



7450 Ethernet Service Switch 7750 Service Router

Releases up to 24.3.R2

Triple Play Service Delivery Architecture Advanced Configuration Guide for MD CLI

3HE 20811 AAAA TQZZA
Edition: 01
July 2024

Nokia is committed to diversity and inclusion. We are continuously reviewing our customer documentation and consulting with standards bodies to ensure that terminology is inclusive and aligned with the industry. Our future customer documentation will be updated accordingly.

This document includes Nokia proprietary and confidential information, which may not be distributed or disclosed to any third parties without the prior written consent of Nokia.

This document is intended for use by Nokia's customers ("You"/"Your") in connection with a product purchased or licensed from any company within Nokia Group of Companies. Use this document as agreed. You agree to notify Nokia of any errors you may find in this document; however, should you elect to use this document for any purpose(s) for which it is not intended, You understand and warrant that any determinations You may make or actions You may take will be based upon Your independent judgment and analysis of the content of this document.

Nokia reserves the right to make changes to this document without notice. At all times, the controlling version is the one available on Nokia's site.

No part of this document may be modified.

NO WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF AVAILABILITY, ACCURACY, RELIABILITY, TITLE, NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IS MADE IN RELATION TO THE CONTENT OF THIS DOCUMENT. IN NO EVENT WILL NOKIA BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO SPECIAL, DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL OR ANY LOSSES, SUCH AS BUT NOT LIMITED TO LOSS OF PROFIT, REVENUE, BUSINESS INTERRUPTION, BUSINESS OPPORTUNITY OR DATA THAT MAY ARISE FROM THE USE OF THIS DOCUMENT OR THE INFORMATION IN IT, EVEN IN THE CASE OF ERRORS IN OR OMISSIONS FROM THIS DOCUMENT OR ITS CONTENT.

Copyright and trademark: Nokia is a registered trademark of Nokia Corporation. Other product names mentioned in this document may be trademarks of their respective owners.

© 2024 Nokia.

Table of contents

List of tables.....	4
List of figures.....	5
Preface.....	7
BNG Dual-Homing with EVPN VPWS in the Access Network and SRv6 Transport.....	8
Diameter Base Protocol: Establishing a Diameter Peer Connection.....	288
L2TP for Subscriber Access — LAC.....	301
Vport-Based Load Balancing on a LAG.....	350

List of tables

Table 1: SRv6 endpoint behaviors.....	14
Table 2: L2TPv2 header fields and descriptions.....	304
Table 3: AVP header fields and descriptions.....	305
Table 4: Generic L2TP RADIUS attributes.....	311
Table 5: Nokia specific L2TP RADIUS attributes.....	311
Table 6: Subscriber association with Vports.....	354
Table 7: Vport distribution over member ports.....	370
Table 8: Vport distribution over member ports.....	377

List of figures

Figure 1: Example topology.....	10
Figure 2: DHCP pool synchronization in access-driven mode.....	12
Figure 3: SRv6 SID.....	13
Figure 4: Separation of routing domains.....	15
Figure 5: Optimal traffic flow during network failures.....	16
Figure 6: Suboptimal traffic flow during network failure.....	17
Figure 7: Static SRv6 policy paths.....	18
Figure 8: Baseline traffic flow.....	19
Figure 9: Access port failure.....	20
Figure 10: Network port failure.....	22
Figure 11: Diameter protocol stack.....	289
Figure 12: Diameter network topology.....	289
Figure 13: PPP access architectures.....	302
Figure 14: Supported L2TP reachability options.....	303
Figure 15: RADIUS triggered tunnel/session setup without LNS renegotiation.....	307
Figure 16: RADIUS triggered tunnel/session setup with LNS renegotiation.....	308
Figure 17: Running multiple PPP sessions over a single L2TP tunnel.....	309
Figure 18: PPP user-initiated release/terminate.....	309
Figure 19: L2TP tunnel and session state diagram.....	310
Figure 20: Base router hosted LAC with single endpoint/single tunnel.....	313
Figure 21: Base router hosted LAC with multiple endpoints.....	314

Figure 22: VRF hosted LAC.....	315
Figure 23: RADIUS returns L2TP tunnel group.....	317
Figure 24: LUDB returns L2TP tunnel group.....	318
Figure 25: L2TP keepalive mechanism.....	340
Figure 26: Floating peers accept.....	343
Figure 27: Floating peers ignore.....	343
Figure 28: Floating peers reject.....	344
Figure 29: Vport concept.....	351
Figure 30: Example topology.....	353
Figure 31: Vport bandwidth distribution.....	357

Preface

About This Guide

Each Advanced Configuration Guide is organized alphabetically and provides feature and configuration explanations, CLI descriptions, and overall solutions. The Advanced Configuration Guide chapters are written for and based on several Releases, up to 24.7.R2. The Applicability section in each chapter specifies on which release the configuration is based.

The Advanced Configuration Guides supplement the user configuration guides listed in the 7450 ESS, 7750 SR, and 7950 XRS Guide to Documentation.

Audience

This manual is intended for network administrators who are responsible for configuring the routers. It is assumed that the network administrators have a detailed understanding of networking principles and configurations.

BNG Dual-Homing with EVPN VPWS in the Access Network and SRv6 Transport

This chapter describes BNG dual-homing with EVPN VPWS in the access network and SRv6 transport.

Topics in this chapter include:

- [Applicability](#)
- [Overview](#)
- [Configuration](#)
- [Conclusion](#)
- [Appendix](#) with configuration files

Applicability

The information and configuration in this chapter is based on SR OS Release 22.10.R1. The feature described in this chapter applies to all FP4 and above based SR systems; it is not supported on VSR.

Enhanced subscriber management (ESM) is prerequisite knowledge. This chapter can serve as an SRv6 primer for subscriber management users who are less familiar with this technology.

Overview

Segment routing over IPv6 dataplane (SRv6) is a technology that supports overlay network designs over a single dataplane protocol (IPv6). The size of an IPv6 address (128 bits) is large enough to carry more information than only the addressing of interfaces on a network device. SRv6 allows for additional information so that an IPv6 address can encode functions that extend beyond simple node reachability information. Mature routing protocols (IGP and BGP) with proven fast rerouting mechanisms continue to be used to disseminate SRv6 information across the networks. The mix of those fast-rerouting mechanisms, SRv6, and synchronized subscribers in dual-homed environment enhanced subscriber management with multi-chassis synchronization (ESM MCS) results in simplified and robust access networks that benefit service providers and their customers.

This chapter describes an example topology with:

- redundant BNGs
- synchronized subscribers
- an SRv6-based network providing access to the subscribers
- routing on the core side where the cost of advertised subscriber routes depends on the forwarding state—specifically, the subscriber routed redundancy protocol (SRRP) state—in the access network



Note: Although SRv6 is the transport technology described in this chapter, SRv6 is not a prerequisite for active/standby BNG with EVPN VPWS in the access network. Multi-chassis BNG redundancy can be realized with a variety of other transport technologies in the access network.

This chapter provides integrated configuration content for BNG and SRv6.

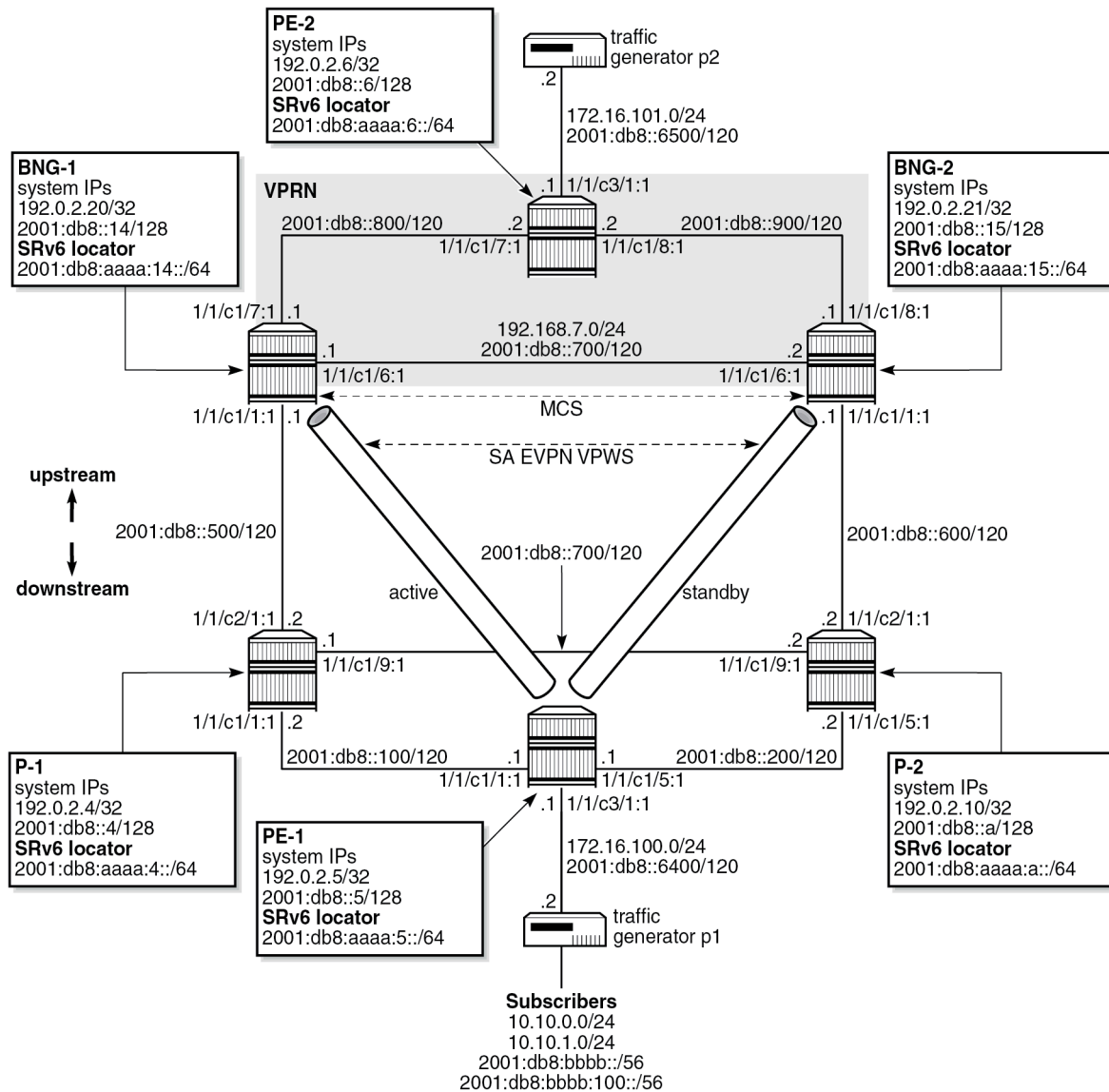
Figure 1: Example topology shows the example topology used throughout this chapter. The terminology is as follows:

- The access network refers to all nodes downstream of the BNGs, including the interfaces and SAPs on the BNGs connected to that part of the network.
- The core part of the network refers to all nodes upstream of the BNGs, including the interfaces and SAPs on the BNGs connecting them to that part of the network.
- The term "EVPN VPWS" is used interchangeably with "Epipe" because the EVPN VPWS deployed in the access network is configured in SR OS nodes as an Epipe.



Note: Although terms such as "active or standby subscriber" or "active or standby node" are commonly used in redundant BNG topologies and may occasionally be used within this document, it is important to state that subscribers and nodes do not have redundancy states, such as "active" or "standby". Only SRRP has states that are here referred to as "active" and "standby".

Figure 1: Example topology



38345

At a high level, the topology in [Figure 1: Example topology](#) can be described in terms of access-related configuration, subscriber-related configuration, and core-related configuration.

Access-related configuration

- Subscribers are connected to the first-mile access node (PE-1), which is dual-homed to the two BNGs (BNG-1 and BNG-2).
- Pseudowire (PW) ports on the two BNGs are part of an Ethernet segment (ES) configured in single-active (SA) mode in the EVPN VPWS multihoming (MH) environment.
- The EVPN transport technology in the access network is SRv6.

Subscriber-related configuration

- There are 10 IPoE and 10 PPPoE dual-stack sessions terminated on a PW-SAP in a VPRN on both BNGs.
- Each IPoE and PPPoE session has an IPv4 address, a DHCPv6 identity association for non-temporary addresses (IA-NA), and a DHCPv4 identity association for prefix delegation (IA-PD) addresses. IA-PD addresses are modeled as managed routes with IPv6 next hops.
- Each session is mapped to a separate subscriber.
- Subscriber sessions are synchronized between the two BNGs. A fully synchronized model offers redundancy protection with minimal loss during network outages.
- DHCPv4/v6 servers are instantiated on the BNGs and their pools are synchronized, except for DHCPv4 pools used for internal address assignment to PPPoEv4 sessions. IPv4 addresses for PPPoEv4 sessions are synchronized in DHCPv4 pools through PPPoE session synchronization and not directly through DHCP pools.
- The SRRP state is indirectly derived from the state of the dual-homed EVPN ES in the access network and does not rely on exchange of SRRP keepalive messages between the two BNGs.
- A redundant interface between the two BNGs provides a temporary path for subscriber traffic while the network is converging during switchovers.

Core-related configuration

- A VPRN with SRv6 transport is deployed in the core.
- SRRP-aware routing on the core side ensures that the core traffic follows the BNG with the active SRRP instance. In other words, traffic in both directions (upstream and downstream) is attracted to one BNG or the other based on the SRRP state.

The example topology provides protection against failures of network elements in the access and core networks, including the BNGs themselves.

Subscriber traffic is run between two ports of a traffic generator. For topology verification purposes, network failures are purposefully introduced and their effect on the subscriber traffic is examined.

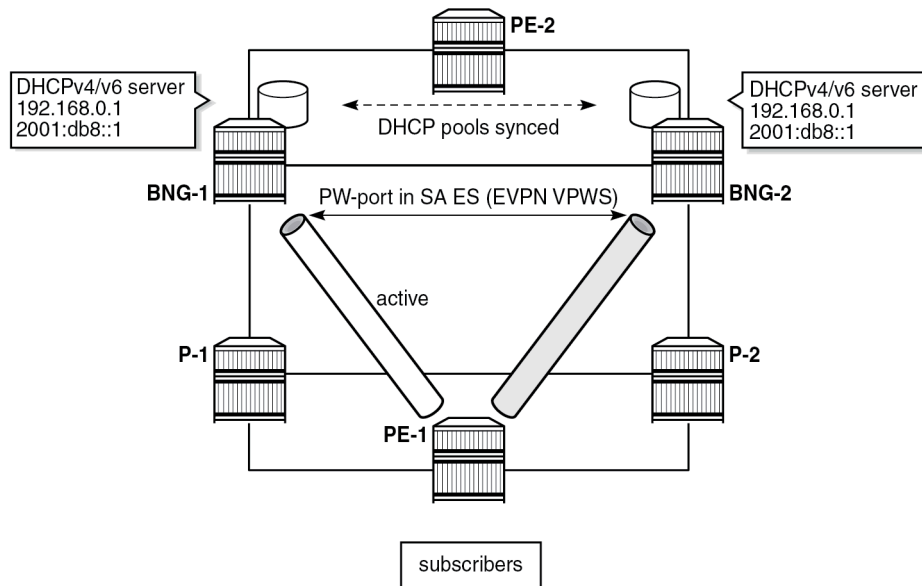
Subscriber synchronization

The subscriber state is synchronized between the two BNGs, including DHCPv4/v6 lease state and PPPoEv4/v6 states.

DHCPv4/v6 pools on the local DHCP servers in both BNGs are synchronized in access-driven mode (except for the pools used for internal IP address allocation to PPPoEv4, which are synchronized indirectly through PPPoE session synchronization). In access driven mode, the DHCPv4/v6 servers in each BNG are configured identically and are attached to an interface with the same IP address. Both servers can allocate IP addresses at any time; however, to prevent duplication of IP addresses, access to only one server is allowed at any given time. This restriction is achieved through the redundancy model, which relies on the SA mode of operation on the ES coupled with SRRP.

[Figure 2: DHCP pool synchronization in access-driven mode](#) shows a topology using the redundancy model, where subscribers have access only to BNG-1 via EVPN VPWS multihoming. The path of the EVPN VPWS on the left side is active while the path on the right side is standby.

Figure 2: DHCP pool synchronization in access-driven mode



38349

SRv6

This section provides a brief introduction to SRv6. For more information about SRv6, refer to the "Segment Routing over IPv6" chapter in the *7750 SR and 7950 XRS Segment Routing and PCE Advanced Configuration Guide for Classic CLI* and "EVPN VPWS Services with SRv6 Transport" chapter in the *7450 ESS, 7750 SR, and 7950 XRS Layer 2 Services and EVPN Advanced Configuration Guide for MD CLI* and to the *7750 SR and 7950 XRS Segment Routing and PCE User Guide*.

SRv6 allows for more flexible network management over a single IPv6 dataplane protocol, using the following concepts:

- traffic engineering, where traffic is securely steered through pre-selected network nodes on its way to the destination
- network programmability, which includes encoding higher-level functions (such as service identification) into the IPv6 address

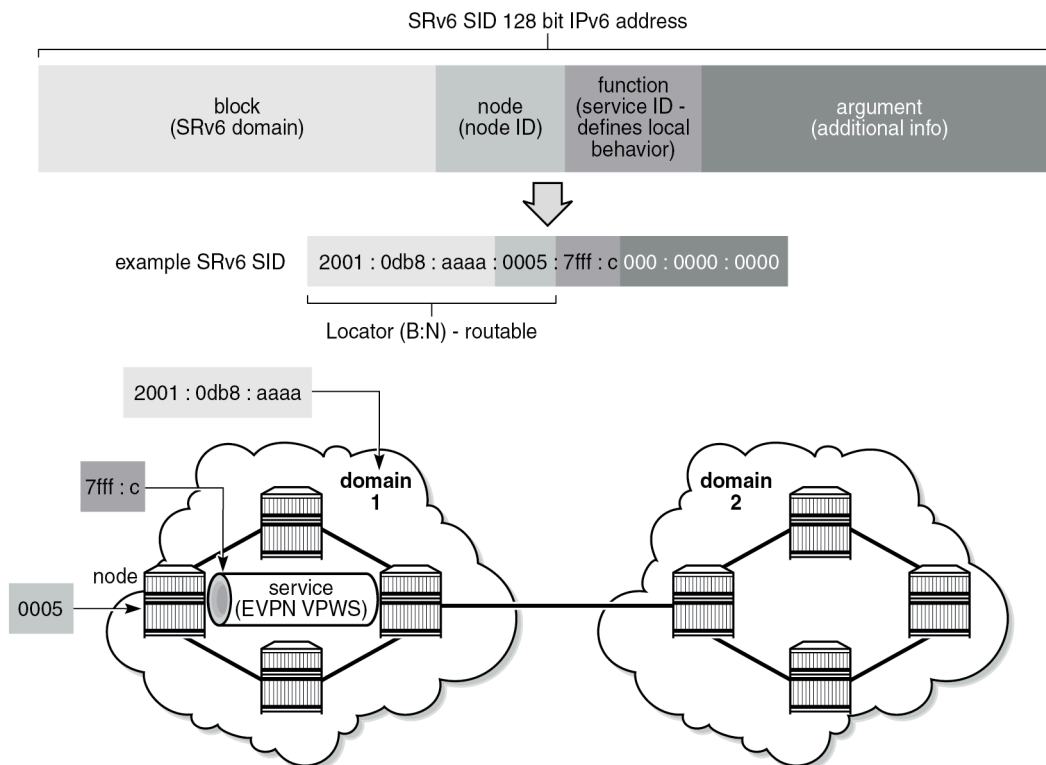
At the dataplane level, SRv6-based traffic steering is implemented with the help of a routing extension header, called a segment routing header (SRH). Each application typically provides its own type of the routing header, as is the case here, with inherent support for security.

The SRH contains a list of segments, each of which has a unique segment identifier (SID), through which a packet is steered as it transits the network on its way to the destination. These segments may be nodes, adjacencies, bindings to downstream tunnels, and so on. Each node that owns a SID in the SRH needs to intercept the SRv6 packet for inspection and consequently update the IPv6 header. Transit nodes that are not in the SRH list do not intercept SRv6 packets because the packet is not addressed to them. Such transit nodes forward the packet to the destination based on a lookup of the destination address (DA) in the outer IPv6 header.

As well as identifying specific segments via IPv6 addresses in SRv6, SIDs carry additional information beyond node reachability. This additional information instructs the target node how to map arriving IPv6 packets to a service. For example, a SID can be an IPv6 address that, in addition to carrying the address of the target node (SRv6 prefix or a locator), also carries specific EVPN VPWS information. This additional information is interpreted at the target node as “extract the payload of this packet and process it in the context of EVPN Epipe ID=10”. In this way, an arriving IPv6 packet is directly mapped into the corresponding service based on the IPv6 address, without the need for additional transport protocols such as MPLS with its VC labels.

Figure 3: SRv6 SID shows the SID structure, where the length of the fields is configurable.

Figure 3: SRv6 SID



38386

To differentiate between SIDs used in plain routing and the higher level SIDs that are used with services (such as EVPN and VPRN), the SIDs are sometimes referred to as transport SIDs and service SIDs. SIDs are advertised in routing protocols through segment routing extensions. Nokia SR OS supports such extensions in IS-IS for transport-related SIDs and in BGP for Layer 2 and Layer 3 service-related SIDs.

SIDs are an integral part of routing in SRv6, but SIDs are not interface addresses; SIDs are configured and allocated in respective **segment-routing-v6** contexts (outside of the interface configuration) to the Base router and service to which they pertain.

As **Figure 3: SRv6 SID** shows, the block and the node form a locator field in the SID. The locator field is used for node reachability in basic destination-based routing. Typically, a node advertises IPv6 prefixes matching the locator function of its SIDs. In SR OS, when the locator prefix is advertised in IS-IS, it is encoded in an SRv6 Locator Sub-TLV, which is an SRv6 extension in IS-IS. A node can advertise multiple locators simultaneously (for example, one locator per Flexible-Algorithm).

The block part of the locator defines an SRv6 domain. In an SRv6 domain, nodes share the same block prefix. SRv6 domains can be considered as administrative units that can be formed based on geography or some other logical entity, such as enterprise VPN. The node part of the locator is unique to each node.

The function part of the locator defines a local behavior on the node that owns the SID. Specific functions that can be associated with SIDs are described in RFC 8986 and RFC 8402. The End and End.X functions are used by IS-IS to create repair tunnels and backup paths (topology-independent loop-free-alternate (TI-LFA) and remote LFA). The combination of TI-LFA and remote LFA provides full coverage of any access network. The End function represents the node prefix which is reachable based on the shortest path. The End.X function represents links between the nodes (these links are router adjacencies which can be local or remote) and is used to specify the router adjacency (for example, for strict mode routing) out of which the frame is forwarded. Together, the End and End.X functions are used to install optimal and loop-free backup paths in the forwarding plane with achievable failover times of less than 50 ms.

The table [Table 1: SRv6 endpoint behaviors](#) shows the functions used in this chapter:

Table 1: SRv6 endpoint behaviors

Function	Description	Advertised in
End	SRv6 instantiation of a node SID	IS-IS SRv6 End SID sub-TLV
End.X	SRv6 instantiation of an adjacency SID	IS-IS SRv6 End.X SID sub-TLV
End.DX2	decapsulation and L2 cross-connect (L2VPN)	EVPN VPWS AD per-EVI route
End.DT4	decapsulation and specific IPv4 table lookup (IPv4-L3VPN)	BGP
End.DT6	decapsulation and specific IPv6 table lookup (IPv6-L3VPN)	BGP
End.B6.Encap.Red	function bound to an SRv6-policy with reduced encapsulation	N/A

The argument field is optional, and it can carry additional information related to the local function. It is set to 0 in SR OS.

Routing

IS-IS is used as IGP to disseminate node reachability information (the node's interface routes, BGP next hops, SRv6 locators, and node and adjacency SIDs), while BGP is used to disseminate SRv6 service SIDs and VPN and EVPN routes.

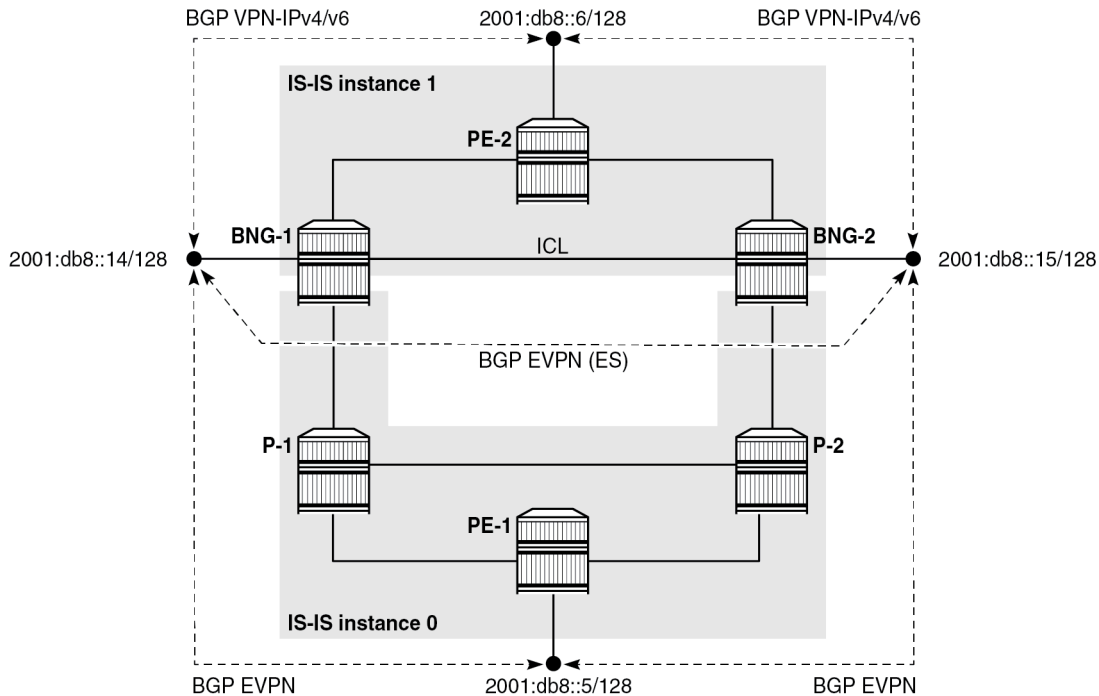
As shown in [Figure 4: Separation of routing domains](#), IS-IS is segmented into two instances:

- IS-IS instance 0 runs in the access network
- IS-IS instance 1 runs in the core part of the network, including the inter-chassis link (ICL) between the two BNGs

The system IPv6 addresses are included in both instances. There is no route exchange between the two IS-IS instances.

IPv6 BGP peering is established directly (with no route reflector) between the service endpoints with respective BGP address families, as shown in [Figure 4: Separation of routing domains](#). IPv6 BGP peering is not a prerequisite and IPv4 BGP peering would work just as well.

Figure 4: Separation of routing domains

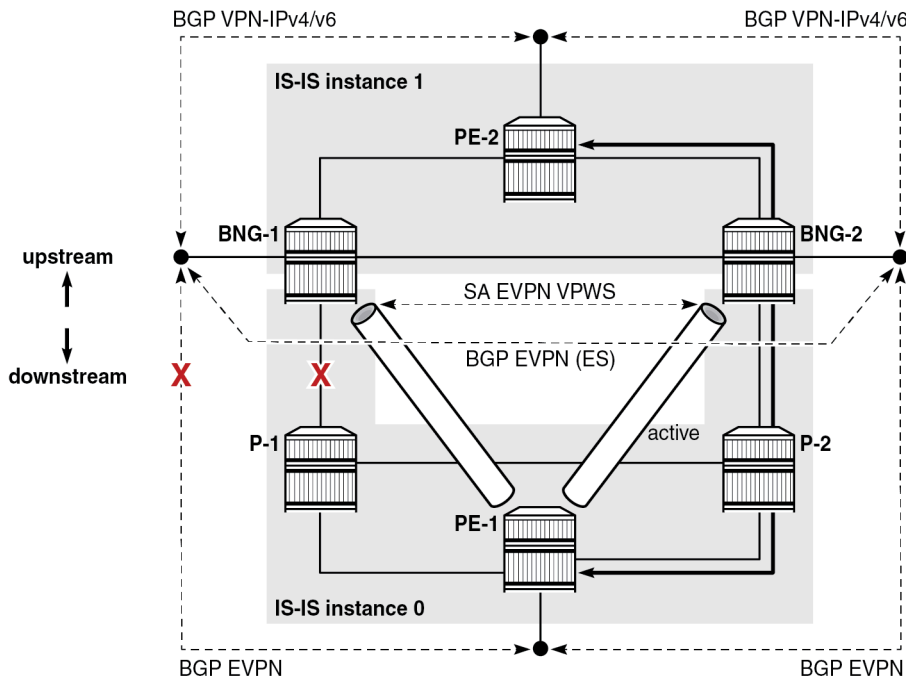


38346

The ICL must be highly redundant but does not need to support high bandwidth. Its use is typically limited to subscriber synchronization and to shunt data traffic between BNGs during transient network conditions while the network reconverges during switchovers. For cost reductions, it may not be desirable to dimension this ICL to carry all subscriber traffic during prolonged periods of network failures. To minimize the use of ICL for data traffic, the topology shown in [Figure 4: Separation of routing domains](#) relies on the separation of IS-IS routing domains between the access network and the core network, as described in the [Examining failovers](#) section. The hard separation of IS-IS routing domains is not a prerequisite or the only design option, but rather an arbitrary choice used in this chapter.

When the link between the nodes BNG-1 (with the active SRRP) and P-1 fails, the PE-1 BGP next hop becomes unreachable on BNG-1 because of the separation of IS-IS routing domains, which causes the active EVPN VPWS between BNG-1 and PE-1 to switch over to BNG-2. The switch to BNG-2, combined with SRRP-aware routing on the core side, ensures that the use of ICL is limited to transient conditions while routing is converging during the failure. [Figure 5: Optimal traffic flow during network failures](#) shows the steady state traffic path after the network has converged: the path from PE-1 to PE-2 via P-2 and BNG-2.

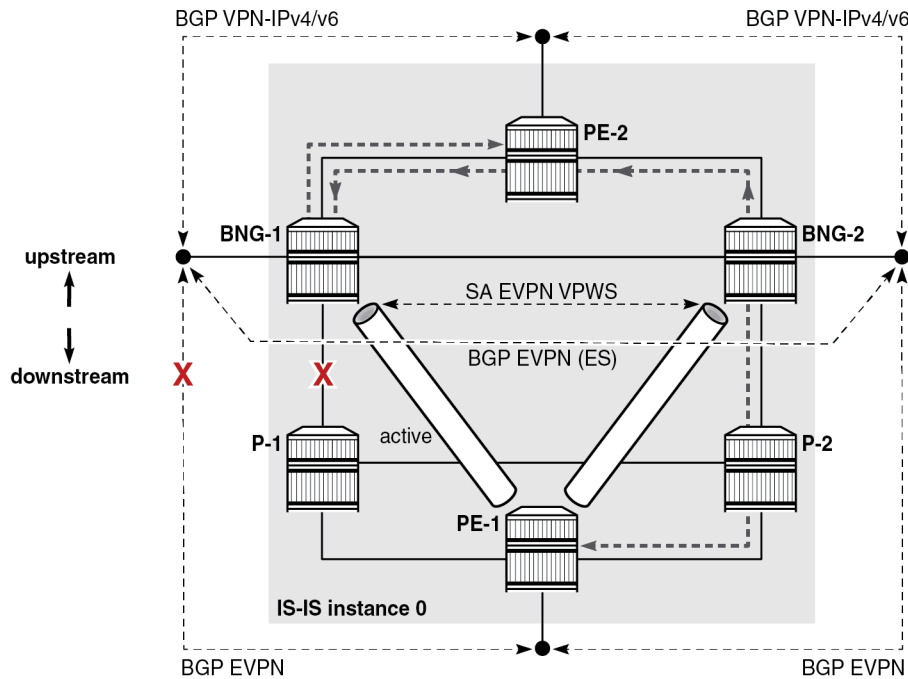
Figure 5: Optimal traffic flow during network failures



38347

In an alternative design where all nodes are in the same IS-IS routing instance 0, the PE-1 node continues to be reachable from BNG-1 (via BNG-2 or PE-2) even after the access link on BNG-1 fails. As a result, BNG-1 remains the designated forwarder (DF) for the ES and SRRP on BNG-1 remains in the active state. This causes traffic in both directions to take a path over the ICL link or even to cross some of the core links twice, as shown in [Figure 6: Suboptimal traffic flow during network failure](#). Traffic from PE-1 goes via P-2 to BNG-2, which sends the traffic to DF BNG-1 via PE-2 (the ICL is not used). BNG-1 forwards the traffic (back to) PE-2.

Figure 6: Suboptimal traffic flow during network failure



38348

IPv4 addressing

Subscriber traffic in the overlay network utilizes both IPv4 and IPv6 address families, as part of dual-stack configuration. Comparatively, the underlay network is based on SRv6, with the advantage that IPv4 addressing is no longer needed.

Therefore, in the example topology, IPv4 addresses in the underlay network are removed from most interfaces. There are a few exceptions where local IPv4 addresses are kept, but without advertising them into the network, which means that routing protocols in the underlay network remain free of IPv4 addresses.

The following are exceptions where IPv4 addresses in the underlay network are still used:

- System IPv4 addresses are still used locally on each node for legacy reasons where some functionalities may still require it. For example, in EVPN VPWS multihoming, an IPv4 system address is required to derive the route distinguisher (RD) for the ES route (even if static RD for the EVPN VPWS is configured).
- Multi-chassis synchronization (MCS) peering between the two nodes is supported only over IPv4 addresses. For the MCS peering, the system IP addresses of the BNGs are used, with static routes over the IPv4 next hops configured on the direct link between the two BNG nodes. Because this link directly connects the two BNGs, no advertisement of the IPv4 prefix is required.
- The **redundant-interface** command under the BNG **group-interface** context also requires IPv4 addressing. Those IPv4 addresses are also not advertised into the network.

SRv6 policy

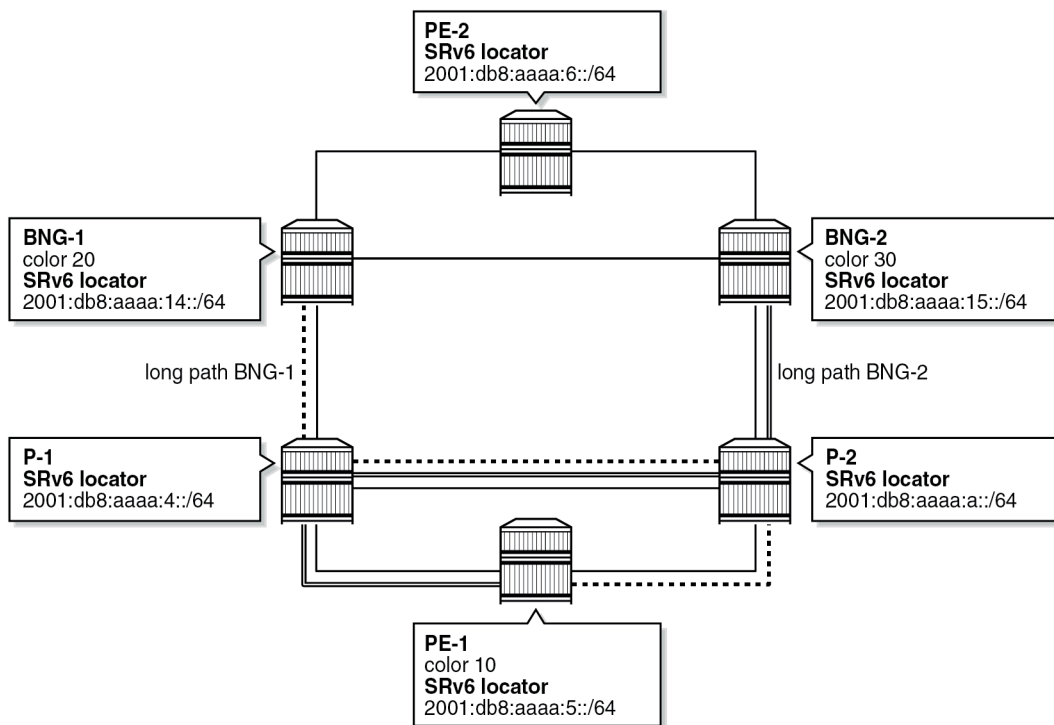
For illustrative purposes, the example uses a static SR policy of type SRv6 in the access network. This SR policy is configured with segment list entries, which are node SIDs that are to be visited on the way to the final destination.

The SR policy is treated as a routing entity whose configured endpoint is installed as an entry in the tunnel table. The SR policy becomes the protocol owner of such an entry in the routing or tunnel table. The tunnel entry can be used for BGP next-hop resolution.

Configuring hops in the SR policy triggers the generation of an SRH, which is further described in the [Configuration](#) section.

The SR policy in the example steers traffic onto a longer path, despite a shorter path with lower cost being available. This behavior is shown in [Figure 7: Static SRv6 policy paths](#) where traffic from the BNGs to PE-1, and vice versa, always flows through both P-1 and P-2.

Figure 7: Static SRv6 policy paths



38353

Examining failovers

The configuration used in this chapter has been tested by running traffic and incurring network failures at various points. Traffic was monitored after the failures to ensure the traffic was flowing through a predicted path.

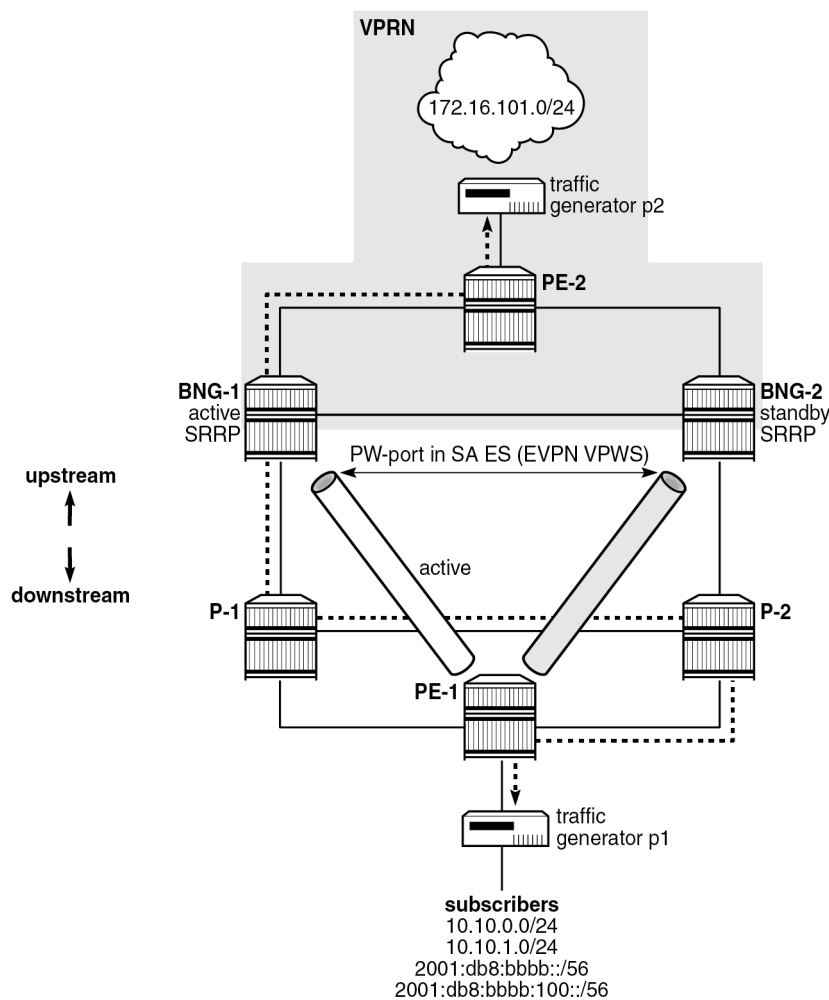
Traffic is run bidirectionally between two ports on a traffic generator, representing the subscribers on the 10.10.x.x networks and the Internet on the 172.16.101.x network.

BNG-1 advertises subscriber IPv4 and IPv6 subnets into the core network (VPRN) with lower cost than BNG-2, because SRRP is active on BNG-1 and standby on BNG-2.

In the access network, the ES in EVPN VPWS on BNG-1 is selected as DF due to a higher preference.

Traffic through the access network is steered by the SRH, which is inserted by the static SR policy configured on both BNGs and PE-1. In the upstream direction, traffic follows the path depicted in [Figure 8: Baseline traffic flow](#): from traffic generator port 1 via PE-1, P-2, P-1, BNG-1, and PE-2 to traffic generator port 2. Downstream traffic follows the same path in reverse direction.

Figure 8: Baseline traffic flow



38350

Three switchovers are examined:

- switchover due to failure of the link between BNG-1 and P-1
- switchover due to failure of the network link connecting BNG-1 to PE-2

- switchover due to failure of the entire BNG-1 node

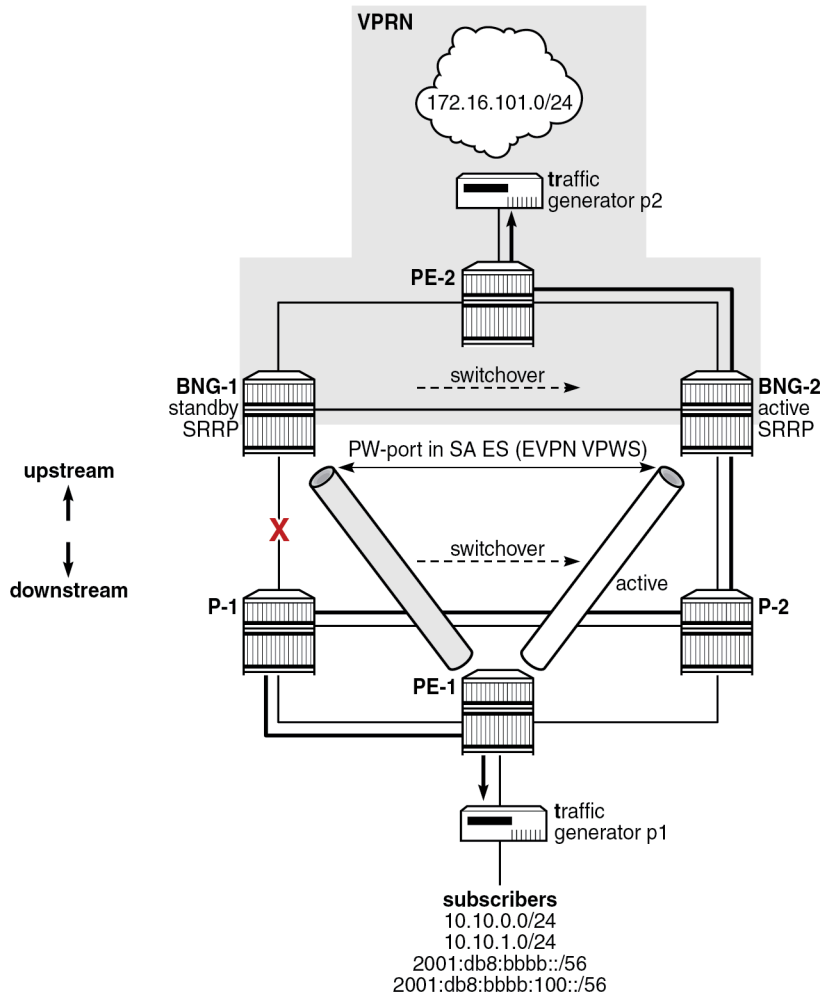
In all three cases, the failover time depends on the failure detection speed and convergence of the routing protocols. Nokia encourages operators to run performance-related tests, which includes measuring failover times, in their own test environment on service routers with Nokia native hardware (non-server based service routers).

Failure detection speed can, in some cases, be improved by bi-directional forwarding detection (BFD). In the example topology, BFD is configured for detection of BGP peer failures.

Switchover caused by the failure of the access link on BNG-1

Figure 9: Access port failure shows a switchover scenario where the access port on BNG-1 toward P-1 is disabled and all traffic is diverted to BNG-2 as indicated. The traffic detour over the link between P-1 and P-2 is taken because the static SR policies favor longer paths over shorter.

Figure 9: Access port failure



38351

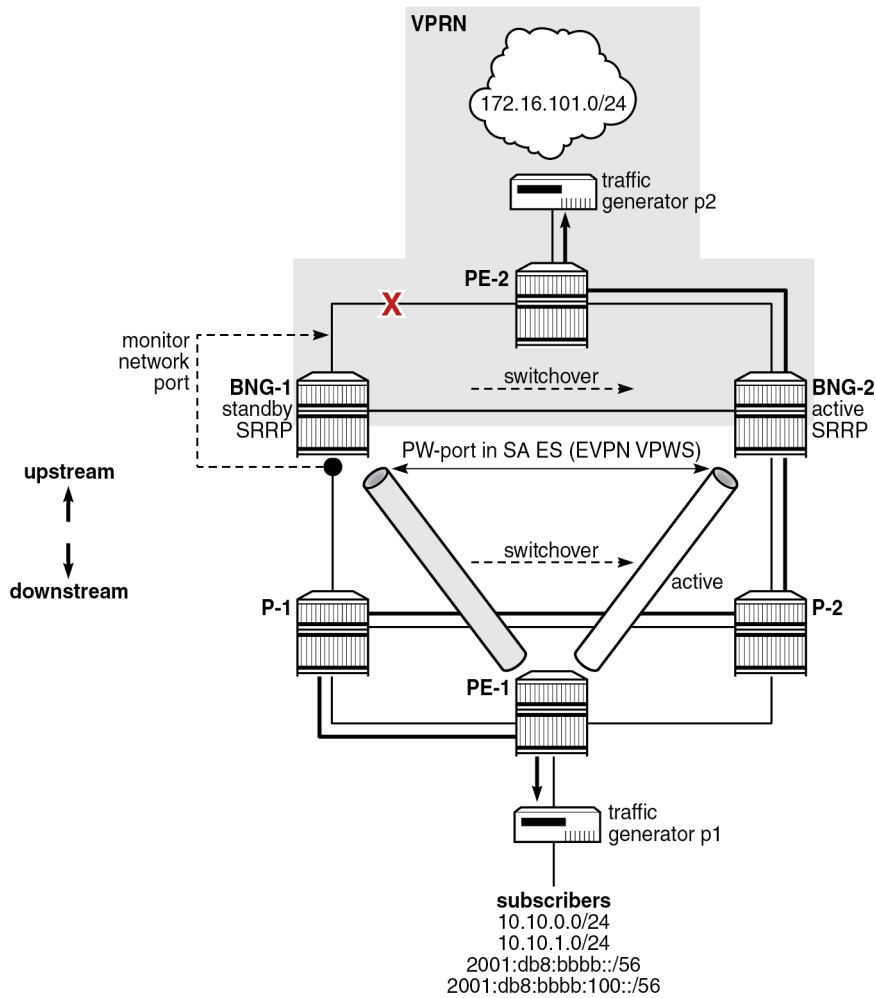
The following events trigger the traffic switchover from BNG-1 to BNG-2:

- When the access port on BNG-1 is disabled, the BGP peering connection between BNG-1 and PE-1 is lost because of the separation of IS-IS routing domains. The BGP connection is required for the advertisement of the overlay EVPN routes.
- On BNG-1, the speed of detecting the BGP connection failure is locally driven by the speeds of the link loss detection and the consequent IS-IS algorithm that is run to determine that an alternate path to the BGP peer (PE-1) does not exist.
- On PE-1, the speed of detecting the BGP connection failure is driven by the speed of IS-IS link state advertisement (LSA) propagation.
- The severed BGP connection between BNG-1 and PE-1 triggers the DF election process on the ES between the two BNGs, which is driven by BGP. BNG-2 is selected as the DF and BNG-1 as the non-DF.
- The newly elected DF on BNG-2 performs the following actions:
 - It activates EVPN VPWS toward PE-1 so that traffic can be sent to it and be received from it. (More explicitly, it advertises an Auto-Discovery route with the Primary flag (P-bit) set to 1 to indicate that it is active, and the Backup flag (B-bit) set to zero.)
 - It triggers activation of SRRP on BNG-2 (but does not activate it). SRRP continues to run through its own state machine, which involves waiting for three times the SRRP transmit interval (SRRP keepalive messages) before it becomes active. Due to this delay in becoming active, it is still important to have a short SRRP transmit interval configured under SRRP, even if SRRP keepalive messages are not exchanged between the two BNGs, as in this example. In other words, SRRP activation is driven by the DF outcome of the EVPN ES election process, which then triggers the SRRP activation process with its own state machine.
- PE-1 does not wait for the BGP update from BNG-2 that contains the new DF decision. PE-1 activates the stored backup route from BNG-2 as soon as it realizes, via IS-IS, that the BGP connection to BNG-1 is lost.
- Lastly, the activation of SRRP on BNG-2 triggers the advertisement of subscriber routes into the core with a lower cost than that advertised by BNG-1. After the core network converges, traffic in the downstream direction is diverted from the link between PE-2 and BNG-1 to the link between PE-2 and BNG-2. While the routing is converging, traffic in the downstream direction might be flowing from BNG-1 to BNG-2 through the redundant interface (over the ICL) between the two BNGs.

Switchover caused by the network link failure between BNG-1 and PE-2

In [Figure 10: Network port failure](#), the port on BNG-1 toward PE-2 is disabled, which results in a switchover due to the network link failure between BNG-1 and PE-2. All traffic is diverted to BNG-2. The traffic detour over the link between P-1 and P-2 is taken because of the static SR policies on BNGs and PE-1.

Figure 10: Network port failure



38352

A failure of the core link on BNG-1 diverts downstream traffic to BNG-2 in the core network, which uses VPRN. But in the access network, which uses EVPN, traffic still flows through BNG-1, which remains the DF on EVPN ES and where SRRP is active. To prevent a scenario where the inter-chassis link is used to carry traffic between the two BNGs during the failure, a feedback loop from the core port to the access port is required. In this way, the state change of the core port is reflected in the access port and, as result, traffic is completely diverted from BNG-1 to BNG-2. This feedback loop is implemented through an operational group associated with a core port and monitored by the access port.

The remainder of the switchover mechanics are the same as those in the [Switchover caused by the failure of the access link on BNG-1](#) section.

Switchover caused by the BNG-1 node failure

After the loss of the BGP peering connection to BNG-1, BNG-2 becomes the DF for the EVPN ES. The BGP peering connection loss can be detected by a loss of link on BNG-2, by BFD, or by IS-IS LSA propagation.

BNG-2 becoming DF has the same effects as already described in the previous two cases.

Recovery

To restore the network to its state from before the failure, the operators have the option to revert traffic automatically to the primary paths that were available before the failure. The revertive behavior involves another switchover, which is associated with possible traffic loss. Whether to enable revertive behavior is a choice between the cost of another switchover measured by affected user experience due to a small traffic loss and the cost of keeping the traffic on backup paths which may not be optimized for such traffic.

To ensure minimal traffic loss when revertive behavior is enabled, the network must have fully converged after the recovery, before the switchover to the previous state occurs. For example, upon reboot, the recovered BNG must be fully integrated into the network; that is, all subscribers must be synchronized between the two BNGs, the BGP peering sessions must be reestablished, and routes exchanged. The synchronization between the BNGs is independent of the exchange of BGP routes and these events may occur in any sequence. For this reason, bootup timers must be configured properly to make sure that all relevant processes are completed before the switchover occurs. Bootup timers are described in the [Configuration](#) section.

Configuration

The complete configuration files for all six nodes in this example topology are provided in the [Appendix](#).

The examples in this section focus on the Forwarding Path Extension (FPE)-based PW port in multihomed EVPN environments with SRv6 transport.

The configuration shown in this section is mainly for the two nodes that represent the two endpoints of the EVPN VPWS: BNG-1 and PE-1.

The configuration blocks, together with the output of the **show** commands, cover the following topics:

- FPE
- SRv6
- IS-IS routing related to SRv6
- BGP routing related to SRv6
- EVPN VPWS (including ES and PW port) and service-related SRv6 configuration
- VPRN-related SRv6 configuration
- multi-chassis redundancy configuration
- DHCP server configuration
- subscriber management configuration

While many of these topics are described in other chapters, the purpose of this chapter is to show how they interact together.

The less important parts in the configuration blocks or the output from the **show** commands are removed for brevity.

FPE

In SR OS Release 22.10, the example setup requires three FPE-based port cross-connects (PXC) on each BNG, one for each of:

- the SRv6 origin
- the SRv6 termination
- the PW port

All three PXC are port-based and they are set up on the same port. Selecting port-based PXC in this example versus MAC- or internal-based PXC is an arbitrary choice. Either type of PXC can be used.

The PXC configuration on BNG-1 is as follows. The configuration on BNG-2 is identical. Other nodes do not have a PW port and require only two PXC for SRv6.

```
[pr:/configure port-xc]
A:admin@bng-1#
  pxc 1 {
    admin-state enable
    description "fpe srv6 origin"
    port-id 1/1/c4/1
  }
  pxc 2 {
    admin-state enable
    description "fpe srv6 termination"
    port-id 1/1/c4/1
  }
  pxc 3 {
    admin-state enable
    description "fpe pw-port"
    port-id 1/1/c4/1
  }
}
```

The logical PXC ports are configured as follows:

```
[pr:/configure]
A:admin@bng-1#
  port pxc-1.a {
    admin-state enable
  }
  port pxc-1.b {
    admin-state enable
  }
  port pxc-2.a {
    admin-state enable
  }
  port pxc-2.b {
    admin-state enable
  }
  port pxc-3.a {
    admin-state enable
  }
  port pxc-3.b {
```



```
    admin-state enable
  }
}
```

The following FPE configuration is required for PW port and SRv6 configuration:

```
[pr:/configure]
A:admin@bng-1#
  fwd-path-ext {
    sdp-id-range {
      start 17500
      end 17600
    }
    fpe 1 {
      description "srv6 origination"
      path {
        pxc 1
      }
      application {
        srv6 {
          type origination
        }
      }
    }
    fpe 2 {
      description "srv6 termination"
      path {
        pxc 2
      }
      application {
        srv6 {
          type termination
        }
      }
    }
    fpe 3 {
      description "pw-port on a single port"
      path {
        pxc 3
      }
      application {
        pw-port-extension { }
      }
    }
  }
```

SRv6

SRv6 is configured on several levels:

- the base routing context level (which is the focus of this section)
- the IS-IS routing protocol level
- the services level

The static SRv6 policy is configured in the base routing context and is examined in the context of the Epipe to which it is applied.

Relevant to the example setup, the global SRv6 configuration under the base router provides:

- an SRv6 association with an FPE

- an SRv6 locator
- the source address
- the allocation and behavior of End and End.X SIDs



Note: Nokia encourages that the source address is configured at the Base routing context level. Although some entities, such as EVPN or VPRN services, provide the configuration option for the source address, other entities, such as the static SR policy, do not. In these cases, the entities inherit the source address from the global configuration provided here. Without the configured source address, SRv6 is not operational.

```
[pr:/configure router "Base" segment-routing segment-routing-v6]
A:admin@bng-1#
  origination-fpe [1]
  source-address 2001:db8::14
  locator "bng-1-loc" {
    admin-state enable
    block-length 48
    termination-fpe [2]
    prefix {
      ip-prefix 2001:db8:aaaa:14::/64
    }
  }
  base-routing-instance {
    locator "bng-1-loc" {
      function {
        end 1 {
          srh-mode usp
        }
        end-x-auto-allocate usp protection protected { }
      }
    }
  }
}
```

The following **show** command displays a summary of SRv6 on a global level:

```
A:admin@bng-1# /show router segment-routing-v6 summary
=====
Segment Routing v6
=====
Origination FPE           : 1
Source IPv6 Address       : 2001:db8::14
=====
Locator                    Admin State
  Prefix
-----
bng-1-loc                  Up
  2001:db8:aaaa:14::/64
---snip---
```

The following **show** output lists the node and adjacency SIDs:

```
A:admin@bng-1# /show router segment-routing-v6 base-routing-instance
=====
Segment Routing v6 Base Routing Instance
=====
Locator                    Status/InstId
  Type      Function    SID
  SRH-mode Protection Interface
-----
```

```

bng-1-loc
End          1 2001:db8:aaaa:14:0:1000::      ok
USP
-----
Auto-allocated End.X: USP Protected,
-----
End.X      *524287 2001:db8:aaaa:14:7fff:f000::      1
USP        Protected int-1-bng-1-pe-2
ISIS Level: L2 Mac Address: b4:a0:01:01:00:07 Nbr Sys Id: 1920.0000.2006
End.X      *524288 2001:db8:aaaa:14:8000::      0
USP        Protected int-1-bng-1-p-1
ISIS Level: L2 Mac Address: b4:9e:01:01:00:0b Nbr Sys Id: 1920.0000.2004
End.X      *524289 2001:db8:aaaa:14:8000:1000::  1
USP        Protected int-1-bng-1-bng-2
ISIS Level: L2 Mac Address: b4:98:01:01:00:06 Nbr Sys Id: 1920.0000.2021
-----
Legend: * - System allocated
    
```

The InstId field for End.X SIDs shows the IS-IS instance in which they are configured.

SRv6 locators are used for node reachability and are, through route advertisements, installed in the route tables of other nodes. For example, the following output shows the SRv6 locator of BNG-1 is installed in the IPv6 routing table of BNG-2:

```

A:admin@bng-2# /show router route-table ipv6

=====
IPv6 Route Table (Router: Base)
=====
Dest Prefix[Flags]                Type  Proto  Age      Pref
Next Hop[Interface Name]          Metric
-----
---snip---
2001:db8:aaaa:14::/64              Remote ISIS(1) 02h14m11s 18
      2001:db8:aaaa:14::/64 (tunneled:SRV6-ISIS) 20
---snip---
    
```

IS-IS routing related to SRv6

As described in the [Routing](#) section, IS-IS is split into two instances. Instance 0, as indicated by its configured interfaces, is active on the access side. Instance 1 is active on the core side, including the link between the two BNGs.

The **segment-routing-v6** section in the IS-IS configuration block references the SRv6 locator that IS-IS, together with its basic functions (node and adjacency SIDs), advertises into the network.

Some of the IS-IS configuration outside of the **isis segment-routing-v6** context is directly pertinent to SRv6. For example, the SRv6 locator is only advertised when the **wide-metrics** command is configured.

BNG-2 is configured similarly to BNG-1. P-1, P-2, and PE-1 have only IS-IS instance 0 configured, while PE-2 has only IS-IS instance 1 configured. Although only a portion of the configuration on BNG-1 is provided, the IS-IS configuration on other nodes in respective IS-IS instances is similar with different naming for interfaces and for the SRv6 locator.

Between the two IS-IS instances in BNG-1, the only configuration difference is that they reference different interfaces. In the following example, only one repeated part of the IS-IS instance 1 configuration is shown:

```

[pr:/configure router "Base"]
isis 0 {
    
```

```

admin-state enable
advertise-passive-only false
advertise-router-capability area
ipv6-routing native
level-capability 2
traffic-engineering true
area-address [49.0001]
loopfree-alternate {
    remote-lfa {
    }
    ti-lfa {
    }
}
traffic-engineering-options {
    ipv6 true
    application-link-attributes {
    }
}
segment-routing-v6 {
    admin-state enable
    locator "bng-2-loc" {
        level-capability 2
        level 2 {
            metric 10
        }
    }
}
interface "int-1-bng-2-p-2" {
}
interface "system" {
}
level 2 {
    wide-metrics-only true
}
}
isis 1 {
    ---snip---
    interface "int-1-bng-2-bng-1" {
    }
    interface "int-1-bng-2-pe-2" {
    }
    interface "system" {
    }
    ---snip---
}
    
```

The following **show** command confirms that IS-IS adjacencies in instance 1 are up. A similar command can be used for IS-IS instance 0.

```

A:admin@bng-1# /show router isis 1 adjacency

=====
Rtr Base ISIS Instance 1 Adjacency
=====
System ID                Usage State Hold Interface                MT-ID
-----
bng-2                    L2    Up    24    int-1-bng-1-bng-2                0
pe-2                    L2    Up    9    int-1-bng-1-pe-2                0
-----
Adjacencies : 2
    
```

Further SRv6-related information in IS-IS, such as exchanged locators or node SIDs, can be explored by using commands under the following hierarchy:

```
A:admin@bng-1# /show router isis 1 segment-routing-v6
```

The following **show** command lists the locators that are present in IS-IS instance 1 on BNG-1. These locators can be local or learned through IS-IS. For BNG-1, locator 2001:db8:aaaa:14::/64 is local.

```
A:admin@bng-1# /show router isis 1 segment-routing-v6 locator
```

```
=====
Rtr Base ISIS Instance 1 SRv6 Locator Table
=====
```

Prefix	AdvRtr	MT	Lvl/Typ
AttributeFlags	Tag	Flags	Algo
2001:db8:aaaa:6::/64	pe-2	0	2/Int.
-	0	-	0
2001:db8:aaaa:14::/64	bng-1	0	2/Int.
-	0	-	0
2001:db8:aaaa:15::/64	bng-2	0	2/Int.
-	0	-	0

```
-----
```

BGP peering

IBGP is used to exchange EVPN and VPRN routes between the BNGs and the edge nodes (PE-1 and PE-2). IBGP peering sessions with corresponding address families are shown in [Figure 4: Separation of routing domains](#).

In the EVPN part of the network, BGP is used between the two BNGs to elect the DF on the ES, and between the BNGs and PE-1 to exchange the reachability EVPN routes. PE-1 uses the advertised EVPN route from the BNGs to set up and activate an EVPN VPWS connection toward the active (DF) BNG.

In the VPRN, the two BNGs exchange VPN-IPv4 and VPN-IPv6 routes (subscriber and Internet routes from the traffic generator) with PE-2.

BGP is not configured on nodes P-1 and P-2.

Consider the following when configuring BGP:

- All BGP peers are IPv6 peers.
- The **advertise-ipv6-next-hops** command for the VPN IPv4 and VPN IPv6 address families must be explicitly enabled. By default, only IPv4 next hops are advertised, which in this case do not exist. The counterpart command for EVPN address family is enabled under the **bgp-evpn** configuration for the corresponding Epipe: the **route-next-hop system-ipv6** command is configured in the **configure service epipe <..> bgp-evpn segment-routing-v6** context.
- The **extended-nh-encoding** command must be enabled to allow IPv6 next hops for the VPN IPv4 address family.
- The SR policy used for traffic steering is deployed in the access network.
- BFD is enabled for faster failure detection of all BGP neighbors.

For the SR policy to take effect, the target node referenced in the **endpoint** command must advertise its routes with a color extended community, in the format **community:color**, that matches the one configured

in the policy. The configured color extended community advertised by BNG-1 is color-20. Rather than exporting this color extended community through a VSI-export policy at the service level, for simplicity reasons, it is exported at the global BGP level. This way, the color extended community can be easily added to the existing communities, such as the route target (RT) community in the Epipe.



Note: With the alternative approach relying on the VSI export policy, the RT community would need to be explicitly readvertised along with the color extended community.

The routing policy name used to export the color extended community is "pol-color-20". It is applied only toward the BGP peer PE-1 (neighbor 2001:db8::5). To activate the export policy, the **vpn-apply-export** command must be specifically enabled in MD-CLI.

The BGP configuration on BNG-1 is as follows:

```
[pr:/configure router "Base"]
A:admin@bng-1#
  bgp {
    admin-state enable
    vpn-apply-export true
    vpn-apply-import true
    rapid-withdrawal true
    rapid-update {
      vpn-ipv4 true
      vpn-ipv6 true
      evpn true
    }
    extended-nh-encoding {
      vpn-ipv4 true
    }
    advertise-ipv6-next-hops {
      vpn-ipv6 true
      vpn-ipv4 true
    }
    group "evpn" {
      peer-as 64500
      local-address 2001:db8::14
      bfd-liveness true
      family {
        evpn true
      }
    }
    group "ipvpn" {
      peer-as 64500
      local-address 2001:db8::14
      bfd-liveness true
      family {
        vpn-ipv4 true
        vpn-ipv6 true
      }
    }
    neighbor "2001:db8::5" {
      group "evpn"
      export {
        policy ["pol-color-20"]
      }
    }
    neighbor "2001:db8::6" {
      group "ipvpn"
    }
    neighbor "2001:db8::15" {
      group "evpn"
    }
  }
```

```
}

```

The following shows the export policy "pol-color-20", which adds the community "color-20" to all BGP route advertisements with the family type EVPN originating from the service with the tag 11. For this purpose, the EVPN VPWS (Epipe) is explicitly tagged with tag 11, as shown in the [Epipe configuration](#) section.

```
[pr:/configure policy-options]
A:admin@bng-1#
  community "color-20" {
    member "color:00:20" { }
  }
  policy-statement "pol-color-20" {
    entry 10 {
      from {
        family [evpn]
        tag 11
      }
      action {
        action-type accept
        community {
          add ["color-20"]
        }
      }
    }
  }
}
```

BFD is enabled on the interface advertised as the next hop in BGP updates:

```
[pr:/configure router "Base"]
A:admin@bng-1#
  autonomous-system 64500
  router-id 192.0.2.20
  interface "system" {
    ipv4 {
      primary {
        address 192.0.2.20
        prefix-length 32
      }
    }
    ipv6 {
      bfd {
        admin-state enable
        transmit-interval 100
        receive 100
        multiplier 2
      }
      address 2001:db8::14 {
        prefix-length 128
      }
    }
  }
}
```

The BGP configurations on nodes BNG-2, PE-1, and PE-2 are similar in that both PE-1 and PE-2 nodes only interact with the two BNGs within their respective address families.

The following command shows a summary of the BGP status. The output of this command has been shortened to show only that the peers are communicating and exchanging routes. The advertised routes are examined in the service configuration sections.

```
A:admin@bng-1# show router bgp summary
=====
```

```

BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
BGP Admin State      : Up      BGP Oper State      : Up
---snip---
=====
Neighbor
Description
          AS PktRcvd InQ  Up/Down  State|Rcv/Act/Sent (Addr Family)
          PktSent OutQ
-----
2001:db8::5
          64500  11617  0 04d00h46m 1/1/3 (Evpn)
          11621  0
2001:db8::6
          64500  11618  0 04d00h46m 1/1/2 (VpnIPv4)
          11620  0          1/1/2 (VpnIPv6)
2001:db8::15
          64500  11621  0 04d00h46m 3/3/3 (Evpn)
          11620  0
-----
    
```

EVPN VPWS (including ES and PW port) and related SRv6 configuration

EVPN VPWS is configured as an Epipe. The three instances to be configured are:

- SRv6
- BGP
- BGP-EVPN

The SRv6 instance is configured at the top level of the Epipe and represents the dataplane instantiation of SRv6. In Release 22.10, SRv6 can be used only with the EVPN control plane (BGP-EVPN). Under this hierarchy:

- The SRv6 locator is referenced.
- The function part (End.DX2) required for creating the service SID is defined. The function value can be allocated statically or automatically; in this case, it is allocated automatically.

The BGP instance is configured at the top level of the Epipe (**bgp 1** in the example), where RT and RD can be optionally configured (otherwise they are auto-derived) and where VSI policies are applied.

The BGP-EVPN instance is configured at the top level of the Epipe, with information related to EVPN control plane signaling. The number 1 in the **segment-routing-v6 1** configuration under the **bgp-evpn** context refers to the **bgp 1** instance. Consider the following aspects of this configuration:

- The source IPv6 address of the SRv6 tunnel is, in this case, the system IP address (2001:db8::14). If the source address is not defined in the configuration, the one from the global SRv6 configuration is used. Without the source address defined in one of those two places, the SRv6 transport for the service is non-operational.
- The Epipe is tagged with a tag 11 (0xb), which is used to identify the Epipe in the BGP export policy for the color extended community, as described in the [BGP peering](#) section.
- The **resolution fallback-tunnel-to-route-table** command forces the system to first check if the next hops for the received EVPN routes are present (or resolved) in the tunnel table, before falling back to the routing table for the resolution. This is required because the endpoint in the SR policy, along with the color, is installed in the tunnel table. A valid next-hop resolution via SR policy is a trigger for the

addition of the SRH to the packet header. Without the SR policy, the SRH is not added, and the packet takes the shortest path to the final destination based on plain destination-based routing.

- The **route-next-hop** command identifies the next hop that is used in EVPN route advertisements. In this case, it is the system IPv6 address, but it can be any reachable locally configured IPv6 address.

The benefit of using the multi-instance provisioning model via three provisioning instances (SRv6, BGP, and BGP-EVPN) within the Epipe is that it offers more configuration flexibility when it comes to provisioning multiple data and control planes in the same service.

The Epipes on the two BNGs are configured with the same Ethernet tags. When the AD per-EVI routes with those tags are advertised, the AD per-EVI route advertised from BNG-1 has the P-bit set to 1 and the B-bit set to 0, making it the active route on PE-1. BNG-2 advertises the same AD per-EVI route (but with a different next-hop) with the value of the P-bit set to 0 and the B-bit to 1, making it the standby route on the PE-1.

```
[pr:/configure service epipe "evpn-dual-homing"]
A:admin@bng-1#
  admin-state enable
  service-id 11
  customer "1"
  segment-routing-v6 1 {
    locator "bng-1-loc" {
      function {
        end-dx2 {
        }
      }
    }
  }
  bgp 1 {
  }
  bgp-evpn {
    evi 11
    local-attachment-circuit "bng" {
      eth-tag 2
    }
    remote-attachment-circuit "access" {
      eth-tag 1
    }
    segment-routing-v6 1 {
      admin-state enable
      default-route-tag 0xb
      source-address 2001:db8::14
      resolution fallback-tunnel-to-route-table
      srv6 {
        instance 1
        default-locator "bng-1-loc"
      }
      route-next-hop {
        system-ipv6
      }
    }
  }
}
```

The preceding configuration defines the remote EVPN destination (or connection to the remote node over SRv6) in the Epipe. The local termination point in the Epipe is a PW port. The PW port is FPE-based and associated with the Epipe, as follows:

```
[pr:/configure pw-port 1]
A:admin@bng-1#
  encap-type qinq
```

```
epipe "evpn-dual-homing" {
    admin-state enable
    fpe-id 3
    oper-up-on-mh-standby true
}
```

The **oper-up-on-mh-standby** command is related to an optimization of the ES in EVPN VPWS multihoming. The effect of this command is that the PW port and its SAPs remain operationally up when the associated ES is non-DF. This effect results in faster recovery during switchovers when the PW port has a large number of PW SAPs in the subscriber-management environment. In other words, during a non-DF to DF transition (standby to active), the system does not have to wait additional time to bring up thousands of PW SAPs from a down to an up state before it starts forwarding traffic.

The geo-redundant BNG setup in this chapter relies on two superimposed redundancy mechanisms:

- EVPN multihoming deployed in the access network-based DF election on the ES
- SRRP-based redundancy in ESM

These two redundancy mechanisms are, by themselves, independent of each other. However, to provide predictable results, they must be made co-dependent where one mechanism drives the other. In this context, EVPN MH as a technology deployed in the access network is used to detect the failures and to drive the state of SRRP. SRRP follows the states of the EVPN MH through operational groups.

ESM geo-redundancy based on SRRP does not support active-active mode of operation for a set of paired SRRP instances. As a result, the EVPN MH must be configured in the single-active (SA) mode of operation. The load-balancing between the two BNGs is achieved by distributing the activity of multiple SRRP instances across the two BNGs, some of them being active on one side and some of them on the other. In other words, the granularity of load balancing in ESM is per SRRP instance.

The configuration for coupling EVPN MH and SRRP through operational groups is shown in the following three configuration snippets, involving the definition of the operational group, the SA ES, and the SRRP messaging SAP.

The following configures the operational group "ES-1" with hold times of 0 s to prevent any reaction time delays during switchovers. Only the up time is set explicitly to 0 (from a default value of 4 s). The default value for a hold down time is already set to 0.

```
[pr:/configure service oper-group "ES-1"]
A:admin@bng-1#
    hold-time {
        up 0
    }
```

The following configures SA ES "ES-1" as part of the operational group "ES-1" and associated with PW-port 1. The state of the operational group "ES-1" depends on the state of the ES. If the ES is elected as the DF, then the operational group is up. Otherwise, it is down.

```
[pr:/configure service system]
A:admin@bng-1#
    bgp {
        evpn {
            ethernet-segment "ES-1" {
                admin-state enable
                esi 0x010101010101010101
                orig-ip 2001:db8::14
                route-next-hop 2001:db8::14
                multi-homing-mode single-active
                oper-group "ES-1"
                df-election {
```

```

        es-activation-timer 0
        service-carving-mode manual
        manual {
            preference {
                mode revertive
                value 150
            }
        }
        association {
            pw-port 1 {
                pw-port-headend true
            }
        }
    }
}

```

In the preceding ES configuration, the **orig-ip** command and the **route-next-hop** command must be explicitly configured in pure IPv6 environments. By default, the ES route is advertised with an IPv4 address as the next hop, which is not reachable in this example.

Under the **df-election** context, the configuration of the preference value influences which side becomes active and which becomes standby and the configuration of the preference mode indicates whether to enable revertive behavior, as explained in the [Recovery](#) section. In this example, the **es-activation-timer** command is set to 0 s, which means that the DF election occurs immediately after the failure is detected. Configuring this timer to a value greater than 0 allows some time for the peer routes to be received and collected before DF election is run. This configuration is applicable to environments with multiple routes and nodes in the same ES, but can be ignored in this example topology with only two BNGs.

The following configures the SRRP messaging SAP that tracks the state of the ES (active/standby) by monitoring the operational group "ES-1". The state of the SRRP messaging SAP is up if the ES is a DF, and down if it is a non-DF. An SRRP instance with a messaging SAP in a down state assumes the INIT state, rendering its side as standby. The pairing SRRP instance on the other BNG becomes active.

```

[pr:/configure service vprn "dual-homing" subscriber-interface "sub-int-1" group-interface
"group-int-1"]
A:admin@bng-1#
    srrp 1 {
        admin-state enable
        keep-alive-interval 2
        message-path pw-1:2.4094
    }
    sap pw-1:2.4094 {
        monitor-oper-group "ES-1"
    }
}

```

The boot timer, whose purpose is to wait for routing to converge after a node reboots, is also important when revertive mode is enabled in the ES. The boot timer accounts for completion of subscriber synchronization between the two BNGs upon reboot. In this example, there is a wait time of 2 minutes after the node reboot for the network to converge before the ES is considered stable and ready for DF election.

```

*[pr:/configure redundancy]
A:admin@bng-1#
    bgp-evpn {
        ethernet-segment {
            boot-timer 120
        }
    }
}

```

The multihomed Epipe configuration on PE-1 (the subscriber-connecting access node) is as follows:

```
[pr:/configure service epipe "dual-homing"]
A:admin@pe-1# info
  admin-state enable
  service-id 11
  customer "1"
  segment-routing-v6 1 {
    locator "pe-1-loc" {
      function {
        end-dx2 {
        }
      }
    }
  }
  sap 1/1/c3/1:*. * {
  }
  bgp-evpn {
    evi 11
    local-attachment-circuit "access" {
      eth-tag 1
    }
    remote-attachment-circuit "bng" {
      eth-tag 2
    }
  }
  segment-routing-v6 1 {
    admin-state enable
    default-route-tag 0xb
    source-address 2001:db8::5
    resolution fallback-tunnel-to-route-table
    srv6 {
      instance 1
      default-locator "pe-1-loc"
    }
    route-next-hop {
      system-ipv6
    }
  }
}
```

SR policy

An SR policy is identified by the tuple <headend, color, endpoint>, and its origin can be derived from the path computation element protocol (PCEP), BGP, or may be static via configuration.

In this example, a static SR policy is used in the access network as a traffic-engineering tool to guide traffic through a predetermined network path. This path is configured in the SR policy **segment-list** command as a list of next hop SIDs that are programmed into the SRH.

The SR policy is not explicitly applied to an object in a classical sense, such as routing policies, which are applied in routing and service contexts. Instead, the end-node and the color parameters configured in the SR policy are programmed (or activated) in the tunnel table. As such, the SR policy is used for the BNG advertised next-hop resolution in the tunnel table. Forcing the next-hop resolution through the tunnel-table is configured via the **resolution route-table | tunnel-table | fallback-tunnel-to-route-table** command under the Epipe configuration.

The **segment-list** command references the node-SIDs, while the **endpoint** configured in the SR policy is not a SID but instead a regular IPv6 address of the destination node. When multiple routing policies with

the same endpoint and color are defined, the one with the highest preference prevails and is installed in the tunnel-table.

The **head-end local** command signifies that the SR policy is locally defined and activated, as opposed to advertised to BGP peers.

The binding SID is a mandatory local SID associated with the SR policy. Its function value is end-b6-encaps-red.

The reachability of the first SID in the SR policy must be validated before the SR policy is activated.

Multiple segment lists can be defined in the SR policy. Traffic between these segment lists can be distributed according to the configured weight (not shown in the following configuration).

The SR policy does not have the configuration option for the **source-address**. Instead, it uses the one configured for the segment-routing configuration in the global routing context. Without the **source-address** configured in the global SRv6 context, the SR policy is not activated.

```
[pr:/configure router "Base" segment-routing sr-policies]
A:admin@bng-1#
  admin-state enable
  static-policy "to-pe-1-long-path" {
    admin-state enable
    color 20
    endpoint 2001:db8::5
    preference 150
    head-end local
    type srv6
    segment-routing-v6 {
      binding-sid 1 {
        locator {
          locator-name "bng-1-loc"
          function end-b6-encaps-red
        }
      }
    }
  }
  segment-list 1 {
    admin-state enable
    segment 1 {
      srv6-sid 2001:db8:aaaa:4:0:1000::
    }
    segment 2 {
      srv6-sid 2001:db8:aaaa:a:0:1000::
    }
  }
}
```

To verify that the SR policy has been activated:

```
A:admin@pe-1# show router segment-routing sr-policies static
```

```
=====
SR-Policies Path
=====
```

```
-----
Type           : srv6
Active         : Yes           Owner           : static
Color          : 20
Head           : 0.0.0.0       Endpoint Addr   : 2001:db8::14
RD             : 0             Preference      : 150
SRv6 BSID 1   : 2001:db8:aaaa:5:0:7000::
```

```

TunnelId      : 917506          Age           : 189018
Origin ASN    : 0              Origin        : 0.0.0.0
NumReEval     : 1              ReEvalReason  : route-add
NumActPathChange: 0           Last Change   : 11/01/2022 08:39:33
Maintenance Policy: N/A

Path Segment Lists:
Segment-List  : 1              Weight        : 1
S-BFD State   : Down          S-BFD Transitio*: 0
Num Segments  : 2              Last Change   : 11/01/2022 08:39:30
  Seg 1 SID   : 2001:db8:aaaa:a:0:1000:: State : resolved-up
  Seg 2 SID   : 2001:db8:aaaa:4:0:1000:: State : N/A
-----
Type          : srv6
Active        : Yes            Owner          : static
Color         : 30
Head          : 0.0.0.0        Endpoint Addr  : 2001:db8::15
RD            : 0              Preference     : 150
SRv6 BSID 1  : 2001:db8:aaaa:5:0:6000::
TunnelId      : 917507          Age           : 189036
Origin ASN    : 0              Origin        : 0.0.0.0
NumReEval     : 1              ReEvalReason  : route-add
NumActPathChange: 0           Last Change   : 11/01/2022 08:39:33
Maintenance Policy: N/A

Path Segment Lists:
Segment-List  : 1              Weight        : 1
S-BFD State   : Down          S-BFD Transitio*: 0
Num Segments  : 2              Last Change   : 11/01/2022 08:39:30
  Seg 1 SID   : 2001:db8:aaaa:4:0:1000:: State : resolved-up
  Seg 2 SID   : 2001:db8:aaaa:a:0:1000:: State : N/A
    
```

Verify routes

In this section, **show** commands are used to verify forwarding and show routing-related information. The outputs from the following **show** commands focus primarily (but not exclusively) on nodes BNG-1 and PE-1, which are the endpoints of the active leg of EVPN VPWS multihoming.

The following command shows the SRv6 information on BNG-1. The locator SID is advertised to other nodes via IS-IS. The locator SID is installed in the routing table of all other nodes and is used for reachability information.

```

A:admin@bng-1# show router segment-routing-v6 locator
=====
Locator bng-1-loc
=====
Admin State      : Up
Prefix          : 2001:db8:aaaa:14::/64
Block Length    : 48
Label Block     :
Function Length  : 20
Flex Algorithm   : 0
Termination FPE : 2
Static Function
  Max Entries    : 1
  Label-Block    :
---snip---
    
```

The following command lists different SIDs allocated to BNG-1:

- one node SID (End), advertised in IS-IS
- three adjacency SIDs (End.X), representing the BNG-1 connections to adjacent nodes BNG-2, PE-2, and P-1 (these SIDs are used to build fast failover alternate paths and are also advertised in IS-IS)
- one EVPN SID (End.DX2), advertised via BGP-EVPN for EVPN routes
- two VPN SIDs (End.DT4 and End.DT6), advertised via BGP-IPVPN for VPN-IPv4 and VPN-IPv6 routes
- one binding SID (End.b6.encaps.red), for the SRv6 static segment-policy (this SID is not advertised in this case)

```
A:admin@bng-1# show router segment-routing-v6 local-sid

=====
Segment Routing v6 Local SIDs
=====
SID                                     Type      Function
Locator
Context
-----
2001:db8:aaaa:14:0:1000::              End       1
  bng-1-loc
  Base
2001:db8:aaaa:14:0:2000::              End.b6.encaps* 2
  bng-1-loc
  None
2001:db8:aaaa:14:7fff:c000::           End.DT6   524284
  bng-1-loc
  SvcId: 10 Name: dual-homing
2001:db8:aaaa:14:7fff:d000::           End.DT4   524285
  bng-1-loc
  SvcId: 10 Name: dual-homing
2001:db8:aaaa:14:7fff:e000::           End.DX2   524286
  bng-1-loc
  SvcId: 11 Name: evpn-dual-homing
2001:db8:aaaa:14:7fff:f000::           End.X     524287
  bng-1-loc
  None
2001:db8:aaaa:14:8000::                End.X     524288
  bng-1-loc
  None
2001:db8:aaaa:14:8000:1000::          End.X     524289
  bng-1-loc
  None
```

The following route table on BNG-1 shows:

- system IPv6 interfaces from all other nodes learned through IS-IS
- IPv6 prefixes on links between all nodes learned through IS-IS
- SRv6 locators from all nodes learned through IS-IS
- all local SIDs except for service SIDs, which are part of services and not global routing

BNGs are connected to both the core network (VPRN) and the access network (EVPN), so network addresses from all nodes are visible on a BNG. By contrast, the PE-1 node in the EVPN part of the network sees only routes in the EVPN part of the network, but not the routes in the VPRN part of the network ([Figure 1: Example topology](#)).

```
A:admin@bng-1# show router route-table ipv6

=====
```

```
IPv6 Route Table (Router: Base)
=====
Dest Prefix[Flags]
Next Hop[Interface Name]
Type Proto Age Pref
Metric
-----
2001:db8::4/128 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 10
2001:db8::5/128 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8::6/128 [L] Remote ISIS(1) 02d03h06m 18
fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 10
2001:db8::a/128 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8::14/128 Local Local 02d03h06m 0
system 0
2001:db8::15/128 [L] Remote ISIS(1) 02d03h06m 18
fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" 10
2001:db8::100/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8::200/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8::300/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8::400/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8::500/120 Local Local 02d03h06m 0
int-1-bng-1-p-1 0
2001:db8::600/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8::700/120 Local Local 02d03h06m 0
int-1-bng-1-bng-2 0
2001:db8::800/120 Local Local 02d03h06m 0
int-1-bng-1-pe-2 0
2001:db8::900/120 [L] Remote ISIS(1) 02d03h06m 18
fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 20
2001:db8::a00/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8::6400/120 Remote ISIS 02d03h06m 18
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8::6500/120 [L] Remote ISIS(1) 02d03h06m 18
fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 20
2001:db8:aaaa:4::/64 Remote ISIS 02d03h06m 18
2001:db8:aaaa:4::/64 (tunneled:SRV6-ISIS) 20
2001:db8:aaaa:5::/64 Remote ISIS 02d03h06m 18
2001:db8:aaaa:5::/64 (tunneled:SRV6-ISIS) 30
2001:db8:aaaa:6::/64 Remote ISIS(1) 02d03h06m 18
2001:db8:aaaa:6::/64 (tunneled:SRV6-ISIS) 20
2001:db8:aaaa:a::/64 Remote ISIS 02d03h06m 18
2001:db8:aaaa:a::/64 (tunneled:SRV6-ISIS) 30
2001:db8:aaaa:14::/64 Local SRV6 02d03h06m 3
fe80::201-"_tmnx_fpe_2.a" 0
2001:db8:aaaa:14:0:1000::/128 Local SRV6 02d03h06m 3
Black Hole 0
2001:db8:aaaa:14:0:2000::/128 Local SRV6-Pol* 02d03h06m 14
2001:db8::5 (tunneled:SRV6-Policy:917506) 1
2001:db8:aaaa:14:7fff:f000::/128 Local ISIS(1) 02d03h06m 18
2001:db8:aaaa:14:7fff:f000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:14:8000::/128 Local ISIS 02d03h06m 18
2001:db8:aaaa:14:8000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:14:8000:1000::/128 Local ISIS(1) 02d03h06m 18
2001:db8:aaaa:14:8000:1000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:15::/64 Remote ISIS(1) 02d03h06m 18
2001:db8:aaaa:15::/64 (tunneled:SRV6-ISIS) 20
```


The state of the ES "ES-1" on the two BNGs is DF for BNG-1 and NDF for BNG-2, as follows:

```
A:admin@bng-1# /show service id "evpn-dual-homing" ethernet-segment "ES-1"
---snip---
Pw-Port          Eth-Seg          Status
-----
1                 ES-1             DF

A:admin@bng-2# /show service id "evpn-dual-homing" ethernet-segment "ES-1"
---snip---
Pw-Port          Eth-Seg          Status
-----
1                 ES-1             NDF
```

PE-1 receives the following two AD per-EVI EVPN routes: the first AD per-EVI route is received from BNG-1 as primary (P=1, B=0), while the second AD per-EVI route is received from BNG-2 as backup (P=0, B=1):

```
A:admin@pe-1# show router bgp routes evpn auto-disc tag 2 hunt
=====
BGP Router ID:192.0.2.5      AS:64500      Local AS:64500
=====
Legend -
Status codes : u - used, s - suppressed, h - history, d - decayed, * - valid
               l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete

=====
BGP EVPN Auto-Disc Routes
=====
-----
RIB In Entries
-----
Nexthop      : 2001:db8::14
From           : 2001:db8::14
Res. Nexthop   : fe80::b69e:ffff:fe00:0
Local Pref.    : 100                               Interface Name : int-1-pe-1-p-1
AIGP Metric    : None                               IGP Cost       : 30
Community      : color:00:20 target:64500:11
                l2-attribute:MTU: 1514 C: 0 P: 1 B: 0
Originator Id  : None                               Peer Router Id  : 192.0.2.20
Flags          : Used Valid Best IGP
Route Source   : Internal
EVPN type      : AUTO-DISC
ESI            : 01:01:01:01:01:01:01:01:01:01
Tag         : 2
Route Dist.    : 192.0.2.20:11
MPLS Label     : 524286
Route Tag      : 0
Last Modified  : 02d03h38m
SRv6 TLV Type  : SRv6 L2 Service TLV (6)
SRv6 SubTLV    : SRv6 SID Information (1)
Sid            : 2001:db8:aaaa:14::
Full Sid    : 2001:db8:aaaa:14:7fff:e000::
Behavior       : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                               Loc-Node-Len   : 16
Func-Len       : 20                               Arg-Len        : 0
Tpose-Len      : 20                               Tpose-offset   : 64
```

```

Nexthop      : 2001:db8::15
From        : 2001:db8::15
Res. Nexthop : fe80::b6a1:ffff:fe00:0
Local Pref. : 100                Interface Name : int-1-pe-1-p-2
AIGP Metric : None                IGP Cost      : 30
Community   : color:00:30 target:64500:11
                l2-attribute:MTU: 1514 C: 0 P: 0 B: 1
Originator Id : None                Peer Router Id : 192.0.2.21
Flags       : Used Valid Best IGP
Route Source : Internal
EVPN type   : AUTO-DISC
ESI        : 01:01:01:01:01:01:01:01:01:01
Tag        : 2
Route Dist. : 192.0.2.21:11
MPLS Label  : 524286
Route Tag   : 0
Last Modified : 02d03h38m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid         : 2001:db8:aaaa:15::
Full Sid    : 2001:db8:aaaa:15:7fff:e000::
Behavior    : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                Loc-Node-Len  : 16
Func-Len     : 20                Arg-Len       : 0
Tpose-Len    : 20                Tpose-offset  : 64
    
```

When an IPv4 packet from the traffic generator enters the SAP of the Epipe on PE-1, the packet goes through the Epipe toward the Epipe's other endpoint, which is the EVPN destination on BNG-1. BNG-1 is the primary EVPN destination because PE-1 receives an active (P=1, B=0) AD-per EVI route with the tag 2 from BNG-1. This route has:

- color 20
- next-hop 2001:db8::14 (BNG-1)
- service SID 2001:db8:aaaa:14:7fff:e000:: (End.DX2 on BNG-1)

The service SID is the final destination of the packet and it is inserted in the SRH as the first segment. The received next-hop in the route must be resolved before the route is validated and installed in the routing table. The first attempt to resolve the next-hop for this route is performed through the tunnel table, as indicated by the **resolution fallback-tunnel-to-route-table** command. The following command shows the IPv6 tunnel table with an entry for the next-hop address 2001:db8::14 and color 20, as received in the AD per-EVI route. The owner of this entry is SRv6-policy and the encapsulation is SRv6.

```

A:admin@pe-1# show router tunnel-table ipv6

=====
IPv6 Tunnel Table (Router: Base)
=====
Destination                               Owner      Encap TunnelId  Pref
Nexthop                                   Color
-----
2001:db8::14/128                          srv6-pol  SRV6  917506    14
  fpe_1.a                                   20
2001:db8::15/128                          srv6-pol  SRV6  917507    14
  fpe_1.a                                   30
2001:db8:aaaa:4::/64 [L]                  srv6-isis SRV6  524290    0
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"  20
2001:db8:aaaa:5:8000:1000::/128 [L]      srv6-isis SRV6  524289    0
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"  10
2001:db8:aaaa:5:8000:2000::/128 [L]      srv6-isis SRV6  524292    0
    
```

```

fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"          10
2001:db8:aaaa:a::/64 [L]                srv6-isis SRV6 524293 0
fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"          20
2001:db8:aaaa:14::/64 [L]                srv6-isis SRV6 524297 0
fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"          30
2001:db8:aaaa:15::/64 [L]                srv6-isis SRV6 524294 0
fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"          30
---snip---
    
```

A more detailed output for the next-hop entry in the tunnel table reveals two additional SIDs, which are the SIDs from the configured SR policy:

- 2001:db8:aaaa:a:0:1000:: is the node SID for P-2
- 2001:db8:aaaa:4:0:1000:: is the node SID for P-1

```

A:admin@pe-1# show router tunnel-table ipv6 detail

Tunnel Table (Router: Base)
---snip---
Destination      : 2001:db8::14/128
NextHop          : fpe_1.a
NextHop Weight   : 1
Tunnel Flags     : has-color
Age              : 03d02h15m          Color          : 20
CBF Classes     : (Not Specified)
Owner           : srv6-pol          Encap           : SRV6
Tunnel ID       : 917506           Preference      : 14
Tunnel SRV6 SID : 2001:db8:aaaa:a:0:1000::   Tunnel Metric : 0
                  : 2001:db8:aaaa:4:0:1000::
Tunnel MTU      : -                Max Label Stack : 2
---snip---
    
```

The presence of the two node SIDs for P-2 and P-1 implies that the nodes P-2 and P-1 must be visited, in that order, on the path from PE-1 to BNG-1. This path is accomplished by inserting the SRH header into the packet. The trigger for the SRH creation and insertion into the packet is the next-hop resolution via SR policy.

Because the **End.B6.Encap.Red** function for the binding SID in the SR policy reduces the encapsulation, as defined in RFC 8986, the node SID for P-2 is not part of the SRH, even though it is listed as the first node to be visited in the segment list of the SR policy. As the first node to be visited, its SID is directly included in the DA in the SRv6 header of the packet without repeating itself in the SRH. The SRH contains two SIDs: the node SID for P-1 (2001:db8:aaaa:4:0:1000::) and the service SID (2001:db8:aaaa:14:7fff:e000::) which represents the Epipe on BNG-1, retrieved from the received EVPN AD-per-EVI route. These two SIDs are, in turn, copied to the IPv6 DA field of the packet by the visited nodes, as described in the "Segment Routing over IPv6" chapter in the *7750 SR and 7950 XRS Segment Routing and PCE Advanced Configuration Guide for MD CLI*.

The longest match lookup for the DA 2001:db8:aaaa:a:0:1000:: (P-2 node-SID) reveals the next hop leading to its SRv6 locator (P-2 locator):

```

A:admin@pe-1# show router route-table ipv6 2001:db8:aaaa:a:0:1000:: extensive
=====
Route Table (Router: Base)
=====
Dest Prefix      : 2001:db8:aaaa:a::/64
Protocol        : ISIS
Age             : 03d02h40m
Preference      : 18
Next-Hop       : 2001:db8:aaaa:a::/64 (SRV6-ISIS tunnel)
    
```

---snip---

The tunnel table for next hop 2001:db8:aaaa:a::/64 (P-2 SRv6 locator) points to the link-local IPv6 address of the adjacent node that advertised this next hop (P-2 SRv6 locator) in IS-IS:

```
A:admin@pe-1# show router tunnel-table ipv6 2001:db8:aaaa:a::/64 detail
=====
Tunnel Table (Router: Base)
Destination      : 2001:db8:aaaa:a::/64 [L]
NextHop       : fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"
Tunnel Flags    : has-lfa
Age             : 03d02h42m
CBF Classes     : (Not Specified)
Owner           : srv6-isis (0)          Encap           : SRV6
Tunnel ID      : 524293                 Preference      : 0
Tunnel SRV6 SID : -                     Tunnel Metric   : 20
Tunnel MTU     : 8894                   Max Label Stack : 0
-----
```

The neighbor cache on PE-1 shows the mapping between the link local IPv6 of the adjacent next hop and its MAC address, which is the destination MAC address in the packet:

```
A:admin@pe-1# show router neighbor
=====
Neighbor Table (Router: Base)
=====
IPv6 Address      Interface
MAC Address      State      Expiry      Type      RTR
-----
---snip---
fe80::b6a1:ffff:fe00:0
b4:a1:01:01:00:05    REACHABLE  00h00m25s   Dynamic   Yes
---snip---
```

In summary:

- PE-1 receives an AD per-EVI from BNG-1 with the address of the final destination (service SID), the route color, and the next-hop of the advertised route.
- The next-hop resolution in the tunnel table points to the SR policy with SRv6 encapsulation.
- The SR policy is configured with a list of node SIDs that need to be visited, with the first SID in the list copied to the destination IPv6 address of the packet.
- The remaining SID in the SR policy along with the service SID advertised in the route are populated in the SRH.
- The destination MAC address is resolved through a series of lookups that lead to the directly connected IS-IS node that advertised the SRv6 locator for the first node to be visited.

Without the SR policy, the SRH would not be inserted into the packet. As a result, the final destination (the service SID on BNG-1 for EVPN, 2001:db8:aaaa:14:7fff:e000::) would immediately be populated in the DA field of the packet. The destination-based lookup for this DA gives us a different next hop for the packet (P-1 instead of P-2):

```
A:admin@pe-1# show router route-table ipv6 2001:db8:aaaa:14:7fff:e000:: extensive
Route Table (Router: Base)
Dest Prefix      : 2001:db8:aaaa:14::/64
Protocol         : ISIS
Age              : 04d07h47m
```

```

Preference          : 18
Next-Hop            : 2001:db8:aaaa:14::/64 (SRV6-ISIS tunnel)
---snip---

A:admin@pe-1# show router tunnel-table 2001:db8:aaaa:14::/64 detail
Tunnel Table (Router: Base)
Destination        : 2001:db8:aaaa:14::/64 [L]
NextHop          : fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"
---snip---
Owner              : srv6-isis (0)           Encap          : SRV6
Tunnel ID          : 524297                 Preference    : 0
Tunnel SRV6 SID    : -                     Tunnel Metric  : 30
Tunnel MTU         : 8894                   Max Label Stack : 0
    
```

VRPN related SRv6 configuration

The SRv6 locator and functions in a VRPN are configured in a similar way as in the EVPN.

The export VRF policy advertises the subscriber subnets on the active SRRP node with a better metric than the same routes on the node with standby SRRP. The result is that traffic in the downstream direction is attracted to the node with the active SRRP instance.

```

[pr:/configure service vprn "dual-homing"]
A:admin@bng-1#
  admin-state enable
  service-id 10
  customer "1"
  segment-routing-v6 1 {
    locator "bng-1-loc" {
      function {
        end-dt4 {
        }
        end-dt6 {
        }
      }
    }
  }
  bgp-ipvprn {
    segment-routing-v6 1 {
      admin-state enable
      route-distinguisher "192.0.2.20:10"
      source-address 2001:db8::14
      vrf-target {
        community "target:64500:10"
      }
      vrf-export {
        policy ["srrp-aware-routing"]
      }
      srv6 {
        instance 1
        default-locator "bng-1-loc"
      }
    }
  }
  bgp {
  }
}

[pr:/configure policy-options policy-statement "srrp-aware-routing"]
A:admin@bng-1# info
  description "vrf-export; advertising sub-if routes based on srrp state"
    
```

```

entry 10 {
  from {
    state srrp-master
    protocol {
      name [direct]
    }
  }
  action {
    action-type accept
    local-preference 150
    community {
      add ["dual-homing"]
    }
  }
}
entry 20 {
  from {
    state srrp-non-master
    protocol {
      name [direct]
    }
  }
  action {
    action-type accept
    local-preference 100
    community {
      add ["dual-homing"]
    }
  }
}
}
    
```

Multi-chassis redundancy configuration

The full configuration under the **configure redundancy multi-chassis peer <IP address>** context is provided in the configuration files in the [Appendix](#).

This section emphasizes on the time synchronization of each node to the same clock, which is an aspect of the subscriber synchronization that is easily overlooked. Without times that match on both BNGs, the subscribers are not synchronized. In the example, simple network timing protocol (SNTP) is used.

```

[pr:/configure system time]
A:admin@bng-1#
  prefer-local-time true
  zone {
    standard {
      name cst
    }
  }
  dst-zone "CDT" {
    end {
      day sunday
      month november
      hours-minutes "02:00"
    }
    start {
      day sunday
      month march
      hours-minutes "02:00"
    }
  }
}
sntp {
    
```

```
admin-state enable
server 135.227.160.253 {
}
}
```

DHCP server configuration

DHCP configuration shows that all pools are synchronized via the **peer** command, except for the pool for PPPoEv4 sessions. The IP addresses in the pool for PPPoE sessions are synchronized indirectly as part of the PPPoE session synchronization.

The second important aspect of the DHCP redundancy in access driven mode is that the DHCP servers are associated with interfaces configured with the same IP address on both BNGs (see the [Appendix](#)).

```
[pr:/configure service vprn "dual-homing"]
A:admin@bng-1#
dhcp-server {
  dhcpv4 "dhcpv4" {
    admin-state enable
    pool-selection {
      use-gi-address {
        scope pool
      }
      use-pool-from-client {
      }
    }
  }
  pool "dhcpv4-1" {
    max-lease-time 1200
    failover {
      admin-state enable
      peer 192.0.2.21 {
        sync-tag "dhcp4"
      }
    }
    subnet 10.10.0.0/24 {
      address-range 10.10.0.10 end 10.10.0.100 {
        failover-control-type access-driven
      }
    }
  }
  pool "pppoev4-1" {
    max-lease-time 1200
    subnet 10.10.1.0/24 {
      address-range 10.10.1.10 end 10.10.1.100 {
        failover-control-type access-driven
      }
    }
  }
}
dhcpv6 "dhcpv6" {
  admin-state enable
  pool-selection {
    use-pool-from-client {
    }
  }
}
pool "dhcpv6-1" {
  delegated-prefix {
    minimum 56
  }
  failover {
    admin-state enable
  }
}
```

```
        peer 192.0.2.21 {
            sync-tag "dhcp6"
        }
    }
    prefix 2001:db8:bbbb::/56 {
        failover-control-type access-driven
        preferred-lifetime 900
        valid-lifetime 1200
        renew-time 600
        rebind-time 1000
        prefix-type {
            wan-host true
        }
    }
    prefix 2001:db8:bbbb:100::/56 {
        failover-control-type access-driven
        preferred-lifetime 900
        valid-lifetime 1200
        renew-time 600
        rebind-time 1000
        prefix-type {
            pd true
        }
    }
}
}
}

[pr:/configure service vprn "dual-homing" interface "loopback-1"]
A:admin@bng-1#
admin-state enable
loopback true
ipv4 {
    local-dhcp-server "dhcpv4"
    primary {
        address 192.168.0.1
        prefix-length 32
    }
}
ipv6 {
    local-dhcp-server "dhcpv6"
    address 2001:db8::1 {
        prefix-length 128
    }
}
}
```

Subscriber management configuration

The subscriber management configuration is provided in the configuration files shown in the [Appendix](#).

The following output shows that there are 20 dual-stack subscribers instantiated:

```
A:admin@bng-1# show service active-subscribers summary

=====
Active Subscriber table summary
=====
Total Count      : 20
=====
```


The following output, showing a hierarchical view of each subscriber type, is shortened for brevity.

```
A:admin@bng-1# show service active-subscribers hierarchy

=====
Active Subscribers Hierarchy
=====
-- ipoe-ds-1
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.11] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:01 - svc:10
      |
      |-- 10.10.0.10 - DHCP
      |
      +-- 2001:db8:bbbb:14::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:15::/64 - DHCP6-PD-MR

---snip---

-- pppoe-1
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.1] - sla:sla-profile-1
    |
    +-- PPP-session - mac:00:11:01:00:00:01 - sid:1 - svc:10
      |
      |-- 10.10.1.10 - IPCP
      |
      +-- 2001:db8:bbbb::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:1::/64 - DHCP6-PD-MR

---snip---
```

Summary of show commands

Show commands are powerful tools when building and troubleshooting networks. An extensive set of **show** command outputs relevant to the example topology described in this chapter are provided in separate files for [BNG-1](#), [P-1](#), and [PE-1](#). The following is the list of these commands. Not all commands are applicable to all nodes; for example, commands related to subscriber management do not apply to P and PE nodes.

The following commands show ports and router interfaces:

```
show port
show router <id> interface
```

The following command shows FPE information:

```
show fwd-path-ext fpe <id>
```

The following commands show EVPN VPWS information:

```
show service id <name> base
```

```
show service id <name> bgp-evpn
show service system bgp-evpn ethernet-segment name <name>
show service system bgp-evpn ethernet-segment name <name> evi evi-1 <id>
show router bgp routes evpn eth-seg detail
show router bgp routes evpn auto-disc tag <id> detail
show service id <name> ethernet-segment <name>
show service id <name> segment-routing-v6 detail
show service id <name> segment-routing-v6 instance 1 destinations
show service id <name> segment-routing-v6 instance 1 end-dx2
show service id <name> segment-routing-v6 instance 1 locator <name>
```

The following commands show VPRN information:

```
show service id <name> base
show service id <name> bgp-ipvpn segment-routing-v6
show service id <name> segment-routing-v6 instance 1 locator <name>
show router <id> route-table
show router <id> route-table ipv6
show router bgp routes vpn-ipv4 hunt
show router bgp routes vpn-ipv6 hunt
```

The following commands show SRv6-related information:

```
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router segment-routing-v6 local-sid context <id>
```

The following commands show routing and forwarding information:

```
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
```

The following commands show BGP and IS-IS information:

```
show router bgp summary
show router isis adjacency
show router isis database
show router isis 1 adjacency
show router isis 1 database
show router isis <instance-id> adjacency
show router isis <instance-id> database
```

The following commands show redundancy-related information:

```
show redundancy multi-chassis sync peer <ip-address> detail
tools dump redundancy multi-chassis sync-database
```

The following commands show subscriber-related information:

```
show service active-subscribers summary
show service active-subscribers hierarchy
show service id <id> subscriber-hosts detail
show service id <id> ipoe session
show service id <id> pppoe session
show service id <id> dhcp lease-state
show service id <id> dhcp6 lease-state
show srrp <id> detail
```

The following commands show DHCP information:

```
show router <id> dhcp local-dhcp-server <name> summary
show router <id> dhcp6 local-dhcp-server <name> summary
show router <id> dhcp local-dhcp-server <name> leases
show router <id> dhcp6 local-dhcp-server <name> leases
```

Conclusion

Resilient overlay networks that support traffic engineering can be built with the simplicity of a single dataplane protocol (IPv6) using SRv6. When SRv6 is deployed in the access network in combination with BNG dual-homing, subscribers are protected against network failures with minimal recovery times. This chapter shows one example of such network.

Appendix

The following configurations are included.

- [bng-1-config](#)
- [bng-2-config](#)
- [p-1-config](#)
- [p-2-config](#)
- [pe-1-config](#)
- [pe-2-config](#)
- [users.radius](#)

bng-1-config

```
# TiMOS-C-22.10.R1 cpm/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-11-01T10:41:30.6-05:00 by admin from 135.231.208.32
# Commit ID 5
# Committed 2022-11-01T10:37:59.8-05:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 4
# Committed 2022-11-01T10:36:36.8-05:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 3
# Committed 2022-11-01T10:33:20.1-05:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 2
# Committed 2022-11-01T10:32:34.0-05:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 1
# Committed 2022-11-01T10:04:53.3-05:00 by system (MD-CLI) from Console
# Log "System booted version C-22.10.R1."

configure {
  aaa {
    radius {
```

```
server-policy "radius-server-1" {
    servers {
        router-instance "Base"
        server 1 {
            server-name "free-radius-1"
        }
    }
}
card 1 {
    card-type iom5-e
    mda 1 {
        mda-type me6-100gb-qsfp28
    }
    mda 2 {
        mda-type me6-100gb-qsfp28
    }
}
fwd-path-ext {
    sdp-id-range {
        start 17500
        end 17600
    }
    fpe 1 {
        description "srv6 origination"
        path {
            pxc 1
        }
        application {
            srv6 {
                type origination
            }
        }
    }
    fpe 2 {
        description "srv6 termination"
        path {
            pxc 2
        }
        application {
            srv6 {
                type termination
            }
        }
    }
    fpe 3 {
        description "pw-port on a single port"
        path {
            pxc 3
        }
        application {
            pw-port-extension {
            }
        }
    }
}
log {
    filter "1001" {
        named-entry "10" {
            description "Collect only events of major severity or higher"
            action forward
            match {
                severity {
```

```
        gte major
      }
    }
  }
}
log-id "100" {
  description "Default Serious Errors Log"
  filter "1001"
  source {
    main true
  }
  destination {
    memory {
      max-entries 500
    }
  }
}
log-id "99" {
  description "Default System Log"
  source {
    main true
  }
  destination {
    memory {
      max-entries 500
    }
  }
}
}
policy-options {
  community "color-20" {
    member "color:00:20" { }
  }
  community "dual-homing" {
    member "target:64500:10" { }
  }
  policy-statement "pol-color-20" {
    entry 10 {
      from {
        family [evpn]
        tag 12
      }
      action {
        action-type accept
        community {
          add ["color-20"]
        }
      }
    }
    entry 20 {
      from {
        family [evpn]
        tag 11
      }
      action {
        action-type accept
        community {
          add ["color-20"]
        }
      }
    }
  }
  policy-statement "srrp-aware-routing" {
    description "vrf-export; advertizing sub-if routes based on srrp state"
```

```
        entry 10 {
            from {
                state srrp-master
                protocol {
                    name [direct]
                }
            }
            action {
                action-type accept
                local-preference 150
                community {
                    add ["dual-homing"]
                }
            }
        }
    entry 20 {
        from {
            state srrp-non-master
            protocol {
                name [direct]
            }
        }
        action {
            action-type accept
            local-preference 100
            community {
                add ["dual-homing"]
            }
        }
    }
}
policy-statement "sub-mgmt-routes" {
    description "this is not applied, but if it was - it would work fine through vrf-
export"
    entry 10 {
        from {
            protocol {
                name [sub-mgmt]
            }
        }
        action {
            action-type accept
            community {
                add ["dual-homing"]
            }
        }
    }
}
}
port 1/1/c1 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    description "to p-1 access; mutually exclusive with lag-2"
    monitor-oper-group "network-port"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
```

```
    admin-state disable
    description "lag-2 to p-1 access; mutually exclusive with port 1/1/c1/1"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state disable
    description "lag-2 to p-1 access; mutually exclusive with port 1/1/c1/1"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    description "spare port to p-1 access"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    description "to bng-2"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    description "to pe-2 network"
    oper-group "network-port"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c1/10 {
    admin-state enable
    description "RADIUS and mirroring"
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
```

```
    admin-state enable
    connector {
        breakout c1-100g
    }
}
port 1/1/c2/1 {
    admin-state enable
    ethernet {
        mode hybrid
        encap-type dot1q
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c4 {
    admin-state enable
    connector {
        breakout c4-10g
    }
}
port 1/1/c4/1 {
    admin-state enable
    description "PXC 1,2,3; fpe 1,2,3; srv6 orig, term, pw-port single port"
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c4/2 {
    admin-state enable
}
port 1/1/c4/3 {
    admin-state enable
}
port 1/1/c4/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port pxc-1.a {
    admin-state enable
}
port pxc-1.b {
    admin-state enable
}
port pxc-2.a {
    admin-state enable
}
port pxc-2.b {
    admin-state enable
}
port pxc-3.a {
    admin-state enable
}
port pxc-3.b {
    admin-state enable
}
port-xc {
    pxc 1 {
        admin-state enable
    }
}
```



```
        description "fpe srv6 origin"
        port-id 1/1/c4/1
    }
    pxc 2 {
        admin-state enable
        description "fpe srv6 termination"
        port-id 1/1/c4/1
    }
    pxc 3 {
        admin-state enable
        description "fpe pw-port single port"
        port-id 1/1/c4/1
    }
}
pw-port 1 {
    encap-type qinq
    epipe "evpn-dual-homing" {
        admin-state enable
        fpe-id 3
        oper-up-on-mh-standby true
    }
}
redundancy {
    multi-chassis {
        peer 192.0.2.21 {
            admin-state enable
            sync {
                admin-state enable
                local-dhcp-server true
                srrp true
                sub-mgmt {
                    ipoe true
                    pppoe true
                }
                tags {
                    pw-port 1 {
                        sync-tag "pw-port-1"
                    }
                }
                track-srrp 1 {
                }
            }
        }
    }
}
bgp-evpn {
    ethernet-segment {
        boot-timer 120
    }
}
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.20
    interface "int-1-bng-1-bng-2" {
        port 1/1/c1/6:1
        gre-termination true
        ipv4 {
            primary {
                address 192.168.7.1
                prefix-length 24
            }
        }
        ipv6 {
            address 2001:db8::701 {
```

```
        prefix-length 120
    }
}
interface "int-1-bng-1-p-1" {
    port 1/1/c1/1:1
    ipv6 {
        address 2001:db8::501 {
            prefix-length 120
        }
    }
}
interface "int-1-bng-1-pe-2" {
    port 1/1/c1/7:1
    ipv6 {
        address 2001:db8::801 {
            prefix-length 120
        }
    }
}
interface "system" {
    ipv4 {
        primary {
            address 192.0.2.20
            prefix-length 32
        }
    }
    ipv6 {
        bfd {
            admin-state enable
            transmit-interval 100
            receive 100
            multiplier 2
        }
        address 2001:db8::14 {
            prefix-length 128
        }
    }
}
interface "to-radius" {
    port 1/1/c1/10:114
    ipv4 {
        primary {
            address 192.168.114.20
            prefix-length 24
        }
    }
}
bgp {
    admin-state enable
    vpn-apply-export true
    vpn-apply-import true
    rapid-withdrawal true
    rapid-update {
        vpn-ipv4 true
        vpn-ipv6 true
        evpn true
    }
    extended-nh-encoding {
        vpn-ipv4 true
    }
    advertise-ipv6-next-hops {
        vpn-ipv6 true
        vpn-ipv4 true
    }
}
```

```
    }
    group "evpn" {
        peer-as 64500
        local-address 2001:db8::14
        bfd-liveness true
        family {
            evpn true
        }
    }
    group "ipvpn" {
        peer-as 64500
        local-address 2001:db8::14
        bfd-liveness true
        family {
            vpn-ipv4 true
            vpn-ipv6 true
        }
    }
    neighbor "2001:db8::5" {
        group "evpn"
        export {
            policy ["pol-color-20"]
        }
    }
    neighbor "2001:db8::6" {
        group "ipvpn"
    }
    neighbor "2001:db8::15" {
        group "evpn"
    }
}
isis 0 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    loopfree-alternate {
        remote-lfa {
        }
        ti-lfa {
        }
    }
}
traffic-engineering-options {
    ipv6 true
    application-link-attributes {
    }
}
}
segment-routing-v6 {
    admin-state enable
    locator "bng-1-loc" {
        level-capability 2
        level 2 {
            metric 10
        }
    }
}
}
interface "int-1-bng-1-p-1" {
}
interface "system" {
}
level 2 {
```

```
        wide-metrics-only true
    }
}
isis 1 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    loopfree-alternate {
        remote-lfa {
        }
        ti-lfa {
        }
    }
    traffic-engineering-options {
        ipv6 true
        application-link-attributes {
        }
    }
    segment-routing-v6 {
        admin-state enable
        locator "bng-1-loc" {
            level-capability 2
            level 2 {
                metric 10
            }
        }
    }
}
interface "int-1-bng-1-bng-2" {
}
interface "int-1-bng-1-pe-2" {
}
interface "system" {
}
level 2 {
    wide-metrics-only true
}
}
radius {
    server "free-radius-1" {
        address 192.168.114.2
        secret "HDqTwZYSvEu934VNHUQy/pubZxTKpSDzvHg=" hash2
        accept-coa true
    }
}
segment-routing {
    sr-policies {
        admin-state enable
        static-policy "to-pe-1-long-path" {
            admin-state enable
            color 10
            endpoint 2001:db8::5
            preference 150
            head-end local
            type srv6
            segment-routing-v6 {
                binding-sid 1 {
                    locator {
                        locator-name "bng-1-loc"
                        function end-b6-encaps-red
                    }
                }
            }
        }
    }
}
```

```
    }
  }
  segment-list 1 {
    admin-state enable
    segment 1 {
      srv6-sid 2001:db8:aaaa:4:0:1000::
    }
    segment 2 {
      srv6-sid 2001:db8:aaaa:a:0:1000::
    }
  }
}
segment-routing-v6 {
  origination-fpe [1]
  source-address 2001:db8::14
  locator "bng-1-loc" {
    admin-state enable
    block-length 48
    termination-fpe [2]
    prefix {
      ip-prefix 2001:db8:aaaa:14::/64
    }
  }
  base-routing-instance {
    locator "bng-1-loc" {
      function {
        end 1 {
          srh-mode usp
        }
        end-x-auto-allocate usp protection protected { }
      }
    }
  }
}
}
static-routes {
  route 192.0.2.21/32 route-type unicast {
    next-hop "192.168.7.2" {
      admin-state enable
    }
  }
}
}
service {
  oper-group "ES-1" {
    hold-time {
      up 0
    }
  }
  oper-group "network-port" {
    hold-time {
      up 0
    }
  }
}
system {
  bgp {
    evpn {
      ethernet-segment "ES-1" {
        admin-state enable
        esi 0x010101010101010101
        orig-ip 2001:db8::14
        route-next-hop 2001:db8::14
        multi-homing-mode single-active
      }
    }
  }
}
```

```

        oper-group "ES-1"
        df-election {
            es-activation-timer 0
            service-carving-mode manual
            manual {
                preference {
                    mode revertive
                    value 150
                }
            }
        }
        association {
            pw-port 1 {
                pw-port-headend true
            }
        }
    }
}

epipe "evpn-dual-homing" {
    admin-state enable
    service-id 11
    customer "1"
    segment-routing-v6 1 {
        locator "bng-1-loc" {
            function {
                end-dx2 {
                }
            }
        }
    }
}

bgp 1 {
}

bgp-evpn {
    evi 11
    local-attachment-circuit "bng" {
        eth-tag 2
    }
    remote-attachment-circuit "access" {
        eth-tag 1
    }
    segment-routing-v6 1 {
        admin-state enable
        default-route-tag 0xb
        source-address 2001:db8::14
        resolution fallback-tunnel-to-route-table
        srv6 {
            instance 1
            default-locator "bng-1-loc"
        }
        route-next-hop {
            system-ipv6
        }
    }
}

sdp 1 {
    admin-state enable
    signaling off
    far-end {
        ip-address 192.168.7.2
    }
}

```

```
vpls "capture-sap" {
  admin-state enable
  service-id 5
  customer "1"
  capture-sap pw-1:*.* {
    radius-auth-policy "radius-1"
    track-srrp 1
    trigger-packet {
      dhcp true
      dhcp6 true
      pppoe true
    }
    ipoe-session {
      admin-state enable
      ipoe-session-policy "ipoe-session-policy-1"
    }
    pppoe {
      policy "ppp-policy-1"
    }
  }
}
vprn "dual-homing" {
  admin-state enable
  service-id 10
  customer "1"
  segment-routing-v6 1 {
    locator "bng-1-loc" {
      function {
        end-dt4 {
        }
        end-dt6 {
        }
      }
    }
  }
}
bgp-ipvpn {
  segment-routing-v6 1 {
    admin-state enable
    route-distinguisher "192.0.2.20:10"
    source-address 2001:db8::14
    vrf-target {
      community "target:64500:10"
    }
    vrf-export {
      policy ["srrp-aware-routing"]
    }
    srv6 {
      instance 1
      default-locator "bng-1-loc"
    }
  }
}
bgp {
}
interface "loopback-1" {
  admin-state enable
  loopback true
  ipv4 {
    local-dhcp-server "dhcpv4"
    primary {
      address 192.168.0.1
      prefix-length 32
    }
    neighbor-discovery {
```

```
        local-proxy-arp false
        remote-proxy-arp false
    }
    dhcp {
        admin-state enable
    }
}
ipv6 {
    local-dhcp-server "dhcpv6"
    address 2001:db8::1 {
        prefix-length 128
    }
}
}
redundant-interface "red-int-bng-1-bng-2" {
    admin-state enable
    description "static to system ip"
    spoke-sdp 1:1 {
        admin-state enable
        ingress {
            vc-label 1000
        }
        egress {
            vc-label 1000
        }
    }
    ipv4 {
        primary {
            address 192.168.11.1
            prefix-length 24
            remote-ip 192.168.11.2
        }
    }
}
}
dhcp-server {
    dhcpv4 "dhcpv4" {
        admin-state enable
        pool-selection {
            use-gi-address {
                scope pool
            }
            use-pool-from-client {
            }
        }
    }
    pool "dhcpv4-1" {
        max-lease-time 1200
        failover {
            admin-state enable
            peer 192.0.2.21 {
                sync-tag "dhcp4"
            }
        }
        subnet 10.10.0.0/24 {
            address-range 10.10.0.10 end 10.10.0.100 {
                failover-control-type access-driven
            }
        }
    }
    pool "pppoev4-1" {
        max-lease-time 1200
        subnet 10.10.1.0/24 {
            address-range 10.10.1.10 end 10.10.1.100 {
                failover-control-type access-driven
            }
        }
    }
}
```



```
        host-type pd
    }
    link-local-address {
        address fe80::b696:ffff:fe00:0
    }
}
group-interface "group-int-1" {
    admin-state enable
    radius-auth-policy "radius-1"
    oper-up-while-empty true
    redundant-interface "red-int-bng-1-bng-2"
    dynamic-routes-track-srrp {
    }
    ipv4 {
        neighbor-discovery {
            remote-proxy-arp true
            populate false
        }
        dhcp {
            admin-state enable
            server [192.168.0.1]
            trusted true
            gi-address 10.10.0.1
            match-circuit-id true
            option-82 {
                action keep
                vendor-specific-option {
                    pool-name true
                }
            }
            lease-populate {
                max-leases 100
            }
            client-applications {
                dhcp true
            }
        }
    }
    ipv6 {
        auto-reply {
            neighbor-solicitation true
            router-solicitation true
        }
        dhcp6 {
            pd-managed-route {
            }
            relay {
                admin-state enable
                server ["2001:db8::1"]
                client-applications {
                    dhcp true
                    ppp true
                }
            }
        }
    }
    router-advertisements {
        admin-state enable
        force-mcast ip-mac
        options {
            managed-configuration true
            reachable-time 10000
            retransmit-timer 3
        }
    }
}
```



```
password "ncd8qyrNUMhYfa2SfrUqHMDZ9IXn3sVSmYBzbw==" hash2
pppoe-access-method pap-chap
radius-server-policy "radius-server-1"
user-name {
    format circuit-id
}
include-radius-attribute {
    circuit-id true
    nas-identifier true
}
}
msap-policy "msap-policy-1" {
    sub-sla-mgmt {
        subscriber-limit 100
        sub-ident-policy "sub-ident-policy-1"
        defaults {
            subscriber-id {
                sap-id
            }
        }
    }
    ies-vprn-only-sap-parameters {
        anti-spoof next-hop-ip-and-mac-addr
        ingress {
            qos {
                queuing-type service
            }
        }
    }
}
}
}
system {
    name "bng-1"
    management-interface {
        configuration-mode model-driven
        cli {
            cli-engine [md-cli classic-cli]
        }
        yang-modules {
            nokia-submodules true
            nokia-combined-modules false
        }
        snmp {
            admin-state disable
        }
    }
    login-control {
        idle-timeout none
    }
    security {
        aaa {
            local-profiles {
                profile "administrative" {
                    default-action permit-all
                    entry 10 {
                        match "configure system security"
                        action permit
                    }
                    entry 20 {
                        match "show system security"
                        action permit
                    }
                    entry 30 {
                        match "tools perform security"
                    }
                }
            }
        }
    }
}
```

```
        action permit
    }
    entry 40 {
        match "tools dump security"
        action permit
    }
    entry 50 {
        match "admin system security"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
    entry 110 {
        match "show li"
        action deny
    }
    entry 111 {
        match "clear li"
        action deny
    }
    entry 112 {
        match "tools dump li"
        action deny
    }
    netconf {
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            kill-session true
            lock true
            validate true
        }
    }
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
        action permit
    }
}
```

```
        entry 50 {
            match "password"
            action permit
        }
        entry 60 {
            match "show config"
            action deny
        }
        entry 65 {
            match "show li"
            action deny
        }
        entry 66 {
            match "clear li"
            action deny
        }
        entry 67 {
            match "tools dump li"
            action deny
        }
        entry 68 {
            match "state li"
            action deny
        }
        entry 70 {
            match "show"
            action permit
        }
        entry 75 {
            match "state"
            action permit
        }
        entry 80 {
            match "enable-admin"
            action permit
        }
        entry 90 {
            match "enable"
            action permit
        }
        entry 100 {
            match "configure li"
            action deny
        }
    }
}
ssh {
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
    }
}
```

```
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
client-cipher-list-v2 {
    cipher 190 {
        name aes256-ctr
    }
    cipher 192 {
        name aes192-ctr
    }
    cipher 194 {
        name aes128-ctr
    }
    cipher 200 {
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
server-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
```

```
        name hmac-md5
      }
      mac 240 {
        name hmac-md5-96
      }
    }
  }
  user-params {
    local-user {
      user "admin" {
        password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwD9lLxMuFyPVSm00Gy6"
        access {
          console true
        }
        console {
          member ["administrative"]
        }
      }
    }
  }
}
time {
  prefer-local-time true
  zone {
    standard {
      name cst
    }
  }
  dst-zone "CDT" {
    end {
      day sunday
      month november
      hours-minutes "02:00"
    }
    start {
      day sunday
      month march
      hours-minutes "02:00"
    }
  }
  sntp {
    admin-state enable
    server 135.227.160.253 {
    }
  }
}
}
}

# Finished 2022-11-01T10:41:30.6-05:00
```

bng-2-config

```
# TiMOS-C-22.10.R1 cpm/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-11-01T10:41:32.5-05:00 by admin from 135.231.208.32
# Commit ID 1
# Committed 2022-11-01T10:04:58.4-05:00 by system (MD-CLI) from Console
# Log "System booted version C-22.10.R1."
```



```
configure {
  aaa {
    radius {
      server-policy "radius-server-1" {
        servers {
          router-instance "Base"
          server 1 {
            server-name "free-radius-1"
          }
        }
      }
    }
  }
  card 1 {
    card-type iom5-e
    mda 1 {
      mda-type me6-100gb-qsfp28
    }
    mda 2 {
      mda-type me6-100gb-qsfp28
    }
  }
  fwd-path-ext {
    sdp-id-range {
      start 17500
      end 17600
    }
    fpe 1 {
      description "srv6 origination"
      path {
        pxc 1
      }
      application {
        srv6 {
          type origination
        }
      }
    }
    fpe 2 {
      description "srv6 termination"
      path {
        pxc 2
      }
      application {
        srv6 {
          type termination
        }
      }
    }
    fpe 3 {
      description "pw-port on a single port"
      path {
        pxc 3
      }
      application {
        pw-port-extension {
        }
      }
    }
  }
  log {
    filter "1001" {
      named-entry "10" {
```

```
        description "Collect only events of major severity or higher"
        action forward
        match {
            severity {
                gte major
            }
        }
    }
}
log-id "100" {
    description "Default Serious Errors Log"
    filter "1001"
    source {
        main true
    }
    destination {
        memory {
            max-entries 500
        }
    }
}
log-id "99" {
    description "Default System Log"
    source {
        main true
    }
    destination {
        memory {
            max-entries 500
        }
    }
}
}
policy-options {
    community "color-30" {
        member "color:00:30" { }
    }
    community "dual-homing" {
        member "target:64500:10" { }
    }
}
policy-statement "pol-color-30" {
    entry 10 {
        from {
            family [evpn]
            tag 11
        }
        action {
            action-type accept
            community {
                add ["color-30"]
            }
        }
    }
}
}
policy-statement "srrp-aware-routing" {
    description "vrf-export; advertizing sub-if routes based on srrp state"
    entry 10 {
        from {
            state srrp-master
            protocol {
                name [direct]
            }
        }
        action {
```

```
        action-type accept
        local-preference 150
        community {
            add ["dual-homing"]
        }
    }
}
entry 20 {
    from {
        state srrp-non-master
        protocol {
            name [direct]
        }
    }
    action {
        action-type accept
        local-preference 100
        community {
            add ["dual-homing"]
        }
    }
}
}
policy-statement "sub-mgmt-routes" {
    description "this is not applied, but if it was - it would work fine through vrf-
export"
    entry 10 {
        from {
            protocol {
                name [sub-mgmt]
            }
        }
        action {
            action-type accept
            community {
                add ["dual-homing"]
            }
        }
    }
}
}
}
port 1/1/c1 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    description "to p-2 access; mutually exclusive with lag-2"
    monitor-oper-group "network-port"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
    admin-state disable
    description "lag-2 to p-2 access; mutually exclusive with port 1/1/c1/1"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state disable
}
```

```
description "lag-2 to p-2 access; mutually exclusive with port 1/1/c1/1"
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/4 {
  admin-state enable
  description "spare port to p-2 access"
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/5 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/6 {
  admin-state enable
  description "to bng-1"
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/7 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/8 {
  admin-state enable
  description "to pe-2 network"
  oper-group "network-port"
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/9 {
  admin-state enable
  ethernet {
    mode hybrid
    dot1x {
      tunneling true
    }
  }
}
port 1/1/c1/10 {
  admin-state enable
  description "RADIUS and mirroring"
  ethernet {
    mode hybrid
  }
}
port 1/1/c4 {
  admin-state enable
  connector {
    breakout c4-10g
  }
}
port 1/1/c4/1 {
  admin-state enable
  description "PXC 1,2,3; fpe 1,2,3; srv6 orig, term, pw-port single port"
```

```
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c4/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port pxc-1.a {
    admin-state enable
}
port pxc-1.b {
    admin-state enable
}
port pxc-2.a {
    admin-state enable
}
port pxc-2.b {
    admin-state enable
}
port pxc-3.a {
    admin-state enable
}
port pxc-3.b {
    admin-state enable
}
}
port-xc {
    pxc 1 {
        admin-state enable
        description "fpe srv6 origin"
        port-id 1/1/c4/1
    }
    pxc 2 {
        admin-state enable
        description "fpe srv6 termination"
        port-id 1/1/c4/1
    }
    pxc 3 {
        admin-state enable
        description "fpe pw-port single port"
        port-id 1/1/c4/1
    }
}
pw-port 1 {
    encap-type qinq
    epipe "evpn-dual-homing" {
        admin-state enable
        fpe-id 3
        oper-up-on-mh-standby true
    }
}
}
redundancy {
    multi-chassis {
        peer 192.0.2.20 {
            admin-state enable
            sync {
                admin-state enable
                local-dhcp-server true
                srrp true
            }
        }
    }
}
```

```
        sub-mgmt {
            ipoe true
            pppoe true
        }
        tags {
            pw-port 1 {
                sync-tag "pw-port-1"
            }
        }
        track-srrp 1 {
        }
    }
}
bgp-evpn {
    ethernet-segment {
        boot-timer 120
    }
}
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.21
    interface "int-1-bng-2-bng-1" {
        port 1/1/c1/6:1
        gre-termination true
        ipv4 {
            primary {
                address 192.168.7.2
                prefix-length 24
            }
        }
        ipv6 {
            address 2001:db8::702 {
                prefix-length 120
            }
        }
    }
    interface "int-1-bng-2-p-2" {
        port 1/1/c1/1:1
        ipv6 {
            address 2001:db8::601 {
                prefix-length 120
            }
        }
    }
    interface "int-1-bng-2-pe-2" {
        port 1/1/c1/8:1
        ipv6 {
            address 2001:db8::901 {
                prefix-length 120
            }
        }
    }
    interface "system" {
        ipv4 {
            primary {
                address 192.0.2.21
                prefix-length 32
            }
        }
        ipv6 {
            bfd {
                admin-state enable
            }
        }
    }
}
```

```
        transmit-interval 100
        receive 100
        multiplier 2
    }
    address 2001:db8::15 {
        prefix-length 128
    }
}
interface "to-radius" {
    port 1/1/c1/10:114
    ipv4 {
        primary {
            address 192.168.114.21
            prefix-length 24
        }
    }
}
bgp {
    admin-state enable
    vpn-apply-export true
    vpn-apply-import true
    rapid-withdrawal true
    rapid-update {
        vpn-ipv4 true
        vpn-ipv6 true
        evpn true
    }
    extended-nh-encoding {
        vpn-ipv4 true
    }
    advertise-ipv6-next-hops {
        vpn-ipv6 true
        vpn-ipv4 true
    }
    group "evpn" {
        peer-as 64500
        local-address 2001:db8::15
        bfd-liveness true
        family {
            evpn true
        }
    }
    group "ipvpn" {
        peer-as 64500
        local-address 2001:db8::15
        bfd-liveness true
        family {
            vpn-ipv4 true
            vpn-ipv6 true
        }
    }
    neighbor "2001:db8::5" {
        group "evpn"
        export {
            policy ["pol-color-30"]
        }
    }
    neighbor "2001:db8::6" {
        group "ipvpn"
    }
    neighbor "2001:db8::14" {
        group "evpn"
    }
}
```

```
}
isis 0 {
  admin-state enable
  advertise-passive-only false
  advertise-router-capability area
  ipv6-routing native
  level-capability 2
  traffic-engineering true
  area-address [49.0001]
  loopfree-alternate {
    remote-lfa {
    }
    ti-lfa {
    }
  }
}
traffic-engineering-options {
  ipv6 true
  application-link-attributes {
  }
}
segment-routing-v6 {
  admin-state enable
  locator "bng-2-loc" {
    level-capability 2
    level 2 {
      metric 10
    }
  }
}
interface "int-1-bng-2-p-2" {
}
interface "system" {
}
level 2 {
  wide-metrics-only true
}
}
isis 1 {
  admin-state enable
  advertise-passive-only false
  advertise-router-capability area
  ipv6-routing native
  level-capability 2
  traffic-engineering true
  area-address [49.0001]
  loopfree-alternate {
    remote-lfa {
    }
    ti-lfa {
    }
  }
}
traffic-engineering-options {
  ipv6 true
  application-link-attributes {
  }
}
segment-routing-v6 {
  admin-state enable
  locator "bng-2-loc" {
    level-capability 2
    level 2 {
      metric 10
    }
  }
}
}
```



```
}
interface "int-1-bng-2-bng-1" {
}
interface "int-1-bng-2-pe-2" {
}
interface "system" {
}
level 2 {
    wide-metrics-only true
}
}
radius {
    server "free-radius-1" {
        address 192.168.114.2
        secret "HDqTwZYSvEu934VNHUQy/pubZxTKpSDzvHg=" hash2
        accept-coa true
    }
}
}
segment-routing {
    sr-policies {
        admin-state enable
        static-policy "to-pe-1-long-path" {
            admin-state enable
            color 10
            endpoint 2001:db8::5
            preference 150
            head-end local
            type srv6
            segment-routing-v6 {
                binding-sid 1 {
                    locator {
                        locator-name "bng-2-loc"
                        function end-b6-encaps-red
                    }
                }
            }
        }
        segment-list 1 {
            admin-state enable
            segment 1 {
                srv6-sid 2001:db8:aaaa:a:0:1000::
            }
            segment 2 {
                srv6-sid 2001:db8:aaaa:4:0:1000::
            }
        }
    }
}
}
segment-routing-v6 {
    origination-fpe [1]
    source-address 2001:db8::15
    locator "bng-2-loc" {
        admin-state enable
        block-length 48
        termination-fpe [2]
        prefix {
            ip-prefix 2001:db8:aaaa:15::/64
        }
    }
}
base-routing-instance {
    locator "bng-2-loc" {
        function {
            end 1 {
                srh-mode usp
            }
        }
    }
}
```

```
        end-x-auto-allocate usp protection protected { }
      }
    }
  }
}
static-routes {
  route 192.0.2.20/32 route-type unicast {
    next-hop "192.168.7.1" {
      admin-state enable
    }
  }
}
service {
  oper-group "ES-1" {
    hold-time {
      up 0
    }
  }
  oper-group "network-port" {
    hold-time {
      up 0
    }
  }
}
system {
  bgp {
    evpn {
      ethernet-segment "ES-1" {
        admin-state enable
        esi 0x010101010101010101
        orig-ip 2001:db8::15
        route-next-hop 2001:db8::15
        multi-homing-mode single-active
        oper-group "ES-1"
        df-election {
          es-activation-timer 0
          service-carving-mode manual
          manual {
            preference {
              mode revertive
              value 50
            }
          }
        }
        association {
          pw-port 1 {
            pw-port-headend true
          }
        }
      }
    }
  }
}
epipe "evpn-dual-homing" {
  admin-state enable
  service-id 11
  customer "1"
  segment-routing-v6 1 {
    locator "bng-2-loc" {
      function {
        end-dx2 {
        }
      }
    }
  }
}
```

```
    }
  }
  bgp-evpn {
    evi 11
    local-attachment-circuit "bng" {
      eth-tag 2
    }
    remote-attachment-circuit "access" {
      eth-tag 1
    }
    segment-routing-v6 1 {
      admin-state enable
      default-route-tag 0xb
      source-address 2001:db8::15
      resolution fallback-tunnel-to-route-table
      srv6 {
        instance 1
        default-locator "bng-2-loc"
      }
      route-next-hop {
        ip-address 2001:db8::15
      }
    }
  }
}
sdp 1 {
  admin-state enable
  signaling off
  far-end {
    ip-address 192.168.7.1
  }
}
vpls "capture-sap" {
  admin-state enable
  service-id 5
  customer "1"
  capture-sap pw-1:*.* {
    radius-auth-policy "radius-1"
    track-srrp 1
    trigger-packet {
      dhcp true
      dhcp6 true
      pppoe true
    }
    ipoe-session {
      admin-state enable
      ipoe-session-policy "ipoe-session-policy-1"
    }
    pppoe {
      policy "ppp-policy-1"
    }
  }
}
vprn "dual-homing" {
  admin-state enable
  service-id 10
  customer "1"
  segment-routing-v6 1 {
    locator "bng-2-loc" {
      function {
        end-dt4 {
        }
        end-dt6 {
        }
      }
    }
  }
}
```

```
    }
  }
}
bgp-ipvpn {
  segment-routing-v6 1 {
    admin-state enable
    route-distinguisher "192.0.2.21:10"
    source-address 2001:db8::15
    vrf-target {
      community "target:64500:10"
    }
    vrf-export {
      policy ["srrp-aware-routing"]
    }
    srv6 {
      instance 1
      default-locator "bng-2-loc"
    }
  }
}
bgp {
}
interface "loopback-1" {
  admin-state enable
  loopback true
  ipv4 {
    local-dhcp-server "dhcpv4"
    primary {
      address 192.168.0.1
      prefix-length 32
    }
    neighbor-discovery {
      local-proxy-arp false
      remote-proxy-arp false
    }
    dhcp {
      admin-state enable
    }
  }
  ipv6 {
    local-dhcp-server "dhcpv6"
    address 2001:db8::1 {
      prefix-length 128
    }
  }
}
redundant-interface "red-int-bng-2-bng-1" {
  admin-state enable
  spoke-sdp 1:1 {
    admin-state enable
    ingress {
      vc-label 1000
    }
    egress {
      vc-label 1000
    }
  }
  ipv4 {
    primary {
      address 192.168.11.2
      prefix-length 24
      remote-ip 192.168.11.1
    }
  }
}
```

```
}
dhcp-server {
  dhcpv4 "dhcpv4" {
    admin-state enable
    pool-selection {
      use-gi-address {
        scope pool
      }
      use-pool-from-client {
      }
    }
    pool "dhcpv4-1" {
      max-lease-time 1200
      failover {
        admin-state enable
        peer 192.0.2.20 {
          sync-tag "dhcp4"
        }
      }
      subnet 10.10.0.0/24 {
        address-range 10.10.0.10 end 10.10.0.100 {
          failover-control-type access-driven
        }
      }
    }
    pool "pppoev4-1" {
      max-lease-time 1200
      subnet 10.10.1.0/24 {
        address-range 10.10.1.10 end 10.10.1.100 {
          failover-control-type access-driven
        }
      }
    }
  }
}
dhcpv6 "dhcpv6" {
  admin-state enable
  pool-selection {
    use-pool-from-client {
    }
  }
  pool "dhcpv6-1" {
    delegated-prefix {
      minimum 56
    }
    failover {
      admin-state enable
      peer 192.0.2.20 {
        sync-tag "dhcp6"
      }
    }
    prefix 2001:db8:bbbb::/56 {
      failover-control-type access-driven
      preferred-lifetime 900
      valid-lifetime 1200
      renew-time 600
      rebind-time 1000
      prefix-type {
        wan-host true
      }
    }
    prefix 2001:db8:bbbb:100::/56 {
      failover-control-type access-driven
      preferred-lifetime 900
      valid-lifetime 1200
    }
  }
}
```

```
        renew-time 600
        rebind-time 1000
        prefix-type {
            pd true
        }
    }
}
subscriber-interface "sub-int-1" {
    admin-state enable
    ipv4 {
        address 10.10.0.2 {
            prefix-length 24
            gateway 10.10.0.254
            track-srrp 1
        }
        address 10.10.1.2 {
            prefix-length 24
            gateway 10.10.1.254
            track-srrp 1
        }
    }
    ipv6 {
        delegated-prefix-length variable
        prefix 2001:db8:bbbb::/56 {
            track-srrp 1
            host-type wan
        }
        prefix 2001:db8:bbbb:100::/56 {
            track-srrp 1
            host-type pd
        }
        link-local-address {
            address fe80::b696:ffff:fe00:0
        }
    }
}
group-interface "group-int-1" {
    admin-state enable
    radius-auth-policy "radius-1"
    oper-up-while-empty true
    redundant-interface "red-int-bng-2-bng-1"
    dynamic-routes-track-srrp {
    }
    ipv4 {
        neighbor-discovery {
            remote-proxy-arp true
            populate false
        }
        dhcp {
            admin-state enable
            server [192.168.0.1]
            trusted true
            gi-address 10.10.0.2
            match-circuit-id true
            option-82 {
                action keep
                vendor-specific-option {
                    pool-name true
                }
            }
            lease-populate {
                max-leases 100
            }
        }
    }
}
```

```
        client-applications {
            dhcp true
        }
    }
}
ipv6 {
    auto-reply {
        neighbor-solicitation true
        router-solicitation true
    }
    dhcp6 {
        pd-managed-route {
        }
        relay {
            admin-state enable
            server ["2001:db8::1"]
            client-applications {
                dhcp true
                ppp true
            }
        }
    }
    router-advertisements {
        admin-state enable
        force-mcast ip-mac
        options {
            managed-configuration true
            reachable-time 10000
            retransmit-timer 3
        }
    }
    router-solicit {
        admin-state disable
    }
}
ipoe-session {
    admin-state enable
    ipoe-session-policy "ipoe-session-policy-1"
    sap-session-limit 100
    force-auth {
        cid-change false
        rid-change false
    }
}
pppoe {
    admin-state enable
    policy "ppp-policy-1"
    session-limit 100
    sap-session-limit 100
}
local-address-assignment {
    admin-state enable
    ipv4 {
        server "dhcpv4"
        client-applications {
            ppp true
        }
    }
}
srrp 1 {
    admin-state enable
    keep-alive-interval 2
    message-path pw-1:2.4094
}
```



```
management-interface {
  configuration-mode model-driven
  cli {
    cli-engine [md-cli classic-cli]
  }
  yang-modules {
    nokia-submodules true
    nokia-combined-modules false
  }
  snmp {
    admin-state disable
  }
}
login-control {
  idle-timeout none
}
security {
  aaa {
    local-profiles {
      profile "administrative" {
        default-action permit-all
        entry 10 {
          match "configure system security"
          action permit
        }
        entry 20 {
          match "show system security"
          action permit
        }
        entry 30 {
          match "tools perform security"
          action permit
        }
        entry 40 {
          match "tools dump security"
          action permit
        }
        entry 50 {
          match "admin system security"
          action permit
        }
        entry 100 {
          match "configure li"
          action deny
        }
        entry 110 {
          match "show li"
          action deny
        }
        entry 111 {
          match "clear li"
          action deny
        }
        entry 112 {
          match "tools dump li"
          action deny
        }
      }
      netconf {
        base-op-authorization {
          action true
          cancel-commit true
          close-session true
          commit true
          copy-config true
        }
      }
    }
  }
}
```

```
        create-subscription true
        delete-config true
        discard-changes true
        edit-config true
        get true
        get-config true
        get-data true
        get-schema true
        kill-session true
        lock true
        validate true
    }
}
profile "default" {
  entry 10 {
    match "exec"
    action permit
  }
  entry 20 {
    match "exit"
    action permit
  }
  entry 30 {
    match "help"
    action permit
  }
  entry 40 {
    match "logout"
    action permit
  }
  entry 50 {
    match "password"
    action permit
  }
  entry 60 {
    match "show config"
    action deny
  }
  entry 65 {
    match "show li"
    action deny
  }
  entry 66 {
    match "clear li"
    action deny
  }
  entry 67 {
    match "tools dump li"
    action deny
  }
  entry 68 {
    match "state li"
    action deny
  }
  entry 70 {
    match "show"
    action permit
  }
  entry 75 {
    match "state"
    action permit
  }
  entry 80 {
```

```
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
ssh {
server-cipher-list-v2 {
cipher 190 {
name aes256-ctr
}
cipher 192 {
name aes192-ctr
}
cipher 194 {
name aes128-ctr
}
cipher 200 {
name aes128-cbc
}
cipher 205 {
name 3des-cbc
}
cipher 225 {
name aes192-cbc
}
cipher 230 {
name aes256-cbc
}
}
client-cipher-list-v2 {
cipher 190 {
name aes256-ctr
}
cipher 192 {
name aes192-ctr
}
cipher 194 {
name aes128-ctr
}
cipher 200 {
name aes128-cbc
}
cipher 205 {
name 3des-cbc
}
cipher 225 {
name aes192-cbc
}
cipher 230 {
name aes256-cbc
}
}
server-mac-list-v2 {
mac 200 {
name hmac-sha2-512
}
```

```
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
}
user-params {
    local-user {
        user "admin" {
            password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
            access {
                console true
            }
            console {
                member ["administrative"]
            }
        }
    }
}
}
time {
    prefer-local-time true
    zone {
        standard {
            name cst
        }
    }
    dst-zone "CDT" {
        end {
            day sunday
            month november
            hours-minutes "02:00"
        }
    }
}
```

```
    }
    start {
        day sunday
        month march
        hours-minutes "02:00"
    }
}
sntp {
    admin-state enable
    server 135.227.160.253 {
    }
}
}
}
}
}

# Finished 2022-11-01T10:41:32.6-05:00
```

p-1-config

```
# TiMOS-B-22.10.R1 both/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-11-01T06:45:18.0Z by admin from 135.231.208.32
# Commit ID 1
# Committed 2022-11-01T06:08:15.6Z by system (MD-CLI) from Console
# Log "System booted version B-22.10.R1."

configure {
    card 1 {
        card-type iom-1
        mda 1 {
            mda-type me6-100gb-qsfp28
        }
        mda 2 {
            mda-type me6-100gb-qsfp28
        }
        fp 1 {
        }
    }
    fwd-path-ext {
        fpe 1 {
            path {
                pxc 1
            }
            application {
                srv6 {
                    type origination
                }
            }
        }
        fpe 2 {
            path {
                pxc 2
            }
            application {
                srv6 {
                    type termination
                }
            }
        }
    }
}
```

```
    }
  }
  log {
    filter "1001" {
      named-entry "10" {
        description "Collect only events of major severity or higher"
        action forward
        match {
          severity {
            gte major
          }
        }
      }
    }
    log-id "100" {
      description "Default Serious Errors Log"
      filter "1001"
      source {
        main true
      }
      destination {
        memory {
          max-entries 500
        }
      }
    }
    log-id "99" {
      description "Default System Log"
      source {
        main true
      }
      destination {
        memory {
          max-entries 500
        }
      }
    }
  }
  port pxc-1.a {
    admin-state enable
  }
  port pxc-1.b {
    admin-state enable
  }
  port pxc-2.a {
    admin-state enable
  }
  port pxc-2.b {
    admin-state enable
  }
  port 1/1/c1 {
    admin-state enable
    connector {
      breakout c10-10g
    }
  }
  port 1/1/c1/1 {
    admin-state enable
    ethernet {
      mode hybrid
      encap-type dot1q
    }
  }
  port 1/1/c1/2 {
```

```
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c2/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
```

```
}
port 1/1/c2/2 {
  admin-state disable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/3 {
  admin-state disable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/4 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/5 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/6 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/7 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/8 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/9 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/10 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c3 {
  admin-state enable
  connector {
    breakout c10-10g
  }
}
port 1/1/c3/1 {
  admin-state enable
  ethernet {
```



```
        mode hybrid
    }
}
port 1/1/c3/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c4 {
    admin-state enable
    connector {
        breakout c4-10g
    }
}
port 1/1/c4/1 {
```

```
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c5 {
}
port 1/1/c6 {
}
port 1/2/c1 {
}
port 1/2/c2 {
}
port 1/2/c3 {
}
port 1/2/c4 {
}
port 1/2/c5 {
}
port 1/2/c6 {
}
port-xc {
    pxc 1 {
        admin-state enable
        port-id 1/1/c4/1
    }
    pxc 2 {
        admin-state enable
        port-id 1/1/c4/1
    }
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.4
    interface "int-1-p-1-bng-1" {
        port 1/1/c2/1:1
        ipv6 {
            address 2001:db8::502 {
                prefix-length 120
            }
        }
    }
    interface "int-1-p-1-p-2" {
        port 1/1/c1/9:1
        ipv6 {
            address 2001:db8::a01 {
                prefix-length 120
            }
        }
    }
    interface "int-1-p-1-pe-1" {
        port 1/1/c1/1:1
        ipv6 {
            address 2001:db8::102 {
                prefix-length 120
            }
        }
    }
}
interface "system" {
    ipv4 {
        primary {
```

```
        address 192.0.2.4
        prefix-length 32
    }
}
ipv6 {
    address 2001:db8::4 {
        prefix-length 128
    }
}
interface "to-radius" {
    port 1/1/c3/10:114
    ipv4 {
        primary {
            address 192.168.114.4
            prefix-length 24
        }
    }
}
bgp {
}
isis 0 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    loopfree-alternate {
        remote-lfa {
        }
        ti-lfa {
        }
    }
}
traffic-engineering-options {
    ipv6 true
    application-link-attributes {
    }
}
}
segment-routing-v6 {
    admin-state enable
    locator "p-1-loc" {
        level-capability 2
        level 2 {
            metric 10
        }
    }
}
}
interface "int-1-p-1-bng-1" {
}
interface "int-1-p-1-p-2" {
}
interface "int-1-p-1-pe-1" {
}
interface "system" {
}
level 2 {
    wide-metrics-only true
}
}
segment-routing {
    segment-routing-v6 {
        origination-fpe [1]
    }
}
```

```
        source-address 2001:db8::4
        locator "p-1-loc" {
            admin-state enable
            block-length 48
            function-length 20
            termination-fpe [2]
            prefix {
                ip-prefix 2001:db8:aaaa:4::/64
            }
        }
        base-routing-instance {
            locator "p-1-loc" {
                function {
                    end 1 {
                        srh-mode usp
                    }
                }
                end-x-auto-allocate usp protection protected { }
            }
        }
    }
}
system {
    name "p-1"
    management-interface {
        configuration-mode model-driven
        cli {
            cli-engine [md-cli classic-cli]
        }
        yang-modules {
            nokia-submodules true
            nokia-combined-modules false
        }
        snmp {
            admin-state disable
        }
    }
    bluetooth {
        advertising-timeout 30
    }
    login-control {
        idle-timeout none
    }
    security {
        aaa {
            local-profiles {
                profile "administrative" {
                    default-action permit-all
                    entry 10 {
                        match "configure system security"
                        action permit
                    }
                    entry 20 {
                        match "show system security"
                        action permit
                    }
                    entry 30 {
                        match "tools perform security"
                        action permit
                    }
                    entry 40 {
                        match "tools dump security"
                        action permit
                    }
                }
            }
        }
    }
}
```

```
    }
    entry 50 {
        match "admin system security"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
    entry 110 {
        match "show li"
        action deny
    }
    entry 111 {
        match "clear li"
        action deny
    }
    entry 112 {
        match "tools dump li"
        action deny
    }
    }
    netconf {
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            kill-session true
            lock true
            validate true
        }
    }
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
        action permit
    }
    entry 50 {
        match "password"
        action permit
    }
    entry 60 {
```

```
        match "show config"
        action deny
    }
    entry 65 {
        match "show li"
        action deny
    }
    entry 66 {
        match "clear li"
        action deny
    }
    entry 67 {
        match "tools dump li"
        action deny
    }
    entry 68 {
        match "state li"
        action deny
    }
    entry 70 {
        match "show"
        action permit
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
}
ssh {
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
        cipher 225 {
            name aes192-cbc
        }
        cipher 230 {
            name aes256-cbc
        }
    }
}
```

```
    }
  }
  client-cipher-list-v2 {
    cipher 190 {
      name aes256-ctr
    }
    cipher 192 {
      name aes192-ctr
    }
    cipher 194 {
      name aes128-ctr
    }
    cipher 200 {
      name aes128-cbc
    }
    cipher 205 {
      name 3des-cbc
    }
    cipher 225 {
      name aes192-cbc
    }
    cipher 230 {
      name aes256-cbc
    }
  }
  server-mac-list-v2 {
    mac 200 {
      name hmac-sha2-512
    }
    mac 210 {
      name hmac-sha2-256
    }
    mac 215 {
      name hmac-sha1
    }
    mac 220 {
      name hmac-sha1-96
    }
    mac 225 {
      name hmac-md5
    }
    mac 240 {
      name hmac-md5-96
    }
  }
  client-mac-list-v2 {
    mac 200 {
      name hmac-sha2-512
    }
    mac 210 {
      name hmac-sha2-256
    }
    mac 215 {
      name hmac-sha1
    }
    mac 220 {
      name hmac-sha1-96
    }
    mac 225 {
      name hmac-md5
    }
    mac 240 {
      name hmac-md5-96
    }
  }
}
```

```
    }
  }
  user-params {
    local-user {
      user "admin" {
        password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
        access {
          console true
        }
        console {
          member ["administrative"]
        }
      }
    }
  }
}

# Finished 2022-11-01T06:45:18.0Z
```

p-2-config

```
# TiMOS-B-22.10.R1 both/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-11-01T08:50:39.8Z by admin from 135.231.208.32
# Commit ID 1
# Committed 2022-11-01T08:13:40.0Z by system (MD-CLI) from Console
# Log "System booted version B-22.10.R1."

configure {
  card 1 {
    card-type iom-1
    mda 1 {
      mda-type me6-100gb-qsfp28
    }
    mda 2 {
      mda-type me6-100gb-qsfp28
    }
  }
  fwd-path-ext {
    fpe 1 {
      path {
        pxc 1
      }
      application {
        srv6 {
          type origination
        }
      }
    }
    fpe 2 {
      path {
        pxc 2
      }
      application {
        srv6 {
          type termination
        }
      }
    }
  }
}
```



```
    }
  }
}
log {
  filter "1001" {
    named-entry "10" {
      description "Collect only events of major severity or higher"
      action forward
      match {
        severity {
          gte major
        }
      }
    }
  }
}
log-id "100" {
  description "Default Serious Errors Log"
  filter "1001"
  source {
    main true
  }
  destination {
    memory {
      max-entries 500
    }
  }
}
log-id "99" {
  description "Default System Log"
  source {
    main true
  }
  destination {
    memory {
      max-entries 500
    }
  }
}
}
port pxc-1.a {
  admin-state enable
}
port pxc-1.b {
  admin-state enable
}
port pxc-2.a {
  admin-state enable
}
port pxc-2.b {
  admin-state enable
}
port 1/1/c1 {
  admin-state enable
  connector {
    breakout c10-10g
  }
}
port 1/1/c1/1 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c1/2 {
```

```
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c2/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
```

```
}
port 1/1/c2/2 {
  admin-state disable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/3 {
  admin-state disable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/4 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/5 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/6 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/7 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/8 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/9 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/10 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c3 {
  admin-state enable
  connector {
    breakout c10-10g
  }
}
port 1/1/c3/1 {
  admin-state enable
  ethernet {
```

```
        mode hybrid
    }
}
port 1/1/c3/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c4 {
    admin-state enable
    connector {
        breakout c4-10g
    }
}
port 1/1/c4/1 {
```

```
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port-xc {
    pxc 1 {
        admin-state enable
        port-id 1/1/c4/1
    }
    pxc 2 {
        admin-state enable
        port-id 1/1/c4/1
    }
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.10
    interface "int-1-p-2-bng-2" {
        port 1/1/c2/1:1
        ipv6 {
            address 2001:db8::602 {
                prefix-length 120
            }
        }
    }
    interface "int-1-p-2-p-1" {
        port 1/1/c1/9:1
        ipv6 {
            address 2001:db8::a02 {
                prefix-length 120
            }
        }
    }
    interface "int-1-p-2-pe-1" {
        port 1/1/c1/5:1
        ipv6 {
            address 2001:db8::202 {
                prefix-length 120
            }
        }
    }
}
interface "system" {
    ipv4 {
        primary {
            address 192.0.2.10
            prefix-length 32
        }
    }
    ipv6 {
        address 2001:db8::a {
            prefix-length 128
        }
    }
}
interface "to-radius" {
    port 1/1/c3/10:114
    ipv4 {
        primary {
            address 192.168.114.10
            prefix-length 24
        }
    }
}
```

```
    }
  }
}
isis 0 {
  admin-state enable
  advertise-passive-only false
  advertise-router-capability area
  ipv6-routing native
  level-capability 2
  traffic-engineering true
  area-address [49.0001]
  loopfree-alternate {
    remote-lfa {
    }
    ti-lfa {
    }
  }
}
traffic-engineering-options {
  ipv6 true
  application-link-attributes {
  }
}
}
segment-routing-v6 {
  admin-state enable
  locator "p-2-loc" {
    level-capability 2
    level 2 {
      metric 10
    }
  }
}
}
interface "int-1-p-2-bng-2" {
}
interface "int-1-p-2-p-1" {
}
interface "int-1-p-2-pe-1" {
}
interface "system" {
}
}
level 2 {
  wide-metrics-only true
}
}
segment-routing {
  segment-routing-v6 {
    origination-fpe [1]
    source-address 2001:db8::a
    locator "p-2-loc" {
      admin-state enable
      block-length 48
      termination-fpe [2]
      prefix {
        ip-prefix 2001:db8:aaaa:a::/64
      }
    }
  }
  base-routing-instance {
    locator "p-2-loc" {
      function {
        end 1 {
          srh-mode usp
        }
      }
      end-x-auto-allocate usp protection protected { }
    }
  }
}
}
```

```
    }
  }
}
system {
  name "p-2"
  management-interface {
    configuration-mode model-driven
    cli {
      cli-engine [md-cli classic-cli]
    }
    yang-modules {
      nokia-submodules true
      nokia-combined-modules false
    }
    snmp {
      admin-state disable
    }
  }
  login-control {
    idle-timeout none
  }
  security {
    aaa {
      local-profiles {
        profile "administrative" {
          default-action permit-all
          entry 10 {
            match "configure system security"
            action permit
          }
          entry 20 {
            match "show system security"
            action permit
          }
          entry 30 {
            match "tools perform security"
            action permit
          }
          entry 40 {
            match "tools dump security"
            action permit
          }
          entry 50 {
            match "admin system security"
            action permit
          }
          entry 100 {
            match "configure li"
            action deny
          }
          entry 110 {
            match "show li"
            action deny
          }
          entry 111 {
            match "clear li"
            action deny
          }
          entry 112 {
            match "tools dump li"
            action deny
          }
        }
      }
    }
  }
  netconf {
```

```
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            kill-session true
            lock true
            validate true
        }
    }
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
        action permit
    }
    entry 50 {
        match "password"
        action permit
    }
    entry 60 {
        match "show config"
        action deny
    }
    entry 65 {
        match "show li"
        action deny
    }
    entry 66 {
        match "clear li"
        action deny
    }
    entry 67 {
        match "tools dump li"
        action deny
    }
    entry 68 {
        match "state li"
        action deny
    }
    entry 70 {
        match "show"
        action permit
    }
}
```



```
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
}
ssh {
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
        cipher 225 {
            name aes192-cbc
        }
        cipher 230 {
            name aes256-cbc
        }
    }
    client-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
        cipher 225 {
            name aes192-cbc
        }
        cipher 230 {
```

```
        name aes256-cbc
      }
    }
    server-mac-list-v2 {
      mac 200 {
        name hmac-sha2-512
      }
      mac 210 {
        name hmac-sha2-256
      }
      mac 215 {
        name hmac-sha1
      }
      mac 220 {
        name hmac-sha1-96
      }
      mac 225 {
        name hmac-md5
      }
      mac 240 {
        name hmac-md5-96
      }
    }
    client-mac-list-v2 {
      mac 200 {
        name hmac-sha2-512
      }
      mac 210 {
        name hmac-sha2-256
      }
      mac 215 {
        name hmac-sha1
      }
      mac 220 {
        name hmac-sha1-96
      }
      mac 225 {
        name hmac-md5
      }
      mac 240 {
        name hmac-md5-96
      }
    }
  }
  user-params {
    local-user {
      user "admin" {
        password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
        access {
          console true
        }
        console {
          member ["administrative"]
        }
      }
    }
  }
}
# Finished 2022-11-01T08:50:39.8Z
```

pe-1-config

```
# TiMOS-B-22.7.R1 both/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Tue Aug 2 14:18:47 PDT 2022 by builder in /builds/c/227B/R1/panos/main/sros
# Configuration format version 22.7 revision 0

# Generated 2022-10-27T09:42:24.8Z by admin from 135.231.208.32
# Commit ID 1
# Committed 2022-10-27T09:13:22.5Z by system (MD-CLI) from Console
# Log "System booted version B-22.7.R1."

configure {
  card 1 {
    card-type iom-1
    mda 1 {
      mda-type me6-100gb-qsfp28
    }
    mda 2 {
      mda-type me6-100gb-qsfp28
      xconnect {
        mac 1 {
          loopback 1 {
          }
        }
      }
    }
  }
  fp 1 {
  }
}
connection-profile {
  vlan 1 {
    qtag-range 2 {
      end 2
    }
  }
  vlan 20 {
    qtag-range 20 {
      end 30
    }
  }
}
fwd-path-ext {
  fpe 1 {
    path {
      pxc 1
    }
    application {
      srv6 {
        type origination
      }
    }
  }
  fpe 2 {
    path {
      pxc 2
    }
    application {
      srv6 {
        type termination
      }
    }
  }
}
}
```

```
log {
  filter "1001" {
    named-entry "10" {
      description "Collect only events of major severity or higher"
      action forward
      match {
        severity {
          gte major
        }
      }
    }
  }
  log-id "100" {
    description "Default Serious Errors Log"
    filter "1001"
    source {
      main true
    }
    destination {
      memory {
        max-entries 500
      }
    }
  }
  log-id "50" {
    source {
      debug true
    }
    destination {
      cli {
        max-entries 1000
      }
    }
  }
  log-id "99" {
    description "Default System Log"
    source {
      main true
    }
    destination {
      memory {
        max-entries 500
      }
    }
  }
}
policy-options {
  community "color-10" {
    member "color:00:10" { }
  }
  policy-statement "pol-color-10" {
    entry 10 {
      from {
        family [evpn]
        tag 11
      }
      action {
        action-type accept
        community {
          add ["color-10"]
        }
      }
    }
    entry 20 {
```

```
        from {
            family [evpn]
            tag 12
        }
        action {
            action-type accept
            community {
                add ["color-10"]
            }
        }
    }
}
port pxc-1.a {
    admin-state enable
}
port pxc-1.b {
    admin-state enable
}
port pxc-2.a {
    admin-state enable
}
port pxc-2.b {
    admin-state enable
}
port 1/1/c1 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
```

```
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c2/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/6 {
```

```
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c3/1 {
    admin-state enable
    ethernet {
        mode hybrid
        encap-type qinq
    }
}
port 1/1/c3/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
```

```
    }  
  }  
  port 1/1/c3/6 {  
    admin-state enable  
    ethernet {  
      mode hybrid  
    }  
  }  
  port 1/1/c3/7 {  
    admin-state enable  
    ethernet {  
      mode hybrid  
    }  
  }  
  port 1/1/c3/8 {  
    admin-state enable  
    ethernet {  
      mode hybrid  
    }  
  }  
  port 1/1/c3/9 {  
    admin-state enable  
    ethernet {  
      mode hybrid  
    }  
  }  
  port 1/1/c3/10 {  
    admin-state enable  
    ethernet {  
      mode hybrid  
      encap-type dot1q  
    }  
  }  
  port 1/1/c4 {  
    admin-state enable  
    connector {  
      breakout c4-10g  
    }  
  }  
  port 1/1/c4/1 {  
    admin-state enable  
    ethernet {  
      mode hybrid  
      dot1x {  
        tunneling true  
      }  
    }  
  }  
  port 1/1/c5 {  
  }  
  port 1/1/c6 {  
  }  
  port 1/2/c1 {  
  }  
  port 1/2/c2 {  
  }  
  port 1/2/c3 {  
  }  
  port 1/2/c4 {  
  }  
  port 1/2/c5 {  
  }  
  port 1/2/c6 {  
  }
```



```
port 1/2/m1/1 {
}
port-xc {
  pxc 1 {
    admin-state enable
    port-id 1/1/c4/1
  }
  pxc 2 {
    admin-state enable
    port-id 1/1/c4/1
  }
}
router "Base" {
  autonomous-system 64500
  router-id 192.0.2.5
  interface "int-1-pe-1-p-1" {
    port 1/1/c1/1:1
    ipv6 {
      address 2001:db8::101 {
        prefix-length 120
      }
    }
  }
  interface "int-1-pe-1-p-2" {
    port 1/1/c1/5:1
    ipv6 {
      address 2001:db8::201 {
        prefix-length 120
      }
    }
  }
  interface "system" {
    ipv4 {
      primary {
        address 192.0.2.5
        prefix-length 32
      }
    }
    ipv6 {
      bfd {
        admin-state enable
        transmit-interval 100
        receive 100
        multiplier 2
      }
      address 2001:db8::5 {
        prefix-length 128
      }
    }
  }
  interface "to-ixia" {
    port 1/1/c3/1:1.1
    ipv4 {
      primary {
        address 172.16.100.1
        prefix-length 24
      }
    }
    ipv6 {
      address 2001:db8::6401 {
        prefix-length 120
      }
    }
  }
}
```

```
interface "to-radius" {
  port 1/1/c3/10:114
  ipv4 {
    primary {
      address 192.168.114.5
      prefix-length 24
    }
  }
}
bgp {
  admin-state enable
  vpn-apply-export true
  vpn-apply-import true
  rapid-withdrawal true
  rapid-update {
    evpn true
  }
  advertise-ipv6-next-hops {
    evpn true
  }
  group "evpn" {
    peer-as 64500
    local-address 2001:db8::5
    bfd-liveness true
    family {
      evpn true
    }
  }
  neighbor "2001:db8::14" {
    group "evpn"
    export {
      policy ["pol-color-10"]
    }
  }
  neighbor "2001:db8::15" {
    group "evpn"
    export {
      policy ["pol-color-10"]
    }
  }
}
isis 0 {
  admin-state enable
  advertise-passive-only false
  advertise-router-capability area
  ipv6-routing native
  level-capability 2
  traffic-engineering true
  area-address [49.0001]
  loopfree-alternate {
    remote-lfa {
    }
    ti-lfa {
    }
  }
}
traffic-engineering-options {
  ipv6 true
  application-link-attributes {
  }
}
segment-routing-v6 {
  admin-state enable
  locator "pe-1-loc" {
    level-capability 2
  }
}
```

```
        level 2 {
            metric 10
        }
    }
}
interface "int-1-pe-1-p-1" {
}
interface "int-1-pe-1-p-2" {
}
interface "system" {
}
interface "to-ixia" {
}
level 2 {
    wide-metrics-only true
}
}
segment-routing {
    sr-policies {
        admin-state enable
        static-policy "to-bng-1-long-path" {
            admin-state enable
            color 20
            endpoint 2001:db8::14
            preference 150
            head-end local
            type srv6
            segment-routing-v6 {
                binding-sid 1 {
                    locator {
                        locator-name "pe-1-loc"
                        function end-b6-encaps-red
                    }
                }
            }
        }
        segment-list 1 {
            admin-state enable
            segment 1 {
                srv6-sid 2001:db8:aaaa:a:0:1000::
            }
            segment 2 {
                srv6-sid 2001:db8:aaaa:4:0:1000::
            }
        }
    }
}
static-policy "to-bng-2-long-path" {
    admin-state enable
    color 30
    endpoint 2001:db8::15
    preference 150
    head-end local
    type srv6
    segment-routing-v6 {
        binding-sid 1 {
            locator {
                locator-name "pe-1-loc"
                function end-b6-encaps-red
            }
        }
    }
}
segment-list 1 {
    admin-state enable
    segment 1 {
        srv6-sid 2001:db8:aaaa:4:0:1000::
    }
}
```

```
        }
        segment 2 {
            srv6-sid 2001:db8:aaaa:a:0:1000::
        }
    }
}
segment-routing-v6 {
    origination-fpe [1]
    source-address 2001:db8::5
    locator "pe-1-loc" {
        admin-state enable
        block-length 48
        termination-fpe [2]
        prefix {
            ip-prefix 2001:db8:aaaa:5::/64
        }
        static-function {
            max-entries 5
        }
    }
    base-routing-instance {
        locator "pe-1-loc" {
            function {
                end 1 {
                    srh-mode usp
                }
                end-x-auto-allocate usp protection protected { }
            }
        }
    }
}
}
}
}
service {
    system {
        extended-default-qinq-sap-lookup true
    }
    epipe "dual-homing" {
        admin-state enable
        service-id 11
        customer "1"
        segment-routing-v6 1 {
            locator "pe-1-loc" {
                function {
                    end-dx2 {
                    }
                }
            }
        }
    }
    sap 1/1/c3/1:*. * {
    }
    bgp-evpn {
        evi 11
        local-attachment-circuit "access" {
            eth-tag 1
        }
        remote-attachment-circuit "bng" {
            eth-tag 2
        }
    }
    segment-routing-v6 1 {
        admin-state enable
        default-route-tag 0xb
        source-address 2001:db8::5
    }
}
```

```
        resolution fallback-tunnel-to-route-table
        srv6 {
            instance 1
            default-locator "pe-1-loc"
        }
        route-next-hop {
            system-ipv6
        }
    }
}
system {
    name "pe-1"
    management-interface {
        configuration-mode model-driven
        cli {
            cli-engine [md-cli classic-cli]
        }
        yang-modules {
            nokia-submodules true
            nokia-combined-modules false
        }
        snmp {
            admin-state disable
        }
    }
    ip {
        allow-qinq-network-interface true
    }
    bluetooth {
        advertising-timeout 30
    }
    login-control {
        idle-timeout none
    }
    security {
        aaa {
            local-profiles {
                profile "administrative" {
                    default-action permit-all
                    entry 10 {
                        match "configure system security"
                        action permit
                    }
                    entry 20 {
                        match "show system security"
                        action permit
                    }
                    entry 30 {
                        match "tools perform security"
                        action permit
                    }
                    entry 40 {
                        match "tools dump security"
                        action permit
                    }
                    entry 50 {
                        match "admin system security"
                        action permit
                    }
                    entry 100 {
                        match "configure li"
                        action deny
                    }
                }
            }
        }
    }
}
```

```
    }
    entry 110 {
        match "show li"
        action deny
    }
    entry 111 {
        match "clear li"
        action deny
    }
    entry 112 {
        match "tools dump li"
        action deny
    }
    netconf {
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            kill-session true
            lock true
            validate true
        }
    }
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
        action permit
    }
    entry 50 {
        match "password"
        action permit
    }
    entry 60 {
        match "show config"
        action deny
    }
    entry 65 {
        match "show li"
        action deny
    }
    entry 66 {
```

```
        match "clear li"
        action deny
    }
    entry 67 {
        match "tools dump li"
        action deny
    }
    entry 68 {
        match "state li"
        action deny
    }
    entry 70 {
        match "show"
        action permit
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
    netconf {
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            validate true
        }
    }
}
ssh {
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
```

```
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
client-cipher-list-v2 {
    cipher 190 {
        name aes256-ctr
    }
    cipher 192 {
        name aes192-ctr
    }
    cipher 194 {
        name aes128-ctr
    }
    cipher 200 {
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
server-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
}
```



```
        type origination
      }
    }
  }
  fpe 2 {
    path {
      pxc 2
    }
    application {
      srv6 {
        type termination
      }
    }
  }
}
log {
  filter "1001" {
    named-entry "10" {
      description "Collect only events of major severity or higher"
      action forward
      match {
        severity {
          gte major
        }
      }
    }
  }
  log-id "100" {
    description "Default Serious Errors Log"
    filter "1001"
    source {
      main true
    }
    destination {
      memory {
        max-entries 500
      }
    }
  }
  log-id "99" {
    description "Default System Log"
    source {
      main true
    }
    destination {
      memory {
        max-entries 500
      }
    }
  }
}
port pxc-1.a {
  admin-state enable
}
port pxc-1.b {
  admin-state enable
}
port pxc-2.a {
  admin-state enable
}
port pxc-2.b {
  admin-state enable
}
port 1/1/c1 {
```

```
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
```

```
}
port 1/1/c2 {
  admin-state enable
  connector {
    breakout c10-10g
  }
}
port 1/1/c2/1 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/2 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/3 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/4 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/5 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/6 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/7 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/8 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/9 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c2/10 {
  admin-state enable
  ethernet {
```

```
        mode hybrid
    }
}
port 1/1/c3 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c3/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/10 {
```

```
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c4 {
    admin-state enable
    connector {
        breakout c4-10g
    }
}
port 1/1/c4/1 {
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
}
port 1/1/c5 {
}
port 1/1/c6 {
}
port 1/2/c1 {
}
port 1/2/c2 {
}
port 1/2/c3 {
}
port 1/2/c4 {
}
port 1/2/c5 {
}
port 1/2/c6 {
}
port-xc {
    pxc 1 {
        admin-state enable
        port-id 1/1/c4/1
    }
    pxc 2 {
        admin-state enable
        port-id 1/1/c4/1
    }
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.6
    interface "int-1-pe-2-bng-1" {
        port 1/1/c1/7:1
        ipv6 {
            address 2001:db8::802 {
                prefix-length 120
            }
        }
    }
    interface "int-1-pe-2-bng-2" {
        port 1/1/c1/8:1
        ipv6 {
            address 2001:db8::902 {
                prefix-length 120
            }
        }
    }
}
```

```
}
interface "system" {
  ipv4 {
    primary {
      address 192.0.2.6
      prefix-length 32
    }
  }
  ipv6 {
    bfd {
      admin-state enable
      transmit-interval 100
      receive 100
      multiplier 2
    }
    address 2001:db8::6 {
      prefix-length 128
    }
  }
}
interface "to-ixia" {
  port 1/1/c3/1:1
  ipv4 {
    primary {
      address 172.16.101.1
      prefix-length 24
    }
  }
  ipv6 {
    address 2001:db8::6501 {
      prefix-length 120
    }
  }
}
interface "to-radius" {
  port 1/1/c3/10:114
  ipv4 {
    primary {
      address 192.168.114.6
      prefix-length 24
    }
  }
}
bgp {
  admin-state enable
  bfd-liveness true
  rapid-withdrawal true
  rapid-update {
    vpn-ipv4 true
    vpn-ipv6 true
  }
  extended-nh-encoding {
    vpn-ipv4 true
  }
  advertise-ipv6-next-hops {
    vpn-ipv6 true
    vpn-ipv4 true
  }
  group "ipvpn" {
    peer-as 64500
    local-address 2001:db8::6
    bfd-liveness true
    family {
      vpn-ipv4 true
    }
  }
}
```

```
        vpn-ipv6 true
    }
}
neighbor "2001:db8::14" {
    group "ipvpn"
}
neighbor "2001:db8::15" {
    group "ipvpn"
}
}
isis 1 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    loopfree-alternate {
        remote-lfa {
        }
        ti-lfa {
        }
    }
}
traffic-engineering-options {
    ipv6 true
    application-link-attributes {
    }
}
}
segment-routing-v6 {
    admin-state enable
    locator "pe-2-loc" {
        level-capability 2
        level 2 {
            metric 10
        }
    }
}
}
interface "int-1-pe-2-bng-1" {
}
interface "int-1-pe-2-bng-2" {
}
interface "system" {
}
interface "to-ixia" {
}
level 2 {
    wide-metrics-only true
}
}
segment-routing {
    segment-routing-v6 {
        origination-fpe [1]
        source-address 2001:db8::6
        locator "pe-2-loc" {
            admin-state enable
            block-length 48
            termination-fpe [2]
            prefix {
                ip-prefix 2001:db8:aaaa:6::/64
            }
        }
    }
    base-routing-instance {
        locator "pe-2-loc" {
```



```
        function {
            end 1 {
                srh-mode usp
            }
            end-x-auto-allocate usp protection protected { }
        }
    }
}
service {
    vprn "dual-homing" {
        admin-state enable
        service-id 10
        customer "1"
        segment-routing-v6 1 {
            locator "pe-2-loc" {
                function {
                    end-dt4 {
                    }
                    end-dt6 {
                    }
                }
            }
        }
    }
    bgp-ipvpn {
        segment-routing-v6 1 {
            admin-state enable
            route-distinguisher "192.0.2.6:10"
            source-address 2001:db8::6
            vrf-target {
                community "target:64500:10"
            }
            srv6 {
                instance 1
                default-locator "pe-2-loc"
            }
        }
    }
    interface "vprn-10-to-ixia" {
        ipv4 {
            primary {
                address 172.16.102.1
                prefix-length 24
            }
        }
        sap 1/1/c3/1:2 {
        }
        ipv6 {
            address 2001:db8::6601 {
                prefix-length 120
            }
        }
    }
    ipv6 {
        router-advertisement {
            interface "vprn-10-to-ixia" {
                admin-state enable
                max-advertisement-interval 15
                min-advertisement-interval 10
            }
        }
    }
}
```

```
    }
  }
  system {
    name "pe-2"
    management-interface {
      configuration-mode model-driven
      cli {
        cli-engine [md-cli classic-cli]
      }
      yang-modules {
        nokia-submodules true
        nokia-combined-modules false
      }
      snmp {
        admin-state disable
      }
    }
    bluetooth {
      advertising-timeout 30
    }
    login-control {
      idle-timeout none
    }
    security {
      aaa {
        local-profiles {
          profile "administrative" {
            default-action permit-all
            entry 10 {
              match "configure system security"
              action permit
            }
            entry 20 {
              match "show system security"
              action permit
            }
            entry 30 {
              match "tools perform security"
              action permit
            }
            entry 40 {
              match "tools dump security"
              action permit
            }
            entry 50 {
              match "admin system security"
              action permit
            }
            entry 100 {
              match "configure li"
              action deny
            }
            entry 110 {
              match "show li"
              action deny
            }
            entry 111 {
              match "clear li"
              action deny
            }
            entry 112 {
              match "tools dump li"
              action deny
            }
          }
        }
      }
    }
  }
}
```

```
netconf {
  base-op-authorization {
    action true
    cancel-commit true
    close-session true
    commit true
    copy-config true
    create-subscription true
    delete-config true
    discard-changes true
    edit-config true
    get true
    get-config true
    get-data true
    get-schema true
    kill-session true
    lock true
    validate true
  }
}
profile "default" {
  entry 10 {
    match "exec"
    action permit
  }
  entry 20 {
    match "exit"
    action permit
  }
  entry 30 {
    match "help"
    action permit
  }
  entry 40 {
    match "logout"
    action permit
  }
  entry 50 {
    match "password"
    action permit
  }
  entry 60 {
    match "show config"
    action deny
  }
  entry 65 {
    match "show li"
    action deny
  }
  entry 66 {
    match "clear li"
    action deny
  }
  entry 67 {
    match "tools dump li"
    action deny
  }
  entry 68 {
    match "state li"
    action deny
  }
  entry 70 {
    match "show"
  }
}
```

```
        action permit
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
ssh {
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
        cipher 225 {
            name aes192-cbc
        }
        cipher 230 {
            name aes256-cbc
        }
    }
    client-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
        cipher 225 {
            name aes192-cbc
        }
    }
}
```


users.radius

```
#
# Configuration file for the rlm_files module.
# Please see rlm_files(5) manpage for more information.
#
# This file contains authentication security and configuration
# information for each user. Accounting requests are NOT processed
# through this file. Instead, see 'accounting', in this directory.
#
# The first field is the user's name and can be up to
# 253 characters in length. This is followed (on the same line) with
# the list of authentication requirements for that user. This can
# include password, comm server name, comm server port number, protocol
# type (perhaps set by the "hints" file), and huntgroup name (set by
# the "huntgroups" file).
#
# If you are not sure why a particular reply is being sent by the
# server, then run the server in debugging mode (radiusd -X), and
# you will see which entries in this file are matched.
#
# When an authentication request is received from the comm server,
# these values are tested. Only the first match is used unless the
# "Fall-Through" variable is set to "Yes".
#
# A special user named "DEFAULT" matches on all usernames.
# You can have several DEFAULT entries. All entries are processed
# in the order they appear in this file. The first entry that
# matches the login-request will stop processing unless you use
# the Fall-Through variable.
#
# Indented (with the tab character) lines following the first
# line indicate the configuration values to be passed back to
# the comm server to allow the initiation of a user session.
# This can include things like the PPP configuration values
# or the host to log the user onto.
#
# You can include another `users' file with `INCLUDE users.other'
#
# For a list of RADIUS attributes, and links to their definitions,
# see: http://www.freeradius.org/rfc/attributes.html
#
# Entries below this point are examples included in the server for
# educational purposes. They may be deleted from the deployed
# configuration without impacting the operation of the server.
#
#####
# You should add test accounts to the TOP of this file! #
# See the example user "bob" above. #
#####

cid-1      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-1",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
```

```
Alc-Int-Dest-Id-Str = "vport-1",
  Fall-Through = No

cid-2      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-2",
Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
  Fall-Through = No

cid-3      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-3",
Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
  Fall-Through = No

cid-4      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-4",
Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
  Fall-Through = No

cid-5      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-5",
Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
  Fall-Through = No

cid-6      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-6",
Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
Framed-IPv6-Pool = "dhcpv6-1",
```

```
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
    Fall-Through = No

cid-7      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-7",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-1",
           Fall-Through = No

cid-8      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-8",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-1",
           Fall-Through = No

cid-9      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-9",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-1",
           Fall-Through = No

cid-10     Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-10",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-2",
           Fall-Through = No

pppoe-1    Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "pppoe-1",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "pppoev4-1",
```



```
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
    Fall-Through = No

pppoe-2      Cleartext-Password := "cse-password"
              Alc-Subsc-ID-Str = "pppoe-2",
Alc-Subsc-Prof-Str = "sub-profile-1",
              Alc-SLA-Prof-Str = "sla-profile-1",
              Alc-MSAP-Interface = "group-int-1",
              Alc-MSAP-Policy = "msap-policy-1",
              Alc-MSAP-Serv-Id = "10",
              Framed-Pool = "pppoev4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
    Fall-Through = No

pppoe-3      Cleartext-Password := "cse-password"
              Alc-Subsc-ID-Str = "pppoe-3",
Alc-Subsc-Prof-Str = "sub-profile-1",
              Alc-SLA-Prof-Str = "sla-profile-1",
              Alc-MSAP-Interface = "group-int-1",
              Alc-MSAP-Policy = "msap-policy-1",
              Alc-MSAP-Serv-Id = "10",
              Framed-Pool = "pppoev4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
    Fall-Through = No

pppoe-4      Cleartext-Password := "cse-password"
              Alc-Subsc-ID-Str = "pppoe-4",
Alc-Subsc-Prof-Str = "sub-profile-1",
              Alc-SLA-Prof-Str = "sla-profile-1",
              Alc-MSAP-Interface = "group-int-1",
              Alc-MSAP-Policy = "msap-policy-1",
              Alc-MSAP-Serv-Id = "10",
              Framed-Pool = "pppoev4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
    Fall-Through = No

pppoe-5      Cleartext-Password := "cse-password"
              Alc-Subsc-ID-Str = "pppoe-5",
Alc-Subsc-Prof-Str = "sub-profile-1",
              Alc-SLA-Prof-Str = "sla-profile-1",
              Alc-MSAP-Interface = "group-int-1",
              Alc-MSAP-Policy = "msap-policy-1",
              Alc-MSAP-Serv-Id = "10",
              Framed-Pool = "pppoev4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
    Fall-Through = No

pppoe-6      Cleartext-Password := "cse-password"
              Alc-Subsc-ID-Str = "pppoe-6",
Alc-Subsc-Prof-Str = "sub-profile-1",
              Alc-SLA-Prof-Str = "sla-profile-1",
              Alc-MSAP-Interface = "group-int-1",
              Alc-MSAP-Policy = "msap-policy-1",
              Alc-MSAP-Serv-Id = "10",
```

```
        Framed-Pool = "pppoev4-1",
        Framed-IPv6-Pool = "dhcpv6-1",
        Alc-Delegated-IPv6-Pool = "dhcpv6-1",
        Alc-Int-Dest-Id-Str = "vport-1",
        Fall-Through = No

pppoe-7      Cleartext-Password := "cse-password"
             Alc-Subsc-ID-Str = "pppoe-7",
             Alc-Subsc-Prof-Str = "sub-profile-1",
             Alc-SLA-Prof-Str = "sla-profile-1",
             Alc-MSAP-Interface = "group-int-1",
             Alc-MSAP-Policy = "msap-policy-1",
             Alc-MSAP-Serv-Id = "10",
             Framed-Pool = "pppoev4-1",
             Framed-IPv6-Pool = "dhcpv6-1",
             Alc-Delegated-IPv6-Pool = "dhcpv6-1",
             Alc-Int-Dest-Id-Str = "vport-1",
             Fall-Through = No

pppoe-8      Cleartext-Password := "cse-password"
             Alc-Subsc-ID-Str = "pppoe-8",
             Alc-Subsc-Prof-Str = "sub-profile-1",
             Alc-SLA-Prof-Str = "sla-profile-1",
             Alc-MSAP-Interface = "group-int-1",
             Alc-MSAP-Policy = "msap-policy-1",
             Alc-MSAP-Serv-Id = "10",
             Framed-Pool = "pppoev4-1",
             Framed-IPv6-Pool = "dhcpv6-1",
             Alc-Delegated-IPv6-Pool = "dhcpv6-1",
             Alc-Int-Dest-Id-Str = "vport-1",
             Fall-Through = No

pppoe-9      Cleartext-Password := "cse-password"
             Alc-Subsc-ID-Str = "pppoe-9",
             Alc-Subsc-Prof-Str = "sub-profile-1",
             Alc-SLA-Prof-Str = "sla-profile-1",
             Alc-MSAP-Interface = "group-int-1",
             Alc-MSAP-Policy = "msap-policy-1",
             Alc-MSAP-Serv-Id = "10",
             Framed-Pool = "pppoev4-1",
             Framed-IPv6-Pool = "dhcpv6-1",
             Alc-Delegated-IPv6-Pool = "dhcpv6-1",
             Alc-Int-Dest-Id-Str = "vport-1",
             Fall-Through = No

pppoe-10     Cleartext-Password := "cse-password"
             Alc-Subsc-ID-Str = "pppoe-10",
             Alc-Subsc-Prof-Str = "sub-profile-1",
             Alc-SLA-Prof-Str = "sla-profile-1",
             Alc-MSAP-Interface = "group-int-1",
             Alc-MSAP-Policy = "msap-policy-1",
             Alc-MSAP-Serv-Id = "10",
             Framed-Pool = "pppoev4-1",
             Framed-IPv6-Pool = "dhcpv6-1",
             Alc-Delegated-IPv6-Pool = "dhcpv6-1",
             Alc-Int-Dest-Id-Str = "vport-2",
             Fall-Through = No
```

Show commands

In this section, the following show commands are used:

```
# FPE
====
show fwd-path-ext fpe 1 associations
show fwd-path-ext fpe 1

# EVPN
====
show service id "evpn-dual-homing" base
show service id "evpn-dual-homing" bgp-evpn
show service system bgp-evpn ethernet-segment name "ES-1"
show service system bgp-evpn ethernet-segment name "ES-1" evi evi-1 11
show router bgp routes evpn eth-seg detail
show router bgp routes evpn auto-disc tag 1 detail
show service id "evpn-dual-homing" ethernet-segment "ES-1"
show service id "evpn-dual-homing" segment-routing-v6 detail
show service id "evpn-dual-homing" segment-routing-v6 instance 1 destinations
show service id "evpn-dual-homing" segment-routing-v6 instance 1 end-dx2
show service id "evpn-dual-homing" segment-routing-v6 instance 1 locator "bng-1-loc"

# IP-VPN
====
show service id "dual-homing" base
show service id "dual-homing" bgp-ipvpn segment-routing-v6
show service id "dual-homing" segment-routing-v6 instance 1 locator "bng-2-loc"
show router 10 route-table
show router 10 route-table ipv6
show router bgp routes vpn-ipv4 hunt
show router bgp routes vpn-ipv6 hunt

# SRv6
====
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router segment-routing-v6 local-sid context "10"

# GRT router and tunnel table
====
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6

# BGP
====
show router bgp summary

# MCS
====
show redundancy multi-chassis sync peer 192.0.2.20 detail
tools dump redundancy multi-chassis sync-database

# subscribers:
====
show service active-subscribers summary
show service active-subscribers hierarchy
show service id 10 subscriber-hosts detail
show service id 10 ipoe session
show service id 10 pppoe session
show service id 10 dhcp lease-state
show service id 10 dhcp6 lease-state
show srrp 1 detail
```

```
# DHCP server:
====
show router 10 dhcp local-dhcp-server "dhcpv4" summary
show router 10 dhcp6 local-dhcp-server "dhcpv6" summary
show router 10 dhcp local-dhcp-server "dhcpv4" leases
show router 10 dhcp6 local-dhcp-server "dhcpv6" leases

#
=====
show port
show router interface
show router 10 interface
show fwd-path-ext fpe 1
show fwd-path-ext fpe 2
show fwd-path-ext fpe 3
show service id "evpn-dual-homing" base
show service id "evpn-dual-homing" bgp-evpn
show service system bgp-evpn ethernet-segment name "ES-1"
show service system bgp-evpn ethernet-segment name "ES-1" evi evi-1 11
show router bgp routes evpn eth-seg detail
show router bgp routes evpn auto-disc tag 1 detail
show service id "evpn-dual-homing" ethernet-segment "ES-1"
show service id "evpn-dual-homing" segment-routing-v6 detail
show service id "evpn-dual-homing" segment-routing-v6 instance 1 destinations
show service id "evpn-dual-homing" segment-routing-v6 instance 1 end-dx2
show service id "evpn-dual-homing" segment-routing-v6 instance 1 locator "bng-1-loc"
show service id "dual-homing" base
show service id "dual-homing" bgp-ipvpn segment-routing-v6
show service id "dual-homing" segment-routing-v6 instance 1 locator "bng-1-loc"
show router 10 route-table
show router 10 route-table ipv6
show router bgp routes vpn-ipv4 hunt
show router bgp routes vpn-ipv6 hunt
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router segment-routing-v6 local-sid context "10"
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
show router bgp summary
show router isis adjacency
show router isis database
show router isis 1 adjacency
show router isis 1 database
show redundancy multi-chassis sync peer 192.0.2.21 detail
tools dump redundancy multi-chassis sync-database
show service active-subscribers summary
show service active-subscribers hierarchy
show service id 10 subscriber-hosts detail
show service id 10 ipoe session
show service id 10 pppoe session
show service id 10 dhcp lease-state
show service id 10 dhcp6 lease-state
show srrp 1 detail
show router 10 dhcp local-dhcp-server "dhcpv4" summary
show router 10 dhcp6 local-dhcp-server "dhcpv6" summary
show router 10 dhcp local-dhcp-server "dhcpv4" leases
show router 10 dhcp6 local-dhcp-server "dhcpv6" leases

#
====
show port
show router interface
```

```
show router 10 interface
show fwd-path-ext fpe 1
show fwd-path-ext fpe 2
show fwd-path-ext fpe 3
show service id "evpn-dual-homing" base
show service id "evpn-dual-homing" bgp-evpn
show service system bgp-evpn ethernet-segment name "ES-1"
show service system bgp-evpn ethernet-segment name "ES-1" evi evi-1 11
show router bgp routes evpn eth-seg detail
show router bgp routes evpn auto-disc tag 1 detail
show service id "evpn-dual-homing" ethernet-segment "ES-1"
show service id "evpn-dual-homing" segment-routing-v6 detail
show service id "evpn-dual-homing" segment-routing-v6 instance 1 destinations
show service id "evpn-dual-homing" segment-routing-v6 instance 1 end-dx2
show service id "evpn-dual-homing" segment-routing-v6 instance 1 locator "bng-2-loc"
show service id "dual-homing" base
show service id "dual-homing" bgp-ipvpn segment-routing-v6
show service id "dual-homing" segment-routing-v6 instance 1 locator "bng-2-loc"
show router 10 route-table
show router 10 route-table ipv6
show router bgp routes vpn-ipv4 hunt
show router bgp routes vpn-ipv6 hunt
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router segment-routing-v6 local-sid context "10"
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
show router bgp summary
show router isis adjacency
show router isis database
show router isis 1 adjacency
show router isis 1 database
show router isis 1 database
show redundancy multi-chassis sync peer 192.0.2.20 detail
tools dump redundancy multi-chassis sync-database
show service active-subscribers summary
show service active-subscribers hierarchy
show service id 10 subscriber-hosts detail
show service id 10 ipoe session
show service id 10 pppoe session
show service id 10 dhcp lease-state
show service id 10 dhcp6 lease-state
show srrp 1 detail
show router 10 dhcp local-dhcp-server "dhcpv4" summary
show router 10 dhcp6 local-dhcp-server "dhcpv6" summary
show router 10 dhcp local-dhcp-server "dhcpv4" leases
show router 10 dhcp6 local-dhcp-server "dhcpv6" leases

# on PE-1:
====
show port
show router interface
show fwd-path-ext fpe 1
show fwd-path-ext fpe 2
show service id "dual-homing" base
show service id "dual-homing" bgp-evpn
show router bgp routes evpn auto-disc tag 2 detail
show service id "dual-homing" segment-routing-v6 detail
show service id "dual-homing" segment-routing-v6 instance 1 destinations
show service id "dual-homing" segment-routing-v6 instance 1 end-dx2
show service id "dual-homing" segment-routing-v6 instance 1 locator "pe-1-loc"
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
```

```
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
show router bgp summary
show router isis adjacency
show router isis database

# on PE-2:
=====
show port
show router interface
show router 10 interface
show fwd-path-ext fpe 1
show fwd-path-ext fpe 2
show service id "dual-homing" base
show service id "dual-homing" bgp-ipvpn segment-routing-v6
show service id "dual-homing" segment-routing-v6 instance 1 locator "pe-2-loc"
show router 10 route-table
show router 10 route-table ipv6
show router bgp routes vpn-ipv4 hunt
show router bgp routes vpn-ipv6 hunt
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router segment-routing-v6 local-sid context "10"
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
show router bgp summary
show router isis 1 adjacency
show router isis 1 database

# on P-1:
=====
show port
show router interface
show fwd-path-ext fpe 1
show fwd-path-ext fpe 2
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
show router isis adjacency
show router isis database

# on P-2:
=====
show port
show router interface
show fwd-path-ext fpe 1
show fwd-path-ext fpe 2
show router segment-routing-v6 base-routing-instance all
show router segment-routing-v6 local-sid context "Base"
show router route-table ipv6
show router tunnel-table ipv6
show router fp-tunnel-table 1 ipv6
show router isis adjacency
show router isis database
```

The output of several show commands is provided for the following nodes:

- bng-1
- p-1

- pe-1

Show commands on bng-1

```
A:admin@bng-1# /show port
```

```
=====
Ports on Slot 1
=====
```

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
1/1/c1	Up		Link Up						conn	100GBASE-LR4*
1/1/c1/1	Up	Yes	Up	8936	8936	-	hybr dotq		xgige	
1/1/c1/2	Down	No	Down	8936	8936	-	hybr dotq		xgige	
1/1/c1/3	Down	No	Down	8936	8936	-	hybr dotq		xgige	
1/1/c1/4	Up	Yes	Up	8936	8936	-	hybr dotq		xgige	
1/1/c1/5	Up	No	Down	8936	8936	-	hybr dotq		xgige	
1/1/c1/6	Up	Yes	Up	8936	8936	-	hybr dotq		xgige	
1/1/c1/7	Up	Yes	Up	8936	8936	-	hybr dotq		xgige	
1/1/c1/8	Up	No	Down	8936	8936	-	hybr dotq		xgige	
1/1/c1/9	Up	No	Down	8936	8936	-	hybr dotq		xgige	
1/1/c1/10	Up	Yes	Up	8936	8936	-	hybr dotq		xgige	
1/1/c2	Up		Link Up						conn	100G CWDM4 M*
1/1/c2/1	Up	Yes	Up	8936	8936	-	hybr dotq		cgige	
1/1/c3	Down		Down						conn	100G CLR4 *
1/1/c4	Up		Link Up						conn	100GBASE-LR4*
1/1/c4/1	Up	Yes	Up	8936	8936	-	hybr dotq		xgige	
1/1/c4/2	Up	No	Down	8936	8936	-	netw null		xgige	
1/1/c4/3	Up	No	Down	8936	8936	-	netw null		xgige	
1/1/c4/4	Up	No	Down	8936	8936	-	hybr dotq		xgige	
1/1/c5	Down		Down						conn	100G CWDM4 M*
1/1/c6	Down		Down						conn	100G CLR4 *
1/2/c1	Down		Down						conn	100GBASE-LR4*
1/2/c2	Down		Down						conn	100G CWDM4 M*
1/2/c3	Down		Down						conn	100G CLR4 *
1/2/c4	Down		Down						conn	100GBASE-LR4*
1/2/c5	Down		Down						conn	100G CWDM4 M*
1/2/c6	Down		Down						conn	100G CLR4 *

```
=====
Ports on Slot A
=====
```

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
A/1	Up	Yes	Up	1514	1514	-	netw null		faste	MDI
A/3	Down	No	Down	1514	1514	-	netw null		faste	
A/4	Down	No	Down	1514	1514	-	netw null		faste	

```
=====
Ports on Slot B
=====
```

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
B/1	Up	No	Ghost	1514	1514	-	netw null		faste	
B/3	Down	No	Ghost	1514	1514	-	netw null		faste	
B/4	Down	No	Ghost	1514	1514	-	netw null		faste	

```
=====
Ports on Port Cross Connect 1
=====
```

```

Port      Admin Link Port   Cfg  Oper  LAG/  Port  Port  Port   C/QS/S/XFP/
Id        State      State State  MTU  MTU  Bndl  Mode  Encp  Type   MDIMDX
-----
pxc-1.a   Up    Yes  Up     8932 8932  -    hybr dotq xgige
pxc-1.b   Up    Yes  Up     8932 8932  -    hybr dotq xgige

=====
Ports on Port Cross Connect 2
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port  Port  Port   C/QS/S/XFP/
Id        State      State State  MTU  MTU  Bndl  Mode  Encp  Type   MDIMDX
-----
pxc-2.a   Up    Yes  Up     8932 8932  -    hybr dotq xgige
pxc-2.b   Up    Yes  Up     8932 8932  -    hybr dotq xgige

=====
Ports on Port Cross Connect 3
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port  Port  Port   C/QS/S/XFP/
Id        State      State State  MTU  MTU  Bndl  Mode  Encp  Type   MDIMDX
-----
pxc-3.a   Up    Yes  Up     8932 8932  -    hybr dotq xgige
pxc-3.b   Up    Yes  Up     8932 8932  -    hybr dotq xgige

=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router interface

=====
Interface Table (Router: Base)
=====
Interface-Name      Adm    Opr(v4/v6)  Mode    Port/SapId
IP-Address          PfxState
-----
_tmnx_fpe_1.a      Up     Up/Up       Network pxc-1.a:1
 fe80::100/64      PREFERRED
_tmnx_fpe_1.b      Up     Up/Up       Network pxc-1.b:1
 fe80::101/64      PREFERRED
_tmnx_fpe_2.a      Up     Up/Up       Network pxc-2.a:1
 fe80::200/64      PREFERRED
_tmnx_fpe_2.b      Up     Up/Up       Network pxc-2.b:1
 fe80::201/64      PREFERRED
_tmnx_fpe_3.a      Up     Up/Up       Network pxc-3.a:1
 fe80::300/64      PREFERRED
_tmnx_fpe_3.b      Up     Up/Up       Network pxc-3.b:1
 fe80::301/64      PREFERRED
int-1-bng-1-bng-2  Up     Up/Up       Network 1/1/c1/6:1
 192.168.7.1/24    n/a
 2001:db8::701/120 PREFERRED
 fe80::b696:ffff:fe00:0/64 PREFERRED
int-1-bng-1-p-1    Up     Down/Up     Network 1/1/c1/1:1
 2001:db8::501/120 PREFERRED
 fe80::b696:ffff:fe00:0/64 PREFERRED
int-1-bng-1-pe-2   Up     Down/Up     Network 1/1/c1/7:1
 2001:db8::801/120 PREFERRED
 fe80::b696:ffff:fe00:0/64 PREFERRED
system             Up     Up/Up       Network system
 192.0.2.20/32     n/a
 2001:db8::14/128  PREFERRED
to-radius          Up     Up/Down     Network 1/1/c1/10:114
 192.168.114.20/24 n/a
    
```



```

-----
Interfaces : 11
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 interface

=====
Interface Table (Service: 10)
=====
Interface-Name      Adm      Opr(v4/v6)  Mode      Port/SapId
IP-Address          PfxState
-----
group-int-1         Up        Up/Up       VPRN G*  pw-1
loopback-1          Up        Up/Up       VPRN     loopback
192.168.0.1/32      n/a
2001:db8::1/128    PREFERRED
fe80::b696:ffff:fe00:0/64  PREFERRED
red-int-bng-1-bng-2 Up        Up/Up       VPRN R*  spoke-1:1
192.168.11.1/24    n/a
sub-int-1           Up        Up/Up       VPRN S*  subscriber
10.10.0.1/24       n/a
10.10.1.1/24       n/a
2001:db8:bbbb::/56  PREFERRED
2001:db8:bbbb:100::/56  PREFERRED
fe80::b696:ffff:fe00:0/64  PREFERRED
-----

Interfaces : 4
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show fwd-path-ext fpe 1

=====
FPE Id: 1
=====
Description      : srv6 origination
Multi-Path       : Disabled
Path             : pxc 1
Pw Port Extension : Disabled          Oper      : down
Sub Mgmt Extension : Disabled          Oper      : N/A
Vxlan            : Disabled          Oper      : down
Segment-Routing V6 : Enabled          Oper      : up
SRv6 Type        : origination
If-A Qos Policy   : default
If-B MTU          : 9786 bytes      Oper MTU  : 8914 bytes
If-B Qos Policy   : default
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show fwd-path-ext fpe 2

=====
FPE Id: 2
    
```

```

=====
Description      : srv6 termination
Multi-Path      : Disabled
Path            : pxc 2
Pw Port Extension : Disabled          Oper    : down
Sub Mgmt Extension : Disabled          Oper    : N/A
Vxlan           : Disabled          Oper    : down
Segment-Routing V6 : Enabled          Oper    : up
SRv6 Type       : termination
If-A Qos Policy  : default
If-B MTU         : 0 bytes           Oper MTU : 8914 bytes
If-B Qos Policy  : default
=====
    
```

```

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show fwd-path-ext fpe 3
    
```

```

=====
FPE Id: 3
=====
    
```

```

Description      : pw-port on a single port
Multi-Path      : Disabled
Path            : pxc 3
Pw Port Extension : Enabled          Oper    : up
Sub Mgmt Extension : Disabled          Oper    : N/A
Vxlan           : Disabled          Oper    : down
Segment-Routing V6 : Disabled
If-A Qos Policy  : default
If-B Qos Policy  : default
=====
    
```

```

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" base
    
```

```

=====
Service Basic Information
=====
    
```

```

Service Id       : 11                Vpn Id          : 0
Service Type     : Epipe
MACSec enabled   : no
Name             : evpn-dual-homing
Description      : (Not Specified)
Customer Id      : 1                Creation Origin  : manual
Last Status Change: 11/12/2022 16:22:36
Last Mgmt Change  : 11/12/2022 16:21:35
Test Service     : No
Admin State      : Up                Oper State       : Up
MTU              : 1514
Vc Switching     : False
SAP Count        : 0                SDP Bind Count   : 1
Per Svc Hashing  : Disabled          Lbl Eth/IP L4 TEID: Disabled
Ignore MTU Mismatch*: Disabled
Vxlan Src Tep Ip : N/A
Force QTag Fwd   : Disabled
Lcl Switch Svc St : sap
Oper Group       : <none>
    
```

```

Service Access & Destination Points
-----
Identifier                               Type      AdmMTU  OprMTU  Adm  Opr
-----
sdp:17500:1 SB(fpe_3.b)                  Fpe       0       8910   Up   Up
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" bgp-evpn

=====
BGP EVPN Table
=====
EVI          : 11                Creation Origin   : manual

-----
Local AC Name      Eth Tag  Endpoint          Ingress Label
-----
bng                2                0

Number of local ACs : 1

-----
Remote AC Name      Eth Tag  Endpoint
-----
access              1

Number of Remote ACs : 1

=====
Segment Routing v6 Instance 1 Service 11
=====
Admin State          : Enabled
Srv6 Instance        : 1
Default Locator      : bng-1-loc

Oper Group           : (Not Specified)
Default Route Tag    : 0xb
Source Address        : 2001:db8::14
ECMP                  : 1
Force Vlan VC Fwd    : disabled
Next Hop Type        : system-ipv6
Evi 3-byte Auto-RT   : disabled
Route Resolution      : fallback-tunnel-to-route-table
Force QinQ VC Fwd    : none
MH Mode              : network

=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service system bgp-evpn ethernet-segment name "ES-1"

=====
Service Ethernet Segment
=====
Name                : ES-1
Eth Seg Type        : None
    
```

```

Admin State      : Enabled          Oper State      : Up
ESI             : 01:01:01:01:01:01:01:01:01
Oper ESI        : 01:01:01:01:01:01:01:01:01
Auto-ESI Type   : None
AC DF Capability : Include
Multi-homing    : singleActive      Oper Multi-homing : singleActive
ES SHG Label    : None
Source BMAC LSB : None
PW Port Id      : 1
PW Port Headend : enabled
ES Activation Timer : 0 secs
Oper Group      : ES-1
Svc Carving     : manual            Oper Svc Carving  : manual
Cfg Range Type  : lowest-pref

-----
DF Pref Election Information
-----
Preference      Preference   Last Admin Change   Oper Pref   Do No
Mode            Value                               Value       Preempt
-----
revertive      150           11/12/2022 16:21:35   150         Disabled
-----

EVI Ranges: <none>
ISID Ranges: <none>
Vprn NextHop EVI Ranges : <none>
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service system bgp-evpn ethernet-segment name "ES-1" evi evi-1 11

=====
EVI DF and Candidate List
=====
EVI      SvcId      Actv Timer Rem      DF  DF Last Change
-----
11       11         0                   yes 11/12/2022 16:21:35
=====

DF Candidates                               Oper Pref   Do Not
                                           Value       Preempt
-----
2001:db8::14                            11/12/2022 16:23:33  150         Disabl*
2001:db8::15                            11/12/2022 16:22:36   50         Disabl*
-----

Number of entries: 2
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes evpn eth-seg detail

=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====

Legend -
Status codes : u - used, s - suppressed, h - history, d - decayed, * - valid
              l - leaked, x - stale, > - best, b - backup, p - purge
    
```

Origin codes : i - IGP, e - EGP, ? - incomplete

=====

BGP EVPN Eth-Seg Routes

=====

Original Attributes

Network : n/a
NextHop : 2001:db8::15
Path Id : None
From : 2001:db8::15
Res. NextHop : fe80::b697:ffff:fe00:0
Local Pref. : 100
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric : None
Connector : None
Community :
df-election::DF-Type:Preference/DP:0/DF-Preference:50/AC:1
target:01:01:01:01:01:01
Cluster : No Cluster Members
Originator Id : None
Flags : Used Valid Best IGP
Route Source : Internal
AS-Path : No As-Path
EVPN type : ETH-SEG
ESI : 01:01:01:01:01:01:01:01:01
Originator IP : 2001:db8::15
Route Dist. : 192.0.2.21:0
Route Tag : 0
Neighbor-AS : n/a
Orig Validation: N/A
Source Class : 0
Add Paths Send : Default
Last Modified : 01d23h12m

Modified Attributes

Network : n/a
NextHop : 2001:db8::15
Path Id : None
From : 2001:db8::15
Res. NextHop : fe80::b697:ffff:fe00:0
Local Pref. : 100
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric : None
Connector : None
Community :
df-election::DF-Type:Preference/DP:0/DF-Preference:50/AC:1
target:01:01:01:01:01:01
Cluster : No Cluster Members
Originator Id : None
Flags : Used Valid Best IGP
Route Source : Internal
AS-Path : No As-Path
EVPN type : ETH-SEG
ESI : 01:01:01:01:01:01:01:01:01
Originator IP : 2001:db8::15
Route Dist. : 192.0.2.21:0
Route Tag : 0
Neighbor-AS : n/a
Orig Validation: N/A
Source Class : 0

```
Add Paths Send : Default
Last Modified  : 01d23h12m

-----
-----
Routes : 1
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes evpn auto-disc tag 1 detail
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====

Legend -
Status codes : u - used, s - suppressed, h - history, d - decayed, * - valid
              l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete

=====
BGP EVPN Auto-Disc Routes
=====

Original Attributes

Network       : n/a
Nexthop      : 2001:db8::5
Path Id      : None
From         : 2001:db8::5
Res. Nexthop : fe80::b69e:ffff:fe00:0
Local Pref.  : 100
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric  : None
Connector    : None
Community    : color:00:10 target:64500:11
              l2-attribute:MTU: 1514 C: 0 P: 0 B: 0
Cluster      : No Cluster Members
Originator Id : None
Flags        : Used Valid Best IGP
Route Source : Internal
AS-Path      : No As-Path
EVPN type    : AUTO-DISC
ESI          : ESI-0
Tag          : 1
Route Dist.  : 192.0.2.5:11
MPLS Label   : 524288
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:5::
Full Sid      : 2001:db8:aaaa:5:8000::
Behavior      : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48
Func-Len      : 20
Tpose-Len     : 20
Interface Name : int-1-bng-1-p-1
Aggregator     : None
MED            : None
IGP Cost       : 30
Peer Router Id : 192.0.2.5
Dest Class    : 0
Loc-Node-Len  : 16
Arg-Len       : 0
Tpose-offset  : 64
```

Modified Attributes

```

Network      : n/a
Nexthop     : 2001:db8::5
Path Id     : None
From        : 2001:db8::5
Res. Nexthop : fe80::b69e:ffff:fe00:0
Local Pref. : 100
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric  : None
Connector    : None
Community    : color:00:10 target:64500:11
              l2-attribute:MTU: 1514 C: 0 P: 0 B: 0
Cluster     : No Cluster Members
Originator Id : None
Flags       : Used Valid Best IGP
Route Source : Internal
AS-Path     : No As-Path
EVPN type   : AUTO-DISC
ESI         : ESI-0
Tag         : 1
Route Dist. : 192.0.2.5:11
MPLS Label  : 524288
Route Tag   : 0
Neighbor-AS : n/a
Orig Validation: N/A
Source Class : 0
Dest Class  : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:5::
Full Sid      : 2001:db8:aaaa:5:8000::
Behavior      : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48
Func-Len      : 20
Tpose-Len     : 20
Interface Name : int-1-bng-1-p-1
Aggregator    : None
MED           : None
IGP Cost      : 30
Peer Router Id : 192.0.2.5
    
```

 Routes : 1
 =====

```

[/]
A:admin@bng-1#
    
```

```

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" ethernet-segment "ES-1"
No sap entries
No sdp entries
No vxlan instance entries
    
```

=====

SDP Ethernet-Segment Information

=====

Pw-Port	Eth-Seg	Status
1	ES-1	DF

=====

```

[/]
A:admin@bng-1#
    
```

```
[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 detail

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function SID                               Status
-----
bng-1-loc
End.DX2      *524286 2001:db8:aaaa:14:7fff:e000::         ok
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 instance 1 destinations

=====
TEP, SID
=====
Instance  TEP Address                               Segment Id
-----
1          2001:db8::5                                     2001:db8:aaaa:5:8000::
-----
Number of TEP, SID: 1
-----

=====
Segment Routing v6 Ethernet Segment Dest
=====
Instance  Eth SegId                               Num. Macs   Last Change
-----
No Matching Entries
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 instance 1 end-dx2

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function SID                               Status
-----
bng-1-loc
End.DX2      *524286 2001:db8:aaaa:14:7fff:e000::         ok
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 instance 1 locator
"bng-1-loc"
```



```

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function  SID                               Status
-----
bng-1-loc
  End.DX2      *524286  2001:db8:aaaa:14:7fff:e000::    ok
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "dual-homing" base

=====
Service Basic Information
=====
Service Id      : 10                Vpn Id          : 0
Service Type    : VPRN
MACSec enabled  : no
Name            : dual-homing
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/12/2022 16:21:35
Last Mgmt Change : 11/12/2022 16:21:35
Admin State     : Up                Oper State      : Up

Router Oper State : Up
Route Dist.      : None                VPRN Type      : regular
Oper Route Dist  : 0:0
Oper RD Type     : none
AS Number       : None                Router Id      : 192.0.2.20
ECMP             : Enabled            ECMP Max Routes : 1
Max IPv4 Routes  : No Limit
Local Rt Domain-Id: None            D-Path Lng Ignore : Disabled

Auto Bind Tunnel
Allow Flex-Alg-Fb : Disabled
Resolution        : disabled
Weighted ECMP     : Disabled            ECMP Max Routes : 1
Strict Tnl Tag    : Disabled

Max IPv6 Routes  : No Limit
Ignore NH Metric : Disabled
Hash Label       : Disabled
Entropy Label    : Disabled
Vrf Target       : None
Vrf Import       : None
Vrf Export       : None
MVPN Vrf Target  : None
MVPN Vrf Import  : None
MVPN Vrf Export  : None
Car. Sup C-VPN   : Disabled
Label mode       : vrf
BGP VPN Backup   : Disabled
BGP Export Inactv : Disabled
LOG all events   : Disabled

SAP Count       : 21                SDP Bind Count  : 1
VSD Domain      : <none>
    
```

```

-----
Service Access & Destination Points
-----
Identifier                               Type      AdmMTU  OprMTU  Adm  Opr
-----
sap:[pw-1:2.1]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.2]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.3]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.4]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.5]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.6]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.7]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.8]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.9]                          qinq     8932    8888    Up   Up
sap:[pw-1:2.10]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.11]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.12]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.13]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.14]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.15]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.16]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.17]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.18]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.19]                         qinq     8932    8888    Up   Up
sap:[pw-1:2.20]                         qinq     8932    8888    Up   Up
sap:pw-1:2.4094                          qinq     8932    8888    Up   Up
sdp:1:1 S(192.168.7.2)                   None      0        8890    Up   Up
-----
[<sap-id>] indicates a Managed SAP
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "dual-homing" bgp-ipvpn segment-routing-v6

=====
Service 10 BGP-IPVPN Segment-Routing-V6 Information
=====

Admin State      : Up
VRF Import      : None
VRF Export       : srrp-aware-routing
Route Dist.     : 192.0.2.20:10
Oper Route Dist : 192.0.2.20:10
Oper RD Type    : configured
Route Target    : target:64500:10
Route Target Expor: None
Route Target Impor: None
Def Route Tag   : 0x0
Route Resolution : route-table

Srv6 Instance   : 1
Default Locator : bng-1-loc
Source Address   : 2001:db8::14
Domain-Id       : None

=====

[/]
A:admin@bng-1#

[/]
    
```

```
A:admin@bng-1# /show service id "dual-homing" segment-routing-v6 instance 1 locator "bng-1-loc"
```

```
=====
Segment Routing v6 Instance 1 Service 10
=====
Locator
Type          Function SID                               Status
-----
bng-1-loc
  End.DT4      *524285 2001:db8:aaaa:14:7fff:d000::       ok
  End.DT6      *524284 2001:db8:aaaa:14:7fff:c000::       ok
=====
```

```
Legend: * - System allocated
```

```
[/]
```

```
A:admin@bng-1#
```

```
[/]
```

```
A:admin@bng-1# /show router 10 route-table
```

```
=====
Route Table (Service: 10)
=====
Dest Prefix[Flags]          Type  Proto  Age           Pref
Next Hop[Interface Name]   Metric
-----
10.10.0.0/24                Local  Local  01d23h11m    0
  sub-int-1                  0
10.10.0.2/32                Remote Sub Mgmt 01d23h12m    0
  [red-int-bng-1-bng-2]     0
10.10.0.10/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.11/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.12/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.13/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.14/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.15/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.16/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.17/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.18/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.0.19/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.1.0/24                Local  Local  01d23h11m    0
  sub-int-1                  0
10.10.1.2/32                Remote Sub Mgmt 01d23h12m    0
  [red-int-bng-1-bng-2]     0
10.10.1.10/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.1.11/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.1.12/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.1.13/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
10.10.1.14/32               Remote Sub Mgmt 01d23h11m    0
  [group-int-1]             0
=====
```

```

10.10.1.15/32 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
10.10.1.16/32 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
10.10.1.17/32 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
10.10.1.18/32 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
10.10.1.19/32 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
172.16.102.0/24 Remote BGP VPN 01d23h12m 170
    2001:db8:aaaa:6:8000:: (tunneled:SRV6) 20
192.168.0.1/32 Local Local 01d23h13m 0
    loopback-1 0
192.168.11.0/24 Local Local 01d23h13m 0
    red-int-bng-1-bng-2 0
-----
No. of Routes: 27
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
      S = Sticky ECMP requested
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 route-table ipv6

=====
IPv6 Route Table (Service: 10)
=====
Dest Prefix[Flags] Type Proto Age Pref
Next Hop[Interface Name] Metric
-----
2001:db8::1/128 Local Local 01d23h13m 0
    loopback-1 0
2001:db8::6600/120 Remote BGP VPN 01d23h12m 170
    2001:db8:aaaa:6:7fff:f000:: (tunneled:SRV6) 20
2001:db8:bbbb::/56 Local Local 01d23h11m 0
    sub-int-1 0
2001:db8:bbbb::1/128 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
2001:db8:bbbb:1::/64 Remote Managed 01d23h11m 0
    2001:db8:bbbb::1 0
2001:db8:bbbb:2::1/128 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
2001:db8:bbbb:3::/64 Remote Managed 01d23h11m 0
    2001:db8:bbbb:2::1 0
2001:db8:bbbb:4::1/128 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
2001:db8:bbbb:5::/64 Remote Managed 01d23h11m 0
    2001:db8:bbbb:4::1 0
2001:db8:bbbb:6::1/128 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
2001:db8:bbbb:7::/64 Remote Managed 01d23h11m 0
    2001:db8:bbbb:6::1 0
2001:db8:bbbb:8::1/128 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
2001:db8:bbbb:9::/64 Remote Managed 01d23h11m 0
    2001:db8:bbbb:8::1 0
2001:db8:bbbb:a::1/128 Remote Sub Mgmt 01d23h11m 0
    [group-int-1] 0
    
```

2001:db8:bbbb:b::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:a::1			0	
2001:db8:bbbb:c::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:d::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:c::1			0	
2001:db8:bbbb:e::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:f::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:e::1			0	
2001:db8:bbbb:10::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:11::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:10::1			0	
2001:db8:bbbb:12::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:13::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:12::1			0	
2001:db8:bbbb:14::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:15::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:14::1			0	
2001:db8:bbbb:16::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:17::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:16::1			0	
2001:db8:bbbb:18::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:19::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:18::1			0	
2001:db8:bbbb:1a::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:1b::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:1a::1			0	
2001:db8:bbbb:1c::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:1d::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:1c::1			0	
2001:db8:bbbb:1e::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:1f::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:1e::1			0	
2001:db8:bbbb:20::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:21::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:20::1			0	
2001:db8:bbbb:22::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:23::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:22::1			0	
2001:db8:bbbb:24::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:25::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:24::1			0	
2001:db8:bbbb:26::1/128	Remote	Sub Mgmt	01d23h11m	0
[group-int-1]			0	
2001:db8:bbbb:27::/64	Remote	Managed	01d23h11m	0
2001:db8:bbbb:26::1			0	
2001:db8:bbbb:100::/56	Local	Local	01d23h11m	0
sub-int-1			0	

No. of Routes: 44				
Flags: n = Number of times nextthop is repeated				
B = BGP backup route available				

```

L = LFA nexthop available
S = Sticky ECMP requested
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes vpn-ipv4 hunt
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete

=====
BGP VPN-IPv4 Routes
=====
-----
RIB In Entries
-----
Network       : 172.16.102.0/24
Nexthop       : 2001:db8::6
Route Dist.   : 192.0.2.6:10      VPN Label     : 524288
Path Id       : None
From          : 2001:db8::6
Res. Nexthop  : n/a
Local Pref.   : 100
Aggregator AS : None              Interface Name : int-1-bng-1-pe-2
Atomic Aggr.  : Not Atomic        Aggregator     : None
AIGP Metric   : None              MED            : None
Connector     : None              IGP Cost       : 20
Community     : target:64500:10
Cluster       : No Cluster Members
Originator Id : None              Peer Router Id : 192.0.2.6
Fwd Class     : None              Priority        : None
Flags         : Used Valid Best IGP
Route Source  : Internal
AS-Path       : No As-Path
Route Tag     : 0
Neighbor-AS   : n/a
Orig Validation: N/A
Source Class  : 0                  Dest Class     : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:6::
Full Sid      : 2001:db8:aaaa:6:8000::
Behavior      : End.DT4 (19)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                  Loc-Node-Len   : 16
Func-Len      : 20                  Arg-Len        : 0
Tpose-Len     : 20                  Tpose-offset   : 64
VPRN Imported : 10

-----
RIB Out Entries
-----
Network       : 10.10.0.0/24
Nexthop       : 2001:db8::14
Route Dist.   : 192.0.2.20:10      VPN Label     : 524285
    
```

```

Path Id      : None
To          : 2001:db8::6
Res. Nexthop : n/a
Local Pref. : 150
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric  : None
Connector    : None
Community    : target:64500:10
Cluster      : No Cluster Members
Originator Id : None
Origin       : IGP
AS-Path      : No As-Path
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid          : 2001:db8:aaaa:14::
Full Sid     : 2001:db8:aaaa:14:7fff:d000::
Behavior     : End.DT4 (19)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48
Func-Len     : 20
Tpose-Len    : 20
Interface Name : NotAvailable
Aggregator    : None
MED           : None
IGP Cost      : n/a
Peer Router Id : 192.0.2.6
Dest Class    : 0
Loc-Node-Len : 16
Arg-Len       : 0
Tpose-offset  : 64

Network      : 10.10.1.0/24
Nexthop     : 2001:db8::14
Route Dist.  : 192.0.2.20:10
Path Id      : None
To          : 2001:db8::6
Res. Nexthop : n/a
Local Pref. : 150
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric  : None
Connector    : None
Community    : target:64500:10
Cluster      : No Cluster Members
Originator Id : None
Origin       : IGP
AS-Path      : No As-Path
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid          : 2001:db8:aaaa:14::
Full Sid     : 2001:db8:aaaa:14:7fff:d000::
Behavior     : End.DT4 (19)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48
Func-Len     : 20
Tpose-Len    : 20
Interface Name : NotAvailable
Aggregator    : None
MED           : None
IGP Cost      : n/a
Peer Router Id : 192.0.2.6
Dest Class    : 0
Loc-Node-Len : 16
Arg-Len       : 0
Tpose-offset  : 64
    
```

 Routes : 3
 =====

[/]
 A:admin@bng-1#

```
[/]
A:admin@bng-1# /show router bgp routes vpn-ipv6 hunt
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete
=====
BGP VPN-IPv6 Routes
=====
-----
RIB In Entries
-----
Network       : 2001:db8::6600/120
Nextthop     : 2001:db8::6
Route Dist.   : 192.0.2.6:10      VPN Label     : 524287
Path Id       : None
From         : 2001:db8::6
Res. Nextthop : n/a
Local Pref.   : 100
Aggregator AS : None              Interface Name : int-1-bng-1-pe-2
Atomic Aggr.  : Not Atomic      Aggregator     : None
AIGP Metric   : None            MED            : None
Connector     : None            IGP Cost       : 20
Community     : target:64500:10
Cluster       : No Cluster Members
Originator Id : None              Peer Router Id : 192.0.2.6
Fwd Class     : None              Priority        : None
Flags         : Used Valid Best IGP
Route Source  : Internal
AS-Path       : No As-Path
Route Tag     : 0
Neighbor-AS   : n/a
Orig Validation: N/A
Source Class  : 0                  Dest Class     : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:6::
Full Sid      : 2001:db8:aaaa:6:7fff:f000::
Behavior      : End.DT6 (18)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                  Loc-Node-Len   : 16
Func-Len      : 20                  Arg-Len        : 0
Tpose-Len     : 20                  Tpose-offset   : 64
VPRN Imported : 10
-----
RIB Out Entries
-----
Network       : 2001:db8:bbbb::/56
Nextthop     : 2001:db8::14
Route Dist.   : 192.0.2.20:10     VPN Label     : 524284
Path Id       : None
To           : 2001:db8::6
Res. Nextthop : n/a
Local Pref.   : 150
Aggregator AS : None              Interface Name : NotAvailable
Atomic Aggr.  : Not Atomic      Aggregator     : None
AIGP Metric   : None            MED            : None
Connector     : None            IGP Cost       : n/a
```



```

Connector      : None
Community      : target:64500:10
Cluster        : No Cluster Members
Originator Id  : None                Peer Router Id : 192.0.2.6
Origin         : IGP
AS-Path        : No As-Path
Route Tag      : 0
Neighbor-AS    : n/a
Orig Validation: N/A
Source Class   : 0                  Dest Class    : 0
SRv6 TLV Type  : SRv6 L3 Service TLV (5)
SRv6 SubTLV    : SRv6 SID Information (1)
Sid            : 2001:db8:aaaa:14::
Full Sid       : 2001:db8:aaaa:14:7fff:c000::
Behavior        : End.DT6 (18)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len  : 48                  Loc-Node-Len  : 16
Func-Len       : 20                  Arg-Len        : 0
Tpose-Len      : 20                  Tpose-offset   : 64

Network        : 2001:db8:bbbb:100::/56
NextHop        : 2001:db8::14
Route Dist.    : 192.0.2.20:10      VPN Label     : 524284
Path Id        : None
To             : 2001:db8::6
Res. NextHop   : n/a
Local Pref.    : 150
Aggregator AS  : None                Interface Name : NotAvailable
Atomic Aggr.   : Not Atomic          Aggregator    : None
AIGP Metric    : None                MED           : None
Connector      : None                IGP Cost      : n/a
Community      : target:64500:10
Cluster        : No Cluster Members
Originator Id  : None                Peer Router Id : 192.0.2.6
Origin         : IGP
AS-Path        : No As-Path
Route Tag      : 0
Neighbor-AS    : n/a
Orig Validation: N/A
Source Class   : 0                  Dest Class    : 0
SRv6 TLV Type  : SRv6 L3 Service TLV (5)
SRv6 SubTLV    : SRv6 SID Information (1)
Sid            : 2001:db8:aaaa:14::
Full Sid       : 2001:db8:aaaa:14:7fff:c000::
Behavior        : End.DT6 (18)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len  : 48                  Loc-Node-Len  : 16
Func-Len       : 20                  Arg-Len        : 0
Tpose-Len      : 20                  Tpose-offset   : 64

-----
Routes : 3
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router segment-routing-v6 base-routing-instance all

=====
Segment Routing v6 Base Routing Instance
=====
Locator
    
```

```

Type          Function      SID              Status/InstId
SRH-mode Protection Interface
-----
bng-1-loc
End           1 2001:db8:aaaa:14:0:1000::      ok
USP
-----
Auto-allocated End.X: USP Protected,
-----
End.X        *524287 2001:db8:aaaa:14:7fff:f000::      1
USP          Protected int-1-bng-1-bng-2
ISIS Level: L2 Mac Address: b4:98:01:01:00:06 Nbr Sys Id: 1920.0000.2021
End.X        *524288 2001:db8:aaaa:14:8000::            0
USP          Protected int-1-bng-1-p-1
ISIS Level: L2 Mac Address: b4:9e:01:01:00:0b Nbr Sys Id: 1920.0000.2004
End.X        *524289 2001:db8:aaaa:14:8000:1000::        1
USP          Protected int-1-bng-1-pe-2
ISIS Level: L2 Mac Address: b4:a0:01:01:00:07 Nbr Sys Id: 1920.0000.2006
-----
Legend: * - System allocated

=====
Micro Segment Routing v6 Base Routing Instance
=====
Micro Segment Locator
Type          Function      SID              Status/InstId
SRH-mode Oper Func Interface Protection
-----
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router segment-routing-v6 local-sid context "Base"

=====
Segment Routing v6 Local SIDs
=====
SID          Type          Function
Locator
Context
-----
2001:db8:aaaa:14:0:1000::      End          1
bng-1-loc
Base
-----
SIDs : 1
-----

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router segment-routing-v6 local-sid context "10"

=====
Segment Routing v6 Local SIDs
=====
SID          Type          Function
Locator
    
```

```

Context
-----
2001:db8:aaaa:14:7fff:c000::                               End.DT6           524284
  bng-1-loc
  SvcId: 10 Name: dual-homing
2001:db8:aaaa:14:7fff:d000::                               End.DT4           524285
  bng-1-loc
  SvcId: 10 Name: dual-homing
-----
SIDs : 2
-----
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router route-table ipv6

=====
IPv6 Route Table (Router: Base)
=====
Dest Prefix[Flags]                                         Type  Proto  Age      Pref
  Next Hop[Interface Name]                                Metric
-----
2001:db8::4/128                                           Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                10
2001:db8::5/128                                           Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                20
2001:db8::6/128 [L]                                       Remote  ISIS(1) 01d23h12m 18
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"                10
2001:db8::a/128                                           Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                20
2001:db8::14/128                                          Local   Local  01d23h13m  0
  system                                                    0
2001:db8::15/128 [L]                                       Remote  ISIS(1) 01d23h12m 18
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"                10
2001:db8::100/120                                         Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                20
2001:db8::200/120                                         Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                30
2001:db8::500/120                                         Local   Local  01d23h13m  0
  int-1-bng-1-p-1                                           0
2001:db8::600/120                                         Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                30
2001:db8::700/120                                         Local   Local  01d23h13m  0
  int-1-bng-1-bng-2                                         0
2001:db8::800/120                                         Local   Local  01d23h13m  0
  int-1-bng-1-pe-2                                           0
2001:db8::900/120 [L]                                       Remote  ISIS(1) 01d23h12m 18
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"                20
2001:db8::a00/120                                         Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                20
2001:db8::6400/120                                        Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"                30
2001:db8::6500/120 [L]                                       Remote  ISIS(1) 01d23h12m 18
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"                20
2001:db8:aaaa:4::/64                                       Remote  ISIS   01d23h12m 18
  2001:db8:aaaa:4::/64 (tunneled:SRV6-ISIS)                 20
2001:db8:aaaa:5::/64                                       Remote  ISIS   01d23h12m 18
  2001:db8:aaaa:5::/64 (tunneled:SRV6-ISIS)                 30
2001:db8:aaaa:6::/64                                       Remote  ISIS(1) 01d23h12m 18
  2001:db8:aaaa:6::/64 (tunneled:SRV6-ISIS)                 20
2001:db8:aaaa:a::/64                                       Remote  ISIS   01d23h12m 18
    
```

```

2001:db8:aaaa:a::/64 (tunneled:SRV6-ISIS) 30
2001:db8:aaaa:14::/64 Local SRV6 01d23h13m 3
fe80::201-"_tmnx_fpe_2.a" 0
2001:db8:aaaa:14:0:1000::/128 Local SRV6 01d23h13m 3
Black Hole 0
2001:db8:aaaa:14:0:2000::/128 Local SRV6-Pol* 01d23h13m 14
2001:db8::5 (tunneled:SRV6-Policy:917506) 1
2001:db8:aaaa:14:7fff:f000::/128 Local ISIS(1) 01d23h12m 18
2001:db8:aaaa:14:7fff:f000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:14:8000::/128 Local ISIS 01d23h12m 18
2001:db8:aaaa:14:8000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:14:8000:1000::/128 Local ISIS(1) 01d23h12m 18
2001:db8:aaaa:14:8000:1000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:15::/64 Remote ISIS(1) 01d23h12m 18
2001:db8:aaaa:15::/64 (tunneled:SRV6-ISIS) 20
-----
No. of Routes: 27
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
      S = Sticky ECMP requested
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router tunnel-table ipv6

=====
IPv6 Tunnel Table (Router: Base)
=====
Destination      Owner      Encap TunnelId  Pref
Nexthop          Color      Metric
-----
2001:db8::5/128  srv6-pol  SRV6  917506  14
fpe_1.a          10        0
2001:db8:aaaa:4::/64  srv6-isis SRV6  524296  0
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8:aaaa:5::/64  srv6-isis SRV6  524299  0
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8:aaaa:6::/64 [L]  srv6-isis SRV6  524295  0
fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 20
2001:db8:aaaa:a::/64  srv6-isis SRV6  524297  0
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8:aaaa:14:7fff:f000::/128 [L]  srv6-isis SRV6  524291  0
fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" 10
2001:db8:aaaa:14:8000::/128  srv6-isis SRV6  524292  0
fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 10
2001:db8:aaaa:14:8000:1000::/128 [L]  srv6-isis SRV6  524293  0
fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 10
2001:db8:aaaa:15::/64 [L]  srv6-isis SRV6  524294  0
fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" 20
-----
Flags: B = BGP or MPLS backup hop available
      L = Loop-Free Alternate (LFA) hop available
      E = Inactive best-external BGP route
      k = RIB-API or Forwarding Policy backup hop
=====

[/]
A:admin@bng-1#
    
```

```
[/]
A:admin@bng-1# /show router fp-tunnel-table 1 ipv6

=====
IPv6 Tunnel Table Display

Legend:
label stack is ordered from bottom-most to top-most
B - FRR Backup
=====
Destination                                Protocol      Tunnel-ID
Lbl/SID
NextHop                                     Intf/Tunnel
Lbl/SID (backup)
NextHop (backup)
-----
2001:db8:aaaa:4::/64                        SRV6          524296
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  1/1/c1/1:1
2001:db8:aaaa:5::/64                        SRV6          524299
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  1/1/c1/1:1
2001:db8:aaaa:6::/64                        SRV6          524295
-
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"  1/1/c1/7:1
-
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" (B) 1/1/c1/6:1
2001:db8:aaaa:a::/64                        SRV6          524297
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  1/1/c1/1:1
2001:db8:aaaa:15::/64                       SRV6          524294
-
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"  1/1/c1/6:1
-
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" (B) 1/1/c1/7:1
2001:db8::5/128                             SRV6-Policy   -
  2001:db8:aaaa:a:0:1000::/2001:db8:aaaa:4:0:1000::
  0.140.1.1                                  pxc-1.b:1
2001:db8:aaaa:14:7fff:f000::/128            SRV6          524291
-
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"  1/1/c1/6:1
  2001:db8:aaaa:15:0:1000::
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" (B) 1/1/c1/7:1
2001:db8:aaaa:14:8000::/128                  SRV6          524292
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  1/1/c1/1:1
2001:db8:aaaa:14:8000:1000::/128            SRV6          524293
-
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"  1/1/c1/7:1
  2001:db8:aaaa:6:0:1000::
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" (B) 1/1/c1/6:1
-----
Total Entries : 9
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp summary

=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
```

```

BGP Admin State      : Up          BGP Oper State      : Up
Total Peer Groups    : 2           Total Peers          : 3
Total VPN Peer Groups : 0         Total VPN Peers      : 0
Current Internal Groups : 3       Max Internal Groups  : 3
Total BGP Paths       : 59        Total Path Memory    : 21280

Total IPv4 Remote Rts : 0         Total IPv4 Rem. Active Rts : 0
Total IPv6 Remote Rts : 0         Total IPv6 Rem. Active Rts : 0
Total IPv4 Backup Rts : 0         Total IPv6 Backup Rts    : 0
Total LblIPv4 Rem Rts : 0         Total LblIPv4 Rem. Act Rts : 0
Total LblIPv6 Rem Rts : 0         Total LblIPv6 Rem. Act Rts : 0
Total LblIPv4 Bkp Rts : 0         Total LblIPv6 Bkp Rts    : 0
Total Supressed Rts   : 0         Total Hist. Rts       : 0
Total Decay Rts       : 0

Total VPN-IPv4 Rem. Rts : 1       Total VPN-IPv4 Rem. Act. Rts: 1
Total VPN-IPv6 Rem. Rts : 1       Total VPN-IPv6 Rem. Act. Rts: 1
Total VPN-IPv4 Bkup Rts : 0       Total VPN-IPv6 Bkup Rts   : 0
Total VPN Local Rts     : 7       Total VPN Supp. Rts      : 0
Total VPN Hist. Rts     : 0       Total VPN Decay Rts      : 0

Total MVPN-IPv4 Rem Rts : 0       Total MVPN-IPv4 Rem Act Rts : 0
Total MVPN-IPv6 Rem Rts : 0       Total MVPN-IPv6 Rem Act Rts : 0
Total MDT-SAFI Rem Rts  : 0       Total MDT-SAFI Rem Act Rts  : 0
Total McIPv4 Remote Rts : 0       Total McIPv4 Rem. Active Rts: 0
Total McIPv6 Remote Rts : 0       Total McIPv6 Rem. Active Rts: 0
Total McVpnIPv4 Rem Rts : 0       Total McVpnIPv4 Rem Act Rts : 0
Total McVpnIPv6 Rem Rts : 0       Total McVpnIPv6 Rem Act Rts : 0

Total EVPN Rem Rts      : 4         Total EVPN Rem Act Rts     : 4
Total L2-VPN Rem. Rts   : 0         Total L2VPN Rem. Act. Rts  : 0
Total MSPW Rem Rts      : 0         Total MSPW Rem Act Rts     : 0
Total RouteTgt Rem Rts  : 0         Total RouteTgt Rem Act Rts : 0
Total FlowIpv4 Rem Rts  : 0         Total FlowIpv4 Rem Act Rts : 0
Total FlowIpv6 Rem Rts  : 0         Total FlowIpv6 Rem Act Rts : 0
Total FlowVpvn4 Rem Rts : 0         Total FlowVpvn4 Rem Act Rts : 0
Total FlowVpvn6 Rem Rts : 0         Total FlowVpvn6 Rem Act Rts : 0
Total Link State Rem Rts : 0       Total Link State Rem Act Rts : 0
Total SrPlcyIpv4 Rem Rts : 0       Total SrPlcyIpv4 Rem Act Rts : 0
Total SrPlcyIpv6 Rem Rts : 0       Total SrPlcyIpv6 Rem Act Rts : 0
    
```

=====
 BGP Summary
 =====

Legend : D - Dynamic Neighbor
 =====

Neighbor
 Description

	AS	PktRcvd	InQ	Up/Down	State	Rcv/Act/Sent (Addr Family)
		PktSent	OutQ			
2001:db8::5	64500	5669	0	01d23h12m	1/1/3	(Evpn)
		5672	0			
2001:db8::6	64500	5670	0	01d23h12m	1/1/2	(VpnIPv4)
		5672	0		1/1/2	(VpnIPv6)
2001:db8::15	64500	5673	0	01d23h12m	3/3/3	(Evpn)
		5672	0			

[/]
 A:admin@bng-1#

```
[/]
A:admin@bng-1# /show router isis adjacency

=====
Rtr Base ISIS Instance 0 Adjacency
=====
System ID                Usage State Hold Interface                MT-ID
-----
p-1                      L2   Up   7   int-1-bng-1-p-1                0
-----
Adjacencies : 1
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router isis database

=====
Rtr Base ISIS Instance 0 Database
=====
LSP ID                    Sequence  Checksum Lifetime Attributes
-----

Displaying Level 1 database
-----
Level (1) LSP Count : 0

Displaying Level 2 database
-----
p-1.00-00                0x13d    0x8ffb   762    L1L2
p-1.01-00                0x134    0x4d03   902    L1L2
pe-1.00-00               0x139    0x659e   863    L1L2
pe-1.01-00               0x133    0xe585  1063    L1L2
p-2.00-00                0x137    0xfd42  1085    L1L2
p-2.01-00                0x135    0x6dc8   938    L1L2
p-2.02-00                0x135    0xe56c  1042    L1L2
p-2.03-00                0x132    0xfa58   764    L1L2
bng-1.00-00              0x13d    0x160f   748    L1L2
bng-2.00-00              0x137    0x777b   675    L1L2
Level (2) LSP Count : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router isis 1 adjacency

=====
Rtr Base ISIS Instance 1 Adjacency
=====
System ID                Usage State Hold Interface                MT-ID
-----
bng-2                    L2   Up   27   int-1-bng-1-bng-2                0
pe-2                     L2   Up   7    int-1-bng-1-pe-2                0
-----
Adjacencies : 2
=====

[/]
A:admin@bng-1#
```

```
[/]
A:admin@bng-1# /show router isis 1 database

=====
Rtr Base ISIS Instance 1 Database
=====
LSP ID                               Sequence  Checksum Lifetime Attributes
-----
Displaying Level 1 database
-----
Level (1) LSP Count : 0

Displaying Level 2 database
-----
pe-2.00-00                            0x13a    0x105f   963    L1L2
pe-2.01-00                            0x133    0x51fb   708    L1L2
pe-2.02-00                            0x133    0x60ea  1055    L1L2
bng-1.00-00                           0x13c    0x29a7   747    L1L2
bng-1.01-00                           0x136    0x7b99   670    L1L2
bng-2.00-00                           0x138    0x8827  1129    L1L2
Level (2) LSP Count : 6
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show redundancy multi-chassis sync peer 192.0.2.21 detail

=====
Multi-chassis Peer Table
=====
Peer
-----
Peer IP Address      : 192.0.2.21
Description          : (Not Specified)
Authentication       : Disabled
Source IP Address    : 192.0.2.20
Admin State          : Enabled
Warm standby         : No
Remote warm standby  : No
Sub-mgmt options     :
  DHCP lease threshold : Inactive
  Local / Remote       : -- / --
-----
Sync-status
-----
Client Applications  : SUBMGMT-IPOE SUBMGMT-PPPOE SRRP DHCPserver
Sync Admin State     : Up
Sync Oper State      : Up
Sync Oper Flags      :
DB Sync State        : inSync
Num Entries          : 100
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
Rem Num Entries      : 100
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries : 0
Rem OMCR Alarm Entries : 0
```



```
=====
MCS Application Stats
=====
Application          : igmp
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : igmpSnooping
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : subMgmtIpoee
Num Entries          : 10
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 10
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : srrp
Num Entries          : 26
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 26
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : mcRing
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
```

```
Rem Lcl Deleted Entries : 0
Rem Alarm Entries      : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : mldSnooping
Num Entries           : 0
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : dhcpServer
Num Entries           : 54
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 54
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : subHostTrk
Num Entries           : 0
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : subMgmtPppoe
Num Entries           : 10
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 10
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : ipsec
Num Entries           : 0
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
```

```
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : mld
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : python
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : l2tp
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : diameterProxy
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : pimSnpGsap
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
```

```
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : pimSnpgSdp
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : diameterNode
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : nat
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
=====
Ports synced on peer 192.0.2.21
=====
Port/Encap          Tag
-----
pw-1                pw-port-1
=====
SDPs synced on peer 192.0.2.21
=====
SDP/Vc-Id          Tag
-----
=====
```

```
DHCP Server instances synced on peer 192.0.2.21
=====
Router-Name          Server-Name
  Tag
-----
No instances found
=====

Python cache instances synced on peer 192.0.2.21
=====
Python-Policy       Tag
-----
No instances found
=====
No L2TP instances found.

Track SRRP instances
=====
SRRP                : 1
-----
L2TP tunnel ID start : 0
L2TP tunnel ID end   : 0
=====

Diameter proxy instances synced on peer 192.0.2.21
=====
Diameter-Peer-Policy Tag
-----
No instances found
=====

Diameter node instances synced on peer 192.0.2.21
=====
Diameter Node          Tag
-----
No. of Diameter Nodes: 0
=====

Nat groups synced on peer 192.0.2.21
=====
Nat group              Tag
-----
No. of Nat groups: 0
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /tools dump redundancy multi-chassis sync-database

The following totals are for:
 peer ip ALL, port/lag/sdp ALL, sync-tag ALL, application ALL
Valid Entries:          100
Locally Deleted Entries: 0
```

```
Locally Deleted Alarmed Entries: 0
Pending Global Delete Entries: 0
Omcrc Alarmed Entries: 0
Omcrc Standby Entries: 0
Associated Shared Records (ALL): 0
Associated Shared Records (LD): 0

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service active-subscribers summary

=====
Active Subscriber table summary
=====
Total Count      : 20
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service active-subscribers hierarchy

=====
Active Subscribers Hierarchy
=====
-- ipoe-ds-1
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.11] - sla:sla-profile-1
    |
    +- IPoe-session - mac:00:13:01:00:00:01 - svc:10
      |
      |-- 10.10.0.12 - DHCP
      |
      +-- 2001:db8:bbbb::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:1::/64 - DHCP6-PD-MR

-- ipoe-ds-10
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.20] - sla:sla-profile-1
    |
    +- IPoe-session - mac:00:13:01:00:00:0a - svc:10
      |
      |-- 10.10.0.13 - DHCP
      |
      +-- 2001:db8:bbbb:10::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:11::/64 - DHCP6-PD-MR

-- ipoe-ds-2
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.12] - sla:sla-profile-1
    |
    +- IPoe-session - mac:00:13:01:00:00:02 - svc:10
      |
      |-- 10.10.0.10 - DHCP
      |
      +-- 2001:db8:bbbb:2::1/128 - DHCP6
```

```
        |
        +-- 2001:db8:bbbb:3::/64 - DHCP6-PD-MR
-- ipoe-ds-3
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.13] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:03 - svc:10
      |
      |-- 10.10.0.14 - DHCP
      |
      +-- 2001:db8:bbbb:c::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:d::/64 - DHCP6-PD-MR
-- ipoe-ds-4
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.14] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:04 - svc:10
      |
      |-- 10.10.0.17 - DHCP
      |
      +-- 2001:db8:bbbb:8::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:9::/64 - DHCP6-PD-MR
-- ipoe-ds-5
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.15] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:05 - svc:10
      |
      |-- 10.10.0.11 - DHCP
      |
      +-- 2001:db8:bbbb:4::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:5::/64 - DHCP6-PD-MR
-- ipoe-ds-6
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.16] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:06 - svc:10
      |
      |-- 10.10.0.19 - DHCP
      |
      +-- 2001:db8:bbbb:e::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:f::/64 - DHCP6-PD-MR
-- ipoe-ds-7
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.17] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:07 - svc:10
      |
      |-- 10.10.0.18 - DHCP
      |
```

```
        +-- 2001:db8:bbbb:a::1/128 - DHCP6
           |
           +-- 2001:db8:bbbb:b::/64 - DHCP6-PD-MR
-- ipoe-ds-8
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.18] - sla:sla-profile-1
     |
     +-- IPOE-session - mac:00:13:01:00:00:08 - svc:10
        |
        |-- 10.10.0.16 - DHCP
        |
        +-- 2001:db8:bbbb:6::1/128 - DHCP6
           |
           +-- 2001:db8:bbbb:7::/64 - DHCP6-PD-MR
-- ipoe-ds-9
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.19] - sla:sla-profile-1
     |
     +-- IPOE-session - mac:00:13:01:00:00:09 - svc:10
        |
        |-- 10.10.0.15 - DHCP
        |
        +-- 2001:db8:bbbb:12::1/128 - DHCP6
           |
           +-- 2001:db8:bbbb:13::/64 - DHCP6-PD-MR
-- pppoe-1
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.1] - sla:sla-profile-1
     |
     +-- PPP-session - mac:00:11:01:00:00:01 - sid:1 - svc:10
        |
        |-- 10.10.1.10 - IPCP
        |
        +-- 2001:db8:bbbb:14::1/128 - DHCP6
           |
           +-- 2001:db8:bbbb:15::/64 - DHCP6-PD-MR
-- pppoe-10
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.10] - sla:sla-profile-1
     |
     +-- PPP-session - mac:00:11:01:00:00:0a - sid:1 - svc:10
        |
        |-- 10.10.1.19 - IPCP
        |
        +-- 2001:db8:bbbb:26::1/128 - DHCP6
           |
           +-- 2001:db8:bbbb:27::/64 - DHCP6-PD-MR
-- pppoe-2
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.2] - sla:sla-profile-1
     |
     +-- PPP-session - mac:00:11:01:00:00:02 - sid:1 - svc:10
        |
        |-- 10.10.1.11 - IPCP
```



```

        |
        +-- 2001:db8:bbbb:18::1/128 - DHCP6
            |
            +-- 2001:db8:bbbb:19::/64 - DHCP6-PD-MR
-- pppoe-3
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.3] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:03 - sid:1 - svc:10
          |
          |-- 10.10.1.12 - IPCP
          |
          +-- 2001:db8:bbbb:16::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:17::/64 - DHCP6-PD-MR
-- pppoe-4
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.4] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:04 - sid:1 - svc:10
          |
          |-- 10.10.1.13 - IPCP
          |
          +-- 2001:db8:bbbb:1a::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:1b::/64 - DHCP6-PD-MR
-- pppoe-5
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.5] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:05 - sid:1 - svc:10
          |
          |-- 10.10.1.14 - IPCP
          |
          +-- 2001:db8:bbbb:1c::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:1d::/64 - DHCP6-PD-MR
-- pppoe-6
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.6] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:06 - sid:1 - svc:10
          |
          |-- 10.10.1.15 - IPCP
          |
          +-- 2001:db8:bbbb:1e::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:1f::/64 - DHCP6-PD-MR
-- pppoe-7
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.7] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:07 - sid:1 - svc:10
          |
    
```

```

|-- 10.10.1.16 - IPCP
|
+-- 2001:db8:bbbb:20::1/128 - DHCP6
|
+-- 2001:db8:bbbb:21::/64 - DHCP6-PD-MR

-- pppoe-8
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.8] - sla:sla-profile-1
    |
    +-- PPP-session - mac:00:11:01:00:00:08 - sid:1 - svc:10
      |
      |-- 10.10.1.17 - IPCP
      |
      +-- 2001:db8:bbbb:22::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:23::/64 - DHCP6-PD-MR

-- pppoe-9
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.9] - sla:sla-profile-1
    |
    +-- PPP-session - mac:00:11:01:00:00:09 - sid:1 - svc:10
      |
      |-- 10.10.1.18 - IPCP
      |
      +-- 2001:db8:bbbb:24::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:25::/64 - DHCP6-PD-MR

-----
Number of active subscribers : 20
Flags: (N) = the host or the managed route is in non-forwarding state
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id 10 subscriber-hosts detail

=====
Subscriber Host table
=====

Sap
  IP Address
  MAC Address
  Subscriber
  PPPoE-SID
  Origin
  Fwding State

-----
[pw-1:2.1]
10.10.1.10
00:11:01:00:00:01
1
IPCP
Fwding

-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile        : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000029636FE951
    
```

```
Acct-Q-Inst-Session-Id: B496FF000002A636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.1]
 2001:db8:bbbb:14::1/128
 00:11:01:00:00:01          1          PPP-DHCP6      Fwding
  pppoe-1
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id     : B496FF0000047636FE951
Acct-Q-Inst-Session-Id: B496FF000002A636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.2]
 10.10.1.11
 00:11:01:00:00:02          1          IPCP          Fwding
  pppoe-2
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id     : B496FF000002C636FE951
Acct-Q-Inst-Session-Id: B496FF000002D636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.2]
 2001:db8:bbbb:18::1/128
 00:11:01:00:00:02          1          PPP-DHCP6      Fwding
  pppoe-2
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
```

```
Egress Vport      : N/A
Acct-Session-Id  : B496FF00000049636FE951
Acct-Q-Inst-Session-Id: B496FF0000002D636FE951
Address Origin   : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.3]
 10.10.1.12
 00:11:01:00:00:03      1          IPCP          Fwding
  pppoe-3
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000002F636FE951
Acct-Q-Inst-Session-Id: B496FF00000030636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.3]
 2001:db8:bbbb:16::1/128
 00:11:01:00:00:03      1          PPP-DHCP6      Fwding
  pppoe-3
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000046636FE951
Acct-Q-Inst-Session-Id: B496FF00000030636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.4]
 10.10.1.13
 00:11:01:00:00:04      1          IPCP          Fwding
  pppoe-4
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
```

```

App Profile           : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000032636FE951
Acct-Q-Inst-Session-Id: B496FF00000033636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.4]
  2001:db8:bbbb:1a::1/128
    00:11:01:00:00:04          1          PPP-DHCP6          Fwding
    pppoe-4
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000048636FE951
Acct-Q-Inst-Session-Id: B496FF00000033636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.5]
  10.10.1.14
    00:11:01:00:00:05          1          IPCP              Fwding
    pppoe-5
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000035636FE951
Acct-Q-Inst-Session-Id: B496FF00000036636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.5]
  2001:db8:bbbb:1c::1/128
    00:11:01:00:00:05          1          PPP-DHCP6          Fwding
    pppoe-5
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
    
```

```
Sub Profile      : sub-profile-1
SLA Profile      : sla-profile-1
App Profile      : N/A
Egress Q-Group   : N/A
Egress Vport     : N/A
Acct-Session-Id : B496FF0000004A636FE951
Acct-Q-Inst-Session-Id: B496FF00000036636FE951
Address Origin   : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.6]
 10.10.1.15
 00:11:01:00:00:06      1          IPCP          Fwding
  pppoe-6
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport        : N/A
Acct-Session-Id     : B496FF00000038636FE951
Acct-Q-Inst-Session-Id: B496FF00000039636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.6]
 2001:db8:bbbb:le::1/128
 00:11:01:00:00:06      1          PPP-DHCP6      Fwding
  pppoe-6
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport        : N/A
Acct-Session-Id     : B496FF0000004B636FE951
Acct-Q-Inst-Session-Id: B496FF00000039636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.7]
 10.10.1.16
 00:11:01:00:00:07      1          IPCP          Fwding
  pppoe-7
-----
```

```
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000003B636FE951
Acct-Q-Inst-Session-Id: B496FF0000003C636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.7]
 2001:db8:bbbb:20::1/128
 00:11:01:00:00:07          1          PPP-DHCP6          Fwding
  pppoe-7
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000004C636FE951
Acct-Q-Inst-Session-Id: B496FF0000003C636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.8]
 10.10.1.17
 00:11:01:00:00:08          1          IPCP          Fwding
  pppoe-8
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000003E636FE951
Acct-Q-Inst-Session-Id: B496FF0000003F636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.8]
 2001:db8:bbbb:22::1/128
 00:11:01:00:00:08          1          PPP-DHCP6          Fwding
```

```

pppoe-8
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000004D636FE951
Acct-Q-Inst-Session-Id: B496FF0000003F636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.9]
 10.10.1.18
 00:11:01:00:00:09          1          IPCP          Fwding
  pppoe-9
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000041636FE951
Acct-Q-Inst-Session-Id: B496FF00000042636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.9]
 2001:db8:bbbb:24::1/128
 00:11:01:00:00:09          1          PPP-DHCP6          Fwding
  pppoe-9
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000004E636FE951
Acct-Q-Inst-Session-Id: B496FF00000042636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.10]
    
```


10.10.1.19	00:11:01:00:00:0a	1	IPCP	Fwding
ppoe-10				

Subscriber-interface	: sub-int-1			
Group-interface	: group-int-1			
Sub Profile	: sub-profile-1			
SLA Profile	: sla-profile-1			
App Profile	: N/A			
Egress Q-Group	: N/A			
Egress Vport	: N/A			
Acct-Session-Id	: B496FF00000044636FE951			
Acct-Q-Inst-Session-Id	: B496FF00000045636FE951			
Address Origin	: Dynamic			
OT HTTP Rdr IP-FltrId	: N/A			
OT HTTP Rdr Status	: N/A			
OT HTTP Rdr Fltr Src	: N/A			
HTTP Rdr URL Override	: N/A			
GTP local break-out	: No			
DIAMETER session ID Gx	: N/A			

[pw-1:2.10]				
2001:db8:bbbb:26::1/128	00:11:01:00:00:0a	1	PPP-DHCP6	Fwding
ppoe-10				

Subscriber-interface	: sub-int-1			
Group-interface	: group-int-1			
Sub Profile	: sub-profile-1			
SLA Profile	: sla-profile-1			
App Profile	: N/A			
Egress Q-Group	: N/A			
Egress Vport	: N/A			
Acct-Session-Id	: B496FF0000004F636FE951			
Acct-Q-Inst-Session-Id	: B496FF00000045636FE951			
Address Origin	: Dynamic			
OT HTTP Rdr IP-FltrId	: N/A			
OT HTTP Rdr Status	: N/A			
OT HTTP Rdr Fltr Src	: N/A			
HTTP Rdr URL Override	: N/A			
GTP local break-out	: No			
DIAMETER session ID Gx	: N/A			

[pw-1:2.11]				
10.10.0.12	00:13:01:00:00:01	N/A	DHCP	Fwding
ipoe-ds-1				

Subscriber-interface	: sub-int-1			
Group-interface	: group-int-1			
Sub Profile	: sub-profile-1			
SLA Profile	: sla-profile-1			
App Profile	: N/A			
Egress Q-Group	: N/A			
Egress Vport	: N/A			
Acct-Session-Id	: B496FF00000013636FE94C			
Acct-Q-Inst-Session-Id	: B496FF00000010636FE94C			
Address Origin	: Dynamic			
OT HTTP Rdr IP-FltrId	: N/A			
OT HTTP Rdr Status	: N/A			
OT HTTP Rdr Fltr Src	: N/A			
HTTP Rdr URL Override	: N/A			
GTP local break-out	: No			
DIAMETER session ID Gx	: N/A			

```

-----
[pw-1:2.11]
 2001:db8:bbbb::1/128
 00:13:01:00:00:01          N/A          IPoE-DHCP6      Fwding
 ipoe-ds-1
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000000F636FE94C
Acct-Q-Inst-Session-Id: B496FF00000010636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.12]
 10.10.0.10
 00:13:01:00:00:02          N/A          DHCP            Fwding
 ipoe-ds-2
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000000A636FE94C
Acct-Q-Inst-Session-Id: B496FF00000005636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.12]
 2001:db8:bbbb:2::1/128
 00:13:01:00:00:02          N/A          IPoE-DHCP6      Fwding
 ipoe-ds-2
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000004636FE94C
Acct-Q-Inst-Session-Id: B496FF00000005636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
    
```

```

GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.13]
 10.10.0.14
 00:13:01:00:00:03      N/A      DHCP      Fwding
 ipoe-ds-3
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF0000001B636FE94C
Acct-Q-Inst-Session-Id: B496FF0000001C636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.13]
 2001:db8:bbbb:c::1/128
 00:13:01:00:00:03      N/A      IPoE-DHCP6  Fwding
 ipoe-ds-3
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF0000001F636FE94C
Acct-Q-Inst-Session-Id: B496FF0000001C636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.14]
 10.10.0.17
 00:13:01:00:00:04      N/A      DHCP      Fwding
 ipoe-ds-4
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000025636FE951
Acct-Q-Inst-Session-Id: B496FF00000012636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
    
```

```
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.14]
  2001:db8:bbbb:8::1/128
    00:13:01:00:00:04      N/A      IPoE-DHCP6      Fwding
      ipoe-ds-4
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000011636FE94C
Acct-Q-Inst-Session-Id: B496FF00000012636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.15]
  10.10.0.11
    00:13:01:00:00:05      N/A      DHCP      Fwding
      ipoe-ds-5
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000000B636FE94C
Acct-Q-Inst-Session-Id: B496FF00000007636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.15]
  2001:db8:bbbb:4::1/128
    00:13:01:00:00:05      N/A      IPoE-DHCP6      Fwding
      ipoe-ds-5
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000006636FE94C
Acct-Q-Inst-Session-Id: B496FF00000007636FE94C
Address Origin     : Dynamic
```

```

OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.16]
 10.10.0.19
 00:13:01:00:00:06          N/A          DHCP          Fwding
 ipoe-ds-6
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000027636FE951
Acct-Q-Inst-Session-Id: B496FF0000001E636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.16]
 2001:db8:bbbb:e::1/128
 00:13:01:00:00:06          N/A          IPoE-DHCP6      Fwding
 ipoe-ds-6
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000001D636FE94C
Acct-Q-Inst-Session-Id: B496FF0000001E636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.17]
 10.10.0.18
 00:13:01:00:00:07          N/A          DHCP          Fwding
 ipoe-ds-7
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000026636FE951
    
```

```
Acct-Q-Inst-Session-Id: B496FF00000015636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.17]
  2001:db8:bbbb:a::1/128
  00:13:01:00:00:07      N/A          IPoE-DHCP6      Fwding
  ipoe-ds-7
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id     : B496FF00000014636FE94C
Acct-Q-Inst-Session-Id: B496FF00000015636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.18]
  10.10.0.16
  00:13:01:00:00:08      N/A          DHCP          Fwding
  ipoe-ds-8
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id     : B496FF00000024636FE950
Acct-Q-Inst-Session-Id: B496FF00000009636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.18]
  2001:db8:bbbb:6::1/128
  00:13:01:00:00:08      N/A          IPoE-DHCP6      Fwding
  ipoe-ds-8
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
```

```

Egress Vport      : N/A
Acct-Session-Id  : B496FF0000008636FE94C
Acct-Q-Inst-Session-Id: B496FF0000009636FE94C
Address Origin   : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.19]
 10.10.0.15
 00:13:01:00:00:09      N/A      DHCP      Fwding
 ipoe-ds-9
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile           : sub-profile-1
SLA Profile           : sla-profile-1
App Profile           : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id     : B496FF00000020636FE94C
Acct-Q-Inst-Session-Id: B496FF00000021636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.19]
 2001:db8:bbbb:12::1/128
 00:13:01:00:00:09      N/A      IPoE-DHCP6      Fwding
 ipoe-ds-9
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile           : sub-profile-1
SLA Profile           : sla-profile-1
App Profile           : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id     : B496FF00000023636FE94E
Acct-Q-Inst-Session-Id: B496FF00000021636FE94C
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.20]
 10.10.0.13
 00:13:01:00:00:0a      N/A      DHCP      Fwding
 ipoe-ds-10
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile           : sub-profile-1
SLA Profile           : sla-profile-1
    
```

```

App Profile           : N/A
Egress Q-Group       : N/A
Egress Vport        : N/A
Acct-Session-Id     : B496FF00000016636FE94C
Acct-Q-Inst-Session-Id: B496FF00000017636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.20]
  2001:db8:bbbb:10::1/128
    00:13:01:00:00:0a      N/A      IPoE-DHCP6      Fwding
    ipoe-ds-10
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport        : N/A
Acct-Session-Id     : B496FF00000022636FE94E
Acct-Q-Inst-Session-Id: B496FF00000017636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
Number of subscriber hosts : 40
=====

[/]
A:admin@bng-1# /show service id 10 ipoe session

=====
IPoE sessions for svc-id 10
=====
Sap Id      Subscriber-Id      Mac Address      Up Time      MC-Stdby
  [CircuitID] | [RemoteID]
-----
[pw-1:2.11]      ipoe-ds-1      00:13:01:00:00:01      2d 02:51:27
[pw-1:2.12]      ipoe-ds-2      00:13:01:00:00:02      2d 02:51:27
[pw-1:2.13]      ipoe-ds-3      00:13:01:00:00:03      2d 02:51:26
[pw-1:2.14]      ipoe-ds-4      00:13:01:00:00:04      2d 02:51:26
[pw-1:2.15]      ipoe-ds-5      00:13:01:00:00:05      2d 02:51:27
[pw-1:2.16]      ipoe-ds-6      00:13:01:00:00:06      2d 02:51:26
[pw-1:2.17]      ipoe-ds-7      00:13:01:00:00:07      2d 02:51:26
[pw-1:2.18]      ipoe-ds-8      00:13:01:00:00:08      2d 02:51:26
    
```



```
[pw-1:2.19]          00:13:01:00:00:09  2d 02:51:26
 ipoe-ds-9
[pw-1:2.20]          00:13:01:00:00:0a  2d 02:51:26
 ipoe-ds-10
-----
CID | RID displayed when included in session-key
Number of sessions : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id 10 pppoe session

=====
PPPoE sessions for svc-id 10
=====
Sap Id           Mac Address           Sid  Up Time           Type
IP/L2TP-Id/Interface-Id           MC-Stdby
-----
[pw-1:2.1]       00:11:01:00:00:01  1    2d 02:51:21      local
 10.10.1.10
 00:01:00:02:00:01:00:01
[pw-1:2.2]       00:11:01:00:00:02  1    2d 02:51:21      local
 10.10.1.11
 00:02:00:02:00:02:00:01
[pw-1:2.3]       00:11:01:00:00:03  1    2d 02:51:21      local
 10.10.1.12
 00:03:00:02:00:03:00:01
[pw-1:2.4]       00:11:01:00:00:04  1    2d 02:51:21      local
 10.10.1.13
 00:04:00:02:00:04:00:01
[pw-1:2.5]       00:11:01:00:00:05  1    2d 02:51:21      local
 10.10.1.14
 00:05:00:02:00:05:00:01
[pw-1:2.6]       00:11:01:00:00:06  1    2d 02:51:21      local
 10.10.1.15
 00:06:00:02:00:06:00:01
[pw-1:2.7]       00:11:01:00:00:07  1    2d 02:51:21      local
 10.10.1.16
 00:07:00:02:00:07:00:01
[pw-1:2.8]       00:11:01:00:00:08  1    2d 02:51:21      local
 10.10.1.17
 00:08:00:02:00:08:00:01
[pw-1:2.9]       00:11:01:00:00:09  1    2d 02:51:21      local
 10.10.1.18
 00:09:00:02:00:09:00:01
[pw-1:2.10]      00:11:01:00:00:0a  1    2d 02:51:21      local
 10.10.1.19
 00:0A:00:02:00:0A:00:01
-----
Number of sessions : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id 10 dhcp lease-state

=====
DHCP lease state table, service 10
=====
```

IP Address	Mac Address	Sap/Sdp Id	Remaining LeaseTime	Lease Origin	MC Stdby
10.10.0.10	00:13:01:00:00:02	[pw-1:2.12]	00h13m42s	DHCP	
10.10.0.11	00:13:01:00:00:05	[pw-1:2.15]	00h13m42s	DHCP	
10.10.0.12	00:13:01:00:00:01	[pw-1:2.11]	00h13m42s	DHCP	
10.10.0.13	00:13:01:00:00:0a	[pw-1:2.20]	00h13m42s	DHCP	
10.10.0.14	00:13:01:00:00:03	[pw-1:2.13]	00h13m42s	DHCP	
10.10.0.15	00:13:01:00:00:09	[pw-1:2.19]	00h13m42s	DHCP	
10.10.0.16	00:13:01:00:00:08	[pw-1:2.18]	00h13m43s	DHCP	
10.10.0.17	00:13:01:00:00:04	[pw-1:2.14]	00h13m44s	DHCP	
10.10.0.18	00:13:01:00:00:07	[pw-1:2.17]	00h13m44s	DHCP	
10.10.0.19	00:13:01:00:00:06	[pw-1:2.16]	00h13m44s	DHCP	

Number of lease states : 10

[/]

A:admin@bng-1#

[/]

A:admin@bng-1# /show service id 10 dhcp6 lease-state

=====
 DHCP lease state table, service 10
 =====

IP Address	Mac Address	Sap/Sdp Id	Remaining LeaseTime	Lease Origin	MC Stdby
2001:db8:bbbb:1:1/128	00:13:01:00:00:01	[pw-1:2.11]	23h43m37s	DHCP	
2001:db8:bbbb:1::/64	00:13:01:00:00:01	[pw-1:2.11]	23h43m37s	DHCP	
2001:db8:bbbb:2:1/128	00:13:01:00:00:02	[pw-1:2.12]	23h43m36s	DHCP	
2001:db8:bbbb:3::/64	00:13:01:00:00:02	[pw-1:2.12]	23h43m36s	DHCP	
2001:db8:bbbb:4:1/128	00:13:01:00:00:05	[pw-1:2.15]	23h43m36s	DHCP	
2001:db8:bbbb:5::/64	00:13:01:00:00:05	[pw-1:2.15]	23h43m36s	DHCP	
2001:db8:bbbb:6:1/128	00:13:01:00:00:08	[pw-1:2.18]	23h43m36s	DHCP	
2001:db8:bbbb:7::/64	00:13:01:00:00:08	[pw-1:2.18]	23h43m36s	DHCP	
2001:db8:bbbb:8:1/128	00:13:01:00:00:04	[pw-1:2.14]	23h43m37s	DHCP	
2001:db8:bbbb:9::/64	00:13:01:00:00:04	[pw-1:2.14]	23h43m37s	DHCP	
2001:db8:bbbb:a:1/128	00:13:01:00:00:07	[pw-1:2.17]	23h43m37s	DHCP	
2001:db8:bbbb:b::/64	00:13:01:00:00:07	[pw-1:2.17]	23h43m37s	DHCP	
2001:db8:bbbb:c:1/128	00:13:01:00:00:03	[pw-1:2.13]	23h43m37s	DHCP	
2001:db8:bbbb:d::/64	00:13:01:00:00:03	[pw-1:2.13]	23h43m37s	DHCP	
2001:db8:bbbb:e:1/128	00:13:01:00:00:06	[pw-1:2.16]	23h43m37s	DHCP	
2001:db8:bbbb:f::/64	00:13:01:00:00:06	[pw-1:2.16]	23h43m37s	DHCP	
2001:db8:bbbb:10:1/128	00:13:01:00:00:0a	[pw-1:2.20]	23h38m40s	DHCP	
2001:db8:bbbb:11::/64					

```

00:13:01:00:00:0a [pw-1:2.20]          23h38m40s  DHCP
2001:db8:bbbb:12::1/128
00:13:01:00:00:09 [pw-1:2.19]          23h38m40s  DHCP
2001:db8:bbbb:13::/64
00:13:01:00:00:09 [pw-1:2.19]          23h38m40s  DHCP
2001:db8:bbbb:14::1/128
00:11:01:00:00:01 [pw-1:2.1]           23h43m41s  DHCP
2001:db8:bbbb:15::/64
00:11:01:00:00:01 [pw-1:2.1]           23h43m41s  DHCP
2001:db8:bbbb:16::1/128
00:11:01:00:00:03 [pw-1:2.3]          23h43m41s  DHCP
2001:db8:bbbb:17::/64
00:11:01:00:00:03 [pw-1:2.3]          23h43m41s  DHCP
2001:db8:bbbb:18::1/128
00:11:01:00:00:02 [pw-1:2.2]          23h43m41s  DHCP
2001:db8:bbbb:19::/64
00:11:01:00:00:02 [pw-1:2.2]          23h43m41s  DHCP
2001:db8:bbbb:1a::1/128
00:11:01:00:00:04 [pw-1:2.4]          23h43m41s  DHCP
2001:db8:bbbb:1b::/64
00:11:01:00:00:04 [pw-1:2.4]          23h43m41s  DHCP
2001:db8:bbbb:1c::1/128
00:11:01:00:00:05 [pw-1:2.5]          23h43m42s  DHCP
2001:db8:bbbb:1d::/64
00:11:01:00:00:05 [pw-1:2.5]          23h43m42s  DHCP
2001:db8:bbbb:1e::1/128
00:11:01:00:00:06 [pw-1:2.6]          23h43m41s  DHCP
2001:db8:bbbb:1f::/64
00:11:01:00:00:06 [pw-1:2.6]          23h43m41s  DHCP
2001:db8:bbbb:20::1/128
00:11:01:00:00:07 [pw-1:2.7]          23h43m41s  DHCP
2001:db8:bbbb:21::/64
00:11:01:00:00:07 [pw-1:2.7]          23h43m41s  DHCP
2001:db8:bbbb:22::1/128
00:11:01:00:00:08 [pw-1:2.8]          23h43m42s  DHCP
2001:db8:bbbb:23::/64
00:11:01:00:00:08 [pw-1:2.8]          23h43m42s  DHCP
2001:db8:bbbb:24::1/128
00:11:01:00:00:09 [pw-1:2.9]          23h43m41s  DHCP
2001:db8:bbbb:25::/64
00:11:01:00:00:09 [pw-1:2.9]          23h43m41s  DHCP
2001:db8:bbbb:26::1/128
00:11:01:00:00:0a [pw-1:2.10]         23h43m41s  DHCP
2001:db8:bbbb:27::/64
00:11:01:00:00:0a [pw-1:2.10]         23h43m41s  DHCP
-----
Number of lease states : 40
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show srrp 1 detail

=====
SRRP Instance 1
=====
Description      : (Not Specified)
Admin State      : Up                Oper State      : master
Preempt         : yes                One GARP per SAP : no
Monitor Oper Group : None
System IP       : 192.0.2.20
Service ID      : VPRN 10
    
```

```

Group If      : group-int-1      MAC Address   : b4:96:ff:00:00:00
Grp If Description : N/A
Grp If Admin State : Up          Grp If Oper State: Up
Subscriber If   : sub-int-1
Sub If Admin State : Up          Sub If Oper State: Up
Address        : 10.10.0.1/24    Gateway IP    : 10.10.0.254
Address        : 10.10.1.1/24    Gateway IP    : 10.10.1.254
Redundant If   : red-int-bng-1-bng*
Red If Admin State : Up          Red If Oper State: Up
Address        : 192.168.11.1/24
Red Spoke-sdp  : 1:1
Msg Path SAP   : pw-1:2.4094     Passive       : no
Admin Gateway MAC :              Oper Gateway MAC : 00:00:5e:00:01:01
Standby-Forwarding : Disabled
Config Priority : 100            In-use Priority : 100
Master Priority  : 100
Keep-alive Interval : 2 deci-seconds Master Since   : 11/12/2022 16:23:34
Fib Population Mode : all
VRRP Policy 1     : None         VRRP Policy 2  : None
    
```

 Statistics

```

Become Master      : 1          Master Changes   : 1
Become Bkup Routing : 0          Become Bkup Shunt: 1
Become Non-Master  : 0
Adv Sent           : 849384     Adv Received     : 0
Pri 0 Pkts Sent   : 0          Pri 0 Pkts Rcvd : 0
Preempt Events    : 0          Preempted Events : 0
Mesg Intvl Discards : 0       Mesg Intvl Errors: 0
    
```

=====
 * indicates that the corresponding row element may have been truncated.

[/]

A:admin@bng-1#

[/]

A:admin@bng-1# /show router 10 dhcp local-dhcp-server "dhcpv4" summary

=====
 DHCP server dhcpv4 router 10
 =====

```

Admin State      : inService
Operational State : inService
Persistency State : shutdown
User Data Base   : N/A
Use gateway IP address : enabled (scope pool)
Use pool from client : enabled
Send force-renewals : disabled
Creation Origin   : manual
Lease Hold Time   : 0h0m0s
Lease Hold Time For : N/A
User-ident       : mac-circuit-id
    
```

```

Failover Admin State : outOfService
Failover Oper State  : shutdown
Failover Persist Key : N/A
Administrative MCLT  : 0h10m0s
Operational MCLT     : 0h10m0s
Startup wait time    : 0h2m0s
Partner down delay   : 23h59m59s
Ignore MCLT          : disabled
    
```

```

Pool name : dhcpv4-1
-----
Failover Admin State : inService
Failover Oper State  : normal
Failover Persist Key : N/A
Administrative MCLT  : 0h10m0s
Operational MCLT    : 0h10m0s
Startup wait time    : 0h2m0s
Partner down delay   : 23h59m59s
  Ignore MCLT        : disabled
-----
Subnet              Free    %    Stable  Declined Offered  Rem-pend Drain
-----
10.10.0.0/24       (A) 81    89%  10      0        0        0        N
Totals for pool    81    89%  10      0        0        0
-----

Pool name : pppoev4-1
-----
Failover Admin State : outOfService
Failover Oper State  : shutdown
Failover Persist Key : N/A
Administrative MCLT  : 0h10m0s
Operational MCLT    : 0h10m0s
Startup wait time    : 0h2m0s
Partner down delay   : 23h59m59s
  Ignore MCLT        : disabled
-----
Subnet              Free    %    Stable  Declined Offered  Rem-pend Drain
-----
10.10.1.0/24       81    89%  10      0        0        0        N
Totals for pool    81    89%  10      0        0        0
-----

Totals for server  162    89%  20      0        0        0
-----

Interface associations
Interface              Admin
-----
loopback-1            Up
-----

Local Address Assignment associations
Group interface        Admin
-----
group-int-1            Up
No associated firewall domains found.
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp6 local-dhcp-server "dhcpv6" summary
=====
DHCP server dhcpv6  router 10
=====
Admin State          : inService
Operational State    : inService
Persistency State    : shutdown
    
```

```

Use Link Address      : disabled
Use pool from client : enabled
Creation Origin       : manual
Lease Hold Time       : 0h0m0s
Lease Hold Time For   : N/A
User-ident            : duid
Interface-id-mapping  : disabled
Ignore-rapid-commit   : disabled
Allow-lease-query     : disabled
Auto-provisioned      : false

Failover Admin State  : outOfService
Failover Oper State   : shutdown
Failover Persist Key  : N/A
Administrative MCLT   : 0h10m0s
Operational MCLT     : 0h10m0s
Startup wait time     : 0h2m0s
Partner down delay    : 23h59m59s
    Ignore MCLT       : disabled
-----
Pool name : dhcpv6-1
-----
Failover Admin State  : inService
Failover Oper State   : normal
Failover Persist Key  : N/A
Administrative MCLT   : 0h10m0s
Operational MCLT     : 0h10m0s
Startup wait time     : 0h2m0s
Partner down delay    : 23h59m59s
    Ignore MCLT       : disabled
-----
Prefix
-----
                Stable  Declined  Advert  Rem-pend  Drain
-----
2001:db8:bbbb::/56          (A)  40      0      0      0      N
2001:db8:bbbb:100::/56     (A)  0      0      0      0      N
-----
Totals for pool            40      0      0      0
-----
Totals for server          40      0      0      0
-----
Interface associations
Interface                Admin
-----
loopback-1              Up
-----
Local Address Assignment associations
Group interface          Admin
-----
No associated firewall domains found.
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp local-dhcp-server "dhcpv4" leases
    
```

```

=====
Leases for DHCP server dhcpv4 router 10
=====
IP Address      Lease State      Mac Address      Remaining      Clnt  Fail
  PPP user name/Opt82 Circuit Id      LifeTime      Type  Ctrl
  User-db/Sticky-lease Hostname
-----
10.10.0.10      stable          00:13:01:00:00:02 0h23m42s     dhcp  local
  cid-2
10.10.0.11      stable          00:13:01:00:00:05 0h23m42s     dhcp  local
  cid-5
10.10.0.12      stable          00:13:01:00:00:01 0h23m42s     dhcp  local
  cid-1
10.10.0.13      stable          00:13:01:00:00:0a 0h23m42s     dhcp  local
  cid-10
10.10.0.14      stable          00:13:01:00:00:03 0h23m42s     dhcp  local
  cid-3
10.10.0.15      stable          00:13:01:00:00:09 0h23m42s     dhcp  local
  cid-9
10.10.0.16      stable          00:13:01:00:00:08 0h23m43s     dhcp  local
  cid-8
10.10.0.17      stable          00:13:01:00:00:04 0h23m44s     dhcp  local
  cid-4
10.10.0.18      stable          00:13:01:00:00:07 0h23m44s     dhcp  local
  cid-7
10.10.0.19      stable          00:13:01:00:00:06 0h23m44s     dhcp  local
  cid-6
10.10.1.10      internal        N/A              N/A           ppp   N/A
10.10.1.11      internal        N/A              N/A           ppp   N/A
10.10.1.12      internal        N/A              N/A           ppp   N/A
10.10.1.13      internal        N/A              N/A           ppp   N/A
10.10.1.14      internal        N/A              N/A           ppp   N/A
10.10.1.15      internal        N/A              N/A           ppp   N/A
10.10.1.16      internal        N/A              N/A           ppp   N/A
10.10.1.17      internal        N/A              N/A           ppp   N/A
10.10.1.18      internal        N/A              N/A           ppp   N/A
10.10.1.19      internal        N/A              N/A           ppp   N/A
-----
20 leases found
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp6 local-dhcp-server "dhcpv6" leases

=====
Leases for DHCPv6 server dhcpv6
=====
IP Address/Prefix      Lease State      Remaining      Fail
  Link-local Address      LifeTime      LifeTime      Ctrl
-----
2001:db8:bbbb::1/64
    
```

fe80::213:1ff:fe00:1	stable	1d0h13m	local
2001:db8:bbbb:1::/64			
fe80::213:1ff:fe00:1	stable	1d0h13m	local
2001:db8:bbbb:2::/64			
fe80::213:1ff:fe00:2	stable	1d0h13m	local
2001:db8:bbbb:3::/64			
fe80::213:1ff:fe00:2	stable	1d0h13m	local
2001:db8:bbbb:4::/64			
fe80::213:1ff:fe00:5	stable	1d0h13m	local
2001:db8:bbbb:5::/64			
fe80::213:1ff:fe00:5	stable	1d0h13m	local
2001:db8:bbbb:6::/64			
fe80::213:1ff:fe00:8	stable	1d0h13m	local
2001:db8:bbbb:7::/64			
fe80::213:1ff:fe00:8	stable	1d0h13m	local
2001:db8:bbbb:8::/64			
fe80::213:1ff:fe00:4	stable	1d0h13m	local
2001:db8:bbbb:9::/64			
fe80::213:1ff:fe00:4	stable	1d0h13m	local
2001:db8:bbbb:a::/64			
fe80::213:1ff:fe00:7	stable	1d0h13m	local
2001:db8:bbbb:b::/64			
fe80::213:1ff:fe00:7	stable	1d0h13m	local
2001:db8:bbbb:c::/64			
fe80::213:1ff:fe00:3	stable	1d0h13m	local
2001:db8:bbbb:d::/64			
fe80::213:1ff:fe00:3	stable	1d0h13m	local
2001:db8:bbbb:e::/64			
fe80::213:1ff:fe00:6	stable	1d0h13m	local
2001:db8:bbbb:f::/64			
fe80::213:1ff:fe00:6	stable	1d0h13m	local
2001:db8:bbbb:10::/64			
fe80::213:1ff:fe00:a	stable	1d0h8m	local
2001:db8:bbbb:11::/64			
fe80::213:1ff:fe00:a	stable	1d0h8m	local
2001:db8:bbbb:12::/64			
fe80::213:1ff:fe00:9	stable	1d0h8m	local
2001:db8:bbbb:13::/64			
fe80::213:1ff:fe00:9	stable	1d0h8m	local
2001:db8:bbbb:14::/64			
fe80::1:2:1:1	stable	1d0h13m	local
2001:db8:bbbb:15::/64			
fe80::1:2:1:1	stable	1d0h13m	local
2001:db8:bbbb:16::/64			
fe80::3:2:3:1	stable	1d0h13m	local
2001:db8:bbbb:17::/64			
fe80::3:2:3:1	stable	1d0h13m	local
2001:db8:bbbb:18::/64			
fe80::2:2:2:1	stable	1d0h13m	local
2001:db8:bbbb:19::/64			
fe80::2:2:2:1	stable	1d0h13m	local
2001:db8:bbbb:1a::/64			
fe80::4:2:4:1	stable	1d0h13m	local
2001:db8:bbbb:1b::/64			
fe80::4:2:4:1	stable	1d0h13m	local
2001:db8:bbbb:1c::/64			
fe80::5:2:5:1	stable	1d0h13m	local
2001:db8:bbbb:1d::/64			
fe80::5:2:5:1	stable	1d0h13m	local
2001:db8:bbbb:1e::/64			
fe80::6:2:6:1	stable	1d0h13m	local
2001:db8:bbbb:1f::/64			
fe80::6:2:6:1	stable	1d0h13m	local
2001:db8:bbbb:20::/64			


```

fe80::7:2:7:1                stable                1d0h13m    local
2001:db8:bbbb:21::/64
fe80::7:2:7:1                stable                1d0h13m    local
2001:db8:bbbb:22::/64
fe80::8:2:8:1                stable                1d0h13m    local
2001:db8:bbbb:23::/64
fe80::8:2:8:1                stable                1d0h13m    local
2001:db8:bbbb:24::/64
fe80::9:2:9:1                stable                1d0h13m    local
2001:db8:bbbb:25::/64
fe80::9:2:9:1                stable                1d0h13m    local
2001:db8:bbbb:26::/64
fe80::a:2:a:1                stable                1d0h13m    local
2001:db8:bbbb:27::/64
fe80::a:2:a:1                stable                1d0h13m    local
-----
40 leases found
=====A:admin@bng-1# /show
port

=====
Ports on Slot 1
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port  Port  Port  C/QS/S/XFP/
Id        State  State State  MTU  MTU  Bndl  Mode  Encp  Type  MDIMDX
-----
1/1/c1    Up      Yes  Link Up      8936 8936  -   hybr dotq  xgige  conn  100GBASE-LR4*
1/1/c1/1  Up      Yes  Up      8936 8936  -   hybr dotq  xgige
1/1/c1/2  Down   No   Down    8936 8936  -   hybr dotq  xgige
1/1/c1/3  Down   No   Down    8936 8936  -   hybr dotq  xgige
1/1/c1/4  Up      Yes  Up      8936 8936  -   hybr dotq  xgige
1/1/c1/5  Up      No   Down    8936 8936  -   hybr dotq  xgige
1/1/c1/6  Up      Yes  Up      8936 8936  -   hybr dotq  xgige
1/1/c1/7  Up      Yes  Up      8936 8936  -   hybr dotq  xgige
1/1/c1/8  Up      No   Down    8936 8936  -   hybr dotq  xgige
1/1/c1/9  Up      No   Down    8936 8936  -   hybr dotq  xgige
1/1/c1/10 Up      Yes  Up      8936 8936  -   hybr dotq  xgige
1/1/c2    Up      Link Link Up      8936 8936  -   hybr dotq  cgige  conn  100G CWDM4 M*
1/1/c2/1  Up      Yes  Up      8936 8936  -   hybr dotq  cgige
1/1/c3    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CLR4 *
1/1/c4    Up      Link Link Up      8936 8936  -   netw null  xgige  conn  100GBASE-LR4*
1/1/c4/1  Up      Yes  Up      8936 8936  -   hybr dotq  xgige
1/1/c4/2  Up      No   Down    8936 8936  -   netw null  xgige
1/1/c4/3  Up      No   Down    8936 8936  -   netw null  xgige
1/1/c4/4  Up      No   Down    8936 8936  -   hybr dotq  xgige
1/1/c5    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CWDM4 M*
1/1/c6    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CLR4 *
1/2/c1    Down   No   Down    8936 8936  -   netw null  xgige  conn  100GBASE-LR4*
1/2/c2    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CWDM4 M*
1/2/c3    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CLR4 *
1/2/c4    Down   No   Down    8936 8936  -   netw null  xgige  conn  100GBASE-LR4*
1/2/c5    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CWDM4 M*
1/2/c6    Down   No   Down    8936 8936  -   netw null  xgige  conn  100G CLR4 *
=====
Ports on Slot A
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port  Port  Port  C/QS/S/XFP/
Id        State  State State  MTU  MTU  Bndl  Mode  Encp  Type  MDIMDX
-----
A/1       Up      Yes  Up      1514 1514  -   netw null  faste  MDI
A/3       Down   No   Down    1514 1514  -   netw null  faste
A/4       Down   No   Down    1514 1514  -   netw null  faste
    
```

```

=====
Ports on Slot B
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port Port Port  C/QS/S/XFP/
Id        State      State MTU   MTU   Bndl  Mode Encp Type MDIMDX
-----
B/1       Up    No   Ghost  1514 1514   - netw null faste
B/3       Down  No   Ghost  1514 1514   - netw null faste
B/4       Down  No   Ghost  1514 1514   - netw null faste
    
```

```

=====
Ports on Port Cross Connect 1
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port Port Port  C/QS/S/XFP/
Id        State      State MTU   MTU   Bndl  Mode Encp Type MDIMDX
-----
pxc-1.a   Up    Yes  Up     8932 8932   - hybr dotq xgige
pxc-1.b   Up    Yes  Up     8932 8932   - hybr dotq xgige
    
```

```

=====
Ports on Port Cross Connect 2
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port Port Port  C/QS/S/XFP/
Id        State      State MTU   MTU   Bndl  Mode Encp Type MDIMDX
-----
pxc-2.a   Up    Yes  Up     8932 8932   - hybr dotq xgige
pxc-2.b   Up    Yes  Up     8932 8932   - hybr dotq xgige
    
```

```

=====
Ports on Port Cross Connect 3
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port Port Port  C/QS/S/XFP/
Id        State      State MTU   MTU   Bndl  Mode Encp Type MDIMDX
-----
pxc-3.a   Up    Yes  Up     8932 8932   - hybr dotq xgige
pxc-3.b   Up    Yes  Up     8932 8932   - hybr dotq xgige
    
```

```

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router interface
    
```

```

=====
Interface Table (Router: Base)
=====
Interface-Name      Adm    Opr(v4/v6)  Mode    Port/SapId
IP-Address          PfxState
-----
_tmnx_fpe_1.a      Up     Up/Up       Network pxc-1.a:1
fe80::100/64       PREFERRED
_tmnx_fpe_1.b      Up     Up/Up       Network pxc-1.b:1
fe80::101/64       PREFERRED
_tmnx_fpe_2.a      Up     Up/Up       Network pxc-2.a:1
fe80::200/64       PREFERRED
_tmnx_fpe_2.b      Up     Up/Up       Network pxc-2.b:1
fe80::201/64       PREFERRED
_tmnx_fpe_3.a      Up     Up/Up       Network pxc-3.a:1
fe80::300/64       PREFERRED
_tmnx_fpe_3.b      Up     Up/Up       Network pxc-3.b:1
fe80::301/64       PREFERRED
int-1-bng-1-bng-2  Up     Up/Up       Network 1/1/c1/6:1
192.168.7.1/24     n/a
    
```

```

2001:db8::701/120                                PREFERRED
fe80::b696:ffff:fe00:0/64                       PREFERRED
int-1-bng-1-p-1                                Up      Down/Up    Network 1/1/c1/1:1
2001:db8::501/120                                PREFERRED
fe80::b696:ffff:fe00:0/64                       PREFERRED
int-1-bng-1-pe-2                               Up      Down/Up    Network 1/1/c1/7:1
2001:db8::801/120                                PREFERRED
fe80::b696:ffff:fe00:0/64                       PREFERRED
system                                          Up      Up/Up      Network system
192.0.2.20/32                                   n/a
2001:db8::14/128                                PREFERRED
to-radius                                       Up      Up/Down    Network 1/1/c1/10:114
192.168.114.20/24                               n/a
-----
Interfaces : 11
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 interface

=====
Interface Table (Service: 10)
=====
Interface-Name      Adm      Opr(v4/v6)  Mode      Port/SapId
IP-Address          PfxState
-----
group-int-1        Up      Up/Up       VPRN G*  pw-1
loopback-1         Up      Up/Up       VPRN      loopback
192.168.0.1/32     n/a
2001:db8::1/128   PREFERRED
fe80::b696:ffff:fe00:0/64 PREFERRED
red-int-bng-1-bng-2 Up      Up/Up       VPRN R*  spoke-1:1
192.168.11.1/24   n/a
sub-int-1          Up      Up/Up       VPRN S*  subscriber
10.10.0.1/24      n/a
10.10.1.1/24      n/a
2001:db8:bbbb::/56 PREFERRED
2001:db8:bbbb:100::/56 PREFERRED
fe80::b696:ffff:fe00:0/64 PREFERRED
-----
Interfaces : 4
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show fwd-path-ext fpe 1

=====
FPE Id: 1
=====
Description      : srv6 origination
Multi-Path       : Disabled
Path             : pxc 1
Pw Port Extension : Disabled          Oper   : down
Sub Mgmt Extension : Disabled          Oper   : N/A
Vxlan            : Disabled          Oper   : down
Segment-Routing V6 : Enabled          Oper   : up
SRv6 Type        : origination
    
```

```
If-A Qos Policy      : default
If-B MTU             : 9786 bytes          Oper MTU : 8914 bytes
If-B Qos Policy      : default
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show fwd-path-ext fpe 2

=====
FPE Id: 2
=====
Description          : srv6 termination
Multi-Path           : Disabled
Path                 : pxc 2
Pw Port Extension    : Disabled           Oper    : down
Sub Mgmt Extension   : Disabled           Oper    : N/A
Vxlan                : Disabled           Oper    : down
Segment-Routing V6  : Enabled             Oper    : up
SRv6 Type            : termination
If-A Qos Policy      : default
If-B MTU             : 0 bytes            Oper MTU : 8914 bytes
If-B Qos Policy      : default
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show fwd-path-ext fpe 3

=====
FPE Id: 3
=====
Description          : pw-port on a single port
Multi-Path           : Disabled
Path                 : pxc 3
Pw Port Extension    : Enabled            Oper    : up
Sub Mgmt Extension   : Disabled           Oper    : N/A
Vxlan                : Disabled           Oper    : down
Segment-Routing V6  : Disabled
If-A Qos Policy      : default
If-B Qos Policy      : default
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" base

=====
Service Basic Information
=====
Service Id          : 11                Vpn Id           : 0
Service Type        : Epipe
MACSec enabled      : no
Name                : evpn-dual-homing
Description          : (Not Specified)
Customer Id         : 1                 Creation Origin   : manual
Last Status Change : 11/12/2022 16:22:36
Last Mgmt Change    : 11/12/2022 16:21:35
```

```

Test Service      : No
Admin State      : Up           Oper State       : Up
MTU              : 1514
Vc Switching    : False
SAP Count       : 0           SDP Bind Count  : 1
Per Svc Hashing : Disabled    Lbl Eth/IP L4 TEID: Disabled
Ignore MTU Mismatch*: Disabled
Vxlan Src Tep Ip : N/A
Force QTag Fwd  : Disabled
Lcl Switch Svc St : sap
Oper Group      : <none>
    
```

 Service Access & Destination Points

Identifier	Type	AdmMTU	OprMTU	Adm	Opr
sdp:17500:1 SB(fpe_3.b)	Fpe	0	8910	Up	Up

=====

* indicates that the corresponding row element may have been truncated.

[/]
 A:admin@bng-1#

[/]
 A:admin@bng-1# /show service id "evpn-dual-homing" bgp-evpn

=====

BGP EVPN Table
 =====

EVI : 11 Creation Origin : manual

Local AC Name	Eth Tag	Endpoint	Ingress Label
bng	2		0

Number of local ACs : 1

Remote AC Name	Eth Tag	Endpoint
access	1	

Number of Remote ACs : 1
 =====

Segment Routing v6 Instance 1 Service 11
 =====

```

Admin State      : Enabled
Srv6 Instance    : 1
Default Locator  : bng-1-loc

Oper Group      : (Not Specified)
Default Route Tag : 0xb
Source Address   : 2001:db8::14
ECMP            : 1
Force Vlan VC Fwd : disabled
Next Hop Type    : system-ipv6
Evi 3-byte Auto-RT : disabled
Route Resolution : fallback-tunnel-to-route-table
Force QinQ VC Fwd : none
MH Mode         : network
    
```

```

=====
[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service system bgp-evpn ethernet-segment name "ES-1"

=====
Service Ethernet Segment
=====
Name                : ES-1
Eth Seg Type        : None
Admin State         : Enabled           Oper State           : Up
ESI                 : 01:01:01:01:01:01:01:01
Oper ESI            : 01:01:01:01:01:01:01:01
Auto-ESI Type       : None
AC DF Capability    : Include
Multi-homing        : singleActive     Oper Multi-homing    : singleActive
ES SHG Label        : None
Source BMAC LSB     : None
PW Port Id          : 1
PW Port Headend     : enabled
ES Activation Timer : 0 secs
Oper Group           : ES-1
Svc Carving         : manual           Oper Svc Carving     : manual
Cfg Range Type      : lowest-pref

-----
DF Pref Election Information
-----
Preference Mode    Preference Value    Last Admin Change    Oper Pref Value    Do No Preempt
-----
revertive          150                 11/12/2022 16:21:35    150                 Disabled

EVI Ranges: <none>
ISID Ranges: <none>
Vprn NextHop EVI Ranges : <none>

=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service system bgp-evpn ethernet-segment name "ES-1" evi evi-1 11

=====
EVI DF and Candidate List
=====
EVI      SvcId      Actv Timer Rem      DF  DF Last Change
-----
11       11          0                   yes 11/12/2022 16:21:35

=====

DF Candidates                                     Time Added           Oper Pref Value    Do Not Preempt
-----
2001:db8::14                                     11/12/2022 16:23:33  150                 Disabl*
2001:db8::15                                     11/12/2022 16:22:36  50                  Disabl*

Number of entries: 2
=====
    
```

```
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes evpn eth-seg detail
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete
=====
BGP EVPN Eth-Seg Routes
=====
Original Attributes

Network       : n/a
Nexthop       : 2001:db8::15
Path Id       : None
From          : 2001:db8::15
Res. Nexthop  : fe80::b697:ffff:fe00:0
Local Pref.   : 100
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     :
                df-election::DF-Type:Preference/DP:0/DF-Preference:50/AC:1
                target:01:01:01:01:01:01
Cluster       : No Cluster Members
Originator Id : None
Peer Router Id : 192.0.2.21
Flags         : Used Valid Best IGP
Route Source  : Internal
AS-Path       : No As-Path
EVPN type     : ETH-SEG
ESI           : 01:01:01:01:01:01:01:01:01
Originator IP : 2001:db8::15
Route Dist.   : 192.0.2.21:0
Route Tag     : 0
Neighbor-AS   : n/a
Orig Validation: N/A
Source Class  : 0
Dest Class    : 0
Add Paths Send : Default
Last Modified  : 01d23h12m

Modified Attributes

Network       : n/a
Nexthop       : 2001:db8::15
Path Id       : None
From          : 2001:db8::15
Res. Nexthop  : fe80::b697:ffff:fe00:0
Local Pref.   : 100
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     :
                df-election::DF-Type:Preference/DP:0/DF-Preference:50/AC:1
                target:01:01:01:01:01:01
```

```
Cluster      : No Cluster Members
Originator Id : None                      Peer Router Id : 192.0.2.21
Flags        : Used Valid Best IGP
Route Source  : Internal
AS-Path      : No As-Path
EVPN type    : ETH-SEG
ESI          : 01:01:01:01:01:01:01:01:01
Originator IP : 2001:db8::15
Route Dist.  : 192.0.2.21:0
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0                          Dest Class    : 0
Add Paths Send : Default
Last Modified : 01d23h12m

-----
Routes : 1
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes evpn auto-disc tag 1 detail
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
Legend -
Status codes : u - used, s - suppressed, h - history, d - decayed, * - valid
               l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete

=====
BGP EVPN Auto-Disc Routes
=====
Original Attributes

Network      : n/a
Nexthop     : 2001:db8::5
Path Id     : None
From        : 2001:db8::5
Res. Nexthop : fe80::b69e:ffff:fe00:0
Local Pref. : 100
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric  : None
Connector    : None
Community   : color:00:10 target:64500:11
              l2-attribute:MTU: 1514 C: 0 P: 0 B: 0
Cluster     : No Cluster Members
Originator Id : None                      Peer Router Id : 192.0.2.5
Flags       : Used Valid Best IGP
Route Source  : Internal
AS-Path      : No As-Path
EVPN type    : AUTO-DISC
ESI          : ESI-0
Tag          : 1
Route Dist.  : 192.0.2.5:11
MPLS Label   : 524288
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
```



```
Source Class : 0                               Dest Class : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV : SRv6 SID Information (1)
Sid : 2001:db8:aaaa:5::
Full Sid : 2001:db8:aaaa:5:8000::
Behavior : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                               Loc-Node-Len : 16
Func-Len : 20                                   Arg-Len : 0
Tpose-Len : 20                                  Tpose-offset : 64

Modified Attributes

Network : n/a
Nexthop : 2001:db8::5
Path Id : None
From : 2001:db8::5
Res. Nexthop : fe80::b69e:ffff:fe00:0
Local Pref. : 100                               Interface Name : int-1-bng-1-p-1
Aggregator AS : None                           Aggregator : None
Atomic Aggr. : Not Atomic                       MED : None
AIGP Metric : None                             IGP Cost : 30
Connector : None
Community : color:00:10 target:64500:11
           l2-attribute:MTU: 1514 C: 0 P: 0 B: 0
Cluster : No Cluster Members
Originator Id : None                           Peer Router Id : 192.0.2.5
Flags : Used Valid Best IGP
Route Source : Internal
AS-Path : No As-Path
EVPN type : AUTO-DISC
ESI : ESI-0
Tag : 1
Route Dist. : 192.0.2.5:11
MPLS Label : 524288
Route Tag : 0
Neighbor-AS : n/a
Orig Validation: N/A
Source Class : 0                               Dest Class : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV : SRv6 SID Information (1)
Sid : 2001:db8:aaaa:5::
Full Sid : 2001:db8:aaaa:5:8000::
Behavior : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                               Loc-Node-Len : 16
Func-Len : 20                                   Arg-Len : 0
Tpose-Len : 20                                  Tpose-offset : 64

-----
-----
Routes : 1
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" ethernet-segment "ES-1"
No sap entries
```

```

No sdp entries
No vxlan instance entries

=====
SDP Ethernet-Segment Information
=====
Pw-Port          Eth-Seg          Status
-----
1                 ES-1             DF
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 detail

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function SID          Status
-----
bng-1-loc
End.DX2      *524286 2001:db8:aaaa:14:7fff:e000::
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 instance 1 destinations

=====
TEP, SID
=====
Instance  TEP Address          Segment Id
-----
1         2001:db8::5          2001:db8:aaaa:5:8000::
-----
Number of TEP, SID: 1
=====

Segment Routing v6 Ethernet Segment Dest
=====
Instance  Eth SegId          Num. Macs    Last Change
-----
No Matching Entries
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 instance 1 end-dx2

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function SID          Status
=====
    
```

```

-----
bng-1-loc
  End.DX2          *524286 2001:db8:aaaa:14:7fff:e000::      ok
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "evpn-dual-homing" segment-routing-v6 instance 1 locator
"bng-1-loc"

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
  Type          Function  SID                                     Status
-----
bng-1-loc
  End.DX2      *524286 2001:db8:aaaa:14:7fff:e000::      ok
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "dual-homing" base

=====
Service Basic Information
=====
Service Id       : 10                Vpn Id          : 0
Service Type    : VPRN
MACSec enabled  : no
Name            : dual-homing
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/12/2022 16:21:35
Last Mgmt Change  : 11/12/2022 16:21:35
Admin State     : Up                Oper State      : Up

Router Oper State : Up
Route Dist.      : None            VPRN Type       : regular
Oper Route Dist  : 0:0
Oper RD Type     : none
AS Number       : None            Router Id       : 192.0.2.20
ECMP             : Enabled         ECMP Max Routes : 1
Max IPv4 Routes  : No Limit
Local Rt Domain-Id: None         D-Path Lng Ignore : Disabled

Auto Bind Tunnel
Allow Flex-Alg-Fb : Disabled
Resolution        : disabled
Weighted ECMP     : Disabled         ECMP Max Routes : 1
Strict Tnl Tag    : Disabled

Max IPv6 Routes  : No Limit
Ignore NH Metric  : Disabled
Hash Label       : Disabled
Entropy Label    : Disabled
Vrf Target       : None
Vrf Import       : None
    
```

```
Vrf Export      : None
MVPN Vrf Target : None
MVPN Vrf Import : None
MVPN Vrf Export : None
Car. Sup C-VPN  : Disabled
Label mode     : vrf
BGP VPN Backup  : Disabled
BGP Export Inactv : Disabled
LOG all events  : Disabled

SAP Count      : 21          SDP Bind Count   : 1
VSD Domain     : <none>
```

 Service Access & Destination Points

Identifier	Type	AdmMTU	OprMTU	Adm	Opr
sap:[pw-1:2.1]	qinq	8932	8888	Up	Up
sap:[pw-1:2.2]	qinq	8932	8888	Up	Up
sap:[pw-1:2.3]	qinq	8932	8888	Up	Up
sap:[pw-1:2.4]	qinq	8932	8888	Up	Up
sap:[pw-1:2.5]	qinq	8932	8888	Up	Up
sap:[pw-1:2.6]	qinq	8932	8888	Up	Up
sap:[pw-1:2.7]	qinq	8932	8888	Up	Up
sap:[pw-1:2.8]	qinq	8932	8888	Up	Up
sap:[pw-1:2.9]	qinq	8932	8888	Up	Up
sap:[pw-1:2.10]	qinq	8932	8888	Up	Up
sap:[pw-1:2.11]	qinq	8932	8888	Up	Up
sap:[pw-1:2.12]	qinq	8932	8888	Up	Up
sap:[pw-1:2.13]	qinq	8932	8888	Up	Up
sap:[pw-1:2.14]	qinq	8932	8888	Up	Up
sap:[pw-1:2.15]	qinq	8932	8888	Up	Up
sap:[pw-1:2.16]	qinq	8932	8888	Up	Up
sap:[pw-1:2.17]	qinq	8932	8888	Up	Up
sap:[pw-1:2.18]	qinq	8932	8888	Up	Up
sap:[pw-1:2.19]	qinq	8932	8888	Up	Up
sap:[pw-1:2.20]	qinq	8932	8888	Up	Up
sap:pw-1:2.4094	qinq	8932	8888	Up	Up
sdp:1:1 S(192.168.7.2)	None	0	8890	Up	Up

 [<sap-id>] indicates a Managed SAP
 =====

```
[/]
A:admin@bng-1#
```

```
[/]
A:admin@bng-1# /show service id "dual-homing" bgp-ipvpn segment-routing-v6
```

=====

```
Service 10 BGP-IPVPN Segment-Routing-V6 Information
=====
Admin State      : Up
VRF Import      : None
VRF Export      : srrp-aware-routing
Route Dist.     : 192.0.2.20:10
Oper Route Dist : 192.0.2.20:10
Oper RD Type    : configured
Route Target    : target:64500:10
Route Target Expor: None
Route Target Impor: None
Def Route Tag   : 0x0
```

```

Route Resolution : route-table

Srv6 Instance      : 1
Default Locator    : bng-1-loc
Source Address     : 2001:db8::14
Domain-Id         : None

=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id "dual-homing" segment-routing-v6 instance 1 locator "bng-1-loc"

=====
Segment Routing v6 Instance 1 Service 10
=====
Locator
Type          Function  SID                               Status
-----
bng-1-loc
  End.DT4      *524285  2001:db8:aaaa:14:7fff:d000::    ok
  End.DT6      *524284  2001:db8:aaaa:14:7fff:c000::    ok
=====
Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 route-table

=====
Route Table (Service: 10)
=====
Dest Prefix[Flags]          Type  Proto  Age      Pref
Next Hop[Interface Name]   Metric
-----
10.10.0.0/24                Local  Local  01d23h11m 0
      sub-int-1              0
10.10.0.2/32                Remote Sub Mgmt 01d23h12m 0
      [red-int-bng-1-bng-2]  0
10.10.0.10/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.11/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.12/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.13/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.14/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.15/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.16/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.17/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.18/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.0.19/32               Remote Sub Mgmt 01d23h11m 0
      [group-int-1]          0
10.10.1.0/24                Local  Local  01d23h11m 0
    
```

```

sub-int-1
10.10.1.2/32 Remote Sub Mgmt 01d23h12m 0
 [red-int-bng-1-bng-2]
10.10.1.10/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.11/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.12/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.13/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.14/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.15/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.16/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.17/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.18/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
10.10.1.19/32 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
172.16.102.0/24 Remote BGP VPN 01d23h12m 170
 2001:db8:aaaa:6:8000:: (tunneled:SRV6)
192.168.0.1/32 Local Local 01d23h13m 0
 loopback-1
192.168.11.0/24 Local Local 01d23h13m 0
 red-int-bng-1-bng-2
-----
No. of Routes: 27
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
      S = Sticky ECMP requested
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 route-table ipv6

=====
IPv6 Route Table (Service: 10)
=====
Dest Prefix[Flags] Type Proto Age Pref
Next Hop[Interface Name] Metric
-----
2001:db8::1/128 Local Local 01d23h13m 0
 loopback-1
2001:db8::6600/120 Remote BGP VPN 01d23h12m 170
 2001:db8:aaaa:6:7fff:f000:: (tunneled:SRV6)
2001:db8:bbbb::/56 Local Local 01d23h11m 0
 sub-int-1
2001:db8:bbbb::1/128 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
2001:db8:bbbb:1::/64 Remote Managed 01d23h11m 0
 2001:db8:bbbb::1
2001:db8:bbbb:2::1/128 Remote Sub Mgmt 01d23h11m 0
 [group-int-1]
2001:db8:bbbb:3::/64 Remote Managed 01d23h11m 0
 2001:db8:bbbb:2::1
2001:db8:bbbb:4::1/128 Remote Sub Mgmt 01d23h11m 0

```

[group-int-1]				0	
2001:db8:bbbb:5::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:4::1			0		
2001:db8:bbbb:6::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:7::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:6::1			0		
2001:db8:bbbb:8::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:9::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:8::1			0		
2001:db8:bbbb:a::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:b::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:a::1			0		
2001:db8:bbbb:c::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:d::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:c::1			0		
2001:db8:bbbb:e::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:f::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:e::1			0		
2001:db8:bbbb:10::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:11::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:10::1			0		
2001:db8:bbbb:12::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:13::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:12::1			0		
2001:db8:bbbb:14::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:15::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:14::1			0		
2001:db8:bbbb:16::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:17::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:16::1			0		
2001:db8:bbbb:18::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:19::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:18::1			0		
2001:db8:bbbb:1a::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:1b::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:1a::1			0		
2001:db8:bbbb:1c::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:1d::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:1c::1			0		
2001:db8:bbbb:1e::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:1f::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:1e::1			0		
2001:db8:bbbb:20::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:21::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:20::1			0		
2001:db8:bbbb:22::1/128	Remote	Sub Mgmt	01d23h11m	0	
[group-int-1]			0		
2001:db8:bbbb:23::/64	Remote	Managed	01d23h11m	0	
2001:db8:bbbb:22::1			0		
2001:db8:bbbb:24::1/128	Remote	Sub Mgmt	01d23h11m	0	

```

    [group-int-1]
2001:db8:bbbb:25::/64          Remote  Managed  01d23h11m  0
    2001:db8:bbbb:24::1
2001:db8:bbbb:26::1/128      Remote  Sub Mgmt  01d23h11m  0
    [group-int-1]
2001:db8:bbbb:27::/64          Remote  Managed  01d23h11m  0
    2001:db8:bbbb:26::1
2001:db8:bbbb:100::/56       Local   Local    01d23h11m  0
    sub-int-1
    0
-----
No. of Routes: 44
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
      S = Sticky ECMP requested
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes vpn-ipv4 hunt
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete
=====
BGP VPN-IPv4 Routes
=====
-----
RIB In Entries
-----
Network       : 172.16.102.0/24
Nexthop       : 2001:db8::6
Route Dist.   : 192.0.2.6:10      VPN Label     : 524288
Path Id       : None
From          : 2001:db8::6
Res. Nexthop  : n/a
Local Pref.   : 100
Aggregator AS : None              Interface Name : int-1-bng-1-pe-2
Atomic Aggr.  : Not Atomic        Aggregator    : None
AIGP Metric   : None              MED           : None
Connector     : None              IGP Cost      : 20
Community     : target:64500:10
Cluster       : No Cluster Members
Originator Id : None              Peer Router Id : 192.0.2.6
Fwd Class     : None              Priority       : None
Flags         : Used Valid Best IGP
Route Source  : Internal
AS-Path       : No As-Path
Route Tag     : 0
Neighbor-AS   : n/a
Orig Validation: N/A
Source Class  : 0                  Dest Class     : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:6::
Full Sid      : 2001:db8:aaaa:6:8000::
    
```



```

Behavior      : End.DT4 (19)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48
Func-Len      : 20
Tpose-Len     : 20
VPRN Imported : 10
Loc-Node-Len  : 16
Arg-Len       : 0
Tpose-offset  : 64
-----
RIB Out Entries
-----
Network       : 10.10.0.0/24
Nextthop     : 2001:db8::14
Route Dist.   : 192.0.2.20:10
Path Id      : None
To           : 2001:db8::6
Res. Nextthop : n/a
Local Pref.   : 150
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     : target:64500:10
Cluster       : No Cluster Members
Originator Id : None
Origin        : IGP
AS-Path       : No As-Path
Route Tag     : 0
Neighbor-AS   : n/a
Orig Validation: N/A
Source Class  : 0
Dest Class    : 0
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:14::
Full Sid      : 2001:db8:aaaa:14:7fff:d000::
Behavior      : End.DT4 (19)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48
Func-Len      : 20
Tpose-Len     : 20
Loc-Node-Len  : 16
Arg-Len       : 0
Tpose-offset  : 64
-----
Network       : 10.10.1.0/24
Nextthop     : 2001:db8::14
Route Dist.   : 192.0.2.20:10
Path Id      : None
To           : 2001:db8::6
Res. Nextthop : n/a
Local Pref.   : 150
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     : target:64500:10
Cluster       : No Cluster Members
Originator Id : None
Origin        : IGP
AS-Path       : No As-Path
Route Tag     : 0
Neighbor-AS   : n/a
Orig Validation: N/A
Source Class  : 0
Dest Class    : 0
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:14::
Full Sid      : 2001:db8:aaaa:14:7fff:d000::
-----

```

```

Behavior      : End.DT4 (19)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                      Loc-Node-Len : 16
Func-Len      : 20                      Arg-Len      : 0
Tpose-Len     : 20                      Tpose-offset : 64
-----
Routes : 3
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp routes vpn-ipv6 hunt
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
Legend -
Status codes : u - used, s - suppressed, h - history, d - decayed, * - valid
               l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete
=====
BGP VPN-IPv6 Routes
=====
-----
RIB In Entries
-----
Network      : 2001:db8::6600/120
Nextthop     : 2001:db8::6
Route Dist.  : 192.0.2.6:10           VPN Label    : 524287
Path Id      : None
From         : 2001:db8::6
Res. Nextthop : n/a
Local Pref.  : 100                    Interface Name : int-1-bng-1-pe-2
Aggregator AS : None                  Aggregator    : None
Atomic Aggr. : Not Atomic              MED           : None
AIGP Metric  : None                    IGP Cost      : 20
Connector    : None
Community    : target:64500:10
Cluster      : No Cluster Members
Originator Id : None                    Peer Router Id : 192.0.2.6
Fwd Class    : None                      Priority      : None
Flags        : Used Valid Best IGP
Route Source : Internal
AS-Path      : No As-Path
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0                          Dest Class    : 0
Add Paths Send : Default
Last Modified : 01d23h12m
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV   : SRv6 SID Information (1)
Sid           : 2001:db8:aaaa:6::
Full Sid      : 2001:db8:aaaa:6:7fff:f000::
Behavior      : End.DT6 (18)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                      Loc-Node-Len : 16
Func-Len      : 20                      Arg-Len      : 0
Tpose-Len     : 20                      Tpose-offset : 64
VPRN Imported : 10
    
```

```

-----
RIB Out Entries
-----
Network      : 2001:db8:bbbb::/56
Nextthop    : 2001:db8::14
Route Dist.  : 192.0.2.20:10      VPN Label    : 524284
Path Id      : None
To           : 2001:db8::6
Res. Nextthop : n/a
Local Pref.  : 150
Aggregator AS : None                Interface Name : NotAvailable
Atomic Aggr. : Not Atomic        Aggregator    : None
AIGP Metric  : None              MED           : None
Connector    : None              IGP Cost     : n/a
Community    : target:64500:10
Cluster      : No Cluster Members
Originator Id : None                Peer Router Id : 192.0.2.6
Origin       : IGP
AS-Path      : No As-Path
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0                  Dest Class    : 0
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid          : 2001:db8:aaaa:14::
Full Sid     : 2001:db8:aaaa:14:7fff:c000::
Behavior     : End.DT6 (18)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                Loc-Node-Len  : 16
Func-Len     : 20                  Arg-Len       : 0
Tpose-Len    : 20                  Tpose-offset  : 64

Network      : 2001:db8:bbbb:100::/56
Nextthop    : 2001:db8::14
Route Dist.  : 192.0.2.20:10      VPN Label    : 524284
Path Id      : None
To           : 2001:db8::6
Res. Nextthop : n/a
Local Pref.  : 150
Aggregator AS : None                Interface Name : NotAvailable
Atomic Aggr. : Not Atomic        Aggregator    : None
AIGP Metric  : None              MED           : None
Connector    : None              IGP Cost     : n/a
Community    : target:64500:10
Cluster      : No Cluster Members
Originator Id : None                Peer Router Id : 192.0.2.6
Origin       : IGP
AS-Path      : No As-Path
Route Tag    : 0
Neighbor-AS  : n/a
Orig Validation: N/A
Source Class : 0                  Dest Class    : 0
SRv6 TLV Type : SRv6 L3 Service TLV (5)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid          : 2001:db8:aaaa:14::
Full Sid     : 2001:db8:aaaa:14:7fff:c000::
Behavior     : End.DT6 (18)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                Loc-Node-Len  : 16
Func-Len     : 20                  Arg-Len       : 0
Tpose-Len    : 20                  Tpose-offset  : 64
-----
    
```

```

Routes : 3
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router segment-routing-v6 base-routing-instance all

=====
Segment Routing v6 Base Routing Instance
=====

Locator
Type          Function      SID                               Status/InstId
  SRH-mode Protection  Interface
-----
bng-1-loc
End                               1 2001:db8:aaaa:14:0:1000::      ok
USP
-----
Auto-allocated End.X: USP Protected,
-----
End.X          *524287 2001:db8:aaaa:14:7fff:f000::      1
USP            Protected int-1-bng-1-bng-2
ISIS Level: L2 Mac Address: b4:98:01:01:00:06 Nbr Sys Id: 1920.0000.2021
End.X          *524288 2001:db8:aaaa:14:8000::          0
USP            Protected int-1-bng-1-p-1
ISIS Level: L2 Mac Address: b4:9e:01:01:00:0b Nbr Sys Id: 1920.0000.2004
End.X          *524289 2001:db8:aaaa:14:8000:1000::      1
USP            Protected int-1-bng-1-pe-2
ISIS Level: L2 Mac Address: b4:a0:01:01:00:07 Nbr Sys Id: 1920.0000.2006
-----

Legend: * - System allocated

=====
Micro Segment Routing v6 Base Routing Instance
=====

Micro Segment Locator
Type          Function      SID                               Status/InstId
  SRH-mode Oper Func  Interface  Protection
-----

Legend: * - System allocated

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router segment-routing-v6 local-sid context "Base"

=====
Segment Routing v6 Local SIDs
=====

SID                               Type          Function
Locator
Context
-----
2001:db8:aaaa:14:0:1000::        End           1
  bng-1-loc
  Base
-----

SIDs : 1
=====
    
```

```

=====
[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router segment-routing-v6 local-sid context "10"

=====
Segment Routing v6 Local SIDs
=====
SID                               Type          Function
Locator
Context
-----
2001:db8:aaaa:14:7fff:c000::      End.DT6       524284
  bng-1-loc
  SvcId: 10 Name: dual-homing
2001:db8:aaaa:14:7fff:d000::      End.DT4       524285
  bng-1-loc
  SvcId: 10 Name: dual-homing
-----
SIDs : 2
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router route-table ipv6

=====
IPv6 Route Table (Router: Base)
=====
Dest Prefix[Flags]                Type  Proto  Age      Pref
Next Hop[Interface Name]          Metric
-----
2001:db8::4/128                   Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  10
2001:db8::5/128                   Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  20
2001:db8::6/128 [L]               Remote  ISIS(1) 01d23h12m 18
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"  10
2001:db8::a/128                   Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  20
2001:db8::14/128                  Local   Local   01d23h13m  0
  system
2001:db8::15/128 [L]              Remote  ISIS(1) 01d23h12m 18
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"  10
2001:db8::100/120                 Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  20
2001:db8::200/120                 Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  30
2001:db8::500/120                 Local   Local   01d23h13m  0
  int-1-bng-1-p-1
2001:db8::600/120                 Remote  ISIS   01d23h12m 18
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"  30
2001:db8::700/120                 Local   Local   01d23h13m  0
  int-1-bng-1-bng-2
2001:db8::800/120                 Local   Local   01d23h13m  0
  int-1-bng-1-pe-2
2001:db8::900/120 [L]            Remote  ISIS(1) 01d23h12m 18
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"  20
    
```

```

2001:db8::a00/120 Remote ISIS 01d23h12m 18
    fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8::6400/120 Remote ISIS 01d23h12m 18
    fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8::6500/120 [L] Remote ISIS(1) 01d23h12m 18
    fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 20
2001:db8:aaaa:4::/64 Remote ISIS 01d23h12m 18
    2001:db8:aaaa:4::/64 (tunneled:SRV6-ISIS) 20
2001:db8:aaaa:5::/64 Remote ISIS 01d23h12m 18
    2001:db8:aaaa:5::/64 (tunneled:SRV6-ISIS) 30
2001:db8:aaaa:6::/64 Remote ISIS(1) 01d23h12m 18
    2001:db8:aaaa:6::/64 (tunneled:SRV6-ISIS) 20
2001:db8:aaaa:a::/64 Remote ISIS 01d23h12m 18
    2001:db8:aaaa:a::/64 (tunneled:SRV6-ISIS) 30
2001:db8:aaaa:14::/64 Local SRV6 01d23h13m 3
    fe80::201-"_tmnx_fpe_2.a" 0
2001:db8:aaaa:14:0:1000::/128 Local SRV6 01d23h13m 3
    Black Hole 0
2001:db8:aaaa:14:0:2000::/128 Local SRV6-Pol* 01d23h13m 14
    2001:db8::5 (tunneled:SRV6-Policy:917506) 1
2001:db8:aaaa:14:7fff:f000::/128 Local ISIS(1) 01d23h12m 18
    2001:db8:aaaa:14:7fff:f000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:14:8000::/128 Local ISIS 01d23h12m 18
    2001:db8:aaaa:14:8000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:14:8000:1000::/128 Local ISIS(1) 01d23h12m 18
    2001:db8:aaaa:14:8000:1000:: (tunneled:SRV6-ISIS) 10
2001:db8:aaaa:15::/64 Remote ISIS(1) 01d23h12m 18
    2001:db8:aaaa:15::/64 (tunneled:SRV6-ISIS) 20
-----
No. of Routes: 27
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
      S = Sticky ECMP requested
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router tunnel-table ipv6

=====
IPv6 Tunnel Table (Router: Base)
=====
Destination Owner Encap TunnelId Pref
Nexthop Color Metric
-----
2001:db8::5/128 srv6-pol SRV6 917506 14
    fpe_1.a 10 0
2001:db8:aaaa:4::/64 srv6-isis SRV6 524296 0
    fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 20
2001:db8:aaaa:5::/64 srv6-isis SRV6 524299 0
    fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8:aaaa:6::/64 [L] srv6-isis SRV6 524295 0
    fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" 20
2001:db8:aaaa:a::/64 srv6-isis SRV6 524297 0
    fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 30
2001:db8:aaaa:14:7fff:f000::/128 [L] srv6-isis SRV6 524291 0
    fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" 10
2001:db8:aaaa:14:8000::/128 srv6-isis SRV6 524292 0
    fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1" 10
2001:db8:aaaa:14:8000:1000::/128 [L] srv6-isis SRV6 524293 0
    
```

```

fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"          10
2001:db8:aaaa:15::/64 [L]          srv6-isis SRV6 524294 0
fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"      20
-----
Flags: B = BGP or MPLS backup hop available
      L = Loop-Free Alternate (LFA) hop available
      E = Inactive best-external BGP route
      k = RIB-API or Forwarding Policy backup hop
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router fp-tunnel-table 1 ipv6

=====
IPv6 Tunnel Table Display

Legend:
label stack is ordered from bottom-most to top-most
B - FRR Backup
=====
Destination                                Protocol          Tunnel-ID
Lbl/SID
NextHop                                    Intf/Tunnel
Lbl/SID (backup)
NextHop (backup)
-----
2001:db8:aaaa:4::/64                        SRV6              524296
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"    1/1/c1/1:1
2001:db8:aaaa:5::/64                        SRV6              524299
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"    1/1/c1/1:1
2001:db8:aaaa:6::/64                        SRV6              524295
-
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"    1/1/c1/7:1
-
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" (B) 1/1/c1/6:1
2001:db8:aaaa:a::/64                        SRV6              524297
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"    1/1/c1/1:1
2001:db8:aaaa:15::/64                      SRV6              524294
-
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"    1/1/c1/6:1
-
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" (B) 1/1/c1/7:1
2001:db8::5/128                            SRV6-Policy      -
  2001:db8:aaaa:a:0:1000::/2001:db8:aaaa:4:0:1000::
  0.140.1.1                                pxc-1.b:1
2001:db8:aaaa:14:7fff:f000::/128          SRV6              524291
-
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2"    1/1/c1/6:1
  2001:db8:aaaa:15:0:1000::
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2" (B) 1/1/c1/7:1
2001:db8:aaaa:14:8000::/128                SRV6              524292
-
  fe80::b69e:ffff:fe00:0-"int-1-bng-1-p-1"    1/1/c1/1:1
2001:db8:aaaa:14:8000:1000::/128          SRV6              524293
-
  fe80::b6a0:ffff:fe00:0-"int-1-bng-1-pe-2"    1/1/c1/7:1
  2001:db8:aaaa:6:0:1000::
  fe80::b697:ffff:fe00:0-"int-1-bng-1-bng-2" (B) 1/1/c1/6:1
    
```

```

-----
Total Entries : 9
-----
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router bgp summary
=====
BGP Router ID:192.0.2.20      AS:64500      Local AS:64500
=====
BGP Admin State      : Up          BGP Oper State      : Up
Total Peer Groups    : 2            Total Peers          : 3
Total VPN Peer Groups: 0            Total VPN Peers      : 0
Current Internal Groups: 3          Max Internal Groups  : 3
Total BGP Paths      : 59           Total Path Memory    : 21280

Total IPv4 Remote Rts : 0          Total IPv4 Rem. Active Rts : 0
Total IPv6 Remote Rts : 0          Total IPv6 Rem. Active Rts : 0
Total IPv4 Backup Rts : 0          Total IPv6 Backup Rts     : 0
Total LblIpv4 Rem Rts : 0          Total LblIpv4 Rem. Act Rts : 0
Total LblIpv6 Rem Rts : 0          Total LblIpv6 Rem. Act Rts : 0
Total LblIpv4 Bkp Rts : 0          Total LblIpv6 Bkp Rts     : 0
Total Supressed Rts  : 0          Total Hist. Rts        : 0
Total Decay Rts      : 0

Total VPN-IPv4 Rem. Rts : 1          Total VPN-IPv4 Rem. Act. Rts: 1
Total VPN-IPv6 Rem. Rts : 1          Total VPN-IPv6 Rem. Act. Rts: 1
Total VPN-IPv4 Bkup Rts : 0          Total VPN-IPv6 Bkup Rts    : 0
Total VPN Local Rts     : 7          Total VPN Supp. Rts       : 0
Total VPN Hist. Rts     : 0          Total VPN Decay Rts       : 0

Total MVPN-IPv4 Rem Rts : 0          Total MVPN-IPv4 Rem Act Rts : 0
Total MVPN-IPv6 Rem Rts : 0          Total MVPN-IPv6 Rem Act Rts : 0
Total MDT-SAFI Rem Rts  : 0          Total MDT-SAFI Rem Act Rts  : 0
Total McIPv4 Remote Rts : 0          Total McIPv4 Rem. Active Rts: 0
Total McIPv6 Remote Rts : 0          Total McIPv6 Rem. Active Rts: 0
Total McVpnIPv4 Rem Rts : 0          Total McVpnIPv4 Rem Act Rts : 0
Total McVpnIPv6 Rem Rts : 0          Total McVpnIPv6 Rem Act Rts : 0

Total EVPN Rem Rts      : 4          Total EVPN Rem Act Rts     : 4
Total L2-VPN Rem. Rts   : 0          Total L2VPN Rem. Act. Rts  : 0
Total MSPW Rem Rts      : 0          Total MSPW Rem Act Rts     : 0
Total RouteTgt Rem Rts  : 0          Total RouteTgt Rem Act Rts : 0
Total FlowIpv4 Rem Rts  : 0          Total FlowIpv4 Rem Act Rts : 0
Total FlowIpv6 Rem Rts  : 0          Total FlowIpv6 Rem Act Rts : 0
Total FlowVpvn4 Rem Rts : 0          Total FlowVpvn4 Rem Act Rts : 0
Total FlowVpvn6 Rem Rts : 0          Total FlowVpvn6 Rem Act Rts : 0
Total Link State Rem Rts: 0          Total Link State Rem Act Rts: 0
Total SrPlcyIpv4 Rem Rts: 0          Total SrPlcyIpv4 Rem Act Rts: 0
Total SrPlcyIpv6 Rem Rts: 0          Total SrPlcyIpv6 Rem Act Rts: 0

=====
BGP Summary
=====
Legend : D - Dynamic Neighbor
=====
Neighbor
Description
          AS Pktrcvd InQ Up/Down State|Rcv/Act/Sent (Addr Family)
          PktSent OutQ
-----

```



```

2001:db8::5          64500    5669    0 01d23h12m 1/1/3 (Evpn)
                   5672    0
2001:db8::6          64500    5670    0 01d23h12m 1/1/2 (VpnIPv4)
                   5672    0          1/1/2 (VpnIPv6)
2001:db8::15         64500    5673    0 01d23h12m 3/3/3 (Evpn)
                   5672    0
-----

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router isis adjacency

=====
Rtr Base ISIS Instance 0 Adjacency
=====
System ID          Usage State Hold Interface          MT-ID
-----
p-1                L2    Up    7    int-1-bng-1-p-1          0
-----
Adjacencies : 1
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router isis database

=====
Rtr Base ISIS Instance 0 Database
=====
LSP ID              Sequence  Checksum Lifetime Attributes
-----
Displaying Level 1 database
-----
Level (1) LSP Count : 0

Displaying Level 2 database
-----
p-1.00-00          0x13d    0x8ffb    762    L1L2
p-1.01-00          0x134    0x4d03    902    L1L2
pe-1.00-00         0x139    0x659e    863    L1L2
pe-1.01-00         0x133    0xe585    1063   L1L2
p-2.00-00          0x137    0xfd42    1085   L1L2
p-2.01-00          0x135    0x6dc8    938    L1L2
p-2.02-00          0x135    0xe56c    1042   L1L2
p-2.03-00          0x132    0xfa58    764    L1L2
bng-1.00-00        0x13d    0x160f    748    L1L2
bng-2.00-00        0x137    0x777b    675    L1L2
Level (2) LSP Count : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router isis 1 adjacency
    
```

```

=====
Rtr Base ISIS Instance 1 Adjacency
=====
System ID                Usage State Hold Interface                MT-ID
-----
bng-2                    L2    Up    27    int-1-bng-1-bng-2                0
pe-2                     L2    Up    7     int-1-bng-1-pe-2                0
-----
Adjacencies : 2
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router isis 1 database

=====
Rtr Base ISIS Instance 1 Database
=====
LSP ID                    Sequence  Checksum Lifetime Attributes
-----
Displaying Level 1 database
-----
Level (1) LSP Count : 0

Displaying Level 2 database
-----
pe-2.00-00                0x13a    0x105f   963    L1L2
pe-2.01-00                0x133    0x51fb   708    L1L2
pe-2.02-00                0x133    0x60ea   1055   L1L2
bng-1.00-00               0x13c    0x29a7   747    L1L2
bng-1.01-00               0x136    0x7b99   670    L1L2
bng-2.00-00               0x138    0x8827   1129   L1L2
Level (2) LSP Count : 6
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show redundancy multi-chassis sync peer 192.0.2.21 detail

=====
Multi-chassis Peer Table
=====
Peer
-----
Peer IP Address          : 192.0.2.21
Description              : (Not Specified)
Authentication          : Disabled
Source IP Address       : 192.0.2.20
Admin State              : Enabled
Warm standby             : No
Remote warm standby     : No
Sub-mgmt options        :
  DHCP lease threshold  : Inactive
  Local / Remote        : -- / --
-----
Sync-status
-----
Client Applications      : SUBMGMT-IPOE SUBMGMT-PPPOE SRRP DHCPserver
Sync Admin State        : Up
    
```

```
Sync Oper State      : Up
Sync Oper Flags     :
DB Sync State       : inSync
Num Entries         : 100
Lcl Deleted Entries : 0
Alarm Entries       : 0
OMCR Standby Entries : 0
OMCR Alarm Entries  : 0
Rem Num Entries     : 100
Rem Lcl Deleted Entries : 0
Rem Alarm Entries   : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
```

=====
MCS Application Stats
=====

```
Application         : igmp
Num Entries         : 0
Lcl Deleted Entries : 0
Alarm Entries       : 0
OMCR Standby Entries : 0
OMCR Alarm Entries  : 0
```

```
-----
Rem Num Entries     : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries   : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
```

```
-----
Application         : igmpSnooping
Num Entries         : 0
Lcl Deleted Entries : 0
Alarm Entries       : 0
OMCR Standby Entries : 0
OMCR Alarm Entries  : 0
```

```
-----
Rem Num Entries     : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries   : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
```

```
-----
Application         : subMgmtIpo
Num Entries         : 10
Lcl Deleted Entries : 0
Alarm Entries       : 0
OMCR Standby Entries : 0
OMCR Alarm Entries  : 0
```

```
-----
Rem Num Entries     : 10
Rem Lcl Deleted Entries : 0
Rem Alarm Entries   : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
```

```
-----
Application         : srrp
Num Entries         : 26
Lcl Deleted Entries : 0
Alarm Entries       : 0
OMCR Standby Entries : 0
OMCR Alarm Entries  : 0
```

```
-----
Rem Num Entries     : 26
```

```
Rem Lcl Deleted Entries : 0
Rem Alarm Entries      : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : mcRing
Num Entries           : 0
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : mldSnooping
Num Entries           : 0
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : dhcpServer
Num Entries           : 54
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 54
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : subHostTrk
Num Entries           : 0
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
Rem Num Entries       : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries     : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application           : subMgmtPppoe
Num Entries           : 10
Lcl Deleted Entries   : 0
Alarm Entries         : 0
OMCR Standby Entries  : 0
OMCR Alarm Entries    : 0
-----
```

```
Rem Num Entries      : 10
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : ipsec
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : mld
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : python
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : l2tp
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
-----
Rem Num Entries      : 0
Rem Lcl Deleted Entries : 0
Rem Alarm Entries    : 0
Rem OMCR Standby Entries: 0
Rem OMCR Alarm Entries : 0
-----
Application          : diameterProxy
Num Entries          : 0
Lcl Deleted Entries  : 0
Alarm Entries        : 0
OMCR Standby Entries : 0
OMCR Alarm Entries   : 0
```

```
-----  
Rem Num Entries      : 0  
Rem Lcl Deleted Entries : 0  
Rem Alarm Entries    : 0  
Rem OMCR Standby Entries: 0  
Rem OMCR Alarm Entries : 0  
-----  
Application          : pimSnpgSap  
Num Entries          : 0  
Lcl Deleted Entries  : 0  
Alarm Entries        : 0  
OMCR Standby Entries : 0  
OMCR Alarm Entries   : 0  
-----  
Rem Num Entries      : 0  
Rem Lcl Deleted Entries : 0  
Rem Alarm Entries    : 0  
Rem OMCR Standby Entries: 0  
Rem OMCR Alarm Entries : 0  
-----  
Application          : pimSnpgSdp  
Num Entries          : 0  
Lcl Deleted Entries  : 0  
Alarm Entries        : 0  
OMCR Standby Entries : 0  
OMCR Alarm Entries   : 0  
-----  
Rem Num Entries      : 0  
Rem Lcl Deleted Entries : 0  
Rem Alarm Entries    : 0  
Rem OMCR Standby Entries: 0  
Rem OMCR Alarm Entries : 0  
-----  
Application          : diameterNode  
Num Entries          : 0  
Lcl Deleted Entries  : 0  
Alarm Entries        : 0  
OMCR Standby Entries : 0  
OMCR Alarm Entries   : 0  
-----  
Rem Num Entries      : 0  
Rem Lcl Deleted Entries : 0  
Rem Alarm Entries    : 0  
Rem OMCR Standby Entries: 0  
Rem OMCR Alarm Entries : 0  
-----  
Application          : nat  
Num Entries          : 0  
Lcl Deleted Entries  : 0  
Alarm Entries        : 0  
OMCR Standby Entries : 0  
OMCR Alarm Entries   : 0  
-----  
Rem Num Entries      : 0  
Rem Lcl Deleted Entries : 0  
Rem Alarm Entries    : 0  
Rem OMCR Standby Entries: 0  
Rem OMCR Alarm Entries : 0  
-----  
=====  
Ports synced on peer 192.0.2.21  
=====
```

```
Port/Encap          Tag
-----
pw-1                pw-port-1
=====

SDPs synced on peer 192.0.2.21
=====
SDP/Vc-Id          Tag
-----
=====

DHCP Server instances synced on peer 192.0.2.21
=====
Router-Name        Server-Name
  Tag
-----
No instances found
=====

Python cache instances synced on peer 192.0.2.21
=====
Python-Policy      Tag
-----
No instances found
=====
No L2TP instances found.

=====
Track SRRP instances
=====
SRRP                : 1
-----
L2TP tunnel ID start : 0
L2TP tunnel ID end   : 0
=====

Diameter proxy instances synced on peer 192.0.2.21
=====
Diameter-Peer-Policy Tag
-----
No instances found
=====

Diameter node instances synced on peer 192.0.2.21
=====
Diameter Node      Tag
-----
No. of Diameter Nodes: 0
=====

Nat groups synced on peer 192.0.2.21
=====
Nat group          Tag
-----
No. of Nat groups: 0
```

```
=====  
=====  
[/]  
A:admin@bng-1#  
  
[/]  
A:admin@bng-1# /tools dump redundancy multi-chassis sync-database  
  
The following totals are for:  
peer ip ALL, port/lag/sdp ALL, sync-tag ALL, application ALL  
Valid Entries: 100  
Locally Deleted Entries: 0  
Locally Deleted Alarmed Entries: 0  
Pending Global Delete Entries: 0  
Omcrc Alarmed Entries: 0  
Omcrc Standby Entries: 0  
Associated Shared Records (ALL): 0  
Associated Shared Records (LD): 0  
  
[/]  
A:admin@bng-1#  
  
[/]  
A:admin@bng-1# /show service active-subscribers summary  
  
=====  
Active Subscriber table summary  
=====  
Total Count : 20  
=====  
  
[/]  
A:admin@bng-1#  
  
[/]  
A:admin@bng-1# /show service active-subscribers hierarchy  
  
=====  
Active Subscribers Hierarchy  
=====  
-- ipoe-ds-1  
  (sub-profile-1)  
  |  
  +-- sap:[pw-1:2.11] - sla:sla-profile-1  
    |  
    +-- IPOE-session - mac:00:13:01:00:00:01 - svc:10  
      |  
      |-- 10.10.0.12 - DHCP  
      |  
      +-- 2001:db8:bbbb::1/128 - DHCP6  
        |  
        +-- 2001:db8:bbbb:1::/64 - DHCP6-PD-MR  
  
-- ipoe-ds-10  
  (sub-profile-1)  
  |  
  +-- sap:[pw-1:2.20] - sla:sla-profile-1  
    |  
    +-- IPOE-session - mac:00:13:01:00:00:0a - svc:10  
      |  
      |-- 10.10.0.13 - DHCP  
      |  
      +-- 2001:db8:bbbb:10::1/128 - DHCP6
```



```

        |
        +-- 2001:db8:bbbb:11::/64 - DHCP6-PD-MR
-- ipoe-ds-2
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.12] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:02 - svc:10
      |
      |-- 10.10.0.10 - DHCP
      |
      +-- 2001:db8:bbbb:2::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:3::/64 - DHCP6-PD-MR
-- ipoe-ds-3
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.13] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:03 - svc:10
      |
      |-- 10.10.0.14 - DHCP
      |
      +-- 2001:db8:bbbb:c::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:d::/64 - DHCP6-PD-MR
-- ipoe-ds-4
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.14] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:04 - svc:10
      |
      |-- 10.10.0.17 - DHCP
      |
      +-- 2001:db8:bbbb:8::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:9::/64 - DHCP6-PD-MR
-- ipoe-ds-5
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.15] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:05 - svc:10
      |
      |-- 10.10.0.11 - DHCP
      |
      +-- 2001:db8:bbbb:4::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:5::/64 - DHCP6-PD-MR
-- ipoe-ds-6
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.16] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:13:01:00:00:06 - svc:10
      |
      |-- 10.10.0.19 - DHCP
      |

```

```

        +-- 2001:db8:bbbb:e::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:f::/64 - DHCP6-PD-MR
    -- ipoe-ds-7
       (sub-profile-1)
       |
       +-- sap:[pw-1:2.17] - sla:sla-profile-1
          |
          +-- IPOE-session - mac:00:13:01:00:00:07 - svc:10
             |
             |-- 10.10.0.18 - DHCP
             |
             +-- 2001:db8:bbbb:a::1/128 - DHCP6
                |
                +-- 2001:db8:bbbb:b::/64 - DHCP6-PD-MR
    -- ipoe-ds-8
       (sub-profile-1)
       |
       +-- sap:[pw-1:2.18] - sla:sla-profile-1
          |
          +-- IPOE-session - mac:00:13:01:00:00:08 - svc:10
             |
             |-- 10.10.0.16 - DHCP
             |
             +-- 2001:db8:bbbb:6::1/128 - DHCP6
                |
                +-- 2001:db8:bbbb:7::/64 - DHCP6-PD-MR
    -- ipoe-ds-9
       (sub-profile-1)
       |
       +-- sap:[pw-1:2.19] - sla:sla-profile-1
          |
          +-- IPOE-session - mac:00:13:01:00:00:09 - svc:10
             |
             |-- 10.10.0.15 - DHCP
             |
             +-- 2001:db8:bbbb:12::1/128 - DHCP6
                |
                +-- 2001:db8:bbbb:13::/64 - DHCP6-PD-MR
    -- pppoe-1
       (sub-profile-1)
       |
       +-- sap:[pw-1:2.1] - sla:sla-profile-1
          |
          +-- PPP-session - mac:00:11:01:00:00:01 - sid:1 - svc:10
             |
             |-- 10.10.1.10 - IPCP
             |
             +-- 2001:db8:bbbb:14::1/128 - DHCP6
                |
                +-- 2001:db8:bbbb:15::/64 - DHCP6-PD-MR
    -- pppoe-10
       (sub-profile-1)
       |
       +-- sap:[pw-1:2.10] - sla:sla-profile-1
          |
          +-- PPP-session - mac:00:11:01:00:00:0a - sid:1 - svc:10
             |
             |-- 10.10.1.19 - IPCP
    
```

```
    |
    +-- 2001:db8:bbbb:26::1/128 - DHCP6
        |
        +-- 2001:db8:bbbb:27::/64 - DHCP6-PD-MR
-- pppoe-2
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.2] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:02 - sid:1 - svc:10
          |
          |-- 10.10.1.11 - IPCP
          |
          +-- 2001:db8:bbbb:18::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:19::/64 - DHCP6-PD-MR
-- pppoe-3
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.3] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:03 - sid:1 - svc:10
          |
          |-- 10.10.1.12 - IPCP
          |
          +-- 2001:db8:bbbb:16::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:17::/64 - DHCP6-PD-MR
-- pppoe-4
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.4] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:04 - sid:1 - svc:10
          |
          |-- 10.10.1.13 - IPCP
          |
          +-- 2001:db8:bbbb:1a::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:1b::/64 - DHCP6-PD-MR
-- pppoe-5
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.5] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:05 - sid:1 - svc:10
          |
          |-- 10.10.1.14 - IPCP
          |
          +-- 2001:db8:bbbb:1c::1/128 - DHCP6
              |
              +-- 2001:db8:bbbb:1d::/64 - DHCP6-PD-MR
-- pppoe-6
  (sub-profile-1)
  |
  +-- sap:[pw-1:2.6] - sla:sla-profile-1
      |
      +-- PPP-session - mac:00:11:01:00:00:06 - sid:1 - svc:10
          |
```

```

|-- 10.10.1.15 - IPCP
|
+-- 2001:db8:bbbb:1e::1/128 - DHCP6
|
+-- 2001:db8:bbbb:1f::/64 - DHCP6-PD-MR

-- pppoe-7
(sub-profile-1)
|
+-- sap:[pw-1:2.7] - sla:sla-profile-1
|
+-- PPP-session - mac:00:11:01:00:00:07 - sid:1 - svc:10
|
|-- 10.10.1.16 - IPCP
|
+-- 2001:db8:bbbb:20::1/128 - DHCP6
|
+-- 2001:db8:bbbb:21::/64 - DHCP6-PD-MR

-- pppoe-8
(sub-profile-1)
|
+-- sap:[pw-1:2.8] - sla:sla-profile-1
|
+-- PPP-session - mac:00:11:01:00:00:08 - sid:1 - svc:10
|
|-- 10.10.1.17 - IPCP
|
+-- 2001:db8:bbbb:22::1/128 - DHCP6
|
+-- 2001:db8:bbbb:23::/64 - DHCP6-PD-MR

-- pppoe-9
(sub-profile-1)
|
+-- sap:[pw-1:2.9] - sla:sla-profile-1
|
+-- PPP-session - mac:00:11:01:00:00:09 - sid:1 - svc:10
|
|-- 10.10.1.18 - IPCP
|
+-- 2001:db8:bbbb:24::1/128 - DHCP6
|
+-- 2001:db8:bbbb:25::/64 - DHCP6-PD-MR

-----
Number of active subscribers : 20
Flags: (N) = the host or the managed route is in non-forwarding state
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id 10 subscriber-hosts detail

=====
Subscriber Host table
=====

Sap
IP Address
MAC Address
Subscriber
PPPoe-SID
Origin
Fwding State
-----

```

```
[pw-1:2.1]
 10.10.1.10
 00:11:01:00:00:01          1          IPCP          Fwding
  pppoe-1
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000029636FE951
Acct-Q-Inst-Session-Id: B496FF0000002A636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.1]
 2001:db8:bbbb:14::1/128
 00:11:01:00:00:01          1          PPP-DHCP6      Fwding
  pppoe-1
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000047636FE951
Acct-Q-Inst-Session-Id: B496FF0000002A636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.2]
 10.10.1.11
 00:11:01:00:00:02          1          IPCP          Fwding
  pppoe-2
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000002C636FE951
Acct-Q-Inst-Session-Id: B496FF0000002D636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
```

```

DIAMETER session ID Gx: N/A
-----
[pw-1:2.2]
  2001:db8:bbbb:18::1/128
    00:11:01:00:00:02          1          PPP-DHCP6          Fwding
    pppoe-2
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000049636FE951
Acct-Q-Inst-Session-Id: B496FF0000002D636FE951
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.3]
  10.10.1.12
    00:11:01:00:00:03          1          IPCP          Fwding
    pppoe-3
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000002F636FE951
Acct-Q-Inst-Session-Id: B496FF00000030636FE951
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.3]
  2001:db8:bbbb:16::1/128
    00:11:01:00:00:03          1          PPP-DHCP6          Fwding
    pppoe-3
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000046636FE951
Acct-Q-Inst-Session-Id: B496FF00000030636FE951
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
    
```

```
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.4]
 10.10.1.13
 00:11:01:00:00:04      1          IPCP          Fwding
  pppoe-4
-----
Subscriber-interface  : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000032636FE951
Acct-Q-Inst-Session-Id: B496FF00000033636FE951
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.4]
 2001:db8:bbbb:1a::1/128
 00:11:01:00:00:04      1          PPP-DHCP6      Fwding
  pppoe-4
-----
Subscriber-interface  : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000048636FE951
Acct-Q-Inst-Session-Id: B496FF00000033636FE951
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.5]
 10.10.1.14
 00:11:01:00:00:05      1          IPCP          Fwding
  pppoe-5
-----
Subscriber-interface  : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000035636FE951
Acct-Q-Inst-Session-Id: B496FF00000036636FE951
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
```

```

OT HTTP Rdr Status      : N/A
OT HTTP Rdr Fltr Src   : N/A
HTTP Rdr URL Override  : N/A
GTP local break-out    : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.5]
  2001:db8:bbbb:1c::1/128
    00:11:01:00:00:05      1          PPP-DHCP6      Fwding
      pppoe-5
-----
Subscriber-interface   : sub-int-1
Group-interface       : group-int-1
Sub Profile            : sub-profile-1
SLA Profile           : sla-profile-1
App Profile           : N/A
Egress Q-Group        : N/A
Egress Vport          : N/A
Acct-Session-Id       : B496FF0000004A636FE951
Acct-Q-Inst-Session-Id: B496FF00000036636FE951
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status    : N/A
OT HTTP Rdr Fltr Src  : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.6]
  10.10.1.15
    00:11:01:00:00:06      1          IPCP          Fwding
      pppoe-6
-----
Subscriber-interface   : sub-int-1
Group-interface       : group-int-1
Sub Profile            : sub-profile-1
SLA Profile           : sla-profile-1
App Profile           : N/A
Egress Q-Group        : N/A
Egress Vport          : N/A
Acct-Session-Id       : B496FF00000038636FE951
Acct-Q-Inst-Session-Id: B496FF00000039636FE951
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status    : N/A
OT HTTP Rdr Fltr Src  : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.6]
  2001:db8:bbbb:1e::1/128
    00:11:01:00:00:06      1          PPP-DHCP6      Fwding
      pppoe-6
-----
Subscriber-interface   : sub-int-1
Group-interface       : group-int-1
Sub Profile            : sub-profile-1
SLA Profile           : sla-profile-1
App Profile           : N/A
Egress Q-Group        : N/A
Egress Vport          : N/A
Acct-Session-Id       : B496FF0000004B636FE951
Acct-Q-Inst-Session-Id: B496FF00000039636FE951
    
```



```

Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.7]
10.10.1.16
  00:11:01:00:00:07      1          IPCP          Fwding
  pppoe-7
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group      : N/A
Egress Vport        : N/A
Acct-Session-Id     : B496FF0000003B636FE951
Acct-Q-Inst-Session-Id: B496FF0000003C636FE951
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.7]
2001:db8:bbbb:20::1/128
  00:11:01:00:00:07      1          PPP-DHCP6      Fwding
  pppoe-7
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group      : N/A
Egress Vport        : N/A
Acct-Session-Id     : B496FF0000004C636FE951
Acct-Q-Inst-Session-Id: B496FF0000003C636FE951
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.8]
10.10.1.17
  00:11:01:00:00:08      1          IPCP          Fwding
  pppoe-8
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group      : N/A
Egress Vport        : N/A
    
```

```
Acct-Session-Id      : B496FF0000003E636FE951
Acct-Q-Inst-Session-Id: B496FF0000003F636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.8]
  2001:db8:bbbb:22::1/128
    00:11:01:00:00:08      1          PPP-DHCP6      Fwding
    pppoe-8
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport        : N/A
Acct-Session-Id      : B496FF0000004D636FE951
Acct-Q-Inst-Session-Id: B496FF0000003F636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.9]
  10.10.1.18
    00:11:01:00:00:09      1          IPCP          Fwding
    pppoe-9
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport        : N/A
Acct-Session-Id      : B496FF00000041636FE951
Acct-Q-Inst-Session-Id: B496FF00000042636FE951
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.9]
  2001:db8:bbbb:24::1/128
    00:11:01:00:00:09      1          PPP-DHCP6      Fwding
    pppoe-9
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
```

```

Egress Q-Group      : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000004E636FE951
Acct-Q-Inst-Session-Id: B496FF00000042636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.10]
 10.10.1.19
 00:11:01:00:00:0a          1          IPCP          Fwding
  pppoe-10
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group      : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000044636FE951
Acct-Q-Inst-Session-Id: B496FF00000045636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.10]
 2001:db8:bbbb:26::1/128
 00:11:01:00:00:0a          1          PPP-DHCP6      Fwding
  pppoe-10
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group      : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000004F636FE951
Acct-Q-Inst-Session-Id: B496FF00000045636FE951
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.11]
 10.10.0.12
 00:13:01:00:00:01          N/A          DHCP          Fwding
  ipoe-ds-1
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
    
```

```

SLA Profile           : sla-profile-1
App Profile           : N/A
Egress Q-Group        : N/A
Egress Vport          : N/A
Acct-Session-Id       : B496FF00000013636FE94C
Acct-Q-Inst-Session-Id : B496FF00000010636FE94C
Address Origin         : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status    : N/A
OT HTTP Rdr Fltr Src  : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx : N/A
-----
[pw-1:2.11]
  2001:db8:bbbb::1/128
    00:13:01:00:00:01          N/A          IPoE-DHCP6      Fwding
    ipoe-ds-1
-----
Subscriber-interface   : sub-int-1
Group-interface        : group-int-1
Sub Profile            : sub-profile-1
SLA Profile            : sla-profile-1
App Profile            : N/A
Egress Q-Group         : N/A
Egress Vport           : N/A
Acct-Session-Id       : B496FF000000F636FE94C
Acct-Q-Inst-Session-Id : B496FF00000010636FE94C
Address Origin         : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status    : N/A
OT HTTP Rdr Fltr Src  : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx : N/A
-----
[pw-1:2.12]
  10.10.0.10
    00:13:01:00:00:02          N/A          DHCP            Fwding
    ipoe-ds-2
-----
Subscriber-interface   : sub-int-1
Group-interface        : group-int-1
Sub Profile            : sub-profile-1
SLA Profile            : sla-profile-1
App Profile            : N/A
Egress Q-Group         : N/A
Egress Vport           : N/A
Acct-Session-Id       : B496FF000000A636FE94C
Acct-Q-Inst-Session-Id : B496FF00000005636FE94C
Address Origin         : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status    : N/A
OT HTTP Rdr Fltr Src  : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx : N/A
-----
[pw-1:2.12]
  2001:db8:bbbb:2::1/128
    00:13:01:00:00:02          N/A          IPoE-DHCP6      Fwding
    ipoe-ds-2
-----
Subscriber-interface   : sub-int-1
    
```

```

Group-interface      : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000004636FE94C
Acct-Q-Inst-Session-Id: B496FF0000005636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.13]
 10.10.0.14
 00:13:01:00:00:03      N/A      DHCP      Fwding
 ipoe-ds-3
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000001B636FE94C
Acct-Q-Inst-Session-Id: B496FF0000001C636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.13]
 2001:db8:bbbb:c::1/128
 00:13:01:00:00:03      N/A      IPoE-DHCP6      Fwding
 ipoe-ds-3
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF0000001F636FE94C
Acct-Q-Inst-Session-Id: B496FF0000001C636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.14]
 10.10.0.17
 00:13:01:00:00:04      N/A      DHCP      Fwding
 ipoe-ds-4
    
```

```
-----  
Subscriber-interface : sub-int-1  
Group-interface      : group-int-1  
Sub Profile          : sub-profile-1  
SLA Profile          : sla-profile-1  
App Profile          : N/A  
Egress Q-Group       : N/A  
Egress Vport        : N/A  
Acct-Session-Id     : B496FF00000025636FE951  
Acct-Q-Inst-Session-Id: B496FF00000012636FE94C  
Address Origin       : Dynamic  
OT HTTP Rdr IP-FltrId : N/A  
OT HTTP Rdr Status   : N/A  
OT HTTP Rdr Fltr Src : N/A  
HTTP Rdr URL Override : N/A  
GTP local break-out  : No  
DIAMETER session ID Gx: N/A  
-----  
[pw-1:2.14]  
  2001:db8:bbbb:8::1/128  
  00:13:01:00:00:04      N/A      IPoE-DHCP6      Fwding  
  ipoe-ds-4  
-----  
Subscriber-interface : sub-int-1  
Group-interface      : group-int-1  
Sub Profile          : sub-profile-1  
SLA Profile          : sla-profile-1  
App Profile          : N/A  
Egress Q-Group       : N/A  
Egress Vport        : N/A  
Acct-Session-Id     : B496FF00000011636FE94C  
Acct-Q-Inst-Session-Id: B496FF00000012636FE94C  
Address Origin       : Dynamic  
OT HTTP Rdr IP-FltrId : N/A  
OT HTTP Rdr Status   : N/A  
OT HTTP Rdr Fltr Src : N/A  
HTTP Rdr URL Override : N/A  
GTP local break-out  : No  
DIAMETER session ID Gx: N/A  
-----  
[pw-1:2.15]  
  10.10.0.11  
  00:13:01:00:00:05      N/A      DHCP      Fwding  
  ipoe-ds-5  
-----  
Subscriber-interface : sub-int-1  
Group-interface      : group-int-1  
Sub Profile          : sub-profile-1  
SLA Profile          : sla-profile-1  
App Profile          : N/A  
Egress Q-Group       : N/A  
Egress Vport        : N/A  
Acct-Session-Id     : B496FF0000000B636FE94C  
Acct-Q-Inst-Session-Id: B496FF00000007636FE94C  
Address Origin       : Dynamic  
OT HTTP Rdr IP-FltrId : N/A  
OT HTTP Rdr Status   : N/A  
OT HTTP Rdr Fltr Src : N/A  
HTTP Rdr URL Override : N/A  
GTP local break-out  : No  
DIAMETER session ID Gx: N/A  
-----  
[pw-1:2.15]  
  2001:db8:bbbb:4::1/128
```

00:13:01:00:00:05 ipoe-ds-5	N/A	IPoE-DHCP6	Fwding

Subscriber-interface : sub-int-1			
Group-interface : group-int-1			
Sub Profile : sub-profile-1			
SLA Profile : sla-profile-1			
App Profile : N/A			
Egress Q-Group : N/A			
Egress Vport : N/A			
Acct-Session-Id : B496FF00000006636FE94C			
Acct-Q-Inst-Session-Id: B496FF00000007636FE94C			
Address Origin : Dynamic			
OT HTTP Rdr IP-FltrId : N/A			
OT HTTP Rdr Status : N/A			
OT HTTP Rdr Fltr Src : N/A			
HTTP Rdr URL Override : N/A			
GTP local break-out : No			
DIAMETER session ID Gx: N/A			

[pw-1:2.16]			
10.10.0.19			
00:13:01:00:00:06 ipoe-ds-6	N/A	DHCP	Fwding

Subscriber-interface : sub-int-1			
Group-interface : group-int-1			
Sub Profile : sub-profile-1			
SLA Profile : sla-profile-1			
App Profile : N/A			
Egress Q-Group : N/A			
Egress Vport : N/A			
Acct-Session-Id : B496FF00000027636FE951			
Acct-Q-Inst-Session-Id: B496FF0000001E636FE94C			
Address Origin : Dynamic			
OT HTTP Rdr IP-FltrId : N/A			
OT HTTP Rdr Status : N/A			
OT HTTP Rdr Fltr Src : N/A			
HTTP Rdr URL Override : N/A			
GTP local break-out : No			
DIAMETER session ID Gx: N/A			

[pw-1:2.16]			
2001:db8:bbbb:e::1/128			
00:13:01:00:00:06 ipoe-ds-6	N/A	IPoE-DHCP6	Fwding

Subscriber-interface : sub-int-1			
Group-interface : group-int-1			
Sub Profile : sub-profile-1			
SLA Profile : sla-profile-1			
App Profile : N/A			
Egress Q-Group : N/A			
Egress Vport : N/A			
Acct-Session-Id : B496FF0000001D636FE94C			
Acct-Q-Inst-Session-Id: B496FF0000001E636FE94C			
Address Origin : Dynamic			
OT HTTP Rdr IP-FltrId : N/A			
OT HTTP Rdr Status : N/A			
OT HTTP Rdr Fltr Src : N/A			
HTTP Rdr URL Override : N/A			
GTP local break-out : No			
DIAMETER session ID Gx: N/A			

```
[pw-1:2.17]
10.10.0.18
00:13:01:00:00:07          N/A          DHCP          Fwding
  ipoe-ds-7
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000026636FE951
Acct-Q-Inst-Session-Id: B496FF00000015636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.17]
2001:db8:bbbb:a::1/128
00:13:01:00:00:07          N/A          IPoE-DHCP6     Fwding
  ipoe-ds-7
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000014636FE94C
Acct-Q-Inst-Session-Id: B496FF00000015636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.18]
10.10.0.16
00:13:01:00:00:08          N/A          DHCP          Fwding
  ipoe-ds-8
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000024636FE950
Acct-Q-Inst-Session-Id: B496FF00000009636FE94C
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
```



```
DIAMETER session ID Gx: N/A
-----
[pw-1:2.18]
  2001:db8:bbbb:6::1/128
    00:13:01:00:00:08      N/A      IPoE-DHCP6      Fwding
    ipoe-ds-8
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000008636FE94C
Acct-Q-Inst-Session-Id: B496FF00000009636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.19]
  10.10.0.15
    00:13:01:00:00:09      N/A      DHCP      Fwding
    ipoe-ds-9
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000020636FE94C
Acct-Q-Inst-Session-Id: B496FF00000021636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.19]
  2001:db8:bbbb:12::1/128
    00:13:01:00:00:09      N/A      IPoE-DHCP6      Fwding
    ipoe-ds-9
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group     : N/A
Egress Vport       : N/A
Acct-Session-Id    : B496FF00000023636FE94E
Acct-Q-Inst-Session-Id: B496FF00000021636FE94C
Address Origin     : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
```

```

HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.20]
 10.10.0.13
 00:13:01:00:00:0a      N/A          DHCP          Fwding
 ipoe-ds-10
-----
Subscriber-interface  : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000016636FE94C
Acct-Q-Inst-Session-Id: B496FF00000017636FE94C
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
[pw-1:2.20]
 2001:db8:bbbb:10::1/128
 00:13:01:00:00:0a      N/A          IPoE-DHCP6     Fwding
 ipoe-ds-10
-----
Subscriber-interface  : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport         : N/A
Acct-Session-Id      : B496FF00000022636FE94E
Acct-Q-Inst-Session-Id: B496FF00000017636FE94C
Address Origin        : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out   : No
DIAMETER session ID Gx: N/A
-----
Number of subscriber hosts : 40
=====

[/]
A:admin@bng-1# /show service id 10 ipoe session

=====
IPoE sessions for svc-id 10
=====
Sap Id          Mac Address          Up Time          MC-Stdby
Subscriber-Id
[CircuitID] | [RemoteID]
-----
[pw-1:2.11]          00:13:01:00:00:01    2d 02:51:27
 ipoe-ds-1          |
[pw-1:2.12]          00:13:01:00:00:02    2d 02:51:27

```

```

    ipoe-ds-2
[pw-1:2.13]          00:13:01:00:00:03  2d 02:51:26
    ipoe-ds-3
[pw-1:2.14]          00:13:01:00:00:04  2d 02:51:26
    ipoe-ds-4
[pw-1:2.15]          00:13:01:00:00:05  2d 02:51:27
    ipoe-ds-5
[pw-1:2.16]          00:13:01:00:00:06  2d 02:51:26
    ipoe-ds-6
[pw-1:2.17]          00:13:01:00:00:07  2d 02:51:26
    ipoe-ds-7
[pw-1:2.18]          00:13:01:00:00:08  2d 02:51:26
    ipoe-ds-8
[pw-1:2.19]          00:13:01:00:00:09  2d 02:51:26
    ipoe-ds-9
[pw-1:2.20]          00:13:01:00:00:0a  2d 02:51:26
    ipoe-ds-10
-----
CID | RID displayed when included in session-key
Number of sessions : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show service id 10 pppoe session

=====
PPPoE sessions for svc-id 10
=====
Sap Id      Mac Address      Sid  Up Time      Type
  IP/L2TP-Id/Interface-Id      MC-Stdby
-----
[pw-1:2.1]  00:11:01:00:00:01 1    2d 02:51:21  local
  10.10.1.10
  00:01:00:02:00:01:00:01
[pw-1:2.2]  00:11:01:00:00:02 1    2d 02:51:21  local
  10.10.1.11
  00:02:00:02:00:02:00:01
[pw-1:2.3]  00:11:01:00:00:03 1    2d 02:51:21  local
  10.10.1.12
  00:03:00:02:00:03:00:01
[pw-1:2.4]  00:11:01:00:00:04 1    2d 02:51:21  local
  10.10.1.13
  00:04:00:02:00:04:00:01
[pw-1:2.5]  00:11:01:00:00:05 1    2d 02:51:21  local
  10.10.1.14
  00:05:00:02:00:05:00:01
[pw-1:2.6]  00:11:01:00:00:06 1    2d 02:51:21  local
  10.10.1.15
  00:06:00:02:00:06:00:01
[pw-1:2.7]  00:11:01:00:00:07 1    2d 02:51:21  local
  10.10.1.16
  00:07:00:02:00:07:00:01
[pw-1:2.8]  00:11:01:00:00:08 1    2d 02:51:21  local
  10.10.1.17
  00:08:00:02:00:08:00:01
[pw-1:2.9]  00:11:01:00:00:09 1    2d 02:51:21  local
  10.10.1.18
  00:09:00:02:00:09:00:01
[pw-1:2.10] 00:11:01:00:00:0a 1    2d 02:51:21  local
  10.10.1.19
  00:0A:00:02:00:0A:00:01
    
```

```

-----
Number of sessions      : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show  service id 10 dhcp lease-state

=====
DHCP lease state table, service 10
=====
IP Address      Mac Address      Sap/Sdp Id      Remaining Lease  MC
                Mac Address      Sap/Sdp Id      LeaseTime  Origin  Stdby
-----
10.10.0.10      00:13:01:00:00:02 [pw-1:2.12]     00h13m42s  DHCP
10.10.0.11      00:13:01:00:00:05 [pw-1:2.15]     00h13m42s  DHCP
10.10.0.12      00:13:01:00:00:01 [pw-1:2.11]     00h13m42s  DHCP
10.10.0.13      00:13:01:00:00:0a [pw-1:2.20]     00h13m42s  DHCP
10.10.0.14      00:13:01:00:00:03 [pw-1:2.13]     00h13m42s  DHCP
10.10.0.15      00:13:01:00:00:09 [pw-1:2.19]     00h13m42s  DHCP
10.10.0.16      00:13:01:00:00:08 [pw-1:2.18]     00h13m43s  DHCP
10.10.0.17      00:13:01:00:00:04 [pw-1:2.14]     00h13m44s  DHCP
10.10.0.18      00:13:01:00:00:07 [pw-1:2.17]     00h13m44s  DHCP
10.10.0.19      00:13:01:00:00:06 [pw-1:2.16]     00h13m44s  DHCP
-----
Number of lease states : 10
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show  service id 10 dhcp6 lease-state

=====
DHCP lease state table, service 10
=====
IP Address      Mac Address      Sap/Sdp Id      Remaining Lease  MC
                Mac Address      Sap/Sdp Id      LeaseTime  Origin  Stdby
-----
2001:db8:bbbb::1/128
                00:13:01:00:00:01 [pw-1:2.11]     23h43m37s  DHCP
2001:db8:bbbb:1::/64
                00:13:01:00:00:01 [pw-1:2.11]     23h43m37s  DHCP
2001:db8:bbbb:2::1/128
                00:13:01:00:00:02 [pw-1:2.12]     23h43m36s  DHCP
2001:db8:bbbb:3::/64
                00:13:01:00:00:02 [pw-1:2.12]     23h43m36s  DHCP
2001:db8:bbbb:4::1/128
                00:13:01:00:00:05 [pw-1:2.15]     23h43m36s  DHCP
2001:db8:bbbb:5::/64
                00:13:01:00:00:05 [pw-1:2.15]     23h43m36s  DHCP
2001:db8:bbbb:6::1/128
                00:13:01:00:00:08 [pw-1:2.18]     23h43m36s  DHCP
2001:db8:bbbb:7::/64
                00:13:01:00:00:08 [pw-1:2.18]     23h43m36s  DHCP
2001:db8:bbbb:8::1/128
                00:13:01:00:00:04 [pw-1:2.14]     23h43m37s  DHCP
2001:db8:bbbb:9::/64
                00:13:01:00:00:04 [pw-1:2.14]     23h43m37s  DHCP
2001:db8:bbbb:a::1/128
                00:13:01:00:00:07 [pw-1:2.17]     23h43m37s  DHCP
    
```

```
2001:db8:bbbb:b::/64
    00:13:01:00:00:07 [pw-1:2.17]      23h43m37s  DHCP
2001:db8:bbbb:c::1/128
    00:13:01:00:00:03 [pw-1:2.13]      23h43m37s  DHCP
2001:db8:bbbb:d::/64
    00:13:01:00:00:03 [pw-1:2.13]      23h43m37s  DHCP
2001:db8:bbbb:e::1/128
    00:13:01:00:00:06 [pw-1:2.16]      23h43m37s  DHCP
2001:db8:bbbb:f::/64
    00:13:01:00:00:06 [pw-1:2.16]      23h43m37s  DHCP
2001:db8:bbbb:10::1/128
    00:13:01:00:00:0a [pw-1:2.20]      23h38m40s  DHCP
2001:db8:bbbb:11::/64
    00:13:01:00:00:0a [pw-1:2.20]      23h38m40s  DHCP
2001:db8:bbbb:12::1/128
    00:13:01:00:00:09 [pw-1:2.19]      23h38m40s  DHCP
2001:db8:bbbb:13::/64
    00:13:01:00:00:09 [pw-1:2.19]      23h38m40s  DHCP
2001:db8:bbbb:14::1/128
    00:11:01:00:00:01 [pw-1:2.1]       23h43m41s  DHCP
2001:db8:bbbb:15::/64
    00:11:01:00:00:01 [pw-1:2.1]       23h43m41s  DHCP
2001:db8:bbbb:16::1/128
    00:11:01:00:00:03 [pw-1:2.3]       23h43m41s  DHCP
2001:db8:bbbb:17::/64
    00:11:01:00:00:03 [pw-1:2.3]       23h43m41s  DHCP
2001:db8:bbbb:18::1/128
    00:11:01:00:00:02 [pw-1:2.2]       23h43m41s  DHCP
2001:db8:bbbb:19::/64
    00:11:01:00:00:02 [pw-1:2.2]       23h43m41s  DHCP
2001:db8:bbbb:1a::1/128
    00:11:01:00:00:04 [pw-1:2.4]       23h43m41s  DHCP
2001:db8:bbbb:1b::/64
    00:11:01:00:00:04 [pw-1:2.4]       23h43m41s  DHCP
2001:db8:bbbb:1c::1/128
    00:11:01:00:00:05 [pw-1:2.5]       23h43m42s  DHCP
2001:db8:bbbb:1d::/64
    00:11:01:00:00:05 [pw-1:2.5]       23h43m42s  DHCP
2001:db8:bbbb:1e::1/128
    00:11:01:00:00:06 [pw-1:2.6]       23h43m41s  DHCP
2001:db8:bbbb:1f::/64
    00:11:01:00:00:06 [pw-1:2.6]       23h43m41s  DHCP
2001:db8:bbbb:20::1/128
    00:11:01:00:00:07 [pw-1:2.7]       23h43m41s  DHCP
2001:db8:bbbb:21::/64
    00:11:01:00:00:07 [pw-1:2.7]       23h43m41s  DHCP
2001:db8:bbbb:22::1/128
    00:11:01:00:00:08 [pw-1:2.8]       23h43m42s  DHCP
2001:db8:bbbb:23::/64
    00:11:01:00:00:08 [pw-1:2.8]       23h43m42s  DHCP
2001:db8:bbbb:24::1/128
    00:11:01:00:00:09 [pw-1:2.9]       23h43m41s  DHCP
2001:db8:bbbb:25::/64
    00:11:01:00:00:09 [pw-1:2.9]       23h43m41s  DHCP
2001:db8:bbbb:26::1/128
    00:11:01:00:00:0a [pw-1:2.10]      23h43m41s  DHCP
2001:db8:bbbb:27::/64
    00:11:01:00:00:0a [pw-1:2.10]      23h43m41s  DHCP
```

Number of lease states : 40
=====

[/]
A:admin@bng-1#

```
[/]
A:admin@bng-1# /show srrp 1 detail

=====
SRRP Instance 1
=====
Description          : (Not Specified)
Admin State          : Up                Oper State          : master
Preempt              : yes                One GARP per SAP   : no
Monitor Oper Group   : None
System IP            : 192.0.2.20
Service ID           : VPRN 10
Group If             : group-int-1        MAC Address         : b4:96:ff:00:00:00
Grp If Description   : N/A
Grp If Admin State   : Up                Grp If Oper State   : Up
Subscriber If        : sub-int-1
Sub If Admin State   : Up                Sub If Oper State   : Up
Address              : 10.10.0.1/24          Gateway IP          : 10.10.0.254
Address              : 10.10.1.1/24        Gateway IP          : 10.10.1.254
Redundant If         : red-int-bng-1-bng*
Red If Admin State   : Up                Red If Oper State   : Up
Address              : 192.168.11.1/24
Red Spoke-sdp        : 1:1
Msg Path SAP         : pw-1:2.4094          Passive             : no
Admin Gateway MAC    :                    Oper Gateway MAC    : 00:00:5e:00:01:01
Standby-Forwarding   : Disabled
Config Priority       : 100                In-use Priority     : 100
Master Priority       : 100
Keep-alive Interval : 2 deci-seconds    Master Since        : 11/12/2022 16:23:34
Fib Population Mode  : all
VRRP Policy 1        : None                VRRP Policy 2      : None

-----
Statistics
-----
Become Master        : 1                Master Changes     : 1
Become Bkup Routing  : 0                Become Bkup Shunt  : 1
Become Non-Master    : 0
Adv Sent             : 849384            Adv Received       : 0
Pri 0 Pkts Sent      : 0                Pri 0 Pkts Rcvd    : 0
Preempt Events       : 0                Preempted Events   : 0
Msg Intvl Discards   : 0                Msg Intvl Errors   : 0

=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp local-dhcp-server "dhcpv4" summary
=====
DHCP server dhcpv4  router 10
=====
Admin State          : inService
Operational State    : inService
Persistency State    : shutdown
User Data Base       : N/A
Use gateway IP address : enabled (scope pool)
Use pool from client  : enabled
Send force-renewals  : disabled
Creation Origin       : manual
Lease Hold Time       : 0h0m0s
```

```

Lease Hold Time For      : N/A
User-ident               : mac-circuit-id

Failover Admin State    : outOfService
Failover Oper State     : shutdown
Failover Persist Key    : N/A
Administrative MCLT     : 0h10m0s
Operational MCLT       : 0h10m0s
Startup wait time       : 0h2m0s
Partner down delay      : 23h59m59s
  Ignore MCLT           : disabled
-----
Pool name : dhcpv4-1
-----
Failover Admin State    : inService
Failover Oper State     : normal
Failover Persist Key    : N/A
Administrative MCLT     : 0h10m0s
Operational MCLT       : 0h10m0s
Startup wait time       : 0h2m0s
Partner down delay      : 23h59m59s
  Ignore MCLT           : disabled
-----
Subnet                   Free      %      Stable  Declined Offered  Rem-pend Drain
-----
10.10.0.0/24             (A) 81      89%  10      0        0        0        N
Totals for pool          81      89%  10      0        0        0
-----
Pool name : pppoev4-1
-----
Failover Admin State    : outOfService
Failover Oper State     : shutdown
Failover Persist Key    : N/A
Administrative MCLT     : 0h10m0s
Operational MCLT       : 0h10m0s
Startup wait time       : 0h2m0s
Partner down delay      : 23h59m59s
  Ignore MCLT           : disabled
-----
Subnet                   Free      %      Stable  Declined Offered  Rem-pend Drain
-----
10.10.1.0/24            81      89%  10      0        0        0        N
Totals for pool          81      89%  10      0        0        0
-----
Totals for server        162     89%  20      0        0        0
-----
Interface associations
Interface                 Admin
-----
loopback-1                Up
-----
Local Address Assignment associations
Group interface           Admin
-----
group-int-1               Up
No associated firewall domains found.
    
```

```

=====
[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp6 local-dhcp-server "dhcpv6" summary
=====
DHCP server dhcpv6 router 10
=====
Admin State           : inService
Operational State     : inService
Persistency State     : shutdown
Use Link Address      : disabled
Use pool from client  : enabled
Creation Origin       : manual
Lease Hold Time       : 0h0m0s
Lease Hold Time For   : N/A
User-ident            : duid
Interface-id-mapping  : disabled
Ignore-rapid-commit   : disabled
Allow-lease-query     : disabled
Auto-provisioned      : false

Failover Admin State  : outOfService
Failover Oper State   : shutdown
Failover Persist Key  : N/A
Administrative MCLT   : 0h10m0s
Operational MCLT     : 0h10m0s
Startup wait time     : 0h2m0s
Partner down delay    : 23h59m59s
Ignore MCLT           : disabled

-----
Pool name : dhcpv6-1
-----
Failover Admin State  : inService
Failover Oper State   : normal
Failover Persist Key  : N/A
Administrative MCLT   : 0h10m0s
Operational MCLT     : 0h10m0s
Startup wait time     : 0h2m0s
Partner down delay    : 23h59m59s
Ignore MCLT           : disabled

-----
Prefix
-----
Stable Declined Advert Rem-pend Drain
-----
2001:db8:bbbb::/56      (A) 40      0      0      0      N
2001:db8:bbbb:100::/56 (A)  0      0      0      0      N
Totals for pool         40      0      0      0
-----
Totals for server       40      0      0      0
-----
Interface associations
Interface                Admin
-----
loopback-1              Up
    
```



```

-----
Local Address Assignment associations
Group interface          Admin
-----
No associated firewall domains found.
=====

[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp local-dhcp-server "dhcpv4" leases

=====
Leases for DHCP server dhcpv4 router 10
=====
IP Address      Lease State      Mac Address      Remaining      Clnt  Fail
  PPP user name/Opt82 Circuit Id      LifeTime      Type  Ctrl
  User-db/Sticky-lease Hostname
-----
10.10.0.10      stable           00:13:01:00:00:02 0h23m42s      dhcp  local
  cid-2
10.10.0.11      stable           00:13:01:00:00:05 0h23m42s      dhcp  local
  cid-5
10.10.0.12      stable           00:13:01:00:00:01 0h23m42s      dhcp  local
  cid-1
10.10.0.13      stable           00:13:01:00:00:0a 0h23m42s      dhcp  local
  cid-10
10.10.0.14      stable           00:13:01:00:00:03 0h23m42s      dhcp  local
  cid-3
10.10.0.15      stable           00:13:01:00:00:09 0h23m42s      dhcp  local
  cid-9
10.10.0.16      stable           00:13:01:00:00:08 0h23m43s      dhcp  local
  cid-8
10.10.0.17      stable           00:13:01:00:00:04 0h23m44s      dhcp  local
  cid-4
10.10.0.18      stable           00:13:01:00:00:07 0h23m44s      dhcp  local
  cid-7
10.10.0.19      stable           00:13:01:00:00:06 0h23m44s      dhcp  local
  cid-6
10.10.1.10      internal         N/A              N/A           ppp   N/A
10.10.1.11      internal         N/A              N/A           ppp   N/A
10.10.1.12      internal         N/A              N/A           ppp   N/A
10.10.1.13      internal         N/A              N/A           ppp   N/A
10.10.1.14      internal         N/A              N/A           ppp   N/A
10.10.1.15      internal         N/A              N/A           ppp   N/A
10.10.1.16      internal         N/A              N/A           ppp   N/A
10.10.1.17      internal         N/A              N/A           ppp   N/A
10.10.1.18      internal         N/A              N/A           ppp   N/A
10.10.1.19      internal         N/A              N/A           ppp   N/A
-----
20 leases found
=====
    
```

```
[/]
A:admin@bng-1#

[/]
A:admin@bng-1# /show router 10 dhcp6 local-dhcp-server "dhcpv6" leases

=====
Leases for DHCPv6 server dhcpv6
=====
```

IP Address/Prefix Link-local Address	Lease State	Remaining LifeTime	Fail Ctrl
2001:db8:bbbb:1/64 fe80::213:1ff:fe00:1	stable	1d0h13m	local
2001:db8:bbbb:1::/64 fe80::213:1ff:fe00:1	stable	1d0h13m	local
2001:db8:bbbb:2::/64 fe80::213:1ff:fe00:2	stable	1d0h13m	local
2001:db8:bbbb:3::/64 fe80::213:1ff:fe00:2	stable	1d0h13m	local
2001:db8:bbbb:4::/64 fe80::213:1ff:fe00:5	stable	1d0h13m	local
2001:db8:bbbb:5::/64 fe80::213:1ff:fe00:5	stable	1d0h13m	local
2001:db8:bbbb:6::/64 fe80::213:1ff:fe00:8	stable	1d0h13m	local
2001:db8:bbbb:7::/64 fe80::213:1ff:fe00:8	stable	1d0h13m	local
2001:db8:bbbb:8::/64 fe80::213:1ff:fe00:4	stable	1d0h13m	local
2001:db8:bbbb:9::/64 fe80::213:1ff:fe00:4	stable	1d0h13m	local
2001:db8:bbbb:a::/64 fe80::213:1ff:fe00:7	stable	1d0h13m	local
2001:db8:bbbb:b::/64 fe80::213:1ff:fe00:7	stable	1d0h13m	local
2001:db8:bbbb:c::/64 fe80::213:1ff:fe00:3	stable	1d0h13m	local
2001:db8:bbbb:d::/64 fe80::213:1ff:fe00:3	stable	1d0h13m	local
2001:db8:bbbb:e::/64 fe80::213:1ff:fe00:6	stable	1d0h13m	local
2001:db8:bbbb:f::/64 fe80::213:1ff:fe00:6	stable	1d0h13m	local
2001:db8:bbbb:10::/64 fe80::213:1ff:fe00:a	stable	1d0h8m	local
2001:db8:bbbb:11::/64 fe80::213:1ff:fe00:a	stable	1d0h8m	local
2001:db8:bbbb:12::/64 fe80::213:1ff:fe00:9	stable	1d0h8m	local
2001:db8:bbbb:13::/64 fe80::213:1ff:fe00:9	stable	1d0h8m	local
2001:db8:bbbb:14::/64 fe80::1:2:1:1	stable	1d0h13m	local
2001:db8:bbbb:15::/64 fe80::1:2:1:1	stable	1d0h13m	local
2001:db8:bbbb:16::/64 fe80::3:2:3:1	stable	1d0h13m	local
2001:db8:bbbb:17::/64 fe80::3:2:3:1	stable	1d0h13m	local
2001:db8:bbbb:18::/64 fe80::2:2:2:1	stable	1d0h13m	local
2001:db8:bbbb:19::/64 fe80::2:2:2:1	stable	1d0h13m	local

```

2001:db8:bbbb:1a::1/64
fe80::4:2:4:1          stable          1d0h13m      local
2001:db8:bbbb:1b::/64
fe80::4:2:4:1          stable          1d0h13m      local
2001:db8:bbbb:1c::1/64
fe80::5:2:5:1          stable          1d0h13m      local
2001:db8:bbbb:1d::/64
fe80::5:2:5:1          stable          1d0h13m      local
2001:db8:bbbb:1e::1/64
fe80::6:2:6:1          stable          1d0h13m      local
2001:db8:bbbb:1f::/64
fe80::6:2:6:1          stable          1d0h13m      local
2001:db8:bbbb:20::1/64
fe80::7:2:7:1          stable          1d0h13m      local
2001:db8:bbbb:21::/64
fe80::7:2:7:1          stable          1d0h13m      local
2001:db8:bbbb:22::1/64
fe80::8:2:8:1          stable          1d0h13m      local
2001:db8:bbbb:23::/64
fe80::8:2:8:1          stable          1d0h13m      local
2001:db8:bbbb:24::1/64
fe80::9:2:9:1          stable          1d0h13m      local
2001:db8:bbbb:25::/64
fe80::9:2:9:1          stable          1d0h13m      local
2001:db8:bbbb:26::1/64
fe80::a:2:a:1          stable          1d0h13m      local
2001:db8:bbbb:27::/64
fe80::a:2:a:1          stable          1d0h13m      local
-----
40 leases found
=====
    
```

Show commands on P-1

```
A:admin@p-1# /show port
```

```
=====
Ports on Slot 1
=====
```

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/MDIMDX
1/1/c1	Up		Link Up						conn	100GBASE-LR4*
1/1/c1/1	Up	Yes	Up	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/2	Up	Yes	Up	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/3	Up	Yes	Up	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/4	Up	Yes	Up	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/5	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/6	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/7	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/8	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/9	Up	Yes	Up	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c1/10	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2	Up		Link Up						conn	100G CWDM4 M*
1/1/c2/1	Up	Yes	Up	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/2	Down	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/3	Down	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/4	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/5	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/6	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/7	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/8	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	
1/1/c2/9	Up	No	Down	8936	8936	-	hybr dotq	dotq	xgige	

1/1/c2/10	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3	Up		Link Up						conn	100G	CLR4	*
1/1/c3/1	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/2	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/3	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/4	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/5	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/6	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/7	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/8	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/9	Up	No	Down	8936	8936	-	hybr	dotq	xgige			
1/1/c3/10	Up	Yes	Up	8936	8936	-	hybr	dotq	xgige			
1/1/c4	Up		Link Up						conn	100GBASE	-LR4*	
1/1/c4/1	Up	Yes	Up	8936	8936	-	hybr	dotq	xgige			
1/1/c4/2	Down	No	Down	8936	8936	-	netw	null	xgige			
1/1/c4/3	Down	No	Down	8936	8936	-	netw	null	xgige			
1/1/c4/4	Down	No	Down	8936	8936	-	netw	null	xgige			
1/1/c5	Down		Down						conn	100G	CWDM4	M*
1/1/c6	Down		Down						conn	100G	CLR4	*
1/2/c1	Down		Down						conn	100GBASE	-LR4*	
1/2/c2	Down		Down						conn	100G	CWDM4	M*
1/2/c3	Down		Down						conn	100G	CLR4	*
1/2/c4	Down		Down						conn	100GBASE	-LR4*	
1/2/c5	Down		Down						conn	100G	CWDM4	M*
1/2/c6	Down		Down						conn	100G	CLR4	*

=====
 Ports on Slot A
 =====

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
A/1	Up	Yes	Up	1514	1514	-	netw	null	faste	MDI
A/3	Down	No	Down	1514	1514	-	netw	null	faste	
A/4	Down	No	Down	1514	1514	-	netw	null	faste	

=====
 Ports on Port Cross Connect 1
 =====

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
pxc-1.a	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	
pxc-1.b	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	

=====
 Ports on Port Cross Connect 2
 =====

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
pxc-2.a	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	
pxc-2.b	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	

[/]
 A:admin@p-1#

[/]
 A:admin@p-1# /show router interface

=====
 Interface Table (Router: Base)
 =====

```

Interface-Name      Adm    Opr(v4/v6)  Mode    Port/SapId
IP-Address          PfxState
-----
_tmnx_fpe_1.a      Up     Up/Up       Network pxc-1.a:1
  fe80::100/64      PREFERRED
_tmnx_fpe_1.b      Up     Up/Up       Network pxc-1.b:1
  fe80::101/64      PREFERRED
_tmnx_fpe_2.a      Up     Up/Up       Network pxc-2.a:1
  fe80::200/64      PREFERRED
_tmnx_fpe_2.b      Up     Up/Up       Network pxc-2.b:1
  fe80::201/64      PREFERRED
int-1-p-1-bng-1    Up     Down/Up     Network 1/1/c2/1:1
  2001:db8::502/120 PREFERRED
  fe80::b69e:ffff:fe00:0/64 PREFERRED
int-1-p-1-p-2      Up     Down/Up     Network 1/1/c1/9:1
  2001:db8::a01/120 PREFERRED
  fe80::b69e:ffff:fe00:0/64 PREFERRED
int-1-p-1-pe-1     Up     Down/Up     Network 1/1/c1/1:1
  2001:db8::102/120 PREFERRED
  fe80::b69e:ffff:fe00:0/64 PREFERRED
system             Up     Up/Up       Network system
  192.0.2.4/32      n/a
  2001:db8::4/128  PREFERRED
to-radius          Up     Up/Down     Network 1/1/c3/10:114
  192.168.114.4/24 n/a
-----
Interfaces : 9
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show fwd-path-ext fpe 1

=====
FPE Id: 1
=====
Description      : (Not Specified)
Multi-Path       : Disabled
Path             : pxc 1
Pw Port Extension : Disabled           Oper    : down
Sub Mgmt Extension : Disabled           Oper    : N/A
Vxlan            : Disabled           Oper    : down
Segment-Routing V6 : Enabled           Oper    : up
SRv6 Type        : origination
If-A Qos Policy   : default
If-B MTU          : 9786 bytes       Oper MTU : 8914 bytes
If-B Qos Policy   : default
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show fwd-path-ext fpe 2

=====
FPE Id: 2
=====
Description      : (Not Specified)
Multi-Path       : Disabled
Path             : pxc 2
Pw Port Extension : Disabled           Oper    : down
    
```

```

Sub Mgmt Extension : Disabled           Oper      : N/A
Vxlan              : Disabled           Oper      : down
Segment-Routing V6 : Enabled            Oper      : up
SRv6 Type          : termination
If-A Qos Policy    : default
If-B MTU           : 0 bytes            Oper MTU  : 8914 bytes
If-B Qos Policy    : default
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router segment-routing-v6 base-routing-instance all

=====
Segment Routing v6 Base Routing Instance
=====
Locator
Type      Function      SID                               Status/InstId
  SRH-mode Protection  Interface
-----
p-1-loc
End              1 2001:db8:aaaa:4:0:1000::      ok
  USP
-----
Auto-allocated End.X: USP Protected,
-----
End.X              *2 2001:db8:aaaa:4:0:2000::      0
  USP              Protected int-1-p-1-pe-1
  ISIS Level: L2 Mac Address: b4:9f:01:01:00:01 Nbr Sys Id: 1920.0000.2005
End.X              *4 2001:db8:aaaa:4:0:4000::      0
  USP              Protected int-1-p-1-p-2
  ISIS Level: L2 Mac Address: b4:a1:01:01:00:09 Nbr Sys Id: 1920.0000.2010
End.X              *5 2001:db8:aaaa:4:0:5000::      0
  USP              Protected int-1-p-1-bng-1
  ISIS Level: L2 Mac Address: b4:99:01:01:00:01 Nbr Sys Id: 1920.0000.2020
-----

Legend: * - System allocated

=====
Micro Segment Routing v6 Base Routing Instance
=====
Micro Segment Locator
Type      Function      SID                               Status/InstId
  SRH-mode Oper Func  Interface  Protection
-----
Legend: * - System allocated

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router segment-routing-v6 local-sid context "Base"

=====
Segment Routing v6 Local SIDs
=====
SID                               Type      Function
Locator
Context
-----
    
```

```

2001:db8:aaaa:4:0:1000::                               End          1
p-1-loc
Base
-----
SIDs : 1
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router route-table ipv6

=====
IPv6 Route Table (Router: Base)
=====
Dest Prefix[Flags]                                     Type   Proto   Age          Pref
  Next Hop[Interface Name]                             Metric
-----
2001:db8::4/128                                       Local  Local   02d03h09m    0
  system                                               0
2001:db8::5/128 [L]                                    Remote  ISIS    02d03h08m    18
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"           10
2001:db8::a/128 [L]                                    Remote  ISIS    02d03h08m    18
  fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"           10
2001:db8::14/128                                       Remote  ISIS    01d23h20m    18
  fe80::b696:ffff:fe00:0-"int-1-p-1-bng-1"         10
2001:db8::15/128 [L]                                    Remote  ISIS    02d03h08m    18
  fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"           20
2001:db8::100/120                                       Local  Local   02d03h08m    0
  int-1-p-1-pe-1                                       0
2001:db8::200/120 [L]                                    Remote  ISIS    02d03h08m    18
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"           20
2001:db8::500/120                                       Local  Local   02d03h08m    0
  int-1-p-1-bng-1                                       0
2001:db8::600/120 [L]                                    Remote  ISIS    02d03h08m    18
  fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"           20
2001:db8::a00/120                                       Local  Local   02d03h08m    0
  int-1-p-1-p-2                                       0
2001:db8::6400/120 [L]                                    Remote  ISIS    02d03h08m    18
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"           20
2001:db8:aaaa:4::/64                                     Local  SRV6    02d03h08m    3
  fe80::201-"_tmnx_fpe_2.a"                           0
2001:db8:aaaa:4:0:1000::/128                             Local  SRV6    02d03h09m    3
  Black Hole                                             0
2001:db8:aaaa:4:0:2000::/128                             Local  ISIS    02d03h08m    18
  2001:db8:aaaa:4:0:2000:: (tunneled:SRV6-ISIS)       10
2001:db8:aaaa:4:0:4000::/128                             Local  ISIS    02d03h08m    18
  2001:db8:aaaa:4:0:4000:: (tunneled:SRV6-ISIS)       10
2001:db8:aaaa:4:0:5000::/128                             Local  ISIS    01d23h20m    18
  2001:db8:aaaa:4:0:5000:: (tunneled:SRV6-ISIS)       10
2001:db8:aaaa:5::/64                                     Remote  ISIS    02d03h08m    18
  2001:db8:aaaa:5::/64 (tunneled:SRV6-ISIS)           20
2001:db8:aaaa:a::/64                                     Remote  ISIS    02d03h08m    18
  2001:db8:aaaa:a::/64 (tunneled:SRV6-ISIS)           20
2001:db8:aaaa:14::/64                                    Remote  ISIS    01d23h20m    18
  2001:db8:aaaa:14::/64 (tunneled:SRV6-ISIS)          20
2001:db8:aaaa:15::/64                                    Remote  ISIS    02d03h08m    18
  2001:db8:aaaa:15::/64 (tunneled:SRV6-ISIS)          30
-----
No. of Routes: 20
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
    
```

```

L = LFA nexthop available
S = Sticky ECMP requested
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router tunnel-table ipv6

=====
IPv6 Tunnel Table (Router: Base)
=====
Destination                               Owner      Encap TunnelId  Pref
NextHop                                   Color
-----
2001:db8:aaaa:4:0:2000::/128 [L]          srv6-isis SRV6  524289    0
    fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"  10
2001:db8:aaaa:4:0:4000::/128 [L]          srv6-isis SRV6  524293    0
    fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"  10
2001:db8:aaaa:4:0:5000::/128             srv6-isis SRV6  524300    0
    fe80::b696:ffff:fe00:0-"int-1-p-1-bng-1" 10
2001:db8:aaaa:5::/64 [L]                  srv6-isis SRV6  524290    0
    fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"  20
2001:db8:aaaa:a::/64 [L]                  srv6-isis SRV6  524294    0
    fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"  20
2001:db8:aaaa:14::/64                     srv6-isis SRV6  524301    0
    fe80::b696:ffff:fe00:0-"int-1-p-1-bng-1" 20
2001:db8:aaaa:15::/64 [L]                 srv6-isis SRV6  524295    0
    fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"  30
-----
Flags: B = BGP or MPLS backup hop available
       L = Loop-Free Alternate (LFA) hop available
       E = Inactive best-external BGP route
       k = RIB-API or Forwarding Policy backup hop
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router fp-tunnel-table 1 ipv6

=====
IPv6 Tunnel Table Display

Legend:
label stack is ordered from bottom-most to top-most
B - FRR Backup
=====
Destination                               Protocol   Tunnel-ID
Lbl/SID
NextHop                                   Intf/Tunnel
Lbl/SID (backup)
NextHop (backup)
-----
2001:db8:aaaa:5::/64                       SRV6      524290
-
    fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1" 1/1/c1/1:1
-
    fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"(B) 1/1/c1/9:1
2001:db8:aaaa:a::/64                       SRV6      524294
-
    fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2" 1/1/c1/9:1
    
```



```

-
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"(B)          1/1/c1/1:1
2001:db8:aaaa:14::/64                               SRV6      524301
-
  fe80::b696:ffff:fe00:0-"int-1-p-1-bng-1"          1/1/c2/1:1
2001:db8:aaaa:15::/64                               SRV6      524295
-
  fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"            1/1/c1/9:1
-
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"(B)          1/1/c1/1:1
2001:db8:aaaa:4:0:2000::/128                       SRV6      524289
-
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"            1/1/c1/1:1
2001:db8:aaaa:5:0:1000::
  fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"(B)          1/1/c1/9:1
2001:db8:aaaa:4:0:4000::/128                       SRV6      524293
-
  fe80::b6a1:ffff:fe00:0-"int-1-p-1-p-2"            1/1/c1/9:1
2001:db8:aaaa:a:0:1000::
  fe80::b69f:ffff:fe00:0-"int-1-p-1-pe-1"(B)          1/1/c1/1:1
2001:db8:aaaa:4:0:5000::/128                       SRV6      524300
-
  fe80::b696:ffff:fe00:0-"int-1-p-1-bng-1"          1/1/c2/1:1
-----
Total Entries : 7
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router isis adjacency

=====
Rtr Base ISIS Instance 0 Adjacency
=====
System ID           Usage State Hold Interface           MT-ID
-----
bng-1               L2    Up    22   int-1-p-1-bng-1           0
p-2                 L2    Up    7    int-1-p-1-p-2            0
pe-1                L2    Up    7    int-1-p-1-pe-1           0
-----
Adjacencies : 3
=====

[/]
A:admin@p-1#

[/]
A:admin@p-1# /show router isis database

=====
Rtr Base ISIS Instance 0 Database
=====
LSP ID              Sequence  Checksum Lifetime Attributes
-----
Displaying Level 1 database
-----
Level (1) LSP Count : 0

Displaying Level 2 database
-----

```

```

p-1.00-00          0x13e    0x8dfc   952     L1L2
p-1.01-00          0x135    0x4b04  1027    L1L2
pe-1.00-00         0x13a    0x639f  1012    L1L2
pe-1.01-00         0x133    0xe585   626    L1L2
p-2.00-00          0x137    0xfd42   647    L1L2
p-2.01-00          0x136    0x6bc9  1146    L1L2
p-2.02-00          0x136    0xe36d  1149    L1L2
p-2.03-00          0x133    0xf859   886    L1L2
bng-1.00-00        0x13e    0x1410   947    L1L2
bng-2.00-00        0x138    0x757c   837    L1L2
Level (2) LSP Count : 10
=====
[/]
    
```

Show commands on PE-1

```

A:admin@pe-1# /show port

=====
Ports on Slot 1
=====
Port      Admin Link Port   Cfg  Oper  LAG/  Port  Port  Port  C/QS/S/XFP/
Id        State State State  MTU  MTU  Bndl  Mode  Encp  Type  MDIMDX
-----
1/1/c1    Up      Link Up
1/1/c1/1  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/2  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/3  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/4  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/5  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/6  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/7  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/8  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c1/9  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c1/10 Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2    Up      Link Up
1/1/c2/1  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/2  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/3  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/4  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/5  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/6  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/7  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/8  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/9  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c2/10 Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3    Up      Link Up
1/1/c3/1  Up      Yes  Up    8936 8936  -  hybr qinq xgige
1/1/c3/2  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/3  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/4  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/5  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/6  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/7  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/8  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/9  Up      No   Down  8936 8936  -  hybr dotq xgige
1/1/c3/10 Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c4    Up      Link Up
1/1/c4/1  Up      Yes  Up    8936 8936  -  hybr dotq xgige
1/1/c4/2  Down    No   Down  8936 8936  -  netw null xgige
1/1/c4/3  Down    No   Down  8936 8936  -  netw null xgige
1/1/c4/4  Down    No   Down  8936 8936  -  netw null xgige
    
```

1/1/c5	Down	Down				conn	100G CWD4	M*
1/1/c6	Down	Down				conn	100G CLR4	*
1/2/c1	Down	Down				conn	100GBASE-LR4*	
1/2/c2	Down	Down				conn	100G CWD4	M*
1/2/c3	Down	Down				conn	100G CLR4	*
1/2/c4	Down	Down				conn	100GBASE-LR4*	
1/2/c5	Down	Down				conn	100G CWD4	M*
1/2/c6	Down	Down				conn	100G CLR4	*
1/2/m1/1	Down	Link Up				anchor		

Ports on Slot A

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl Mode	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
A/1	Up	Yes	Up	1514	1514	-	netw	null	faste	MDI
A/3	Down	No	Down	1514	1514	-	netw	null	faste	
A/4	Down	No	Down	1514	1514	-	netw	null	faste	

Ports on Port Cross Connect 1

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl Mode	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
pxc-1.a	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	
pxc-1.b	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	

Ports on Port Cross Connect 2

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl Mode	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
pxc-2.a	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	
pxc-2.b	Up	Yes	Up	8932	8932	-	hybr	dotq	xgige	

[/]
 A:admin@pe-1#

[/]
 A:admin@pe-1# /show router interface

Interface Table (Router: Base)

Interface-Name IP-Address	Adm	Opr(v4/v6)	Mode	Port/SapId PfxState
_tmnx_fpe_1.a fe80::100/64	Up	Up/Up	Network	pxc-1.a:1 PREFERRED
_tmnx_fpe_1.b fe80::101/64	Up	Up/Up	Network	pxc-1.b:1 PREFERRED
_tmnx_fpe_2.a fe80::200/64	Up	Up/Up	Network	pxc-2.a:1 PREFERRED
_tmnx_fpe_2.b fe80::201/64	Up	Up/Up	Network	pxc-2.b:1 PREFERRED
int-1-pe-1-p-1 2001:db8::101/120 fe80::b69f:ffff:fe00:0/64	Up	Down/Up	Network	1/1/c1/1:1 PREFERRED PREFERRED
int-1-pe-1-p-2 2001:db8::201/120	Up	Down/Up	Network	1/1/c1/5:1 PREFERRED

```

    fe80::b69f:ffff:fe00:0/64
system      Up      Up/Up      Network    system
192.0.2.5/32
2001:db8::5/128
to-ixia    Up      Up/Up      Network    1/1/c3/1:1.1
172.16.100.1/24
2001:db8::6401/120
fe80::b69f:ffff:fe00:0/64
to-radius  Up      Up/Down    Network    1/1/c3/10:114
192.168.114.5/24
-----
Interfaces : 9
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show fwd-path-ext fpe 1

=====
FPE Id: 1
=====
Description      : (Not Specified)
Multi-Path       : Disabled
Path             : pxc 1
Pw Port Extension : Disabled           Oper      : down
Sub Mgmt Extension : Disabled           Oper      : N/A
Vxlan            : Disabled           Oper      : down
Segment-Routing V6 : Enabled           Oper      : up
SRv6 Type        : origination
If-A Qos Policy  : default
If-B MTU         : 9786 bytes       Oper MTU  : 8914 bytes
If-B Qos Policy  : default
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show fwd-path-ext fpe 2

=====
FPE Id: 2
=====
Description      : (Not Specified)
Multi-Path       : Disabled
Path             : pxc 2
Pw Port Extension : Disabled           Oper      : down
Sub Mgmt Extension : Disabled           Oper      : N/A
Vxlan            : Disabled           Oper      : down
Segment-Routing V6 : Enabled           Oper      : up
SRv6 Type        : termination
If-A Qos Policy  : default
If-B MTU         : 0 bytes         Oper MTU  : 8914 bytes
If-B Qos Policy  : default
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show service id "dual-homing" base
    
```

```

=====
Service Basic Information
=====
Service Id       : 11                Vpn Id          : 0
Service Type    : Epipe
MACSec enabled  : no
Name            : dual-homing
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/12/2022 15:58:53
Last Mgmt Change  : 11/12/2022 12:08:24
Test Service    : No
Admin State     : Up                Oper State       : Up
MTU             : 1514
Vc Switching    : False
SAP Count       : 1                SDP Bind Count   : 0
Per Svc Hashing : Disabled         Lbl Eth/IP L4 TEID: Disabled
Ignore MTU Mismatch*: Disabled
Vxlan Src Tep Ip : N/A
Force QTag Fwd  : Disabled
Lcl Switch Svc St : sap
Oper Group      : <none>

-----
Service Access & Destination Points
-----
Identifier                Type      AdmMTU  OprMTU  Adm  Opr
-----
sap:1/1/c3/1:*.*.        qinq     8936    8936    Up   Up
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show service id "dual-homing" bgp-evpn

=====
BGP EVPN Table
=====
EVI           : 11                Creation Origin  : manual

-----
Local AC Name      Eth Tag  Endpoint                Ingress Label
-----
access             1                0

Number of local ACs : 1

-----
Remote AC Name      Eth Tag  Endpoint
-----
bng                 2

Number of Remote ACs : 1
=====

Segment Routing v6 Instance 1 Service 11
=====
Admin State       : Enabled
Srv6 Instance     : 1
Default Locator   : pe-1-loc
    
```

```
Oper Group           : (Not Specified)
Default Route Tag    : 0xb
Source Address       : 2001:db8::5
ECMP                 : 1
Force Vlan VC Fwd    : disabled
Next Hop Type        : system-ipv6
Evi 3-byte Auto-RT   : disabled
Route Resolution     : fallback-tunnel-to-route-table
Force QinQ VC Fwd    : none
MH Mode              : network
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router bgp routes evpn auto-disc tag 2 detail
=====
BGP Router ID:192.0.2.5      AS:64500      Local AS:64500
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                l - leaked, x - stale, > - best, b - backup, p - purge
Origin codes  : i - IGP, e - EGP, ? - incomplete
=====
BGP EVPN Auto-Disc Routes
=====
Original Attributes

Network          : n/a
Nexthop          : 2001:db8::14
Path Id          : None
From             : 2001:db8::14
Res. Nexthop     : fe80::b69e:ffff:fe00:0
Local Pref.      : 100
Aggregator AS    : None
Atomic Aggr.     : Not Atomic
AIGP Metric      : None
Connector        : None
Community        : color:00:20 target:64500:11
                  l2-attribute:MTU: 1514 C: 0 P: 1 B: 0
Cluster          : No Cluster Members
Originator Id    : None
Flags            : Used Valid Best IGP
Route Source     : Internal
AS-Path          : No As-Path
EVPN type        : AUTO-DISC
ESI              : 01:01:01:01:01:01:01:01:01:01
Tag              : 2
Route Dist.      : 192.0.2.20:11
MPLS Label       : 524286
Route Tag        : 0
Neighbor-AS      : n/a
Orig Validation  : N/A
Source Class     : 0
Add Paths Send   : Default
Last Modified    : 01d23h16m
SRv6 TLV Type    : SRv6 L2 Service TLV (6)
SRv6 SubTLV     : SRv6 SID Information (1)
Sid              : 2001:db8:aaaa:14::
Full Sid         : 2001:db8:aaaa:14:7fff:e000::
Behavior         : End.DX2 (21)
Dest Class       : 0
```

```

SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len  : 48                      Loc-Node-Len   : 16
Func-Len       : 20                      Arg-Len        : 0
Tpose-Len      : 20                      Tpose-offset   : 64

Modified Attributes

Network        : n/a
NextHop        : 2001:db8::14
Path Id        : None
From           : 2001:db8::14
Res. NextHop   : fe80::b69e:ffff:fe00:0
Local Pref.    : 100                      Interface Name : int-1-pe-1-p-1
Aggregator AS  : None                      Aggregator     : None
Atomic Aggr.   : Not Atomic                MED            : None
AIGP Metric    : None                      IGP Cost       : 30
Connector      : None
Community      : color:00:20 target:64500:11
                l2-attribute:MTU: 1514 C: 0 P: 1 B: 0
Cluster        : No Cluster Members
Originator Id  : None                      Peer Router Id  : 192.0.2.20
Flags          : Used Valid Best IGP
Route Source   : Internal
AS-Path        : No As-Path
EVPN type      : AUTO-DISC
ESI           : 01:01:01:01:01:01:01:01:01
Tag            : 2
Route Dist.    : 192.0.2.20:11
MPLS Label     : 524286
Route Tag      : 0
Neighbor-AS    : n/a
Orig Validation: N/A
Source Class   : 0                          Dest Class      : 0
Add Paths Send : Default
Last Modified  : 01d23h16m
SRv6 TLV Type  : SRv6 L2 Service TLV (6)
SRv6 SubTLV    : SRv6 SID Information (1)
Sid            : 2001:db8:aaaa:14::
Full Sid       : 2001:db8:aaaa:14:7fff:e000::
Behavior       : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len  : 48                      Loc-Node-Len   : 16
Func-Len       : 20                      Arg-Len        : 0
Tpose-Len      : 20                      Tpose-offset   : 64
    
```

 Original Attributes

```

Network        : n/a
NextHop        : 2001:db8::15
Path Id        : None
From           : 2001:db8::15
Res. NextHop   : fe80::b6a1:ffff:fe00:0
Local Pref.    : 100                      Interface Name : int-1-pe-1-p-2
Aggregator AS  : None                      Aggregator     : None
Atomic Aggr.   : Not Atomic                MED            : None
AIGP Metric    : None                      IGP Cost       : 30
Connector      : None
Community      : color:00:30 target:64500:11
                l2-attribute:MTU: 1514 C: 0 P: 0 B: 1
Cluster        : No Cluster Members
Originator Id  : None                      Peer Router Id  : 192.0.2.21
Flags          : Used Valid Best IGP
Route Source   : Internal
    
```

```
AS-Path      : No As-Path
EVPN type   : AUTO-DISC
ESI         : 01:01:01:01:01:01:01:01:01
Tag         : 2
Route Dist. : 192.0.2.21:11
MPLS Label  : 524286
Route Tag   : 0
Neighbor-AS : n/a
Orig Validation: N/A
Source Class : 0                      Dest Class : 0
Add Paths Send : Default
Last Modified : 01d23h16m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid          : 2001:db8:aaaa:15::
Full Sid     : 2001:db8:aaaa:15:7fff:e000::
Behavior     : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                    Loc-Node-Len : 16
Func-Len      : 20                    Arg-Len      : 0
Tpose-Len     : 20                    Tpose-offset : 64

Modified Attributes

Network      : n/a
Nextthop    : 2001:db8::15
Path Id     : None
From        : 2001:db8::15
Res. Nextthop : fe80::b6a1:ffff:fe00:0
Local Pref. : 100                    Interface Name : int-1-pe-1-p-2
Aggregator AS : None                Aggregator    : None
Atomic Aggr. : Not Atomic           MED           : None
AIGP Metric  : None                 IGP Cost      : 30
Connector    : None
Community    : color:00:30 target:64500:11
              l2-attribute:MTU: 1514 C: 0 P: 0 B: 1
Cluster     : No Cluster Members
Originator Id : None                Peer Router Id : 192.0.2.21
Flags       : Used Valid Best IGP
Route Source : Internal
AS-Path     : No As-Path
EVPN type   : AUTO-DISC
ESI         : 01:01:01:01:01:01:01:01:01
Tag         : 2
Route Dist. : 192.0.2.21:11
MPLS Label  : 524286
Route Tag   : 0
Neighbor-AS : n/a
Orig Validation: N/A
Source Class : 0                      Dest Class : 0
Add Paths Send : Default
Last Modified : 01d23h16m
SRv6 TLV Type : SRv6 L2 Service TLV (6)
SRv6 SubTLV  : SRv6 SID Information (1)
Sid          : 2001:db8:aaaa:15::
Full Sid     : 2001:db8:aaaa:15:7fff:e000::
Behavior     : End.DX2 (21)
SRv6 SubSubTLV : SRv6 SID Structure (1)
Loc-Block-Len : 48                    Loc-Node-Len : 16
Func-Len      : 20                    Arg-Len      : 0
Tpose-Len     : 20                    Tpose-offset : 64

-----
-----
```



```

Routes : 2
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show service id "dual-homing" segment-routing-v6 detail

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function SID                               Status
-----
pe-1-loc
  End.DX2      *524288 2001:db8:aaaa:5:8000::             ok
=====
Legend: * - System allocated

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show service id "dual-homing" segment-routing-v6 instance 1 destinations

=====
TEP, SID
=====
Instance  TEP Address                               Segment Id
-----
No Matching Entries
=====

=====
Segment Routing v6 Ethernet Segment Dest
=====
Instance  Eth SegId                               Num. Macs   Last Change
-----
1         01:01:01:01:01:01:01:01:01:01:01:01:01:01  0           11/12/2022 15:58:53
-----
Number of entries: 1
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show service id "dual-homing" segment-routing-v6 instance 1 end-dx2

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function SID                               Status
-----
pe-1-loc
  End.DX2      *524288 2001:db8:aaaa:5:8000::             ok
=====
Legend: * - System allocated

[/]
A:admin@pe-1#
    
```

```
[/]
A:admin@pe-1# /show service id "dual-homing" segment-routing-v6 instance 1 locator "pe-1-loc"

=====
Segment Routing v6 Instance 1 Service 11
=====
Locator
Type          Function  SID                               Status
-----
pe-1-loc
End.DX2       *524288 2001:db8:aaaa:5:8000::          ok
=====
Legend: * - System allocated

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router segment-routing-v6 base-routing-instance all

=====
Segment Routing v6 Base Routing Instance
=====
Locator
Type          Function  SID                               Status/InstId
SRH-mode Protection Interface
-----
pe-1-loc
End           1 2001:db8:aaaa:5:0:1000::        ok
USP
-----
Auto-allocated End.X: USP Protected,
-----
End.X        *524289 2001:db8:aaaa:5:8000:1000::      0
USP          Protected int-1-pe-1-p-1
ISIS Level: L2 Mac Address: b4:9e:01:01:00:01 Nbr Sys Id: 1920.0000.2004
End.X        *524290 2001:db8:aaaa:5:8000:2000::      0
USP          Protected int-1-pe-1-p-2
ISIS Level: L2 Mac Address: b4:a1:01:01:00:05 Nbr Sys Id: 1920.0000.2010
-----
Legend: * - System allocated

=====
Micro Segment Routing v6 Base Routing Instance
=====
Micro Segment Locator
Type          Function  SID                               Status/InstId
SRH-mode Oper Func Interface Protection
-----
Legend: * - System allocated

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router segment-routing-v6 local-sid context "Base"

=====
Segment Routing v6 Local SIDs
=====
SID                               Type          Function
```

```

Locator
Context
-----
2001:db8:aaaa:5:0:1000::                               End           1
pe-1-loc
Base
-----
SIDs : 1
-----
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router route-table ipv6

=====
IPv6 Route Table (Router: Base)
=====
Dest Prefix[Flags]                                     Type  Proto  Age      Pref
  Next Hop[Interface Name]                             Metric
-----
2001:db8::4/128 [L]                                     Remote  ISIS   02d03h05m 18
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"              10
2001:db8::5/128                                         Local   Local  02d03h06m  0
  system                                                0
2001:db8::a/128 [L]                                     Remote  ISIS   02d03h05m 18
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"              10
2001:db8::14/128 [L]                                    Remote  ISIS   01d23h17m 18
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"              20
2001:db8::15/128 [L]                                    Remote  ISIS   02d03h05m 18
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"              20
2001:db8::100/120                                       Local   Local  02d03h06m  0
  int-1-pe-1-p-1                                       0
2001:db8::200/120                                       Local   Local  02d03h06m  0
  int-1-pe-1-p-2                                       0
2001:db8::500/120 [L]                                    Remote  ISIS   02d03h05m 18
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"              20
2001:db8::600/120 [L]                                    Remote  ISIS   02d03h05m 18
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"              20
2001:db8::a00/120 [L]                                    Remote  ISIS   02d03h05m 18
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"              20
2001:db8::6400/120                                       Local   Local  02d03h06m  0
  to-ixia                                              0
2001:db8:aaaa:4::/64                                     Remote  ISIS   02d03h05m 18
  2001:db8:aaaa:4::/64 (tunneled:SRV6-ISIS)             20
2001:db8:aaaa:5::/64                                     Local   SRV6   02d03h06m  3
  fe80::201-"_tmnx_fpe_2.a"                             0
2001:db8:aaaa:5:0:1000::/128                             Local   SRV6   02d03h06m  3
  Black Hole                                            0
2001:db8:aaaa:5:0:6000::/128                             Local   SRV6-Pol* 02d03h06m 14
  2001:db8::15 (tunneled:SRV6-Policy:917507)            1
2001:db8:aaaa:5:0:7000::/128                             Local   SRV6-Pol* 02d03h05m 14
  2001:db8::14 (tunneled:SRV6-Policy:917506)            1
2001:db8:aaaa:5:8000:1000::/128                          Local   ISIS   02d03h05m 18
  2001:db8:aaaa:5:8000:1000:: (tunneled:SRV6-ISIS)     10
2001:db8:aaaa:5:8000:2000::/128                          Local   ISIS   02d03h05m 18
  2001:db8:aaaa:5:8000:2000:: (tunneled:SRV6-ISIS)     10
2001:db8:aaaa:a::/64                                     Remote  ISIS   02d03h05m 18
  2001:db8:aaaa:a::/64 (tunneled:SRV6-ISIS)             20
2001:db8:aaaa:14::/64                                    Remote  ISIS   01d23h17m 18
  2001:db8:aaaa:14::/64 (tunneled:SRV6-ISIS)           30
2001:db8:aaaa:15::/64                                    Remote  ISIS   02d03h05m 18
    
```

```

2001:db8:aaaa:15::/64 (tunneled:SRV6-ISIS)          30
-----
No. of Routes: 21
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
      S = Sticky ECMP requested
=====
* indicates that the corresponding row element may have been truncated.

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router tunnel-table ipv6

=====
IPv6 Tunnel Table (Router: Base)
=====
Destination                               Owner      Encap TunnelId  Pref
Nexthop                                   Color      Color  Metric
-----
2001:db8::14/128                          srv6-pol   SRV6   917506    14
  fpe_1.a                                   20        0
2001:db8::15/128                          srv6-pol   SRV6   917507    14
  fpe_1.a                                   30        0
2001:db8:aaaa:4::/64 [L]                  srv6-isis  SRV6   524290    0
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"  20
2001:db8:aaaa:5:8000:1000::/128 [L]       srv6-isis  SRV6   524289    0
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"  10
2001:db8:aaaa:5:8000:2000::/128 [L]       srv6-isis  SRV6   524292    0
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"  10
2001:db8:aaaa:a::/64 [L]                  srv6-isis  SRV6   524293    0
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"  20
2001:db8:aaaa:14::/64 [L]                  srv6-isis  SRV6   524297    0
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"  30
2001:db8:aaaa:15::/64 [L]                  srv6-isis  SRV6   524294    0
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"  30
-----
Flags: B = BGP or MPLS backup hop available
      L = Loop-Free Alternate (LFA) hop available
      E = Inactive best-external BGP route
      k = RIB-API or Forwarding Policy backup hop
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router fp-tunnel-table 1 ipv6

=====
IPv6 Tunnel Table Display
Legend:
label stack is ordered from bottom-most to top-most
B - FRR Backup
=====
Destination                               Protocol   Tunnel-ID
Lbl/SID
  NextHop                                   Intf/Tunnel
Lbl/SID (backup)
  NextHop   (backup)
-----

```

```

2001:db8:aaaa:4::/64          SRV6          524290
-
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"          1/1/c1/1:1
-
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"(B)       1/1/c1/5:1
2001:db8:aaaa:a::/64          SRV6          524293
-
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"          1/1/c1/5:1
-
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"(B)       1/1/c1/1:1
2001:db8:aaaa:14::/64         SRV6          524297
-
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"          1/1/c1/1:1
-
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"(B)       1/1/c1/5:1
2001:db8:aaaa:15::/64         SRV6          524294
-
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"          1/1/c1/5:1
-
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"(B)       1/1/c1/1:1
2001:db8::14/128              SRV6-Policy   -
  2001:db8:aaaa:4:0:1000::/2001:db8:aaaa:a:0:1000::
  0.140.1.1                    pxc-1.b:1
2001:db8::15/128              SRV6-Policy   -
  2001:db8:aaaa:a:0:1000::/2001:db8:aaaa:4:0:1000::
  0.140.1.1                    pxc-1.b:1
2001:db8:aaaa:5:8000:1000::/128 SRV6          524289
-
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"          1/1/c1/1:1
  2001:db8:aaaa:4:0:1000::
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"(B)       1/1/c1/5:1
2001:db8:aaaa:5:8000:2000::/128 SRV6          524292
-
  fe80::b6a1:ffff:fe00:0-"int-1-pe-1-p-2"          1/1/c1/5:1
  2001:db8:aaaa:a:0:1000::
  fe80::b69e:ffff:fe00:0-"int-1-pe-1-p-1"(B)       1/1/c1/1:1
-----
Total Entries : 8
-----
=====

[/]
A:admin@pe-1#

[/]
A:admin@pe-1# /show router bgp summary
=====
BGP Router ID:192.0.2.5      AS:64500      Local AS:64500
=====
BGP Admin State      : Up      BGP Oper State      : Up
Total Peer Groups    : 1      Total Peers          : 2
Total VPN Peer Groups : 0      Total VPN Peers      : 0
Current Internal Groups : 1      Max Internal Groups  : 1
Total BGP Paths       : 45     Total Path Memory    : 16136

Total IPv4 Remote Rts : 0      Total IPv4 Rem. Active Rts : 0
Total IPv6 Remote Rts : 0      Total IPv6 Rem. Active Rts : 0
Total IPv4 Backup Rts : 0      Total IPv6 Backup Rts   : 0
Total LblIpv4 Rem Rts : 0      Total LblIpv4 Rem. Act Rts : 0
Total LblIpv6 Rem Rts : 0      Total LblIpv6 Rem. Act Rts : 0
Total LblIpv4 Bkp Rts : 0      Total LblIpv6 Bkp Rts   : 0
Total Suppressed Rts  : 0      Total Hist. Rts      : 0
Total Decay Rts       : 0
    
```

```

Total VPN-IPv4 Rem. Rts : 0      Total VPN-IPv4 Rem. Act. Rts: 0
Total VPN-IPv6 Rem. Rts : 0      Total VPN-IPv6 Rem. Act. Rts: 0
Total VPN-IPv4 Bkup Rts : 0      Total VPN-IPv6 Bkup Rts    : 0
Total VPN Local Rts    : 1      Total VPN Supp. Rts       : 0
Total VPN Hist. Rts    : 0      Total VPN Decay Rts      : 0

Total MVPN-IPv4 Rem Rts : 0      Total MVPN-IPv4 Rem Act Rts : 0
Total MVPN-IPv6 Rem Rts : 0      Total MVPN-IPv6 Rem Act Rts : 0
Total MDT-SAFI Rem Rts  : 0      Total MDT-SAFI Rem Act Rts  : 0
Total McIPv4 Remote Rts : 0      Total McIPv4 Rem. Active Rts: 0
Total McIPv6 Remote Rts : 0      Total McIPv6 Rem. Active Rts: 0
Total McVpnIPv4 Rem Rts : 0      Total McVpnIPv4 Rem Act Rts : 0
Total McVpnIPv6 Rem Rts : 0      Total McVpnIPv6 Rem Act Rts : 0

Total EVPN Rem Rts      : 4      Total EVPN Rem Act Rts    : 4
Total L2-VPN Rem. Rts   : 0      Total L2VPN Rem. Act. Rts : 0
Total MSPW Rem Rts      : 0      Total MSPW Rem Act Rts    : 0
Total RouteTgt Rem Rts  : 0      Total RouteTgt Rem Act Rts : 0
Total FlowIpv4 Rem Rts  : 0      Total FlowIpv4 Rem Act Rts : 0
Total FlowIpv6 Rem Rts  : 0      Total FlowIpv6 Rem Act Rts : 0
Total FlowVpvn4 Rem Rts : 0      Total FlowVpvn4 Rem Act Rts : 0
Total FlowVpvn6 Rem Rts : 0      Total FlowVpvn6 Rem Act Rts : 0
Total Link State Rem Rts: 0      Total Link State Rem Act Rts: 0
Total SrPlcyIpv4 Rem Rts: 0      Total SrPlcyIpv4 Rem Act Rts: 0
Total SrPlcyIpv6 Rem Rts: 0      Total SrPlcyIpv6 Rem Act Rts: 0
    
```

=====
 BGP Summary
 =====

Legend : D - Dynamic Neighbor
 =====

Neighbor
 Description

	AS	PktRcvd	InQ	Up/Down	State	Rcv/Act/Sent (Addr Family)
		PktSent	OutQ			

2001:db8::14	64500	5682	0	01d23h17m	2/2/1	(Evpn)
		5680	0			
2001:db8::15	64500	6146	0	02d03h05m	2/2/1	(Evpn)
		6135	0			

[/]
 A:admin@pe-1#

[/]
 A:admin@pe-1# /show router isis adjacency

=====
 Rtr Base ISIS Instance 0 Adjacency
 =====

System ID	Usage	State	Hold	Interface	MT-ID
p-1	L2	Up	26	int-1-pe-1-p-1	0
p-2	L2	Up	9	int-1-pe-1-p-2	0

 Adjacencies : 2
 =====

[/]
 A:admin@pe-1#

```
[/]
A:admin@pe-1# /show router isis database

=====
Rtr Base ISIS Instance 0 Database
=====
LSP ID                               Sequence  Checksum Lifetime Attributes
-----
Displaying Level 1 database
-----
Level (1) LSP Count : 0

Displaying Level 2 database
-----
p-1.00-00                             0x13e    0x8dfc   1100    L1L2
p-1.01-00                             0x135    0x4b04   1175    L1L2
pe-1.00-00                             0x13a    0x639f   1161    L1L2
pe-1.01-00                             0x133    0xe585   775     L1L2
p-2.00-00                             0x137    0xfd42   796     L1L2
p-2.01-00                             0x135    0x6dc8   648     L1L2
p-2.02-00                             0x135    0xe56c   752     L1L2
p-2.03-00                             0x133    0xf859   1034    L1L2
bng-1.00-00                           0x13e    0x1410   1095    L1L2
bng-2.00-00                           0x138    0x757c   985     L1L2
Level (2) LSP Count : 10
=====
```

Diameter Base Protocol: Establishing a Diameter Peer Connection

This chapter provides information about configuring and troubleshooting the Diameter Base protocol to establish a Diameter peer connection.

Topics in this chapter include:

- [Applicability](#)
- [Overview](#)
- [Configuration](#)
- [Conclusion](#)

Applicability

This information and configuration in this chapter are based on SR OS Release 19.10.R1.



Note:

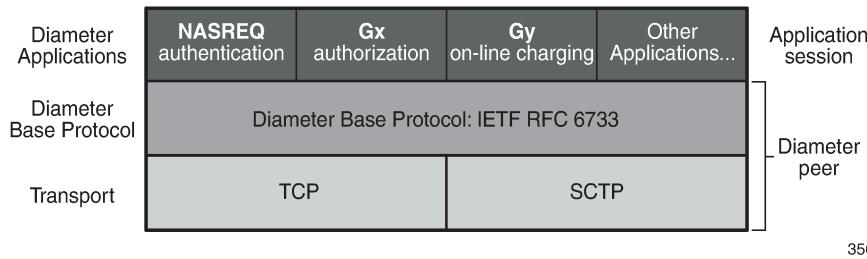
This chapter covers the Diameter base protocol implementation that is available from SR OS Release 16.0.R4 onward (configured in **aaa** CLI context as **diameter node**). The legacy Diameter base implementation (configured in the **aaa** CLI context as **diameter-peer-policy**) is supported in maintenance mode only, without any further feature enhancement planned. Nokia recommends using or transitioning to the new Diameter base protocol implementation.

Overview

Diameter is an Authentication, Authorization and Accounting (AAA) protocol defined by the IETF in RFC 6733, *Diameter Base Protocol*. While historically wireline access networks were largely based on RADIUS for subscriber authentication, authorization, and accounting, it was decided by 3rd Generation Partnership Project (3GPP) that wireless access networks will be largely based on Diameter. Over time, operators are looking to converge both types of networks, and one of the aspects of this is to replace RADIUS in wireline access networks by Diameter.

Diameter is based on three layers: the transport layer, the Diameter base protocol layer and the Diameter applications as shown in [Figure 11: Diameter protocol stack](#).

Figure 11: Diameter protocol stack

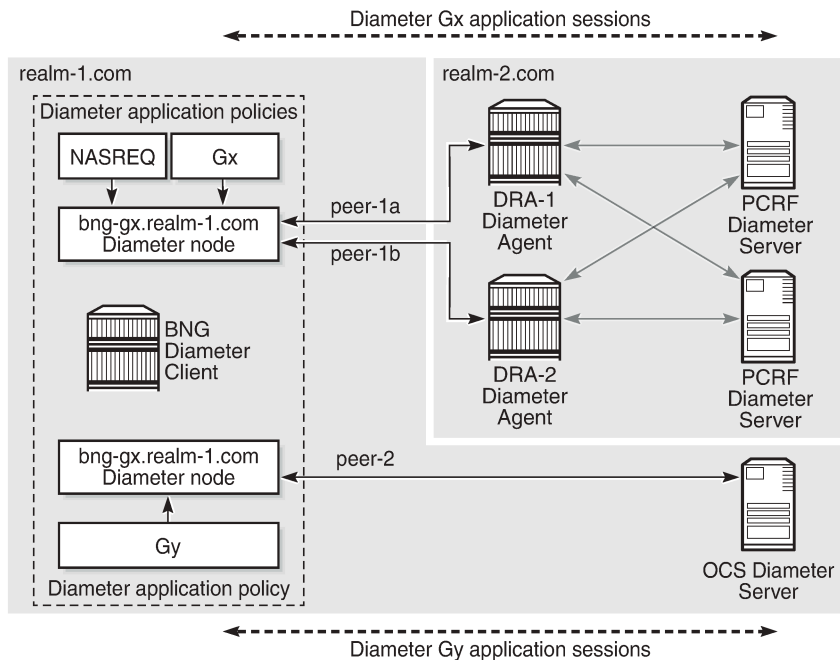


The bottom layer is the transport layer and can be either TCP or SCTP. SR OS supports TCP. The Diameter base protocol implementation in SR OS is based on RFC 6733. The top layer contains the Diameter applications. SR OS supports NASREQ for authentication, Gx for authorization, policy management and usage monitoring and Gy or Diameter Credit Control Application (DCCA) for online charging.

Figure 12: Diameter network topology shows a Diameter network topology that will be used in the configuration examples in this chapter.

A Diameter Client (BNG) is connected via peer-1a and peer-1b to two Diameter Agents (DRA-1 and DRA-2) that provide connectivity to the Diameter Application Servers (PCRF). Via these peers, the BNG can authenticate and perform policy control of subscriber sessions using the NASREQ and Gx applications. The same Diameter Client (BNG) is also directly connected to another Diameter Application Server (OCS) via peer-2. Via this peer, on-line charging can be done for the subscriber sessions using the Gy application.

Figure 12: Diameter network topology



Configuration

The Diameter base protocol and the Diameter applications are configured separately, where the Diameter base protocol must be configured first, and the Diameter applications next. The transport layer configuration is part of the Diameter base protocol layer. This example describes the Diameter base protocol configuration.

The Diameter base protocol and the corresponding transport layer configuration is based on Diameter Nodes. Each Diameter Node represents a Diameter routing instance and contains a list of peers in the routing domain that provide direct or indirect connectivity to application servers.

An example Diameter node configuration that corresponds with the topology in [Figure 12: Diameter network topology](#) is shown below.

```
configure {
  aaa {
    diameter {
      node "bng-gx.realm-1.com" {
        description "Authentication and Policy Management"
        connection {
          ipv4 {
            local-address 192.0.2.2
          }
          ipv6 {
            local-address 2001:db8::2
          }
        }
        peer index 1 {
          admin-state enable
          address 2001:db8:2:6::1
          destination-host "dra-1.realm-2.com"
          preference 10
        }
        peer index 2 {
          admin-state enable
          address 172.16.7.2
          destination-host "dra-2.realm-2.com"
          preference 20
        }
      }
      node "bng-gy.realm-1.com" {
        description "Credit Control"
        origin-realm "realm-1.com"
        router-instance "management"
        peer index 1 {
          admin-state enable
          address 192.99.3.0
          destination-host "ocs.realm-1.com"
        }
      }
    }
  }
}
```

A Diameter node configuration requires a unique origin host as key. The origin host is used in Diameter application policies to associate the application with the node. All Diameter base and application messages forwarded via the peers of that node use the configured origin host in the Origin-Host AVP. The value for the Origin-Realm AVP is by default derived from the configured origin host: the realm is the part of the origin host after the first dot (".") as delimiter or equal to the origin host when it does not contain a delimiter. For example, for **node** *"bng-gx.realm-1.com"*: Origin-Host = "bng-gx.realm-1.com", Origin-Realm

= "realm-1.com". It is also possible to explicitly configure an origin realm as shown in the example for the **node "bng-gy.realm-1.com"**.

A node configuration can include a routing context, and an IPv4 and/or IPv6 source address. These parameters are used to establish the TCP transport connection for all peers in the node. The specified **local-address** must be a reachable local interface address in the specified or in the default router instance. For **node "bng-gx.realm-1.com"** in the example, no router instance is specified. By default, the TCP connections are established in the Base router using the specified local addresses. For **node "bng-gy.realm-1.com"** in the example, the out of band router instance "management" is used to establish the TCP connection of its peer. As no local address is specified, the system will automatically select an interface address, in this case an out of band IP address configured in the Boot Options File (BOF).

Within a Diameter node, up to 5 peers can be configured with an index value between 1 and 5 as key, an IPv4 or IPv6 destination address for the TCP connection, and a mandatory destination host that is used as Destination-Host AVP value for all Diameter base messages on the peer. In a Diameter node, one peer is selected to forward application messages for a specific application session. The other peers provide redundancy when supported by the Diameter application, such as Gy session failover. A Diameter peer for application messages is selected based on following criteria:

1. Forwarding:

If the application message contains a Destination-Host AVP, select the peer in the peer table with a matching configured destination host. This is the forwarding phase.

2. Routing:

When the lookup in the peer table fails, perform a lookup in the realm routing table and select the peer with realm name equal to the Destination-Realm AVP in the application message, and with matching application ID. When multiple peers are matched, select in order or priority until a single peer is found:

- a. the peer with the lowest configured preference (default preference is 50)
- b. the peer with the lowest index

3. Default peer:

When both forwarding lookup in the peer table and routing lookup in the realm routing table were unsuccessful, use the peer configured as **default-peer**. Only a single peer in a node can be configured as a default-peer. Multiple peers in a node configured as default-peer results in a validation error:

```
MINOR: MGMT_CORE #5001: configure aaa diameter node "bng-gx.realm-1.com" peer index 2 -
Multiple default peer is not allowed
```

For **node "bng-gx.realm-1.com"** in the example, peer-1a with index 1 has a configured preference of 10 and peer-2 with index 2 has a configured preference of 20. Diameter Gx application messages will fail the peer table lookup as the destination host of the PCRF will not be present (no direct connection between Diameter client and Diameter application server):

```
# /show aaa diameter-node "bng-gx.realm-1.com" peers

=====
Peers
=====
Host identity                Status      Default Preference Active
-----
dra-1.realm-2.com            I-Open     No      10      Yes
dra-2.realm-2.com            I-Open     No      20      Yes
-----
No. of peers: 2
```

Instead a realm routing table lookup is performed to find the peer for forwarding the application messages. In this case peer-1a (dra-1.realm-2.com) is selected based on the matching destination realm (realm-2.com), application ID (Gx) and the lower preference value:

```
# /show aaa diameter-node "bng-gx.realm-1.com" routing-table
```

```
=====
Routes
=====
Realm-Name
Application  Pref. Id  Server-Identifier
-----
realm-2.com
nasreq gx    10    1    dra-1.realm-2.com
realm-2.com
nasreq gx    20    2    dra-2.realm-2.com
-----
No. of routes: 2
=====
```

The realm routing table is populated based on the Origin-Realm AVP and Application-Id AVP received in the Capability Exchange Answer message together with the configured index and preference values.

Note that Diameter answer messages do not rely on peer or realm routing table lookups. Answers are forwarded over the same route in the reverse direction of the matching requests. This is achieved with a transactional cache in each traversed Diameter node, using the Hop-by-Hop AVP to match requests with answers.

When enabling the peer (**admin-state enable**), the system tries to establish the transport TCP connection. Once the TCP session is up, the system starts a Diameter Capability Exchange using the configured Diameter identity (Origin-Host and Origin-Realm AVPs) and advertising support for all SR OS Diameter applications in Application-Id AVP's (NASREQ, Gx, and Gy). When the Origin-Host AVP in the received CEA message corresponds with the destination host configured for the peer (case insensitive) and at least one application in the CEA is common with the SR OS advertised applications, then the peer moves to the I-Open state (I from Initiator). An example of a Capability Exchange is illustrated in detail in the troubleshooting section.

Optionally, a connection and a watchdog timer can be configured in the Diameter node:

```
configure {
  aaa {
    diameter {
      node "bng-gx.realm-1.com" {
        connection {
          timer 30
          ---snip---
        }
        peer index 1 {
          connection-timer 30
          watchdog-timer 30
          ---snip---
        }
      }
    }
  }
}
```

- **connection-timer**

The connection timer or Tc timer controls the frequency at which a transport connection is attempted to be established. The default value is 30 seconds. This timer can be configured per node to be used by all peers or overridden per peer.

- **watchdog-timer**

The watchdog timer controls the frequency at which Device-Watchdog-Request messages are transmitted to the peer, and is called the Tw timer in RFC 3539, *Authentication, Authorization and Accounting (AAA) Transport Profile*. A small timer results in a faster detection of a peer failure at the expense of generating more messages. The timer is configured per peer and its default value is 30 seconds.

A Python policy can be configured in the Diameter node to manipulate Diameter messages transmitted to and/or received on its peers.

```
configure {
  aaa {
    diameter {
      node "bng-gy.realm-1.com" {
        python-policy "py-diameter-1"
        ---snip---
```

Manipulating Diameter messages, such as changing the content or format of AVPs using Python is out of the scope of this chapter.

By default, Diameter messages are sent with a DSCP set to AF41. The DSCP value can be changed with the sgt-qos configuration:

```
# /configure router sgt-qos dscp application diameter dscp ncl
```

SR OS uses TCP as transport and the TCP destination port number is fixed to the standard Diameter base protocol port 3868. The source port is randomly chosen from the ephemeral port range.

Troubleshooting

The status and statistics of the Diameter peers can be verified with following show commands:

```
# /show aaa diameter-node "bng-gx.realm-1.com" peers
```

```
=====
Peers
=====
Host identity                Status      Default Preference Active
-----
dra-1.realm-2.com           I-Open     No      10      Yes
dra-2.realm-2.com           I-Open     No      20      Yes
-----
No. of peers: 2
=====
```

```
# /show aaa diameter-node "bng-gx.realm-1.com" peer "dra-1.realm-2.com"
```

```
=====
Peer "dra-1.realm-2.com"
=====
Index                : 1
Status               : I-Open
Administrative state : enabled
Active               : Yes
Active applications  : nasreq gx
Last disconnect cause : rebooting
Preference           : 10
```

```

Default peer          : No
Connection timer (s) : N/A
Watchdog timer (s)   : 13
Pending messages     : 0
Remote realm         : realm-2.com
Remote IP address    : 2001:db8:2:6::1
Remote TCP port      : 3868
Remote Origin-State-Id : 1574235027
Local host identity  : bng-gx.realm-1.com
Local realm          : realm-1.com
Local IP address     : 2001:db8::2
Local TCP port       : 53734
Last management change : 11/19/2019 15:05:48
=====
    
```

```
# /show aaa diameter-node "bng-gx.realm-1.com" peer "dra-1.realm-2.com" statistics
```

```

=====
Peer "dra-1.realm-2.com"
=====
Message                Sent          Received
-----
Capabilities-Exchange-Request    7             0
Capabilities-Exchange-Answer     0             7
Disconnect-Peer-Request          1             4
Disconnect-Peer-Answer           4             1
Device-Watchdog-Request         1217          778
Device-Watchdog-Answer           778          1217
Application message request      0             0
Application message answer       0             0

Last cleared time: N/A
=====
    
```

To clear the peer statistics, use following command:

```
# /clear aaa diameter-node "bng-gx.realm-1.com" peer "dra-1.realm-2.com" statistics
```

Diameter debugging is split between node and application level:

```

debug
  diameter
    application
      policy "diam-nasreq-1"
      session-messages
    exit
  exit
  node "bng-gx.realm-1.com"
  peer "dra-1.realm-2.com"
  peer-to-peer
  exit
  exit
  exit
exit
    
```

In this chapter, the Diameter base protocol debugging for peer messages is explained, configured at the node level debug. When a Python script is active for the node, the debug messages are logged after Python processing.

To debug the Diameter base protocol messages for **peer "dra-1.realm-2.com"**, use the following debug commands:

```
debug
  diameter
    node "bng-gx.realm-1.com"
      peer "dra-1.realm-2.com"
        peer-to-peer
      exit
    exit
  exit
exit
```

The **peer-to-peer** option enables debug output for all Diameter base messages of the specified peer: Capabilities Exchange, Device Watchdog and Disconnect Peer messages. By default, error conditions are also logged in the debug output. Debug for error conditions can be disabled per Diameter node or per peer with the debug option **no on-error**. Errors reported at the node level include Diameter base errors that are unrelated to a peer, such as a routing problem for a Diameter application message. Errors reported at the peer level include all errors that occur after peer selection and peer connection errors.

Let's start with the peer connection in Closed state (remote end rebooting):

```
# /show aaa diameter-node "bng-gx.realm-1.com" peer "dra-1.realm-2.com"

=====
Peer "dra-1.realm-2.com"
=====
Index                : 1
Status               : Closed
Administrative state : enabled
Active               : No
Active applications  :
Last disconnect cause : rebooting
Preference           : 10
Default peer         : No
Connection timer (s) : 18
Watchdog timer (s)   : N/A
Pending messages     : 0
Remote realm         : (Not Specified)
Remote IP address    : (Not Specified)
Remote TCP port      : (Not Specified)
Remote Origin-State-Id : (Not Specified)
Local host identity   : bng-gx.realm-1.com
Local realm          : realm-1.com
Local IP address     : (Not Specified)
Local TCP port       : (Not Specified)
Last management change : 11/19/2019 15:05:48
=====
```

The *Connection timer(s)* field in above peer details output show that in 18 seconds, a new connection attempt will be made, followed by a Capabilities Exchange when successful. The transmitted Capabilities-Exchange-Request (CER) and received Capabilities-Exchange-Answer (CEA) are shown in the debug output:

```
233997 2019/11/20 19:17:16.271 UTC minor: DEBUG #2001 Base DIAMETER
DIAMETER: Message Transmission
Transmit: "CER"
Application policy: N/A
Node: "bng-gx.realm-1.com"
Received peer: N/A
```

```
Transmit peer: "dra-1.realm-2.com"
Python policy: N/A
Header
  ver 1 len 284 flags R----- code 257
  app-id 0 hbh-id 19864 e2e-id 3486524428
AVPs
  origin-host (264) -M----- [26]
    data [18] (DiameterIdentity) : bng-gx.realm-1.com
  origin-realm (296) -M----- [19]
    data [11] (DiameterIdentity) : realm-1.com
  host-ip-addr (257) -M----- [26]
    data [18] (Address) : ipv6 2001:db8::2
  vendor-id (266) -M----- [12]
    data [4] (Unsigned32) : 6527
  product-name (269) ----- [13]
    data [5] (UTF8String) : SR-0S
  auth-appl-id (258) -M----- [12]
    data [4] (Unsigned32) : 1 : Nasreq
  auth-appl-id (258) -M----- [12]
    data [4] (Unsigned32) : 4 : Gy
  auth-appl-id (258) -M----- [12]
    data [4] (Unsigned32) : 16777238 : Gx
  vend-specific-appl-id (260) -M----- [32]
    data [24] (Grouped)
      vendor-id (266) -M----- [12]
        data [4] (Unsigned32) : 10415
      auth-appl-id (258) -M----- [12]
        data [4] (Unsigned32) : 4 : Gy
  vend-specific-appl-id (260) -M----- [32]
    data [24] (Grouped)
      vendor-id (266) -M----- [12]
        data [4] (Unsigned32) : 10415
      auth-appl-id (258) -M----- [12]
        data [4] (Unsigned32) : 16777238 : Gx
  supported-vendor-id (265) -M----- [12]
    data [4] (Unsigned32) : 3561
  supported-vendor-id (265) -M----- [12]
    data [4] (Unsigned32) : 6527
  supported-vendor-id (265) -M----- [12]
    data [4] (Unsigned32) : 10415
  supported-vendor-id (265) -M----- [12]
    data [4] (Unsigned32) : 13019
  firmware-revision (267) ----- [12]
    data [4] (Unsigned32) : 191001
```

233998 2019/11/20 19:17:16.275 UTC minor: DEBUG #2001 Base DIAMETER

DIAMETER: Message Reception

Receive: "CEA"

Application policy: N/A

Node: "bng-gx.realm-1.com"

Received peer: "dra-1.realm-2.com"

Transmit peer: N/A

Python policy: N/A

Header

```
  ver 1 len 240 flags ----- code 257
  app-id 0 hbh-id 19864 e2e-id 3486524428
```

AVPs

```
  result-code (268) -M----- [12]
    data [4] (Unsigned32) : 2001 : DIAM_RESCODE_SUCCESS
  origin-host (264) -M----- [25]
    data [17] (DiameterIdentity) : dra-1.realm-2.com
  origin-realm (296) -M----- [19]
    data [11] (DiameterIdentity) : realm-2.com
```



```

host-ip-addr (257) -M----- [26]
  data [18] (Address) : ipv6 2001:db8:2:6::1
vendor-id (266) -M----- [12]
  data [4] (Unsigned32) : 6527
product-name (269) ----- [28]
  data [20] (UTF8String) : PythonDiameterAgent1
origin-state-id (278) -M----- [12]
  data [4] (Unsigned32) : 1574277432
supported-vendor-id (265) -M----- [12]
  data [4] (Unsigned32) : 10415
auth-appl-id (258) -M----- [12]
  data [4] (Unsigned32) : 1 : Nasreq
auth-appl-id (258) -M----- [12]
  data [4] (Unsigned32) : 16777238 : Gx
vend-specific-appl-id (260) -M----- [32]
  data [24] (Grouped)
    vendor-id (266) -M----- [12]
      data [4] (Unsigned32) : 10415
    auth-appl-id (258) -M----- [12]
      data [4] (Unsigned32) : 16777238 : Gx
  firmware-revision (267) ----- [12]
    data [4] (Unsigned32) : 1
    
```

The result of the successful Capabilities Exchange is that the peer moved to the I-Open state, ready to forward NASREQ and Gx application messages:

```

# /show aaa diameter-node "bng-gx.realm-1.com" peer "dra-1.realm-2.com"

=====
Peer "dra-1.realm-2.com"
=====
Index                : 1
Status               : I-Open
Administrative state : enabled
Active               : Yes
Active applications  : nasreq gx
Last disconnect cause : rebooting
Preference           : 10
Default peer        : No
Connection timer (s) : N/A
Watchdog timer (s)  : 9
Pending messages    : 0
Remote realm        : realm-2.com
Remote IP address   : 2001:db8:2:6::1
Remote TCP port     : 3868
Remote Origin-State-Id : 1574277432
Local host identity  : bng-gx.realm-1.com
Local realm         : realm-1.com
Local IP address    : 2001:db8::2
Local TCP port      : 55199
Last management change : 11/19/2019 15:05:48
=====
    
```

The *Watchdog timer(s)* field in preceding peer details output shows that in 9 seconds, a Device Watchdog exchange will be initiated. The transmitted Device-Watchdog-Request (DWR) and received Device-Watchdog-Answer (DWA) are shown in the debug output:

```

233999 2019/11/20 19:17:44.268 UTC minor: DEBUG #2001 Base DIAMETER
DIAMETER: Message Transmission
Transmit: "DWR"
Application policy: N/A
Node: "bng-gx.realm-1.com"
    
```

```

Received peer: N/A
Transmit peer: "dra-1.realm-2.com"
Python policy: N/A
Header
  ver 1 len 68 flags R----- code 280
  app-id 0 hbh-id 19865 e2e-id 3486524431
AVPs
  origin-host (264) -M----- [26]
    data [18] (DiameterIdentity) : bng-gx.realm-1.com
  origin-realm (296) -M----- [19]
    data [11] (DiameterIdentity) : realm-1.com

234000 2019/11/20 19:17:44.271 UTC minor: DEBUG #2001 Base DIAMETER
DIAMETER: Message Reception
Receive: "DWA"
Application policy: N/A
Node: "bng-gx.realm-1.com"
Received peer: "dra-1.realm-2.com"
Transmit peer: N/A
Python policy: N/A
Header
  ver 1 len 92 flags ----- code 280
  app-id 0 hbh-id 19865 e2e-id 3486524431
AVPs
  result-code (268) -M----- [12]
    data [4] (Unsigned32) : 2001 : DIAM_RESCODE_SUCCESS
  origin-host (264) -M----- [25]
    data [17] (DiameterIdentity) : dra-1.realm-2.com
  origin-realm (296) -M----- [19]
    data [11] (DiameterIdentity) : realm-2.com
  origin-state-id (278) -M----- [12]
    data [4] (Unsigned32) : 1574277432
    
```

Now let's try to bring up the peer in the **node bng-gy.realm-1.com**:

```

# /show aaa diameter-node "bng-gy.realm-1.com" peers

=====
Peers
=====
Host identity                Status      Default Preference Active
-----
ocs.realm-1.com              Closed     No      50      No
-----
No. of peers: 1
=====
    
```

Debug is enabled at the peer level for error conditions without the **peer-to-peer** option. Failures are reported, but not all transmitted and received peer messages.

```

debug
  diameter
    node "bng-gy.realm-1.com"
    peer "ocs.realm-1.com"
    exit
  exit
exit
exit
    
```

The Diameter server is provisioned with an origin host different from the configured destination host for the peer, resulting in a failure and peer reset:

```

234330 2019/11/22 14:57:32.272 UTC minor: DEBUG #2001 management DIAMETER
DIAMETER: Failure
Receive: "CEA"
Application policy: N/A
Node: "bng-gy.realm-1.com"
Received peer: "ocs.realm-1.com"
Transmit peer: N/A
Python policy: N/A
Result code: "DIAM_RESCODE_INVALID_AVP_VALUE"
Error message: "mismatch with locally stored information"
Failed AVP:
    origin-host (264) -M----- [27]
        data [19] (DiameterIdentity) : ocs.wrong-realm.com

Message:
Header
  ver 1 len 176 flags ----- code 257
  app-id 0 hbh-id 6050 e2e-id 3486524894
AVPs
  result-code (268) -M----- [12]
    data [4] (Unsigned32) : 2001 : DIAM_RESCODE_SUCCESS
  origin-host (264) -M----- [27]
    data [19] (DiameterIdentity) : ocs.wrong-realm.com
  origin-realm (296) -M----- [23]
    data [15] (DiameterIdentity) : wrong-realm.com
  host-ip-addr (257) -M----- [14]
    data [6] (Address) : ipv4 192.99.3.0
  vendor-id (266) -M----- [12]
    data [4] (Unsigned32) : 6527
  product-name (269) ----- [28]
    data [20] (UTF8String) : PythonDiameterServer
  origin-state-id (278) -M----- [12]
    data [4] (Unsigned32) : 1574434643
  auth-appl-id (258) -M----- [12]
    data [4] (Unsigned32) : 4 : Gy
  firmware-revision (267) ----- [12]
    data [4] (Unsigned32) : 1

234331 2019/11/22 14:57:32.272 UTC minor: DEBUG #2001 management DIAMETER
DIAMETER: Peer Reset
Node: "bng-gy.realm-1.com"
Peer: "ocs.realm-1.com"
Reason: "failed to parse received CEA"
    
```

Events

Following events are defined for the Diameter base protocol:

```

=====
Application
ID#   Event Name                               P   g/s   Logged   Dropped
-----
 2007 tmnxDiamMessageDropped                MI thr         0         0
 2008 tmnxDiamNdPeerStatActiveChanged       MI thr        46         0
=====
    
```

The **tmnxDiamNdPeerStatActiveChanged** event is generated when the state of a Diameter peer toggles between active / not active:

```
38080 2019/11/22 14:52:02.269 UTC MINOR: DIAMETER #2008 management peer state change  
"DIAMETER node bng-gy.realm-1.com, peer ocs.realm-1.com is active"
```

The **tmnxDiamMessageDropped** event is generated when Diameter base drops a malformed message.

Conclusion

As a result of fixed mobile network convergence, Diameter is used in fixed access networks as an alternative for Radius based AAA. Diameter peering provides reliable and secure transport with peer redundancy. Its functionality is defined in a base Diameter protocol specified in RFC 6733. Various applications can be layered on top of base Diameter and they can utilize the robust transport capabilities that Diameter provides.

L2TP for Subscriber Access — LAC

This chapter provides information about L2TP for subscriber access.

Topics in this chapter include:

- [Applicability](#)
- [Overview](#)
- [Configuration](#)
- [Conclusion](#)

Applicability

This chapter describes L2TP Access Concentrator (LAC) support for the L2TP Access Aggregation (LAA) architecture model and was initially written for SR OS Release 11.0.R4. The MD-CLI in the current edition is based on Release 19.5.R1. PPP hosts are supported in a Routed CO model (with IES or VPRN services) using ATM, Ethernet or Ethernet over Pseudowire SAPs. A description of the L2TP Tunnel Switch (LTS) and L2TP Network Server (LNS) functions are out of the scope of this chapter.

Overview

PPP access architectures

The Broadband Forum proposes two architectures for Point-to-Point Protocol (PPP) access.

- The PPP Terminated Aggregation architecture (PTA)
- The L2TP Access Aggregation architecture (LAA)

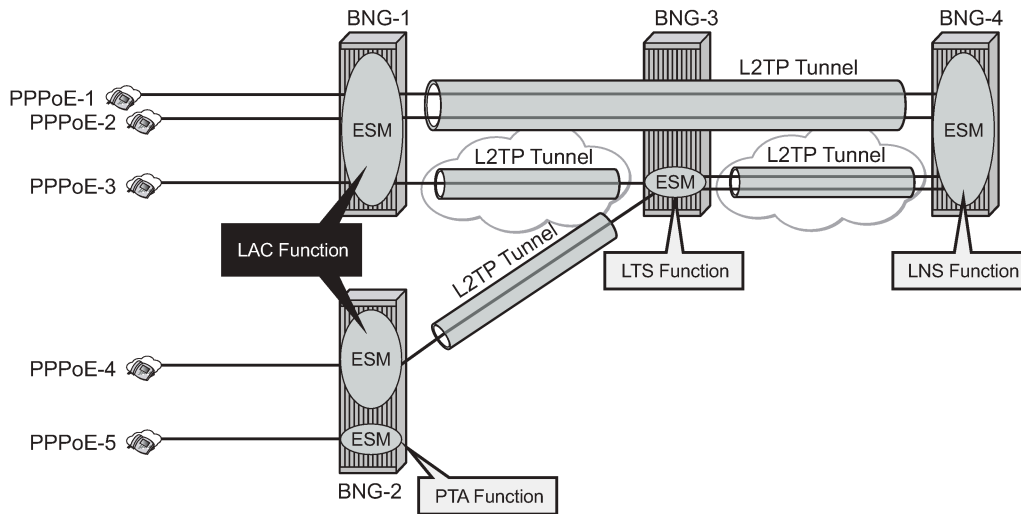
The PTA architecture (local-access model) uses the Broadband Network Gateway (BNG) to terminate user PPP sessions (see scenario PPPoE-5 in [Figure 13: PPP access architectures](#)).

The LAA architecture (which is a tunneled access model) uses a LAC and an LNS to transport PPP sessions from the LAC to the LNS which performs tunnel termination (see scenario PPPoE-1 and PPPoE-2 in [Figure 13: PPP access architectures](#)).

Optionally, an LTS can be used in the transport network to perform the grooming of traffic between tunnels (see scenarios PPPoE-3 and PPPoE-4 in [Figure 13: PPP access architectures](#)).

The LNS is the logical termination point of the PPP sessions originated by the remote clients and tunneled by the LAC/LTS.

Figure 13: PPP access architectures

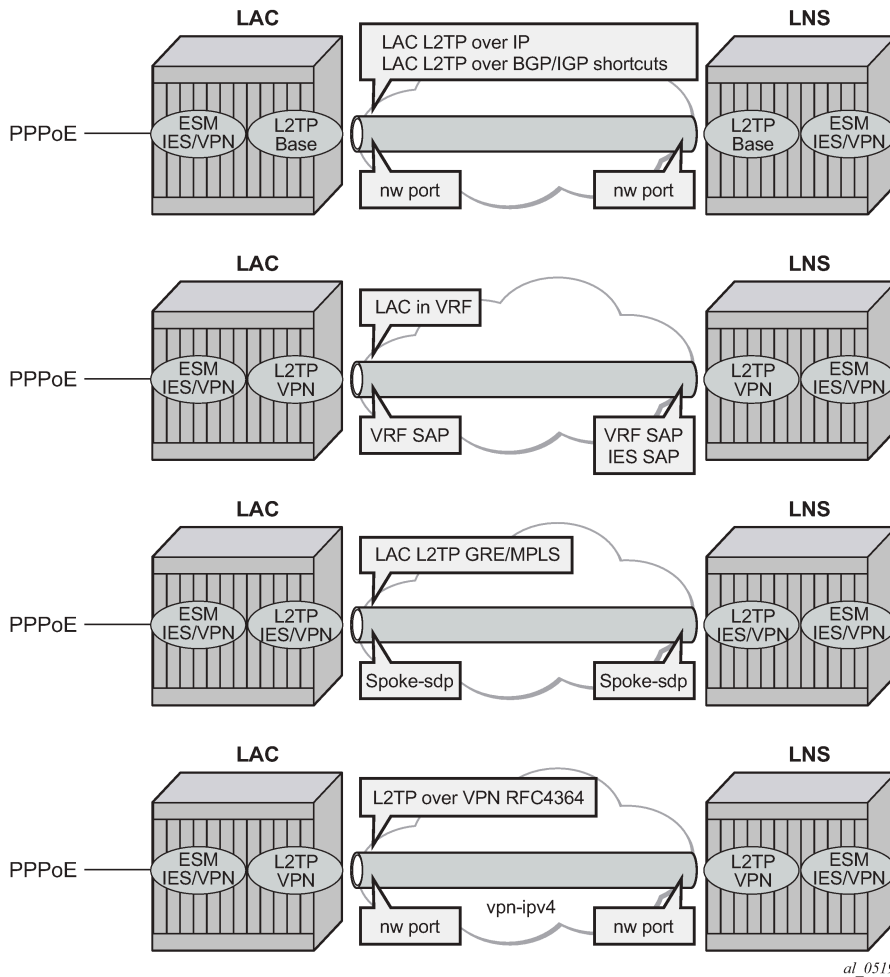


al_0521

L2TP tunnels - LAC and LNS reachability options

The router instance where the L2TP tunnel starts and where ESM is handled can be one and the same, but does not need to be the same. The LNS peer address can be reachable via IP, BGP/IGP shortcuts, over a spoke SDP (GRE/MPLS), RFC 4364 VPRNs (*BGP/MPLS IP Virtual Private Networks*), but cannot be an address belonging to a directly connected interface. See [Figure 14: Supported L2TP reachability options](#).

Figure 14: Supported L2TP reachability options



Recap of the L2TPv2 protocol

L2TPv2 is a client-server protocol relying on UDP and encapsulates Layer 2 packets such as PPP for transmission across a network. L2TPv2 passes control and data messages over separate control and data channels, thus defines following message types:

- Control messages—The in-band control channel passes sequenced control messages, supporting connection management, call management, error reporting, and session control. Optionally, a shared-secret challenge authentication method can be used between the tunnel endpoints.

The following messages are used for L2TP tunnel management:

- Tunnel setup (Control Connection Management)
 - Start-Control-Connection-Request (SCCRQ)
 - Start-Control-Connection-Reply (SCCRP)
 - Start-Control-Connection-Connected (SCCCN)

- Stop-Control-Connection-Notification (StopCCN)
- Tunnel keepalive
 - Hello (HELLO)

The following messages are used for L2TP session (call) management:

- Session setup over an existing tunnel
 - Incoming-Call-Request (ICRQ)
 - Incoming-Call-Reply (ICRP)
 - Incoming-Call-Connected (ICCN)
 - Call-Disconnect-Notify (CDN)

Zero-Length Body (ZLB) messages are control packets with an L2TP header only and are used to explicitly acknowledge packets, making the control channel reliable.

L2TP message encoding is done through Attribute Value Pairs (AVP).

- Data messages — Data messages encapsulate the PPP frames that are sent into the L2TP tunnel.

L2TPv2 sessions run over an L2TP tunnel and are referenced by an L2TP session-id. An L2TP tunnel can carry none, one, or multiple L2TP sessions. An L2TP session corresponds to a PPPoE session. L2TPv3 for LAC-LNS dynamic tunnel setup is not supported.

L2TP header and AVP layout

The L2TPv2 header consists of following fields (RFC 2611, *URN Namespace Definition Mechanisms*):

0	8	16	31
T	L	-	S
-	O	P	-
Tunnel-ID		Session-ID	
Ns		Nr	
Offset Size		Offset Pad	

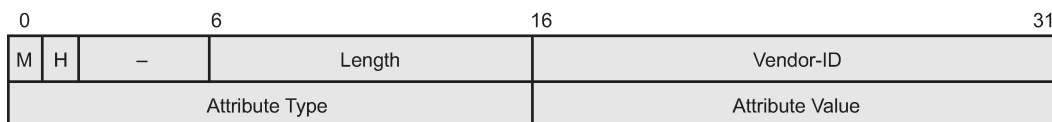
al_0513A

Table 2: L2TPv2 header fields and descriptions

Field	Description
T	Type of L2TP message (1 bit): 0—data message 1—control message
L	Indicates if the optional Length field is present in the message (1 bit): 0—the field is left out of the message entirely 1—the field is included (must be included in control messages)
-	Reserved for future use, must be set to zero.
S	Indicates if the Ns and Nr fields are present (1 bit): 0 — the fields are left out of the message; entirely 1 — the fields are included (must be included in control messages)
O	Indicates if the Offset field is present (1 bit): 0 — the field is left out of the message entirely (must be left out of control messages); 1 — the field is included

Field	Description
P	Used with data messages only. Indicates priority of the data message (1 bit): 0 — no (this value is used for all control messages); 1 — yes
Version	The version of the message (4 bits): 2 — this is the latest version of the L2TP data message header; 1 — indicates an L2F packet as described in RFC 2341 Packets with an unknown version number are discarded.
Length	The total length (in bytes) of the L2TP message (16 bits).
Tunnel-ID	Identifies the L2TP tunnel (that is, the control connection). This number has local significance — each end gives the same tunnel different tunnel IDs. The ID refers to the receiver, not the sender, and is assigned during tunnel creation (16 bits).
Session-ID	Identifies the PPP session within a tunnel. This number has local significance — each end gives the same session different session IDs. The ID refers to the receiver, not the sender, and is assigned during session creation (16 bits).
Ns	The sequence number of the message. This is mandatory for control messages (to enable re-transmission of lost messages) but optional for data messages (to re-order data messages that were mis-sequenced during forwarding). The number, which starts at 0 and increments by 1, is assigned by an L2TP peer for each session in a tunnel (16 bits).
Nr	The sequence number of the next control message expected to be received. This is equal to the sequence number of last received control message plus 1. Used by the receiving peer to ensure that control messages are sent in order without duplication. In data messages, the field (if present as indicated by the S bit) is ignored (16 bits).
Offset Size	The location of the L2TP payload, expressed as the number of octets from the start of the message header (16 bits).
Offset pad	User-defined bytes used to pad the message header so that the payload starts at the location indicated by the Offset Size field (16 bits).

The AVP header consists of following fields (RFC 2611):



al_0513B

Table 3: AVP header fields and descriptions

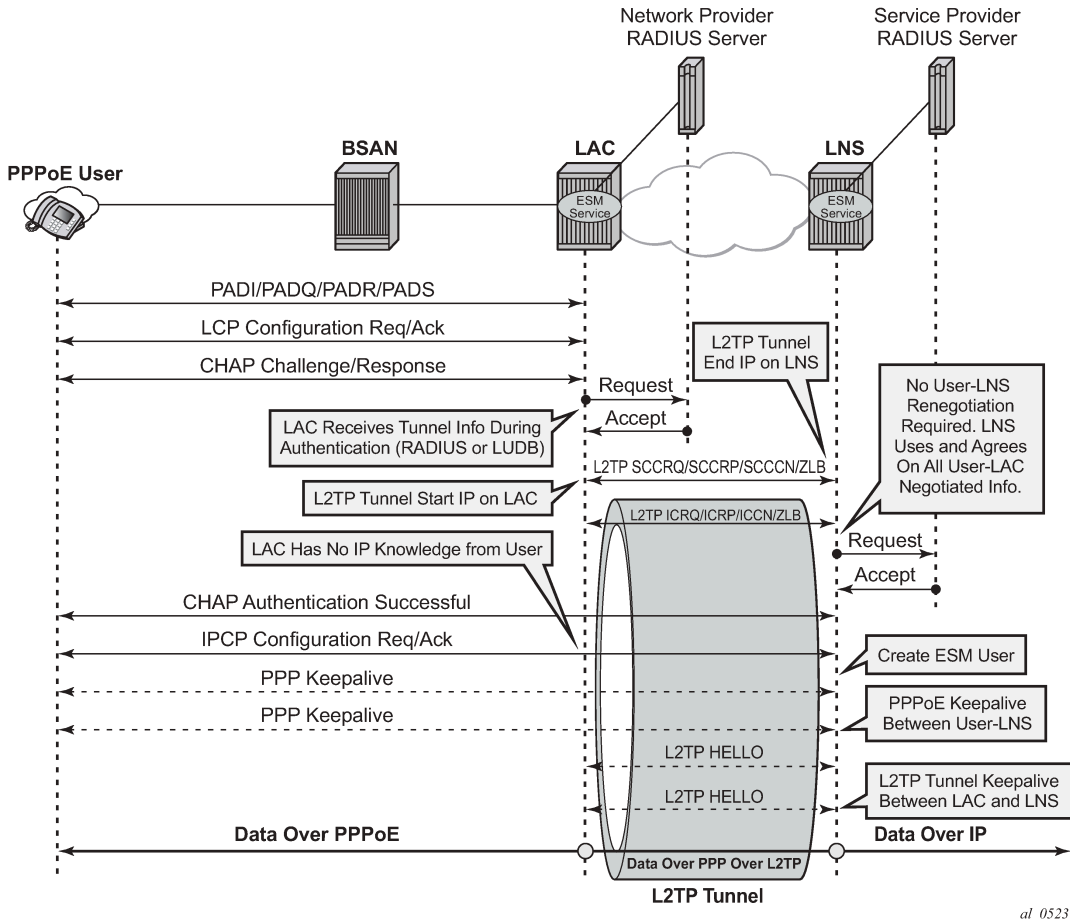
Field	Description
M	Mandatory bit — If the M bit is set on an unrecognized AVP within a message associated with a particular session, the session associated with this message MUST be terminated (1 bit).
H	Hidden bit — Identifies the hiding of data in the Attribute-Value field of an AVP. This capability can be used to avoid the passing of sensitive data, such as user passwords, as clear text in an AVP. The H-bit MUST only be set if a shared secret exists between the LAC and LNS. The shared secret is the same secret that is used for tunnel authentication. If the H-bit is set in any

Field	Description
	AVP(s) in a given control message, a Random Vector AVP must also be present in the message and MUST precede the first AVP having an H bit of 1 (1 bit).
-	Reserved for future use, must be set to zero (4 bits).
Length	Indicates the total number of bytes (including the overall length and bitmask fields) contained in this AVP (10 bits).
Vendor-id	Any vendor wishing to implement their own L2TP extensions can use their own Vendor ID along with private Attribute values. Vendor-ID=0 means that the standard AVPs are used (2 bytes).
Attribute Type	A value with a unique interpretation across all AVPs defined under a given Vendor (2 bytes).
Attribute Value	This is the actual value as indicated by the Vendor ID and Attribute Type (2 bytes).

RADIUS-triggered tunnel/session setup without LNS renegotiation

[Figure 15: RADIUS triggered tunnel/session setup without LNS renegotiation](#) depicts the complete PPP session setup, using RADIUS authentication on both LAC and LNS. After the discovery phase (PADI/PADO/PADR/PADS) and LCP negotiation phase (LCP config_request/Ack), the LAC initiates the L2TP tunnel setup based on RADIUS authentication information (RADIUS Request/Accept) and includes the negotiated PPP user-LAC information (called LCP proxy information). The LNS replies directly with a successful CHAP authentication if it agrees with the received proxy information. IP negotiation (IPCP config_request/Ack) is handled between the user and the LNS, and the LAC has no IP knowledge of this PPP session.

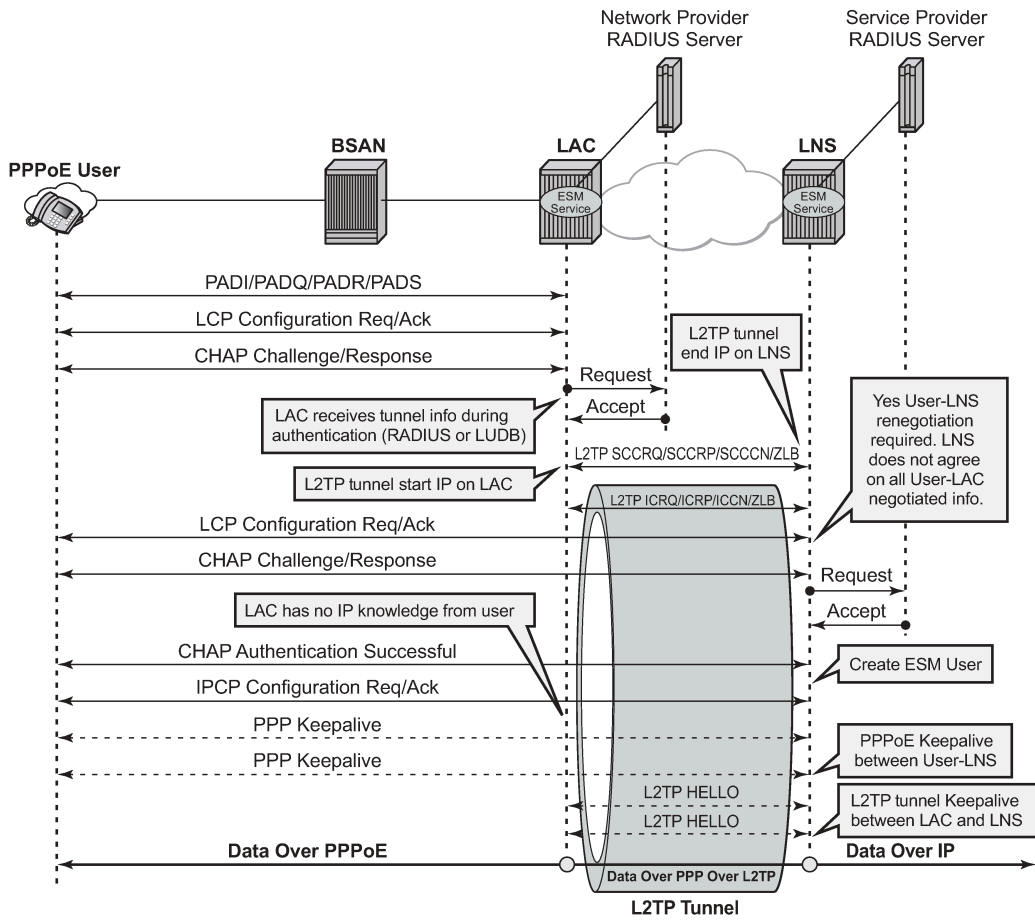
Figure 15: RADIUS triggered tunnel/session setup without LNS renegotiation



RADIUS-triggered tunnel/session setup with LNS renegotiation

Figure 16: RADIUS triggered tunnel/session setup with LNS renegotiation shows the scenario where the LNS does not agree with the received LCP proxy information and (re)starts the LCP phase (LCP config_request/Ack) directly with the PPP user. The rest of this scenario is the same as shown in Figure 15: RADIUS triggered tunnel/session setup without LNS renegotiation.

Figure 16: RADIUS triggered tunnel/session setup with LNS renegotiation

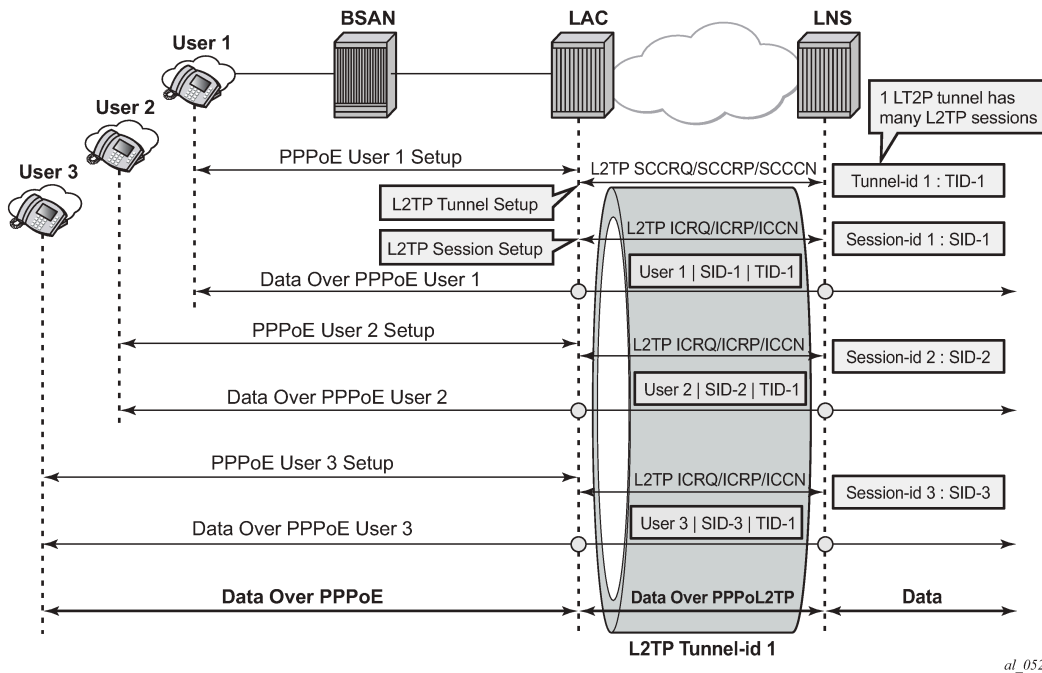


al_0524

Running multiple PPP sessions over a single L2TP tunnel

Figure 17: Running multiple PPP sessions over a single L2TP tunnel shows multiple PPP sessions tunneled over a single L2TP Tunnel. The LAC encapsulates each PPP session with a different L2TP session-id (SID) but with the same L2TP tunnel-id (TID).

Figure 17: Running multiple PPP sessions over a single L2TP tunnel

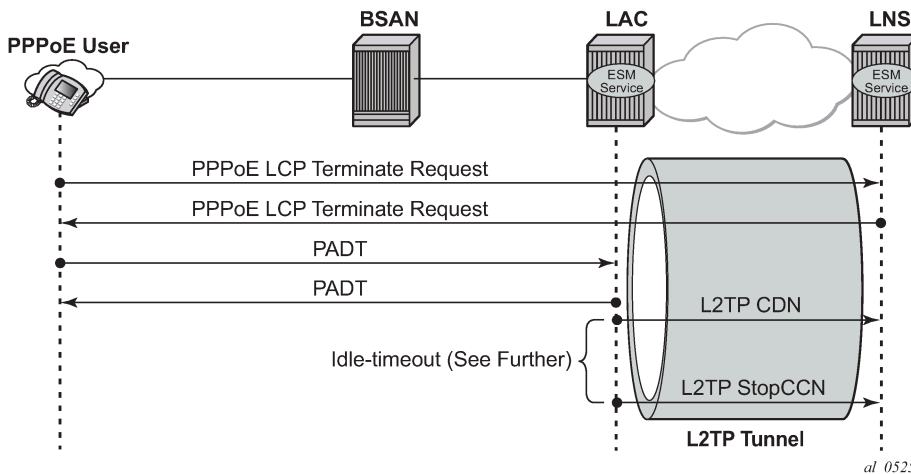


al_0522

PPP user-initiated release/terminate

Figure 18: PPP user-initiated release/terminate shows the user initiated terminate_request tunneled by the LAC followed by the user initiated PADT terminated on the LAC. The LAC informs the LNS about the termination of the session via the L2TP CDN message. The L2TP tunnel can be optionally (idle-timeout) terminated via the L2TP StopCCN message.

Figure 18: PPP user-initiated release/terminate



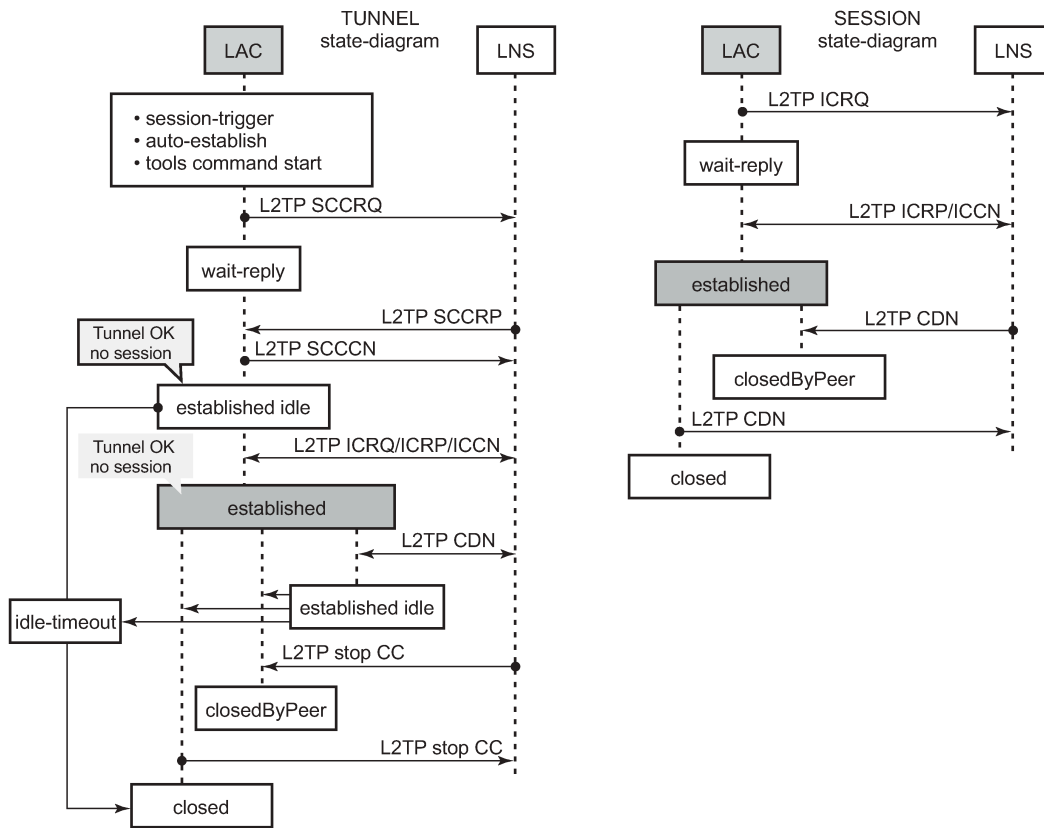
al_0525

L2TP tunnel/session state diagram

Figure 19: L2TP tunnel and session state diagram gives an overview of the main L2TP tunnel and session states. An L2TP tunnel in the establishedIdle state is a tunnel without sessions. A **tools** command (see [Advanced topics](#)) can put an L2TP tunnel in a draining state (this prevents adding new sessions to the tunnel but leaves the current sessions intact) or in a drained state (moved from draining to drained when all sessions are terminated). The draining and drained state are not shown in the state diagram.

The L2TP tunnel setup occurs first with the triggers being: session activation, auto-establish, and a **tools start** command (see the [Advanced topics](#) section). An L2TP session setup trigger is always session based.

Figure 19: L2TP tunnel and session state diagram



al_0515

Configuration

Scenario 1: RADIUS-derived L2TP parameters

In the first scenario, the LAC receives an incoming connection and contacts the LAC RADIUS server. The RADIUS server retrieves the attributes for the user's domain (for example @wholesale.com) and passes the tunnel attributes to the LAC. Based on these RADIUS provided tunnel attributes, the LAC

selects or initiates a new tunnel to the LTS or directly to the LNS. Once the tunnel is established, the LNS authenticates the end user using its own RADIUS server. Configuring the LNS and the LTS are out of the scope of this example.

In a RADIUS driven L2TP setup, either all or some of the required L2TP attributes are returned via RADIUS. If the RADIUS server only returns the L2TP [67] Tunnel-Server-Endpoint attributes, then the L2TP tunnel/session is established using the 'l2tp node parameter values' for the other required L2TP parameters. The 'l2tp node parameters' are defined under the configure router/service l2tp hierarchy. If the RADIUS server does not return all of the L2TP attributes and the node values are not configured, then the system falls back to default settings for these L2TP parameters.

The standard and vendor specific [26-6572] L2TP RADIUS attributes are listed in the tables below, together with the corresponding l2tp node parameters and defaults.

Table 4: Generic L2TP RADIUS attributes

Attribute ID	Attribute name	Mandatory	CLI node parameter	Corresponding defaults	
64	Tunnel-Type	Y	-	-	-
65	Tunnel-Medium-Type	Y	-	-	-
66	Tunnel-Client-Endpoint: [0-31]	N	local-address	no local-address	system-ip
67	Tunnel-Server-Endpoint	N	-	-	-
69	Tunnel-Password	N	password	no password	-
82	Tunnel-Assignment-ID:0	N	-	-	default_radius_group
82	Tunnel-Assignment-ID: [1..31]	N	-	-	Unnamed
83	Tunnel-Preference	N	preference	no preference	50
90	Tunnel-Client-Auth-ID	N	local-name	no local-name	system-name
91	Tunnel-Server-Auth-ID	N	-	-	-

Table 5: Nokia specific L2TP RADIUS attributes

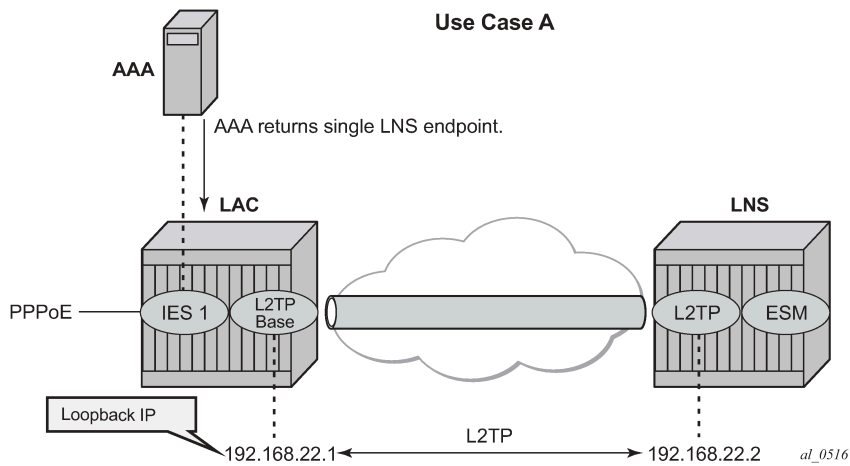
26-6527	Attribute name	Mandatory	CLI node parameter	Corresponding defaults	
-46	Alc-Tunnel-Group	N	-	-	-
-47	Alc-Tunnel-Algorithm	N	session-assign-method	no session-assign-method	existingFirst

26-6527	Attribute name	Mandatory	CLI node parameter	Corresponding defaults	
-48	Alc-Tunnel-Max-Sessions:0	N	-	group-session-limit	131071
-48	Alc-Tunnel-Max-Sessions:[1..31]	N	-	tunnel-session-limit	32767
-49	Alc-Tunnel-Idle-Timeout	N	idle-timeout	no idle-timeout	Infinite
-50	Alc-Tunnel-Hello-Interval	N	hello-interval	no hello-interval	300 sec
-51	Alc-Tunnel-Destruct-Timeout	N	destruct-timeout	no destruct-timeout	60 sec
-52	Alc-Tunnel-Max-Retrieves-Estab	N	max-retrieves-estab	no max-retrieves-estab	5
-53	Alc-Tunnel-Max-Retrieves-Not-Estab	N	max-retrieves-not-estab	no max-retrieves-not-estab	5
-54	Alc-Tunnel-AVP-Hiding	N	avp-hiding	no avp-hiding	Never
-97	Alc-Tunnel-Challenge	N	challenge	no challenge	Never
-104	Alc-Tunnel-Serv-Id	N	-	-	Base
-120	Alc-Tunnel-Rx-Window-Size	N	receive-window-size	no receive-window-size	64
-144	Alc-Tunnel-Acct-Policy	N	radius-accounting-policy	no radius-accounting-policy	-

Base router hosted LAC with single endpoint/single tunnel

Using the mandatory L2TP RADIUS attributes (see the following RADIUS user file) the LAC initiates an L2TP tunnel, as shown in [Figure 20: Base router hosted LAC with single endpoint/single tunnel](#). The source address for the tunnel is the IPv4 address of a loopback interface in the Base router system (LAC tunnel endpoint). The destination for the tunnel is defined by the Tunnel-Server-Endpoint RADIUS attribute [67], and is also known as the peer tunnel LNS endpoint address.

Figure 20: Base router hosted LAC with single endpoint/single tunnel



The PPPoE user terminates on IES service 1, sap 1/1/3:100, and is authenticated via RADIUS **authentication-policy radius-1** which provides wholesale/retail (L2TP) information.

```

configure {
  service {
    ies "ies-1" {
      admin-state enable
      service-id 1
      customer "1"
      subscriber-interface "sub-l2tp" {
        ipv4 {
          unnumbered {
            ip-int-name "system"
          }
        }
      }
      group-interface "grp-l2tp" {
        radius-auth-policy "radius-1"
        pppoe {
          admin-state enable
          session-limit 3
          sap-session-limit 10
        }
        sap 1/1/3:100 {
          sub-sla-mgmt {
            admin-state enable
            sub-ident-policy "all-subscribers"
            subscriber-limit 1000
          }
        }
      }
    }
  }
}
commit
    
```

The excerpt from the FreeRADIUS users file below shows the attributes to be returned.

```

user1@wholesale.com    Cleartext-Password := "letmein", NAS-Identifier == "LAC"
                      Alc-Subsc-ID-Str = "%{User-name}",
                      Alc-Subsc-Prof-Str = "sub-profile-1",
    
```

```
Alc-SLA-Prof-Str = "sla-profile-1",
Tunnel-Type:1 += L2TP,
Tunnel-Medium-Type:1 +=IP,
Tunnel-Server-Endpoint:1 += 192.168.22.2,
```

L2TP is enabled (no shutdown) in the related service instance.

The L2TP tunnel is set up in the base instance and not in a VRF because the attribute Alc-Tunnel-Serv-Id is not returned from RADIUS.

Missing L2TP parameters are taken from defaults defined in the router l2tp context.

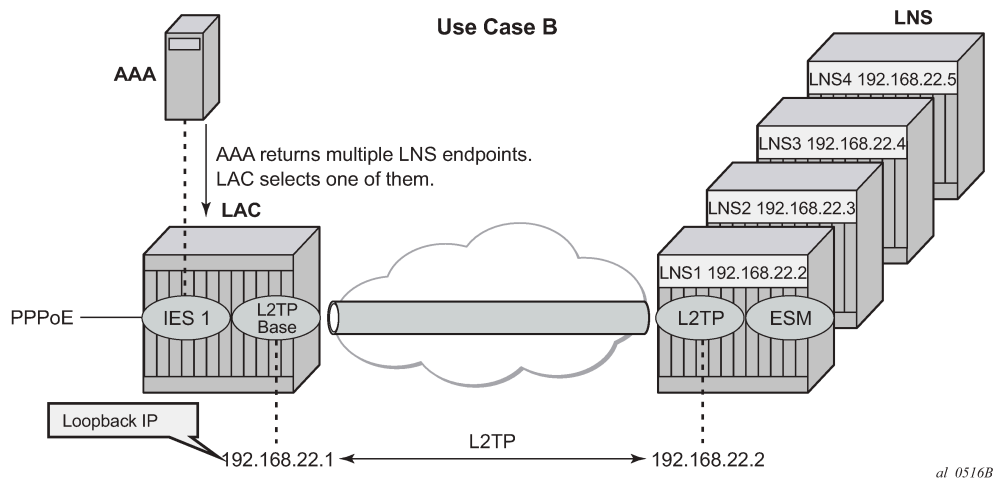
```
configure router l2tp
  calling-number-format "%S %s" # L2TP AVP 22 format
                                # Default format 'system-name sap-id'
  ---snip---
  no local-name                 # default name equals system-name
  no max-retries-estab         # default value equals 5
  ---snip---
  no shutdown                   # enable L2TP
```

This scenario shows the PPPoE session termination (base IES service 1) and the L2TP tunnel setup in the base router instance.

Base router hosted LAC with multiple endpoints

Figure 21: Base router hosted LAC with multiple endpoints shows a scenario with the PPPoE session termination (base IES service 1) and the L2TP tunnel setup in the base router instance.

Figure 21: Base router hosted LAC with multiple endpoints



The following excerpt from the FreeRADIUS users file shows that user *user1@wholesale.com* has four possible endpoints (LNS), each with its own tunnel preference. The LAC selects one L2TP endpoint out of these four tunnel specifications according to the configured L2TP selection process. This use case uses

weighted load balancing between RADIUS-tunnel-1 and RADIUS-tunnel-2. The L2TP tunnel selection process is out of the scope of this chapter.

```

user1@wholesale.com      Cleartext-Password := "letmein", NAS-Identifier == "LAC"
                        Alc-Subsc-ID-Str = "%{User-name}",
                        Alc-Subsc-Prof-Str = "sub-profile-1",
                        Alc-SLA-Prof-Str = "sla-profile-1",

# group related info
                        Tunnel-Client-Endpoint:0 = 192.168.22.1,
                        Alc-Tunnel-Algorithm:0 = weighted-access,
                        Tunnel-Client-Auth-Id:0 = "lac-pe1",
                        Tunnel-Assignment-Id:0 = "RADIUS-group",
                        Alc-Tunnel-Max-Retries-Estab:0 = 2,

# tunnel-1 related info
                        Tunnel-Type:1 += L2TP,
                        Tunnel-Medium-Type:1 +=IP,
                        Tunnel-Server-Endpoint:1 += 192.168.22.2,
                        Tunnel-Assignment-Id:1 += "RADIUS-tunnel-1",
                        Tunnel-Preference:1 += 100,

# tunnel-2 related info
                        Tunnel-Type:2 += L2TP,
                        Tunnel-Medium-Type:2 +=IP,
                        Tunnel-Server-Endpoint:2 += 192.168.22.3,
                        Tunnel-Assignment-Id:2 += "RADIUS-tunnel-2",
                        Tunnel-Preference:2 += 100,

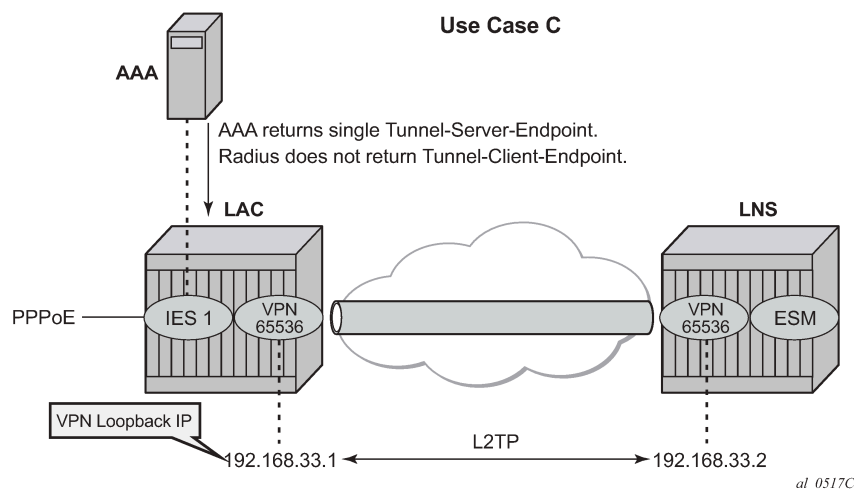
# tunnel-3 related info
                        Tunnel-Type:3 += L2TP,
                        Tunnel-Medium-Type:3 +=IP,
                        Tunnel-Server-Endpoint:3 += 192.168.22.4,
                        Tunnel-Assignment-Id:3 += "RADIUS-tunnel-3",

---snip---
```

VRF hosted LAC

Figure 22: VRF hosted LAC shows the PPPoE session termination (base IES service 1) and the L2TP tunnel setup in a different router instance (VPRN 65536).

Figure 22: VRF hosted LAC



Using the following L2TP RADIUS attributes, the LAC initiates an L2TP tunnel in VPRN 65536. The PPPoE session is still handled by IES service 1, which proves that both router instances can be different. (See use-case A for configuration details of IES service 1).

```

user1@wholesale.com      Cleartext-Password := "letmein", NAS-Identifier == "LAC"
                        Alc-Subsc-ID-Str = "%{User-name}",
                        Alc-Subsc-Prof-Str = "sub-profile-1",
                        Alc-SLA-Prof-Str = "sla-profile-1",
                        Alc-Tunnel-Serv-Id = 65536,
                        Tunnel-Client-Auth-Id:0 = "lac-pe1",
                        Tunnel-Assignment-Id:0 = "RADIUS-returned-TG",
                        Tunnel-Type:1 += L2TP,
                        Tunnel-Medium-Type:1 +=IP,
                        Tunnel-Server-Endpoint:1 += 192.168.33.2,
                        Tunnel-Assignment-Id:1 += "RADIUS-returned-TN",
    
```

If RADIUS does not return the L2TP source IP address (Tunnel-Client-Endpoint), then the IP address from the VPRN 65536 interface named 'system' is used as the L2TP source address. The tunnel setup fails if this system interface does not exist.

```

configure {
  service {
    vprn "vprn-65536" {
      admin-state enable
      customer "1"
      service-id 65536
      route-distinguisher "64496:65536"
      l2tp {
        admin-state enable
      }
      vrf-target {
        community "target:64496:65536"
      }
      interface "system" {
        loopback true
        ipv4 {
          primary {
            address 192.168.33.1
            prefix-length 32
          }
        }
      }
    }
  }
}
    
```

Scenario 2: Node-derived L2TP parameters

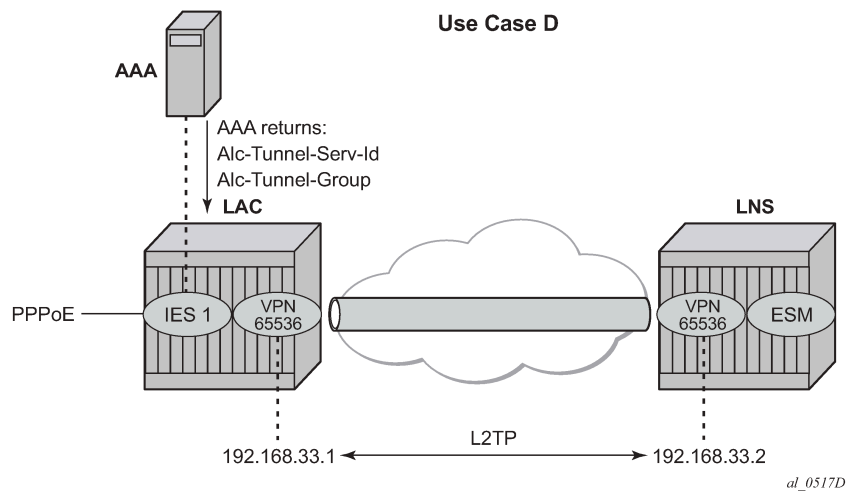
In the second scenario, the LAC receives the incoming connection and an 'L2TP tunnel-group-name' is assigned during LUDB or RADIUS authentication. This tunnel-group-name refers to the CLI preconfigured tunnel-group name context (**configure router <router-name> l2tp group <tunnel-group-name>**), which provides the context for all relevant tunnel attributes.

Based on these attributes, the LAC selects and initiates a tunnel to the LTS or directly to the LNS as in [Scenario 1: RADIUS-derived L2TP parameters](#).

RADIUS returns L2TP tunnel group

Figure 23: RADIUS returns L2TP tunnel group shows a use case where the L2TP tunnel-group-name is assigned during RADIUS authentication.

Figure 23: RADIUS returns L2TP tunnel group



```
user1@wholesale.com      Cleartext-Password := "letmein", NAS-Identifier == "LAC"
                          Alc-Subsc-ID-Str = "%{User-name}",
                          Alc-Subsc-Prof-Str = "sub-profile-1",
                          Alc-SLA-Prof-Str = "sla-profile-1",
                          Alc-Tunnel-Serv-Id = 65536,
                          Alc-Tunnel-Group = "wholesale.com",
```

The L2TP tunnel is initiated from VPRN 65536 (Alc-Tunnel-Serv-Id) and all L2TP tunnel information is taken from the l2tp group wholesale.com hierarchy (Alc-Tunnel-Group) as defined on the node.

```
configure {
  service {
    vprn "vprn-65536" {
      admin-state enable
      customer "1"
      service-id 65536
      route-distinguisher "64496:65536"
      ---snip---
    }
    l2tp {
      admin-state enable
      group "wholesale.com" {
        admin-state enable
        tunnel "wholesale.com" {
          admin-state enable
          auto-establish false
          peer 192.168.33.2
          local-address 192.168.33.1
          local-name "lac-pe1"
        }
      }
    }
  }
}
```

```

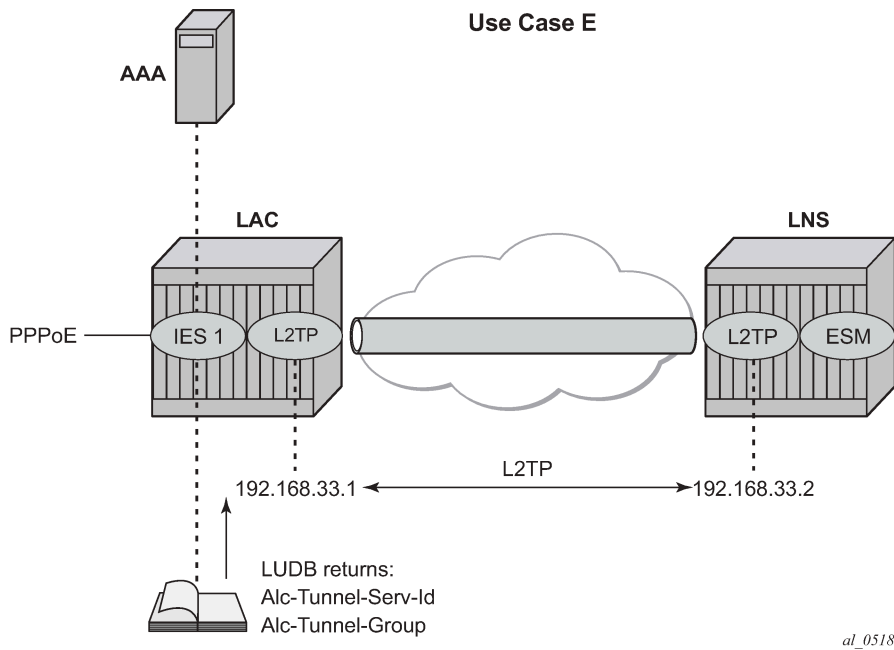
interface "system" {
  loopback true
  ipv4 {
    primary {
      address 192.168.33.1
      prefix-length 32
    }
  }
}
    
```

An L2TP tunnel is set up by either a PPP session-trigger, a **tools** command or by the `l2tp group tunnel auto-establish` parameter configuration. See the [Advanced topics](#) section for the non-session-triggered tunnel setup.

LUDB returns L2TP tunnel group

[Figure 24: LUDB returns L2TP tunnel group](#) shows use case E, where the L2TP tunnel-group-name is assigned during LUDB authentication, so this essentially is a RADIUS-less scenario.

Figure 24: LUDB returns L2TP tunnel group



The PPPoE user enters on an IES service 1, sap 1/1/3:100, and is authenticated via the LUDB which provides L2TP wholesale/retail and ESM information. The PPPoE context refers to a local-user database `l2tp` to provide the subscriber authentication and the tunnel setup parameters, so no RADIUS is needed.

```

configure {
  service {
    ies "ies-1" {
      admin-state enable
      service-id 1
      customer "1"
    }
  }
}
    
```

```

subscriber-interface "sub-l2tp" {
    ipv4 {
        unnumbered {
            ip-int-name "system"
        }
    }
    group-interface "grp-l2tp" {
        pppoe {
            admin-state enable
            session-limit 3
            sap-session-limit 10
            user-db "l2tp"
        }
        sap 1/1/3:100 {
            sub-sla-mgmt {
                admin-state enable
                sub-ident-policy "all-subscribers"
                subscriber-limit 1000
            }
        }
    }
}

```

The referenced local user database *l2tp* configuration provides all of the required L2TP and ESM information.

```

configure {
    subscriber-mgmt {
        local-user-db "l2tp" {
            admin-state enable
            ppp {
                match-list [user-name]
                host "wholesale.com" {
                    admin-state enable
                    host-identification {
                        user-name {
                            name "wholesale.com"
                            format domain-only
                        }
                    }
                }
                identification {
                    sla-profile-string "sla-profile-1"
                    sub-profile-string "sub-profile-1"
                    subscriber-id "user@wholesale.com"
                }
                l2tp {
                    group {
                        name "wholesale.com"
                        service-id 65536
                    }
                }
                password {
                    ignore
                }
            }
        }
    }
}

```

Operation and troubleshooting

The subsequent sections explain how the use cases A to E described in the configuration section are verified using show, debug, and tools commands.

The standard router debugging tools can be used to monitor and troubleshoot the L2TP tunnel and session setup.

Useful show commands are:

```
show service id <service-id> ppp session [detail]
show router l2tp tunnel [detail]
show router l2tp session [detail]
show router l2tp peer [ip-address]
```

To debug and show PPPoE packets:

```
debug service id <service-id> ppp packet mode egr-ingr-and-dropped
debug service id <service-id> ppp packet detail-level medium
```

To debug and show RADIUS authentication:

```
debug router radius packet-type authentication
```

To debug and show LUDB authentication:

```
debug subscriber-mgmt local-user-db <local-user-db-name> detail all
```

To debug and show the LAC tunnel selection process and L2TP state machine:

```
debug router l2tp event lac-session-setup
debug router l2tp event finite-state-machine
```

To debug and show the L2TP tunnel and session setup:

```
debug router l2tp packet direction both
debug router l2tp packet detail-level high
```

Understanding the L2TP debug output

The following L2TP ICRQ message (**debug router l2tp packet**) is used to explain how the displayed debug output should be interpreted. See [Recap of the L2TPv2 protocol -L2TP header and AVP layout](#) for more details.

```
19 2019/05/28 11:15:51.766 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.0.2.1:1701 -> 192.168.22.2:1701
tunnel 4734 session 0, ns 2 nr 1, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    IncomingCallRequest(10)
  AVP AssignedSessionId(0,14), flags: mandatory, reserved=0
    8018
  AVP CallSerialNumber(0,15), flags: mandatory, reserved=0
    256975
  AVP CallingNumber(0,22), flags: mandatory, reserved=0
```



```
"LAC 1/1/3:100"  
AVP AgentCircuitId(3561,1), flags:, reserved=0  
"circuit0"  
AVP AgentRemoteId(3561,2), flags:, reserved=0  
"remote0"  
AVP ActDataRateUp(3561,129), flags:, reserved=0  
2000000  
AVP ActDataRateDown(3561,130), flags:, reserved=0  
4000000"
```

- L2TP(v2, ctrl, egress): UDP 192.0.2.1:1701 -> 192.168.22.2:1701
 - version: v2
 - type field (T-bit): control message (ctrl)
 - 192.0.2.1:1701 -> 192.168.22.2:1701
 - 192.0.2.1:1701 - source tunnel-end-point:source udp port
 - 192.168.22.2:1701 - destination tunnel-end-point:destination udp port
- tunnel 13008 session 0, ns 2 nr 1, flags:, reserved=0
 - tunnel-id: 13008
 - session-id: 0
 - ns:2
 - nr:1
 - flags: 0 (refers to T/L/S/O/P bits L2TP header)
 - reserved field:0
- AVP CallingNumber(0,22), flags: mandatory, reserved=0
 - AVP MessageType(0,22): "LAC 1/1/3:100"
 - Vendor-id: 0 - Standard Attribute
 - Attribute Type: 22 – Calling Number AVP
 - Attribute Value: "LAC 1/1/3:100"

Scenario 1: RADIUS-derived L2TP parameters

Base router hosted LAC with single endpoint/single tunnel

The **debug service id <service-id> ppp packet mode egr-ingr-and-dropped** command shows the PPPoE packet exchange. The following PADI packet shows the service, SAP, and received PPPoE tags. The received PPPoE DSL forum tags are by default copied during the LAC L2TP tunnel setup into the Incoming Call Request (ICRQ) DSL Forum AVP's (RFC 5515).

```
1 2019/05/28 11:15:51.724 CEST MINOR: DEBUG #2001 Base PPPoE  
"PPPoE: RX Packet  
IES 1, SAP 1/1/3:100  
  
DMAC: ff:ff:ff:ff:ff:ff  
SMAC: 00:00:00:00:01:01  
Ether Type: 0x8863 (Discovery)
```

```

PPPoE Header:
Version: 1                Type      : 1
Code   : 0x09 (PADI)      Session-Id: 0x0000 (0)
Length : 48

PPPoE Tags:
[0x0101] Service-Name: ""
[0x0103] Host-Uniq: len = 1, value = 31
[0x0105] Vendor-Specific: vendor-id = 0x0de9 (ADSL Forum)
        [0x01] Agent-Circuit-Id: "circuit0"
        [0x02] Agent-Remote-Id: "remote0"
        [0x81] Actual-Upstream: 2000
        [0x82] Actual-Downstream: 4000
    "
    
```

The **debug router radius packet-type authentication** command shows the actual authentication parameters returned by RADIUS. This example returns the minimum set of L2TP related RADIUS attributes.

```

12 2019/05/28 11:15:51.762 CEST MINOR: DEBUG #2001 Base RADIUS
"RADIUS: Receive
  Access-Accept(2) id 242 len 89 from 172.16.1.11:1812 vrid 1 pol rsp-radius-1
  VSA [26] 15 Nokia(6527)
    SUBSC PROF STR [12] 13 sub-profile-1
  VSA [26] 15 Nokia(6527)
    SLA PROF STR [13] 13 sla-profile-1
  TUNNEL TYPE [64] 4 1 L2TP(3)
  TUNNEL MEDIUM TYPE [65] 4 1 IPv4(1)
  TUNNEL SERVER ENDPOINT [67] 13 1 192.168.22.2
"
    
```

The **debug router l2tp event lac-session-setup** command shows the LAC tunnel selection for this example. An L2TP group-name '*default_radius_group*' with tunnel-name '*unnamed*' is created in this case, because RADIUS did not return an explicit group and tunnel name.

```

13 2019/05/28 11:15:51.763 CEST MINOR: DEBUG #2001 Base PPPoE 255217->L2TP
"PPPoE 255217->L2TP: UDP 192.0.2.1:1701 -> 192.168.22.2:1701
  preference 50 tunnel default_radius_group:unnamed
  request to open new tunnel 12082"
    
```

```

14 2019/05/28 11:15:51.763 CEST MINOR: DEBUG #2001 Base PPPoE 255217->L2TP
"PPPoE 255217->L2TP: UDP 192.0.2.1:1701 -> 192.168.22.2:1701
  preference 50 tunnel default_radius_group:unnamed
  create session 791813970"
    
```

The **debug router l2tp packet detail-level** command shows the L2TP tunnel and session setup for this example.

For the tunnel setup, the LAC sends a Start-Control-Connection-Request (SCCRQ) containing the assigned tunnel-id (no tunnel authentication in the example). The tunnel is now in a wait-reply state.

```

15 2019/05/28 11:15:51.763 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.0.2.1:1701 -> 192.168.22.2:1701
  tunnel 0 session 0, ns 0 nr 0, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    StartControlConnectionRequest(1)
  AVP ProtocolVersion(0,2), flags: mandatory, reserved=0
    version=1, revision=0
  AVP HostName(0,7), flags: mandatory, reserved=0
    
```

```
"lac-pe1"  
AVP WindowSize(0,10), flags: mandatory, reserved=0  
64  
AVP FramingCapabilities(0,3), flags: mandatory, reserved=0  
sync=no, async=no  
AVP BearerCapabilities(0,4), flags: mandatory, reserved=0  
digital=yes, analogue=no  
AVP FirmwareRevision(0,6), flags:, reserved=0  
4869  
AVP VendorName(0,8), flags:, reserved=0  
"Nokia"  
AVP AssignedTunnelId(0,9), flags: mandatory, reserved=0  
12082"
```

The LNS can bring up the tunnel, so the LNS replies with a Start-Control-Connection-Reply (SCCRP) including the assigned tunnel-id.

```
16 2019/05/28 11:15:51.765 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, ingress)  
"L2TP(v2, ctrl, ingress): UDP 192.168.22.2:1701 -> 192.0.2.1:1701  
tunnel 12082 session 0, ns 0 nr 1, flags:, reserved=0  
AVP MessageType(0,0), flags: mandatory, reserved=0  
StartControlConnectionReply(2)  
AVP ProtocolVersion(0,2), flags: mandatory, reserved=0  
version=1, revision=0  
AVP HostName(0,7), flags: mandatory, reserved=0  
"lns-pe2"  
AVP WindowSize(0,10), flags: mandatory, reserved=0  
64  
AVP FramingCapabilities(0,3), flags: mandatory, reserved=0  
sync=no, async=no  
AVP BearerCapabilities(0,4), flags: mandatory, reserved=0  
digital=yes, analogue=no  
AVP FirmwareRevision(0,6), flags:, reserved=0  
4869  
AVP VendorName(0,8), flags:, reserved=0  
"Nokia"  
AVP AssignedTunnelId(0,9), flags: mandatory, reserved=0  
4734"
```

As the last step in the tunnel setup phase, the LAC responds with a Start-Control-Connection-Connected (SCCCN) message. After an LNS ZLB acknowledgment, the tunnel is in the establishedIdle state.

```
17 2019/05/28 11:15:51.765 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, egress)  
"L2TP(v2, ctrl, egress): UDP 192.0.2.1:1701 -> 192.168.22.2:1701  
tunnel 4734 session 0, ns 1 nr 1, flags:, reserved=0  
AVP MessageType(0,0), flags: mandatory, reserved=0  
StartControlConnectionConnected(3)"
```

Once the tunnel exists the session setup starts, a three-way exchange for session establishment within the tunnel is performed. The LAC sends an Incoming-Call-Request (ICRQ) with the parameter information for the session. The session is now in the wait-reply state.

```
19 2019/05/28 11:15:51.766 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, egress)  
"L2TP(v2, ctrl, egress): UDP 192.0.2.1:1701 -> 192.168.22.2:1701  
tunnel 4734 session 0, ns 2 nr 1, flags:, reserved=0  
AVP MessageType(0,0), flags: mandatory, reserved=0  
IncomingCallRequest(10)  
AVP AssignedSessionId(0,14), flags: mandatory, reserved=0  
8018  
AVP CallSerialNumber(0,15), flags: mandatory, reserved=0  
256975"
```

```

AVP CallingNumber(0,22), flags: mandatory, reserved=0
  "LAC 1/1/3:100"
AVP AgentCircuitId(3561,1), flags:, reserved=0
  "circuit0"
AVP AgentRemoteId(3561,2), flags:, reserved=0
  "remote0"
AVP ActDataRateUp(3561,129), flags:, reserved=0
  2000000
AVP ActDataRateDown(3561,130), flags:, reserved=0
  4000000"
    
```

The LNS then sends an Incoming-Call-Reply (ICRP) that contains the assigned session-id. The session is now in the connect state.

```

21 2019/05/28 11:15:51.768 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, ingress)
"L2TP(v2, ctrl, ingress): UDP 192.168.22.2:1701 -> 192.0.2.1:1701
tunnel 12082 session 8018, ns 1 nr 3, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    IncomingCallReply(11)
  AVP AssignedSessionId(0,14), flags: mandatory, reserved=0
    24477"
    
```

Finally the LAC sends an Incoming Call Connected (ICCN) and provides the LNS with additional information from the user initiated session. This information includes the LCP information from the negotiation that the LAC and remote user performed. This information is used by the LNS to decide whether to start LCP re-negotiation and/or Authentication re-negotiation with the PPP user or not. After an LNS ZLB acknowledgment, the session is in the established state.

```

24 2019/05/28 11:15:51.769 CEST MINOR: DEBUG #2001 Base L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.0.2.1:1701 -> 192.168.22.2:1701
tunnel 4734 session 24477, ns 3 nr 2, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    IncomingCallConnected(12)
  AVP FramingType(0,19), flags: mandatory, reserved=0
    sync=no, async=no
  AVP TxConnectSpeed(0,24), flags: mandatory, reserved=0
    4294967295
  AVP InitialRxLcpConfReq(0,26), flags:, reserved=0
    01 04 05 d4
    [1] MRU: 1492
  AVP LastTxLcpConfReq(0,27), flags:, reserved=0
    01 04 05 d4 03 05 c2 23 05 05 06 29 c0 85 ab
    [1] MRU: 1492
    [3] Authentication-Protocol: 0xc223 (CHAP), Algorithm = 5 (MD5)
    [5] Magic-Number: 0x29c085ab
  AVP LastRxLcpConfReq(0,28), flags:, reserved=0
    01 04 05 d4
    [1] MRU: 1492
  AVP ProxyAuthenType(0,29), flags:, reserved=0
    chap(2)
  AVP ProxyAuthenName(0,30), flags:, reserved=0
    "user1@wholesale.com"
  AVP ProxyAuthenChallenge(0,31), flags:, reserved=0
    4c 1c 3d e9 8f 11 7a 09 e0 2a 4e 9e d6 d4 c6 78
    eb d2 bc e0 72 27 41 a2 77 61 67 22 95 2b 1a 61
    c6 57 4b
  AVP ProxyAuthenId(0,32), flags:, reserved=0
    id=1, reserved=0
  AVP ProxyAuthenResponse(0,33), flags:, reserved=0
    65 2f 0f 3e 28 24 5c 8a ff 63 66 98 93 29 97 3d
  AVP RxConnectSpeed(0,38), flags:, reserved=0
    
```

4294967295"

The operational PPPoE session information for the IES 1 (base router) instance is as follows.

```
[ ]
A:admin@LAC# show service id 1 ppp session

=====
PPP sessions for service 1
=====
User-Name
  Descr.
  Up Time      Type  Termination      IP/L2TP-Id/Interface-Id MC-Stdby
-----
user1@wholesale.com
  svc:1 sap:1/1/3:100 mac:00:00:00:00:01:01 sid:1
      0d 00:01:21   oE   lac              791813970
-----
No. of PPP sessions: 1
=====
```

The operational tunnel information in the base instance shows that the tunnel is established.

```
[ ]
A:admin@LAC# show router l2tp tunnel

=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state   Ses Active
  Group                                     Ses Total
  Assignment
-----
791805952 12082     4734     established     not-blacklisted   1
  default_radius_group
  unnamed
-----
No. of tunnels: 1
=====
```

Detailed operational tunnel information is obtained using following command.

```
[ ]
A:admin@LAC# show router l2tp tunnel tunnel-id 12082 detail

=====
L2TP Tunnel Status
=====

Connection ID: 791805952
Protocol      : v2
State        : established
IP           : 192.0.2.1
UDP         : 1701
Peer IP     : 192.168.22.2
Peer UDP   : 1701
Tx dst-IP  : 192.168.22.2
Tx dst-UDP : 1701
Rx src-IP  : 192.168.22.2
Rx src-UDP : 1701
Name       : lac-pe1
Remote Name : lns-pe2
Assignment ID: unnamed
Group Name : default_radius_group
Acct. Policy : N/A
```

```

Error Message: N/A

Tunnel ID       : 12082           Remote Conn ID   : 310247424
Preference      : 50              Remote Tunnel ID : 4734
Hello Interval (s) : 300          Receive Window   : 64
Idle T0 (s)     : infinite        AVP Hiding       : never
Max Retr Estab  : 5               Destruct T0 (s) : 60
Cfg'd Sess Limit : unlimited      Max Retr Not Estab: 5
Transport Type  : udpIp           Oper Session Limit: 32767
Time Started    : 05/28/2019 11:15:52 Challenge        : never
Time Established : 05/28/2019 11:15:52 Time Idle        : N/A
Stop CCN Result : noError         Time Closed      : N/A
Blacklist-state : not-blacklisted General Error     : noError
Set Dont Fragment : true

Failover
State          : not-recoverable
Recovery Conn ID : N/A
Recovery state  : not-applicable
Recovered Conn ID : N/A
Recovery method : mcs
Track SRRP     : (Not specified)
Ctrl msg behavior : handle
Recovery time (ms) :
Requested      : N/A
Peer           : N/A
    
```

The operational L2TP session information shows the L2TP session is established.

```

[]
A:admin@LAC# show router l2tp session

=====
L2TP Session Summary
=====
ID           Control Conn ID   Tunnel-ID   Session-ID   State
-----
791813970    791805952         12082      8018         established
-----
No. of sessions: 1
=====
    
```

For detailed operational L2TP session information use the following command.

```

[]
A:admin@LAC# show router l2tp session session-id 8018 detail

=====
L2TP Session 791813970
=====
Connection ID: 791813970
State        : established
Tunnel Group : default_radius_group
Assignment ID: unnamed
Error Message: N/A

Control Conn ID : 791805952           Rem Cntrl Conn ID : 310247424
Tunnel ID       : 12082              Remote Tunnel ID   : 4734
Session ID      : 8018               Remote Session ID  : 24477
PW Type         : ppp                Remote Conn ID     : 310271901
    
```

```

Time Started      : 05/28/2019 11:15:52
Time Established  : 05/28/2019 11:15:52 Time Closed      : N/A
CDN Result       : noError                    General Error   : noError
-----
-----
No. of sessions: 1
=====
    
```

Base router hosted LAC with multiple endpoints

The **debug router radius packet-type authentication** command shows the actual RADIUS authentication parameters returned. This example returns multiple tunnel endpoints from which the LAC selects one. This example uses weighted load balancing. (The L2TP tunnel selection process is out of the scope of this example).

```

12 2019/05/28 15:04:49.128 CEST MINOR: DEBUG #2001 Base RADIUS
"RADIUS: Receive
  Access-Accept(2) id 235 len 225 from 172.16.1.11:1812 vrid 1 pol rsp-radius-1
    VSA [26] 15 Nokia(6527)
      SUBSC PROF STR [12] 13 sub-profile-1
    VSA [26] 15 Nokia(6527)
      SLA PROF STR [13] 13 sla-profile-1
    TUNNEL CLIENT ENDPOINT [66] 12 192.168.22.1
    VSA [26] 6 Nokia(6527)
      TUNNEL ALGORITHM [47] 4 weighted access(1)
    TUNNEL CLIENT AUTH ID [90] 7 lac-pe1
    TUNNEL ASSIGNMENT ID [82] 12 RADIUS-group
    VSA [26] 6 Nokia(6527)
      TUNNEL MAX RETRIES ESTAB [52] 4 0 2
    TUNNEL TYPE [64] 4 1 L2TP(3)
    TUNNEL MEDIUM TYPE [65] 4 1 IPv4(1)
    TUNNEL SERVER ENDPOINT [67] 13 1 192.168.22.2
    TUNNEL ASSIGNMENT ID [82] 16 1 RADIUS-tunnel-1
    TUNNEL PREFERENCE [83] 4 1 100
    TUNNEL TYPE [64] 4 2 L2TP(3)
    TUNNEL MEDIUM TYPE [65] 4 2 IPv4(1)
    TUNNEL SERVER ENDPOINT [67] 13 2 192.168.22.3
    TUNNEL ASSIGNMENT ID [82] 16 2 RADIUS-tunnel-2
    TUNNEL PREFERENCE [83] 4 2 100
"
    
```

The **debug router l2tp event lac-session-setup** command shows the LAC tunnel LNS2-T2 is selected for this example.

```

13 2019/05/28 15:04:49.129 CEST MINOR: DEBUG #2001 Base PPPoE 263408->L2TP
"PPPoE 263408->L2TP: UDP 192.168.22.1:1701 -> 192.168.22.2:1701
preference 100 tunnel RADIUS-group:RADIUS-tunnel-1
request to open new tunnel 5288"
    
```

```

14 2019/05/28 15:04:49.129 CEST MINOR: DEBUG #2001 Base PPPoE 263408->L2TP
"PPPoE 263408->L2TP: UDP 192.168.22.1:1701 -> 192.168.22.2:1701
preference 100 tunnel RADIUS-group:RADIUS-tunnel-1
create session 346586242"
    
```

The operational PPPoE session information in IES 1/base instance is shown as follows.

```
[ ]
```

```
A:admin@LAC# show service id 1 ppp session

=====
PPP sessions for service 1
=====
User-Name
  Descr.
      Up Time      Type  Termination      IP/L2TP-Id/Interface-Id MC-Stdby
-----
user1@wholesale.com
  svc:1 sap:1/1/3:100 mac:00:00:00:00:01:01 sid:1
      0d 00:00:56   oE   lac              346586242
-----
No. of PPP sessions: 1
=====
```

The operational L2TP tunnel information (base instance) is shown below.

```
[ ]
A:admin@LAC# show router l2tp tunnel

=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
Group                                          Ses Total
-----
346554368 5288      8368      established     not-blacklisted  1
RADIUS-group
RADIUS-tunnel-1
-----
No. of tunnels: 1
=====
```

Operational session information (base instance) shows the session is in the established state.

```
[ ]
A:admin@LAC# show router l2tp session

=====
L2TP Session Summary
=====
ID          Control Conn ID  Tunnel-ID  Session-ID  State
-----
346586242   346554368       5288      31874      established
-----
No. of sessions: 1
=====
```

The L2TP endpoint/peer information shows there are two tunnels for tunnel endpoint 192.168.22.2.

```
[ ]
A:admin@LAC# show router l2tp peer

=====
L2TP Peers
=====
Peer IP          Drain Reachability  Port  Tun Active Ses Active
                                     Tun Total  Ses Total
-----
192.168.22.2    1701               1     1           1
                                     1           1
192.168.22.3    1701               0     0           0
                                     0           0
-----
```



```
No. of peers: 2
=====
```

The following command gives a system overview of subscriber session related data. This system overview shows the current and peak values per session type (local PTA, LAC, LTS, LNS) and an overview of the number of originated or terminated L2TP tunnels. Peak values can be cleared via the **clear subscriber-mgmt peakvalue-stats** command.

```
[ ]
A:admin@LAC# show subscriber-mgmt statistics system statistics-id session

=====
Subscriber Management Statistics for System
=====
Type                               Current    Peak      Peak Timestamp
-----
PPP Session Statistics
-----
Local  PPP Sessions - PPPoE           0         0
      PPP Sessions - PPPoEoA        0         0
      PPP Sessions - PPPoA          0         0
      PPP Sessions - L2TP (LNS)     0         0
-----
LAC    PPP Sessions - PPPoE           1         2 05/28/2019 13:16:38
      PPP Sessions - PPPoEoA        0         0
      PPP Sessions - PPPoA          0         0
      PPP Sessions - L2TP (LTS)     0         0
-----
Total  PPP Sessions - established    1         2 05/28/2019 13:16:38
      PPP Sessions - in setup        0         1 05/28/2019 15:04:49
      PPP Sessions - local           0         0
      PPP Sessions - LAC             1         2 05/28/2019 13:16:38
-----
L2TP   L2TP Tunnels - originator      1         2 05/28/2019 15:02:39
      L2TP Tunnels - receiver        0         0
      Total L2TP Tunnels             1         2 05/28/2019 15:02:39
-----
IPOE Session Statistics
-----
Total  IPOE Sessions - established    0         0
      IPOE Sessions - in setup        0         0
-----
Peak values last reset at : n/a
```

VRF hosted LAC

This example returns VPRN 65536 as the L2TP service instance [26-6527-104 Alc-Tunnel-Serv-Id]. The VPRN 65536 interface system address is used as the L2TP source address since the attribute Tunnel-Client-Endpoint is not returned.

The IP address 192.168.33.1 (Tunnel-Server-Endpoint) needs to be routable in VRF 65536 over a SAP or to a remote PE. This example uses BGP/MPLS IP Virtual Private Networks (VPNs) (RFC 4364) to access the remote PE.

```
[ ]
A:admin@LAC# show router 65536 route-table
=====
Route Table (Service: 65536)
=====
Dest Prefix[Flags]                Type   Proto   Age           Pref
  Next Hop[Interface Name]          Metric
-----
---snip---
192.168.33.1/32                    Local  Local   23h44m06s    0
  system                            0
192.168.33.2/32                    Remote BGP VPN 05h39m09s   170
  192.0.2.2 (tunneled)              10
---snip---
-----
No. of Routes: 4
Flags: n = Number of times nexthop is repeated
       B = BGP backup route available
       L = LFA nexthop available
       S = Sticky ECMP requested
=====
```

Operational PPPoE session information for IES 1 (base instance) is shown using following command.

```
[ ]
A:admin@LAC# show service id 1 ppp session
=====
PPP sessions for service 1
=====
User-Name
  Descr.
  Up Time      Type  Termination  IP/L2TP-Id/Interface-Id MC-Stdby
-----
user1@wholesale.com
  svc:1 sap:1/1/3:100 mac:00:00:00:00:01:01 sid:1
    0d 00:03:55  oE   lac          643922850
-----
No. of PPP sessions: 1
=====
```

Operational tunnel information for VPRN 65536 is displayed as follows.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
  Group                                         Ses Total
  Assignment
-----
643891200 9825      9819      established     not-blacklisted  1
  RADIUS-returned-TG                            1
  RADIUS-returned-TN
-----
No. of tunnels: 1
=====
```

Operational session information for VPRN 65536 is displayed using following command, and shows that the session is established.

```
[ ]
A:admin@LAC# show router 65536 l2tp session

=====
L2TP Session Summary
=====
ID                Control Conn ID   Tunnel-ID   Session-ID   State
-----
643922850         643891200         9825        31650        established
-----
No. of sessions: 1
=====
```

Scenario 2: Node-derived L2TP parameters

RADIUS returns L2TP group

This example returns VPRN 65536 as the L2TP service instance [26-6527-104] Alc-Tunnel-Serv-Id and an l2tp group-name wholesale.com [26-6527-46] Alc-Tunnel-Group.

```
12 2019/05/28 15:26:19.861 CEST MINOR: DEBUG #2001 Base RADIUS
"RADIUS: Receive
Access-Accept(2) id 237 len 95 from 172.16.1.11:1812 vrid 1 pol rsp-radius-1
VSA [26] 15 Nokia(6527)
SUBSC PROF STR [12] 13 sub-profile-1
VSA [26] 15 Nokia(6527)
SLA PROF STR [13] 13 sla-profile-1
VSA [26] 6 Nokia(6527)
TUNNEL SERVICE ID [104] 4 65536
VSA [26] 15 Nokia(6527)
TUNNEL GROUP [46] 13 wholesale.com
"
```

For operational PPPoE session information in IES 1/base instance, use following command.

```
[ ]
A:admin@LAC# show service id 1 ppp session

=====
PPP sessions for service 1
=====
User-Name
Descr.      Up Time      Type Termination      IP/L2TP-Id/Interface-Id MC-Stdby
-----
user1@wholesale.com
svc:1 sap:1/1/3:100 mac:00:00:00:00:01:01 sid:1
      0d 00:02:38  oE  lac                181162829
-----
No. of PPP sessions: 1
=====
```

Operational tunnel information for VPRN 65536 shows the tunnel is in the established state.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
Group                                           Ses Total
Assignment
-----
181141504 2764      38          established      not-blacklisted  1
wholesale.com                               1
wholesale.com
-----
No. of tunnels: 1
=====
```

The operational session information for VPRN 65536 shows the session is in the established state.

```
[ ]
A:admin@LAC# show router 65536 l2tp session
=====
L2TP Session Summary
=====
ID          Control Conn ID  Tunnel-ID  Session-ID  State
-----
181162829   181141504        2764       21325       established
-----
No. of sessions: 1
=====
```

LUDB returns L2TP group

This example returns VPRN 65536 as the L2TP service instance and l2tp group-name wholesale.com (LUDB l2tp group "wholesale.com" service-id 65536).

The **debug subscriber-mgmt local-user-db l2tp detail all** command shows the LUDB authentication access (The returned parameter details are not shown).

```
11 2019/05/28 15:32:48.859 CEST MINOR: DEBUG #2001 Base LUDB
"LUDB: User lookup success - host found
user-name:
original:  user1@wholesale.com
masked:    user1@wholesale.com

Host wholesale.com found in user data base l2tp"
```

To show the operational data from LUDB l2tp, use the following command.

```
[ ]
A:admin@LAC# show subscriber-mgmt local-user-db "l2tp" ppp-host "wholesale.com"
| match N/A invert-match
| match none invert-match
=====
PPP Host "wholesale.com"
=====
Admin State           : Up
Last Mgmt Change      : 05/27/2019 15:26:46
Host Identification
```

```

User Name      : wholesale.com (domain only)
Matched Objects : userName
Password Type  : ignore
PADO Delay     : 0msec
Diameter app policy : (Not Specified)
Diameter auth policy : (Not Specified)
Force IPv6CP   : Disabled
Ignore DF Bit  : Disabled
DHCPv6 lease times
Renew timer    : > 9999 days
Rebind timer   : > 9999 days
Preferred lifetime : 0d 00:00:00
Valid lifetime  : 0d 00:00:00
Identification Strings (option 254)
Subscriber Id   : user@wholesale.com
SLA Profile String : sla-profile-1
Sub Profile String : sub-profile-1
L2TP
Service        : 65536
Tunnel Group   : wholesale.com
MSAP defaults
Filter Overrides
Access loop info
=====
    
```

The **debug router l2tp event lac-session-setup** command shows the LAC tunnel selected for this example.

```

12 2019/05/28 15:32:48.860 CEST MINOR: DEBUG #2001 vprn65536 PPPoE 263411->L2TP
"PPPoE 263411->L2TP: UDP 192.168.33.1:1701 -> 192.168.33.2:1701
preference 50 tunnel wholesale.com:wholesale.com
request to open new tunnel 7432"
    
```

```

13 2019/05/28 15:32:48.860 CEST MINOR: DEBUG #2001 vprn65536 PPPoE 263411->L2TP
"PPPoE 263411->L2TP: UDP 192.168.33.1:1701 -> 192.168.33.2:1701
preference 50 tunnel wholesale.com:wholesale.com
create session 487068937"
    
```

For the operational PPPoE session information in IES 1/base instance, use the following command:

```

[]
A:admin@LAC# show service id 1 ppp session

=====
PPP sessions for service 1
=====
User-Name
  Descr.
      Up Time      Type  Termination      IP/L2TP-Id/Interface-Id MC-Stdby
-----
user1@wholesale.com
  svc:1 sap:1/1/3:100 mac:00:00:00:00:01:01 sid:1
      0d 00:02:56  oE   lac              487068937
-----
No. of PPP sessions: 1
=====
    
```

Operational tunnel information for VPRN 65536 can be obtained using following command.

```

[]
A:admin@LAC# show router 65536 l2tp tunnel
    
```

```

=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
Group                                          Ses Total
Assignment
-----
487063552 7432      10509     established     not-blacklisted  1
wholesale.com                               1
wholesale.com
-----
No. of tunnels: 1
=====
    
```

The operational session information for VPRN 65536 shows the session is in the established state.

```

[]
A:admin@LAC# show router 65536 l2tp session

=====
L2TP Session Summary
=====
ID          Control Conn ID   Tunnel-ID   Session-ID   State
-----
487068937   487063552         7432       5385         established
-----
No. of sessions: 1
=====
    
```

Advanced topics

Non-session-triggered L2TP tunnel setup

In addition to the ppp-session-triggered setup, an L2TP tunnel can also be set up via a tools command or an auto-establish command.

These non-session-triggers are useful, for example, during the initial configuration phase where the LAC-LNS tunnel setup can be tested without the need for a user to attempt and establish a PPPoE connection.

The PPPoE user still triggers the L2TP session-setup over this L2TP tunnel and RADIUS needs to return an l2tp group-name with the relevant name during authentication.

Auto-establish

Every minute, a check is performed to determine if tunnels need to be established (a process referred to as scan auto-establish). The tunnel state is establishedIdle when the tunnel is setup, and becomes established when user triggered sessions are set up over this tunnel.

```

service
  vprn 65536
  l2tp {
    admin-state enable
    group "wholesale.com" {
      admin-state enable
      tunnel "wholesale.com" {
        admin-state enable
        auto-establish true
      }
    }
  }
    
```

```
peer 192.168.33.2
local-address 192.168.33.1
local-name "lac-pe1"
}
}
}
```

There is no difference in operational behavior for a tunnel set up via a session-trigger or an auto-establish command. Removing the auto-establish parameter has no impact on active tunnels (establishedIdle or established).

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state   Ses Active
  Group                                     Ses Total
  Assignment
-----
876150784 13369     11022     establishedIdle   not-blacklisted   0
  wholesale.com                                     0
  wholesale.com
-----
No. of tunnels: 1
=====
```

Tools tunnel start

First revert to the original situation, without auto-establish, as follows:

```
configure exclusive
service vprn 65536 l2tp group "wholesale.com" tunnel "wholesale.com"
                                                delete auto-establish
commit
```

Verify the tunnel does not exist anymore, as follows:

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
No entries found.
```

Issue the tools command to manually establish the L2TP tunnel, as follows:

```
[ ]
A:admin@LAC# tools perform router 65536 l2tp group "wholesale.com" tunnel
                                                "wholesale.com" start
```

Verify a new tunnel has been created, as follows:

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state   Ses Active
  Group                                     Ses Total
  Assignment
-----
45940736  701       8671      establishedIdle   not-blacklisted   0
-----
```

```
wholesale.com                                0
wholesale.com
-----
No. of tunnels: 1
=====
```

How long remains a tunnel idle before torn down?

An L2TP tunnel can be torn down automatically, after the expiration of an idle-timer, or manually through a tools command.

Idle-timeout

A persistent tunnel is a tunnel that remains available after the last session over that tunnel is closed. To create a persistent tunnel, the idle-timeout parameter must be set to infinite.

A non-persistent tunnel is torn down immediately (idle-timeout zero) after the last session over that tunnel is closed or after a configurable delay. The idle-timeout parameter is set via the RADIUS [26-6527-49] Alc-Tunnel-Idle-Timeout attribute or the corresponding node parameter. The default value for this parameter is infinite (persistent).

```
configure router l2tp | configure service vprn l2tp
  idle-timeout [0..3600] s
  ---snip---
  group <tunnel-group-name>
    idle-timeout [0..3600] s | infinite
    ---snip---
  tunnel <tunnel-name>
    idle-timeout [0..3600] s | infinite
    ---snip---
```

The following shows an example of a non-persistent tunnel (idle-timeout 30 seconds). The tunnel changes state from established to establishedIdle when the last session is terminated. Idle-timeout seconds later, the session changes to the closed state. For the purpose of troubleshooting, the operational data stays available for destruct-timeout seconds (see later).

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel detail

=====
L2TP Tunnel 1068892160
=====

Connection ID: 1068892160
Protocol      : v2
State       : closed
IP           : 192.168.33.1

---snip---

Name          : lac-pe1
Remote Name   : LNS1
Assignment ID: wholesale.com
Group Name    : wholesale.com
Acct. Policy  : N/A
Error Message: idle timeout (30 seconds) expired
```



```

Tunnel ID       : 16310           Remote Conn ID   : 192479232
Preference      : 50              Remote Tunnel ID : 2937
Hello Interval (s) : 60           Receive Window   : 64
Idle T0 (s)     : 30              AVP Hiding       : never
Max Retr Estab  : 5               Destruct T0 (s) : 60
Cfg'd Sess Limit : unlimited      Max Retr Not Estab: 5
Transport Type   : udpIp          Oper Session Limit: 32767
Challenge       : never

---snip---

No. of tunnels: 1
=====
    
```

The following shows an example of a persistent tunnel (idle-timeout infinite).

```

[]
A:admin@LAC# show router 65536 l2tp tunnel detail

=====
L2TP Tunnel 9240576
=====

Connection ID: 9240576
Protocol      : v2
State        : establishedIdle
IP           : 192.168.33.1

---snip---

Name          : lac-pe1
Remote Name   : LNS1
Assignment ID : wholesale.com
Group Name    : wholesale.com
Acct. Policy  : N/A
Error Message : N/A

Tunnel ID       : 141           Remote Conn ID   : 750714880
Preference      : 50              Remote Tunnel ID : 11455
Hello Interval (s) : 60           Receive Window   : 64
Idle T0 (s)     : infinite      AVP Hiding       : never
Max Retr Estab  : 5               Destruct T0 (s) : 60
Cfg'd Sess Limit : unlimited      Max Retr Not Estab: 5
Transport Type   : udpIp          Oper Session Limit: 32767
Challenge       : never

---snip---

No. of tunnels: 1
=====
    
```

Tools tunnel stop

In addition to the idle-timeout used for tunnel termination, a tools stop command is also available that can be used to terminate persistent and non-persistent tunnels at any moment in time. Be aware that this command is very destructive and destroys all sessions carried over the closed tunnel.

Following command shows the tunnel is in the establishedIdle state.

```

[]
    
```

```
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID      Loc-Tu-ID  Rem-Tu-ID  State          Blacklist-state  Ses Active
Group                               Assignment                               Ses Total
-----
331022336   5051      9053      establishedIdle  not-blacklisted  0
wholesale.com                               0
wholesale.com
-----
No. of tunnels: 1
=====
```

The following command terminates the l2tp tunnel. The tunnel is aborted (the LAC sends StopCCN) using the <connection-id> or <tunnel-group-name>+<tunnel-name> as input. This StopCCN indicates "operator request" as the error reason.

```
[]
A:admin@LAC# tools perform router 65536 l2tp group wholesale.com
                                     tunnel wholesale.com stop
INFO: CLI #2007: Info while processing command - INFO: CLI stopped 1 tunnels,
                                               destructed 0 tunnels.
```

The following debug output shows the tunnel being aborted.

```
5 2019/05/28 16:01:14.824 CEST MINOR: DEBUG #2001 vprn65536 L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.168.33.1:1701 -> 192.168.33.2:1701
tunnel 9053 session 0, ns 2 nr 1, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    StopControlConnectionNotification(4)
  AVP ResultCode(0,1), flags: mandatory, reserved=0
    result-code: "generalRequestToClearControlConnection"(1),
    error-code: "noGeneralError"(0)
    error-msg: "operator request"
  AVP AssignedTunnelId(0,9), flags: mandatory, reserved=0
  5051"
```

Alternatively, the tunnel can also be stopped with the following command. The effect would be the same.

```
[]
A:admin@LAC# tools perform router 65536 l2tp tunnel 964886528 stop
```

Keepalive - L2TP Hello

A keepalive mechanism is employed by L2TP in order to differentiate between tunnel outages and no control or data activity on a tunnel for an extended period. This is accomplished by injecting Hello control messages after a specified period of time has elapsed since the last data or control message (ZLB not included) was received on a tunnel. As for any other L2TP control message, if the Hello message is not reliably delivered, then the tunnel is declared down and reset, as defined in RFC 2661, *Layer Two Tunneling Protocol "L2TP"*. This means that SR OS does not send Hello packets if session control traffic is handled over this tunnel. The hello timer is reset if the system transmits any control packet over this tunnel (ZLB packets and data traffic are not taken into account).

The keepalive function is disabled (not recommended) using RADIUS [26-6527-50] Alc-Tunnel-Hello-Interval -1 or hello-interval infinite (default 300). The number of retries for unsuccessful Hello packet delivery equals RADIUS [26-6527-52] Alc-Tunnel-Max-Retries-Estab or node parameter max-retries-estab

(default 5). The retry interval is initially set to 1 second and doubles on each retry with a maximum interval of 8 seconds. Using a max-retries-estab 7 results in a retry of [1,2,4,8,8,8,8 seconds].

```
configure router l2tp | configure service vprn l2tp]
  hello-interval [60..3600] s | infinite # default 300 s
  max-retries-estab [2..7] # default 5
  ---snip---
  group <tunnel-group-name>
    hello-interval [60..3600] s | infinite
    max-retries-estab [2..7]
    ---snip---
  tunnel <tunnel-name>
    hello-interval [60..3600] s | infinite
    max-retries-estab [2..7]
    ---snip---
```

For example, the LAC can be configured with an hello-timer of 1 minute and the LNS with an hello-timer of 2 minutes. The hello-timer interval for LAC and LNS do not have to be same because the keepalive mechanism works asynchronous. See [Figure 25: L2TP keepalive mechanism](#).

```
[]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
  Group                                     Ses Total
  Assignment
-----
1002438656 15296     15972     established     not-blacklisted  1
  wholesale.com                               1
  wholesale.com
-----
No. of tunnels: 1
=====
```

Figure 25: L2TP keepalive mechanism

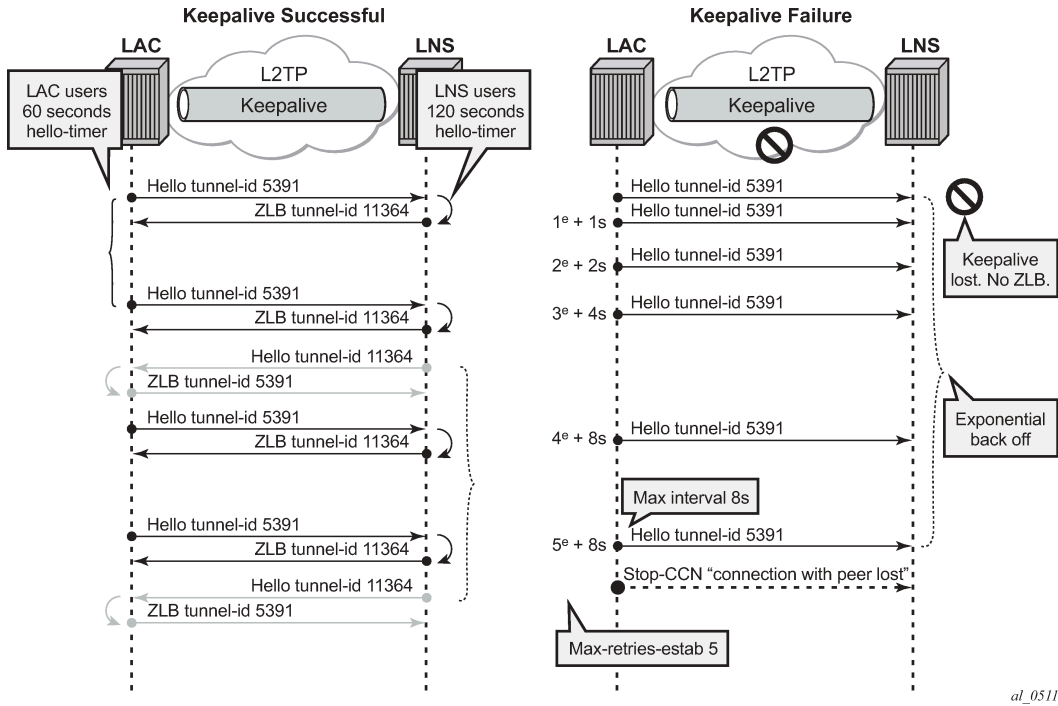


Figure 25: L2TP keepalive mechanism shows the tunnel being closed after 5 unsuccessful Hello deliveries with error-message connection with peer lost.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel detail
=====
L2TP Tunnel 1002438656
=====
Connection ID: 1002438656
Protocol      : v2

---snip---

Acct. Policy : N/A
Error Message: connection with peer lost

Tunnel ID      : 15296          Remote Conn ID   : 1046740992
Preference     : 50            Remote Tunnel ID : 15972
Hello Interval (s): 60        Receive Window   : 64
AVP Hiding     : never

---snip---

No. of tunnels: 1
=====
```

Keeping closed tunnel and session information

The `destruct-timeout` parameter (expressed in seconds) controls the period of time that the tunnel, or session data related to a closed (disconnected) tunnel, or session persists before being removed. The `destruct_timeout` is a debugging aid by keeping underlying memory structures after the tunnel or session is terminated. It is configured via the RADIUS [26-6527-51] `Alc-Tunnel-Destruct-Timeout` attribute or the corresponding node parameter. Default value for this parameter is 60 seconds.

```
configure router l2tp | configure service vprn l2tp
destruct-timeout [60..86400]
---snip---
group <tunnel-group-name>
destruct-timeout [60..86400]
---snip---
tunnel <tunnel-name>
destruct-timeout [60..86400]
```

The following output shows a session that is closed and the reason for it being terminated.

```
[ ]
A:admin@LAC# show router 65536 l2tp session detail

=====
L2TP Session 904095211
=====
Connection ID: 904095211
State          : closed
Tunnel Group   : wholesale.com
Assignment ID  : wholesale.com
Error Message: Terminated by PPPoE: Received PPPoE PADT

Control Conn ID : 904069120          Rem Cntrl Conn ID : 716898304
Tunnel ID       : 13795              Remote Tunnel ID  : 10939
Session ID      : 26091              Remote Session ID : 20875
PW Type         : ppp                 Remote Conn ID    : 716919179
Time Started    : 05/28/2019 16:18:17
Time Established : 05/28/2019 16:18:17 Time Closed       : 05/28/2019 16:18:20
CDN Result      : generalError        General Error     : vendorSpecific
-----
No. of sessions: 1
=====
```

The following output shows a tunnel that is closed and the reason for it being closed.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel detail

=====
L2TP Tunnel 904069120
=====

Connection ID: 904069120
Protocol      : v2
State         : closedByPeer
IP            : 192.168.33.1
UDP          : 1701
Peer IP      : 192.168.33.2
Peer UDP     : 1701
```

```
Tx dst-IP : 192.168.33.2
Tx dst-UDP : 1701
Rx src-IP : 192.168.33.2
Rx src-UDP : 1701
Name : lac-pe1
Remote Name : LNS1
Assignment ID: wholesale.com
Group Name : wholesale.com
Acct. Policy : N/A
Error Message: idle timeout (60 seconds) expired

---snip---

No. of tunnels: 1
=====
```

When the Destruct TO expires the tunnel and session is deleted, as follows:

```
[]
A:admin@LAC# show router l2tp session detail
No entries found.

>[]
A:admin@LAC# show router l2tp tunnel detail
No entries found.
```

Floating peers

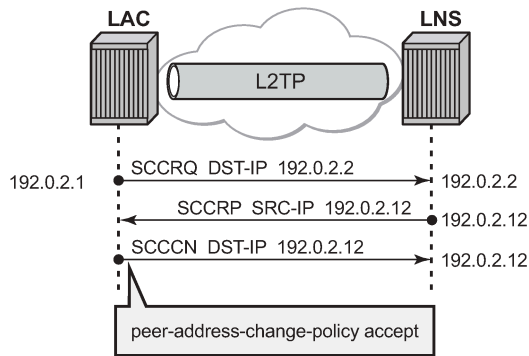
A floating peer exists if the peer LNS address indicated in the source address of the SCCRPs is different from the peer address known on the LAC. Floating peer allowance is configuration driven and is rejected by default.

The parameter `peer-address-change-policy` specifies whether the LAC accepts, ignores or rejects requests from a peer to change the destination IP address or UDP port.

```
configure router l2tp | configure service vprn l2tp
  peer-address-change-policy accept | ignore | reject
```

- `accept` — Specifies that this system accepts any source IP address change for received L2TP control messages related to a locally originated tunnel in the state `wait-reply` and rejects any peer address change for other tunnels, as shown in [Figure 26: Floating peers accept](#). In case the new peer IP address is accepted, it is learned and used as destination address in subsequent L2TP messages.

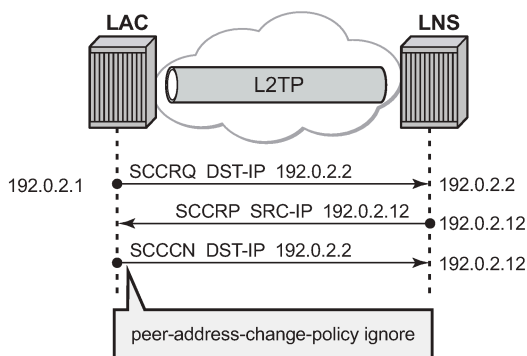
Figure 26: Floating peers accept



al_0512B

- ignore — Specifies that this system ignores any source IP address change for received L2TP control messages, does not learn any new peer IP address and does not change the destination address in subsequent L2TP messages, as shown in [Figure 27: Floating peers ignore](#).

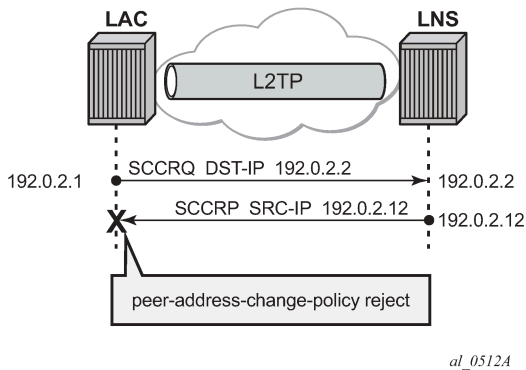
Figure 27: Floating peers ignore



al_0512C

- reject — Specifies that this system rejects any source IP address change for received L2TP control messages and drops those messages, as shown in [Figure 28: Floating peers reject](#).

Figure 28: Floating peers reject



The values Peer IP, Tx dst-IP and Rx src-IP in the **show router l2tp tunnel detail** command indicates if floating peers are used or not.

An example of a floating peer (peer-address-change-policy accept) is as follows.

```
[ ]
A:admin@:LAC# show router l2tp tunnel detail
=====
L2TP Tunnel Status
=====
Connection ID: 897122304
State       : established
IP          : 192.0.2.1
UDP         : 1701
Peer IP     : 192.0.2.2 # (1) peer address used in SCCRQ
Peer UDP    : 1701
Tx dst-IP   : 192.0.2.12 # (3) peer address used in SCCCN
Tx dst-UDP  : 1701
Rx src-IP   : 192.0.2.12 # (2) SCCRP different IP received
Rx src-UDP  : 1701
---snip---
```

Tx/Rx connect speed - AVP 24/38

The connect speed (TX AVP 24 and RX AVP 38) is passed in the ICCN messages sent from the LAC to the LNS. The L2TP AVP 24 defines the (Tx) connect speed in bps from the perspective of traffic flowing from the LAC towards the subscriber (BNG downstream rate). The L2TP AVP 38 defines the (Rx) connect speed in bps from the perspective of traffic flowing from the subscriber towards the LAC (BNG upstream rate).

The report-rate configuration option indicates what rate is reported to the LNS when creating an L2TP session.

```
configure subscriber-mgmt sla-profile <sla-profile-name> ingress | egress
  report-rate agg-rate-limit|scheduler|pppoe-actual-rate|
  policer|rfc5515-actual-rate
```

- **agg-rate-limit** — Take the aggregate rate as received from the RADIUS Access-Accept message in VSA Alc-Subscriber-QoS-Override. When this RADIUS VSA is not present in the Access-Accept, or

when RADIUS is not used, then take the configured aggregate rate limit. In the case where this is not configured, then take the port rate.

- scheduler <scheduler-name> — Take the rate of the specified scheduler. In case the scheduler is not linked with the scheduler-policy from the subscriber-profile, then take the port rate.
- pppoe-actual-rate — Take the rate from the DSL-Forum Vendor-Specific PPPoE Tag when available, otherwise take the port rate.
- rfc5515-actual-rate — Put the same value as the transmitted Actual-Data-Rate-Upstream AVP in the Rx-Connect-Speed AVP, and the same value as the transmitted Actual-Data-Rate-Downstream AVP in the Tx-Connect-Speed AVP.

Calling number AVP 22 format

The format of AVP 22 Calling Number in the ICRQ message is configurable via the parameter calling-number-format. The default format is "%S<space>%s" and corresponds to the concatenation of system-name<space>sap-id. Available parameters are %S (system-name), %c (Agent Circuit Id), %r Agent Remote Id, %s (sap-id), %l (Logical Line ID) and fixed strings. A combination can be configured from any of these parameters, but the total configured format cannot exceed 255 characters.

Example 1: Default configuration.

```
configure exclusive
service vprn 65536 l2tp lac calling-number-format "%S %s"
```

```
18 2019/05/28 16:26:20.903 CEST MINOR: DEBUG #2001 vprn65536 L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.168.33.1:1701 -> 192.168.33.2:1701
tunnel 11703 session 0, ns 2 nr 1, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    IncomingCallRequest(10)
  AVP AssignedSessionId(0,14), flags: mandatory, reserved=0
    20683
  AVP CallSerialNumber(0,15), flags: mandatory, reserved=0
    283037
  AVP CallingNumber(0,22), flags: mandatory, reserved=0
    "LAC 1/1/3:100"
  AVP AgentCircuitId(3561,1), flags:, reserved=0
    "circuit0"
  AVP AgentRemoteId(3561,2), flags:, reserved=0
    "remote0"
  AVP ActDataRateUp(3561,129), flags:, reserved=0
    2000000
  AVP ActDataRateDown(3561,130), flags:, reserved=0
    4000000"
```

Example 2: Customized configuration and all parameters (%S %s %c) are available to construct the requested AVP 22.

```
configure exclusive
service vprn 65536 l2tp lac calling-number-format "start-%S###%s###%c-end"
```

```
18 2019/05/28 16:29:39.771 CEST MINOR: DEBUG #2001 vprn65536 L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.168.33.1:1701 -> 192.168.33.2:1701
tunnel 4838 session 0, ns 2 nr 1, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    IncomingCallRequest(10)
```

```

AVP AssignedSessionId(0,14), flags: mandatory, reserved=0
16185
AVP CallSerialNumber(0,15), flags: mandatory, reserved=0
283038
AVP CallingNumber(0,22), flags: mandatory, reserved=0
"start-LAC###1/1/3:100###circuit0-end"
AVP AgentCircuitId(3561,1), flags:, reserved=0
"circuit0"
AVP AgentRemoteId(3561,2), flags:, reserved=0
"remote0"
AVP ActDataRateUp(3561,129), flags:, reserved=0
2000000
AVP ActDataRateDown(3561,130), flags:, reserved=0
4000000"
    
```

Example 3: Customized configuration and not all parameters are available to construct the requested AVP 22. Option-82 circuit-id (%c),remote-id (%r), and LLID (%l) information are lacking and therefore missing (skipped) in the formatted attribute.

```

configure exclusive
router vprn 65536 l2tp lac calling-number-format "%S#%c#%r#%l#%s"
    
```

```

18 2019/05/28 16:32:11.553 CEST MINOR: DEBUG #2001 vprn65536 L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.168.33.1:1701 -> 192.168.33.2:1701
tunnel 14364 session 0, ns 2 nr 1, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
  IncomingCallRequest(10)
  AVP AssignedSessionId(0,14), flags: mandatory, reserved=0
  14710
  AVP CallSerialNumber(0,15), flags: mandatory, reserved=0
  283039
  AVP CallingNumber(0,22), flags: mandatory, reserved=0
  "LAC#circuit0#remote0##1/1/3:100"
  AVP AgentCircuitId(3561,1), flags:, reserved=0
  "circuit0"
  AVP AgentRemoteId(3561,2), flags:, reserved=0
  "remote0"
  AVP ActDataRateUp(3561,129), flags:, reserved=0
  2000000
  AVP ActDataRateDown(3561,130), flags:, reserved=0
  4000000"
    
```

Prevent LAC from transmitting calling number AVP 22 to LNS

By default, the LAC includes the Calling Number AVP 22 in the L2TP incoming-call-request (ICRQ) packets transmitted to LNS. This AVP identifies the interface that is connected to the customer in the access network. Network access interface information can be hidden by configuring the LAC not to send the Calling Number AVP to the LNS.

Use the following command to disable the sending of L2TP Calling Number AVP 22.

```

configure exclusive
router l2tp exclude-avps calling-number
    
```

AVP 100 - Cisco-Nas-Port

Interoperation with a Cisco LNS requires that the LAC communicates a NAS port type to the LNS via the L2TP ICRQ 'Cisco Nas Port Info AVP (100)'. This AVP (100) includes information that identifies the NAS port and indicates whether the port type is Ethernet or ATM and is configured via the `cisco-nas-port` parameter.

The Cisco AVP 100 format is as follows:

- First 5 bytes are NAS-Port-Type:
 - 0f10090203 (Ethernet)
 - 0f10090201 (ATM)
- Remaining 4 bytes corresponds with the configured `cisco-nas-port` value

Example:

- Ethernet 12b s-vlan-id; 10b c-vlan-id; 3b slot number; 2b MDA nbr; 5b port
- ATM 12b VPI; 10b VCI; 3b slot number; 2b MDA nbr; 5b port

```
configure exclusive
service vprn 65536 l2tp lac cisco-nas-port ethernet "*12o*10i*3s*2m*5p"
```

`nas-port 1/1/3:100` corresponds to 102563 (000000000000 0001100100 001 01 00011).

```
22 2019/05/28 16:37:35.879 CEST MINOR: DEBUG #2001 vprn65536 L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.168.33.1:1701 -> 192.168.33.2:1701
tunnel 6288 session 0, ns 2 nr 1, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    IncomingCallRequest(10)
  AVP CiscoNasPort(9,100), flags:, reserved=0
    102563 type=ethernet(0f:10:09:02:03)
  AVP AssignedSessionId(0,14), flags: mandatory, reserved=0
    28354
  AVP CallSerialNumber(0,15), flags: mandatory, reserved=0
    283041
  AVP CallingNumber(0,22), flags: mandatory, reserved=0
    "LAC 1/1/3:100"
  AVP AgentCircuitId(3561,1), flags:, reserved=0
    "circuit0"
  AVP AgentRemoteId(3561,2), flags:, reserved=0
    "remote0"
  AVP ActDataRateUp(3561,129), flags:, reserved=0
    2000000
  AVP ActDataRateDown(3561,130), flags:, reserved=0
    4000000"
```

L2TP group/peer/tunnel draining

When the LAC has established sessions, the LAC can avoid the creation of new sessions for a specific group, peer, or tunnel, via the `drain` command.

No new sessions are created for a group, peer or tunnel that is being drained (draining state) but the current sessions are left intact.

After the **drain** command is issued, the group, peer, or tunnel moves from a draining to drained state when the last session is closed. A drained group, peer, or tunnel can then be managed (reconfigured, deleted) without any user impact.

Be aware that a group, peer, or tunnel in a draining or drained state is skipped in the tunnel selection process. The next example shows a tunnel draining; group and peer draining works according in the same way.

A tunnel has 1 session and is in established state.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
Group                                          Ses Total
Assignment
-----
285540352 4357      7237      established      not-blacklisted  1
wholesale.com                               1
wholesale.com
-----
No. of tunnels: 1
=====
```

The following tools **drain** command puts the tunnel in a draining state and leaves the sessions intact.

```
[ ]
A:admin@LAC# tools perform router 65536 l2tp tunnel 1023868928 drain
```

Initially the tunnel is in the draining state.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
Group                                          Ses Total
Assignment
-----
285540352 4357      7237      draining         not-blacklisted  1
wholesale.com                               1
wholesale.com
-----
No. of tunnels: 1
=====
```

The tunnel moves to the drained state at the moment the last session is closed. Debugging shows that a drained tunnel is also not used as last resort and is skipped during the tunnel selection process.

```
[ ]
A:admin@LAC# show router 65536 l2tp tunnel
=====
Conn ID   Loc-Tu-ID Rem-Tu-ID State           Blacklist-state  Ses Active
Group                                          Ses Total
Assignment
-----
285540352 4357      7237      drained          not-blacklisted  0
wholesale.com                               1
wholesale.com
-----
No. of tunnels: 1
=====
```

```
=====
```

The following output shows new sessions cannot select a drained tunnel.

```
19821 2019/05/28 16:46:52.549 CEST MINOR: DEBUG #2001 vprn65536 PPPoE 282635->L2TP
"PPPoE 282635->L2TP: UDP 192.168.33.1:1701 -> 192.168.33.2:1701
preference 50 tunnel wholesale.com:wholesale.com
no additional session can be created in tunnel 4357"
```

```
19822 2019/05/28 16:46:52.549 CEST MINOR: DEBUG #2001 vprn65536 PPPoE 282635->L2TP
"PPPoE 282635->L2TP:
stop: no more tunnels can be tried"
```

The drained tunnel can then be closed without user impact.

```
[ ]
A:admin@LAC# tools perform router "65536" l2tp tunnel 285540352 stop
```

```
19846 2019/05/28 16:48:57.338 CEST MINOR: DEBUG #2001 vprn65536 L2TP(v2, ctrl, egress)
"L2TP(v2, ctrl, egress): UDP 192.168.33.1:1701 -> 192.168.33.2:1701
tunnel 7237 session 0, ns 8 nr 2, flags:, reserved=0
  AVP MessageType(0,0), flags: mandatory, reserved=0
    StopControlConnectionNotification(4)
  AVP ResultCode(0,1), flags: mandatory, reserved=0
    result-code: "generalRequestToClearControlConnection"(1),
      error-code: "noGeneralError"(0)
    error-msg: "operator request"
  AVP AssignedTunnelId(0,9), flags: mandatory, reserved=0
    4357"
```

For draining and undraining for example a group, following commands can be used.

```
tools perform router 65536 l2tp group "wholesale.com" drain
tools perform router 65536 l2tp group "wholesale.com" no drain
```

Conclusion

This example provides the LAC L2TP access server configuration and troubleshooting commands for the LAA architecture (tunneled-access) model.

Vport-Based Load Balancing on a LAG

This chapter describes Vport-based load balancing on a LAG.

Topics in this chapter include:

- [Applicability](#)
- [Overview](#)
- [Configuration](#)
- [Conclusion](#)
- [Appendix](#) with configuration files

Applicability

The information and MD-CLI configuration in this chapter is based on SR OS Release 22.10.R1.

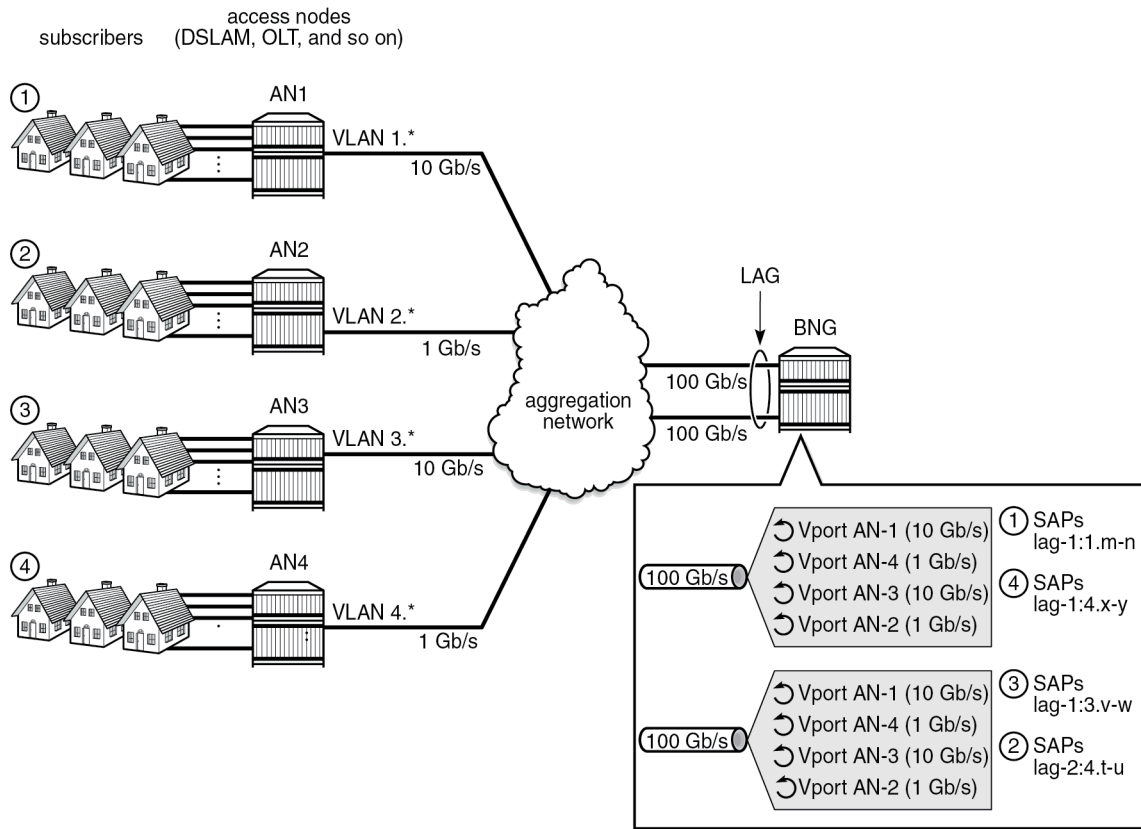
Vport-based load balancing on a LAG applies to all service router (SR) systems based on FP4 and higher. This functionality is not supported on Virtualized Service Router (VSR) because VSR does not support Vports.

The target audience for this chapter is subscriber management users who are already familiar with subscriber management and EVPN VPWS. In this chapter, the emphasis is on the LAG configuration.

Overview

In enhanced subscriber management (ESM), a Vport is a representation of a downstream access node that hosts subscribers. A Vport is used to control bandwidth toward the access node. When deployed on a link aggregation group (LAG), Vports must be configured on every LAG member port, as shown in the figure [Figure 29: Vport concept](#).

Figure 29: Vport concept



38344

The Vport bandwidth in a LAG can be configured in two ways:

- The configured Vport bandwidth is assigned to every LAG member port.
- The Vport on each link gets only a fraction of the total bandwidth of the access node that it represents.

In both cases, the configured Vport bandwidth corresponds to the full capacity of the access node that it controls (a bandwidth cap or ceiling per access node). The difference is in how this bandwidth is assigned by the system to each LAG member port, which is controlled by the **lag access adapt-qos mode link | port-fair** command.

When the configured Vport bandwidth is assigned to every LAG member port, oversubscription of the access node must be avoided by directing all traffic associated with a Vport to a single LAG member link. This configuration requires load balancing per Vport and is the focus of this chapter. Per-Vport load balancing is suitable in environments with a large variation in bandwidth consumption between subscribers within a Vport.

When the Vport on each link gets only a fraction of the total bandwidth of the access node, the configured Vport bandwidth is automatically distributed over the LAG member links: the Vport bandwidth per LAG member port is the Vport bandwidth divided by the number of LAG member ports.

In other words, each LAG member port gets an equal share of the configured bandwidth. This scenario calls for load balancing per subscriber, where traffic toward the same access node is distributed over the member links. This scenario is suitable for environments with subscribers with similar bandwidth

requirements. Otherwise, a few high-bandwidth-consuming subscribers within a Vport can use the same link, causing the aggregate bandwidth to exceed the Vport cap per LAG member port. This issue can cause unnecessary congestion and packet drops, while the instance of the same Vport on the other links remain underutilized.

In Releases earlier than Release 22.10, the implementation of load balancing per Vport, where the configured Vport bandwidth is assigned to every member, implies the following:

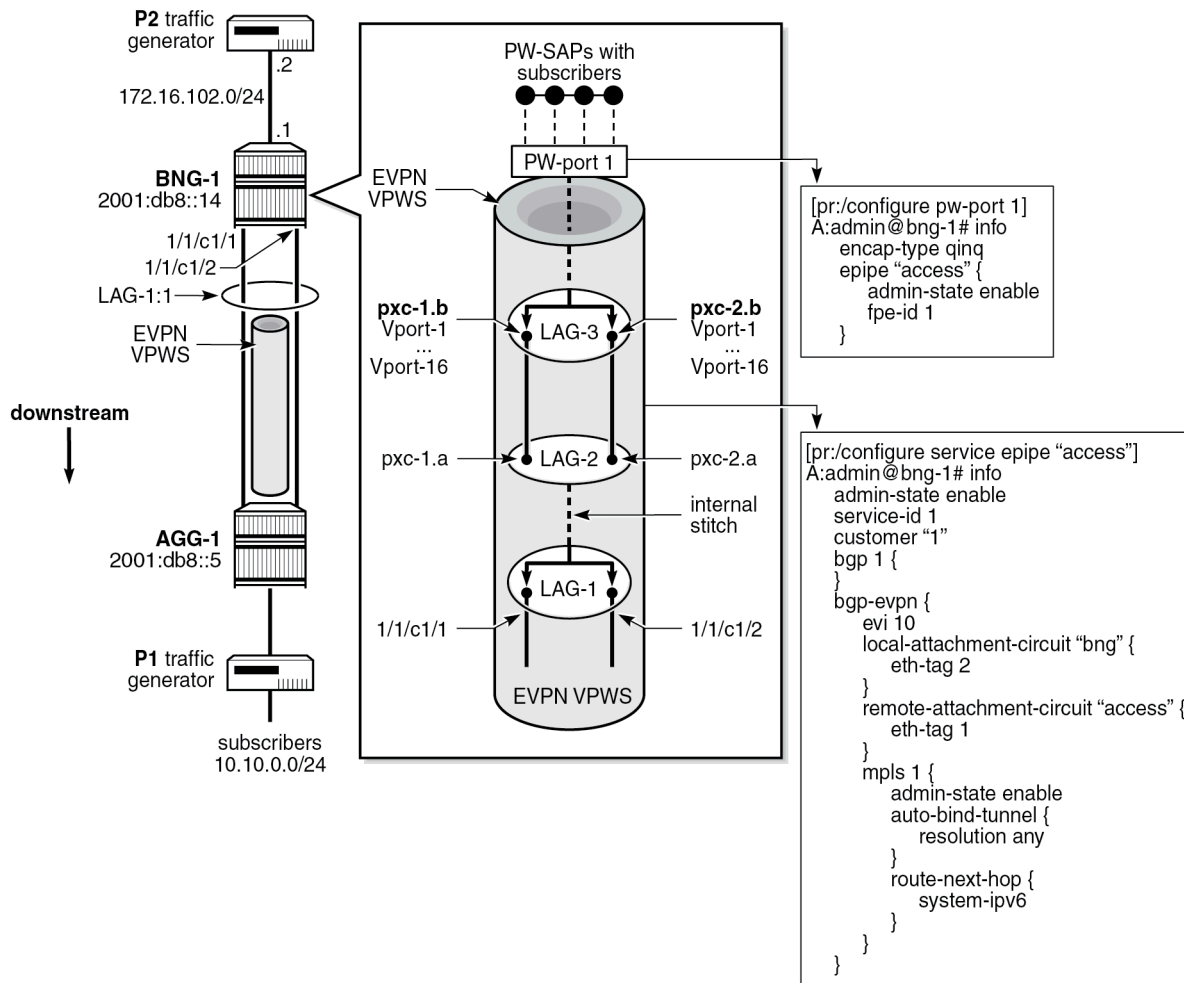
- The subscriber SAPs must be instantiated on all LAG member ports, which has a negative effect on the subscriber scalability that is driven by the finite number of SAPs per forwarding complex.
- All Vports are accounted with equal weight in the hashing algorithm, regardless of the configured bandwidth of the Vports, which could lead to suboptimal load balancing when Vports with different bandwidths are present on the LAG.

Release 22.10 expands load balancing per Vport to include the class and weight per Vport and the support for a single subscriber SAP instance per forwarding complex.

The focus of this chapter is on the class- and weight-based Vport load balancing where a single copy of a SAP is created per forwarding complex for each subscriber.

The figure [Figure 30: Example topology](#) shows the example topology used in this chapter.

Figure 30: Example topology



38342

In this setup:

- The subscribers are instantiated in 1:1 mode of operation (one subscriber per SAP) on a pseudowire (PW) port in the Broadband Network Gateway (BNG) "BNG-1".
- The PW-port is the termination point for the EVPN VPWS, which connects the BNG to an aggregation node "AGG-1" in the access network.
- The PW-port is based on the Forwarding Path Extension (FPE), with the LAG "lag-3" containing two PXC member ports, pxc-1.b and pxc-2.b.
- There are 16 Vports configured on each of the PXC ports in the LAG "lag-3".
- 32 IPv4 subscribers are associated with these Vports. The individual subscriber association with Vports is shown in Table 1.
- The EVPN VPWS connecting the BNG to "AGG-1" is configured over the LAG "lag-1" with two member ports on the BNG (ports 1/1/c1/1 and 1/1/c1/2).

- Traffic is sent in the downstream direction, from traffic generator port "p2" toward the simulated subscribers on traffic generator port "p1".
- The traffic flow and traffic load balancing in the BNG is examined at two points:
 - on the "lag-3" underlying the PW-port, where traffic is load-balanced per Vport in the ESM context
 - on the "lag-1" where traffic is load-balanced in the service context, outside of the ESM
- Bandwidth utilization on the LAG links is examined via **show** and **monitor** commands at the BNG.

Traffic load balancing on the LAGs "lag-1" and "lag-3" are independent of each other. Traffic on the LAG "lag-3" is load-balanced in the subscriber context and is Vport-aware, while traffic on the LAG "lag-1" is disjointed from the subscriber context. On the LAG "lag-1", service hashing mechanisms apply; on the LAG "lag-3", subscriber management hashing mechanisms apply.



Note: An example topology with FPE-based PW ports might give the impression that load balancing on the external links connecting the BNG to the AGG node is performed in the subscriber context, based on subscriber ID or Vport. This is not the case.

To demonstrate the two-stage load balancing, first on "lag-3" and then on "lag-1", an example topology with subscribers instantiated on a FPE based PW-port is chosen.

Although the focus of this chapter is class- and weight-based Vport load balancing, using the same traffic patterns, in addition, the following two other types of load balancing are evaluated:

- load balancing based on Vports without class and weights
- load balancing based on subscribers (subscriber IDs that are internally assigned identifiers for each subscriber)

Comparing the three types of load balancing helps to form a better overall picture about load balancing traffic options in a subscriber management context.

Association between subscribers and Vports

Subscribers are associated with Vports during the subscriber authentication phase. In this example, RADIUS is used for authentication.

The table [Table 6: Subscriber association with Vports](#) shows the mapping between subscribers and Vport names, Vport configured rates (bandwidth), classes, weights, and transmission (Tx) rates in frames per second (FPS) of generated traffic (offered traffic).

Table 6: Subscriber association with Vports

Class	Vport	Weight	Vport rate in kb/s	Tx rate FPS	Subscriber
1	vport-1	15	9 000 000	900	1
1	vport-2	5	3 000 000	300	2, 3
1	vport-3	5	3 000 000	300	4, 5
1	vport-4	5	3 000 000	300	6, 7
2	vport-5	15	3 000 000	300	8

Class	Vport	Weight	Vport rate in kb/s	Tx rate FPS	Subscriber
2	vport-6	5	1 000 000	100	9, 10
2	vport-7	5	1 000 000	100	11, 12
2	vport-8	5	1 000 000	100	13, 14
3	vport-9	7	1 400 000	140	15
3	vport-10	1	200 000	20	16, 17
3	vport-11	1	200 000	20	18, 19
3	vport-12	1	200 000	20	20, 21
3	vport-13	1	200 000	20	22, 23
3	vport-14	1	200 000	20	24, 25
3	vport-15	1	200 000	20	26, 27
3	vport-16	1	200 000	20	28, 29, 30, 31, 32

The Vports in SR have names from "vport-1" to "vport-16".

The class represents a bandwidth tier. Vports with similarly configured bandwidth values can be grouped into classes and can be load-balanced independently of Vports in other classes. For example, Vports in class 1 are distributed over the LAG member ports independently of the Vports in classes 2 and 3.

The weight is configured for each Vport. Within each class, the hashing algorithm tries to equalize the sum of weights across the LAG member ports.

The traffic generator sends a traffic stream for each subscriber. For example, the traffic generator sends 900 fps toward subscriber 1 associated with Vport "vport-1", while toward the subscribers 28, 29, 30, 31, and 32 associated with "vport-16", the traffic generator sends an aggregated rate of 20 fps, or 4 fps toward each subscriber. The packet size is uniform (200 bytes) across the subscribers.

The selected traffic rates represent the Vport bandwidth. In other words, the ratio of the traffic rates within each Vport is the same as the ratio between the configured Vport bandwidths, which allows for a more intuitive interpretation of the results.

Because this setup is run on PC-based sims, the selected offered rates are low (tens of fps rather than millions of fps). However, the rates are high enough for the purpose of this chapter.

For brevity, the subscribers in this table are represented by numerical values. In SR, the subscriber numbers are prepended with the string "ipoe -", for example, subscriber 1 in the table represents subscriber "ipoe-1" in the SR.

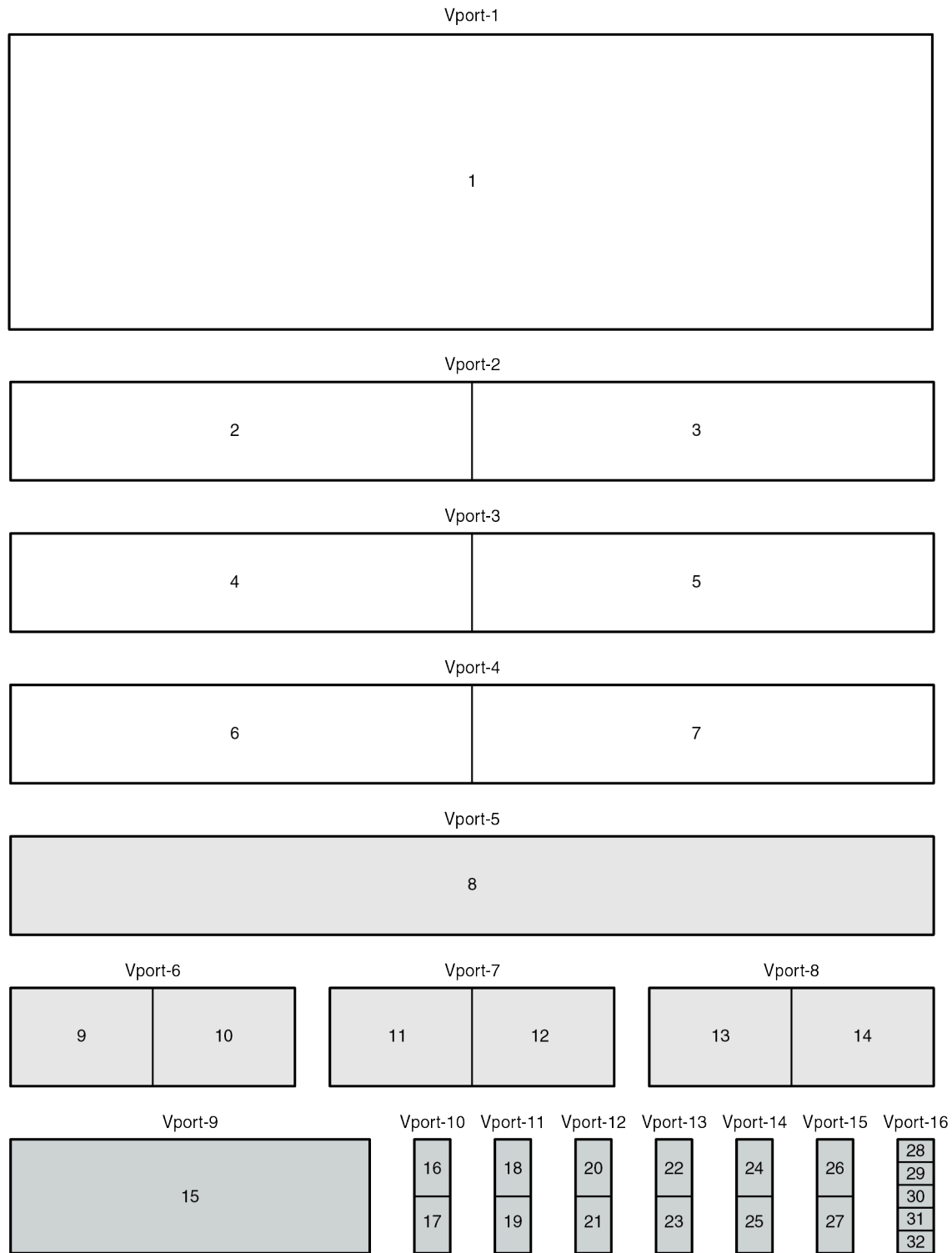
The table [Table 6: Subscriber association with Vports](#) shows that the configured Vport bandwidth and, consequently, the transmission rates are selected in a very unbalanced way. These unbalanced values are used to allow for a clearer interpretation of the results that are presented later in this chapter.

For example, traffic for "vport-9" is seven times higher than traffic in each of the Vports from 10 to 16. If the eight Vports from 9 to 16 were distributed without regarding their configured Vport bandwidth, then the most likely outcome would be that four Vports would be hashed to one link and four to the other. This outcome would result in a very uneven load balancing with traffic utilization on one link being more than twice the utilization on the other link.

Vport classes and weights ensure that uneven load balancing does not happen and that traffic is more evenly split across the two LAG member ports.

The figure [Figure 31: Vport bandwidth distribution](#) is a graphical representation of the Vport bandwidth in the table [Table 6: Subscriber association with Vports](#), where the size of each rectangle represents the Vport bandwidth configured rate. Vports in different classes are represented in different colors. Vports are divided into smaller areas, where each area represents the bandwidth of subscribers associated with the Vport. For example, the size of Vport 1 (9 Gb/s) is three times the size of each of the Vports 2, 3, 4, and 5 (3 Gb/s), or 45 times the size of any of the Vports from 10 to 16 (200 Mb/s). The SR independently attempts to equalize traffic in class 1, class 2, and class 3.

Figure 31: Vport bandwidth distribution



38343

Configuration

Complete configuration files for the AGG-1 and the BNG-1 node in this topology are provided in the [appendix](#).

This section describes key configuration blocks and **show** output on the BNG.

The configuration section is split into the three following sections:

- FPE
- Vports
- LAG

FPE

The setup on the BNG requires FPE-based PXC's for the PW-port. An arbitrary choice is made to select a port-based PXC instead of the MAC- or internal-based PXC. The following two PXC's will become part of the PXC-based LAG on which the subscribers are instantiated.

```
[pr:/configure port-xc]
A:admin@bng-1#

    pxc 1 {
        admin-state enable
        description "pw-port lag 2,3"
        port-id 1/1/c4/2
    }
    pxc 2 {
        admin-state enable
        description "pw-port lag 2,3"
        port-id 1/1/c4/3
    }

A:admin@bng-1# /show port-xc

=====
Port Cross-Connect Information
=====
PXC   Admin   Oper    Port      Description
Id    State  State   Id
-----
1     Up      Up      1/1/c4/2  pw-port lag 2,3
2     Up      Up      1/1/c4/3  pw-port lag 2,3
-----
No. of PXC's: 2
=====
```

The logical PXC ports must be explicitly configured and enabled by the operator:

```
[pr:/configure]
A:admin@bng-1#
    port pxc-1.a {
        admin-state enable
    }
    port pxc-1.b {
```

```

        admin-state enable
    }
    port pxc-2.a {
        admin-state enable
    }
    port pxc-2.b {
        admin-state enable
    }

```

The FPE configuration that is required for the PW-port is as follows:

```

[pr:/configure]
A:admin@bng-1#
    fwd-path-ext {
        sdp-id-range {
            start 17500
            end 17600
        }
        fpe 1 {
            description "pw-port on a lag"
            path {
                xc-lag-a "lag-2"
                xc-lag-b "lag-3"
            }
            application {
                pw-port-extension {
                }
            }
        }
    }

```

A:admin@bng-1#/show fwd-path-ext fpe 1

```

=====
FPE Id: 1
=====
Description      : pw-port on a lag
Multi-Path       : Disabled
Path             : lag-2, lag-3
Pw Port Extension : Enabled
Sub Mgmt Extension : Disabled
Vxlan            : Disabled
Segment-Routing V6 : Disabled
If-A Qos Policy  : default
If-B Qos Policy  : default
=====
Oper             : up
Oper             : N/A
Oper             : down

```

Vports

The egress QoS hierarchy for the subscriber is the following:

- subscriber queues with their own rates and buffering capabilities
- the aggregate rate of the subscriber – the total traffic from all the queues of a subscriber cannot exceed this rate
- the aggregate rate of a group of subscribers connected to the same access node or a PON – this aggregate rate is controlled by a Vport
- the aggregate rate of subscribers connected to the same local port – this aggregate rate is controlled by a port-scheduler-policy

Vports are configured on every member port of "lag-3". The LAG underlies the PW-port on which the subscribers are terminated. The member ports of "lag-3" are pxc-1.b and pxc-2.b.

The Vports are attached to the port scheduler via a port scheduler policy named "lag-3-pxc", which is shown in the following configuration.

Only the configuration of the pxc-1.b is shown. The configuration of port-2.b is identical to that for port pxc-1.b.

Each Vport is configured with an aggregate rate, the class, and the weight as described in the table [Table 6: Subscriber association with Vports](#).

The mapping between the Vport and the subscriber is based on the `int-dest-id` string returned by RADIUS during subscriber authentication. For example, the RADIUS-returned string for subscriber "ipoe-1" is carried in the Nokia VSA `Alc-Int-Dest-Id-Str` with value "vport-1".

The Vport configuration and port-scheduler policy reference under pxc-1.b (a member port of "lag-3") is as follows:

```
pr:/configure port pxc-1.b]
A:admin@bng-1#
  admin-state enable
  description "PXC lag-3, pw-port termination"
  ethernet {
    access {
      egress {
        virtual-port "vport-1" {
          aggregate-rate {
            rate 9000000
          }
          host-match {
            int-dest-id "vport-1" { }
          }
          lag-per-link-hash {
            class 1
            weight 15
          }
        }
        virtual-port "vport-2" {
          aggregate-rate {
            rate 3000000
          }
          host-match {
            int-dest-id "vport-2" { }
          }
          lag-per-link-hash {
            class 1
            weight 5
          }
        }
        virtual-port "vport-3" {
          aggregate-rate {
            rate 3000000
          }
          host-match {
            int-dest-id "vport-3" { }
          }
          lag-per-link-hash {
            class 1
            weight 5
          }
        }
        virtual-port "vport-4" {
```



```
        aggregate-rate {
            rate 3000000
        }
        host-match {
            int-dest-id "vport-4" { }
        }
        lag-per-link-hash {
            class 1
            weight 5
        }
    }
    virtual-port "vport-5" {
        aggregate-rate {
            rate 3000000
        }
        host-match {
            int-dest-id "vport-5" { }
        }
        lag-per-link-hash {
            class 2
            weight 15
        }
    }
    virtual-port "vport-6" {
        aggregate-rate {
            rate 1000000
        }
        host-match {
            int-dest-id "vport-6" { }
        }
        lag-per-link-hash {
            class 2
            weight 5
        }
    }
    virtual-port "vport-7" {
        aggregate-rate {
            rate 1000000
        }
        host-match {
            int-dest-id "vport-7" { }
        }
        lag-per-link-hash {
            class 2
            weight 5
        }
    }
    virtual-port "vport-8" {
        aggregate-rate {
            rate 1000000
        }
        host-match {
            int-dest-id "vport-8" { }
        }
        lag-per-link-hash {
            class 2
            weight 5
        }
    }
    virtual-port "vport-9" {
        aggregate-rate {
            rate 1400000
        }
        host-match {
```

```
        int-dest-id "vport-9" { }
    }
    lag-per-link-hash {
        class 3
        weight 7
    }
}
virtual-port "vport-10" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-10" { }
    }
    lag-per-link-hash {
        class 3
        weight 1
    }
}
virtual-port "vport-11" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-11" { }
    }
    lag-per-link-hash {
        class 3
        weight 1
    }
}
virtual-port "vport-12" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-12" { }
    }
    lag-per-link-hash {
        class 3
        weight 1
    }
}
virtual-port "vport-13" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-13" { }
    }
    lag-per-link-hash {
        class 3
        weight 1
    }
}
virtual-port "vport-14" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-14" { }
    }
    lag-per-link-hash {
        class 3
    }
}
```

```

        weight 1
    }
}
virtual-port "vport-15" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-15" { }
    }
    lag-per-link-hash {
        class 3
        weight 1
    }
}
virtual-port "vport-16" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-16" { }
    }
    lag-per-link-hash {
        class 3
        weight 1
    }
}
}
}
egress {
    port-scheduler-policy {
        policy-name "lag-3-pxc"
    }
}
}
}

```

The following command shows the Vport instances created under port pxc-1.b:

```

A:admin@bng-1# show port pxc-1.b vport

=====
Port pxc-1.b Access Egress vport
=====
VPort Name      : vport-1
Description     : (Not Specified)
Port Sched Policy : None
Sched Policy    : None
Rate Limit      : 90000000
Limit Unused BW : Disabled
Rate Modify     : disabled
Modify delta    : 0
Monitor Port Sched : Disabled
Lag PLHW class  : 1
Lag PLHW weight : 15

Host-Matches
-----
Dest: vport-1
-----

VPort Name      : vport-2
Description     : (Not Specified)
Port Sched Policy : None

```

```
Sched Policy      : None
Rate Limit       : 3000000
Limit Unused BW  : Disabled
Rate Modify      : disabled
Modify delta     : 0
Monitor Port Sched : Disabled
Lag PLHW class   : 1
Lag PLHW weight  : 5

Host-Matches
-----
Dest: vport-2
-----

VPort Name       : vport-3
Description      : (Not Specified)
Port Sched Policy : None
Sched Policy     : None
Rate Limit       : 3000000
Limit Unused BW  : Disabled
Rate Modify      : disabled
Modify delta     : 0
Monitor Port Sched : Disabled
Lag PLHW class   : 1
Lag PLHW weight  : 5

Host-Matches
-----
Dest: vport-3
-----
---snip---
```

The following command shows the association between the Vports and the subscribers for port pxc-1.b:

```
A:admin@bng-1# show port pxc-1.b vport associations
```

```
=====
Port pxc-1.b Access Egress vport
=====
-----
VPort "vport-1"
-----
svc-id : 10
sap    : pw-1:1.1
subscr: ipoe-1
ip     : 10.10.0.16
mac    : 00:14:01:00:00:01 pppoe-sid: N/A
-----
VPort "vport-2"
-----
svc-id : 10
sap    : pw-1:1.2
subscr: ipoe-2
ip     : 10.10.0.21
mac    : 00:14:01:00:00:02 pppoe-sid: N/A
svc-id : 10
sap    : pw-1:1.3
subscr: ipoe-3
ip     : 10.10.0.41
mac    : 00:14:01:00:00:03 pppoe-sid: N/A
```

```
-----
VPort "vport-3"
-----
svc-id : 10
sap   : pw-1:1.4
subscr: ipoe-4
ip    : 10.10.0.24
mac   : 00:14:01:00:00:04 pppoe-sid: N/A
svc-id : 10
sap   : pw-1:1.5
subscr: ipoe-5
ip    : 10.10.0.38
mac   : 00:14:01:00:00:05 pppoe-sid: N/A
---snip---
```

The following configuration shows that each subscriber has only one egress queue, which is port-parented. This queue is configured in the egress SAP policy, which is then referenced in the SLA profile assigned to the subscriber during the authentication phase.

Port-schedule policy "lag-3-pxc" is also configured under the QoS hierarchy, using default values in this case (which is why there is nothing explicitly configured under **port-scheduler-policy**).

```
[pr:/configure qos]
A:admin@bng-1#
  sap-egress "sap-egess-1" {
    policy-id 2
    queue 1 {
      port-parent {
      }
    }
  }
  port-scheduler-policy "lag-3-pxc" {
  }
```

The SLA profile for the subscriber must include **vport** as the port-parent location, otherwise the subscriber would not be associated with the Vport:

```
[pr:/configure subscriber-mgmt sla-profile "sla-profile-1"]
A:admin@bng-1#
  egress {
    qos {
      sap-egress {
        policy-name "sap-egess-1"
        port-parent-location vport
      }
    }
  }
```

There are 32 subscribers instantiated in the BNG:

```
A:admin@bng-1# show service active-subscribers summary
```

```
=====
Active Subscriber table summary
=====
Total Count      : 32
=====
```

The following **show** command displays the subscriber hierarchy:

```
A:admin@bng-1# show service active-subscribers hierarchy

=====
Active Subscribers Hierarchy
=====
-- ipoe-1
  (sub-profile-1)
  |
  +-- sap:[pw-1:1.1] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:14:01:00:00:01 - svc:10
      |
      +-- 10.10.0.25 - DHCP

-- ipoe-2
  (sub-profile-1)
  |
  +-- sap:[pw-1:1.2] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:14:01:00:00:02 - svc:10
      |
      +-- 10.10.0.26 - DHCP

-- ipoe-3
  (sub-profile-1)
  |
  +-- sap:[pw-1:1.3] - sla:sla-profile-1
    |
    +-- IPOE-session - mac:00:14:01:00:00:03 - svc:10
      |
      +-- 10.10.0.27 - DHCP

---snip---

-----
Number of active subscribers : 32
Flags: (N) = the host or the managed route is in non-forwarding state
-----
---snip---
```

Some of the additional **show** commands that can be used to display subscriber states are:

```
show service active-subscribers detail
show service id "vport-hashing" subscriber-hosts detail
show service id "vport-hashing" ipoe session detail
show service id "vport-hashing" dhcp lease-state detail
```

The following **show** commands display information related to the QoS hierarchy:

```
show qos scheduler-hierarchy port pxc-1.b detail
show qos agg-rate port pxc-1.b vport "vport-1" detail
```

LAG

The two LAGs examined in this chapter are:

- PXC LAG "lag-3", which underlies the PW-port where the subscribers are terminated. This LAG is implicitly applied to the ESM context (directly via FPE, indirectly via PW-port and PW capture SAP) where load balancing is performed based on Vports.
- LAG "lag-1" connects the BNG to the aggregation node "AGG-1". This LAG is applied in the service context. Load balancing on this LAG is performed based on the service context.

This chapter examines load balancing over member links for both LAGs.

PXC LAG "lag-3" (ESM)

The configuration for "lag-3" is the following:

```
[pr:/configure lag "lag-3"]
A:admin@bng-1#
  admin-state enable
  description "fpe pw-port pxc lag - termination side"
  mode hybrid
  max-ports 64
  access {
    per-fp-ing-queuing true
    per-fp-egr-queuing true
    per-fp-sap-instance true
    adapt-qos {
      mode link
    }
  }
  per-link-hash {
    weighted {
      subscriber-hash-mode vport
    }
  }
  port pxc-1.b {
  }
  port pxc-2.b {
  }
```

The **per-link-hash** command enables weighted Vport hashing in the subscriber context.

If classes and weights for Vports are not configured, hashing is still performed per Vport, in which case all Vports are treated equally, regardless of the bandwidth.

With the **per-fp-sap-instance** command enabled, the system allocates only one SAP instance per subscriber per forwarding complex.

For example, if a LAG has two member ports on the same forwarding complex, then for each subscriber, only one SAP instance is allocated (as opposed to one SAP instance on each member port). The result of this allocation is improved scaling because the number of SAPs per forwarding complex is finite. The scaling improvement can be verified with the following commands.

Before any subscriber is instantiated, the number of subscriber hosts and SLA profile instances is 0. A number of SAPs are already allocated (three in this case), related to non-subscriber interfaces (EVPN VPWS, regular interfaces, and so on).



Note: The setup runs on PC-based simulators where total scaling figures are reduced.

```
A:admin@bng-1# tools dump resource-usage card "1" fp 1
```

```

=====
Resource Usage Information for Card Slot #1 FP #1
=====
-----
Total  Allocated  Free
-----
Subscriber Hosts -      262143      0      262143
Subscriber SLA Profile Instances |    131071      0    131071
SAP Instances |        98303      3    98300
=====
    
```

After 32 subscribers are instantiated on the PW-port and on "lag-3", only 32 SAP instances are allocated:

35 allocated SAP instances – 3 residual SAP instances = 32 SAP instances (for 32 subscriber hosts)

The following command shows that 32 subscriber hosts and 35 SAP instances are allocated:

```

A:admin@bng-1# /tools dump resource-usage card 1 fp 1

=====
Resource Usage Information for Card Slot #1 FP #1
=====
-----
Total  Allocated  Free
-----
Subscriber Hosts -      262143      32    262111
Subscriber SLA Profile Instances |    131071      32    131039
SAP Instances |        98303      35    98268
=====
    
```

The **per-fp-ing-queuing** and **per-fp-egr-queuing** commands have similar effect for queues, although the **per-fp-egr-queuing true** command is the only mode of operation in subscriber management on a LAG.

The **access adapt-qos mode link** command instructs the system to apply the configured Vport bandwidth to every member port of a LAG. This command is required in per-Vport load balancing.

The alternative mode is **port-fair**, where the configured Vport bandwidth is divided across the member ports in the LAG (each member port gets a share of the configured bandwidths). Per-Vport load balancing is not recommended in this case due to likely overshoot of the Vport assigned bandwidth to each member port, which would result in unnecessary packet drops.

Examining Vport load balancing effects

For a better understanding of what per-Vport load balancing means, the results for three cases are compared:

- traffic utilization on LAG member links with weighted (for class and weight) per-Vport load balancing
- traffic utilization on LAG member links with Vport load balancing but without classes and weights configured
- traffic utilization on LAG member links with per-subscriber load balancing (Vport load balancing is disabled)

The expectation is that there is a higher degree of load balancing in the first case than in the next two cases. This different degree for load balancing is because of the unequal nature of the generated traffic,

where some subscribers send significantly more traffic than others, and the inability of the latter two cases to deal with this lack of balance.

Load balancing per Vport with classes and weights

The configuration file for BNG-1 can be found [here](#).

In this setup, classes and weights configured under Vports are considered in the hashing algorithm. The following command shows how Vports are distributed over the LAG member ports. Although all Vports are instantiated on both member ports of "lag-3", this command shows how the actual traffic for each Vport is distributed over the member links of "lag-3":

```
A:admin@bng-1# show lag "lag-3" associations per-link-hash vport
```

```
=====
VPort Associations
=====
Vport Name                Active Link
-----
vport-1                   pxc-1.b
vport-2                   pxc-2.b
vport-3                   pxc-2.b
vport-4                   pxc-2.b
vport-5                   pxc-1.b
vport-6                   pxc-2.b
vport-7                   pxc-2.b
vport-8                   pxc-2.b
vport-9                   pxc-2.b
vport-10                  pxc-1.b
vport-11                  pxc-1.b
vport-12                  pxc-1.b
vport-13                  pxc-1.b
vport-14                  pxc-1.b
vport-15                  pxc-1.b
vport-16                  pxc-1.b
=====
Number of VPort associations: 16
=====
```

The following command shows how subscriber traffic is distributed over the member ports, based on each subscriber's association with a Vport. For example, the subscriber "ipoe-1" is associated with "vport-1". The output of the previous command shows that "vport-1" is hashed to port pxc-1.b and, therefore, the LAG active link (as shown below) for the subscriber "ipoe-1" is pxc-1.b.

```
A:admin@bng-1# show service id "vport-hashing" subscriber-hosts detail
```

```
=====
Subscriber Host table
=====
Sap
  IP Address
  MAC Address
  Subscriber
  PPPoE-SID
  Origin
  Fwding State
-----
[pw-1:1.1]
  10.10.0.42
  00:14:01:00:00:01
  ipoe-1
  N/A
  DHCP
  Fwding
-----
```

```

Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport      : vport-1
LAG Active Link   : pxc-1.b
Acct-Session-Id     : B496FF00000070639A19D0
Acct-Q-Inst-Session-Id: B496FF00000071639A19D0
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
[pw-1:1.2]
10.10.0.43
00:14:01:00:00:02          N/A          DHCP          Fwding
ipoe-2
-----
Subscriber-interface : sub-int-1
Group-interface      : group-int-1
Sub Profile          : sub-profile-1
SLA Profile          : sla-profile-1
App Profile          : N/A
Egress Q-Group       : N/A
Egress Vport      : vport-2
LAG Active Link   : pxc-2.b
Acct-Session-Id     : B496FF00000072639A19D0
Acct-Q-Inst-Session-Id: B496FF00000073639A19D0
Address Origin       : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status   : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out  : No
DIAMETER session ID Gx: N/A
-----
---snip---
    
```

The table [Table 7: Vport distribution over member ports](#) repeats the Vport distribution shown in the table [Table 6: Subscriber association with Vports](#), but adds a column with the active member link for each Vport:

Table 7: Vport distribution over member ports

Class	Vport	Weight	Vport rate in kb/s	Tx rate FPS	Subscriber	Member link
1	vport-1	15	9 000 000	900	1	pxc-1.b
1	vport-2	5	3 000 000	300	2, 3	pxc-2.b
1	vport-3	5	3 000 000	300	4, 5	pxc-2.b
1	vport-4	5	3 000 000	300	6, 7	pxc-2.b
2	vport-5	15	3 000 000	300	8	pxc-1.b
2	vport-6	5	1 000 000	100	9, 10	pxc-2.b

Class	Vport	Weight	Vport rate in kb/s	Tx rate FPS	Subscriber	Member link
2	vport-7	5	1 000 000	100	11, 12	pxc-2.b
2	vport-8	5	1 000 000	100	13, 14	pxc-2.b
3	vport-9	7	1 400 000	140	15	pxc-2.b
3	vport-10	1	200 000	20	16, 17	pxc-1.b
3	vport-11	1	200 000	20	18, 19	pxc-1.b
3	vport-12	1	200 000	20	20, 21	pxc-1.b
3	vport-13	1	200 000	20	22, 23	pxc-1.b
3	vport-14	1	200 000	20	24, 25	pxc-1.b
3	vport-15	1	200 000	20	26, 27	pxc-1.b
3	vport-16	1	200 000	20	28, 29, 30, 31, 32	pxc-1.b

To verify the Vport distribution over member ports, the traffic on the member ports of "lag-3" can be monitored.

An efficient way to observe utilization on ports in an SR is to run a **monitor port** command that periodically collects the port data (forwarded octets and packets) and displays them in various forms (raw counts or as rates). This **monitor port** command is used on regular ports on "lag-1" in the next section. However, the **monitor port** command cannot be used on PXC ports.

Because the **monitor port** command is not supported on PXC ports, a dedicated **monitor-lag** command is developed via pysros. The output of this command shows the distribution of traffic per LAG member port, per Vport, and per subscriber. Rates are displayed in percentages of the total downstream traffic sent toward all subscribers. During each command execution, the data is, by default, collected three times in 10 second intervals (this frequency is configurable).

This example demonstrates that bandwidth is evenly distributed over the two LAG member ports (approximately 50% on pxc-1.b port and 50% on pxc-2.b port). Subscriber rates and subscriber to Vport mappings are also consistent with the expectations according to the table [Table 7: Vport distribution over member ports](#).

The output shows that in each class, the high-bandwidth Vports ("vport-1" in class 1, "vport-5" in class 2, and "vport-9" in class 3) are counterbalanced with lower-bandwidth Vports from the same class that are hashed to the opposite link. In this way, load balancing is distributed in 50/50 ratio over the two member ports on the "lag-3": both member ports pxc-1.b and pxc-2.b get approximately 50% of the load.

```
A:admin@bng-1# monitor-lag -l lag-3 -i 10 -r 3

-----
                        Run 1
-----
Object                   |           BW % of Total
-----
pxc-1.b-----49.41
|-----vport-1-----34.41
|           |-----ipoe-1-----34.41
```

```

-----vport-2-----0.00
-----vport-3-----0.00
-----vport-4-----0.00
-----vport-5-----11.47
|-----ipoe-8-----11.47
-----vport-6-----0.00
-----vport-7-----0.00
-----vport-8-----0.00
-----vport-9-----0.00
-----vport-10-----0.59
|-----ipoe-16-----0.29
|-----ipoe-17-----0.29
-----vport-11-----0.59
|-----ipoe-19-----0.29
|-----ipoe-18-----0.29
-----vport-12-----0.59
|-----ipoe-20-----0.29
|-----ipoe-21-----0.29
-----vport-13-----0.59
|-----ipoe-23-----0.29
|-----ipoe-22-----0.29
-----vport-14-----0.59
|-----ipoe-25-----0.29
|-----ipoe-24-----0.29
-----vport-15-----0.59
|-----ipoe-27-----0.29
|-----ipoe-26-----0.29
-----vport-16-----0.00
|-----ipoe-32-----0.00
|-----ipoe-30-----0.00
|-----ipoe-31-----0.00
|-----ipoe-29-----0.00
|-----ipoe-28-----0.00

pxc-2.b-----50.59
|-----vport-1-----0.00
|-----vport-2-----11.47
|-----ipoe-3-----5.88
|-----ipoe-2-----5.59
-----vport-3-----11.47
|-----ipoe-4-----5.88
|-----ipoe-5-----5.59
-----vport-4-----11.18
|-----ipoe-7-----5.59
|-----ipoe-6-----5.59
-----vport-5-----0.00
-----vport-6-----3.53
|-----ipoe-10-----1.76
|-----ipoe-9-----1.76
-----vport-7-----3.53
|-----ipoe-12-----1.76
|-----ipoe-11-----1.76
-----vport-8-----4.12
|-----ipoe-14-----2.06
|-----ipoe-13-----2.06
-----vport-9-----5.29
|-----ipoe-15-----5.29
-----vport-10-----0.00
-----vport-11-----0.00
-----vport-12-----0.00
-----vport-13-----0.00
-----vport-14-----0.00
-----vport-15-----0.00
    
```

```

|-----vport-16-----0.00

-----
Run 2
-----
Object | BW % of Total
-----
pxc-1.b-----49.99
|-----vport-1-----33.58
| |-----ipoe-1-----33.58
|-----vport-2-----0.00
|-----vport-3-----0.00
|-----vport-4-----0.00
|-----vport-5-----11.20
| |-----ipoe-8-----11.20
|-----vport-6-----0.00
|-----vport-7-----0.00
|-----vport-8-----0.00
|-----vport-9-----0.00
|-----vport-10-----0.74
| |-----ipoe-16-----0.37
| |-----ipoe-17-----0.37
|-----vport-11-----0.74
| |-----ipoe-19-----0.37
| |-----ipoe-18-----0.37
|-----vport-12-----0.74
| |-----ipoe-20-----0.37
| |-----ipoe-21-----0.37
|-----vport-13-----0.74
| |-----ipoe-23-----0.37
| |-----ipoe-22-----0.37
|-----vport-14-----0.74
| |-----ipoe-25-----0.37
| |-----ipoe-24-----0.37
|-----vport-15-----0.74
| |-----ipoe-27-----0.37
| |-----ipoe-26-----0.37
|-----vport-16-----0.75
| |-----ipoe-32-----0.15
| |-----ipoe-30-----0.15
| |-----ipoe-31-----0.15
| |-----ipoe-29-----0.15
| |-----ipoe-28-----0.15

pxc-2.b-----50.01
|-----vport-1-----0.00
|-----vport-2-----11.19
| |-----ipoe-3-----5.60
| |-----ipoe-2-----5.59
|-----vport-3-----11.20
| |-----ipoe-4-----5.60
| |-----ipoe-5-----5.60
|-----vport-4-----11.20
| |-----ipoe-7-----5.60
| |-----ipoe-6-----5.59
|-----vport-5-----0.00
|-----vport-6-----3.73
| |-----ipoe-10-----1.87
| |-----ipoe-9-----1.87
|-----vport-7-----3.73
    
```

```

|-----ipoe-12-----1.87
|-----ipoe-11-----1.87
|-----vport-8-----3.73
|-----ipoe-14-----1.86
|-----ipoe-13-----1.86
|-----vport-9-----5.22
|-----ipoe-15-----5.22
|-----vport-10-----0.00
|-----vport-11-----0.00
|-----vport-12-----0.00
|-----vport-13-----0.00
|-----vport-14-----0.00
|-----vport-15-----0.00
|-----vport-16-----0.00

-----
                                Run 3
-----
Object          |          BW % of Total
-----
pxc-1.b-----50.01
|-----vport-1-----33.58
|-----ipoe-1-----33.58
|-----vport-2-----0.00
|-----vport-3-----0.00
|-----vport-4-----0.00
|-----vport-5-----11.19
|-----ipoe-8-----11.19
|-----vport-6-----0.00
|-----vport-7-----0.00
|-----vport-8-----0.00
|-----vport-9-----0.00
|-----vport-10-----0.74
|-----ipoe-16-----0.37
|-----ipoe-17-----0.37
|-----vport-11-----0.74
|-----ipoe-19-----0.37
|-----ipoe-18-----0.37
|-----vport-12-----0.75
|-----ipoe-20-----0.38
|-----ipoe-21-----0.38
|-----vport-13-----0.75
|-----ipoe-23-----0.38
|-----ipoe-22-----0.38
|-----vport-14-----0.75
|-----ipoe-25-----0.38
|-----ipoe-24-----0.38
|-----vport-15-----0.75
|-----ipoe-27-----0.38
|-----ipoe-26-----0.38
|-----vport-16-----0.74
|-----ipoe-32-----0.15
|-----ipoe-30-----0.15
|-----ipoe-31-----0.15
|-----ipoe-29-----0.15
|-----ipoe-28-----0.15

pxc-2.b-----49.99
|-----vport-1-----0.00
|-----vport-2-----11.19
    
```

```

|-----ipoe-3-----5.60
|-----ipoe-2-----5.60
|-----vport-3-----11.19
|-----ipoe-4-----5.60
|-----ipoe-5-----5.60
|-----vport-4-----11.19
|-----ipoe-7-----5.60
|-----ipoe-6-----5.60
|-----vport-5-----0.00
|-----vport-6-----3.73
|-----ipoe-10-----1.86
|-----ipoe-9-----1.86
|-----vport-7-----3.73
|-----ipoe-12-----1.87
|-----ipoe-11-----1.86
|-----vport-8-----3.74
|-----ipoe-14-----1.87
|-----ipoe-13-----1.87
|-----vport-9-----5.22
|-----ipoe-15-----5.22
|-----vport-10-----0.00
|-----vport-11-----0.00
|-----vport-12-----0.00
|-----vport-13-----0.00
|-----vport-14-----0.00
|-----vport-15-----0.00
|-----vport-16-----0.00
    
```

Another way to verify the Vport distribution over member ports is to run the following command:

```
show port "pxc-1.b" vport statistics
```

The output of this command shows the number of forwarded octets and packets. By running this command periodically, and with the help of some arithmetic, it can be deduced how much traffic is forwarded by each port.

Load balancing per Vport without classes and weights

In this example, Vport classes and weights are all set to the same value. This scenario is the same as one where classes and weight are not used at all. Traffic is still load-balanced per Vport but with no regard to the bandwidth of each Vport. In other words, all Vports are treated equally, contrary to the fact that their configured bandwidth is very different.

The configuration file for BNG-1 can be found [here](#) .

The same commands are used as in the previous example. The output of the following command shows that the ports are hashed very differently than before, with Vports evenly distributed between the two member ports (eight Vports hashed to pxc-1.b and eight Vports hashed to pxc-2.b).

```

A:admin@bng-1# show lag "lag-3" associations per-link-hash vport
=====
VPort Associations
=====
Vport Name          Active Link
-----
vport-1             pxc-1.b
vport-2             pxc-2.b
vport-3             pxc-1.b
    
```

```

vport-4          pxc-2.b
vport-5          pxc-2.b
vport-6          pxc-1.b
vport-7          pxc-1.b
vport-8          pxc-2.b
vport-9          pxc-1.b
vport-10         pxc-2.b
vport-11         pxc-1.b
vport-12         pxc-2.b
vport-13         pxc-1.b
vport-14         pxc-2.b
vport-15         pxc-1.b
vport-16         pxc-2.b
=====
Number of VPort associations: 16
=====
    
```

The subscriber association with Vports and member ports is consistent with the output of the preceding command:

```

A:admin@bng-1# show service id "vport-hashing" subscriber-hosts detail

=====
Subscriber Host table
=====
Sap
  IP Address
  MAC Address          PPPoE-SID      Origin      Fwding State
  Subscriber
-----
[pw-1:1.1]
  10.10.0.74
  00:14:01:00:00:01    N/A          DHCP        Fwding
  ipoe-1
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
Egress Q-Group      : N/A
Egress Vport       : vport-1
LAG Active Link     : pxc-1.b
Acct-Session-Id    : B496FF000000D0639A24FD
Acct-Q-Inst-Session-Id: B496FF000000D1639A24FD
Address Origin      : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status  : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
[pw-1:1.2]
  10.10.0.75
  00:14:01:00:00:02    N/A          DHCP        Fwding
  ipoe-2
-----
Subscriber-interface : sub-int-1
Group-interface     : group-int-1
Sub Profile         : sub-profile-1
SLA Profile         : sla-profile-1
App Profile         : N/A
    
```



```
Egress Q-Group      : N/A
Egress Vport       : vport-2
LAG Active Link    : pxc-2.b
Acct-Session-Id   : B496FF000000D4639A24FD
Acct-Q-Inst-Session-Id: B496FF000000D5639A24FD
Address Origin    : Dynamic
OT HTTP Rdr IP-FltrId : N/A
OT HTTP Rdr Status : N/A
OT HTTP Rdr Fltr Src : N/A
HTTP Rdr URL Override : N/A
GTP local break-out : No
DIAMETER session ID Gx: N/A
-----
---snip---
```

The table [Table 8: Vport distribution over member ports](#) repeats the Vport distribution over member ports from the table [Table 6: Subscriber association with Vports](#) while adding a column with the active member link for each Vport.

Table 8: Vport distribution over member ports

Class	Vport	Weight	Vport rate in kb/s	Tx rate FPS	Subscriber	Member link
1	Vport-1	15	9 000 000	900	1	pxc-1.b
1	Vport-2	5	3 000 000	300	2, 3	pxc-2.b
1	Vport-3	5	3 000 000	300	4, 5	pxc-1.b
1	Vport-4	5	3 000 000	300	6, 7	pxc-2.b
2	Vport-5	15	3 000 000	300	8	pxc-2.b
2	Vport-6	5	1 000 000	100	9, 10	pxc-1.b
2	Vport-7	5	1 000 000	100	11, 12	pxc-1.b
2	Vport-8	5	1 000 000	100	13, 14	pxc-2.b
3	Vport-9	7	1 400 000	140	15	pxc-1.b
3	Vport-10	1	200 000	20	16, 17	pxc-2.b
3	Vport-11	1	200 000	20	18, 19	pxc-1.b
3	Vport-12	1	200 000	20	20, 21	pxc-2.b
3	Vport-13	1	200 000	20	22, 23	pxc-1.b
3	Vport-14	1	200 000	20	24, 25	pxc-2.b
3	Vport-15	1	200 000	20	26, 27	pxc-2.b
3	Vport-16	1	200 000	20	28, 29, 30, 31, 32	pxc-2.b

The output of the **monitor-lag** command for "lag-3" shows unequal load balancing: member port pxc-1.b receives approximately 60% of the load and member port pxc-2.b only 40%.

```
A:admin@bng-1# monitor-lag -l lag-3 -i 10 -r 3
```

```

-----
                                Run 1
-----
Object                          |          BW % of Total
-----
pxc-1.b-----60.29
|-----vport-1-----34.49
|   |-----ipoe-1-----34.49
|-----vport-2-----0.00
|-----vport-3-----11.30
|   |-----ipoe-4-----5.51
|   |-----ipoe-5-----5.80
|-----vport-4-----0.00
|-----vport-5-----0.00
|-----vport-6-----4.06
|   |-----ipoe-10-----2.03
|   |-----ipoe-9-----2.03
|-----vport-7-----3.48
|   |-----ipoe-12-----1.74
|   |-----ipoe-11-----1.74
|-----vport-8-----0.00
|-----vport-9-----5.22
|   |-----ipoe-15-----5.22
|-----vport-10-----0.00
|-----vport-11-----0.58
|   |-----ipoe-19-----0.29
|   |-----ipoe-18-----0.29
|-----vport-12-----0.00
|-----vport-13-----0.58
|   |-----ipoe-23-----0.29
|   |-----ipoe-22-----0.29
|-----vport-14-----0.00
|-----vport-15-----0.58
|   |-----ipoe-27-----0.29
|   |-----ipoe-26-----0.29
|-----vport-16-----0.00
pxc-2.b-----39.71
|-----vport-1-----0.00
|-----vport-2-----11.30
|   |-----ipoe-3-----5.51
|   |-----ipoe-2-----5.80
|-----vport-3-----0.00
|-----vport-4-----11.30
|   |-----ipoe-7-----5.51
|   |-----ipoe-6-----5.80
|-----vport-5-----11.30
|   |-----ipoe-8-----11.30
|-----vport-6-----0.00
|-----vport-7-----0.00
|-----vport-8-----3.77
|   |-----ipoe-14-----2.03
|   |-----ipoe-13-----1.74
|-----vport-9-----0.00
|-----vport-10-----0.87
|   |-----ipoe-16-----0.58
|   |-----ipoe-17-----0.29
|-----vport-11-----0.00
|-----vport-12-----0.58
|   |-----ipoe-20-----0.29
    
```

```

|-----ipoe-21-----0.29
|-----vport-13-----0.00
|-----vport-14-----0.58
|-----ipoe-25-----0.29
|-----ipoe-24-----0.29
|-----vport-15-----0.00
|-----vport-16-----0.00
|-----ipoe-32-----0.00
|-----ipoe-30-----0.00
|-----ipoe-31-----0.00
|-----ipoe-29-----0.00
|-----ipoe-28-----0.00

-----
Run 2
-----
Object | BW % of Total
-----
pxc-1.b-----59.70
|-----vport-1-----33.58
|-----ipoe-1-----33.58
|-----vport-2-----0.00
|-----vport-3-----11.20
|-----ipoe-4-----5.60
|-----ipoe-5-----5.60
|-----vport-4-----0.00
|-----vport-5-----0.00
|-----vport-6-----3.73
|-----ipoe-10-----1.87
|-----ipoe-9-----1.87
|-----vport-7-----3.73
|-----ipoe-12-----1.87
|-----ipoe-11-----1.87
|-----vport-8-----0.00
|-----vport-9-----5.23
|-----ipoe-15-----5.23
|-----vport-10-----0.00
|-----vport-11-----0.74
|-----ipoe-19-----0.37
|-----ipoe-18-----0.37
|-----vport-12-----0.00
|-----vport-13-----0.74
|-----ipoe-23-----0.37
|-----ipoe-22-----0.37
|-----vport-14-----0.00
|-----vport-15-----0.74
|-----ipoe-27-----0.37
|-----ipoe-26-----0.37
|-----vport-16-----0.00

pxc-2.b-----40.30
|-----vport-1-----0.00
|-----vport-2-----11.19
|-----ipoe-3-----5.60
|-----ipoe-2-----5.59
|-----vport-3-----0.00
|-----vport-4-----11.20
|-----ipoe-7-----5.60
|-----ipoe-6-----5.60
|-----vport-5-----11.20
    
```

```

|-----ipoe-8-----11.20
|-----vport-6-----0.00
|-----vport-7-----0.00
|-----vport-8-----3.73
|-----ipoe-14-----1.86
|-----ipoe-13-----1.87
|-----vport-9-----0.00
|-----vport-10-----0.74
|-----ipoe-16-----0.37
|-----ipoe-17-----0.37
|-----vport-11-----0.00
|-----vport-12-----0.74
|-----ipoe-20-----0.37
|-----ipoe-21-----0.37
|-----vport-13-----0.00
|-----vport-14-----0.74
|-----ipoe-25-----0.37
|-----ipoe-24-----0.37
|-----vport-15-----0.00
|-----vport-16-----0.75
|-----ipoe-32-----0.15
|-----ipoe-30-----0.15
|-----ipoe-31-----0.15
|-----ipoe-29-----0.15
|-----ipoe-28-----0.15

```

Run 3

Object	BW % of Total
pxc-1.b	59.70
-----vport-1-----	33.58
-----ipoe-1-----	33.58
-----vport-2-----	0.00
-----vport-3-----	11.19
-----ipoe-4-----	5.60
-----ipoe-5-----	5.59
-----vport-4-----	0.00
-----vport-5-----	0.00
-----vport-6-----	3.73
-----ipoe-10-----	1.86
-----ipoe-9-----	1.86
-----vport-7-----	3.73
-----ipoe-12-----	1.87
-----ipoe-11-----	1.86
-----vport-8-----	0.00
-----vport-9-----	5.22
-----ipoe-15-----	5.22
-----vport-10-----	0.00
-----vport-11-----	0.75
-----ipoe-19-----	0.38
-----ipoe-18-----	0.38
-----vport-12-----	0.00
-----vport-13-----	0.75
-----ipoe-23-----	0.38
-----ipoe-22-----	0.38
-----vport-14-----	0.00
-----vport-15-----	0.75
-----ipoe-27-----	0.38
-----ipoe-26-----	0.38

```

|-----vport-16-----0.00
pxc-2.b-----40.30
|-----vport-1-----0.00
|-----vport-2-----11.19
|         |-----ipoe-3-----5.59
|         |-----ipoe-2-----5.59
|-----vport-3-----0.00
|-----vport-4-----11.20
|         |-----ipoe-7-----5.60
|         |-----ipoe-6-----5.60
|-----vport-5-----11.20
|         |-----ipoe-8-----11.20
|-----vport-6-----0.00
|-----vport-7-----0.00
|-----vport-8-----3.73
|         |-----ipoe-14-----1.87
|         |-----ipoe-13-----1.87
|-----vport-9-----0.00
|-----vport-10-----0.74
|         |-----ipoe-16-----0.37
|         |-----ipoe-17-----0.37
|-----vport-11-----0.00
|-----vport-12-----0.75
|         |-----ipoe-20-----0.38
|         |-----ipoe-21-----0.38
|-----vport-13-----0.00
|-----vport-14-----0.75
|         |-----ipoe-25-----0.38
|         |-----ipoe-24-----0.38
|-----vport-15-----0.00
|-----vport-16-----0.74
|         |-----ipoe-32-----0.15
|         |-----ipoe-30-----0.15
|         |-----ipoe-31-----0.15
|         |-----ipoe-29-----0.15
|         |-----ipoe-28-----0.15
    
```

Per-subscriber load balancing

In this example, Vports are not considered in hashing, due to the removal of the **subscriber-hash-mode vport** command:

```

per-link-hash {
    weighted {
        delete subscriber-hash-mode
    }
}
    
```

The configuration file for BNG-1 can be found [here](#) .

The "lag-3" configuration is now as follows:

```

lag "lag-3" {
    admin-state enable
    description "fpe pw-port pxc lag - termination side"
    mode hybrid
    max-ports 64
    access {
        per-fp-ing-queuing false
        per-fp-egr-queuing false
    }
}
    
```

```

        per-fp-sap-instance false
        adapt-qos {
            mode port-fair
        }
    }
    port pxc-1.b {
    }
    port pxc-2.b {
    }
}
    
```

Because Vports are not used, a simpler **monitor** command is used to collect the data that is going through the port scheduler without visibility into subscribers. The output of this command is:

```
A:admin@bng-1# monitor-scheduler -l lag-3 -i 10 -r 3
```

```

-----
                        Run 1 (interval = 10 seconds)
-----
Lag Member Port      |          BW % of Total
-----
        pxc-1.b      |          36.27
        pxc-2.b      |          63.73
-----

                        Run 2 (interval = 10 seconds)
-----
Lag Member Port      |          BW % of Total
-----
        pxc-1.b      |          36.27
        pxc-2.b      |          63.73
-----

                        Run 3 (interval = 10 seconds)
-----
Lag Member Port      |          BW % of Total
-----
        pxc-1.b      |          36.27
        pxc-2.b      |          63.73
    
```

The output shows that the per-subscriber hashing also produces unequal load balancing due to the significant difference in rates between the subscribers.

This unequal load balancing can be corrected by configuring classes and weights per subscriber (defined in the sub-profile), but this configuration is beyond the scope of this chapter.

LAG "lag-1"

This section describes the load balancing on the LAG that connects the BNG to the aggregation node "AGG-1". LAG "lag-1" contains regular ports (no PXC) and is referenced under the L3 interfaces that connect the BNG to the aggregation node.

```

[pr:/configure router "Base"]
A:admin@bng-1#
    autonomous-system 64500
    router-id 192.0.2.20
    
```

```
interface "int-1-bng-1-p-1" {
    port lag-1:1
    ipv6 {
        address 2001:db8::501 {
            prefix-length 120
        }
    }
}
```

Although not explicitly referenced in the Epipe (EVPN VPWS), this LAG is used to reach the network destination in EVPN, which is the BGP neighbor in the following configuration:

```
[pr:/configure service epipe "access"]
A:admin@bng-1#
admin-state enable
service-id 1
customer "1"
bgp 1 {
}
bgp-evpn {
    evi 10
    local-attachment-circuit "bng" {
        eth-tag 2
    }
    remote-attachment-circuit "access" {
        eth-tag 1
    }
    mpls 1 {
        admin-state enable
        send-tunnel-encap {
            mpls-over-udp false
        }
        auto-bind-tunnel {
            resolution any
        }
        route-next-hop {
            system-ipv6
        }
    }
}

[pr:/configure router "Base" bgp]
A:admin@bng-1#
admin-state enable
vpn-apply-export true
vpn-apply-import true
rapid-withdrawal true
rapid-update {
    evpn true
}
group "evpn" {
    peer-as 64500
    local-address 2001:db8::14
    family {
        evpn true
    }
}
neighbor "2001:db8::5" {
    group "evpn"
}
```

LAG "lag-1" is configured as follows with the member ports shown in the figure [Figure 30: Example topology](#):

```
[pr:/configure lag "lag-1"]
A:admin@bng-1#
  admin-state enable
  description "lag to p-1"
  mode hybrid
  max-ports 64
  port 1/1/c1/1 {
  }
  port 1/1/c1/2 {
  }
```

This section describes two ways of traffic load balancing toward the network destination (in this case, the system IPv6 address, 2001:db8::5, on the aggregation node) in the Epipe (EVPN VPWS).

By default, traffic is load-balanced per source and destination IP address pair. Traffic is sent from the same source IP address on the traffic generator toward each individual subscriber, each subscriber with its own IP address. Because every <source, destination> IP address pair in the setup represents a unique subscriber, one could conclude that this would be equivalent to per-subscriber load balancing. However, the hashing keys here are the source and destination IP address, while in per-subscriber hashing, the hashing key is the subscriber ID (and internal SR number). As a result, the outcome of traffic distribution is different in "lag-1" and "lag-3" in the preceding **monitor-scheduler** command with load-balancing per subscriber.

Optimally, L4 ports can be added to the source and destination IP address as the hashing input.

The output of the **monitor lag** command when load balancing per source and destination IP address is enabled is shown below.



Note: The **monitor lag** command is a native SR command, not to be confused with the **monitor-lag** command using pysros.

The distribution of this traffic is 30/70 (811 output packet on port 1/1/c1/1 versus 1864 output packets on port 1/1/c1/2; all packets are the same size of 200 bytes).

This is a very different distribution from the output in the preceding **monitor-scheduler** command with load balancing per subscriber where the traffic distribution over the two ports was approximately 36/63.

```
A:admin@bng-1# monitor lag 1 interval 3 repeat 999 rate packets

=====
Monitor statistics for LAG ID 1
=====
Port-id          Input packets          Output packets
-----
-----
At time t = 3 sec (Mode: Rate)
-----
1/1/c1/1         0                      811
1/1/c1/2         0                      1864
-----
Totals           0                      2675
-----
-----
At time t = 6 sec (Mode: Rate)
-----
1/1/c1/1         0                      812
```



```

1/1/c1/2      0      1868
-----
Totals        0      2680
-----
At time t = 9 sec (Mode: Rate)
-----
1/1/c1/1      2      813
1/1/c1/2      1     1869
-----
Totals        3     2682
---snip---
```

A more even distribution is achieved by enabling additional fields for hashing purposes. In the following example, in addition to the source and destination IP addresses, the hashing algorithm also considers L4 ports, which in this example, are randomly changing in each packet.

```

[pr:/configure system load-balancing]
A:admin@bng-1#
    l4-load-balancing true
```

The result of such hashing is more even load balancing (approximately 50/50), as follows:

```

A:admin@bng-1# monitor lag 1 interval 3 repeat 5 rate packets

=====
Monitor statistics for LAG ID 1
=====
Port-id      Input packets      Output packets
-----
At time t = 3 sec (Mode: Rate)
-----
1/1/c1/1      1      1354
1/1/c1/2      0      1319
-----
Totals        1      2673
-----

At time t = 6 sec (Mode: Rate)
-----
1/1/c1/1      1      1341
1/1/c1/2      1     1339
-----
Totals        2     2680
-----

At time t = 9 sec (Mode: Rate)
-----
1/1/c1/1      0     1326
1/1/c1/2      0     1354
-----
Totals        0     2680
-----

At time t = 12 sec (Mode: Rate)
-----
1/1/c1/1      0     1326
1/1/c1/2      0     1353
-----
Totals        0     2679
-----
```

```
At time t = 15 sec (Mode: Rate)
-----
1/1/c1/1      2      1360
1/1/c1/2      1      1321
-----
Totals        3      2681
```

Conclusion

This chapter provides fundamentals for understanding and configuring the class- and weight-based Vport traffic load balancing on a LAG in ESM. This is used in deployments where not only the bandwidth service offerings for subscribers vary greatly, but also where there is a significant variation in configured bandwidth between the Vports.

The configuration setup relies on FPE-based PW-ports, with two stage LAGs. The first stage LAG contains PXC based member ports as the subscriber termination points. This stage is the focus of this chapter. The second stage LAG is applied in the EVPN VPWS service context with the regular faceplate ports connecting the BNG to the access nodes. The distinct role of each LAG is explained, and the outcome of the load balancing techniques in each stage is explored.

Traffic utilization on the LAG member links is analyzed and compared between different hashing algorithms (per Vport with classes and weights, per Vport without classes and weights, and per subscriber).

Appendix

The following files are used in this chapter:

- configuration of AGG-1
- configuration of BNG-1 with per-Vport load balancing with classes and weights
- configuration of BNG-1 with per-Vport load balancing without classes and weights
- configuration of BNG-1 with per-subscriber load balancing
- RADIUS users

agg-1

```
# TiMOS-B-22.10.R1 both/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-11-18T08:49:28.3Z by admin from 135.231.208.32
# Commit ID 1
# Committed 2022-11-17T11:34:34.8Z by system (MD-CLI) from Console
# Log      "System booted version B-22.10.R1."

configure {
  card 1 {
    card-type iom-1
    mda 1 {
      mda-type me6-100gb-qsfp28
    }
    mda 2 {
```

```
    mda-type me6-100gb-qsfp28
    xconnect {
        mac 1 {
            loopback 1 {
            }
        }
    }
}
fp 1 {
}
}
log {
    filter "1001" {
        named-entry "10" {
            description "Collect only events of major severity or higher"
            action forward
            match {
                severity {
                    gte major
                }
            }
        }
    }
    log-id "100" {
        description "Default Serious Errors Log"
        filter "1001"
        source {
            main true
        }
        destination {
            memory {
                max-entries 500
            }
        }
    }
    log-id "99" {
        description "Default System Log"
        source {
            main true
        }
        destination {
            memory {
                max-entries 500
            }
        }
    }
}
port 1/1/c1 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
```

```
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c2/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/2 {
    admin-state enable
    ethernet {
```

```
        mode hybrid
    }
}
port 1/1/c2/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c2/10 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c3/1 {
    admin-state enable
    ethernet {
        mode hybrid
        encap-type qinq
    }
}
}
```

```
port 1/1/c3/2 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/7 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/9 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c3/10 {
    admin-state enable
    ethernet {
        mode hybrid
        encap-type dot1q
    }
}
port 1/1/c4 {
    admin-state enable
    connector {
        breakout c4-10g
    }
}
port 1/1/c4/1 {
    admin-state enable
    ethernet {
```

```
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c5 {
}
port 1/1/c6 {
}
port 1/2/c1 {
}
port 1/2/c2 {
}
port 1/2/c3 {
}
port 1/2/c4 {
}
port 1/2/c5 {
}
port 1/2/c6 {
}
port 1/2/m1/1 {
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.5
    interface "int-1-pe-1-p-1" {
        port 1/1/c1/1:1
        ipv6 {
            address 2001:db8::101 {
                prefix-length 120
            }
        }
    }
}
interface "system" {
    ipv4 {
        primary {
            address 192.0.2.5
            prefix-length 32
        }
    }
    ipv6 {
        address 2001:db8::5 {
            prefix-length 128
        }
    }
}
interface "to-ixia" {
    port 1/1/c3/1:1.1
    ipv4 {
        primary {
            address 172.16.100.1
            prefix-length 24
        }
    }
    ipv6 {
        address 2001:db8::6401 {
            prefix-length 120
        }
    }
}
interface "to-radius" {
    port 1/1/c3/10:114
```

```
    ipv4 {
        primary {
            address 192.168.114.5
            prefix-length 24
        }
    }
}
bgp {
    admin-state enable
    vpn-apply-export true
    vpn-apply-import true
    rapid-withdrawal true
    rapid-update {
        evpn true
    }
    advertise-ipv6-next-hops {
        evpn true
    }
    group "evpn" {
        peer-as 64500
        local-address 2001:db8::5
        family {
            evpn true
        }
    }
    neighbor "2001:db8::14" {
        group "evpn"
    }
}
isis 0 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    interface "int-1-pe-1-p-1" {
    }
    interface "system" {
    }
    interface "to-ixia" {
    }
}
ldp {
    interface-parameters {
        interface "int-1-pe-1-p-1" {
            ipv6 {
                admin-state enable
            }
        }
    }
}
}
service {
    system {
        extended-default-qinq-sap-lookup true
    }
    epipe "access" {
        admin-state enable
        service-id 1
        customer "1"
        bgp 1 {
        }
    }
}
```



```
    sap 1/1/c3/1:*. * {
    }
    bgp-evpn {
        evi 10
        local-attachment-circuit "access" {
            eth-tag 1
        }
        remote-attachment-circuit "bng" {
            eth-tag 2
        }
    }
    mpls 1 {
        admin-state enable
        send-tunnel-encap {
            mpls-over-udp true
        }
        auto-bind-tunnel {
            resolution any
        }
        route-next-hop {
            system-ipv6
        }
    }
}
system {
    name "AGG-1"
    management-interface {
        configuration-mode model-driven
        cli {
            cli-engine [md-cli classic-cli]
        }
        yang-modules {
            nokia-submodules true
            nokia-combined-modules false
        }
        snmp {
            admin-state disable
        }
    }
    ip {
        allow-qinq-network-interface true
    }
    bluetooth {
        advertising-timeout 30
    }
    login-control {
        idle-timeout none
    }
    security {
        aaa {
            local-profiles {
                profile "administrative" {
                    default-action permit-all
                    entry 10 {
                        match "configure system security"
                        action permit
                    }
                    entry 20 {
                        match "show system security"
                        action permit
                    }
                    entry 30 {
                        match "tools perform security"
                    }
                }
            }
        }
    }
}
```

```
        action permit
    }
    entry 40 {
        match "tools dump security"
        action permit
    }
    entry 50 {
        match "admin system security"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
    entry 110 {
        match "show li"
        action deny
    }
    entry 111 {
        match "clear li"
        action deny
    }
    entry 112 {
        match "tools dump li"
        action deny
    }
    }
    netconf {
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            kill-session true
            lock true
            validate true
        }
    }
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
        action permit
    }
}
```

```
entry 50 {
    match "password"
    action permit
}
entry 60 {
    match "show config"
    action deny
}
entry 65 {
    match "show li"
    action deny
}
entry 66 {
    match "clear li"
    action deny
}
entry 67 {
    match "tools dump li"
    action deny
}
entry 68 {
    match "state li"
    action deny
}
entry 70 {
    match "show"
    action permit
}
entry 75 {
    match "state"
    action permit
}
entry 80 {
    match "enable-admin"
    action permit
}
entry 90 {
    match "enable"
    action permit
}
entry 100 {
    match "configure li"
    action deny
}
netconf {
    base-op-authorization {
        action true
        cancel-commit true
        close-session true
        commit true
        copy-config true
        create-subscription true
        delete-config true
        discard-changes true
        edit-config true
        get true
        get-config true
        get-data true
        get-schema true
        validate true
    }
}
}
```

```
}
ssh {
  server-cipher-list-v2 {
    cipher 190 {
      name aes256-ctr
    }
    cipher 192 {
      name aes192-ctr
    }
    cipher 194 {
      name aes128-ctr
    }
    cipher 200 {
      name aes128-cbc
    }
    cipher 205 {
      name 3des-cbc
    }
    cipher 225 {
      name aes192-cbc
    }
    cipher 230 {
      name aes256-cbc
    }
  }
  client-cipher-list-v2 {
    cipher 190 {
      name aes256-ctr
    }
    cipher 192 {
      name aes192-ctr
    }
    cipher 194 {
      name aes128-ctr
    }
    cipher 200 {
      name aes128-cbc
    }
    cipher 205 {
      name 3des-cbc
    }
    cipher 225 {
      name aes192-cbc
    }
    cipher 230 {
      name aes256-cbc
    }
  }
  server-mac-list-v2 {
    mac 200 {
      name hmac-sha2-512
    }
    mac 210 {
      name hmac-sha2-256
    }
    mac 215 {
      name hmac-sha1
    }
    mac 220 {
      name hmac-sha1-96
    }
    mac 225 {
      name hmac-md5
    }
  }
}
```

```

    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
}
user-params {
    local-user {
        user "admin" {
            password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
            access {
                console true
            }
            console {
                member ["administrative"]
            }
        }
    }
}
}
}
}
}
}
}
}

# Finished 2022-11-18T08:49:28.3Z

```

bng-per-vport-balancing-with-classes-weights

```

# TiMOS-C-22.10.R1 cpm/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-12-14T13:31:35.4-06:00 by admin from 135.231.208.32
# Commit ID 2
# Committed 2022-12-14T12:45:28.3-06:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 1
# Committed 2022-12-14T12:38:03.7-06:00 by system (MD-CLI) from Console
# Log "System booted version C-22.10.R1."

configure {
    aaa {
        radius {
            server-policy "radius-server-1" {

```

```
        servers {
            router-instance "Base"
            server 1 {
                server-name "free-radius-1"
            }
        }
    }
}
card 1 {
    card-type iom5-e
    mda 1 {
        mda-type me6-100gb-qsfp28
    }
    mda 2 {
        mda-type me6-100gb-qsfp28
    }
}
fwd-path-ext {
    sdp-id-range {
        start 17500
        end 17600
    }
    fpe 1 {
        description "pw-port on a lag"
        path {
            xc-lag-a "lag-2"
            xc-lag-b "lag-3"
        }
        application {
            pw-port-extension {
            }
        }
    }
}
lag "lag-1" {
    admin-state enable
    description "lag to p-1"
    mode hybrid
    max-ports 64
    port 1/1/c1/1 {
    }
    port 1/1/c1/2 {
    }
}
lag "lag-2" {
    admin-state enable
    description "fpe pw-port pxc lag - transit side"
    mode hybrid
    max-ports 64
    port pxc-1.a {
    }
    port pxc-2.a {
    }
}
lag "lag-3" {
    admin-state enable
    description "fpe pw-port pxc lag - termination side"
    mode hybrid
    max-ports 64
    access {
        per-fp-ing-queuing true
        per-fp-egr-queuing true
        per-fp-sap-instance true
    }
}
```

```
        adapt-qos {
            mode link
        }
    }
    per-link-hash {
        weighted {
            subscriber-hash-mode vport
        }
    }
    port pxc-1.b {
    }
    port pxc-2.b {
    }
}
log {
    filter "1001" {
        named-entry "10" {
            description "Collect only events of major severity or higher"
            action forward
            match {
                severity {
                    gte major
                }
            }
        }
    }
}
log-id "100" {
    description "Default Serious Errors Log"
    filter "1001"
    source {
        main true
    }
    destination {
        memory {
            max-entries 500
        }
    }
}
log-id "99" {
    description "Default System Log"
    source {
        main true
    }
    destination {
        memory {
            max-entries 500
        }
    }
}
}
port 1/1/c1 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    description "lag-1 to p-1 access"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
```

```
    admin-state enable
    description "lag-1 to p-1 access"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    description "to pe-2 network"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c1/10 {
    admin-state enable
    description "RADIUS and mirroring"
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
    admin-state enable
    connector {
        breakout c1-100g
    }
}
```



```
}
port 1/1/c2/1 {
  admin-state enable
  ethernet {
    mode hybrid
    encap-type dot1q
    dot1x {
      tunneling true
    }
  }
}
port 1/1/c4 {
  admin-state enable
  connector {
    breakout c4-10g
  }
}
port 1/1/c4/1 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port 1/1/c4/2 {
  admin-state enable
  description "PXC 1; pw-port lag 2,3"
  ethernet {
    mode hybrid
    dot1x {
      tunneling true
    }
  }
}
port 1/1/c4/3 {
  admin-state enable
  description "PXC 2; pw-port lag 2,3"
  ethernet {
    mode hybrid
    dot1x {
      tunneling true
    }
  }
}
port 1/1/c4/4 {
  admin-state enable
  ethernet {
    mode hybrid
  }
}
port pxc-1.a {
  admin-state enable
}
port pxc-1.b {
  admin-state enable
  description "PXC lag-3, pw-port termination"
  ethernet {
    access {
      egress {
        virtual-port "vport-1" {
          aggregate-rate {
            rate 9000000
          }
        }
        host-match {
          int-dest-id "vport-1" { }
        }
      }
    }
  }
}
```

```
    }
    lag-per-link-hash {
      class 1
      weight 15
    }
  }
  virtual-port "vport-10" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-10" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
  virtual-port "vport-11" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-11" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
  virtual-port "vport-12" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-12" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
  virtual-port "vport-13" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-13" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
  virtual-port "vport-14" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-14" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
}
```

```
    }
  }
  virtual-port "vport-15" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-15" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
  virtual-port "vport-16" {
    aggregate-rate {
      rate 200000
    }
    host-match {
      int-dest-id "vport-16" { }
    }
    lag-per-link-hash {
      class 3
      weight 1
    }
  }
  virtual-port "vport-2" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-2" { }
    }
    lag-per-link-hash {
      class 1
      weight 5
    }
  }
  virtual-port "vport-3" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-3" { }
    }
    lag-per-link-hash {
      class 1
      weight 5
    }
  }
  virtual-port "vport-4" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-4" { }
    }
    lag-per-link-hash {
      class 1
      weight 5
    }
  }
  virtual-port "vport-5" {
    aggregate-rate {
```

```
        rate 3000000
      }
      host-match {
        int-dest-id "vport-5" { }
      }
      lag-per-link-hash {
        class 2
        weight 15
      }
    }
  virtual-port "vport-6" {
    aggregate-rate {
      rate 1000000
    }
    host-match {
      int-dest-id "vport-6" { }
    }
    lag-per-link-hash {
      class 2
      weight 5
    }
  }
  virtual-port "vport-7" {
    aggregate-rate {
      rate 1000000
    }
    host-match {
      int-dest-id "vport-7" { }
    }
    lag-per-link-hash {
      class 2
      weight 5
    }
  }
  virtual-port "vport-8" {
    aggregate-rate {
      rate 1000000
    }
    host-match {
      int-dest-id "vport-8" { }
    }
    lag-per-link-hash {
      class 2
      weight 5
    }
  }
  virtual-port "vport-9" {
    aggregate-rate {
      rate 1400000
    }
    host-match {
      int-dest-id "vport-9" { }
    }
    lag-per-link-hash {
      class 3
      weight 7
    }
  }
}
egress {
  port-scheduler-policy {
    policy-name "lag-3-pxc"
  }
}
```

```
    }
  }
}
port pxc-2.a {
  admin-state enable
}
port pxc-2.b {
  admin-state enable
  description "PXC lag-3, pw-port termination"
  ethernet {
    access {
      egress {
        virtual-port "vport-1" {
          aggregate-rate {
            rate 9000000
          }
          host-match {
            int-dest-id "vport-1" { }
          }
          lag-per-link-hash {
            class 1
            weight 15
          }
        }
        virtual-port "vport-10" {
          aggregate-rate {
            rate 200000
          }
          host-match {
            int-dest-id "vport-10" { }
          }
          lag-per-link-hash {
            class 3
            weight 1
          }
        }
        virtual-port "vport-11" {
          aggregate-rate {
            rate 200000
          }
          host-match {
            int-dest-id "vport-11" { }
          }
          lag-per-link-hash {
            class 3
            weight 1
          }
        }
        virtual-port "vport-12" {
          aggregate-rate {
            rate 200000
          }
          host-match {
            int-dest-id "vport-12" { }
          }
          lag-per-link-hash {
            class 3
            weight 1
          }
        }
        virtual-port "vport-13" {
          aggregate-rate {
            rate 200000
          }
        }
      }
    }
  }
}
```

```
        host-match {
            int-dest-id "vport-13" { }
        }
        lag-per-link-hash {
            class 3
            weight 1
        }
    }
    virtual-port "vport-14" {
        aggregate-rate {
            rate 200000
        }
        host-match {
            int-dest-id "vport-14" { }
        }
        lag-per-link-hash {
            class 3
            weight 1
        }
    }
    virtual-port "vport-15" {
        aggregate-rate {
            rate 200000
        }
        host-match {
            int-dest-id "vport-15" { }
        }
        lag-per-link-hash {
            class 3
            weight 1
        }
    }
    virtual-port "vport-16" {
        aggregate-rate {
            rate 200000
        }
        host-match {
            int-dest-id "vport-16" { }
        }
        lag-per-link-hash {
            class 3
            weight 1
        }
    }
    virtual-port "vport-2" {
        aggregate-rate {
            rate 3000000
        }
        host-match {
            int-dest-id "vport-2" { }
        }
        lag-per-link-hash {
            class 1
            weight 5
        }
    }
    virtual-port "vport-3" {
        aggregate-rate {
            rate 3000000
        }
        host-match {
            int-dest-id "vport-3" { }
        }
        lag-per-link-hash {
```

```
        class 1
        weight 5
    }
}
virtual-port "vport-4" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-4" { }
    }
    lag-per-link-hash {
        class 1
        weight 5
    }
}
virtual-port "vport-5" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-5" { }
    }
    lag-per-link-hash {
        class 2
        weight 15
    }
}
virtual-port "vport-6" {
    aggregate-rate {
        rate 1000000
    }
    host-match {
        int-dest-id "vport-6" { }
    }
    lag-per-link-hash {
        class 2
        weight 5
    }
}
virtual-port "vport-7" {
    aggregate-rate {
        rate 1000000
    }
    host-match {
        int-dest-id "vport-7" { }
    }
    lag-per-link-hash {
        class 2
        weight 5
    }
}
virtual-port "vport-8" {
    aggregate-rate {
        rate 1000000
    }
    host-match {
        int-dest-id "vport-8" { }
    }
    lag-per-link-hash {
        class 2
        weight 5
    }
}
}
```

```

        virtual-port "vport-9" {
            aggregate-rate {
                rate 1400000
            }
            host-match {
                int-dest-id "vport-9" { }
            }
            lag-per-link-hash {
                class 3
                weight 7
            }
        }
    }
}
egress {
    port-scheduler-policy {
        policy-name "lag-3-pxc"
    }
}
}
port-xc {
    pxc 1 {
        admin-state enable
        description "pw-port lag 2,3"
        port-id 1/1/c4/2
    }
    pxc 2 {
        admin-state enable
        description "pw-port lag 2,3"
        port-id 1/1/c4/3
    }
}
pw-port 1 {
    encap-type qinq
    epipe "access" {
        admin-state enable
        fpe-id 1
    }
}
python {
    python-script "monitor" {
        admin-state enable
        urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/
monitor_lag_sr.py"]
        version python3
    }
    python-script "monitor-sched" {
        admin-state enable
        urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/
monitor_lag_port_scheduler_sr.py"]
        version python3
    }
    python-script "monitor-sched-clear" {
        admin-state enable
        urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/
monitor_lag_port_scheduler_clear_sr.py"]
        version python3
    }
}
qos {
    sap-egress "sap-egress-1" {
        policy-id 2
        queue 1 {

```



```
        port-parent {
        }
    }
    port-scheduler-policy "lag-3-pxc" {
    }
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.20
    interface "int-1-bng-1-p-1" {
        port lag-1:1
        ipv6 {
            address 2001:db8::501 {
                prefix-length 120
            }
        }
    }
    interface "system" {
        ipv4 {
            primary {
                address 192.0.2.20
                prefix-length 32
            }
        }
        ipv6 {
            address 2001:db8::14 {
                prefix-length 128
            }
        }
    }
    interface "to-radius" {
        port 1/1/c1/10:114
        ipv4 {
            primary {
                address 192.168.114.20
                prefix-length 24
            }
        }
    }
}
bgp {
    admin-state enable
    vpn-apply-export true
    vpn-apply-import true
    rapid-withdrawal true
    rapid-update {
        evpn true
    }
    group "evpn" {
        peer-as 64500
        local-address 2001:db8::14
        family {
            evpn true
        }
    }
    neighbor "2001:db8::5" {
        group "evpn"
    }
}
isis 0 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
}
```

```
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    interface "int-1-bng-1-p-1" {
    }
    interface "system" {
    }
  }
  ldp {
    interface-parameters {
      interface "int-1-bng-1-p-1" {
        ipv6 {
          admin-state enable
        }
      }
    }
  }
  radius {
    server "free-radius-1" {
      address 192.168.114.2
      secret "HDqTwZYSvEu934VNhUQy/pubZxTKpSDzvHg=" hash2
      accept-coa true
    }
  }
}
service {
  epipe "access" {
    admin-state enable
    service-id 1
    customer "1"
    bgp 1 {
    }
    bgp-evpn {
      evi 10
      local-attachment-circuit "bng" {
        eth-tag 2
      }
      remote-attachment-circuit "access" {
        eth-tag 1
      }
    }
    mpls 1 {
      admin-state enable
      send-tunnel-encap {
        mpls-over-udp false
      }
      auto-bind-tunnel {
        resolution any
      }
      route-next-hop {
        system-ipv6
      }
    }
  }
}
vpls "capture-sap" {
  admin-state enable
  service-id 5
  customer "1"
  load-balancing {
    per-service-hashing true
  }
  capture-sap pw-1:*.* {
    radius-auth-policy "radius-1"
    trigger-packet {
```

```
        dhcp true
    }
    ipoe-session {
        admin-state enable
        ipoe-session-policy "ipoe-session-policy-1"
    }
}
vprn "vport-hashing" {
    admin-state enable
    service-id 10
    customer "1"
    interface "loopback-1" {
        admin-state enable
        loopback true
        ipv4 {
            local-dhcp-server "dhcpv4"
            primary {
                address 192.168.0.1
                prefix-length 32
            }
            neighbor-discovery {
                local-proxy-arp false
                remote-proxy-arp false
            }
            dhcp {
                admin-state enable
            }
        }
    }
    interface "to-ixia" {
        ipv4 {
            primary {
                address 172.16.102.1
                prefix-length 24
            }
        }
        sap 1/1/c1/7:2 {
        }
        ipv6 {
            address 2001:db8::6601 {
                prefix-length 120
            }
        }
    }
    ipv6 {
        router-advertisement {
            interface "to-ixia" {
                admin-state enable
                max-advertisement-interval 15
                min-advertisement-interval 10
            }
        }
    }
}
dhcp-server {
    dhcpv4 "dhcpv4" {
        admin-state enable
        pool-selection {
            use-gi-address {
                scope pool
            }
            use-pool-from-client {
            }
        }
    }
}
```



```
}
sub-profile "sub-profile-1" {
  egress {
    qos {
      agg-rate {
        rate 1000
      }
    }
  }
}
sla-profile "sla-profile-1" {
  egress {
    qos {
      sap-egress {
        policy-name "sap-egress-1"
        port-parent-location vport
        overrides {
          queue 1 {
            stat-mode v4-v6
          }
        }
      }
    }
  }
}
sub-ident-policy "sub-ident-policy-1" {
  sla-profile-map {
    use-direct-map-as-default true
  }
  sub-profile-map {
    use-direct-map-as-default true
  }
}
radius-authentication-policy "radius-1" {
  password "ncd8qyrNUMhYfa2SfrUqHMDZ9IXn3sVSmYBzbw==" hash2
  pppoe-access-method pap-chap
  radius-server-policy "radius-server-1"
  user-name {
    format circuit-id
  }
  include-radius-attribute {
    circuit-id true
    nas-identifier true
  }
}
msap-policy "msap-policy-1" {
  sub-sla-mgmt {
    subscriber-limit 1
    sub-ident-policy "sub-ident-policy-1"
    defaults {
      subscriber-id {
        sap-id
      }
    }
    single-sub-parameters {
      profiled-traffic-only true
    }
  }
  ies-vprn-only-sap-parameters {
    anti-spoof next-hop-ip-and-mac-addr
    ingress {
      qos {
        queuing-type service
      }
    }
  }
}
```

```
    }
  }
}
system {
  name "bng-1"
  management-interface {
    configuration-mode model-driven
    cli {
      cli-engine [md-cli classic-cli]
      md-cli {
        environment {
          more false
          command-alias {
            alias "monitor-lag" {
              admin-state enable
              python-script "monitor"
              mount-point global { }
            }
            alias "monitor-schd-clear" {
              admin-state enable
              python-script "monitor-sched-clear"
              mount-point global { }
            }
            alias "monitor-scheduler" {
              admin-state enable
              python-script "monitor-sched"
              mount-point global { }
            }
          }
        }
      }
    }
  }
}
netconf {
  admin-state enable
}
yang-modules {
  nokia-submodules false
  nokia-combined-modules true
}
snmp {
  admin-state disable
}
login-control {
  idle-timeout none
}
security {
  aaa {
    local-profiles {
      profile "administrative" {
        default-action permit-all
        entry 10 {
          match "configure system security"
          action permit
        }
        entry 20 {
          match "show system security"
          action permit
        }
        entry 30 {
          match "tools perform security"
          action permit
        }
      }
    }
  }
}
```

```
entry 40 {
    match "tools dump security"
    action permit
}
entry 50 {
    match "admin system security"
    action permit
}
entry 100 {
    match "configure li"
    action deny
}
entry 110 {
    match "show li"
    action deny
}
entry 111 {
    match "clear li"
    action deny
}
entry 112 {
    match "tools dump li"
    action deny
}
netconf {
    base-op-authorization {
        action true
        cancel-commit true
        close-session true
        commit true
        copy-config true
        create-subscription true
        delete-config true
        discard-changes true
        edit-config true
        get true
        get-config true
        get-data true
        get-schema true
        kill-session true
        lock true
        validate true
    }
}
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
        action permit
    }
    entry 50 {
        match "password"
    }
}
```

```
        action permit
    }
    entry 60 {
        match "show config"
        action deny
    }
    entry 65 {
        match "show li"
        action deny
    }
    entry 66 {
        match "clear li"
        action deny
    }
    entry 67 {
        match "tools dump li"
        action deny
    }
    entry 68 {
        match "state li"
        action deny
    }
    entry 70 {
        match "show"
        action permit
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
ssh {
    server-admin-state enable
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
        cipher 205 {
            name 3des-cbc
        }
        cipher 225 {
```



```
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
client-cipher-list-v2 {
    cipher 190 {
        name aes256-ctr
    }
    cipher 192 {
        name aes192-ctr
    }
    cipher 194 {
        name aes128-ctr
    }
    cipher 200 {
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
server-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
}
```

```
    }
    mac 240 {
        name hmac-md5-96
    }
}
}
user-params {
    local-user {
        user "admin" {
            password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
            access {
                console true
                netconf true
            }
            console {
                member ["administrative"]
            }
        }
    }
}
}
time {
    prefer-local-time true
    zone {
        standard {
            name cst
        }
    }
    dst-zone "CDT" {
        end {
            day sunday
            month november
            hours-minutes "02:00"
        }
        start {
            day sunday
            month march
            hours-minutes "02:00"
        }
    }
    sntp {
        admin-state enable
        server 135.227.160.253 {
        }
    }
}
}
}
}

# Finished 2022-12-14T13:31:35.4-06:00
```

bng-per-vport-balancing-wo-classes-weights

```
# TiMOS-C-22.10.R1 cpm/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0

# Generated 2022-12-14T13:38:31.1-06:00 by admin from 135.231.208.32
# Commit ID 3
# Committed 2022-12-14T13:33:11.3-06:00 by admin (MD-CLI) from 135.231.208.32
```

```
configure {
  aaa {
    radius {
      server-policy "radius-server-1" {
        servers {
          router-instance "Base"
          server 1 {
            server-name "free-radius-1"
          }
        }
      }
    }
  }
  card 1 {
    card-type iom5-e
    mda 1 {
      mda-type me6-100gb-qsfp28
    }
    mda 2 {
      mda-type me6-100gb-qsfp28
    }
  }
  fwd-path-ext {
    sdp-id-range {
      start 17500
      end 17600
    }
    fpe 1 {
      description "pw-port on a lag"
      path {
        xc-lag-a "lag-2"
        xc-lag-b "lag-3"
      }
      application {
        pw-port-extension {
        }
      }
    }
  }
}
lag "lag-1" {
  admin-state enable
  description "lag to p-1"
  mode hybrid
  max-ports 64
  port 1/1/c1/1 {
  }
  port 1/1/c1/2 {
  }
}
lag "lag-2" {
  admin-state enable
  description "fpe pw-port pxc lag - transit side"
  mode hybrid
  max-ports 64
  port pxc-1.a {
  }
  port pxc-2.a {
  }
}
lag "lag-3" {
  admin-state enable
  description "fpe pw-port pxc lag - termination side"
  mode hybrid
  max-ports 64
}
```

```
access {
    per-fp-ing-queuing true
    per-fp-egr-queuing true
    per-fp-sap-instance true
    adapt-qos {
        mode link
    }
}
per-link-hash {
    weighted {
        subscriber-hash-mode vport
    }
}
port pxc-1.b {
}
port pxc-2.b {
}
}
log {
    filter "1001" {
        named-entry "10" {
            description "Collect only events of major severity or higher"
            action forward
            match {
                severity {
                    gte major
                }
            }
        }
    }
}
log-id "100" {
    description "Default Serious Errors Log"
    filter "1001"
    source {
        main true
    }
    destination {
        memory {
            max-entries 500
        }
    }
}
log-id "99" {
    description "Default System Log"
    source {
        main true
    }
    destination {
        memory {
            max-entries 500
        }
    }
}
}
port 1/1/c1 {
    admin-state enable
    connector {
        breakout c10-10g
    }
}
port 1/1/c1/1 {
    admin-state enable
    description "lag-1 to p-1 access"
    ethernet {
```

```
        mode hybrid
    }
}
port 1/1/c1/2 {
    admin-state enable
    description "lag-1 to p-1 access"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    description "to pe-2 network"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c1/10 {
    admin-state enable
    description "RADIUS and mirroring"
    ethernet {
        mode hybrid
    }
}
port 1/1/c2 {
```

```
    admin-state enable
    connector {
        breakout c1-100g
    }
}
port 1/1/c2/1 {
    admin-state enable
    ethernet {
        mode hybrid
        encap-type dot1q
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c4 {
    admin-state enable
    connector {
        breakout c4-10g
    }
}
port 1/1/c4/1 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c4/2 {
    admin-state enable
    description "PXC 1; pw-port lag 2,3"
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c4/3 {
    admin-state enable
    description "PXC 2; pw-port lag 2,3"
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c4/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port pxc-1.a {
    admin-state enable
}
port pxc-1.b {
    admin-state enable
    description "PXC lag-3, pw-port termination"
    ethernet {
        access {
            egress {
                virtual-port "vport-1" {
                    aggregate-rate {
```

```
        rate 9000000
    }
    host-match {
        int-dest-id "vport-1" { }
    }
}
virtual-port "vport-10" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-10" { }
    }
}
virtual-port "vport-11" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-11" { }
    }
}
virtual-port "vport-12" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-12" { }
    }
}
virtual-port "vport-13" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-13" { }
    }
}
virtual-port "vport-14" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-14" { }
    }
}
virtual-port "vport-15" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-15" { }
    }
}
virtual-port "vport-16" {
    aggregate-rate {
        rate 200000
    }
    host-match {
        int-dest-id "vport-16" { }
    }
}
virtual-port "vport-2" {
    aggregate-rate {
```

```
        rate 3000000
    }
    host-match {
        int-dest-id "vport-2" { }
    }
}
virtual-port "vport-3" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-3" { }
    }
}
virtual-port "vport-4" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-4" { }
    }
}
virtual-port "vport-5" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-5" { }
    }
}
virtual-port "vport-6" {
    aggregate-rate {
        rate 1000000
    }
    host-match {
        int-dest-id "vport-6" { }
    }
}
virtual-port "vport-7" {
    aggregate-rate {
        rate 1000000
    }
    host-match {
        int-dest-id "vport-7" { }
    }
}
virtual-port "vport-8" {
    aggregate-rate {
        rate 1000000
    }
    host-match {
        int-dest-id "vport-8" { }
    }
}
virtual-port "vport-9" {
    aggregate-rate {
        rate 1400000
    }
    host-match {
        int-dest-id "vport-9" { }
    }
}
}
}
```



```
        egress {
            port-scheduler-policy {
                policy-name "lag-3-pxc"
            }
        }
    }
}
port pxc-2.a {
    admin-state enable
}
port pxc-2.b {
    admin-state enable
    description "PXC lag-3, pw-port termination"
    ethernet {
        access {
            egress {
                virtual-port "vport-1" {
                    aggregate-rate {
                        rate 9000000
                    }
                    host-match {
                        int-dest-id "vport-1" { }
                    }
                }
                virtual-port "vport-10" {
                    aggregate-rate {
                        rate 200000
                    }
                    host-match {
                        int-dest-id "vport-10" { }
                    }
                }
                virtual-port "vport-11" {
                    aggregate-rate {
                        rate 200000
                    }
                    host-match {
                        int-dest-id "vport-11" { }
                    }
                }
                virtual-port "vport-12" {
                    aggregate-rate {
                        rate 200000
                    }
                    host-match {
                        int-dest-id "vport-12" { }
                    }
                }
                virtual-port "vport-13" {
                    aggregate-rate {
                        rate 200000
                    }
                    host-match {
                        int-dest-id "vport-13" { }
                    }
                }
                virtual-port "vport-14" {
                    aggregate-rate {
                        rate 200000
                    }
                    host-match {
                        int-dest-id "vport-14" { }
                    }
                }
            }
        }
    }
}
```

```
virtual-port "vport-15" {
  aggregate-rate {
    rate 200000
  }
  host-match {
    int-dest-id "vport-15" { }
  }
}
virtual-port "vport-16" {
  aggregate-rate {
    rate 200000
  }
  host-match {
    int-dest-id "vport-16" { }
  }
}
virtual-port "vport-2" {
  aggregate-rate {
    rate 3000000
  }
  host-match {
    int-dest-id "vport-2" { }
  }
}
virtual-port "vport-3" {
  aggregate-rate {
    rate 3000000
  }
  host-match {
    int-dest-id "vport-3" { }
  }
}
virtual-port "vport-4" {
  aggregate-rate {
    rate 3000000
  }
  host-match {
    int-dest-id "vport-4" { }
  }
}
virtual-port "vport-5" {
  aggregate-rate {
    rate 3000000
  }
  host-match {
    int-dest-id "vport-5" { }
  }
}
virtual-port "vport-6" {
  aggregate-rate {
    rate 1000000
  }
  host-match {
    int-dest-id "vport-6" { }
  }
}
virtual-port "vport-7" {
  aggregate-rate {
    rate 1000000
  }
  host-match {
    int-dest-id "vport-7" { }
  }
}
```

```
        virtual-port "vport-8" {
            aggregate-rate {
                rate 1000000
            }
            host-match {
                int-dest-id "vport-8" { }
            }
        }
        virtual-port "vport-9" {
            aggregate-rate {
                rate 1400000
            }
            host-match {
                int-dest-id "vport-9" { }
            }
        }
    }
    egress {
        port-scheduler-policy {
            policy-name "lag-3-pxc"
        }
    }
}
port-xc {
    pxc 1 {
        admin-state enable
        description "pw-port lag 2,3"
        port-id 1/1/c4/2
    }
    pxc 2 {
        admin-state enable
        description "pw-port lag 2,3"
        port-id 1/1/c4/3
    }
}
pw-port 1 {
    encap-type qinq
    epipe "access" {
        admin-state enable
        fpe-id 1
    }
}
python {
    python-script "monitor" {
        admin-state enable
        urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/monitor_lag_sr.py"]
        version python3
    }
    python-script "monitor-sched" {
        admin-state enable
        urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/monitor_lag_port_scheduler_sr.py"]
        version python3
    }
    python-script "monitor-sched-clear" {
        admin-state enable
        urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/monitor_lag_port_scheduler_clear_sr.py"]
        version python3
    }
}
```

```
qos {
  sap-egress "sap-egress-1" {
    policy-id 2
    queue 1 {
      port-parent {
      }
    }
  }
  port-scheduler-policy "lag-3-pxc" {
  }
}
router "Base" {
  autonomous-system 64500
  router-id 192.0.2.20
  interface "int-1-bng-1-p-1" {
    port lag-1:1
    ipv6 {
      address 2001:db8::501 {
        prefix-length 120
      }
    }
  }
  interface "system" {
    ipv4 {
      primary {
        address 192.0.2.20
        prefix-length 32
      }
    }
    ipv6 {
      address 2001:db8::14 {
        prefix-length 128
      }
    }
  }
  interface "to-radius" {
    port 1/1/c1/10:114
    ipv4 {
      primary {
        address 192.168.114.20
        prefix-length 24
      }
    }
  }
}
bgp {
  admin-state enable
  vpn-apply-export true
  vpn-apply-import true
  rapid-withdrawal true
  rapid-update {
    evpn true
  }
  group "evpn" {
    peer-as 64500
    local-address 2001:db8::14
    family {
      evpn true
    }
  }
  neighbor "2001:db8::5" {
    group "evpn"
  }
}
isis 0 {
```

```
admin-state enable
advertise-passive-only false
advertise-router-capability area
ipv6-routing native
level-capability 2
traffic-engineering true
area-address [49.0001]
interface "int-1-bng-1-p-1" {
}
interface "system" {
}
}
ldp {
interface-parameters {
interface "int-1-bng-1-p-1" {
ipv6 {
admin-state enable
}
}
}
}
radius {
server "free-radius-1" {
address 192.168.114.2
secret "HDqTwZYSvEu934VNhUQy/pubZxTKpSDzvHg=" hash2
accept-coa true
}
}
}
service {
epipe "access" {
admin-state enable
service-id 1
customer "1"
bgp 1 {
}
bgp-evpn {
evi 10
local-attachment-circuit "bng" {
eth-tag 2
}
remote-attachment-circuit "access" {
eth-tag 1
}
}
mpls 1 {
admin-state enable
send-tunnel-encap {
mpls-over-udp false
}
auto-bind-tunnel {
resolution any
}
route-next-hop {
system-ipv6
}
}
}
}
}
vpls "capture-sap" {
admin-state enable
service-id 5
customer "1"
load-balancing {
per-service-hashing true
}
```

```
    }
    capture-sap pw-1:*.* {
        radius-auth-policy "radius-1"
        trigger-packet {
            dhcp true
        }
        ipoe-session {
            admin-state enable
            ipoe-session-policy "ipoe-session-policy-1"
        }
    }
}
vprn "vport-hashing" {
    admin-state enable
    service-id 10
    customer "1"
    interface "loopback-1" {
        admin-state enable
        loopback true
        ipv4 {
            local-dhcp-server "dhcpv4"
            primary {
                address 192.168.0.1
                prefix-length 32
            }
            neighbor-discovery {
                local-proxy-arp false
                remote-proxy-arp false
            }
            dhcp {
                admin-state enable
            }
        }
    }
    interface "to-ixia" {
        ipv4 {
            primary {
                address 172.16.102.1
                prefix-length 24
            }
        }
        sap 1/1/c1/7:2 {
        }
        ipv6 {
            address 2001:db8::6601 {
                prefix-length 120
            }
        }
    }
    ipv6 {
        router-advertisement {
            interface "to-ixia" {
                admin-state enable
                max-advertisement-interval 15
                min-advertisement-interval 10
            }
        }
    }
}
dhcp-server {
    dhcpv4 "dhcpv4" {
        admin-state enable
        pool-selection {
            use-gi-address {
                scope pool
            }
        }
    }
}
```



```
    sfm-type m-sfm6-7/12
  }
  subscriber-mgmt {
    ipoe-session-policy "ipoe-session-policy-1" {
    }
    sub-profile "sub-profile-1" {
      egress {
        qos {
          agg-rate {
            rate 1000
          }
        }
      }
    }
    sla-profile "sla-profile-1" {
      egress {
        qos {
          sap-egress {
            policy-name "sap-egress-1"
            port-parent-location vport
            overrides {
              queue 1 {
                stat-mode v4-v6
              }
            }
          }
        }
      }
    }
  }
  sub-ident-policy "sub-ident-policy-1" {
    sla-profile-map {
      use-direct-map-as-default true
    }
    sub-profile-map {
      use-direct-map-as-default true
    }
  }
  radius-authentication-policy "radius-1" {
    password "ncd8qyrNUMhYfa2SfrUqHMDZ9IXn3sVSmYBzbw==" hash2
    pppoe-access-method pap-chap
    radius-server-policy "radius-server-1"
    user-name {
      format circuit-id
    }
    include-radius-attribute {
      circuit-id true
      nas-identifier true
    }
  }
  msap-policy "msap-policy-1" {
    sub-sla-mgmt {
      subscriber-limit 1
      sub-ident-policy "sub-ident-policy-1"
      defaults {
        subscriber-id {
          sap-id
        }
      }
      single-sub-parameters {
        profiled-traffic-only true
      }
    }
    ies-vprn-only-sap-parameters {
      anti-spoof next-hop-ip-and-mac-addr
    }
  }
}
```



```
        ingress {
            qos {
                queuing-type service
            }
        }
    }
}
system {
    name "bng-1"
    management-interface {
        configuration-mode model-driven
        cli {
            cli-engine [md-cli classic-cli]
            md-cli {
                environment {
                    more false
                    command-alias {
                        alias "monitor-lag" {
                            admin-state enable
                            python-script "monitor"
                            mount-point global { }
                        }
                        alias "monitor-schd-clear" {
                            admin-state enable
                            python-script "monitor-sched-clear"
                            mount-point global { }
                        }
                        alias "monitor-scheduler" {
                            admin-state enable
                            python-script "monitor-sched"
                            mount-point global { }
                        }
                    }
                }
            }
        }
    }
}
netconf {
    admin-state enable
}
yang-modules {
    nokia-submodules false
    nokia-combined-modules true
}
snmp {
    admin-state disable
}
login-control {
    idle-timeout none
}
security {
    aaa {
        local-profiles {
            profile "administrative" {
                default-action permit-all
                entry 10 {
                    match "configure system security"
                    action permit
                }
                entry 20 {
                    match "show system security"
                    action permit
                }
            }
        }
    }
}
```

```
entry 30 {
    match "tools perform security"
    action permit
}
entry 40 {
    match "tools dump security"
    action permit
}
entry 50 {
    match "admin system security"
    action permit
}
entry 100 {
    match "configure li"
    action deny
}
entry 110 {
    match "show li"
    action deny
}
entry 111 {
    match "clear li"
    action deny
}
entry 112 {
    match "tools dump li"
    action deny
}
netconf {
    base-op-authorization {
        action true
        cancel-commit true
        close-session true
        commit true
        copy-config true
        create-subscription true
        delete-config true
        discard-changes true
        edit-config true
        get true
        get-config true
        get-data true
        get-schema true
        kill-session true
        lock true
        validate true
    }
}
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
    entry 40 {
        match "logout"
    }
}
```

```
        action permit
    }
    entry 50 {
        match "password"
        action permit
    }
    entry 60 {
        match "show config"
        action deny
    }
    entry 65 {
        match "show li"
        action deny
    }
    entry 66 {
        match "clear li"
        action deny
    }
    entry 67 {
        match "tools dump li"
        action deny
    }
    entry 68 {
        match "state li"
        action deny
    }
    entry 70 {
        match "show"
        action permit
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
}
ssh {
    server-admin-state enable
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
        cipher 200 {
            name aes128-cbc
        }
    }
}
```

```
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
client-cipher-list-v2 {
    cipher 190 {
        name aes256-ctr
    }
    cipher 192 {
        name aes192-ctr
    }
    cipher 194 {
        name aes128-ctr
    }
    cipher 200 {
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
server-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
```

```
        name hmac-sha1-96
      }
      mac 225 {
        name hmac-md5
      }
      mac 240 {
        name hmac-md5-96
      }
    }
  }
  user-params {
    local-user {
      user "admin" {
        password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
        access {
          console true
          netconf true
        }
        console {
          member ["administrative"]
        }
      }
    }
  }
}
time {
  prefer-local-time true
  zone {
    standard {
      name cst
    }
  }
  dst-zone "CDT" {
    end {
      day sunday
      month november
      hours-minutes "02:00"
    }
    start {
      day sunday
      month march
      hours-minutes "02:00"
    }
  }
  sntp {
    admin-state enable
    server 135.227.160.253 {
    }
  }
}
}
}

# Finished 2022-12-14T13:38:31.1-06:00
```

bng-vport-per-subscriber-balancing

```
# TiMOS-C-22.10.R1 cpm/x86_64 Nokia 7750 SR Copyright (c) 2000-2022 Nokia.
# All rights reserved. All use subject to applicable license agreements.
# Built on Sun Oct 30 14:49:55 PDT 2022 by builder in /builds/c/2210B/R1/panos/main/sros
# Configuration format version 22.10 revision 0
```

```
# Generated 2022-12-14T13:42:02.4-06:00 by admin from 135.231.208.32
# Commit ID 5
# Committed 2022-12-14T13:41:47.9-06:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 4
# Committed 2022-12-14T13:41:11.6-06:00 by admin (MD-CLI) from 135.231.208.32
# Commit ID 3
# Committed 2022-12-14T13:33:11.3-06:00 by admin (MD-CLI) from 135.231.208.32

configure {
  aaa {
    radius {
      server-policy "radius-server-1" {
        servers {
          router-instance "Base"
          server 1 {
            server-name "free-radius-1"
          }
        }
      }
    }
  }
  card 1 {
    card-type iom5-e
    mda 1 {
      mda-type me6-100gb-qsfp28
    }
    mda 2 {
      mda-type me6-100gb-qsfp28
    }
  }
  fwd-path-ext {
    sdp-id-range {
      start 17500
      end 17600
    }
    fpe 1 {
      description "pw-port on a lag"
      path {
        xc-lag-a "lag-2"
        xc-lag-b "lag-3"
      }
      application {
        pw-port-extension {
        }
      }
    }
  }
  lag "lag-1" {
    admin-state enable
    description "lag to p-1"
    mode hybrid
    max-ports 64
    port 1/1/c1/1 {
    }
    port 1/1/c1/2 {
    }
  }
  lag "lag-2" {
    admin-state enable
    description "fpe pw-port pxc lag - transit side"
    mode hybrid
    max-ports 64
    port pxc-1.a {
    }
  }
}
```

```
    port pxc-2.a {
    }
}
lag "lag-3" {
  admin-state enable
  description "fpe pw-port pxc lag - termination side"
  mode hybrid
  max-ports 64
  access {
    per-fp-ing-queuing false
    per-fp-egr-queuing false
    per-fp-sap-instance false
    adapt-qos {
      mode port-fair
    }
  }
  port pxc-1.b {
  }
  port pxc-2.b {
  }
}
log {
  filter "1001" {
    named-entry "10" {
      description "Collect only events of major severity or higher"
      action forward
      match {
        severity {
          gte major
        }
      }
    }
  }
}
log-id "100" {
  description "Default Serious Errors Log"
  filter "1001"
  source {
    main true
  }
  destination {
    memory {
      max-entries 500
    }
  }
}
log-id "99" {
  description "Default System Log"
  source {
    main true
  }
  destination {
    memory {
      max-entries 500
    }
  }
}
}
port 1/1/c1 {
  admin-state enable
  connector {
    breakout c10-10g
  }
}
port 1/1/c1/1 {
```

```
    admin-state enable
    description "lag-1 to p-1 access"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/2 {
    admin-state enable
    description "lag-1 to p-1 access"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/3 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/4 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/5 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/6 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/7 {
    admin-state enable
    description "to pe-2 network"
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/8 {
    admin-state enable
    ethernet {
        mode hybrid
    }
}
port 1/1/c1/9 {
    admin-state enable
    ethernet {
        mode hybrid
        dot1x {
            tunneling true
        }
    }
}
port 1/1/c1/10 {
    admin-state enable
    description "RADIUS and mirroring"
    ethernet {
        mode hybrid
    }
}
```



```
    }
  }
  port 1/1/c2 {
    admin-state enable
    connector {
      breakout c1-100g
    }
  }
  port 1/1/c2/1 {
    admin-state enable
    ethernet {
      mode hybrid
      encap-type dot1q
      dot1x {
        tunneling true
      }
    }
  }
  port 1/1/c4 {
    admin-state enable
    connector {
      breakout c4-10g
    }
  }
  port 1/1/c4/1 {
    admin-state enable
    ethernet {
      mode hybrid
    }
  }
  port 1/1/c4/2 {
    admin-state enable
    description "PXC 1; pw-port lag 2,3"
    ethernet {
      mode hybrid
      dot1x {
        tunneling true
      }
    }
  }
  port 1/1/c4/3 {
    admin-state enable
    description "PXC 2; pw-port lag 2,3"
    ethernet {
      mode hybrid
      dot1x {
        tunneling true
      }
    }
  }
  port 1/1/c4/4 {
    admin-state enable
    ethernet {
      mode hybrid
    }
  }
  port pxc-1.a {
    admin-state enable
  }
  port pxc-1.b {
    admin-state enable
    description "PXC lag-3, pw-port termination"
    ethernet {
      access {
```

```
egress {
  virtual-port "vport-1" {
    aggregate-rate {
      rate 1500000
    }
    host-match {
      int-dest-id "vport-1" { }
    }
  }
  virtual-port "vport-10" {
    aggregate-rate {
      rate 9000000
    }
    host-match {
      int-dest-id "vport-10" { }
    }
  }
  virtual-port "vport-11" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-11" { }
    }
  }
  virtual-port "vport-12" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-12" { }
    }
  }
  virtual-port "vport-13" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-13" { }
    }
  }
  virtual-port "vport-14" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-14" { }
    }
  }
  virtual-port "vport-15" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-15" { }
    }
  }
  virtual-port "vport-16" {
    aggregate-rate {
      rate 3000000
    }
    host-match {
      int-dest-id "vport-16" { }
    }
  }
}
```

```
}
virtual-port "vport-2" {
  aggregate-rate {
    rate 500000
  }
  host-match {
    int-dest-id "vport-2" { }
  }
}
virtual-port "vport-3" {
  aggregate-rate {
    rate 500000
  }
  host-match {
    int-dest-id "vport-3" { }
  }
}
virtual-port "vport-4" {
  aggregate-rate {
    rate 500000
  }
  host-match {
    int-dest-id "vport-4" { }
  }
}
virtual-port "vport-5" {
  aggregate-rate {
    rate 4500000
  }
  host-match {
    int-dest-id "vport-5" { }
  }
}
virtual-port "vport-6" {
  aggregate-rate {
    rate 1500000
  }
  host-match {
    int-dest-id "vport-6" { }
  }
}
virtual-port "vport-7" {
  aggregate-rate {
    rate 1500000
  }
  host-match {
    int-dest-id "vport-7" { }
  }
}
virtual-port "vport-8" {
  aggregate-rate {
    rate 1500000
  }
  host-match {
    int-dest-id "vport-8" { }
  }
}
virtual-port "vport-9" {
  aggregate-rate {
    rate 9000000
  }
  host-match {
    int-dest-id "vport-9" { }
  }
}
```

```
    }
  }
  egress {
    port-scheduler-policy {
      policy-name "lag-3-pxc"
    }
  }
}
port pxc-2.a {
  admin-state enable
}
port pxc-2.b {
  admin-state enable
  description "PXC lag-3, pw-port termination"
  ethernet {
    access {
      egress {
        virtual-port "vport-1" {
          aggregate-rate {
            rate 1500000
          }
          host-match {
            int-dest-id "vport-1" { }
          }
        }
        virtual-port "vport-10" {
          aggregate-rate {
            rate 9000000
          }
          host-match {
            int-dest-id "vport-10" { }
          }
        }
        virtual-port "vport-11" {
          aggregate-rate {
            rate 3000000
          }
          host-match {
            int-dest-id "vport-11" { }
          }
        }
        virtual-port "vport-12" {
          aggregate-rate {
            rate 3000000
          }
          host-match {
            int-dest-id "vport-12" { }
          }
        }
        virtual-port "vport-13" {
          aggregate-rate {
            rate 3000000
          }
          host-match {
            int-dest-id "vport-13" { }
          }
        }
        virtual-port "vport-14" {
          aggregate-rate {
            rate 3000000
          }
          host-match {
```

```
        int-dest-id "vport-14" { }
    }
}
virtual-port "vport-15" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-15" { }
    }
}
virtual-port "vport-16" {
    aggregate-rate {
        rate 3000000
    }
    host-match {
        int-dest-id "vport-16" { }
    }
}
virtual-port "vport-2" {
    aggregate-rate {
        rate 500000
    }
    host-match {
        int-dest-id "vport-2" { }
    }
}
virtual-port "vport-3" {
    aggregate-rate {
        rate 500000
    }
    host-match {
        int-dest-id "vport-3" { }
    }
}
virtual-port "vport-4" {
    aggregate-rate {
        rate 500000
    }
    host-match {
        int-dest-id "vport-4" { }
    }
}
virtual-port "vport-5" {
    aggregate-rate {
        rate 4500000
    }
    host-match {
        int-dest-id "vport-5" { }
    }
}
virtual-port "vport-6" {
    aggregate-rate {
        rate 1500000
    }
    host-match {
        int-dest-id "vport-6" { }
    }
}
virtual-port "vport-7" {
    aggregate-rate {
        rate 1500000
    }
    host-match {
```

```
        int-dest-id "vport-7" { }
      }
    }
    virtual-port "vport-8" {
      aggregate-rate {
        rate 1500000
      }
      host-match {
        int-dest-id "vport-8" { }
      }
    }
    virtual-port "vport-9" {
      aggregate-rate {
        rate 9000000
      }
      host-match {
        int-dest-id "vport-9" { }
      }
    }
  }
  egress {
    port-scheduler-policy {
      policy-name "lag-3-pxc"
    }
  }
}
port-xc {
  pxc 1 {
    admin-state enable
    description "pw-port lag 2,3"
    port-id 1/1/c4/2
  }
  pxc 2 {
    admin-state enable
    description "pw-port lag 2,3"
    port-id 1/1/c4/3
  }
}
pw-port 1 {
  encap-type qinq
  epipe "access" {
    admin-state enable
    fpe-id 1
  }
}
python {
  python-script "monitor" {
    admin-state enable
    urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/monitor_lag_sr.py"]
    version python3
  }
  python-script "monitor-sched" {
    admin-state enable
    urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/monitor_lag_port_scheduler_sr.py"]
    version python3
  }
  python-script "monitor-sched-clear" {
    admin-state enable
    urls ["ftp://135.231.216.68/pub/configs/alu/SIMS/ACGs/hashing-per-vport-on-pxc/monitor_lag_port_scheduler_clear_sr.py"]
  }
}
```

```
        version python3
    }
}
qos {
    sap-egress "sap-egress-1" {
        policy-id 2
        queue 1 {
            port-parent {
            }
        }
    }
    port-scheduler-policy "lag-3-pxc" {
    }
}
router "Base" {
    autonomous-system 64500
    router-id 192.0.2.20
    interface "int-1-bng-1-p-1" {
        port lag-1:1
        ipv6 {
            address 2001:db8::501 {
                prefix-length 120
            }
        }
    }
    interface "system" {
        ipv4 {
            primary {
                address 192.0.2.20
                prefix-length 32
            }
        }
        ipv6 {
            address 2001:db8::14 {
                prefix-length 128
            }
        }
    }
    interface "to-radius" {
        port 1/1/c1/10:114
        ipv4 {
            primary {
                address 192.168.114.20
                prefix-length 24
            }
        }
    }
}
bgp {
    admin-state enable
    vpn-apply-export true
    vpn-apply-import true
    rapid-withdrawal true
    rapid-update {
        evpn true
    }
    group "evpn" {
        peer-as 64500
        local-address 2001:db8::14
        family {
            evpn true
        }
    }
    neighbor "2001:db8::5" {
        group "evpn"
    }
}
```

```
    }
  }
  isis 0 {
    admin-state enable
    advertise-passive-only false
    advertise-router-capability area
    ipv6-routing native
    level-capability 2
    traffic-engineering true
    area-address [49.0001]
    interface "int-1-bng-1-p-1" {
    }
    interface "system" {
    }
  }
  ldp {
    interface-parameters {
      interface "int-1-bng-1-p-1" {
        ipv6 {
          admin-state enable
        }
      }
    }
  }
  radius {
    server "free-radius-1" {
      address 192.168.114.2
      secret "HDqTwZYSvEu934VnhUQy/pubZxTKpSDzvHg=" hash2
      accept-coa true
    }
  }
}
service {
  epipe "access" {
    admin-state enable
    service-id 1
    customer "1"
    bgp 1 {
    }
    bgp-evpn {
      evi 10
      local-attachment-circuit "bng" {
        eth-tag 2
      }
      remote-attachment-circuit "access" {
        eth-tag 1
      }
    }
    mpls 1 {
      admin-state enable
      send-tunnel-encap {
        mpls-over-udp false
      }
      auto-bind-tunnel {
        resolution any
      }
      route-next-hop {
        system-ipv6
      }
    }
  }
}
vpls "capture-sap" {
  admin-state enable
  service-id 5
}
```



```
customer "1"
load-balancing {
  per-service-hashing true
}
capture-sap pw-1:*.* {
  radius-auth-policy "radius-1"
  trigger-packet {
    dhcp true
  }
  ipoe-session {
    admin-state enable
    ipoe-session-policy "ipoe-session-policy-1"
  }
}
}
vprn "vport-hashing" {
  admin-state enable
  service-id 10
  customer "1"
  interface "loopback-1" {
    admin-state enable
    loopback true
    ipv4 {
      local-dhcp-server "dhcpv4"
      primary {
        address 192.168.0.1
        prefix-length 32
      }
      neighbor-discovery {
        local-proxy-arp false
        remote-proxy-arp false
      }
      dhcp {
        admin-state enable
      }
    }
  }
  interface "to-ixia" {
    ipv4 {
      primary {
        address 172.16.102.1
        prefix-length 24
      }
    }
    sap 1/1/c1/7:2 {
    }
    ipv6 {
      address 2001:db8::6601 {
        prefix-length 120
      }
    }
  }
  ipv6 {
    router-advertisement {
      interface "to-ixia" {
        admin-state enable
        max-advertisement-interval 15
        min-advertisement-interval 10
      }
    }
  }
}
}
dhcp-server {
  dhcpv4 "dhcpv4" {
    admin-state enable
  }
}
```

```
pool-selection {
    use-gi-address {
        scope pool
    }
    use-pool-from-client {
    }
}
pool "dhcpv4-1" {
    max-lease-time 1200
    subnet 10.10.0.0/24 {
        address-range 10.10.0.10 end 10.10.0.100 {
            failover-control-type access-driven
        }
    }
}
}
}
subscriber-interface "sub-int-1" {
    admin-state enable
    ipv4 {
        address 10.10.0.254 {
            prefix-length 24
        }
    }
    group-interface "group-int-1" {
        admin-state enable
        radius-auth-policy "radius-1"
        oper-up-while-empty true
        ipv4 {
            neighbor-discovery {
                remote-proxy-arp true
                populate false
            }
            dhcp {
                admin-state enable
                server [192.168.0.1]
                trusted true
                gi-address 10.10.0.254
                match-circuit-id true
                option-82 {
                    action keep
                    vendor-specific-option {
                        pool-name true
                    }
                }
                lease-populate {
                    max-leases 100
                }
                client-applications {
                    dhcp true
                }
            }
        }
    }
    ipoe-session {
        admin-state enable
        ipoe-session-policy "ipoe-session-policy-1"
        sap-session-limit 100
        force-auth {
            cid-change false
            rid-change false
        }
    }
}
}
```

```
    }
  }
  sfm 1 {
    sfm-type m-sfm6-7/12
  }
  subscriber-mgmt {
    ipoe-session-policy "ipoe-session-policy-1" {
    }
    sub-profile "sub-profile-1" {
      egress {
        qos {
          agg-rate {
            rate 1000
          }
        }
      }
    }
    sla-profile "sla-profile-1" {
      egress {
        qos {
          sap-egress {
            policy-name "sap-egress-1"
            port-parent-location vport
            overrides {
              queue 1 {
                stat-mode v4-v6
              }
            }
          }
        }
      }
    }
    sub-ident-policy "sub-ident-policy-1" {
      sla-profile-map {
        use-direct-map-as-default true
      }
      sub-profile-map {
        use-direct-map-as-default true
      }
    }
    radius-authentication-policy "radius-1" {
      password "ncd8qyrNUMhYfa2SfrUqHMDZ9IXn3sVSmYBzbw==" hash2
      pppoe-access-method pap-chap
      radius-server-policy "radius-server-1"
      user-name {
        format circuit-id
      }
      include-radius-attribute {
        circuit-id true
        nas-identifier true
      }
    }
    msap-policy "msap-policy-1" {
      sub-sla-mgmt {
        subscriber-limit 1
        sub-ident-policy "sub-ident-policy-1"
        defaults {
          subscriber-id {
            sap-id
          }
        }
        single-sub-parameters {
          profiled-traffic-only true
        }
      }
    }
  }
}
```

```
    }
    ies-vprn-only-sap-parameters {
        anti-spoof next-hop-ip-and-mac-addr
        ingress {
            qos {
                queuing-type service
            }
        }
    }
}
system {
    name "bng-1"
    management-interface {
        configuration-mode model-driven
        cli {
            cli-engine [md-cli classic-cli]
            md-cli {
                environment {
                    more false
                    command-alias {
                        alias "monitor-lag" {
                            admin-state enable
                            python-script "monitor"
                            mount-point global { }
                        }
                        alias "monitor-schd-clear" {
                            admin-state enable
                            python-script "monitor-sched-clear"
                            mount-point global { }
                        }
                        alias "monitor-scheduler" {
                            admin-state enable
                            python-script "monitor-sched"
                            mount-point global { }
                        }
                    }
                }
            }
        }
    }
    netconf {
        admin-state enable
    }
    yang-modules {
        nokia-submodules false
        nokia-combined-modules true
    }
    snmp {
        admin-state disable
    }
}
login-control {
    idle-timeout none
}
security {
    aaa {
        local-profiles {
            profile "administrative" {
                default-action permit-all
                entry 10 {
                    match "configure system security"
                    action permit
                }
                entry 20 {
```

```
        match "show system security"
        action permit
    }
    entry 30 {
        match "tools perform security"
        action permit
    }
    entry 40 {
        match "tools dump security"
        action permit
    }
    entry 50 {
        match "admin system security"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
    entry 110 {
        match "show li"
        action deny
    }
    entry 111 {
        match "clear li"
        action deny
    }
    entry 112 {
        match "tools dump li"
        action deny
    }
    }
    netconf {
        base-op-authorization {
            action true
            cancel-commit true
            close-session true
            commit true
            copy-config true
            create-subscription true
            delete-config true
            discard-changes true
            edit-config true
            get true
            get-config true
            get-data true
            get-schema true
            kill-session true
            lock true
            validate true
        }
    }
}
profile "default" {
    entry 10 {
        match "exec"
        action permit
    }
    entry 20 {
        match "exit"
        action permit
    }
    entry 30 {
        match "help"
        action permit
    }
}
```

```
    }
    entry 40 {
        match "logout"
        action permit
    }
    entry 50 {
        match "password"
        action permit
    }
    entry 60 {
        match "show config"
        action deny
    }
    entry 65 {
        match "show li"
        action deny
    }
    entry 66 {
        match "clear li"
        action deny
    }
    entry 67 {
        match "tools dump li"
        action deny
    }
    entry 68 {
        match "state li"
        action deny
    }
    entry 70 {
        match "show"
        action permit
    }
    entry 75 {
        match "state"
        action permit
    }
    entry 80 {
        match "enable-admin"
        action permit
    }
    entry 90 {
        match "enable"
        action permit
    }
    entry 100 {
        match "configure li"
        action deny
    }
}
}
}
ssh {
    server-admin-state enable
    server-cipher-list-v2 {
        cipher 190 {
            name aes256-ctr
        }
        cipher 192 {
            name aes192-ctr
        }
        cipher 194 {
            name aes128-ctr
        }
    }
}
```

```
    cipher 200 {
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
client-cipher-list-v2 {
    cipher 190 {
        name aes256-ctr
    }
    cipher 192 {
        name aes192-ctr
    }
    cipher 194 {
        name aes128-ctr
    }
    cipher 200 {
        name aes128-cbc
    }
    cipher 205 {
        name 3des-cbc
    }
    cipher 225 {
        name aes192-cbc
    }
    cipher 230 {
        name aes256-cbc
    }
}
server-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
        name hmac-sha1
    }
    mac 220 {
        name hmac-sha1-96
    }
    mac 225 {
        name hmac-md5
    }
    mac 240 {
        name hmac-md5-96
    }
}
client-mac-list-v2 {
    mac 200 {
        name hmac-sha2-512
    }
    mac 210 {
        name hmac-sha2-256
    }
    mac 215 {
```

```
        name hmac-sha1
      }
      mac 220 {
        name hmac-sha1-96
      }
      mac 225 {
        name hmac-md5
      }
      mac 240 {
        name hmac-md5-96
      }
    }
  }
  user-params {
    local-user {
      user "admin" {
        password "$2y$10$TQrZlpBDra86.qoexZUzQeBXDY1FcdDhGwdD9lLxMuFyPVSm00Gy6"
        access {
          console true
          netconf true
        }
        console {
          member ["administrative"]
        }
      }
    }
  }
}
time {
  prefer-local-time true
  zone {
    standard {
      name cst
    }
  }
  dst-zone "CDT" {
    end {
      day sunday
      month november
      hours-minutes "02:00"
    }
    start {
      day sunday
      month march
      hours-minutes "02:00"
    }
  }
  sntp {
    admin-state enable
    server 135.227.160.253 {
    }
  }
}
}
}
}

# Finished 2022-12-14T13:42:02.4-06:00
```

radius users

```
cid-1          Cleartext-Password := "cse-password"
              Alc-Subsc-ID-Str = "ipoe-ds-1",
```



```
Alc-Subsc-Prof-Str = "sub-profile-1",
Alc-SLA-Prof-Str = "sla-profile-1",
Alc-MSAP-Interface = "group-int-1",
Alc-MSAP-Policy = "msap-policy-1",
Alc-MSAP-Serv-Id = "10",
Framed-Pool = "dhcipv4-1",
Framed-IPv6-Pool = "dhcipv6-1",
Alc-Delegated-IPv6-Pool = "dhcipv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
Fall-Through = No

cid-2
Cleartext-Password := "cse-password"
Alc-Subsc-ID-Str = "ipoe-ds-2",
Alc-Subsc-Prof-Str = "sub-profile-1",
Alc-SLA-Prof-Str = "sla-profile-1",
Alc-MSAP-Interface = "group-int-1",
Alc-MSAP-Policy = "msap-policy-1",
Alc-MSAP-Serv-Id = "10",
Framed-Pool = "dhcipv4-1",
Framed-IPv6-Pool = "dhcipv6-1",
Alc-Delegated-IPv6-Pool = "dhcipv6-1",
Alc-Int-Dest-Id-Str = "vport-1",
Fall-Through = No

cid-3
Cleartext-Password := "cse-password"
Alc-Subsc-ID-Str = "ipoe-ds-3",
Alc-Subsc-Prof-Str = "sub-profile-1",
Alc-SLA-Prof-Str = "sla-profile-1",
Alc-MSAP-Interface = "group-int-1",
Alc-MSAP-Policy = "msap-policy-1",
Alc-MSAP-Serv-Id = "10",
Framed-Pool = "dhcipv4-1",
Framed-IPv6-Pool = "dhcipv6-1",
Alc-Delegated-IPv6-Pool = "dhcipv6-1",
Alc-Int-Dest-Id-Str = "vport-2",
Fall-Through = No

cid-4
Cleartext-Password := "cse-password"
Alc-Subsc-ID-Str = "ipoe-ds-4",
Alc-Subsc-Prof-Str = "sub-profile-1",
Alc-SLA-Prof-Str = "sla-profile-1",
Alc-MSAP-Interface = "group-int-1",
Alc-MSAP-Policy = "msap-policy-1",
Alc-MSAP-Serv-Id = "10",
Framed-Pool = "dhcipv4-1",
Framed-IPv6-Pool = "dhcipv6-1",
Alc-Delegated-IPv6-Pool = "dhcipv6-1",
Alc-Int-Dest-Id-Str = "vport-2",
Fall-Through = No

cid-5
Cleartext-Password := "cse-password"
Alc-Subsc-ID-Str = "ipoe-ds-5",
Alc-Subsc-Prof-Str = "sub-profile-1",
Alc-SLA-Prof-Str = "sla-profile-1",
Alc-MSAP-Interface = "group-int-1",
Alc-MSAP-Policy = "msap-policy-1",
Alc-MSAP-Serv-Id = "10",
Framed-Pool = "dhcipv4-1",
Framed-IPv6-Pool = "dhcipv6-1",
Alc-Delegated-IPv6-Pool = "dhcipv6-1",
Alc-Int-Dest-Id-Str = "vport-3",
Fall-Through = No

cid-6
Cleartext-Password := "cse-password"
```

```
Alc-Subsc-ID-Str = "ipoe-ds-6",
Alc-Subsc-Prof-Str = "sub-profile-1",
Alc-SLA-Prof-Str = "sla-profile-1",
Alc-MSAP-Interface = "group-int-1",
Alc-MSAP-Policy = "msap-policy-1",
Alc-MSAP-Serv-Id = "10",
Framed-Pool = "dhcpv4-1",
Framed-IPv6-Pool = "dhcpv6-1",
Alc-Delegated-IPv6-Pool = "dhcpv6-1",
Alc-Int-Dest-Id-Str = "vport-3",
Fall-Through = No

cid-7      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-7",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-4",
           Fall-Through = No

cid-8      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-8",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-4",
           Fall-Through = No

cid-9      Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-9",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-5",
           Fall-Through = No

cid-10     Cleartext-Password := "cse-password"
           Alc-Subsc-ID-Str = "ipoe-ds-10",
           Alc-Subsc-Prof-Str = "sub-profile-1",
           Alc-SLA-Prof-Str = "sla-profile-1",
           Alc-MSAP-Interface = "group-int-1",
           Alc-MSAP-Policy = "msap-policy-1",
           Alc-MSAP-Serv-Id = "10",
           Framed-Pool = "dhcpv4-1",
           Framed-IPv6-Pool = "dhcpv6-1",
           Alc-Delegated-IPv6-Pool = "dhcpv6-1",
           Alc-Int-Dest-Id-Str = "vport-5",
           Fall-Through = No
```

```
cid-11      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-11",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpx4-1",
            Framed-IPv6-Pool = "dhcpx6-1",
            Alc-Delegated-IPv6-Pool = "dhcpx6-1",
            Alc-Int-Dest-Id-Str = "vport-6",
            Fall-Through = No

cid-12      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-12",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpx4-1",
            Framed-IPv6-Pool = "dhcpx6-1",
            Alc-Delegated-IPv6-Pool = "dhcpx6-1",
            Alc-Int-Dest-Id-Str = "vport-6",
            Fall-Through = No

cid-13      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-13",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpx4-1",
            Framed-IPv6-Pool = "dhcpx6-1",
            Alc-Delegated-IPv6-Pool = "dhcpx6-1",
            Alc-Int-Dest-Id-Str = "vport-7",
            Fall-Through = No

cid-14      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-14",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpx4-1",
            Framed-IPv6-Pool = "dhcpx6-1",
            Alc-Delegated-IPv6-Pool = "dhcpx6-1",
            Alc-Int-Dest-Id-Str = "vport-7",
            Fall-Through = No

cid-15      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-15",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpx4-1",
            Framed-IPv6-Pool = "dhcpx6-1",
            Alc-Delegated-IPv6-Pool = "dhcpx6-1",
            Alc-Int-Dest-Id-Str = "vport-8",
            Fall-Through = No
```

```
cid-16      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-16",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-8",
            Fall-Through = No

cid-17      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-17",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-9",
            Fall-Through = No

cid-18      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-18",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-9",
            Fall-Through = No

cid-19      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-19",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-10",
            Fall-Through = No

cid-20      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-20",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-10",
```

	Fall-Through = No
cid-21	Cleartext-Password := "cse-password" Alc-Subsc-ID-Str = "ipoe-ds-21", Alc-Subsc-Prof-Str = "sub-profile-1", Alc-SLA-Prof-Str = "sla-profile-1", Alc-MSAP-Interface = "group-int-1", Alc-MSAP-Policy = "msap-policy-1", Alc-MSAP-Serv-Id = "10", Framed-Pool = "dhcpv4-1", Framed-IPv6-Pool = "dhcpv6-1", Alc-Delegated-IPv6-Pool = "dhcpv6-1", Alc-Int-Dest-Id-Str = "vport-11", Fall-Through = No
cid-22	Cleartext-Password := "cse-password" Alc-Subsc-ID-Str = "ipoe-ds-22", Alc-Subsc-Prof-Str = "sub-profile-1", Alc-SLA-Prof-Str = "sla-profile-1", Alc-MSAP-Interface = "group-int-1", Alc-MSAP-Policy = "msap-policy-1", Alc-MSAP-Serv-Id = "10", Framed-Pool = "dhcpv4-1", Framed-IPv6-Pool = "dhcpv6-1", Alc-Delegated-IPv6-Pool = "dhcpv6-1", Alc-Int-Dest-Id-Str = "vport-11", Fall-Through = No
cid-23	Cleartext-Password := "cse-password" Alc-Subsc-ID-Str = "ipoe-ds-23", Alc-Subsc-Prof-Str = "sub-profile-1", Alc-SLA-Prof-Str = "sla-profile-1", Alc-MSAP-Interface = "group-int-1", Alc-MSAP-Policy = "msap-policy-1", Alc-MSAP-Serv-Id = "10", Framed-Pool = "dhcpv4-1", Framed-IPv6-Pool = "dhcpv6-1", Alc-Delegated-IPv6-Pool = "dhcpv6-1", Alc-Int-Dest-Id-Str = "vport-12", Fall-Through = No
cid-24	Cleartext-Password := "cse-password" Alc-Subsc-ID-Str = "ipoe-ds-24", Alc-Subsc-Prof-Str = "sub-profile-1", Alc-SLA-Prof-Str = "sla-profile-1", Alc-MSAP-Interface = "group-int-1", Alc-MSAP-Policy = "msap-policy-1", Alc-MSAP-Serv-Id = "10", Framed-Pool = "dhcpv4-1", Framed-IPv6-Pool = "dhcpv6-1", Alc-Delegated-IPv6-Pool = "dhcpv6-1", Alc-Int-Dest-Id-Str = "vport-12", Fall-Through = No
cid-25	Cleartext-Password := "cse-password" Alc-Subsc-ID-Str = "ipoe-ds-25", Alc-Subsc-Prof-Str = "sub-profile-1", Alc-SLA-Prof-Str = "sla-profile-1", Alc-MSAP-Interface = "group-int-1", Alc-MSAP-Policy = "msap-policy-1", Alc-MSAP-Serv-Id = "10", Framed-Pool = "dhcpv4-1", Framed-IPv6-Pool = "dhcpv6-1", Alc-Delegated-IPv6-Pool = "dhcpv6-1",

```
Alc-Int-Dest-Id-Str = "vport-13",
Fall-Through = No

cid-26      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-26",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcipv4-1",
            Framed-IPv6-Pool = "dhcipv6-1",
            Alc-Delegated-IPv6-Pool = "dhcipv6-1",
            Alc-Int-Dest-Id-Str = "vport-13",
            Fall-Through = No

cid-27      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-27",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcipv4-1",
            Framed-IPv6-Pool = "dhcipv6-1",
            Alc-Delegated-IPv6-Pool = "dhcipv6-1",
            Alc-Int-Dest-Id-Str = "vport-14",
            Fall-Through = No

cid-28      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-28",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcipv4-1",
            Framed-IPv6-Pool = "dhcipv6-1",
            Alc-Delegated-IPv6-Pool = "dhcipv6-1",
            Alc-Int-Dest-Id-Str = "vport-14",
            Fall-Through = No

cid-29      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-29",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcipv4-1",
            Framed-IPv6-Pool = "dhcipv6-1",
            Alc-Delegated-IPv6-Pool = "dhcipv6-1",
            Alc-Int-Dest-Id-Str = "vport-15",
            Fall-Through = No

cid-30      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-30",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcipv4-1",
            Framed-IPv6-Pool = "dhcipv6-1",
```

```
cid-31      Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-15",
            Fall-Through = No

cid-31      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-31",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-16",
            Fall-Through = No

cid-32      Cleartext-Password := "cse-password"
            Alc-Subsc-ID-Str = "ipoe-ds-32",
            Alc-Subsc-Prof-Str = "sub-profile-1",
            Alc-SLA-Prof-Str = "sla-profile-1",
            Alc-MSAP-Interface = "group-int-1",
            Alc-MSAP-Policy = "msap-policy-1",
            Alc-MSAP-Serv-Id = "10",
            Framed-Pool = "dhcpv4-1",
            Framed-IPv6-Pool = "dhcpv6-1",
            Alc-Delegated-IPv6-Pool = "dhcpv6-1",
            Alc-Int-Dest-Id-Str = "vport-16",
            Fall-Through = No
```

Customer document and product support



Customer documentation

[Customer documentation welcome page](#)



Technical support

[Product support portal](#)



Documentation feedback

[Customer documentation feedback](#)