Yes
WaveStar® ADM 16/1	No	Yes
Metropolis® ADM (Compact shelf)	No	Yes
WaveStar® ADM 4/1	No	Yes
WaveStar® BandWidth Manager	Yes	Yes
WaveStar® DACS 4/4/1	No	Yes
WaveStar® Engineering Orderwire (EOW)	Yes	Yes
WaveStar® Optical Line System (OLS) 1.6T	Yes	Yes
WaveStar® TDM 10G (OC-192)	Yes	No
WaveStar® TDM 10G (STM-64)	No	Yes
WaveStar® TDM 2.5G (OC-48)	Yes	No

Family features

The optical networking products family offers customers

- SONET and/or SDH-based services
- Scalable cross-connect, multiplex, and transport services
- Ethernet transport over SONET or SDH networks
- Network consolidation and reliability
- Interoperability with other vendors' products
- Coordination of network element and element management services

Hardware family with the *WaveStar*® ADM16/1 Compact

The architecture of the *Metropolis*® ADM (Universal shelf) is based on the architecture of the *Metropolis*® ADM (Compact shelf). Therefore the tributary circuit packs can be interchanged between these two types of network elements. Since both NEs are planned for the network in question, significant cost savings can be archieved because of the reduced need for spare parts.

The following circuit packs are used by both network elements

- PI-E1/63
- PI-E3DS3/12
- SI-1/4 (STM-1e)
- SI-S1.1/4
- SI-L1.2/4
- SI-S4.1
- SI-L4.2

- IP-LAN/8 and
- IP-GE/2
- SC.

Deployment of transmission systems

From a network point of view, SDH is the answer to the rapidly changing demand for services on the one hand and to the increasing cost of implementing these services in switching equipment on the other hand. The latter means that the switching equipment has to provide for larger and larger areas to keep the cost per line at an economical level. This causes an increase in the deployment of transmission systems because the average distance between subscribers and the central exchange (and also the distance between exchanges) increases. The cost penalty for extra transmission equipment has been relatively low thanks to new developments in transmission technology (e.g. optical fiber).

PDH transmission network

The existing PDH (Plesiochronous Digital Hierarchy) transmission network has a fixed multiplex architecture (2/8, 8/34, 34/140 Mbit/s). Digital distribution frames are installed between the multiplex equipment where the signal cabling is connected. The routing of some of the data streams is established with these connections. The other streams are demultiplexed to 2 Mbit/s and connected to the exchange. Making changes in such a transmission network requires manual action and accurate administration. So flexibility is not optimal and operating costs increase when the demand is changing continuously.

□

Metropolis® ADM (Universal shelf) system description

Overview

The *Metropolis®* ADM (Universal shelf) is an optical data multiplexer that multiplexes a broad range of PDH and SDH signals into 10 Gbit/s (STM–64), 2.5 Gbit/s (STM-16), 622 Mbit/s (STM-4), or 155 Mbit/s (STM-1) and provides direct LAN interfaces that can be used for LAN interconnection.

Applications

The system can be used as an add/drop multiplexer, a terminal multiplexer or a data-integrated multiplexer. It provides built-in cross-connect facilities and flexible interface circuit packs. Local and remote management and control facilities are provided via the Q and F interfaces and the embedded communication channels.

The *Metropolis®* ADM (Universal shelf) shares hardware and software assets of the *Metropolis®* ADM (Compact shelf). Therefore the tributary circuit packs may be interchanged between these two types of network elements. Since both NEs are planned for the network in question, the significant cost savings can be archieved because of the reduced need for spare parts.

Basic architecture

The system architecture makes it possible to use an interface circuit pack in almost any other slot position Hence the system becomes very flexible. A broad range of applications can be served from the same shelf using a common software platform.

Metropolis® ADM (Universal shelf) subrack

The following figure illustrates the *Metropolis®* ADM (Universal shelf) sub-rack.

□

2 Features

Overview

Purpose

This chapter briefly describes the features of the *Metropolis*® ADM (Universal shelf).

For more information on the physical design features and the applicable standards, please refer to Chapter 6, "System planning and engineering"" and to Chapter 10, "Technical specifications".

Standards compliance

Lucent Technologies SDH products comply with the relevant SDH ETSI and ITU-T standards. Important functions defined in SDH standards such as the Data Communication Channel (DCC), the associated 7-layer OSI protocol stack, the SDH multiplexing structure and the Operations, Administration, Maintenance, and Provisioning (OAM&P) functions are implemented in Lucent Technologies product families.

Lucent Technologies is heavily involved in various study groups with ITU-T, *Telcordia*™ and ETSI work creating and maintaining the latest worldwide SDH standards. *Metropolis*® ADM (Universal shelf) complies with all relevant and latest *Telcordia*™, ETSI and ITU-T standards and supports SDH protocols in a single hardware-software configuration.

Contents

Physical interfaces

Overview

Purpose

This section provides information about all kinds of physical external interfaces of *Metropolis*® ADM (Universal shelf). For detailed technical data and optical parameters of the interfaces please refer to Chapter 10, “Technical specifications”.

Metropolis® ADM (Universal shelf) supports a variety of configurations as described in the previous chapter, due to its flexible architecture within the same subrack with a single common SW load. The choice of synchronous and data interfaces described below provides outstanding transmission flexibility and integration capabilities.

Contents

Synchronous interfaces

SDH interface overview

Metropolis® ADM (Universal shelf) supports the whole range of synchronous transmission rates from 10 Gbit/s down to 155 Mbit/s. All optical interface units support SDH formatted signals.

The following synchronous interfaces are available in the present release:

- 10-Gbit/s very long haul optical interface (120 km), 1550 nm
- 10-Gbit/s long haul optical interface (80 km), 1550 nm
- 10-Gbit/s short haul optical interface (40 km), 1550 nm
- 10-Gbit/s intra-office optical interface (600 m), 1310 nm
- 2.5-Gbit/s long haul optical interface with integrated OBA (120 km), 1550 nm
- 2.5-Gbit/s long haul optical interface (80 km), 1550 nm
- 2.5-Gbit/s short haul optical interface (40 km), 1310 nm
- 2.5-Gbit/s intermediate reach / short haul SFP optical module (15 km), 1310 nm
- 2.5-Gbit/s intermediate reach / short haul upstream SFP optical module (single fibre working 15km), 1310 nm
- 2.5-Gbit/s intermediate reach / short haul downstream stream SFP optical module (single fibre working 15km), 1490 nm
- 2.5-Gbit/s intra-office optical interface (2 km), 1310 nm
- 2.5-Gbit/s long haul SFP optical module (80 km), 1310 nm
- 2.5-Gbit/s long haul SFP optical module (40 km), 1310 nm
- 2.5-Gbit/s intra-office SFP optical module (2 km), 1310 nm
- 2.5-Gbit/s long haul SFP optical module (80 km), CWDM compatible, (4 colours)
- 2.5-Gbit/s short haul SFP optical module (40 km), CWDM compatible, (4 colours)
- 622-Mbit/s long haul optical module (80 km), 1550 nm
- 622-Mbit/s short haul optical interface (15 km), 1310 nm
- 155-Mbit/s long haul optical module (80 km), 1550 nm
- 155-Mbit/s intermediate reach / short haul optical interface (15 km), 1310 nm
- 155-Mbit/s intermediate reach / short haul SFP optical module (15 km), 1310 nm
- 155-Mbit/s intermediate reach / short haul upstream SFP optical module (single fibre working 15km), 1310 nm
- 155-Mbit/s intermediate reach / short haul downstream stream SFP optical module (single fibre working 15km), 1490 nm
- 155-Mbit/s intra-office interface for electrical STM-1 signals

PDH interface overview

Metropolis® ADM (Universal shelf) supports the the some plesiochronous transmission rates.

The following plesiochronous interfaces are available in the present release:

- 2 Mbit/s interface for electrical E1 signals
- 1.5 Mbit/s interface for electrical DS1 signals
  For the transport through SDH the DS1 signal is asynchronously mapped into TU-12.
- 34 Mbit/s interface for electrical E3 signals
- 45 Mbit/s interface for electrical DS3 signals

☐

Data interfaces

Gigabit Ethernet interface

Metropolis® ADM (Universal shelf) supports optical 1-Gbit/s (1000BASE) Ethernet interfaces, as part of the *TransLAN*™ Ethernet SDH Transport Solution.

Three optical 1-Gbit/s Ethernet interface units are supported, the short reach interface, called GE1/SX, the long reach interface, called GE1/LX and GE1/ZX long reach interface (1550 nm long haul, single mode fiber, with a target distance of 70km) , with two ports each. These interfaces are in accordance with IEEE 802.3-2000 Clause 38. To optimize communication the Ethernet interface supports flow control and auto-negotiation, as defined in Section 37 of IEEE 802.3. This feature, among others, enables IEEE-802.3 compliant devices with different technologies to communicate their enhanced mode of operation in order to inter-operate and to take maximum advantage of their abilities.

- 155-Mbit/s intermediate reach / short haul upstream SFP optical module (single fibre working 15km), 1310 nm
- 155-Mbit/s intermediate reach / short haul downstream stream SFP optical module (single fibre working 15km), 1490 nm

The GE1 interfaces provide enhanced flexibility for Gigabit Ethernet packet routing, for example virtual concatenation, multipoint MAC bridge, VLAN trunking and Spanning Tree Protocol (STP) with Generic VLAN Registration Protocol (GVRP). For further information please refer to “Key features of Ethernet/Fast Ethernet” (p. 3-6) and “Key features of Gigabit Ethernet” (p. 3-8).

Each GE1 circuit packs offer four bidirectional 1000BASE Ethernet LAN ports with LC connectors. If *Metropolis*® ADM (Universal shelf) is mounted in a rack with doors you must use fiber connectors with angled boots.

Ethernet/Fast Ethernet interface

For the *Metropolis*® ADM (Universal shelf) there are the LKA4 or LKA412 E/FE units, that can provide a simple, managed solution for multi-site LAN interconnection by mapping ethernet frames into VC-12-xv (x=1,2...5) or VC-3-xv (x=1,2). The *Metropolis*® ADM (Universal shelf) support 10/100BASE-T Ethernet and provides the integrated data connections within the SDH network.

For further information please refer to “Key features of Ethernet/Fast Ethernet” (p. 3-6)
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Timing interfaces

Metropolis® ADM (Universal shelf) provides two physical timing inputs and two timing outputs. ITU-T compliant 2,048 kHz and 2 Mbit/s (framed or unframed) timing signals can be used as inputs and outputs, see also "Timing interface features" (p. 2-106).

The japanese market requires different station clock interfaces: 64 kHz + 8 kHz (+ 400 Hz) for NE input and 6312 kHz for NE output. These two independent 64 kHz signals coming from outside are converted by the so-called MIOR-J unit into two independent 2048 kHz signals.

□

Operations interfaces

Operations interfaces

The *Metropolis®* ADM (Universal shelf) offers a wide range of operations interfaces to meet the needs of an evolving Operations System (OS) network. The operation interfaces include:

- office alarm interface
  This interface provides a set of discrete relay contacts that controls an offices audible and visible alarms
- user-settable miscellaneous discrete interface
  This interface provides 8 user-selectable miscellaneous discrete inputs and 4 control outputs. These miscellaneous discrete inputs and outputs can be used to read the status of external alarm points and to drive external devices. Labels can be associated to an MDI. An MDO can be coupled to an alarm event
- one F interface for a local workstation
  One RJ-45 connectorised F-interface is provided, at the connection board of the Metroplis® ADM (Universal shelf). This interface provides operation access for a PC-based workstation which is also known as a Craft Interface Terminal (ITM-CIT)
- Q interface
  The Q-interface enables network-oriented communication between *Metropolis®* ADM (Universal shelf) systems and the element/network manager. This interface uses a Qx interface protocol that is compliant with ITU-T recommendation G.773-CLNS1 to provide the capability for remote management via the Data Communication Channels (DCCs). A connectorised Q LAN 10BASE-T (twisted pair Ethernet, for twisted pair cables) is used for the Q interface.

Local and remote inventory capabilities

The *Metropolis®* ADM (Universal shelf) system provides automatic version recognition for all hardware and software that is installed in the system. Circuit pack types and circuit pack codes (‘comcodes’) are accessible via the local ITM-CIT or via the OMS. This greatly simplifies troubleshooting, dispatch decisions, and inventory audits.

□

Power interfaces and grounding

Power supply

Two redundant power supply inputs are available per shelf. The supply voltage is –48 V DC to –60 V DC nominal, and the maximum power consumption supported is 850 W. The system powering meets the ETSI requirements ETS 300132-2, *Telcordia*™ Technologies General Requirements GR-1089-CORE and GR-499-CORE. Operation range is –40 V DC to –72 V DC.

System grounding

The *Metropolis*® ADM (Universal shelf) subrack has central fixed earthing point (refer to the Metropolis® *ADM (Universal shelf) Installation Guide*).

□

SDH Transmission features

Overview

Purpose

This section gives an overview of the transmission related features of the *Metropolis*® ADM (Universal shelf). For more detailed information on the implementation of the switch function in the NE please refer to Chapter 4, "Product description".

Network protection

To guarantee service availability a variety of network-protection mechanisms are supported by the *Metropolis*® ADM (Universal shelf). These mechanisms include:

- multiplex section protection (MSP) for STM-1o, STM-4, STM-16, and STM-64.
- subnetwork connection protection with non intrusive monitoring (SNCP/N) as path protection or for higher and lower order VCs
- 2-fiber multiplex section shared protection ring (MS-SPRing) at STM-16 and STM-64 level (on 10-Gbit/s and 2.5-Gbit/s interfaces).
- dual node interconnection (DNI) with drop and continue.

A maximum of 50 ms switch time is provided for the above mentioned mechanisms.

- LCAS on GbE
- Spanning Tree Protocol.

Contents

Cross-connection features

Cross-connection rates

Metropolis® ADM (Universal shelf) supports unidirectional and bidirectional cross-connections for VC-3, VC-4, VC-4-4c, VC-4-16c, and VC-12 payloads. The assignment of unidirectional cross-connection does not occupy or restrict cross-connection capacity or cross-connection types in the reverse direction.

Cross-connection capacity

The overall TDM transmission capacity of the system is determined by the size of the higher-order switch matrix on the Core Units.

On the 2.5G Core Unit the total TDM switch capacity is 68 STM-1 equivalents (10.6 Gbit/s) for higher order and 32 for lower order.

On the 1 port 2.5G Core Units the total TDM switch capacity is 176 STM-1 equivalents (10.6 Gbit/s) for higher order and 64for lower order.

On the new quad 2.5G Core Unit the total TDM switch capacity is 272 STM-1 equivalents for higher order and 128 for lower order.

On the 10G Core Unit the total TDM switch capacity is 272 STM-1 equivalents (42.3 Gbit/s) for higher order and 64 for lower order.

On the new 10G Core Units the total TDM switch capacity is 272 STM-1 equivalents (42.3 Gbit/s) for higher order and 128 for lower order.

□

Ring protection

Metropolis® ADM (Universal shelf) supports SDH ring protection features:

- SDH: Multiplex Section Shared Protection Ring (MS-SPRing)

MS-SPRing

The following MS-SPRing protection scheme can be configured:

- 2-fiber MS-SPRing STM-64 and on STM-16 interfaces

The protection scheme complies with ITU-T Rec. G.841.

MS-SPRing principle

MS-SPRing is a self-healing ring configuration in which traffic is bidirectional between each pair of adjacent nodes and is protected by redundant bandwidth on the bidirectional lines that inter-connect the nodes in the ring. Because traffic flow is bidirectional between the nodes, traffic can be added at one node and dropped at the next without traveling around the entire ring. This leaves the spans between other nodes available for additional traffic. Therefore, with many traffic patterns a bidirectional ring can carry much more traffic than the same facilities could carry if configured for a unidirectional ring.

Self-healing Rings

Metropolis® ADM (Universal shelf) MS-SPRings are self healing, that means transport is automatically restored after node or fiber failures. This is realized by using only half capacity for protected traffic (working), reserving the other half of the capacity for back up purpose (protection).

In the event of a fiber or node failure, service is restored by switching traffic from the working capacity of the failed line to the protection capacity in the opposite direction around the ring.

MS-SPRing at STM-16 and STM-64 level

MS-SPRing is a shared protection mechanism, which means that the protection bandwidth is shared by multiple connections. MS-SPRing can operate in a ring network only and it operates at the VC-4 level. The protection is applicable from the node where the VC-4 enters the ring until the node where the VC-4 leaves the ring.

Selective MS-SPRing NUT/NPPA

It is allowed to decide per channel pair (1,9), (2,10) etc. whether or not it is part of the MS-SPRing (selective MS SPRing or NUT/NPPA). An application for this exclusion of a certain pair from MS-SPRing could be to avoid double protection on an connection that is already VC-4 SNC protected and thus save bandwidth.

APS/K-byte protocol

The MS-SPRing protocol uses an APS channel for signaling, which is transmitted in K1/K2 bytes in the multiplex section overhead, according to ITU-T Recommendation G.841. The APS/K-byte protocol supports full STM-16 MS-SPRing interworking with the *Metropolis*® ADM (Compact shelf), *WaveStar*® BWM, *WaveStar*® TDM 10 G and LambdaUnit MSS. The protocol provides protection within 60 ms (10 ms defect detection time and 50ms switching time).

MS-SPRing channels

In MS-SPRing protected rings it is useful to define (bidirectional) channels (time slots). There are 16 such channels in an STM-16 MS-SPRing and 64 in an STM-64 MS-SPRing. A channel can be thought of as the capacity of a single, bidirectional STM-1 that goes fully around the ring in a certain fixed position within the STM-16 or STM-64 connections that make up the ring. Each channel can transport one VC-4 payload in both directions at a time. If a VC-4 is added/dropped from the channel in a node, the channel can pick up a new VC-4 there and carry it further around the ring.

2.5 Gbit/s application

In the MS-SPRing in the 2.5 Gbit/s application, channels #1 through #8 are available for protected VC-4 traffic. They are protected by the capacity provided by channels #9 through #16, on a pair-by-pair basis, so channel #9 protects channel #1, #10 protects #2, etc. up to channel #16 which protects #8. It is allowed to decide per VC–4 or VC-4–4c whether or not it is part of the MS-SPRing.

10 Gbit/s application

In the MS-SPRing in the 10 Gbit/s application, the channels #1 through #32 are available for protected VC-4 traffic. They are protected by the capacity provided by channels #33 through #64, on a pair-by-pair basis, so channel #33 protects channel #1, #32 protects #2, etc. up to channel #64 protecting #32. It is allowed to decide per VC-4, VC-4–4c or VC-4–16c whether or not the pair is part of the MS-SPRing.

An application for this exclusion of a certain pair from MS-SPRing could be to avoid double protection on a connection that is already VC-4 SNC protected and thus save bandwidth.

Useful definitions

To summarize, within an MS-SPRing the bandwidth can be split in three parts: Worker capacity, protection capacity and un-protected capacity. Each channel pair be an unprotected pair or a worker/protection pair. The following table depicts some useful definitions:

Term	Definition
Protected channel	Channel that is protected

Term	Definition
Protecting channel	Channel used to protect a worker channel
Unprotected channel	Channel that is not protected but also does not protect other channels
Worker channel	Static first half (2–fiber ring) of the available channels for an SDH transport port
Protection channel	Static second half (2–fiber ring) of the available channels for an SDH transport port

The protection capacity can be accessed and used to transport of low-priority traffic ("extra traffic"), in order to make even better use of the bandwidth. Under failure conditions this traffic will be lost ("pre-empted").

Parameters for provisioning MS-SPRing

- Set/view switching commands
  - lockout
  - forced switch
  - manual switch
  - clear
- Provisioning protection group
- select VC-4, VC-4-4c or VC-4-16c for participating in ring
- setting the APS/K-byte protocol.

□

DNI

Metropolis® ADM (Universal shelf) supports the SDH dual node ring interworking features (DNI) (in collapsed mode) for MS-SPRing and LO-SNCP.

Features

The following features are supported:

- the traffic between the primary and secondary node in the MS-SPRing can be transported over “worker” capacity, called “continue over worker”.
- upgrading a link that runs between two “adjacent” MS-SPRing protected rings and which is protected on both rings, but which is not protected on the connection between the rings, to a situation where the interconnection is also protected by means of Dual Node Interworking with Drop and Continue. A necessary condition is that a secondary connection between both rings is available and sufficient bandwidth of the right type (working or protection) between the primary and secondary interconnection nodes in both rings is still free
- upgrading a link that runs between “adjacent” MS-SPRing and SNC protected sub-networks and which is protected on both sub-networks, but which is not protected on the connection between them, to a situation where the interconnection is also protected by means of Dual Node Interworking with Drop and Continue. A necessary condition is that a secondary connection between both sub-networks is available and sufficient bandwidth between the two interconnection nodes in both sub-networks is still free
- It is possible to support a lower-order SNCP network on the tributary side of two Network Elements in a STM-N MS-SPRing protected ring. For traffic between the MS-SPRing and the LO-SNCP protected networks, Dual Node Inter connection with Drop & Continue can be set-up, to protect against node failures. ″Primary″ and ″Secondary″ interconnect nodes can be selected per VC-4. Within the MS-SPRing the ″continue″ traffic can be carried over protected or protection bandwidth.
- primary and Secondary nodes can be selected for each VC-4 transported over the MS-SPRing, both at the entry and at the exit side. These nodes need not be adjacent.

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Line protection

Metropolis® ADM (Universal shelf) supports SDH linear protection features on all optical 10-Gbit/s, 2.5-Gbit/s, 622-Mbit/s and 155-Mbit/s ports:

Multiplex Section Protection (MSP)

A 1+1 MSP protection relation can be set up between a pair of STM-1, STM-4 or STM-16 optical tributary interfaces and STM-16 and STM-64 line interfaces. The applied protocol is according to G.841/clause 7.1, and G.841/Annex B (STM-1 and STM-4) and supports both revertive and non-revertive operation and both unidirectional and bidirectional control. In addition, for this interface type, interworking with SONET type MSP is supported in non-revertive operation with unidirectional control.

MSP for STM-1o, STM-4, STM-16 and STM-64

1+1 Multiplex Section Protection is a relatively simple scheme to protect an STM-N link between two adjacent SDH network elements (excluding regenerators) by providing dedicated protection capacity. There are different versions of MSP protocol: G.841/Clause 7 (mostly used internationally), G.841/Annex B (Japan) and SONET style according to ANSI T1.105 and Telcordia GR-253-CORE (US, Canada).

To maximize the interworking and application possibilities, the *Metropolis®* ADM (Universal shelf) supports G.841/Clause 7 STM-[1, 4, 16, 64] Annex B STM-[1, 4] optical tributary interfaces.

The following parameters can be provisioned and commands can be issued for each 1+1 MSP protection process:

- Operation: revertive operation or non-revertive operation. Revertive operation means that after repair of a failure the traffic is switched back to the “worker” capacity. Non-revertive operation means that after repair of a failure the traffic will not switch back to the “worker” capacity
- Wait-to-Restore time. The time that should elapse before a switch back to “worker” is initiated after repair of a failure. The timer can be provisioned between 0 and 60 minutes in 1 minute increments. The default is 5 minutes. Only available with revertive operation
- Wait-to-Rename time. The time that should elapse after a switch is issued to rename the worker connection. The timer can be provisioned between 0 and 60 minutes in 1 minute increments. The default is 5 minutes. Only available with revertive operation
- Control: bidirectional or unidirectional control. Unidirectional control means that each receive end decides separately which traffic stream is active. Bidirectional control means that both ends switch in conjunction. In unidirectional schemes the traffic in one direction may be selected from the “worker” and in the other direction from the “protection” capacity
- Forced switch command. By issuing a forced switch command the user forces the traffic to either “worker” (force to worker) or to “protection” (force to protection)

- Manual switch command. By issuing a manual switch command the user requests that the traffic go to either “worker” (manual to worker) or to the “protection” (manual to protection) side. The request is only honored if the designated capacity is not affected by “Signal Fail” or “Signal Degrade” defects.
- Clear command. Clears all pending requests.

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Path protection

Metropolis® ADM (Universal shelf) supports SDH path protection features on all available cross-connection rates.

SNCP protection switching

Subnetwork Connection protection switching is selectable per VC using non-intrusive monitoring (SNC/N).

The VC-n SNC protection scheme is in essence a 1+1 point-to-point protection mechanism. The head end is dual fed (permanently bridged) and the tail end is switched. The switching criteria at the tail end are determined from the server layer defects in combination with the non-intrusive monitoring information.

SNC protection can be applied per individual VC-pair (VC-12, VC-3, VC-4, VC-4-4c and VC-4-16c). For lower-order VCs the total number of VCs that can be SNC-protected is limited only by the capacity of the lower order cross-connect. SNC/N protects against:

- server failures
- open matrix connections (“unequipped signal”)
- an excessive number of bit errors (“signal degrade”)
- misconnections (“trail trace identifier mismatch”)

SNCP/N

The *Metropolis®* ADM (Universal shelf) supports Non-Intrusive Sub-Network Connection (SNC) protection, which is also known as path protection, according to ITU-T Recommendation G.841/Clause 8.

This protection is available at the VC-12, VC-3, VC-4 VC-4–4c, and VC4–16c level. SNC protection is a simple 1+1 protection scheme that only supports unidirectional operation. The big advantage over the MS-SPRing and MSP schemes is that the protection can be applied over the whole VC-n path from source to sink or over multiple parts of the end-to-end path. In this way SNC protection is very flexible.

SNCP/N for HO

The *Metropolis®* ADM (Universal shelf) supports VC-4 SNC protection between two arbitrary incoming VC-4, VC-4–4c and VC-4–16c, either arriving via two different line port units or two different tributary port units or via a line port unit and a tributary unit a non-intrusively monitored subnetwork connection protection relation can be set up.

SNCP/N for LO

The *Metropolis®* ADM (Universal shelf) supports, as long as the capacity of the lower order cross-connect permits, between two arbitrary incoming VC-3 and VC-12 a non-intrusively monitored subnetwork connection protection relation can be set up.

Non-intrusively monitoring

The SNC protection scheme supported in the *Metropolis*® ADM (Universal shelf) is of the non-intrusive monitoring type (SNC/N). This variety not only protects against defects in the server layer (as Inherently monitored SNC or SNC/I does) but also against defects in the VC-n layer itself.

So SNC/N protected VC-4s are protected against:

- AIS or LOP at the AU-4 level (server layer defects)
- against misconnections (trace identifier mismatch VC-4 dTIM) or disconnections (unequipped signal or VC-4 dUNEQ)
- signal degradations (VC-4 dDEG) in the VC-4 itself.

Likewise, SNC/N protected VC-3s and VC-12s are protected against:

- TU3/12-AIS and TU3/12-LOP (server layer defects)
- VC-3/12 dTIM, dUNEQ and dDEG.

Disabling TIM detection

For each SNC process there is an option of disabling detection of trace identifier mismatches. This option allows interworking with equipment that transmits an unknown trace identifier or that uses a different format for the identifier. The *Metropolis*® ADM (Universal shelf) supports the 15 byte API plus 1 byte CRC-7 format for its Trail Trace Identifiers (TTIs).

SNC protection for complete end-to-end connection or for sub-network connection

Within the SNC protection mechanism it is possible to protect the complete end-to-end VC-n connection, but it is also possible to protect one or more parts of that connection . When the end-to-end connection is split into multiple parts (which truly creates subnetwork connections), each part can be individually protected by an SNCP scheme.

SNC protection for cascaded SNCP sections

The *Metropolis*® ADM (Universal shelf) supports the cascading of two such SNCP sections within one network element. This scheme can be applied for example in cases where the *Metropolis*® ADM (Universal shelf) interconnects between a ring over its tributaries and another ring over its aggregates. The protection mechanism in rings can be two cascaded SNCP schemes, which will separating out the protection in both rings. This helps in fault localization, because failures in a ring lead to protection switches in that same ring.

Hold-off timers

The *Metropolis*® ADM (Universal shelf) supports “hold-off” timers for SNC protection. For each SNC/N process the user can provision a timer between 0 and 10 seconds in 0.1 second increments, which defines how much time should elapse before an SNC switch is initiated. This mechanism can be applied if several protection schemes are nested. For example a VC-12 SNCP scheme is used on top of an MS-SPRing.

Normally, the MS-SPRing reacts within 60 ms (10 ms defect detection time and 50ms switching time). By provisioning a 100 ms hold-off time on the VC-12 SNC protection, the MS-SPRing is given the opportunity to react to a failure first. This avoids multiple switches.

Commands for SNCP/N protection

The following commands can be issued for each SNCP/N protection process:

- Force switch command. By issuing a force switch the user forces the traffic to either “worker connection” or to “protection connection”
- Manual switch command. By issuing a manual switch the user requests the traffic to either “worker connection” or to “protection connection.
- Clear command. Clears all pending requests.

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Ethernet features

Overview

Purpose

This section describes the *Metropolis*® ADM (Universal shelf) Ethernet feature.

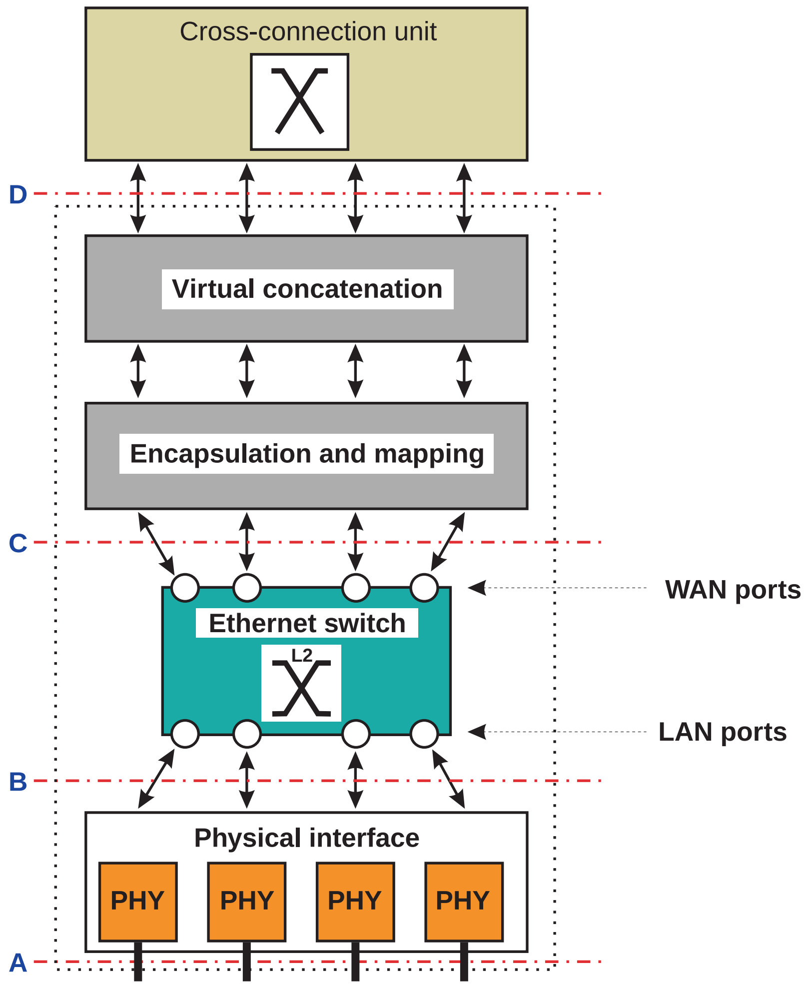
Contents

Ethernet over SDH

Introduction

To connect remote PC LAN network sites via an SDH network without the need for intermediate bridges or routers, the *Metropolis*® ADM (Universal shelf) network element is equipped with the Ethernet Interface card. The Ethernet Interface extension card can be a Fast Ethernet card or a Gigabit Ethernet card.

The following figure visualizes the basic design of a *TransLAN*® card:



Legend:

A	The external interfaces, to which the end-customer's Ethernet LANs are physically connected.

B	The interface between the Ethernet physical interface port and the Ethernet switch. The internal interfaces of the Ethernet switch towards the Ethernet physical interface port are referred to as “LAN ports”. Note that two types of LAN ports can be differentiated according to their port role: “customer LAN ports” and “network LAN ports” (cf. “Port provisioning” (p. 2-75)).
C	The internal interface between the Ethernet switch and the encapsulation and mapping function. The internal interfaces of the Ethernet switch towards the encapsulation and mapping function are referred to as “WAN ports”. Note that two types of WAN ports can be differentiated according to their port role: “network WAN ports” and “customer WAN ports” (cf. “Port provisioning” (p. 2-75)).
D	The interface between the encapsulation and mapping function and the cross-connect function of the network element. This is were the virtually concatenated payload is cross-connected to be transported over the SDH network.

The *TransLAN®* implementations use standardized protocols to transport Ethernet frames over the SDH network. The Ethernet over SDH (EoS) method and the generic framing procedure (GFP) are used to encapsulate the Ethernet frames into the SDH transmission payload. Virtual concatenation and LCAS are used to allocate a flexible amount of WAN bandwidth for the transport of Ethernet frames as needed for the end-user’s application.

Physical interfaces

The physical interface function provides the connection to the Ethernet network of the end-customer. It performs autonegotiation, and carries out flow control.

The following physical interfaces are enabled on Lucent Technologies *TransLAN®* cards:

- 10BASE-T
- 100BASE-LX10
- 100BASE-TX
- 1000BASE-SX
- 1000BASE-BX
- 1000BASE-LX
- 1000BASE-ZX

The supported LAN interfaces for Ethernet and Fast Ethernet applications are 10BASE-T and 100BASE-TX. The numbers “10” and “100” indicate the bitrate of the LAN, 10 Mbit/s (Ethernet) and 100 Mbit/s (Fast Ethernet) respectively. The “T” or “TX” indicates the wiring and the connector type: Twisted pair wiring with RJ-45 connectors.

The supported LAN interfaces for Gigabit Ethernet applications are 1000BASE-SX, 1000BASE-LX, and 1000BASE-ZX. Again, the number indicates the bitrate of the LAN, 1 Gbit/s (Gigabit Ethernet). “SX” indicates a short-haul interface, “LX” and “ZX” indicate a long-haul interface.

Ethernet switch

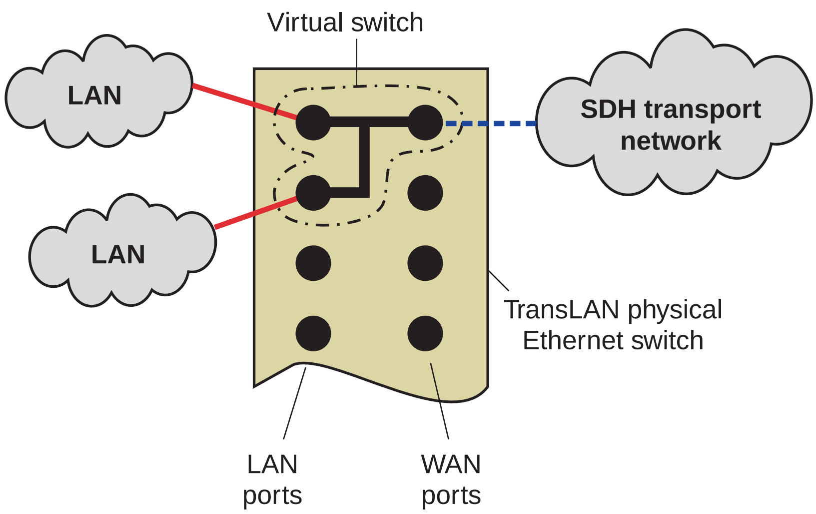
The Ethernet switch connects the LAN ports with the WAN ports. It performs learning, filtering and forwarding according to the IEEE 802.1D standard.

The physical Ethernet switch can be logically split in multiple, independent switches or port groups, called “virtual switch”. In the transparent tagging modes (LAN interconnect, LAN-VPN or LAN-VPN with QoS), also the name “LAN group” is used instead of “virtual switch”.

The following applies to port groups or virtual switches, respectively:

- A virtual switch defines a spanning tree domain, and can be assigned a mode of operation (LAN interconnect, LAN-VPN or LAN-VPN with QoS).
- A virtual switch includes any number (at least 2) of external Ethernet LAN ports and/or internal WAN ports associated with a VC-n-Xv payload.
- Traffic *between* virtual switches is *not* possible.
- Each port can be a member of only one virtual switch at a time.
- A VLAN must have all its port members inside a single virtual switch.

In the following example, a virtual switch is provisioned that connects 2 LAN ports with 1 WAN port:



Supported frame sizes

Depending on the Ethernet units, the following frame sizes are supported:

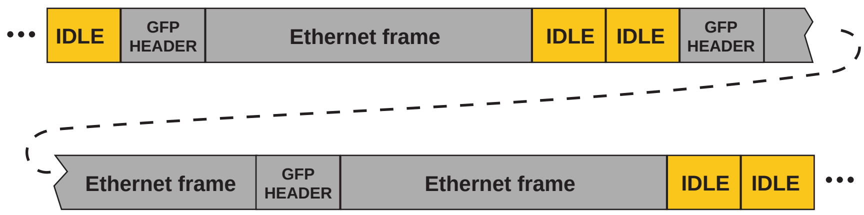
- LKA4: 64 to 2048 bytes.
- LKA412: 64 to 1526 bytes

- LKA12: up to 9022 bytes
- LKA53: up to 9216 bytes ("jumbo frames)"

Ethernet encapsulation with GFP

The generic framing procedure (GFP) is used to adapt the asynchronous Ethernet payload to the synchronous SDH server layer.

A GFP-header (8 octets) is prepended to each Ethernet frame to indicate frame length and payload type. Gaps between Ethernet frames are filled with "IDLE" frames (4 octets each).



GFP, standardized by the ITU-T in the recommendations G.7041 and Y.1303, is a very efficient encapsulation protocol because it has a fixed and small overhead per packet.

In earlier versions (prior to the Garnet network release of June 2002) of the *TransLAN*® equipment, the Ethernet over SDH (EoS) encapsulation and mapping method is used for VC-12 and/or VC-3 based designs (10/100BASE-T Ethernet / Fast Ethernet cards). EoS is a proprietary encapsulation protocol, based on the ANSI T1X1.5/99-268r1 standard, and can be regarded as a precursor of GFP. EoS and GFP are both length-based encapsulation methods. EoS is similar to GFP in terms of frame delineation and mapping (incl. scrambling); differences between the two encapsulation methods lie in the size and interpretation of the EoS/GFP encapsulation core headers, as well as the length of the Idle frames.

The generic framing procedure, framed mode (GFP-F) compliant to the ITU-T Rec. G.7041 is available on all *TransLAN*® products since the Garnet Maintenance / Mercury network release of January 2003.

The following GFP encapsulation are possible:

- Mapping of Ethernet MAC frames into Lower Order SDH VC12–Xv
- Mapping of Ethernet MAC frames into Lower Order SDH VC3–Xv
- Mapping of Ethernet MAC frames into Higher Order SDH VC4–Xv.

VC12–Xv GFP encapsulation

The *Metropolis*® ADM (Universal shelf) supports virtual concatenation of Lower Order SDH VC-12 as inverse multiplexing technique to size the bandwidth of a single internal WAN port for transport of encapsulated Ethernet and Fast Ethernet packets over the SDH/SONET network. This is noted VC12-Xv, where X = 1...5. Usage is in conformance with ITU-T G.707 Clause 11 (2000 Edition) and G.783 Clause 12.5 (2000).

This feature implies specific processing of some overhead bytes:

- Source direction: Each individual VC-12 (from the VC12-Xv group) K4-byte (bit 1-2 multiframed) will be written to indicate the values of the multiframe indicator (timestamping), as well as the sequence indicator (individual VC-12 position inside a VC12-Xv)
- Sink direction: Each individual VC-12 (from the VC12-Xv group) K4-byte (bit 1-2 multiframed) multi-framing indicator and sequence indicator is used to check that the differential delay between the individual VC-12s of the VC12-Xv remains within implementation limits.

Additionally, the use of G.707 Extended Signal Label is supported using V5(bits 5-7) field, in which the "101" value is written, which points to the appropriate bits of K4(bit 1) multiframe for writing in the Extended Signal Label value.

VC3–Xv GFP encapsulation

The *Metropolis®* ADM (Universal shelf) supports virtual concatenation of Lower Order SDH VC-3 as inverse multiplexing technique to size the bandwidth of a single internal WAN port for transport of encapsulated Ethernet and Fast Ethernet packets over the SDH/SONET network. This is noted VC3–Xv, where X = 1,2 (SDH). Usage is in conformance with ITU-T G.707 Clause 11 (2000 Edition) and G.783 Clause 12.5 (2000) and T1X1 T1.105 Clause 7.3.2 (2001 Edition).

This feature implies specific processing of some overhead bytes:

- Source direction; each individual VC-3 (from the VC3–Xv group) H4-byte will be written to indicate the values of the two-stage- multiframe indicator (timestamping), as well as the sequence indicator (individual VC-3 position inside a VC3–Xv)
- Sink direction; each individual VC-3 (from the VC3–Xv group) H4-byte two-stage-multi-framing indicator and sequence indicator is used to check that the differential delay between the individual VC-3 of the VC3–Xv remains within implementation limits.

VC4–Xv GFP encapsulation

The *Metropolis®* ADM (Universal shelf) supports virtual concatenation of Higher Order SDH VC-4 as inverse multiplexing technique to size the bandwidth of a single internal WAN port for transport of encapsulated Gigabit Ethernet packets over the SDH/SONET network. This is noted VC4/STS3c-Xv, where X = 1...4.

Usage is in conformance with ITU-T G.707 Clause 11 (2000 Edition) and G.783 Clause 12.5 (2000) and T1X1 T1.105 Clause 7.3.2 (2001 Edition).

This feature implies specific processing of some overhead bytes:

- Source direction; each individual VC-4 (from the VC4–Xv/STS3c-Xv group) H4-byte will be written to indicate the values of the two-stage multiframe indicator (timestamping), as well as the sequence indicator (individual VC-4 position inside a VC4/STS3x-Xv group).
- Sink direction; each individual VC-4 (from the VC4/STS3c-Xv group) H4-byte two-stage-multi-framing indicator and sequence indicator is used to check That the differential delay between the individual VC-4 of the VC-4/STS3c-Xv remains within implementation limits.

Virtual concatenation

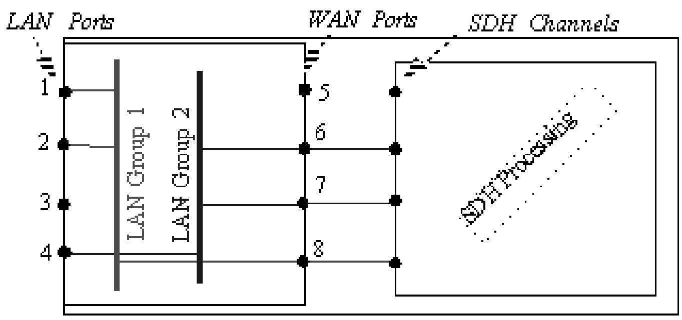
The virtual concatenation function arranges the Ethernet frames into the right SDH virtual container. It is possible to map the client's data signal over a number of grouped virtual containers.

Related information

Please refer to "Virtual concatenation" (p. 2-29) for more detailed information.

LAN and WAN ports and VLAN

A VLAN can contain multiple LAN ports and multiple WAN ports.



Multiple LAN ports can be assigned to different VLANs, also mentioned as Virtual LAN's. This keeps the traffic on each VLAN totally separate. VLAN groups are used to connect LAN ports and WAN ports. The LAN ports are the physical 10BaseT or 100BaseT or 100Base-LX10 or gigabit Ethernet ports on the NE. All valid Ethernet packets are accepted (both Ethernet 2 and IEEE 802.3). The WAN ports are the logical connection points to the SDH channels. The LAN port is the interface between the customers Ethernet LAN and the Ethernet switch on the LAN unit. The WAN port is the internal port between the Ethernet switch and the part of the LAN unit where the Ethernet frame is mapped into or de-mapped from SDH payloads.

VLAN trunking

VLAN trunks carry the traffic of multiple VLANs over one single Ethernet link. They allow handling of aggregated LAN traffic from multiple end users, via one single high capacity Ethernet link (Fast Ethernet or Giga Ethernet), to data equipment in a Central Office or an IP Edge Router, IP Service Switch or an ATM Switch. The main benefit of VLAN trunking is that TransLAN cards can hand off end user LAN traffic via one high capacity LAN port instead of multiple low speed LAN ports.

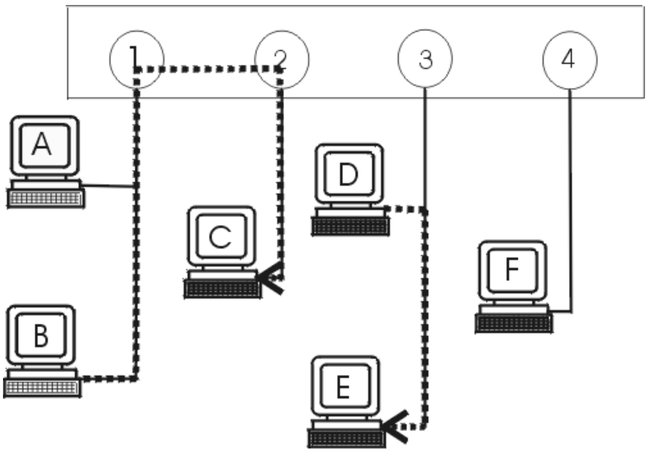
Advantages of VLAN trunking are:

- it does not require the assignment of customer identifiers (CID tags)
- it permits different 802.1 tagged frames to share the same physical LAN port
- it gives additional flexibility for egress logical WAN port assignment
- it permits successfully routing via an aggregation function.

Learning bridges

To increases the efficiency of the network, it can be separated into segments. A bridge, which may have several parts, passes packets between multiple network segments. By noting at which port an Ethernet packet with a certain source address arrives, the bridge learns to which ports a packet with a certain destination address must be sent. If the port does not know the destination address, then it will send it to all the ports except the port where it comes from. The tables which the learning bridge uses to pass the Ethernet packets to its ports are not shown to the user by the management systems.

Example



After the bridge has received a packet from station C it knows that station C is attached to port 2. When the bridge knows to which ports a station is attached, it will send packets with destination addresses of these stations only to the port the station is attached to (e.g. a packet from station B to station C is only forwarded to port 2). When a destination address of a packet is of a station in its own segment, the packet is not forwarded by the bridge (e.g. a packet from station D to station E).

Quality of service

Refer to "Quality of Service (QoS) overview" (p. 2-80).

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Virtual concatenation

The SDH granularity problem

The virtual containers of the SDH have fixed sizes. These virtual containers are important for the transport of Ethernet frames over the SDH network:

- VC-12: 2 Mbit/s
- VC-3: 50 Mbit/s
- VC-4: 150 Mbit/s

It is difficult to fit the Ethernet traffic into one of these virtual containers. For many applications the containers, or contiguously concatenated virtual containers, such as VC-4-4C (600 Mbit/s) for example, are either too small or too big. This is known as the granularity problem.

Virtual concatenation is a mechanism by which a number of independent VCs can be used to carry a single payload. This way, the granularity problem is solved.

The following table shows the possible payload sizes, and the virtual containers that are used for the transport.

Payload	Virtual containers	Concatenation
2 Mbit/s	1 × VC-12	VC-12
4 Mbit/s	2 × VC-12	VC-12-2v
6 Mbit/s	3 × VC-12	VC-12-3v
8 Mbit/s	4 × VC-12	VC-12-4v
10 Mbit/s	5 × VC-12	VC-12-5v
50 Mbit/s	1 × VC-3	VC-3
100 Mbit/s	2 × VC-3	VC-3-2v
150 Mbit/s	1 × VC-4	VC-4
300 Mbit/s	2 × VC-4	VC-4-2v
450 Mbit/s	3 × VC-4	VC-4-3v
600 Mbit/s	4 × VC-4	VC-4-4v
750 Mbit/s	5 × VC-4	VC-4-5v
900 Mbit/s	6 × VC-4	VC-4-6v
1 Gbit/s	7 × VC-4	VC-4-7v

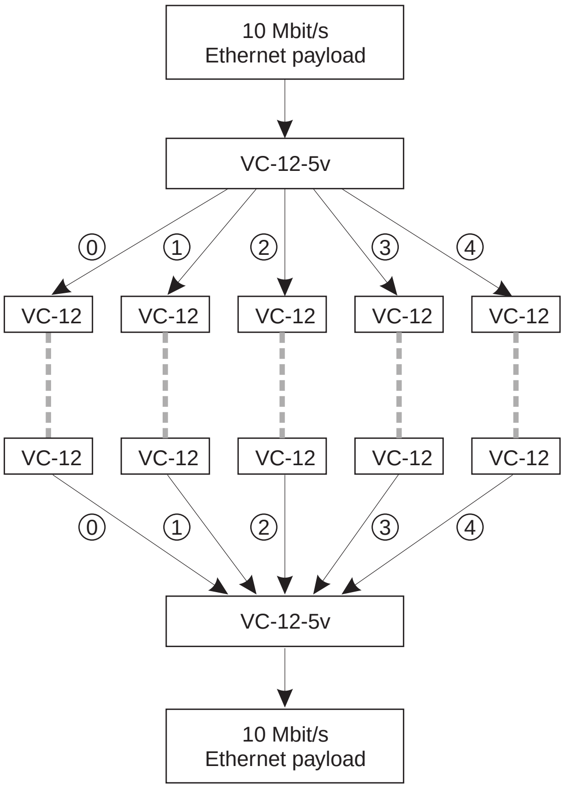
Virtual concatenation

Virtual concatenation can be used for the transport of payloads that do not fit efficiently into the standard set of virtual containers (VCs).

Virtual concatenation splits the contiguous bandwidth into individual VCs, transports these VCs separately over the SDH network, and recombines them to a contiguous signal at the path termination. An important aspect of virtual concatenation is that it *only needs to be supported at the end nodes* (i.e. at the *TransLAN®* cards that interface with the end-customer's LAN). The rest of the network simply transports the separate channels.

Example 1

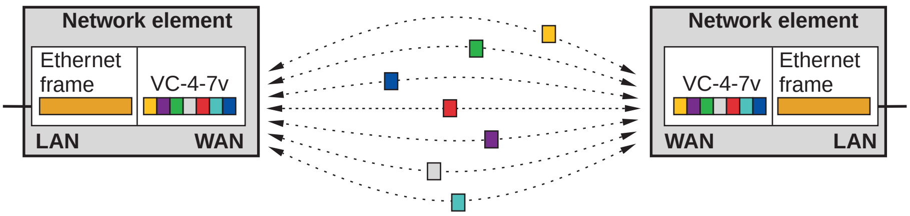
As an example, the following figure shows the virtual concatenation of 5 × VC-12:



The 10 Mbit/s payload is put into a VC-12–5v, i.e. into a virtual concatenation group (VCG) consisting of 5 virtually concatenated VC-12s. These VC-12s can travel the network independently, and do not have to follow the same route. At the endpoint, the VC-12–5v is reassembled, and the payload is extracted.

Example 2

The second example shows the principle of virtual concatenation in a Gigabit Ethernet (GbE) network application. Protection of the virtually concatenated payload is possible via standard SDH transmission protection schemes.



Differential delay

Due to the different propagation delay of the VCs a differential delay occurs between the individual VCs. This differential delay has to be compensated and the individual VCs have to be re-aligned for access to the contiguous payload area.

The *TransLAN®* re-alignment process covers at least a differential delay of 32 ms.

Link Capacity Adjustment Scheme (LCAS)

LCAS is an extension of virtual concatenation that allows dynamic changes in the number of channels in a connection. In case channels are added or removed by management actions this will happen without loosing any customer traffic.

LCAS allows a bandwidth service with scalable throughput in normal operation mode. In case of failure the connection will not be dropped completely but only the affected channel(s). The remaining channels will continue carrying traffic. LCAS provides automatic decrease of bandwidth in case of link failure and re-establishment after link recovery.

In case only one end supports (or has turned on) the LCAS protocol, the side that does support LCAS adapts automatically to the restrictions that are dictated by the non-supporting end, i.e. the entire link behaves as a link that does not support in-service bandwidth adaptations.

Dynamic bandwidth adjustment (GbE)

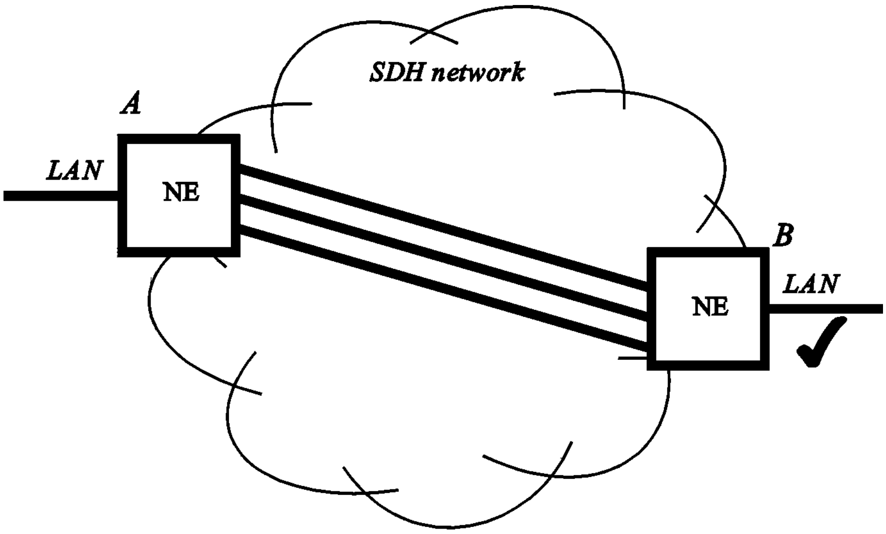
One of the major problems with using Virtual Concatenation is that if one of the VCs has a fault and fails the whole signal fails. This means that if a single VC fails the entire SDH Channel/VCG is lost. The GbE card for the *Metropolis®* ADM (Universal shelf) network element supports the Link Capacity Adjustment Scheme (LCAS). This LCAS allows dynamic bandwidth increase or decrease without loss of signal. Furthermore, if the signal of one or more of the components becomes degraded then LCAS will autonomously remove those VCs from the group. When the failure is repaired LCAS will automatically return those component VCs to the SDH Channel/VCG.

The following table indicates the effect LCAS has on the transmission capacity:

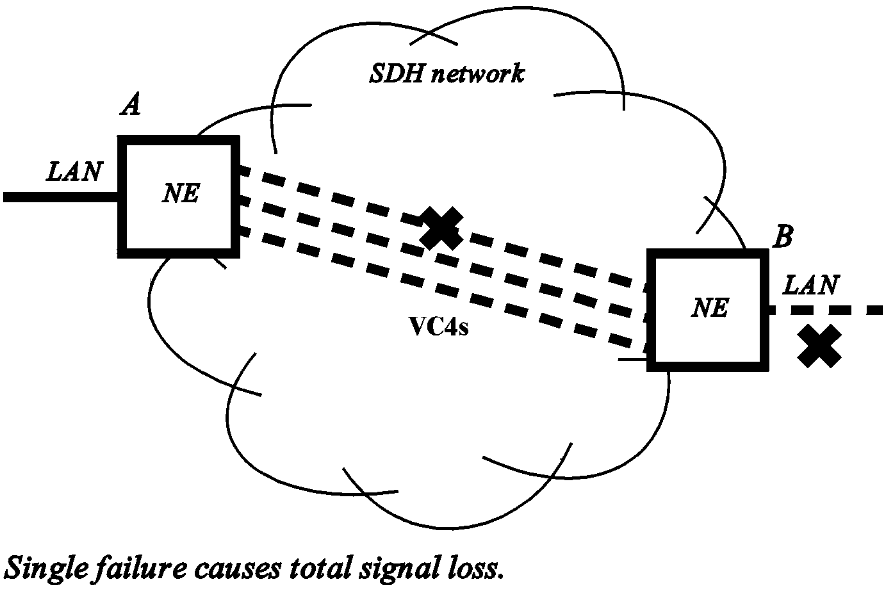
Enabling/disabling LCAS	Capacity no VC-n failures	One or more (but not all) VC-ns failures	All VC-ns fail.
LCAS disabled	Working Capacity = Provisioned Capacity	Working Capacity = 0	Working Capacity = 0
LCAS enabled	Working Capacity = Provisioned Capacity	Working Capacity is reduced by amount of failed VC-ns service degraded.	Working Capacity = 0

With the introduction of LCAS for VC4-Xv an additional attribute “SDHWorkingCapacity” is needed. The working capacity shows the value of the actual capacity available, this allows the operator to see when service is degraded. The working capacity will also be displayed for non-LCAS, showing a zero if the signal is degraded on any VC-n. When LCAS is enabled Working Capacity show a zero only when the signal is fully degraded. The next three figures depict the effect of LCAS.

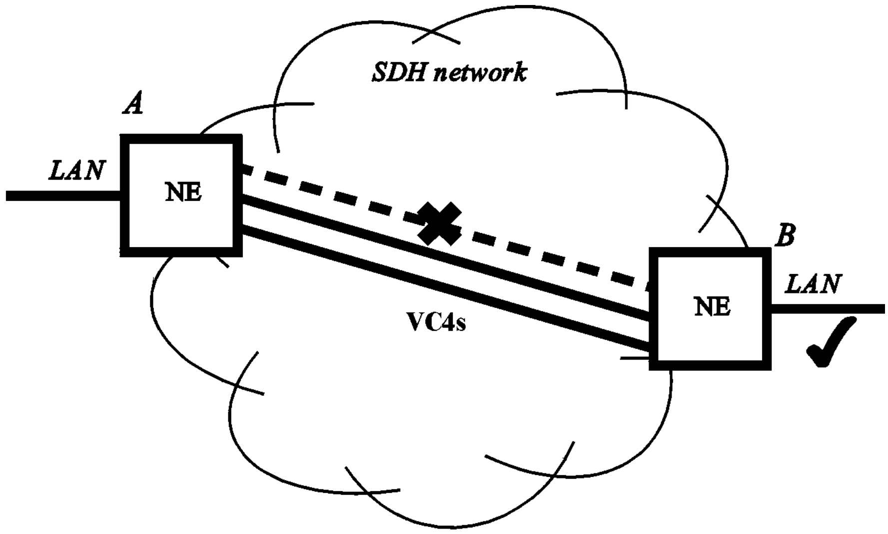
Non-degraded service



Non LCAS causing degraded service



With LCAS enabled only signal degradation is caused



Single failure only causes signal degradation.

VC allocation (GbE)

There are 4 x VC-4 TTPs on the GbE card. Each of these can be substructured to VC-3 TTPs or used as VC-4 TTPs. When the operator requests an SDH Channel/VCG he has a choice of various capacities from a single VC-3 (50 Mbit/s) up to VC-4-4v (600 Mbit/s). If the operator requires a bandwidth of say 100 Mbit/s, one of the VC-4 TTPs must be adapted into VC-3 TTPs, and two of these will be virtually concatenated as a VC-3-2v. For the next SDH Channel/VCG the operator will then only have a maximum bandwidth of 450 Mbit/s (VC-4-3v) as this is what is still available.

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Spanning tree protocol (STP)

Overview

The spanning tree protocol (STP) is a standard Ethernet method for eliminating loops and providing alternate routes for service protection. Standard STP depends on information sharing among Ethernet switches/bridges to reconfigure the spanning tree in the event of a failure. The STP algorithm calculates the best loop-free path throughout the network.

STP defines a tree that spans all switches in the network; it e.g. uses the capacity of available bandwidth on a link (path cost) to find the optimum tree. It forces redundant links into a standby (blocked) state. If a link fails or if a STP path cost changes the STP algorithm reconfigures the spanning tree topology and may reestablish previously blocked links. The STP also determines one switch that will be the root switch; all leaves in the spanning tree extend from the root switch.

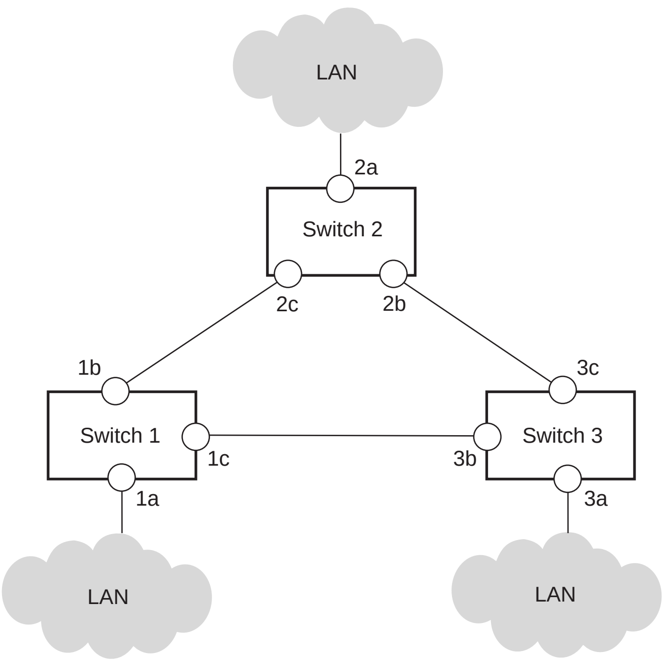
Maximum bridge diameter

The maximum bridge diameter is the maximum number of bridges between any two hosts on the bridged LAN for any spanning tree configuration.

For *TransLAN*® applications the maximum bridge diameter is 25 nodes.

Spanning tree example

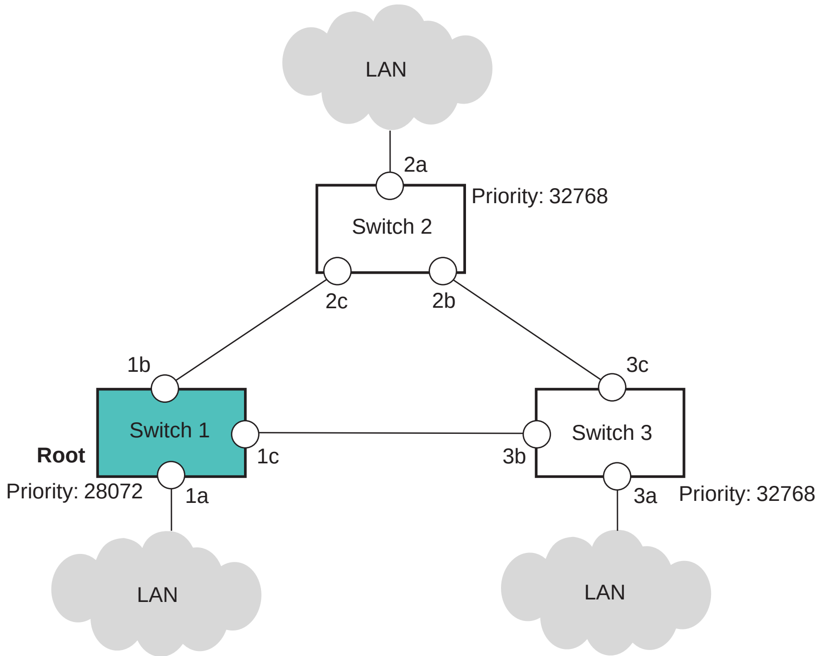
The following example network serves to illustrate the principle how a spanning tree is constructed.



Determination of the root

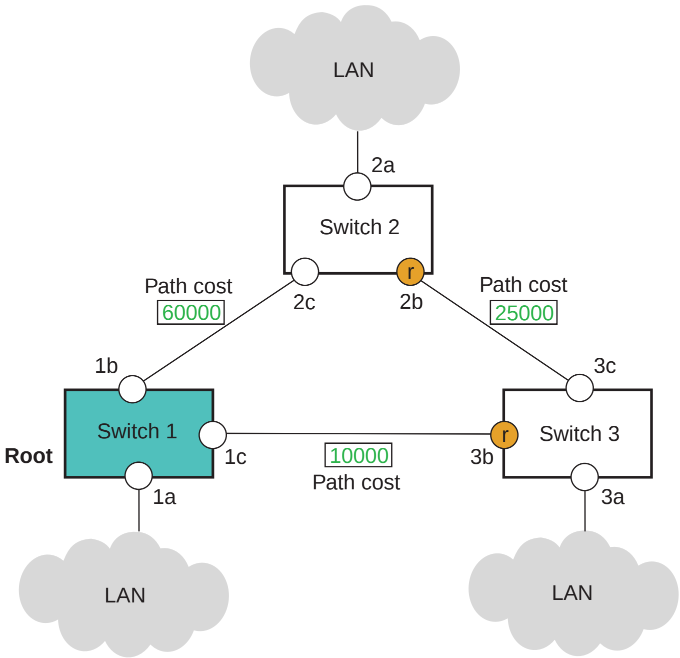
For every switch a priority can be configured. The switch priority is a number between 0 (highest priority) and 61440 (lowest priority) in steps of 4096. The switch with the highest priority will become root.

If there are two or more switches with the same highest priority, then the switch with the lowest number for the MAC address will become root. This rule ensures that there is always exactly one root, as MAC addresses are unique.



Determination of the root ports

Root ports are those ports that will be used to reach the root. For each switch the port with the lowest root path cost is chosen, where the root path cost is determined by adding the path costs to the root. In the example port 2b and 3b are root ports.

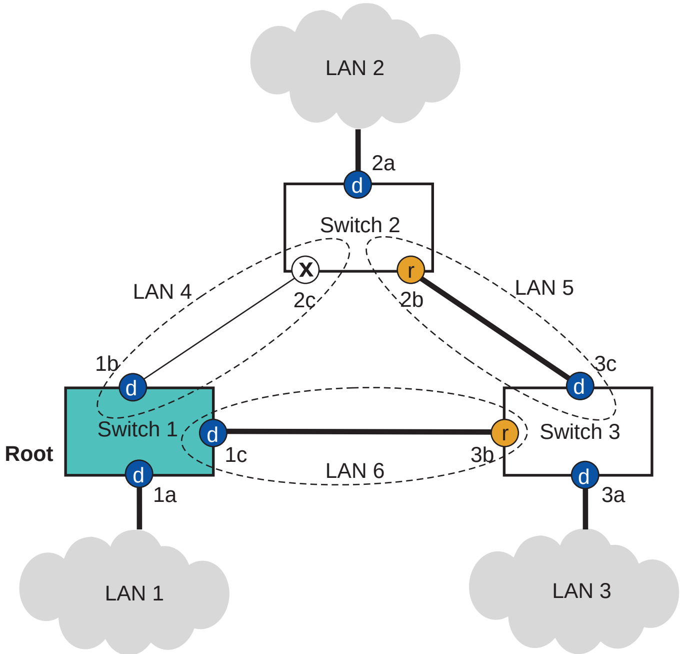


For every port a path cost value can be configured. The default path cost parameter of each port depends on the bandwidth of the link to which the port is connected.

Determination of the designated and blocked ports

The designated port is the one port that is going to be used for a certain LAN. In the example, there are 6 LANs.

The designated ports for LAN 1, LAN 2 and LAN 3 are the ports 1a, 2a and 3a respectively, because these LANs have only one connection to a switch. If there are more connections to a switch, then the port with the lowest root path cost is chosen. Thus the designated ports for LAN 4, LAN 5 and LAN 6 are the ports 1b, 1c and 3c respectively.



Ports that are neither root ports nor designated ports are blocked. In the example port 2c is a blocked port.

Thus the loop free spanning tree is constructed.

Rapid spanning tree protocol (rSTP)

The rapid spanning tree protocol reduces the time that the standard spanning tree protocol needs to reconfigure after network failures. Instead of several tens of seconds, rSTP can reconfigure in less than a second. The actual reconfiguration time depends on several parameters, the two most prominent are the network size and complexity. IEEE802.1w describes the standard implementation for rSTP.

For the special case of multiple cross-connection switches in between the last 60 seconds, a filtering function concerning STP notification is implemented. This repetition filter modifies the hold-off time for recalculation of the STP.

Specific attributes for *TransLAN*® STP enhancements:

- Failure Detection - Use SDH-layer failure detection to trigger STP reconfiguration.
- Convergence Time - Key aspects of the message-based IEEE 802.1w/D10 (rSTP) protocol instead of timer-based 802.1D (STP) protocol.
- Support larger network diameter by adjusting the “Maximum Age Timer” parameter and enhanced STP configuration controls and reports.
- Automatic mode detection - The rSTP is supported as an enhancement to STP, it cannot be enabled explicitly. It rather will operate by default and will fall back to STP as soon as it finds peer nodes that do not support rSTP. The STP mode that the bridge elected can be retrieved per port.

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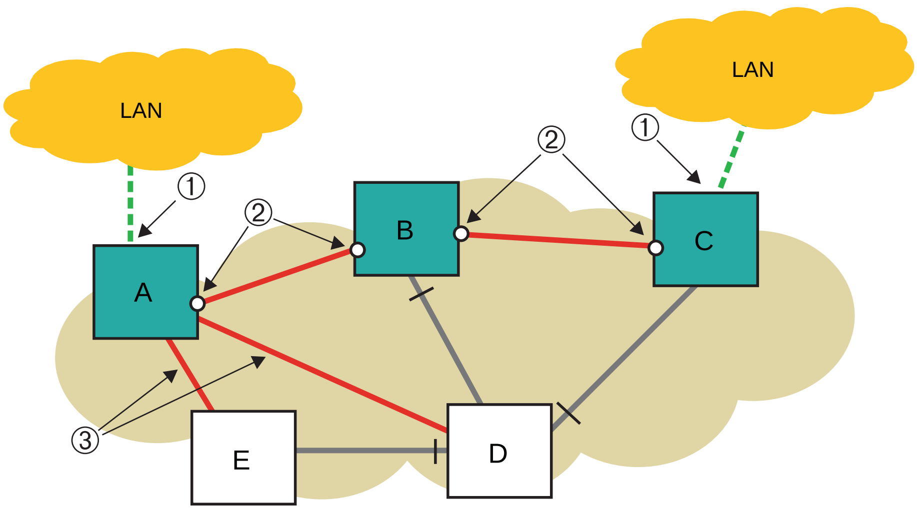
GARP VLAN Registration Protocol (GVRP)

Automatic configuration of VLANs

The GARP VLAN Registration Protocol (GVRP) is a protocol that simplifies VLAN assignment on network-role ports and ensures consistency among switches in a network.

GVRP is supported only in the IEEE 802.1Q / IEEE 802.1ad VLAN tagging modes. In the transparent tagging modes (VPN tagging modes), a similar protocol, the proprietary spanning tree with VPN registration protocol (STVRP) is supported. STVRP is enabled per default and cannot be disabled.

By using GVRP, VLAN identifiers (VLAN IDs) only need to be provisioned on customer-role ports of access nodes. VLAN IDs on network-role ports of intermediate and access nodes are automatically configured by means of GVRP. The provisioned VLAN IDs on customer-role ports are called static VLAN entries; the VLANs assigned by GVRP are called dynamic VLAN entries. In addition, GVRP prevents unnecessary broadcasting of Ethernet frames by forwarding VLAN frames only to those parts of the network that have customer-role ports with that VLAN ID. Thus, the traffic of a VLAN is limited to the STP branches that are actually connecting the VLAN members.



Legend:

1	Static VLAN IDs need to be entered manually at customer-role ports.
2	Dynamic VLAN IDs of intermediate and access nodes are automatically configured.
3	No automatic configuration of VLAN IDs on ports towards those access nodes where the respective VLAN ID is *not* provisioned, i.e. no unnecessary broadcasting of Ethernet frames by forwarding VLAN frames only to those parts of the network that have customer-role ports with that VLAN ID.

Note that GVRP and the spanning tree protocol (STP) interact with each other. After a stable spanning tree is determined (at initialization or after a reconfiguration due to a failure) the GVRP protocol recomputes the best VLAN assignments on all network-role ports, given the new spanning tree topology.

GVRP can be enabled (default setting) or disabled per virtual switch. However, all virtual switches on an Ethernet network need to be in the same GVRP mode. For interworking flexibility one can optionally disable STP per network-role port; implicitly GVRP is then disabled as well on that port. GVRP must be disabled in order to interwork with nodes that do not support GVRP.

Max. number of VLANs

The maximum supported number of active VLANs (VLAN identifiers) is limited for reasons of controller performance, and varies depending on product, tagging mode and GVRP activation status. The following table shows the applicable values. Note that even if the maximum number of active VLANs is limited to 64, 247, or 1024, VLAN identifiers out of the full range of VLAN identifiers (0 … 4093) can be used for tagging purposes.

Max. number of active VLANs			
Product	**Transparent tagging (VPN tagging) mode**[1]	**IEEE 802.1Q / IEEE 802.1ad tagging mode**	
		GVRP enabled	**GVRP disabled**
Metropolis® AM / *Metropolis®* AMS[2]	64 VLANs per card6	64 VLANs per card	64 VLANs per NE
Metropolis® AMU	64 VLANs per card	247 VLANs per card	1024 VLANs per NE
WaveStar® ADM 16/1[2]	64 VLANs per card	247 VLANs per card	1024 VLANs per NE
Metropolis® ADM (Compact shelf)[2]	64 VLANs per card	247 VLANs per card	1024 VLANs per NE
Metropolis® ADM (Universal shelf)[2]	64 VLANs per card	247 VLANs per card	1024 VLANs per NE
LambdaUnite® MSS	–[3]	64 VLANs per card	4093 VLANs per NE
WaveStar® TDM 10G (STM-64)	–	64 VLANs per card	4093 VLANs per NE

Notes:

1. No distinction is made with respect to the STVRP activation status, because STVRP is enabled per default and cannot be disabled.
2. An alarm (`MACcVLANOVFW – Maximum number of VLAN instances exceeded`) will be reported when the max. number of active VLANs per *TransLAN®* card is exceeded.
3. The *LambdaUnite®* MSS transparent tagging mode rather compares to the provider bridge tagging mode (see “IEEE 802.1ad VLAN tagging” (p. 2-59)) than to this transparent tagging (VPN tagging) mode.

A maximum number of 1024 active VLANs per network element is supported.

A maximum of 5000 VLAN/port associations is supported per network element, except for the *Metropolis*® AM/*Metropolis*® AMS, where the maximum number of VLAN/port associations is 2000. An alarm (`MIBcVLANOVFW` – `Maximum number of VLAN instances exceeded in MIB`) will be reported when the max. number of VLAN/port associations per network element is exceeded.

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Ethernet over SDH applications

Purpose

This section gives an introduction to the possible *TransLAN®* Ethernet over SDH applications.

Types of applications

Layer-2 switching allows different types of applications, including:

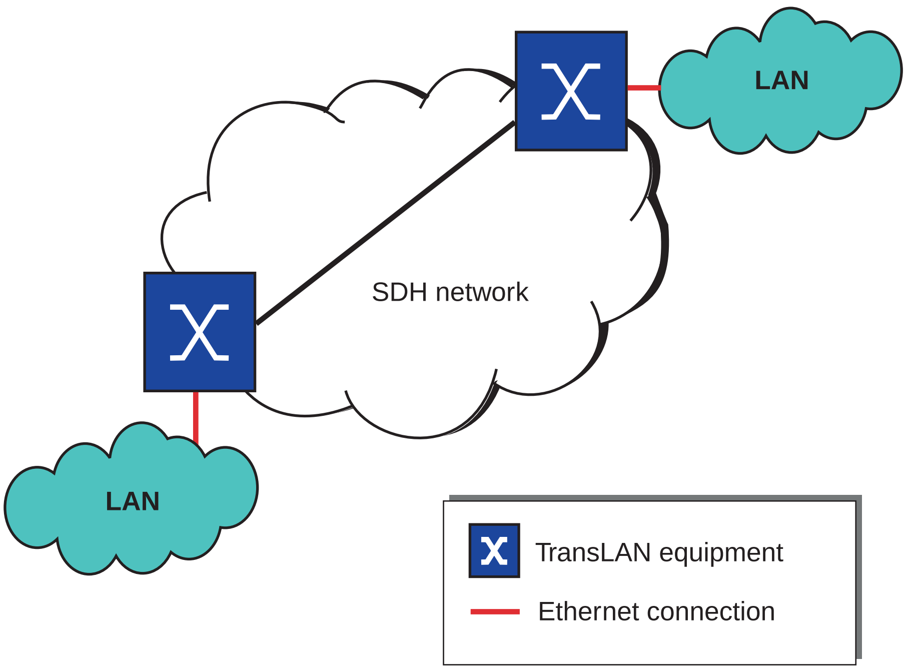
- Ethernet point-to-point transport
- Ethernet point-to-point transport in buffered repeater mode
- Ethernet multipoint transport (dedicated bandwidth)
- Ethernet multipoint transport (shared bandwidth)
- Ethernet multiplexing (VLAN trunking)

TransLAN® supports all Ethernet transport solutions. Specific system configuration is required for each network application.

Direct interconnection of two LANs - Ethernet point-to-point transport

The most straight-forward Ethernet application on the *TransLAN®* equipment is a leased line type of service with dedicated bandwidth to interconnect two LAN segments which are at a distance that cannot be bridged by using a simple Ethernet repeater, because the collision domain size rules would be violated.

The two interconnected LANs need not be of the same speed; it is possible to interconnect a 10BASE-T and a 100BASE-T LAN this way for example.



Mode of operation

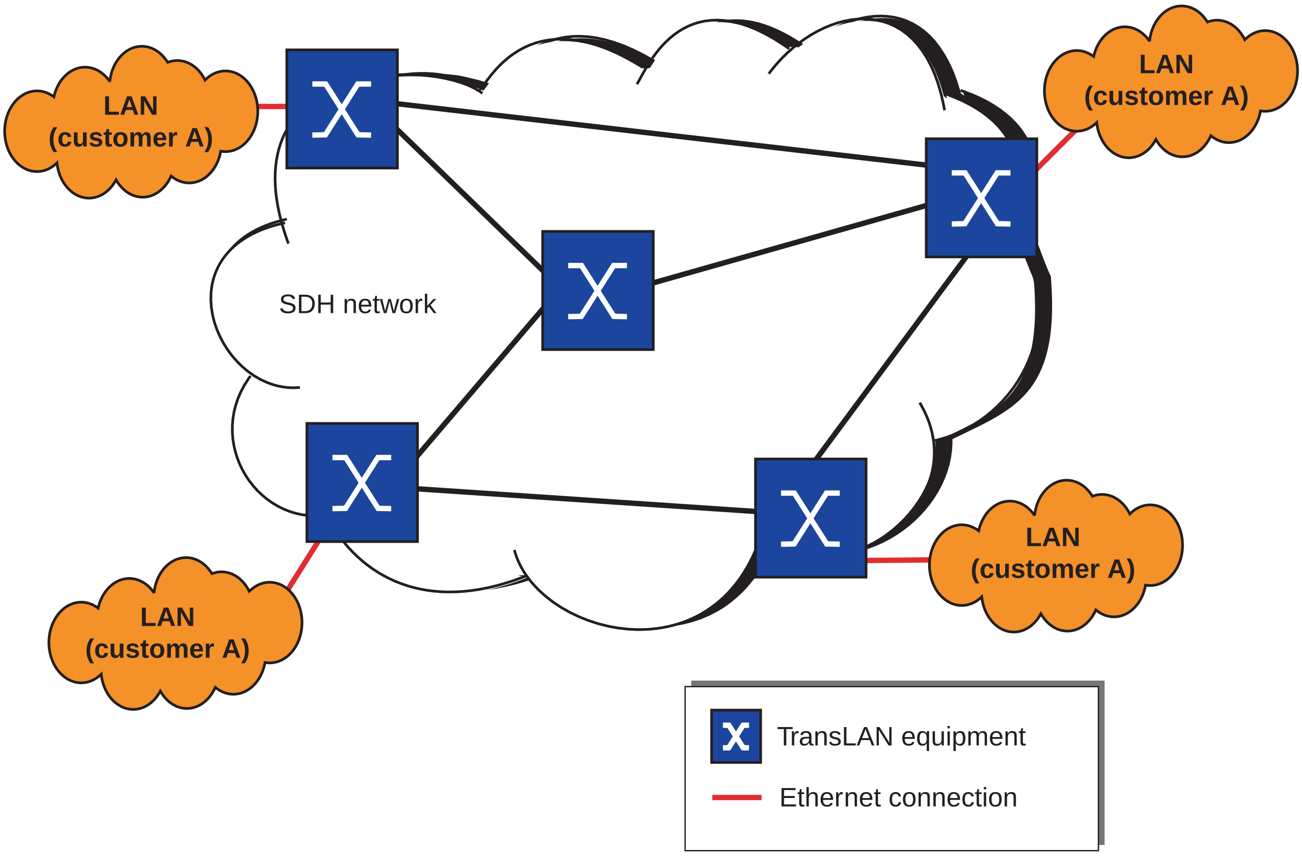
Ethernet point-to-point transport can be realized by using any of the *TransLAN*® operational modes. However, the preferred mode of operation for the direct interconnection of two LANs is the repeater mode.

Related information

Please also refer to "Repeater mode" (p. 2-49).

Ethernet multipoint transport with dedicated bandwidth

The following figure shows a network example of a multipoint Ethernet over SDH network with dedicated bandwidth:



This multipoint network is dedicated to a single user.

Mode of operation

Ethernet multi-point transport with dedicated bandwidth can be realized by using any of the following *TransLAN*® operational modes:

- LAN-VPN mode
- STP virtual switch mode compliant with IEEE 802.1Q
- STP virtual switch mode compliant with IEEE 802.1ad (provider bridge mode)

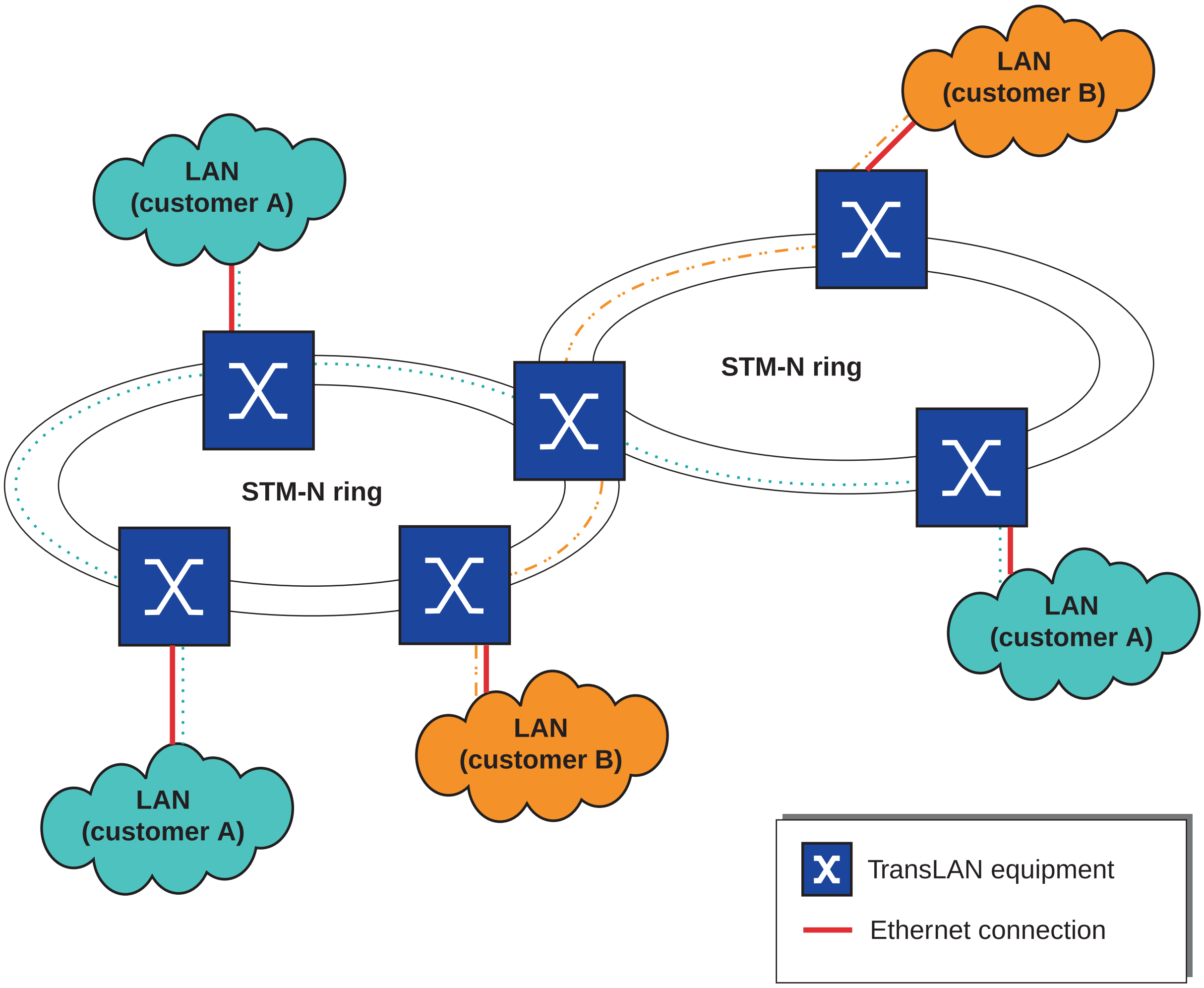
Related information

Please also refer to:

- "LAN-VPN (M-LAN) mode" (p. 2-53)
- "IEEE 802.1Q STP virtual switch mode" (p. 2-55)
- "Provider bridge mode" (p. 2-57)

Ethernet multipoint transport with shared bandwidth

The following figure shows a network example of a multipoint Ethernet over SDH network with shared bandwidth:



The SDH capacity is shared among more than one customer in this multipoint network. This allows customer A to use the complete SDH bandwidth at the moment that customer B is inactive, and vice versa. As Ethernet traffic is inherently bursty, sharing bandwidth can increase the efficiency of the network usage.

Isolation of the traffic of different end-users can be accomplished by using transparent tagging or VLAN tagging (see "Tagging modes" (p. 2-58)), depending on the desired mode of operation.

Mode of operation

Ethernet multi-point transport with shared bandwidth can be realized by using any of the following *TransLAN*® operational modes:

- LAN-VPN mode
- STP virtual switch mode compliant with IEEE 802.1Q
- STP virtual switch mode compliant with IEEE 802.1ad (provider bridge mode)

Related information

Please also refer to:

- "LAN-VPN (M-LAN) mode" (p. 2-53)
- "IEEE 802.1Q STP virtual switch mode" (p. 2-55)
- "Provider bridge mode" (p. 2-57)

VLAN trunking

Trunking applications are a special case of Ethernet multipoint transport, either with dedicated or shared bandwidth.

Trunking applications are those applications where traffic of multiple end-users is handed-off via a single physical Ethernet interface to a router or switch for further processing. This scenario is also called "back-hauling", since all traffic is transported to a central location, e.g. a point-of-presence (PoP) of a service provider.

Trunking applications can be classified into two topology types:

- Trunking in the hub-node
- Distributed aggregation in the access network

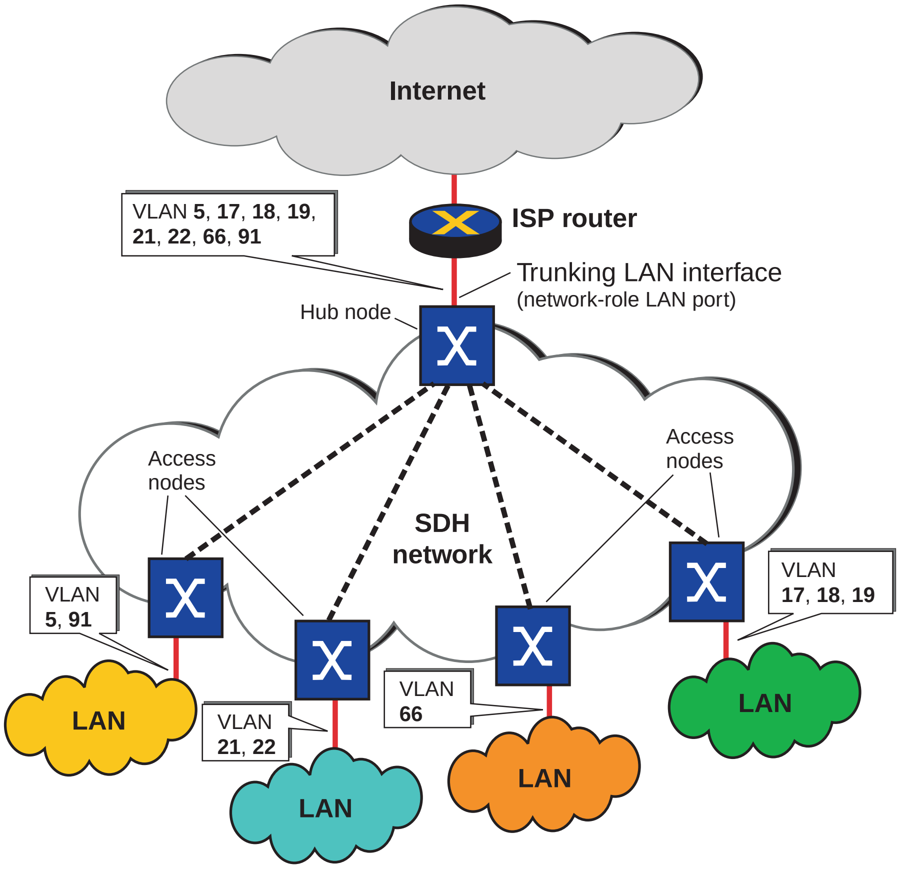
Common to both topology types is that the Ethernet traffic of multiple LANs is aggregated on one or a few well filled Ethernet interfaces, the trunking LAN interface(s). Thus, the Ethernet traffic of multiple end-users can be made available to a service provider at a central location via a limited mumber of physical connections. Without VLAN trunking, each end-user would need to be connected to the service provider equipment via his own Ethernet interface.

Trunking applications include the aggregation of Ethernet traffic of a single end-user as well as the aggregation of Ethernet traffic of multiple different end-users. Isolation of the traffic of different end-users can be accomplished by using transparent tagging or VLAN tagging (see "Tagging modes" (p. 2-58)), depending on the desired mode of operation.

A typical *TransLAN*® trunking application would be a configuration where many E/FE access nodes are combined with a trunking GbE hub node (cf. "Distributed aggregation in the access network" (p. 2-45)).

Trunking in the hub node

This figure shows an example of VLAN trunking in the hub node:



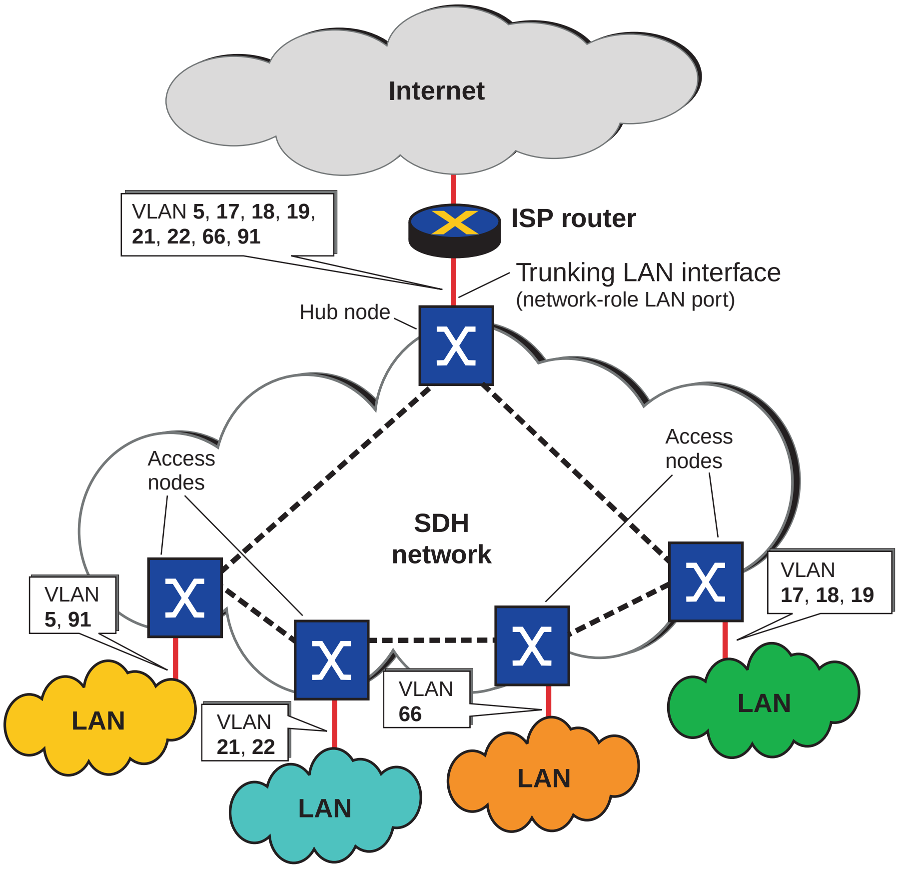
Each access node is individually connected to the hub node over a single SDH connection (or even one SDH connection per LAN port). The trunking LAN interface is a network-role LAN port. The VLAN tags in the Ethernet frames are preserved, i.e. made available to the service provider, and can thus be used for further processing.

A high WAN port density is required in the hub-node.

Averaging of the peak traffic loads of each access node (or LAN port) is not used. Each SDH link bandwidth has to be engineered for the corresponding amount of peak traffic.

Distributed aggregation in the access network

This figure shows an example of distributed aggregation in the access network:



The SDH bandwidth can be shared by many end-users, which allows to gain from the statistical effects in the traffic offered by each end-user ("statistical multiplexing"). Thus, the distributed aggregation in the access network configuration is more bandwidth efficient than the trunking in the hub node topology.

Another difference is that in the trunking in the hub-node topology, the hub node has to support many WAN ports, which is not the case in the distributed aggregation in the access network configuration.

A certain bandwidth allocation fairness can be guaranteed by applying ingress rate control in the access nodes. Please note that ingress rate control is *not* supported on GbE *TransLAN*® cards but only on E/FE *TransLAN*® cards.

Mode of operation

Trunking applications can be realized by using any of the following *TransLAN*® operational modes:

- LAN-VPN mode
- STP virtual switch mode compliant with IEEE 802.1Q
- STP virtual switch mode compliant with IEEE 802.1ad (provider bridge mode)

Related information

Please also refer to:

- "LAN-VPN (M-LAN) mode" (p. 2-53)
- "IEEE 802.1Q STP virtual switch mode" (p. 2-55)
- "Provider bridge mode" (p. 2-57)

Operational modes

Overview of operational modes

These *TransLAN*® operational modes exist:

- Proprietary VPN modes:
  – Multipoint LAN bridging mode (“LAN-VPN mode”, “MLAN mode”)
- Standard compliant IEEE modes:
  – STP virtual switch mode compliant with IEEE 802.1Q
  – STP virtual switch mode compliant with IEEE 802.1ad (“Provider bridge mode”)

Virtual Switch operation mode

When the transparent tagging mode has been selected on the Ethernet Interface card (LAN unit) level, a different Virtual Switch operational mode must be chosen per Virtual Switch. The Virtual Switch can be configured in the following operation modes:

- Repeater
- LAN-interconnect
- LAN-VPN (MLAN)

When the IEE802.1Q/IEEE 802.1a tagging mode has been selected, the operation mode of the Virtual Switch is always Spanning Tree.

The physical Layer 2 (L2) switch that is present on an Ethernet LAN tributary board can be split into several logical or virtual switches. A Virtual Switch is a set of LAN/WAN ports on a Ethernet LAN tributary board that are used by different VLAN’s which can share the common WAN bandwidth. Each of the virtual switches can operate in a specific Virtual Switch mode depending on the VLAN tagging scheme, and each Virtual Switch mode allows specific LAN-WAN port associations as explained in the following paragraphs.

First the VLAN tagging mode has to be specified on LAN unit level, this can be either IEEE 802.1Q/IEEE 802.1aVLAN tagging or VPN tagging. In VPN tagging mode, end-user VLAN tags that optionally may appear in the end user traffic are ignored in the forwarding process. These VLAN tags are carried transparently through the ″TransLAN Network″. In VLAN-tagging mode, the VLAN tags are also carried transparently, but the VLAN ID in the VLAN tags is used in the forwarding decision. Therefore customers’ VLAN IDs may not overlap on a physical Ethernet switch, the VLAN IDs must be unique per switch pack. (FEP 1_188_14221)

After having provisioned the tagging mode, per virtual switch a different Virtual Switch operational mode may be chosen. The Ethernet LAN tributary board supports either the Repeater mode, LAN-Interconnect, LAN-VPN, and Spanning Tree Protocol Virtual Switch mode of operation. IEEE 802.1D MAC forwarding and address filtering, multi-point bridging and spanning tree protocol (STP) are supported under all modes of operation, except the Repeater mode.

The following table gives an overview of the different modes and a list of the corresponding supported functionality:

VLAN Tagging Mode	**Virtual Switch Mode**	**Ethertype/TPID**	**QoS_CQS (Quality of Service - Classification Queueing Scheduling)**	**Dynamic VLAN Registration Protocol**	**Spanning Tree Implementation**
valid per pack	**valid perunit**				
VPN Tagging	Repeater	N/A	N/A	N/A	No STP
	LAN Interconnect (Dedicated Bandwidth)	N/A	N/A	STVRP	Multiple STP
	LAN-VPN (Shared Bandwidth)	N/A	N/A		
	LAN-VPN with QoS	N/A	enabled		
IEEE 802.1Q/IEEE 802.1ad VLAN tagging	Spanning Tree Switched Network	600 ... FFFF, except for 8100	disabled	GVRP	Single STP
			enabled		
		8100	enabled		
	Repeater	600 ... FFFF, except for 8100	disabled	N/A	No STP

Interoperability of operational modes

Virtual Switches that are configured in the same operational mode can interwork. Virtual Switches not configured in the same operational mode do not interwork in all cases. If a Virtual Switch is configured in the “Repeater” mode or the “STP Switch” mode, it can only interwork with Virtual Switches that are configured in the same mode.

Interworking between a remote LAN-interconnect virtual switch and a VPN virtual switch is not prohibited, because the LAN-interconnect mode can be seen as a special case of the VPN mode.

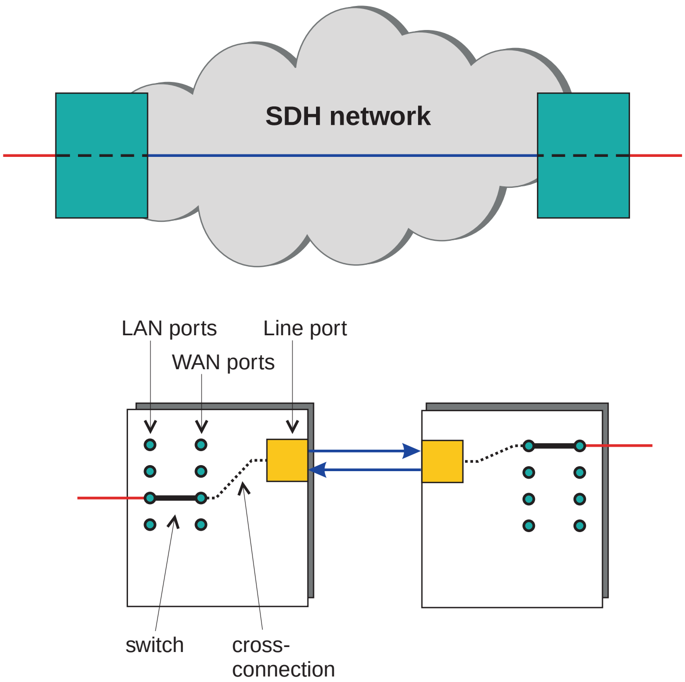
Repeater mode

A virtual switch in repeater mode consists of exactly *one LAN port* and *one WAN port* in a fix 1:1 relationship. All Ethernet frames entering the virtual switch at a LAN port are transparently forwarded to the corresponding WAN port and transported over the network. None of the standard IEEE Std 802.1D/Q processes (MAC address learning, MAC frames forwarding and filtering, VLAN classification and filtering) applies. Received frames are relayed to the other port of the virtual switch, irrespective of their format or contents.

The WAN port that supports the Repeater mode requires the provisioning of the following parameters:

- WAN port capacity; for the Fast Ethernet card requires manual provisioning at 2, 4, 6, 8, 10, 50 or 100 Mbit/s and for the Gigabit Ethernet card requires manual provisioning at VC-12,VC-12, VC-4–4c, VC-4 and VC-3.
- association of the WAN port to a LAN port
- create cross-connections between VC-X and TU-X (where X=12 or 3).

The following figure shows the network element configured in the Repeater operation mode.



A virtual switch in repeater mode emulates an Ethernet repeater except that it

- breaks-up the collision domains,
- removes the length limitation of CSMA/CD LANs, and
- also works in full-duplex mode.

Synonyms

The *TransLAN*® repeater mode of operation is often also referred to as “promiscuous mode” or “buffered repeater mode”.

Intended use

The repeater mode is only intended to be used in point-to-point configurations to offer a leased-lines type of service. The repeater mode is supported by E/FE as well as GbE *TransLAN*® cards.

Configuration rules and guidelines

Please observe these configuration rules and guidelines:

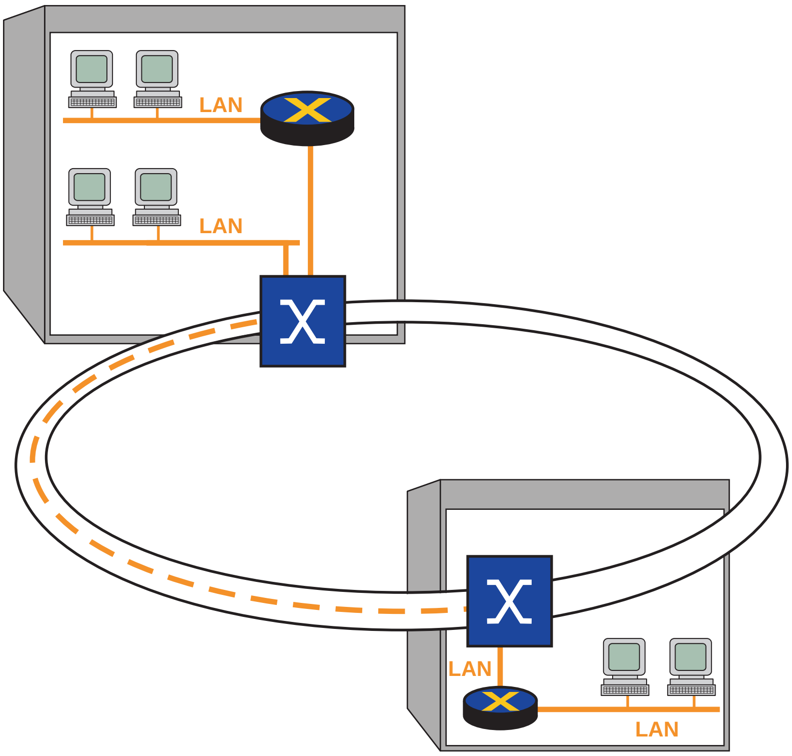
- The use of the repeater mode is limited to virtual switches consisting of exactly *one customer LAN port* and *one network WAN port*. Only point-to-point connections are supported.
- *No* customer identifier (CID) can be configured.
- It is *not* possible to provision QoS functions.
- Flow control can be enabled or disabled per LAN port.
- *No* WAN port configurations are possible.
- When a virtual switch is switched from any of the other operational modes into repeater mode, then all VLAN and QoS configuration information will be reset. When the virtual switch is switched back again into the previous mode, then these configuration settings will *not* become operational again but must be provisioned again.

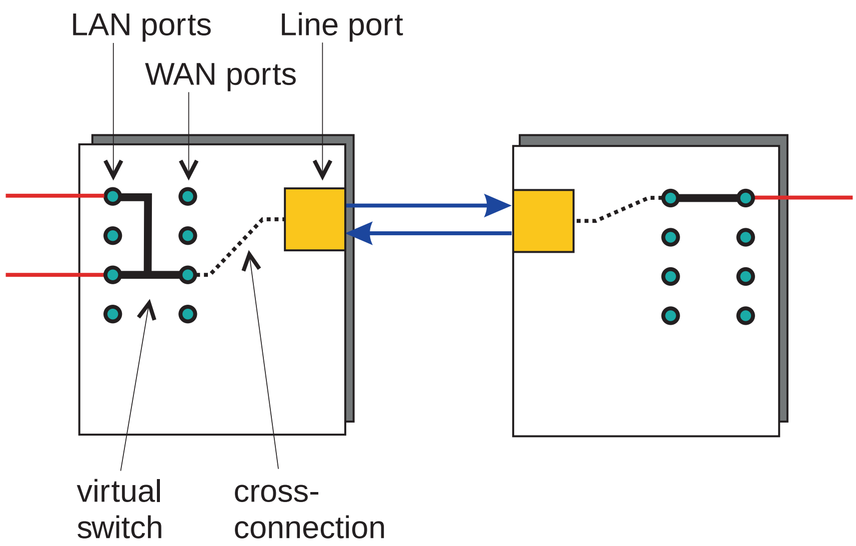
The Ethernet packets are carried across the SDH network in a channel. When using the Fast Ethernet card, each channel comprises up to 5 VC12 or up to 2 VC3 concatenated. These VC12s and VC3s behave in the same way as normal SDH VC12s from an E1 port or SDH VC3s from an E3 port. There is some buffering in the NE, but it is still possible to lose packets because the channel bandwidth can be less than the Ethernet traffic rate. When using the Gigabit Ethernet card, each channel comprises VC-12, VC-4–4c, VC-4 or VC-3.

LAN-interconnect mode

The LAN-interconnect mode of operation offers dedicated WAN bandwidth to a single end-user. Under the LAN-interconnect mode of operation, a Virtual Switch must only contain LAN ports with the same CID (Customer ID) to ensure the entire WAN port bandwidth allocated for the group is dedicated to a single end-user. Any combination of LAN- and WAN-ports is allowed, but with a minimum of two ports to be meaningful.

The following figure shows the network element configured in the LAN-interconnect operation mode.





The Ethernet packets are carried across the SDH network in a channel. When using the Fast Ethernet card, each channel comprises of up to 5 VC12 or of up to 2 VC3 concatenated. These VC12s and VC3s behave in the same way as normal SDH VC12s from an E1 port respectively normal SDH VC3s from an E3 port. When using the Gigabit Ethernet card, each channel comprises of VC-4 or of VC-3.

This operation mode support the following features:

- Learning bridges
- Spanning tree
- Additional SDH bandwidth
- Virtual Switch and
- CID (Customer Identifier).

Special case of the LAN-VPN mode

The LAN interconnect mode of operation is a special case of the LAN-VPN operation. In the LAN interconnect mode a virtual switch may contain LAN and WAN ports of a single user only.

The *TransLAN*® cards can support both modes of operation simultaneously as long as the corresponding virtual switches do *not* include the same WAN ports.

Configuration rules and guidelines

Please observe these configuration rules and guidelines:

- On LAN ports the CID needs to be provisioned manually.
  The permitted CID value range is [0 … 4093]. However, note that only values out of the value range [1 … 4093] can be used to identify a user while the value “0” cannot. The corresponding LAN port is disabled if the CID is set to “0”.
- In the LAN interconnect mode, the virtual switch is dedicated to a single customer. Therefore, all LAN ports of a virtual switch must have the *same* customer identifier (CID).
- In the LAN interconnect mode, LAN ports are always customer-role ports, and WAN ports are always network-role ports (see “Port provisioning” (p. 2-75)).

LAN-VPN (M-LAN) mode

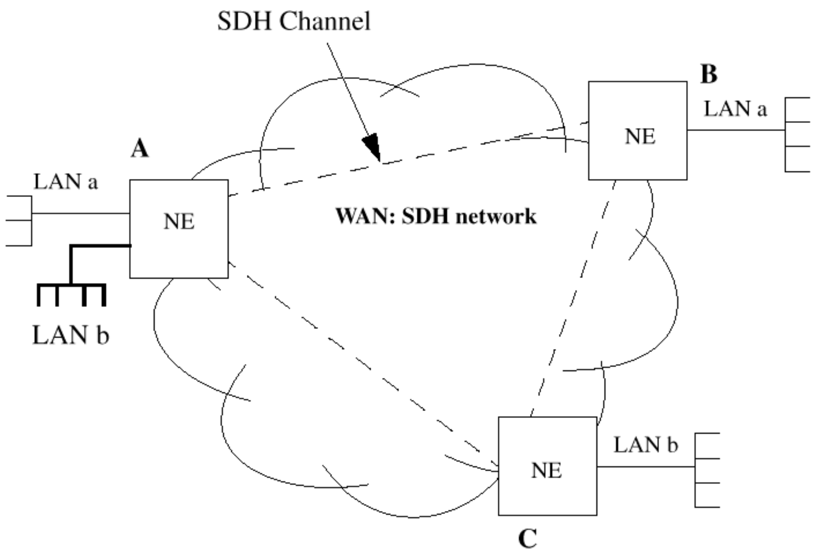
Under the LAN-VPN (Virtual Private Network) operation mode, a number of LAN- and WAN ports are grouped together to form one virtual switch. The Virtual Switch contains LAN ports of multiple end-users sharing the same WAN port(s) bandwidth. To safeguard each individual end-user’s data flow and to identify an end-user’s VPN from the shared WAN, the Ethernet Interface card assigns a CID to each LAN port within a Virtual Switch. The CID of each end-user (or LAN port) must be unique within a shared WAN port to create a fully independent VPN. The VPN provisioning on the WAN ports on the access and intermediate nodes is done automatically by the proprietary protocol STVRP (Spanning Tree with VPN Registration Protocol) that runs without operator intervention.

The end-users are assigned bandwidth by the operator. It allows multiple end-users to share the same SDH WAN bandwidth with each end-user being allocated a sub-VC-12-Xv (X= 1, 2, 3, 4, 5) or sub-VC-3-Xv (X=1, 2) rate of bandwidth when using the Fast Ethernet card and sub-VC-4-Xv (X=1, 2,...7) or sub-VC-3-Xv (X=1, 2) when using the Gigabit Ethernet card. The combined end-user bandwidth is then mapped to the SDH time-slots and transported in the SDH network as a single data load. The minimum rate that can be configured per end-user at a LAN port is 150 kbit/s. The operator also specifies a traffic policy for each end-user.

The LAN-VPN operation mode controls the shared bandwidth by making use of the following features:

- Learning bridges
- Spanning tree
- V-LAN (Virtual-LAN)
- CID (Customer Identifier)
- Assigned bandwidth policy (CIR = Committed Information Rate and PIR = Peak Information Rate)
- Additional SDH bandwidth and SDH WAN bandwidth sharing
- Traffic policy (Strict policing/Oversubscription).

The following figure shows the network element configures in the LAN-VPN operation mode



LAN-VPN with QoS mode

Starting with release 4.0, the LAN-VPN with QoS mode, which was supported in releases prior to release 4.0, is no longer supported.

The QoS features which were supported by the LAN-VPN with QoS mode in previous releases are different to the new QoS features supported in the *Metropolis*® ADM (Universal shelf) release 4.0.

VPN tagging mode

VPN tagging is used to identify user frames in the LAN-VPN mode of operation. VPN tagging is often also referred to as “transparent tagging”.

VPN tagging is characterized as follows:

- Selecting the VPN tagging mode implies that the port role of the ports is fixed. LAN ports are always customer role ports, and WAN ports are always network role ports (see "Flexible port role assignment" (p. 2-76)).
- VPN tagging is a double tagging mode. This means that a customer identifier (CID tag) is inserted into each frame at each network ingress LAN port. User frames that are already tagged become double tagged. The CID tag is removed from the frame at each network egress LAN port.
- Ports forward only those frames that have a CID tag which "belongs" to that port (i.e. which has previously been provisioned on that port).

In the VPN tagging mode, the term "LAN group" is synonymously used to the term "virtual switch".

Configuration rules and guidelines

Please observe these configuration rules and guidelines:

- Be aware that the port role of the LAN and WAN ports is fixed (see above):
  - LAN ports are always customer role ports.
  - WAN ports are always network role ports.
- On LAN ports the CID needs to be provisioned *manually*.
- The CID provisioned on each LAN port must be *unique* within a shared WAN to create a fully independent VPN.
  The VPN provisioning on the WAN ports is done automatically by means of the proprietary spanning tree with VPN registration protocol (STVRP).

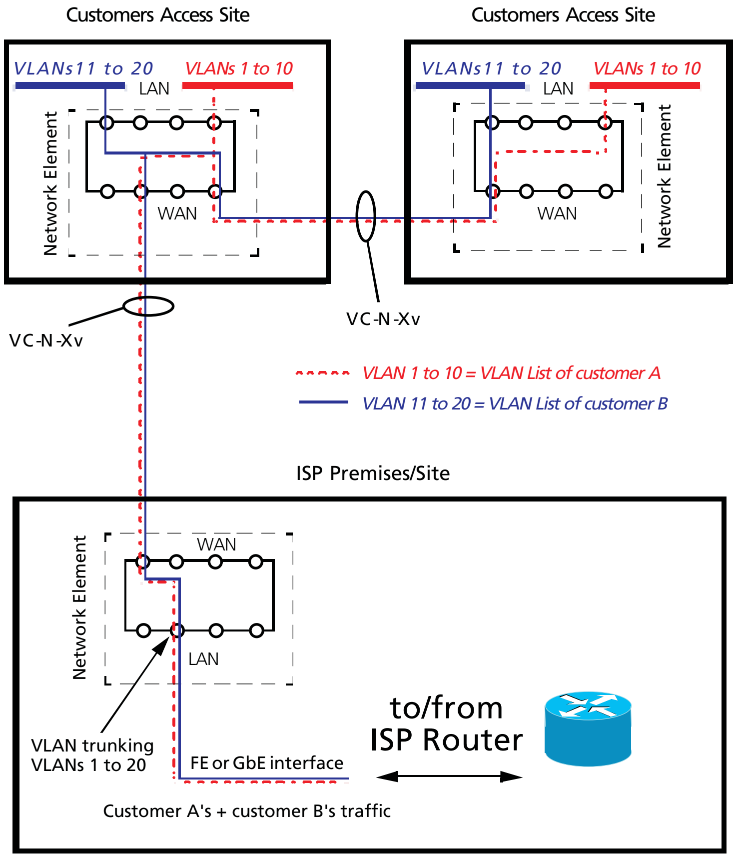
IEEE 802.1Q STP virtual switch mode

The IEE802.1Q/IEEE 802.1a VLAN tagging scheme can be seen as an extension of the LAN-VPN mode, providing more flexibility in defining the VPN's and in general leading to a more efficient use of bandwidth. In IEEE 802.1Q VLAN tagging mode, a virtual switch is formed by a combination of LAN- and WAN ports on a physical switch that is used by different VLAN's which can share the common WAN bandwidth. Each port can be part of only one virtual switch, but a certain port may be associated with more than one VLAN. The ports that are associated with a certain VLAN ID form the VLAN Port Member Set.

On ingress, each packet is filtered on its VLAN ID. If the receiving port is a member of the VLAN to which a received MAC frame is classified, then the frame is forwarded. The user can provision whether untagged packets are dropped, or tagged with a PVID (Port VLAN ID), via the acceptable frame type parameter.

Example VLAN trunking

The VLAN trunking example shown in the next figure is one of the possible applications in this operation mode.



VLAN IDs assigned to LAN Ports should not overlap in case the operator wants to ensure Layer-2 security between those LAN Ports (in many applications, LAN Ports are likely to be dedicated to one customer). It is the responsibility of the operator to define appropriately non-overlapping VLAN IDs on all the created virtual switches.

Also the provisioned PVID, with which untagged incoming frames are tagged, should not overlap with any VLAN ID on the virtual switch of which the customers' port is part (again, this is the responsibility of the operator). Manual provisioning of intermediate nodes can be cumbersome and difficult. Therefore it is recommended to use the auto-provisioning mode for VLAN ID's on the intermediate nodes. A protocol named GVRP (GARP VLAN Registration Protocol) provides this functionality. GVRP is an application of the Generic Attribute Registration Protocol (GARP) application, which runs on top of the active spanning tree topology.

IEEE 802.1Q defines two kinds of VLAN registration entries in the Bridge Filtering Database: static and dynamic entries. In the *TransLAN*® implementation, static entries need to be provisioned on access node LAN ports only. GVRP will take care of configuring dynamic entries on the WAN ports of intermediate and access nodes.

A spanning tree per virtual switch is implemented. If the user wants the traffic to be protected by the spanning tree protocol and uses the manual-provisioning mode, he must make sure that the WAN ports in the alternative path also will have the corresponding VLAN IDs assigned. E.g. in a ring topology, all NE's in the ring must be provisioned with this VLAN ID. In automatic mode, the GVRP protocol will take care of the dynamic VLAN ID provisioning. The user has the possibility to flush dynamic VLAN's, thus remove dynamic VLAN's that are no longer used.

Only independent VLAN learning is supported. This means, if a given MAC address is learned in a VLAN, the learned information is used in forwarding decisions taken for that address only relative to that VLAN.

For the IEEE 802.1Q VLAN tagging mode, the oversubscription mode is not supported (cf. "Quality of Service (QoS) overview" (p. 2-80)).

Configurable spanning tree parameters

Even though the management system is an SDH network element manager, the data networking problems still need to be addressed when managing network elements carrying Ethernet traffic. As such the following parameters are visible/provisionable per virtual switch.

- bridge address
- bridge priority
- root cost
- root port
- port priority
- bridge priority

Provider bridge mode

The provider bridge mode, a double tagging mode with provisionable TPID ("Ethertype"), is - from a functional point of view - comparable to the LAN-VPN with the chief difference that the provider bridge mode is compliant to the IEEE 802.1ad standard while the VPN modes are Lucent Technologies proprietary modes, and that the provider bridge mode supports Quality of Service features while the LAN-VPN does not.

Traffic is forwarded based on the destination MAC address and the outer VLAN tag (S-tag).

As in the IEEE 802.1Q STP virtual switch mode, a virtual switch in the provider bridge mode is a set of LAN/WAN ports on a physical switch that are used by different VLANs which can share the common WAN bandwidth. VLANs in the same virtual switch are defined by their VLAN port member set. An instance of the spanning tree protocol runs on the WAN ports for each virtual switch.

The LAN ports and WAN ports can be configured to be customer-role or network-role ports (see "Flexible port role assignment" (p. 2-76)).

In the provider bridge mode, the IEEE 802.1ad VLAN tagging mode is used (see "IEEE 802.1ad VLAN tagging" (p. 2-59)).

□

Tagging modes

Overview

Sharing transport channels between multiple users requires the identification of MAC frames. Tagging is the process of attaching an identifier, a “tag”, to a MAC frame in order to identify the user to which the frame pertains.

These tagging modes are supported:

- *Transparent* tagging (“VPN tagging”)
- *IEEE 802.1Q/IEEE 802.1ad* VLAN tagging
  - VLAN tagging compliant with IEEE 802.1Q-1998 (“IEEE 802.1Q VLAN tagging”)
  - VLAN tagging compliant with IEEE 802.1ad (“IEEE 802.1ad VLAN tagging”, “Provider bridge tagging mode”)

The different tagging modes are explained later-on in this section.

Important! Note that it is *not* possible to use different tagging modes at the same time on the same *TransLAN*® card.

However, within the transparent tagging mode there can be virtual switches in the repeater mode, LAN interconnect mode, or LAN-VPN mode (with or without IEEE 802.1p QoS) at the same time on the same physical switch.

Transparent tagging

Transparent tagging (or “VPN tagging”) is a double tagging mode used to identify end-user frames in the LAN-VPN mode of operation.

Selecting the transparent tagging mode implicitely means that the port role of the ports is fixed. LAN ports are always customer-role ports, and WAN ports are always network-role ports (see “Flexible port role assignment” (p. 2-76)).

To enable bandwidth sharing, a customer identification (CID) is associated with every LAN port. This CID is inserted into incoming Ethernet frames, in an extra tag. MAC address filtering and learning is done independently for every CID.

Ethernet frames that are already tagged become double tagged. Already present end-user VLAN tags remain unused in the transparent tagging mode, i.e. every VLAN tag is transmitted transparently through the SDH network.

Outgoing frames are only transmitted on LAN ports which have the respective CID associated. The extra tag is removed before the Ethernet frames are forwarded to an external LAN.

Note that in the VPN tagging mode the term “LAN group” is synonymously used to the term “virtual switch”.

Configuration rules and guidelines

Please observe these configuration rules and guidelines:

- The port role of the LAN and WAN ports is fixed in the operational modes that make use of the VPN tagging mode (see above):
  - LAN ports are always customer role ports.
  - WAN ports are always network role ports.
- On LAN ports the CID needs to be provisioned *manually*.
- The CID provisioned on each LAN port must be *unique* within a shared WAN to create a fully independent VPN.

The VPN provisioning on the WAN ports is done automatically by means of the proprietary spanning tree with VPN registration protocol (STVRP).

> **Important!** Changing the tagging mode from transparent tagging to IEEE 802.1Q/IEEE 802.1ad VLAN tagging or vice versa is *traffic affecting*! Furthermore, most objects provisioned in one mode will be deleted or reset to default - except the LAN group / virtual switch infrastructure - when switching to the other mode.

IEEE 802.1Q VLAN tagging

IEEE 802.1Q VLAN tagging is used to identify end-user frames in the STP virtual switch mode compliant with IEEE 802.1Q.

These are the IEEE 802.1Q VLAN tagging rules:

- On end-user LAN interfaces:
  - At each network ingress port, untagged user frames are tagged with a default identifier, the port VLAN identifier (PVID) which is removed from the frame at the network egress port.

    Already tagged frames are forwarded if their VLAN identifier is in the port's static or dynamic list of VLAN IDs, i.e. if the port belongs to the configured port member set for that VLAN ID. The static VLAN ID list is configurable. The dynamic VLAN ID list is automatically generated by making use of the GARP VLAN Registration Protocol (GVRP).
  - At each network egress port, the port VLAN identifier (PVID) is removed from previously untagged frames that were tagged with the PVID at the ingress port. VLAN tagged frames are forwarded if the port belongs to the configured port member set for the respective VLAN ID.
- On trunking LAN interfaces, *all* tagged frames are forwarded in both directions. Untagged frames are discarded (dropped).
- The end-customer VLAN tag sets have to be disjunct.

IEEE 802.1ad VLAN tagging

The IEEE 802.1ad VLAN tagging mode (“provider bridge tagging mode”) is a double tagging mode with provisionable Ethertype (TPID), used to identify end-user frames in the STP virtual switch mode compliant with IEEE 802.1ad (“provider bridge mode”).

At each customer role port, a provider bridge tag carrying a customer identifier (CID) is inserted into each Ethernet frame in the ingress direction, and removed from the frame in the reverse direction. Frames that are already tagged become double tagged. The IEEE 802.1ad VLAN tagging mechanism is transparent to the end-customer. VPNs on transit nodes (no customer LAN port) are automatically instantiated by means of the standard GVRP protocol which optionally can be disabled.

The value of the Ethertype (TPID) can be flexibly chosen. However, some values are reserved for specific purposes, for example:

- 0x0800 for IP
- 0x0806 for ARP
- 0x8847 for MPLS
- 0x8100 is not selectable because this is the default value for the STP virtual switch mode compliant with IEEE 802.1Q.

The recommended value for the Ethertype in the provider bridge tagging mode is 0x9100.

Configuration rules and guidelines

Please observe these configuration rules and guidelines:

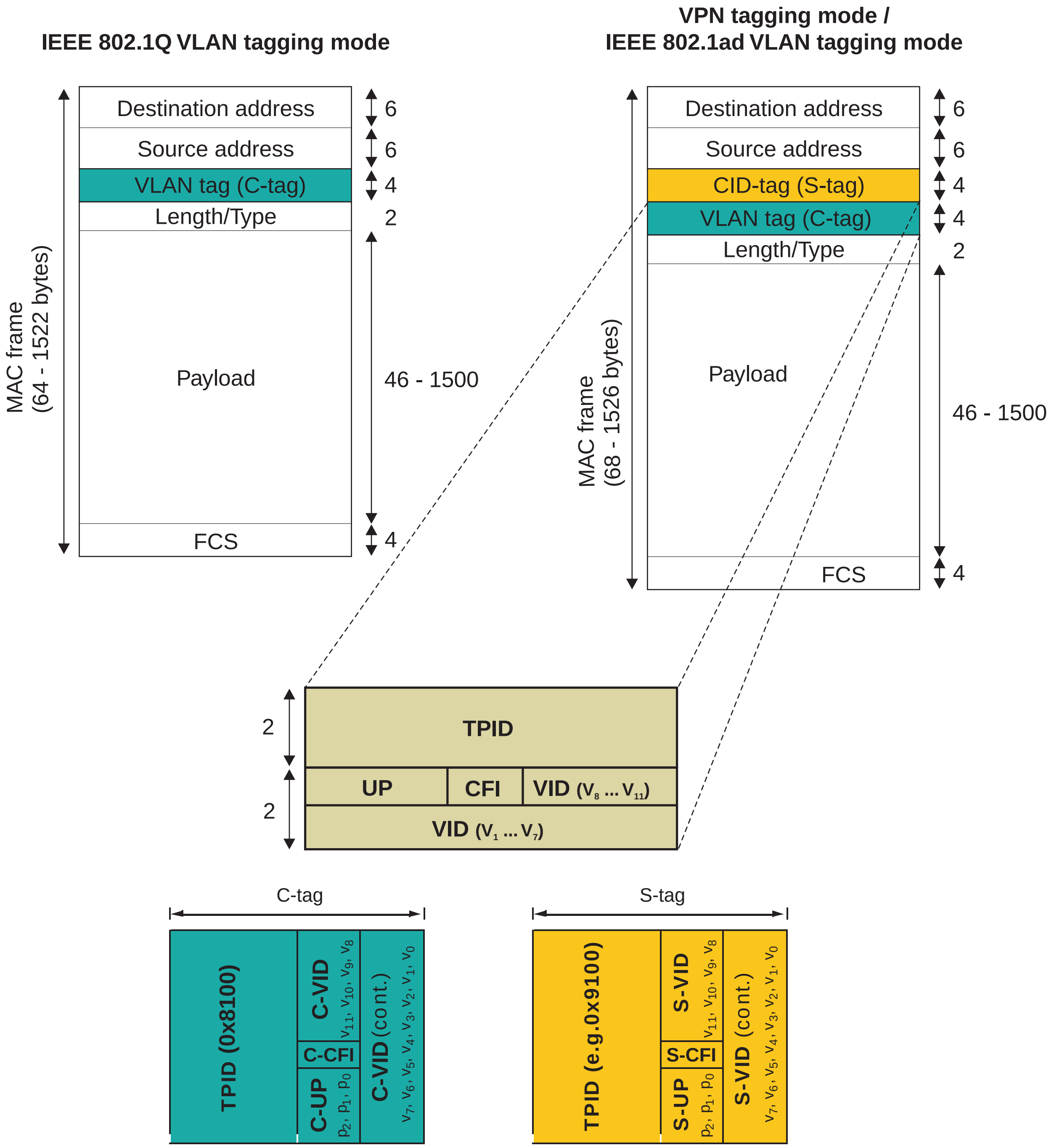
- The provider bridge mode can be configured by selecting the IEEE 802.1Q / IEEE 802.1ad tagging mode in combination with provisioning an Ethertype *in the range 0x0601 … 0xFFFF, but unequal to 0x8100*. Provisioning the value 0x8100 for the Ethertype results in the selection of the STP virtual switch mode compliant with IEEE 802.1Q.
  The recommended value for the Ethertype in the provider bridge tagging mode is 0x9100. Please also observe the reserved values as given above.
- The customer identification (CID) can be configured in the range [0 … 4093].

  Important! *Changing the tagging mode is traffic affecting!*

  Furthermore, most objects provisioned in one mode will be deleted or reset to default - except the LAN group / virtual switch infrastructure - when switching to a different mode.

Tagged MAC frame

The following figure illustrates the structure of the MAC frame in different tagging modes as well as the structure of the respective tags.



Legend:

TPID	Tag protocol identifier ("Ethertype") - indicates the presence of a VLAN tag (or CID tag, respectively). Furthermore, it indicates that the lenght/type field can be found at a different position in the frame (moved by 4 bytes).
UP (3 bits)	User priority - "0" (low priority) … "7" (high priority).
CFI (1 bit)	Canonical Format Identifier - indicates the presence or absence of routing information.

ID (12 bits) Identification - customer identification which can be configured in the range [0 … 4093].

Concerning their structure there is no difference between a VLAN tag (C-tag) and a CID tag (S-tag). A distinction between both types of tags can be made by means of the value in the TPID field, the “Ethertype”. In the IEEE 802.1ad VLAN tagging mode (provider bridge tagging mode), the Ethertype can be provisioned per virtual switch.

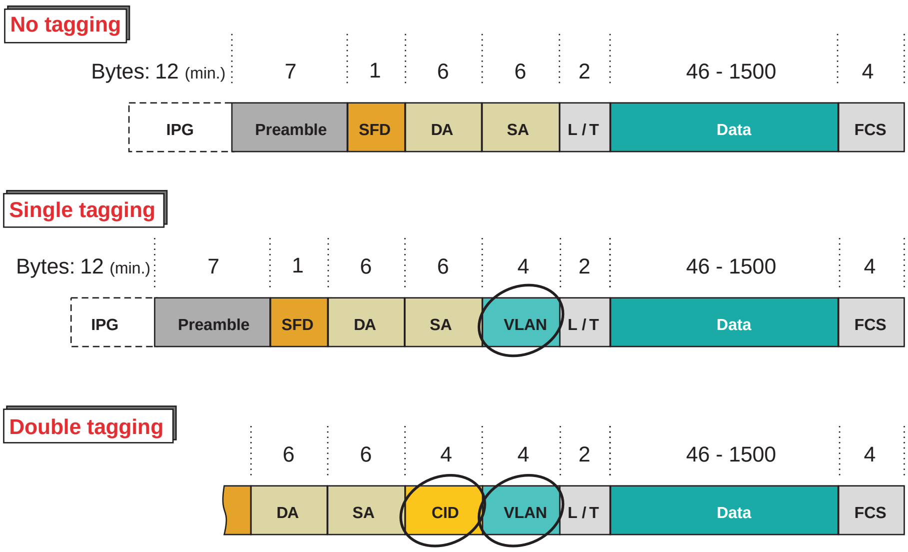
The value of the Ethertype depends on the mode of operation:

- In the transparent tagging modes (VPN tagging modes), the value of the Ethertype is 0xFFFF, and cannot be changed.
- In the IEEE 802.1Q VLAN tagging mode, the value of the Ethertype is 0x8100, and cannot be changed.
- In the IEEE 802.1ad VLAN tagging mode (provider bridge tagging mode), the value of the Ethertype can be flexibly chosen in the range 0x0601 … 0xFFFF, but unequal to 0x8100. The recommended value for the Ethertype in the provider bridge tagging mode is 0x9100.

Comparison of different tagging schemes

The next figure summarizes the possible tagging schemes:

- No tagging
- Single tagging (IEEE 802.1Q VLAN tagging)
- Double tagging (VPN tagging, IEEE 802.1ad VLAN tagging)



□

Link Pass Through

General

The Gigabit Ethernet and Fast Ethernet interfaces on the *Metropolis*® ADM (Universal shelf) network elements support the so-called Link Pass Through (LPT) mode.

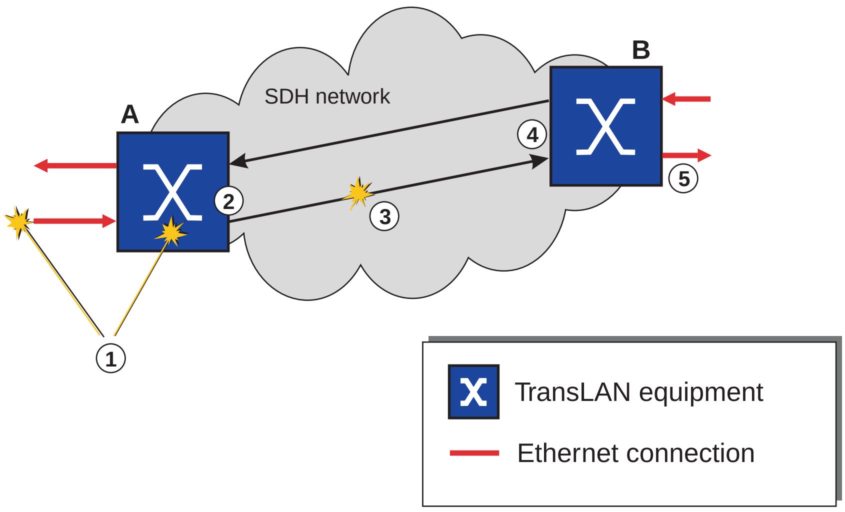
The LPT mode can be used to enable or improve network protection schemes on the equipment external to the *TransLAN*® systems.

The LPT mode can be enabled or disabled per GbE/FE port.

Important! The LPT mode is only supported on GbE/FE ports (LAN ports) that operate in a *strict one-to-one association* with a WAN port using *GFP encapsulation*.

LPT operation

Please refer to the following figure for clarification and further reference.



If an upstream GbE/FE fiber failure (e.g. a fiber cut) or equipment failure (1) is detected at node A, then a Client Signal Fail (CSF) indication is inserted into the GFP-encapsulated signal (2). If such a CSF indication or a Server Signal Fail (SSF) condition (due to a failure on the transmission line (3) for example) is detected at node B (4), then this can be used to trigger the inhibition of the transmitter at the LAN egress port (5) as a consequent action for 3 seconds.

LPT interworking with MRV Fiber Driver

When MRV fiber driver interwork with *Metropolis*® ADM (Universal shelf) TransLAN network via IEEE802.3ah OAM, *Metropolis*® ADM (Universal shelf) is able to “integrate” this MRV Firber Driver Module to provide an extended ″link pass through″ (LPT) function between MRV’s customer LAN ports.

Important! GbE/LPT interworking feature is only supported by LKA53.

Link aggregation

Purpose

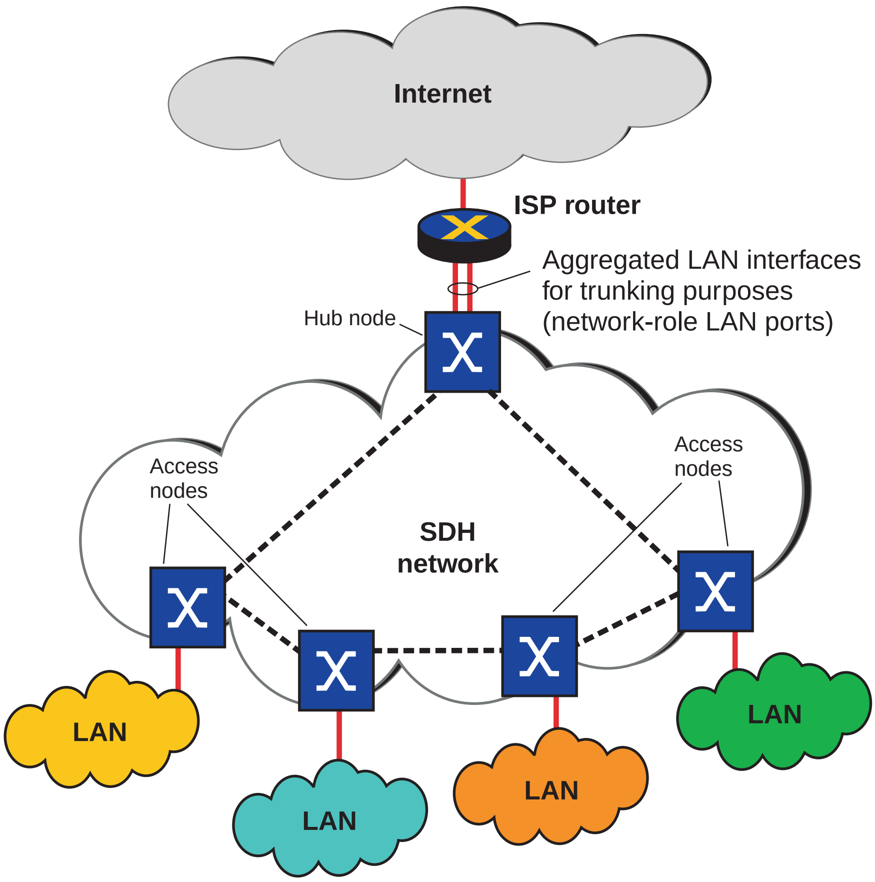
Metropolis® ADM (Universal shelf) systems support link aggregation of Gigabit Ethernet LAN ports in compliance with IEEE 802.3ad.

Link aggregation allows to bundle (“aggregate”) a number of ports with their transmission capacity to form a link aggregation group (LAG), which can be treated as if it was a single (logical) link.

Thus, link aggregation can be used to *increase the transmission capacity* by transporting a higher capacity signal over a number of bundled, lower capacity links, and/or to *provide link protection*.

Link aggregation for high-density trunking applications

Link aggregation is especially of interest for high-density trunking applications.



Without link aggregation, the second GbE trunking interface between the hub node and the ISP router would be blocked by the spanning tree protocol (STP) in order to avoid loops.

Characteristics

Link aggregation in *Metropolis®* ADM (Universal shelf) systems is characterized as follows:

- Link aggregation is available for the two GbE ports on the IP-GE/2F-OS (LKA53) Gigabit Ethernet unit only.
- Link aggregation is only possible between two GbE ports that reside on the same circuit pack.
- Link aggregation provides both link protection and load sharing across the aggregated ports.

Load balancing

The distribution of Ethernet frames across the aggregated ports is important in order to provide load balancing.

Frame distribution is accomplished as follows:

- If only one of the ports is available for transmission, then all frames to be transmitted will be sent over this port.
- If both ports are available for transmission, then the traffic will be distributed among the two ports. The distribution algorithm is based on the evaluation of the source and destination MAC address.

Fault management

There are two alarms related to the aggregation of GbE links:

- The `GBE Local Link Agregation partial link loss` alarms the situation where only one of the two GbE ports is available for transmission.
- The `GBE Local Link Agregation total link loss` alarms the situation where the transmission is completely blocked because none of the two GbE ports is available for transmission.

Note that all the fault management functionality related to the individual ports or to the virtual switch works independently of the LAG.

Configuration settings concerning the Link Pass-Through (LPT) functionality or flow control (pause operation) are automatically applied to both ports of the LAG.

☐

IGMP snooping

Purpose

Metropolis® ADM (Universal shelf) systems support IGMP snooping.

IGMP snooping can be understood as a generalized MAC address learning mechanism for multicast MAC addresses. It is based on observing ("snooping") some network-layer messages exchanged between the multicast routers and the hosts interested in receiving multicast traffic. IGMP snooping deals only with IPv4 multicast traffic (which is the prevalent form of multicast in networks nowadays).

IP Group Multicast Protocol IGMP

The Internet Engineering Task Force (IETF) defined IGMP as a means of associating groups of IP multicast transmitters and receivers. Each member host of an IP multicast is either a transmitter or a receiver.

It provides

- a protocol for hosts actively joining / leaving multicast groups
- routers/gateways announcing to other routers that there are hosts willing to join / leave particular multicast groups in their networks
- routers/gateways querying / reporting the multicast participation in their particular networks ·

A station that wishes to become a receiver sends an IGMP "group join" message to that group's transmitter. Each Layer 3 device that forwards an IGMP join message records the group ID and source interface in its multicast forwarding table. When the transmitter sends IP multicast traffic, the Layer 3 device will then forward the traffic only to those interfaces from which it has received join messages. Thus, the Layer 3 device forwards IP multicast traffic only to those hosts that have requested it. Applications that use IP multicast, such as those involving streaming media, automatically handle IP multicast group membership. Users do not have to manually send IGMP messages.

Over time, the IETF has defined three versions of IGMP:

- IGMPv1:
  IETF Request for Comments 1112 (RFC 1112) defines the original version of IGMP. RFC 1112 defines the join message that hosts use to join an IP multicast group. However, IGMPv1 does not define a method for hosts to leave a multicast group. With IGMPv1, routers must use a timer to determine which hosts are still members of the group.
- IGMPv2: RFC 2236 defines "group leave" messages that enable IP multicast-aware devices to keep current information on group membership.
- IGMPv3: RFC 3376 represents a major revision of IGMP. Instead of the one-transmitter/many-receiver model of IGMP versions 1 and 2, hosts using IGMPv3 specify lists of transmitters to listen to.

IGMP snooping

IGMP snooping, as the name implies, is a method by which Layer 2 devices can "listen in" on IGMP conversations between hosts and routers. When a switch hears a group join message from a host, it notes which switch interface it heard the message on, and adds that interface to the group. Similarly, when a Layer 2 switch hears a group leave message or a response timer expires, the switch will remove that host's switch interface from the group.

IP multicast traffic has some special characteristics. Destination IP addresses for multicast traffic fall within the range of 224.0.0.1 through 239.255.255.255 (although some addresses within this range are reserved). Destination Ethernet addresses for multicast traffic begin with 01:00:5E and end with the lower order 23 bits of the destination IP address.

IGMP snooping enabled VALN ports support the following IGMP interface roles, which are provisionable and retrievable per VLAN port via management system:

- Non-Router: IGMP snooping will consider that only hosts (and no routers) are reachable through this vlan port
- Router: IGMP snooping will consider that multicast routers (and possibly hosts) are reach-able through this vlan port
- Auto (default): IGMP snooping will auto-detect the vlan port role

Multicast group

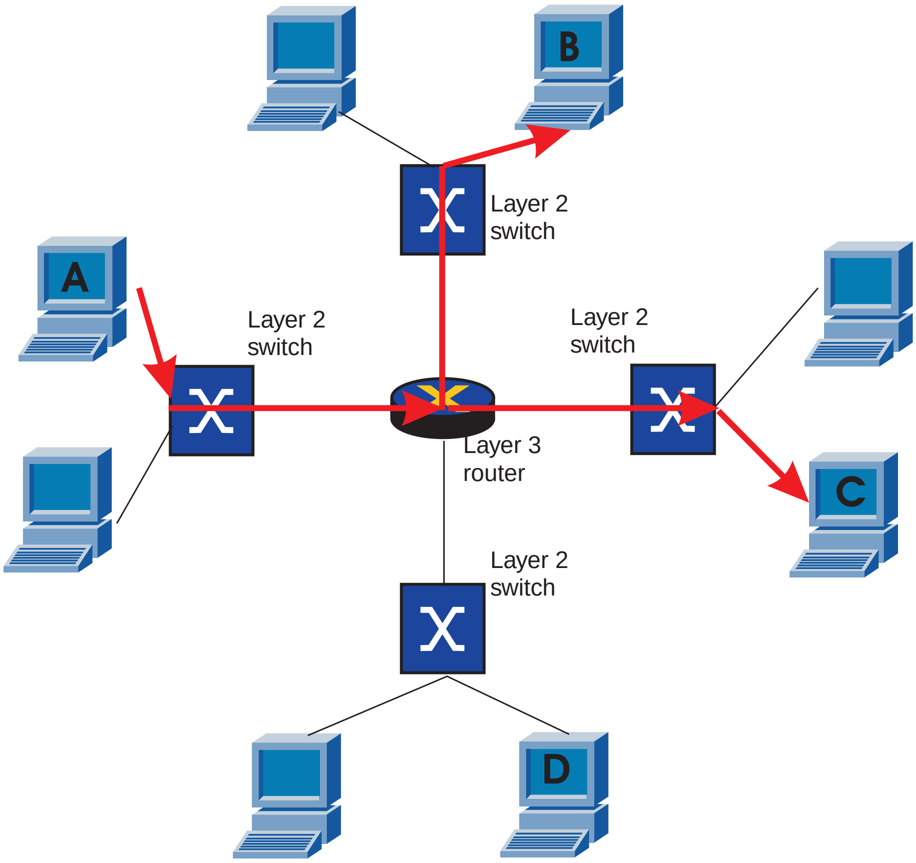
A multicast group is a group of zero or more hosts that listen to a particular IP multicast group address.

- Multicast groups are identified by the IP multicast address.
  - 224.0.0.0 is a no-group address
  - 224.0.0.1 is the permanent group of all multicast IP hosts (including gateways) on the directly connected network
- There is a fixed mapping defined between IP multicast group addresses and link-layer addresses for many link layers. The link layer multicast address is used as the link-layer destination address (DA) when sending IP datagrams to an IP multicast group address.
- One link-layer for which a mapping exists is Ethernet.

  The mapping of IP multicast group addresses and Ethernet MAC multicast group addresses is as follows:
  - IP multicast frames all use MAC addresses beginning with: 0x0100.5Exx.xxxx
  - xx.xxxx are the last 23-bits of the IGMP multicast group address.
  - Note that the (2**28)-1 defined multicast group IP addresses are mapped onto (2**23)-1 Ethernet MAC multicast group addresses. This is a 32-to-1 mapping, not a one-to-one. Practically, this is only relevant when choosing the IP multicast group addresses within a network based on Ethernet.
- Max. 3.2 K IP multicast groups aresupported per Ethernet unit.

Example for multicast traffic

In the following example host A is an multicast transmitter and hosts B and C are multicast receivers in the same multicast group as host A. The layer 3 router forwards the IP multicast traffic only to those segments with registered receivers (hosts B and C). The layer 2 switches, forward the IP multicast traffic only to hosts that are multicast receivers.



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IEEE 802.3ah Operations, Administration and Maintenance (OAM)

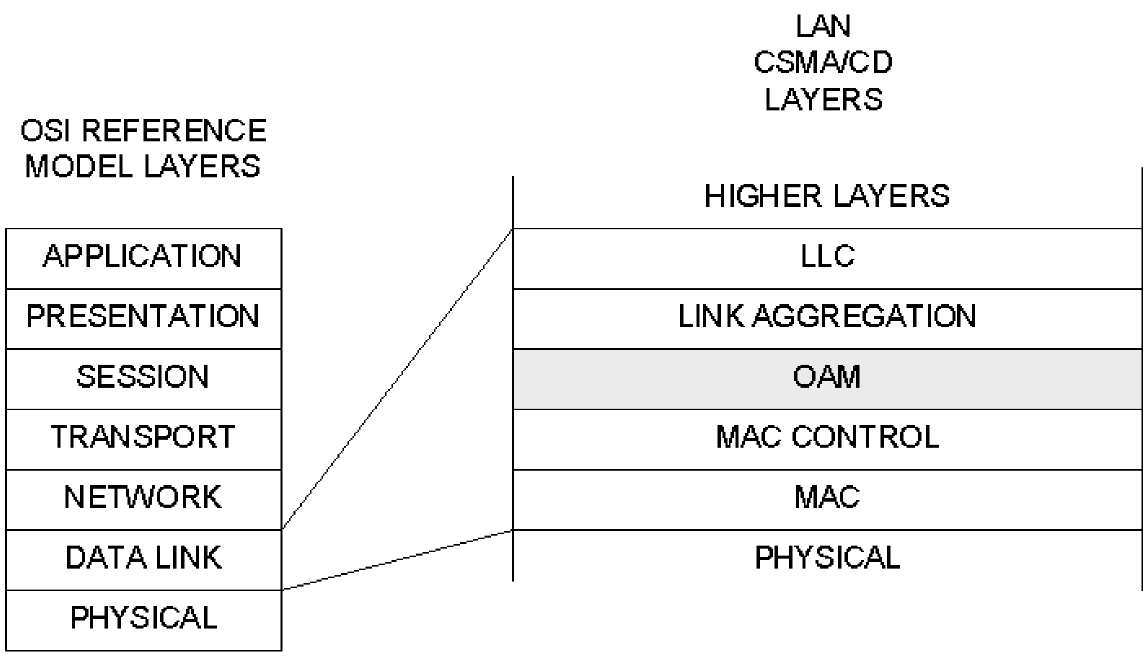
Introduction

Metropolis® ADM (Universal shelf) systems support Operations, Administration and Maintenance (OAM) functions according to clause 57 of the IEEE 802.3ah-2004 standard (included in IEEE 802.3-2005, section 5). OAM provides network operators the ability to monitor the health of the network and quickly determine the location of failing links or fault conditions.

The IEEE 802.3ah OAM mechanism is based on the exchange of information using frames (802.3ah OAMPDUs) with standardized formats and a standardized protocol (802.3ah OAM protocol).

OAM sublayer

In the IEEE reference model, the IEEE 802.3ah OAM functionality is represented by the so called OAM sublayer, that is a sublayer between the between the MAC Control sublayer and the MAC client layers (such as the Link Aggregation (LAG) sublayer, for example).

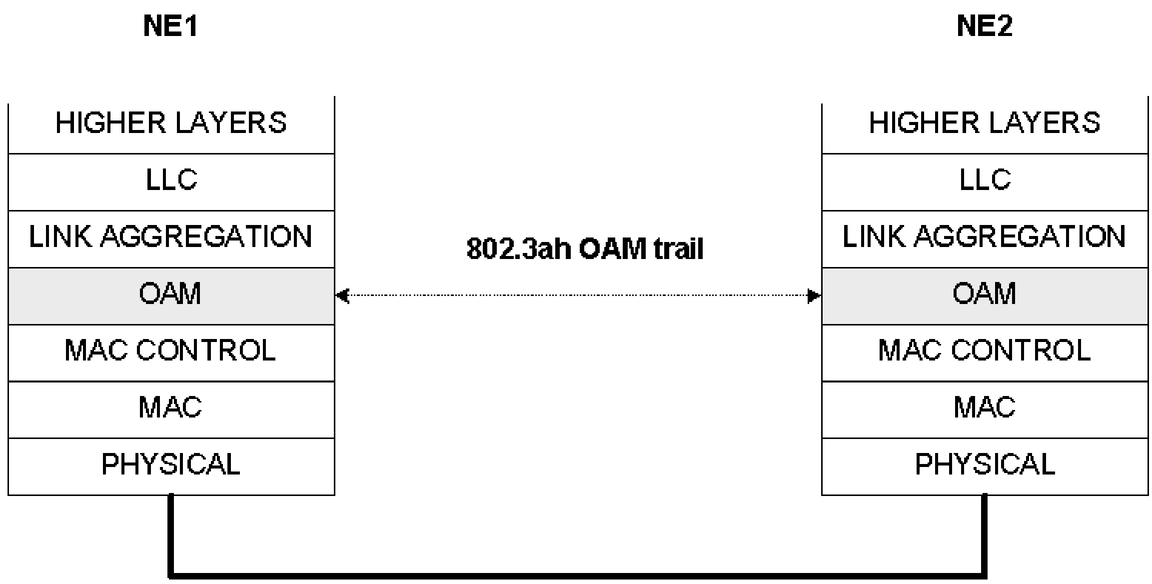


The positioning of the OAM sublayer implicates some important aspects regarding the behavior of the IEEE 802.3ah OAM functionality in the context of Ethernet networking:

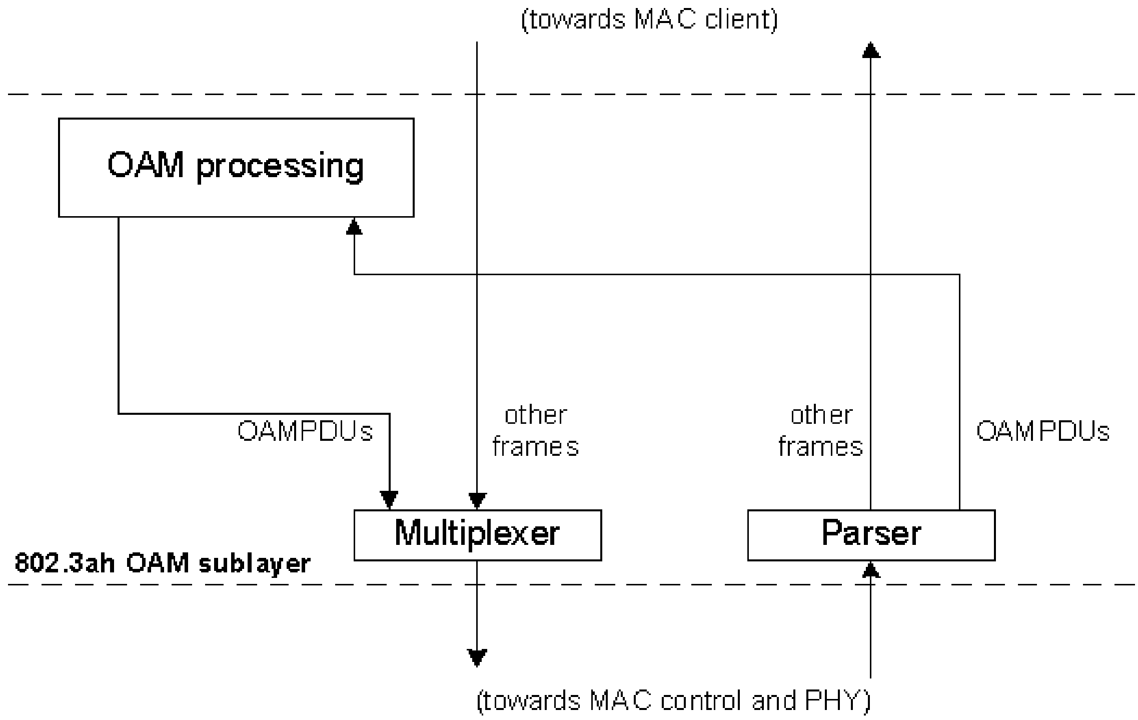
- The OAM sublayer is positioned on top of the MAC control sublayer. Thus, the pause mechanism (flow control) - when active - will delay not only Ethernet service frames but also IEEE 802.3ah OAM frames.
- The OAM sublayer is positioned below the Link Aggregation (LAG) sublayer, if present. Thus, the OAM sublayer exists once for each link in a LAG implementation.
- The OAM sublayer is positioned below the MAC client layers. Thus, all upper-layer frames will pass through the OAM sublayer (for example Ethernet service frames, bridge PDUs, LACP PDUs, ...). This implies for instance that, if the OAM sublayer is in a state where it does not pass through frames, all upper-layer frames will be blocked at the OAM sublayer.

Communication between NEs

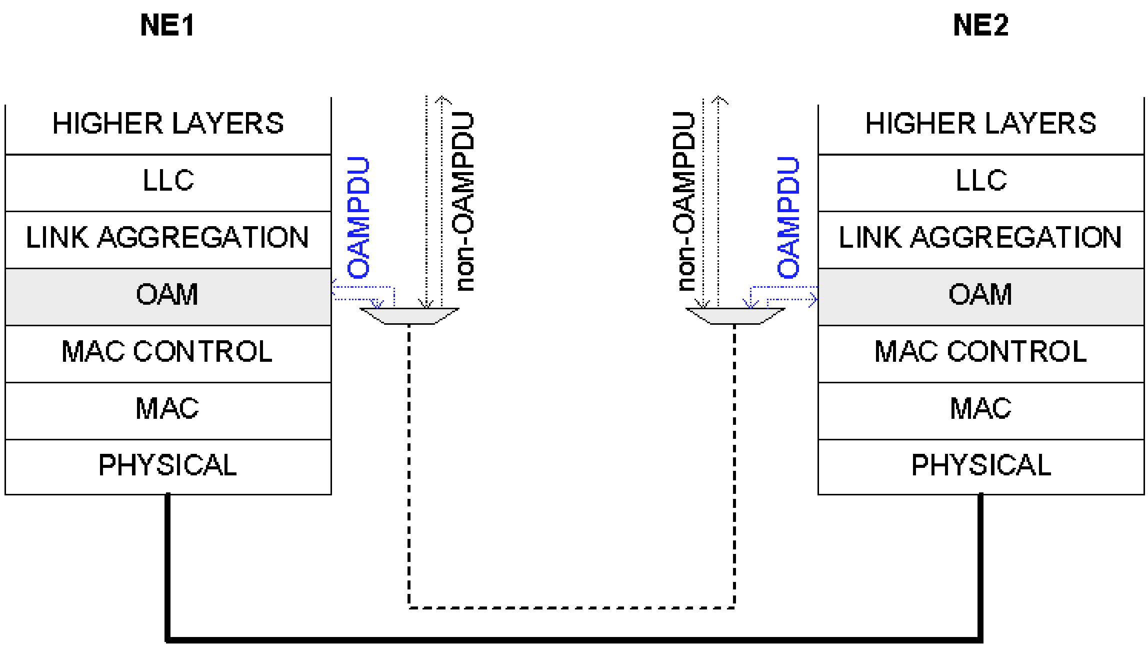
When two NEs are connected by an Ethernet link with IEEE 802.3ah OAM enabled, the OAM sublayers in each of the NEs perform the OAM functions by exchanging OAMPDUs according to the 802.3ah OAM protocol.



The following graphic illustrates the transmission view of the IEEE 802.3ah OAM functionality.

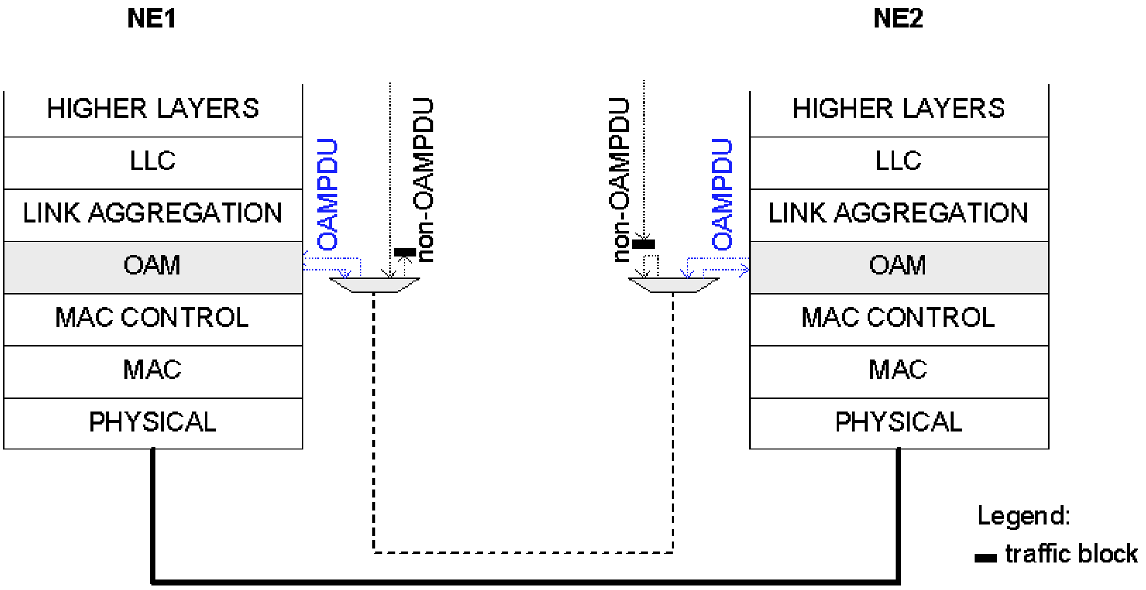


Taking the transmission view of the IEEE 802.3ah OAM functionality into account, the following graphic shows in more detail the traffic flows in a configuration where two NEs are connected by an Ethernet link with IEEE 802.3ah OAM enabled.



IEEE 802.3ah OAM loopbacks

The IEEE standard describes the IEEE 802.3ah OAM loopback as a remotely-controlled facility that can be used for fault localization and link performance testing. The loopback is defined as an OAM-layer loopback, i.e. the affected traffic is looped at the OAM layer. The following graphic shows the flow of traffic when an 802.3ah OAM loopback is enabled.



IEEE 802.3ah OAM loopbacks are intended to be used to assess the quality of a link during network maintenance operations.

□

IEEE 802.3ah OAM interworking with MRV Fiber Driver

Overview

The MRV Firber Driver Module (refer to “MRV module ” (p. 4-40)) interworks with *Metropolis*® ADM (Universal shelf) LKA53 TransLAN card via IEEE802.3ah OAM.

The MRV Firber Driver Module helps to:

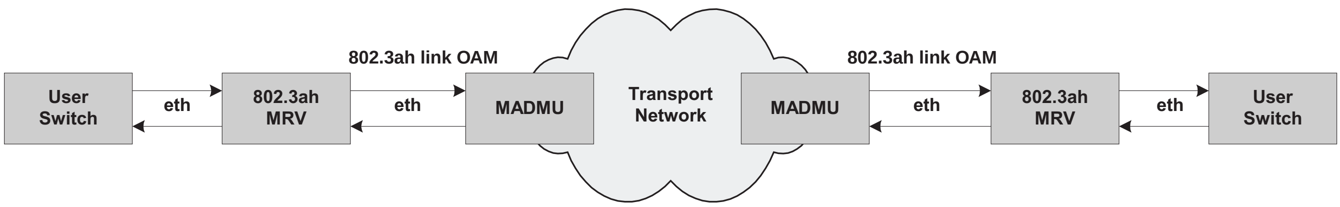
- Manage ethernet links,
- localize failures cumbersome on unmanaged links
  Failures can be seperated
  - Operator domain
  - Customer location
- Set a demarcation point that allows to expand the operator domain to the customer premise

The LKA53 together with MRV Firber Driver Module supports the following 802.3ah OAM functions:

- PM for OAM-enabled Ethernet links (based on the errored symbols). When interworking with MRV only near-end PM is available
- Remote loopback enabling/disabling
- MRV LPT interworking
  Extended Link Pass Through (LPT) function between MRV’s customer LAN ports.

Configuration example

The following figure gives a example for the interworking of *Metropolis*® ADM (Universal shelf) with the MRV Firber Driver Module.



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Static MAC Address Provisioning

Overview

The switches on the *Metropolis*® ADM (Universal shelf) data packs operate in self-learning mode, i.e. the source addresses (SA) of received frames are stored in a MAC address table and the destination addresses (DA) of received frames will be compared to those in the table to find the right egress port. Packets whose DA is not found in the table will be broadcasted to all relevant ports. The dynamic MAC address table entries age out after a while (300s) to make room for new entries.

The "Static MAC Address Provisioning" feature allows the user to make manual entries into the MAC address table. These entries will be called static entries and are not subject to address aging. In case of unicast addresses a single egress port can be provisioned. In case of multicast addresses (refer to "Multicast group" (p. 2-67)) a list of egress ports can be provisioned.

It is possible to retrieve and remove single dynamic and static MAC address table entries. This applies to LKA4, LKA12 and LKA53. Note that LKA4 also includes LKA412 and LKA12 also includes LKA12B.

Unlike the other data packs the LKA53 will not automatically share the address table evenly among all VLANs. So here we can have the situation that the whole table is used up by one VLAN although other VLANs exist. To avoid this the user will be able to limit the number of dynamically learned addresses per VLAN. This applies to LKA53 only.

□

Port provisioning

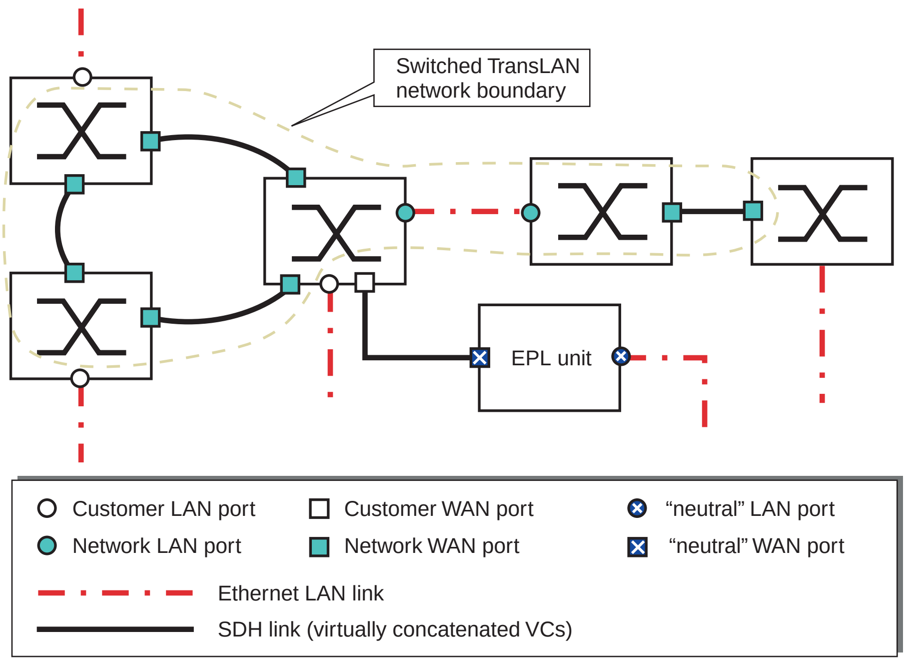
Customer-role and network-role ports

The user can assign a so-called "port role" to WAN ports as well as to LAN ports. In this way it is possible to forward VLAN tags , especially in double-tagging mode, also via LAN ports. Additionally it is possible to run the STP and GVRP protocols on physical LAN ports, too.

Each LAN port or WAN port can have one of the following port roles:

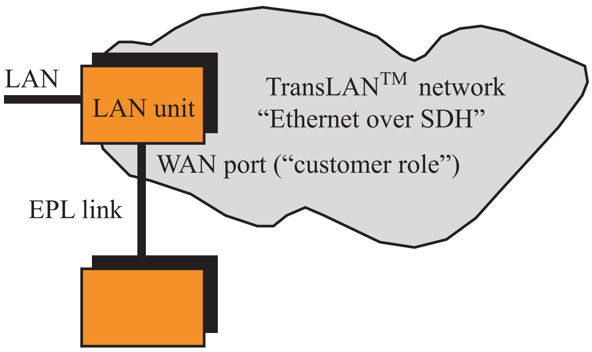
Customer role	Customer-role ports are usually located at the edge of the switched *TransLAN*™ network boundary, providing the Ethernet interface to the end-customer. Ethernet frames may be but need not necessarily to be tagged. In the majority of cases, LAN ports are customer-role ports. However, two LAN ports connected via an Ethernet LAN link would be an example of network-role LAN ports. Another example would be a trunking LAN port connected via an Ethernet LAN link to an ISP router (where VLAN tags are needed for further processing).
Network role	Network-role ports usually interconnect the nodes that make up the *TransLAN*™ network. Ethernet frames need to be tagged. In the majority of cases, WAN ports are network-role ports. However, a WAN port which is connected to an Ethernet private line unit (EPL unit), thus extending the switched *TransLAN*™ network boundary, would be an example of a customer-role WAN port.

The following figure serves to visualize the concept of customer-role and network-role ports.

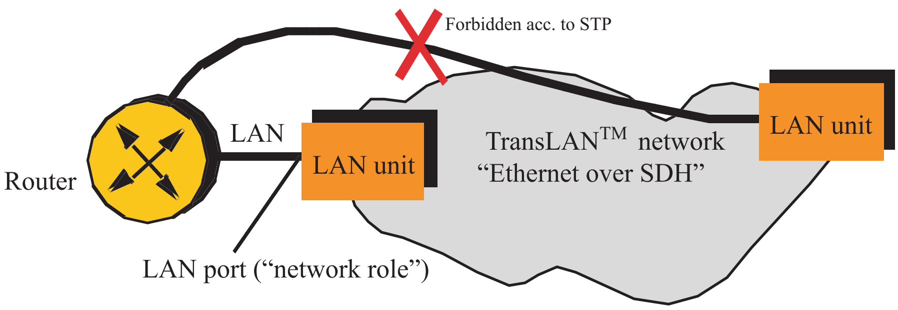


Flexible port role assignment

In most cases physical LAN ports have the customer role and physical WAN ports have the network role, but there may be exceptions in some applications. In the following figure the WAN port connects an EPL link and is therefore at the edge of the *TransLAN*™ network. Thus it has the customer role in this case.



In the example in the figure below the VLAN tags have to be forwarded to a router. The router uses the tagging information for its switch decisions. Additionally the LAN port must fulfil a network role. In this case it behaves like a node of the *TransLAN*™ network. It could also participate in the STP in order to avoid loops, if there was another link from a Router LAN interface to a second node within the *TransLAN*™ network.



A LAN port which operates in the "network role" behaves like a WAN port in terms of VLAN tagging, STP and GVRP.

The default settings are shown in the following table

	Physical ports	
Port role	**LAN port**	**WAN port**
Customer role	default	
Network role		default

In the IEEE 802.1Q STP virtual switch mode and in the provider bridge mode, the port role of each LAN and WAN port can be flexibly assigned. Each LAN or WAN port can be configured to be either a customer-role or network-role port.

These are the characteristics of customer-role and network-role ports:

Customer-role port	Network-role port
In the *IEEE 802.1Q STP virtual switch mode*: In the ingress direction, untagged Ethernet frames are tagged with a default identifier, the port VLAN identifier (PVID). The PVID is removed from each frame at each network egress port. See also: "IEEE 802.1Q VLAN tagging" (p. 2-59) In the *provider bridge mode*: A provider bridge tag carrying a customer identifier (CID) is inserted into each Ethernet frame in the ingress direction, and removed from the frame in the reverse direction. Frames that are already tagged become double tagged. See also: "IEEE 802.1ad VLAN tagging" (p. 2-59)	No tagging or untagging operations are performed.
The spanning tree protocol (STP) is *not* supported.	The spanning tree protocol (STP) can be enabled (default setting) or disabled.
GVRP is *not* supported. VLAN IDs or CIDs need to be configured manually.	GVRP can be enabled (default setting) or disabled. Dynamic VLAN IDs or CIDs of intermediate and access nodes are automatically configured if GVRP is enabled.
Ingress rate control exists at customer-role ports only (see "Quality of Service (QoS) overview" (p. 2-80)).	There is no rate control on network-role ports. The traffic class encoded in the p1 and p2 bits of the incoming frames is evaluated and transparently passed through.

Fix port-role assignment in the VPN tagging modes

In all the operational modes relying on the VPN tagging mode (see "Transparent tagging" (p. 2-58)) the port role is fixed:

- LAN ports are *always* customer role ports.
- WAN ports are *always* network role ports.

This port-role assignment in the VPN tagging modes cannot be changed. Corresponding provisioning options that might be available on the graphical user interfaces of the management systems do not apply to the VPN tagging modes and are blocked.

Repeater mode

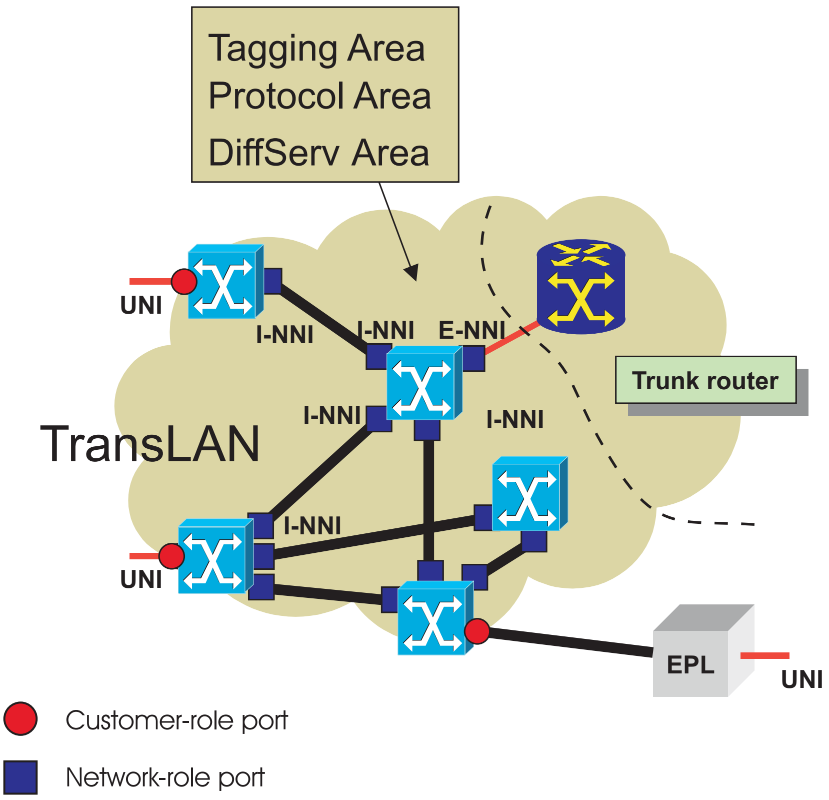
In the repeater mode, there is no necessity to distinguish between customer-role and network-role ports, because the repeater mode can only be used in point-to-point configurations, and there is:

- no tagging mechanism,
- no spanning tree, and
- no GVRP or STVRP.

In the repeater mode, there is simply a LAN port and a WAN port. The LAN port provides the connection to the end-customer LAN, and the WAN port provides the connection to the SDH transport network (see "Repeater mode" (p. 2-49)).

Example

As an example, the following figure shows a possible network application:



Legend:

UNI port	User-Network-Interface (always a customer-role port)

I-NNI port	Internal Network-Network Interface (always a network-role port)
E-NNI port	External Network-Network Interface (here a trunking network-role port)

Quality of Service (QoS) overview

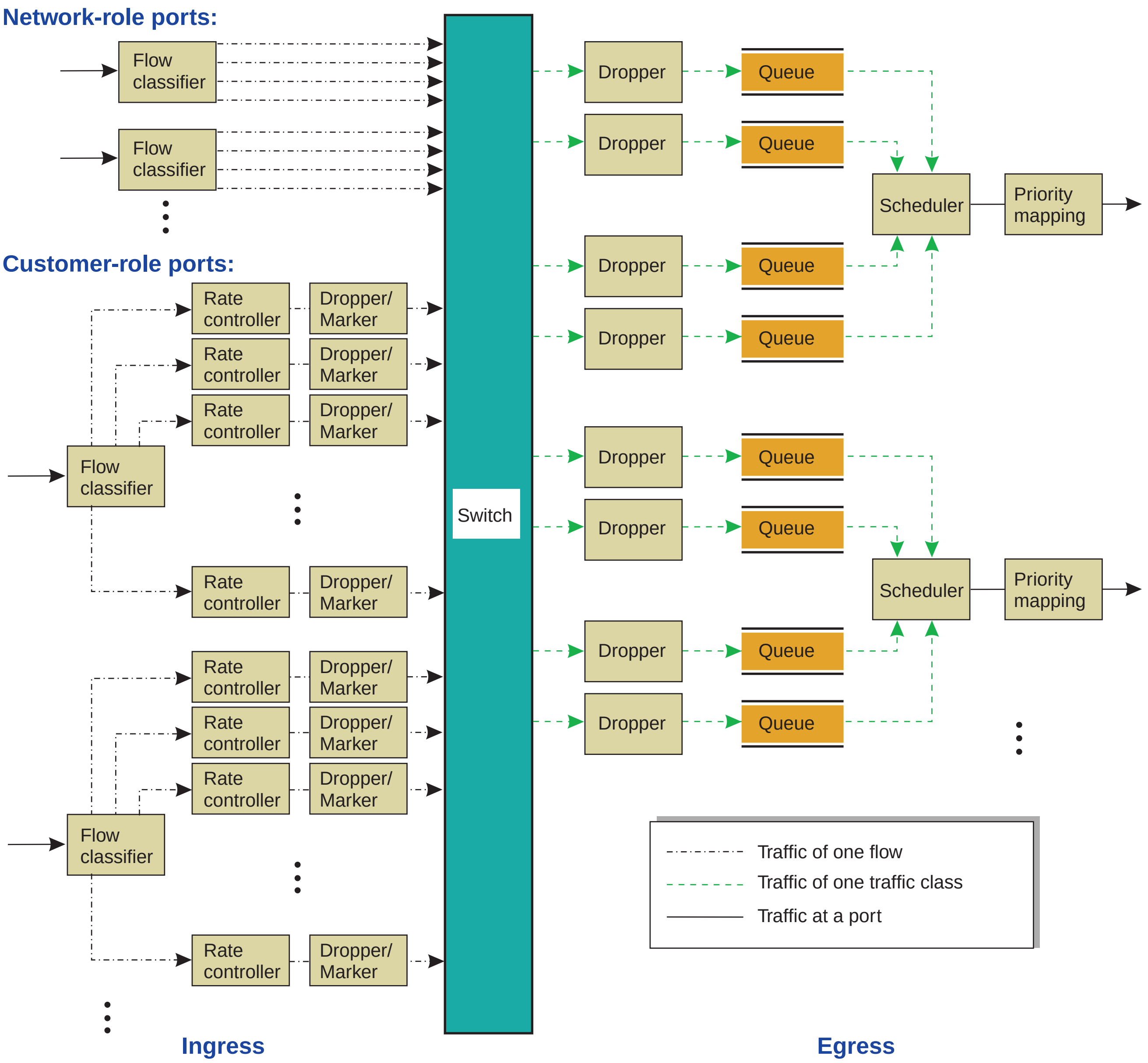
Introduction

Quality of service (QoS) control allows to differentiate between Ethernet frames with different priorities. If traffic with a high priority and traffic with a low priority compete for SDH capacity, the traffic with the high priority should be served first. This can be realized through quality of service control.

QoS control is supported on the E/FE and Gigabit Ethernet cards, in the IEEE 802.1Q VLAN tagging mode and the IEEE 802.1ad VLAN tagging mode (provider bridge mode). QoS control is implemented as a DiffServ architecture applied to layer 2 (in accordance with IETF recommendations on Differentiated Services, cf. www.ietf.org).

Flow classification, queueing and scheduling

The following figure provides an overview of the QoS control:



Quality of Service configuration options

The following table gives on overview of the QoS provisioning options depending on the configured mode of operation.

Mode of operation	Ethertype (hex. value)	QoS CQS	QoS_osub	Ingress rate control	HoL blocking prevention
Repeater mode	–	[disabled]	[disabled]	[none]	[disabled]

Mode of operation		Ethertype (hex. value)	QoS CQS	QoS_osub	Ingress rate control	HoL blocking prevention
VPN mode	LAN interconnect	[0xFFFF]	[disabled]	[disabled]	[none]	[disabled]
	LAN-VPN	[0xFFFF]	[disabled]	[enabled]	strict policing	[enabled]
					oversubscription	
	LAN-VPN with QoS	This mode of operation was supported in previous releases. However, it is no longer supported in the *Metropolis*® ADM (Universal shelf) release 4.0.				
IEEE mode	STP virtual switch mode compliant with *IEEE 802.1Q*	0x8100	[enabled]	disabled	strict policing	[enabled]
				enabled	strict policing, oversubscription	
	STP virtual switch mode compliant with *IEEE 802.1ad* (Provider bridge mode)	0x0601 … 0xFFFF (≠ 0x8100)	[enabled]	enabled	strict policing, oversubscription	[enabled]

Notes:

1. QoS CQS: Quality of Service - Classification, Queueing and Scheduling
2. “QoS_osub” represents a configuration parameter which determines if the encoding and evaluation of the dropping precedence is supported (supported if QoS_osub is enabled).
3. Entries in square brackets indicate an implicite selection. If in the “QoS CQS” column for example the entry is “[disabled]”, then the preceding selection of tagging and operation mode implies that Quality of Service - Classification, Queueing and Scheduling (QoS CQS) is not available. It is implicitly disabled, and cannot be enabled.
4. The Ethertype can be set per virtual switch. However, as all virtual switches of a *TransLAN*™ card are switched in common, it is effectively set per *TransLAN*™ card.
5. The distinction between the STP virtual switch mode compliant with IEEE 802.1Q and the STP virtual switch mode compliant with IEEE 802.1ad (provider bridge mode) can be realized by provisioning the Ethertype. In the STP virtual switch mode compliant with IEEE 802.1Q, the Ethertype is fix preset to 0x8100. In the provider bridge mode, the Ethertype can be provisioned in the range 0x0600 … 0xFFFF, but unequal to 0x8100.
6. If “HoL blocking prevention” is enabled then frames that are destined for an uncongested port will not be discarded as a result of head-of-line blocking.

Ingress rate control provisioning method

If Quality of Service - Classification, Queueing and Scheduling (QoS CQS) is enabled, then ingress rate control can be provisioned per flow by using QoS profiles (see “Quality of Service provisioning” (p. 2-93)). Otherwise, ingress rate control can only be provisioned per port.

Service level agreements

On the *Metropolis*® ADM (Universal shelf) the responsibility for admission control is left to the operator. This means there is no check that the Service Level Agreements on already existing connections can be fulfilled, when a new user starts sending data from node A to B.

In this respect the notion of over-subscription factor is important. This is the factor by which the calculated bandwidth, based on e.g. the traffic matrices of the operators sharing a link, exceeds the physically available bandwidth. Although theoretically the bandwidth can only be guaranteed for an over-subscription factor ≤ 1, in practice an over-subscription factor of 5-10 can be used without giving problems. Due to the effects of statistical multiplexing it is safe to “sell the bandwidth more than once”. The burstiness of the traffic from individual customers that share a common link makes this possible. The Service Level Agreements give a quantification for the “statistics” of the multiplexing.

Provisioning LAN and WAN ports details

The provisioning of the classifier and rate controller per flow is done only on the ingress customer-role port (LAN port). On the network ports (WAN port), only the scheduler for the egress queues is provisionable.

It is important that some of the QoS settings are provisioned consistently on all ports throughout the whole customer’s VPN domain. In the LAN-VPN (M-LAN) operation mode, the rate controller mode (none, strict policing, oversubscription) must be provisioned consistently (per virtual switch). The latter applies to the only. For the scheduler, for each egress queue the mode = strict_priority/weighted_bandwidth and corresponding weights (per virtual switch) must be provisioned consistently. This is ensured by a background aging function of the system. The parameter will be enforced to be set equally.

□

Classification, queueing and scheduling

Flow classification

The flow classifier determines into which flow each incoming packet is mapped. On customer-role ingress ports, a number of flows can be defined, based on port, user priority, VLAN ID, IP-ToS field and Destination MAC ADdress. For each flow a rate controller can be specified (CIR/PIR value).

Apart from these flows based on input criteria, a default flow is defined for packets that do not fulfil any of the specified criteria for the flows, e.g. untagged packets that have no user priority field. Thus, untagged traffic is classified per port. All traffic on a certain port is treated equally and attached a configurable default port user priority value to map the traffic on the appropriate queues.

A default user priority can be specified on port level to be added to each packet in the default flow (see “Default user priority” (p. 2-88)). Furthermore, the rate controller behaviour for the default flow can be specified. The same fixed mapping table from user priority to traffic class to egress queue is applied to packets in the default flow as to packets in the specified flows.

Provided that Quality of Service - Classification, Queueing and Scheduling (QoS CQS, cf. “Quality of Service configuration options” (p. 2-81)) is enabled, each flow can be assigned a traffic class by using QoS profiles (see “Quality of Service provisioning” (p. 2-93)).

Each traffic class is associated with a certain egress queue (see “Traffic class to queue assignment” (p. 2-90)).

Ingress direction for network-role ports

For network-role ports, two cases need to be differentiated:

- On *I-NNI ports*, explicit provisioning of the flow identification (flow configuration) is not provisionable. I-NNI ports always have the default QoS profile assigned. On an I-NNI port, the only purpose of the flow classifier is to evaluate the traffic class. The traffic class determines the egress queue.
- *E-NNI trunk ports* may be split in so-called virtual ports which can be provisioned by means of virtual port descriptors (VPDs). Explicit provisioning of the flow identification (flow configuration) enables the DiffServEdge function for this fraction of the network-role port. Ingress rate control of these virtual ports is the same as for customer-role ports.

Ingress rate control

A rate controller is a means to limit the users access to the network, in case the available bandwidth is too small to handle all offered ingress packets.

Rate control is supported for every ingress flow on every DiffServEdge port. There is one rate controller per flow.

The actual ingressing data rate is permanently measured and compaired against two provisionable data rates, the committed information rate (CIR), and the peak information rate (PIR).

On the LKA4 E/FE *TransLAN*® and the LKA12(B) GbE *TransLAN*® units, a single rate two color marker acc. to IETF RFC2697 is supported.

On the LKA53 GbE *TransLAN*® unit, a two-rate three-color marker acc. to IETF RFC2698 is supported.

Please note that the Token Bucket rate controller as proposed by the standards may lead to the effect that longer frames will more likely be dropped. Consider a signal containing two flows, consisting of frames with fixed frame lengths, that are interleaved with a frequency ratio invers to their frame lengths. If this signal is fed to a rate controller, then one frame length will more likely to be dropped than the other. This is not a wrong behavior. However, please note that the effect is a typical testing issue. In reality this will not happen, because usually many different frame lengths are received.

The colors are used to specify the dropping precedence. The two rates are used as delimiter between the colors.

The three colors indicate:

- *Green:* Low dropping precedence.
- *Yellow:* Higher dropping precedence.
- *Red:* The packet will be dropped.

The two rates mean:

Committed Information Rate (CIR)	If the ingressing data rate is less than the committed information rate, all frames will be admitted to the egress queues. These frames will be marked “green”, and have a low probability to be dropped at the egress queues. The committed information rate is the delimiter between green and yellow packets.
Peak Information Rate (PIR)	The peak information rate is the delimiter between yellow and red packets. If the ingressing data rate is greater than the committed information rate (CIR), but less than the peak information rate (PIR), the frames will be admitted to the egress queues. They will be marked “yellow” and have an increased probability to be dropped. If the information rate is greater than the PIR, the frames will be marked “red” and dropped immediately.

Committed Burst Size (CBS)	For any QoS profile, except the default profiles, you can assign a Committed Burst Size (CBS). The CBS can either be directly provisioned or derived from the CIR. The CBS is the maximum number of bytes allowed for incoming packets to burst above the CIR, but still be marked green. When the CBS has been exceeded, packets above the CIR are marked yellow. The Peak Burst Size (PBS) must be greater than or equal to the Committed Burst Size (CBS).
eak Burst Size (PBS)	For any QoS profile, except the default profiles, you can assign a Peak Burst Size (PBS). The PBS can either be directly provisioned or derived from the PIR. The PBS is the maximum number of bytes allowed for incoming packets to burst above the PIR and still be marked yellow (or green). When the burst size has been exceeded, packets above the PIR are marked red (dropped). *The Peak Burst Size (PBS) must be greater than or equal to the Committed Burst Size (CBS).*

In general, the behavior of the rate controller is characterized as follows:

- All packets below CIR are marked green.
- All packets above CIR are marked yellow.
- All packets above PIR are marked red and dropped.

A precondition for marking to take place is that the oversubscription mode is enabled. Marking of frames affects the p0 bit of the VLAN Priority Tag (VPT). If a frame is marked green the p0 bit is set to 1. If a frame is marked yellow the p0 bit is set to 0.

All *TransLAN®* rate controllers are *color-unaware* rate controllers. Possible color information that is already available in an incoming frame is *not* taken into consideration.

Important! Provisioning of rate controllers does not apply to DiffServInt ports. Rate controllers are only present on DiffServEdge ports in the ingress direction.

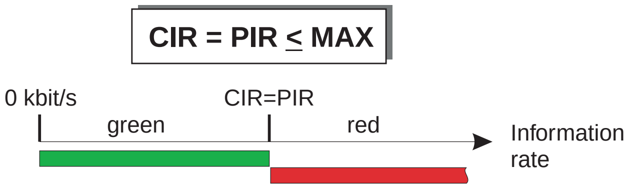
Rate control modes

The rate controller can operate in two different modes:

1. Strict policing mode (CIR = PIR)

The strict policing mode allows each user to subscribe to a minimum committed SDH WAN bandwidth, or CIR (committed information rate). This mode will guarantee the bandwidth up to CIR but will drop any additional incoming frames at the ingress LAN port that would exceed the CIR.

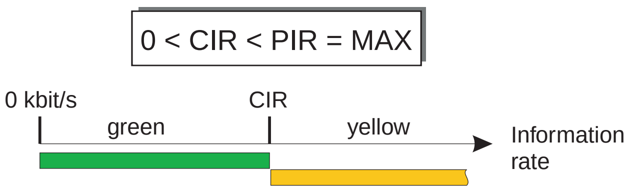
All packets below CIR are marked green; all packets above PIR (= CIR) are marked red and dropped.

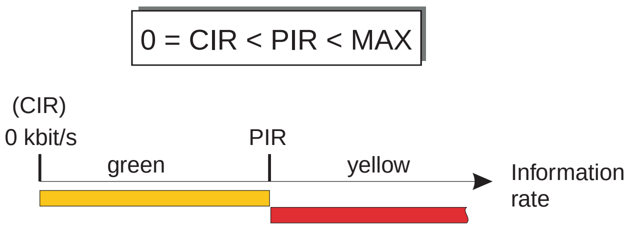


2. Oversubscription mode (CIR < PIR)

The oversubscription mode allows users to burst their data flow to a maximum available WAN bandwidth at a given instance. When PIR is set equal to the maximum of the physical network port bandwidth, then a user is allowed to send more data than the specified CIR. The additional data flow above CIR has a higher dropping probability.

The following two cases can be differentiated in oversubscription mode.





Provisioning the rate control mode

The desired rate control mode can be chosen by enabling/disabling oversubscription support (QoS_osub = enabled/disabled), and by setting the CIR and PIR values. CIR and PIR values can be set by means of QoS profiles (see "Quality of Service provisioning" (p. 2-93)).

The setting of the QoS_osub configuration parameter in combination with the relationship between CIR and PIR determines which rate control mode becomes effective. If, for example, oversubscription support is enabled, and the relationship between CIR and PIR is CIR = PIR ≤ MAX, then the rate controller is operated in strict policing mode.

Important!

1. Which of the rate control modes can actually be configured depends on the mode of operation (see "Quality of Service configuration options" (p. 2-81)).
2. As a general rule it is recommended to use the oversubscription mode for TCP/IP applications, especially in case of meshed or ring network topologies where multiple end-users share the available bandwidth.

Dropper / Marker

Based on the indication of the rate controller, and the rate control mode for the flow, the dropper/marker will do the following:

	No rate control	Oversubscription mode	Strict policing mode
Incoming rate < CIR	mark "green"	mark "green"	mark "green"
Incoming rate > CIR	mark "green"	mark "yellow"	drop

In the dropper function a decision is made whether to drop or forward a packet. On a *TransLAN*™ card a deterministic dropping from tail when the queue is full is implemented.

The LKA53 supports Random Early Drop (RED), instead of tail drop. The LKA53 RED parameters are internally fixed, not provisionable.

Packets that are marked red are always dropped. If WAN Ethernet link congestion occurs, frames are dropped. Yellow packets are always dropped before any of the green packets are dropped. This is the only dependency on queue occupation and packet color that is currently present in the dropper function. No provisioning is needed.

Default user priority

A default user priority can be configured for each customer-role port. Possible values are 0 (lowest priority) … 7 (highest priority) in steps of 1. The default setting is 0.

Provisioning of the default user priority does *not* apply to network-role ports.

The default user priority is treated differently depending on the tagging mode:

- LAN-VPN (M-LAN) mode
  Incoming frames without a user priority encoding (untagged frames) are treated as if they had the default user priority.
- IEEE 802.1Q VLAN tagging mode and provider bridge mode
  Incoming frames without a user priority encoding (untagged frames) get a default user priority assigned. This C-UP may be furtheron equal to a user priority given by one of the provisioned flow descriptors. The subsequent traffic class assignment for this flow, however, will overwrite this C-UP bits again.

Traffic classes

At each ingress port, the traffic class (TC) for each frame is determined. At customer-role ports, this is done via the flow identification and the related provisioned traffic class. At network-role ports, the traffic class is directly derived from the p-bits of the outermost VLAN tag.

Depending on the operation mode, these traffic classes exist:

Provider bridge mode and IEEE 802.1Q VLAN tagging mode *with* encoding of the dropping precedence	The traffic class is encoded in the user priority bits using p2 and p1. Thus, 4 traffic classes are defined: 0, 1, 2, 3.
IEEE 802.1Q VLAN tagging mode *without* encoding of the dropping precedence	The traffic class is encoded in the user priority bits using p2, p1, and p0. Thus, 8 traffic classes are defined: 0, 0-, 1, 1-, 2, 2-, 3, 3-. The “n” traffic classes differ from the “n-” traffic classes in the value of the p0 bit.

Notes:

1. The support of dropping precedence encoding and evaluation can be enabled or disabled per virtual switch by means of the QoS_osub configuration parameter (QoS_osub = enabled/disabled). All virtual switches belonging to the same *TransLAN*™ network must be provisioned equally for their TPID and this QoS_osub configuration parameter.

These tables show the traffic class encoding in the user priority bits:

Traffic class	p2	p1
0	0	0
1	0	1
2	1	0
3	1	1

Traffic class	p2	p1	p0
0	0	0	1
1	0	1	1
2	1	0	1
3	1	1	1
0-	0	0	0
1-	0	1	0
2-	1	0	0
3-	1	1	0

For the IEEE 802.1Q VLAN tagging mode with oversubscription support (QoS_osub = enabled) it is recommended not to use the n- classes, otherwise all frames will always be marked yellow (i.e. they will have a higher dropping precedence; p0 = 0). In the provider bridge mode, any assignment of an n- class will be recognized as the related n class (tolerant system behavior for inconsistent provisioning).

Traffic class to queue assignment

The assignment of the traffic classes to the egress queues is as follows:

Transparent tagging		**IEEE 802.1Q VLAN tagging and IEEE 802.1ad VLAN tagging (provider bridge mode)**	
Traffic class	**Queue**	**Traffic class**	**Queue**
3, and Internal use	4	Internal use	3
2	3	3 (and 3 -)	4
1	2	2 (and 2-)	2
0	1	1 (and 1-) and 0 (and 0-)	1

Notes:

1. “Internal use” means that the queue is used for network management traffic (spanning tree BPDU’s or GVRP PDU’s, for example).

Queueing

The egress treatment is the same for customer-role and network-role ports.

Every port has four associated egress queues. The queues 1 and 2 are to be used for delay-insensitive traffic (for instance file transfer); the queues 3 and 4 are to be used for delay-sensitive traffic (for instance voice or video).

Please refer to “Traffic class to queue assignment” (p. 2-90) for the assignment of the traffic classes to the egress queues.

Repeater mode

In the repeater mode, there is no queueing process as described above. All frames go through the same queue.

Scheduler

The preceding functional blocks assure that all packets are mapped into one of the egress queues, and that no further packets need to be dropped.

The scheduler determines the order, in which packets from the four queues are forwarded. The scheduler on each of the four queues can be in one of two operational modes, strict priority or weighted bandwidth. Any combination of queues in either of the two modes is allowed. When exactly one queue is in weighted bandwidth mode, it is interpreted as a strict priority queue with the lowest priority.

Provided that Quality of Service - Classification, Queueing and Scheduling (QoS CQS, cf. "Quality of Service configuration options" (p. 2-81)) is enabled, the queue scheduling method can be configured as follows:

Queue scheduling method	
Strict priority	The packets in strict priority queues are forwarded strictly according to the queue ranking. The queue with the highest ranking will be served first. A queue with a certain ranking will only be served when the queues with a higher ranking are empty. The strict priority queues are always served before the weighted bandwidth queues.
Weighted bandwidth	The weights of the weighted bandwidth queues will be summed up; each queue gets a portion relative to its weight divided by this summed weight, the so-called normalized weight. The packets in the weighted bandwidth queues are handled in a Round-Robin order according to their normalized weight.

Each of the two modes has his well-known advantages and drawbacks. Strict priority queues will always be served before weighted bandwidth queues. So with strict priority, starvation of the lower priority queues cannot be excluded. Starvation should be avoided by assuring that upstream policing is configured such that the queue is only allowed to occupy some fraction of the output link's capacity. This can be done by setting the strict policing rate control mode for the flows that map into this queue, and specifying an appropriate value for the CIR. The strict priority scheme can be used for low-latency traffic such as Voice over IP and protocol data such as spanning tree BPDU's or GVRP PDU's.

Weighted bandwidth queues are useful to assign a guaranteed bandwidth to each of the queues. The bandwidth can of course only be guaranteed if concurrent strict priority queues are appropriately rate-limited.

Usually the queue with the lowest number also has the lowest ranking order, but the ranking order of the strict priority queues can be redefined.

> **Important!** It is recommended *not* to change the mode and ranking of the queue which is used by protocol packets like spanning tree BPDU's and GVRP PDU's (queue 3 or queue 4, respectively; cf. "Traffic class to queue assignment" (p. 2-90)).

Weight

A weight can be assigned to each port's egress queue in order to define the ranking of the queue.

The weight of a strict priority queue has a significance compared to the weight of other strict priority queues only.

The weight of a weighted bandwidth queue has a significance compared to the weight of other weighted bandwidth queues only.

The weights of the weighted bandwidth queues are normalized to 100%, whereas the normalized weights of the strict priority queues indicate just ordering.

Example

The following table shows an example of a scheduler table:

Queue	Queue scheduling method	Weight	Normalized weight
1	Weighted bandwidth	5	50%
2	Strict priority	9	1
3	Weighted bandwidth	5	50%
4	Strict priority	15	2

The strict priority queues are served before the weighted bandwidth queues. The strict priority queue with the highest weight is served first, queue 4 in this example.

In this example, after serving the strict priority queues 4 and 2, the remaining bandwidth is evenly divided over queues 1 and 3.

Depending on the mode of operation, queue 3 or queue 4 is used for network management traffic, for instance for the spanning tree protocol (see "Traffic class to queue assignment" (p. 2-90)). Hindering this traffic can influence Ethernet network stability.

Default settings

These are the default settings of the queue scheduling method and weight:

Queue	Queue scheduling method	Weight
1	Strict priority	1
2	Strict priority	2
3	Strict priority	3
4	Strict priority	4

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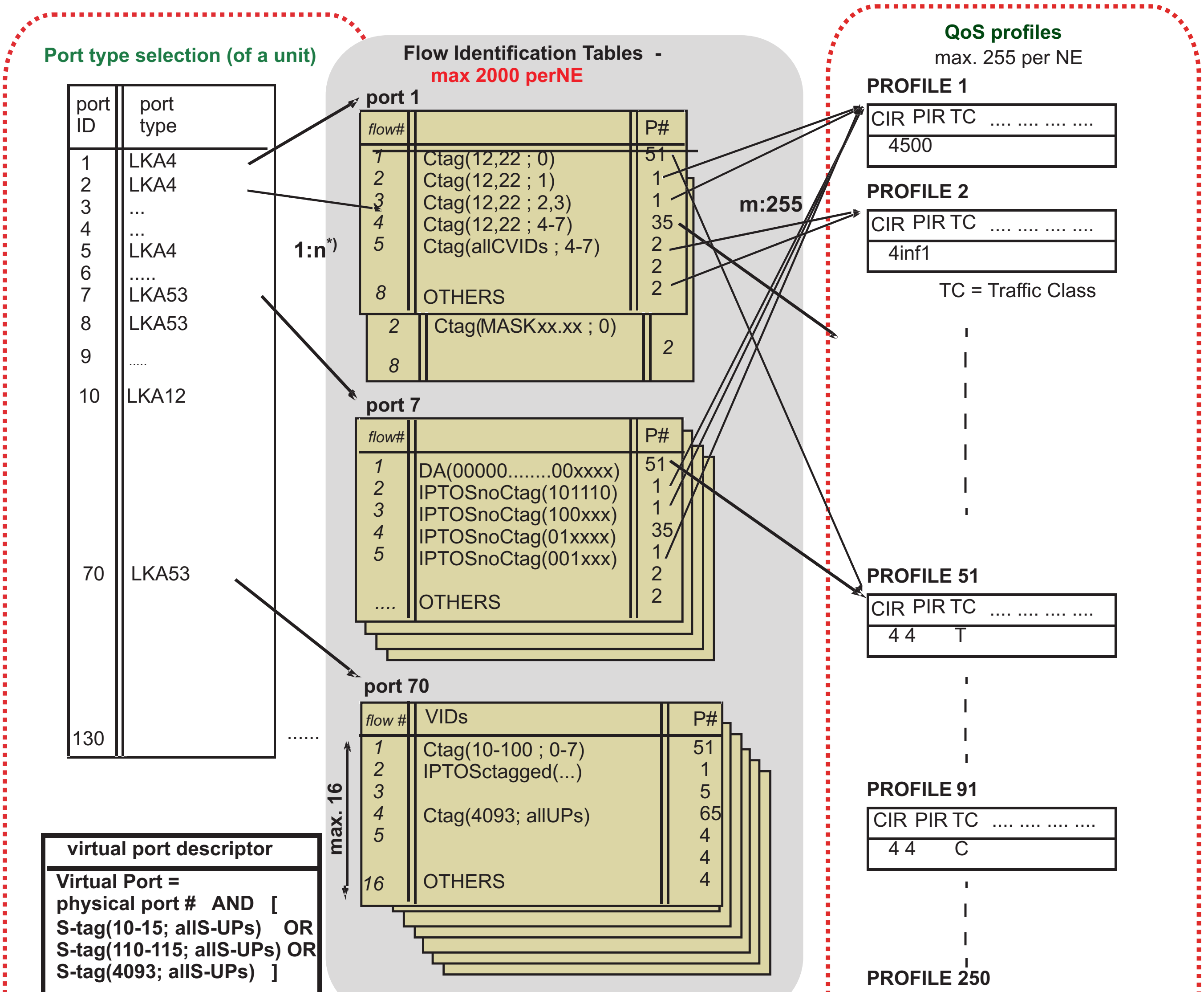
Quality of Service provisioning

QoS provisioning concept

A 3-stage provisioning concept is used for QoS provisioning. This concept can easily be adapted to different provisioning needs in different network applications.



virtual port descriptor
Virtual Port = physical port # AND [S-tag(10-15; allS-UPs) OR S-tag(110-115; allS-UPs) OR S-tag(4093; allS-UPs)]

*) 4 of the physical ports per unit (2 at LKA4) may - if they run in NR - split up into virtual ports.
The '**virtual port descriptor**' defines criterias based on the S-VID.

P# = ID of assigned QoS profile

The basic QoS provisioning concept consists of the following stages:

1. For each *port* one or more customized flow identification tables (FIT) can be assigned.
   An FIT can be assigned either to an entire physical port, or to a fraction of a physical port, i.e. to a so-called "*virtual port*". Only E-NNI trunk ports can be split into virtual ports each having an FIT assigned. A virtual port can be defined by means of a virtual port descriptor (VPD).
   In case more than one FIT is assigned, each FIT is related to usually one virtual port. Each FIT may also be related to several virtual ports, provided they are identified by the same virtual port descriptor (VPD).
2. The *flow identification tables* contain the identification criterias for the flows (for example the values of the C-VID and/or C-UP). Furthermore, the flow identification tables contain a reference identifying the assigned QoS profile.
   Up to 2000 flow identification tables are supported per network element.
3. The *QoS profiles* contain the provisioning parameters (CIR, PIR, traffic class).

Using this method of QoS provisioning via QoS profiles can be enabled or disabled on a per-NE basis.

On a per-port basis you can decide to only use default QoS profiles, or to define your own QoS profiles in order to accomplish flow configuration.

Provisioning defaults

The parameter settings in the default QoS profiles for customer-role and network-role ports are:

Port role	CIR	PIR	TC
Customer-role	MAX	MAX	0
Network-role	MAX	MAX	T

The traffic class "T" is the so-called "transparent traffic class". The p-bits of the outermost tag (S-UP of the S-tag, or UP of the VLAN tag) remain unchanged, i.e. keep their value which has been assigned by a data unit anywhere upstream.

Explicit provisioning of the flow identification at network-role ports is only intended in the case of so called external network-network interfaces (E-NNIs) connecting to the network of other operators, or to trunking routers, respectively.

□

Performance monitoring

Performance counters

On the VC-12, VC-3 or VC-4 termination points connected to a WAN port, standard SDH performance monitoring can be activated. The same counters that apply for VC-12, VC-3 or VC-4 termination points on any other port also apply to the VC-12, VC-3 or VC-4 termination points on a WAN port.

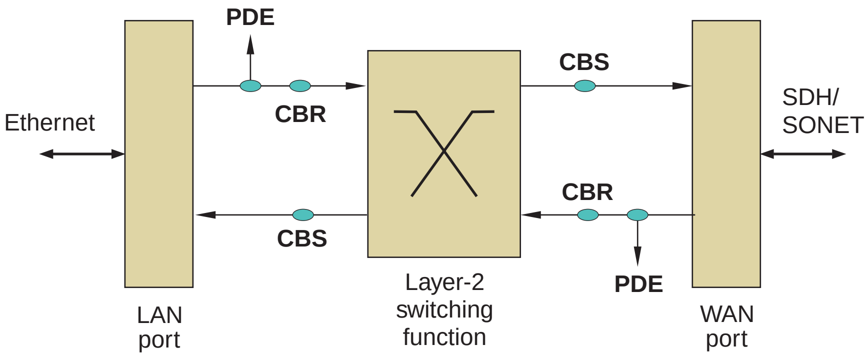
Apart from this standard SDH performance monitoring, a limited amount of counters that are dedicated to LAN/WAN ports are defined. Activation of these counters can be established by setting:

- the LAN/WAN port mode to monitored
- selecting a LAN port or WAN port as active PM point
- setting the PM point type to LAN or WAN.

The supported counters are:

- *CbS (total number of bytes sent)*
- *CbR (total number of bytes received)*
- *pDe (total number of errored packets dropped)*

Note that CbS and CbR are rather traffic monitoring counters than performance monitoring counters, as they give insight in the traffic load in all places in the network. pDe is a real performance monitoring counter as it gives an indication about the performance of the network. Only unidirectional PM is supported for these parameters. See the following figure for the location of the measurements. Note that because of the difference in units, bytes versus packets, the counters cannot be correlated with each other. Also the counter for dropped packets considers only packets dropped due to errors, and does not include packets dropped due to congestion.



Performance counters for aggregated ports

The performance counters related to a link aggregation group (LAG) reflect the counts of the signals transmitted/received over all the aggregated ports of the LAG.

Ethernet performance monitoring counters

The Ethernet performance monitoring counters can be categorized according to the different purposes they are serving.

The following types of counters can be distinguished:

- Counters for basic Ethernet performance monitoring
- Service monitoring:
  - Counters for Ethernet service flow performance monitoring
- Traffic management:
  - High quality traffic counters for Ethernet network load performance monitoring
  - Low quality traffic counters for Ethernet network load performance monitoring
  - Counters for Ethernet congestion monitoring
- Counters for IEEE 802.3ah OAM performance monitoring
- Counters for Ethernet service route round trip delay measurements

Ethernet PM counters per *TransLAN*® card

Ethernet performance monitoring counter	*TransLAN*® card			
	LKA4	LKA412	LKA12	LKA53
Basic Ethernet performance monitoring counters	✔	✔	✔	✔
Ethernet service flow performance monitoring counters	✔	✔	–	✔
Ethernet high quality traffic counters	✔	✔	–	✔
Ethernet low quality traffic counters	✔	✔	–	✔
Ethernet congestion monitoring counters	–	–	–	✔
IEEE 802.3ah OAM performance monitoring counters	–	–	–	✔
Ethernet service route round trip delay measurements	✔	✔	–	✔

Binning and reporting

The following bins exist for Ethernet performance monitoring parameters:

- 1 current 15-minutes bin
- 16 history 15-minutes bins
- 1 current 24-hours bin
- 1 history 24-hours bin

□

Equipment features

Overview

Purpose

This section provides information about *Metropolis*® ADM (Universal shelf) features concerning hardware protection, inventory and failure reports.

Contents

Equipment protection

The following equipment protection is available:

- 1:N (N ≤ 4); in addition 4 x E1 units can be deployed unprotected
- 1+1 E3/DS3
- 1+1 STM-1e
- 1+1 DS1
- 1+1 on Cross-connect/Timing (core units)
- 1:N (N ≤ 4); in addition 4 x DS1 units can be deployed unprotected
- Power (50% + 50%)

Equipment protection configurations

Tributary Slots TSn (n=1..8) can be used with “electrical” port units in combination with Paddle Boards. Core 1 and Core 2 slots are used for protection of Cross-Connect/Timing equipment (Core units). A number of equipment protection schemes can be applied to these units, as depicted in the figure below. The boxes with dark outlines indicate the possible positions of Worker (W) and Protection (P) units. The 1+1 protection schemes for tributaries are always in adjacent odd/even slot positions. The 1:N protection scheme provides more flexibility in positioning the worker units. The slot position of the protection unit however, is fixed. Free mixing of protection schemes is possible, as illustrated in the example configuration at the bottom of the figure.

	TS1	TS2	SC	CORE1	TS3	TS4	TS5	TS6	TS9	CORE2	TS7	TS8
SI-1e/4 1+1 Prot	U[a]	U			U	U	U	U			U	U
	W	P			W	P	W	P			W	P
PI-E3DS3/12 1+1 Prot	U	U			U	U	U	U			U	U
	W	P			W	P	W	P			W	P
PI-E1/63 1:N Prot N<= 4	U	U			U	U	U	U			U	U
							W	W	P		W	W
PI-DS1/63 1:N Prot N<= 4	U	U			U	U	U	U			U	U
							W	W	P		W	W
CC/Timing				W						P		
Example	W	P		W	W	P	W	W	P	P	W	P

1:N (N $\leq$ 4) E1 or 1:N (N $\leq$ 4) DS1

To one set of up to four worker E1 tributary units (or DS1 tributary units) one protection unit can be added. If one of the worker units fails, automatically this protection unit takes over. The E1/DS1 equipment protection is possible by assigning an E1/DS1 tributary unit to a slot position designated for this purpose.

Up to 4 worker units can then be added to or deleted from the E1/DS1 protection group. Worker units in the protection group must be in one of the four slots designated for this purpose. E1 or DS1 units that are not included in the protection group operate unprotected. The protection switching is revertive.

Manual and forced switch commands, as well as temporary lockout of protection are supported. A protection switch interrupts the traffic of the protected pack. A working unit, with its traffic switched to the protection unit, can be pulled or replaced without causing bit errors in the traffic, but as soon as a functioning unit is present again, the (revertive) protection algorithm will perform another switch, which does again interrupt the traffic.

The traffic interruption time is less than 50 ms with manual switch commands and less than 50 ms plus the detection time for automatic protection switches triggered by a failure. Note that the system provides a second set of four E1 tributary units that can not be made part of the 1:N protection group.

1+1 E3/DS3

For each working tributary plug-in unit for E3/DS3 interfaces, one protection unit can be added. If the working unit fails, automatically the protection circuit pack takes over. The switching operation is non-revertive. Clear, manual and forced switch commands are supported.

Unprotected operation is possible, whereby the slot space for the protection unit can be used to add an extra unprotected unit. If the 1+1 E3/DS3 unit equipment protection scheme is chosen, the working and protection units need to be in adjacent slots (4 designated odd/even slot pairs). A protection switch interrupts the traffic. The unit that is not active can be pulled or replaced without causing bit errors in the traffic.

The traffic interruption time is less than 50 ms with manual switch commands and less than 50 ms plus the detection time for automatic protection switches triggered by a failure.

1+1 STM1e

For each working tributary plug-in unit for STM-1e interfaces, one protection unit can be added. If the working unit fails, automatically the protection circuit pack takes over. The switching operation is non-revertive. Clear, manual and forced switch commands are supported.

Unprotected operation is possible, whereby the slot space for the protection unit can be used to add an extra unprotected unit. If the 1+1 STM-1e unit equipment protection scheme is chosen, the working and protection units need to be in adjacent slots (4 designated odd/even slot pairs). A protection switch interrupts the traffic. The unit that is not active can be pulled or replaced without causing bit errors in the traffic.

The traffic interruption time is less than 50 ms with manual switch commands and less than 50 ms plus the detection time for automatic protection switches triggered by a failure.

1+1 cross-connect/timing unit

The timing, cross-connect and line-port unit can be duplicated. If two units are present an automatic protection switch relation between the two is set up. The switching is non-revertive. Manual operation of protection is supported. Unprotected operation is possible.

The traffic interruption time is less than 50 ms with manual switch commands and less than 50 ms plus the detection time for automatic protection switches triggered by a failure. The unit that is not active can be pulled or replaced without causing bit errors in the traffic.

□

Optical interface modules

Metropolis® ADM (Universal shelf) supports optical port units consisting of a parent board which can be equipped with field-replaceable optical interface modules, also called Small Form Factor Pluggable modules (SFPs).

An optical interface module is a replaceable unit with a receiver and transmitter function providing the optical port. *Metropolis*® ADM (Universal shelf) optical interface modules are "hot pluggable" (field-replaceable), i.e. the interface modules can be inserted or removed while the parent board is in operation, without affecting the service of other interface modules on the same parent board.

Advantages of the optical interface modules

The *Metropolis*® ADM (Universal shelf) optical interface modules provide excellent pay-as-you-grow opportunities for smaller or start-up applications, as only the up-to-date required number of ports must be purchased. An additional advantage of this flexible interface are ease of handling and cost reduction when it comes to maintenance and repair activities.

The number of modules inserted into the parent board can be varied flexibly between zero and the maximum number of sockets; the possibly unused sockets can be left empty.

Small Form Factor Pluggable module (SFPs)

The *Metropolis*® ADM (Universal shelf) SFPs are marked by the manufacturer, and they are checked upon insertion, in order to protect from accidental insertion of non *Metropolis*® ADM (Universal shelf) specific SFPs. Only for the *Metropolis*® ADM (Universal shelf) specific SFPs Lucent Technologies can guarantee the full functionality and warranty.

For further information please refer to the "Equipment provisioning concepts" chapter of the UOG.

☐

Equipment reports

Equipment inventory

Metropolis® ADM (Universal shelf) automatically maintains an inventory of the following information of each installed circuit pack:

- Serial number
- Equipment Carrier Code or Equipment Catalog Item ECI
- Functional name
- Apparatus code
- Series number
- Functional qualifier
- Software release (of the NE)

You can obtain this information by an inventory request command.

Equipment failure reports

Failure reports are generated for equipment faults and can be forwarded via the ITM-CIT interfaces.

□

Synchronization and timing

Overview

Purpose

This section provides information about synchronization features, timing protection and timing interfaces of *Metropolis*® ADM (Universal shelf).

Contents

Timing features

Synchronization modes

Several synchronization configurations can be used. The *Metropolis*® ADM (Universal shelf) can be provisioned for the following timing modes:

- free-running operation
- holdover mode
- locked mode

In locked mode the internal SDH Equipment Clock (SEC) is locked to:

- one of the external sync inputs (2048 kHz or 2048 kbit/s)
- two independent 64 kHz signals (for the japanese market; the japanes market requires different station clock interfaces: 64 kHz + 8 kHz (+ 400 Hz) for NE input and 6312 kHz for NE output.)
  These two independent 64 kHz signals coming from outside are converted by the so-called MIOR-J unit into two independent 2048 kHz signals.
- one of the 2 Mbit/s tributary signals
- one of the STM-N inputs (line or tributary port).

Handling of a frequency offset

By comparing the frequencies of all assigned references with the frequencies of the internal oscillator on both timing circuits of the core units, it can be decided in the event of an excessive frequency difference, whether a reference is off-frequency or the internal oscillator of one of the timing circuits. If so, the affected unit is declared faulty.

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Timing protection

Protection timing references

The external timing references are non-revertively 1+1 protected. The external timing references can also operate in unprotected mode.

Protection of the timing mode

If the primary timing reference fails, the system will automatically switch to the holdover mode. The Synchronization Status Message is supported, which enables timing reference priority settings and gives information about the quality of the timing signal.

☐

Timing interface features

Synchronization Status Message (SSM) signal

A timing marker or synchronization status message signal can be used to transfer the signal-quality level throughout a network. This will guarantee that all network elements are always synchronized to the highest-quality clock that is available.

On the *Metropolis*® ADM (Universal shelf) system the SSM algorithm or the timing marker is supported according to G.781. The SSM is supported on all STM-N interfaces and on the 2 Mbit/s synchronization input and output signals.

2 Mbit/s tributary re-timing

The user can choose whether individual 2 Mbit/s tributary outputs operate in "self-timed" or "re-synchronized" mode. In the (standard) self-timed mode, the phase of the outgoing signal is a moving average of the phase of the 2 Mbit/s signal because the 2 Mbit/s signal is embedded in the VC-12 that is disassembled. In the re-synchronized mode the 2 Mbit/s signal is timed by the SDH Equipment Clock (SEC) of the network element; frequency differences between the local clock and the 2 Mbit/ssignal embedded in the VC-12 to be disassembled are accommodated by a slip buffer.

There is also the following option: whenever the traceability of the local clock drops below a certain threshold, the re-timing 2 Mbit/s interfaces automatically switch to self-timing. When this fail condition disappears, these interfaces return to re-timing. These changes do not involve any hits in the traffic.

□

Operations, Administration, Maintenance and Provisioning

Overview

Purpose

The following section provides information about interfaces for Operations, Administration, Maintenance, and Provisioning (OAM&P) activities and the monitoring and diagnostics features of *Metropolis*® ADM (Universal shelf).

Contents

Interfaces

User panel

The maintenance procedures of the *Metropolis®* ADM (Universal shelf) system are built on two levels of system information and control. The first maintenance tier consists of the user panel display (LEDs) and push-buttons (all on the front of the system controller), and the light-emitting diodes (LEDs) on the circuit pack faceplate. The push-buttons are still accessible when the front cover is closed (EMC boundary). Most typical maintenance tasks can be performed using these buttons without aid of the the ITM-Craft Interface Terminal (ITM-CIT) or element manager (OMS).

ITM-CIT

The second maintenance tier employs the Lucent Technologies network management system. Detailed information and system control are obtained by using the ITM-CIT (Craft Interface Terminal), which supports provisioning, maintenance and configuration on a local basis.

ITM-NM and OMS

At network level (customer’s network management center), Lucent Technologies’ ITM-NM and the OMS perform all the tasks that are necessary to supervise, operate, control and maintain an SDH network with the *Metropolis®* ADM (Universal shelf).

Security

Metropolis® ADM (Universal shelf) uses logins, passwords, authentication, and access levels to protect against unauthorized access.

Local and remote software downloads

With *Metropolis®* ADM (Universal shelf) software can be downloaded from the ITM-CIT. Software downloading does not affect transmission or operations. Activating the newly downloaded software may affect operations but does not affect transmission.

TCP/IP tunneling

The *Metropolis®* ADM (Universal shelf) is capable of tunneling IP traffic through the OSI DCN network. The tunnel provides a virtual interconnection for IP traffic between the “Ethernet interfaces (LAN)” and/or “end-points of other IP-tunnels (terminating in the NE)” of two NE’s that support this feature.

Note that a tunnel may forward IP traffic for many destinations, that can either be connected to the QLAN of the far end tunneling NE, or must be reached through subsequent routing towards/through other IP-tunnels and/or towards/through external IP routers.

The LAN interface supports both IP and OSI traffic simultaneously. Tunneling is achieved by encapsulating the IP packets in CLNP (OSI) packets.

This feature has no effect on the OSI management of the *Metropolis®* ADM (Universal shelf) itself, apart from the performance impact of additional IP traffic. This feature requires the NE to act as an IP router itself. The IP router supports ports to the Ethernet Interface (Q-LAN) and to the CLNP (OSI) network (i.e. a number of tunnels).

DCC interfaces

The *Metropolis®* ADM (Universal shelf) system supports operations via the standard 7-layer OSI protocol over Data Communications Channel (DCC). Up to 32 DCC terminations of section DCC (DCC_R) and line DCC (DCC_M) channels can be configured on 155-Mbit/s, 622-Mbit/s, 2.5-Gbit/s, 10-Gbit/s ports. DCC channel protection switching is supported in conjunction with line MSP protection switching of the respective optical port ("slaving").

□

Monitoring and diagnostics features

Performance monitoring

Metropolis® ADM (Universal shelf) monitors performance parameters for 24-hour and 15-minute intervals on the plesiochronous, synchronous and Ethernet transmission interfaces, so monitoring can be full-time for each signal without requiring any additional cross-connect capacity. For further information please refer to "Performance monitoring" (p. 5-24).

Threshold reports

Additional to the common alarm status and normal/abnormal condition reports *Metropolis*® ADM (Universal shelf) supports threshold reports (TRs). A TR is generated when a performance monitoring parameter threshold is exceeded, that can be set individually by the user for 24-hour and 15-minute intervals. For further information please refer to "Performance monitoring" (p. 5-24).

Port monitoring modes

Each physical interface can be in one of three different modes: automatic (AUTO), monitored (MON) or non-monitored (NMON). In NMON mode all alarms that originate in the physical section termination function are suppressed, while in the MON mode they are reported. In the AUTO mode alarms are suppressed until an incoming signal is detected, then the mode of the port switches automatically to MON.

Transmission maintenance signals

Regenerator section, multiplex section, and higher order path maintenance signals are supported as per ITU-T Rec. G.783. The system can generate and retrieve path trace messages on STS-1 respectively higher order VC-3 and VC-4 level as well as section trace messages respectively STM-N RSOH messages.

Path termination point monitoring modes

Each Path Termination Point can be in one of two different modes, monitored (MON) or non-monitored (NMON). In NMON mode all alarms that originate in the termination point are suppressed, while in the MON mode they are reported .

Alarm Severity Assignment Profiles

An Alarm Severity Assignment Profile (ASAP) is a list of alarms which can occur in a network element and which each have an alarm severity assigned.

ASAPs can be assigned to *Metropolis*® ADM (Universal shelf) functional system components (a circuit pack or a specific port for example) during provisioning.

Each ASAP can be uniquely identified by its type and its name.

ASAPs allow the user to control alarm reporting with more flexibility, and to create multiple alarm profiles for each alarm category and to assign these profiles to entities within the system.

All alarms are grouped into types of alarms. The alarms contained in each category are predefined. The categories containing the alarms are referred to as predefined profile types. Each profile type has a default profile and a set of user-created profiles. The user-created profiles and the default profiles within the profile types are referred to as ASAPs. The assigned alarm severity levels refer to each alarm within each ASAP. The default profiles are available after system installation.

The created ASAPs are used to specify the alarm severity level that the system reports when a failure occurs.

Note that predefined or default alarms or profile types cannot be changed or deleted by the user. Only the profiles created by the user can be changed or deleted.

Loopbacks

Metropolis® ADM (Universal shelf) supports facility loopbacks for testing and maintenance purposes. These loopbacks are available for each supported signal type. Facility loopbacks are established electrically on port-level on a port unit. The available types are:

- Near-side loopback (in-loop)
- Far-side loopback (out-loop)

The loopbacks can be configured via ITM-CIT

Local and remote inventory

The *Metropolis®* ADM (Universal shelf) system provides automatic version recognition of the entire hardware and software installed in the system. This greatly simplifies troubleshooting, dispatch decisions, and inventory audits. A list of detailed information, is accessible via *WaveStar®* CIT, via *Navis®* OMS or via *Navis®* EMS.

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3 Network topologies

Overview

Purpose

This chapter describes the key applications of *Metropolis*® ADM (Universal shelf). It gives an overview of the various network applications and identifies the key functions associated with these applications.

The *Metropolis*® ADM (Universal shelf) is a highly flexible product that is capable of supporting a variety of network applications like bandwidth access, service-on-demand and LAN services.

Network tiers

Optical networks can be structured into three tiers in order to simplify their understanding, modelling and implementation:

- Backbone (tier 3)
- Metro core/regional (tier 2)
- Access (tier1)

The *Metropolis*® ADM (Universal shelf) can be applied in all three tiers of a network. The system allows for growth and changing service needs by supporting in-service conversions and upgrades. Because of its basic design, the system operates equally well in a fully synchronous and in an asynchronous environment and provides a flexible link between the two.

The *Metropolis*® ADM (Universal shelf) can be configured in such a way that it supports a wide variety of network applications. The following sections will identify some of the main applications and configurations for which *Metropolis*® ADM (Universal shelf) is optimized.

Contents

Access/metro applications

Overview

Purpose

This section provides information about access/metro tier characteristics and access/metro applications for *Metropolis*® ADM (Universal shelf).

Characterization of tier 1 topologies

The access/metro network tier typically shows the following features:

- Point to point and ring network topology
- Short distance (up to ~ 40 km)
- Low capacity per fiber (2.5 Gbit/s and lower)
- Mixed traffic patterns (from 2 Mbit/s up to 2.5 Gbit/s services)
- Edge concentration
- Circuit and data interfaces

Contents

Access/metro core networking

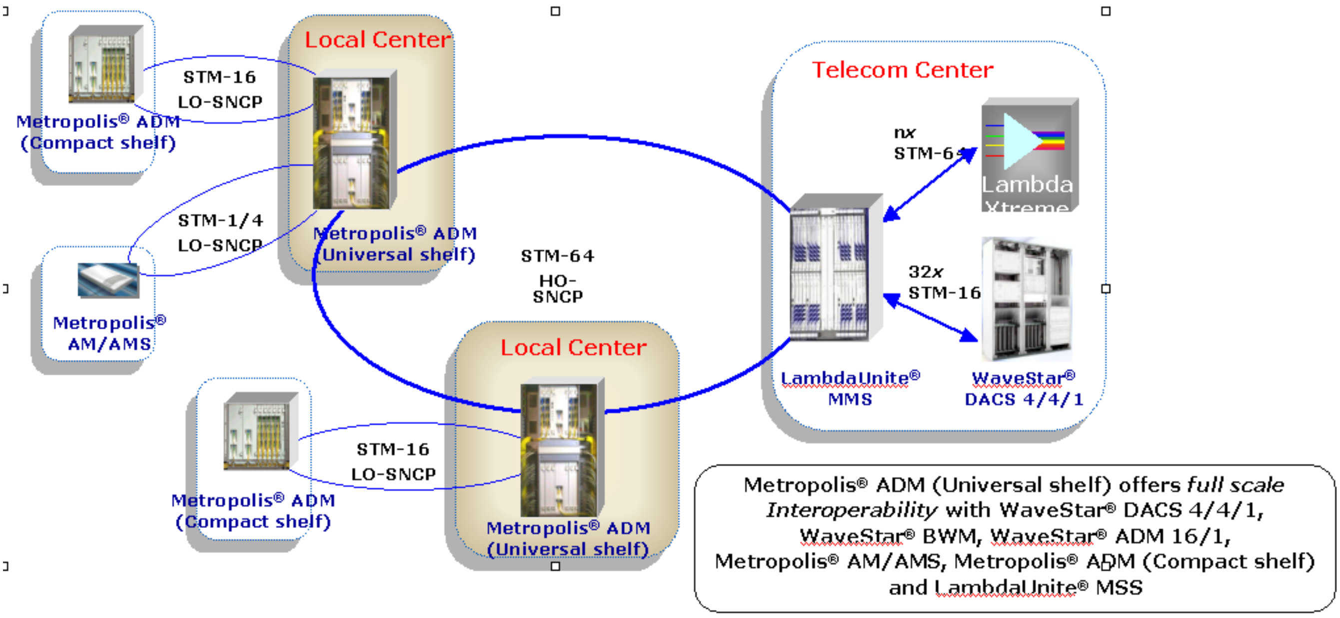
Introduction

Since the *Metropolis*® ADM (Universal shelf) can be equipped with STM-64 interfaces it can interwork with typical core network elements like the *WaveStar*® 10G (STM-64) and the LambdaUnite MSS as a part of the core level.

In such a case the flexibility of the *Metropolis*® ADM (Universal shelf) greatly reduces the number of network elements in the Local Centers where Access/Metro rings are closed.

One network element can interface with different layers of the network.

The figure below schematically illustrates an example for access metro core networking.



Application details

Overview

Purpose

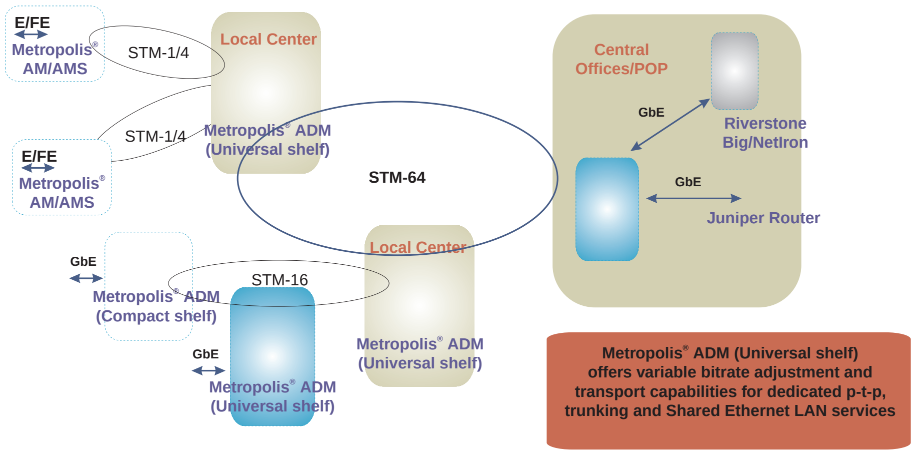
This chapter gives an overview of *Metropolis*® ADM (Universal shelf) application details in basic topologies.

Contents

Ethernet services - packets over SDH

Ethernet services

The Ethernet cards are available for the *Metropolis*® ADM (Universal shelf) as well as for the *WaveStar*® ADM 16/1, *Metropolis*® ADM (Compact shelf) and *Metropolis*® AM / *Metropolis*® AMS. Together with the *Metropolis*® ADM (Universal shelf), a total solution can be configured for small, medium and large business environments. The figure below gives an example of how to implement the Ethernet services in the SDH network architecture.



The solution presented above eliminates the need for DS/CSUs or interface converters between end-user's data equipment and the SDH network, which provides significant cost savings on equipment and operation costs.

Key features of Ethernet/Fast Ethernet

The *Metropolis*® ADM (Universal shelf) support 10/100BASE-T Ethernet and provides the integrated data connections within the SDH network.

In the IEEE 802.1Q tagging mode the *TransLAN*™ board can be configured in the Spanning Tree operation mode. The Spanning Tree operation mode is described in "Spanning tree protocol (STP)" (p. 2-34).

The key features of Ethernet/Fast Ethernet include the following:

- 8 x 10/100BASE-T auto-negotiation Ethernet ports
- 12 x 100BASE-LX optical Ethernet interfaces
- Ethernet frames are mapped into VC-12-xv (x=1,2...5) or into VC-3-xv (x=1,2) for 2Mbit/s, 4Mbit/s, 6Mbit/s, 8Mbit/s, 10Mbit/s, 50Mbit/s and 100Mbit/s bandwidth
- VC-12-xv (x=1...5) means 2 Mbit/s, 4 Mbit/s, 6 Mbit/s, 8 Mbit/s, 10Mbit/s
- VC-3 and VC-3-2v means 50 Mbit/s and 100 Mbit/s
- Point-to-point LAN interconnect, multiple LAN interconnect, WAN Sharing (LAN-VPN)
- IEEE 802.1Q trunking from VLAN tagging-Ethernet to VLAN Fast Ethernet

- VLAN tagging compliant with IEEE 802.1ad (“IEEE 802.1ad VLAN tagging mode”, “Provider bridge tagging mode”)
- Dedicated bandwidth for each customer
- Available bandwidth on each WAN link
- Provide shared network bandwidth: multiple ports share n x VC-12 or n x VC-3
- Support for point-to-multipoint LAN connection
- WAN access bandwidth is shared between with multiple customers
- Eliminates loops in bridged network
- Spanning Tree per VLAN, which complies with IEEE802.1D and IEEE802.1s
- WAN formed by SDH NEs that will maintain its own spanning tree that is independent of the spanning tree maintained by CPE LANs
- MAC Bridging and VLAN
- Compliance with IEEE802.1D for Ethernet Bridging
- The *TransLAN*™ bridge operates in promiscuous mode: no filtering database is used and received frames are relayed to all other ports of the virtual bridge. This mode is only intended for use in point-to-point configurations

Ethernet communication mode, speed negotiation

Data devices connected through a single collision domain of a Fast Ethernet LAN usually communicate in half-duplex mode, a communication method in which a device either send or receive data at a given instance, but not both.

The newer design of ethernet switches and hubs support both half-duplex and full-duplex mode of communication.

Full-duplex mode is a communication method that allows a device connected to the switch or hub to simultaneously send data and receive data. To support communication in full-duplex mode, it requires the use of full-duplex media, the cable/wire that provides independent transmit and receive data paths.

Note: an Ethernet LAN with full-duplex media does not mean it operates in full-duplex mode.

Auto-negotiation

Before sending and receiving data between two devices connected through an ethernet LAN, they must both agree to the communication speed (e.g., 10 Mbit/s or 100 Mbit/s), communication mode (half-duplex or full-duplex) and support of flow control capability.

The auto-negotiation protocol defined in the Ethernet standard, specifies a process to reach such agreement between the devices during the device initialization phase. The process uses special signals to carry the auto-negotiation information between the devices. The *Metropolis*® ADM (Universal shelf) support the auto-negotiation protocol and by default, the auto-negotiation function is always on. In some field cases, it is known that auto-negotiation can fail. In order to allow interworking with equipment not supporting this function, the *Metropolis*® ADM (Universal shelf) supports an option to override the auto-negotiation. It is possible to disable the auto-negotiation and to force the port speed (10 or 100 Mbit/s) and the half- or full-duplex mode.

Key features of Gigabit Ethernet

The Gigabit Ethernet interface provides an enhanced feature set for flexible Ethernet over SDH transport.

The Gigabit Ethernet card supported by the *Metropolis*® ADM (Universal shelf) allows transport of Gigabit Ethernet signals over SDH networks by encapsulating ethernet packets in virtually concatenated Virtual Containers (VCs). The Gigabit Ethernet card port support point-to-point connectivity. The card offers two 1000BASE Ethernet LAN ports. Each LAN port supports two Ethernet lines (one transmit and one receive, allowing full duplex operation). Each line can be associated with a virtual concatenated link over the SDH network (also called "WAN link"). The capacity per Gigabit Ethernet line is user provisionable to a maximum of 7 VC-4s.

The key features of Gigabit Ethernet include the following:

- Compliance with to IEEE 802.3 (2000) Clause 38
- Pluggable optics for 1000BASE-SX, 1000BASE-LX and 1000BASE-ZX
- Ethernet frames:
  - VC-3-xv (x=1 .. 2), EOS—mapped or GFP mapped or
  - VC-4-xv (x=1 .. 4) GFP-mapped

  The new GbE LAN unit LKA 53 supports mapping of Ethernet traffic into
  - VC-12Xv (x=1, …63), VC-3-xv (x=1, …24) and VC-4-xv (x=1, …8)(x=1,2,3,4,5,6,7).,
  - VPN and VLAN Trunking and
  - LCAS.
- IEEE 802.1Q VLAN tagging-Gigabit Ethernet "Lite": point-to-point and rings
- VLAN tagging compliant with IEEE 802.1ad ("IEEE 802.1ad VLAN tagging mode", "Provider bridge tagging mode")
- VLAN trunking from E/FE to Gigabit Ethernet
- Scalable bandwidth through virtual concatenation VC3/4-Xv and LCAS

Ethernet cards provide very attractive services to the end customers at minimal equipment investment. These services include:

- Scalable bandwidth without changing interfaces
- A transparent LAN service that hides the complexity of the WAN for end users (a WAN that looks like a LAN)
- A high level of availability of the LAN service because of end to end SDH protection switching.

Speed and connectors

The LAN interfaces that are supported are 10Base-T and 100Base-TX. The numbers “10” and “100” indicate the bit-rate of the LAN, 10 Mbit/s and 100 Mbit/s respectively. The “T” or “TX” indicates the wiring and connector type: Twisted pair wiring with RJ-45 connectors.

The actual LAN speed does not need to be configured, since the Ethernet interfaces support the auto-negotiation protocol which enables them to select automatically the proper LAN speed.

The auto-negotiation function on the *TransLAN*™ board is configurable. This feature allows the auto-negotiation function to be manually overridden from ITM-CIT. If this auto-negotiation function is disabled, it is possible to select a specific operational mode (10 or 100Base-T, half/full-duplex).

At the system side, the GbE card (LKA12/LKA12B) provides a quad EQSTM-1 (~600 Mbit/s) interface towards the cross-connect function.

At the external interface side, the GbE card (LKA12/LKA12B) provides 2 ethernet interfaces 1000BASE-X. Up to 600 Mbit/s WAN capacity is available, allowing “lite” GbE services only. This GbE card can be used with two “on board” plugable optics interfaces (SX-GbE and/or LX-GbE and/or ZX-GbE).

The new GbE LAN unit (LKA 53) provides four TXI-622Mb (~2.4Gbs) interfaces towards the cross-connect (CC) function for working and protection. This link is 1 + 1 protected.

At the external interface side, the new GbE LAN unit (LKA 53) provides 2 GbE interfaces (1000Base-X).

Up to 2488.32 Mbs (including TXI overhead) WAN capacity in total is available, allowing up to 2 LAN interfaces to operate at the full speed of 1000Mbs speed. The unit is used with SFP pluggable optics interface (SX-GbE and/or LX-GbE and/or ZX-GbE).

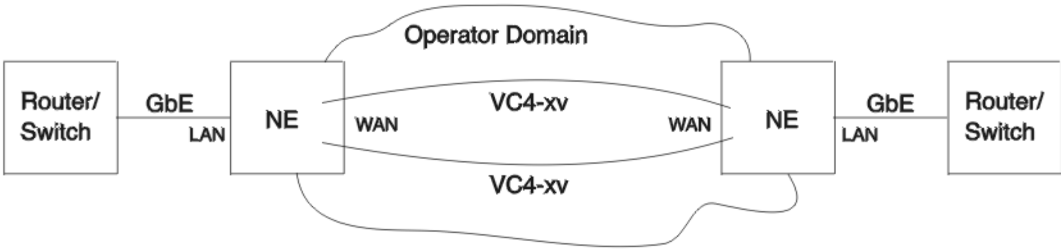
Point-to-point connectivity

The following two figures show possible point-to-point Gigabit Ethernet (GbE) network applications.

SNCP or MS-SPRing protection

Protection of the individual VC-4s that form the VC-4-Xv is possible via SNCP and MS-SPRing protection schemes.

The figure below schematically illustrates a point-to-point Gigabit Ethernet (GbE) network application with SNCP or MS-SPRing protection.

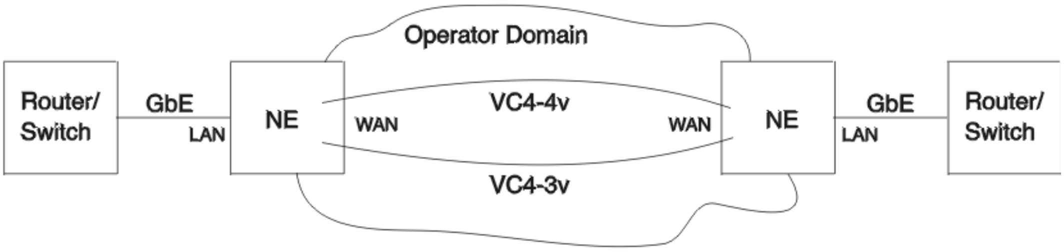


LCAS based protection

If that protection scheme is used half of the VC4s of the virtual concatenated bundle is routed over one fiber, the other half over another fiber. If one fiber fails, about half of the GbE WAN bandwidth is maintained during failures.

If MS-SPRing is available (optional): half of the VC4 is routed via pre-emptible protection access bandwidth.

The figure below schematically illustrates a point-to-point Gigabit Ethernet (GbE) network application with LCAS based protection.



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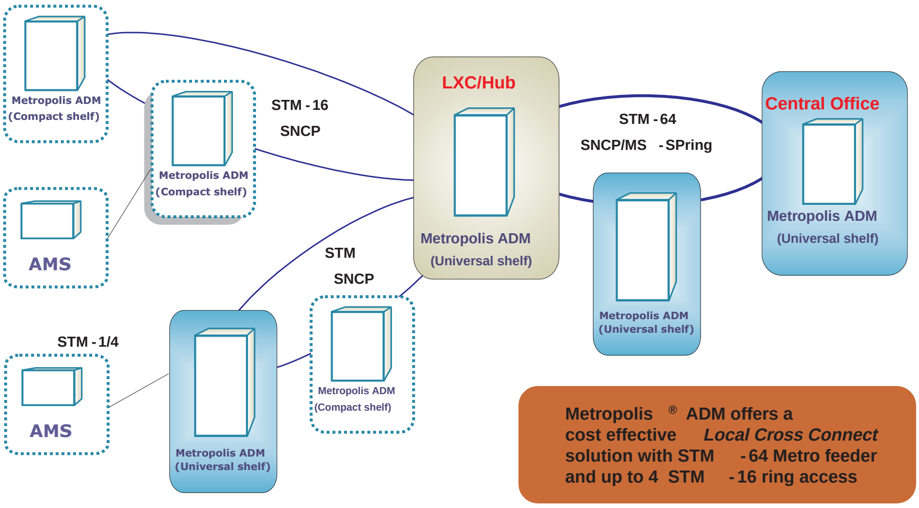
Metro access multi-ring node with LXC functionality

Introduction

The *Metropolis*® ADM (Universal shelf) can act as a hub for STM-1, STM-4 or STM-16 ring. It also supports point-to-point connections to the *Metropolis*® AM / *Metropolis*® AMS, *WaveStar*® ADM 16/1 and *Metropolis*® ADM (Compact Shelf) with 1+1 MSP or unprotected point-to-point connections.



4 Product description

Overview

Purpose

This chapter describes the *Metropolis*® ADM (Universal shelf) in terms of basic architecture, physical configuration and circuit packs.

Chapter structure

After a concise system overview, the transmission architecture is presented. A closer look is taken to the switch function.

The shelf configuration of the *Metropolis*® ADM (Universal shelf) is described, followed by a short description of the circuit packs contained.

Furthermore, this chapter deals with synchronization aspects within the network element and outlines the control architecture and the power distribution concept.

Contents

Concise system description

The *Metropolis®* ADM (Universal shelf) is a multiplexer and transport system that multiplexes a broad range of PDH, SDH and Ethernet signals into 10 Gbit/s (STM-64), 2.5 Gbit/s (STM-16), 622 Mbit/s (STM-4), or 155 Mbit/s (STM-1).

The method used to map interface signals complies with the AU-4 mapping procedure specified by ITU-T. The STM-1 and STM-4 optical tributary units support SONET-SDH conversion by remapping of a VC-3 from AU-3 to TU-3.

The *Metropolis®* ADM (Universal shelf) provides built-in cross-connect facilities and flexible interface circuit packs. Local and remote management and control facilities are provided via the Q and F interfaces and the Data Communications Channels (DCC).

Applications

Depending on the required line interface, *Metropolis®* ADM (Universal shelf) can be configured for a 10G application or a 2.5G application. The application determines the type of Core Unit to be used.

Basic architecture

The figures below give an outline of the basic *Metropolis®* ADM (Universal shelf) building blocks both for the 2.5G application and for the 10G application.

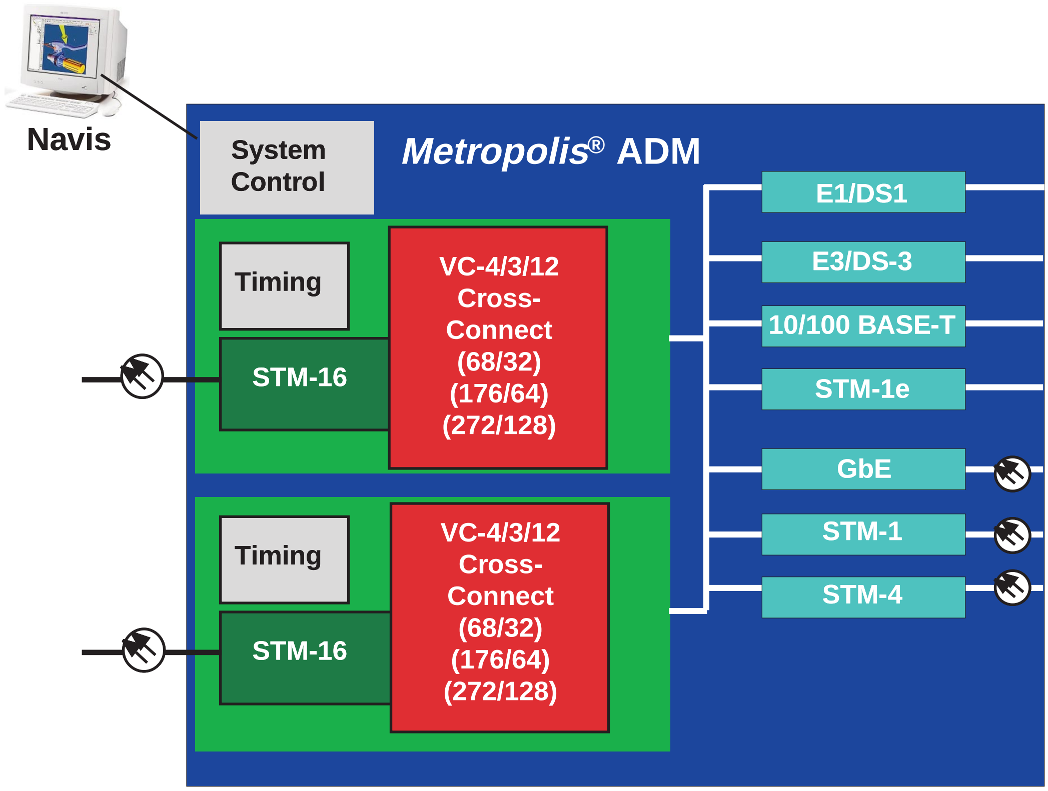
2.5G Core Unit

For the 2.5G application of the *Metropolis®* ADM (Universal shelf) system the following Core Units can be used:

- the STM-16 L16.1 1310 nm CC-68/32 (SI-L 16.1 C2/1) unit (item code: LKA24)
- the STM-16 L16.2 1550 nm CC-68/32 (SI-L 16.2 C2/1) unit (item code: LKA25)
- the 4 x STM-16 SFP CC272/128 (SI-16 SFP C2/4) unit (item code: LKA48)
- the 1 x STM-16 SFP CC-176/64 (SI-16 SFP C3/1) unit (item code: LKA481)
- the 1 x STM-16 VH CC-176/64 OBA (SI-16 VH C3/1 OBA) unit (item code: LKA482)

The circuit pack functionally consists of three main parts:

- higher- and lower order cross-connect function,
- timing function, and
- one/four STM-16 line interface.



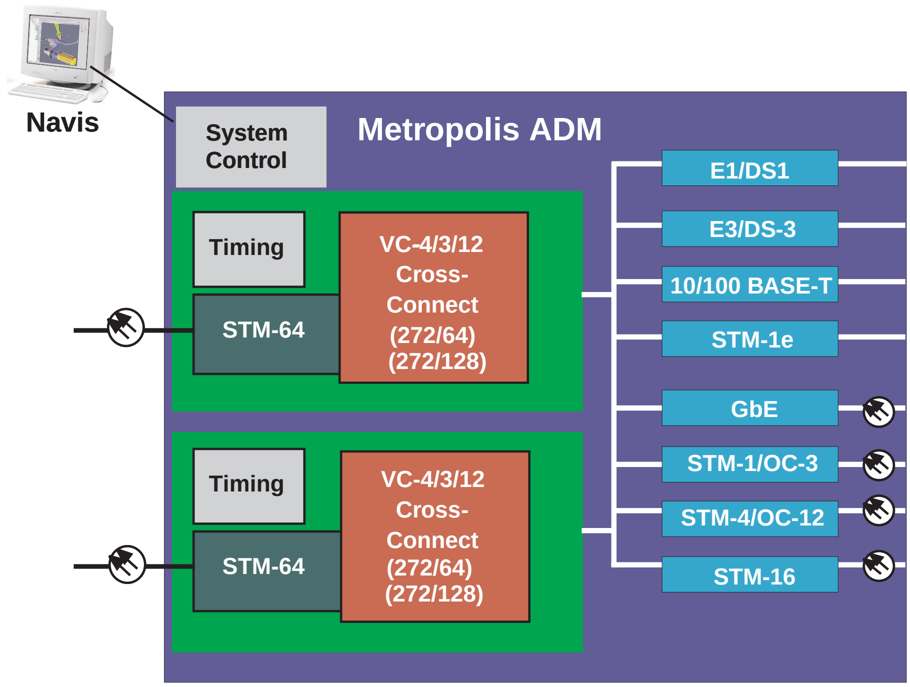
10G Core Unit

For the 10G application of the *Metropolis*® ADM (Universal shelf) system the following Core Units can be used:

- the STM-64 S64.2b/3b 1550 nm CC-272/64 (SI-S64.2 C1/1) unit (item code: LKA27)
- the STM-64 L64.2b/3 1550 nm CC-272/64 (SI-L64.2 C1/1) unit (item code: LKA26)
- the STM-64 I64.1r 1550 nm CC-272/64 (SI-I64.1r C1/1) unit (item code: LKA47)
- the STM-64 S64.2b/3b 1550 nm CC-272/128 (SI-S64.2 C2/1) unit (item code: LKA29)
- the STM-64 L64.2c/3 1550 nm CC-272/128 (SI-L64.2 C2/1) unit (item code: LKA28)
- the STM-64 U64.2c/3 1550 nm CC-272/128 (SI-U64.2 C2/1) unit (item code: LKA281)
- the STM-64 I64.1r 1310 nm CC-272/128 (SI-I64.1r C2/1) unit (item code: LKA49)
- the STM-64 V64.2 1550 nm CC-272/128 (SI-V64.2 C2/1) unit (item code: LKA350).

The circuit pack functionally consists of three main parts:

- higher and lower order Cross-connect function,
- timing function, and
- one STM-64 line interface.



System Controller Unit

The System Controller Unit (SC) provides the central control, supervision and security functions in the network element. For this purpose, it communicates with the function controllers on the individual interface circuit packs.

Interface circuit packs

The *Metropolis*® ADM (Universal shelf) supports a large variety of interface circuit packs: 2, 1,5, 34, 45, 155, 622 Mbit/s, 2.5 Gbit/s, and 10 Gbit/s are the supported bit rates. An Ethernet interface, that works with 10/100 Mbit/s BASE-T and a Gigabit Ethernet interface fit within a tributary slots. For details of these circuit packs, please refer to the descriptions in "Circuit packs" (p. 4-24).

□

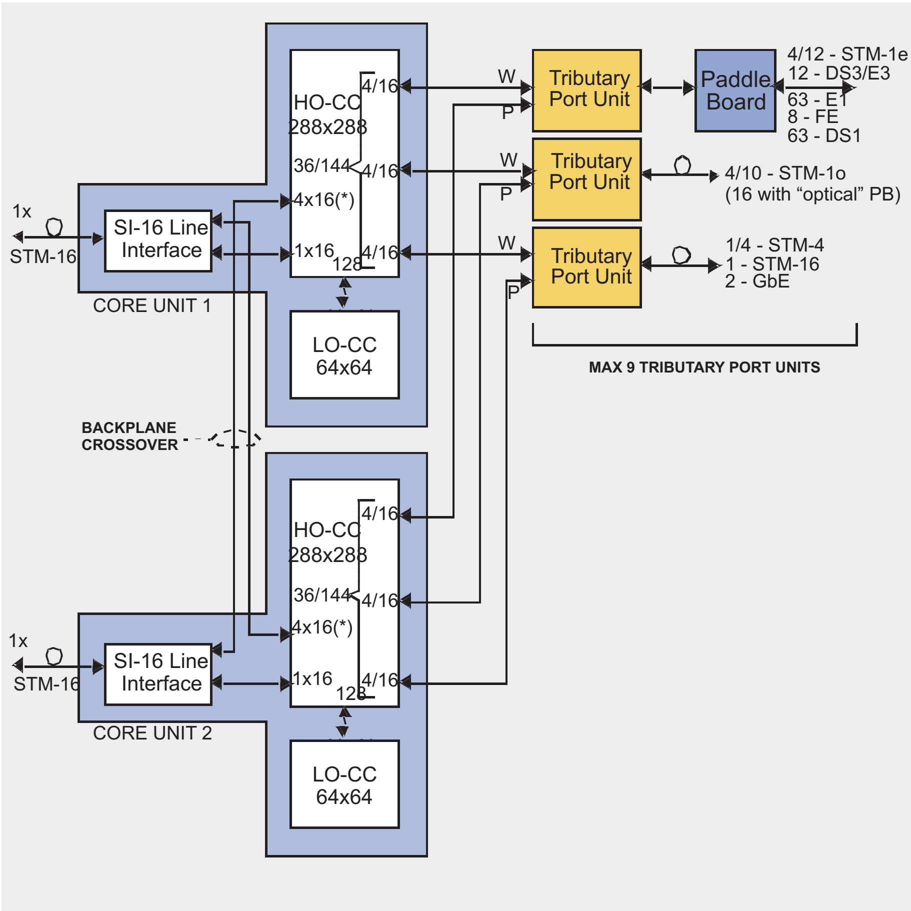
Transmission architecture

As depicted in the illustrations below, the Core Unit is the central part of the *Metropolis*® ADM (Universal shelf) transmission architecture. On a single circuit pack, the unit supplies three different functionalities, which are highly important to every multiplexer:

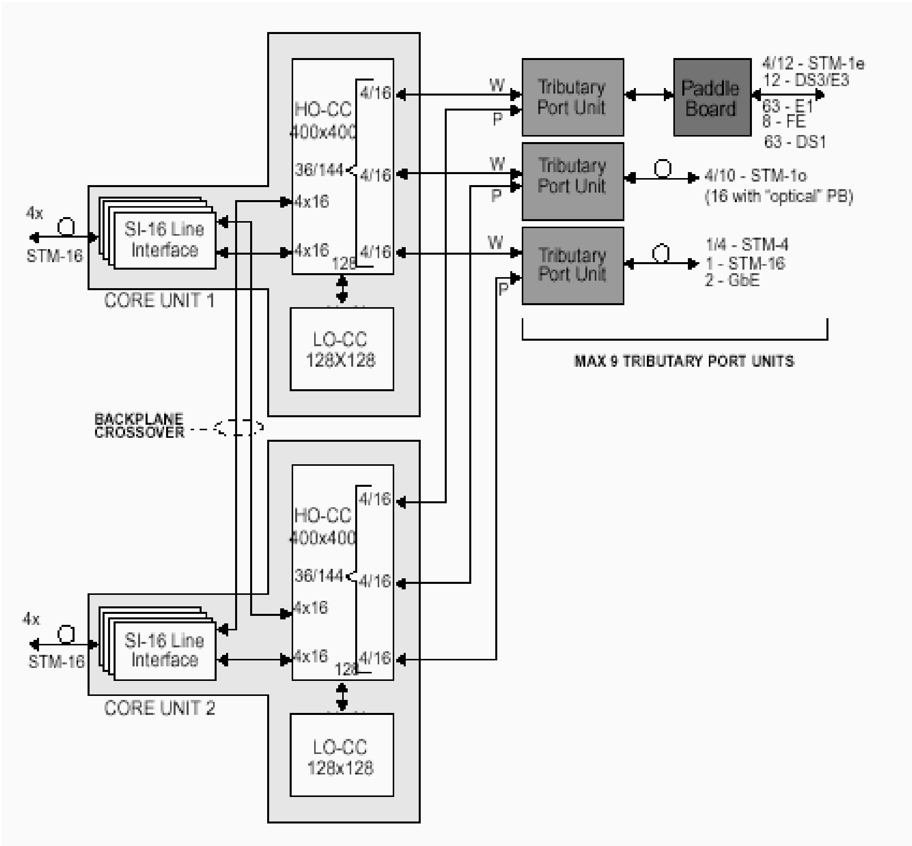
- line interface
- higher order and lower order cross-connect
- timing

System with 2.5 G Core Units

The following figure shows a core unit architecture as it wa used for release 3.0:

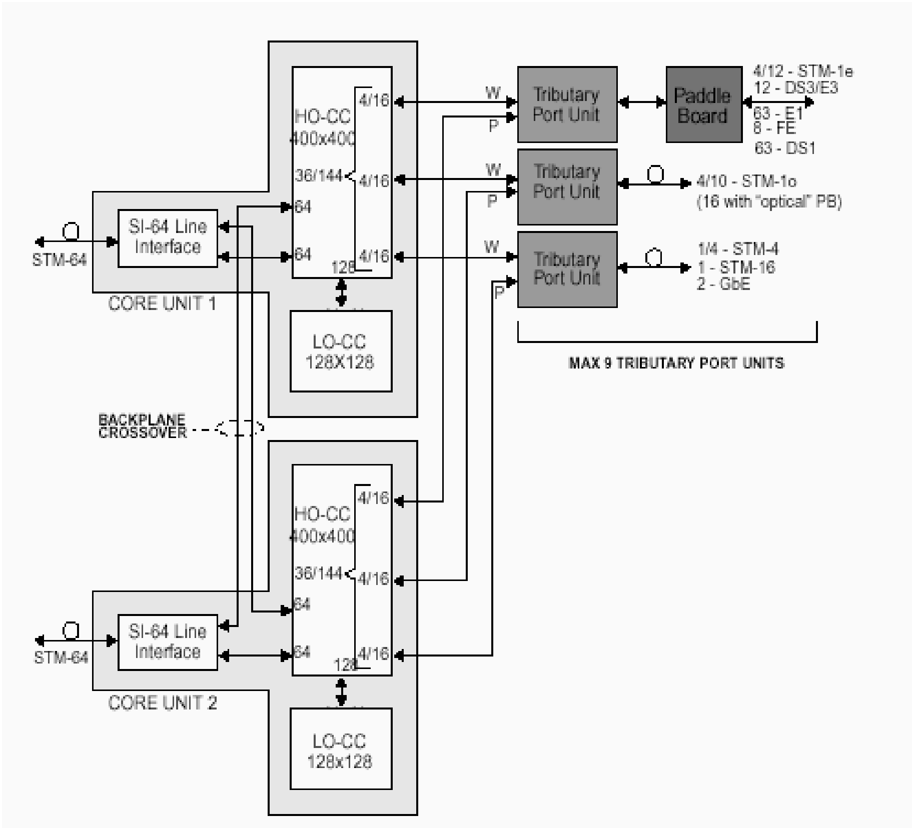


The following figure shows a core unit architecture as it wa used from release 1.0 to release 3.0:



System with 10G core unit

The following figure shows a core unit architecture as it wa used for release 3.0:


HO-CC
400x400
36/144
64
64
128
4/16
4/16
4/16
SI-64 Line Interface
STM-64
CORE UNIT 1
LO-CC
128X128
BACKPLANE CROSSOVER
HO-CC
400x400
36/144
64
64
128
4/16
4/16
4/16
SI-64 Line Interface
STM-64
CORE UNIT 2
LO-CC
128x128
W
P
Tributary Port Unit
Paddle Board
4/12 - STM-1e
12 - DS3/E3
63 - E1
8 - FE
63 - DS1
W
P
Tributary Port Unit
4/10 - STM-1o
(16 with "optical" PB)
W
P
Tributary Port Unit
1/4 - STM-4
1 - STM-16
2 - GbE
MAX 9 TRIBUTARY PORT UNITS

Switch function

All cross-connections are switched on the Core Unit. The 10G Core Units (272/128) and the 2.5G Core Unit (64/32 respectively 272/128 (Quad STM-16 core unit (4x STM-16 SFP CC-272/128)) have a cross-connect that consists of two parts: a higher order and a lower order cross-connect part. The Core Units can connect *n* VC-4s from the higher order to the lower order cross-connect part, where *n* is the number after the “/” of a core units denotation (example: 10G Core Unit (CC-272/*128*)).

The following types of cross-connections are possible on both Core Units:

- unidirectional
- bidirectional
- loopback
- multi-cast

The following types of traffic can be cross-connected:

- VC-4-16c
- VC-4-4c
- VC-4
- VC-3
- VC-12

Higher and lower order cross-connect parts are interconnected via an internal cross-connect bus that is 32, 64or 128 bidirectional VC-4s wide.

VC11 cannot be cross-connected. The DS1 signal is mapped into a VC11 but then transported and cross-connected on TU-12 level.

The VC-4-16c, VC-4-4c and VC-4 traffic only passes the higher order switch matrix. Grooming and aggregation of Lower Order traffic requires VC-3 and VC-12 traffic passes both the higher and lower order switch matrices.

Flexible routing and cross-connecting of VC-4, VC-4-4c, VC-4-16c, VC-3 and VC-12 between line port ↔ line port, line port ↔ tributary port, and tributary port ↔ tributary port is supported.

Tributary and line interface circuit packs are directly connected to the higher order cross-connect via STM-1 equivalent signals (AU-4). *Metropolis®* ADM (Universal shelf) uses both, STM-1 (EQSTM-1) and STM-4 (TXI622) equivalent signals.

Higher order cross-connect

The higher order cross-connect switches VC-4s. Other functions of the higher order cross-connect are:

- VC-4 SNC protection switching
- STM-16 and STM-64 MS-SPRing protection
- STM-1, STM-4, STM-16 or STM-64 MSP
- equipment protection for tributary units

- non-intrusive monitoring of VC-4s
- broadcasting.

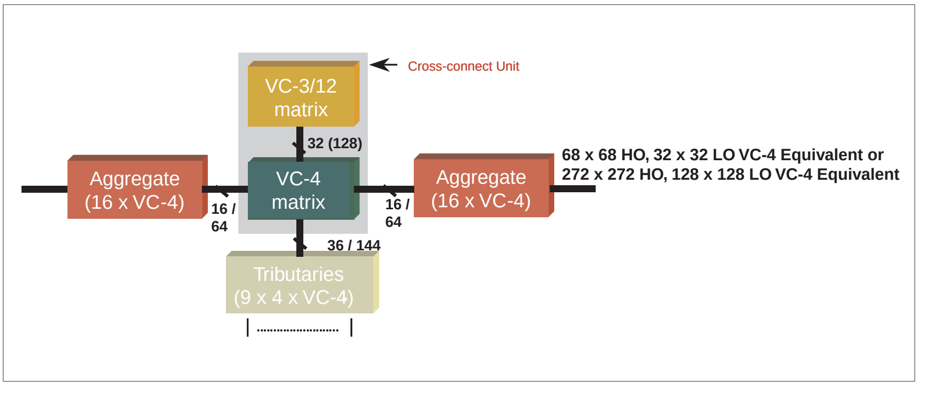
Lower order cross-connect

The lower order cross-connect switches/grooms VC-3s and VC-12s. Other functions of the lower order cross-connect are:

- lower order SNC protection
- non-intrusive monitoring of lower order VCs
- lower order broadcasting.
- VC-4 termination.

2.5G application

Depending on the core units to be used the 2.5G application comprises different tranmission capacities.



2.5G Core Unit (CC-68/32)

With the 2.5G Core Unit the *Metropolis*® ADM (Universal shelf) has a total switching capacity of 68 x 68 VC-4 equivalents (9 x 4 + 2 x 16). The two Line Interfaces on this Unit each have STM-16 capacity (32 VC-4 equivalents). The nine Tributary Port Units each have STM-4 capacity (36 VC-4 equivalents in total).

The 2.5G Core Unit contains a lower order switch matrix (LO-CC) for VC-3 and VC-12 connectivity. This switch matrix has a capacity of 32 x 32 VC-4 equivalents (5 Gbps). The total capacity of the higher order switch matrix (HO-CC) is 100 x 100 VC-4 equivalents (2x16 + 9x4 + 32).

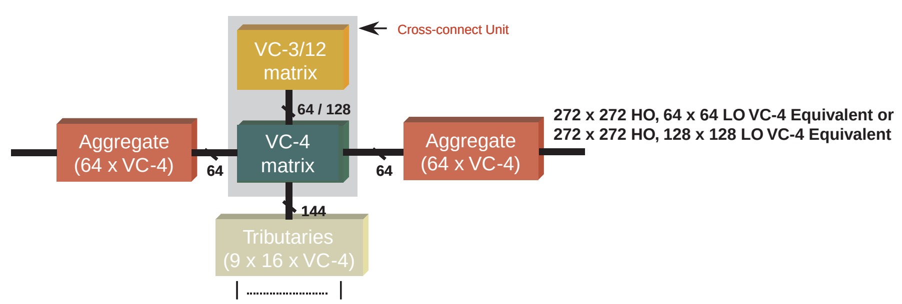
4x 2.5G Core Unit

With the 4x 2.5G Core Unit the *Metropolis*® ADM (Universal shelf) has a total transmission capacity of 272x272 VC-4 equivalents (42.3 Gbps). The eight Line Interfaces on this Unit each have STM-16 capacity (128 VC-4 equivalents). The nine Tributary Port Units each can either have STM-4 or STM-16 capacity (36 or 144 VC-4 equivalents).

The 4x 2.5G Core Unit contains a lower order switch matrix for VC-3 and VC-12 connectivity (LO-CC). This switch matrix has a capacity of 128x 128 VC-4 equivalents (20 Gbps). The total capacity of the higher order switch matrix (HO-CC) is 400 x 400 VC-4 equivalents (8x16 + 9x16 + 128).

10G application

Depending on the core units to be used the 10G application comprises different tranmission capacities.



10G Core Unit (CC-272/64)

With the 10G Core Unit the *Metropolis*® ADM (Universal shelf) has a total transmission capacity of 272x272 VC-4 equivalents (42.3 Gbit/s). The two Line Interfaces on this Unit each have STM-64 capacity (128 VC-4 equivalents). The nine Tributary Port Units each can either have STM-4 or STM-16 capacity (36 or 144 VC-4 equivalents).

The 10G Core Unit contains a lower order switch matrix for VC-3 and VC-12 connectivity (LO-CC). This switch matrix has a capacity of 64 x 64 VC-4 equivalents (10 Gbit/s). The total capacity of the higher order switch matrix (HO-CC) is 336 x 336 VC-4 equivalents (2x64 + 9x16 + 64).

10G Core Unit (CC-272/128)

With the 10G Core Unit the *Metropolis*® ADM (Universal shelf) has a total transmission capacity of 272x272 VC-4 equivalents (42.3 Gbit/s). The two Line Interfaces on this Unit each have STM-64 capacity (128 VC-4 equivalents). The nine Tributary Port Units each can either have STM-4 or STM-16 capacity (36 or 144 VC-4 equivalents).

The 10G Core Unit contains a lower order switch matrix for VC-3 and VC-12 connectivity (LO-CC). This switch matrix has a capacity of 128x 128 VC-4 equivalents (20 Gbit/s). The total capacity of the higher order switch matrix (HO-CC) is 400 x 400 VC-4 equivalents (2x64 + 9x16 + 128).

Add/drop capacity

Refer to “Circuit pack capacities” (p. 6-7).

Shelf configurations

The *Metropolis*® ADM (Universal shelf) is part of Lucent Technologies' next generation of SDH equipment. The overall system requirements of compact design and flexibility were given special attention, particular in the mechanical design of the system.

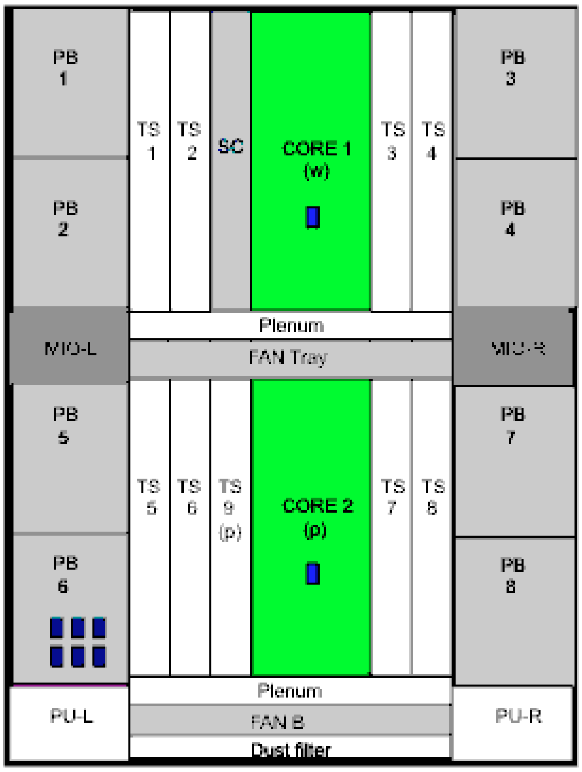
Subrack

The *Metropolis*® ADM (Universal shelf) consists of the following slots:

- 2 slots for the Core Units
- 9 universal slots for tributary units (optical and electrical)
- 1 slot for the System Controller Unit

The dimensions of a fully equipped *Metropolis*® ADM (Universal shelf) subrack are 925 × 495 × 270 mm (H × W × D), which includes I/O modules and cable routing. This subrack is designed for front access so that all the connectors can be accessed from the front panel. One fan unit is considered as mandatory unit for the 2.5G and the 10G application; therefore space for fans is reserved in the middle and bottom of the subrack. The fan at the bottom of the subrack is optional, the fan in the middle is mandatory.

The figure below schematically shows the *Metropolis*® ADM (Universal shelf) subrack. Abbreviations used are explained in the table below.



The following abbreviations are used:

SC	System Controller Unit slot, user panel and visual indicators
TS1…4	Universal “tributary” port slot for 1,5Mbit/s (no equipment protection), 2 Mbit/s (no equipment protection), STM-1e, STM-1, STM-4, STM-16, DS3/E3, E/FE, GE1; maximum backplane capacity (TDM) per slot is 2.5 Gbit/s
TS5…8	Universal “tributary” port slot for 1,5Mbit/s (including 1:4 equipment protection), 2 Mbit/s (including 1:4 equipment protection), STM-1e, STM-1, STM-4, STM-16, DS3/E3, E/FE, DS1, GE1; maximum backplane capacity (TDM) per slot is 2.5 Gbit/s
TS9	Tributary slot without associated paddle board: STM-1, STM-4, STM-16, GE1. Also used as protection slot for DS1 and E1.
TS*n* and TS(*n*+1)	*n* = 1, 3, 5, 7: slot pair for STM-1e and E3/DS3 equipment protection
Core 1,2	Core Unit slot: 2.5 Gbit/s (64/32), 2.5 Gbit/s (176/64) ,Quad 2.5 Gbit/s (4x STM-16 SFP CC-272/128), 10 Gbit/s (272/64) and 10 Gbit/s (272/128)
PB1…4	Paddle Board slot for 1,5Mbit/s, 2 Mbit/s, E3/DS3, STM1e and FE. No 2 Mbit/s protection provided
PB5…8	Paddle Board slot for 1,5Mbit/s, 2 Mbit/s, E3/DS3, STM1e and FE. Includes 2 Mbit/s protection
MIO-L/R	Left and right area for miscellaneous connectors
PU-L/R	Left and right area for Power Unit
FANM, FANB	Middle and bottom fan area

Circuit packs

The *Metropolis*® ADM (Universal shelf) has a broad range of optical interface circuit packs. The line ports can be equipped with STM-16 units at 1310/1550 nm or with STM-64 units at 1550 nm.

Optical interface circuit packs

Optical units	**Optical connectors**
SI-S1.1/4	SC
IP-GE/2	Small form factor pluggable (SFP) device, normally equipped with an LC connector.
2.5G and 10G Core Unit	Universal build-out, which allows SC, FC, and ST types of connectors; default is SC.

Optical units	Optical connectors
SI-L16.1 C2/1 and SI-L16.2 C2/1	Universal build-out, which allows SC, FC, and ST types of connectors; default is SC.

STM-64 optical line-port units

Description
S-64.2b/3b (1550 nm, ITU-T G.691)
L-64.2b/3 (1550 nm, ITU-T G.691)
SI-I64.1r (1310 nm, very short reach 10G 600 m)
U-64.2c, (1550 nm very long haul line interface 120 km)-
L-64.2c/3 (1550 nm , ITU-T G.691)
S-64.2b/3b (1550 nm, ITU-T G.691)
SI-I64.1r (1310 nm, very short reach 10G 600 m)
V-64.2 line interface (1550 nm, with compatible optics for 120km span width)

STM-16 optical line-port units

Description
L-16.1 (1310 nm, ITU-T G.957)
L-16.2/3 (1550 nm, ITU-T G.957)
4 x STM-16 SFP CC-272/128 (SI-16 SFP C2/4) unit (item code: LKA48) comprising the following interface variants: • L- 16.2/ 3 (1550nm, 80km) • L- 16.1 (1310nm, 40km) • I- 16 (1310nm, 2km) • CWDM (80 km, 4 colours) • CWDM (40 km, 4 colours)
1 x STM-16 SFP CC-176/64 (SI-16 SFP C3/1) unit (item code: LKA481)
1 x STM-16 VH CC-176/64 OBA (SI-16SFP/C,) unit (item code: LKA482).

Optical interfaces for tributaries

Description
L-16.1 (1310 nm, ITU-T G.957)
L-16.2/3 (1550 nm, ITU-T G.957)
S-4.1 (1310 nm, ITU-T G.957)

Description
L-4.2 (1550 nm, ITU-T G.957)
S-1.1 (1310 nm, ITU-T G.957)
L-1.2 (1550 nm, ITU-T G.957)
STM- 1/ 4 trib unit • Increased density: – up to • 16 STM-1o or – 4 STM-4o or – 12 STM-1e ports • Mixed operation STM- 1o/ 4o • Optical ports are SFP- based • Optical interface variants (SFP): S-1.1, L-1.1, L-1.2, S-4. 1, L-4.1, L- 4.2 (i. e. 15 Km, 40 Km, 80 Km) • Optional 1+ 1 Equipment Protection for STM- 1e
IP-GE/2 - pluggable optics (SFP based) for: • 1000BASE-SX (850 nm short haul multi-mode; IEEE 802.3 clause 38) • 1000BASE-LX (1310 nm long haul multi-mode; IEEE 802.3 clause 38) • 1000BASE-ZX (1550 nm long haul single-mode; IEEE 802.3 clause 38)
IP-LAN12 - pluggable optics (SFP based) for: • OM100B-LX (100BASE-LX (1310 nm SMF; 10km)

STM-16 optical tributary interfaces:

Apparatus code	Description
LKA50	1XSTM-16 SFP
OMI16	SFP 2G5-I16 / 2 km
OML16.1	SFP 2G5-L16.1 40 km
OM2G5-S16.1	SFP 2G5-S16.1 15 km
OM2G5-L16.2	SFP 2G5-L16.2/3 80 km
OM16CL51	STM-16 cWDM SFP color 13 (1510nm) 80 km
OM16CL53	STM-16 cWDM SFP color 14 (1530nm) 80 km
OM16CL55	STM-16 cWDM SFP color 15 (1550nm) 80 km
OM16CL57	STM-16 cWDM SFP color 16 (1570nm) 80 km
OM16CS51	STM-16 cWDM SFP color 13 (1510nm) 40 km
OM16CS53	STM-16 cWDM SFP color 14 (1530nm) 40 km
OM16CS55	STM-16 cWDM SFP color 15 (1550nm) 40 km
OM16CS57	STM-16 cWDM SFP color 16 (1570nm) 40 km

STM-4 & 1 optical tributary interfaces:

Apparatus code	Description	
LKA39	SI-1/12	Multi-STM Main Board (12*STM-1e, 16*STM-1o, 4*STM-4)
PBP8	PB-STM-1o/6	PB 6xSTM-1o
OMS4.1	SFP 622M-S4.1	SFP SH 15km S-4.1
OM622M-L4.1	SFP 622M-L4.1	SFP LH 40km L-4.1
OM622M-L4.2	SFP 622M-L4.2	SFP LH 80km L-4.2
OM155M-S1.1	SFP 155M-S1.1	SFP SH 15km S-1.1
OM155M-L1.1	SFP 155M-L1.1	SFP LH 40km L-1.1
OM155M-L1.2	SFP 155M-L1.2	SFP LH 80km L-1.2
OM155SF1	SFP SFW-1490 BD-D	Downstream SFP STM-1/4/GbE 1490nm single fibre working 15km
OM155SF2	SFP SFW-1310 BD-U	Upstream SFP STM-1/4/GbE 1310nm single fibre working 15km

Electrical tributary circuit packs

Description
PI-E1/63: 2 Mbit/s
PI-DS1/63: 1.5 Mbit/s
PI-E3DS3/12: 34 and 45 Mbit/s
SI-1/4 (STM-1e): 155 Mbit/s
IP-LAN/8 (Ethernet LAN): 10/100 Base-T

Paddle boards

The tables below informs about Protection and impedance conversion using paddle boards (PB)

PB name	Item code	Comcode	Description
PB-E1e/P75/63	PBE3	109192120	Unprotected or protected 75 Ω applications, 63 channels, enhanced version

PB name	Item code	Comcode	Description
PB-E1/P75/63	PBE3D	109585620	Unprotected or protected 75 Ω applications, 63 channels, enhanced version
PB-E1/120/63	PBE4	109199521	Unprotected or protected 120 Ω applications, 63 channels, high density paddle board
PB-E1/P120/63	PBE41	109536763	Unprotected or protected 120 Ω applications, 63 channels, high density paddle board

PB name	Item code	Comcode	Description
PB-DS1/P100/63	PBE12	109464222	Unprotected or protected 100 Ω applications, 63 channels, high density paddle board

PB name	Item code	Comcode	Description
PB-E3DS3/75/12	PBG4	108905597	Unprotected 75 Ω applications, 12 channels
PB-E3DS3/75/P12	PBP1	109209262	Protected 75 Ω applications, 12 channels

PB name	Item code	Comcode	Description
PB-1/P75/4S	PBG2	108746033	Unprotected 75 Ω applications, 4 channels

PB name	Item code	Comcode	Description
PB-1/P75/4D	PBP2	109209270	Protected 75 Ω applications, 4 channels
PB-1/75/12S	PBP5	109285478	Unprotected 75 Ω applications, 12 channels
PB-1/P75/12D	PBP6	109285486	Protected 75 Ω applications, 12 channels
PB-STM-1o/6	PBP8	109481333	6 SFP cages for STM-1o interfaces

PB name	Item code	Comcode	Description
PB-LAN/100/8	PBG1	108720228	Unprotected 10/100Base—T LAN 8 channels
PB-OPT/12 SFP	PBO12	109553693	Paddle Brd. 12xLAN SFP
PB-LAN100/12	PBL12	109553685	Paddle Brd. 12xLAN 100 Ohm

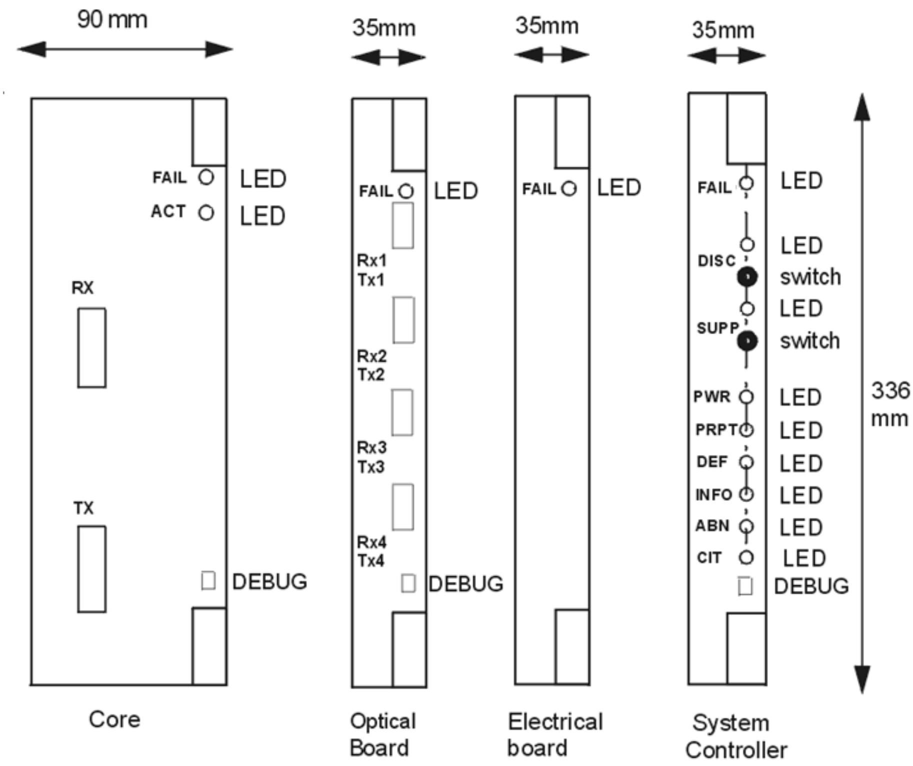
Printed circuit boards

The *Metropolis*® ADM (Universal shelf) subrack can accommodate a number of circuit packs. The dimensions of the circuit packs are 336 mm high and 220 mm deep. The circuit packs are connected to the backplane by pins only: special coax and power connectors are not used. All optical connections are located at the front of the circuit pack.

There is a latching mechanism on the top and bottom of the circuit pack for insertion or extraction. LEDs are positioned in the area between the circuit pack’s latches.

Apart from the System Controller Unit, which has several LEDs, all other front packs have one LED for alarm purposes.

The figure below schematically shows the front view of the circuit packs.



Paddle boards

A variety of paddle boards exists for connection between customer cabling and the backplane in case of protection or impedance conversion. The electrical components needed for conversion and/or protection are optional and will be located on the paddle board. The paddle boards are accessible at the front side of the backplane and are located at the left and right side of the subrack.

For each electrical tributary unit, these paddle boards have to be used in the case of impedance conversion and/or equipment protection. The paddle boards can be plugged in on the front of the extended back panel of the subrack in such a way that cables can enter the subrack from the left and the right side.

The paddle boards have a guiding system to prevent damage to connectors and a latching mechanism for insertion and extraction.

Interconnection system

Type of interconnections:

- Optical connections
- Circuit pack to back panel
- Back panel to paddle boards
- Paddle boards to customer cable
- Miscellaneous I/O on back panel to customer cable
- Power connections.

The customer connectors form the physical interface for the permanent and semi permanent supervision interfaces of the *Metropolis*® ADM (Universal shelf). A suppress button on the SC and the station station alarm disconnect button makes it possible to suppress alarms without opening the EMC boundary of the subrack.

Customer interface

Customer interfaces that are available:

- timing
- station alarms
- miscellaneous discretes
- access to overhead bytes
- network management interfaces.

Customer connectors

The table below gives an overview of the customer connectors.

Connector	Connector type	Use
Power (XB1,XB2)	3W3 D-sub power connector, Male	Power connection
Station Clock IN 1	D-SUB 9P MALE	External Timing input 1
Station Clock IN 2	D-SUB 9P MALE	External Timing input 2
Station Clock OUT 1	D-SUB 9P FEMALE	External Timing output 1
Station Clock OUT 2	D-SUB 9P FEMALE	External Timing output 2
BTALM	D-SUB 9P FEMALE	Bay (rack) top alarms
MDI	D-SUB 15P FEMALE	Miscellaneous input
MDO	D-SUB 9P FEMALE	Miscellaneous output
Station Alarm	D-SUB 15P FEMALE	Station Alarm cabling
V11-1	D-SUB 15P FEMALE	Access to user overhead bytes, V.11 provisionable
V11-2	D-SUB 15P FEMALE	Access to user overhead bytes, V.11 provisionable
G.703-1 and G.703-2	D-SUB 9P FEMALE	Access to user overhead bytes, G.703 provisionable

Connector	Connector type	Use
Q-LAN	RJ 45	OMS connection, (Twisted-Pair Ethernet) 10 BASE-T LAN
CIT-F	RJ 45	ITM CIT connection,
H-LAN	RJ 45	10/100 BASE-T LAN (for future use)

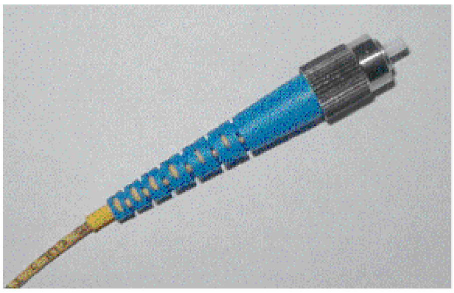
Connectors

The electrical connectors are located on the paddle board. The front-accesse connectors make implementation and maintenance easier and quicker. All the optical interfaces are located on the front side of the circuit packs. The following table shows an overview of interface types, cables and connectors.

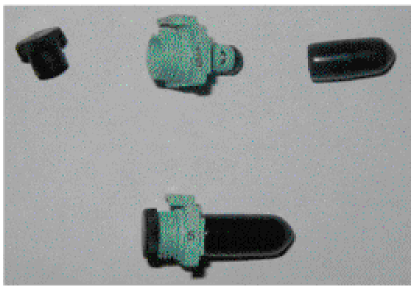
Interface type	Cable type	Connector type on connector plate	Number of cables / connectors per slot
1,5 Mbit/s	STP	2 mm FCI - BP50	16 × 8 = 128 cables
2 Mbit/s	COAX or STP	2 mm FCI - BP50	16 × 8 = 128 cables
34/45 Mbit/s	COAX	coax 1.6/5.6 connector, female	24 coax
STM-1e	COAX	coax 1.6/5.6 connector, female	8 coax
10/100 BASE-T LAN	UTP	RJ45	8 or 12 UTP
1 GbE/ZX2	SM fibre	LC	4 fibres
100 BASE-LX10	SM fibre	LC	24 fibres
STM-1o	SM-fibre	SC	8 fibres
STM-4o	SM-fibre	SC	2 fibres
STM1o trib high density packs	SM-fibre	LC	16 fibres (10 of these on the pack itself, the other 6 on a STM-1o paddleboard:).
STM4o trib high density packs	SM break out cable	LC	4 fibres
1 GbE/SX2	SM-fibre / MMF-fibre	LC	4 fibres
1 GbE/LX2	SM fibre	LC	4 fibres

Interface type	**Cable type**	**Connector type on connector plate**	**Number of cables / connectors per slot**
STM-16	SM-fibre	SC or FC/PC	2 fibres
STM-16 SFPs (used in LKA48, LKA482/482)	SM-fibre	LC	2 fibres
STM-64	SM-fibre	SC or FC/PC	2 fibres

FC type connections

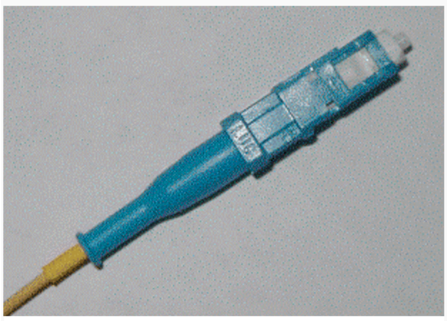


FC Type connector

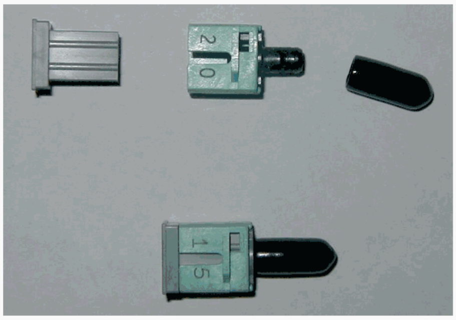


FC type LBO

SC type connections

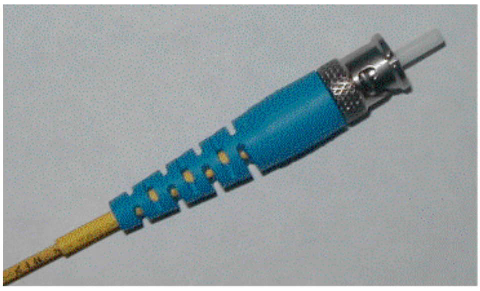


SC Type Connector

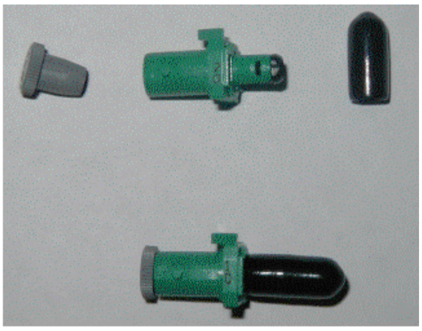


SC Type LBO

ST type connections

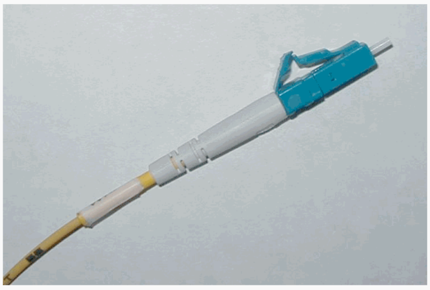


ST Type connector

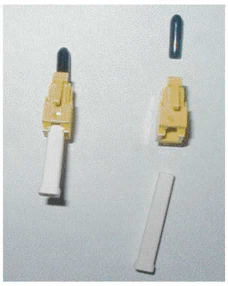


ST type LBO

LC type connections



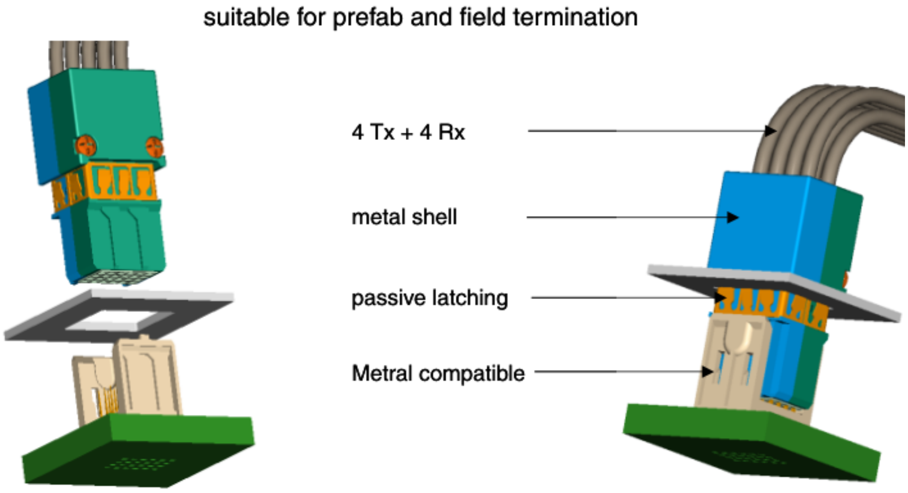
LC Type Connector



LC Type LBO

FCI - BP50

The following figure shows an 2 mm FCI with COAX or STP cable:



Cables and fibres

The *Metropolis*® ADM (Universal shelf) requires a number of cable types to connect the system. The cables can be:

- 2 Mbit/s 75 Ω 8 coax cable AWG30, 2GE564*
- 2 Mbit/s 120 Ω 8 (shielded) twisted pair AWG26, 2GE134*
- 1,5 Mbit/s 100 Ω 8 (shielded) twisted pair AWG26, 2GE134*
- 34/45 Mbit/s single coaxial cable 75 Ω
- 155 Mbit/s single coaxial cable 75 Ω
- LAN4 twisted pair CAT5 cable
- misc. I/O several types of wires
- power 4 mm^2 power wires
- STM-1 optical cables
- STM-4 optical cables
- STM-16 optical cables
- STM-64 optical cables.

  Important! The use of multi-mode fibers with STM-1 SFPs is never considered as the S-1.1 or other STM-1 or STM-4 interfaces are only specified for single-mode applications. Using multi-mode fibers (MMFS) should never be used for tests and optical loops. This will damage the receiver.

☐

Circuit packs

2.5G Core Units 64/32

The 2.5G Core Units can be placed in the core slots of the *Metropolis*® ADM (Universal shelf) system. The units have a red fault LED and a green activity LED.

The unit's main functions are:

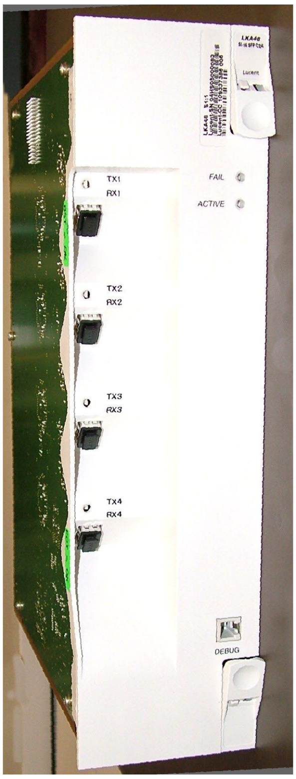
- type L-16.1, 1310 nm long haul line interface for a 40 km target distance (LKA24)
- type L-16.2/3, 1550 nm long haul line interface for a 80 km target distance (LKA25)
- OS, RS, MS termination and NIM (VC-*n*, with $n = 12, 3, 4$)
- 64 × 64 STM-1 eqv. higher order cross-connecting (VC-4/4-4c)
- 32 × 32 STM-1 eqv. lower order cross-connecting (VC-*n*, with $n = 12, 3$)
- timing collection, generation, and distribution.

2.5G Core Unit 272/128 (LKA48)

The SI-16SFP C2/4 2.5G Core Unit can be placed in the core slots of the *Metropolis*® ADM (Universal shelf) system. The unit has a red fault LED and a green activity LED.

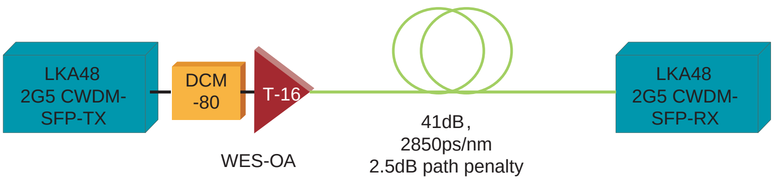
The unit's main functions are:

- four STM-16, Small Formfactor Plugable (SFP) interfaces,
- SFP with optical amplifier for 40dB reach
- OS, RS, MS termination and NIM (VC- n , with n =12, 3, 4),
- 272x272 STM-1 eqv. higher-order cross connecting (VC-4/ 4-4c/4-16c),
- 128x128 STM-1 eqv. lower-order cross connecting (VC- n , with n =12, 3 and VC-11 (when mapped as TU-12)),
- timing collection, generation, and distribution.
- This unit can be equipped with 0, 1, 2, 3, or 4 hot-plugable STM-16 interfaces.
- This unit supports timing reference selection from just one arbitrary STM-16 port.



2.5G Core Unit application for STM-16 Long Span on G.652 fiber

This application is reached by using the SI-16SFP C2/4 2.5G Core Unit together with an SFP with optical amplifier for 41dB reach.



2.5G Core Unit 176/64 (LKA481)

The SI-16 SFP C3/1, 1 port STM-16 unit can be placed in the core slots of the system. The unit has one red fault LED plus one for the SFP.

The unit's main functions are:

- 1 STM-16, Small Formfactor Plugable (SFP) interface,
- OS, RS, MS termination and NIM (VC- n , with n =12, 3, 4),
- 176 x 176 STM-1 eqv. higher-order cross connecting (VC-4/4-4c/4-16c),
- 64x64 STM-1eqv. lower-order cross connecting (VC- n , with n =12, 3 and VC-11 (when mapped as TU-12)),
- timing collection, generation, and distribution.

- This unit can be equipped with 0 or 1 hot-plugable STM-16 SFP.
- This unit supports timing reference selection from the STM-16 port.

2.5G Core Unit 176/64 (LKA482)

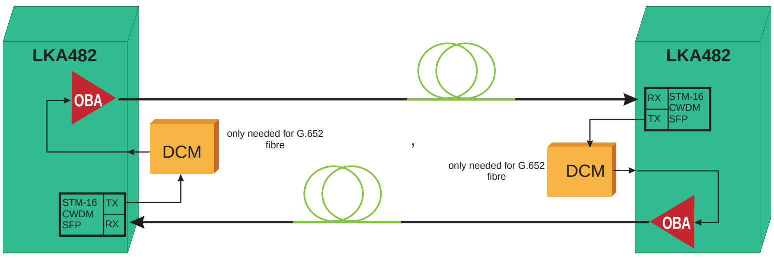
The SI-16 VH C3/1 OBA, 1 port STM-16 unit with Very Long Haul can be placed in the core slots of the system. The unit has an integrated OBA. The optical link between LD and OBA allows the inclusion of an external DCF. The unit has one red fault LED plus one for the SFP.

The unit’s main functions are:

- 1 STM-16, Small Formfactor Plugable (SFP) interface,
- OS, RS, MS termination and NIM (VC- n , with n =12, 3, 4),
- 176 x 176 STM-1 eqv. higher-order cross connecting (VC-4/4-4c/4-16c),
- 64x64 STM-1eqv. lower-order cross connecting (VC- n , with n =12, 3 and VC-11 (when mapped as TU-12)),
- timing collection, generation, and distribution.
- This unit can be equipped with 0 or 1 hot-plugable STM-16 SFP.
- This unit supports timing reference selection from the STM-16 port.

2.5G Core Unit application for STM-16 Long Span on G.652 fiber

This application is reached by using the SI-16 VH C3/1 OBA 2.5G Core Unit together with an SFP with onboard optical amplifier.



The DCM is needed to extend the tolerable chromatic dispersion to a value of 2540 ps/nm within the bandwidth of the 1551nm CWDM channel. For G.653 and G.655 fibre or shorter distances of G.652 fibre where the dispersion is less than 1600 ps/nm no DCM is needed.

The following table gives an overview to the different scenarios and the selection of the right DCM:

Chromatic Dispersion Range [ps/nm] @ 1551nm		Required DCM Type	
Min.	**Max.**		
0	1600	no	
1400	1760	DCM-10	
1600	1920	DCM-20	
1700	2070	DCM-30	
1800	2230	DCM-40	
2000	2390	DCM-50	
2200	2540	DCM-60	
0	1000	no	*This values are only relevant if the transmission cable has very high loss or if additional component loss applies.*
800	1160	DCM-10	
900	1320	DCM-20	
1000	1475	DCM-30	
1200	1630	DCM-40	
1400	1790	DCM-50	
1500	1950	DCM-60	

10G Core Units

The 10G Core Units can be placed in the core slots of the *Metropolis*® ADM (Universal shelf) system. The units have a red fault LED and a green activity LED.

Type L-64.2b/3 (LKA26), 1550 nm long haul line interface for a 80 km target distance

The unit’s main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)
- 64 × 64 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.

Type S-64.2b/3b (LKA27), 1550 nm short haul line interface for a 40 km target distance

The unit’s main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)

- 64 × 64 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.

Type I-64.1r (LKA47), 1310 nm intra-office interface, for 600 m target distance

The unit's main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)
- 64 × 64 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.

Type L64.2c2/3 (LKA28) 1550 nm long haul line interface, for a 120 km target distance

L-64.2c/3 is achieved without booster amplifier.

The unit's main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)
- 128 × 128 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.

Type U64.2c2/3 (LKA281) 1550 nm long haul line interface, for up to 150 km target distance

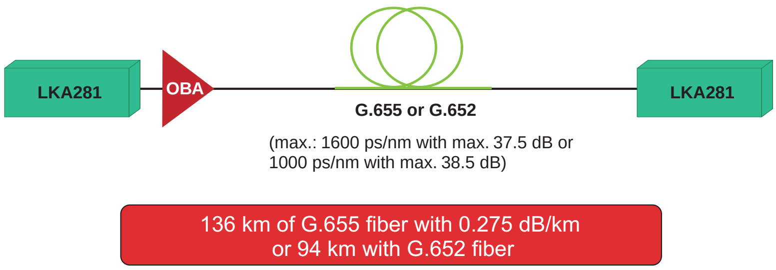
Similar to LKA28, but with SBS suppression on, in order to support interworking with an external Optical Amplifier:

The unit's main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)
- 128 × 128 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.

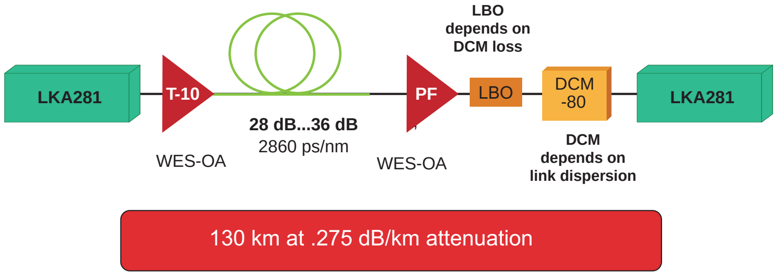
10G Core Unit application for STM-64 Long Span with optical booster amplifier only

This application is reached by using the U64.2c2/3 line interface (LKA281) together with external collocated Booster Amplifier only.



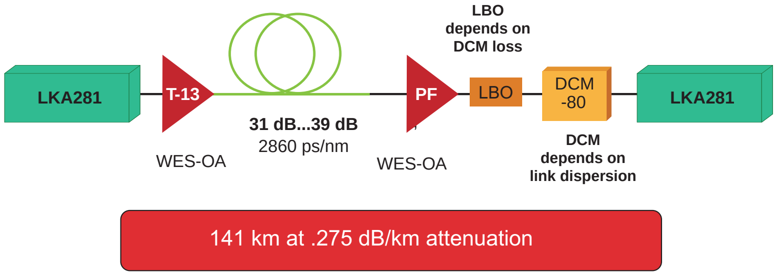
10G Core Unit application for STM-64 Long Span on G.652 Fiber (2a/2)

This application is reached by using the U64.2c2/3 line interface (LKA281) together with external collocated Booster- and Pre-Amplifier and an external collocated DCM.



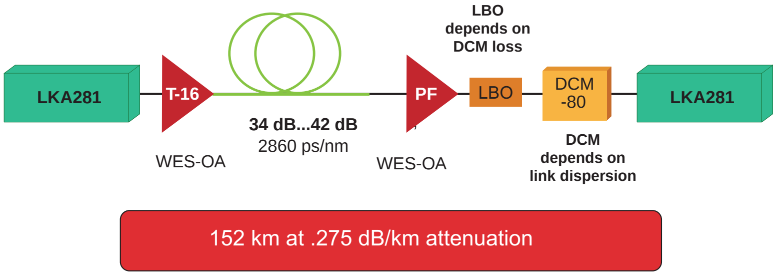
10G Core Unit application for STM-64 Long Span on G.652 Fiber (2b/2)

This application is reached by using the U64.2c2/3 line interface (LKA281) together with external collocated Booster- and Pre-Amplifier and an external collocated DCM.



10G Core Unit application for STM-64 Long Span on G.652 Fiber (2c/2)

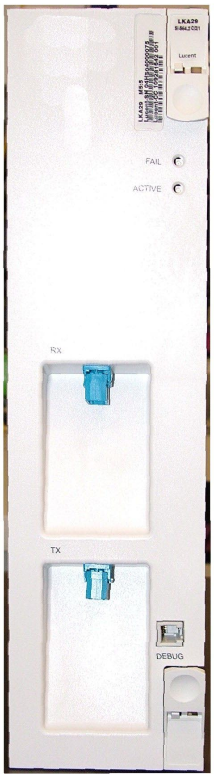
This application is reached by using the U64.2c2/3 line interface (LKA281) together with external collocated Booster- and Pre-Amplifier and an external collocated DCM.



Type S64.2b/3b (LKA29) 1550 nm short haul line interface for a 40 km target distance

The unit's main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)
- 128 × 128 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.



Type I64.1r (LKA49) 1310 nm intra-office interface, for 600 m target distance

The unit's main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)

- 128 × 128 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.

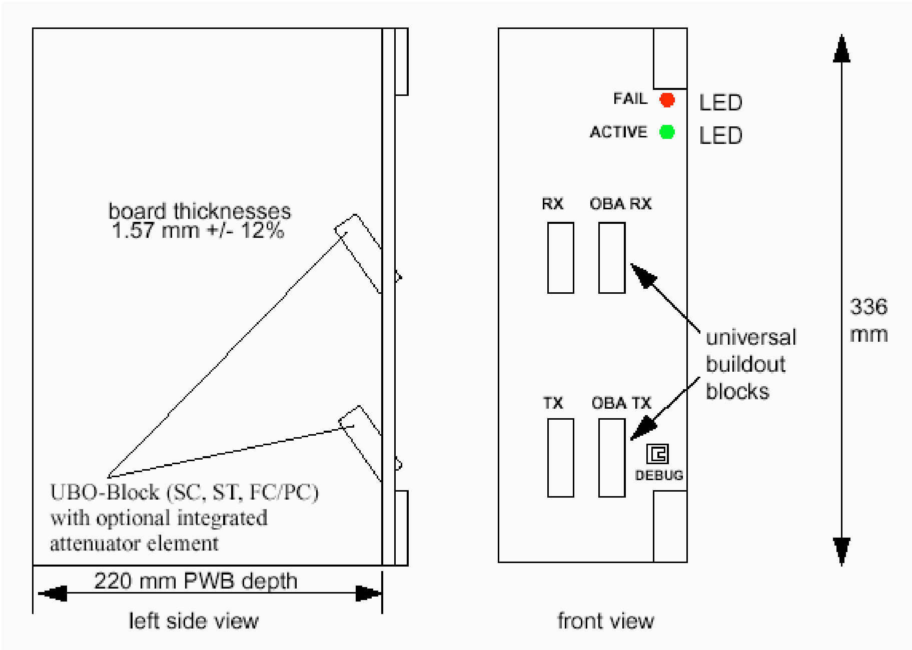
Type V-64.2/3 line interface (LKA350), with compatible optics for up to 120 km span width

Depending on the used 10G transponder used in the interface, different span width can be supported.

- LKA350 units of the series numbers S1:1 to S1:4 supports span widths of up to 110 km on G.652 fibers
- LKA350 units of the series S5:5 number supports span widths of up to 125 km on G.652 fibers and attenuation limited distances on G.655 fiber

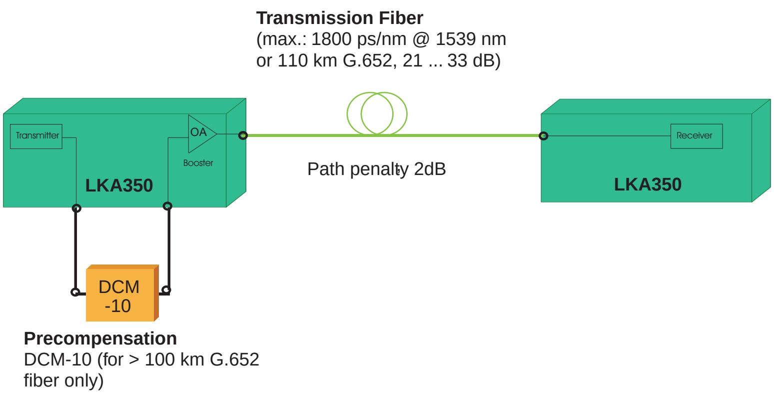
The unit’s main functions are

- OS, RS, MS termination and NIM (VC4, VC4-4c, VC4–16c)
- 272 × 272 STM-1 eqv. higher order cross-connecting (VC-4/4-4c/4–16c)
- 128 × 128 STM-1 eqv. lower order cross-connecting and NIM (VC-*n*, with *n* = 12, 3)
- timing collection, generation, and distribution.



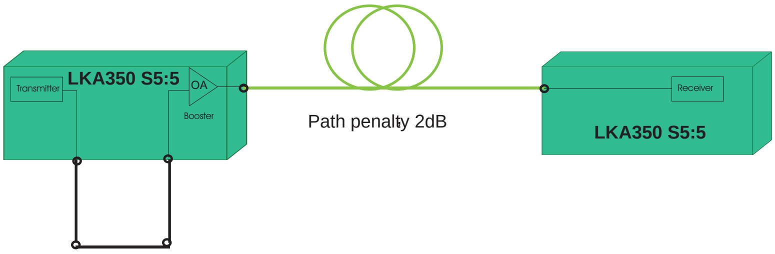
10G Core Unit application (LKA350 Series S1:1 to S1:4) for STM-64 Long Span on G.652 fiber

This application is reached by using the V-64.2/3 line interface (LKA350 S1:1 to S1:4) together with an integrated booster amplifier and an external Dispersion Compensation Module (DCM).



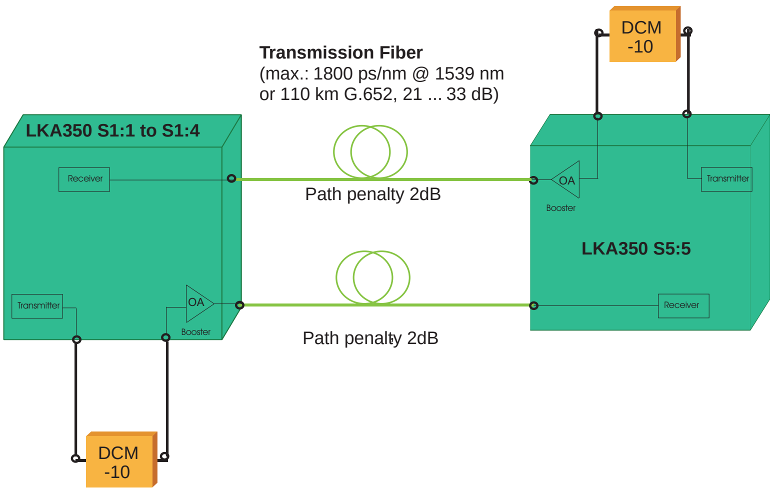
10G Core Unit application (LKA350 Series S5:5) for STM-64 Long Span on G.652 and G.655 fiber

This application is reached by using the V-64.2/3 line interface (LKA350 S5:5) with integrated booster amplifier. No external Dispersion Compensation Module (DCM) needed.



10G Core Unit application for STM-64 Long Span on G.652 fiber, interworking of LKA350 (series S1:1 to S1:4) with LKA350 (series S5:5)

This interworking scenario can be reached by using both interface (LKA350 (S1:1 to S1:4) and LKA350 (S1:5) together with integrated booster amplifiers and external Dispersion Compensation Modules (DCM).



1.5 Mbit/s plesiochronous interface unit (LKA16)

The PI-DS1/63 unit can be placed in one of the tributary slots of the *Metropolis*® ADM (Universal shelf) system. In combination with a paddle board, the unit provides 63 bidirectional 1.5 Mbit/s interfaces. The unit has a red fault LED. The unit can be placed in tributary slots TS1 ... TS9.

According to [G.783]e, the unit implements:

- the PDH physical interface (PPI)
- lower order path adaptation (LPA)
- lower order path termination (LPT)
- higher-order path adaptation (HPA)
- higher-order path termination (HPT)
- the EQSTM1 backplane interface

2 Mbit/s plesiochronous interface unit (LKA2)

The PI-E1/63 unit can be placed in one of the tributary slots of the *Metropolis*® ADM (Universal shelf) system. In combination with a paddle board, the unit provides 63 bidirectional 2 Mbit/s interfaces. The unit has a red fault LED. The unit can be placed in tributary slots TS1 … TS9.

According to [G.783]e, the unit implements:

- the PDH physical interface (PPI)
- lower order path adaptation (LPA)
- lower order path termination (LPT)
- higher-order path adaptattion (HPA)
- higher-order path termination (HPT)
- the EQSTM1 backplane interface

34 Mbit/s / 45 Mbit/s plesiochronous interface unit (LKA8/LKA8B)

This PI-E3DS3/12 unit can be placed in tributary slots [1 … 8] of the *Metropolis*® ADM (Universal shelf) system. On this unit there are twelve integrated switchable bidirectional external interfaces that comply with either the G.703-8 specification for 34 Mbit/s (E3) or the G.703-5 specification for 45 Mbit/s (DS3).

In the egress direction, AU-4 pointer processing and VC-4 termination (POH processing) for four AU-4s takes place. This is followed by TU-3 pointer processing, VC-3 termination (again POH processing), desynchronization and conversion to HDB3/B3ZS of the twelve 34/45 Mbit/s signals.

In the ingress direction exactly the inverse processes happen.

On this unit any mixture of twelve 34/45 Mbit/s interfaces can be realized. One unit occupies one of the slots that are reserved for tributary-port units. The unit has a red fault LED. The unit can be placed in tributary slots TS1 … TS8. The choice between E3 and DS3 modes will be made per interface. By default all interfaces will run in DS3 mode.

STM-1e synchronous interface unit (LKA3)

This SI-1e/4 unit can be placed in the tributary slots of the *Metropolis*® ADM (Universal shelf) system. The unit has four bidirectional external CMI interfaces that comply with the G.703-15 specification for 155 Mbit/s (STM-1e). The unit provides

CMI encoding/decoding, pointer processing, and RS/MS termination functionality for 4 STM-1s. The unit operates in AU-4 mode. The unit has a red fault LED. The unit can be placed in tributary slots TS1 … TS8.

For STM-1e see also "Parent pack for STM-4, STM-1o and STM-1e (LKA39)" (p. 4-36).

STM-1o synchronous interface units (LKA6, LKA13)

The STM-1o synchronous interface units can be placed in the tributary slots of the *Metropolis*® ADM (Universal shelf) system. The units support four optical STM-1 interfaces (1310 nm short haul or 1550 nm long haul)). The unit has a red fault LED. The units can be placed in tributary slots TS1 … TS9.

The unit's main functions are:

- type SI-S1.1/4 short haul interface
- type SI-L1.1/4 long haul interface
- OS, RS and MS termination
- 1+1 equipment protection (EQP) with a mate unit (only in combination with MSP)
- 1+1 MSP with a mate unit
- conversion between AU-3s and TU-3s.

For STM-1o see also "Parent pack for STM-4, STM-1o and STM-1e (LKA39)" (p. 4-36).

STM-4 synchronous interface units (LKA11 / LKA14)

The STM-4 synchronous interface units can be placed in the tributary slots of the *Metropolis*® ADM (Universal shelf) system. The units support one optical STM-4 interface (1310 nm short haul or 1550 nm long haul). The units have a red fault LED. The units can be placed in tributary slots TS1 … TS9.

The unit's main functions are:

- type SI-S-4.1/1 short haul interface
- type SI-L4.2/1 long haul interface
- OS, RS and MS termination
- 1+1 equipment protection (EQP) with a mate unit (only in combination with MSP)
- 1+1 MSP with a mate unit
- conversion between AU-3s and TU-3s.

STM-16 synchronous interface units

The STM-16 synchronous interface units can be placed in one of the 9 tributary slots of the *Metropolis*® ADM (Universal shelf) system. The units provide access to one optical interface and occupy one tributary slot.

Type SI L-16.1/1 1310 nm long haul interface for a 40 km target distance (LKA23)

The unit's main functions are:

- The unit supports the universal optical connector (default SC connector) and has a red fault LED.
- OS, RS, MS termination
- support of VC-4/4-4c/4-16c ↔ AUG16 adaptation

Type SI L-16.2/1 1550 nm long haul interface for an 80 km target distance (LKA22)

The unit's main functions are:

- The unit supports the universal optical connector (default SC connector) and has a red fault LED.
- OS, RS, MS termination
- support of VC-4/4-4c/4-16c ↔ AUG16 adaptation

Type SI-x16 SFP/1 (LKA50)

The unit supports one SFP with one optical interface. These SFP's are the same as on the 4 x STM-16 SFP CC-272/128 core unit. This unit supports the LC connector and has a red fault LED plus one per SFP cage.

The unit's main functions are:

- support of 1 STM-16 SFP,
- SFP with optical amplifier for 40dB reach
- OS, RS, MS termination
- support of VC-4/4-4c/4-16c ↔ AUG16 adaptation

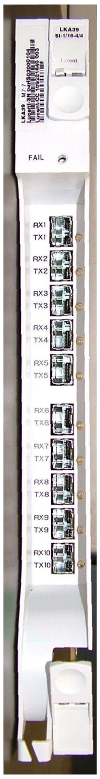
Parent pack for STM-4, STM-1o and STM-1e (LKA39)

This unit (SI-1/M) supports up to

- 4 STM-4 SFP's (on the pack itself),
- 16 STM-1 SFP's,
(10 of these SFP's on the pack itself, the other 6 on a STM-1o paddleboard: P.224.2)
- 12 STM-1e ports on a STM-1e paddleboard (unprotected: P.224.0, 1+1 protected: P.224.1).

The unit has a red LED plus one per SFP cage.

Note: Only the ports 1, 5, 9 and 10 can be used for STM-4.



Data interface unit LAN Fast Ethernet Mb-EOS (IP–LAN/8) (LKA4)

This LAN unit (IP-LAN/8) is a tributary port unit of the *Metropolis®* ADM (Universal shelf) system. At the system side, the unit provides a double EQSTM-1(~300 Mbit/s) interface towards the cross-connect (CC) function. WAN capacity of up to 260 Mbit/s is available. At the external interface side, the unit provides 8 Ethernet interfaces at 10/100 Mbit/s (10BaseT/100BaseT). The Ethernet connectors are located on the paddle boards. The unit has a red fault LED. The unit can be placed in tributary slots TS1 … TS8.

E/FE switched Card (LKA412)

This LAN unit is a tributary port unit of the *Metropolis®* ADM (Universal shelf) system. This unit supports L2 Ethernet switch and mapping of Ethernet traffic into VC-3-Xv (x=1..9) , VC-12-Xv (x=1..63) and VC-4-Xv (x=1..3) according GFP, IEEE tagging , VLAN trunking, LCAS and LPT.

At the system side, the unit provides a 3x TXI-622Mb interface towards the cross-connect (CC) function. Up to total 1200 Mb/s WAN capacity is available and one WAN port capacity is in Max. 100Mbps. All 12x Ethernet interfaces can operate at full wirespeed (100Mb/s).

At the external interface side, via paddle boards, the unit can provide 12 Ethernet interfaces, like 10/100BASE-T and Ethernet SFP.

> **Important!** LKA412 has limitations in supporting applications requiring full hardware (forwarding) capacity, like all 12 ports in full-rate repeater application. For details on such configuration limitation and recommended configurations of high capacity applications, refer to “LKA412 engineering doc” and *TransLan*®APG

The unit has a red fault LED. The unit can be placed in tributary slots TS1 .. TS8.

This unit supports exactly the same QoS and Ethernet switch function as LKA4 (excluding legacy transparent VPN mode).

Data interface unit IP-GE/2 (LKA12)

This IP-GE/2 Gigabit Ethernet unit is a tributary port unit of the *Metropolis*® ADM (Universal shelf) system. This port unit supports mapping of Ethernet traffic into VC-3-Xv and VC-4-Xv, according EOS/GFP mapping, VPN, VLAN trunking and LCAS.

At the system side, the unit provides a quad EQSTM-1 (~600 Mbit/s) interface towards the cross-connect (CC) function.

At the external interface side, the unit provides 2 Ethernet 1000BASE-X interfaces. Up to 600 Mbit/s WAN capacity is available, which means that only “lite” GbE services are allowed. This unit can be used with two “on board” plugable optics interfaces (SX-GBE, LX-GBE and ZX-GBE).

The unit has a red fault LED. The unit can be placed in tributary slots TS1 … TS9.

Data interface unit IP-GE/2 (LKA12B)

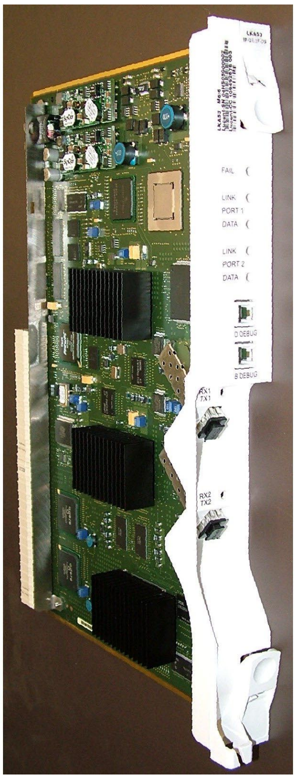
For this unit the same applies as for LKA12.

IP-GE/2F-OS (LKA53)

The IP-GE/2F-OS pack (Gigabit Ethernet Full Rate / One Slot Pack) enhances *Metropolis*® ADM (Universal shelf) Gigabit Ethernet transport capabilities in the following aspects, as compared to the R1 and R2 packs LKA12:

- full rate GbE capability with a single slot board (LKA12: 600 Mbit/s backplane capacity)
- 2.5 Gbit/s connectivity to the backplane (LKA12: 4/8 times EQSTM1 only)
- full low order VC12/VC3 as well as higher order VC4 termination (LKA12: VC3, VC4 only)
- LCAS for all levels (LKA12: VC4-Xv only) ·
- high number of WAN ports (up to 64) (LKA12: up to 8)

The IP-GE/2F-OS (LKA53) Gigabit Ethernet LAN interface unit is a single slot full-rate Gigabit Ethernet unit which can be used in any of the tributary slots TS1 ... TS9 of the *Metropolis*® ADM (Universal shelf).



Characteristics

The characteristics of the IP-GE/2F-OS (LKA53) are:

LAN interfaces	2 × 1000Base-X (SFPs for 1000Base-SX / 1000Base-LX / 1000Base-ZX / 1000Base-BX)
Max. number of WAN ports	64
Supported rates (all with virtual concatenation)	VC-12, VC-3, VC-4
Max. VCG group size	VC-12-63v VC-3-21v VC-4-7v
Max. number of tributaries	VC-12: 1008 VC-3: 48 VC-4: 16
LCAS support	VC-12, VC-3, VC-4
Encapsulation method	GFP
Total transmission capacity	2 × 1.0 Gbit/s point-to-point (2488.32 Mbit/s from backplane)

Important! The IP-GE/2F-OS (LKA53) Gigabit Ethernet unit can only be used in combination with

- an LKA21 System Controller, and
- a 2.5-Gbit/s or 10-Gbit/s core unit of type SI-L64.2 C1/1 (LKA26), SI-I64.1r C1/1) (LKA47), SI-S64.2 C1/1 (LKA27), SI-16SFP C2/4 (LKA48), SI-16 SFP C3/1(LKA481), SI-16 VH C3/1 OBA (LKA482), SI-L64.2 C2/1 (LKA28), SI-U64.2 C2/1 (LKA281), SI-S64.2 C2/1 (LKA29), SI-I64.1r C2/1 (LKA49), or SI-V64.2 C2/1 (LKA350).

Gigabit Ethernet port LEDs

On the faceplate of the Gigabit Ethernet circuit packs, there are two additional LEDs ("LINK" and "DATA") associated with each external Ethernet port (LAN port) which provide the following information:

- The green LED labelled "LINK"" indicates the link status, i.e. the green LED is lit if the corresponding link is active.
  The LAN port status LED behaves slightly differently on IP-GE/2F-OS when compared to other packs. Upon some transmission defect conditions, the LED does not blink with 1 Hz (as the other units do), but with 15 Hz.
- The yellow LED labelled "DATA" indicates the link activity (transceived data in both transmission directions).

MRV module

The only supported MRV module by *Metropolis*® ADM (Universal shelf) is MRV *Fiber*® Driver EM316-GRMAHSH (10/100/1000 Mbps)

MRV equipment comcodes

MRV equipment part	Comcode
GRMAHSH-RL User port Auto-sensing between 10/100/1000Mpbs Copper and SFP Based Fiber, to Redundant Fiber SFP Based Trunk, 802.3AH, with IP-Less Remote Management RoHS 5/6 Compliant (SW revision - Lucent 1.0	300894011
LU BNDL EU1 GR-RL Single-slot chassis with internal 200-250 VAC Power Supply (European version), no power cable is provided with User port Auto-sensing between 10/100/1000Mpbs Copper and SFP Based Fiber, to Redundant Fiber SFP Based Trunk, 802.3AH, with IP-Less Remote Management RoHS 5/6 Compliant (SW revision - Lucent 1.0)	300894029

MRV equipment part	Comcode
LU BNDL DC1 GR-RL Single-slot Chassis with Internal -48V DC Power Supply. Desk Top with User port Auto-sensing between 10/100/1000Mpbs Copper and SFP Based Fiber, to Redundant Fiber SFP Based Trunk, 802.3AH, with IP-Less Remote Management (SW revision - Lucent 1.0)	300894037

Notes:

1. A bundle consists of the MRV Fieber driver module and the chassis.

Supported MRV SW version

MRV DIP switch settings

The MRV DIP switch must be set as follows:

Block	Switch	Label	Supported setting	Notes
SW1	1	MX DIS	don’t care	Ignored by MRV if AUTO==ON.
	2	AUTO	ON	Selects user-port autonegotiation enabled
	3	1000Tx	don’t care	Ignored by MRV if AUTO==ON
	4	100Tx	don’t care	Ignored by MRV if AUTO==ON
	5	HDPLX	don’t care	Ignored by MRV if AUTO==ON
	6	CPE EN	ON	Selects CPE mode
	7	LIN EN	ON	Selects LIN-enabled mode
	8	RM DIS	OFF	Currently reserved for future use by MRV.
SW2	1	NM DIS	ON	Disables NM write access to the MRV module.
	2	LPBK	OFF	Disables local loopback.
	3	PRE EN	OFF	Currently reserved for future use by MRV.
	4	T-AUTO	OFF	Disables autonegotiation on trunk interface.

When using this settings, the MRV module is expected to bring up the links as follows, after connecting the equipment and powering up the MRV module:

User Link (P3 for SFP 1000/100 Mbps or P4 for 10/100 Mbps):

- Autonegotiation: on
- Rate: autonegotiated

- Duplexity: autonegotiated
- Flow Control: off (will not be negotiated)

Trunk Link (P1):

- Autonegotiation: off
- Rate: 1000
- Duplexity: full
- Flow Control: off

Important! The LKA53 Default Port Mode is “Autonegotiation enabled” !

1.5 Mbit/s paddle board, 100 Ω, protected

The *PB-DS1/P100/63.* unit can be placed in the PB slots of the *Metropolis®* ADM (Universal shelf) systems. This PB is an extension of the PI-DS1/63, and provides:

- protection 1:N in case of PI-DS1/63 unit, (in TS9)
- 100 Ω adaption
- simplicity for subscriber cable connections

The board is placed in the I/O slot positions associated with the (worker) tributary slots and responsible for the protection and connection function for the PI-DS1/63 unit. The paddle board can also be used for operation without 1:N protection. The paddle board has a red fault LED.

2 Mbit/s paddle board, 75 Ω or 120 Ω protected

The PB-E1/P75/63 (PBE3D) unit and PB-E1/P120/63 (PBE41) unit can be placed in the PB slots of the *Metropolis®* ADM (Universal shelf) systems. This PB module is an extension of the PI-E1/63 and provides:

- high density interconnect
- protection 1:N in case of PI-E1/63 unit (in TS9)
- 75 Ω adaption in case of type PB-E1/P75/63
- 120 Ω adaption in case of type PB-E1/P120/63.

The board is placed in the I/O slot positions associated with the (worker) tributary slots and responsible for the protection and connection function for the PI-E1/63 unit. The paddle board can also be used for operation without 1:N protection. The paddle board has a red fault LED.

34/45 Mbit/s paddle boards

Paddle boards for 12 × E3/DS3 unprotected interface and 1.6/5.6 connectors (PBG4)

This PB-E3DS3/75/12 unit can be placed in PB slots PB1 … PB8 of the *Metropolis®* ADM (Universal shelf) system. On this paddle board there are 1.6/5.6 connectors for twelve bidirectional external HDB3/B3ZS interfaces. These connectors comply with either the G.703-8 specification for 34 Mbit/s (E3) or the G.703-5 specification for 45 Mbit/s (DS3). The paddle board can be used for unprotected interfaces in combination with one unit. The unit has a red fault LED.

Paddle boards for 12 × E3/DS3 interface with 1+1 protection and 1.6/5.6 connectors (PBP1)

This PB-E3DS3/P75/12 unit can be placed in PB slots PB1 … PB8 of the *Metropolis®* ADM (Universal shelf) system. On this paddle board there are 1.6/5.6 connectors for twelve bidirectional external HDB3/B3ZS interfaces. These connectors comply with the either G.703-8 specification for 34 Mbit/s (E3) or the G.703-5 specification for 45 Mbit/s (DS3) The paddle board can be used for 1+1 protection in combination with two units in two adjacent trib slots (trib slots 1&2, 3&4 and 5&6, 7&8 are allowed). The unit has a red fault LED.

STM-1e paddle boards

The following STM-1e paddle boards are supported:

PB 4 × STM-1e

Paddle board PB-1/P75/4D (PBP2) and PB-1/P75/4S (PBG2) for 4 × STM-1e interfaces with 1+1 protection with 1.6/5.6 connectors. On this paddle board there are 1.6/5.6 connectors for four bidirectional external CMI interfaces. These connectors comply with the G.703-15 specification for 155 Mbit/s (STM-1e). The paddle board can be used for 1+1 protection in combination with two units in two adjacent tributary slots (trib slots 1&2, 3&4, 5&6 and 7&8 are allowed).

PB 12 x STM-1e (unprotected) (PBP5)

On this paddle board 1.6/5.6 connectors for 12 bi-directional external CMI interfaces, complying with G.703-15 specification for 155 Mbit/s (STM-1e), are available. This unit supports unprotected STM-1e interfaces only. This board will be used for unprotected applications in combination with units as described in “Parent pack for STM-4, STM-1o and STM-1e (LKA39)” (p. 4-36). It will be used in the I/O slot positions belonging to tributary slots TS1 .. TS8. The PB has a red fault LED.

PB 12 x STM-1e (1+1 protected) (PBP6)

On this paddle board 1.6/5.6 connectors for 12 bi-directional external CMI interfaces, complying with G.703-15 specification for 155 Mbit/s (STM-1e), are available. The paddle board can be used for 1+1 protection in combination with two units, as described in “Parent pack for STM-4, STM-1o and STM-1e (LKA39)” (p. 4-36), in two adjacent trib slots (trib slots 1&2, 3&4 and 5&6, 7&8 are allowed). The PB has a red fault LED.

6 x STM-1o paddle board (PBP8)

On this paddle board are 6 SFP cages for STM-1o interfaces. The PB will have a dedicated fault LED for each SFP cage plus one for the PB itself.

12x10/100BaseT Paddle board for unprotected LAN interfaces (PBL12)

This PB-LAN/100/12 unit can be placed in the I/O slots of the *Metropolis*® ADM (Universal shelf). This LAN interface paddle board provides RJ45 connectors for 12 EtherNet UTP interfaces at 10 Mbit/s/100 Mbit/s(10BaseT/100BaseT). The paddle board does not perform equipment protection for the Ethernet connections.Each RJ45 port has 2 LEDs linked, one green LED for Link status and one yellow LED for Activity status. Thepaddle board will have a red fault LED.For Metropolis(R) ADM (Universal) the unit can be placed in the I/O slots associated with TS1 .. TS8.

12x Ethernet SFP paddle board for unprot. LAN interfaces (PBO12)

This PB-LAN/opt/12 SFP unit can be placed in the I/O slots of the *Metropolis*® ADM (Universal shelf). This LAN interface paddle board provides SFP sockets for 12 Ethernet electrical / optical interfaces at 10 Mbit/s/100Mbit/s (10/100BASE-T, 100BASE-LX10). The paddle board does not perform equipment protection for the Ethernet connections. Each SFP socket has 3 LEDs linked, one green LED for Link status, one yellow LED for Activity status and one red LED for SFP Fault status. The paddle board has a red fault LED. The unit can be placed in the I/O slots associated with TS1 .. TS8.

Paddle board-LAN/100/8

This PB-LAN/100/8 unit can be placed in the PB slots of the *Metropolis*® ADM (Universal shelf) system. This LAN interface paddle board provides connectors for 8 Ethernet UTP interfaces at 10/100 Mbit/s (10BaseT/100BaseT). The paddle board does not perform equipment protection for the Ethernet connection. Each RJ-45 connector has a green link-status LED. The paddle board has a red fault LED.

System Controller Unit (SC)

The System Controller Unit (SC) provides the central control, supervision, and security functions in the network element. For this purpose, it communicates with the function controllers on the individual interface circuit packs.

The System Controller Unit (SC) controls and provisions all circuit packs via a local LAN bus. The SC also provides the external operations interfaces for office alarms, miscellaneous discretes and connections to the overhead channels (a maximum of four overhead bytes may be selected for connection to four connectors on the interconnection box).

The SC also facilitates first line maintenance via several LEDs and buttons on the front panel. General status and alarm information is displayed. The System Controller Unit houses the systems’ LEDs and buttons for station alarms. The SC has a red fault LED. Various controls and an F-interface connector, for a local maintenance PC (ITM-CIT), are also located on this panel. The SC communicates with the centralized management system (*Navis*® OMS). One part of the SC, which routes management information between SDH equipment and the element management system, is the Data Packet

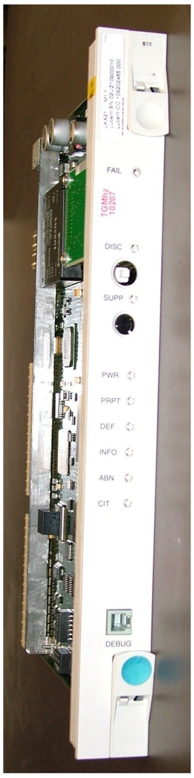
Switch (DPS). Communication is established via the Data Communication Channels (DCC) (= D1-3/D4-12 bytes), within the STM-N section-overhead signals or via one of the Q-interfaces of the system.

Information that is destined for the local system is routed to the System Controller Unit, while other information is routed from the node via the appropriate embedded channels of the STM-*N* line or tributary signals (N= 1, 4, 16 or 64). The OMS manages the *Metropolis®* ADM (Universal shelf) at the element level and the network level. The ITM-Craft Interface Terminal (ITM-CIT) can be used to manage small networks and for maintenance.

The System Controller Unit is part of the minimum equipment of any system configuration. The SC is needed to store/change all system configuration data and to control many of the automatic processes (e.g. equipment-protection switching) within the system. The SC contains the system memory banks. A system cannot start up without a System Controller Unit.

When a System Controller Unit is removed from a working system the system continues to operate, but some automatic maintenance actions will no longer take place. Although the System Controller Unit is not protected. However this does not represent a single point of failure since the SC functionalities are distributed through the system and mainly in the Core Units which are equipment protected. This implies that in case of a simultaneous SC failure and network link failure, line and path protection schemes will still function.

The following figure shows the System Controller unit, LKA21:

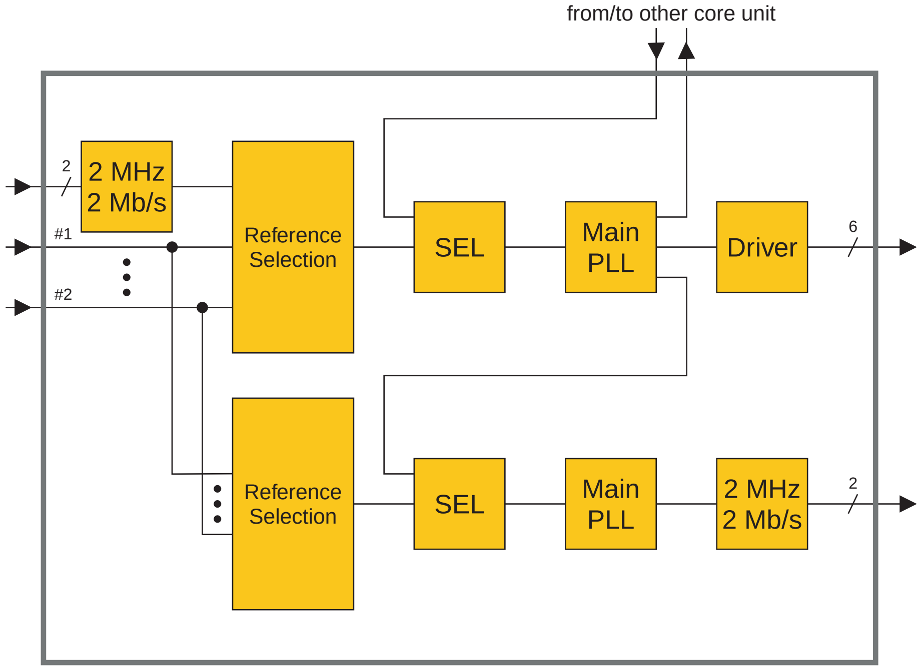


□

Synchronization and timing

Timing architecture

The figure below depicts the architecture of the timing function on the 2.5G and 10G Core Units of the *Metropolis*® ADM (Universal shelf) system. A 1+1 equipment protection scheme will be provisioned automatic between the two Core Units.



External timing reference inputs

There are two external timing reference inputs for synchronization purposes. The signal format can be either 2048 kHz according to the G.703-10 or 2048 kbit/s according to the G.703-6. The 2048 kbit/s reference signal can be either framed according to G.704 or unframed (in that case also AIS is a valid format).

The desired format can be selected for each input. The impedance of the interfaces (75 Ω coaxial or 120 Ω symmetrical) is determined at installation according to customer prescription (but equal for both interfaces). Even if only one timing unit is present in the system, two input signals can be applied.

SSM support (Synchronization Status Message)

If the selected format of an external synchronization signal is 2048 kbit/s with G.704 framing, the reception and transmission of SSM's in a user assignable Sa bit (4 to 8) location can optionally be supported. Bit 4 is default.

Excessive reference frequency offset mapped to reference fail

If the active reference of the *Metropolis*® ADM (Universal shelf) is outside the acceptable range (at least ±11 ppm), the reference is declared failed.

By comparing the frequencies of all assigned references to the frequencies of the internal oscillator on both timing units, it can be decided, in case an excessive frequency difference is detected, whether a timing reference or the internal oscillator of one of the timing units is off-frequency. In the latter case that unit is declared failed.

Reference signal switching

Two synchronization inputs of the same type (e.g. two external synchronization signals or two 2 Mbit/s tributaries or 2 STM-N tributary signals) can be set up to have a non-revertive 1+1 protection relation. Such a pair counts as a single synchronization reference for the internal clock or the external synchronization output. Manual and automatic switching are supported.

If two STM-N inputs form an MSP pair, they also count as one syn-chronization reference, following the MSP switch. If restoration by means of a reference signal switch is possible this method will prevail over protection through timing link switching.

Timing link switching for internal clock

A large number of possible input references or outputs from reference signal switch processes can be assigned to the timing link switch that selects the reference for the internal clock. Input references are either suitable synchronization inputs directly assigned to the timing link switch or the active reference from a reference signal switch pair or MSP pair.

Limitations in the assignment are:

- two external synchronization signals (or one reference signal switch pair)
- two timing signals derived from the line interfaces
- four from the tributary interfaces can be assigned at any time (where reference signal switching pairs count as two assignments, but MSP pairs count as one assignment).

Automatic and manual switching (forced, manual and lock-out) between the assigned references is possible. A wait-to-restore timer (0 to 60 minutes, programmable in 1 minute increments, default 5 minutes) is present to time re-qualification of a synchronization source after a failure. Can be reset manually.

Timing link switching for external synchronization output

A number of possible input references or outputs from reference signal switch processes can be assigned to the timing link switch that selects the reference for the external synchronization outputs.

The limitations are:

- at most two timing signals derived from the line interfaces and .
- at most four timing signals derived from the tributary interfaces can be assigned at any time (where reference signal switching pairs count as two assignments, but MSP pairs count as one assignment)

Automatic and manual switching (forced, manual and lock-out) between the assigned references is possible. A wait-to-restore timer (0 to 60 minutes, programmable in 1 minute increments, default 5 minutes) is present to time re-qualification of a synchronization source after a failure. Can be reset manually.

Support of ETSI SSM algorithm

Automatic protection switching between the references that are available to both timing link switches (for the internal oscillator and the external synchronization output) is supported. The switching algorithm is according to ETSI ETS 300417-6. The algorithm acts on those inputs which are assigned to participate and to which the customer can assign a certain priority. The SSM algorithm can be turned off. In that case only the assigned priorities are considered to determine the active reference.

It is possible to assign a certain SSM value (overriding the received SSM, if any) to any synchronization reference signal that can be made available to the SSM selection algorithm.

External timing reference outputs

"Timing architecture" (p. 4-46) shows two output connection points with signals that can be used to synchronize other equipment. The format is either 2048 kHz according to G.703-10 or 2048 kbit/s according to G.703-6, with or without a G.704 frame.

The desired format can be selected for both outputs or an output disabled altogether. The impedance of the interfaces (75 Ω coaxial or 120 Ω symmetrical) is determined at installation according to customer prescription (but equal for both interfaces). Even if only one timing unit is present in the system, two output signals are available.

In case the framed 2048 kbit/s format is selected for the external synchronization output signal, the user can force a DNU (Do Not Use for synchronization) message to be transmitted in the Sa -bit channel selected for SSMs.

DNU (Do Not Use)

In case the framed 2048 kbit/s format is selected for the external synchronization output signal, a DNU (Do Not Use for synchronization) message can be transmitted in the Sa bit channel selected for SSMs (Synchronization Status Message).

Automatic squelching of the external synchronization output (2 Mbit/s or 2 MHz)

The external synchronisation output(s) will automatically be squelched as soon as its/their associated Quality Level (QL) drops below a certain threshold, which can be set by the customer. Squelching is implemented by turning the 2048 kHz or unframed 2048 kbit/s signal off. For framed 2048 kbit/s the squelching method is user selectable between AIS substitution or forwarding of the DNU message.

In case a framed 2048 kbit/s format is selected as external synchronization output signal, the customer can select the squelching method to be substitution of AIS or insertion of a DNU message in the applicable Sa-bit channel.

External timing interfaces

The external timing interfaces are located on the MIO-R unit.

There are two types of MIO-R units:

- A unit supporting 2 Mbit/s (framed and unframed) and 2 MHz timing inputs / outputs
- A unit supporting 64 kHz inputs / 6 MHz outputs (called MIOR-J).

Each one of these units supports two inputs and two outputs. Only one of these units can be equipped in a system. For further details please refer to "External timing reference inputs" (p. 4-46) and "External timing reference outputs" (p. 4-48).

64 kHz to 2048 kHz conversion (via the MIOR-J unit)

The MIOR-J unit converts two independent 64 kHz signals coming from outside to two independent 2048 kHz signals towards backplane. The 110 ohm 64 kHz signals, which serve as system station clock inputs, can be either (64 kHz + 8 kHz) or (64 kHz + 8 kHz + 400 Hz). The conversion is done by means of transformer, CPLD, 2048 kHz PLLs. The 2048 kHz signals are then sent to core units which can be used for system timing source. The signal status is monitored by CPLD. Once Loss of Signal (LOS) happens on 64 kHz, the related 2048 kHz output will be disabled (high impedance) and LOS reported through I2C bus; once Loss of Lock (LOL) happens in the conversion process, the related 2048 kHz output will not be disabled as the Core unit(s) can handle it: either the signal still can be accepted and therefore used or if not, system raises certain alarm, the LOL will be reported through I2C bus. 4.2

2048 kHz to 6312 kHz conversion (via the MIOR-J unit)

The MIOR-J unit converts two independent 2048 kHz signals coming from backplane to two independent 6312 kHz signals towards outside. The 2048 kHz signals are system station clock outputs. The conversion is done by means of CPLD, 6312 kHz PLLs and transformers. The 75 ohm 6312 kHz signals, can be used to synchronize other Network Elements. The signal status is monitored by CPLD. Once Loss of Signal (LOS) happens on 2048 kHz, the related 6312 kHz output will be disabled (high impedance) and LOS reported. Once Loss of Lock (LOL) happens in the conversion process, the related 6312 kHz output will be disabled (high impedance) and LOL reported through.

PLL

The external timing reference outputs are driven by two PLLs (phase lock loops), which are shown in the figure Timing architecture:

- the main PLL; the central clock driving six external timing outputs
- the External PLL, driving two external timing output ports.

The signal driving the individual PLLs can be selected as follows:

- for the MAIN PLL: out of either the sync. signal provided by the other (protect) SI-16 Core Unit or SI-64 Core Unit or out of the reference signal selected by the reference selector shown to its left.
- for the EXT. PLL: out of either the sync. signal provided by the MAIN PLL or out of the reference signal selected by the reference selector shown to its left.

Select timing reference

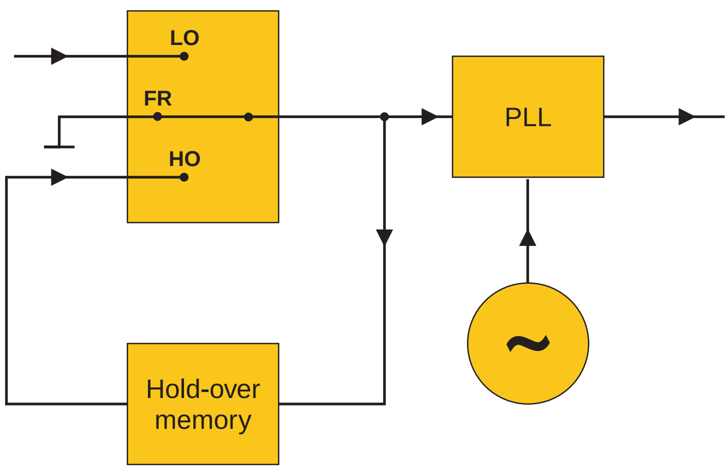
Hence it is possible to select individual timing references for the outgoing station clock signals and for the internal reference clock signals. Reference selections are software selectable by the user.

Timing modes

As shown in next figure, the system can be provisioned for the following synchronization conditions / modes:

- *free running* from an internal oscillator (FR)
- *internal timing* from an incoming line or tributary signal
- *external timing*, timed from an external 2 MHz or 2 Mbit/s clock signal
- *hold-over mode* (HO).

The figure below illustrates the operation when the free running mode is selected.



The user can select the system to function in any one of the three sync. modes specified above. This selection can be done by software (user input) or be fully automatically. If set to automatic, the system will automatically switch to hold-over mode if the input timing reference signal fails.

Free Running operation (FR)

The *Metropolis*® ADM (Universal shelf) is designed to operate without any external synchronization reference in the free running mode. In the free running mode (switch set to FR), the SI-16 or SI-64 Core Unit derives timing from an internal station equipment clock (SEC) oscillator. The internal SEC oscillator's long-term accuracy is higher than 4.6 ppm. The SI-16 or SI-64 Core Unit generates and distributes the timing signals to the interface circuit packs.

Locked mode (LO)

Locked to selected reference (switch to LO).

Locked-to-line or tributary timing mode

In the locked-to-line or tributary timing mode (switch set to LO), the system derives timing from the incoming line or tributary signals. In turn, the SI-16 or SI-64 Core Unit generates timing signals and distributes them to the transmission circuit packs.

The signal references are continuously monitored for error-free operation. If the working line or tributary reference in a protected system becomes corrupted, the SI-16 or SI-64 timing circuit selects the protection line/tributary reference without causing service degradation. If both references fail, the PLL circuit holds the on-board oscillator frequency at the last good reference sample while the references are repaired, (hold-over mode: switch set to HO automatically!).

This mechanism is provided so that operation with or without an external clock can be easily accommodated. In both timing modes, the SI-16 or SI-64 Core Unit can still provide two synchronization outputs to other central office equipment.

Locked to external timing reference operation

Locked to External timing reference Operation (with hold-over). In the external timing mode (switch set to LO), each SI-16 or SI-64 circuit pack accepts a 2 MHz or 2 Mbit/s synchronization reference signal from a 4.6 ppm or better station clock. These references synchronize the local terminal.

Within the SI-16 or SI-64 circuit pack, a highly stable PLL circuit removes any transient impairments from the 2 MHz or 2 Mbit/s reference for improved jitter performance. If the external reference fails, the PLL circuit on the SI-16 or SI-64 circuit pack holds the on-board oscillator frequency at the last reference sample while the external clock signal is repaired (hold-over mode: switch set to HO automatically!).

Hold-over mode (HO)

As described above, the system provides a so-called hold-over mode to ensure that the timing of the system is as accurate as possible when all timing references fail. It therefore memorizes the most recently used timing frequency in a hold-over memory on-board the 2.5G or 10G 64 Core Units. The SI-16 or SI-64 timing circuit pack is equipped with an internal clock with Stratum-3 Hold-over Performance according to ITU-T recommendation G.813 option 1 with in addition a frequency stability of 0.37 ppm over the first 24 hours of hold-over.

Back-up hold-over

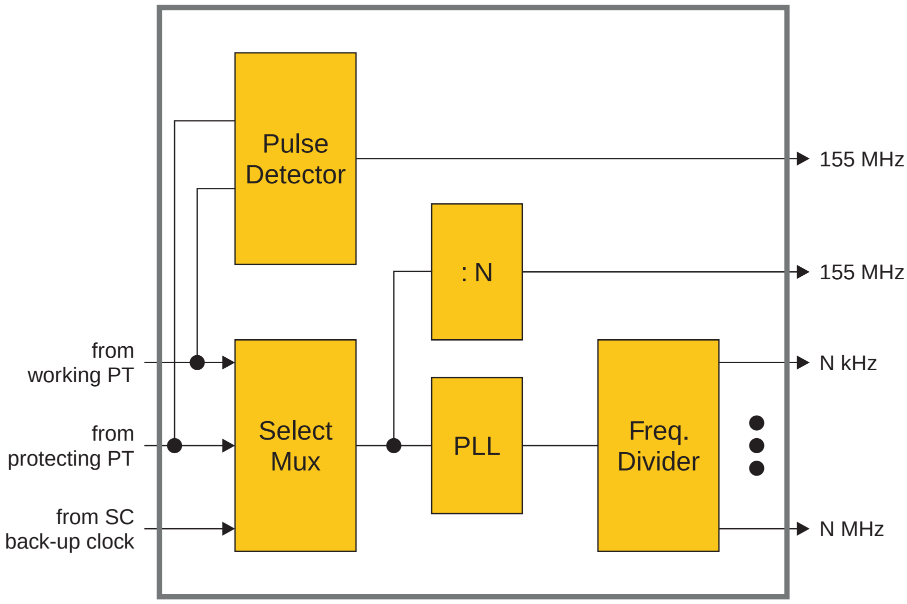
In locked mode of operation, if no acceptable references are available, the internal clock will switch to the back-up hold-over state.

Back-up timing

To keep the software on all circuit packs alive when there is no synchronization signal from one or both 2.5G or 10G 64 Core Units, the System Controller Unit (SC) distributes a back-up timing signal. This timing allows for the execution of circuit pack tests and equipment loop-backs. The SC timing signal is distributed to all slots of the system. The accuracy of the back-up timing signal is approximately 50 ppm. When the back-up clock is selected, the circuit packs switch all transmission ports to SQUELCH mode.

Clock/synchronous distribution on circuit packs

The following figure gives an overview of timing at circuit-pack level.



One of the following three timing sources is selected:

- Reference signal selected by the working SI-16 or SI-64 circuit pack
- Reference signal selected by the protecting SI-16 or SI-64 circuit pack
- Back-up clock signal derived from the SC.

All timing signals are checked for availability and if a signal fails, then the message “Timing Fail” (including the missing source) is sent to the on-board Function Controller (FC). Then the FC immediately initiates the command to switch to the system’s backup timing and all transmission ports are switched off (squelch mode).

Switching between the input references is non-revertive. A PLL on the circuit pack itself locks to the selected timing source and supplies the circuit pack with all necessary frequencies.

System control and management

Optical Management System OMS

The System Controller (SC) controls and provisions all circuit packs via a local LAN bus. The SC also provides the external operations interfaces for office alarms, miscellaneous discrete inputs and outputs and connections to the overhead channels.

The SC also facilitates first line maintenance by several LEDs and buttons on the front panel. General status and alarm information is displayed. Various controls and an F interface connector, for a local maintenance PC (ITM-CIT), are also located on this panel. The SC communicates with the centralized management system (OMS). Communication is established via so-called Data Communication Channels ((DCC= D1-3/D4-12 bytes), within the STM-N section overhead signals or via one of the Q-interfaces of the system. Information destined for the local system is routed to the System Controller, while other information is routed from the node via the appropriate embedded channels of the STM-N line or tributary signals. The Optical Management System OMS manages the system at the Network Level. The ITM-Craft interface terminal (ITM-CIT) can be used for managing single network elements and for maintenance.

The OMS manages the *Metropolis*® ADM (Universal shelf) at element level and network level. The ITM-Craft Interface Terminal (ITM-CIT) can be used for managing small networks and for maintenance.

Software download

It is possible to download software from OMS to the System Controller to replace or add applications in the local database. During download the old software is stored in the memory as a backup. This means that after download, two complete software versions are available on the SC. The Local Craft Terminal (ITM-CIT) can also download the software.

Management features

The most important management features are:

- Optical Management System OMS
- OSI stack with IS-IS level 2 routing and a flexible NSAP address
- D4-D12 and D1-D3 support on optical STM-n interfaces
- 8 × miscellaneous discrete input (MDI) and 4 × miscellaneous discrete output (MDO)
- Remote login on the ITM-CIT from the *Metropolis*® ADM (Universal shelf) to the *Metropolis*® ADM (Compact shelf), the *WaveStar*® ADM 16/1, the *WaveStar*® TM 1 and the *Metropolis*® AM / *Metropolis*® AMS.

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Power

The system power supply is able to provide 650 W power in the range –40 V to –72 V DC, respectively –48 V to –60 V DC nominal.

Power Unit (PU)

The Power Unit performs a limited part of the filtering of electrical noise (in both directions). The major part of the filtering is done on the circuit pack itself. Protection against transients on the power feeders is located in the Power Unit. Each power filter acts on one of the incoming supplies (A or B).

If a Power Unit is not present, the corresponding power feed is not available to the system. Protection against reverse polarity will be provided by the individual circuit pack (OR-ing diodes). The PU contains auxiliary voltage sources that are used in the system. The unit has a red fault LED and a green power LED. No single point of failure must be present in the system, in the case of a duplicated power feed (except for the backplane).

Power distribution

Optionally the power supply of the rack can be provided by a Power Distribution Panel (PDP) at the top of the rack.

Power indicators

LED indicators

- Green: feeder power
- Red: central auxiliary supply failure.

□

Cooling

Cooling is provided by a plug-in fan unit placed on the middle of the sub-rack. Fans pull air through a filter below the circuit packs and force it through the sub-rack from bottom to top. An air flow baffle with air filter is integrated in the lower part of the subrack to prevent the intake of particles or exhaust air from below.

Fan unit

Two fan units each of which contains two fans are integrated in those subracks for which the dissipation under fully loaded conditions could otherwise cause the thermal limits of the components to be exceeded. Proper cooling is still ensured if one of the four fans is failing. A subrack containing two fan units meets the acoustic noise requirements in P.301.1.

One fan unit is considered as mandatory unit for the 2.5G and the 10G application; therefore space for the fans is reserved in the middle and bottom of the subrack. If needed, a second fan can optionally be ordered.

Fan controller

The fan unit includes two fans and a microcontroller that senses air flow, air temperature and fan faults. The microcontroller adjusts the speed of the fans to compensate for the failure of a fan or to conserve power when full air flow is not needed. It also reports the status of the fan unit to the shelf controller.

Proper cooling is still ensured if one of the four fans is failing. Failed fans cannot be replaced individually. A complete fan unit must be replaced. This is achieved without interruption of service.

Air filter

The subrack also contain an air filter which can be easily replaced or cleaned (both types are available). The air filter, located below the subrack, must be replaced or cleaned under regular conditions once every 3 months to ensure the proper cooling.

Important! The fan unit must be installed and operating in a shelf before any circuit packs are installed.

□

5 Operations, administration, maintenance and provisioning

Overview

Purpose

This chapter describes hardware and software interfaces used for administration, maintenance, and provisioning activities. It also describes the system management function for administrating the *Metropolis*® ADM (Universal shelf) and the maintenance and provisioning features available in *Metropolis*® ADM (Universal shelf).

The Element and Network Management aspects of the *Metropolis*® ADM (Universal shelf) are based on the SDH concepts as laid down in ITU-T recommendations, for instance G.784.

Local operations facilities are based on long-term experience and several commonly applied operations and alarms procedures.

The *Metropolis*® ADM (Universal shelf) also has advanced diagnostic features that can be used to check equipment performance and for detailed location of faults.

Contents

Operations

Overview

Purpose

This section describes the hardware and software interfaces used for administration, maintenance, and provisioning activities. These include

- Visible and audible indicators
- Graphical User Interface (GUI) on the ITM Craft Interface Terminal (ITM-CIT)
- Operations interfaces

Visible and audible indicators

Visible and audible indicators notify you of maintenance conditions such as faults and alarms.

Graphical user interface

The GUI on the ITM-CIT retrieves detailed information about local and remote network elements. The GUI is also used to provision local and remote *Metropolis*® ADM (Universal shelf) circuit packs and the switching matrix.

Operations system interfaces

Operations interfaces include the DCC interfaces on the OC-M/STM-N port units and the IAO LAN (intra-office LAN) interface. Both the DCC interface and the IAO LAN interface can receive commands from operations systems (network element management systems) or from a remote ITM-CIT.

Contents

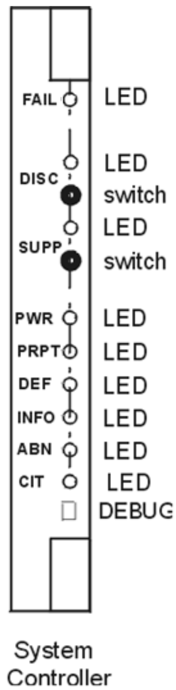
Visible alarm indicators

This section describes the visible indicators of the *Metropolis*® ADM (Universal shelf) network element that are located on the

- User panel
  The user panel is the primary source of shelf-level visible alarm indicators.
- Circuit pack faceplates

User panel: Controls and indicators

The User Panel of the *Metropolis*® ADM (Universal shelf) is integrated in the faceplate of the System Controller (SC) circuit pack, as shown below. Lightguides are used to make the alarm and status indicators on the SC visible when the front door of the subrack is closed. The user panel provides system-level information.



Indicators

The user panel provides the following indicators:

PWR (Green)	indicates that voltage is present on at least one of the –48 V secondary power-distribution feeds, or that there is central auxiliary voltage inside the system.
PRPT (Red)	The *red* PROMPT LED indicates a transmission-affecting malfunction.
DEF (Red)	The *red* DEFERRED LED indicates a malfunction that does not affect transmission-affecting malfunction

INFO (Yellow)	indicates a failure that is not located within the terminal. If only the INFO indicator is lit, no immediate maintenance action is required. The user can provision the alarm severities (PROMPT, DEFERRED and INFO) of the fault messages.
ABN (Yellow)	indicates the existence of abnormal conditions in the network element, for example a protection lock-out, a forced switch, a manual switch, a protection line in use, an alarm disconnected, or a failed installation self-test.
SUPP (Yellow)	indicates that the SUPPRESS key has been activated while an active office alarm condition exists.
DISC (Yellow)	indicates that the DISC (disconnect) key has been activated, which means that office alarms are disconnected.
CIT (Yellow)	indicates when the ITM-CIT must be used to obtain more detailed information about system status.

Controls and connectors

Two manual controls (switches) and one connector are mounted on the SC faceplate. The functions are as follows:

- SUPP SWITCH: An alarm that is shown on the user panel can be suppressed by pressing the SUPPRESS SWITCH push-button, which will light up the SUPPRESS LED. If another alarm of the same class occurs, it will now be noticed.
- DISC SWITCH: Pressing the DISC SWITCH push-button inhibits the activation of disconnectable office alarms and lights up the DISC LED.

Circuit pack indicators

To supplement the user panel’s system-level view, each circuit pack has a red FAIL LED on its faceplate (at the top of the faceplate).

- During normal fault-free operation, the LED is not lit.
- A continuously lit FAIL LED means that the *Metropolis*® ADM (Universal shelf) has isolated a failure to this circuit pack, or that the circuit pack has been inserted in a slot that cannot support or is not configured to support this type of pack.

- An 1 Hz flashing FAIL LED shows the following:
  - a flashing FAIL LED on an interface circuit pack indicates that an incoming signal to that circuit pack has failed
  - a flashing FAIL LED on the STM-16 core unit or STM-64 core unit indicates an external timing reference failure. The green LED indicates the correct operation of the timing and cross connect functions of the core unit.
  - a flashing FAIL LED on the SC indicates loss of communication with the management system.
- a rapidly flashing FAIL LED on a circuit pack indicates that the primary boot code (a piece of software located in the nonvolatile memory of each circuit pack) is automatically upgraded by the system. The primary boot upgrade happens during upgrades but also if a pack with an older primary boot version (i.e.from spare stock) is inserted to the system.

□

ITM-CIT

Metropolis® ADM (Universal shelf) is shipped with software for a *Windows®* 2000 or *Windows®* XP-based GUI that runs on a customer-furnished desktop or laptop computer. The GUI provides

- Control of operations, administration, maintenance and provisioning activities
- Security features to prevent unauthorized access

Definition

ITM CIT is a PC-based GUI software handling the *Metropolis®* ADM (Universal shelf) network elements one-by-one. It provides pull-down menus. It offers a unified set of features for provisioning, testing, and reporting. The ITM CIT is necessary to install and accept the system.

PC requirements

For the ITM-CIT a personal computer is necessary which fulfils the following minimum requirements:

- *Pentium®* processor with 450 MHz or higher
- 128 MB RAM or higher
- Keyboard
- Mouse
- 300 MB of free hard-disk drive space
- CD-ROM drive
- SVGA monitor set to 1024x768 resolution or greater, 16 million colors recommended
- RS-232 communication port (serial asynchronous port)
- *Windows XP®* or *Windows®* 2000 operating system
- ITM-CIT connector (F-interface) cable (one end RS-232 and the other end RJ-45 modular jack).

The performance can be enhanced by using a higher performance personal computer. Independent of the requirements listed above the minimum requirements of the operating system must be fulfilled.

ITM CIT access

Metropolis® ADM (Universal shelf) supports local and remote access using a ITM CIT. Remote access uses the DCC (data communications channel) or an external WAN connected to a *Metropolis®* ADM (Universal shelf) LAN port.

Security function

Metropolis® ADM (Universal shelf) provides a security function to protect against unauthorized access to the ITM-CIT system functions (such as provisioning). Security is controlled through logins, passwords, and authorization levels for the system functions.

Maintenance and administrative activities

The ITM CIT provides detailed information and system control of the following specialized local/remote maintenance and administrative activities:

- provisioning
- cross-connection assignments
- protection switching
- displaying performance-monitoring data
- fault management (alarms lists, etc.)
- polling inventory data of the NE
- software download to the NE
- loopback operation and testing
- reporting.

□

Operations interfaces

Metropolis® ADM (Universal shelf) supports the following operations interfaces

- Rack top alarm indicators
- Station alarm interface
- Miscellaneous discrete interfaces
- Network management interfaces
- Data communications channels (DCC).

These features enable maintenance tasks (i.e., replacement of circuit packs) to be performed without an ITM-CIT (Craft Interface Terminal) or external test equipment. The second maintenance tier uses the ITM-CIT to retrieve detailed reports about alarms and status, and about system configuration for local terminals.

Rack top alarm indicators

One red and one yellow indicator are present in top of the rack to signal a “prompt” or a “deferred” alarm respectively in one of the systems in the rack. The lamps are controlled from the “bay-top alarm outputs”.

Station alarm interface

The station alarm interface offers a number of hard contacts which can be used to extend the alarm signals from the *Metropolis®* ADM (Universal shelf) system into the station alarm scheme. These contacts can be divided in four groups:

- Bay-top alarms (two outputs: prompt and deferred, not disconnectable)
- End-of-suite alarms (two outputs: prompt and deferred, disconnectable)
- Station alarms (two outputs: prompt and deferred, either disconnectable or non-disconnectable)
- Miscellaneous maintenance information (three outputs: suppressed alarms present, disconnect function activated and main-controller removed).

Programmable station alarm raise/clear delay

The delay between the generation of the station alarm cause and the start of the actual station-alarm and likewise the delay between the disappearing of the station-alarm cause and the clearing of the station-alarm is programmable. These two parameters are global for the system and can range between 0 and 60 seconds in 1 second increments.

Miscellaneous discrete interfaces

The miscellaneous discrete interface allows an operations system to control and monitor equipment that is co-located with the *Metropolis®* ADM (Universal shelf) system through a series of input (MDI) and output (MDO) contact closures.

Eight miscellaneous-discrete inputs can monitor such conditions as open doors, high temperature or high humidity, and four miscellaneous discrete control output labels can be associated to alarms.

The status of the miscellaneous discrete environmental inputs is reported to the network element management system. It is possible to activate these miscellaneous-discrete control outputs from the network element management system when the system reports an alarm condition. Miscellaneous-discretes are provided to the user through a connector at the MIO-L.

Network management interfaces

There are three network management interfaces:

- Q-LAN interfaces:
  The Q-LAN interfaces enable network-oriented communication between the *Metropolis*® ADM (Universal shelf) and the OMS. This is the standardized interface to Lucent Technologies management solutions.
  10 Base-T interfaces for Q-LAN are used on the miscellaneuos I/O area (MIO-L).
- CIT-F (Craft Interface Terminal) Interfaces:
  There is a RJ-45 interface on the miscellaneuos I/O area (MIO-L). The electrical characteristics of the CIT-F port comply with V.10.
- H-LAN (Hybrid LAN): 10/100 BASE-T LAN for future use.

Remote login/single ended operations/NSAP addresses (programmable)

The interfaces for the CIT-F (F-interface) provide the facility to log onto the local *Metropolis*® ADM (Universal shelf). Via the ITM-CIT a remote login is also possible to other *Metropolis*® ADM (Universal shelf) systems or to a *Metropolis*® ADM (Compact shelf) etc.

The OMS can perform control and provisioning tasks remotely.

The NSAP address is programmable to enable compatibility with the NSAP addresses of existing products like ISM, SLM, PHASE, *WaveStar*® ADM 16/1 etc. This will allow DCC interworking with other kinds of equipment.

Data communications channel (DCC)

This network operations capability uses the data communication channel (DCC) bytes of the SDH section (MSOH, D4 … D12 and RSOH, D1 … D3) . Management interface dialogs and operations interface messages travel in these DCC bytes on each STM-N interface (N = 1, 4, 16, or 64).

The *Metropolis*® ADM (Universal shelf) supports at most 32 tributary and line DCC channels simultaneously (counting RS-DCC and MS-DCC separately), while maintaining an acceptable throughput of management traffic.

□

Administration

Overview

Purpose

The system management function for the administration of *Metropolis*® ADM (Universal shelf) is operator administrated.

Security

The *Metropolis*® ADM (Universal shelf) provides for secure system access by means of a two-tier security mechanism.

Contents

Security

This section describes the various security features that the *Metropolis*® ADM (Universal shelf) provides to monitor and control access to the system.

User login security

The Optical Management System OMS provide security protection against unauthorized access to the network element functions (for example provisioning). This feature controls access to the system per user and includes:

- Login ID and password assignment: The user has to enter a valid Login ID and password to access the system
- User authorization levels: Provides three levels of access on a per session basis:
  - Administrator: The Administrator is authorized to perform system control activities. These include starting and stopping management of the transmission network. Only this user can administer other users of the OMS application. In addition, backups can be created or restored by this user.
  - Operator: The Operator is authorized to perform all retrieval and operate commands that are not service-affected and do not change the system configuration
  - Supervisor: The Supervisor is authorized to perform all retrieval, provisioning and operate commands whether or not they are service affecting, with the exception of provisioning of security data and software downloads.

Login and password aging

The following aging processes provide additional means of monitoring and controlling access to the system:

- Login aging deletes individual logins if they remain unused for a pre-set number of days or on a particular date (for example, a visitor’s login or a login for temporary access during installation)
- Password aging requires users to change passwords periodically.

□

NE administration concept

Target Identifier (TID)

It is possible to enter strings to be stored in the *Metropolis*® ADM (Universal shelf) denoting the target identifier (TID) of the NE.

Version recognition

The system provides automatic version recognition for all hardware and software installed on the system. The system can report the type, version and serial number of the circuit pack that is installed in each slot. Each circuit pack identification code is stored on the circuit pack itself and can be accessed by the system controller.

Inventory control

During normal operation, it is at any time possible to obtain (through the CIT or OMS) an inventory list with information on type, version and slot occupation of each system part (these include units, backplane, I/O modules and converter boxes). Also information regarding the current and fallback software can be obtained.

Each field-replaceable unit is labeled in such a way that information needed to install proper units in the proper slot is contained on that label. The label also contains a serial (production) number.

Software upgrades

The *Metropolis*® ADM (Universal shelf) can easily be upgraded and reconfigured to support new services or to incorporate feature enhancements by downloading a new software generic via the appropriate (F/Q) operations interface. Service is not normally interrupted by downloading and replacing software generics

The *Metropolis*® ADM (Universal shelf) stores two images of the software, the active image and the fall-back image. These images may be different. In an upgrade procedure, the new software release is down-loaded in the fall-back memory area to be activated by a special command.

□

Maintenance

Overview

Purpose

This section introduces the maintenance features available in the *Metropolis*® ADM (Universal shelf).

Definition

Maintenance is the system's capability to continuously monitor its equipment and the signals that it carries in order to notify the user of any current or potential problems. This enables the user to take appropriate proactive (preventive) or reactive (corrective) action.

The maintenance applications are based on ITU-T recommendations M.2101.1, M.2110 and M.2120 and are used for "Bringing Into Service (BIS)" and other initial testing procedures and localization/monitoring of under-performing parts of an end-to-end path.

Contents

Maintenance signals

This section describes the maintenance signals available in *Metropolis*® ADM (Universal shelf).

Definition

The system maintenance signals notify downstream equipment that a failure has been detected and alarmed by upstream equipment and notify upstream equipment to initiate trunk conditioning due to a failure that has been detected downstream. These alarm signals include Alarm Indication Signals (AIS), Far End Receive Failure ((MS-)RDI) signals, and UNEQuipped signals (UNEQ).

Alarms and status reports

The system provides a report that lists all active alarm and status conditions. This report is made available to the network management system on demand. The identity of the condition is included in the report along with a time stamp that indicate when the condition was detected. There is an option to display specified subsets of alarm conditions.

Enable/disable autonomous alarm forwarding to the OMS

The *Metropolis*® ADM (Universal shelf) provides the option to inhibit, temporarily, the forwarding of autonomously generated alarms from the NE to the OMS. To restart the or to restart again the autonomous forwarding of alarms an enable command has to be issued by the user.

Programmable severity per fault-type per location instance

For each fault-type it is possible to provision the associated severity (values: “prompt”, “deferred” or “info”), individually for each location (e.g. port, TTP, CTP or unit) capable of generating this fault-type. It is possible to change the severity associated with a certain fault-type globally for all location instances with a single command. The maximum amount of severity instances is 1000.

Element management and remote operations interfaces

Before it can begin providing services, the *Metropolis*® ADM (Universal shelf) requires a large amount of provisioning data. This data will be loaded upon installation in non-volatile memory but needs a reliable backup to support repair and maintenance procedures. It is therefore assumed that the equipment is connected to a back-up database either via a local port or via the embedded operations channels.

The *Metropolis*® ADM (Universal shelf) can be connected to a co-located OMS via the Q-LAN. At station level and besides local or remote network-management facilities, a Craft Interface Terminal (ITM-CIT) can be used to carry out local management functions.

Fault detection, isolation and reporting

When a fault is detected, the *Metropolis*® ADM (Universal shelf) employs an automatic diagnostics to isolate the failed circuit pack or signal. Failures are reported to local maintenance personnel and operations systems so that repair decisions can be made. If desired, operations system personnel and local maintenance personnel can use the ITM-CIT to gain more detailed information on the fault condition.

Maintenance history report

A maintenance-history report past alarms, status, protection switching, and craft or management events is provided and this report is made available to the network management system on demand. This summary contains a time stamps that indicates when each condition was detected and cleared, or when a command was entered.

The *Metropolis*® ADM (Universal shelf) system also automatically and autonomously reports all detected alarm and status conditions through the office alarm relays, the user panel, equipment LEDs, and message based operations systems.

SDH non-intrusive monitor failure reports

The VC-4(-4c/16c), VC-3, VC-12 and VC-11 (in TU-12) Non-Intrusive Monitors (NIM’s) can be in Monitored (MON) or Non-Monitored (NMON) mode. If a NIM is part of an SNC/N scheme it is put in MON mode. If a NIM is not part of an SNC/N scheme it is normally NMON, but it can be put in MON mode, provided the necessary configuration data is provided.

In MON mode the cTIM, cUNEQ, and cDEG alarms are forwarded to the OMS and CIT and optionally cRDI and cSSF.

Performance LAN interface

For each LAN interface the performance of the incoming and outgoing LAN streams (3 × 8 counters) as well as the incoming and outgoing WAN streams (up to 3 × 8) counters are monitored for (refer to “Ethernet performance monitoring counters” (p. 2-96)):

- incoming packets dropped due to error
- bytes sent
- bytes received.

LAN related alarms

The *Metropolis*® ADM (Universal shelf) reports LAN related data and switching alarms. Loss of Signal (for ports in monitored state) or unexpected presence of a signal (for ports in non-monitored state) at the LAN interfaces are alarmed per LAN interface.

Quality of service application

The Quality of Service (QoS) application is based on ITU-T Recommendations G.826 and G.827. In contrast to the maintenance application, the QoS application requires a performance assessment of the bidirectional path over longer periods.

To support the QoS application in the network element, the *Metropolis®* ADM (Universal shelf) logs the current and most recent 24 hour periods of the UAP, UAP-count (number of unavailable periods) and UAS for the bidirectional connection, whereby the bidirectional connection is considered unavailable as soon as one of the directions is unavailable.

In addition, for each monitoring point the BBE, ES and SES counts are reported for directions individually. So there are nine parameters altogether per bidirectional monitoring point.

Note that all six BBE, ES and SES counters are inhibited as soon as the bidirectional connection is unavailable. This is why the bidirectional counts may differ from the uni-directional counts, even if they are for the same path and the same monitoring interval.

Bidirectional performance monitoring comes in two flavors:

- in “end-points” or TTPs
- in “mid-points” or CTPs

The following monitoring points in the *Metropolis®* ADM (Universal shelf) support bi-directional PM:

- VC-12 TTPs, VC-3 TTPs and VC-4 TTPs and
- VC-12 CTPs, VC-3 CTPs, VC-4 CTPs, VC-4-4c CTPs and VC-4–16c CTPs.

Bidirectional performance reports in end-points are based on the near-end and far-end (RDI) information that is received on the incoming signal. Bidirectional performance reports in midpoints are based on the far-end information that is contained in the incoming signal in both directions of transmission.

Severity settings for alarms on each termination-point instance

Since different clients pay for different levels of Quality of Service (QoS), the priority and the time to repair can differ for different paths. By setting a higher severity for the alarms on paths that require a high QoS, than for the paths that require a low QoS, the QoS performance can be improved. In the subsection on Performance Monitoring the concept of quality of service is explained in more detail.

Support for a multiplex-section trace identifier (JO byte)

The user can provide a multiplex section trace identifier on all STM-N (N = 1, 4, 16, 64) outputs of the *Metropolis®* ADM (Universal shelf) via the OMS or ITM-CIT. In the receive direction an expected value for this trace identifier can be provided. In the case of a mismatch a TIM (Trace Identifier Mismatch) alarm is generated and consequent actions are invoked. The TIM detection mechanism can be disabled per interface.

Recovery from database failures

If the *Metropolis*® ADM (Universal shelf) detects that its MIB is empty or corrupted, a mechanism is in place to automaically start a MIB download from the OMS.

If the serial number in the NE database (located on the controller unit) does not match the (unique) serial number of the NE on the backplane, the NE will inform the operator. This allows the operator to make a choice on either to accept the database or not.

□

Loopbacks and tests

This section describes the loopbacks and tests that the *Metropolis*® ADM (Universal shelf) performs.

Loopback definition

A loopback is a troubleshooting test in which a signal is transmitted through a port unit to a set destination and then returned to the originating port unit. The transmitted and received signals are measured and evaluated by the user to ensure that the received signal is accurate and complete when compared to the originating signal.

Loopbacks can be distinquished in loop-backs for incoming and outgoing signals.

These loopbacks can be setup per input from the ITM-CIT or OMS.

Loopbacks on incoming STM-64 signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on the corresponding line input. The looped back input is routed directly to its corresponding output, passing through as few system parts as possible and leaving the signal format intact.

The loopbacks are “non-transparent”, i.e. the signal is replaced by AU-AIS signal indication downstream from the loopback point.

Simultaneous loopback and 1+1 MSP on the same tributary port is permitted.

Loopbacks on incoming STM-16 signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on an STM-16 system input, the incoming signal is looped back to the corresponding system output. The complete STM-16 is looped back, while the forwarded signal is replaced by AU-AIS.

The loopbacks are “non-transparent”, i.e. the signal is replaced by AU-AIS signal indication downstream from the loopback point.

Simultaneous loopback and 1+1 MSP on the same tributary port is permitted.

Loopbacks on incoming E1, E3, DS1,DS3, and STM-1e signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on the corresponding tributary input or line input. The looped back input is routed directly to its corresponding output, passing through as few system parts as possible and leaving the signal format intact.

The loopbacks are “non-transparent”, i.e. the signal is replaced by AIS signal indication downstream from the loopback point.

Specifically for E1 or DS1 loopbacks, there is a limitation that at most one incoming loopback per E1 unit can be active at any time.

Loopbacks on incoming STM-1o signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on the STM-1o tributary unit. The incoming signal is looped back to the corresponding system output.

The loopbacks are “non-transparent”, i.e. the signal is replaced by AIS signal indication downstream from the loopback point.

Note that simultaneous loopback and 1+1 MSP on the same tributary port is permitted

Loopbacks on incoming STM-4 signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on an STM-4 system input, i.e. on the STM-4 tributary unit. The incoming signal is looped back to the corresponding system output. The complete STM-4 is looped back, while the forwarded signal is replaced by AIS.

The loopbacks are “non-transparent”, i.e. the signal is replaced by AIS signal indication downstream from the loopback point.

Note that simultaneous loopback and 1+1 MSP on the same tributary port is permitted

Loopbacks on outgoing STM-64 signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on the corresponding tributary output or line ouput. The outgoing signal is looped back to its corresponding (backplane) input, passing though as many system parts as possible.

The loopbacks are “non-transparent”, i.e. the signal is replaced by MS-AIS signal downstream from the loopback point.

> **Important!** This feature is only supported by LKA49, LKA29, LKA28, LKA281 and LKA350.

Loopbacks on outgoing STM-16 signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on STM-16 system output, the outgoing signal is looped back at the VC-4 level to the corresponding (backplane) inputs. The loopback is ″″ non-transparent″″ : The forwarded signal is replaced by MS-AIS.

Simultaneous loopback and 1+1 MSP on the same tributary port is permitted.

Loopbacks on outgoing E1, E3, DS1, DS3 and STM-1e signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on the corresponding tributary output or line ouput. The outgoing signal is looped back to its corresponding (backplane) input, passing though as many system parts as possible.

The loopbacks are “non-transparent”, i.e. the signal is replaced by AIS signal downstream from the loopback point.

Specifically for E1 loopbacks, there is a limitation that at most one outgoing loopback per E1 unit can be active at any time.

Loopbacks on outgoing STM-1 optical signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on STM-1 system output, i.e. on the STM-1o tributary unit. The outgoing signal is looped back at the VC-4 level to the corresponding (backplane) input. The loopback is “non-transparent”, i.e. the forwarded signal is replaced by MS-AIS for STM-1o tributary unit.

Simultaneous loopback and 1+1 MSP on the same tributary port is permitted.

Loopbacks on outgoing STM-4 optical signals

Within the *Metropolis*® ADM (Universal shelf) temporary loopbacks can be set on STM-4 system output, i.e. on the STM-4 tributary unit the outgoing signal is looped back at the VC-4 level to the corresponding (backplane) inputs. The loopback is “non-transparent”; the forwarded signal is squelched.

Simultaneous loopback and 1+1 MSP on the same tributary port is permitted.

Software-initiated loopbacks

Metropolis® ADM (Universal shelf) can perform software-initiated facility loopbacks within the port units (near-end or in-loopbacks and far-end or out-loopbacks), as well as software-initiated cross-connect loopbacks. Active loopbacks are indicated by the abnormal (ABN) LED on the user panel.

Local system test

The local system test and diagnostics are executed on demand from the CIT to verify correct operation of those parts of the system that can be covered by test signals. Additional diagnostic tests are performed for fault isolation.

LED test

An LED test can be performed on demand from a CIT to verify whether all LEDs on the system still function. This operation can not be initiated from the OMS.

Self-diagnostics (in service)

The *Metropolis*® ADM (Universal shelf) runs audits and diagnostics to monitor its health. These self-diagnostics don’t have any effect on the performance of the system.

The system will automatically run diagnostic tests:

- Processor system:
  - Power-on tests: memory write/read tests (RAM), Checksum tests (ROM, FLASH). These tests are only performed when a unit is inserted in the system
  - Run time tests: non-volatile memory checksum tests, watchdog. These tests are performed continuously.
- Transmission system: such as parity checks at transmission devices (ASICs), data bus supervision, power supply supervision at plug-in units, internal synchronization supervision. These are monitored continuously.

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Protection and redundancy

Overview

The following specifications apply to the *Metropolis*® ADM (Universal shelf) with regard to protection and redundancy.

Equipment protection

1:N equipment protection on E1/DS1 (N = max. 4)

1+1 equipment protection on the E3/DS3 and STM-1e units.

1+1 equipment protection on the STM-16 and STM-64 core units

- Power
- Timing
- Cross-connection

MSP

STM-1, STM-4 and STM-16, and STM-64 optical interface circuit packs support 1+1 MSP according to G.841 annex B, G.841 Clause 7.1 and ETSI 300417–3–1.

MS-SPRing

MS-SPRing is used in two fiber ring add/drop applications.

Selective MS-SPRing in two fiber add/drop ring applications. The VC-4 (-4c,-16c)s in the ring can be protected by MS-SPRing algorithm according to G.841 and ETS 300417.

The customer has the option to determine for each VC-4(-4c,-16c) individually, whether or not it participates in the MS-SPRing scheme. If an individual VC-4 (-4c,-16c) does not participate then it can be either VC-4(-4c,-16c) SNC protected or not protected at all.

The protection scheme provides also “extra traffic” on STM-16 and STM-64 interfaces in the MS-SPRing configuration. Preemptible Protection Access (PPA) or extra traffic is a feature using the protection capacity of a MS-SPRing in order to carry some extra “low priority” traffic.

SNCP/N

SubNetwork Connection Protection (SNCP) on VC-12, VC-3, VC-4, VC-4-4c or VC-4-16c signal level according to G.841/Clause 8. The SNCP is based on non-intrusive monitoring of the sub-network connection (SNC/N).

SNCP protection switching can be configured revertive or non-revertive. When revertive switching is configured, a wait-to-restore time can be defined. The default configuration is non-revertive.

During the set up of non-revertive SNCP schemes, the user can assign which connection of the protection pair will become the working one.

Other specifications

The following specifications apply also to the *Metropolis*® ADM (Universal shelf) too:

- cascading of protection schemes in one network element
- maximum of 50 ms switching time for all protection mechanisms.
- programmable hold-off timers.

□

Performance monitoring

Performance Monitoring provides the user with the facility to systematically track the quality of a particular transport entity. This is done by means of continuous collection and analysis of the data derived from defined measurement points.

Basic measurement parameters

To support these applications the *Metropolis®* ADM (Universal shelf) provides, for each performance-monitoring process, the current 15 minute and current 24 hour counts of the

- BBE (Background Block Errors)
- ES (Errored Seconds)
- SES (Severely Errored Seconds)
- UAS (UnAvailable Seconds) and
- UAP (UnAvailable Period).

Performance monitoring on the Gigabit Ethernet card

Ethernet performance monitoring in SDH network elements is kept as closely related to SDH performance monitoring as possible. This means that the concepts of binning and thresholding are completely reused. Refer to "Ethernet performance monitoring counters" (p. 2-96).

There are two levels of Ethernet performance monitoring possible:

- monitoring per port
- monitoring per port per traffic class. This option monitors all packets of all customers that belong to a specific traffic class

The following list is an overview of the Ethernet performance parameters related to the transmit direction. These parameters are presented in 15 minute and 24 hour reports. Thresholding is applicable for Ethernet parameter for:

- outgoing number of Mbytes (EONB)
- dropped frames - errors (EDFE)
- incoming number of Mbytes (EINB)

Enabling performance measurement points

Performance measurement points can be enabled via ITM-CIT or OMS. Please refer to the Metropolis® *ADM (Universal shelf) User Operations Guide*.

Monitoring points

For maintenance applications the *Metropolis®* ADM (Universal shelf) supports the counting, threshold monitoring and logging of all the parameters mentioned above for the incoming traffic direction (or "unidirectional near-end" performance monitoring).

Possible monitoring points are:

- VC-12, VC-3 and VC-4 Trail Terminations Points (TTPs)
- MS-1, MS-4, MS-16, RS-16, MS-64 and RS-64 termination points
- VC-12, VC-3, VC-4, VC-4-4c,VC-4-16c transit points or Connection Termination Points (CTPs).

Note that the unidirectional near-end performance monitoring indicates the performance of the incoming signal between the source of the signal trail and the monitoring point.

The BBE, ES, SES, UAS and UAP parameters are derived from the errors in the incoming signal and are based on the B1, B2, B3 or V5 (bit 1,2) parity information that is part of the RSOH, MSOH or VC-POH. Periods of unavailable time are, also based on local defects or defects in the incoming signal. For the duration of a period of unavailable time the BBE, ES and SES counters are inhibited.

Number of performance monitoring points

The *Metropolis*® ADM (Universal shelf) can support 1200 monitoring points simultaneously. These points can be randomly selected from all the possible TTPs and CTPs that are indicated above, where the “uni-directional near-end” and “bidirectional” applications are each counted seperately. Once a performance monitoring point is activated the full set of performance parameters is supported.

Threshold report and reset threshold report

In addition the recent history of these parameters remains stored in the network element, namely the 16 most recent complete 15 minute counts and the 1 most recent complete 24 hour count. For all current-interval counters, thresholds can be set that control the forwarding of Threshold Report (TR) and Reset Threshold Report (RTR) information to the management system.

A TR is generated at the moment that the current count in a register crosses the “set” threshold level for the first time since the last RTR. An RTR is generated at the end of the first interval in which the current count remains below the “clear” threshold. So the TRs and RTRs are generated in an altemetely way.

In the period between a TR and an RTR the monitored part of the path is considered to be degraded, while it is considered normal in the period between an RTR and a TR. The “set” and “clear” thresholds can be assigned by the user via the ITM-CIT or the OMS.

Unavailable periods

In addition to the above parameters, the 6 most recent UAPs (Unavailable Periods) are also logged in the system. Each UAP is represented by two time stamps. The first indicates the moment of entry into “unavailable time” and the second indicates the moment of entry into subsequent “available time”.

□

Reports

This topic contains information about the

- active alarms and status reports
- performance monitoring reports
- history reports
- report on circuit pack, slot, port and switch states
- version/equipment list
- synchronization reports

Active alarms and status

The *Metropolis*® ADM (Universal shelf) provides a report that is shows all the active alarm and status conditions. The local alarms and the status report are displayed automatically on the local ITM-CIT immediately after log in or directly on the network element management system. The report shows the following alarm levels:

- PROMPT
- DEFERRED
- INFO
- NO REPORT.

The source address description of the alarm condition (for example controller failure, high-speed signal failure) is included in the report along with the date and time when the alarm was detected. The report also shows whether the alarm condition affects operations. There is also the option of displaying specified subsets of alarm conditions by severity.

Provisionable reporting mode per fault-type per instance

For each fault-type the associated reporting mode (values: “reported” and “non-reported”) is provisionable, individually for each location (e.g. port, TTP, CTP or unit) capable of generating this fault-type. It is possible to change the reporting mode associated with a certain fault-type globally for all location instances with a single command. The maximum amount of “reported/non-reported” instances is 1000.

Date and time function

The *Metropolis*® ADM (Universal shelf) has a real time clock signal available that is synchronized with the management system. It can be set through the ITM-CIT or OMS. The clock is used to timestamp operations, maintenance and performance monitoring events.

Reporting of analog parameters

Upon user request, the ITM-CIT and OMS can report the values of the laser bias current and optical transmitted power (derived from the backface current) of any STM-16 or STM-64 unit in the system. In addition, the value of the optical received power is reported.

State

An on-demand report displays the equipment and the equipment status.

Equipment report indicates:

- equipment
- location
- circuit pack type
- version
- slot status (the slot status can be auto or equipped).

Equipment status indicates:

- equipment
- location
- circuit pack type
- port status (if applicable)
- service status (if applicable).

Support subsystem failure reports

Failure reports are generated for faults in support subsystems.

Possible support subsystems are:

- the power supply subsystem
- the timing subsystem
- the control subsystem and
- the temperature control subsystem.

Resolution of failure reports

The resolution of the failure reports is such that the operator can identify whether the fault is inside or outside the system. In both cases the operator will get enough information to identify the next step in the fault correction process, e.g. replace a unit, change a configuration value, reconnect a cable, start a cable fault location process.

Version/equipment list

The version/equipment list is an on-demand report that lists the circuit pack version and the software generic (if applicable). This report also lists all of the circuit packs that are present.

Synchronization report

The synchronization report is an on-demand report that lists the status of the system synchronization. This report lists all of the clock parameters that can be interrogated.

Fan unit alarm

One fan unit, a dust filter and a controlling unit, must be present in the subrack. A fan unit contains two fans for redundancy. The fan unit (fan tray) can be replaced from the subrack at full operational conditions, without any service interruption or cabling rearrangements. This is needed for exchanging a failed fan unit.

The rotation speed of the fan unit is controlled by the fan controlling unit. This is to lower the noise level under low temperature conditions. The System Control unit measures the temperature in the subrack. The dust filter can be replaced or cleaned (both types are available) easily by the craft. Under normal conditions, the maintenance interval is at least 3 months depending on environmental dust loads. Proper cooling is still ensured if one of the two fans is failing.

The fan unit has a red fault LED and reports:

- FAN unit failure (FANc EQF)
- FAN unit power failure (FANc PWR)

□

Orderwire

This section provides information about orderwire.

Description

Engineering Orderwire (EOW) provides voice or data communications for maintenance personnel to perform facility maintenance.

User channels

The section overhead of all SDH interfaces and the VC-3/VC-4 path overhead contain several bytes, for instance E and F bytes, that can be used to provide 64 kbit/s operations channels.

The *Metropolis®* ADM (Universal shelf) provides for a maximum of four transparent 64 kbit/s channels that are selected from the following overhead bytes:

- E1 and E2 bytes: Channels from these bytes are mainly called Engineering Order Wire channels
- F1 bytes: Channels from these bytes are mainly called: user channels

□

Provisioning

Overview

Purpose

The *Metropolis*® ADM (Universal shelf) system supports many system applications by its provisioning features. Provisioning parameters are set by software control. These parameters vary from one installation to the next, and a wide range of options or in-service changes can be provisioned locally or remotely with the aid of ITM-CIT or OMS.

Definition

Provisioning refers to assigning values to parameters used for specific functions by network elements. The values of the provisioned parameters determine many operating characteristics of a network element.

References

For more information about provisioning parameters and original values using the ITM-CIT, refer to the Metropolis® *ADM (Universal shelf) User Operations Guide*.

Contents

Introduction

Default provisioning

Installation provisioning is minimized with the aid of carefully chosen default values/parameters that are defined and maintained in the System Controller, and a simple command can be given to restore all default values. All provisioning data is stored in non-volatile memory to prevent data loss during power failures.

Circuit pack replacement provisioning

Replacement of a faulty circuit pack is simplified by the automatic provisioning of the original values. The System Controller maintains a provisioning map of the entire subrack, so when a transmission circuit pack or a core unit is replaced the System Controller automatically downloads values to the new circuit pack and initiates testing of the new circuit pack. If the System Controller itself is replaced, provisioning data from a backup database in OMS is automatically downloaded to the new System Controller's non-volatile memory if that memory it is empty.

If the controller database is not empty but valid, the choice is offered between downloading and uploading.

Flexible circuit pack replacement

The system allows to exchange optical circuit packs and SFP's against others of the same bitrate, but with other wavelength or other haul without any need for changing the traffic related configuration data, e.g. protection groups, links, synch., ... provided the new pack supports the configuration (counter-example: exchanged pack had FEC, the new one not).

Provisioning reports

The provisioning report, which is made available to the OMS on demand, contains the current values of all provisionable parameters.

Provisionable SS bits

This feature allows users to provision the value of bits 5 and 6 (the SS bits) which are transmitted in the first H1 pointer byte of a VC signal. Present SONET (Telcordia) and SDH (ITU-T) standards require the receiving equipment to ignore these bits, but some older embedded SONET and SDH equipment may not ignore these bits.

In the source direction, provisioning the SS bits to "10" (overwrite disabled) allows interworking with older embedded SDH equipment.

In the source direction, provisioning the SS bits to "00" (overwrite enabled) allows interworking with older embedded SONET equipment.

In the sink direction, the incoming SS bits are ignored.

The SS bits are provisionable per port basis.

Provisioning of slots

Via the ITM-CIT or OMS, each slot or position in the system which can hold a plug-in unit, I/O module or converter box can be put in the UNASSIGNED, ASSIGNED or AUTO state. When a position in the system is put in the AUTO or ASSIGNED state, an identifier (type, version) of the entity to be inserted needs to be entered as well.

Depending on the configuration, the NE maintains a list of allowed (compatible) units for each position and keeps track of restrictions that may apply on the allowed states for some (mandatory) positions.

- if a slot or position is put in the UNASSIGNED state, a configuration alarm will be generated as soon as a unit is plugged in; no service is provided on the unit and no other alarms are generated
- if a slot or position is put in the ASSIGNED state a configuration alarm will be generated as soon as the unit is removed or an incompatible unit is inserted
- if a slot or position is put in the AUTO state, no configuration alarms will be generated as long as the position remains unequipped. As soon as the position is equipped the slot state will automatically change to ASSIGNED.

Provisioning port monitoring modes

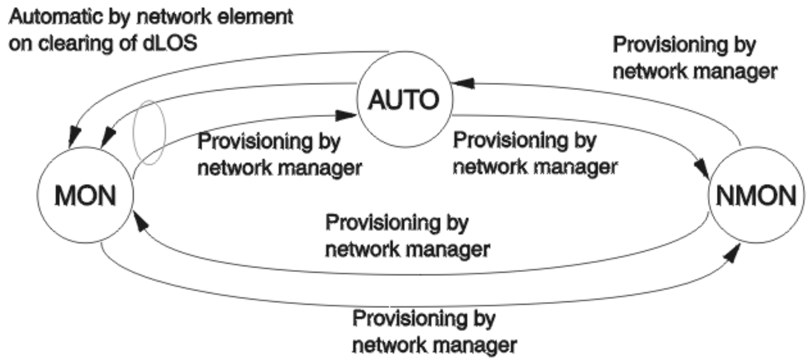
Port monitoring modes represent the monitoring state for each port in the system at any given time. Each port monitoring mode has its own characteristics for signal failure alarms and PM (Performance Monitoring) data collection. Transitions between modes occur due to events such as applying a good signal or *WaveStar*® Management commands. The detection of a fault does not affect the state of the port monitoring mode.

Port modes

The port modes in the *Metropolis*® ADM (Universal shelf) are:

- Automatic (AUTO): AUTO refers to a port that is available for automatic provisioning. A port changes from the AUTO mode to the MON mode if a good signal is detected. The original port monitoring mode value is AUTO. When the port monitoring mode is AUTO, the port is not alarmed
- Monitored (MON): MON refers to a port that is fully monitored and alarmed
- Not Monitored (NMON): NMON refers to a port that is not monitored and does not change to the MON state even if a good signal is detected. Any port modes can be user-provisioned independently to the NMON state at any time, regardless of the auto-provisioned mode of the terminating interface slot. This port mode is used to suppress alarms.
  A port that is not monitored will not raise any alarms. If there still is a signal present on the not monitored port, it is possible to receive a Not Expected Input Signal (NES) alarm. The alarm status of NES must then be provisioned Reported.

The figure below shows the possible port modes and the transitions between them.



Provisioning of Trail Termination Point modes

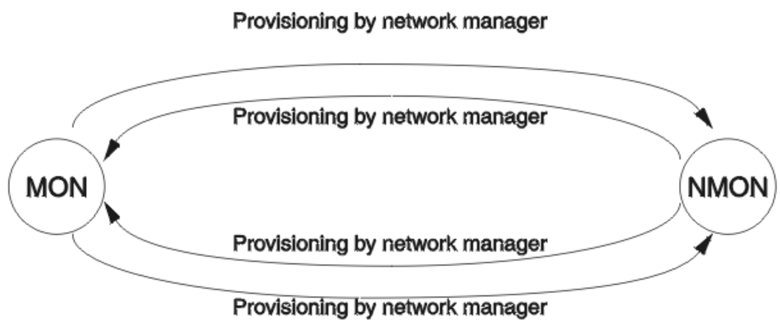
To prevent alarms from being raised and failures from being reported during trail provisioning, trail termination functions can enable and disable fault cause declarations.

Modes

The Trail Termination Point modes in the *Metropolis®* ADM (Universal shelf) are:

- Monitored (MON): MON refers to a tTrail Termination Point that is fully monitored and alarmed
- Not Monitored (NMON): NMON refers to a Trail Termination Point that is not monitored. This trail termination point mode is used to suppress alarms.

The figure below shows the possible trail termination point modes and the transitions between them.



IS-IS level 2

The *Metropolis®* ADM (Universal shelf) can act as a network layer (OSI protocol stack layer 3) relay system in the Data Communication Network (DCN), which can be interconnected via LAN (including TMN Q-interfaces) and DCC channels. Management messages between the OMS and SDH network elements of any type in the managed network can be routed via one or more connections including *Metropolis®* ADM (Universal shelf).

The nodes in this management information network can be organized in two levels:

- on level 1, each node can route messages to an other node in the same area
- on level 2, each gateway node of an area can route messages to an other gateway node in the same DCN.

OSI-Layer 3 functionality via the Q-LAN is implemented according to ISO-IEC-8648 (General), ISO-IEC-8473 (CLNP), ISO-IEC-9542 (ES-IS) and ISO-IEC-10589 (IS-IS).

DCC-partition repair

Partition Repair provides a way to repair the intra-area routing function in spite of IS-IS area partitioning. This is done by creating a path outside the area, between two Level-2 nodes (which are provisioned to be Partition Capable Level-2 nodes), belonging to distinct partitions of the same IS-IS area. Level-1 IS-IS/CLNP PDUs are encapsulated and transferred over that path. This is sometimes referred to as level1-tunneling.

□

6 System planning and engineering

Overview

Purpose

This chapter provides general System Planning and Engineering information for the *Metropolis*® ADM (Universal shelf).

Contents

General planning information

This section provides general planning information for *Metropolis*® ADM (Universal shelf).

There are a number of issues to consider when planning a network. Projected customer requirements determine the network topology and traffic capacities that are needed, both initially and in the future. These considerations drive, in their turn, the equipment planning and physical installation. In addition, synchronization and management need to be planned.

Planning considerations

When planning your network, you should consider the

- Power planning
- Cooling Equipment
- Environmental conditions
- Transmission capacity
- Port location rules
- Synchronization
- Floor plan layout
- Equipment interconnection.

Engineering and installation services group

Lucent Technologies maintains an Engineering and Installation Services group to assist you in planning and engineering a new system. The Engineering and Installation Services group is a highly skilled force of support personnel dedicated to providing customers with quality engineering and installation services. These specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services.

For more information about the Engineering and Installation Services group, refer to Chapter 8, "Product support".

Intended use

This equipment shall be used only in accordance with intended use, corresponding installation and maintenance statements as specified in this documentation. Any other use or modification is prohibited.

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Power planning

This section provides general power planning information for *Metropolis*® ADM (Universal shelf). The system power supply is able to provide 850 W power in the range –40 V to –72 V DC, respectively –48 V to –60 V DC nominal.

Power distribution

Optionally the power supply of the rack can be provided by a Power Distribution Panel (PDP) at the top of the rack.

Grounding

The *Metropolis*® ADM (Universal shelf) subrack has central fixed earthing point (refer to the Metropolis® *ADM (Universal shelf) Installation Guide*).

Power consumption

For more information about power consumption of the whole subrack and of the individual circuit packs, refer to Chapter 10, “Technical specifications”.

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Cooling equipment

This section provides general cooling equipment information for *Metropolis*® ADM (Universal shelf).

Fan units

Cooling is done by fans. Two fan units each of which contains one fan are integrated in those subracks for which the dissipation under fully loaded conditions could otherwise cause the thermal limits of the components to be exceeded. They aspirate air through a filter located below the lower row of boards and force the air through the subrack from bottom to top.

One fan unit is considered as mandatory unit for the 2.5G and the 10G application; therefore space for the fans is reserved in the middle and bottom of the subrack. If only one fan unit is used, it must be installed in the middle of the rack. If needed a second fan can optionally be ordered.

Fan unit design life

The fan unit design life is 7 years. After that the fan unit has to be replaced.

Heat baffle

The heat baffle is mounted above subrack to structure the airflow of the subrack within the structure of the rack.

Mounting the subrack allows no gaps between the baffle mounted below the *Metropolis*® ADM (Universal shelf) subrack and any equipment mounted directly below. Observing this rule avoids thermal stress due to hot exhaust air from the equipment below the subrack entering the air flow baffle.

References

For more information about cooling, please refer to “Cooling” (p. 4-56) and to the Metropolis® *ADM (Universal shelf) Alarm Messages and Trouble Clearing Guide*.

□

Environmental conditions

Environment

The environment is compliant with the specifications of EN300 019-1-3 for a Class 3.1 Environment “Stationary use at weather protected locations”:

	Temperature range	Humidity	ETSI class
Normal operation	–5 ºC to +45 ºC	5 to 90 %	3.1e
Storage Transport	–25 ºC to +55 ºC –40 ºC to +70 ºC	up to 100% up to 95 %	1.2 2.3

EMC/ESD requirements

Important! This equipment has been tested and found to comply with the limits for a Class A product. 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 must be installed and used in accordance with the instruction manual. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

The system complies to the EMC Directive 2004/108/EC and bears the CE-marking mandatory for the EEA (European Economic Area). i.e

The *Metropolis*® ADM (Universal shelf) is compliant with EN 300386 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements” and the therein specified standards:

Radiated emission	EN 55 022 / CISPR 22, Class A
Conducted emission • DC power • Telecom ports	• EN 55 022 / CISPR 22, Class A • EN 55 022 / CISPR 22, Class A
Electrostatic discharge	EN/IEC 61000–4–2 level 2
Radiated immunity	EN/IEC 61000–4–3 level 3
Electrical fast transient • DC power • Telecom ports	• EN/IEC 61000–4–4, level 1 • EN/IEC 61000–4–4, level 2
Surge immunity • Indoor telecom port	• EN/IEC 61000–4–5, level 1

Continuous wave immunity • DC power • Telecom ports	• EN/IEC 61000–4–6 level 2 • EN/IEC 61000–4–6 level 2

FCC certification

Metropolis® ADM (Universal shelf) is certified according to FCC part 15 class A.

Transmission capacity

This section provides general information about transmission capacity for *Metropolis®* ADM (Universal shelf).

The overall TDM transmission capacity of the system is determined by the size of the higher-order switch matrix on the core units.

Capacity

On the 2.5G Core Unit the total TDM switch capacity is 64 STM-1 equivalents (10.6 Gbit/s) for high order and 32 for low order.

On the 10G Core Unit the total TDM switch capacity is 272 STM-1 equivalents (42.3 Gbit/s) for high order and 64 for low order.

Circuit pack capacities

The following table gives an overview of the add/drop capacity for the 2.5 Gbit/s core unit and the 10 Gbit/s core unit.

	2.5 Gbit/s application	**10 Gbit/s application**
E1	maximum 504 of which a maximum of 252 hardware protected (in this case up to 4 units are protected)	maximum 504 of which a maximum of 252 hardware protected (in this case up to 4 units are protected)
DS1	maximum 504 of which a maximum of 252 hardware protected (in this case up to 4 units are protected)	maximum 504 of which a maximum of 252 hardware protected (in this case up to 4 units are protected)
E3/DS3	maximum 96 of which a maximum of 48 hardware protected (in this case 4 units are protected)	maximum 96 of which a maximum of 48 hardware protected (in this case 4 units are protected)
STM-1e	maximum 32 of which a maximum of 16 hardware protected (in this case all units are protected)	maximum 32 of which a maximum of 16 hardware protected (in this case all units are protected)
STM-1e (using LKA39)	maximum 96 of which a maximum of 48 hardware protected (in this case all units are protected)	maximum 96 of which a maximum of 48 hardware protected (in this case all units are protected)
E/FE	maximum 144 unprotected	maximum 144 unprotected
GbE	18 unprotected	18 unprotected
STM-1o	maximum 36 unprotected (in this case all units are unprotected) or a maximum of 16 protected (in this case all units are protected)	maximum 36 unprotected (in this case all units are unprotected) or a maximum of 16 protected (in this case all units are protected)
STM-1o (using LKA39)	maximum 138 unprotected (in this case all units are unprotected) or a maximum of 64 protected (in this case all units are protected)	maximum 138 unprotected (in this case all units are unprotected) or a maximum of 64 protected (in this case all units are protected)

	2.5 Gbit/s application	10 Gbit/s application
STM-4	maximum 9 unprotected (in this case all units are unprotected) or a maximum of 4 protected (in this case all units are protected)	maximum 9 unprotected (in this case all units are unprotected) or a maximum of 4 protected (in this case all units are protected)
STM-4 (using LKA39)	maximum 36 unprotected (in this case all units are unprotected) or a maximum of 16 protected (in this case all units are protected)	maximum 36 unprotected (in this case all units are unprotected) or a maximum of 16 protected (in this case all units are protected)
STM-16	—	maximum 9 unprotected (in this case all units are unprotected) or a maximum of 4 protected (in this case all units are protected)

References

For more information about transmission capacity, please refer to Chapter 4, “Product description”.

□

Port location rules

This section provides configuration restrictions and recommendations about using circuit packs and slots efficiently. For information about the subrack in general, please refer to "Subrack" (p. 4-11). Brief descriptions about the function of the circuit packs can be found in "Circuit packs" (p. 4-12).

Positions of the tributary port circuit packs

The following is an overview of the tributary port circuit packs and the position that they can occupy in the *Metropolis*® ADM (Universal shelf) subrack.

Apparatus code	Circuit Pack Name	Circuit pack (CP) Function	Slot position
LKA2	PI-E1/63	Tributary port 2 Mbit/s signals	TS1–TS4 and TS5–TS8
LKA2	PI-E1/63	Tributary port 2 Mbit/s signals - 1:N eqpt. protection TS9 for protection	TS5–TS8
LKA16	PI-DS1/63	Tributary port 1.5 Mbit/s signals	TS1–TS4 and TS5–TS8
LKA16	PI-DS1/63	Tributary port 1.5 Mbit/s signals - 1:N eqpt. protection TS9 for protection	TS5–TS8
LKA8	PI-E3DS3/12	Tributary port 34/45 Mbit/s signals (unprotected function in combination with PBG4)	TS1–TS8
LKA8	PI-E3DS3/12	Tributary port 34/45 Mbit/s signals - 1+1 eqpt. protection (in combination with PBP1)	TS1–TS8
LKA3	SI-1/4	Tributary port 155.520 Mbit/s signals - 1+1 eqpt. protection (in combination with PBP2)	TS1–TS8
LKA13	SI-1/4	Tributary port STM-1o signals	TS1–TS9
LKA11	SI-S4.1/1	Tributary port STM-4 signals	TS1–TS9
LKA14	SI-L4.2/1	Tributary port STM-4 signals	TS1–TS8
LKA23	SI-L16.1/1	Tributary port STM-16 signalsted	TS1–TS9
LKA22	SI-L16.2/1	Tributary port STM-16 signals	TS1–TS8
LKA39	SI-1/16-4/4	Parent board for STM-4, STM-1o and STM-1e To be used with PBP5/ 6/ 8	TS1–TS8 TS9 (for optical ports)
LKA50	SI-x16 SFP/1	Tributary unit using STM-16 SFP's To be used with PBP-5, PBP-6 and PBP-8.	TS1–TS9
LKA4	IP-LAN8	E/FE 10/100 BASE-T Ethernet	TS1–TS8
LKA412	IP-LAN12	12 switched E/FE 10/100 BASE-T Ethernet	TS1–TS8

Apparatus code	Circuit Pack Name	Circuit pack (CP) Function	Slot position
LKA53	IP-GE/2F-OS	GbE LAN interface The IP-GE/2F-OS (LKA53) Gigabit Ethernet unit can only be used in combination with • an LKA21 System Controller, and • a 2.5-Gbit/s core unit of type SI-16SFP C2/4 (LKA48, LKA481, LKA482), or a 10-Gbit/s core unit of type L-64.2b/3 (LKA26), S-64.2b/3b (LKA27), SI-L64.2 C2/1 (LKA28), SI-S64.2 C2/1 (LKA29), SI-I64.1r C2/1 (LKA49), or SI-V64.2 C2/1 (LKA350).	TS1–TS9
LKA12	IP-GE/2	GbE LAN interface	TS1–TS9
LKA12B	IP-GE/2	GbE LAN interface	TS1–TS9

Paddle boards

A variety of paddle boards can be used to interconnect the system directly or indirectly with the office cabling. In addition, paddle boards can be used for equipment protection and/or impedance adaptation. All paddle boards can be inserted from the front of the equipment and fit on the 2 mm pitch bac-plane connectors.

Short name	Long description	Use together with
PB-SI1e/4	Paddle Board STM-1e	SI-1e/4
PB-SI1e/P4	Paddle Board STM-1e Protection	SI-1e/4
PB-E3DS3/12	Paddle Board 34/45 Mbit/s	PI-E3DS3/12
PB-E3DS3/P12	Paddle Board 34/45 Mbit/s Protection	PI-E3DS3/12
PB-E1/75/63	Paddle Board 2 Mbit/s, 75 Ω	PI-E1/63
PB-E1/120/63	Paddle Board 2 Mbit/s, 120 Ω	PI-E1/63
PB-E1/75/P63	Paddle Board 2 Mbit/s, 75 Ω 1:N P/un-P	PI-E1/63
PB-E1/120/P63	Paddle Board 2 Mbit/s, 120 Ω 1:N P/un-P	PI-E1/63
PB-DS1/P100/63	Paddle Board 1.5Mbit/s, 100 Ω	PI-DS1/63
PB-LAN/100/8	Paddle Board 8 × LAN 100 Ω	IP-FE/8

Paddle boards are always needed for electrical interfaces.

The STM-1 Paddle Boards (PBs) to be used together with LKA39 (for protection and impedance adaption) are listed below.

Item code	PB name	Description	Position
PBP5	PB-1/75/12S	On this paddle board are 1.6/5.6 connectors for 12 bi-directional external CMI interfaces.	PB1–PB4 and PB5–PB8
PBP6	PB-1/P75/12D	The paddle board can be used for 1+1 protection in combination with two units, in two adjacent trib slots (trib slots 1&2, 3&4 and 5&6, 7&8 are allowed).	PB1–PB4 and PB5–PB8
PBP8	PB-STM-1o/6	On this paddle board are 6 SFP cages for STM-1o interfaces.	PB1–PB4 and PB5–PB8

2 Mbit/s Paddle Boards (PBs) for protection and impedance adaption are listed below.

Item code	PB name	Description	Position
PBE3	PB-E1/P75/63	Protected 75 Ω applications, 63 channels + connector type *Metal*™ 2 mm	PB5–PB8
PBE3D	PB-E1/P75/63	Protected 75 Ω applications, 63 channels + connector type SubD15 interconnect	PB5–PB8
PBE4	PB-E1/P120/63	Protected 120 Ω applications, 63 channels + connector type *Metal*™ 2 mm	PB5–PB8
PBE41	PB-E1/P120/63	Protected 120 Ω applications, 63 channels + connector type *Metal*™ 2 mm	PB5–PB8
PBE5	PB-E1/75/63	Unprotected 75 Ω applications, 63 channels + connector type *Metal*™ 2 mm	PB1–PB4 and PB5–PB8
PBE6	PB-E1/120/63	Unprotected 120 Ω applications, 63 channels + connector type *Metal*™ 2 mm	PB1–PB4 and PB5–PB8
PBP7	PB-E1/75/63	Unprotected 75 Ω applications, 63 channels + connector type SubD15 interconnect	PB1–PB4 and PB5–PB8

34/45 Mbit/s paddle boards (PBs) for protection are listed below.

Item code	PB name	Description	Position
PBG4	PB-E3DS3/75/12	Unprotected 75 Ω applications, 12 channels + connector 1.5/5.6	PB1–PB4 and PB5–PB8
PBP1	PB-E3DS3/ P75/12	Protected 75 Ω applications, 12 channels + connector 1.5/5.6	PB1–PB4 and PB5–PB8

155 Mbit/s paddle boards (PBs) for protection are listed below.

Item code	PB name	Description	Position
PBG2	PB-1/75/4	Unprotected 75 Ω applications, 4 channels + connector 1.5/5.6	PB1–PB4 and PB5–PB8
PBP2	PB-1/P75/4	Protected 75 Ω applications, 4 channels + connector 1.5/5.6	PB1–PB4 and PB5–PB8

Paddle boards for PB-LAN/100/12 are listed below.

Item code	PB name	Description	Position
PBL12	PB-LAN/100/12	Unprotected 10/100Base-T LAN, 12 channels + connector type RJ45	I/O slots associated with TS1 .. TS8
PBO12	PB-LAN/100/12	Unprotected 10/100Base-T LAN, 12 channels + connector type RJ45	I/O slots associated with TS1 .. TS8

Paddle boards for PB-LAN/100/8 are listed below.

Item code	PB name	Description	Position
PBG1	PB-LAN/100/8	Unprotected 10/100Base-T LAN, 8 channels + connector type RJ45	PB1–PB4 and PB5–PB8

SFP modules

The optical plug-in modules for the parent boards are so called Small Form Factor Pluggable (SFPs). They can be inserted and removed in a live system (“hot pluggable”).

The number of inserted SFPs can be configured flexibly between 0 and the maximum number. The remaining SFP slots can be left empty and should be covered by a faceplate.

The *Metropolis®* ADM (Universal shelf) SFPs are marked by the manufacturer and checked upon insertion, in order to protect from accidental insertion of non Lucent SFPs or SFPs not certified by Lucent.

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Metropolis® ADM (Universal shelf) core engineering

Minimum configuration

The minimum recommended complement of circuit packs required for an operational *Metropolis®* ADM (Universal shelf) subrack is

- one working and one protection 2.5G/10G Core Unit
- one System Controller Unit
- any optical circuit packs in the universal slots.
- one Power Supply Unit
- one Fan Unit

Metropolis® ADM (Universal shelf) 2.5G core engineering

The core configuration of the *Metropolis®* ADM (Universal shelf) for 2.5G application always consists of the following:

Apparatus code	Circuit-pack name	Description	Slot position
LKA1D	SC	System Controller Unit. This item includes the current *Metropolis®* ADM (Universal shelf) system software.	SC
LKA21/LAK21B	SC	System Controller Unit. This item includes the current *Metropolis®* ADM (Universal shelf) system software.	SC
LKA24	SI-L16.1 or	Core Unit: cross-connect, line interface, and timing	CO1 (W) and CO2 (P)
LKA25	SI-L16.2/3		
LKA48	SI-16SFP C2/4	4x2G5 Core Unit: cross-connect, line interface, and timing	
LKA481	SI-16 SFP C3/1	1 port-SFP STM-16 Core Unit: cross-connect, line interface, and timing	
LKA482	SI-16 VH C3/1 OBA	1 port-SFP STM-16 VH Core Unit: cross-connect, line interface, and timing	
PU	PU	Power Unit	PU-L and PU-R
FAN	FAN	Fan Unit	FANM and FANB

Metropolis® ADM (Universal shelf) 10G application core engineering

The core configuration of the *Metropolis®* ADM (Universal shelf) for 10G application consists of:

Apparatus code	Circuit-pack name	Description	Slot position
LKA1D	SC	System Controller Unit. This item includes the current *Metropolis®* ADM (Universal shelf) system software.	SC

Apparatus code	Circuit-pack name	Description	Slot position
LKA21/LAK21B	SC	System Controller Unit. This item includes the current *Metropolis*® ADM (Universal shelf) system software.	SC
LKA26 (release 1.0)	SI-L64.2 C1/1	Core Unit: cross-connect, line interface, and timing	CO1 (W) and CO2 (P)
LKA27 (release 1.0)	SI-S64.2 C1/1		
LKA47 (release 1.0)	SI-I64.1r C1/1		
LKA28	SI-L64.2 C2/1		
LKA29	SI-S64.2 C2/1		
LKA49	SI-I64.1r C2/1		
LKA281	SI-U64.2 C2/1		
LKA350	SI-V64.2 C2/1		
PU	PU	Power Unit	PU-L and PU-R
FAN	FAN	Fan Unit	FANM and FANB

Restrictions

Configuring a *Metropolis*® ADM (Universal shelf) system the following restrictions have to be considered:

- It is recommended not to configure a system with mixed core units (i.e. release 1.0 core unites together with release 3.0 (or higher) 10G core units). Such a mixed configuration is only supported in the context of an HW upgrade from release 1.0 hardware to, for instance, release 3.0 hardware.
- Upgrading HW from release 1.0 core units to release 3.0 or later
  If unexpected state information is reported, the operator should just follow the upgrade procedure and ignore the state information.
  There is no way back if the first core unit is re-assigned. The operator has to continue with the upgrade procedure. In worst case, there will be a longer traffic interruption until the second core unit is replaced.
- The system allows in service upgrade of the single port 2.5G core units LKA481 & LKA482 (introduced with Release 5.0) to the 10G core units LKA49, LKA29, LKA28, LKA350 (introduced with Release 3.0) and LKA281. The traffic of line interface must be protected by SNC/N. Short traffic interuptions in the range of a protection hit (<50ms) are acceptable. The upgrade is described in the OMS Provisioning Guide
- Do not use the *Metropolis*® ADM (Universal shelf) STM-1 tributary packs LKA6 (108680042), LKA3 (108676651) , LKA11 (109047811) and LKA13 (109202291) together with *Metropolis*® ADM (Universal shelf) core units of release 3.0 or higer.
- If STM-1 access is needed, use the high density STM-1/ STM-4 pack (LKA39).
- R3.0.x does not support the LKA21B!

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Network synchronization

The planning of the synchronization network should be considered for the network as a whole. The guidelines for synchronization network engineering can be found in ITU-T Recommendation G.803, Annex III. The *Metropolis*® ADM (Universal shelf) supports all the synchronization features that are needed (as specified in ITU-T Recommendation G.781, Option 1) to engineer the network synchronization according to ITU-T Recommendations. Careful consideration should be given to the correct design of the SDH network's synchronization. Proper synchronization engineering minimizes timing instabilities, maintains quality transmission network performance and limits network degradation due to unwanted propagation of network synchronization faults.

References

Timing and synchronization functionality is described at

- "Synchronization and timing" (p. 4-46)

Key recommendations

The following list contains some key recommendations with respect to network synchronization:

- from a synchronization point of view, a group of interconnected SDH network elements, like the *Metropolis*® ADM (Universal shelf), which all contain an internal clock according to G.813 option 1, form a so-called "SEC subnetwork". All SDH network elements in this cloud provide each other with timing information via STM-N links. Such a network part should receive synchronization from the network clock, via at least two independent paths. The network clock usually consist of a PRC (See ITU-T Recommendation G.811) and a back-up clock (usually an SSU according to G.812) in case the PRC fails
- 2 MHz and 2 Mbit/s links are used to bring the timing information from the network clock into the SEC subnetwork. The planning of the links between the PRC and all SSUs in a network is part of the overall operator's network-synchronization plan
- within the SEC subnetwork the SDH network elements should be configured in such a way that each network element receives at least two reference signals. Selection between the alternative references should be based on the SSM protocol
- the SEC subnetwork synchronization should be engineered such that no chains of SECs are present or can be formed that exceed the number of 20 nodes (excluding SDH regenerators)
- as a guideline, it is recommended that the SEC sub-network synchronization be engineered in such a way that no combination of two independent failures can lead to the creation of timing loops or the occurence of instabilities in the reference selectors.

ITU-T Recommendation G.781

The *Metropolis*® ADM (Universal shelf) is in accordance with ITU-T Recommendation G.781 and supports the following features to support the engineering of the synchronization network:

- Possibility to assign STM-N inputs (both aggregate and tributary), 2 Mbit/s traffic inputs and external synchronization inputs (2 MHz or 2 Mbit/s) as references for the system or for the external synchronization output
- Assignment/Unassignment of synchronization references. Up to 8 references can be assigned (two external timing inputs, two aggregate interfaces and four tributary interfaces). Each of these references can be provisioned with a priority
- Independent selection of references for the system clock and the external timing output
- Optional enabling/disabling of the SSM algorithm
- The possibility within the SSM algorithm to assign a fixed SSM value to any incoming reference and to define a squelch threshold for the external synchronization output.

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Floor plan layout

This section gives information about the space needed to mount *Metropolis*® ADM (Universal shelf) subracks.

For a complete and up-to-date list of all hardware items with the respective comcodes please refer to the Engineering Drawings ED8C937-10 and ED8C937-20, that you can:

- find appended at the end of this document, up to date of the printing date (if it was ordered at the Customer Information Center (CIC))
- order in the latest version at CIC under http://www.cic.lucent.com/drawings.html with the order codes “ED8C937-10” and “ED8C937-20”.

Rack dimensions (based on an ETSI subrack (300 mm))

The *Metropolis*® ADM (Universal shelf) is housed in a self-supporting double-row shelf to fit in standard ETSI racks that are 300 mm deep and 600 mm wide. The maximum size of a subrack that contains one *Metropolis*® ADM (Universal shelf) is 495 mm wide and 270 mm deep. The subrack height is a maximum of 925 mm (fully equipped, including I/O modules and cable routing.

2000 mm by 300 mm

This rack can hold one subrack and miscellanous equipment according to ETS 200119-4 in the remaining space. The rack is 600 mm wide, 300 mm deep and 2000 mm high. The subracks can be mounted from the front side. The design conforms to ETS 300119-3 specifications. The rack is designed for installation of rack-level power and fusing facilities as well as alarm lamps.

2200 mm by 300 mm

This rack can hold two subracks. The rack is 600 mm wide, 300 mm deep and 2200 mm high. The subracks can be mounted from the front side. The design conforms to ETS 300119-3 specifications. The rack is designed for installation of rack-level power and fusing facilities as well as alarm lamps.

2600 mm by 300 mm

This rack can hold two subracks. The rack is 600 mm wide, 300 mm deep and 2600 mm high. The subrack can only be mounted from the front side. The design conforms to ETS 300119-3 specifications. The rack is designed for installation of rack-level power and fusing facilities as well as alarm lamps.

2200 mm by 600 mm

This rack can hold four subracks. The rack is 600 mm wide, 600 mm deep and 2200 mm high. The subracks can mounted from both sides. The design conforms to ETS 300119-3 specifications. The rack is designed for installation of rack level power and fusing facilities as well as alarm lamps.

2600 mm by 600 mm

This rack can hold four subracks. The rack is 600 mm wide, 600 mm deep and 2600 mm high. The subracks can mounted from both sides. The design conforms to ETS 300119-3 specifications. The rack is designed for installation of rack-level power and fusing facilities as well as alarm lamps.

LambdaUnite® MultiService Switch (MSS) earthquake proof rack

The subrack of the *Metropolis®* ADM (Universal shelf) system can be mounted back-to-back in a 600 mm deep, 2200 mm high earthquake proof *LambdaUnite®* MultiService Switch (MSS) rack. The subrack can be mounted from both sides. Two *Metropolis®* ADM (Universal shelf) subracks can be mounted below one *LambdaUnite®* MultiService Switch (MSS) rack. Cabling restrictions may apply, i.e. strict top cabling access for the *LambdaUnite®* MultiService Switch (MSS) and strict bottom cabling access for the *Metropolis®* ADM (Universal shelf).

The *LambdaUnite®* MultiService Switch (MSS) rack-top alarm unit (LEDs) is supported by the *Metropolis®* ADM (Universal shelf).

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7 Ordering

Overview

Purpose

This chapter provides an overview of the ordering process and the current software & licence ordering information for *Metropolis*® ADM (Universal shelf).

Contents

Ordering information

Metropolis® ADM (Universal shelf) has been carefully engineered and all equipment kitted to simplify the ordering process. In this chapter the current software and licence items and spare unit recommendations are shown, as available on the issue date of this document. For a complete and up-to-date list of the hardware items please refer to the Engineering Drawings described below.

Contact and further information

For all questions concerning ordering of *Metropolis*® ADM (Universal shelf), for any information about the marketable items and their comcodes, and for ordering the equipment please contact your Account Executive for *Metropolis*® ADM (Universal shelf) or your Lucent Technologies local customer team.

Engineering Drawing

For a complete and up-to-date list of the orderable hw items with the respective comcodes please refer to the Engineering Drawing ED8C937-10, that you can

- find appended at the end of this document, up to date of the printing date (if it was ordered at the Customer Information Center (CIC))
- order in the latest version at CIC under http://www.cic.lucent.com/drawings.html with the order code ED8C937-10.

Software & licence items

The following table lists the ordering information concerning the current software and licence items for *Metropolis*® ADM (Universal shelf).

Item code	Description	Short name	Comcode
SCA354	Software MADM Universal R5.1 STM-16 Core including Data features supporting controller LKA21	ID.SW R5.1 STM-16	109578328
SCA355	Software CD MADM Universal STM-16 Core R5.1 including Data features supporting controller LKA21	CD.SW R5.1 STM-16	109578310
SCA356	Software MADM Universal R5.1 Basic STM-16, STM-64 supporting controller LKA1D and LKA21	ID.SW R5.1 Basic STM-16, STM-64	109578161
SCA357	Software CD MADM Universal R5.1 Basic STM-16, STM-64 supporting controller LKA1D and LKA21	CD.SW R5.1 Basic STM-16, STM-64	109578153
SCA358	Software MADM Universal R5.1 STM-16, STM-64 Extended Version supporting controller LKA21 and Data features	ID.SW R5.1 Extended STM-16, STM-64	109578229

Item code	Description	Short name	Comcode
SCA359	Software CD MADM Universal R5.1 STM-16, STM-64 Extended Version supporting controller LKA21 and Data features	CD.SW R5.1 Extended STM-16, STM-64	109578211

Lightguide build-outs and cables

For a complete list of the available lightguide build-outs (LBOs, optical attenuating adapters) and of the different cables for *Metropolis*® ADM (Universal shelf) with the relative comcodes refer to the *Metropolis*® ADM (Universal shelf) engineering drawing ED8C937-10, described in "Engineering Drawing" (p. 7-2).

Documentation items

For the order codes of the current *Metropolis*® ADM (Universal shelf) documentation please refer to "Related documentation" (p. xiv).

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8 Product support

Overview

Purpose

This chapter provides information about the support for the *Metropolis*® ADM (Universal shelf).

Contents

Installation services

This section describes the installation services available to support *Metropolis*® ADM (Universal shelf).

Lucent Technologies offers Installation Services focused on providing the technical support and resources needed to efficiently and cost-effectively install your network equipment. Lucent Technologies Installation Services provide unparalleled network implementation expertise to help install your wire line and wireless networks. We use state-of-the-art tools and technology, and highly skilled technicians to install your equipment and help to ensure the timely and complete implementation of your network solution. By relying on our installation experts, we can rapidly build or expand your network, help manage the complexity of implementing new technologies, reduce operational costs, and help improve your competitive position by enabling your staff to focus on the core aspects of your business rather than focusing on infrastructure details.

Description

Within Lucent Technologies' overall Installation Services portfolio, Basic Equipment Installation and Site Supplemental Installation are the two services most closely linked to the initial deployment of Lucent Technologies' *Metropolis*® ADM (Universal shelf) product into your network.

Basic Equipment Installation

Provides the resources, experience and tools necessary to install the *Metropolis*® ADM (Universal shelf) product into your network. We assemble, cable and wire, and test the *Metropolis*® ADM (Universal shelf), helping to ensure it is fully functioning as engineered and specified.

Site Supplemental Installation

Enhances the Basic Equipment Installation service by performing supplemental work that is unique to your specific site location, configuration, or working requirements. Includes installation of material other than the main footprint product (such as earthquake bracing); provision of services unique to your site (such as, hauling and hoisting, multi-floor cabling, rental and local purchases) or as may be required by your operations (such as, overtime to meet your compressed schedules, night work requested by you, abnormal travel expenses, abnormal transportation or warehousing); and any other additional effort or charges associated with your environment.

Benefits

When implementing our Installation Services, Lucent Technologies becomes a strategic partner in helping you realize your long-term strategies and achieve your business and technological goals. We combine our state-of-the-art technical background, high-quality processes, expertise in the latest technologies, knowledge of revolutionary equipment breakthroughs, and feature-rich project management tools to get your network up and running - quickly, efficiently, and reliably. With Lucent Technologies, you can concentrate on your core business, while we apply our years of knowledge and experience to installing your network.

Our Installation Services let you:

- *Rapidly expand your network* — by turning hardware into working systems, with the capability to deploy multiple networks in parallel rollouts
- *Reduce operational expense* — of recruiting, training, and retaining skilled installation personnel
- *Leverage Lucent Technologies' resources and expertise* — by utilizing our team of knowledgeable and fully equipped experts that implement projects of any size, anywhere around the world
- *Implement quality assurance* — through our total quality management approach
- *Reduce operational expenses* — by avoiding the purchase of the necessary state-of-the-art tools, test equipment, specialized test software, and spare parts that Lucent Technologies Installation Services utilize
- *Ensure high-quality support* — with Lucent Technologies' extensive support structure, including proven methods and procedures, mechanized tools, professional training, technical support, and access to Bell Labs.

Reference

For more information about specialized installation services and/or database preparation, please contact your local Account Executive.

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Engineering services

This section describes the engineering services available to support *Metropolis*® ADM (Universal shelf).

Lucent Technologies Worldwide Services (LWS) offers Engineering Services focused on providing the technical support and resources needed to efficiently and cost-effectively engineer your network equipment. We provide the best, most economical equipment solution by ensuring your network equipment is configured correctly, works as specified, and is ready for installation upon delivery. With our proven, end-to-end solutions and experienced network engineering staff, Lucent Technologies Worldwide Services is the ideal partner to help service providers engineer and implement the technology that supports their business.

Description

Within Lucent Technologies' overall Engineering Services portfolio, Site Survey, Basic Equipment Engineering, Site Engineering, and Site Records are the four services most closely linked to the initial deployment of *Metropolis*® ADM (Universal shelf) into your network; each is described below.

Site Survey

A Site Survey may be required to collect your site requirements needed for proper equipment engineering. If adequate site requirements and records are not available up front, a site survey would be performed to collect information required for configuration of the equipment and integration of the equipment into the site.

Basic Equipment Engineering

Ensures that the correct footprint hardware is ordered and that the ordered equipment is configured for optimal performance in the network for the customer. Lucent Technologies Engineering configures equipment requirements based on inputs from the customer order, completed questionnaires, and/or site survey data. The decisions as to specific equipment needs are based on each component's functionality and capacity, and the application of engineering rules associated with each component.

Site Engineering

Ensures that the correct site material is ordered and that the optimal equipment layout for the installation of the ordered equipment in the customer's site is determined. Site Engineering will be used in assisting the customer with determining the necessary site conditions, layout and equipment required to properly install/integrate the footprint hardware components into a specific location.

Site Records

Site Records Service provides detailed record keeping which accurately documents the physical placement and configuration of specified customer equipment. Depending on the customer request, this can involve the initial creation of site records, updating of existing records, or ongoing maintenance of the customer's records.

Benefits

When implementing our Engineering Services, Lucent Technologies becomes a strategic partner in helping you realize your long-term strategies and achieve your business and technological goals. Our Engineering Services portfolio delivers quick, responsive support, with state-of-the-art tools, top technicians and end-to-end services to help you engineer an optimal network solution. Whether you are looking to outsource your total engineering effort or simply supplement basic coverage gaps, our portfolio of services provides the flexible level of support you need. With Lucent Technologies, you can concentrate on your core business while we apply our years of knowledge and experience in engineering your equipment solutions.

Our Engineering Services let you:

- *Rapidly expand your network* — by turning products into working systems, with the capability to deploy multiple networks in parallel rollouts
- *Reduce costs* — by determining the most cost-effective network configuration and optimal use of office space when planning and providing an equipment solution
- *Reduce operational expense* — of recruiting, training, and retaining skilled engineering personnel
- *Leverage Lucent Technologies' resources and expertise* — by utilizing our team of knowledgeable and fully equipped experts that can plan, design, and implement projects of any size, anywhere around the world
- *Implement quality assurance* — through our total quality management approach and use of ISO-certified processes
- *Provide one–stop shopping* with a globally deployed engineering workforce, saving the time, delays and coordination challenges of dealing with multiple equipment vendors and service providers
- *Keep pace with rapidly changing technology* — by supporting the latest technologies and equipment breakthroughs, including Lucent Technologies' and other vendor's products
- *Ensure high-quality support* — with Lucent Technologies' extensive support structure, including proven methods and procedures, mechanized tools, professional training, technical support, and access to Bell Labs
- *Maintain and track vital office records* — keep track of equipment locations and connections.

Reference

For more information about specialized engineering services, engineering consultations, and/or database preparation, please contact your local Account Executive.

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Maintenance services

This section describes the maintenance services available to support *Metropolis*® ADM (Universal shelf).

Description

Maintenance Services is composed of three primary services to support your maintenance needs. The services are

- Remote Technical Support Service (RTS)
- On-site Technical Support Service (OTS)
- Repair and Exchange Services (RES)

Remote Technical Support Service (RTS)

RTS provides remote technical support and Software Patches and Software Updates, as available, for deployed Lucent Technologies network elements to help cost-effectively maximize network availability and performance. With this service, system engineers deliver remote support via phone or modem connection for rapid response, diagnoses, and resolution of system outages and issues.

Support from our expert remote system engineers will:

- enable trouble tracking, resolution, and restoration
- answer technical product-related questions and specific feature and function questions
- help identify and apply available Software Patches and Software Updates on Covered Products.

Single Point of Contact — access to Lucent Technologies engineers and information to help identify and resolve technical issues via phone or modem.

Lucent Technologies OnLine Customer Support —

- web-based tracking and management of Assistance Requests (AR)
- self-help services i.e., Knowledge Database, Documentation, E-mail.

Service Options —

- Premium RTS: 24 hours a day, 7 days a week (24 × 7)
- Standard RTS: 8 hours a day (8 am – 5 pm Client local time) 5 days per week (8 × 5), Monday - Friday, excluding Lucent Technologies holidays.

On-site Technical Support (OTS)

OTS provides cost-effective support for Lucent Technologies products including systems that incorporate select third-party equipment.

- OTS Dispatched Technician — Lucent Technologies will dispatch a technician to your location to provide on-site assistance. We offer multiple coverage options to meet your needs from same-day dispatch, with 24 × 7 or 8 × 5 response, to next-business-day dispatch, with 8 × 5 response.
- OTS Dedicated Technician — a Lucent Technologies technician works at your location to perform daily maintenance tasks that keep your system running at peak performance.
- OTS Dedicated Engineer — an expert Lucent Technologies engineer provides you with customized on-site support and assistance in areas such as maintenance of new equipment, administration of software releases, and support with your administrative processes.

Repair and Exchange Services (RES)

RES provides rapid replacement or repair of your defective hardware, eliminating the need for you to purchase and maintain a costly spares inventory. These services can dramatically reduce investment capital and recurring operating expenses while helping to assure maximum network availability. RES offers

- Same Day Advanced Exchange — delivers a replacement part to Customer equipment site within four hours to enable rapid restoration of service to equipment and the ability to return parts to Lucent Technologies later. We have established an infrastructure of multi-point, overlapping-coverage field stocking locations and automated electronic process controls that help us approach a 100% on-time delivery track record.
- Next Day Advanced Exchange — delivers a replacement part on the very next day, 7 days a week, including holidays. Consider what is at risk when you compare this service to a "business day" program.
- Return for Repair — is an economical solution, which allows the Customer to return your field-replaceable parts to Lucent Technologies for repair or replacement. Lucent Technologies returns them in a very timely manner and without unexpected repair fees.

Contact

For maintenance service contact information please refer to "Technical support" (p. 8-8).

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Technical support

This section describes the technical support available for *Metropolis*® ADM (Universal shelf).

Services

Metropolis® ADM (Universal shelf) is complemented by a full range of services available to support planning, maintaining, and operating your system. Applications testing, network integration, and upgrade/conversion support is also available.

Technical support groups

Technical support is available through

- Local/Regional Customer Support (LCS/RCS)
- Technical Support Service (TSS).

Contacting your LCS/RCS

LCS/RCS personnel troubleshoot field problems 24 hours a day over the phone and on site (if necessary) based on Lucent Technologies Service Contracts:

for Europe, Africa, Asia and the pacific region (EMEA and APAC)	International Customer Management Centre (ICMC): • +353 1 692 4579 (toll number) • 00 800 00Lucent (toll free number in most EMEA countries)

For technical assistance, call your Local/Regional Customer Support Team. If the request cannot be solved by LCS/RCS, it will be escalated to the central Technical Support Service (TSS) teams in Nuremberg, Germany.

Technical support service

Lucent Technologies Technical Support Service (TSS) organization is committed to providing customers with quality product support services. Each segment of the TSS organization regards the customer as its highest priority and understands your obligations to maintain quality services for your customers.

The TSS team maintains direct contact with Lucent Technologies manufacturing, Bell Laboratories development, and other organizations to assure fast resolution of all assistance requests.

Technical support platform

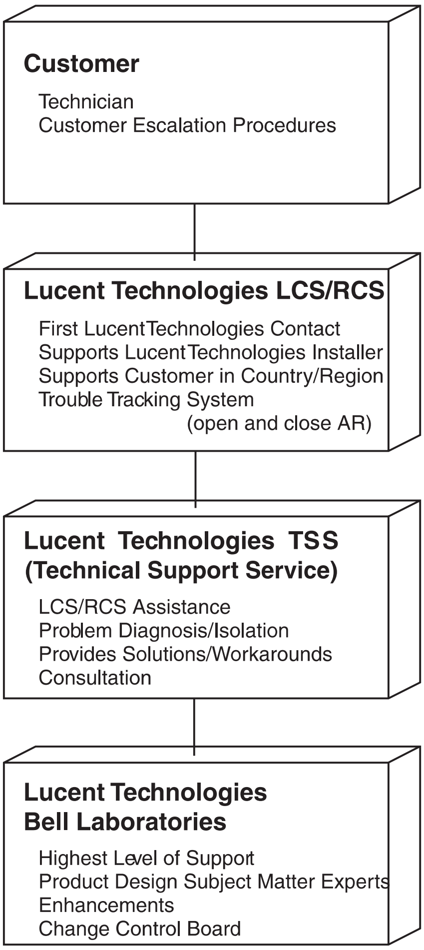
A global online trouble tracking system is used by all support teams to track customer assistance requests. The system communicates details about product bulletins, troubleshooting procedures, and other critical information to customers. All details of a request are entered into this database until closure. For online access to your trouble tickets via the web please contact your local support team.

Reference

For additional information about technical support, please contact your Lucent Technologies Customer Team.

Product support levels

The following figure shows the levels of product support for Lucent Technologies products.



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Documentation support

Lucent Technologies provides comprehensive product documentation tailored to the needs of the different audiences. An overview of the documentation set can be found at “Related documentation” (p. xiv).

Customer comment

As customer satisfaction is extremely important to Lucent Technologies, every attempt is made to encourage feedback from customers about our information products. Thank you for your feedback.

To comment on this information product online, go to http://www.lucent-info.com/comments or email your comments to ctiphotline@lucent.com.

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Training support

To complement your product needs, the Lucent IP&T organization offers a formal training package, with the single training courses scheduled regularly at Lucent Technologies' corporate training centers or to be arranged as on-site trainings at your facility.

Registering for a course or arranging an on-site training

To enroll in a training course at one of the Lucent Technologies corporate training centers or to arrange an on-site training at your facility (suitcasing), please contact:

Asia, Pacific, and China	Training Center Singapore, Singapore voice: +65 6240 8394 fax: +65 6240 8017
Central America and Latin America	Training Center Mexico City, Mexico voice: +52 55 527 87187 fax: +52 55 527 87185
Europe, Middle East, and Africa	Training Center Nuremberg, Germany voice: +49 911 526 3831 fax: +49 911 526 6142
North American Region	Training Center Altamonte Springs, USA voice: +1-888-582-3688 - prompt 2 (+1-888-LUCENT8 - prompt 2).

To review the available courses, to enroll for a training course at one of Lucent Technologies' corporate training centers, or to obtain contact information please visit:

- https://www.lucent-product-training.com.

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9 Quality and reliability

Overview

Purpose

This chapter presents Lucent Technologies' quality policy and describes the reliability of the *Metropolis*® ADM (Universal shelf).

Contents

Quality

Overview

Purpose

This section describes Lucent Technologies' commitment to quality and reliability and how quality is ensured.

Contents

Lucent Technologies’ commitment to quality and reliability

Lucent Technologies is extremely committed to providing our customers with products of the highest level of quality and reliability in the industry. *Metropolis*® ADM (Universal shelf) is a prime example of this commitment.

In line with this policy, all major transmission facilities in the USA, Europe and China are ISO-9000 certified. In line with the above, Lucent Technologies’ policy statement in this respect is as follows.

Quality policy

Lucent Technologies is committed to achieving sustained business excellence by integrating quality principles and methods into all we do at every level of our company to

- Anticipate and meet customer needs and exceed their expectations, every time
- Relentlessly improve how we work – to deliver the world’s best and most innovative communications solutions – faster and more cost-effectively than our competitors

Reliability in the product life-cycle

Each stage of the life cycle of *Metropolis*® ADM (Universal shelf) relies on people and processes that contribute to the highest product quality and reliability possible. The reliability of a product begins at the earliest planning stage and is controlled by the product life cycle process and therefore monitored and reviewed during:

- Product architecture
- Design and simulation
- Documentation
- Prototype testing during development
- Design change control
- Manufacturing and product testing (including 100% screening)
- Product quality assurance
- Product field performance
- Product field return management

The R&D community of Lucent Technologies is certified by ISO 9001.

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Ensuring quality

This section describes the critical elements that ensure product quality and reliability within

- Product development
- Manufacturing

Critical elements of product development

The product development group's strict adherence to the following critical elements ensures the product's reliability

- Design standards
- Design and test practices
- Comprehensive qualification programs
- System-level reliability integration
- Reliability audits and predictions
- Development of quality assurance standards for manufactured products

Critical elements of manufacturing

Note: Quality Representatives are also present at manufacturing locations to ensure shipped product quality.

The manufacturing and field deployment groups' strict adherence to the following critical elements ensures the product's reliability

- Pre-manufacturing
- Qualification
- Accelerated product testing
- Product screening
- Production quality tracking
- Failure mode analysis
- Feedback and corrective actions

□

Conformity statements

CE conformity

Hereby, Lucent Technologies declares that the Lucent Technologies product

Metropolis® ADM (Universal shelf), Release 5.2

is in compliance with the essential requirements and other relevant provisions of the following Directive:

Directive 1999/5/EC of 9 March 1999 on Radio and Telecommunication Terminal Equipment of the European Parliament and of the Council

is tested and conforms with the essential requirements for protection of health and the safety of the user and any other person and Electromagnetic Compatibility. Conformity is indicated by the CE mark affixed to the product. For more information regarding CE marking and Declaration of Conformity (DoC), please contact your local Lucent Technologies Customer Service Organization.

This product is in conformity with Article 3, Paragraph 3 of the R&TTE Directive and interworks in networks with other equipment connected to the optical telecommunication network.

Conformance with specifications of optical interfaces is granted as stated in the Official Journal of the European Union.

Compliance Statement in other European Languages

English

Lucent Technologies hereby declares that *Metropolis®* ADM (Universal shelf) is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Finnish

Lucent Technologies vakuuttaa täten että *Metropolis®* ADM (Universal shelf) tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.

Dutch

Bij deze verklaart Lucent Technologies dat deze *Metropolis®* ADM (Universal shelf) voldoet aan de essentiële eisen en aan de overige relevante bepalingen van Richtlijn 1999/5/EC.

French

Par la présente, Lucent Technologies déclare que ce *Metropolis®* ADM (Universal shelf) est conforme aux exigences essentielles et aux autres dispositions de la directive 1999/5/CE qui lui sont applicables.

Swedish

Härmed intygar Lucent Technologies att denna *Metropolis®* ADM (Universal shelf) står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.

Danish

Undertegnede Lucent Technologies erklærer herved, at følgende udstyr *Metropolis®* ADM (Universal shelf) overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF

German

Hiermit erklärt Lucent Technologies die Übereinstimmung des Gerätes *Metropolis®* ADM (Universal shelf) mit den grundlegenden Anforderungen und den anderen relevanten Festlegungen der Richtlinie 1999/5/EG.

Greek

ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ Lucent Technologies ΔΗΛΩΝΕΙ ΟΤΙ *Metropolis®* ADM (Universal shelf) ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ

Italian

Con la presente Lucent Technologies dichiara che questo *Metropolis®* ADM (Universal shelf) è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.

Spanish

Por medio de la presente Lucent Technologies declara que el *Metropolis®* ADM (Universal shelf) cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE

Portuguese

Lucent Technologies declara que este *Metropolis®* ADM (Universal shelf) está conforme com os requisitos essenciais e outras provisões da Directiva 1999/5/CE.

CE conformity declaration

The EC Declaration of Conformity (DoC) for *Metropolis®* ADM (Universal shelf) Release 5.2 is shown in the following figure, as available upon issue.

EC DECLARATION OF CONFORMITY

We

Lucent Technologies Network System GmbH
Thurn-und-Taxis-Str. 10
90411 Nuremberg
Germany

declare under our sole responsibility that the product:

Metropolis® ADM (Universal Shelf) Release 5.1

to which this declaration relates is in conformity with the following specifications

EN 300 386	***V 1.3.3 (2005)***
EN 60950-1	***(2001-12)***

following the provisions of Council Directive 89/336/EEC and 73/23/EEC, as amended by Directive 93/68/EEC, on the approximation of the laws of the Member States relating to electromagnetic compatibility and electrical equipment designed for use within certain voltage limits.

Nuremberg, Sept. 26,2006

Dr. Rainer Fechner
Vice President & Managing Director

Nuremberg, Sept. 26,2006

Siegfried Träger
E&H Manager

ECL-CE-ONG-06-005-V 01.00

Supplementary Information

Manufacturer
Lucent Technologies Network System GmbH
Thurn-und-Taxis-Str. 10
90411 Nuremberg

Competent Body (if applicable) :

Technical Construction File No (if applicable) :
Number

Test report No: HERBERG Service Plus GmbH
European Compliance Laboratory
ECL-EMC-TR-06-168-V 01.00
ECL-SAF -TR-06-083-V 01.00

Technical Certificate No (if applicable) :

Lucent Technologies
Bell Labs Innovations

Eco-environmental statements

The statements that follow are the eco-environmental statements that apply to the *Waste from Electrical and Electronic Equipment (WEEE) directive*.

Packaging collection and recovery requirements

Countries, states, localities, or other jurisdictions may require that systems be established for the return and/or collection of packaging waste from the consumer, or other end user, or from the waste stream. Additionally, reuse, recovery, and/or recycling targets for the return and/or collection of the packaging waste may be established.

For more information regarding collection and recovery of packaging and packaging waste within specific jurisdictions, please contact the Lucent Technologies Field Services / Installation - Environmental Health and Safety organization.

For installations not performed by Lucent Technologies, please contact the Lucent Customer Support Center at::

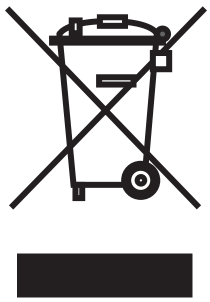
Technical Support Services, Lucent Technologies.

Within the United States: 1 866 LUCENT8 (866 582 3688), prompt 1

From all other countries: +1 630 224 4672, prompt 2

Recycling / take-back / disposal of product

Electronic products bearing or referencing the symbol shown below when put on the market within the European Union, shall be collected and treated at the end of their useful life, in compliance with applicable European Union and local legislation. They shall not be disposed of as part of unsorted municipal waste. Due to materials that may be contained in the product, such as heavy metals or batteries, the environment and human health may be negatively impacted as a result of inappropriate disposal.



Note: In the European Union, a solid bar under the crossed-out wheeled bin indicates that the product was put on the market after 13 August 2005.

Moreover, in compliance with legal requirements and contractual agreements, where applicable, Lucent Technologies will offer to provide for the collection and treatment of Lucent Technologies products at the end of their useful life, or products displaced by Lucent Technologies equipment offers.

For information regarding take-back of equipment by Lucent Technologies, or for more information regarding the requirements for recycling/disposal of product, please contact your Lucent Account Manager or Lucent Takeback Support at takeback@lucent.com.

Material content compliance

European Union (EU) Directive 2002/95/EC, “Restriction of the use of certain Hazardous Substances” (RoHS), restricts the use of lead, mercury, cadmium, hexavalent chromium, and certain flame retardants in electrical and electronic equipment. This Directive applies to electrical and electronic products placed on the EU market from 1 July 2006, with various exemptions, including an exemption for lead solder in network infrastructure equipment. Lucent products shipped to the EU from 1 July 2006 will comply with the RoHS Directive.

Technical documentation

The technical documentation as required by the Conformity Assessment procedure is kept at Lucent Technologies location which is responsible for this product. For more information please contact your local Lucent Technologies representative.

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Reliability specifications

Overview

Purpose

This section describes how reliability is specified.

Contents

General specifications

This section provides general reliability specifications for *Metropolis*® ADM (Universal shelf).

Mean time between failures

The Mean Time Between Failures (MTBF) for the whole *Metropolis*® ADM (Universal shelf) is 2.5 years.

MTBF is the mean duration of system hardware maintenance due to hardware failure. It does not reflect any service / traffics failure (service is be protected by redundant hardware).

The Mean Time Between Failures (MTBF) can derived from the FIT rate using the following formula:

MTBF [years] = 1 / (FIT value x 1x10exp-9 x 365 x 24)

Mean time to repair

The mean time to repair for *Metropolis*® ADM (Universal shelf) is predicted to be 2 hours. This figure includes dispatch, diagnostic, and repair time.

Infant mortality factor

The number of failures that a product experiences during the first year of service after turn-up may be greater than the number of subsequent annual steady state failures. This is the early life or infant mortality period. The ratio of the first year failure rate to the steady state failure rate is termed the infant mortality factor (IMF).

The prediction of the *Metropolis*® ADM (Universal shelf) circuit pack reliability is based on an infant mortality factor (IMF) smaller than 2.5. That means the first year failure rate (or infant mortality rate [IMR]) is assumed to be ≤ 2.5 times the steady state failure rate.

Product design life

The product design life for *Metropolis*® ADM (Universal shelf) is 15 years except for the fan units. The fan unit design life is 7 years.

Maintainability specifications

The air filter, located below the subrack, must be replaced or cleaned under regular conditions once every 3 to 6 months to ensure proper cooling.

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Reliability program

Introduction

Reliability is a key ingredient of products life cycle from the earliest planning stage. Major occurrences at the start of the project involve modeling of system reliability. During the design and development stage, reliability predictions, qualification and selection of components, definition of quality assurance standards and prototyping of critical system areas ensured built-in reliability. Manufacturing and field deployment, techniques such as pre-manufacturing, qualification, tracking of production quality, burn-in tests, failure mode analysis and feedback and correction further enhance the ongoing reliability of the *Metropolis*® ADM (Universal shelf).

□

Reliability specifications

Introduction

The *Metropolis®* ADM (Universal shelf) provides various hardware redundancy and protective switching mechanisms where necessary to support a high level of service availability.

Redundancy and protective switching

The *Metropolis®* ADM (Universal shelf) supports the principle that protective switching options should be available for all units and busses that could cause service degradation when a failure occurs. Therefore, the system is divided into blocks, which allow for separate protection switching. The *Metropolis®* ADM (Universal shelf) provides protection switching options for the following units:

Unit protection	Switching plan	Apparatus code
2.5G Core Unit 1 + 1	non-revertive	LKA24, LKA25, LKA48, LKA481, LKA482
10G Core Unit 1 + 1	non-revertive	LKA27, LKA28, LKA47, LKA28, LKA29, LKA281, LKA47, LKA350
PI-E1/63 1 : N	N = 4 at maximum revertive	LKA2
PI-E3DS3/12 1 + 1 protection	non-revertive	LKA8
SI-1 1/4 1 + 1 protection	non-revertive	LKA3

Reliability and service availability

Protection mechanisms are supported by the *Metropolis®* ADM (Universal shelf):

- path protection or SNC/N protection (SubNetwork Connection protection with Non-intrusive monitoring) for higher and lower order VCs
- multiplex section shared protection ring (MS-SPRing) (selective) at STM-16 and STM-64 level.
- 1+1 multiplex section protection (MSP) for STM-16, STM-4, and STM-1 optical interfaces
- dual node interworking (DNI)

Ethernet traffic can be protected by:

- spanning tree protocol
- link capacity adjustment scheme (LCAS)

Metropolis® ADM (Universal shelf) circuit-pack fit rates

The following tables gives an overview of the circuit packs fit rates. Those FIT rates are based on a steady state failure rate at a shelf room temperature of 25°C. The basic assumption is that the failure of any component would result in a failure of the circuit pack.

Common

Short unit name	Long description	FIT rate	Apparatus code
SC1	System Controller Unit 1	5196	LKA1D
SC2	System Controller Unit 2	4814	LKA21
SC2	System Controller Unit 2	4778	LKA21B
PU	Power Unit	855	PU
FAN	Fan Unit	1472.3	FAN

STM-16 and STM-64 Core Units

Short unit name	Long description	FIT rate	Apparatus code
SI-L16.1 C2/1	Core Unit 64/32 2.5G	7053	LKA24
SI-L16.2 C2/1	Core Unit 64/32 2.5G	7053	LKA25
SI-16 SFP C2/4	Core Unit 4 x STM-16 SFP CC-272/128 (without SFP)	7324	LKA48
SI-16 SFP C3/1	Core Unit 1 x STM-16 SFP CC-176/64 (without SFP)	6617	LKA481
SI-16 VH C3/1 OBA	Core Unit 1 x STM-16 VH CC-176/64 OBA	7570	LKA482
SI-L64.2, C1/1	Core Unit 256/64 10G	13824	LKA26
SI-S64.2, C1/1	Core Unit 256/64 10G	12834	LKA27
SI-I64.1r C1	Core Unit 256/64 10G	11546	LKA47
SI-L64.2 C2/1	Core Unit 272/128 10G	11788	LKA28
SI-U64.2 C2/1	Core Unit 272/128 10G	7935	LKA281
SI-S64.2 C2/1	Core Unit 272/128 10G	11291	LKA29
SI-I64.1r C2/1	Core Unit 272/128 10G	8190	LKA49
SI-V64.2 C2/1	Core Unit 272/128 10G	12034	LKA350

Tributary units

Short unit name	Long description	FIT rate	Apparatus code
SI-L16.1/1	Synchronous Interface unit STM-16 1300 nm	4703	LKA23
SI-L16.2/1	Synchronous Interface unit STM-16 1500 nm	4703	LKA22
SI-1/16-4/4	Synchronous Interface unit STM-16 1500 nm	2853	LKA39
SI-x16 SFP/1	Tributary unit using STM-16 SFP's (without SFP)	2079	LKA50
SI-S4.1/1	Synchronous Interface unit STM-4 1300 nm	2071	LKA11
SI-S1.1/4	Synchronous Interface unit STM-1 1300 nm	3408	LKA6
SI-L1.2/4	Synchronous Interface unit STM-1 1500 nm	4948	LKA13
SI-1e/4	Synchronous Interface unit STM-1e	2096	LKA3
PI-E1/63	Plesiosynchronous Interface unit 2 Mbit/s	3566	LKA2
PI-DS1/63	Plesiosynchronous Interface unit 1,55 Mbit/s	2303	LKA16
PI-E3DS3/12	Plesiosynchronous Interface unit 34Mbit/s/45Mbit/s	5851	LKA8
IP-LAN/8	Data Interface unit LAN FastEtherNet Mb-EOS	4517	LKA4
IP-LAN/12	Data Interface unit LAN FastEtherNet Mb-EOS	5566	LKA412
DI-GE1/2	Data Interface unit LAN GbEthernet Gb-EOS, base-X	2700	LKA38
SX/LX/ZX module	SX/LX/ZX module	670	
SI-IP-GE/2	GbE module	3957	LKA12
SI-IP-GE/2	GbE module	3957	LKA12B
SI-IP-GE/2	IP-GE/2F-OS	4988	LKA53

Paddle boards

Short unit name	Long description	FIT rate	Apparatus code
PB-1/75/P4S	Paddle Board STM1e Protection	327	PBG 2
PB-E3DS3/12	Paddle Board 34/45 Mbit/s	266	PBG 4
PB-E3DS3/ P75/12	Paddle Board 34/45 Mbit/s Protection	1126	PBG 1
PB-DS1/ P100/63	Paddle Board 1,55 Mbit/s, 100 Ω Protection	271	PBE 12
PB-E1/75/63	Paddle Board 2 Mbit/s, 75 Ω	980	PBE 5
PB-E1/P120/63	Paddle Board 2 Mbit/s, 120 Ω	980	PBE 6
PB-E1/P75/63	Paddle Board 2 Mbit/s, 75 Ω Protection	980	PBE 3
PB-E1/P75/63	Paddle Board 2 Mbit/s, 75 Ω Protection, Sub-D conn.	576	PBE3D
PB-E1/120/P63	Paddle Board 2 Mbit/s, 120 Ω 980Protection	584	PBE 4
PB-E1/120/P63	63 × 2 Mbit/s, 120 Ω (1:N protected/un-protected)	584	PBE 41
PB-LAN/100/8	IO module 100BASE-T	763	PBG 1
PB OPT/12 SFP	Paddle Brd. 12xLAN SFP	1106	PBO12
PB LAN100/12 SFP	Paddle Brd. 12xLAN 100 Ohm	759	PBL12
PB-E3DS3/ P75/12	PB 12 x E3/DS3 (Prot.1+1)	1126	PBP1
PB-1/P75/4D	PB 4xSTM-1 (Prot.1+1)	604	PBP2
PB-1/75/12S	PB 12xSTM-1e Un-protected	1432	PBP5
PB-1/P75/12D	PB 12xSTM-1e (Prot. 1+1)	1948	PBP6
PB-STM-1o/6	PB 6xSTM-1o	478	PBP8

SFPs

SFP name	FIT rates	Apparatus code
SFP I-16, 2Km	544	OM2G5-I16
SFP L-16.1, LR-1, 40km	864	OM2G5-L16.1
SFP L-16.2, LR-2, 80km	960	OM2G5-L16.2

SFP name	FIT rates	Apparatus code
SFP 2G5-S16.1, 15km	450	OM2G5-S16.1
SFP SH S-4.1, 15Km	968	OM622M-S4.1
SFP L-4.1, 40Km	556	OM622M-L4.1
SFP L-4.2, 80Km	548	OM622M-L4.2
SFP S-1.1, 15Km	544	OM155M-S1.1
SFP L-1.1, 40Km	552	OM155M-L1.1
SFP L-1.2, LH 80Km	538	OM155M-L1.2
SFP SFW-1490 BD-D	450	OM155SF1
SFP SFW-1310 BD-U	450	OM155SF2
STM-16 cWDM SFP color 13 (1510nm) 80 km	772	OM16CL51
STM-16 cWDM SFP color 14 (1530nm) 80 km	772	OM16CL53
STM-16 cWDM SFP color 15 (1550nm) 80 km	772	OM16CL55
STM-16 cWDM SFP color 16 (1570nm) 80 km	772	OM16CL57
STM-16 cWDM SFP color 13 (1510nm) 40 km	538	OM16CS51
STM-16 cWDM SFP color 14 (1530nm) 40 km	538	OM16CS53
STM-16 cWDM SFP color 15 (1550nm) 40 km	538	OM16CS55
STM-16 cWDM SFP color 16 (1570nm) 40 km	538	OM16CS57
SFP 100 BaseX Ethernet 10km	450	OM100B-LX
SFP GbE 500m	500	OMGBE-SX
SFP GbE 5km	105	OMGBE-LX
SFP GbE 70km (supplier: JDSU)	500	OMGBE-ZX
SFP GbE 70km (supplier: Excelight)	280	OMGBE-ZX

Dispersion Compensation Modules

Short name	Fit rate
DCM/LC CPL DK-50	160
DCM/LC CPL DK-60	160

Miscellaneous discretes

Short name	Fit rate
MIO-L	214
MIO-R	298

Short name	Fit rate
MIOR-J	979

Robustness

The *Metropolis*® ADM (Universal shelf) meets ITU recommendations on robustness. This means that:

- incorrect provisioning of options (software and/or hardware) does not lead to damage or degradation of the unit.
- changing a unit under operational conditions does not lead to damage or degradation of the units
- when a non-traffic-carrying unit is plugged in or removed, no transmission errors will be caused in the system
- when a traffic-carrying unit is plugged in or removed, no errors will be caused in any traffic that is not directly related to that unit
- short-circuiting of any electrical inputs or outputs (except the Primary Power feeds) on user accessible connectors will not cause any damage or degradation
- there will be no degradation in the equipment performance when the subrack and each card are individually subjected to a “percussion test”
- insertion of the incorrect card in any slot will not cause damage to the card or the slot
- removal of any card will not inhibit the reporting of alarms to the station-alarm scheme or to the management system. When the SC card is removed, only the System Controller Removed alarm loop will close to indicate this situation.

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10 Technical specifications

Overview

Purpose

This chapter provides the technical specifications of the *Metropolis®* ADM (Universal shelf):

The specifications are used to plan the *Metropolis®* ADM (Universal shelf) network element in an existing or a new network.

Contents

Optical interfaces

STM-64 optical line cards

The table below lists some parameters and the end of life power budgets.

Apparatus code	**LKA27**	**LKA26**	**LKA47**
Short unit name	**SI-S64.2 C1/1**	**SI-L64.2 C1/1**	**SI-I64.1r C1/1**
Physical interface standard acc. to . ITU-T G691	**STM-64 S64.2b** **STM-64 S64.3b**	**STM-64 L64.2b** **STM-64 L64.3**	**STM-64 I64.1r**
SDH level	STM-64	STM-64	STM-64
Transmission rate [kbit/s]	9 953 280	9 953 280	9 953 280
Transmission code	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)
Optical wavelength range [nm]	1530 … 1565	1530 … 1565	1310
Transmitter at reference point S and MPI-S (acc. G.691), respectively			
Source type	SLM	SLM	SLM
Max. spectral RMS width (σ) [nm]	NA	NA	NA
Max. spectral –20 dB width [nm]	NA	NA	NA
Min. side mode suppression [dB]	30	30	30
Chirp parameter [rad]			
Mean launched power range [dBm]	–1 … 2	10 … 13	-6 … -1
Min. extinction ration [dB]	8.2	8.2	6.0
Receiver at reference point R and MPI-R (acc. G.691, respectively)			
Min. optical sensivity [dBm]	–14	–14	-11
Max. optical path penalty [dB]	2	2	1
Min. overload [dBm]	–1	–1	—1
Max. reflectance of receiver, measured at R [dB]	–27	–27	—27
Optical path between S and R			
Min. optical return loss [dB]	24	24	14
Max. discrete reflectance [dB]	–27	–27	—27
Max. chromatic dispersion [ps/nm]	• 800 (STM-64 S64.2b) • 400 (STM-64 S64.3b)	• 1600 (STM-64 L64.2b) • 800 (STM-64 L64.3)	3.8
Optical attenuation range [dB]	• 3 … 11 (STM-64 S64.2b) • 3 … 12 (STM-64 S64.3b)	• 14 … 22 (STM-64 L64.2b) • 14 … 23 (STM-64 L64.3)	0 … 4

The table below lists some parameters and the end of life power budgets of the STM-64 optical line cards.

Apparatus code	**LKA29**	**LKA28**	**LKA281**	**LKA49**	**LKA350**
Short unit name	**SI-S64.2 C2/1**	**SI-L64.2 C2/1**	**SI-U64.2 C2/1**	**SI-I64.1r C2/1**	**SI-V64.2 C2/1**
Physical interface standard acc. to . ITU-T G691	**STM-64 S64.2b STM-64 S64.3b**	**STM-64 L64.2c STM-64 L64.3**	**STM-64 L64.2c STM-64 L64.3**	**STM-64 I64.1r**	**not standard compliant (close to L64.2c)**
SDH level	STM-64	STM-64	STM-64	STM-64	STM-64
Transmission rate [kbit/s]	9 953 280	9 953 280	9 953 280	9 953 280	9 953 280
Transmission code	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)
Optical wavelength range [nm]	1530 … 1565	1530 … 1565	1552.52	1310	1530 … 1565
Transmitter at reference point S and MPI-S (acc. G.691), respectively					
Source type	SLM	SLM	EML	SLM	SLM
Max. spectral RMS width (σ) [nm]	NA	NA	NA	NA	NA
Max. spectral –20 dB width [nm]	NA	NA	< 1	NA	NA
Min. side mode suppression [dB]	30	30	30	30	30
Chirp parameter [rad]					-0.6 … -0.75
Mean launched power range [dBm]	–1 … 2	0 … 4	15,5 … 17 (T-16 OBA) 12,5 … 14 (T-13 OBA) 9,5 … 11 (T-10 OBA)	-6 … -1	11 … 14
Min. extinction ratio [dB]	8.29	9	9	6.0	10
Receiver at reference point R and MPI-R (acc. G.691, respectively)					
Min. optical sensivity [dBm]	–13	–24	–24 (R) –26,5 (MPI-R)	-11	-24
Max. optical path penalty [dB]	2	2 (over G.652 fiber) / 1 (over G.655 fiber)	2	1	2 (over G.652 fiber) / 1 (over G.653 and G.655 fiber)
Min. overload [dBm]	–1	–7	–7 (R) –17 (MPI-R)	—1	-7
Max. reflectance of receiver, measured at MPI-R [dB]	–27	–27	–27	—27	-27
Optical path between S and R					

Apparatus code	LKA29	LKA28	LKA281	LKA49	LKA350
Short unit name	**SI-S64.2 C2/1**	**SI-L64.2 C2/1**	**SI-U64.2 C2/1**	**SI-I64.1r C2/1**	**SI-V64.2 C2/1**
Physical interface standard acc. to . ITU-T G691	**STM-64 S64.2b STM-64 S64.3b**	**STM-64 L64.2c STM-64 L64.3**	**STM-64 L64.2c STM-64 L64.3**	**STM-64 I64.1r**	**not standard compliant (close to L64.2c)**
Min. optical return loss [dB]	24	24	24	14	24
Max. discrete reflectance [dB]	–27	–27	–27	–27	-27
Max. chromatic dispersion [ps/nm]	• 800 (STM-64 S64.2b) • 400 (STM-64 S64.3b)	1600 (STM-64 L64.2c)	2550	3.8	2400 (over G.652 fiber)
Optical attenuation range [dB]	• 3 … 11 (STM-64 S64.2b) • 3 … 12 (STM-64 S64.3b)	11 … 22 (STM-64 L64.2b)	• 34 … 42 (with T-16 booster and DCM-80) • 31 … 39 (with T-13 booster and DCM-80) • 38 … 36 (with T-10 booster and DCM-80)	0 … 4	21 … 33

STM-16 optical line cards

The table below lists some parameters and the end of life power budgets.

Apparatus code	LKA24	LKA25	LKA22	LKA23
Short unit name	**SI-L16.1 C2/1**	**SI-L16.2 C2/1**	**L16.2**	**L16.1**
Physical interface standard acc. to . ITU-T G957	**STM-16 L16.1**	**STM-16 L16.2**	**STM-16 L16.2**	**STM-16 L16.1**
SDH level	STM-16	STM-16	STM-16	STM-16
Transmission rate [kbit/s]	2 488 320	2 488 32	2488320 +/- 20 ppm	2488320 +/- 20 ppm
Transmission code	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)
Optical wavelength range [nm]	1280 … 1335	1535 … 1560	1535 - 1560	1280 … 1335
Transmitter at reference point S and MPI-S (acc. G.691), respectively				
Source type	SLM	SLM	DFB (uncooled)	DFB (uncooled)
Max. spectral RMS width (σ) [nm]	NA	NA	NA	NA

Apparatus code	LKA24	LKA25	LKA22	LKA23
Short unit name	**SI-L16.1 C2/1**	**SI-L16.2 C2/1**	**L16.2**	**L16.1**
Physical interface standard acc. to . ITU-T G957	**STM-16 L16.1**	**STM-16 L16.2**	**STM-16 L16.2**	**STM-16 L16.1**
Max. spectral –20 dB width [nm]	1	< 1	< 1	< 1
Min. side mode suppression [dB]	30	30	30	30
Mean launched power range [dBm]	–2 … 2	–2 … 3	–2 … 3	–2 … 2
Min. extinction ration [dB]	8.2	8.2	8.2	8.2
Receiver at reference point R and MPI-R (acc. G.691, respectively)				
Min. optical sensivity [dBm]	–27	–28	–27	–27
Max. optical path penalty [dB]	1	2	2	1
Min. overload [dBm]	–8	–8	–8	–8
Max. reflectance of receiver, measured at R [dB]	–27	–27	–27	–27
Optical path between S and R				
Min. optical return loss [dB]	24	24	24	24
Max. discrete reflectance [dB]	–27	–27	–27	–27
Max. chromatic dispersion [ps/nm]	230	1600	1800	230
Optical attenuation range [dB]	10 … 24	11 … 24	11 … 24	10 … 24

STM-16 optical modules (SFPs)

The table below lists some parameters and the end of life power budgets for the SFPs to be used.

Application	I-16	S-16.1	L-16.1	L-16.2
Optical wavelength range	1266 - 1360 nm	1260-1360 nm	1280 - 1335 nm	1500 - 1580 nm
Transmission rate	2 488 320 kbit/s	2 488 320 kbit/s	2 488 320 kbit/s	2 488 320 kbit/s
Transmitter at reference point S				
Source type	MLM	SLM	SLM	SLM
Max. spectral RMS width (σ)	4 nm	NA	NA	NA
Max. spectral –20 dB width	NA	1 nm	1 nm	1 nm
Min. side mode suppression	NA	30 dB	30 dB	30 dB

Application	**I-16**	**S-16.1**	**L-16.1**	**L-16.2**
Mean launched power (max)	-3 dBm	0 dBm	3 dBm	3 dBm
Mean launched power (min)	–10 dBm	–5 dBm	–2 dBm	–2 dBm…
Extinction ratio (min)	8.2 dB	8.2 dB	8.2 dB	8.2dB
Optical path between S and R				
Optical return loss of the cable plant at point S including the optical connector	14 dB	24 dB	24 dB	24 dB
Max. chromatic dispersion	12 ps/nm	NA	230 ps/nm	1600 ps/nm
Optical attenuation range	0 … 7 dB	0 … 12 dB	10 … 24 dB	10 … 24 dB
Max. discrete reflectance	–27 dB	-27 dB	–27 dB	–27 dB
Optical return loss of the cable plant at point S including the optical connector	14 dB	24 dB	24 dB	24 dB
Receiver at reference point R				
Min. optical sensivity (BER = 1×10^{-10})	–18 dBm	–18 dBm	–27 dBm	–28 dBm
Min. optical sensivity (BER = 1×10^{-12})	–17 dBm	–17 dBm	–26 dBm	–27 dBm
Max. optical path penalty	1 dB	1 dB	1 dB	2 dB
Min. overload	–3 dBm	0 dBm	–9 dBm	–9 dBm
Min. return loss at receiver, measured at R	27 dB	27 dB	27 dB	27 dB

The table below lists some parameters and the end of life power budgets for the CWDM SFPs to be used in the 4 x STM-16 SFP CC-272/128 core unit, the 2.5G Core Unit 176/64 (LKA481), the 2.5G Core Unit 176/64 (LKA482) and the STM-x16 SFP/1 (LKA50). Deviating values recommended by G.695 are in brackets.

Apparatus code		**OM16CS47** **OM16CS49** **OM16CS51** **OM16CS53** **OM16CS55** **OM16CS57** **OM16CS59** **OM16CS61**	**OM16CL47** **OM16CL49** **OM16CL51** **OM16CL53** **OM16CL55** **OM16CL57** **OM16CL59** **OM16CL61**
Physical interface standard acc. to . ITU-T		**S-C8S1-1D2**	**S-C8L1-1D2**
Parameter	**Units**		
Maximum number of channels		8	8
Bit rate / line coding of optical tributary signals	kbit/s	NRZ / 2488320	NRZ / 2488320
Maximum bit error ratio	-	10-12	12-Oct
Fibre type		G.652, G.653, G.655	G.652, G.653, G.655

Apparatus code		**OM16CS47** **OM16CS49** **OM16CS51** **OM16CS53** **OM16CS55** **OM16CS57** **OM16CS59** **OM16CS61**	**OM16CL47** **OM16CL49** **OM16CL51** **OM16CL53** **OM16CL55** **OM16CL57** **OM16CL59** **OM16CL61**
Physical interface standard acc. to . ITU-T		**S-C8S1-1D2**	**S-C8L1-1D2**
Parameter	**Units**		
Interface at point SS			
Maximum mean channel output power	dBm	5	5
Minimum mean channel output power	dBm	0	0
Central wavelength	nm	1511 + 20m (m = 0 to 3)	1511 + 20m (m = 0 to 3)
Maximum central wavelength deviation	nm	+/- 6.5	+/- 6.5
Minimum extinction ratio	dB	8.2	8.2
Eye mask	-	STM-16 per G.957	STM-16 per G.957
Optical path from point SS and RS			
Maximum channel insertion loss	dB	17.3 (16.5)	25.5
Minimum channel insertion loss	dB	5	13 (14)
Maximum dispersion	ps / nm	refer to "Wavelength specific maximum cumulative dispersion" (p. 10-7)	refer to "Wavelength specific maximum cumulative dispersion" (p. 10-7)
Minimum optical return loss at SS	dB	24	24
Maximum discrete reflectance between SS and RS	dB	-27	-27
Maximum differential group delay	ps	120	120
Maximum optical cross talk	dB	20	20
Interface at point RS			
Maximum mean channel input power	dBm	0	-8 (-9)
Minimum sensitivity	dBm	-18.5 (-18)	28
Maximum optical path penalty	dB	1.2 (1,5)	2.5
Maximum reflectance of receiver	dB	-27	-27

Wavelength specific maximum cumulative dispersion

wavelength in vacuum	**frequency**	**Maximum cumulative dispersion [ps/nm]**	
[nm]	[THz]	S-C8S1-1D2	S-C8L1-1D2
1471	203.802	626	1044
1491	201.068	688	1147
1511	198.407	749	1248

wavelength in vacuum	**frequency**	**Maximum cumulative dispersion [ps/nm]**	
1531	195.815	807	1345
1551	193.29	863	1438
1571	190.829	918	1530
1591	188.43	960	1600
1611	186.091	960	1600

STM-4 optical tributary cards

The table below lists some parameters and the end of life power budgets.

Apparatus code	**LKA11**	**LKA14**
Short unit name	**SI-S4.1/1**	**SI-L4.2/1**
Physical interface standard acc. to . ITU-T G957	**STM-4 S4.1**	**STM-4 L4.2**
SDH level	STM-4	STM-4
Transmission rate [kbit/s]	622 080	622 080
Transmission code	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)
Optical wavelength range [nm]	1274 … 1356	1530 … 1565
Transmitter at reference point S and MPI-S (acc. G.691), respectively		
Source type	MLM	SLM
Max. spectral RMS width (σ) [nm]	2.5	NA
Max. spectral –20 dB width [nm]	NA	< 1
Min. side mode suppression [dB]	NA	30
Mean launched power range [dBm]	–15 … –8	–3 … 2
Min. extinction ration [dB]	8.2	10
Receiver at reference point R and MPI-R (acc. G.691, respectively)		
Min. optical sensivity [dBm]	–28	–28
Max. optical path penalty [dB]	1	1
Min. overload [dBm]	–8	–8
Max. reflectance of receiver, measured at R [dB]	NA	–27
Optical path between S and R		
Min. optical return loss [dB]	NA	24
Max. discrete reflectance [dB]	NA	–27
Max. chromatic dispersion [ps/nm]	74	2000
Optical attenuation range [dB]	0 … 12	10 … 24

STM-4 optical modules (SFPs)

The table below lists some parameters and the end of life power budgets for the STM-4 optical modules SFPs to be used together with the Multi-STM Main Board (12*STM-1e, 16*STM-1o, 4*STM-4) (LKA39) .

Application	**STM-4 Short Haul S-4.1**	**STM-4 Long Haul L-4.1**	**STM-4 Long Haul L-4.2**
Operating wavelength range	1274-1356 nm	1280-1335 nm	1480-1580 nm
Source type	MLM	SLM	SLM
Spectral width at -20 dB (max)	NA	1 nm	1 nm
RMS spectral width (max)	2.5 nm	NA	NA
Mean launched power (max)	-8 dBm	+2 dBm	+2 dBm
Mean launched power (min)	-15 dBm	-3 dBm	-3 dBm
Side mode suppression ratio (min)	NA	30 dB	30 dB
Extinction ratio (min)	8.2 dB	10 dB	10 dB
Mask of the eye diagram of the optical transmit signal	see G.957	see G.957	see G.957
Optical path between points S and R			
Maximum dispersion	74 ps/nm	NA	NA
Optical attenuation range	0 - 12 dB	10 - 24 dB	10 - 24 dB
Optical return loss of the cable plant at point S including the optical connector	NA	25 dB	24 dB
Receiver at reference point R			
Sensitivity (min) at BER = 1×10^{-10}	-28 dBm	-28 dBm	-28 dBm
Overload (min)	-8 dBm	-8 dBm	-8 dBm
Optical path penalty	< 1 dB	< 1 dB	< 1 dB
Optical return loss of the receiver (min)	NA	14 dB	27 dB

STM-1 optical tributary cards

The table below lists some parameters and the end of life power budgets.

Apparatus code	**LKA6**	**LKA13**
Short unit name	**SI-S1.1/4**	**SI-L1.2/4**
Physical interface standard acc. to . ITU-T G957	**STM-1 S1.1**	**STM-1 L1.2**
SDH level	STM-1	STM-1
Transmission rate [kbit/s]	155 520	155 520
Transmission code	Scrambled non-return to zero (NRZ)	Scrambled non-return to zero (NRZ)
Optical wavelength range [nm]	1274 … 1356	1480 … 1580
Transmitter at reference point S and MPI-S (acc. G.691), respectively		

Apparatus code	**LKA6**	**LKA13**
Short unit name	**SI-S1.1/4**	**SI-L1.2/4**
Physical interface standard acc. to . ITU-T G957	**STM-1 S1.1**	**STM-1 L1.2**
Source type	MLM	SLM
Max. spectral RMS width (σ) [nm]	4	NA
Max. spectral –20 dB width [nm]	NA	< 1
Min. side mode suppression [dB]	NA	30
Mean launched power range [dBm]	–15 … –8	–5 … –0
Min. extinction ration [dB]	8.2	10
Receiver at reference point R and MPI-R (acc. G.691, respectively)		
Min. optical sensivity [dBm]	–28	–34
Max. optical path penalty [dB]	1	1
Min. overload [dBm]	–8	–10
Max. reflectance of receiver, measured at R [dB]	NA	25
Optical path between S and R		
Min. optical return loss [dB]	NA	20
Max. discrete reflectance [dB]	NA	–25
Max. chromatic dispersion [ps/nm]	185	NA
Optical attenuation range [dB]		10 … 28

STM-1 optical modules (SFPs)

The table below lists some parameters and the end of life power budgets for the STM-1 optical modules SFPs to be used together with the Multi-STM Main Board (12*STM-1e, 16*STM-1o, 4*STM-4) (LKA39) .

Application	**STM-1 Short Haul S-1.1 (I-1)**	**STM-1 Long Haul L-1.1**	**STM-1 Long Haul L-1.2**
Operating wavelength range	1260-1360 nm	1270-1360 nm	1480-1580 nm
Transmitter at reference point S			
Source type	MLM	SLM / MLM	SLM
Spectral width at -20 dB (max)	NA	1 nm (SLM)	1 nm
RMS spectral width (max)	7.7 nm	3 nm (MLM)	NA
Mean launched power (max)	-8 dB	0 dB	0 dB
Mean launched power (min)	-15 dB	-5 dB	-5 dB
Side mode suppression ratio (min)	NA	30 dB / NA	30 dB
Extinction ratio (min)	8.2 dB	10 dB	10 dB

Application	**STM-1 Short Haul S-1.1 (I-1)**	**STM-1 Long Haul L-1.1**	**STM-1 Long Haul L-1.2**
Mask of the eye diagram of the optical transmit signal	see G.957	see G.957	see G.957
Optical path between points S and R			
Maximum dispersion	96 ps/nm	NA / 246 ps/nm	NA
Attenuation range	0 - 12 dB	10 - 28 dB	10 - 28 dB
Optical return loss of the cable plant at point S including the optical connector	NA	NA	20 dB
Receiver at reference point R			
Sensitivity (min) at BER = 1×10^{-10}	-28 dBm	-34 dBm	-34 dBm
Overload (min)	-8 dBm	-10 dBm	-10 dBm
Optical path penalty	< 1 dB	< 1 dB	< 1 dB
Optical return loss of the receiver (min)	NA	NA	> 25 dB

Multi rate Single Fiber optical modules (SFPs)

The table below lists some parameters and the end of life power budgets for the STM-1, STM-4, 1 GbE Single-Fiber (Bidirectional) Short Haul optical modules (SFPs).

	Unit	**Value**			
Application		**S-1.2/S-4.2**	**Downstream 1000BASE-BX10-D**	**S-1.1/S-4.1**	**Upstream 1000BASE-BX10-U**
Data rate	**Mbit/s**	**155/622**	**1250**	**155/622**	**1250**
Target distance	**km**	**15**	**20**	**15**	**20**
Transmitter at reference point S / TP2					
Source type		SLM		SLM	
Wavelength	nm	1480 - 1500		1260 - 1360	
Max. Spectral width at -20 dB	nm	1		1	
Mean launched power (max)		0		0	
Mean launched power (min)	dBm	-6		-6	
Maximum mean launched power in case Tx_Disable = high	dBm	-45		-45	
Minimum extinction ratio	dB	6		6	
Transmitter eye mask definition		see G.957	see Table 59-6, IEEE802.3ah	see G.957	see Table 59-6, IEEE802.3ah

	Unit	**Value**			
Application		**S-1.2/S-4.2**	**Downstream 1000BASE-BX10-D**	**S-1.1/S-4.1**	**Upstream 1000BASE-BX10-U**
Data rate	**Mbit/s**	**155/622**	**1250**	**155/622**	**1250**
Target distance	**km**	**15**	**20**	**15**	**20**
Maximum reflectance of transmitter, measured at S / TP2	dB	NA	-12	NA	-12
Maximum optical path penalty / Maximum transmitter and dispersion penalty	dB	1	3.3	1	3.3
Optical path between S / TP2 and R / TP3					
Available power budget (BER = 1×10^{-10})	dB	13.5	-	13.5	-
Available power budget (BER = 1×10^{-12})	dB	12.5	12.5	12.5	12.5
Minimum attenuation	dB	0	0	0	0
Maximum dispersion	ps/nm	275	275	132	132
Receiver at reference point R / TP3					
Operating wavelength range	nm	1260 - 1360		1480 - 1500	
Minimum sensitivity (@ BER = 1*10-10)	dBm	-19,5	-	-19,5	-
Minimum sensitivity (@ BER = 1*10-12)	dBm	-18,5	-18,5	-18,5	-18,5
Minimum overload	dBm	0	0	0	0
Maximum reflectance of receiver, measured at R / TP3	dB	-12		-12	

Specification 100BASE-LX10 pluggable optic

The 100BASE-LX pluggable optic are insert into a paddle board PBO12 (up to 12 100BASE-LX10 SFP transceivers), which is connected to a LKA412.

	Unit	**Value**
Application code (IEEE802.3ah)		**100BASE-LX10 single-mode**
Data rate	MBd	125 +/- 50 ppm
Target distance	km	10
Transmitter at reference point TP2		
Source type		MLM

	Unit	Value
Application code (IEEE802.3ah)		**100BASE-LX10 single-mode**
Nominal center wavelength	nm	1260 - 1360
Spectral characteristics		
spectral width RMS (s)	nm	7.7
Mean launched power		
maximum	dBm	-8
minimum	dBm	-15
Maximum mean launched power for Tx disabled	dBm	-45
Minimum extinction ratio	dB	5
Transmitter eye mask definition (X1, X2, X3, Y1, Y2, Y3, Y4)	UI	see Table 58-3, IEEE802.3ah
Rise and fall time (10%/90%, unfiltered)	ns	tbd
Maximum transmitter total jitter (peak to peak)	ns	3.2
Maximum optical return loss tolerance	dB	12
Optical path between TP2 and TP3		
Maximum channel insertion loss	dB	6
Minimum channel insertion lossb	dB	0
Minimum and maximum dispersion	ps/nm	see Table 58-12, IEEE802.3ah
Maximum transmitter and dispersion penalty	dB	4.5
Receiver at reference point TP3		
Operating wavelength range	nm	1260 - 1360
Minimum sensitivity (@ BER = 1.0 *10-10)	dBm	-26
Minimum sensitivity (@ BER = 1.0*10-12)	dBm	-25
Stressed receiver sensitivity	dBm	-20.1
Minimum overload	dBm	-8
Total jitter (peak to peak) at TP3	ns	3.54
Minimum LOS assert level	dBm	-45
Maximum LOS de-assert level	dBm	25

	Unit	Value
Application code (IEEE802.3ah)		**100BASE-LX10 single-mode**
LOS hysteresis		
maximum	dB	6
minimum	dB	0.5
Maximum reflectance of receiver, measured at TP3	dB	-12

Specification 1000BASE-SX pluggable optic

The 1000BASE-SX pluggable optic (850 nm short haul, multi-mode) according to FDA/CDRH - 21 CFR 1010 & 1040 / IEC 60825).

The 1000BASE-SX pluggable optic complies with IEEE 802.3-2000 Clause 38.

The table below describes the various operating ranges for the 1000BASE-SX pluggable optic over each optical fiber type.

Fiber Type	Modal Bandwidth @ 850 nm (min. overfilled launch) (MHz × km)	Minimum range (m)
62.5 µm MMF	160	2 … 220
62.5 µm MMF	200	2 … 275
50 µm MMF	400	2 … 500
50 µm MMF	500	2 … 550
10 µm MMF	N/A	Not supported

The following table lists the specific optical characteristics for a 1000BASE-SX pluggable optic.

Application	**1000BASE-SX**
Bit rate	1.25Gb/s +/-100ppm
Operating wavelength range	760 - 860 nm
Transmitter characteristics	
Transmitter type	Shortwave Laser
T^{rise}/T^{fall} (max, 20–80%, λ > 830 nm)	0.26 ns
T^{rise}/T^{fall} (max, 20–80%, $\lambda \leq$ 830 nm)	0.21 ns
RMS spectral width (max)	0.85 nm

Application	**1000BASE-SX**
Average launch power (max)	Is the class 1 safety limit as defined by IEEE 802.3–2000 Clause 38.7.2.
Average launch power (min)	–9.5 dBm
Average launch power of OFF transmitter (max)	–30 dBm
Extinction ratio (min)	9 dB
RIN (max)	–117 dB/Hz
Mask of the eye diagram of the optical transmit signal	see IEEE802.3
Receive Characteristics	
Average receive power (max)	0 dBm
Receive sensitivity	–17 dBm
Return loss (min)	12 dB
Stressed receive sensitivity (measured with conformance test signal at TP3 for BER = 10–12 at the eye center)	–12.5 dBm (62.5 µm MMF) –13.5 dBm (50 µm MMF)

The following table lists the worst-case power budget and link penalties for a 1000BASE-SX pluggable optic. Link penalties are used for link budget calculations.

Description	**Unit**	**62.5 µm MMF**		**50 µm MMF**	
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	MHz × km	160	200	400	500
Link power budget	dB	7.5	7.5	7.5	7.5
Operating distance	m	220	275	500	550
Channel insertion loss (a wavelength of 830 nm is used to calculate the values)	dB	2.38	2.60	3.37	3.56
Link power penalties (a wavelength of 830 nm is used to calculate the values)	dB	4.27	4.29	4.07	3.57
Unallocated margin in link power budget (a wavelength of 830 nm is used to calculate the values)	dB	0.84	0.60	0.05	0.37

Specification 1000BASE-LX pluggable optic

The 1000BASE-LX pluggable optic uses a Low Power Laser (laser class 1/1 according to FDA/CDRH - 21 CFR 1010 & 1040 / IEC 60825).

The 1000BASE-LX pluggable optic complies with IEEE 802.3-2000 Clause 38.

The table below describes the various operating ranges for the 1000BASE-LX pluggable optic over each optical fiber type.

Fiber Type	Modal Bandwidth @ 1300 nm (min. overfilled launch) (MHz × km)	Minimum range (meters)
62.5 µm MMF	500	2 to 550
50 µm MMF	400	2 to 550
50 µm MMF	500	2 to 550
10 µm SSMF	N/A	2 to 5000

The following table lists the specific optical characteristics for a 1000BASE-LX pluggable optic.

Application	1000BASE-LX pluggable optic
Bit rate	1.25Gb/s +/-100ppm
Operating wavelength range	1270 to- 1335 nm
Transmitter Characteristics	
Transmitter type	Shortwave Laser
T^{rise}/T^{fall} (max, 20–80%)	0.26 ns
RMS spectral width (max)	4 nm
Average launch power (max)	-3 dBm
Average launch power (min)	-11.5 dBm (62.5 µm and 50 µm MMF) / -11 dBm (10 µm SMF)
Average launch power of OFF transmitter (max)	-30 dBm
Extinction ratio (min)	9 dB
Mask of the eye diagram of the optical transmit signal	see IEEE802.3
RIN (max)	-117 dB/Hz
Receive Characteristics	
Average receive power (max)	-3 dBm
Receive sensitivity	-19 dBm

Application	1000BASE-LX pluggable optic
Return loss (min)	12 dB
Stressed receive sensitivity (measured with conformance test signal at TP3 for BER = 10–12 at the eye center)	-14.4 dBm

The following table lists the worst-case power budget and link penalties for a 1000BASE-LX pluggable optic. Link penalties are used for link budget calculations.

Description	Unit	10 μm SMF
Modal bandwidth as measured at 1300 nm (minimum, overfilled launch)	MHz × km	N/A
Link power budget	dB	8
Operating distance	m	5000
Channel insertion loss (a wavelength of 1270 nm is used to calculate the values)	dB	4.57
Link power penalties (a wavelength of 1270 nm is used to calculate the values)	dB	3.27
Unallocated margin in link power budget (a wavelength of 1270 nm is used to calculate the values)	dB	0.16

Specification 1000BASE-ZX pluggable optic

The 1000BASE-ZX pluggable optic uses a Low Power Laser (laser class 1/1 according to FDA/CDRH - 21 CFR 1010 & 1040 / IEC 60825).

The 1000BASE-ZX pluggable optic complies with IEEE 802.3-2002 Clause 38.

The following table lists the specific optical characteristics for a 1000BASE-ZX pluggable optic.

Application	1000BASE-ZX pluggable optic
Bit rate	1.25Gb/s +/-100ppm
Operating wavelength range	1500-1580 nm
Transmitter at reference point TP2	
Source type	SLM
Spectral width at 20dB	1.0 nm
Side mode suppression ratio (min)	30dB
Mean launched power (max)	+5 dBm

Application	1000BASE-ZX pluggable optic
Mean launched power (min)	0 dBm
Extinction ratio (min)	9.0 dB
Mask of the eye diagram of the optical transmit signal	see IEEE802.3
Optical path between points TP2 and TP3	
Optical return loss of the cable plant at point TP2 including the optical connector	20 dB
Maximum dispersion	1600 ps/nm
Attenuation range	5 - 21 dB
Optical path penalty (max)	1.5 dB
Receiver at reference point TP3	
Minimum sensitivity	-22.5 dBm
Overload (min)	0 dBm
Optical return loss of the receiver (min)	12 dB

Optical connector interfaces

The following table specifies the optical connector interfaces

Optical units	Optical connectors
Tributaries: LKA6 (SI-S1.1/4), LKA11 (SI-S4.1/1), LKA13 (SI-L1.2/4), LKA14 (SI-L4.2/1)	SC
Ethernet: LKA12 / LKA12 B (IP-GE/2)	Small Form factor Pluggable (SFP) device, normally equipped with an LC connector.
Ethernet: LKA53 (IP-GE/2)	Small Form factor Pluggable (SFP) device, normally equipped with an LC connector.
Core Units: LKA24 (SI-L16.1 C2/1), LKA25 (SI-L16.2 C2/1), LKA26 (SI-L64.2), LKA27 (SI-S64.2), LKA47 (SI-I64.1r), LKA8 (SI-16SFP C2/4)	Universal build out, which allows SC, FC and ST types of connectors; default is SC.
Tributary high-density: LKA50, LKA 39	LC

Optical source and detector

The optical sources and detectors of the *Metropolis*® ADM (Universal shelf) have the following technical specifications.

Optical circuit pack	Laser type	Optical detector	Hazard level (IEC-60825-2)
LKA6 (SI-S1.1/4 G.957 1310 nm)	FP (MLM)	PIN	1
LKA11 (SI-S4.1/1)	FP (MLM)	PIN	1
LKA12 / LAK12B(SI-IP-GE/2)		LC	1
LKA12B (SI-IP-GE/2)		LC	1
LKA13 (SI-L1.2/4 G.957 1550 nm)	DFB (SLM)	PIN	1
LKA14 (SI-L4.2/1)	DFB (SLM)	PIN	1
LKA24 (SI-L16.1 C2/1)	DFB (SLM)	APD	1
LKA25 (SI-L16.2 C2/1)	DFB (SLM)	APD	1
LKA26 (SI-L64.2b/3)	DFB + OA	PIN	1M
LKA27 (SI-S64.2b/3b)	DFB (SLM)	PIN	1
LKA53 (SI-IP-GE/2)		LC	1
LKA47 (SI-I64.1r)	DFB	PIN	1
LKA28 (SI-L64.2 C2/1)	DFB	APD	1
LKA281 (SI-U64.2 C2/1)	DFB+OA	APD	1
LKA29 (SI-S64.2 C2/1)	DFB	PIN	1
LKA49 (SI-I64.1r C2/1)	DFB	PIN	1
LKA350 (SI-V64.2 C2/1)	DFB+OA	APD	1M (OA with +11 .. +14 dBm)

The abbreviations used:

- APD: avalanche photo diode
- DFB: distributed feedback laser (= SLM)
- FP: fabry-perot (= MLM)
- LC: used for LC connector or LC interface
- MLM: multi longitudinal mode
- OA: optical amplifier output power 10...13 dBm at 1550 nm.
- PIN: Positive Intrinsic Negative (PIN) receiver.
- SLM: single longitudinal mode

Optical safety

The system is classified and labelled as specified in IEC 60825-1 and IEC 60825-2 “Radiation safety of laser products equipment, classification, requirements and users guide”. All parts of the equipment are designed for operation and maintenance without any hazards to personnel from optical radiation.

□

Electrical interfaces

Electrical interfaces

The electrical interfaces of the *Metropolis®* ADM (Universal shelf) have the following technical specifications.

	1.5 Mbit/s	**2 Mbit/s**	**34 Mbit/s**	**45 Mbit/s**	**STM-1**	**10/100 Mbit/s Base-T**
Nominal bitrate	1544 kBit/s	2048 kBit/s	34.368 Mbit/s	44.736 Mbit/s	155.520 Mbit/s	10/100 Mbit/s
Line code	AMI (Alternate Mark Inversion) or B8ZS (Bipolar with 8-Zero Substitution).	HDB3 (G.703)	HDB3 (G.703)	B3ZS (ANSI T1.102–1987)	CMI (G.703)	IEEE 802.3-2000
Insertion loss	acc. to G.703	acc. to G.703	acc. to G.703	acc. to G.703	acc. to G.703	acc. to IEEE 802.3-2000
Return loss	acc. to G.703	acc. to G.703	acc. to G.703	acc. to G.703	acc. to G.703	acc. to IEEE 802.3-2000

Amplitude of the DS3 output signal

The amplitude/shape of the DS3 output signal can be provisioned to match the cable between the *Metropolis®* ADM (Universal shelf) and the DDF, in such a way that the pulse shape at the DDF, which can be up to 450 feet away, meets the specification. Two signal levels can be provisioned in the transmitter, covering cable lengths between 0 … 120 and 120 … 450 feet. The receiver has an automatic line build-out capability to handle cable lengths between 0 … 450 feet.

□

Mapping structure

Mapping structure

The following mapping structures are supported:

Between cross-connect and line/tributary interface, SDH mapping:

- C-4-16c ↔ VC-4-16c ↔ AU-4-16c ↔ AUG16 ↔ AUG64 ↔ STM-64
- C-4-16c ↔ VC-4-16c ↔ AU-4-16c ↔ AUG16 ↔ STM-16 (in STM-64 applications)
- AU-4 ↔ AUG1 ↔ AUG4 ↔ AUG16 ↔ AUG64 ↔ STM-64
- AU-4-4c ↔ AUG4 ↔ AUG16 ↔ STM-16
- AU-4 ↔ AUG1 ↔ AUG4 ↔ AUG16 ↔ STM-16
- AU-4 ↔ AUG1 ↔ AUG4 ↔ STM-4
- AU-4 ↔ AUG1 ↔ STM-1
- AU-4 ↔ VC-4 ↔ TUG-3 ↔ TU-3 ↔ VC-3 ↔ E3/DS3
- AU-4 ↔ VC-4 ↔ TUG-3 ↔ TUG-2 ↔ TU-12 ↔ VC-12 ↔ E1

Between cross-connect and tributary interface, with conversion from TU-3 to AU-3:

- AU-4 ↔ VC-4 ↔ TUG-3 ↔ TU-3 ↔ VC-3 ↔ AU-3 ↔ AUG1 ↔ STM-1 (OC-3)
- AU-4 ↔ VC-4 ↔ TUG-3 ↔ TU-3 ↔ VC-3 ↔ AU-3 AUG1 ↔ AUG4 ↔ STM-4 (OC-12)

Between cross-connect and tributary interface, Ethernet mapping:

- AU-4 ↔ VC-4 ↔ VC-4-Xv ↔ GFP ↔ Ethernet
- AU-4 ↔ VC-4 ↔ VC-3-Xv ↔ GFP or EoS ↔ Ethernet
- AU-4 ↔ VC-4 ↔ TUG-3 ↔ VC-12-Xv ↔ GFP or EoS ↔ Ethernet
- STM-4 ↔ AU4 ↔ TU12 ↔ VC12-Xv ↔ GFP/LAPS/PPP ↔ E/FE/GbE (LKA412)
- STM-4 ↔ AU4 ↔ TU3 ↔ VC3-Xv ↔ GFP/LAPS/PPP ↔ E/FE/GbE (LKA412)
- STM-4 ↔ AU4 ↔ VC4-Xv ↔ GFP/LAPS/PPP ↔ E/FE/GbE (LKA412)

□

Transmission performance

Specifications

The following specifications apply to the *Metropolis*® ADM (Universal shelf) with regard to performance:

Jitter on STM-N interfaces	G.813, G.825
Jitter on PDH interfaces	G.823, G.783
Error Performance	G.826
Performance monitoring	G.784, G.826

Timing, network synchronization and timing references

The following specifications apply to the *Metropolis*® ADM (Universal shelf) with regard to timing and synchronization.

References

Timing and synchronization is described at

- "Timing architecture" (p. 4-46)
- "External timing reference inputs" (p. 4-46)
- "External timing reference outputs" (p. 4-48)

External timing reference signals

The table below shows the specifications for external timing reference signals.

2048 kHz, according to G.703-10
2048 kbit/s, according to G.703-6 framed according to G.704
2048 kbit/s, according to G.703-6 unframed (AIS format)
6312 kHz for NE output (required for the Japanese market) The so-called MIOR-J unit converts two independent 2048 kHz signals coming from backplane to two independent 6312 kHz signals towards outside. The 2048 kHz signals are system station clock outputs.

The table below shows the specifications for timing input impedance.

Input impedance 75 Ω coax
Input impedance 120 Ω symmetrical

Oscillator

The internal oscillator has the following specifications:

Oscillator	Specification
Built-in oscillator Stratum-3	Accuracy 4.6 ppm acc. to G.813 option 1; stability 0.37 ppm/ first 24 hours

Timing modes

The timing modes are specified as follows:

Timing mode	**Specification**
Free running mode	Accuracy 4.6 ppm over 15 years
Hold-over mode	Accuracy 4.6 ppm of the frequency of the last source in two weeks
Locked mode with reference to	one of the • external sync. inputs • 2 Mbit/s tributary inputs • STM-N inputs
Automatic ref. signal switching	compliant with ETSI ETS 300 417–6
Support of Sync. Status Marker (SSM)	STM-1, STM-4, STM-16, and STM-64 interfaces 2 Mbit/s framed station clock

Power specifications

Power supply voltage

Voltage range, all components	–48 to –60 V battery voltages, CEPT T/TR02-02 (–40.5 V minimum, –72 V maximum)
Power feeders	Two power feeders

Worst case system power dissipation

Configuration	Power dissipation
Metropolis® ADM (Universal shelf) 2.5G (Fully loaded system: 2 STM-16 core units, 1:4 protected 2 Mbit/s (63 ports), 2x(1+1) protected STM-1E (4 ports)).	390 W
Metropolis® ADM (Universal shelf) 10 G (Fully loaded system : 2 STM-64 core units, 1:4 protected 2 Mbit/s (63 ports), 2x(1+1) protected STM-1E (12 ports))	600 W
Metropolis® ADM (Universal shelf) 10 G (Fully loaded system : 2 STM-64 core units, 9 times IP-GE/2F-OS (LKA53)	850 W

Power consumption per unit

The following specifications apply to *Metropolis*® ADM (Universal shelf) with regard to typical power consumption of the individual parts/circuit packs.

Plugin units

The following informs about the power consumption of the plugin units. The power consumptions of the plugin units are listed without associated SFPs.

Item code	Short name	Description	Consumed power W
System Controller			
LKA1D	SC1	System Controller Plus	14,9
LKA21/LKA21B	SC2	System Controller 2	14,9
Power and Cooling			
FAN	FAN	Fan unit	19
PU	PU	Power unit	3,7

Item code	Short name	Description	Consumed power W
STM-64 optical line port units (Core Units 10G application)			
LKA26	SI-L64.2 C1/1	1 × STM-64 L64.2b/3, 1550 nm, CC-272/64	107
LKA27	SI-S64.2 C1/1	1 × STM-64 S64.2b/3, 1550 nm, CC-272/64	103
LKA47	SI-I64.1r C1/1	1 × STM-64 I64.1r, 1310 nm, CC-272/64	99
LKA28	SI-L64.2 C2/1	1 × STM-64 L64.2c/3, 1550 nm, CC-272/128	116
LKA281	SI-U64.2 C2/1	1 × STM-64 U64.2c/3, 1550 nm, CC-272/128	107
LKA29	SI-S64.2 C2/1	1 × STM-64 S64.2b/3b, 1550 nm, CC-272/128	119
LKA49	SI-I64.1r C2/1	1 × STM-64 I64.1r, 1310 nm, CC-272/128	115
LKA350	SI-V64.2 C2/1	1 × STM-64 V64.2 1.5um CC-272/128	120
STM-16 optical line port units (Core Units 2.5G application)			
LKA24	SI-L16.1 C2/1	1 × STM-16 L16.1, 1310 nm, CC-64/32	47.4
LKA25	SI-L16.2 C2/1	1 × STM-16 L16.1, 1550 nm, CC-64/32	47.4
LKA48	SI-16 SFP C2/4	4 x STM-16 SFP CC-272/128	116
LKA481	SI-16 SFP C3/1	1 x STM-16 SFP CC-176/64	73,1
LKA482	SI-16 VH C3/1 OBA	1 x STM-16 VH CC-176/64 OBA	79,9
Optical tributary port units			
LKA6	SI-S1.1/4	4 × STM-1 S1.1, 1310 nm	14
LKA11	SI-S4.1/1	1 × STM-4 S4.1, 1310 nm	19
LKA12	IP-GE/2	2 × GbE	41.9
LKA12B	IP-GE/2	2 × GbE	41.9
LKA53	IP-GE/2F-OS		45
LKA13	SI-L1.2/4	4 × STM-1 L1.2, 1550 nm	10.4
LKA22	SI-L16.2/1	1 × STM-16 L16.2, 1550 nm (ITU-T G.957; 10 … 24 dB)	47.4
LKA23	SI-L16.1/1	1 × STM-16 L16.1, 1310 nm (ITU-T G.957; 10 … 25 dB)	47.4

Item code	Short name	Description	Consumed power W
LKA39	SI-1/16-4/4	Parent pack for STM-4, STM-1o and STM-1e To be used with PBP5/ 6/ 8	14.5 (without paddle boards and SFPs)
LKA50	SI-x16 SFP/1	Tributary unit using STM-16 SFP's To be used with PBP-5, PBP-6 and PBP-8.	11 (without SFP)
OMGBE-SX	SX-GBE	SX-Gigabit Ethernet Module	1
OMGBE-LX	LX-GBE	LX-Gigabit Ethernet Module	1
OMGBE-ZX	ZX-GBE	ZX-Gigabit Ethernet Module	1.1
Electrical tributary circuit packs			
LKA2	PI-E1/63	63 × 2 Mbit/s	11.4
LKA3	SI-1/4	4 × STM-1e (155 Mbit/s)	10.4
LKA4	IP-LAN/8	8 × Ethernet 10/100 Mbit/s	41.1
LKA412	IP-LAN/12	12 × Ethernet 10/100 Mbit/s	35
LKA8B	PI-E3DS3/12	12 × E3/DS3 (34/45 Mbit/s, switchable)	29.29
LKA16	PI-DS1/63	63 × 1,55 Mbit/s	22 ± 0,2W

STM-16 optical line-SFPs.

The following informs about the power consumption of the STM-16 optical line-SFPs.

Item code	Description	Consumed power (worst case) [W]
OMI16	SFP 2G5-I16 / 2 km	1
OML16.1	SFP 2G5-L16.1 40 km	1
OML16.2	SFP 2G5-L16.2/3 80 km	1
OM16CL47	STM-16 cWDM SFP color 11 (1511nm) 80 km	1
OM16CL49	STM-16 cWDM SFP color 12 (1511nm) 80 km	1
OM16CL51	STM-16 cWDM SFP color 13 (1511nm) 80 km	1
OM16CL53	STM-16 cWDM SFP color 14 (1531nm) 80 km	1
OM16CL55	STM-16 cWDM SFP color 15 (1551nm) 80 km	1
OM16CL57	STM-16 cWDM SFP color 16 (1571nm) 80 km	1
OM16CL59	STM-16 cWDM SFP color 17 (1511nm) 80 km	1
OM16CL61	STM-16 cWDM SFP color 18 (1511nm) 80 km	1
OM16CS47	STM-16 cWDM SFP color 11 (1511nm) 40 km	1

Item code	Description	Consumed power (worst case) [W]
OM16CS49	STM-16 cWDM SFP color 12 (1511nm) 40 km	1
OM16CS51	STM-16 cWDM SFP color 13 (1511nm) 40 km	1
OM16CS53	STM-16 cWDM SFP color 14 (1531nm) 40 km	1
OM16CS55	STM-16 cWDM SFP color 15 (1551nm) 40 km	1
OM16CS57	STM-16 cWDM SFP color 16 (1571nm) 40 km	1
OM16CS59	STM-16 cWDM SFP color 17 (1571nm) 40 km	1
OM16CS61	STM-16 cWDM SFP color 18 (1571nm) 40 km	1

STM-4 & 1 optical tributary interfaces:

The following informs about the power consumption of the STM-4 & 1 optical tributary interfaces.

Item code	Short name	Description	Consumed power (worst case) W
OMS4.1	SFP 622M-S4.1	SFP SH 15km S-4.1	1
OML4.1	SFP 622M-L4.1	SFP LH 40km L-4.1	1
OML4.2	SFP 622M-L4.2	SFP LH 80km L-4.2	1
OMS1.1	SFP 155M-S1.1	SFP SH 15km S-1.1	1
OML1.1	SFP 155M-L1.1	SFP LH 40km L-1.1	1
OML1.2	SFP 155M-L1.2	SFP LH 80km L-1.2	1

Paddle boards

The following informs about the power consumption of the paddle boards. The power consumptions of the paddle boards are listed without associated SFPs.

Item code	Short name	Description	Consumed power (worst case) W
PBE3	PB-E1e/P75/63	Unprotected or protected 75 Ω applications, 63 channels, enhanced version	8.88
PBE3D	PB-E1e/P75/63	Unprotected or protected 75 Ω applications, 63 channels, enhanced version with 15 pin sub-d connector	8.88
PBE4	PB-E1/P120/63	Unprotected or protected 120 Ω applications, 63 channels, high density paddle board	2

Item code	Short name	Description	Consumed power (worst case) W
PBE41	PB-E1/P120/63	Unprotected or protected 120 Ω applications, 63 channels, high density paddle board	22
PBE12	PB-DS1/P100/63	Unprotected or protected 100 Ω applications, 63 channels, high density paddle board	8.88
PBG4	PB-E3DS3/75/12	Unprotected 75 Ω applications, 12 channels	0.15
PBP1	PB-E3DS3/75/P12	Protected 75 Ω applications, 12 channels	2
PBG2	PB-1/P75/4S	Unprotected 75 Ω applications, 4 channels	0.15
PBP2	PB-1/P75/4D	Protected 75 Ω applications, 4 channels	2.4
PBP5	PB-1/75/12S	Unprotected 75 Ω applications, 12 channels	8.5
PBP6	PB-1/P75/12D	Protected 75 Ω applications, 12 channels	15
PBP8	PB-STM-1o/6	6 SFP cages for STM-1o interfaces	0.8
PBO12	PB-OPT/12 SFP	Unprotected 10/100Base—T LAN 12 channels	1
PBL12	PB-LAN/100/12	Unprotected 10/100Base—T LAN 12 channels	1
PBG1	PB-LAN/100/8	Unprotected 10/100Base—T LAN 8 channels	0.4

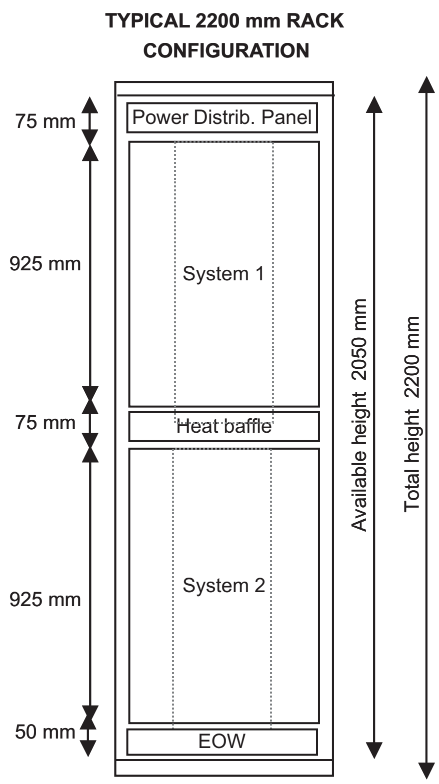
□

Physical system specifications

Dimensions

The following table shows the available racks and their dimensions.

Short name	Dimension (mm H × W × D)
Rack 2200 "new style"	ETSI Rack 600 × 300 × 2200
Rack 2000 "new style"	ETSI Rack 600 × 300 × 2000
Rack 2600 "new style"	ETSI Rack 600 × 300 × 2600
Rack 2200 "old style"	ETSI Rack 600 × 300 × 2200
Rack 2600 "old style"	ETSI Rack 600 × 300 × 2600
Power Distribution Panel PDP	



Dimensions of the subracks

Refer to "Subrack" (p. 4-11).

System weight

The weight of a *Metropolis*® ADM (Universal shelf) (including internal cables) is < 70 kg for all configurations.

Electrical connectors

All electrical interfaces are connected to the special paddle boards that are used for the electrical boards.

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Network management

Specifications

The following specifications apply to the *Metropolis*® ADM (Universal shelf), release 5.2, with regard to network management:

- Lucent OMS, release 5.0
- Local workstation (ITM-CIT) access via RJ45 connections, V.10 (RS-232 compatible)/F-interface
- Access to ECCs via in-station Q-LAN interface.

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Bandwidth management

Specifications

The following specifications apply to the *Metropolis*® ADM (Universal shelf) with regard to bandwidth management:

- System capacity (2.5G application):
  176 x 176 STM-1 eqv. higher-order cross connecting (VC-4/4-4c/4-16c)
  64 × 64 STM-1 equivalents for VC 4
  64x64 STM-1eqv. lower-order cross connecting (VC- n , with n =12, 3 and VC-11 (when mapped as TU-12))
  32 × 32 STM-1 equivalents for VC 12 and VC-3
- System capacity (10G application):
  272 × 272 STM-1 equivalents for VC-4
  64 × 64 STM-1 equivalents for VC-12 and VC-3
- unidirectional and & bidirectional cross-connecting
- 1:9 broadcast connections type VC-4
- VC-4-4c concatenation and VC-4-16c concatenation
- unidirectional drop & continue (e.g. for dual node interworking)
- bridging commands for in-service rearrangement of circuits
- support of virtual concatenation (VC-12–xv, VC-3–xv and VC-4–xv) for mapping of GFP/EoS encapsulated Ethernet frames.

□

Processing of overhead bytes

Regenerator Section overhead byte usage

The table below shows the usage of RSOH bytes at the STM-1, STM-4, STM-16, and STM-64 interfaces.

RSOH bytes	Function	STM-1o inter-station	STM-1e intra-station	STM-4	STM-16	STM-64
A1, A2	Framing	x	x	x	x	x
JO	Trace identifier	x	x	x	x	x
Z0	Spare bytes, for future international standardization					
B1	BIP-8 on RS	x	x	x	x	x
D1-D3	Data Communications Channel (DCC)	x	x	x	x	x
E1 #	OW channel	x	x	x	x	x
F1 #	User channel	x	x	x	x	x
RS-NU	National usage					

Usage of Multiplex Section overhead byte

The table below shows the usage of MSOH bytes at the STM-1, STM-4, STM-16, and STM-64 interfaces.

MSOH bytes	Function	STM-1o inter-station	STM-1e intra-station	STM-4	STM-16	STM-64
B2	BIP-N × 24 on MS	x	x	x	x	x
K1, K2 (bits 1 … 5)	Automatic protection switch	x	x	x	x	x
K2 (bits 6 … 8)	MS AIS/RDI Indicator	x	x	x	x	x
D4 … D12	Data Communications Channel (DCC)	x	x	x	x	x
S1 (bits 5 … 8)	Synchronization status message	x	x	x	x	x
M0	Remote Error Indication (REI) byte, transmit only					x
M1	Remote Error Indication (REI) byte, transmit only	x	x	x	x	x

MSOH bytes	Function	STM-1o inter-station	STM-1e intra-station	STM-4	STM-16	STM-64
E2 #	Order wire channel	x	x	x	x	xx

STM-64 Overhead Access: M0, M1 source (MS-REI)

Source direction:

In every STM-64 MS termination point the Remote Error Information (REI) is written in the M0 and M1 byte (9,6,1). The REI bytes shall be set to convey the count of interleaved bit blocks that have been detected in error by the BIP-1536 (in the range of [0, 1536]). M0 bit 1 is most significant bit and M1 bit 8 is least significant bit. If interworking with old equipment supporting the single byte REI in M1, the value conveyed is truncated at 255 and inserted in M1. Usage is in conformance with ITU-T Rec. G.707 and ETSI ETS 300417.″

STM-64 Overhead Access: M0, M1 sink (MS-REI)

Sink direction:

In every STM-64 MS termination point the received REI is interpreted. If the REI of a received frame is unequal to zero, the corresponding number of errored blocks can be counted for far-end performance monitoring purposes. Usage is in conformance with ITU-T Rec. G.707 (table 9-7 and also table 9-8 for interworking with old equipment that supports the M1 byte only) and ETSI ETS 300417. When this feature is not supported or disabled, the incoming M0 and M1 byte is ignored.″

Path overhead bytes VC-3/4/4–4C/4–16C

VC-3/4/4-4c/4-16c	Function	Core
J1	Path-trace identifier	x
B3	BIP-8	x
C2	Signal label	x
G1	REI/RDI (transmit only)	x
F2	User channel	set to 0
H4	Multiframe indicator Provides a general multiframe indicator for VC-structured payloads. Provides a multiframe and sequence indicator for virtual VC-3/4 concatenation/LCAS.	x
F3	As F2	set to 0
K3	VC trail protection	set to 0

VC-3/4/4-4c/4-16c	Function	Core
N1	Tandem-connection OH	set to 0

Path overhead bytes VC-12

VC-12 POH bytes	Function	2 Mbit/s unit
V5 (bits 1,2)	BIP-2	x
V5 (bit 3)	REI (transmit only)	x
V5 (bit 4)		set to 0
V5 (bits 5,6, and 7)	Signal label	x
V5 (bit 8)	RDI (transmit only)	x
J2	Path trace	x
N2	Network operator	set to 0
K4		set to 0

x = supported

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OAM&P

Specifications

The following specifications apply to the *Metropolis®* ADM (Universal shelf) with regard to operation, administration, maintenance, and provisioning:

- Installation self-test
- Auto recovery after input-power failure
- Local operations and maintenance via faceplate LEDs, buttons on the SC, user panel, F-interfaces
- Centralized operations and maintenance via the Q-interface
- Software downloads via Q- and F-interfaces, DCC link
- Alarm categories for indication of alarm severity and station-alarm interface (9×)
- Local workstation (ITM-CIT)
- 8 × miscellaneous discrete inputs and 4 outputs.

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Performance monitoring

Specifications

The following performance monitoring points are supported by the *Metropolis*® ADM (Universal shelf):

Trail Termination Points	Equipment
MS-1	Multiplex section of the STM-1 interfaces
MS-4	Multiplex section of the STM-4 interfaces
MS-16	Multiplex section of the STM-16 interfaces
MS-64	Multiplex section of the STM-64 interfaces
RS-1	Regenerator section of the STM-1 interfaces
RS-4	Regenerator section of the STM-4 interfaces
RS-16	Regenerator section of the STM-16 interfaces
RS-64	Regenerator section of the STM-64 interfaces
VC-12 TTP/CTP	for each of the VC-12 termination points
VC-3 TTP/CTP	for each of the VC-3 termination points
VC-4 TTP/CTP	for each of the VC-4 termination points

Historic bins

The network element keeps a store of the historic 15-minute and 24-hour bins according to the table below.

Interval	Number of historic bins	Total storage time
15 minute	16	4 hours
24 hours	1	1 day

Ethernet performance monitoring counters

The Ethernet performance monitoring counters can be categorized according to the different purposes they are serving.

The following types of counters can be distinguished:

- Counters for basic Ethernet performance monitoring
- Service monitoring:
  - Counters for Ethernet service flow performance monitoring

- Traffic management:
  - High quality traffic counters for Ethernet network load performance monitoring
  - Low quality traffic counters for Ethernet network load performance monitoring
  - Counters for Ethernet congestion monitoring
- Counters for IEEE 802.3ah OAM performance monitoring
- Counters for Ethernet service route round trip delay measurements

Ethernet PM counters per *TransLAN®* card

Ethernet performance monitoring counter	*TransLAN®* card			
	LKA4	LKA412	LKA12	LKA53
Basic Ethernet performance monitoring counters	✔	✔	✔	✔
Ethernet service flow performance monitoring counters	✔	✔	–	✔
Ethernet high quality traffic counters	✔	✔	–	✔
Ethernet low quality traffic counters	✔	✔	–	✔
Ethernet congestion monitoring counters	–	–	–	✔
IEEE 802.3ah OAM performance monitoring counters	–	–	–	✔
Ethernet service route round trip delay measurements	✔	✔	–	✔

□

Supervision and alarms

Plug-in unit indication

LEDs

- LED continuously on diagnostic error
- LED flashing transmission signal error
- LED green activity continuously on (only on core units)

Ethernet electrical port LED indication

LED indicators

- Green: indicates the link status of a port
- Yellow: indicates the transmit and/or receive activity on a port.

Ethernet optical port LED indication (via SFP)

LED indicators

- Green LED: for Link status,
- Red: indicates the Fault status.
- Yellow: indicates the Activity status.

User panel

LED indicators:

- Power
- Prompt alarm
- Deferred alarm
- Info alarm
- Abnormal
- Suppressed (alarm cut-off)
- Station alarm disconnected
- Use CIT.

Push-buttons:

- Suppress (alarm cut-off)
- Disconnect station alarms.

Power unit

LED indicators

- Green feeder power
- Red central auxiliary supply failure.

Miscellaneous discretes

input/outputs

- 8 inputs
- 4 outputs

CIT

CIT connector F-interfaces V11/RS232

Access to embedded Data Communication Channels (DCC)

In-station Q-LAN interface, 10Base-T.

□

Spare part information

Recommended spare parts

The following tables indicate how many plug-in units, paddle boards and sub-racks are required for the customer's substitution spare stocks, assumed a 14 days lead time (contract specific).. For more specific information please contact your Lucent Technologies local customer team.

The actual recommendable numbers can be calculated from the numbers below by multiplying them with the ratio of the contractual lead time to these 14 days (conservative approach for times ≥ 14 days)

Type	1 pack used	up to 10 packs used	up to 100 packs used	up to 1000 packs used	up to 10000 packs used
FAN unit	1	1	2	4	13
Power unit	1	1	1	3	9
Misc. IO unit LEFT	1	1	1	2	4
Misc. IO unit RIGHT	1	1	1	2	5
System Controller Plus	1	1	2	5	20
STM-64 S64.2b/3b 1.5um CC-272/64	1	1	4	12	65
STM-64 L64.2b/3 1.5um CC-272/64	1	2	4	13	69
STM-64 VSR	1	1	3	11	59
STM-16 L16.1 1.3um CC-64/32	1	1	3	8	40
STM-16 L16.2 1.5um CC-64/32	1	1	3	8	40
1 x STM-16 L16.1 1.3um ITU	1	1	2	7	29
1 x STM-16 L16.2 1.5um ITU	1	1	2	7	29
1 x STM-4 S4.1 1.3um	1	1	2	4	16
1 x STM-4 L4.2 1.5um	1	1	2	5	20
4 x STM-1 S1.1 1.3um	1	1	2	6	23
4 x STM-1 L1.2 1.5um	1	1	2	7	31
4 x STM-1e	1	1	2	4	17
PB 4xSTM-1 Un-Protected	1	1	1	2	5
PB 4xSTM-1 (Prot.1+1)	1	1	1	3	8

Type	1 pack used	up to 10 packs used	up to 100 packs used	up to 1000 packs used	up to 10000 packs used
12 x E3/DS3 (switchable)	1	1	3	7	35
Paddle Brd. 12 x E3/DS3	1	1	1	2	5
PB 12 x E3/DS3 (Prot.1+1)	1	1	1	3	11
63 x E1	1	1	2	6	24
PB 63x2Mb/s 75 1:N P./Un-Prot.	1	1	1	3	10
PB 63x2Mb/s 120 1:N P./Un-prot	1	1	1	3	10
63 x DS1 (1.5 Mbit/s)	1	1	2	5	18
PB 63x1.5Mb/s 100 Ohms P./Un-prot	1	1	1	3	8
2 x GbE	1	1	2	6	26
SX - module	1	1	1	3	8
LX - module	1	1	1	3	8
8 x E/FE	1	1	2	6	29
Paddle Brd. 8xLAN 100 Ohm	1	1	1	3	9

Release 5.1 recommended spare parts

The following table shows the recommended spare part numbers with respect to the number of circuit packs used, assuming a 10 days lead time:

Type	Apparatus code	up to 5 packs used	up to 10 packs used	up to 50 packs used	up to 100 packs used	up to 500 packs used	up to 1000 packs used	up to 2000 packs used
STM-64 I64.1r 1.3um CC-272/128	LKA49	2	2	3	4	7	11	16
STM-64 V64.2 1.5um CC-272/128	LKA350	2	2	4	5	9	13	20
STM-64 L64.2b/3 1.5um CC-272/128	LKA28	2	2	4	4	9	13	20
STM-64 U64.2 1.5um CC-272/128	LKA281	2	3	4	5	9	11	15
STM-64 S64.2b/3b 1.5um CC-272/128	LKA29	2	2	4	4	9	13	19
4 x STM-16 SFP CC-272/128	LKA48	2	2	3	4	7	10	15

Type	Apparatus code	up to 5 packs used	up to 10 packs used	up to 50 packs used	up to 100 packs used	up to 500 packs used	up to 1000 packs used	up to 2000 packs used
1 x STM-16 SFP CC-176/64	LKA481	2	2	3	4	7	10	15
1 x STM-16 VH CC-176/64 OBA	LKA482	2	2	3	4	7	10	15
STM-1/ STM-4 main board SFP	LKA39	2	2	3	3	5	6	9
1 x STM-16 SFP	LKA50	2	2	2	3	4	6	7
PB 12 x STM-1e Un-protected	PBP5	2	2	2	3	4	5	6
PB 12 x STM-1e (Prot. 1+1)	PBP6	2	2	2	3	4	5	7
PB 6 x STM-1o SFP	PBP8	1	2	2	2	3	3	4
PB-E1/P75/63	PBE3D	2	2	2	2	4	4	4
PB 63x2Mb/s 120 1:N P./Un-prot	PBE41	1	1	2	2	4	4	5
PB OPT/12 SFP	PBL12	2	2	2	2	3	4	5
PB OPT/12 SFP	PBO12	2	2	2	2	4	4	6
IP-LAN/12	LKA412	2	2	3	4	6	9	12
2 x GbE-Full/ one slot solution	LKA53	2	2	3	4	6	9	13
System Controller Enhanced	LKA21	2	2	3	3	5	7	9
System Controller Enhanced	LKA21B	2	2	3	3	6	8	11
SFP 2Km I-16	OM2G5-I16	1	2	2	2	3	4	4
SFP 40Km L-16.1	OM2G5-L16.1	2	2	2	2	3	4	4
SFP 80Km L-16.2/3	OM2G5-L16.2	2	2	2	2	3	4	4
SFP SH 15Km S-4.1	OM622M-S4.1	2	2	2	2	3	4	5
SFP LH 40Km L-4.1	OM622M-L4.1	2	2	2	2	3	4	4
SFP LH 80Km L-4.2	OM622M-L4.2	1	2	2	2	3	4	4
SFP SH 15Km S-1.1	OM155M-S1.1	1	2	2	2	3	4	4
SFP LH 40Km L-1.1	OM155M-L1.1	1	2	2	2	3	4	4
SFP LH 80Km L-1.2	OM155M-L1.2	1	2	2	2	3	4	4
SFP 80km, L-1.2, LR-2	OM155M-L1.2	1	1	2	2	4	4	5
SFP 80km, L-4.2, LR-2	OM622M-L4.2	1	1	2	2	4	4	5
SFP 40km, L-16.1, LR-1	OM2G5-L16.1	1	1	2	3	4	5	6
SFP 80km, L-16.2, LR-2	OM2G5-L16.2	1	1	2	3	5	5	6
STM-16 cWDM SFP color 11 (1470nm) 80 km	OM16CL47	2	2	2	2	3	4	5
STM-16 cWDM SFP color 12 (1490nm) 80 km	OM16CL49	2	2	2	2	3	4	5

Type	Apparatus code	up to 5 packs used	up to 10 packs used	up to 50 packs used	up to 100 packs used	up to 500 packs used	up to 1000 packs used	up to 2000 packs used
STM-16 cWDM SFP color 13 (1510nm) 80 km	OM16CL51	2	2	2	2	3	4	5
STM-16 cWDM SFP color 14 (1530nm) 80 km	OM16CL53	2	2	2	2	3	4	5
STM-16 cWDM SFP color 15 (1550nm) 80 km	OM16CL55	2	2	2	2	3	4	5
STM-16 cWDM SFP color 16 (1570nm) 80 km	OM16CL57	2	2	2	2	3	4	5
STM-16 cWDM SFP color 17 (1590nm) 80 km	OM16CL59	2	2	2	2	3	4	5
STM-16 cWDM SFP color 18 (1610nm) 80 km	OM16CL61	2	2	2	2	3	4	5
STM-16 cWDM SFP color 11 (1470nm) 40 km	OM16CS47	1	2	2	2	3	4	4
STM-16 cWDM SFP color 12 (1490nm) 40 km	OM16CS49	1	2	2	2	3	4	4
STM-16 cWDM SFP color 13 (1510nm) 40 km	OM16CS51	1	2	2	2	3	4	4
STM-16 cWDM SFP color 14 (1530nm) 40 km	OM16CS53	1	2	2	2	3	4	4
STM-16 cWDM SFP color 15 (1550nm) 40 km	OM16CS55	1	2	2	2	3	4	4
STM-16 cWDM SFP color 16 (1570nm) 40 km	OM16CS57	1	2	2	2	3	4	4
STM-16 cWDM SFP color 17 (1590nm) 40 km	OM16CS59	1	2	2	2	3	4	4
STM-16 cWDM SFP color 18 (1610nm) 40 km	OM16CS61	1	2	2	2	3	4	4
SFP GbE 500m	OMGBE-SX	1	2	2	2	3	3	4
SFP 550m SX - Gigabit Ethernet Module	OMGBE-SX-b	1	1	2	2	4	4	5
SFP 10km LX - Gigabit Ethernet Module	OMGBE-LX	1	1	1	1	2	3	4
SFP 70Km ZX - Gigabit Ethernet Module	OMGBE-ZX	1	1	2	2	4	4	5
SFP 70Km ZX - Gigabit Ethernet Module	OMGBE-ZX	1	1	1	2	4	4	4
Dispersion Compensation Modul, DCM/LC CPL DK-50	-	1	1	1	2	3	3	4
Dispersion Compensation Modul, DCM/LC CPL DK-60	-	1	1	1	2	3	3	4

The following table shows the recommended spare part numbers with respect to the number of circuit packs used, assuming a 20 days lead time:

Type	Apparatus code	up to 5 packs used	up to 10 packs used	up to 50 packs used	up to 100packs used	up to 500 packs used	up to 1000 packs used	up to 2000 packs used
STM-64 I64.1r 1.3um CC-272/128	LKA49	2	3	4	5	11	16	25
STM-64 V64.2 1.5um CC-272/128	LKA350	2	3	5	6	13	20	33
STM-64 L64.2b/3 1.5um CC-272/128	LKA28	2	3	4	6	13	20	32
STM-64 U64.2 1.5um CC-272/128	LKA281	3	4	5	6	12	15	21
STM-64 S64.2b/3b 1.5um CC-272/128	LKA29	2	3	4	6	13	19	31
4 x STM-16 SFP CC-272/128	LKA48	2	3	4	5	10	15	24
1 x STM-16 SFP CC-176/64	LKA481	2	3	4	5	9	14	21
1 x STM-16 VH CC-176/64 OBA	LKA482	2	3	4	5	10	15	23
STM-1/ STM-4 main board SFP	LKA39	2	2	3	4	6	9	13
1 x STM-16 SFP	LKA50	2	2	3	3	6	7	11
PB 12 x STM-1e Un-protected	PBP5	2	2	3	3	5	6	9
PB 12 x STM-1e (Prot. 1+1)	PBP6	2	2	3	3	5	7	10
PB 6 x STM-1o SFP	PBP8	2	2	2	2	3	4	5
PB-E1/P75/63	PBE3D	2	2	2	2	4	4	6
PB OPT/12 SFP	PBL12	2	2	2	3	4	5	6
PB OPT/12 SFP	PBO12	2	2	2	3	4	6	8
PB 63x2Mb/s 120 1:N P./Un-prot	PBE41	1	1	2	3	5	5	7
IP-LAN/12	LKA412	2	2	4	4	9	12	19
2 x GbE-Full/ one slot solution	LKA53	2	2	4	5	9	13	20
System Controller Enhanced	LKA21	2	2	3	4	7	9	14
SFP 2Km I-16	OM2G5-I16	2	2	2	2	4	4	6
SFP 40Km L-16.1	OM2G5-L16.1	2	2	2	2	4	4	6
SFP 40km, L-16.1, LR-1	OM2G5-L16.1	1	2	3	4	5	6	8
SFP 80Km L-16.2/3	OM2G5-L16.2	2	2	2	2	4	4	6
SFP 80km, L-16.2, LR-2	OM2G5-L16.2	1	2	3	4	6	6	8
SFP SH 15Km S-4.1	OM622M-S4.1	2	2	2	3	4	5	7
SFP LH 40Km L-4.1	OM622M-L4.1	2	2	2	2	4	4	6

Type	Apparatus code	up to 5 packs used	up to 10 packs used	up to 50 packs used	up to 100packs used	up to 500 packs used	up to 1000 packs used	up to 2000 packs used
SFP LH 80Km L-4.2	OM622M-L4.2	2	2	2	2	4	4	6
SFP 80km, L-4.2, LR-2	OM622M-L4.2	1	1	2	3	4	5	6
SFP SH 15Km S-1.1	OM155M-S1.1	2	2	2	2	4	4	6
SFP LH 40Km L-1.1	OM155M-L1.1	2	2	2	2	4	4	6
SFP LH 80Km L-1.2	OM155M-L1.2	2	2	2	2	4	4	6
SFP 80km, L-1.2, LR-2	OM155M-L1.2	1	1	2	3	4	5	6
STM-16 cWDM SFP color 11 (1470nm) 80 km	OM16CL47	2	2	2	3	4	5	7
STM-16 cWDM SFP color 12 (1490nm) 80 km	OM16CL49	2	2	2	3	4	5	7
STM-16 cWDM SFP color 13 (1510nm) 80 km	OM16CL51	2	2	2	3	4	5	7
STM-16 cWDM SFP color 14 (1530nm) 80 km	OM16CL53	2	2	2	3	4	5	7
STM-16 cWDM SFP color 15 (1550nm) 80 km	OM16CL55	2	2	2	3	4	5	7
STM-16 cWDM SFP color 16 (1570nm) 80 km	OM16CL57	2	2	2	3	4	5	7
STM-16 cWDM SFP color 17 (1590nm) 80 km	OM16CL59	2	2	2	3	4	5	7
STM-16 cWDM SFP color 18 (1610nm) 80 km	OM16CL61	2	2	2	3	4	5	7
STM-16 cWDM SFP color 11 (1470nm) 40 km	OM16CS47	2	2	2	2	4	4	6
STM-16 cWDM SFP color 12 (1490nm) 40 km	OM16CS49	2	2	2	2	4	4	6
STM-16 cWDM SFP color 13 (1510nm) 40 km	OM16CS51	2	2	2	2	4	4	6
STM-16 cWDM SFP color 14 (1530nm) 40 km	OM16CS53	2	2	2	2	4	4	6
STM-16 cWDM SFP color 15 (1550nm) 40 km	OM16CS55	2	2	2	2	4	4	6
STM-16 cWDM SFP color 16 (1570nm) 40 km	OM16CS57	2	2	2	2	4	4	6
STM-16 cWDM SFP color 17 (1590nm) 40 km	OM16CS59	2	2	2	2	4	4	6
STM-16 cWDM SFP color 18 (1610nm) 40 km	OM16CS61	2	2	2	2	4	4	6
SFP GbE 500m	OMGBE-SX	2	2	2	2	3	4	5
SFP 550m SX - Gigabit Ethernet Module	OMGBE-SX-b	1	1	2	3	5	5	6
SFP GbE 5km	OMGBE-LX	2	2	2	3	4	6	8

Type	Apparatus code	up to 5 packs used	up to 10 packs used	up to 50 packs used	up to 100packs used	up to 500 packs used	up to 1000 packs used	up to 2000 packs used
SFP 10km LX - Gigabit Ethernet Module	OMGBE-LX	1	1	1	2	3	4	4
SFP 70Km ZX - Gigabit Ethernet Module	OMGBE-ZX	1	1	2	3	5	5	6
SFP 70Km ZX - Gigabit Ethernet Module	OMGBE-ZX	1	1	2	2	4	4	5
Dispersion Compensation Modul, DCM/LC CPL DK-50	-	1	1	2	2	4	4	5
Dispersion Compensation Modul, DCM/LC CPL DK-60	-	1	1	2	2	4	4	5

Appendix A: An SDH overview

Overview

Purpose

This chapter briefly describes the Synchronous Digital Hierarchy (SDH).

Synchronous Digital Hierarchy

In 1988, the ITU-T (formerly CCITT) came to an agreement on the Synchronous Digital Hierarchy (SDH). The corresponding ITU-T Recommendation G.707 forms the basis of a global, uniform optical transmission network. SDH can operate with plesiochronous networks and therefore allows the continuous evolution of existing digital transmission networks.

The major features and advantages of SDH are:

- Compatibility of transmission equipment and networks on a worldwide basis
- Uniform physical interfaces
- Easy cross connection of signals in the network nodes
- Possibility of transmitting PDH (Plesiochronous Digital Hierarchy) tributary signals at bit rates commonly used at present
- Simple adding and dropping of individual channels without special multiplexers (add/drop facility)
- Easy transition to higher transmission rates
- Due to the standardization of the network element functions SDH supports a superordinate network management and new monitoring functions and provides transport capacity and protocols (Telecommunication Management Network, TMN) for this purpose in the overheads of the multiplex signals.
- High flexibility and user-friendly monitoring possibilities, e.g. end-to-end monitoring of the bit error ratio.

Purpose of SDH

The basic purpose of SDH is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in today's network, as well as those planned for the future.

SDH currently defines standard rates and formats and optical interfaces. Today, mid-span meet is possible at the optical transmission level. These and other related issues continue to evolve through the ITU-T committees.

ITU-T addressed issues

The set of ITU-T Recommendations defines

- Optical parameters
- Multiplexing schemes to map existing digital signals (PDH) into SDH payload signals
- Overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions
- Criteria for optical line Automatic Protection Switch (APS)

References

For more detailed information on SDH, refer to

- ITU-T Recommendation G.703, “Physical/electrical characteristics of hierarchical digital interfaces”, October 1996
- ITU-T Recommendation G.707, “Network Node Interface For The Synchronous Digital Hierarchy (SDH)”, March 1996
- ITU-T Recommendation G.780, “Vocabulary of terms for synchronous digital hierarchy (SDH) networks and equipment“ , November 1993
- ITU-T Recommendation G.783, “Characteristics of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks “, April 1997
- ITU-T Recommendation G.784, “Synchronous Digital Hierarchy (SDH) Management “, January 1994
- ITU-T Recommendation G.785, “Characteristics of a flexible multiplexer in a synchronous digital hierarchy environment “, November 1996
- ITU-T Recommendation G.813, “Timing characteristics of SDH equipment slave clocks (SEC)“, August 1996
- ITU-T Recommendation G.823, “The control of jitter and wander within digital networks which are based on the 2048-kbit/s hierarchy“, March 1993
- ITU-T Recommendation G.825, “The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)“, March 1993
- ITU-T Recommendation G.826, “ Error performance Parameters and Objectives for International, Constant Bit Rate Digital Paths at or Above the Primary Rate”, February 1999
- ITU-T Recommendation G.957, “Optical interfaces for equipments and systems relating to the synchronous digital hierarchy“, July 1995

Contents

SDH signal hierarchy

This section describes the basics of the SDH hierarchy.

STM-1 Frame

The SDH signal hierarchy is based on a basic "building block" frame called the Synchronous Transport Module 1 (STM-1), as shown in "SDH STM-1 frame" (p. A-5).

The STM-1 frame has a rate of 8000 frames per second and a duration of 125 microseconds

The STM-1 frame consists of 270 columns and 9 rows.

Each cell in the matrix represents an 8-bit byte.

Transmitting Signals

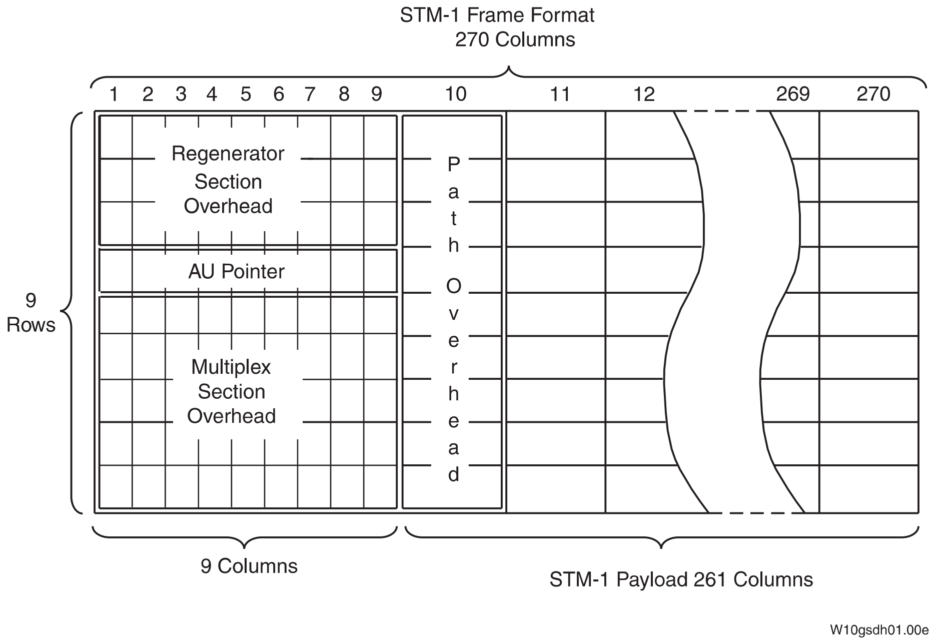
The STM-1 frame (STM = Synchronous Transport Module) is transmitted serially starting from the left with row 1 column 1 through column 270, then row 2 column 1 through 270, continuing on, row-by-row, until all 2430 bytes (9x270) of the STM-1 frame have been transmitted. Because each STM-1 frame consists of 2430 bytes and each byte has 8 bits, the frame contains 19440 bits a frame. There are 8000 STM-1 frames a second, at the STM-1 signal rate of 155.520.000 (19440 x 8000) kbit/s.

Three higher bit rates are also defined:

- 622.080 Mbit/s (STM-4)
- 2488.320 Mbit/s (STM-16)
- 9953.280 Mbit/s (STM-64)
- 39813.120 Mbit/s (STM-256)

The bit rates of the higher order hierarchy levels are integer multiples of the STM-1 transmission rate.

SDH STM-1 frame



Section overhead (SOH)

The first nine bytes of each row with exception of the fourth row are part of the SOH (Section OverHead). The first nine byte of the fourth row contain the AU pointer (AU = Administrative Unit).

STM-1 payload

Columns 10 through 270 (the remainder of the frame), are reserved for payload signals.

□

SDH path and line sections

This section describes and illustrates the SDH path and line sections.

SDH layers

SDH divides its processing functions into the following three path and line sections:

- Regenerator section
- Multiplex section
- Path

These three path and line sections are associated with

- Equipment that reflects the natural divisions in network spans
- Overhead bytes that carry information used by various network elements

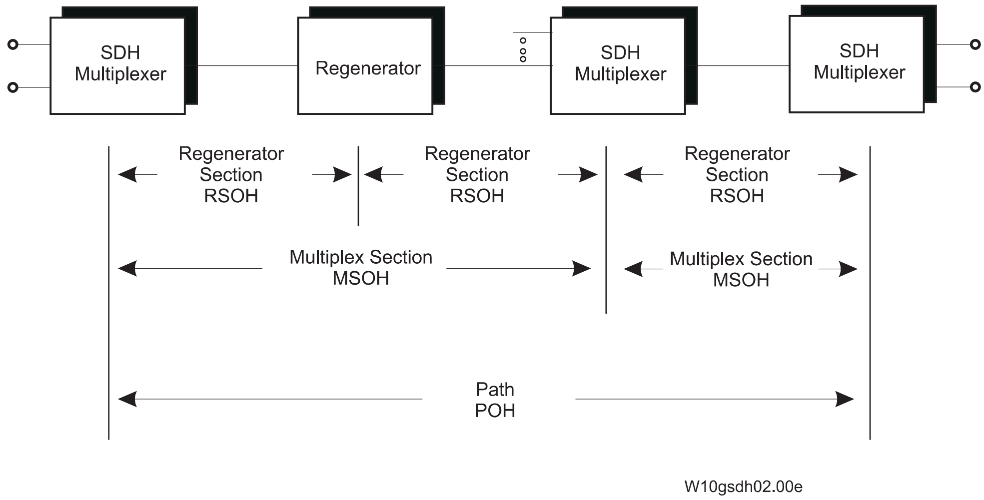
Equipment layers

The following table lists and defines each SDH equipment path and line section.

Path and line sections	Definition
Regenerator section	A regenerator section describes the section between two network elements. The network elements, however, do not necessarily have to be regenerators.
Multiplex section	A multiplex section is the section between two multiplexers. A multiplex section is defined as that part of a path where no multiplexing or demultiplexing of the STM-N frame takes place.
Path	A path is the logical signal connection between two termination points. A path can be composed of a number of multiplex sections which themselves can consist of several regenerator sections.

Path, MS and RS

The following figure illustrates the equipment path, multiplex sections and regenerator sections in a signal path.



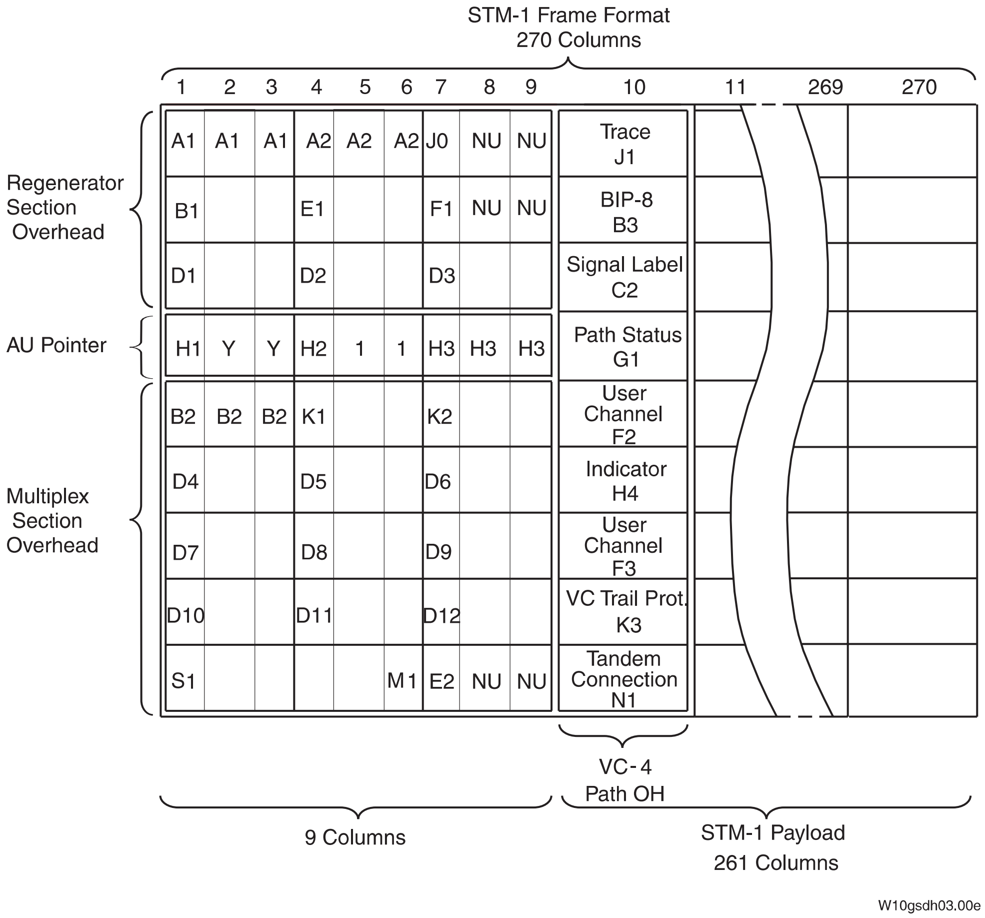
Overhead bytes

The following table lists and defines the overhead associated with each SDH path and line section.

Overhead byte section	Definition
Regenerator section	Contains information that is used by all SDH equipment including repeaters.
Multiplex section	Used by all SDH equipment except repeaters.
Path	The POH contains all the additional signals of the respective hierarchy level so that a VC can be transmitted and switched through independently of its contents.

SDH frame

The following figure illustrates the SDH frame sections and its set of overhead bytes.


STM-1 Frame Format
270 Columns
1 2 3 4 5 6 7 8 9 10 11 269 270
Regenerator Section Overhead
AU Pointer
Multiplex Section Overhead
A1 A1 A1 A2 A2 A2 J0 NU NU
B1 E1 F1 NU NU
D1 D2 D3
H1 Y Y H2 1 1 H3 H3 H3
B2 B2 B2 K1 K2
D4 D5 D6
D7 D8 D9
D10 D11 D12
S1 M1 E2 NU NU
Trace J1
BIP-8 B3
Signal Label C2
Path Status G1
User Channel F2
Indicator H4
User Channel F3
VC Trail Prot. K3
Tandem Connection N1
VC-4 Path OH
9 Columns
STM-1 Payload
261 Columns
W10gsdh03.00e

SDH frame structure

This section provides detailed information on the locations and functions of various overhead bytes for each of the following SDH path and line sections:

- Regenerator Section
- Multiplex Section
- Path

Section overhead

The following table identifies the location and function of each regenerator section overhead byte.

Bytes	Function
A1, A2	Frame alignment A1 = 1111 0110 ; A2 = 0010 1000 ; These fixed-value bytes are used for synchronization.
B1	BIP-8 parity test Regenerator section error monitoring; BIP-8 : Computed over all bits of the previous frame after scrambling; B1 is placed into the SOH before scrambling; BIP-X: (Bit Interleaved Parity X bits) Even parity, X-bit code; first bit of code = even parity over first bit of all X-bit sequences;
B2	Multiplex section error monitoring; BIP-24 : B2 is computed over all bits of the previous STM-1 frame except for row 1 to 3 of the SOH (RSOH); B2 is computed after and placed before scrambling;
Z0	Spare bytes
D1 - D3 (= DCC_R) D4 - D12 (= DCC_M)	Data Communication Channel (network management information exchange)
E1	Orderwire channel
E2	Orderwire channel
F1	User channel
K1, K2	Automatic protection switch
K2	MS-AIS/RDI indicator
S1	Synchronization Status Message
M1	REI (Remote Error Indication) byte
NU	National Usage

Path overhead

The Path Overhead (POH) is generated for all plesiochronous tributary signals in accordance with ITU-T Rec. G.709. The POH provides for integrity of communication between the point of assembly of a Virtual Container VC and its point of disassembly. The following table shows the POH bytes and their functions.

Byte	Location and Function
J1	Path Trace Identifier byte
B3	Path Bit Interleaved Parity (BIP-8) Provides each path performance monitoring. This byte is calculated over all bits of the previous payload before scrambling.
C2	Signal Label All ″0″ means unequipped; other and ″00000001″ means equipped
G1	Path Status Conveys the STM-1 path terminating status, performance, and remote defect indication (RDI) signal conditions back to an originating path terminating equipment.
F2, F3	User Data Channel Reserved for user communication.
H4	Multiframe Indicator Provides a general multiframe indicator for VC-structured payloads.
K3	VC Trail protection.
N1	Tandem connection OH

AU pointer

The AU pointer together with the last 261 columns of the STM-1 frame forms an AUG (Administrative Unit Group). An AUG may contain one AU-4 or three byte-multiplexed AU-3s (an AU-3 is exactly one third of the size of an AU-4). AU-3s are also compatible with the SONET standard (Synchronous Optical NETwork) which is the predecessor of SDH (and still the prevailing technology within the USA). Three byte-multiplexed STS frames (SONET frame), each containing one AU-3 can be mapped into one STM-1.

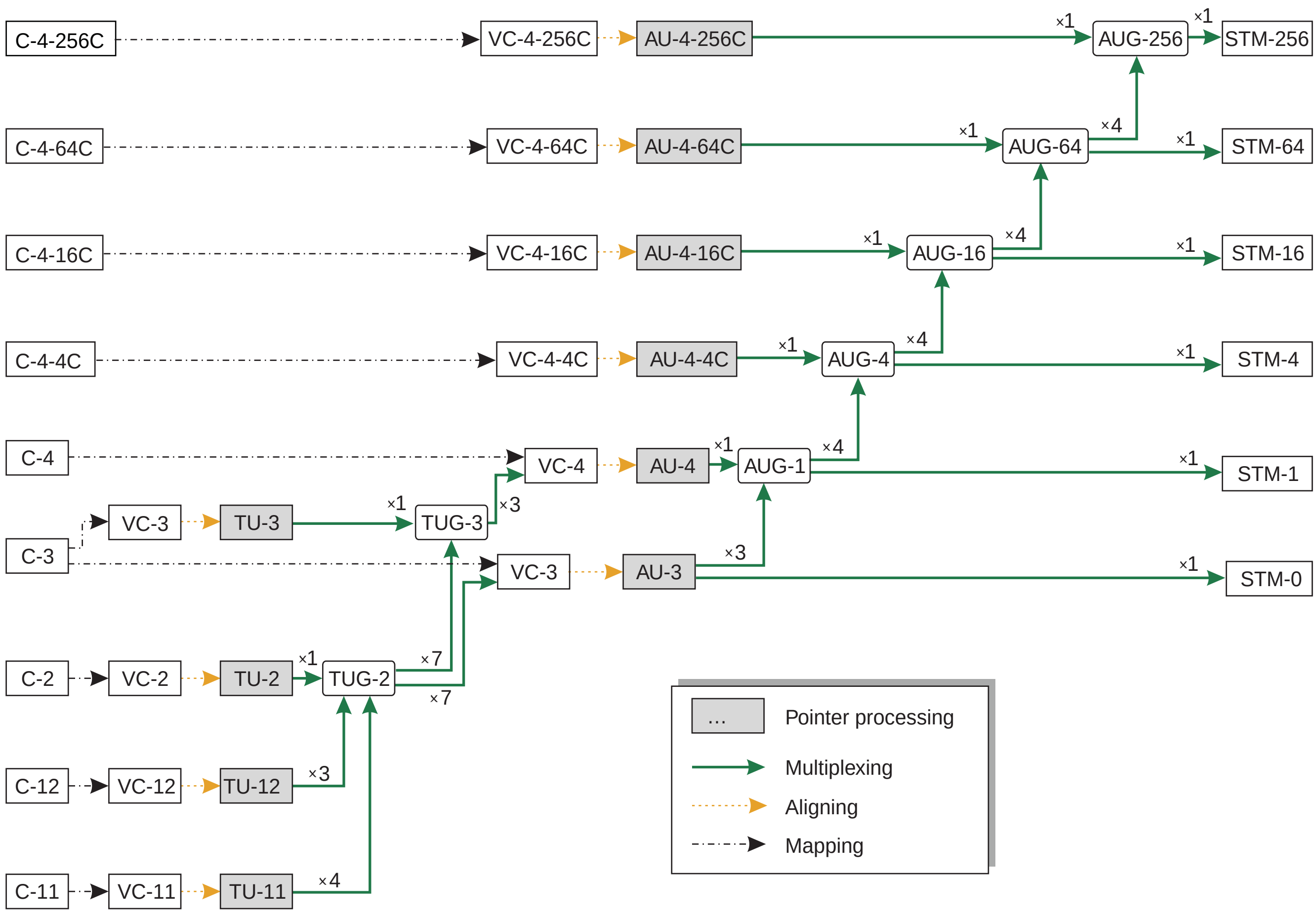
□

SDH digital multiplexing

Digital multiplexing is SDH's method of byte mapping tributary signals to a higher signal rate, which permits economical extraction of a single tributary signal without the need to demultiplex the entire STM-1 payload. In addition, SDH provides overhead channels for use by OAM&P groups.

SDH digital multiplexing

The following figure illustrates the SDH technique of mapping tributary signals into the STM frames.



Transporting SDH payloads

Tributary signals are mapped into a digital signal called a virtual container (VC). The VC is a structure designed for the transport and switching of STM payloads. There are various sizes of VCs: VC-11, VC-12, VC-2, VC-3, VC-4, VC-4-4C, VC-4-16C, VC-4-64C and VC-4-256C.

Table

The following table shows the mapping possibilities of some digital signals into SDH payloads.

Input tributary	Voice Channels	Rate	Mapped Into
1.5 Mbit/s	24	1.544 Mbit/s	VC-11
2 Mbit/s	32	2.048 Mbit/s	VC-12
6 Mbit/s	96	6.312 Mbit/s	VC-2
34 Mbit/s	672	34.368 Mbit/s	VC-3
45 Mbit/s	672	44.736 Mbit/s	VC-3
140 Mbit/s	2016	139.264 Mbit/s	VC-4

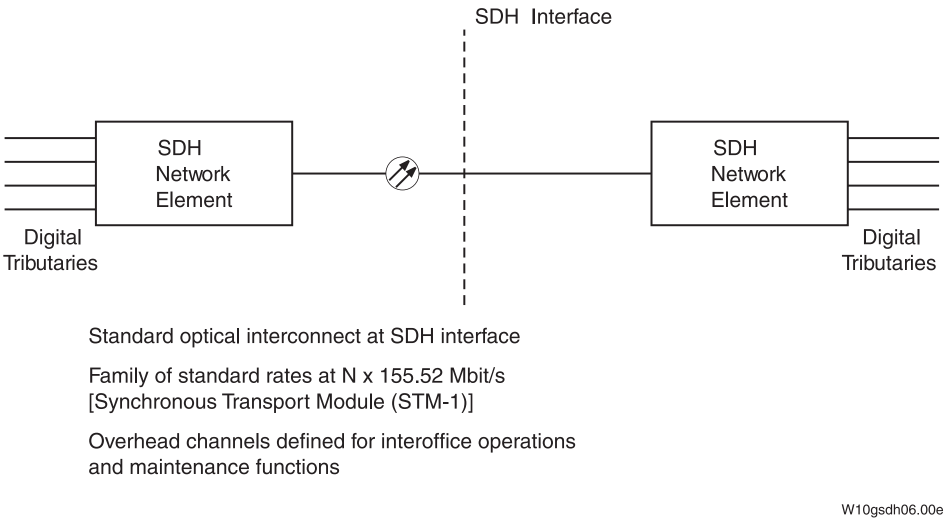
SDH interface

This section describes the SDH interface.

Description

The SDH interface provides the optical mid-span meet between SDH network elements. An SDH network element is the hardware and software that affects the termination or repeating of an SDH standard signal.

SDH interface



SDH multiplexing process

SDH provides for multiplexing of 2-Mbit/s (C-12) and 34-Mbit/s (C-3) signals into an STM-1 frame.

Furthermore, multiplexing paths also exist for the SONET specific 1.5-Mbit/s, 6-Mbit/s and 45-Mbit/s signals.

Process

The following describes the process for multiplexing a 2-Mbit/s signal. The "SDH digital multiplexing" (p. A-11) illustrates the multiplexing process.

1 Input 2-Mbit/s tributary is mapped

- Each VC-12 carries a single 2-Mbit/s payload.
- The VC-12 is aligned into a Tributary Unit TU-2 using a TU pointer.
- Three TU-2 are then multiplexed into a Tributary Unit Group TUG-2.
- Seven TUG-2 are multiplexed into an TUG-3.
- Three TUG-3 are multiplexed into an VC-4.
- The VC-4 is aligned into an Administrative Unit AU-4 using a AU pointer.
- The AU-4 is mapped into an AUG which is then mapped into an STM-1 frame.

2 After VCs are multiplexed into the STM-1 payload, the section overhead is added.

3 Scrambled STM-1 signal is transported to the optical stage.

□

SDH demultiplexing process

Demultiplexing is the inverse of multiplexing. This topic describes how to demultiplex a signal.

Process

The following describes the process for demultiplexing an STM-1 signal to a 2 Mbit/s signal. The "SDH digital multiplexing" (p. A-11) illustrates the demultiplexing process.

1. The unscrambled STM-1 signal from the optical conversion stages is processed to extract the path overhead and accurately locate the payload.

2. The STM-1 path overhead is processed to locate the VCs. The individual VCs are then processed to extract VC overhead and, via the VC pointer, accurately locate the 2-Mbit/s signal.

3. The 2-Mbit/s signal is desynchronized, providing a standard 2-Mbit/s signal to the asynchronous network.

Key points

SDH STM pointers are used to locate the payload relative to the transport overhead.

Remember the following key points about signal demultiplexing:

- The SDH frame is a fixed time (125 µs) and no bit-stuffing is used.
- The synchronous payload can float within the frame. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing).

□

SDH transport rates

Higher rate STM-N frames are built through byte-multiplexing of N STM-1 signals.

Creating higher rate signals

A STM-N signal can only be multiplexed out of N STM-1 frames with their first A1 byte at the same position (i.e. the first A1 byte arriving at the same time).

STM-N frames are built through byte-multiplexing of N STM-1 signals. Not all bytes of the multiplexed SOH (size = N x SOH of STM-1) are relevant in an STM-4/16.

For example there is only one B1 byte in an STM-4/16 frame which is computed the same way as for an STM-1. Generally the SOH of the first STM-1 inside the STM-N is used for SOH bytes that are needed only once. The valid bytes are given in ITU-T G.707.

SDH transport rates

Designation	Line rate (Mbit/s)	Capacity
STM-1	155.520	1 AU-4 or 3 AU-3
STM-4	622.080	4 AU-4 or 12 AU-3
STM-16	2488.320	16 AU-4 or 48 AU-3
STM-64	9953.280	64 AU-4 or 192 AU-3
STM-256	39813.120	256 AU-4 or 768 AU-3

□

Glossary

Numerics

5ESS
Number 5 Electronic Switching System

5TAD
Five Tributary Add-Drop subrack

9TAD
Nine Tributary Add-Drop subrack

12 digit Numerical Code (12NC)
Used to as the unique identifier of an item or product. The first ten digits identify an item. The eleventh digit specifies the particular variant of the item. The twelfth digit indicates the revision issue. Items for which the first eleven digitsare the same are functionally equal and may be exchanged.

A

AAU
Alarm Adapter Unit. Radio Relay circuit pack that is used for the collection of external alarms and remote control of external equipment.

AC
Alternating Current

ACU
Alarm Collection Unit. Radio Relay circuit pack that collects of equipment alarms, analogue measurements from internal monitoring points and calculation data.

ADM
Add-Drop Multiplexer

Administrative Unit (AU)
Carrier for TUs

Administrative-Unit Pointer (AU PTR)
Indicates the phase alignment of the VC-n with respect to the STM-N frame. The pointer position is fixed with respect to the STM-N frame.

Administrator

See System Administrator.

Agent

Performs operations on managed objects and issues events on behalf of these managed objects. All SDH managed objects will support at least one agent. Control of distant agents is possible via local “Managers”.

Alarm

The notification (audible or visual) of a significant event. See also Event.

Alarm Indication Signal (AIS)

Code transmitted downstream in a digital Network that shows that an upstream failure has been detected and also alarmed if the upstream alarm has not been suppressed. Also called to as All OneS.

Alarm Severity

An attribute that defines the priority of the alarm message. The way in which alarms are processed depends on the severity.

Aligning

Using a pointer to indicate the head of a virtual container, e.g. to create an Administrative Unit (AU) or a Tributary Unit (TU).

ALS

Automatic Laser Shutdown

Alternate Mark Inversion (AMI)

A line code that employs a ternary signal to convert binary digits. In this line code successive binary ones are represented by signal elements that are normally of alternately positive and negative polarity but are equal in amplitude, binary zeros are represented by signal elements that have zero amplitude.

American Standard Code for Information Interchange (ASCII)

A standard 8-bit code that is used to exchange information among data processing systems and associated equipment.

Anomaly

A difference between the actual and the desired operation of a function.

ANSI

American National Standards Institute

APS

Automatic Protection Switching

AS

Alarm Suppression assembly

Assembly

Gathering together of payload data with overhead and pointer information (an indication of the direction of the signal).

Association

A logical connection between manager and agent through which management information can be exchanged.

Asynchronous

See Non-synchronous.

ATC

Auxiliary Transmission Channel

ATM

Asynchronous Transfer Mode

ATPC

Automatic Transmit-Power Control

AU

Administrative Unit

AU4AD

Administrative Unit 4 Assembler/Disassembler

AUG

Administrative Unit Group

AUTO

Automatic

Automatic Transmit Power Control (ATPC)

Reduces the power output from the transmitter during normal propagation conditions and increases the power output to maximum during fading periods to try to maintain the nominal level of receiver input.

B

B3ZS

Bipolar 3-Zero Substitution

B8ZS

Bipolar 8-Zero Substitution

BBTR

Backplane Bus TRansceiver

BC

Board Controller

BCC

Board Controller Complex

BIN

BINary

BIP
Bit-Interleaved Parity

BISDN
Broadband Integrated Services Digital Network

Bit Error Ratio (BER)
The ratio of bits received in error to bits sent.

Bit Interleaved Parity (BIP)
A method of error monitoring that uses a specified number of bits (BIP-8)

BLD OUT LG
Build-Out Lightguide

Board Controller Local Area Network (BC-LAN)
The internal local area network that provides communications between the Line Controller circuit pack and board controllers on the circuit packs that are associated with a high-speed line.

BOL
Beginning Of Life

Branching
Interconnection of independent line systems.

Broadband Communication
Voice, data, and/or video communication at greater than 2 Mbit/s rates.

Broadband Service Transport
STM-1 concatenation transport over the SLM for ATM applications.

BUSTR
BUS Transmitter and Receiver

C

CAS
Channel Associated Signaling

CAT
CATastrophic

CC
Cross-Connection, Cross-Connect

CCIR
See ITU-R.

CCITT
See ITU-T.

CCS

Common Channel Signaling

CEPT

Conférence Européenne des Administrations des Postes et des Télécommunications

Channel

A sub-unit of transmission capacity within a defined higher level of transmission capacity, e.g. a CEPT-4 (140 Mbit/s) within a 565 Mbit fiber system.

CIR

Committed Information Rate

Circuit

A combination of two transmission channels that permits bidirectional transmission of signals between two points to support a single communication.

CIT

Craft Interface Terminal

Clear Channel (Cl. Ch.)

A provisionable mode for the 34 and 140 Mbit/s tributary outputs that causes parity violations not to be monitored or corrected before the 34 and 140 Mbit/s outputs are encoded.

Client

Computer in a computer network that generally offers a user interface to a server. See also Server.

CMI

Coded Mark Inversion

CO

Central Office

Co-resident

A hardware configuration where the OMS and ITM-NM applications can be independently active at the same time on the same hardware and software platform without interfering with each other’s functioning.

Common Object Request Broker Architecture (CORBA)

CORBA allows applications to communicate with one another no matter where they are located or who has designed them.

Concatenation

A procedure whereby a multiplicity of Virtual Containers are associated with each other with the result that their combined capacity can be used as a single container across which bit-sequence integrity is maintained.

CONN PCB

Connector Printed Circuit Board

Container (C)
Carries plesiochronous signal, the "payload".

CP
Circuit Pack

Craft Interface Terminal (CIT)
Local manager for SDH network elements.

CRC
Cyclic Redundancy Check

Cross-Connect Map
Connection map for an SDH network element; contains information about how signals are connected between high speed time slots and low speed tributaries. See also Squelch Map.

Cross-Polarization Interference Cancellation
This feature permits both orthogonal polarizations of one Radio Frequency carrier to be used simultaneously, which provides greater spectral efficiency.

CTP
Connection Termination Point

CV
Code Violation

D

DACS
Digital Access & Cross-connect System

DACScan-T
See Integrated Transport Management Network Manager.

Data Communication Channel (DCC)
The embedded overhead communication channel in the SDH line. The DCC is used for end-to-end communication and maintenance. It carries alarm, control, and status information between network elements in an SDH network.

Data Communication Equipment (DCE)
Provides the signal conversion and coding between the data terminating equipment and the line. The DCE may be separate equipment or a part of the data terminating equipment.

Data Terminating Equipment (DTE)
Originates data for transmission and accepts transmitted data.

Database Administrator
A user who administers the database of the OMS application. See also User Privilege.

DC
Direct Current

DCF
Data Communications Function

DCN
Data Communications Network

DCS
Digital Cross-connect System

DDF
Digital Distribution Frame

Dedicated Protection Ring (DP-Ring)
A protection method used in some network elements.

Default Value Provisioning
The original values are preprogrammed at the factory. These values can be overridden using local or remote provisioning.

Defect
A limited interruption of the ability of an item to perform a required function. The defect may or may not lead to maintenance action this depends on the results of additional analysis.

Demultiplexing
A process applied to a multiplexed signal to recover signals combined within it and restore the distinct individual channels of these signals.

Digital Link
A transmission span such as a point-to-point 2 Mbit/s, 34 Mbit/s, 140 Mbit/s, VC12, VC3 or VC4 link between controlled network elements. The channels within a digital link are insignificant.

Digital Section
A transmission span such as an STM-N or 565 Mbit/s signal. A digital section may contain multiple digital channels.

DIL
Dual In Line

Directory-Service Network Element (DSNE)
A designated network element that is responsible for administering a database that maps network element names (node names) to addresses (node Id). There can be one DSNE per (sub)network.

Disassembly
Splitting up of a signal into its constituents as payload data and overhead (an indication of the direction of a signal).

Downstream
At or towards the destination of the considered transmission stream, i.e. in the direction of transmission.

DPLL
Digital Phase-Locked Loop

DPS
Data communication Packet Switch

DR
Digital Radio

DRI
Dual-Ring Interworking

DS-n
Digital Signal, Level n

DTMF
Dual-Tone Multi-Frequency

Dual Homing
An STM-1/STM-4 ring with AM-1 Plus equipment can be dual homed on a ring consisting of *Metropolis*® ADM (Universal shelf), Metropolis® ADM (Compact shelf) or *WaveStar*® ADM 16/1. Also STM-16 rings can be dual homed with the *Metropolis*® ADM (Universal shelf)).

Dual-Node Interworking
Dual Node Interworking (DNI) is a configuration of two ring networks that share two common nodes. DNI allows a circuit with one termination in one ring and one termination in another ring to survive a loss-of-signal failure of the shared node that is currently carrying service for the circuit.

DUS
Do not Use for Synchronization

DWDM
Dense-Wavelength Division Multiplexing

E

EC-n
Electrical Carrier, Level n

ECC
Embedded Control Channel

EDFE
Ethernet Dropped Frames Errors

EH&S
Environmental Health and Safety

EINB
Ethernet Incoming Number of Mbytes

Electronic Industries Association (EIA)
A trade association of the electronic industry that establishes electrical and functional standards.

Element Management System (EMS)
See Integrated Transport Management Subnetwork Controller.

EMC
ElectroMagnetic Compatibility

EMI
ElectroMagnetic Interference

EOL
End Of Life

EONB
Ethernet Outgoing Number of Mbytes

EOW
Engineering Order Wire

Equivalent Bit Error Ratio (EBER)
The calculated average bit error rate over a data stream.

Errored Second (ES)
A performance monitoring parameter.

ES
End System

ESD
ElectroStatic Discharge

ESPG
Elastic Store & Pointer Generator

ETSI
European Telecommunication Standardisation Institute

Event
A significant change. Events in controlled network elements include signal failures, equipment failures, signals exceeding thresholds, and protection switch activity. When an event occurs in a controlled network element, the controlled network element will generate an alarm or status message and send it to the OMS.

Externally Timed
An operating condition of a clock in which it is locked to an external reference and uses time constants that are altered to quickly bring the local oscillator's frequency into approximate agreement with the synchronization reference frequency.

Extra Traffic
Unprotected traffic that is carried over the protection channels when that capacity is not used for the protection of service traffic.

F

FAS
Frame Alignment Signal

FAW
Frame Alignment Word

FC
Full contact Connector

FCC
Federal Communications Commission

FDDI
Fiber Distributed Data Interface

FEP
Front End Processor

Free Running
An operating condition of a network element in which its local oscillator is not locked to any synchronization reference and uses no storage techniques to sustain its accuracy.

G

GARP
Generic Attribute Registration Protocol

Gateway Network Element (GNE)
Passes information between other network elements and management systems via a Data Communications Network.

Gbit/s
Gigabits per second

GFP
Generic Framing Procedure

Global Wait to Restore Time
The time to wait before switching back to the timing reference occurs after a timing link failure has cleared. This time applies for all timing sources in a system hence the name global. This can be between 0 and 60 minutes, in increments of one minute.

GNE
Gateway network element - A network element that passes information between other network elements and operations systems via a data communications network.

GUI
Graphical User Interface

GVRP
GARP VLAN Registration Protocol (refer to “GARP” (p. GL-10))

H

HE
Host Exchange

High Density Bipolar 3 code (HDB3)
Line code for e.g. 2 Mbit/s transmission systems.

High level Data Link Control (HDLC)
Protocol in the data-link layer of the OSI reference model.

Higher order Path Adaptation (HPA)
Function that adapts a lower order Virtual Container to a higher order Virtual Container by processing the Tributary Unit pointer which indicates the phase of the lower order Virtual Container Path Overhead relative to the higher order Virtual-Container Path Overhead, and assembling/disassembling the complete higher order Virtual Container.

Higher order Path Connection (HPC)
Function that provides for flexible assignment of higher order Virtual Containers within an STM-N signal.

Higher order Path Termination (HPT)
Function that terminates a higher order path by generating and adding the appropriate Virtual-Container Path Overhead to the relevant container at the path source and removing the Virtual-Container Path Overhead and reading it at the path sink.

HMI
Human Machine Interface

HO
High Order

Holdover
An operating condition of a clock in which its local oscillator is not locked to an external reference but uses storage techniques to maintain its accuracy with respect to the last known frequency comparison with a synchronized reference.

Host Name
Name of the server on which the OMS is running.

HS
High Speed

I

I/O
Input/Output

ICB
Interconnection Box

ICP
InterConnection Panel

IEC
International Electrotechnical Committee

IEEE
Institute of Electrical and Electronic Engineers

IF
Intermediate Frequency

IFT
InterFace Terminal

Integrated Transport Management Craft Interface Terminal (ITM-CIT)
Local manager for SDH network elements in a subnetwork. Also called the to as Craft Interface Terminal.

Intelligent Synchronous Multiplexer (ISM)
A network multiplexer that is designed to flexibly multiplex plesiochronous and STM-1 tributary port signals into STM-1 or STM-4 line port signals.

Intermediate System (IS)
A system that routes/relays management information. An SDH network element may be a combined Intermediate and end system.

IPS
Inter Processor Status

IS
In-Service

IS-IS Routing
The network elements in a management network, route packets (data) between each other using an IS-IS level protocol. The size of a network that is running IS-IS Level 1 is limited, and therefore certain mechanisms are employed to facilitate the management of larger networks. For STATIC ROUTING, it is possible to disable the protocol over the LAN connections and thereby effectively cause the management network to be partitioned into separate IS-IS Level 1 areas. In order for the OMS to communicate with a specific network element in one of these areas, the OMS must identify the Gateway network elementthrough which this specific network element is connected to the LAN. All packets to this specific network element are routed directly to the Gateway network element by the OMS, before being re-routed (if necessary) within the Level 1 area. For DYNAMIC ROUTING an IS-IS Level 2 routing protocol is used that allows a number of Level 1 areas to interwork. The network elements that connect an IS-IS area to another area are set to run the IS-IS Level 2 protocol within the network element and on the connection to other network elements. Packets can now be routed between IS-IS areas

and the OMS does not have to identify the Gateway network elements.

ISDN

Integrated Services Digital Network

ISO

International Standards Organisation

ITU

International Telecommunications Union

ITU-R

International Telecommunications Union - Radio standardization sector. Formerly known as CCIR: Comité Consultatif International Radio; International Radio Consultative Committee.

ITU-T

International Telecommunications Union - Telecommunication standardization sector. Formerly known as CCITT: Comité Consultatif International Télégraphique & Téléphonique; International Telegraph and Telephone Consultative Committee.

J **Jitter**

Short term variations of amplitude and frequency components of a digital signal from their ideal position in time.

L **LAN**

Local Area Network

LBA

Lightwave Booster Amplifier.

LBO

Line Build Out - An optical attenuator that guarantees the proper signal level and shape at the receiver input.

LCAS

Link Capacity Adjustment Scheme

LCN

Local Communications Network

LDI

Linear Drop/Insert (Add-Drop)

LED

Light Emitting Diode

LEN

Local Exchange Node

LF

Low Frequency

LH

Long Haul

License key

An encrypted code that is required to enable the use of specific modules in the OMS. Valid license keys can be obtained from your provider.

Line

Transmission line; refers to a transmission medium, together with the associated high speed equipment, that are required transport information between two consecutive network elements, one of which originates the line signal and the other terminates the line signal.

Line Build Out (LBO)

An optical attenuator that guarantees the proper signal level and shape at the receiver input.

Line Overhead Controller (LOC)

SLM circuit pack that accesses the overhead bytes from the high speed line.

LNC

LiNe Controller (SLM)

LO

Low Order

LOF

Loss Of Frame

LOM

Loss Of Multiframe

Loop Timing

A timing mode in which the terminal derives its transmit timing from the received line signal.

LOP

Loss Of Pointer

LOS

Loss Of Signal

Lower order Path Adaptation (LPA)

Function that adapts a PDH signal to a synchronous network by mapping the signal into or de-mapping the signal out of a synchronous container.

Lower order Path Connection (LPC)

Function that provides for flexible assignment of lower order VCs in a higher order VC.

Lower order Path Termination (LPT)
Function that terminates a lower order path by generating and adding the appropriate VC POH to the relevant container at the path source and removing the VC POH and reading it at the path sink.

LPU
Line Port Unit

LPU155
Line Port Unit 155 Mbit/s

LRX
Line Receiver

LS
Low Speed

LTA
Line Terminal Application

LTX
Line Transmitter

LTX/EML
Line Transmitter with Electro-absorption Modulated Laser

M

MAF
Management Application Function

Management Connection
Identifies the type of routing used (STATIC or DYNAMIC). If STATIC is selected, Management Connection allows the gateway network element to be identified. See also IS-IS Routing.

Management Information Base (MIB)
The database in the network element. Contains the configuration data of the network element. A copy of each MIB is available in the OMS and is called the the MIB image. Under normal circumstances the MIB and MIB image of one Network Element are synchronized.

Manager
Is capable of issuing network management operations and receiving events

Manager
Capable of issuing network management operations and receiving events. The Manager communicates with the Agent in the controlled network element.

Manufacturer Executable Code (MEC)
Network element system software in binary format that is downloaded to one of the stores can be executed by the system controller of the network element.

Mapping
Gathering together of payload data with overhead, i.e. packing the PDH signal into a Virtual Container.

MDI
Miscellaneous Discrete Input

MDO
Miscellaneous Discrete Output

Mediation Device (MD)
Allows for exchange of management information between Operations System and network elements.

MEF
Maintenance Entity Function (in NE)

MEM
System MEMory unit

Message Communications Function (MCF)
Function that provides facilities for the transport and routing of Telecommunications Management Network messages to and from the Network Manager.

***Metropolis*® ADM (Universal shelf)**
A network multiplexer that is designed to flexibly multiplex plesiochronous and/or STM-1 tributary port signals into STM-4 or STM-16 line port signals.

MF
Mediation Function

MFS
Multi Frame Synchronization signal

MIB
The Management Information Base is the database in the node. The MIB contains the configuration data of the node. A copy of each MIB is available in the EMS and is called the MIB image. Under normal circumstances, the MIB and MIB image of one node are synchronized.

MIB image
See Management Information Base.

Midspan Meet
The capability to interface between two lightwave network elements of different vendors. This applies to high speed optical interfaces.

MLAN
MultiLAN

MMI
Man-Machine Interface Also called Human Machine Interface (HMI)

MO

Managed Object

Motif

X-Windows System supplied by Open Software Foundation.

MS

Multiplexer Section

MSOH

Multiplex Section Overhead. Part of the SOH (Section Overhead). Is accessible only at line terminals and multiplexers.

MSP

Multiplex Section Protection. Provides capability of switching a signal from a working to a protection section.

MTBF

Mean Time Between Failures

MTBMA

Mean Time Between Maintenance Activities

MTIE

Maximum Time Interval Error

MTPI

Multiplexer Timing Physical Interface

MTTR

Mean Time To Repair

Multiplexer Section OverHead (MSOH)

Part of the Section Overhead. Is accessible only at line terminals and multiplexers.

Multiplexer Section Protection (MSP)

Provides capability of switching a signal from a working to a protection section.

Multiplexer Section Shared Protection Ring (MS-SPRING)

A protection method used in multiplex line systems.

Multiplexer Section Termination (MST)

Function that generates the Multiplexer Section Overhead in the transmit direction and terminates the Multiplexer Section Overhead in the receive direction.

Multiplexer Timing Source (MTS)

Function that provides the timing reference to the relevant component parts of the multiplex equipment and represents the SDH network element clock.

Multiplexing

A procedure by which multiple lower order path layer signals are adapted into a higher order path, or by which the multiple higher order path layer signals are adapted into a multiplex section.

N **NE**

Network element. The NE is comprised of telecommunication equipment (or groups/parts of telecommunication equipment) and support equipment that performs network element functions. A Network Element has one or more standard Q-type interfaces.

NEF

Network element function

NEM

Network element manager

Network Element (NE)

A network element is comprised of telecommunication equipment (or groups/parts of telecommunication equipment) and support equipment that performs network element functions. A Network Element has one or more standard Q-type interfaces. A network element ican be directly managed by a management system. See also Node.

Network Service Access Point (NSAP)

An end system address of the System Controller according to ISO 8348 AD2. The format is ISO_DCC_LUCENT, which has the following structure:

NMC

Network Maintenance Center

NMS

Network Management System

NNE

Non-SDH network element

NNI

Network Node Interface

Node

A node or network element is defined as all equipment that is controlled by one system controller.

Node

Defined as all equipment that is controlled by one system controller. A node can not always be directly managed by a management system. See also network element.

NOMC

Network Operation Maintenance Channel

Non-revertive switching

In non-revertive switching, there is an active and standby high-speed line, circuit pack, etc. When a protection switch occurs, the standby line, circuit pack, etc., is selected causing the old standby line, circuit pack, etc., to be used for the new active line, circuit pack, etc. The original active line, circuit pack, etc., becomes the standby line, circuit pack, etc. This status remains in effect when the fault clears. Therefore, this protection scheme is “non-revertive” in that there is no switch back to the original status in effect before the fault occurred.

Non-synchronous

The essential characteristic of timescales or signals such that their significant instants do not necessarily occur at the same average rate.

NPI

Null Pointer Indication

NRZ

Non-Return to Zero

NSA

Non-Service Affecting

NUT

Non pre-emptible Unprotected Traffic

NVM

Non-Volatile Memory

O

OA

Optical Amplifier

OAA case tools

A software package/tool to aid the process of requirements, analysis, design and implementation of object orientated systems.

OAM&P

Operations, Administration, Maintenance and Provisioning

OC-n

Optical Carrier, Level n

ODF

Optical Distribution Frame

ODU

Optical Demultiplexer Unit

OFS

Out of Frame Second

OI

Optical Interface

OMU
Optical Multiplexer Unit

OOF
Out Of Frame

OOS
Out Of Service

Operations System (OS)
The Operations System is the system that provides operations, administration and maintenance functions.

Operator
A user of an application with Operator privileges. See also User Privilege.

Optical Line System (OLS)
A high-capacity lightwave system that is designed to multiplex eight optical signals with different wavelengths into one combined signal through an optical fiber. There is a difference of 1.5 micrometer in wavelength between two multiplexed signals.

OS
Operations System - A central computer-based system that is used to provide operations, administration and maintenance functions.

OSB
Optical Splice Box

OSI
Open Systems Interconnection

OW
(Engineering) Order Wire

P

PABX
Private Automatic Branch eXchange

Paddle Board - Peripheral Control and Timing link (PB-PCT)
A small circuit board used in a 5ESS exchange for protection switching and optical to electrical conversion of the PCT-link.

Path
A logical connection between one termination point at which a standard format for a signal at the given rate is assembled and from which the signal is transmitted, and another termination point at which the received standard frame format for the signal is disassembled.

Path AIS
Path Alarm Indication Signal - A path-level code that is sent downstream in a digital network as an indication that an upstream failure has been detected and alarmed.

Path Overhead (POH)

The Virtual-Container Path Overhead provides integrity of communication between the point of assembly of a Virtual Container and its point of disassembly.

Path Terminating Equipment

Network elements in which the path overhead is terminated.

PC

Personal Computer

PCB

Printed Circuit Board

PCM

Pulse Code Modulation

PCT-link

Peripheral Control and Timing-link

PDH

Plesiochronous Digital Hierarchy

Performance Monitoring (PM)

Measures the quality of service and identifies degrading or marginally operating systems (before an alarm is generated).

Peripheral Control and Timing Facility Interface (PCTFI)

A proprietary physical link interface that supports the transport of 21 * 2 Mbit/s signals.

PI

Physical Interface, Plesiochronous Interface

PIR

Peak Information Rate

PJE

Pointer Justification Event

Platform

Family of equipment and software configurations that are designed to support a particular Application.

Plesiochronous Network

A network that contains multiple subnetworks, each of which is internally synchronous and operates at the same nominal frequency, but the timing of any of the subnetworks may be slightly different at any particular instant.

PLL

Phase Lock Loop

PM
Performance Monitoring - Measures the quality of service and identifies degrading or marginally operating systems (before an alarm is generated).

PMA
Performance Monitoring Application

Pointer
An indicator whose value defines the frame offset of a virtual container with respect to the frame reference of the transport entity on which the Virtual Container is supported.

POTS
Plain Old Telephone Service

PP
Pointer Processing

PPC
Pointer Processor and Cross-connect

Primary Reference Clock (PRC)
The main timing clock reference in SDH equipment.

Protection
Extra capacity (channels, circuit packs) in transmission equipment that is not intended to be used for service, but rather to serve as backup against equipment failures.

Provisioning
Assigning a value to a system parameter.

PSA
Partially Service Affecting

PSDN
Public Switched Data Network

PSF
Power Supply Filter

PSF-SIP
Power Supply Filter; originally designed for an Italian customer.

PSN
Packet-Switched Network

PSTN
Public Switched Telephone Network

PT
Protected Terminal Power-supply filter and Timing circuit pack

PVID
Port VLAN ID

Q **Q-LAN**

Thin Ethernet LAN (10BaseT) that connects the manager to gateway network elements so that management information can be exchanged between network elements and management systems.

QAF

Q-Adapter Function (in NE)

QOS

Quality Of Service

Quality Level (QL)

The quality of the timing signal(s) that are provided to clock a network element. The level is provided by the Synchronization Status Marker which can accompany the timing signal. If the System and Output Timing Quality Level mode is “Enabled”, and if the signal selected for the Station-Clock Output has a quality level below the Acceptance Quality Level, the network element “squelches” the Station-Clock Output Signal, which means that no signal is forwarded at all. Possible levels are: - PRC (Primary Reference Clock) - SSU_T (Synchronization Supply Unit - Transit) - SSU_L (Synchronization Supply Unit - Local) - SEC (SDH Equipment Clock) - DUS (Do not Use for Synchronization).

R **RA**

Regenerator Application

Radio Protection Switching system (RPS)

The main function of the RPS is to handle the automatic and manual switching from a main channel to a common protection channel in an N+1 system.

Radio Relay (RR)

A point-to-point Digital Radio system to transport STM-1 signals via microwaves.

RCU

Rigid Connect Unit

RCVR Data Distribution Unit (RCVR)

Radio Relay circuit pack that distributes of the protection channel and the low-priority traffic in the receiver side.

RDDU

RCVR Data Distribution Unit

RDI

Remote Defect Indicator. Previously known as Far End Receive Failure (FERF).
An indication returned to a transmitting network element that the receiving network element has detected an incoming section failure.

RDI

Ring Drop/Insert (Add-Drop)

RDSV
Running Digital Sum Violations

Receive-direction
The direction towards the cross-connect.

REGEN
Regenerator

Regenerator Loop
Loop in a network element between the Station Clock Output(s) and one or both Station Clock Inputs, which can be used to dejitterize the selected timing reference in network applications.

Regenerator Overhead Controller (ROC)
SLM circuit pack that provides user access to the SDH overhead channels at repeater sites.

Regenerator Section Termination (RST)
Function that generates the Regenerator Section Overhead (RSOH) in the transmit direction and terminates the RSOH in the receive direction.

REI
Remote Error Indication. Previously known as Far End Block Error (FEBE).
An indication returned to the transmitting node that an errored block has been detected at the receiving node. A block is a specified grouping of bits.

Relay Unit (RU)
Radio Relay circuit pack whose main function is to perform protection switching when the Alignment Switch in the demodulator unit is unable to perform protection switching.

Restore Timer
Counts down the time (in minutes) during which the switch waits to let the worker line recover before switching back to it. This option can be set to prevent the protection switch continually switching if a line has a continual transient fault. This field is greyed out if the mode is non-revertive.

Revertive Switching
In revertive switching, there is a working and protection high speed line, circuit pack, etc. When a protection switch occurs, the protection line, circuit pack, etc. is selected. When the fault clears, service reverts back to the original working line.

RF
Radio Frequency

RFI
Remote-Failure Indicator

RGU
ReGenerator Unit

Route
A series of contiguous digital sections.

RPS
Ring Protection Switching

RSM
Remote Switching Module

RSOH
Regenerator-Section OverHead; part of the SOH.

RZ
Return to Zero

S

SA
Service Affecting Synchronous Adapter

SAI
Station Alarm Interface

SC
Square coupled Connector

SD
Signal Degrade

SDH
Synchronous Digital Hierarchy. Definition of the degree of control of the various clocks in a digital network over other clocks.

SDH-TE
SDH - Terminal Equipment

SEC
SDH Equipment Clock

Section
A transport entity in the transmission media layer that provides integrity of information transfer across a section layer network connection by means of a termination function at the section layer.

Section Adaptation (SA)
Function that processes the AU-pointer to indicate the phase of the VC-3/4 POH relative to the STM-N SOH and assembles/disassembles the complete STM-N frame.

Section Overhead (SOH)
Capacity added to either an AU-4 or to an assembly of AU-3s to create an STM-1. Always contains STM-1 framing and can contain maintenance and operational functions. SOH can be subdivided into MSOH (multiplex section overhead) and RSOH (regenerator section overhead).

SEF
Support Entity Function (in NE)

Self-healing
A network's ability to automatically recover from the failure of one or more of its components.

Server
Computer in a computer network that performs dedicated main tasks that require generally sufficient performance. See also Client.

Service
The operational mode of a physical entity that indicates that the entity is providing service. This designation will change with each switch action.

Severely Errored Frame Seconds (SEFS)
A performance monitoring parameter.

Severely Errored Second (SES)
A second that has a binary error ratio. SES is used as a performance monitoring parameter.

Severity
See Alarm Severity

SH
Short Haul

SI
Synchronous Interface

SIB
Subrack Interface Box

SLC
Subscriber Loop Carrier

SLM
Signal Label Mismatch

Smart Communication Channel (SCC)
An HDLC messaging channel between the SDH-TE and the 5ESS host node. Similar to the DCC messaging channels that are located in the STM-N section overhead.

SML
Service Management Level

SMN
SDH Management Network

SMS
SDH Management Subnetwork

SNC/I
SubNetwork Connection (protection) / Inherent monitoring

SNC/NI
SubNetwork Connection / Non Intrusive monitoring

SNR
Signal to Noise Ratio

Soft Windows
PC emulator package for HP platforms.

SOH
Section Overhead. Capacity added to either an AU-4 or to an assembly of AU-3s to create an STM-1. Always contains STM-1 framing and can contain maintenance and operational functions. SOH can be subdivided in MSOH (Multiplex Section OverHead) and RSOH (Regenerator Section OverHead).

SONET
Synchronous Optical Network

Space Diversity (SD)
Reception of the Radio signal via mirror effects on Earth.

SPB2M
Subrack Protection for 2 Mbit/s Board

Specification and Design Language (SDL)
This is a standard formal language for specifying (essentially) finite state machines.

SPI
SDH Physical Interface Synchronous-Plesiochronous Interface

Squelch Map
Traffic map for SLM Add-Drop Multiplexer network elements that contains information for each cross-connection in the ring and indicates the source and destination network elements for the low-speed circuit to which the cross-connection belongs. This information is used to prevent traffic misconnection in rings that have isolated network elements or segments. See also Cross-Connect Map.

SSM
Synchronization Status Marker

Standby
The operational mode of a physical entity that indicates that the entity is not providing service, but standby. This designation changes with each switch action.

Standby
The operational mode of a physical entity that indicates that the entity is not providing service but is on standby. This designation will change with each switch action.

Station Clock Input (SCI)
An external clock may be connected to a Station Clock Input.

STM
Synchronous Transport Module Building block of SDH.

STP
Spanning Tree Protocol

STVRP
Spanning Tree with VPN Registration Protocol

System Administrator
A user an application with System Administrator privileges. See also User Privilege.

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