

AOS-CX 10.17 MPLS Guide

6400 (ROX44C, ROX45C), 8360 Switch Series



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Enterprise

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This document describes features of the AOS-CX network operating system. It is intended for administrators responsible for installing, configuring, and managing HPE Aruba Networking switches on a network.

Latest version available online

Updates to this document can occur after initial publication. For the latest versions of product documentation, see the links provided in [Support and Other Resources](#).

Command syntax notation conventions

Convention	Usage
<code>example-text</code>	Identifies commands and their options and operands, code examples, filenames, pathnames, and output displayed in a command window. Items that appear like the example text in the previous column are to be entered exactly as shown and are required unless enclosed in brackets ([]).
example-text	In code and screen examples, indicates text entered by a user.
Any of the following: <ul style="list-style-type: none">▪ <code><example-text></code>▪ <i><example-text></i>▪ <code>example-text</code>▪ <i>example-text</i>	Identifies a placeholder—such as a parameter or a variable—that you must substitute with an actual value in a command or in code: <ul style="list-style-type: none">▪ For output formats where italic text cannot be displayed, variables are enclosed in angle brackets (< >). Substitute the text—including the enclosing angle brackets—with an actual value.▪ For output formats where italic text can be displayed, variables might or might not be enclosed in angle brackets. Substitute the text including the enclosing angle brackets, if any, with an actual value.
	Vertical bar. A logical OR that separates multiple items from which you can choose only one. Any spaces that are on either side of the vertical bar are included for readability and are not a required part of the command syntax.
{ }	Braces. Indicates that at least one of the enclosed items is required.
[]	Brackets. Indicates that the enclosed item or items are optional.
... or ...	Ellipsis: <ul style="list-style-type: none">▪ In code and screen examples, a vertical or horizontal ellipsis indicates an omission of information.▪ In syntax using brackets and braces, an ellipsis indicates items that can be

repeated. When an item followed by ellipses is enclosed in brackets, zero or more items can be specified.

About the examples

Examples in this document are representative and might not match your particular switch or environment.

The slot and port numbers in this document are for illustration only and might be unavailable on your switch.

Understanding the CLI prompts

When illustrating the prompts in the command line interface (CLI), this document uses the generic term **switch**, instead of the host name of the switch. For example:

```
switch>
```

The CLI prompt indicates the current command context. For example:

```
switch>
```

Indicates the operator command context.

```
switch#
```

Indicates the manager command context.

```
switch (CONTEXT-NAME) #
```

Indicates the configuration context for a feature. For example:

```
switch (config-if) #
```

Identifies the **interface** context.

Variable information in CLI prompts

In certain configuration contexts, the prompt may include variable information. For example, when in the VLAN configuration context, a VLAN number appears in the prompt:

```
switch (config-vlan-100) #
```

When referring to this context, this document uses the syntax:

```
switch (config-vlan-<VLAN-ID>) #
```

Where <VLAN-ID> is a variable representing the VLAN number.

Identifying switch ports and interfaces

Physical ports on the switch and their corresponding logical software interfaces are identified using the format: **member/slot/port**.

On the HPE Aruba Networking 6400 Switch Series

- *member*: Always 1. VSF is not supported on this switch.
- *slot*: Specifies physical location of a module in the switch chassis.
 - Management modules are on the front of the switch in slots 1/1 and 1/2.
 - Line modules are on the front of the switch starting in slot 1/3.
- *port*: Physical number of a port on a line module.

For example, the logical interface **1/3/4** in software is associated with physical port 4 in slot 3 on member 1.

On the HPE Aruba Networking 8xxx, 93xx, and 10xxx Switch Series

- *member*: Always 1. VSF is not supported on this switch.
- *slot*: Always 1. This is not a modular switch, so there are no slots.
- *port*: Physical number of a port on the switch.

For example, the logical interface **1/1/4** in software is associated with physical port 4 on the switch.



If using breakout cables, the port designation changes to x:y, where x is the physical port and y is the lane when split. For example, the logical interface 1/1/4:2 in software is associated with lane 2 on physical port 4 in slot 1 on member 1.

Identifying modular switch components

- Power supplies are on the front of the switch behind the bezel above the management modules. Power supplies are labeled in software in the format: *member/power supply*:
 - *member*: 1.
 - *power supply*: 1 to 4.
- Fans are on the rear of the switch and are labeled in software as: *member/tray/fan*:
 - *member*: 1.
 - *tray*: 1 to 4.
 - *fan*: 1 to 4.
- Fabric modules are not labeled on the switch but are labeled in software in the format: *member/module*:
 - *member*: 1.
 - *member*: 1 or 2.
- The display module on the rear of the switch is not labeled with a member or slot number.

Multiprotocol Label Switching (MPLS) is a routing technique in telecommunications networks that directs data from one node to the next based on short path labels rather than long network addresses. The labels identify virtual links (paths) between distant nodes rather than endpoints. MPLS can encapsulate packets of various network protocols, hence the "multiprotocol" reference on its name.



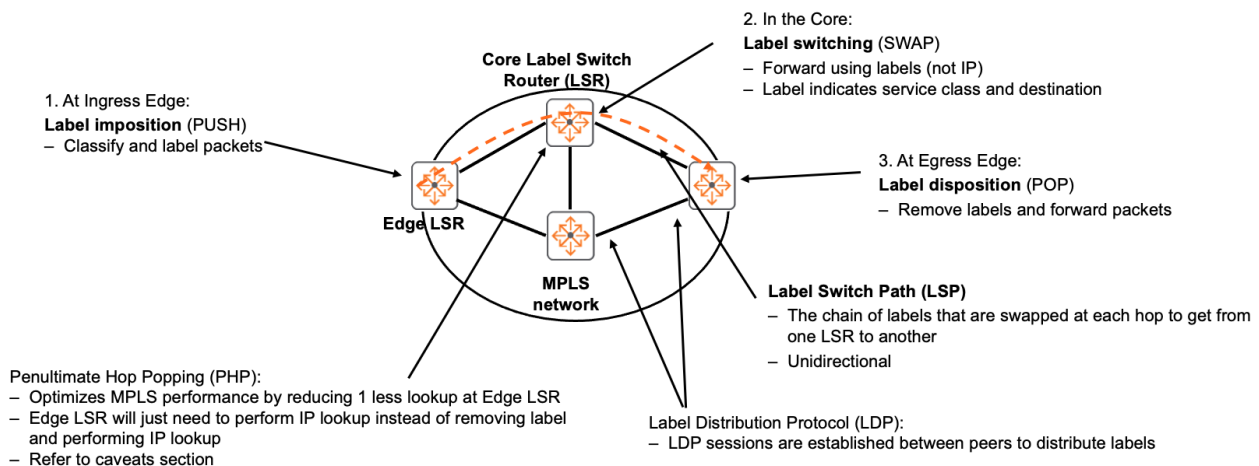
Any features not explicitly mentioned in this document are not supported as of the 10.09 release.

MPLS switches are termed Label Switch Routers (LSRs).

1. At the ingress edge LSR, label imposition or label push is used to classify and label packets.
2. At the transit core LSR, label switching or label swapping is used to forward traffic based on labels instead of IP.
3. At the egress edge LSR, label disposition or label pop is used to remove labels and forward IP packets.

A unidirectional label switched path (LSP) is a chain of labels that are swapped at each hop to get from one LSR to another. Label Distribution Protocol (LDP) sessions are established between LSRs to distribute labels.

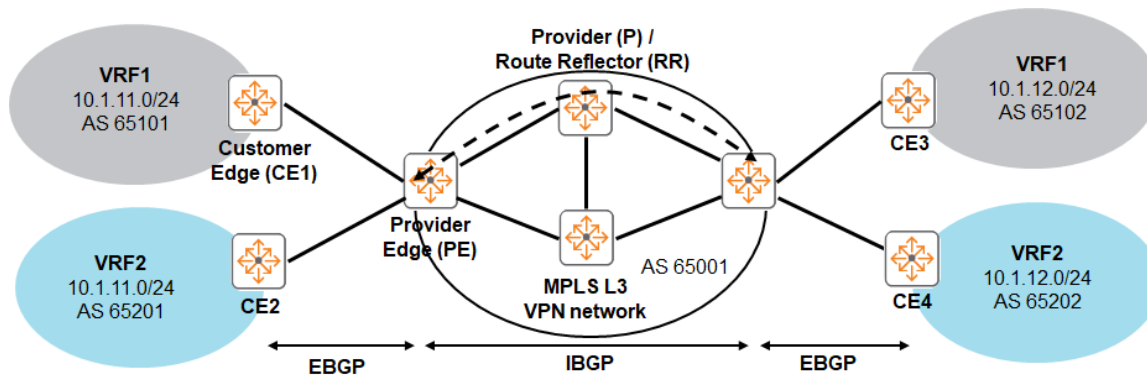
Penultimate Hop Popping (PHP) optimizes MPLS performance by reducing 1 less lookup at the egress edge LSR. With PHP, the egress edge LSR will just need to perform IP lookup instead of removing label and performing IP lookup. The figure below depicts the main MPLS concepts:



MPLS L3 VPN

MPLS L3 VPNs are deployed by service providers to provide L3 network connectivity and multi-tenant traffic isolation using an MPLS network.

In the figure below, the MPLS L3 VPN uses BGP Autonomous System (AS) 65001, CEs in Virtual Routing and Forwarding (VRF1) utilize AS 65101/65102, CEs in VRF2 utilize AS 65201/65202. VRF1 and VRF2 may utilize overlapping IP subnets if desired.



In this example, VRF1 consists of CE1 (LAN subnet 10.1.11.0/24) and CE3 (LAN subnet 10.1.12.0/24). VRF2 consists of CE2 (LAN subnet 10.1.11.0/24) and CE4 (LAN subnet 10.1.12.0/24). The Core LSR now functions as Provider (P) or Route Reflector (RR). The Edge LSR now functions as Provider Edge (PE). Customer Edge (CE) routers are not part of the MPLS L3VPN network but are attached to it. VRFs (without MPLS or VPNv4) could be enabled on CEs to provide locally significant L3 network isolation. Multi Protocol BGP (MP-BGP) is used between PE routers to exchange VPNv4 addresses, extended communities and labels. Full mesh IBGP peering is avoided within the MPLS L3 VPN network when P routers function as VPNv4 RR. PE would peer to dual RRs for redundancy.

The following details provide additional information regarding the configuration of MPLS features.

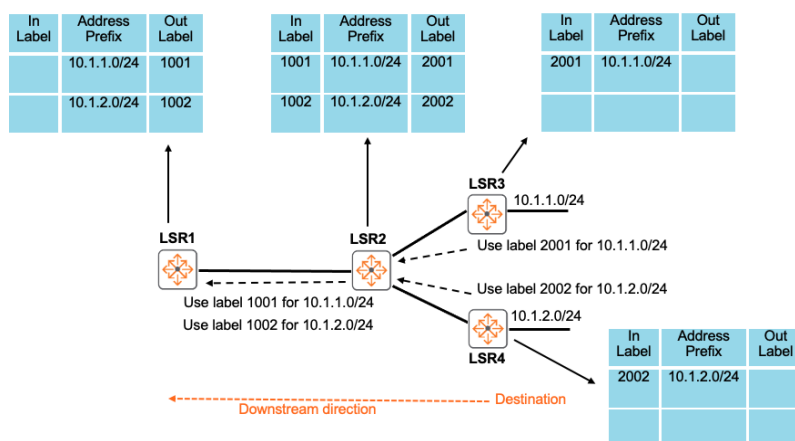
LDP and downstream label allocation

LDP is used for downstream label allocation, Figure 3 describes this MPLS concept. Assuming 10.1.1.0/24 and 10.1.2.0/24 on the right are destination subnets.

From a right to left direction:

1. LSR3 informs LSR2 to use label 2001 for 10.1.1.0/24.
2. LSR4 informs LSR2 to use label 2002 for 10.1.2.0/24.
3. LSR2 will in turn inform LSR1 to use label 1001 for 10.1.1.0/24 and label 1002 for 10.1.2.0/24.

The figure below shows LDP and downstream label allocation:

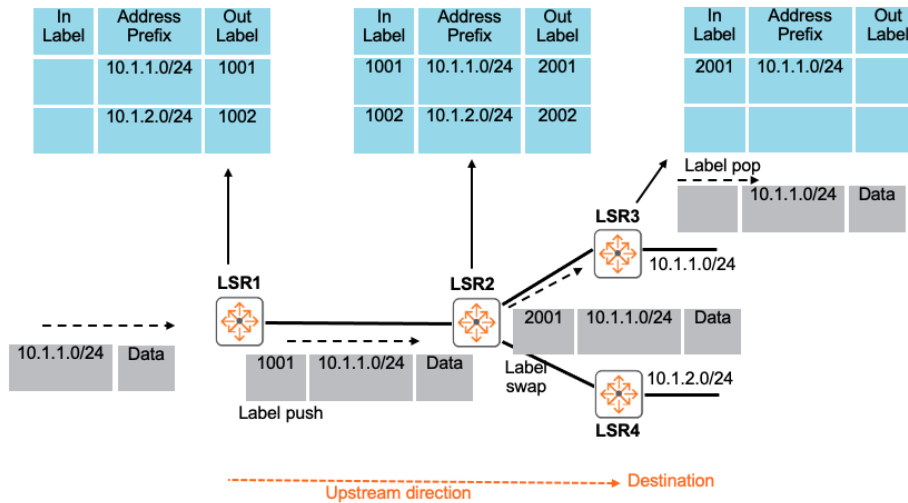


Label-based forwarding

Once the labels are allocated in the downstream direction, label based forwarding in the upstream direction is used next.

1. Data destined for 10.1.1.0/24 arrives at LSR1, LSR1 will refer to the MPLS label table and push 1001 into the packet towards LSR2.
2. LSR2 will receive the packet, see inbound label 1001, swap it with label 2001 and send it towards LSR3.
3. LSR3 will receive the packet, see inbound label 2001, pop it and send the packet using its IP routing table to the destination.

The figure shows label-based forwarding, from the left to right direction:

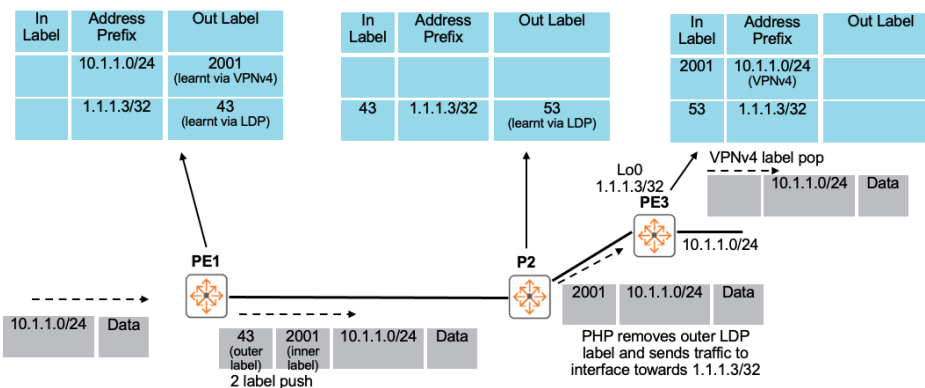


MPLS L3 VPN forwarding

MPLS L3 VPN requires a 2 label stack in order to forward traffic. The outer label (based on LDP) is used to forward traffic towards remote PE loopbacks, while the inner label (based on VPNv4) are used to forward traffic towards CE subnets.

1. Data destined for 10.1.1.0/24 arrives at PE1, PE1 will refer to the LDP, MPLS BGP VPNv4 tables and push both 43 (outer) and 2001 (inner) labels into the packet towards P2.
2. Because of PHP from PE3 to P2, P2 will receive the packet, see inbound label 43, remove outer LDP label and send it towards PE3.
3. PE3 will receive the packet with VPNv4 label, see inbound label 2001, pop it and send the packet using it's IP routing table to the destination.

The figure below shows MPLS L3 VPN forwarding from the left to right direction:



MPLS L3 VPN requirements and recommendations

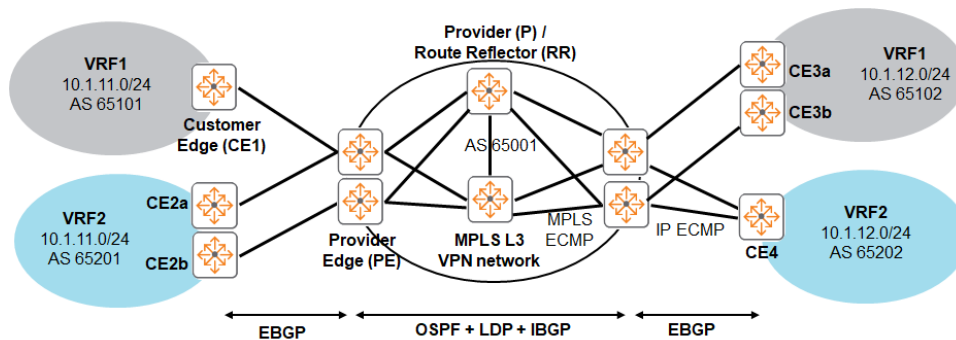
MPLS L3 VPN has the following requirements:

- OSPF is required to exchange loopback IPs between PE/P
- LDP is required to exchange outer labels

- IBGP MP-BGP VPNv4 peering between PE/P(RR) loopbacks are used to exchange inner VPNv4 labels
- EBGP IPv4 peering is recommended between CE and PE

High availability recommendations:

- Dual standalone Ps
- Dual standalone RRs
- Dual standalone PEs for a site
- Dual CEs (could be VSX or 2 standalone switches)
- Redundant Equal Cost Multi Pathing (ECMP) links



MPLS L3 VPN QoS

MPLS packets interact with Quality of Service features, such as queueing and scheduling. AOS-CX supports static Uniform mode queueing and remarking behavior as described below.

At tunnel entry, packets are prioritized and enqueued before entering the MPLS tunnel. Therefore, a device performing tunnel entry assigns a local priority and queue number to packets identically to non-MPLS packets: local priority is derived from both the packet's priority codepoints and the ingress port's QoS trust mode. Refer to the *Quality of Service Guide* for more information about trust mode and local-priority-to-queue mapping. When an IP packet enters an MPLS tunnel, the uppermost 3 bits of the DSCP field will be written into the egress packet's EXP value in the newly pushed MPLS header.

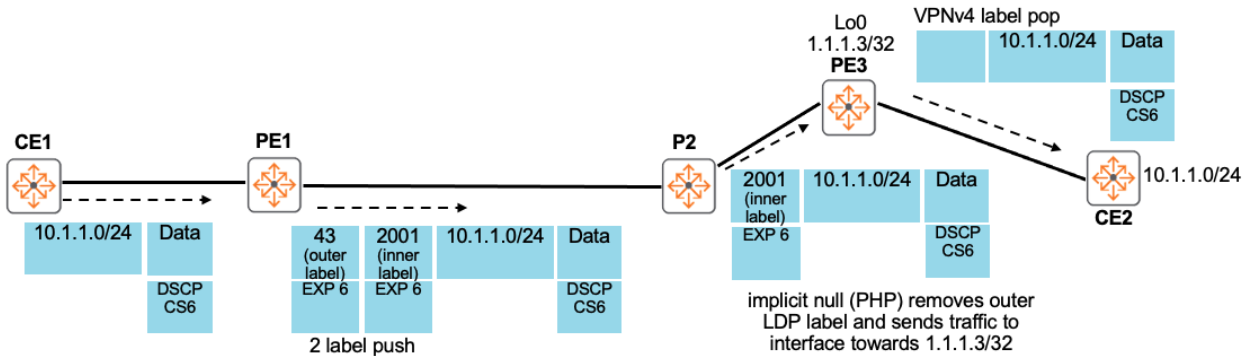
At MPLS transit and tunnel exit, packets are assigned a local priority equal to the EXP value of the incoming packet's outermost MPLS label. The COS and DSCP values of an incoming MPLS packet, and the trust mode of the ingress port, are ignored. EXP values are NOT subject to the CoS map or DSCP map applied on the system, but the local priority derived from the EXP value is still translated to a queue number through the queue profile applied on the system.

At tunnel exit, the device operates in Uniform mode. For IP packets, the EXP value from the popped MPLS label is written to the upper 3 bits of the DSCP field of the egress IP packet's header. The remaining bits of the DSCP field will be set to 0.

For MPLS Layer 3 Virtual Private Network (L3VPN), the protocols that are currently supported for communication between Customer Edge (CE) and Provider Edge (PE) are Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP). Routing Information Protocol (RIP) is not currently supported for communication between Customer Edge and Provider Edge.

MPLS L3 VPN supports QoS for congestion management. In the figure below implicit null/PHP is enabled on egress PE3 towards P2.

1. If CE1 sends traffic to PE1 with CS6 DSCP marking PE1 will automatically copy the CS6 DSCP marking to MPLS EXP 6 for both inner and outer labels
2. P2 will remove the outer label and forward traffic to interface towards PE3 with EXP 6 marking
3. PE3 will receive, pop the VPNv4 label and forward traffic with DSCP CS6

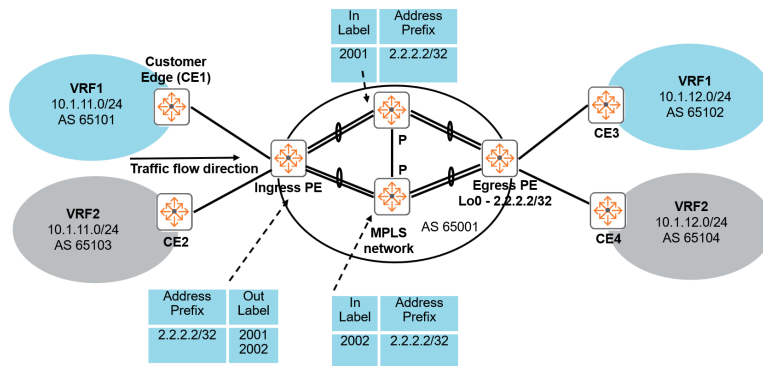


MPLS L3 VPN traffic load balancing

MPLS L3 VPN supports traffic load balancing via MPLS Equal Cost Multi Pathing (ECMP) across Link Aggregation Group (LAG) and links over multiple paths that have the same cost.

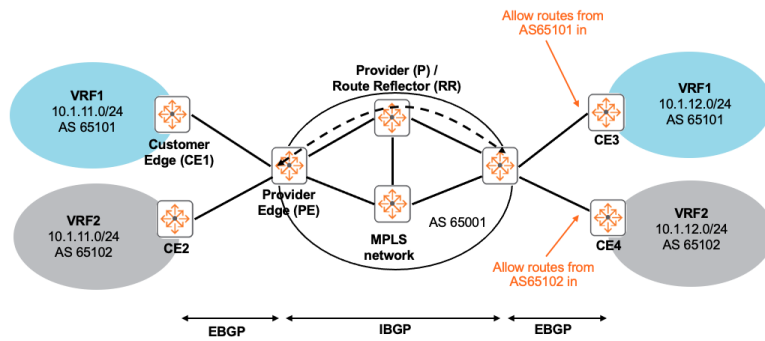
In the figure below, when ingress PE has 2 way ECMP towards egress PE loopback (2.2.2.2/32) via 2 intermediate P routers:

1. Traffic from ingress PE to egress PE will be load balanced across the links via the 2 P routers on a per flow basis
2. On ingress PE, some flows will use outbound label (2001) via top P router, while other flows will use outbound label (2002) via bottom P router



Same CE AS

CEs should be deployed using unique AS numbers to help identify which AS a route originates from, however it is possible to deploy the same CE AS as shown in the figure below, where VRF1 uses AS 65101 and VRF2 uses AS 65102. This is achieved by allowing the same inbound on the CE as a BGP router will (by default) drop routes from the same AS it is configured.



LDP packet capture

As shown in the figure below, a packet capture of LDP traffic between 2 LSRs is provided for reference. This example shows how a PE loopback IP of 2.2.2.2/32 is advertised with outer label of hex 0x12. Packet captures might be required if there is a need to troubleshoot LDP between 2 LSRs.

```

82 83.242435... 30.0.0.1      30.0.0.2      LDP      108 Label Mapping Message
-----
▶ Frame 82: 108 bytes on wire (864 bits), 108 bytes captured (864 bits) on interface \\.\pipe\Ethernet-003-D
▶ Ethernet II, Src: ArubaaHe_5d:7a:80 (b8:d4:e7:5d:7a:80), Dst: ArubaaHe_5d:9a:00 (b8:d4:e7:5d:9a:00)
▶ Internet Protocol Version 4, Src: 30.0.0.1, Dst: 30.0.0.2
▶ Transmission Control Protocol, Src Port: 646, Dst Port: 57159, Seq: 455, Ack: 535, Len: 38
▼ Label Distribution Protocol
  Version: 1
  PDU Length: 34
  LSR ID: 1.1.1.1
  Label Space ID: 0
  ▼ Label Mapping Message
    0... .. = U bit: Unknown bit not set
    Message Type: Label Mapping Message (0x400)
    Message Length: 24
    Message ID: 0x8000000b
    ▼ FEC
      00.. .... = TLV Unknown bits: Known TLV, do not Forward (0x0)
      TLV Type: FEC (0x100)
      TLV Length: 8
      ▼ FEC Elements
        ▼ FEC Element 1
          FEC Element Type: Prefix FEC (2)
          FEC Element Address Type: IPv4 (1)
          FEC Element Length: 32
          Prefix: 2.2.2.2
        ▼ Generic Label
          00.. .... = TLV Unknown bits: Known TLV, do not Forward (0x0)
          TLV Type: Generic Label (0x200)
          TLV Length: 4
          ..... 0000 0000 0000 0001 0010 = Generic Label: 0x00012
  
```

2.2.2.2/32 loopback advertised with label (hex 0x12)

VPNv4 packet capture

As shown in the figure below, a packet capture of MP-BGP VPNv4 traffic between 2 PEs is provided for reference. This example shows how a VRF tenant subnet of 20.0.2.0/24 is advertised with inner label of decimal 22. Packet captures might be required if there is a need to troubleshoot VPNv4 labels between 2 PEs. CEs should be deployed using unique AS numbers to help identify which AS a route originates from, however it is possible to deploy duplicate CE AS as shown in Figure 10, where VRF1 uses AS 65101 and VRF2 uses AS 65102. This is achieved by allowing the same inbound on the CE, as a BGP router will (by default) drop routes from the same AS it is configured.

```

11 12.523021_ 1.1.1.1      2.2.2.2      BGP      154 UPDATE Message
-----
> Frame 11: 154 bytes on wire (1232 bits), 154 bytes captured (1232 bits) on interface \\.\pipe\Etherne
> Ethernet II, Src: ArubaaHe_f1:d3:80 (8c:85:c1:f1:d3:80), Dst: ArubaaHe_f1:b3:00 (8c:85:c1:f1:b3:00)
> Internet Protocol Version 4, Src: 1.1.1.1, Dst: 2.2.2.2
> Transmission Control Protocol, Src Port: 35147, Dst Port: 179, Seq: 20, Ack: 1, Len: 84
▼ Border Gateway Protocol - UPDATE Message
  Marker: ffffffffffffffffffffffffffffffff
  Length: 84
  Type: UPDATE Message (2)
  Withdrawn Routes Length: 0
  Total Path Attribute Length: 61
  ▼ Path attributes
    ▶ Path Attribute - ORIGIN: INCOMPLETE
    ▶ Path Attribute - AS_PATH: empty
    ▶ Path Attribute - LOCAL_PREF: 100
    ▶ Path Attribute - EXTENDED_COMMUNITIES
    ▼ Path Attribute - MP_REACH_NLRI
      ▶ Flags: 0x90, Optional, Extended-Length, Non-transitive, Complete
      Type Code: MP_REACH_NLRI (14)
      Length: 32
      Address family identifier (AFI): IPv4 (1)
      Subsequent address family identifier (SAFI): Labeled VPN Unicast (128)
    ▶ Next hop network address (12 bytes)
    ▶ Number of Subnetwork points of attachment (SNPA): 0
  ▼ Network layer reachability information (15 bytes)
    ▼ BGP Prefix
      Prefix Length: 112
      Label Stack: 22 (bottom) ← Tenant VRF 20.0.2.0/24 prefix
      Route Distinguisher: 1:1      advertised with label (decimal 22)
      MP Reach NLRI IPv4 prefix: 20.0.2.0

```

Supported features and standards

Default behaviors

- Default QoS mode: Uniform
- Default TTL propagation mode: Uniform
- Default egress label: Explicit null
- Per-VPN/VRF label

Supported features

- MPLS L3 VPN
 - IPv4 unicast
- Static LSP
- OSPF between P/RR and PE/P
- LDP between P/RR and PE/P
- MP-BGP VPNv4 RR on PE
- MP-BGP VPNv4 RR client on PE
- QoS uniform mode only

Label bindings are supported with /32 address. For example, if the network between P and PE is X.0.0.0/24 with an interface address of P as X.0.0.1/24 and address of PE as X.0.0.2/24, the LDP binding on PE for the X.0.0.0/24 network will be shown as X.0.0.1/32

- VRFs (intranet and extranet VRF with route leaking)
- Multi-VRF (VRF-Lite) CE
- PE-CE connectivity:
 - EBGp
 - Static route
 - Default route
 - Connected route (PE acting as an L3 first hop)
- Ping over MPLS networks
- Traceroute over MPLS networks

Scale

8360 Switch Series	Profile: Aggregation-Leaf (Default)	Profile: Core-Spine
Max VPNv4 VRFs/EBGP as PE-CE protocol	256	256
Max VPNv4 neighbors/Max dynamic LSPs	256	256
Max VPNv4 VRF routes	65,000	600,000
Max VPNv4 neighbors/Max routes	256 neighbors/32,000 routes	256 neighbors/600,000 routes
Max LDP neighbors	128	128
Max static LSP	4096	4096

6400v2T Switch Series	Profile: v2-Aggregation-High-Bandwidth (non-default)	Profile: v2-Leaf-Extended-High-Bandwidth(non-default)	Profile: v2-Core-High-Bandwidth(non-default)
Max VPNv4 VRFs/EBGP as PE-CE protocol	256	256	256
Max VPNv4 neighbors/Max dynamic LSPs	256	256	256
Max VPNv4 VRF routes	65,000	65,000	600,000
Max VPNv4 neighbors/Max routes	256 neighbors/32,000 routes	256 neighbors/32,000 routes	256 neighbors/600,000 routes
Max LDP neighbors	128	128	128
Max static LSP	4096	4096	4096

Best practices

Recommended best practices for MPLS configuration are as follows:

- Use single area OSPF within the MPLS network to advertise and learn LSR loopbacks
- Use a single AS for the MPLS network
- Utilize EBGP between CE and PE for dynamic routing, use unique CE AS# if possible
- Use redundant VPNv4 RRs to avoid full mesh IBGP peers
- Use peer groups to simplify configs on both P/RR and PE

```

router bgp 65001
neighbor RR-client peer-group
neighbor RR-client remote-as 65001
neighbor RR-client description all RR clients
neighbor RR-client update-source loopback 0
neighbor 1.1.1.1 peer-group RR-client
neighbor 2.2.2.2 peer-group RR-client
address-family vpnv4 unicast
neighbor RR-client route-reflector-client
neighbor RR-client send-community both
neighbor 1.1.1.1 activate
neighbor 2.2.2.2 activate

```

- The **l3vpn-only** command should only be configured under the VRF context
- Implicit null is not supported, explicit null has to be configured on 3rd party egress PE towards AOS-CX P
- If egress PE and P are AOS-CX switches, changing it to explicit null is not required as explicit null is automatically sent

Supported RFCs and standards

The MPLS and MPLS L3 VPN implementation uses standards based protocols as described in the following RFCs:

- RFC 2547, BGP/MPLS VPNs
- RFC 3031, Multiprotocol Label Switching Architecture
- RFC 3032, MPLS Label Stack Encoding
- RFC 3036, LDP Specification
- RFC 3443, Time To Live (TTL) Processing in Multi-Protocol Label Switching (MPLS) Networks
- RFC 4182, Removing a Restriction on the use of MPLS Explicit NULL
- RFC 4364, BGP/MPLS IP Virtual Private Networks (VPNs)
- RFC 6388, Label Distribution Protocol Extensions for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths

Max VPNv4 VRFs/EBGP as PE-CE protocol	256	256	256
Max VPNv4 neighbors/Max dynamic LSPs	256	256	256
Max VPNv4 VRF routes	65,000	65,000	600,000
Max VPNv4 neighbors/Max routes	256 neighbors/32,000 routes	256 neighbors/32,000 routes	256 neighbors/600,000 routes
Max LDP neighbors	128	128	128
Max static LSP	4096	4096	4096

Chapter 5

Configuration task list

The following examples provide configuration steps to follow for basic MPLS configuration. For commands related to BGP configuration refer to the Border Gateway Protocol (BGP) chapter of the *IP Routing Guide*.

Configuring MPLS and LDP globally

Step	Command	Comments
1. Enter MPLS context	mpls	
2. Enable MPLS globally	enable	
3. Enter LDP context	label-protocol ldp	
4. Enable LDP globally	enable	
5. Specify loopback as LDP router-ID	<code>router-id <IP-ADDR></code>	Refer to the <i>IP Routing Guide</i> for command description.

Configuring MPLS and LDP on an interface

Step	Command	Comments
1. Enter desired interface	<code>interface <IFNAME></code>	Desired IP address and OSPF will also need to be added.
2. Enable MPLS	mpls enable	
3. Enable LDP	mpls ldp enable	

Configuring IBGP VPNv4 peering

Step	Command	Comments
1. Enter BGP context	<code>router bgp <AS-NUMBER></code>	
2. Specify remote BGP neighbor and remote AS	<code>neighbor <IP-ADDRESS> remote-as <AS-NUMBER></code>	The same AS number should

Step	Command	Comments
		be used between P/PE. OSPF should be enabled before BGP to advertise loopback IPs between LSRs.
3. Specify source IP/interface for IBGP peering	<code>neighbor <IP-ADDRESS> update-source loopback <NUMBER></code>	
4. Enter VPNv4 address family	<code>address-family vpnv4 unicast</code>	
5. Activate IBGP neighbor	<code>neighbor <IP-ADDRESS> activate</code>	
6. Send extended communities	<code>neighbor <IP-ADDRESS> send-community extended</code>	



The descriptions, syntax, and examples for the commands listed above can be found in the IP Routing Guide.

Configuring VPN

Step	Command	Comments
1. Create desired VRF	<code>vrf <VRF-NAME></code>	This command can be found in the IP Routing Guide.
2. Specify a unique RD per PE, per VRF	<code>rd number:number</code>	This command can be found in the VXLAN Guide.
3. Enable VPNv4 address family	<code>l3vpn-only</code>	<code>l3vpn-only</code> under VRF context is required for VPNv4 address family to be active.
4. Enter IPv4 unicast address family	<code>address-family ipv4 unicast</code>	This command can be found in the IP Routing Guide.
5. Specify desired route-target for export	<code>route-target export <AS-NUMBER:ID> <IP-ADDRESS:ID></code>	The route target both number:number command may also be used as an alternative. This command can be found in the VXLAN Guide.
6. Specify desired route-target for import	<code>route-target import <AS-NUMBER:ID> <IP-ADDRESS:ID></code>	

Configuring EBGP peering between PE and CE

Step	Command	Comments
1. Enter interface facing CE	<code>interface <IFNAME></code>	Desired IP address will also need to be added.
2. Attach VRF to interface	<code>vrf attach <VRF-NAME></code>	
3. Enter BGP context	<code>router bgp <AS-NUMBER></code>	
4. Enter desired VRF context	<code>vrf <VRF-NAME></code>	
5. Specify remote CE IP	<code>neighbor <IP-ADDRESS> remote-as <AS-NUMBER></code>	EBGP should be used between CE/PE with different AS .
6. Enter IPv4 unicast context for VRF	<code>address-family ipv4 unicast</code>	
7. Active the EBGP neighbor	<code>neighbor IP-address activate</code>	
8. Redistribute connected route to remote PEs and CEs	<code>redistribute connected</code>	Optional. Only required if connected routes need to be advertised.



The descriptions, syntax, and examples for the commands listed above can be found in the IP Routing Guide.

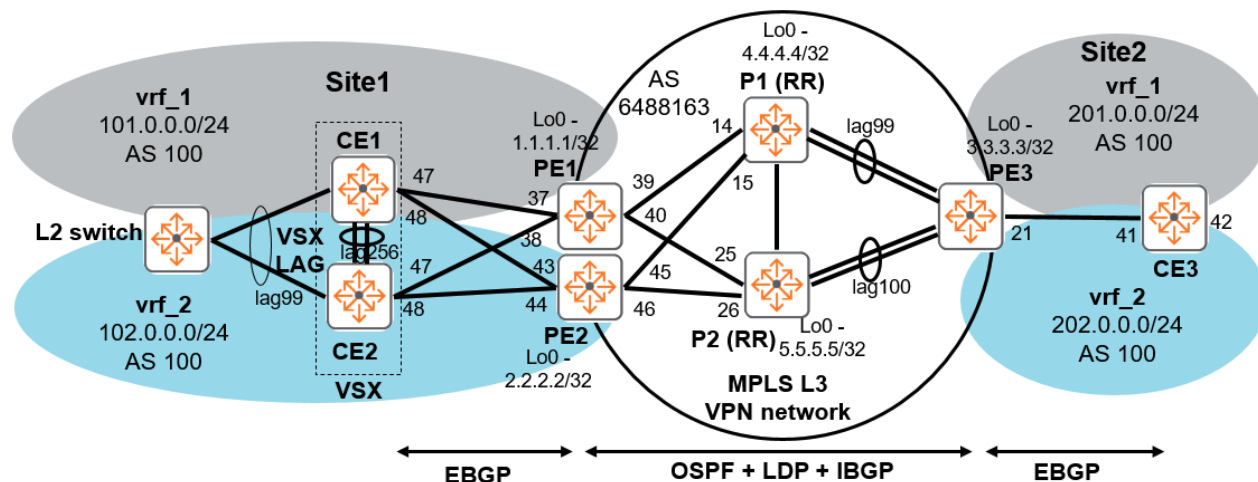
The following use cases provide examples of networks using MPLS VPNs.

Use case 1: MPLS L3 VPN with dual homed VSX CE

This use case covers:

- An MPLS L3 VPN network with redundant PEs, Ps and VRFs across the MPLS network
- Redundant VSX CEs at Site1 and standalone CE at Site2 with locally significant VRFs
- BGP community is used inbound/outbound on PE1 and PE2 to prevent loops from Site1
- Sample configurations
- Relevant verification commands

MPLS L3 VPN with dual homed VSX CE diagram



CE1 configuration

```

CE1# show running
Current configuration:
!
!Version ArubaOS-CX GL.10.09.0001BF
!export-password: default
hostname CE1
no ip icmp redirect
profile l3-core
logging console severity crit
vrf vrf_1
vrf vrf_2
cli-session
    timeout 0
!
    
```

```

!
!
!
!
ssh server vrf mgmt
vlan 1,2001-2002,2011-2012,2021-2022
interface mgmt
    no shutdown
    ip dhcp
system interface-group 1 speed 10g
    !interface group 1 contains ports 1/1/1-1/1/12
system interface-group 4 speed 10g
    !interface group 4 contains ports 1/1/37-1/1/48
interface lag 99 multi-chassis
    no shutdown
    description Towards L2SW
    no routing
    vlan trunk native 1
    vlan trunk allowed 2001-2002
    lacp mode active
interface lag 256
    no shutdown
    description Towards ISL
    no routing
    vlan trunk native 1 tag
    vlan trunk allowed all
    lacp mode active
interface 1/1/1
    no shutdown
    mtu 9000
    description Towards L2SW
    lag 99
interface 1/1/2
    no shutdown
    mtu 9000
    description Towards ISL
    lag 256
interface 1/1/3
    no shutdown
    mtu 9000
    description Towards ISL
    lag 256
interface 1/1/46
    no shutdown
    mtu 9000
    description Towards KA
    ip mtu 9000
    ip address 99.0.0.1/24
interface 1/1/47
    no shutdown
    mtu 9000
    description Towards PE1
    no routing
    vlan trunk native 1
    vlan trunk allowed 2011-2012
interface 1/1/48
    no shutdown
    mtu 9000
    description Towards PE2
    no routing
    vlan trunk native 1
    vlan trunk allowed 2021-2022

```

```

interface vlan 2001
  vrf attach vrf_1
  description Towards LAN
  ip mtu 9000
  vsx active-forwarding
  ip address 20.0.1.2/24
interface vlan 2002
  vrf attach vrf_2
  description Towards LAN
  ip mtu 9000
  vsx active-forwarding
  ip address 20.0.1.2/24
interface vlan 2011
  vrf attach vrf_1
  description Towards PE1
  ip mtu 9000
  ip address 20.1.1.1/24
interface vlan 2012
  vrf attach vrf_2
  description Towards PE1
  ip mtu 9000
  ip address 20.1.1.1/24
interface vlan 2021
  vrf attach vrf_1
  description Towards PE2
  ip mtu 9000
  ip address 20.2.1.1/24
interface vlan 2022
  vrf attach vrf_2
  description Towards PE2
  ip mtu 9000
  ip address 20.2.1.1/24
vsx
  inter-switch-link lag 256
  role primary
  keepalive peer 99.0.0.2 source 99.0.0.1
!
!
!
!
!
router bgp 100
!
  vrf vrf_1
    neighbor 20.0.1.1 remote-as 100
    neighbor 20.0.1.1 description Towards LAN
    neighbor 20.0.1.3 remote-as 100
    neighbor 20.0.1.3 description Towards CE2
    neighbor 20.1.1.2 remote-as 6488163
    neighbor 20.1.1.2 description Towards PE1
    neighbor 20.2.1.2 remote-as 6488163
    neighbor 20.2.1.2 description Towards PE2
    address-family ipv4 unicast
      neighbor 20.0.1.1 activate
      neighbor 20.0.1.1 next-hop-self
      neighbor 20.0.1.1 send-community both
      neighbor 20.0.1.1 soft-reconfiguration inbound
      neighbor 20.0.1.3 activate
      neighbor 20.0.1.3 allowas-in 1
      neighbor 20.0.1.3 next-hop-self
      neighbor 20.0.1.3 send-community both
      neighbor 20.0.1.3 soft-reconfiguration inbound

```

```

        neighbor 20.1.1.2 activate
        neighbor 20.1.1.2 allowas-in 1
        neighbor 20.1.1.2 send-community both
        neighbor 20.1.1.2 soft-reconfiguration inbound
        neighbor 20.2.1.2 activate
        neighbor 20.2.1.2 allowas-in 1
        neighbor 20.2.1.2 send-community both
        neighbor 20.2.1.2 soft-reconfiguration inbound
    exit-address-family
!
vrf vrf_2
    neighbor 20.0.1.1 remote-as 100
    neighbor 20.0.1.1 description Towards LAN
    neighbor 20.0.1.3 remote-as 100
    neighbor 20.0.1.3 description Towards CE2
    neighbor 20.1.1.2 remote-as 6488163
    neighbor 20.1.1.2 description Towards PE1
    neighbor 20.2.1.2 remote-as 6488163
    neighbor 20.2.1.2 description Towards PE2
    address-family ipv4 unicast
        neighbor 20.0.1.1 activate
        neighbor 20.0.1.1 next-hop-self
        neighbor 20.0.1.1 send-community both
        neighbor 20.0.1.1 soft-reconfiguration inbound
        neighbor 20.0.1.3 activate
        neighbor 20.0.1.3 allowas-in 1
        neighbor 20.0.1.3 next-hop-self
        neighbor 20.0.1.3 send-community both
        neighbor 20.0.1.3 soft-reconfiguration inbound
        neighbor 20.1.1.2 activate
        neighbor 20.1.1.2 allowas-in 1
        neighbor 20.1.1.2 send-community both
        neighbor 20.1.1.2 soft-reconfiguration inbound
        neighbor 20.2.1.2 activate
        neighbor 20.2.1.2 allowas-in 1
        neighbor 20.2.1.2 send-community both
        neighbor 20.2.1.2 soft-reconfiguration inbound
    exit-address-family
!
https-server vrf mgmt

```

CE1 verification

```

CE1# show bgp all-vrf all summary
VRF : default
BGP Summary
-----
Local AS           : 100           BGP Router Identifier : 99.0.0.1
Peers              : 0             Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive      : 60
Confederation Id  : 0

Address-family : IPv4 Unicast
-----

Address-family : IPv6 Unicast
-----

Address-family : L2VPN EVPN
-----

```

```

VRF : vrf_1
BGP Summary
-----
Local AS           : 100           BGP Router Identifier : 20.2.1.1
Peers              : 4             Log Neighbor Changes  : No
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60
Confederation Id   : 0

```

```
Address-family : IPv4 Unicast
```

```

-----
Neighbor      Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
20.0.1.1      100        56       63       00h:26m:24s  Established  Up
20.0.1.3      100        37       36       00h:29m:13s  Established  Up
20.1.1.2      6488163   37       36       00h:28m:34s  Established  Up
20.2.1.2      6488163   35       35       00h:28m:01s  Established  Up

```

```
Address-family : IPv6 Unicast
```

```

VRF : vrf_2
BGP Summary
-----
Local AS           : 100           BGP Router Identifier : 20.2.1.1
Peers              : 4             Log Neighbor Changes  : No
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60
Confederation Id   : 0

```

```
Address-family : IPv4 Unicast
```

```

-----
Neighbor      Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
20.0.1.1      100        58       65       00h:26m:25s  Established  Up
20.0.1.3      100        38       38       00h:29m:18s  Established  Up
20.1.1.2      6488163   37       40       00h:28m:33s  Established  Up
20.2.1.2      6488163   38       38       00h:27m:57s  Established  Up

```

```
Address-family : IPv6 Unicast
```

```

CE1# show bgp all-vrf all
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

```

VRF : default
Local Router-ID 99.0.0.1

```

```
Address-family : IPv4 Unicast
```

```

-----
Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

```
Address-family : IPv6 Unicast
```

```

-----
Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

```
Address-family : L2VPN EVPN
```

```

      Network          Nexthop      Metric   LocPrf   Weight Path
-----
Total number of entries 0

VRF : vrf_1
Local Router-ID 20.2.1.1

Address-family : IPv4 Unicast
-----
      Network          Nexthop      Metric   LocPrf   Weight Path
*>i 101.0.0.0/24      20.0.1.1      0         0         0         i
* i 201.0.0.0/24      20.0.1.3      0         100        0        6488163 100 i
*>e 201.0.0.0/24      20.1.1.2      0         100        0        6488163 100 i
*=e 201.0.0.0/24      20.2.1.2      0         100        0        6488163 100 i
Total number of entries 4

Address-family : IPv6 Unicast
-----
      Network          Nexthop      Metric   LocPrf   Weight Path
Total number of entries 0

VRF : vrf_2
Local Router-ID 20.2.1.1

Address-family : IPv4 Unicast
-----
      Network          Nexthop      Metric   LocPrf   Weight Path
*>i 102.0.0.0/24      20.0.1.1      0         0         0         i
* i 202.0.0.0/24      20.0.1.3      0         100        0        6488163 100 i
*=e 202.0.0.0/24      20.1.1.2      0         100        0        6488163 100 i
*>e 202.0.0.0/24      20.2.1.2      0         100        0        6488163 100 i
Total number of entries 4

Address-family : IPv6 Unicast
-----
      Network          Nexthop      Metric   LocPrf   Weight Path
Total number of entries 0

```

CE1# **show ip route all-vrf**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

```

Prefix          Nexthop      Interface      VRF (egress)  Origin/
Distance/      Age
-----
99.0.0.0/24    -            -              -              C
[0/0]          -
99.0.0.1/32    -            1/1/46        -              L
[0/0]          -

```

VRF: vrf_1

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/Type	Metric
20.0.1.0/24	-	-	vlan2001	-	C	
[0/0]	-	-				
20.0.1.2/32	-	-	vlan2001	-	L	
[0/0]	-	-				
20.1.1.0/24	-	-	vlan2011	-	C	
[0/0]	-	-				
20.1.1.1/32	-	-	vlan2011	-	L	
[0/0]	-	-				
20.2.1.0/24	-	-	vlan2021	-	C	
[0/0]	-	-				
20.2.1.1/32	-	-	vlan2021	-	L	
[0/0]	-	-				
101.0.0.0/24		20.0.1.1	vlan2001	-	B/I	
[200/0]	01h:11m:54s					
201.0.0.0/24		20.1.1.2	vlan2011	-	B/E	
[20/0]	01h:10m:33s					
		20.2.1.2	vlan2021	-		
[20/0]	01h:10m:33s					

VRF: vrf_2

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/Type	Metric
20.0.1.0/24	-	-	vlan2002	-	C	
[0/0]	-	-				
20.0.1.2/32	-	-	vlan2002	-	L	
[0/0]	-	-				
20.1.1.0/24	-	-	vlan2012	-	C	
[0/0]	-	-				
20.1.1.1/32	-	-	vlan2012	-	L	
[0/0]	-	-				
20.2.1.0/24	-	-	vlan2022	-	C	
[0/0]	-	-				
20.2.1.1/32	-	-	vlan2022	-	L	
[0/0]	-	-				
102.0.0.0/24		20.0.1.1	vlan2002	-	B/I	
[200/0]	00h:54m:05s					
202.0.0.0/24		20.2.1.2	vlan2022	-	B/E	
[20/0]	00h:54m:05s					
		20.1.1.2	vlan2012	-		
[20/0]	00h:54m:05s					

Total Route Count : 18

CE2 configuration

```
CE2# show running-config
Current configuration:
!
!Version ArubaOS-CX GL.10.09.0001BF
!export-password: default
```

```

hostname CE2
no ip icmp redirect
profile l3-core
logging console severity crit
vrf vrf_1
vrf vrf_2
cli-session
    timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2001-2002,2031-2032,2041-2042
interface mgmt
    no shutdown
    ip dhcp
system interface-group 1 speed 10g
    !interface group 1 contains ports 1/1/1-1/1/12
system interface-group 4 speed 10g
    !interface group 4 contains ports 1/1/37-1/1/48
interface lag 99 multi-chassis
    no shutdown
    description Towards L2SW
    no routing
    vlan trunk native 1
    vlan trunk allowed 2001-2002
    lacp mode active
interface lag 256
    no shutdown
    description Towards ISL
    no routing
    vlan trunk native 1 tag
    vlan trunk allowed all
    lacp mode active
interface 1/1/1
    no shutdown
    mtu 9000
    description Towards L2SW
    lag 99
interface 1/1/2
    no shutdown
    mtu 9000
    description Towards ISL
    lag 256
interface 1/1/3
    no shutdown
    mtu 9000
    description Towards ISL
    lag 256
interface 1/1/46
    no shutdown
    mtu 9000
    description Towards KA
    ip mtu 9000
    ip address 99.0.0.2/24
interface 1/1/47
    no shutdown
    mtu 9000
    description Towards PE1
    no routing

```

```

    vlan trunk native 1
    vlan trunk allowed 2031-2032
interface 1/1/48
    no shutdown
    mtu 9000
    description Towards PE2
    no routing
    vlan trunk native 1
    vlan trunk allowed 2041-2042
interface vlan 2001
    vrf attach vrf_1
    description Towards LAN
    ip mtu 9000
    vsx active-forwarding
    ip address 20.0.1.3/24
interface vlan 2002
    vrf attach vrf_2
    description Towards LAN
    ip mtu 9000
    vsx active-forwarding
    ip address 20.0.1.3/24
interface vlan 2031
    vrf attach vrf_1
    description Towards PE1
    ip mtu 9000
    ip address 20.3.1.1/24
interface vlan 2032
    vrf attach vrf_2
    description Towards PE1
    ip mtu 9000
    ip address 20.3.1.1/24
interface vlan 2041
    vrf attach vrf_1
    description Towards PE2
    ip mtu 9000
    ip address 20.4.1.1/24
interface vlan 2042
    vrf attach vrf_2
    description Towards PE2
    ip mtu 9000
    ip address 20.4.1.1/24
vsx
    inter-switch-link lag 256
    role secondary
    keepalive peer 99.0.0.1 source 99.0.0.2
!
!
!
!
!
router bgp 100
!
    vrf vrf_1
        neighbor 20.0.1.1 remote-as 100
        neighbor 20.0.1.1 description Towards LAN
        neighbor 20.0.1.2 remote-as 100
        neighbor 20.0.1.2 description Towards CE1
        neighbor 20.3.1.2 remote-as 6488163
        neighbor 20.3.1.2 description Towards PE1
        neighbor 20.4.1.2 remote-as 6488163
        neighbor 20.4.1.2 description Towards PE2
        address-family ipv4 unicast

```

```

neighbor 20.0.1.1 activate
neighbor 20.0.1.1 next-hop-self
neighbor 20.0.1.1 send-community both
neighbor 20.0.1.1 soft-reconfiguration inbound
neighbor 20.0.1.2 activate
neighbor 20.0.1.2 allowas-in 1
neighbor 20.0.1.2 next-hop-self
neighbor 20.0.1.2 send-community both
neighbor 20.0.1.2 soft-reconfiguration inbound
neighbor 20.3.1.2 activate
neighbor 20.3.1.2 allowas-in 1
neighbor 20.3.1.2 send-community both
neighbor 20.3.1.2 soft-reconfiguration inbound
neighbor 20.4.1.2 activate
neighbor 20.4.1.2 allowas-in 1
neighbor 20.4.1.2 send-community both
neighbor 20.4.1.2 soft-reconfiguration inbound
exit-address-family
!
vrf vrf_2
neighbor 20.0.1.1 remote-as 100
neighbor 20.0.1.1 description Towards LAN
neighbor 20.0.1.2 remote-as 100
neighbor 20.0.1.2 description Towards CE1
neighbor 20.3.1.2 remote-as 6488163
neighbor 20.3.1.2 description Towards PE1
neighbor 20.4.1.2 remote-as 6488163
neighbor 20.4.1.2 description Towards PE2
address-family ipv4 unicast
neighbor 20.0.1.1 activate
neighbor 20.0.1.1 next-hop-self
neighbor 20.0.1.1 send-community both
neighbor 20.0.1.1 soft-reconfiguration inbound
neighbor 20.0.1.2 activate
neighbor 20.0.1.2 allowas-in 1
neighbor 20.0.1.2 next-hop-self
neighbor 20.0.1.2 send-community both
neighbor 20.0.1.2 soft-reconfiguration inbound
neighbor 20.3.1.2 activate
neighbor 20.3.1.2 allowas-in 1
neighbor 20.3.1.2 send-community both
neighbor 20.3.1.2 soft-reconfiguration inbound
neighbor 20.4.1.2 activate
neighbor 20.4.1.2 allowas-in 1
neighbor 20.4.1.2 send-community both
neighbor 20.4.1.2 soft-reconfiguration inbound
exit-address-family
!
https-server vrf mgmt

```

CE2 verification

```

CE2# show bgp all-vrf all summary
VRF : default
BGP Summary
-----
Local AS           : 100           BGP Router Identifier : 99.0.0.2
Peers              : 0             Log Neighbor Changes  : No
Cfg. Hold Time    : 180           Cfg. Keep Alive       : 60
Confederation Id  : 0

```

```
Address-family : IPv4 Unicast
```

```
Address-family : IPv6 Unicast
```

```
Address-family : L2VPN EVPN
```

```
VRF : vrf_1
```

```
BGP Summary
```

```
-----  
Local AS           : 100           BGP Router Identifier : 20.4.1.1  
Peers              : 4             Log Neighbor Changes  : No  
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60  
Confederation Id   : 0
```

```
Address-family : IPv4 Unicast
```

```
-----  
Neighbor           Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State  
AdminStatus  
20.0.1.1           100        56       65       00h:26m:24s  Established  Up  
20.0.1.2           100        36       37       00h:29m:13s  Established  Up  
20.3.1.2           6488163   36       36       00h:28m:34s  Established  Up  
20.4.1.2           6488163   35       35       00h:27m:58s  Established  Up
```

```
Address-family : IPv6 Unicast
```

```
VRF : vrf_2
```

```
BGP Summary
```

```
-----  
Local AS           : 100           BGP Router Identifier : 20.4.1.1  
Peers              : 4             Log Neighbor Changes  : No  
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60  
Confederation Id   : 0
```

```
Address-family : IPv4 Unicast
```

```
-----  
Neighbor           Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State  
AdminStatus  
20.0.1.1           100        58       65       00h:26m:25s  Established  Up  
20.0.1.2           100        38       38       00h:29m:18s  Established  Up  
20.3.1.2           6488163   38       40       00h:28m:43s  Established  Up  
20.4.1.2           6488163   37       38       00h:27m:56s  Established  Up
```

```
Address-family : IPv6 Unicast
```

```
CE2# show bgp all-vrf all
```

```
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,  
               i internal, e external S Stale, R Removed, a additional-paths  
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
VRF : default
```

```
Local Router-ID 99.0.0.2
```

```
Address-family : IPv4 Unicast
```

```
-----  
Network           Nexthop           Metric           LocPrf           Weight Path
```

```

Total number of entries 0

Address-family : IPv6 Unicast
-----
      Network          Nexthop          Metric      LocPrf      Weight Path
Total number of entries 0

Address-family : L2VPN EVPN
-----
      Network          Nexthop          Metric
      LocPrf      Weight      Path
-----
Total number of entries 0

VRF : vrf_1
Local Router-ID 20.4.1.1

Address-family : IPv4 Unicast
-----
      Network          Nexthop          Metric      LocPrf      Weight Path
*>i 101.0.0.0/24      20.0.1.1          0           0           0           i
* i 201.0.0.0/24      20.0.1.2          0           100          0           6488163 100 i
*>e 201.0.0.0/24      20.3.1.2          0           100          0           6488163 100 i
*=e 201.0.0.0/24      20.4.1.2          0           100          0           6488163 100 i
Total number of entries 4

Address-family : IPv6 Unicast
-----
      Network          Nexthop          Metric      LocPrf      Weight Path
Total number of entries 0

VRF : vrf_2
Local Router-ID 20.4.1.1

Address-family : IPv4 Unicast
-----
      Network          Nexthop          Metric      LocPrf      Weight Path
*>i 102.0.0.0/24      20.0.1.1          0           0           0           i
* i 202.0.0.0/24      20.0.1.2          0           100          0           6488163 100 i
*=e 202.0.0.0/24      20.3.1.2          0           100          0           6488163 100 i
*>e 202.0.0.0/24      20.4.1.2          0           100          0           6488163 100 i
Total number of entries 4

Address-family : IPv6 Unicast
-----
      Network          Nexthop          Metric      LocPrf      Weight Path
Total number of entries 0

```

```
CE2# show ip route all-vrf
```

```
Displaying ipv4 routes selected for forwarding
```

```
Origin Codes: C - connected, S - static, L - local
```

```
R - RIP, B - BGP, O - OSPF
```

```
Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
```

```
IA - OSPF internal area, E1 - OSPF external type 1
```

```
E2 - OSPF external type 2
```

```
VRF: default
```

Prefix Age	NextHop	Interface	VRF (egress)	Origin/	Distance/	Type	Metric
------------	---------	-----------	--------------	---------	-----------	------	--------

```

-----
99.0.0.0/24      -      -      1/1/46      -      C
[0/0]           -
99.0.0.2/32     -      -      1/1/46      -      L
[0/0]           -

```

VRF: vrf_1

Prefix Distance/	Age	NextHop	Interface	VRF (egress)	Origin/	Type	Metric
------------------	-----	---------	-----------	--------------	---------	------	--------

```

-----
20.0.1.0/24     -      -      vlan2001     -      C
[0/0]           -
20.0.1.3/32     -      -      vlan2001     -      L
[0/0]           -
20.3.1.0/24     -      -      vlan2031     -      C
[0/0]           -
20.3.1.1/32     -      -      vlan2031     -      L
[0/0]           -
20.4.1.0/24     -      -      vlan2041     -      C
[0/0]           -
20.4.1.1/32     -      -      vlan2041     -      L
[0/0]           -
101.0.0.0/24    20.0.1.1      -      vlan2001     -      B/I
[200/0]         01h:11m:55s
201.0.0.0/24    20.4.1.2      -      vlan2041     -      B/E
[20/0]          01h:10m:34s
                20.3.1.2
[20/0]          01h:10m:34s

```

VRF: vrf_2

Prefix Distance/	Age	NextHop	Interface	VRF (egress)	Origin/	Type	Metric
------------------	-----	---------	-----------	--------------	---------	------	--------

```

-----
20.0.1.0/24     -      -      vlan2002     -      C
[0/0]           -
20.0.1.3/32     -      -      vlan2002     -      L
[0/0]           -
20.3.1.0/24     -      -      vlan2032     -      C
[0/0]           -
20.3.1.1/32     -      -      vlan2032     -      L
[0/0]           -
20.4.1.0/24     -      -      vlan2042     -      C
[0/0]           -
20.4.1.1/32     -      -      vlan2042     -      L
[0/0]           -
102.0.0.0/24    20.0.1.1      -      vlan2002     -      B/I
[200/0]         00h:54m:06s
202.0.0.0/24    20.4.1.2      -      vlan2042     -      B/E
[20/0]          00h:54m:06s
                20.3.1.2
[20/0]          00h:54m:06s

```

Total Route Count : 18

CE3 configuration

```
CE3# show running-config
Current configuration:
!
!Version ArubaOS-CX GL.10.09.0001BF
!export-password: default
hostname CE3
profile l3-core
logging console severity crit
vrf vrf_1
vrf vrf_2
cli-session
    timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2051-2052,2061-2062
interface mgmt
    no shutdown
    ip dhcp
system interface-group 4 speed 10g
    !interface group 4 contains ports 1/1/37-1/1/48
interface 1/1/41
    no shutdown
    mtu 9000
    description Towards PE3
    no routing
    vlan trunk native 1
    vlan trunk allowed 2051-2052
interface 1/1/42
    no shutdown
    mtu 9000
    description Towards LAN
    no routing
    vlan trunk native 1
    vlan trunk allowed 2061-2062
interface vlan 2051
    vrf attach vrf_1
    description Towards PE3
    ip mtu 9000
    ip address 20.5.1.2/24
interface vlan 2052
    vrf attach vrf_2
    description Towards PE3
    ip mtu 9000
    ip address 20.5.1.2/24
interface vlan 2061
    vrf attach vrf_1
    description Towards LAN
    ip mtu 9000
    ip address 20.6.1.1/24
interface vlan 2062
    vrf attach vrf_2
    description Towards LAN
```

```

ip mtu 9000
ip address 20.6.1.1/24
!
!
!
!
!
router bgp 100
!
  vrf vrf_1
    neighbor 20.5.1.1 remote-as 6488163
    neighbor 20.5.1.1 description Towards PE3
    neighbor 20.6.1.2 remote-as 100
    neighbor 20.6.1.2 description Towards LAN
    address-family ipv4 unicast
      neighbor 20.5.1.1 activate
      neighbor 20.5.1.1 allowas-in 1
      neighbor 20.5.1.1 send-community both
      neighbor 20.5.1.1 soft-reconfiguration inbound
      neighbor 20.6.1.2 activate
      neighbor 20.6.1.2 next-hop-self
      neighbor 20.6.1.2 send-community both
      neighbor 20.6.1.2 soft-reconfiguration inbound
    exit-address-family
  !
  vrf vrf_2
    neighbor 20.5.1.1 remote-as 6488163
    neighbor 20.5.1.1 description Towards PE3
    neighbor 20.6.1.2 remote-as 100
    neighbor 20.6.1.2 description Towards LAN
    address-family ipv4 unicast
      neighbor 20.5.1.1 activate
      neighbor 20.5.1.1 allowas-in 1
      neighbor 20.5.1.1 send-community both
      neighbor 20.5.1.1 soft-reconfiguration inbound
      neighbor 20.6.1.2 activate
      neighbor 20.6.1.2 next-hop-self
      neighbor 20.6.1.2 send-community both
      neighbor 20.6.1.2 soft-reconfiguration inbound
    exit-address-family
  !
https-server vrf mgmt

```

CE3 verification

```

CE3# show bgp all-vrf all summary
VRF : default
BGP Summary
-----
Local AS           : 100           BGP Router Identifier : (null)
Peers              : 0             Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive       : 60
Confederation Id  : 0

Address-family : IPv4 Unicast
-----

Address-family : IPv6 Unicast
-----

```

Address-family : L2VPN EVPN

VRF : vrf_1
BGP Summary

Local AS : 100 BGP Router Identifier : 20.6.1.1
Peers : 2 Log Neighbor Changes : No
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Confederation Id : 0

Address-family : IPv4 Unicast

Neighbor Remote-AS MsgRcvd MsgSent Up/Down Time State
AdminStatus
20.5.1.1 6488163 34 33 00h:25m:12s Established Up
20.6.1.2 100 54 62 00h:25m:04s Established Up

Address-family : IPv6 Unicast

VRF : vrf_2
BGP Summary

Local AS : 100 BGP Router Identifier : 20.6.1.1
Peers : 2 Log Neighbor Changes : No
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Confederation Id : 0

Address-family : IPv4 Unicast

Neighbor Remote-AS MsgRcvd MsgSent Up/Down Time State
AdminStatus
20.5.1.1 6488163 34 34 00h:25m:11s Established Up
20.6.1.2 100 56 63 00h:25m:04s Established Up

Address-family : IPv6 Unicast

CE3# **show bgp all-vrf all**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default

Router-ID not configured

Address-family : IPv4 Unicast

Network Nexthop Metric LocPrf Weight Path
Total number of entries 0

Address-family : IPv6 Unicast

Network Nexthop Metric LocPrf Weight Path
Total number of entries 0

Address-family : L2VPN EVPN

Network Nexthop Metric
LocPrf Weight Path

Total number of entries 0

VRF : vrf_1
Local Router-ID 20.6.1.1

Address-family : IPv4 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
*>e 101.0.0.0/24	20.5.1.1	0	100	0	6488163 100 i
*>i 201.0.0.0/24	20.6.1.2	0	0	0	i

Total number of entries 2

Address-family : IPv6 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
---------	---------	--------	--------	--------	------

Total number of entries 0

VRF : vrf_2
Local Router-ID 20.6.1.1

Address-family : IPv4 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
*>e 102.0.0.0/24	20.5.1.1	0	100	0	6488163 100 i
*>i 202.0.0.0/24	20.6.1.2	0	0	0	i

Total number of entries 2

Address-family : IPv6 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
---------	---------	--------	--------	--------	------

Total number of entries 0

CE3# **show ip route all-vrf**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: vrf_1

Prefix Distance/	Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric
20.5.1.0/24	-	-	vlan2051	-	C	
[0/0]	-	-	-	-	-	-
20.5.1.2/32	-	-	vlan2051	-	L	
[0/0]	-	-	-	-	-	-
20.6.1.0/24	-	-	vlan2061	-	C	
[0/0]	-	-	-	-	-	-
20.6.1.1/32	-	-	vlan2061	-	L	
[0/0]	-	-	-	-	-	-
101.0.0.0/24	-	20.5.1.1	vlan2051	-	B/E	
[20/0]	01h:10m:42s	-	-	-	-	-

```

201.0.0.0/24      20.6.1.2      vlan2061      -      B/I
[200/0]          01h:10m:34s

VRF: vrf_2

Prefix           Nexthop        Interface      VRF(egress)   Origin/
Distance/       Age
-----
20.5.1.0/24     -              vlan2052      -              C
[0/0]           -
20.5.1.2/32     -              vlan2052      -              L
[0/0]           -
20.6.1.0/24     -              vlan2062      -              C
[0/0]           -
20.6.1.1/32     -              vlan2062      -              L
[0/0]           -
102.0.0.0/24    20.5.1.1      vlan2052      -              B/E
[200/0]         00h:54m:06s
202.0.0.0/24    20.6.1.2      vlan2062      -              B/I
[200/0]         00h:54m:06s

Total Route Count : 12

```

P1 configuration

```

P1# show running-config
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001BF
!export-password: default
hostname P1
profile core-spine
logging console severity crit
cli-session
  timeout 0
!
!
!
!
!
!
ssh server vrf mgmt
vlan 1
interface mgmt
  no shutdown
  ip dhcp
system interface-group 1 speed 10g
  !interface group 1 contains ports 1/1/1-1/1/4
interface lag 99
  no shutdown
  description Towards PE3
  ip mtu 9198
  ip address 30.0.2.1/24
  lacp mode active
  ip ospf 1 area 0.0.0.0
  mpls enable
  mpls ldp enable
interface 1/1/14

```

```

no shutdown
mtu 9198
description Towards PE1
ip mtu 9198
ip address 30.0.0.2/24
ip ospf 1 area 0.0.0.0
mpls enable
mpls ldp enable
interface 1/1/15
no shutdown
mtu 9198
description Towards PE2
ip mtu 9198
ip address 30.0.1.2/24
ip ospf 1 area 0.0.0.0
mpls enable
mpls ldp enable
interface 1/1/16
no shutdown
mtu 9198
description Towards PE3
lag 99
interface 1/1/17
no shutdown
mtu 9198
description Towards PE3
lag 99
interface 1/1/27
description Towards PE3
interface 1/1/28
description Towards PE3
interface loopback 0
ip address 4.4.4.4/32
ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1
area 0.0.0.0
router bgp 6488163
neighbor 1.1.1.1 remote-as 6488163
neighbor 1.1.1.1 description Towards PE1
neighbor 1.1.1.1 update-source loopback 0
neighbor 2.2.2.2 remote-as 6488163
neighbor 2.2.2.2 description Towards PE2
neighbor 2.2.2.2 update-source loopback 0
neighbor 3.3.3.3 remote-as 6488163
neighbor 3.3.3.3 description Towards PE2
neighbor 3.3.3.3 update-source loopback 0
neighbor 5.5.5.5 remote-as 6488163
neighbor 5.5.5.5 description Towards RR2
neighbor 5.5.5.5 update-source loopback 0
address-family vpnv4 unicast
neighbor 1.1.1.1 activate
neighbor 1.1.1.1 route-reflector-client
neighbor 1.1.1.1 send-community both
neighbor 2.2.2.2 activate
neighbor 2.2.2.2 route-reflector-client
neighbor 2.2.2.2 send-community both
neighbor 3.3.3.3 activate

```

```

neighbor 3.3.3.3 route-reflector-client
neighbor 3.3.3.3 send-community both
neighbor 5.5.5.5 activate
neighbor 5.5.5.5 send-community both
exit-address-family
!
https-server vrf mgmt
mpls
  enable
  label-protocol ldp
    enable
  router-id loopback0

```

P1 verification

P1# **show ip ospf neighbors**

VRF : default Process : 1

=====
Total Number of Neighbors : 3

Neighbor ID	Priority	State	Nbr Address	Interface
1.1.1.1	1	FULL/DR	30.0.0.1	1/1/14
2.2.2.2	1	FULL/BDR	30.0.1.1	1/1/15
3.3.3.3	1	FULL/BDR	30.0.2.2	lag99

P1# **show mpls ldp neighbor**

Local LDP Identifier: 4.4.4.4:0, Peer LDP Identifier: 2.2.2.2:0

Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:36
State: operational
LDP Discovery Sources: 1/1/15
Addresses bound to this peer:
2.2.2.2 30.0.1.1 30.0.4.1

Local LDP Identifier: 4.4.4.4:0, Peer LDP Identifier: 3.3.3.3:0

Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:12:42
State: operational
LDP Discovery Sources: lag99
Addresses bound to this peer:
3.3.3.3 30.0.2.2 30.0.5.2

Local LDP Identifier: 4.4.4.4:0, Peer LDP Identifier: 1.1.1.1:0

Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:36
State: operational
LDP Discovery Sources: 1/1/14
Addresses bound to this peer:
1.1.1.1 30.0.0.1 30.0.3.1

```

P1# show mpls ldp binding
30.0.4.1/32
    No local binding
    remote binding: lsr:2.2.2.2:0 label: exp-null
30.0.2.1/32
    local binding: label: exp-null
    No remote binding
30.0.1.2/32
    local binding: label: exp-null
    No remote binding
30.0.0.1/32
    No local binding
    remote binding: lsr:1.1.1.1:0 label: exp-null
30.0.1.1/32
    No local binding
    remote binding: lsr:2.2.2.2:0 label: exp-null
30.0.5.2/32
    No local binding
    remote binding: lsr:3.3.3.3:0 label: exp-null
30.0.2.2/32
    No local binding
    remote binding: lsr:3.3.3.3:0 label: exp-null
2.2.2.2/32
    local binding: label: 18
    remote binding: lsr:1.1.1.1:0 label:18
    remote binding: lsr:3.3.3.3:0 label:17
    remote binding: lsr:2.2.2.2:0 label: exp-null
5.5.5.5/32
    local binding: label: 17
    remote binding: lsr:1.1.1.1:0 label:17
    remote binding: lsr:3.3.3.3:0 label:19
    remote binding: lsr:2.2.2.2:0 label:18
30.0.0.2/32
    local binding: label: exp-null
    No remote binding
3.3.3.3/32
    local binding: label: 19
    remote binding: lsr:1.1.1.1:0 label:19
    remote binding: lsr:3.3.3.3:0 label: exp-null
    remote binding: lsr:2.2.2.2:0 label:19
4.4.4.4/32
    local binding: label: exp-null
    remote binding: lsr:1.1.1.1:0 label:16
    remote binding: lsr:3.3.3.3:0 label:18
    remote binding: lsr:2.2.2.2:0 label:17
30.0.3.1/32
    No local binding
    remote binding: lsr:1.1.1.1:0 label: exp-null
1.1.1.1/32
    local binding: label: 16
    remote binding: lsr:1.1.1.1:0 label: exp-null
    remote binding: lsr:3.3.3.3:0 label:16
    remote binding: lsr:2.2.2.2:0 label:16

```

```

P1# show mpls forwarding

```

```

MPLS Bindings

```

```

Entry Bindings    : 4
Exit Bindings     : 2
Transit Bindings  : 4

```

```

PHP Mode      : Explicit-Null
QoS Mode     : Uniform
TTL Propagation : Uniform

```

Entry Bindings:

Origin	Prefix	Ingress VRF	Nextthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	5.5.5.5/32	default	30.0.2.2	19	lag99	default	operational

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	Nextthop Address	Outgoing Label	Status
LDP	1.1.1.1/32	16	1/1/14	default	30.0.0.1	exp-null	Operational
LDP	5.5.5.5/32	17	lag99	default	30.0.2.2	19	Operational
LDP	2.2.2.2/32	18	1/1/15	default	30.0.1.1	exp-null	Operational
LDP	3.3.3.3/32	19	lag99	default	30.0.2.2	exp-null	Operational

P1# **show bgp vpnv4 un neighbors**

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 1.1.1.1 (Internal)

```

Description      : Towards PE1
Peer-group      :

Remote Router Id : 1.1.1.1          Local Router Id : 4.4.4.4
Remote AS       : 6488163         Local AS        : 6488163
Remote Port     : 42093           Local Port      : 179
State          : Established      Admin Status    : Up
Conn. Established : 1             Conn. Dropped  : 0
Passive        : No               Update-Source   : loopback0
Cfg. Hold Time : 180              Cfg. Keep Alive : 60
Neg. Hold Time : 180              Neg. Keep Alive : 60
Up/Down Time   : 00h:15m:55s     Connect-Retry Time : 120
Local-AS Prepend : No             Alt. Local-AS   : 0
BFD            : Disabled
Password      :
Last Err Sent  : No Error
Last SubErr Sent : No Error
Last Err Rcvd : No Error
Last SubErr Rcvd : No Error

```

```

Graceful-Restart      : Enabled          Gr. Restart Time   : 120
Gr. Stalepath Time   : 300              Remove Private-AS : No
TTL                  : 255              Local Cluster-ID   :
Weight               : 0                Fall-over          : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1          1
Notification           0          0
Updates                7          3
Keepalives             18         18
Route Refresh          0          0
Total                  26         22

```

```

Capability              Advertised      Received
-----
Route Refresh           Yes            Yes
Graceful Restart        Yes            Yes
Add-Path                No             No
Four Octet ASN          Yes            Yes
Address family IPv4 Unicast No             No
Address family IPv6 Unicast No             No
Address family VPNv4 Unicast Yes            Yes
Address family L2VPN EVPN No             No

```

```

Address Family : VPNv4 Unicast
-----

```

```

Rt. Reflect. Client : Yes          Send Community     : both
Allow-AS in         : 0            Advt. Interval     : 30
Max. Prefix         : 300000        Soft Reconfig In   :
Nexthop-Self        :              Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       :

```

```

Routemap In         :
Routemap Out        :
ORF type            : Prefix-list
ORF capability      :

```

BGP Neighbor 2.2.2.2 (Internal)

```

Description          : Towards PE2
Peer-group           :

```

```

Remote Router Id     : 2.2.2.2          Local Router Id    : 4.4.4.4
Remote AS            : 6488163        Local AS           : 6488163
Remote Port          : 44703          Local Port         : 179
State                : Established     Admin Status       : Up
Conn. Established    : 1              Conn. Dropped      : 0
Passive              : No              Update-Source      : loopback0
Cfg. Hold Time       : 180            Cfg. Keep Alive    : 60
Neg. Hold Time       : 180            Neg. Keep Alive     : 60
Up/Down Time         : 00h:15m:21s    Connect-Retry Time : 120
Local-AS Prepend     : No              Alt. Local-AS      : 0
BFD                  : Disabled
Password             :
Last Err Sent        : No Error
Last SubErr Sent     : No Error
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

```

```

Graceful-Restart      : Enabled          Gr. Restart Time   : 120
Gr. Stalepath Time   : 300              Remove Private-AS : No
TTL                  : 255              Local Cluster-ID  :
Weight               : 0                Fall-over          : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1          1
Notification           0          0
Updates                5          3
Keepalives             17         18
Route Refresh          0          0
Total                  23         22

```

```

Capability              Advertised      Received
-----
Route Refresh           Yes            Yes
Graceful Restart       Yes            Yes
Add-Path                No             No
Four Octet ASN         Yes            Yes
Address family IPv4 Unicast No             No
Address family IPv6 Unicast No             No
Address family VPNv4 Unicast Yes            Yes
Address family L2VPN EVPN No             No

```

```

Address Family : VPNv4 Unicast
-----

```

```

Rt. Reflect. Client : Yes          Send Community    : both
Allow-AS in         : 0            Advt. Interval    : 30
Max. Prefix         : 300000       Soft Reconfig In  :
Nexthop-Self        :              Default-Originate :
Cfg. Add-Path       :
Neg. Add-Path       :

```

```

Routemap In         :
Routemap Out        :
ORF type             : Prefix-list
ORF capability       :

```

BGP Neighbor 3.3.3.3 (Internal)

```

Description          : Towards PE2
Peer-group           :

```

```

Remote Router Id     : 3.3.3.3          Local Router Id    : 4.4.4.4
Remote AS             : 6488163       Local AS           : 6488163
Remote Port          : 179            Local Port         : 33231
State                : Established    Admin Status       : Up
Conn. Established    : 1              Conn. Dropped      : 0
Passive              : No              Update-Source      : loopback0
Cfg. Hold Time       : 180            Cfg. Keep Alive    : 60
Neg. Hold Time       : 180            Neg. Keep Alive     : 60
Up/Down Time        : 00h:14m:48s    Connect-Retry Time : 120
Local-AS Prepend     : No              Alt. Local-AS      : 0
BFD                  : Disabled
Password             :
Last Err Sent        : No Error
Last SubErr Sent     : No Error
Last Err Rcvd       : No Error
Last SubErr Rcvd    : No Error

```

```

Graceful-Restart      : Enabled          Gr. Restart Time   : 120
Gr. Stalepath Time   : 300              Remove Private-AS  : No
TTL                  : 255              Local Cluster-ID   :
Weight               : 0                Fall-over          : No
Confederation-Peers  : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1          1
Notification           0          0
Updates                3          3
Keepalives             18         17
Route Refresh          0          0
Total                  22         21

```

```

Capability                                Advertised      Received
-----
Route Refresh                             Yes             Yes
Graceful Restart                          Yes             Yes
Add-Path                                   No              No
Four Octet ASN                             Yes             Yes
Address family IPv4 Unicast                 No              No
Address family IPv6 Unicast                 No              No
Address family VPNv4 Unicast                Yes             Yes
Address family L2VPN EVPN                   No              No

```

```

Address Family : VPNv4 Unicast
-----

```

```

Rt. Reflect. Client : Yes          Send Community    : both
Allow-AS in         : 0            Advt. Interval    : 30
Max. Prefix         : 300000       Soft Reconfig In  :
Nexthop-Self       :              Default-Originate :
Cfg. Add-Path      :
Neg. Add-Path      :

```

```

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability     :

```

BGP Neighbor 5.5.5.5 (Internal)

```

Description        : Towards RR2
Peer-group         :

Remote Router Id   : 5.5.5.5          Local Router Id    : 4.4.4.4
Remote AS          : 6488163         Local AS           : 6488163
Remote Port        : 179             Local Port         : 40545
State              : Established     Admin Status       : Up
Conn. Established  : 1               Conn. Dropped      : 0
Passive            : No               Update-Source      : loopback0
Cfg. Hold Time     : 180             Cfg. Keep Alive    : 60
Neg. Hold Time     : 180             Neg. Keep Alive     : 60
Up/Down Time       : 00h:15m:33s     Connect-Retry Time : 120
Local-AS Prepend   : No              Alt. Local-AS      : 0
BFD                : Disabled
Password           :
Last Err Sent      : No Error
Last SubErr Sent   : No Error
Last Err Rcvd     : No Error
Last SubErr Rcvd   : No Error

```

```

Graceful-Restart      : Enabled          Gr. Restart Time   : 120
Gr. Stalepath Time   : 300              Remove Private-AS  : No
TTL                  : 255              Local Cluster-ID   :
Weight               : 0                Fall-over          : No
Confederation-Peers  : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1         1
Notification           0         0
Updates                7         6
Keepalives             17        17
Route Refresh          0         0
Total                  25        24

```

```

Capability              Advertised      Received
-----
Route Refresh           Yes            Yes
Graceful Restart       Yes            Yes
Add-Path                No             No
Four Octet ASN         Yes            Yes
Address family IPv4 Unicast No             No
Address family IPv6 Unicast No             No
Address family VPNv4 Unicast Yes            Yes
Address family L2VPN EVPN No             No

```

```

Address Family : VPNv4 Unicast
-----

```

```

Rt. Reflect. Client : No          Send Community     : both
Allow-AS in         : 0          Advt. Interval     : 30
Max. Prefix         : 300000      Soft Reconfig In   :
Nexthop-Self        :           Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       :

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability      :

```

P1# show bgp vpnv4 unicast

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 4.4.4.4

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (Label 20)					
*>i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 101.0.0.0/24	2.2.2.2	0	100	0	100 i
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 2:1 (Label 22)					
*>i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 102.0.0.0/24	2.2.2.2	0	100	0	100 i
* i 102.0.0.0/24	1.1.1.1	0	100	0	100 i

```

Route Distinguisher: 1:3                               (Label 21)
*>i 201.0.0.0/24      3.3.3.3      0          100      0          100 i
* i 201.0.0.0/24      3.3.3.3      0          100      0          100 i

Route Distinguisher: 2:3                               (Label 22)
*>i 202.0.0.0/24      3.3.3.3      0          100      0          100 i
* i 202.0.0.0/24      3.3.3.3      0          100      0          100 i
Total number of entries 10

```

P1# **show bgp all-vrf all summary**

VRF : default

BGP Summary

```

Local AS           : 6488163      BGP Router Identifier : 4.4.4.4
Peers              : 4            Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive       : 60
Confederation Id  : 0

```

Address-family : IPv4 Unicast

Address-family : IPv6 Unicast

Address-family : VPNv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
1.1.1.1	6488163	36	43	00h:27m:27s		Established Up
2.2.2.2	6488163	37	40	00h:26m:53s		Established Up
3.3.3.3	6488163	35	40	00h:26m:20s		Established Up
5.5.5.5	6488163	39	40	00h:27m:05s		Established Up

Address-family : L2VPN EVPN

P1# **show bgp all-vrf all**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths

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

VRF : default

Local Router-ID 4.4.4.4

Address-family : IPv4 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
Total number of entries 0					

Address-family : IPv6 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
Total number of entries 0					

Address-family : VPNv4 Unicast

Network	Nexthop	Metric	LocPrf	Weight	Path
---------	---------	--------	--------	--------	------

Route Distinguisher: 1:1

(Label 20)

```

*>i 101.0.0.0/24      1.1.1.1      0          100      0          100 i

```

```

* i 101.0.0.0/24      2.2.2.2      0      100      0      100 i
* i 101.0.0.0/24      1.1.1.1      0      100      0      100 i

Route Distinguisher: 2:1      (Label 22)
*>i 102.0.0.0/24      1.1.1.1      0      100      0      100 i
* i 102.0.0.0/24      2.2.2.2      0      100      0      100 i
* i 102.0.0.0/24      1.1.1.1      0      100      0      100 i

Route Distinguisher: 1:3      (Label 21)
*>i 201.0.0.0/24      3.3.3.3      0      100      0      100 i
* i 201.0.0.0/24      3.3.3.3      0      100      0      100 i

Route Distinguisher: 2:3      (Label 22)
*>i 202.0.0.0/24      3.3.3.3      0      100      0      100 i
* i 202.0.0.0/24      3.3.3.3      0      100      0      100 i
Total number of entries 10

Address-family : L2VPN EVPN
-----
      Network                               Nexthop      Metric
      LocPrf  Weight  Path
-----
Total number of entries 0

```

P1# **show ip route all-vrf**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local

R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN

IA - OSPF internal area, E1 - OSPF external type 1

E2 - OSPF external type 2

VRF: default

Prefix Distance/	Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric
1.1.1.1/32 [110/100]	01h:13m:03s	30.0.0.1	1/1/14	-	O	
2.2.2.2/32 [110/100]	01h:12m:33s	30.0.1.1	1/1/15	-	O	
3.3.3.3/32 [110/50]	01h:11m:57s	30.0.2.2	lag99	-	O	
4.4.4.4/32 [0/0]	-	-	loopback0	-	L	
5.5.5.5/32 [110/100]	01h:11m:52s	30.0.2.2	lag99	-	O	
30.0.0.0/24 [0/0]	-	-	1/1/14	-	C	
30.0.0.2/32 [0/0]	-	-	1/1/14	-	L	
30.0.1.0/24 [0/0]	-	-	1/1/15	-	C	
30.0.1.2/32 [0/0]	-	-	1/1/15	-	L	
30.0.2.0/24	-	-	lag99	-	C	

```

[0/0] -
30.0.2.1/32 - lag99 - L
[0/0] -
30.0.3.0/24 30.0.0.1 1/1/14 - O
[110/200] 01h:11m:52s
30.0.2.2 lag99 -
[110/200] 01h:11m:52s
30.0.4.0/24 30.0.1.1 1/1/15 - O
[110/200] 01h:11m:52s
30.0.2.2 lag99 -
[110/200] 01h:11m:52s
30.0.5.0/24 30.0.2.2 lag99 - O
[110/100] 01h:11m:57s

Total Route Count : 14

```

P2 configuration

```

P2# show running
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001BF
!export-password: default
hostname P2
profile core-spine
logging console severity crit
cli-session
    timeout 0
!
!
!
!
!
!
ssh server vrf mgmt
vlan 1
interface mgmt
    no shutdown
    ip dhcp
system interface-group 1 speed 10g
    !interface group 1 contains ports 1/1/1-1/1/4
interface lag 100
    no shutdown
    description Towards PE3
    ip mtu 9198
    ip address 30.0.5.1/24
    lacp mode active
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface 1/1/25
    no shutdown
    mtu 9198
    description Towards PE1
    ip mtu 9198
    ip address 30.0.3.2/24
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface 1/1/26

```

```

no shutdown
mtu 9198
description Towards PE2
ip mtu 9198
ip address 30.0.4.2/24
ip ospf 1 area 0.0.0.0
mpls enable
mpls ldp enable
interface 1/1/27
no shutdown
mtu 9198
description Towards PE3
lag 100
interface 1/1/28
no shutdown
mtu 9198
description Towards PE3
lag 100
interface loopback 0
ip address 5.5.5.5/32
ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1
area 0.0.0.0
router bgp 6488163
neighbor 1.1.1.1 remote-as 6488163
neighbor 1.1.1.1 description Towards PE1
neighbor 1.1.1.1 update-source loopback 0
neighbor 2.2.2.2 remote-as 6488163
neighbor 2.2.2.2 description Towards PE2
neighbor 2.2.2.2 update-source loopback 0
neighbor 3.3.3.3 remote-as 6488163
neighbor 3.3.3.3 description Towards PE3
neighbor 3.3.3.3 update-source loopback 0
neighbor 4.4.4.4 remote-as 6488163
neighbor 4.4.4.4 description Towards RR1
neighbor 4.4.4.4 update-source loopback 0
address-family vpnv4 unicast
neighbor 1.1.1.1 activate
neighbor 1.1.1.1 route-reflector-client
neighbor 1.1.1.1 send-community both
neighbor 2.2.2.2 activate
neighbor 2.2.2.2 route-reflector-client
neighbor 2.2.2.2 send-community both
neighbor 3.3.3.3 activate
neighbor 3.3.3.3 route-reflector-client
neighbor 3.3.3.3 send-community both
neighbor 4.4.4.4 activate
neighbor 4.4.4.4 send-community both
exit-address-family
!
https-server vrf mgmt
mpls
enable
label-protocol ldp
enable
router-id loopback0

```

P2 verification

P2# **show ip ospf neighbors**

VRF : default Process : 1

=====

Total Number of Neighbors : 3

Neighbor ID	Priority	State	Nbr Address	Interface
1.1.1.1	1	FULL/DR	30.0.3.1	1/1/25
2.2.2.2	1	FULL/DR	30.0.4.1	1/1/26
3.3.3.3	1	FULL/BDR	30.0.5.2	lag100

P2# **show mpls ldp neighbor**

Local LDP Identifier: 5.5.5.5:0, Peer LDP Identifier: 3.3.3.3:0

Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:12:42
State: operational
LDP Discovery Sources: lag100
Addresses bound to this peer:
3.3.3.3 30.0.2.2 30.0.5.2

Local LDP Identifier: 5.5.5.5:0, Peer LDP Identifier: 1.1.1.1:0

Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:19
State: operational
LDP Discovery Sources: 1/1/25
Addresses bound to this peer:
1.1.1.1 30.0.0.1 30.0.3.1

Local LDP Identifier: 5.5.5.5:0, Peer LDP Identifier: 2.2.2.2:0

Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:14
State: operational
LDP Discovery Sources: 1/1/26
Addresses bound to this peer:
2.2.2.2 30.0.1.1 30.0.4.1

P2# **show mpls ldp binding**

30.0.3.2/32

local binding: label: exp-null
No remote binding

30.0.1.1/32

No local binding
remote binding: lsr:2.2.2.2:0 label: exp-null

2.2.2.2/32

local binding: label: 18
remote binding: lsr:1.1.1.1:0 label:18
remote binding: lsr:3.3.3.3:0 label:17
remote binding: lsr:2.2.2.2:0 label: exp-null

30.0.5.1/32

local binding: label: exp-null
No remote binding

30.0.4.2/32

local binding: label: exp-null
No remote binding

```

5.5.5.5/32
  local binding: label: exp-null
  remote binding: lsr:1.1.1.1:0 label:17
  remote binding: lsr:3.3.3.3:0 label:19
  remote binding: lsr:2.2.2.2:0 label:18
30.0.0.1/32
  No local binding
  remote binding: lsr:1.1.1.1:0 label: exp-null
30.0.2.2/32
  No local binding
  remote binding: lsr:3.3.3.3:0 label: exp-null
30.0.5.2/32
  No local binding
  remote binding: lsr:3.3.3.3:0 label: exp-null
4.4.4.4/32
  local binding: label: 17
  remote binding: lsr:1.1.1.1:0 label:16
  remote binding: lsr:3.3.3.3:0 label:18
  remote binding: lsr:2.2.2.2:0 label:17
30.0.4.1/32
  No local binding
  remote binding: lsr:2.2.2.2:0 label: exp-null
1.1.1.1/32
  local binding: label: 16
  remote binding: lsr:1.1.1.1:0 label: exp-null
  remote binding: lsr:3.3.3.3:0 label:16
  remote binding: lsr:2.2.2.2:0 label:16
3.3.3.3/32
  local binding: label: 19
  remote binding: lsr:1.1.1.1:0 label:19
  remote binding: lsr:3.3.3.3:0 label: exp-null
  remote binding: lsr:2.2.2.2:0 label:19
30.0.3.1/32
  No local binding
  remote binding: lsr:1.1.1.1:0 label: exp-null

```

P2# **show mpls forwarding**

MPLS Bindings

```

Entry Bindings   : 4
Exit Bindings    : 2
Transit Bindings : 4
PHP Mode         : Explicit-Null
QoS Mode         : Uniform
TTL Propagation  : Uniform

```

Entry Bindings:

Origin	Prefix	Ingress VRF	Nexthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	4.4.4.4/32	default	30.0.5.2	18	lag100	default	operational

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	NextHop Address	Outgoing Label	Status
LDP	1.1.1.1/32	16	1/1/25	default	30.0.3.1	exp-null	operational
LDP	4.4.4.4/32	17	lag100	default	30.0.5.2	18	operational
LDP	2.2.2.2/32	18	1/1/26	default	30.0.4.1	exp-null	operational
operational	LDP	3.3.3.3/32	18	lag100	default	30.0.5.2	exp-null
operational							

P2# **show bgp vpnv4 un neighbors**

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 1.1.1.1 (Internal)

Description : Towards PE1
Peer-group :

Remote Router Id	: 1.1.1.1	Local Router Id	: 5.5.5.5
Remote AS	: 6488163	Local AS	: 6488163
Remote Port	: 40029	Local Port	: 179
State	: Established	Admin Status	: Up
Conn. Established	: 1	Conn. Dropped	: 0
Passive	: No	Update-Source	: loopback0
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Neg. Hold Time	: 180	Neg. Keep Alive	: 60
Up/Down Time	: 00h:15m:40s	Connect-Retry Time	: 120
Local-AS Prepend	: No	Alt. Local-AS	: 0
BFD	: Disabled		
Password	:		
Last Err Sent	: No Error		
Last SubErr Sent	: No Error		
Last Err Rcvd	: No Error		
Last SubErr Rcvd	: No Error		
Graceful-Restart	: Enabled	Gr. Restart Time	: 120
Gr. Stalepath Time	: 300	Remove Private-AS	: No
TTL	: 255	Local Cluster-ID	:
Weight	: 0	Fall-over	: No
Confederation-Peers	: No		

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	5	3
Keepalives	16	17
Route Refresh	0	0
Total	22	21

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes

```

Address family IPv4 Unicast      No          No
Address family IPv6 Unicast      No          No
Address family VPNv4 Unicast     Yes         Yes
Address family L2VPN EVPN        No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : Yes          Send Community      : both
Allow-AS in         : 0            Advt. Interval      : 30
Max. Prefix         : 300000        Soft Reconfig In    :
Nexthop-Self       :                Default-Originate   :
Cfg. Add-Path       :
Neg. Add-Path       :

```

```

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability     :

```

BGP Neighbor 2.2.2.2 (Internal)

```

Description        : Towards PE2
Peer-group         :

```

```

Remote Router Id   : 2.2.2.2          Local Router Id     : 5.5.5.5
Remote AS          : 6488163        Local AS            : 6488163
Remote Port        : 179            Local Port          : 33107
State              : Established     Admin Status        : Up
Conn. Established  : 1              Conn. Dropped       : 0
Passive            : No              Update-Source       : loopback0
Cfg. Hold Time     : 180             Cfg. Keep Alive     : 60
Neg. Hold Time     : 180             Neg. Keep Alive     : 60
Up/Down Time       : 00h:15m:30s    Connect-Retry Time : 120
Local-AS Prepend   : No              Alt. Local-AS      : 0
BFD                : Disabled
Password           :
Last Err Sent      : No Error
Last SubErr Sent   : No Error
Last Err Rcvd     : No Error
Last SubErr Rcvd   : No Error

```

```

Graceful-Restart   : Enabled         Gr. Restart Time    : 120
Gr. Stalepath Time : 300             Remove Private-AS   : No
TTL                : 255             Local Cluster-ID    :
Weight             : 0              Fall-over            : No
Confederation-Peers : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	5	3
Keepalives	17	17
Route Refresh	0	0
Total	23	21

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes

```

Address family IPv4 Unicast      No          No
Address family IPv6 Unicast      No          No
Address family VPNv4 Unicast     Yes         Yes
Address family L2VPN EVPN        No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : Yes          Send Community      : both
Allow-AS in         : 0            Advt. Interval      : 30
Max. Prefix         : 300000       Soft Reconfig In    :
NextHop-Self        :              Default-Originate   :
Cfg. Add-Path       :
Neg. Add-Path       :

```

```

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability     :

```

BGP Neighbor 3.3.3.3 (Internal)

```

Description        : Towards PE3
Peer-group         :

```

```

Remote Router Id   : 3.3.3.3          Local Router Id     : 5.5.5.5
Remote AS          : 6488163       Local AS            : 6488163
Remote Port        : 179           Local Port          : 39781
State              : Established    Admin Status        : Up
Conn. Established  : 1             Conn. Dropped       : 0
Passive           : No             Update-Source       : loopback0
Cfg. Hold Time    : 180           Cfg. Keep Alive    : 60
Neg. Hold Time    : 180           Neg. Keep Alive    : 60
Up/Down Time      : 00h:14m:46s    Connect-Retry Time : 120
Local-AS Prepend  : No            Alt. Local-AS      : 0
BFD               : Disabled
Password          :
Last Err Sent     : No Error
Last SubErr Sent  : No Error
Last Err Rcvd    : No Error
Last SubErr Rcvd : No Error

```

```

Graceful-Restart   : Enabled        Gr. Restart Time   : 120
Gr. Stalepath Time : 300          Remove Private-AS : No
TTL               : 255           Local Cluster-ID   :
Weight            : 0             Fall-over          : No
Confederation-Peers : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	3	3
Keepalives	17	17
Route Refresh	0	0
Total	21	21

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes

```

Address family IPv4 Unicast      No          No
Address family IPv6 Unicast      No          No
Address family VPNv4 Unicast     Yes         Yes
Address family L2VPN EVPN        No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : Yes          Send Community      : both
Allow-AS in         : 0            Advt. Interval      : 30
Max. Prefix         : 300000        Soft Reconfig In    :
Nexthop-Self        :               Default-Originate    :
Cfg. Add-Path        :
Neg. Add-Path        :

```

```

Routemap In         :
Routemap Out        :
ORF type             : Prefix-list
ORF capability       :

```

BGP Neighbor 4.4.4.4 (Internal)

```

Description          : Towards RR1
Peer-group           :

```

```

Remote Router Id     : 4.4.4.4          Local Router Id      : 5.5.5.5
Remote AS            : 6488163        Local AS             : 6488163
Remote Port          : 40545          Local Port           : 179
State                : Established     Admin Status         : Up
Conn. Established    : 1              Conn. Dropped        : 0
Passive              : No              Update-Source        : loopback0
Cfg. Hold Time       : 180             Cfg. Keep Alive      : 60
Neg. Hold Time       : 180             Neg. Keep Alive      : 60
Up/Down Time         : 00h:15m:33s      Connect-Retry Time   : 120
Local-AS Prepend     : No              Alt. Local-AS        : 0
BFD                  : Disabled
Password             :
Last Err Sent        : No Error
Last SubErr Sent     : No Error
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

```

```

Graceful-Restart     : Enabled          Gr. Restart Time     : 120
Gr. Stalepath Time   : 300              Remove Private-AS    : No
TTL                  : 255              Local Cluster-ID     :
Weight               : 0                Fall-over             : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                    1          1
Notification            0          0
Updates                 6          7
Keepalives              17         17
Route Refresh           0          0
Total                   24         25

```

```

Capability              Advertised  Received
-----
Route Refresh           Yes        Yes
Graceful Restart        Yes        Yes
Add-Path                No         No
Four Octet ASN          Yes        Yes

```

```

Address family IPv4 Unicast      No          No
Address family IPv6 Unicast      No          No
Address family VPNv4 Unicast     Yes         Yes
Address family L2VPN EVPN        No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : No          Send Community   : both
Allow-AS in         : 0          Advt. Interval  : 30
Max. Prefix         : 300000     Soft Reconfig In :
NextHop-Self        :           Default-Originate :
Cfg. Add-Path       :
Neg. Add-Path       :

Routemap In         :
Routemap Out        :
ORF type            : Prefix-list
ORF capability      :

```

P2# **show bgp vpnv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths

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

VRF : default

Local Router-ID 5.5.5.5

Network	NextHop	Metric	LocPrf	Weight	Path
Route Distinguisher: 2:1 (Label 21)					
*>i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 101.0.0.0/24	2.2.2.2	0	100	0	100 i
Route Distinguisher: 1:1 (Label 20)					
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 2:3 (Label 20)					
*>i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
Route Distinguisher: 1:3 (Label 21)					
* i 201.0.0.0/24	3.3.3.3	0	100	0	100 i

Total number of entries 5

P2# **show mpls forwarding**

MPLS Bindings

```

Entry Bindings   : 4
Exit Bindings    : 2
Transit Bindings : 4
PHP Mode         : Explicit-Null
QoS Mode         : Uniform
TTL Propagation  : Uniform

```

Entry Bindings:

Origin Prefix	Ingress VRF	NextHop Address	Outgoing Label	Egress Interface	Egress VRF	Status
---------------	-------------	-----------------	----------------	------------------	------------	--------

```
-----
LDP    4.4.4.4/32  default  30.0.5.2  18        lag100    default  operational
```

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	Nextthop Address	Outgoing Label	Status
LDP	1.1.1.1/32	16	1/1/25	default	30.0.3.1	exp-null	operational
LDP	4.4.4.4/32	17	lag100	default	30.0.5.2	18	operational
LDP	2.2.2.2/32	18	1/1/26	default	30.0.4.1	exp-null	operational
operational	LDP	3.3.3.3/32	18	lag100	default	30.0.5.2	exp-null
operational							

P2# **show bgp vpnv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath, i internal, e external S Stale, R Removed, a additional-paths

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

VRF : default

Local Router-ID 5.5.5.5

Network	Nextthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (Label 20)					
*>i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 101.0.0.0/24	2.2.2.2	0	100	0	100 i
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 2:1 (Label 22)					
*>i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 102.0.0.0/24	2.2.2.2	0	100	0	100 i
* i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 1:3 (Label 21)					
*>i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
Route Distinguisher: 2:3 (Label 22)					
*>i 202.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 202.0.0.0/24	3.3.3.3	0	100	0	100 i

Total number of entries 10

P2# **show bgp all-vrf all summary**

VRF : default

BGP Summary

```
-----
Local AS           : 6488163      BGP Router Identifier : 5.5.5.5
Peers              : 4           Log Neighbor Changes  : No
```

```

Cfg. Hold Time      : 180          Cfg. Keep Alive      : 60
Confederation Id   : 0

```

```

Address-family : IPv4 Unicast
-----

```

```

Address-family : IPv6 Unicast
-----

```

```

Address-family : VPNv4 Unicast
-----

```

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
1.1.1.1	6488163	34	39	00h:27m:12s		Established Up
2.2.2.2	6488163	35	41	00h:27m:02s		Established Up
3.3.3.3	6488163	36	39	00h:26m:17s		Established Up
4.4.4.4	6488163	40	39	00h:27m:05s		Established Up

```

Address-family : L2VPN EVPN
-----

```

```

P2# show bgp all-vrf all

```

```

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

```

VRF : default

```

```

Local Router-ID 5.5.5.5

```

```

Address-family : IPv4 Unicast
-----

```

Network	Nexthop	Metric	LocPrf	Weight	Path
Total number of entries 0					

```

Address-family : IPv6 Unicast
-----

```

Network	Nexthop	Metric	LocPrf	Weight	Path
Total number of entries 0					

```

Address-family : VPNv4 Unicast
-----

```

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (Label 20)					
*>i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 101.0.0.0/24	2.2.2.2	0	100	0	100 i
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 2:1 (Label 22)					
*>i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 102.0.0.0/24	2.2.2.2	0	100	0	100 i
* i 102.0.0.0/24	1.1.1.1	0	100	0	100 i

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:3 (Label 21)					
*>i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 201.0.0.0/24	3.3.3.3	0	100	0	100 i

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 2:3 (Label 22)					
*>i 202.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 202.0.0.0/24	3.3.3.3	0	100	0	100 i
Total number of entries 10					

Address-family : L2VPN EVPN

Network		Nexthop	Metric
LocPrf	Weight	Path	

Total number of entries 0			

P2# show ip route all-vrf

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local

R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN

IA - OSPF internal area, E1 - OSPF external type 1

E2 - OSPF external type 2

VRF: default

Prefix		Nexthop	Interface	VRF(egress)	Origin/	
Distance/	Age				Type	Metric

1.1.1.1/32		30.0.3.1	1/1/25	-	O	
[110/100]	01h:12m:46s					
2.2.2.2/32		30.0.4.1	1/1/26	-	O	
[110/100]	01h:12m:21s					
3.3.3.3/32		30.0.5.2	lag100	-	O	
[110/50]	01h:11m:52s					
4.4.4.4/32		30.0.5.2	lag100	-	O	
[110/100]	01h:11m:52s					
5.5.5.5/32		-	loopback0	-	L	
[0/0]	-					
30.0.0.0/24		30.0.5.2	lag100	-	O	
[110/200]	01h:11m:52s					
		30.0.3.1	1/1/25	-		
[110/200]	01h:11m:52s					
30.0.1.0/24		30.0.4.1	1/1/26	-	O	
[110/200]	01h:11m:52s					
		30.0.5.2	lag100	-		
[110/200]	01h:11m:52s					
30.0.2.0/24		30.0.5.2	lag100	-	O	
[110/100]	01h:11m:52s					
30.0.3.0/24		-	1/1/25	-	C	
[0/0]	-					
30.0.3.2/32		-	1/1/25	-	L	
[0/0]	-					
30.0.4.0/24		-	1/1/26	-	C	
[0/0]	-					
30.0.4.2/32		-	1/1/26	-	L	
[0/0]	-					
30.0.5.0/24		-	lag100	-	C	
[0/0]	-					
30.0.5.1/32		-	lag100	-	L	
[0/0]	-					

Total Route Count : 14

PE1 configuration

```
PE1# show running
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001BF
!export-password: default
hostname PE1
profile core-spine
logging console severity crit
vrf vrf_1
  rd 1:1
  l3vpn-only
  address-family ipv4 unicast
    route-target export 1:1
    route-target import 1:1
  exit-address-family
vrf vrf_2
  rd 2:1
  l3vpn-only
  address-family ipv4 unicast
    route-target export 2:1
    route-target import 2:1
  exit-address-family
cli-session
  timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2011-2012,2031-2032
interface mgmt
  no shutdown
  ip dhcp
interface 1/1/37
  no shutdown
  mtu 9000
  description Towards CE1
  no routing
  vlan trunk native 1
  vlan trunk allowed 2011-2012
interface 1/1/38
  no shutdown
  mtu 9000
  description Towards CE2
  no routing
  vlan trunk native 1
  vlan trunk allowed 2031-2032
interface 1/1/39
  no shutdown
  mtu 9198
  description Towards P1
  ip mtu 9198
  ip address 30.0.0.1/24
  ip ospf 1 area 0.0.0.0
  mpls enable
  mpls ldp enable
interface 1/1/40
  no shutdown
  mtu 9198
```

```

    description Towards P2
    ip mtu 9198
    ip address 30.0.3.1/24
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface loopback 0
    ip address 1.1.1.1/32
    ip ospf 1 area 0.0.0.0
interface vlan 2011
    vrf attach vrf_1
    description Towards CE1
    ip mtu 9000
    ip address 20.1.1.2/24
interface vlan 2012
    vrf attach vrf_2
    description Towards CE1
    ip mtu 9000
    ip address 20.1.1.2/24
interface vlan 2031
    vrf attach vrf_1
    description Towards CE2
    ip mtu 9000
    ip address 20.3.1.2/24
interface vlan 2032
    vrf attach vrf_2
    description Towards CE2
    ip mtu 9000
    ip address 20.3.1.2/24
!
ip community-list standard sitel_community description For_setting_community_From_Sitel
ip community-list standard sitel_community seq 10 permit 99:99
!
!
!
route-map rmap1 permit seq 10
    description For_setting_community_For_Sitel_Received_EBGP_routes
    set community 99:99
route-map rmap2 deny seq 10
    description For_Denying_routes_with_Sitel_community_To_EBGP_Peer
    match community-list sitel_community
route-map rmap2 permit seq 20
    description For_Allowing_all_other_route
!
router ospf 1
    area 0.0.0.0
router bgp 6488163
    neighbor 4.4.4.4 remote-as 6488163
    neighbor 4.4.4.4 description Towards RR1{P1}
    neighbor 4.4.4.4 update-source loopback 0
    neighbor 5.5.5.5 remote-as 6488163
    neighbor 5.5.5.5 description Towards RR2{P2}
    neighbor 5.5.5.5 update-source loopback 0
    address-family vpnv4 unicast
        neighbor 4.4.4.4 activate
        neighbor 4.4.4.4 send-community both
        neighbor 5.5.5.5 activate
        neighbor 5.5.5.5 send-community both
    exit-address-family
!
vrf vrf_1

```

```

neighbor 20.1.1.1 remote-as 100
neighbor 20.1.1.1 description Towards CE1
neighbor 20.3.1.1 remote-as 100
neighbor 20.3.1.1 description Towards CE2
address-family ipv4 unicast
    neighbor 20.1.1.1 activate
    neighbor 20.1.1.1 route-map rmap1 in
    neighbor 20.1.1.1 route-map rmap2 out
    neighbor 20.1.1.1 send-community both
    neighbor 20.1.1.1 soft-reconfiguration inbound
    neighbor 20.3.1.1 activate
    neighbor 20.3.1.1 route-map rmap1 in
    neighbor 20.3.1.1 route-map rmap2 out
    neighbor 20.3.1.1 send-community both
    neighbor 20.3.1.1 soft-reconfiguration inbound
exit-address-family
!
vrf vrf_2
neighbor 20.1.1.1 remote-as 100
neighbor 20.1.1.1 description Towards CE1
neighbor 20.3.1.1 remote-as 100
neighbor 20.3.1.1 description Towards CE2
address-family ipv4 unicast
    neighbor 20.1.1.1 activate
    neighbor 20.1.1.1 route-map rmap1 in
    neighbor 20.1.1.1 route-map rmap2 out
    neighbor 20.1.1.1 send-community both
    neighbor 20.1.1.1 soft-reconfiguration inbound
    neighbor 20.3.1.1 activate
    neighbor 20.3.1.1 route-map rmap1 in
    neighbor 20.3.1.1 route-map rmap2 out
    neighbor 20.3.1.1 send-community both
    neighbor 20.3.1.1 soft-reconfiguration inbound
exit-address-family
!
https-server vrf mgmt
mpls
    enable
    label-protocol ldp
        enable
    router-id loopback0

```

PE1 verification

```

PE1# show ip ospf neighbors
VRF : default                               Process : 1
=====

Total Number of Neighbors : 2

Neighbor ID      Priority   State                Nbr Address      Interface
-----
4.4.4.4          1         FULL/BDR              30.0.0.2         1/1/39
5.5.5.5          1         FULL/BDR              30.0.3.2         1/1/40

```

```

PE1# show mpls ldp neighbor
Local LDP Identifier: 1.1.1.1:0, Peer LDP Identifier: 4.4.4.4:0
Graceful Restart: No

```

```
Session Holdtime: 40 sec
Up time: 00:13:36
State: operational
LDP Discovery Sources: 1/1/39
Addresses bound to this peer:
    30.0.0.2 30.0.1.2 30.0.2.1 4.4.4.4

Local LDP Identifier: 1.1.1.1:0, Peer LDP Identifier: 5.5.5.5:0
Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:19
State: operational
LDP Discovery Sources: 1/1/40
Addresses bound to this peer:
    30.0.3.2 30.0.4.2 30.0.5.1 5.5.5.5
```

```
PE1# show mpls ldp binding
5.5.5.5/32
    local binding: label: 17
    remote binding: lsr:5.5.5.5:0 label: exp-null
    remote binding: lsr:4.4.4.4:0 label:17
30.0.1.2/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null
30.0.3.2/32
    No local binding
    remote binding: lsr:5.5.5.5:0 label: exp-null
30.0.2.1/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null
1.1.1.1/32
    local binding: label: exp-null
    remote binding: lsr:5.5.5.5:0 label:16
    remote binding: lsr:4.4.4.4:0 label:16
4.4.4.4/32
    local binding: label: 16
    remote binding: lsr:5.5.5.5:0 label:17
    remote binding: lsr:4.4.4.4:0 label: exp-null
30.0.0.1/32
    local binding: label: exp-null
    No remote binding
3.3.3.3/32
    local binding: label: 19
    remote binding: lsr:5.5.5.5:0 label:19
    remote binding: lsr:4.4.4.4:0 label:19
30.0.0.2/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null
30.0.4.2/32
    No local binding
    remote binding: lsr:5.5.5.5:0 label: exp-null
2.2.2.2/32
    local binding: label: 18
    remote binding: lsr:5.5.5.5:0 label:18
    remote binding: lsr:4.4.4.4:0 label:18
30.0.3.1/32
    local binding: label: exp-null
    No remote binding
30.0.5.1/32
    No local binding
    remote binding: lsr:5.5.5.5:0 label: exp-null
```

PE1# show mpls forwarding

MPLS Bindings

Entry Bindings : 8
Exit Bindings : 4
Transit Bindings : 6
PHP Mode : Explicit-Null
QoS Mode : Uniform
TTL Propagation : Uniform

Entry Bindings:

Origin	Prefix	Ingress VRF	Nexthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	2.2.2.2/32	default	30.0.3.2	18	1/1/40	default	operational
LDP	2.2.2.2/32	default	30.0.0.2	18	1/1/39	default	operational
LDP	3.3.3.3/32	default	30.0.3.2	19	1/1/40	default	operational
LDP	3.3.3.3/32	default	30.0.0.2	19	1/1/39	default	operational
BGP	201.0.0.0/24	vrf_1	3.3.3.3	21	1/1/40	default	operational
BGP	202.0.0.0/24	vrf_2	3.3.3.3	22	1/1/40	default	operational

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
BGP	n/a	imp-null	20	vrf_1	operational
BGP	n/a	imp-null	22	vrf_2	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	Nexthop Address	Outgoing Label	Status
LDP	4.4.4.4/32	16	1/1/39	default	30.0.0.2	exp-null	operational
LDP	5.5.5.5/32	17	1/1/40	default	30.0.3.2	exp-null	operational
LDP	2.2.2.2/32	18	1/1/40	default	30.0.3.2	18	operational
LDP	2.2.2.2/32	18	1/1/39	default	30.0.0.2	18	operational
LDP	3.3.3.3/32	19	1/1/40	default	30.0.3.2	19	operational
LDP	3.3.3.3/32	19	1/1/39	default	30.0.0.2	19	operational

PE1# show bgp vpnv4 un neighbors
Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 4.4.4.4 (Internal)

Description : Towards Rr1{P1}
Peer-group :

Remote Router Id : 4.4.4.4 Local Router Id : 1.1.1.1
Remote AS : 6488163 Local AS : 6488163
Remote Port : 179 Local Port : 42093
State : Established Admin Status : Up
Conn. Established : 1 Conn. Dropped : 0
Passive : No Update-Source : loopback0
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Neg. Hold Time : 180 Neg. Keep Alive : 60
Up/Down Time : 00h:15m:55s Connect-Retry Time : 120
Local-AS Prepend : No Alt. Local-AS : 0
BFD : Disabled
Password :
Last Err Sent : No Error
Last SubErr Sent : No Error
Last Err Rcvd : No Error
Last SubErr Rcvd : No Error

Graceful-Restart : Enabled Gr. Restart Time : 120
Gr. Stalepath Time : 300 Remove Private-AS : No
TTL : 255 Local Cluster-ID :
Weight : 0 Fall-over : No
Confederation-Peers : No

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	3	7
Keepalives	18	18
Route Refresh	0	0
Total	22	26

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

Rt. Reflect. Client : No Send Community : both
Allow-AS in : 0 Advt. Interval : 30
Max. Prefix : 300000 Soft Reconfig In :
NextHop-Self : Default-Originate :
Cfg. Add-Path :
Neg. Add-Path :

```

Routemap In      :
Routemap Out    :
ORF type        : Prefix-list
ORF capability   :

BGP Neighbor 5.5.5.5 (Internal)
Description      : Towards RR2{P2}
Peer-group      :

Remote Router Id : 5.5.5.5          Local Router Id : 1.1.1.1
Remote AS        : 6488163        Local AS         : 6488163
Remote Port      : 179            Local Port       : 40029
State           : Established     Admin Status     : Up
Conn. Established : 1            Conn. Dropped   : 0
Passive         : No              Update-Source    : loopback0
Cfg. Hold Time  : 180            Cfg. Keep Alive : 60
Neg. Hold Time  : 180            Neg. Keep Alive  : 60
Up/Down Time    : 00h:15m:40s    Connect-Retry Time : 120
Local-AS Prepend : No            Alt. Local-AS   : 0
BFD             : Disabled
Password        :
Last Err Sent   : No Error
Last SubErr Sent : No Error
Last Err Rcvd   : No Error
Last SubErr Rcvd : No Error

Graceful-Restart : Enabled        Gr. Restart Time : 120
Gr. Stalepath Time : 300          Remove Private-AS : No
TTL               : 255          Local Cluster-ID  :
Weight            : 0            Fall-over         : No
Confederation-Peers : No

Message statistics      Sent      Rcvd
-----
Open                   1         1
Notification           0         0
Updates                 3         5
Keepalives              17        16
Route Refresh           0         0
Total                   21        22

Capability              Advertised      Received
-----
Route Refresh           Yes            Yes
Graceful Restart       Yes            Yes
Add-Path                No            No
Four Octet ASN         Yes            Yes
Address family IPv4 Unicast No            No
Address family IPv6 Unicast No            No
Address family VPNv4 Unicast Yes           Yes
Address family L2VPN EVPN No            No

Address Family : VPNv4 Unicast
-----

Rt. Reflect. Client : No          Send Community    : both
Allow-AS in         : 0           Advt. Interval    : 30
Max. Prefix         : 300000       Soft Reconfig In  :
Nexthop-Self       :              Default-Originate :
Cfg. Add-Path       :
Neg. Add-Path       :

```

```

Routemap In      :
Routemap Out     :
ORF type         : Prefix-list
ORF capability    :

```

PE1# **show bgp vpnv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 1.1.1.1

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (Label 20)					
*> 101.0.0.0/24	0.0.0.0	0	100	0	100 i
Route Distinguisher: 2:1 (Label 22)					
*> 102.0.0.0/24	0.0.0.0	0	100	0	100 i
Route Distinguisher: 1:3 (Label 21)					
*>i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
Route Distinguisher: 2:3 (Label 22)					
*>i 202.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 202.0.0.0/24	3.3.3.3	0	100	0	100 i
Total number of entries 6					

PE1# **show bgp all-vrf all summary**

VRF : default
BGP Summary

```

-----
Local AS           : 6488163      BGP Router Identifier : 1.1.1.1
Peers              : 2            Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive       : 60
Confederation Id  : 0

```

Address-family : IPv4 Unicast

Address-family : IPv6 Unicast

Address-family : VPNv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
4.4.4.4	6488163	43	36	00h:27m:27s		Established Up
5.5.5.5	6488163	39	34	00h:27m:12s		Established Up

Address-family : L2VPN EVPN

VRF : vrf_1
BGP Summary

```

-----
Local AS           : 6488163      BGP Router Identifier : 20.3.1.2
Peers              : 2            Log Neighbor Changes  : No

```

```

Cfg. Hold Time      : 180          Cfg. Keep Alive      : 60
Confederation Id    : 0

```

```
Address-family : IPv4 Unicast
```

```

-----
Neighbor      Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
20.1.1.1      100        36       37       00h:28m:34s  Established  Up
20.3.1.1      100        36       36       00h:28m:34s  Established  Up

```

```
Address-family : IPv6 Unicast
```

```

VRF : vrf_2
BGP Summary
-----

```

```

Local AS          : 6488163      BGP Router Identifier : 20.3.1.2
Peers             : 2            Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive      : 60
Confederation Id  : 0

```

```
Address-family : IPv4 Unicast
```

```

-----
Neighbor      Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
20.1.1.1      100        40       37       00h:28m:33s  Established  Up
20.3.1.1      100        40       38       00h:28m:42s  Established  Up

```

```
Address-family : IPv6 Unicast
```

```
PE1# show bgp all-vrf all
```

```

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

```
VRF : default
```

```
Local Router-ID 1.1.1.1
```

```
Address-family : IPv4 Unicast
```

```

-----
Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

```
Address-family : IPv6 Unicast
```

```

-----
Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

```
Address-family : VPNv4 Unicast
```

```

-----
Network      Nexthop      Metric      LocPrf      Weight Path

Route Distinguisher: 1:1 (Label 20)
*> 101.0.0.0/24      0.0.0.0      0          100        0          100 i

Route Distinguisher: 2:1 (Label 22)
*> 102.0.0.0/24      0.0.0.0      0          100        0          100 i

Route Distinguisher: 1:3 (Label 21)
*>i 201.0.0.0/24      3.3.3.3      0          100        0          100 i

```

```

* i 201.0.0.0/24      3.3.3.3      0      100      0      100 i
Route Distinguisher: 2:3      (Label 22)
*>i 202.0.0.0/24      3.3.3.3      0      100      0      100 i
* i 202.0.0.0/24      3.3.3.3      0      100      0      100 i
Total number of entries 6

```

Address-family : L2VPN EVPN

```

-----
      Network
      LocPrf  Weight  Path
-----
Total number of entries 0

```

VRF : vrf_1

Local Router-ID 20.3.1.2

Address-family : IPv4 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
* =e 101.0.0.0/24  20.1.1.1      0      100      0      100 i
* >e 101.0.0.0/24  20.3.1.1      0      100      0      100 i
* > 201.0.0.0/24   3.3.3.3      0      100      0      100 i
Total number of entries 3

```

Address-family : IPv6 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

VRF : vrf_2

Local Router-ID 20.3.1.2

Address-family : IPv4 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
* =e 102.0.0.0/24  20.1.1.1      0      100      0      100 i
* >e 102.0.0.0/24  20.3.1.1      0      100      0      100 i
* > 202.0.0.0/24   3.3.3.3      0      100      0      100 i
Total number of entries 3

```

Address-family : IPv6 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

PE1# **show ip route all-vrf**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local

R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN

IA - OSPF internal area, E1 - OSPF external type 1

E2 - OSPF external type 2

VRF: default

```

Prefix          Nexthop          Interface          VRF(egress)  Origin/
Distance/      Age

```

					Type	Metric

1.1.1.1/32	-	-	loopback0	-	L	
[0/0]	-					
2.2.2.2/32		30.0.3.2	1/1/40	-	O	
[110/200]	01h:12m:16s					
		30.0.0.2	1/1/39	-		
[110/200]	01h:12m:16s					
3.3.3.3/32		30.0.3.2	1/1/40	-	O	
[110/150]	01h:11m:52s					
		30.0.0.2	1/1/39	-		
[110/150]	01h:11m:52s					
4.4.4.4/32		30.0.0.2	1/1/39	-	O	
[110/100]	01h:13m:07s					
5.5.5.5/32		30.0.3.2	1/1/40	-	O	
[110/100]	01h:12m:46s					
30.0.0.0/24	-	-	1/1/39	-	C	
[0/0]	-					
30.0.0.1/32	-	-	1/1/39	-	L	
[0/0]	-					
30.0.1.0/24		30.0.0.2	1/1/39	-	O	
[110/200]	01h:13m:07s					
30.0.2.0/24		30.0.0.2	1/1/39	-	O	
[110/150]	01h:12m:42s					
30.0.3.0/24	-	-	1/1/40	-	C	
[0/0]	-					
30.0.3.1/32	-	-	1/1/40	-	L	
[0/0]	-					
30.0.4.0/24		30.0.3.2	1/1/40	-	O	
[110/200]	01h:12m:46s					
30.0.5.0/24		30.0.3.2	1/1/40	-	O	
[110/150]	01h:12m:41s					

VRF: vrf_1

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/	Type	Metric

20.1.1.0/24	-	-	vlan2011	-	C		
[0/0]	-						
20.1.1.2/32	-	-	vlan2011	-	L		
[0/0]	-						
20.3.1.0/24	-	-	vlan2031	-	C		
[0/0]	-						
20.3.1.2/32	-	-	vlan2031	-	L		
[0/0]	-						
101.0.0.0/24		20.3.1.1	vlan2031	-	B/E		
[20/0]	01h:11m:55s						
		20.1.1.1	vlan2011	-			
[20/0]	01h:11m:55s						
201.0.0.0/24		3.3.3.3	1/1/40	default	B/V		
[200/0]	01h:10m:34s						

VRF: vrf_2

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/	Type	Metric

```

-----
20.1.1.0/24      -          -          vlan2012      -          C
[0/0]          -          -          -          -          -
20.1.1.2/32    -          -          vlan2012      -          L
[0/0]          -          -          -          -          -
20.3.1.0/24    -          -          vlan2032      -          C
[0/0]          -          -          -          -          -
20.3.1.2/32    -          -          vlan2032      -          L
[0/0]          -          -          -          -          -
102.0.0.0/24   20.3.1.1   -          vlan2032      -          B/E
[20/0]         00h:54m:06s
                20.1.1.1
[20/0]         00h:54m:06s
202.0.0.0/24   3.3.3.3    -          1/1/40        default        B/V
[200/0]        00h:54m:06s

Total Route Count : 25

```

PE2 configuration

```

PE2# show running
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001BF
!export-password: default
hostname PE2
profile core-spine
logging console severity crit
vrf vrf_1
  rd 1:1
  l3vpn-only
  address-family ipv4 unicast
    route-target export 1:1
    route-target import 1:1
  exit-address-family
vrf vrf_2
  rd 2:1
  l3vpn-only
  address-family ipv4 unicast
    route-target export 2:1
    route-target import 2:1
  exit-address-family
cli-session
  timeout 0
!
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2021-2022,2041-2042
interface mgmt
  no shutdown
  ip dhcp
interface 1/1/43
  no shutdown
  mtu 9000
  description Towards CE1
  no routing

```

```

    vlan trunk native 1
    vlan trunk allowed 2021-2022
interface 1/1/44
    no shutdown
    mtu 9000
    description Towards CE2
    no routing
    vlan trunk native 1
    vlan trunk allowed 2041-2042
interface 1/1/45
    no shutdown
    mtu 9198
    description Towards P1
    ip mtu 9198
    ip address 30.0.1.1/24
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface 1/1/46
    no shutdown
    mtu 9198
    description Towards P2
    ip mtu 9198
    ip address 30.0.4.1/24
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface loopback 0
    ip address 2.2.2.2/32
    ip ospf 1 area 0.0.0.0
interface vlan 2021
    vrf attach vrf_1
    description Towards CE1
    ip mtu 9000
    ip address 20.2.1.2/24
interface vlan 2022
    vrf attach vrf_2
    description Towards CE1
    ip mtu 9000
    ip address 20.2.1.2/24
interface vlan 2041
    vrf attach vrf_1
    description Towards CE2
    ip mtu 9000
    ip address 20.4.1.2/24
interface vlan 2042
    vrf attach vrf_2
    description Towards CE2
    ip mtu 9000
    ip address 20.4.1.2/24
!
ip community-list standard sitel_community description For_setting_community_From_Sitel
ip community-list standard sitel_community seq 10 permit 99:99
!
!
!
route-map rmap1 permit seq 10
    description For_setting_community_For_Sitel_Received_EBGP_routes
    set community 99:99
route-map rmap2 deny seq 10
    description For_Denying_routes_with_Sitel_community_To_EBGP_Peer

```

```

    match community-list sitel_community
route-map rmap2 permit seq 20
    description For_Allowing_all_other_route
!
router ospf 1
    area 0.0.0.0
router bgp 6488163
    neighbor 4.4.4.4 remote-as 6488163
    neighbor 4.4.4.4 description Towards RR1{P1}
    neighbor 4.4.4.4 update-source loopback 0
    neighbor 5.5.5.5 remote-as 6488163
    neighbor 5.5.5.5 description Towards RR2{P2}
    neighbor 5.5.5.5 update-source loopback 0
    address-family vpnv4 unicast
        neighbor 4.4.4.4 activate
        neighbor 4.4.4.4 send-community both
        neighbor 5.5.5.5 activate
        neighbor 5.5.5.5 send-community both
    exit-address-family
!
vrf vrf_1
    neighbor 20.2.1.1 remote-as 100
    neighbor 20.2.1.1 description Towards CE1
    neighbor 20.4.1.1 remote-as 100
    neighbor 20.4.1.1 description Towards CE2
    address-family ipv4 unicast
        neighbor 20.2.1.1 activate
        neighbor 20.2.1.1 route-map rmap1 in
        neighbor 20.2.1.1 route-map rmap2 out
        neighbor 20.2.1.1 send-community both
        neighbor 20.2.1.1 soft-reconfiguration inbound
        neighbor 20.4.1.1 activate
        neighbor 20.4.1.1 route-map rmap1 in
        neighbor 20.4.1.1 route-map rmap2 out
        neighbor 20.4.1.1 send-community both
        neighbor 20.4.1.1 soft-reconfiguration inbound
    exit-address-family
!
vrf vrf_2
    neighbor 20.2.1.1 remote-as 100
    neighbor 20.2.1.1 description Towards CE1
    neighbor 20.4.1.1 remote-as 100
    neighbor 20.4.1.1 description Towards CE2
    address-family ipv4 unicast
        neighbor 20.2.1.1 activate
        neighbor 20.2.1.1 route-map rmap1 in
        neighbor 20.2.1.1 route-map rmap2 out
        neighbor 20.2.1.1 send-community both
        neighbor 20.2.1.1 soft-reconfiguration inbound
        neighbor 20.4.1.1 activate
        neighbor 20.4.1.1 route-map rmap1 in
        neighbor 20.4.1.1 route-map rmap2 out
        neighbor 20.4.1.1 send-community both
        neighbor 20.4.1.1 soft-reconfiguration inbound
    exit-address-family
!
https-server vrf mgmt
mpls
    enable
    label-protocol ldp
        enable
        router-id loopback0

```

```
PE2# show ip ospf neighbors
VRF : default                               Process : 1
=====
```

Total Number of Neighbors : 2

Neighbor ID	Priority	State	Nbr Address	Interface
4.4.4.4	1	FULL/DR	30.0.1.2	1/1/45
5.5.5.5	1	FULL/BDR	30.0.4.2	1/1/46

```
PE2# show mpls ldp neighbor
Local LDP Identifier: 2.2.2.2:0, Peer LDP Identifier: 4.4.4.4:0
Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:36
State: operational
LDP Discovery Sources: 1/1/45
Addresses bound to this peer:
    30.0.0.2 30.0.1.2 30.0.2.1 4.4.4.4
```

```
Local LDP Identifier: 2.2.2.2:0, Peer LDP Identifier: 5.5.5.5:0
Graceful Restart: No
Session Holdtime: 40 sec
Up time: 00:13:14
State: operational
LDP Discovery Sources: 1/1/46
Addresses bound to this peer:
    30.0.3.2 30.0.4.2 30.0.5.1 5.5.5.5
```

```
PE2# show mpls ldp binding
30.0.3.2/32
    No local binding
    remote binding: lsr:5.5.5.5:0 label: exp-null
4.4.4.4/32
    local binding: label: 17
    remote binding: lsr:5.5.5.5:0 label:17
    remote binding: lsr:4.4.4.4:0 label: exp-null
30.0.4.2/32
    No local binding
    remote binding: lsr:5.5.5.5:0 label: exp-null
3.3.3.3/32
    local binding: label: 19
    remote binding: lsr:5.5.5.5:0 label:19
    remote binding: lsr:4.4.4.4:0 label:19
5.5.5.5/32
    local binding: label: 18
    remote binding: lsr:5.5.5.5:0 label: exp-null
    remote binding: lsr:4.4.4.4:0 label:17
30.0.1.1/32
    local binding: label: exp-null
    No remote binding
30.0.1.2/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null
30.0.4.1/32
    local binding: label: exp-null
    No remote binding
1.1.1.1/32
```

```

    local binding: label: 16
    remote binding: lsr:5.5.5.5:0 label:16
    remote binding: lsr:4.4.4.4:0 label:16
30.0.0.2/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null
2.2.2.2/32
    local binding: label: exp-null
    remote binding: lsr:5.5.5.5:0 label:18
    remote binding: lsr:4.4.4.4:0 label:18
30.0.5.1/32
    No local binding
    remote binding: lsr:5.5.5.5:0 label: exp-null
30.0.2.1/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null

```

PE2# **show mpls forwarding**

MPLS Bindings

```

Entry Bindings   : 8
Exit Bindings    : 4
Transit Bindings : 6
PHP Mode         : Explicit-Null
QoS Mode         : Uniform
TTL Propagation  : Uniform

```

Entry Bindings:

Origin	Prefix	Ingress VRF	Nextthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	1.1.1.1/32	default	30.0.1.2	16	1/1/45	default	operational
LDP	1.1.1.1/32	default	30.0.4.2	16	1/1/46	default	operational
LDP	3.3.3.3/32	default	30.0.4.2	19	1/1/46	default	operational
LDP	3.3.3.3/32	default	30.0.1.2	19	1/1/45	default	operational
BGP	201.0.0.0/24	vrf_1	3.3.3.3	21	1/1/46	default	operational
BGP	202.0.0.0/24	vrf_2	3.3.3.3	22	1/1/46	default	operational

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
BGP	n/a	imp-null	20	vrf_1	operational
BGP	n/a	imp-null	22	vrf_2	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	Nextthop Address	Outgoing Label	Status
--------	--------	----------------	------------------	------------	------------------	----------------	--------

```

-----
LDP      4.4.4.4/32   16      1/1/39   default  30.0.0.2  exp-null  operational
LDP      1.1.1.1/32   16      1/1/45   default  30.0.1.2  16        operational
LDP      1.1.1.1/32   16      1/1/46   default  30.0.4.2  16        operational
LDP      4.4.4.4/32   17      1/1/45   default  30.0.1.2  exp-null  operational
LDP      5.5.5.5/32   18      1/1/46   default  30.0.4.2  exp-null  operational
LDP      3.3.3.3/32   19      1/1/45   default  30.0.1.2  19        operational
LDP      3.3.3.3/32   19      1/1/46   default  30.0.4.2  19        operational

```

PE2# **show bgp vpnv4 un neighbors**

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 4.4.4.4 (Internal)

```

Description      : Towards RR1{P1}
Peer-group       :

Remote Router Id : 4.4.4.4           Local Router Id  : 2.2.2.2
Remote AS        : 6488163       Local AS         : 6488163
Remote Port      : 179           Local Port       : 44703
State            : Established   Admin Status     : Up
Conn. Established : 1           Conn. Dropped   : 0
Passive          : No            Update-Source    : loopback0
Cfg. Hold Time   : 180           Cfg. Keep Alive : 60
Neg. Hold Time   : 180           Neg. Keep Alive  : 60
Up/Down Time     : 00h:15m:21s   Connect-Retry Time : 120
Local-AS Prepend : No            Alt. Local-AS   : 0
BFD              : Disabled
Password         :
Last Err Sent    : No Error
Last SubErr Sent : No Error
Last Err Rcvd   : No Error
Last SubErr Rcvd : No Error

Graceful-Restart : Enabled       Gr. Restart Time : 120
Gr. Stalepath Time : 300         Remove Private-AS : No
TTL                : 255         Local Cluster-ID  :
Weight             : 0            Fall-over         : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                    1          1
Notification            0          0
Updates                 3          5
Keepalives              18         17
Route Refresh           0          0
Total                   22         23

```

```

Capability              Advertised  Received
-----
Route Refresh           Yes         Yes
Graceful Restart       Yes         Yes
Add-Path                No          No
Four Octet ASN         Yes         Yes
Address family IPv4 Unicast No          No
Address family IPv6 Unicast No          No
Address family VPNv4 Unicast Yes         Yes
Address family L2VPN EVPN No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : No
Allow-AS in        : 0
Max. Prefix        : 300000
NextHop-Self       :
Cfg. Add-Path      :
Neg. Add-Path      :

Send Community     : both
Advt. Interval     : 30
Soft Reconfig In   :
Default-Originate  :

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability      :
  
```

BGP Neighbor 5.5.5.5 (Internal)

```

Description        : Towards RR2{P2}
Peer-group         :

Remote Router Id   : 5.5.5.5
Remote AS          : 6488163
Remote Port        : 33107
State              : Established
Conn. Established  : 1
Passive           : No
Cfg. Hold Time     : 180
Neg. Hold Time     : 180
Up/Down Time       : 00h:15m:30s
Local-AS Prepend   : No
BFD               : Disabled
Password          :
Last Err Sent      : No Error
Last SubErr Sent   : No Error
Last Err Rcvd     : No Error
Last SubErr Rcvd   : No Error

Local Router Id    : 2.2.2.2
Local AS           : 6488163
Local Port         : 179
Admin Status       : Up
Conn. Dropped      : 0
Update-Source      : loopback0
Cfg. Keep Alive    : 60
Neg. Keep Alive    : 60
Connect-Retry Time : 120
Alt. Local-AS      : 0

Graceful-Restart   : Enabled
Gr. Stalepath Time : 300
TTL               : 255
Weight            : 0
Confederation-Peers : No

Gr. Restart Time   : 120
Remove Private-AS : No
Local Cluster-ID   :
Fall-over          : No
  
```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	3	5
Keepalives	17	17
Route Refresh	0	0
Total	21	23

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

```
Rt. Reflect. Client : No           Send Community      : both
Allow-AS in        : 0             Advt. Interval     : 30
Max. Prefix        : 300000        Soft Reconfig In   :
Nexthop-Self       :               Default-Originate  :
Cfg. Add-Path      :
Neg. Add-Path      :

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability     :
```

PE2# **show bgp vpnv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default

Local Router-ID 2.2.2.2

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (Label 20)					
*> 101.0.0.0/24	0.0.0.0	0	100	0	100 i
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 2:1 (Label 22)					
*> 102.0.0.0/24	0.0.0.0	0	100	0	100 i
* i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 1:3 (Label 21)					
*>i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 201.0.0.0/24	3.3.3.3	0	100	0	100 i
Route Distinguisher: 2:3 (Label 22)					
*>i 202.0.0.0/24	3.3.3.3	0	100	0	100 i
* i 202.0.0.0/24	3.3.3.3	0	100	0	100 i

Total number of entries 10

PE2# **show bgp all-vrf all summary**

VRF : default

BGP Summary

```
Local AS           : 6488163      BGP Router Identifier : 2.2.2.2
Peers              : 2            Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive      : 60
Confederation Id   : 0
```

Address-family : IPv4 Unicast

Address-family : IPv6 Unicast

Address-family : VPNv4 Unicast

```
-----
Neighbor      Remote-AS   MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
4.4.4.4       6488163    40       37       00h:26m:53s  Established  Up
5.5.5.5       6488163    41       35       00h:27m:02s  Established  Up
```

Address-family : L2VPN EVPN

VRF : vrf_1

BGP Summary

```
-----
Local AS           : 6488163      BGP Router Identifier : 20.4.1.2
Peers              : 2           Log Neighbor Changes  : No
Cfg. Hold Time    : 180        Cfg. Keep Alive       : 60
Confederation Id  : 0
```

Address-family : IPv4 Unicast

```
-----
Neighbor      Remote-AS   MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
20.2.1.1     100        35       35       00h:28m:01s  Established  Up
20.4.1.1     100        35       35       00h:27m:58s  Established  Up
```

Address-family : IPv6 Unicast

VRF : vrf_2

BGP Summary

```
-----
Local AS           : 6488163      BGP Router Identifier : 20.4.1.2
Peers              : 2           Log Neighbor Changes  : No
Cfg. Hold Time    : 180        Cfg. Keep Alive       : 60
Confederation Id  : 0
```

Address-family : IPv4 Unicast

```
-----
Neighbor      Remote-AS   MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus
20.2.1.1     100        38       38       00h:27m:57s  Established  Up
20.4.1.1     100        38       37       00h:27m:56s  Established  Up
```

Address-family : IPv6 Unicast

PE2# **show bgp all-vrf all**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default

Local Router-ID 2.2.2.2

Address-family : IPv4 Unicast

```
-----
Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0
```

Address-family : IPv6 Unicast

```

Network          Nexthop      Metric    LocPrf    Weight Path
Total number of entries 0

```

```
Address-family : VPNv4 Unicast
```

```

-----
Network          Nexthop      Metric    LocPrf    Weight Path
Route Distinguisher: 1:1          (Label 20)
*> 101.0.0.0/24    0.0.0.0      0         100      0         100 i
* i 101.0.0.0/24    1.1.1.1      0         100      0         100 i
* i 101.0.0.0/24    1.1.1.1      0         100      0         100 i

```

```

Route Distinguisher: 2:1          (Label 22)
*> 102.0.0.0/24    0.0.0.0      0         100      0         100 i
* i 102.0.0.0/24    1.1.1.1      0         100      0         100 i
* i 102.0.0.0/24    1.1.1.1      0         100      0         100 i

```

```

Route Distinguisher: 1:3          (Label 21)
*>i 201.0.0.0/24    3.3.3.3      0         100      0         100 i
* i 201.0.0.0/24    3.3.3.3      0         100      0         100 i

```

```

Route Distinguisher: 2:3          (Label 22)
*>i 202.0.0.0/24    3.3.3.3      0         100      0         100 i
* i 202.0.0.0/24    3.3.3.3      0         100      0         100 i

```

```
Total number of entries 10
```

```
Address-family : L2VPN EVPN
```

```

-----
Network          Nexthop      Metric
LocPrf    Weight    Path
-----

```

```
Total number of entries 0
```

```
VRF : vrf_1
Local Router-ID 20.4.1.2
```

```
Address-family : IPv4 Unicast
```

```

-----
Network          Nexthop      Metric    LocPrf    Weight Path
*=e 101.0.0.0/24    20.2.1.1      0         100      0         100 i
*>e 101.0.0.0/24    20.4.1.1      0         100      0         100 i
*> 201.0.0.0/24     3.3.3.3       0         100      0         100 i

```

```
Total number of entries 3
```

```
Address-family : IPv6 Unicast
```

```

-----
Network          Nexthop      Metric    LocPrf    Weight Path
Total number of entries 0

```

```
VRF : vrf_2
Local Router-ID 20.4.1.2
```

```
Address-family : IPv4 Unicast
```

```

-----
Network          Nexthop      Metric    LocPrf    Weight Path
*=e 102.0.0.0/24    20.2.1.1      0         100      0         100 i
*>e 102.0.0.0/24    20.4.1.1      0         100      0         100 i
*> 202.0.0.0/24     3.3.3.3       0         100      0         100 i

```

```
Total number of entries 3
```

```
Address-family : IPv6 Unicast
```

```

-----
Network          Nexthop          Metric          LocPrf          Weight Path
Total number of entries 0

```

PE2# **show ip route all-vrf**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

Prefix Distance/ Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric

1.1.1.1/32	30.0.1.2	1/1/45	-	O	
[110/200]	01h:12m:16s				
	30.0.4.2	1/1/46	-		
[110/200]	01h:12m:16s				
2.2.2.2/32	-	loopback0	-	L	
[0/0]	-				
3.3.3.3/32	30.0.1.2	1/1/45	-	O	
[110/150]	01h:11m:52s				
	30.0.4.2	1/1/46	-		
[110/150]	01h:11m:52s				
4.4.4.4/32	30.0.1.2	1/1/45	-	O	
[110/100]	01h:12m:33s				
5.5.5.5/32	30.0.4.2	1/1/46	-	O	
[110/100]	01h:12m:16s				
30.0.0.0/24	30.0.1.2	1/1/45	-	O	
[110/200]	01h:12m:33s				
30.0.1.0/24	-	1/1/45	-	C	
[0/0]	-				
30.0.1.1/32	-	1/1/45	-	L	
[0/0]	-				
30.0.2.0/24	30.0.1.2	1/1/45	-	O	
[110/150]	01h:12m:33s				
30.0.3.0/24	30.0.4.2	1/1/46	-	O	
[110/200]	01h:12m:16s				
30.0.4.0/24	-	1/1/46	-	C	
[0/0]	-				
30.0.4.1/32	-	1/1/46	-	L	
[0/0]	-				
30.0.5.0/24	30.0.4.2	1/1/46	-	O	
[110/150]	01h:12m:16s				

VRF: vrf_1

Prefix Distance/ Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric

20.2.1.0/24	-	vlan2021	-	C	
[0/0]	-				

```

20.2.1.2/32      -          -          vlan2021      -          L
[0/0]          -
20.4.1.0/24     -          -          vlan2041      -          C
[0/0]          -
20.4.1.2/32     -          -          vlan2041      -          L
[0/0]          -
101.0.0.0/24    20.4.1.1   -          vlan2041      -          B/E
[20/0]          01h:11m:55s
                20.2.1.1   -          vlan2021      -
[20/0]          01h:11m:55s
201.0.0.0/24    3.3.3.3    1/1/46     default       B/V
[200/0]         01h:10m:34s

VRF: vrf_2

Prefix          Nexthop          Interface        VRF(egress)     Origin/
Distance/      Age
-----
Type          Metric
-----
20.2.1.0/24     -          -          vlan2022      -          C
[0/0]          -
20.2.1.2/32     -          -          vlan2022      -          L
[0/0]          -
20.4.1.0/24     -          -          vlan2042      -          C
[0/0]          -
20.4.1.2/32     -          -          vlan2042      -          L
[0/0]          -
102.0.0.0/24    20.4.1.1   -          vlan2042      -          B/E
[20/0]          00h:54m:06s
                20.2.1.1   -          vlan2022      -
[20/0]          00h:54m:06s
202.0.0.0/24    3.3.3.3    1/1/46     default       B/V
[200/0]         00h:54m:06s

Total Route Count : 25

```

PE3 configuration

```

PE3# show running
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001BF
!export-password: default
hostname PE3
profile core-spine
logging console severity crit
vrf vrf_1
  rd 1:3
  l3vpn-only
  address-family ipv4 unicast
    route-target export 1:1
    route-target import 1:1
  exit-address-family
vrf vrf_2
  rd 2:3
  l3vpn-only
  address-family ipv4 unicast
    route-target export 2:1
    route-target import 2:1

```

```

    exit-address-family
cli-session
    timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2051-2052
interface mgmt
    no shutdown
    ip dhcp
system interface-group 1 speed 10g
    !interface group 1 contains ports 1/1/1-1/1/4
interface lag 99
    no shutdown
    description Towards P1
    ip mtu 9198
    ip address 30.0.2.2/24
    lacp mode active
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface lag 100
    no shutdown
    description Towards P2
    ip mtu 9198
    ip address 30.0.5.2/24
    lacp mode active
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface 1/1/19
    no shutdown
    mtu 9198
    description Towards P1
    lag 99
interface 1/1/20
    no shutdown
    mtu 9198
    description Towards P1
    lag 99
interface 1/1/21
    no shutdown
    mtu 9000
    description Towards CE3
    no routing
    vlan trunk native 1
    vlan trunk allowed 2051-2052
interface 1/1/22
    no shutdown
    mtu 9198
    description Towards P2
    lag 100
interface 1/1/23
    no shutdown
    mtu 9198
    description Towards P2
    lag 100
interface loopback 0

```

```

    ip address 3.3.3.3/32
    ip ospf 1 area 0.0.0.0
interface vlan 2051
    vrf attach vrf_1
    description Towards CE3
    ip mtu 9000
    ip address 20.5.1.1/24
interface vlan 2052
    vrf attach vrf_2
    description Towards CE3
    ip mtu 9000
    ip address 20.5.1.1/24
!
!
!
!
!
router ospf 1
    area 0.0.0.0
router bgp 6488163
    neighbor 4.4.4.4 remote-as 6488163
    neighbor 4.4.4.4 description Towards RR1{P1}
    neighbor 4.4.4.4 update-source loopback 0
    neighbor 5.5.5.5 remote-as 6488163
    neighbor 5.5.5.5 description Towards RR2{P2}
    neighbor 5.5.5.5 update-source loopback 0
    address-family vpnv4 unicast
        neighbor 4.4.4.4 activate
        neighbor 4.4.4.4 send-community both
        neighbor 5.5.5.5 activate
        neighbor 5.5.5.5 send-community both
    exit-address-family
!
    vrf vrf_1
        neighbor 20.5.1.2 remote-as 100
        neighbor 20.5.1.2 description Towards CE3
        address-family ipv4 unicast
            neighbor 20.5.1.2 activate
            neighbor 20.5.1.2 send-community both
            neighbor 20.5.1.2 soft-reconfiguration inbound
        exit-address-family
!
    vrf vrf_2
        neighbor 20.5.1.2 remote-as 100
        neighbor 20.5.1.2 description Towards CE3
        address-family ipv4 unicast
            neighbor 20.5.1.2 activate
            neighbor 20.5.1.2 send-community both
            neighbor 20.5.1.2 soft-reconfiguration inbound
        exit-address-family
!
https-server vrf mgmt
mpls
    enable
    label-protocol ldp
        enable
    router-id loopback0

```

PE3 verification

PE3# **show ip ospf neighbors**

VRF : default Process : 1

=====

Total Number of Neighbors : 2

Neighbor ID	Priority	State	Nbr Address	Interface
5.5.5.5	1	FULL/DR	30.0.5.1	lag100
4.4.4.4	1	FULL/DR	30.0.2.1	lag99

PE3# **show mpls ldp neighbor**

Local LDP Identifier: 3.3.3.3:0, Peer LDP Identifier: 4.4.4.4:0

Graceful Restart: No

Session Holdtime: 40 sec

Up time: 00:12:42

State: operational

LDP Discovery Sources: lag99

Addresses bound to this peer:

30.0.0.2 30.0.1.2 30.0.2.1 4.4.4.4

Local LDP Identifier: 3.3.3.3:0, Peer LDP Identifier: 5.5.5.5:0

Graceful Restart: No

Session Holdtime: 40 sec

Up time: 00:12:42

State: operational

LDP Discovery Sources: lag100

Addresses bound to this peer:

30.0.3.2 30.0.4.2 30.0.5.1 5.5.5.5

PE3# **show mpls ldp binding**

30.0.5.2/32

local binding: label: exp-null

No remote binding

2.2.2.2/32

local binding: label: 17

remote binding: lsr:5.5.5.5:0 label:18

remote binding: lsr:4.4.4.4:0 label:18

30.0.1.2/32

No local binding

remote binding: lsr:4.4.4.4:0 label: exp-null

4.4.4.4/32

local binding: label: 18

remote binding: lsr:5.5.5.5:0 label:17

remote binding: lsr:4.4.4.4:0 label: exp-null

30.0.4.2/32

No local binding

remote binding: lsr:5.5.5.5:0 label: exp-null

30.0.5.1/32

No local binding

remote binding: lsr:5.5.5.5:0 label: exp-null

30.0.3.2/32

No local binding

remote binding: lsr:5.5.5.5:0 label: exp-null

30.0.2.2/32

local binding: label: exp-null

No remote binding

30.0.0.2/32

No local binding

```

    remote binding: lsr:4.4.4.4:0 label: exp-null
1.1.1.1/32
    local binding: label: 16
    remote binding: lsr:5.5.5.5:0 label:16
    remote binding: lsr:4.4.4.4:0 label:16
5.5.5.5/32
    local binding: label: 19
    remote binding: lsr:5.5.5.5:0 label: exp-null
    remote binding: lsr:4.4.4.4:0 label:17
3.3.3.3/32
    local binding: label: exp-null
    remote binding: lsr:5.5.5.5:0 label:19
    remote binding: lsr:4.4.4.4:0 label:19
30.0.2.1/32
    No local binding
    remote binding: lsr:4.4.4.4:0 label: exp-null

```

PE3# **show mpls forwarding**

MPLS Bindings

```

Entry Bindings      : 8
Exit Bindings       : 4
Transit Bindings    : 6
PHP Mode            : Explicit-Null
QoS Mode            : Uniform
TTL Propagation     : Uniform

```

Entry Bindings:

Origin	Prefix	Ingress VRF	Nextthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	1.1.1.1/32	default	30.0.5.1	16	lag100	default	operational
LDP	1.1.1.1/32	default	30.0.2.1	16	lag99	default	operational
LDP	2.2.2.2/32	default	30.0.2.1	18	lag99	default	operational
LDP	2.2.2.2/32	default	30.0.5.1	18	lag100	default	operational
BGP	101.0.0.0/24	vrf_1	1.1.1.1	20	lag100	default	operational
BGP	102.0.0.0/24	vrf_2	1.1.1.1	22	lag100	default	operational

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
BGP	n/a	imp-null	21	vrf_1	operational
BGP	n/a	imp-null	22	vrf_2	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	Nextthop Address	Outgoing Label	Status

LDP	1.1.1.1/32	16	lag100	default	30.0.5.1	16	operational
LDP	1.1.1.1/32	16	lag99	default	30.0.2.1	16	operational
LDP	2.2.2.2/32	17	lag100	default	30.0.5.1	18	operational
LDP	2.2.2.2/32	17	lag99	default	30.0.2.1	18	operational
LDP	4.4.4.4/32	18	lag99	default	30.0.2.1	exp-null	operational
LDP	5.5.5.5/32	19	lag100	default	30.0.5.1	exp-null	operational

PE3# **show bgp vpnv4 un neighbors**

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 4.4.4.4 (Internal)

Description : Towards RR1{P1}
Peer-group :

Remote Router Id	: 4.4.4.4	Local Router Id	: 3.3.3.3
Remote AS	: 6488163	Local AS	: 6488163
Remote Port	: 33231	Local Port	: 179
State	: Established	Admin Status	: Up
Conn. Established	: 1	Conn. Dropped	: 0
Passive	: No	Update-Source	: loopback0
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Neg. Hold Time	: 180	Neg. Keep Alive	: 60
Up/Down Time	: 00h:14m:47s	Connect-Retry Time	: 120
Local-AS Prepend	: No	Alt. Local-AS	: 0
BFD	: Disabled		
Password	:		
Last Err Sent	: No Error		
Last SubErr Sent	: No Error		
Last Err Rcvd	: No Error		
Last SubErr Rcvd	: No Error		

Graceful-Restart	: Enabled	Gr. Restart Time	: 120
Gr. Stalepath Time	: 300	Remove Private-AS	: No
TTL	: 255	Local Cluster-ID	:
Weight	: 0	Fall-over	: No
Confederation-Peers	: No		

Message statistics	Sent	Rcvd
-----	----	-----
Open	1	1
Notification	0	0
Updates	3	3
Keepalives	17	18
Route Refresh	0	0
Total	21	22

Capability	Advertised	Received
-----	-----	-----
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

```

Rt. Reflect. Client : No
Allow-AS in : 0
Max. Prefix : 300000
Nexthop-Self :
Cfg. Add-Path :
Neg. Add-Path :

Routemap In :
Routemap Out :
ORF type : Prefix-list
ORF capability :

```

BGP Neighbor 5.5.5.5 (Internal)

```

Description : Towards RR2{P2}
Peer-group :

```

```

Remote Router Id : 5.5.5.5
Remote AS : 6488163
Remote Port : 39781
State : Established
Conn. Established : 1
Passive : No
Cfg. Hold Time : 180
Neg. Hold Time : 180
Up/Down Time : 00h:14m:45s
Local-AS Prepend : No
BFD : Disabled
Password :
Last Err Sent : No Error
Last SubErr Sent : No Error
Last Err Rcvd : No Error
Last SubErr Rcvd : No Error

Local Router Id : 3.3.3.3
Local AS : 6488163
Local Port : 179
Admin Status : Up
Conn. Dropped : 0
Update-Source : loopback0
Cfg. Keep Alive : 60
Neg. Keep Alive : 60
Connect-Retry Time : 120
Alt. Local-AS : 0

Graceful-Restart : Enabled
Gr. Stalepath Time : 300
TTL : 255
Weight : 0
Confederation-Peers : No

Gr. Restart Time : 120
Remove Private-AS : No
Local Cluster-ID :
Fall-over : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	3	3
Keepalives	17	17
Route Refresh	0	0
Total	21	21

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

```

Rt. Reflect. Client : No
Allow-AS in : 0
Max. Prefix : 300000
NextHop-Self :
Cfg. Add-Path :
Neg. Add-Path :

Routemap In :
Routemap Out :
ORF type : Prefix-list
ORF capability :

Send Community : both
Advt. Interval : 30
Soft Reconfig In :
Default-Originate :

```

PE3# **show bgp vpnv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 3.3.3.3

Network	NextHop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1 (Label 20)					
*>i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 101.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 2:1 (Label 22)					
*>i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
* i 102.0.0.0/24	1.1.1.1	0	100	0	100 i
Route Distinguisher: 1:3 (Label 21)					
*> 201.0.0.0/24	0.0.0.0	0	100	0	100 i
Route Distinguisher: 2:3 (Label 22)					
*> 202.0.0.0/24	0.0.0.0	0	100	0	100 i
Total number of entries 6					

PE3# **show bgp all-vrf all summary**

VRF : default
BGP Summary

```

-----
Local AS : 6488163
Peers : 2
Cfg. Hold Time : 180
Confederation Id : 0
BGP Router Identifier : 3.3.3.3
Log Neighbor Changes : No
Cfg. Keep Alive : 60

```

Address-family : IPv4 Unicast

Address-family : IPv6 Unicast

Address-family : VPNv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
4.4.4.4	6488163	40	35	00h:26m:19s	Established	Up
5.5.5.5	6488163	39	36	00h:26m:17s	Established	Up

Address-family : L2VPN EVPN

VRF : vrf_1
BGP Summary

Local AS : 6488163 BGP Router Identifier : 20.5.1.1
Peers : 1 Log Neighbor Changes : No
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Confederation Id : 0

Address-family : IPv4 Unicast

Neighbor Remote-AS MsgRcvd MsgSent Up/Down Time State
AdminStatus
20.5.1.2 100 33 34 00h:25m:12s Established Up

Address-family : IPv6 Unicast

VRF : vrf_2
BGP Summary

Local AS : 6488163 BGP Router Identifier : 20.5.1.1
Peers : 1 Log Neighbor Changes : No
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Confederation Id : 0

Address-family : IPv4 Unicast

Neighbor Remote-AS MsgRcvd MsgSent Up/Down Time State
AdminStatus
20.5.1.2 100 34 34 00h:25m:11s Established Up

Address-family : IPv6 Unicast

PE3# **show bgp all-vrf all**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 3.3.3.3

Address-family : IPv4 Unicast

Network Nexthop Metric LocPrf Weight Path
Total number of entries 0

Address-family : IPv6 Unicast

Network Nexthop Metric LocPrf Weight Path
Total number of entries 0

Address-family : VPNv4 Unicast

Network Nexthop Metric LocPrf Weight Path

Route Distinguisher: 1:1 (Label 20)
*>i 101.0.0.0/24 1.1.1.1 0 100 0 100 i

```

* i 101.0.0.0/24      1.1.1.1      0      100      0      100 i
Route Distinguisher: 2:1      (Label 22)
*>i 102.0.0.0/24     1.1.1.1      0      100      0      100 i
* i 102.0.0.0/24     1.1.1.1      0      100      0      100 i

Route Distinguisher: 1:3      (Label 21)
*> 201.0.0.0/24     0.0.0.0      0      100      0      100 i

Route Distinguisher: 2:3      (Label 22)
*> 202.0.0.0/24     0.0.0.0      0      100      0      100 i
Total number of entries 6

```

Address-family : L2VPN EVPN

```

-----
      Network                               Nexthop      Metric
      LocPrf   Weight   Path
-----

```

Total number of entries 0

VRF : vrf_1

Local Router-ID 20.5.1.1

Address-family : IPv4 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
*> 101.0.0.0/24   1.1.1.1      0           100         0      100 i
*>e 201.0.0.0/24 20.5.1.2     0           100         0      100 i
Total number of entries 2

```

Address-family : IPv6 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

VRF : vrf_2

Local Router-ID 20.5.1.1

Address-family : IPv4 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
*> 102.0.0.0/24   1.1.1.1      0           100         0      100 i
*>e 202.0.0.0/24 20.5.1.2     0           100         0      100 i
Total number of entries 2

```

Address-family : IPv6 Unicast

```

-----
      Network      Nexthop      Metric      LocPrf      Weight Path
Total number of entries 0

```

PE3# **show ip route all-vrf**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local

R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN

IA - OSPF internal area, E1 - OSPF external type 1

E2 - OSPF external type 2

VRF: default

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/ Type	Metric
1.1.1.1/32 [110/150]	01h:11m:56s	30.0.5.1	lag100	-	O	
[110/150]	01h:11m:56s	30.0.2.1	lag99	-		
2.2.2.2/32 [110/150]	01h:11m:56s	30.0.5.1	lag100	-	O	
[110/150]	01h:11m:56s	30.0.2.1	lag99	-		
3.3.3.3/32 [0/0]	-	-	loopback0	-	L	
4.4.4.4/32 [110/50]	01h:11m:57s	30.0.2.1	lag99	-	O	
5.5.5.5/32 [110/50]	01h:11m:56s	30.0.5.1	lag100	-	O	
30.0.0.0/24 [110/150]	01h:11m:57s	30.0.2.1	lag99	-	O	
30.0.1.0/24 [110/150]	01h:11m:57s	30.0.2.1	lag99	-	O	
30.0.2.0/24 [0/0]	-	-	lag99	-	C	
30.0.2.2/32 [0/0]	-	-	lag99	-	L	
30.0.3.0/24 [110/150]	01h:11m:56s	30.0.5.1	lag100	-	O	
30.0.4.0/24 [110/150]	01h:11m:56s	30.0.5.1	lag100	-	O	
30.0.5.0/24 [0/0]	-	-	lag100	-	C	
30.0.5.2/32 [0/0]	-	-	lag100	-	L	

VRF: vrf_1

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/ Type	Metric
20.5.1.0/24 [0/0]	-	-	vlan2051	-	C	
20.5.1.1/32 [0/0]	-	-	vlan2051	-	L	
101.0.0.0/24 [200/0]	01h:11m:49s	1.1.1.1	lag100	default	B/V	
201.0.0.0/24 [20/0]	01h:10m:34s	20.5.1.2	vlan2051	-	B/E	

VRF: vrf_2

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/ Type	Metric
20.5.1.0/24	-	-	vlan2052	-	C	

```

[0/0] -
20.5.1.1/32 - vlan2052 - L
[0/0] -
102.0.0.0/24 1.1.1.1 lag100 default B/V
[200/0] 00h:54m:06s
202.0.0.0/24 20.5.1.2 vlan2052 - B/E
[20/0] 00h:54m:06s

Total Route Count : 21

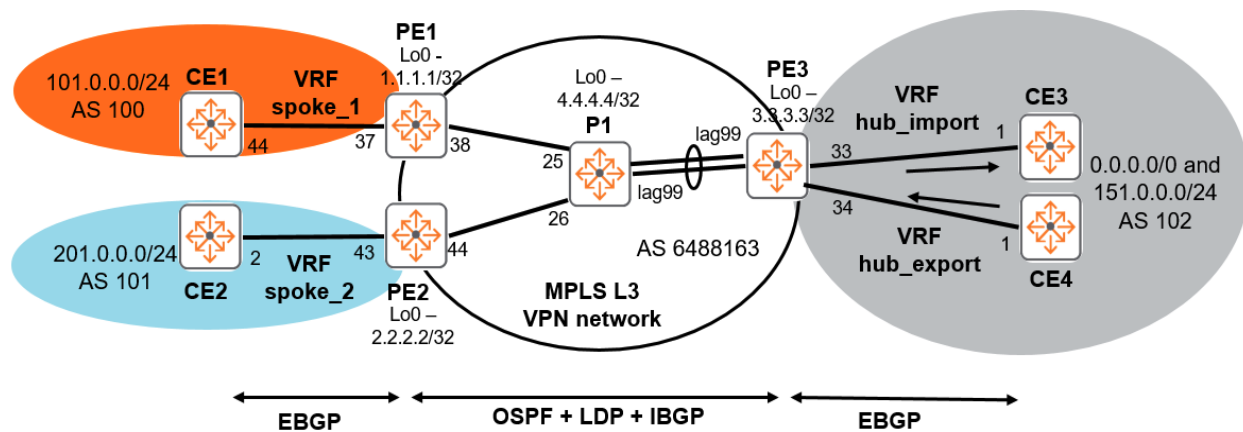
```

Use case 2: MPLS L3 VPN with hub and spoke VRFs

This use case covers:

- An MPLS L3 VPN network with a shared hub VRF that has connectivity to spoke VRFs, while spoke VRFs that are isolated between each other
- CEs in hub VRF are expected to provide hub connectivity between CE spoke subnets (101.0.0.0/24 and 201.0.0.0/24) and hub subnets (151.0.0.0/24 and 0.0.0.0/0 default route)
- PE3 should not allow direct spoke to spoke connectivity, this is achieved through:
 - Using hub_import VRF to advertise spoke CE subnets from PE1/PE2 to CE3
 - Using hub_export VRF to advertise hub and spoke CE subnets from CE4 to PE1/PE2
- Sample configurations
- Relevant verification commands

MPLS L3 VPN with hub and spoke VRFs:



CE1 Configuration

```

CE1# show run
Current configuration:
!
!Version ArubaOS-CX TL.10.09.0001AX
!export-password: default
hostname CE1
profile l3-core
logging console severity crit
cli-session
timeout 0

```

```

!
!
!
!
!
ssh server vrf mgmt
vlan 1,2001,2071
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/43
    no shutdown
    description Towards 101 subnet
    no routing
    vlan trunk native 1
    vlan trunk allowed 2071
interface 1/1/44
    no shutdown
    description Towards PE1
    no routing
    vlan trunk native 1
    vlan trunk allowed 2001
interface vlan 2001
    description Towards PE1
    ip address 20.0.1.1/24
interface vlan 2071
    description Towards 101 subnet
    ip address 20.7.1.2/24
    ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1
    area 0.0.0.0
router bgp 100
    neighbor 20.0.1.2 remote-as 6488163
    neighbor 20.0.1.2 description Towards PE1
    neighbor 20.7.1.1 remote-as 100
    neighbor 20.7.1.1 description Towards 101 subnet
    address-family ipv4 unicast
        neighbor 20.0.1.2 activate
        neighbor 20.0.1.2 send-community both
        neighbor 20.0.1.2 soft-reconfiguration inbound
        neighbor 20.7.1.1 activate
        neighbor 20.7.1.1 next-hop-self
    exit-address-family
!
https-server vrf mgmt

```

CE1 Verification

```

CE1# show bgp ipv4 unicast neighbors
Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 20.0.1.2 (External)
  Description      : Towards PE1
  Peer-group      :

```

```

Remote Router Id      : 20.0.1.2          Local Router Id      : 20.7.1.2
Remote AS             : 6488163          Local AS             : 100
Remote Port           : 57770            Local Port           : 179
State                 : Established        Admin Status         : Up
Conn. Established     : 1                 Conn. Dropped        : 0
Passive               : No                Update-Source        :
Cfg. Hold Time        : 180               Cfg. Keep Alive     : 60
Neg. Hold Time        : 180               Neg. Keep Alive     : 60
Up/Down Time         : 00h:23m:45s       Connect-Retry Time  : 120
Local-AS Prepend     : No                 Alt. Local-AS       : 0
BFD                   : Disabled
Password              :
Last Err Sent         : Cease
Last SubErr Sent      : Administrative Shutdown
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

```

```

Graceful-Restart      : Enabled          Gr. Restart Time    : 120
Gr. Stalepath Time   : 300               Remove Private-AS   : No
TTL                   : 1                 Local Cluster-ID    :
Weight                : 0                 Fall-over            : No
Confederation-Peers  : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	2	9
Keepalives	27	23
Route Refresh	0	0
Total	30	33

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	Yes	Yes
Address family IPv6 Unicast	No	No

Address Family : IPv4 Unicast

```

Rt. Reflect. Client : No                Send Community      : both
Allow-AS in         : 0                  Advt. Interval     : 30
Max. Prefix         : 128000             Soft Reconfig In   : Yes
NextHop-Self        :                    Default-Originate   :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In         :
Routemap Out        :
ORF type            : Prefix-list
ORF capability       :

```

```

BGP Neighbor 20.7.1.1 (Internal)
Description          : Towards Ixial-SPOKE1
Peer-group           :

```

```

Remote Router Id      : 196.0.0.1          Local Router Id      : 20.7.1.2

```

```

Remote AS          : 100                Local AS          : 100
Remote Port       : 32802              Local Port       : 179
State            : Established          Admin Status     : Up
Conn. Established : 1                  Conn. Dropped   : 0
Passive         : No                    Update-Source    :
Cfg. Hold Time  : 180                  Cfg. Keep Alive : 60
Neg. Hold Time  : 90                   Neg. Keep Alive  : 30
Up/Down Time    : 00h:20m:28s         Connect-Retry Time : 120
Local-AS Prepend : No                  Alt. Local-AS   : 0
BFD             : Disabled
Password        :
Last Err Sent   : No Error
Last SubErr Sent : No Error
Last Err Rcvd  : No Error
Last SubErr Rcvd : No Error

Graceful-Restart  : Enabled              Gr. Restart Time : 120
Gr. Stalepath Time : 300                Remove Private-AS : No
TTL              : 255                  Local Cluster-ID  :
Weight           : 0                    Fall-over         : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1         1
Notification           0         0
Updates                8         1
Keepalives             45        42
Route Refresh          0         0
Total                  54        44

```

```

Capability                Advertised      Received
-----
Route Refresh             Yes             Yes
Graceful Restart          Yes             No
Add-Path                  No              No
Four Octet ASN            Yes             No
Address family IPv4 Unicast Yes             Yes
Address family IPv6 Unicast No              Yes

```

```

Address Family : IPv4 Unicast
-----

```

```

Rt. Reflect. Client : No                Send Community   :
Allow-AS in         : 0                  Advt. Interval   : 30
Max. Prefix         : 128000             Soft Reconfig In :
NextHop-Self        : Yes                Default-Originate :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In         :
Routemap Out        :
ORF type            : Prefix-list
ORF capability       :

```

```

CE1# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 20.7.1.2

```

```

Network          Nexthop          Metric          LocPrf          Weight Path
*>e 0.0.0.0/0    20.0.1.2        0               100            0           6488163 102 ?
*>e 20.4.1.0/24  20.0.1.2        0               100            0           6488163 102 ?
*>e 20.5.1.0/24  20.0.1.2        0               100            0           6488163 102 ?
*>e 20.6.1.0/24  20.0.1.2        0               100            0           6488163 102 ?
*>i 101.0.0.0/24 20.7.1.1        0               100            0           i
*>e 151.0.0.0/24 20.0.1.2        0               100            0           6488163 102 ?
*>e 201.0.0.0/24 20.0.1.2        0               100            0           6488163 102 ?
Total number of entries 7

```

CE1#

CE1# show bgp all-vrf all summary

VRF : default

BGP Summary

```

Local AS           : 100           BGP Router Identifier : 20.7.1.2
Peers              : 2             Log Neighbor Changes  : No
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60
Confederation Id   : 0

```

Address-family : IPv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
20.0.1.2	6488163	40	37	00h:29m:45s		Established Up
20.7.1.1	100	56	68	00h:26m:28s		Established Up

Address-family : IPv6 Unicast

CE1#

CE1# show ip route all-vrfs

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local

R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN

IA - OSPF internal area, E1 - OSPF external type 1

E2 - OSPF external type 2

VRF: default

Prefix	Age	Nexthop	Interface	VRF (egress)	Origin/	Type	Metric
0.0.0.0/0		20.0.1.2	vlan2001	-	B/E		
[20/0]	00h:23m:22s						
20.0.1.0/24		-	vlan2001	-	C		
[0/0]	-						
20.0.1.1/32		-	vlan2001	-	L		
[0/0]	-						
20.4.1.0/24		20.0.1.2	vlan2001	-	B/E		
[20/0]	00h:29m:54s						
20.5.1.0/24		20.0.1.2	vlan2001	-	B/E		
[20/0]	00h:30m:36s						
20.6.1.0/24		20.0.1.2	vlan2001	-	B/E		

```

[20/0]          00h:24m:12s
20.7.1.0/24     -                vlan2071      -                C
[0/0]          -                -
20.7.1.2/32    -                vlan2071      -                L
[0/0]          -                -
101.0.0.0/24   20.7.1.1          vlan2071      -                B/I
[200/0]        00h:28m:22s
151.0.0.0/24   20.0.1.2          vlan2001      -                B/E
[20/0]          00h:23m:22s
201.0.0.0/24   20.0.1.2          vlan2001      -                B/E
[20/0]          00h:28m:22s

Total Route Count : 11

```

CE2 Configuration

```

CE2# show run
Current configuration:
!
!Version ArubaOS-CX TL.10.09.0001AX
!export-password: default
hostname CE2
profile l3-core
logging console severity crit
cli-session
    timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2011,2081
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    description Towards 201 subnet
    no routing
    vlan trunk native 1
    vlan trunk allowed 2081
interface 1/1/2
    no shutdown
    description Towards PE2
    no routing
    vlan trunk native 1
    vlan trunk allowed 2011
interface vlan 2011
    description Towards PE2
    ip address 20.1.1.1/24
interface vlan 2081
    description Towards 201 subnet
    ip address 20.8.1.2/24
    ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1

```

```

    area 0.0.0.0
router bgp 101
  neighbor 20.1.1.2 remote-as 6488163
  neighbor 20.1.1.2 description Towards PE2
  neighbor 20.8.1.1 remote-as 101
  neighbor 20.8.1.1 description Towards 201 subnet
  address-family ipv4 unicast
    neighbor 20.1.1.2 activate
    neighbor 20.1.1.2 send-community both
    neighbor 20.1.1.2 soft-reconfiguration inbound
    neighbor 20.8.1.1 activate
    neighbor 20.8.1.1 next-hop-self
  exit-address-family
!
https-server vrf mgmt

```

CE2 Verification

```

CE2# show bgp ipv4 unicast neighbors
Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 20.1.1.2 (External)
  Description      : Towards PE2
  Peer-group      :

  Remote Router Id : 20.1.1.2           Local Router Id  : 20.8.1.2
  Remote AS        : 6488163       Local AS         : 101
  Remote Port      : 60400         Local Port       : 179
  State            : Established   Admin Status     : Up
  Conn. Established : 1           Conn. Dropped   : 0
  Passive          : No           Update-Source    :
  Cfg. Hold Time   : 180         Cfg. Keep Alive : 60
  Neg. Hold Time   : 180         Neg. Keep Alive  : 60
  Up/Down Time     : 00h:23m:27s  Connect-Retry Time : 120
  Local-AS Prepend : No           Alt. Local-AS   : 0
  BFD              : Disabled
  Password         :
  Last Err Sent    : Cease
  Last SubErr Sent : Administrative Shutdown
  Last Err Rcvd   : No Error
  Last SubErr Rcvd : No Error

  Graceful-Restart : Enabled       Gr. Restart Time : 120
  Gr. Stalepath Time : 300       Remove Private-AS : No
  TTL                : 1         Local Cluster-ID  :
  Weight            : 0         Fall-over         : No
  Confederation-Peers : No

  Message statistics      Sent      Rcvd
  -----
  Open                   1          1
  Notification           0          0
  Updates                2          9
  Keepalives            26         22
  Route Refresh          0          0
  Total                  29         32

  Capability              Advertised      Received
  -----

```

```

Route Refresh                Yes                Yes
Graceful Restart             Yes                Yes
Add-Path                     No                 No
Four Octet ASN               Yes                Yes
Address family IPv4 Unicast  Yes                Yes
Address family IPv6 Unicast  No                 No

```

```

Address Family : IPv4 Unicast
-----

```

```

Rt. Reflect. Client : No           Send Community      : both
Allow-AS in         : 0             Advt. Interval     : 30
Max. Prefix         : 128000        Soft Reconfig In   : Yes
NextHop-Self        :                Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In          :
Routemap Out         :
ORF type              : Prefix-list
ORF capability        :

```

BGP Neighbor 20.8.1.1 (Internal)

```

Description          : Towards Ixia2-SPOKE2
Peer-group           :

```

```

Remote Router Id     : 195.0.0.1           Local Router Id     : 20.8.1.2
Remote AS            : 101                Local AS            : 101
Remote Port          : 32798              Local Port          : 179
State                : Established        Admin Status        : Up
Conn. Established    : 1                  Conn. Dropped       : 0
Passive              : No                 Update-Source       :
Cfg. Hold Time       : 180                Cfg. Keep Alive    : 60
Neg. Hold Time       : 90                 Neg. Keep Alive     : 30
Up/Down Time         : 00h:20m:27s         Connect-Retry Time : 120
Local-AS Prepend     : No                 Alt. Local-AS      : 0
BFD                  : Disabled
Password             :
Last Err Sent        : No Error
Last SubErr Sent     : No Error
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

Graceful-Restart     : Enabled                Gr. Restart Time   : 120
Gr. Stalepath Time   : 300                Remove Private-AS  : No
TTL                  : 255                Local Cluster-ID   :
Weight               : 0                  Fall-over           : No
Confederation-Peers : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	8	1
Keepalives	44	42
Route Refresh	0	0
Total	53	44

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	No

```

Add-Path                               No                No
Four Octet ASN                          Yes               No
Address family IPv4 Unicast              Yes               Yes
Address family IPv6 Unicast              No                Yes

```

```

Address Family : IPv4 Unicast
-----

```

```

Rt. Reflect. Client : No                Send Community   :
Allow-AS in         : 0                  Advt. Interval   : 30
Max. Prefix         : 128000             Soft Reconfig In :
Nexthop-Self       : Yes                 Default-Originate:
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In       :
Routemap Out      :
ORF type          : Prefix-list
ORF capability     :

```

```

CE2# show bgp ipv4 unicast

```

```

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
                i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

```

VRF : default

```

```

Local Router-ID 20.8.1.2

```

Network	Nexthop	Metric	LocPrf	Weight	Path
*>e 0.0.0.0/0	20.1.1.2	0	100	0	6488163 102 ?
*>e 20.4.1.0/24	20.1.1.2	0	100	0	6488163 102 ?
*>e 20.5.1.0/24	20.1.1.2	0	100	0	6488163 102 ?
*>e 20.6.1.0/24	20.1.1.2	0	100	0	6488163 102 ?
*>e 101.0.0.0/24	20.1.1.2	0	100	0	6488163 102 ?
*>e 151.0.0.0/24	20.1.1.2	0	100	0	6488163 102 ?
*>i 201.0.0.0/24	20.8.1.1	0	100	0	i

```

Total number of entries 7

```

```

CE2#

```

```

CE2# show bgp all-vrf all summary

```

```

VRF : default

```

```

BGP Summary
-----

```

```

Local AS           : 101                BGP Router Identifier : 20.8.1.2
Peers              : 2                    Log Neighbor Changes  : No
Cfg. Hold Time     : 180                 Cfg. Keep Alive       : 60
Confederation Id   : 0

```

```

Address-family : IPv4 Unicast
-----

```

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
20.1.1.2	6488163	39	36	00h:29m:27s		Established Up
20.8.1.1	101	56	67	00h:26m:28s		Established Up

```

Address-family : IPv6 Unicast
-----

```

```

CE2#

```

```

CE2# show ip route all-vrfs

```

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

Prefix Distance/ Age	Nexthop	Interface	VRF (egress)	Origin/ Type	Metric
0.0.0.0/0 [20/0]	20.1.1.2 00h:23m:22s	vlan2011	-	B/E	
20.1.1.0/24 [0/0]	-	vlan2011	-	C	
20.1.1.1/32 [0/0]	-	vlan2011	-	L	
20.4.1.0/24 [20/0]	20.1.1.2 00h:29m:54s	vlan2011	-	B/E	
20.5.1.0/24 [20/0]	20.1.1.2 00h:30m:36s	vlan2011	-	B/E	
20.6.1.0/24 [20/0]	20.1.1.2 00h:24m:12s	vlan2011	-	B/E	
20.8.1.0/24 [0/0]	-	vlan2081	-	C	
20.8.1.2/32 [0/0]	-	vlan2081	-	L	
101.0.0.0/24 [20/0]	20.1.1.2 00h:28m:22s	vlan2011	-	B/E	
151.0.0.0/24 [20/0]	20.1.1.2 00h:23m:22s	vlan2011	-	B/E	
201.0.0.0/24 [200/0]	20.8.1.1 00h:28m:22s	vlan2081	-	B/I	

Total Route Count : 11

CE3 Configuration

```
CE3# show run
Current configuration:
!
!Version ArubaOS-CX TL.10.09.0001AX
!export-password: default
hostname CE3
profile l3-core
logging console severity crit
cli-session
    timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2021,2041
interface mgmt
    no shutdown
```

```

ip dhcp
interface 1/1/1
  no shutdown
  description Towards PE3
  no routing
  vlan trunk native 1
  vlan trunk allowed 2021
interface 1/1/2
  no shutdown
  description Towards 151 and default subnet
  no routing
  vlan trunk native 1
  vlan trunk allowed 2041
interface vlan 2021
  description Towards PE3
  ip address 20.2.1.2/24
interface vlan 2041
  description Towards 151 and default subnet
  ip address 20.4.1.1/24
  ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1
  redistribute bgp
  area 0.0.0.0
router bgp 102
  neighbor 20.2.1.1 remote-as 6488163
  neighbor 20.2.1.1 description Towards PE3
  address-family ipv4 unicast
    neighbor 20.2.1.1 activate
    neighbor 20.2.1.1 send-community both
    neighbor 20.2.1.1 soft-reconfiguration inbound
  redistribute ospf
  exit-address-family
!
https-server vrf mgmt
CE3#

```

```
CE3# show ip ospf neighbors
```

```
VRF : default Process : 1
```

```
=====
Total Number of Neighbors : 1
```

Neighbor ID	Priority	State	Nbr Address	Interface
20.4.1.2	1	FULL/BDR	20.4.1.2	vlan2041

CE3 Verification

```
CE3# show bgp ipv4 unicast neighbors
Codes: ^ Inherited from peer-group
```

```
VRF : default
```

```
BGP Neighbor 20.2.1.1 (External)
  Description      : Towards PE3
  Peer-group       :
```

```

Remote Router Id      : 20.2.1.1          Local Router Id      : 20.4.1.1
Remote AS             : 6488163          Local AS             : 102
Remote Port           : 179              Local Port           : 48554
State                 : Established       Admin Status         : Up
Conn. Established     : 1                 Conn. Dropped        : 0
Passive               : No                Update-Source        :
Cfg. Hold Time        : 180              Cfg. Keep Alive     : 60
Neg. Hold Time        : 180              Neg. Keep Alive     : 60
Up/Down Time         : 00h:23m:06s       Connect-Retry Time  : 120
Local-AS Prepend     : No                Alt. Local-AS       : 0
BFD                   : Disabled
Password              :
Last Err Sent         : Cease
Last SubErr Sent      : Administrative Shutdown
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

Graceful-Restart      : Enabled          Gr. Restart Time    : 120
Gr. Stalepath Time    : 300              Remove Private-AS   : No
TTL                   : 1                 Local Cluster-ID    :
Weight                : 0                 Fall-over            : No
Confederation-Peers  : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	8	3
Keepalives	23	27
Route Refresh	0	0
Total	32	31

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	Yes	Yes
Address family IPv6 Unicast	No	No

Address Family : IPv4 Unicast

```

Rt. Reflect. Client : No          Send Community      : both
Allow-AS in         : 5           Advt. Interval     : 30
Max. Prefix          : 128000      Soft Reconfig In   : Yes
Nexthop-Self        :             Default-Originate  :
Cfg. Add-Path        :
Neg. Add-Path        : Disable

```

```

Routemap In         :
Routemap Out        :
ORF type             : Prefix-list
ORF capability       :

```

```

CE3# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

VRF : default
Local Router-ID 20.4.1.1

Network	Nexthop	Metric	LocPrf	Weight	Path
*> 0.0.0.0/0	20.4.1.2	0	100	0	?
*> 20.4.1.0/24	0.0.0.0	0	100	0	?
*> 20.5.1.0/24	20.4.1.2	0	100	0	?
*> 20.6.1.0/24	20.4.1.2	0	100	0	?
*>e 101.0.0.0/24	20.2.1.1	0	100	0	6488163 100 i
*> 151.0.0.0/24	20.4.1.2	0	100	0	?
*>e 201.0.0.0/24	20.2.1.1	0	100	0	6488163 101 i

Total number of entries 7

CE3# show bgp all-vrf all summary

VRF : default
BGP Summary

Local AS	: 102	BGP Router Identifier	: 20.4.1.1
Peers	: 1	Log Neighbor Changes	: No
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Confederation Id	: 0		

Address-family : IPv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
20.2.1.1	6488163	38	39	00h:29m:07s	Established	Up

Address-family : IPv6 Unicast

CE3# show ip route all-vrfs

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF
Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

Prefix	Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric
0.0.0.0/0		20.4.1.2	vlan2041	-	O/IA	
[110/200]	00h:23m:22s					
20.2.1.0/24		-	vlan2021	-	C	
[0/0]	-					
20.2.1.2/32		-	vlan2021	-	L	
[0/0]	-					
20.4.1.0/24		-	vlan2041	-	C	
[0/0]	-					
20.4.1.1/32		-	vlan2041	-	L	
[0/0]	-					
20.5.1.0/24		20.4.1.2	vlan2041	-	O	
[110/200]	00h:29m:54s					
20.6.1.0/24		20.4.1.2	vlan2041	-	O	

```

[110/200]    00h:24m:12s
101.0.0.0/24    20.2.1.1          vlan2021    -          B/E
[20/0]      00h:28m:23s
151.0.0.0/24    20.4.1.2          vlan2041    -          O/IA
[110/200]    00h:23m:22s
201.0.0.0/24    20.2.1.1          vlan2021    -          B/E
[20/0]      00h:28m:22s

Total Route Count : 10

```

CE4 Configuration

```

CE4# show run
Current configuration:
!
!Version ArubaOS-CX TL.10.09.0001AX
!export-password: default
hostname CE4
profile l3-core
logging console severity crit
cli-session
    timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2031,2051
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    description Towards PE3
    no routing
    vlan trunk native 1
    vlan trunk allowed 2031
interface 1/1/2
    no shutdown
    description Towards 151 and default subnet
    no routing
    vlan trunk native 1
    vlan trunk allowed 2051
interface vlan 2031
    description Towards PE3
    ip address 20.3.1.2/24
interface vlan 2051
    description Towards 151 and default subnet
    ip address 20.5.1.1/24
    ip ospf 1 area 0.0.0.0
!
!
!
!
!
router ospf 1
    redistribute bgp
    area 0.0.0.0
router bgp 102
    neighbor 20.3.1.1 remote-as 6488163

```

```

neighbor 20.3.1.1 description Towards PE3
address-family ipv4 unicast
    neighbor 20.3.1.1 activate
    neighbor 20.3.1.1 send-community both
    neighbor 20.3.1.1 soft-reconfiguration inbound
    redistribute ospf
exit-address-family
!
https-server vrf mgmt
CE4#

```

```
CE4# show ip ospf neighbors
```

```
VRF : default Process : 1
```

```
=====
```

```
Total Number of Neighbors : 1
```

Neighbor ID	Priority	State	Nbr Address	Interface
20.4.1.2	1	FULL/DR	20.5.1.2	vlan2051

CE4 Verification

```
CE4# show bgp ipv4 unicast neighbors
```

```
Codes: ^ Inherited from peer-group
```

```
VRF : default
```

```
BGP Neighbor 20.3.1.1 (External)
```

```
Description : Towards PE3
```

```
Peer-group :
```

```
Remote Router Id : 20.3.1.1
```

```
Local Router Id : 20.5.1.1
```

```
Remote AS : 6488163
```

```
Local AS : 102
```

```
Remote Port : 52062
```

```
Local Port : 179
```

```
State : Established
```

```
Admin Status : Up
```

```
Conn. Established : 1
```

```
Conn. Dropped : 0
```

```
Passive : No
```

```
Update-Source :
```

```
Cfg. Hold Time : 180
```

```
Cfg. Keep Alive : 60
```

```
Neg. Hold Time : 180
```

```
Neg. Keep Alive : 60
```

```
Up/Down Time : 00h:22m:47s
```

```
Connect-Retry Time : 120
```

```
Local-AS Prepend : No
```

```
Alt. Local-AS : 0
```

```
BFD : Disabled
```

```
Password :
```

```
Last Err Sent : Cease
```

```
Last SubErr Sent : Administrative Shutdown
```

```
Last Err Rcvd : No Error
```

```
Last SubErr Rcvd : No Error
```

```
Graceful-Restart : Enabled
```

```
Gr. Restart Time : 120
```

```
Gr. Stalepath Time : 300
```

```
Remove Private-AS : No
```

```
TTL : 1
```

```
Local Cluster-ID :
```

```
Weight : 0
```

```
Fall-over : No
```

```
Confederation-Peers : No
```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	9	1
Keepalives	22	26

```

Route Refresh          0          0
Total                  32         28

```

```

Capability                Advertised    Received
-----
Route Refresh             Yes          Yes
Graceful Restart         Yes          Yes
Add-Path                  No           No
Four Octet ASN           Yes          Yes
Address family IPv4 Unicast Yes          Yes
Address family IPv6 Unicast No           No

```

```

Address Family : IPv4 Unicast
-----

```

```

Rt. Reflect. Client : No           Send Community      : both
Allow-AS in         : 5            Advt. Interval     : 30
Max. Prefix         : 128000        Soft Reconfig In   : Yes
NextHop-Self        :               Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In         :
Routemap Out        :
ORF type            : Prefix-list
ORF capability       :

```

CE4#

```

CE4# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

```

VRF : default
Local Router-ID 20.5.1.1

```

Network	Nexthop	Metric	LocPrf	Weight	Path
*> 0.0.0.0/0	20.5.1.2	0	100	0	?
*> 20.4.1.0/24	20.5.1.2	0	100	0	?
*> 20.5.1.0/24	0.0.0.0	0	100	0	?
*> 20.6.1.0/24	20.5.1.2	0	100	0	?
*> 101.0.0.0/24	20.5.1.2	0	100	0	?
*> 151.0.0.0/24	20.5.1.2	0	100	0	?
*> 201.0.0.0/24	20.5.1.2	0	100	0	?

Total number of entries 7

CE4#

```

CE4# show bgp all-vrf all summary

```

```

VRF : default
BGP Summary
-----
Local AS           : 102           BGP Router Identifier : 20.5.1.1
Peers              : 1             Log Neighbor Changes  : No
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60
Confederation Id   : 0

```

```

Address-family : IPv4 Unicast
-----

```

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
20.3.1.1	6488163	35	39	00h:28m:48s	Established	Up

```
Address-family : IPv6 Unicast
```

```
-----  
CE4# show ip route all-vrfs
```

```
Displaying ipv4 routes selected for forwarding
```

```
Origin Codes: C - connected, S - static, L - local
```

```
              R - RIP, B - BGP, O - OSPF
```

```
Type Codes:   E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
```

```
              IA - OSPF internal area, E1 - OSPF external type 1
```

```
              E2 - OSPF external type 2
```

```
VRF: default
```

Prefix Distance/ Age	NextHop	Interface	VRF(egress)	Origin/ Type	Metric
0.0.0.0/0 [110/200]	20.5.1.2 00h:23m:22s	vlan2051	-	O/IA	
20.3.1.0/24 [0/0]	-	vlan2031	-	C	
20.3.1.2/32 [0/0]	-	vlan2031	-	L	
20.4.1.0/24 [110/200]	20.5.1.2 00h:29m:55s	vlan2051	-	O	
20.5.1.0/24 [0/0]	-	vlan2051	-	C	
20.5.1.1/32 [0/0]	-	vlan2051	-	L	
20.6.1.0/24 [110/200]	20.5.1.2 00h:24m:12s	vlan2051	-	O	
101.0.0.0/24 [110/25]	20.5.1.2 00h:28m:22s	vlan2051	-	O/E2	
151.0.0.0/24 [110/200]	20.5.1.2 00h:23m:22s	vlan2051	-	O/IA	
201.0.0.0/24 [110/25]	20.5.1.2 00h:28m:22s	vlan2051	-	O/E2	

```
Total Route Count : 10
```

PE1 Configuration

```
PE1# show run  
Current configuration:  
!  
!Version ArubaOS-CX LL.10.09.0001AX  
!export-password: default  
hostname PE1  
profile core-spine  
logging console severity crit  
vrf spoke_1  
  rd 1:1  
  l3vpn-only  
  address-family ipv4 unicast  
    route-target export 1:1  
    route-target import 1:0  
  exit-address-family
```

```

cli-session
  timeout 0
!
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2001
interface mgmt
  no shutdown
  ip dhcp
interface 1/1/37
  no shutdown
  description Towards CE1
  no routing
  vlan trunk native 1
  vlan trunk allowed 2001
interface 1/1/38
  no shutdown
  mtu 9198
  description Towards P1
  ip address 30.0.1.1/24
  ip ospf 1 area 0.0.0.0
  mpls enable
  mpls ldp enable
interface loopback 0
  ip address 1.1.1.1/32
  ip ospf 1 area 0.0.0.0
interface vlan 2001
  vrf attach spoke_1
  description Towards CE1
  ip address 20.0.1.2/24
!
!
!
!
!
router ospf 1
  area 0.0.0.0
router bgp 6488163
  neighbor 2.2.2.2 remote-as 6488163
  neighbor 2.2.2.2 description Towards PE2-SPOKE2
  neighbor 2.2.2.2 update-source loopback 0
  neighbor 3.3.3.3 remote-as 6488163
  neighbor 3.3.3.3 description Towards PE3-HUB
  neighbor 3.3.3.3 update-source loopback 0
  address-family vpnv4 unicast
    neighbor 2.2.2.2 activate
    neighbor 2.2.2.2 send-community both
    neighbor 3.3.3.3 activate
    neighbor 3.3.3.3 send-community both
  exit-address-family
!
vrf spoke_1
  neighbor 20.0.1.1 remote-as 100
  neighbor 20.0.1.1 description Towards CE1
  address-family ipv4 unicast
    neighbor 20.0.1.1 activate
    neighbor 20.0.1.1 send-community both
    neighbor 20.0.1.1 soft-reconfiguration inbound

```

```

        exit-address-family
    !
    https-server vrf mgmt
    mpls
        enable
        label-protocol ldp
            enable
        router-id loopback0

```

PE1 Verification

```
PE1# show ip ospf neighbors
```

```
VRF : default                               Process : 1
```

```
=====
```

```
Total Number of Neighbors : 1
```

Neighbor ID	Priority	State	Nbr Address	Interface
4.4.4.4	1	FULL/BDR	30.0.1.2	1/1/38

```
PE1# show mpls ldp neighbor
```

```
Local LDP Identifier: 1.1.1.1:0, Peer LDP Identifier: 4.4.4.4:0
```

```
Graceful Restart: No
```

```
Session Holdtime: 40 sec
```

```
Up time: 00:17:58
```

```
State: operational
```

```
LDP Discovery Sources: 1/1/38
```

```
Addresses bound to this peer:
```

```
30.0.1.2 30.0.2.2 30.0.3.1 4.4.4.4
```

```
PE1# show mpls forwarding
```

```
MPLS Bindings
```

```
Entry Bindings : 9
```

```
Exit Bindings : 3
```

```
Transit Bindings : 3
```

```
PHP Mode : Explicit-Null
```

```
QoS Mode : Uniform
```

```
TTL Propagation : Uniform
```

```
Entry Bindings:
```

Origin	Prefix	Ingress VRF	Nexthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	2.2.2.2/32	default	30.0.1.2	17	1/1/38	default	operational
LDP	3.3.3.3/32	default	30.0.1.2	18	1/1/38	default	operational
BGP	0.0.0.0/0	spoke_1	3.3.3.3	19	1/1/38	default	operational
BGP	20.4.1.0/24	spoke_1	3.3.3.3	19	1/1/38	default	operational
BGP	20.5.1.0/24	spoke_1	3.3.3.3	19	1/1/38	default	operational
BGP	20.6.1.0/24	spoke_1	3.3.3.3	19	1/1/38	default	operational
BGP	151.0.0.0/24	spoke_1	3.3.3.3	19	1/1/38	default	operational

```
BGP 201.0.0.0/24 spoke_1 3.3.3.3 19 1/1/38 default operational
```

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
BGP	n/a	imp-null	19	spoke_1	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	NextHop Address	Outgoing Label	Status
LDP	4.4.4.4/32	16	1/1/38	default	30.0.1.2	exp-null	operational
LDP	2.2.2.2/32	17	1/1/38	default	30.0.1.2	17	operational
LDP	3.3.3.3/32	18	1/1/38	default	30.0.1.2	18	operational

PE1# show bgp vpnv4 unicast neighbors

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 2.2.2.2 (Internal)

```
Description          : Towards PE2-SPOKE2
Peer-group           :

Remote Router Id     : 2.2.2.2           Local Router Id    : 1.1.1.1
Remote AS            : 6488163          Local AS           : 6488163
Remote Port          : 179              Local Port         : 39729
State                : Established       Admin Status       : Up
Conn. Established    : 1                 Conn. Dropped      : 0
Passive              : No                Update-Source      : loopback0
Cfg. Hold Time       : 180               Cfg. Keep Alive    : 60
Neg. Hold Time       : 180               Neg. Keep Alive    : 60
Up/Down Time        : 00h:19m:46s       Connect-Retry Time : 120
Local-AS Prepend     : No                Alt. Local-AS     : 0
BFD                  : Disabled
Password             :
Last Err Sent        : No Error
Last SubErr Sent     : No Error
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

Graceful-Restart     : Enabled           Gr. Restart Time   : 120
Gr. Stalepath Time   : 300               Remove Private-AS  : No
TTL                  : 255               Local Cluster-ID   :
Weight               : 0                 Fall-over          : No
Confederation-Peers : No
```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	2	2
Keepalives	22	22

```

Route Refresh          0          0
Total                  25          25

```

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

```

Rt. Reflect. Client : No          Send Community      : both
Allow-AS in         : 0           Advt. Interval      : 30
Max. Prefix         : 300000      Soft Reconfig In    :
NextHop-Self        :             Default-Originate   :
Cfg. Add-Path       :
Neg. Add-Path       :

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability     :

```

BGP Neighbor 3.3.3.3 (Internal)

```

Description         : Towards PE3-HUB
Peer-group          :

Remote Router Id    : 3.3.3.3      Local Router Id     : 1.1.1.1
Remote AS           : 6488163     Local AS            : 6488163
Remote Port         : 43547       Local Port          : 179
State               : Established  Admin Status        : Up
Conn. Established   : 1           Conn. Dropped       : 0
Passive             : No           Update-Source       : loopback0
Cfg. Hold Time      : 180          Cfg. Keep Alive     : 60
Neg. Hold Time      : 180          Neg. Keep Alive     : 60
Up/Down Time        : 00h:19m:18s  Connect-Retry Time : 120
Local-AS Prepend    : No           Alt. Local-AS       : 0
BFD                 : Disabled
Password            :
Last Err Sent       : No Error
Last SubErr Sent    : No Error
Last Err Rcvd      : No Error
Last SubErr Rcvd    : No Error

Graceful-Restart    : Enabled      Gr. Restart Time    : 120
Gr. Stalepath Time : 300          Remove Private-AS  : No
TTL                 : 255          Local Cluster-ID    :
Weight              : 0           Fall-over           : No
Confederation-Peers : No

```

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	2	9
Keepalives	22	18

```

Route Refresh          0          0
Total                  25         28

```

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

```

Address Family : VPNv4 Unicast
-----

```

```

Rt. Reflect. Client : No          Send Community      : both
Allow-AS in         : 0           Advt. Interval      : 30
Max. Prefix         : 300000      Soft Reconfig In    :
Nexthop-Self       :              Default-Originate   :
Cfg. Add-Path       :
Neg. Add-Path       :

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability     :

```

PE1# show bgp vrf spoke_1 ipv4 unicast neighbors

Codes: ^ Inherited from peer-group

VRF : spoke_1

BGP Neighbor 20.0.1.1 (External)

```

Description          : Towards CE1
Peer-group           :

```

Remote Router Id	: 20.7.1.2	Local Router Id	: 20.0.1.2
Remote AS	: 100	Local AS	: 6488163
Remote Port	: 179	Local Port	: 57770
State	: Established	Admin Status	: Up
Conn. Established	: 1	Conn. Dropped	: 0
Passive	: No	Update-Source	:
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Neg. Hold Time	: 180	Neg. Keep Alive	: 60
Up/Down Time	: 00h:21m:38s	Connect-Retry Time	: 120
Local-AS Prepend	: No	Alt. Local-AS	: 0
BFD	: Disabled		
Password	:		
Last Err Sent	: Cease		
Last SubErr Sent	: Administrative Shutdown		
Last Err Rcvd	: No Error		
Last SubErr Rcvd	: No Error		

Graceful-Restart	: Enabled	Gr. Restart Time	: 120
Gr. Stalepath Time	: 300	Remove Private-AS	: No
TTL	: 1	Local Cluster-ID	:
Weight	: 0	Fall-over	: No
Confederation-Peers	: No		

```

Message statistics      Sent      Rcvd

```

```

-----
Open                1          1
Notification        0          0
Updates             9          2
Keepalives          21         25
Route Refresh       0          0
Total               31         28

```

```

Capability
-----
Route Refresh      Yes          Yes
Graceful Restart   Yes          Yes
Add-Path           No           No
Four Octet ASN     Yes          Yes
Address family IPv4 Unicast Yes          Yes
Address family IPv6 Unicast No           No
Address family VPNv4 Unicast No           No
Address family L2VPN EVPN No           No

```

Address Family : IPv4 Unicast

```

-----
Rt. Reflect. Client : No          Send Community      : both
Allow-AS in         : 0          Advt. Interval      : 30
Max. Prefix          : 300000      Soft Reconfig In    : Yes
Nexthop-Self         :          Default-Originate   :
Cfg. Add-Path        :
Neg. Add-Path        : Disable
Routemap In         :
Routemap Out        :
ORF type             : Prefix-list
ORF capability       :

```

PE1# **show bgp vrf spoke_1 ipv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : spoke_1

Local Router-ID 20.0.1.2

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1					
*> 0.0.0.0/0	3.3.3.3	0	100	0	102 ?
*> 20.4.1.0/24	3.3.3.3	0	100	0	102 ?
*> 20.5.1.0/24	3.3.3.3	0	100	0	102 ?
*> 20.6.1.0/24	3.3.3.3	0	100	0	102 ?
*>e 101.0.0.0/24	20.0.1.1	0	100	0	100 i
*> 151.0.0.0/24	3.3.3.3	0	100	0	102 ?
*> 201.0.0.0/24	3.3.3.3	0	100	0	102 ?

Total number of entries 7

PE1# **show bgp all-vrf all summary**

VRF : default

BGP Summary

```

-----
Local AS           : 6488163      BGP Router Identifier : 1.1.1.1
Peers              : 2          Log Neighbor Changes  : No
Cfg. Hold Time     : 180        Cfg. Keep Alive       : 60
Confederation Id   : 0

```

Address-family : IPv4 Unicast

Address-family : IPv6 Unicast

Address-family : VPNv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
2.2.2.2	6488163	37	36	00h:29m:42s		Established Up
3.3.3.3	6488163	40	36	00h:29m:14s		Established Up

Address-family : L2VPN EVPN

VRF : spoke_1

BGP Summary

Local AS	: 6488163	BGP Router Identifier	: 20.0.1.2
Peers	: 1	Log Neighbor Changes	: No
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Confederation Id	: 0		

Address-family : IPv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
20.0.1.1	100	37	40	00h:29m:45s		Established Up

Address-family : IPv6 Unicast

PE1# show ip route all-vrfs

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF
Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

Prefix	Age	Nexthop	Interface	VRF (egress)	Origin/	Type	Metric
1.1.1.1/32	-	-	loopback0	-	L		
[0/0]	-						
2.2.2.2/32		30.0.1.2	1/1/38	-	O		
[110/200]	00h:31m:42s						
3.3.3.3/32		30.0.1.2	1/1/38	-	O		
[110/150]	00h:31m:21s						
4.4.4.4/32		30.0.1.2	1/1/38	-	O		
[110/100]	00h:32m:18s						
30.0.1.0/24		-	1/1/38	-	C		
[0/0]	-						
30.0.1.1/32		-	1/1/38	-	L		

```

[0/0] -
30.0.2.0/24 30.0.1.2 1/1/38 - O
[110/200] 00h:32m:18s
30.0.3.0/24 30.0.1.2 1/1/38 - O
[110/150] 00h:32m:06s

VRF: spoke_1

Prefix          Nexthop          Interface          VRF(egress)  Origin/
Distance/      Age
-----
Type          Metric
-----
0.0.0.0/0      3.3.3.3          1/1/38             default       B/V
[200/0]        00h:23m:22s
20.0.1.0/24    -                 vlan2001           -             C
[0/0]          -
20.0.1.2/32    -                 vlan2001           -             L
[0/0]          -
20.4.1.0/24    3.3.3.3          1/1/38             default       B/V
[200/0]        00h:29m:55s
20.5.1.0/24    3.3.3.3          1/1/38             default       B/V
[200/0]        00h:30m:37s
20.6.1.0/24    3.3.3.3          1/1/38             default       B/V
[200/0]        00h:24m:12s
101.0.0.0/24   20.0.1.1         vlan2001           -             B/E
[20/0]         00h:28m:23s
151.0.0.0/24   3.3.3.3          1/1/38             default       B/V
[200/0]        00h:23m:22s
201.0.0.0/24   3.3.3.3          1/1/38             default       B/V
[200/0]        00h:28m:22s

Total Route Count : 17

```

PE2 Configuration

```

PE2# show running-config
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001AX
!export-password: default
hostname PE2
profile core-spine
logging console severity crit
vrf spoke_2
  rd 1:1
  l3vpn-only
  address-family ipv4 unicast
    route-target export 1:1
    route-target import 1:0
  exit-address-family
cli-session
  timeout 0
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2011

```

```

interface mgmt
  no shutdown
  ip dhcp
interface 1/1/43
  no shutdown
  description Towards CE1
  no routing
  vlan trunk native 1
  vlan trunk allowed 2011
interface 1/1/44
  no shutdown
  mtu 9198
  description Towards P1
  ip address 30.0.2.1/24
  ip ospf 1 area 0.0.0.0
  mpls enable
  mpls ldp enable
interface loopback 0
  ip address 2.2.2.2/32
  ip ospf 1 area 0.0.0.0
interface vlan 2011
  vrf attach spoke_2
  description Towards CE1
  ip address 20.1.1.2/24
!
!
!
!
!
router ospf 1
  area 0.0.0.0
router bgp 6488163
  neighbor 1.1.1.1 remote-as 6488163
  neighbor 1.1.1.1 description Towards PE1-SPOKE1
  neighbor 1.1.1.1 update-source loopback 0
  neighbor 3.3.3.3 remote-as 6488163
  neighbor 3.3.3.3 description Towards PE3-HUB
  neighbor 3.3.3.3 update-source loopback 0
  address-family vpnv4 unicast
    neighbor 1.1.1.1 activate
    neighbor 1.1.1.1 send-community both
    neighbor 3.3.3.3 activate
    neighbor 3.3.3.3 send-community both
  exit-address-family
!
  vrf spoke_2
    neighbor 20.1.1.1 remote-as 101
    neighbor 20.1.1.1 description Towards CE2
    address-family ipv4 unicast
      neighbor 20.1.1.1 activate
      neighbor 20.1.1.1 send-community both
      neighbor 20.1.1.1 soft-reconfiguration inbound
    exit-address-family
!
https-server vrf mgmt
mpls
  enable
  label-protocol ldp
  enable
  router-id loopback0

PE2# show ip ospf neighbors

```

```
VRF : default                               Process : 1
```

```
=====
```

```
Total Number of Neighbors : 1
```

Neighbor ID	Priority	State	Nbr Address	Interface
4.4.4.4	1	FULL/DR	30.0.2.2	1/1/44

PE2 Verification

```
PE2# show mpls ldp neighbor
```

```
Local LDP Identifier: 2.2.2.2:0, Peer LDP Identifier: 4.4.4.4:0
```

```
Graceful Restart: No
```

```
Session Holdtime: 40 sec
```

```
Up time: 00:17:57
```

```
State: operational
```

```
LDP Discovery Sources: 1/1/44
```

```
Addresses bound to this peer:
```

```
30.0.1.2 30.0.2.2 30.0.3.1 4.4.4.4
```

```
PE2# show mpls forwarding
```

```
MPLS Bindings
```

```
Entry Bindings : 9
```

```
Exit Bindings : 3
```

```
Transit Bindings : 3
```

```
PHP Mode : Explicit-Null
```

```
QoS Mode : Uniform
```

```
TTL Propagation : Uniform
```

```
Entry Bindings:
```

Origin	Prefix	Ingress VRF	Nexthop Address	Outgoing Label	Egress Interface	Egress VRF	Status
LDP	1.1.1.1/32	default	30.0.2.2	16	1/1/44	default	operational
LDP	3.3.3.3/32	default	30.0.2.2	18	1/1/44	default	operational
BGP	0.0.0.0/0	spoke_2	3.3.3.3	19	1/1/44	default	operational
BGP	20.4.1.0/24	spoke_2	3.3.3.3	19	1/1/44	default	operational
BGP	20.5.1.0/24	spoke_2	3.3.3.3	19	1/1/44	default	operational
BGP	20.6.1.0/24	spoke_2	3.3.3.3	19	1/1/44	default	operational
BGP	101.0.0.0/24	spoke_2	3.3.3.3	19	1/1/44	default	operational
BGP	151.0.0.0/24	spoke_2	3.3.3.3	19	1/1/44	default	operational

```
Exit Bindings:
```

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
BGP	n/a	imp-null	19	spoke_2	operational

```
static n/a 7 - default operational
```

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	Nexthop Address	Outgoing Label	Status
LDP	1.1.1.1/32	16	1/1/44	default	30.0.2.2	16	operational
LDP	4.4.4.4/32	17	1/1/44	default	30.0.2.2	exp-null	operational
LDP	3.3.3.3/32	18	1/1/44	default	30.0.2.2	18	operational

PE2# **show bgp vpnv4 unicast neighbors**

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 1.1.1.1 (Internal)

Description : Towards PE1-SPOKE1
Peer-group :

Remote Router Id	: 1.1.1.1	Local Router Id	: 2.2.2.2
Remote AS	: 6488163	Local AS	: 6488163
Remote Port	: 39729	Local Port	: 179
State	: Established	Admin Status	: Up
Conn. Established	: 1	Conn. Dropped	: 0
Passive	: No	Update-Source	: loopback0
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Neg. Hold Time	: 180	Neg. Keep Alive	: 60
Up/Down Time	: 00h:19m:46s	Connect-Retry Time	: 120
Local-AS Prepend	: No	Alt. Local-AS	: 0
BFD	: Disabled		
Password	:		
Last Err Sent	: No Error		
Last SubErr Sent	: No Error		
Last Err Rcvd	: No Error		
Last SubErr Rcvd	: No Error		
Graceful-Restart	: Enabled	Gr. Restart Time	: 120
Gr. Stalepath Time	: 300	Remove Private-AS	: No
TTL	: 255	Local Cluster-ID	:
Weight	: 0	Fall-over	: No
Confederation-Peers	: No		

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	2	2
Keepalives	22	22
Route Refresh	0	0
Total	25	25

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No

```

Address family IPv6 Unicast      No          No
Address family VPNv4 Unicast    Yes         Yes
Address family L2VPN EVPN       No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : No          Send Community   : both
Allow-AS in        : 0           Advt. Interval   : 30
Max. Prefix        : 300000      Soft Reconfig In :
Nexthop-Self      :              Default-Originate:
Cfg. Add-Path     :
Neg. Add-Path     :

Routemap In       :
Routemap Out      :
ORF type          : Prefix-list
ORF capability    :

```

BGP Neighbor 3.3.3.3 (Internal)

```

Description       : Towards PE3-HUB
Peer-group        :

```

```

Remote Router Id  : 3.3.3.3      Local Router Id   : 2.2.2.2
Remote AS         : 6488163     Local AS          : 6488163
Remote Port      : 179          Local Port        : 38293
State            : Established   Admin Status      : Up
Conn. Established : 1           Conn. Dropped    : 0
Passive          : No           Update-Source     : loopback0
Cfg. Hold Time   : 180          Cfg. Keep Alive  : 60
Neg. Hold Time   : 180          Neg. Keep Alive   : 60
Up/Down Time     : 00h:19m:28s  Connect-Retry Time : 120
Local-AS Prepend : No           Alt. Local-AS    : 0
BFD              : Disabled
Password         :
Last Err Sent    : No Error
Last SubErr Sent : No Error
Last Err Rcvd   : No Error
Last SubErr Rcvd : No Error

Graceful-Restart : Enabled       Gr. Restart Time : 120
Gr. Stalepath Time : 300       Remove Private-AS : No
TTL                : 255       Local Cluster-ID  :
Weight             : 0         Fall-over         : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                    1          1
Notification            0          0
Updates                 2          9
Keepalives              22         17
Route Refresh           0          0
Total                   25         27

```

```

Capability              Advertised  Received
-----
Route Refresh           Yes         Yes
Graceful Restart       Yes         Yes
Add-Path                No          No
Four Octet ASN         Yes         Yes
Address family IPv4 Unicast No          No

```

```

Address family IPv6 Unicast      No          No
Address family VPNv4 Unicast    Yes         Yes
Address family L2VPN EVPN       No          No

```

Address Family : VPNv4 Unicast

```

-----
Rt. Reflect. Client : No          Send Community      : both
Allow-AS in         : 0          Advt. Interval     : 30
Max. Prefix         : 300000     Soft Reconfig In   :
NextHop-Self        :           Default-Originate   :
Cfg. Add-Path       :
Neg. Add-Path       :

Routemap In         :
Routemap Out        :
ORF type            : Prefix-list
ORF capability      :

```

PE2# **show bgp vrf spoke_2 ipv4 unicast neighbors**

Codes: ^ Inherited from peer-group

VRF : spoke_2

BGP Neighbor 20.1.1.1 (External)

```

Description          : Towards CE2
Peer-group           :

Remote Router Id     : 20.8.1.2          Local Router Id     : 20.1.1.2
Remote AS            : 101              Local AS             : 6488163
Remote Port          : 179              Local Port           : 60400
State                : Established      Admin Status        : Up
Conn. Established    : 1                Conn. Dropped       : 0
Passive              : No                Update-Source       :
Cfg. Hold Time       : 180              Cfg. Keep Alive    : 60
Neg. Hold Time       : 180              Neg. Keep Alive     : 60
Up/Down Time         : 00h:21m:33s      Connect-Retry Time : 120
Local-AS Prepend     : No                Alt. Local-AS      : 0
BFD                  : Disabled
Password             :
Last Err Sent        : Cease
Last SubErr Sent     : Administrative Shutdown
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

Graceful-Restart     : Enabled          Gr. Restart Time    : 120
Gr. Stalepath Time   : 300              Remove Private-AS   : No
TTL                  : 1                Local Cluster-ID    :
Weight               : 0                Fall-over           : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1          1
Notification           0          0
Updates                9          2
Keepalives             20         24
Route Refresh          0          0
Total                  30         27

```

```

Capability              Advertised      Received
-----

```

```

Route Refresh                Yes                Yes
Graceful Restart             Yes                Yes
Add-Path                     No                 No
Four Octet ASN               Yes                Yes
Address family IPv4 Unicast  Yes                Yes
Address family IPv6 Unicast  No                 No
Address family VPNv4 Unicast No                 No
Address family L2VPN EVPN    No                 No

```

Address Family : IPv4 Unicast

```

Rt. Reflect. Client : No           Send Community      : both
Allow-AS in         : 0           Advt. Interval     : 30
Max. Prefix         : 300000       Soft Reconfig In   : Yes
Nexthop-Self        :              Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In          :
Routemap Out         :
ORF type             : Prefix-list
ORF capability       :

```

PE2# **show bgp vrf spoke_2 ipv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : spoke_2

Local Router-ID 20.1.1.2

Network	Nexthop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:1					
*> 0.0.0.0/0	3.3.3.3	0	100	0	102 ?
*> 20.4.1.0/24	3.3.3.3	0	100	0	102 ?
*> 20.5.1.0/24	3.3.3.3	0	100	0	102 ?
*> 20.6.1.0/24	3.3.3.3	0	100	0	102 ?
*> 101.0.0.0/24	3.3.3.3	0	100	0	102 ?
*> 151.0.0.0/24	3.3.3.3	0	100	0	102 ?
*>e 201.0.0.0/24	20.1.1.1	0	100	0	101 i

Total number of entries 7

PE2# **show bgp all-vrf all summary**

VRF : default

BGP Summary

```

-----
Local AS                : 6488163      BGP Router Identifier : 2.2.2.2
Peers                   : 2           Log Neighbor Changes  : No
Cfg. Hold Time         : 180         Cfg. Keep Alive       : 60
Confederation Id       : 0

```

Address-family : IPv4 Unicast

Address-family : IPv6 Unicast

Address-family : VPNv4 Unicast

```

-----
Neighbor      Remote-AS  MsgRcvd  MsgSent  Up/Down  Time  State
AdminStatus

```

```

1.1.1.1          6488163      36      37      00h:29m:42s  Established  Up
3.3.3.3          6488163      39      37      00h:29m:24s  Established  Up

```

Address-family : L2VPN EVPN

VRF : spoke_2

BGP Summary

```

Local AS           : 6488163      BGP Router Identifier : 20.1.1.2
Peers              : 1           Log Neighbor Changes  : No
Cfg. Hold Time    : 180         Cfg. Keep Alive       : 60
Confederation Id  : 0

```

Address-family : IPv4 Unicast

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
20.1.1.1	101	36	39	00h:29m:27s		Established Up

Address-family : IPv6 Unicast

PE2# **show ip route all-vrfs**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

Prefix	Age	Nexthop	Interface	VRF(egress)	Origin/	Type	Metric
1.1.1.1/32		30.0.2.2	1/1/44	-	O		
[110/200]	00h:31m:42s						
2.2.2.2/32		-	loopback0	-	L		
[0/0]	-						
3.3.3.3/32		30.0.2.2	1/1/44	-	O		
[110/150]	00h:31m:21s						
4.4.4.4/32		30.0.2.2	1/1/44	-	O		
[110/100]	00h:31m:42s						
30.0.1.0/24		30.0.2.2	1/1/44	-	O		
[110/200]	00h:31m:42s						
30.0.2.0/24		-	1/1/44	-	C		
[0/0]	-						
30.0.2.1/32		-	1/1/44	-	L		
[0/0]	-						
30.0.3.0/24		30.0.2.2	1/1/44	-	O		
[110/150]	00h:31m:42s						

VRF: spoke_2

Prefix	Age	Nexthop	Interface	VRF(egress)	Origin/	Type	Metric
Distance/							

```

-----
-----
0.0.0.0/0          3.3.3.3          1/1/44          default          B/V
[200/0]          00h:23m:22s
20.1.1.0/24       -                vlan2011        -                C
[0/0]           -
20.1.1.2/32       -                vlan2011        -                L
[0/0]           -
20.4.1.0/24       3.3.3.3          1/1/44          default          B/V
[200/0]          00h:29m:55s
20.5.1.0/24       3.3.3.3          1/1/44          default          B/V
[200/0]          00h:30m:37s
20.6.1.0/24       3.3.3.3          1/1/44          default          B/V
[200/0]          00h:24m:12s
101.0.0.0/24     3.3.3.3          1/1/44          default          B/V
[200/0]          00h:28m:22s
151.0.0.0/24     3.3.3.3          1/1/44          default          B/V
[200/0]          00h:23m:22s
201.0.0.0/24     20.1.1.1         vlan2011        -                B/E
[20/0]          00h:28m:22s

Total Route Count : 17

```

PE3 Configuration

```

PE3# show running-config
Current configuration:
!
!Version ArubaOS-CX LL.10.09.0001AX
!export-password: default
hostname PE3
profile core-spine
logging console severity crit
vrf hub_export
  rd 1:0
  l3vpn-only
  address-family ipv4 unicast
    route-target export 1:0
  exit-address-family
vrf hub_import
  rd 0:1
  l3vpn-only
  address-family ipv4 unicast
    route-target import 1:1
  exit-address-family
cli-session
  timeout 0
!
!
!
!
!
!
ssh server vrf mgmt
vlan 1,2021,2031
interface mgmt
  no shutdown
  ip dhcp
system interface-group 1 speed 10g
  !interface group 1 contains ports 1/1/1-1/1/4
interface lag 99

```

```

    no shutdown
    description Towards P1
    ip address 30.0.3.2/24
    lacp mode active
    ip ospf 1 area 0.0.0.0
    mpls enable
    mpls ldp enable
interface 1/1/31
    no shutdown
    mtu 9198
    description Towards P1 LAG 99
    lag 99
interface 1/1/32
    no shutdown
    mtu 9198
    description Towards P1 LAG 99
    lag 99
interface 1/1/33
    no shutdown
    description Towards CE3
    no routing
    vlan trunk native 1
    vlan trunk allowed 2021
interface 1/1/34
    no shutdown
    description Towards CE4
    no routing
    vlan trunk native 1
    vlan trunk allowed 2031
interface loopback 0
    ip address 3.3.3.3/32
    ip ospf 1 area 0.0.0.0
interface vlan 2021
    vrf attach hub_import
    description Towards CE3
    ip address 20.2.1.1/24
interface vlan 2031
    vrf attach hub_export
    description Towards CE4
    ip address 20.3.1.1/24
!
!
!
!
!
router ospf 1
    area 0.0.0.0
router bgp 6488163
    neighbor 1.1.1.1 remote-as 6488163
    neighbor 1.1.1.1 description Towards PE1-SPOKE1
    neighbor 1.1.1.1 update-source loopback 0
    neighbor 2.2.2.2 remote-as 6488163
    neighbor 2.2.2.2 description Towards PE2-SPOKE2
    neighbor 2.2.2.2 update-source loopback 0
    address-family vpnv4 unicast
        neighbor 1.1.1.1 activate
        neighbor 1.1.1.1 send-community both
        neighbor 2.2.2.2 activate
        neighbor 2.2.2.2 send-community both
    exit-address-family
!
    vrf hub_export

```

```

neighbor 20.3.1.2 remote-as 102
neighbor 20.3.1.2 description Towards CE3
address-family ipv4 unicast
    neighbor 20.3.1.2 activate
    neighbor 20.3.1.2 send-community both
    neighbor 20.3.1.2 soft-reconfiguration inbound
exit-address-family
!
vrf hub_import
neighbor 20.2.1.2 remote-as 102
neighbor 20.2.1.2 description Towards CE4
address-family ipv4 unicast
    neighbor 20.2.1.2 activate
    neighbor 20.2.1.2 send-community both
    neighbor 20.2.1.2 soft-reconfiguration inbound
exit-address-family
!
https-server vrf mgmt
mpls
    enable
    label-protocol ldp
        enable
        router-id loopback0

```

```
PE3# show ip ospf neighbors
```

```
VRF : default                               Process : 1
```

```
=====
```

```
Total Number of Neighbors : 1
```

Neighbor ID	Priority	State	Nbr Address	Interface
4.4.4.4	1	FULL/DR	30.0.3.1	lag99

PE3 Verification

```
PE3# show mpls ldp neighbor
```

```
Local LDP Identifier: 3.3.3.3:0, Peer LDP Identifier: 4.4.4.4:0
```

```
Graceful Restart: No
```

```
Session Holdtime: 40 sec
```

```
Up time: 00:17:21
```

```
State: operational
```

```
LDP Discovery Sources: lag99
```

```
Addresses bound to this peer:
```

```
30.0.1.2 30.0.2.2 30.0.3.1 4.4.4.4
```

```
PE3# show mpls forwarding
```

```
MPLS Bindings
```

```
Entry Bindings : 5
```

```
Exit Bindings : 3
```

```
Transit Bindings : 3
```

```
PHP Mode : Explicit-Null
```

```
QoS Mode : Uniform
```

```
TTL Propagation : Uniform
```

```
Entry Bindings:
```

Origin Prefix	Ingress	Nexthop	Outgoing	Egress	Egress	Status
---------------	---------	---------	----------	--------	--------	--------

		VRF	Address	Label	Interface	VRF	
LDP	1.1.1.1/32	default	30.0.3.1	16	lag99	default	operational
LDP	2.2.2.2/32	default	30.0.3.1	17	lag99	default	operational
LDP	4.4.4.4/32	default	30.0.3.1	exp-null	lag99	default	operational
BGP	101.0.0.0/24	hub_import	1.1.1.1	19	lag99	default	operational
BGP	201.0.0.0/24	hub_import	2.2.2.2	19	lag99	default	operational

Exit Bindings:

Origin	Prefix	Incoming Label	Service Label	Egress VRF	Status
static	n/a	exp-null	-	default	operational
BGP	n/a	imp-null	19	hub_export	operational
static	n/a	7	-	default	operational

Transit Bindings:

Origin	Prefix	Incoming Label	Egress Interface	Egress VRF	NextHop Address	Outgoing Label	Status
LDP	1.1.1.1/32	16	lag99	default	30.0.3.1	16	operational
LDP	2.2.2.2/32	17	lag99	default	30.0.3.1	17	operational
LDP	4.4.4.4/32	18	lag99	default	30.0.3.1	exp-null	operational

PE3# show bgp vpnv4 unicast neighbors

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 1.1.1.1 (Internal)

```

Description          : Towards PE1-SPOKE1
Peer-group           :

Remote Router Id     : 1.1.1.1                Local Router Id    : 3.3.3.3
Remote AS            : 6488163                Local AS           : 6488163
Remote Port          : 179                    Local Port         : 43547
State                : Established            Admin Status       : Up
Conn. Established    : 1                      Conn. Dropped      : 0
Passive              : No                     Update-Source      : loopback0
Cfg. Hold Time       : 180                    Cfg. Keep Alive    : 60
Neg. Hold Time       : 180                    Neg. Keep Alive    : 60
Up/Down Time        : 00h:19m:18s            Connect-Retry Time : 120
Local-AS Prepend    : No                      Alt. Local-AS      : 0
BFD                  : Disabled
Password             :
Last Err Sent        : No Error
Last SubErr Sent     : No Error
Last Err Rcvd        : No Error
Last SubErr Rcvd     : No Error

Graceful-Restart     : Enabled                Gr. Restart Time   : 120
Gr. Stalepath Time   : 300                    Remove Private-AS  : No
TTL                  : 255                    Local Cluster-ID   :
Weight               : 0                      Fall-over           : No

```

Confederation-Peers : No

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	9	2
Keepalives	18	22
Route Refresh	0	0
Total	28	25

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

Rt. Reflect. Client	: No	Send Community	: both
Allow-AS in	: 0	Advt. Interval	: 30
Max. Prefix	: 300000	Soft Reconfig In	:
Nexthop-Self	:	Default-Originate	:
Cfg. Add-Path	:		
Neg. Add-Path	:		

Routemap In	:
Routemap Out	:
ORF type	: Prefix-list
ORF capability	:

BGP Neighbor 2.2.2.2 (Internal)

Description	: Towards PE2-SPOKE2
Peer-group	:

Remote Router Id	: 2.2.2.2	Local Router Id	: 3.3.3.3
Remote AS	: 6488163	Local AS	: 6488163
Remote Port	: 38293	Local Port	: 179
State	: Established	Admin Status	: Up
Conn. Established	: 1	Conn. Dropped	: 0
Passive	: No	Update-Source	: loopback0
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Neg. Hold Time	: 180	Neg. Keep Alive	: 60
Up/Down Time	: 00h:19m:28s	Connect-Retry Time	: 120
Local-AS Prepend	: No	Alt. Local-AS	: 0
BFD	: Disabled		
Password	:		
Last Err Sent	: No Error		
Last SubErr Sent	: No Error		
Last Err Rcvd	: No Error		
Last SubErr Rcvd	: No Error		

Graceful-Restart	: Enabled	Gr. Restart Time	: 120
Gr. Stalepath Time	: 300	Remove Private-AS	: No
TTL	: 255	Local Cluster-ID	:
Weight	: 0	Fall-over	: No

Confederation-Peers : No

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	9	2
Keepalives	17	22
Route Refresh	0	0
Total	27	25

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

Rt. Reflect. Client	: No	Send Community	: both
Allow-AS in	: 0	Advt. Interval	: 30
Max. Prefix	: 300000	Soft Reconfig In	:
Nexthop-Self	:	Default-Originate	:
Cfg. Add-Path	:		
Neg. Add-Path	:		
Routemap In	:		
Routemap Out	:		
ORF type	: Prefix-list		
ORF capability	:		

PE3# **show bgp vrf hub_import ipv4 unicast neighbors**

Codes: ^ Inherited from peer-group

VRF : hub_import

BGP Neighbor 20.2.1.2 (External)

Description : Towards CE4
Peer-group :

Remote Router Id	: 20.4.1.1	Local Router Id	: 20.2.1.1
Remote AS	: 102	Local AS	: 6488163
Remote Port	: 48554	Local Port	: 179
State	: Established	Admin Status	: Up
Conn. Established	: 1	Conn. Dropped	: 0
Passive	: No	Update-Source	:
Cfg. Hold Time	: 180	Cfg. Keep Alive	: 60
Neg. Hold Time	: 180	Neg. Keep Alive	: 60
Up/Down Time	: 00h:22m:06s	Connect-Retry Time	: 120
Local-AS Prepend	: No	Alt. Local-AS	: 0
BFD	: Disabled		
Password	:		
Last Err Sent	: Cease		
Last SubErr Sent	: Administrative Shutdown		
Last Err Rcvd	: No Error		
Last SubErr Rcvd	: No Error		

```

Graceful-Restart      : Enabled                Gr. Restart Time   : 120
Gr. Stalepath Time   : 300                    Remove Private-AS  : No
TTL                  : 1                      Local Cluster-ID   :
Weight               : 0                      Fall-over          : No
Confederation-Peers  : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1         1
Notification           0         0
Updates                3         8
Keepalives             26        22
Route Refresh          0         0
Total                  30        31

```

```

Capability                Advertised      Received
-----
Route Refresh              Yes             Yes
Graceful Restart          Yes             Yes
Add-Path                   No              No
Four Octet ASN             Yes             Yes
Address family IPv4 Unicast Yes             Yes
Address family IPv6 Unicast No              No
Address family VPNv4 Unicast No              No
Address family L2VPN EVPN  No              No

```

Address Family : IPv4 Unicast

```

Rt. Reflect. Client : No                Send Community     : both
Allow-AS in         : 0                  Advt. Interval     : 30
Max. Prefix         : 300000              Soft Reconfig In   : Yes
Nexthop-Self        :                    Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In         :
Routemap Out        :
ORF type             : Prefix-list
ORF capability       :

```

PE3# **show bgp vrf hub_export ipv4 unicast neighbors**

Codes: ^ Inherited from peer-group

VRF : hub_export

BGP Neighbor 20.3.1.2 (External)

```

Description          : Towards CE3
Peer-group           :

```

```

Remote Router Id     : 20.5.1.1                Local Router Id    : 20.3.1.1
Remote AS            : 102                    Local AS           : 6488163
Remote Port          : 179                    Local Port         : 52062
State                : Established              Admin Status       : Up
Conn. Established    : 1                      Conn. Dropped      : 0
Passive              : No                     Update-Source      :
Cfg. Hold Time       : 180                    Cfg. Keep Alive    : 60
Neg. Hold Time       : 180                    Neg. Keep Alive    : 60
Up/Down Time         : 00h:21m:56s              Connect-Retry Time : 120
Local-AS Prepend     : No                     Alt. Local-AS      : 0
BFD                  : Disabled

```

```

Password          :
Last Err Sent     : Cease
Last SubErr Sent  : Administrative Shutdown
Last Err Rcvd    : No Error
Last SubErr Rcvd  : No Error

Graceful-Restart   : Enabled           Gr. Restart Time   : 120
Gr. Stalepath Time : 300                 Remove Private-AS  : No
TTL               : 1                   Local Cluster-ID   :
Weight            : 0                   Fall-over          : No
Confederation-Peers : No

```

```

Message statistics      Sent      Rcvd
-----
Open                   1         1
Notification           0         0
Updates                1         9
Keepalives             25        21
Route Refresh          0         0
Total                  27        31

```

```

Capability          Advertised      Received
-----
Route Refresh       Yes            Yes
Graceful Restart    Yes            Yes
Add-Path            No            No
Four Octet ASN      Yes            Yes
Address family IPv4 Unicast Yes            Yes
Address family IPv6 Unicast No             No
Address family VPNv4 Unicast No             No
Address family L2VPN EVPN No             No

```

```

Address Family : IPv4 Unicast
-----

```

```

Rt. Reflect. Client : No           Send Community     : both
Allow-AS in         : 0           Advt. Interval     : 30
Max. Prefix         : 300000       Soft Reconfig In   : Yes
NextHop-Self        :              Default-Originate  :
Cfg. Add-Path       :
Neg. Add-Path       : Disable

```

```

Routemap In        :
Routemap Out       :
ORF type           : Prefix-list
ORF capability      :

```

PE3# **show bgp vrf hub_import ipv4 unicast**

Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

```

VRF : hub_import
Local Router-ID 20.2.1.1

```

```

Network           Nexthop           Metric      LocPrf      Weight Path
Route Distinguisher: 0:1
*>e 0.0.0.0/0      20.2.1.2         0           100         0         102 ?
*>e 20.4.1.0/24    20.2.1.2         0           100         0         102 ?
*>e 20.5.1.0/24    20.2.1.2         0           100         0         102 ?
*>e 20.6.1.0/24    20.2.1.2         0           100         0         102 ?

```

```
*> 101.0.0.0/24      1.1.1.1      0      100      0      100 i
*>e 151.0.0.0/24    20.2.1.2     0      100      0      102 ?
*> 201.0.0.0/24    2.2.2.2     0      100      0      101 i
Total number of entries 7
```

```
PE3# show bgp vrf hub_export ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
VRF : hub_export
Local Router-ID 20.3.1.1
```

Network	NextHop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1:0					
*>e 0.0.0.0/0	20.3.1.2	0	100	0	102 ?
*>e 20.4.1.0/24	20.3.1.2	0	100	0	102 ?
*>e 20.5.1.0/24	20.3.1.2	0	100	0	102 ?
*>e 20.6.1.0/24	20.3.1.2	0	100	0	102 ?
*>e 101.0.0.0/24	20.3.1.2	0	100	0	102 ?
*>e 151.0.0.0/24	20.3.1.2	0	100	0	102 ?
*>e 201.0.0.0/24	20.3.1.2	0	100	0	102 ?

Total number of entries 7

```
PE3# show bgp all-vrf all summary
```

```
VRF : default
```

```
BGP Summary
```

```
-----
Local AS           : 6488163      BGP Router Identifier : 3.3.3.3
Peers              : 2           Log Neighbor Changes  : No
Cfg. Hold Time    : 180         Cfg. Keep Alive       : 60
Confederation Id  : 0
```

```
Address-family : IPv4 Unicast
```

```
Address-family : IPv6 Unicast
```

```
Address-family : VPNv4 Unicast
```

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						
1.1.1.1	6488163	36	40	00h:29m:14s		Established Up
2.2.2.2	6488163	37	39	00h:29m:24s		Established Up

```
Address-family : L2VPN EVPN
```

```
VRF : hub_export
```

```
BGP Summary
```

```
-----
Local AS           : 6488163      BGP Router Identifier : 20.3.1.1
Peers              : 1           Log Neighbor Changes  : No
Cfg. Hold Time    : 180         Cfg. Keep Alive       : 60
Confederation Id  : 0
```

```
Address-family : IPv4 Unicast
```

Neighbor	Remote-AS	MsgRcvd	MsgSent	Up/Down	Time	State
AdminStatus						

20.3.1.2 102 39 35 00h:28m:48s Established Up

Address-family : IPv6 Unicast

VRF : hub_import
BGP Summary

Local AS : 6488163 BGP Router Identifier : 20.2.1.1
Peers : 1 Log Neighbor Changes : No
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Confederation Id : 0

Address-family : IPv4 Unicast

Neighbor Remote-AS MsgRcvd MsgSent Up/Down Time State
AdminStatus
20.2.1.2 102 39 38 00h:29m:07s Established Up

Address-family : IPv6 Unicast

PE3# **show ip route all-vrfs**

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
R - RIP, B - BGP, O - OSPF

Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
IA - OSPF internal area, E1 - OSPF external type 1
E2 - OSPF external type 2

VRF: default

Prefix Distance/ Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric
1.1.1.1/32 [110/150] 00h:31m:22s	30.0.3.1	lag99	-	O	
2.2.2.2/32 [110/150] 00h:31m:22s	30.0.3.1	lag99	-	O	
3.3.3.3/32 [0/0]	-	loopback0	-	L	
4.4.4.4/32 [110/50] 00h:31m:22s	30.0.3.1	lag99	-	O	
30.0.1.0/24 [110/150] 00h:31m:22s	30.0.3.1	lag99	-	O	
30.0.2.0/24 [110/150] 00h:31m:22s	30.0.3.1	lag99	-	O	
30.0.3.0/24 [0/0]	-	lag99	-	C	
30.0.3.2/32 [0/0]	-	lag99	-	L	

VRF: hub_export

Prefix Distance/ Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric
----------------------------	---------	-----------	-------------	-----------------	--------

```

-----
0.0.0.0/0          20.3.1.2          vlan2031          -          B/E
[20/0]            00h:23m:22s
20.3.1.0/24       -                  vlan2031          -          C
[0/0]             -
20.3.1.1/32       -                  vlan2031          -          L
[0/0]             -
20.4.1.0/24       20.3.1.2          vlan2031          -          B/E
[20/0]            00h:29m:55s
20.5.1.0/24       20.3.1.2          vlan2031          -          B/E
[20/0]            00h:30m:37s
20.6.1.0/24       20.3.1.2          vlan2031          -          B/E
[20/0]            00h:24m:12s
101.0.0.0/24      20.3.1.2          vlan2031          -          B/E
[20/0]            00h:28m:22s
151.0.0.0/24      20.3.1.2          vlan2031          -          B/E
[20/0]            00h:23m:22s
201.0.0.0/24      20.3.1.2          vlan2031          -          B/E
[20/0]            00h:28m:22s

```

VRF: hub_import

Prefix Distance/	Age	Nexthop	Interface	VRF (egress)	Origin/ Type	Metric
0.0.0.0/0		20.2.1.2	vlan2021	-	B/E	
[20/0]	00h:23m:22s					
20.2.1.0/24		-	vlan2021	-	C	
[0/0]	-					
20.2.1.1/32		-	vlan2021	-	L	
[0/0]	-					
20.4.1.0/24		20.2.1.2	vlan2021	-	B/E	
[20/0]	00h:30m:57s					
20.5.1.0/24		20.2.1.2	vlan2021	-	B/E	
[20/0]	00h:29m:55s					
20.6.1.0/24		20.2.1.2	vlan2021	-	B/E	
[20/0]	00h:24m:12s					
101.0.0.0/24		1.1.1.1	lag99	default	B/V	
[200/0]	00h:28m:23s					
151.0.0.0/24		20.2.1.2	vlan2021	-	B/E	
[20/0]	00h:23m:22s					
201.0.0.0/24		2.2.2.2	lag99	default	B/V	
[200/0]	00h:28m:23s					

Total Route Count : 26

bind ipv4 (lsp label imposition)

```
bind ipv4 {<IP-ADDR>/<MASK> | <IP-ADDR> <MASK>} output <IFNAME> <IP-ADDR> <OUT-LABEL>  
no bind ipv4 {<IP-ADDR>/<MASK> | <IP-ADDR><MASK>} output <IFNAME><IP-ADDR><OUT-LABEL>
```

Description

Performs LSP label imposition by adding label to an ingress packet (push operation).
The **no** form of this command removes the ingress packet label.

Parameter	Description
<code>ipv4 <IP-ADDR>/<MASK></code>	Specifies the IPv4 destination in x.x.x.x format, where x is a decimal value from 0 to 255 and the number of bits in an IPv4 address mask in CIDR format (x), where x is a decimal number from 0 to 32.
<code>ipv4 <IP-ADDR> <MASK></code>	Specifies the IPv4 destination in x.x.x.x format, where x is a decimal value from 0 to 255 and the destination IP subnet mask in x.x.x.x format, where x is a decimal value from 0 to 255.
<code><IFNAME></code>	Specifies the egress interface of the binding.
<code><IP-ADDR></code>	Specifies the next hop IP address of the binding.
<code><OUT-LABEL></code>	Specifies the MPLS label to apply. Range: 16-1048575.

Usage

- The **no** form of both the **mpls** and **static-lsp** commands deletes all static LSP bindings.
- The static LSP label range must be allocated before configuring static LSP bindings.
- Specifying an outgoing label outside the range of 16-1048575 is not allowed. An outgoing label is not bound by allocated static LSP label range.
- Types of valid egress interfaces are: System, LAG, VLAN, and Tunnel.
 - Routing must be enabled for egress interfaces.
 - Interfaces must be configured before performing the bind command.
 - LAG member interfaces are not allowed as egress interfaces.

Examples

Configuring binding:

```
switch(config-mpls-static-lsp)# bind ipv4 2.2.2.0/24 output 1/1/1 20.0.0.2 20
```

Unconfiguring binding:

```
switch(config-mpls-static-lsp)# no bind ipv4 2.2.2.0/24 output 1/1/1 20.0.0.2 20
```

Configuring binding with an invalid egress interface:

```
switch(config-mpls-static-lsp)# bind ipv4 2.2.2.0/24 output 1/1/1 20.0.0.2 20
The output must be a layer 3 interface with routing enabled.
```

Configuring binding with an interface that does not have an IP address assigned:

```
switch(config-mpls-static-lsp)# bind ipv4 2.2.2.0/24 output 1/1/1 20.0.0.2 20
The egress interface must have an IP address assigned.
```

Configuring binding with a next hop IP that is not in the same subnet as egress interface:

```
switch(config-if)# interface 1/1/1
switch(config-if)# no shutdown
switch(config-if)# ip address 10.0.0.1/24
switch(config-if)# mpls enable
switch(config-if)# mpls
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# bind ipv4 2.2.2.0/24 output 1/1/1 60.0.0.20 40
The next hop IP address must be in the same subnet as interface 1/1/1.
```

Configuring binding with a next hop IP that is the same as the egress interface IP:

```
switch(config-if)# int 1/1/1
switch(config-if)# no shutdown
switch(config-if)# ip address 10.0.0.1/24
switch(config-if)# mpls enable
switch(config)# mpls
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# bind ipv4 2.2.2.0/24 output 1/1/1 10.0.0.1 40
The next hop IP address cannot be the same as any interface 1/1/1 primary or
secondary addresses.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-static-lsp	Administrators or local user group members with execution rights for this command.

bind ipv4 input (static lsp binding)

```
bind ipv4 input <in-label>
no bind ipv4 input <in-label>
```

Description

Performs label disposition by removing label from an egress packet (pop operation). The **no** form of this command removes the static LSP binding configuration.

Parameter	Description
<i><in-label></i>	Specifies the MPLS label to bind. Range: 16-1048575.

Usage

- The **no** form of both the **mpls** and **static-lsp** commands deletes all MPLS binding configurations.
- The static LSP label range must be allocated before configuring static LSP bindings.
- Specifying an incoming label outside the range of 16-1048575 is not allowed. An incoming label is bound by the allocated static LSP label range.

Examples

Configuring static LSP binding for label disposition:

```
switch(config)# mpls
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# bind ipv4 input 20
```

Removing the configuration for static LSP binding:

```
switch(config)# mpls
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# no bind ipv4 input 20
```

Configuring static LSP binding outside the label range:

```
switch(config-mpls-static-lsp)# bind ipv4 input 200
The input label must be within the range specified by label-range.
```

Configuring static LSP binding without first allocating a label range:

```
switch(config-mpls-static-lsp)# bind ipv4 input 20
A label range must be allocated before configuring bindings.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-hpe_anw-central	Administrators or local user group members with execution rights for this command.

clear mpls statistics

```
clear mpls statistics {ingress | egress} <LABEL>  
no syntax
```

Description

Clears MPLS statistics per label for all sessions.

Parameter	Description
ingress	Selects ingress statistics.
egress	Selects egress statistics.
<LABEL>	Specifies the label for which statistics will be cleared.

Examples

Clearing ingress MPLS statistics for a specific label:

```
switch# clear mpls statistics ingress 20
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

crossconnect input (static lsp binding label swap)

```
crossconnect input <in-label> output <IFNAME> <ID-ADDR> {<out-label> | explicit-null}  
no crossconnect input <in-label> output <IFNAME> <ID-ADDR> {<out-label> | explicit-null}
```

Description

Configures a static LSP binding to swap labels and route to the given next hop.

The **no** form of this command removes the static LSP binding label swap configuration.

Parameter	Description
<code><in-label></code>	Specifies the MPLS label to bind. Range: 16-1048575.
<code><IFNAME></code>	Specifies the egress interface of the binding.
<code><IP-ADDR></code>	Specifies the next hop IP address of the binding.
<code><out-label></code>	Specifies the MPLS label to apply. Range: 16-1048575.
<code>explicit-null</code>	Specifies an IETF MPLS IPv4 explicit null label (0).

Usage

- A static LSP label range must be allocated before configuring static LSP bindings.
- An incoming label must be within the allocated static LSP label range. Outgoing labels are not bound by the allocated static LSP label range, but must still be within the range of 16-1048575.
- The types of valid outgoing interfaces are: System, LAG, VLAN, and Tunnel.
 - Routing must be enabled for egress interfaces.
 - LAG member interfaces cannot be used with this command.
- Next hop and outgoing label pairs must be unique for each crossconnect binding.

Examples

Configuring crossconnect with an incoming and outgoing label:

```
switch(config)# mpls
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# crossconnect input 20 output 1/1/2 11.0.3.2 21
```

Configuring explicit-null PHP:

```
switch(config-mpls-static-lsp)# crossconnect input 20 output 1/1/2 11.0.3.2
explicit-null
```

Removing crossconnect binding:

```
switch(config-mpls-static-lsp)# no crossconnect input 20 output 1/1/2 11.0.3.2 21
```

Configuring crossconnect with an incoming label outside the allocated range:

```
switch(config-mpls-static-lsp)# crossconnect input 20 output 11.0.3.2 99
Failed to configure static LSP binding. Incoming label not in range allocated for
static LSP.
```

Configuring crossconnect with an interface that does not have routing enabled:

```
switch(config-mpls-static-lsp)# crossconnect input 20 output 1/1/8 11.0.3.2 21  
The egress interface must have an IP address assigned.
```

Configuring crossconnect with a nexthop IP that is not in the same subnet as egress interface:

```
switch(config-if)# int 1/1/1  
switch(config-if)# no shutdown  
switch(config-if)# ip address 10.0.0.1/24  
switch(config-if)# mpls enable  
switch(config)# mpls  
switch(config-mpls)# static-lsp  
switch(config-mpls-static-lsp)# crossconnect input 35 output 1/1/1 60.0.0.20 40  
The next hop IP address must be in the same subnet as interface 1/1/1.
```

Configuring crossconnect with a nexthop IP that is the same as the egress interface IP:

```
switch(config-if)# int 1/1/1  
switch(config-if)# no shutdown  
switch(config-if)# ip address 10.0.0.1/24  
switch(config-if)# mpls enable  
switch(config)# mpls  
switch(config-mpls)# static-lsp  
switch(config-mpls-static-lsp)# crossconnect input 35 output 1/1/1 10.0.0.1 40  
The next hop IP address cannot be the same as any interface 1/1/1 primary or  
secondary addresses.
```

Configuring crossconnect with a nexthop IP and outgoing label of an already existing binding:

```
switch(config-if)# int 1/1/1  
switch(config-if)# no shutdown  
switch(config-if)# ip address 10.0.0.1/24  
switch(config-if)# mpls enable  
switch(config)# mpls  
switch(config-mpls)# static-lsp  
switch(config-mpls-static-lsp)# crossconnect input 35 output 1/1/1 10.0.0.2 40  
switch(config-mpls-static-lsp)# crossconnect input 36 output 1/1/1 10.0.0.2 40  
A static LSP binding with the same nexthop and outgoing label already exists.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-static-lsp	Administrators or local user group members with execution rights for this command.

enable (mpls globally)

enable
no enable

Description

Enables MPLS forwarding of IPv4 traffic globally.

The **no** form of this command disables MPLS forwarding of IPv4 traffic globally.

Examples

Enabling MPLS forwarding of IPv4 traffic:

```
switch(config)# mpls  
switch(config-mpls)# enable
```

Disabling MPLS forwarding of IPv4 traffic:

```
switch(config)# mpls  
switch(config-mpls)# no enable
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls	Administrators or local user group members with execution rights for this command.

enable (mpls ldp)

enable
no enable

Description

Enables MPLS LDP.

The **no** form of this command disable MPLS LDP.

Usage

The LDP back off timer cannot be configured. It is set to exponentially back off session retry attempts with initial value of 15 seconds and a maximum of 2 minutes.

Examples

Enabling MPLS LDP:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# enable
```

Disabling MPLS LDP:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no enable
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-ldp	Administrators or local user group members with execution rights for this command.

enable (mpls static lsp)

enable
no enable

Description

Enables MPLS static LSPs.

The **no** form of this command disables static LSPs.

Usage

A static LSP binding will be processed when MPLS is globally enabled, static LSP is enabled, and the ingress and egress interface has MPLS enabled.

Examples

Enabling MPLS static LSPs:

```
switch(config)# mpls
switch(config-mpls)# enable
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# enable
```

Disabling static LSPs:

```
switch(config)# mpls
switch(config-mpls)# static-lsp
switch(config-mpls-static-lsp)# no enable
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced.

Command Information

Platforms	Command context	Authority
6400 8360	config config-mpls config-mpls-static-lsp	Administrators or local user group members with execution rights for this command.

enable mpls (interface)

```
mpls enable
no mpls enable
```

Description

Enables MPLS forwarding of IP traffic for the interface.

The **no** form of this command disables MPLS forwarding of IP traffic for the interface.

Usage

- Routing must be configured before enabling MPLS on an interface.

Examples

Enabling MPLS forwarding:

```
switch(config)# interface 1/1/1
switch(config-if)# routing
switch(config-if)# mpls enable
```

Enabling MPLS on a layer 2 interface:

```
switch(config)# interface 1/1/2
switch(config-if)# mpls enable
Routing must be enabled on this interface to use MPLS
```

Disabling MPLS forwarding:

```
switch(config)# interface 1/1/2
```

```
switch(config-if)# no mpls enable
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-if	Administrators or local user group members with execution rights for this command.

graceful-restart (mpls ldp)

graceful-restart

Description

Enables LDP graceful restart. Graceful restart is enabled by default. With graceful restart enabled, the MPLS forwarding state will be temporarily retained if the control plane restarts. The switch will wait after losing LDP neighbors before deleting bindings from that neighbor. See [graceful-restart-timers \(mpls ldp\)](#) for details. Graceful restart is enabled for LDP sessions only when the LDP setting and the overall router setting are enabled. If either is disabled, then graceful restart will not occur for LDP sessions.

Upon being disabled or enabled, any LDP sessions will be restarted, which may result in temporary traffic loss.

The **no** form of this command disables LDP graceful restart

Examples

Enabling MPLS LDP graceful restart:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# graceful-restart
Enabling graceful restart will restart any LDP sessions.
This may result in traffic loss.

Continue (y/n)? y
```

Disabling MPLS LDP graceful restart:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no graceful-restart
Enabling graceful restart will restart any LDP sessions.
This may result in traffic loss.
```

```
Continue (y/n)? y
```

Command History

Release	Modification
10.11	Command introduced.

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-ldp	Administrators or local user group members with execution rights for this command.

graceful-restart-timers (mpls ldp)

```
graceful-restart-timers {forwarding-holding <SECONDS> | max-recovery <SECONDS> |  
neighbor-liveness <SECONDS>}  
no graceful-restart-timers {forwarding-holding <SECONDS> | max-recovery <SECONDS> |  
neighbor-liveness <SECONDS>}
```

Description

Configures MPLS LDP discovery hold time for peers found via hello packets.

The **no** form of this command resets the discovery hello hold time to its default value of 15 seconds.



The BGP restart timer must be configured as 180 seconds or higher for graceful restart to work with MPLS.



It is recommended to configure the OSPF graceful restart timer as lower than the LDP forward-holding timer, which in turn should be configured as lower than the BGP graceful restart timer.

Parameter	Description
forwarding-holding <SECONDS>	Specifies the amount of time in seconds that the MPLS forwarding state should be preserved after the control plane restarts. Range: 30-600. Default: 150.
max-recovery <SECONDS>	Specifies the amount of time in seconds that the stale label bindings should be kept on the router after the LDP session has been reestablished. Range: 15-600. Default: 120.
neighbor-liveness <SECONDS>	Specifies the amount of time in seconds that the router will wait for the LDP session to be reestablished. If the router cannot reestablish the LDP session within that time, the router deletes all the stale LDP bindings received from that LDP neighbor. Range: 5-300. Default: 120.

Examples

Configuring the MPLS LDP graceful restart forwarding holding time for 30 seconds:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# graceful-restart-timers forwarding-holding 30
Changing the timer value will restart any LDP sessions.
This may result in traffic loss.
Continue (y/n)? y
```

Resetting the MPLS LDP graceful restart forwarding holding time to default:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no graceful-restart-timers forwarding-holding
switch(config-mpls-ldp)# no graceful-restart-timers forwarding-holding 30
Changing the timer value will restart any LDP sessions.
This may result in traffic loss.
Continue (y/n)? y
```

Configuring the MPLS LDP graceful restart max recovery time for 30 seconds:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# graceful-restart-timers max-recovery 30
Changing the timer value will restart any LDP sessions.
This may result in traffic loss.

Continue (y/n)? y
```

Resetting the MPLS LDP graceful restart max recovery time to default:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no graceful-restart-timers max-recovery
switch(config-mpls-ldp)# no graceful-restart-timers max-recovery 30
Changing the timer value will restart any LDP sessions.
This may result in traffic loss.

Continue (y/n)? y
```

Configuring the MPLS LDP graceful restart neighbor liveness time for 30 seconds:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# graceful-restart-timers neighbor-liveness 30
Changing the timer value will restart any LDP sessions.
This may result in traffic loss.

Continue (y/n)? y
```

Resetting the MPLS LDP graceful restart neighbor liveness to default:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no graceful-restart-timers neighbor-liveness
Changing the timer value will restart any LDP sessions.
```

This may result in traffic loss.

Continue (y/n)? **y**

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.10	Command introduced.

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-ldp	Administrators or local user group members with execution rights for this command.

label-range (static lsp)

```
label-range <start-label-range> <end-label-range>  
no label-range <start-label-range> <end-label-range>
```

Description

Allocates MPLS labels for use exclusively by static LSP.

The **no** form of this command removes the configured allocation, returning to the default state with no labels allocated for static LSP usage.

Parameter	Description
<i><start-label-range></i>	Selects the start of the static LSP label range. Range: 16-1048575.
<i><end-label-range></i>	Selects the end of the static LSP label range. Range: 16-1048575.

Usage

- The range arguments are inclusive. Configuring a range of 20-30 will allocate the labels 20, 21, ..., 29, 30.
- Static LSP labels must not overlap with labels used by any other protocol, i.e. LDP. This label range allocation command will fail if any labels are shared between protocols.
- Any change to the static LSP label allocation will fail if any static LSP bindings are configured. All bindings must be removed before the static LSP label range can be reallocated.
- Allocated label range affects only the ingress packets. Labels for the outgoing packets must be within the allocated label range of the next hop device.

Examples

Allocating a valid static LSP label range:

```
switch(config-mpls-static-lsp)# label-range 100 2000
```

Changing the static LSP label range while LSP bindings are configured:

```
switch(config-mpls-static-lsp)# label-range 100 2000  
All static LSP bindings must first be deleted.
```

Deallocating static LSP label range; use either command:

```
switch(config-mpls-static-lsp)# no label-range 100 2000  
switch(config-mpls-static-lsp)# no label-range
```

Configuring a static LSP range that intersects with LDP:

```
switch(config-mpls-static-lsp)# label-range 30 99  
The static LSP label range cannot overlap with any other MPLS range.
```

Deallocating static LSP range when bindings are still configured:

```
switch(config-mpls-static-lsp)# no label-range  
All static LSP bindings must be removed before removing the label range.  
All static LSP bindings must be removed before removing the label range.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-static-lsp	Administrators or local user group members with execution rights for this command.

label-protocol ldp

```
label-protocol ldp  
no label-protocol ldp
```

Description

Configures the Label Distribution Protocol (LDP).

The **no** form of this command removes all LDP-related configuration.

Examples

Configuring LDP:

```
switch(config-mpls)# label-protocol ldp
```

Removing all LDP-related configuration:

```
switch(config-mpls)# no label-protocol ldp  
All MPLS LDP configuration will be deleted.  
  
Continue (y/n)? y
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls	Administrators or local user group members with execution rights for this command.

mpls

```
mpls  
no mpls
```

Description

Configures MPLS forwarding of IPv4 traffic globally.
The **no** form of the command removes all MPLS-related configuration.

Examples

Configuring MPLS forwarding for IPv4 traffic:

```
switch(config)# mpls
```

Removing MPLS configuration for IPv4 traffic:

```
switch(config)# no mpls  
All MPLS configuration will be deleted.  
  
Continue (y/n)? y
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config	Administrators or local user group members with execution rights for this command.

mpls ldp enable

```
mpls ldp enable
no mpls ldp enable
```

Description

Enables LDP protocol in the interface level.

The **no** form of this command disables LDP.

Enabling/disabling interface level LDP will also enable/disable **php-mode-explicit-null** by default. **php-mode-explicit-null** is currently the only mode supported and there is no option to disable it when LDP is enabled on an interface.

Usage

- Routing must be configured before enabling LDP on an interface.
- MPLS must be enabled on the interface prior to enabling LDP.

Examples

Enabling the LDP protocol:

```
switch(config)# interface 1/1/1
switch(config-if)# routing
switch(config-if)# mpls enable
switch(config-if)# mpls ldp enable
```

Enabling LDP prior to enabling MPLS:

```
switch(config)# interface 1/1/2
switch(config-if)# routing
switch(config-if)# mpls ldp enable
MPLS must be enabled on this interface to use LDP.
```

Enabling MPLS on a layer 2 interface:

```
switch(config)# interface 1/1/2
switch(config-if)# mpls ldp enable
Routing must be enabled on this interface to use MPLS.
```

Disabling MPLS forwarding:

```
switch(config)# interface 1/1/2
switch(config-if)# no mpls ldp enable
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-if	Administrators or local user group members with execution rights for this command.

mpls ldp entropy label insertion

```
entropy label
no entropy label
```

Description

Enables MPLS LDP entropy label insertion.

The `no` form of this command disables MPLS LDP entropy label insertion. Label insertion happens at the ingress LER where native packets are encapsulated with MPLS labels for forwarding. Entropy label insertion is disabled by default.

Examples

Enabling MPLS LDP entropy label insertion:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# entropy-label
```

Disabling MPLS LDP entropy label insertion:

```
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no entropy-label
```

Command History

Release	Modification
10.09	Command introduced

Command Information

Platforms	Command context	Authority
8360	config-mpls-ldp	Administrators or local user group members with execution rights for this command.

mpls ldp discovery hello hold time (global)

```
discovery hello holdtime <SECONDS>
no discovery hello holdtime <SECONDS>
```

Description

Configures MPLS LDP discovery hold time for peers found via hello packets.

The **no** form of this command resets the discovery hello hold time to its default value of 15 seconds.

Parameter	Description
<SECONDS>	Specifies the discovery hold time in seconds. Range: 15-65535. Default: 15.

Usage

- The default value of discovery hello hold time is 15 seconds
- The discovery hello hold time configured on an interface supersedes the global configuration.
- The discovery hello interval time is auto-computed as one third of the hello hold time.

Examples

Configuring the MPLS LDP discovery hello hold time:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# discovery hello holdtime 30
```

Changing discovery hello hold time:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# discovery hello holdtime 50
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-ldp	Administrators or local user group members with execution rights for this command.

mpls ldp discovery hello hold time (interface)

```
mpls ldp discovery hello holdtime <SECONDS>
no mpls ldp discovery hello holdtime <SECONDS>
```

Description

Overrides the global MPLS LDP discovery hold time for peers found via hello packets from the given interface.

The **no** form of this command resets the discovery hello hold time for the given interface to the global value (if configured) or default value of 15 seconds if global value is not specified.

Parameter	Description
<SECONDS>	Specifies the discover hello hold time on an interface. Range: 15-65535. Default: 15.

Usage

- The interface LDP discovery hello hold time overrides global hello hold time.
- Routing must be configured before changing the LDP discovery hold time on an interface.

Examples

Configuring the interface MPLS LDP discovery hello hold time:

```
switch(config)# interface 1/1/1
switch(config-if)# routing
switch(config-if)# mpls ldp discovery hello holdtime 30
```

Removing the interface MPLS LDP discovery hello hold time configuration:

```
switch(config)# interface 1/1/1
switch(config-if)# no mpls ldp discovery hello holdtime
```

Configuring the interface MPLS LDP discovery hello hold time on a Layer 2 interface:

```
switch(config)# interface 1/1/2
switch(config-if)# mpls ldp discovery hello holdtime 30
Routing must be enabled on this interface to use MPLS.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-if	Administrators or local user group members with execution rights for this command.

mpls ldp session holdtime (interface)

```
mpls ldp session holdtime <TIME>
no mpls ldp session holdtime <TIME>
```

Description

Configures MPLS LDP session hold time for an interface.

The **no** form of this command resets the session hold time to its default value of 15 seconds.

Parameter	Description
<TIME>	Specifies the session hold time for the interface in seconds. Range: 15-65535. Default: 40.

Usage

- The interface LDP session hold time overrides global hello hold time.
- Routing must be configured before changing LDP session holdtime on an interface.

Examples

Configuring the MPLS LDP session hold time for an interface:

```
switch(config)# interface 1/1/1
switch(config-if)# routing
switch(config-if)# mpls ldp session holdtime 30
```

Removing the MPLS LDP session hold time for the interface:

```
switch(config)# interface 1/1/1
switch(config-if)# no mpls ldp session holdtime 30
```

Configuring the MPLS LDP session hold time on a layer 2 interface:

```
switch(config)# interface 1/1/2
switch(config-if)# mpls ldp session holdtime 30
Routing must be enabled on this interface to use MPLS.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-if	Administrators or local user group members with execution rights for this command.

ping mpls

```
ping mpls ipv4 <IP-ADDR/MASK> [source <IP-ADDR> | destination <IP-ADDR> | ttl <HOPS> |  
size <BYTES> | repeat <NUMBER> | timeout <TIME> | interval <TIME>]
```

Description

Ping MPLS is a command which sends LSP ping packets on the MPLS network and displays the responses from the remote target. It is used as a debugging and analytics tool to verify connectivity within MPLS networks.

Parameter	Description
ipv4 <IP-ADDR/MASK>	Specifies target IP address and mask of the remote subnet to ping.
source <IP-ADDR>	Specifies the source IPv4 address for the request packet.
destination <IP-ADDR>	Specifies the destination address for the request packet. Default: 127.0.0.1.
ttl <HOPS>	Specifies the max number of hops a packet can take en route to its destination. Range: 1-255. Default: 64.
size <BYTES>	Specifies the size of the packet to be sent in bytes. Range: 0-9600. Default: 0.
repeat <NUMBER>	Specifies the number of packets to be sent. Range 1-10000. Default: 5.
timeout <TIME>	Specifies the amount of time in seconds after which a packet is considered dropped. Range 1-60. Default: 2.
interval <TIME>	Specifies the interval time between packets in seconds. Range: 1-60 seconds. Default: 1.

Examples

Sending 5 successful pings to the destination to the 10.10.10.10/32 subnet with a source IP address 20.20.20.1, a destination IP of 127.0.0.1, a zero byte payload, 64 hop time to live, 3 second interval between packets, and a 5 second timeout:

```

switch# ping mpls ipv4 10.10.10.10/32 source 20.20.20.1 destination 127.0.0.1
repeat 5 size 0 ttl 64 interval 3 timeout 5
Sending 5 MPLS Echo packets of size 0 bytes to 10.10.10.0/32 from source
20.20.20.1,
timeout is 5 sec, send interval is 3 sec:
Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
        'U' - unreachable, 'M' - malformed request, 'T' - unsupported TLV,
        'E' - malformed response, 'R' - transit router
Type escape sequence (Ctrl + C) to abort.
!!!!
1908 Success rate is 100 percent (5/5), round-trip min/avg/max = 7/10/13 ms

```

Sending an unsuccessful ping that fails because the network is unreachable:

```

switch# ping mpls ipv4 10.10.10.10/32 source 20.20.20.1 destination 127.0.0.1
repeat 5 size 0
Sending 5 MPLS Echo packets of size 0 bytes to 10.10.10.0/32 from source
20.20.20.1,
timeout is 2 sec, send interval is 1 sec:
Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
        'U' - unreachable, 'M' - malformed request, 'T' - unsupported TLV,
        'E' - malformed response, 'R' - transit router
Type escape sequence (Ctrl + C) to abort.
Network unreachable

```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.10	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Manager (#)	Administrators or local user group members with execution rights for this command.

router-id (mpls ldp)

```

router-id <IFNAME> [confirm]
no router-id <IFNAME> [confirm]

```

Description

Configures MPLS LDP router ID which is the IP address of a loopback interface. The **no** form of this command removes the MPLS LDP router ID configuration.

Parameter	Description
<IFNAME>	Specifies the loopback interface for the MPLS LDP router ID.

Usage

- There is a possibility of MPLS traffic disruption whenever a router ID is deleted or updated to another loopback interface.
- The MPLS router ID interface must be a loopback interface with an IPv4 address configured.
- The confirmation prompt is skipped if the router ID is being configured for the first time by the user.
- Changing the IP address of the loopback interface may interrupt MPLS traffic.

Examples

Configuring an MPLS LDP router ID:

```
switch(config)# interface loopback 1
switch(config-loopback-if)# ip address 1.1.1.1/32

switch(config)# mpls
switch(config-mpls)# enable
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# enable
switch(config-mpls-ldp)# router-id loopback1
```

Changing the MPLS LDP router ID loopback interface:

```
switch(config)# interface loopback 2
switch(config-loopback-if)# ip address 2.2.2.2/32

switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# router-id loopback2
Changing the router ID interface may disrupt MPLS traffic.

Continue (y/n)?
```

Changing the MPLS LDP router ID interface without prompting for confirmation:

```
switch(config)# interface loopback 2
switch(config-loopback-if)# ip address 2.2.2.2/24

switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# router-id loopback2 confirm
```

Removing the MPLS LDP router ID configuration:

```
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no router-id loopback2
Removing the router ID interface may disrupt MPLS traffic.

Continue (y/n)?
```

Removing the MPLS LDP router ID without providing loopback interface name:

```
switch(config-mpls)# label-protocol ldp
```

```
switch(config-mpls-ldp)# no router-id
Removing the router ID interface may disrupt MPLS traffic.

Continue (y/n)?
```

Removing the configuration of an MPLS LDP router ID with an interface name which is different than the one configured as router ID:

```
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# router-id loopback1 confirm
switch(config-mpls-ldp)# no router-id loopback2
The value to disable does not match the currently configured value.
```

Removing the MPLS LDP router ID configuration prompting for confirmation:

```
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# no router-id loopback2 confirm
```

Configuring an MPLS LDP router ID with system interface:

```
switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# enable
switch(config-mpls-ldp)# router-id 1/1/1
The router ID must be a loopback interface with an IP address assigned.
```

Configuring MPLS LDP router ID with a loopback interface without an IPv4 address configured:

```
switch(config)# interface loopback 1

switch(config)# mpls
switch(config-mpls)# label-protocol ldp
switch(config-mpls-ldp)# enable
switch(config-mpls-ldp)# router-id loopback1
The router ID interface must have an IP address assigned.
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-loopback-if config-mpls-ldp	Administrators or local user group members with execution rights for this command.

session hold time (mpls ldp globally)

```
session holdtime <SECONDS>  
no session holdtime <SECONDS>
```

Description

Configures MPLS LDP session hold time.

The **no** form of this command resets the session hold time to its default value of 40 seconds.

Parameter	Description
<SECONDS>	Specifies the session hold time in seconds. Range: 15-65535. Default: 40.

Usage

- The default session hold time is 40 seconds
- The session hold time configured on an interface supersedes the global configuration.
- The session keepalive interval time is auto computed as one sixth of the hold time.

Examples

Configuring the MPLS LDP session hold time:

```
switch(config)# mpls  
switch(config-mpls)# label-protocol ldp  
switch(config-mpls-ldp)# session holdtime 30
```

Changing the session hold time:

```
switch(config)# mpls  
switch(config-mpls)# label-protocol ldp  
switch(config-mpls-ldp)# session holdtime 50
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls-ldp	Administrators or local user group members with execution rights for this command.

show bgp vpnv4 unicast

```
show bgp VPNv4 unicast [[<IP-ADDR>/<MASK>] | community | extcommunity |
```

neighbors [<IP-ADDR>] | paths | summary | vsx-peer]

Description

Shows all vpnv4 entries in the BGP routing table .

Parameter	Description
<IP-ADDR>/<MASK>	Specifies the IP network and mask of a specific BGP route in IPv4 format (x.x.x.x/M), where x is a decimal number from 0 to 255 and M is the number of bits in CIDR format from 0 to 32.
community	Selects routes that belong to specified BGP communities.
extcommunity	Selects unicast routes with extended communities.
neighbors [<IP-ADDR>]	Selects BGP neighbor connection parameters for all neighbors or the IP address of a specific neighbor in IPv4 format (x.x.x.x) where x is a decimal number from 0 to 255.
paths	Selects AS Path information of the vpnv4 routes in BGP RIB.
summary	Selects a summary of BGP neighbor status.
vsx-peer	Selects VSX peer switch information.

Examples

Showing all VPNv4 entries in the BGP routing table:

```
switch# show bgp vpnv4 unicast
VRF : default
BGP Summary
-----
Local AS           : 100           BGP Router Identifier : 4.4.4.4
Peers              : 0             Log Neighbor Changes  : No
Cfg. Hold Time    : 180          Cfg. Keep Alive      : 60
Confederation Id  : 0

PE2# show bgp vpnv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 4.4.4.4

      Network           Nexthop           Metric      LocPrf      Weight Path
Route Distinguisher: 100:100
*(Label 22)
*>i 11.1.1.0/30        1.1.1.1          0           100         0          ?
```

```

Route Distinguisher: 1.1.1.1:200          (Label 23)
*>i 11.1.2.0/30          1.1.1.1          0          100          0          ?

Route Distinguisher: 100:300              (Label 24)
*>i 11.1.3.0/30          1.1.1.1          0          100          0          ?

Route Distinguisher: 100:400              (Label 25)
*>i 11.1.4.0/30          1.1.1.1          0          100          0          ?
Total number of entries 4

```

Showing entries in the BGP routing table for the *11.1.3.0/30* network:

```

switch# show bgp vpnv4 unicast 11.1.3.0/30

VRF : default
BGP Local AS 100          BGP Router-id 4.4.4.4

Network          : 11.1.3.0/30          Nexthop          : 1.1.1.1
Peer             : 1.1.1.1              Origin           : incomplete
Metric           : 0                    Local Pref       : 100
Weight           : 0                    Calc. Local Pref : 100
Best             : Yes                   Valid            : Yes
Type             : internal              Stale            : No
Originator ID   : 0.0.0.0              Path ID          : 0
Aggregator ID   :
Aggregator AS   :
Atomic Aggregate :

AS-Path          :
Cluster List     :
Communities      :
Ext-Communities  :

```

Showing entries in the BGP routing table for routes with extended communities:

```

switch# show bgp vpnv4 unicast extcommunity
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 4.4.4.4

Network          Next Hop          Ecommunity
*>i 11.1.1.0/30   1.1.1.1          100:100
*>i 11.1.2.0/30   1.1.1.1          4.4.4.4:200
*>i 11.1.3.0/30   1.1.1.1          100:300
*>i 11.1.4.0/30   1.1.1.1          100:400

Total number of entries 4

```

Showing BGP neighbor connection parameters for all neighbors:

switch# show bgp vpnv4 unicast neighbors

Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 1.1.1.1 (Internal)

Description : MPBGP Session to PE2
Peer-group :

Remote Router Id : 1.1.1.1 Local Router Id : 4.4.4.4
Remote AS : 100 Local AS : 100
Remote Port : 179 Local Port : 38335
State : Established Admin Status : Up
Conn. Established : 1 Conn. Dropped : 0
Passive : No Update-Source : loopback0
Cfg. Hold Time : 180 Cfg. Keep Alive : 60
Neg. Hold Time : 180 Neg. Keep Alive : 60
Up/Down Time : 00h:56m:46s Connect-Retry Time : 120
Local-AS Prepend : No Alt. Local-AS : 0
BFD : Disabled
Password :
Last Err Sent : No Error
Last SubErr Sent : No Error
Last Err Rcvd : No Error
Last SubErr Rcvd : No Error

Graceful-Restart : Enabled Gr. Restart Time : 120
Gr. Stalepath Time : 300 Remove Private-AS : No
TTL : 255 Local Cluster-ID :
Weight : 0 Fall-over : No
Confederation-Peers : No

Message statistics	Sent	Rcvd
Open	1	1
Notification	0	0
Updates	7	7
Keepalives	64	65
Route Refresh	0	0
Total	72	73

Capability	Advertised	Received
Route Refresh	Yes	Yes
Graceful Restart	Yes	Yes
Add-Path	No	No
Four Octet ASN	Yes	Yes
Address family IPv4 Unicast	No	No
Address family IPv6 Unicast	No	No
Address family VPNv4 Unicast	Yes	Yes
Address family L2VPN EVPN	No	No

Address Family : VPNv4 Unicast

Rt. Reflect. Client : No Send Community : both
Allow-AS in : 0 Advt. Interval : 30
Max. Prefix : 32500 Soft Reconfig In :
NextHop-Self : Default-Originate :
Cfg. Add-Path :
Neg. Add-Path :

```

Routemap In      :
Routemap Out     :
ORF type         : Prefix-list
ORF capability    :

```

Showing BGP neighbor connection parameters for the neighbor with IP address 1.1.1.1:

```

switch# show bgp vpv4 unicast neighbors 1.1.1.1
Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 1.1.1.1 (Internal)
  Description      : MPBGP Session to PE2
  Peer-group      :

  Remote Router Id : 1.1.1.1           Local Router Id  : 4.4.4.4
  Remote AS        : 100              Local AS         : 100
  Remote Port      : 179              Local Port       : 38335
  State            : Established      Admin Status     : Up
  Conn. Established : 1               Conn. Dropped    : 0
  Passive          : No               Update-Source    : loopback0
  Cfg. Hold Time   : 180             Cfg. Keep Alive  : 60
  Neg. Hold Time   : 180             Neg. Keep Alive  : 60
  Up/Down Time     : 00h:58m:52s     Connect-Retry Time : 120
  Local-AS Prepend : No              Alt. Local-AS    : 0
  BFD              : Disabled
  Password         :
  Last Err Sent    : No Error
  Last SubErr Sent : No Error
  Last Err Rcvd   : No Error
  Last SubErr Rcvd : No Error

  Graceful-Restart : Enabled          Gr. Restart Time : 120
  Gr. Stalepath Time : 300           Remove Private-AS : No
  TTL                : 255          Local Cluster-ID  :
  Weight             : 0             Fall-over         : No
  Confederation-Peers : No

  Message statistics      Sent      Rcvd
  -----
  Open                    1          1
  Notification            0          0
  Updates                  7          7
  Keepalives              67         67
  Route Refresh            0          0
  Total                   75         75

  Capability              Advertised   Received
  -----
  Route Refresh           Yes         Yes
  Graceful Restart       Yes         Yes
  Add-Path                No         No
  Four Octet ASN         Yes         Yes
  Address family IPv4 Unicast No         No
  Address family IPv6 Unicast No         No
  Address family VPNv4 Unicast Yes        Yes
  Address family L2VPN EVPN No         No
  Address Family : VPNv4 Unicast

```

```

-----
Rt. Reflect. Client : No           Send Community      : both
Allow-AS in        : 0             Advt. Interval     : 30
Max. Prefix        : 32500         Soft Reconfig In   :
Nexthop-Self       :               Default-Originate  :
Cfg. Add-Path      :
Neg. Add-Path      :

Routemap In       :
Routemap Out      :
ORF type          : Prefix-list
ORF capability     :

```

Showing AS Path information of the vpnv4 routes in BGP RIB:

```

switch# show bgp vpnv4 unicast paths
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, e external S Stale, R Removed, a additional-paths
VRF : default
Local Router-ID 4.4.4.4

   Network                Next Hop          PathID    Path
Route Distinguisher: 100:100          (Label 22)
* i 11.1.1.0/30             1.1.1.1          0         ?
Route Distinguisher: 1.1.1.1:200      (Label 23)
* i 11.1.2.0/30             1.1.1.1          0         ?
Route Distinguisher: 100:300          (Label 24)
* i 11.1.3.0/30             1.1.1.1          0         ?
Route Distinguisher: 100:400          (Label 25)
* i 11.1.4.0/30             1.1.1.1          0         ?
Total number of entries 4

```

Showing a summary of BGP neighbor status:

```

switch(config-bgp)# show bgp vpnv4 unicast summary
VRF : default
BGP Summary
Local AS           : 100           BGP Router Identifier : 4.4.4.4
Peers              : 0             Log Neighbor Changes  : No
Cfg. Hold Time     : 180          Cfg. Keep Alive       : 60
Confederation Id   : 0

```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

show capacities mpls

```
show capacities mpls
show capacities-status mpls
```

Description

For capacities command, shows the maximum number of label endpoints, label switch entries, and service label entries that can be configured on the device. For capacities-status command, shows the total number of label endpoints, label switch entries, and service label entries that are currently configured on the device.

Examples

Showing capacities of configurable MPLS options:

```
switch# show capacities mpls
System Capacities: Filter MPLS
Capacities Name
                Value
-----
Maximum number of MPLS Label Endpoints configurable in a system
                8192
Maximum number of MPLS Label Switch entries configurable in a system
                8192
Maximum number of MPLS Service Label entries configurable in a system
                8192
```

Showing the configuration of currently configured MPLS options in relation to their capacities:

```
switch# show capacities-status mpls
System Capacities Status: Filter MPLS
Capacities Status Name
                Value Maximum
-----
Number of MPLS Label Endpoints currently configured
                0      8192
Number of MPLS Label Switch entries currently configured
                0      8192
Number of MPLS Service Label entries currently configured
                0      8192
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Manager (#)	Administrators or local user group members with execution rights for this command.

show mpls forwarding

```
show mpls forwarding [detail]
```

Description

Shows the MPLS forwarding table.

Usage

- Forwarding table filters will be implemented at a later date.
- When running this command on a huge-scale setup, showing the full tables might take a while.

Examples

Showing the MPLS forwarding table:

```
switch# show mpls forwarding
MPLS Bindings
Entry Bindings   : 2
Exit Bindings    : 2
Transit Bindings : 1
PHP Mode         : Explicit-Null
QoS Mode         : Uniform
TTL Propagation  : Uniform
Entry Bindings:
Origin Prefix           Ingress      Nexthop      Outgoing
Egress      Egress           Status
VRF
Interface  VRF
-----
LDP      4.4.4.4/32           default      192.168.10.2  3002      1/1/6
         default          operational
BGP      20.20.20.0/24       vrf-blue    4.4.4.4      5001      1/1/6
         default          operational
Exit Bindings:
Origin Prefix           Incoming   Service   Egress      Status
Label  Label      VRF
-----
static  n/a           exp-null  -         default     operational
BGP     n/a           imp-null  2001     vrf-blue    operational
Transit Bindings:
Origin Prefix           Incoming   Egress      Egress      Nexthop      Outgoing      Status
Label  Label      Label      Interface   VRF          Address      Label
-----
LDP     4.4.4.4/32  2002      1/1/6      default     192.168.10.2  3002
operational
```

```

switch# show mpls forwarding detail
MPLS Bindings
Entry Bindings : 2
Exit Bindings : 2
Transit Bindings : 1
PHP Mode : Explicit-Null
QoS Mode : Uniform
TTL Propagation : Uniform
Entry Bindings:
Origin Prefix Ingress Nextthop Outgoing
Egress Egress Status Tx Packets Tx
Bytes
VRF Address Label Interface VRF
-----
LDP 4.4.4.4/32 default 192.168.10.2 3002 1/1/6
default operational 99 100
BGP 20.20.20.0/24 vrf-blue 4.4.4.4 5001 1/1/6
default operational 66 88
Exit Bindings:
Origin Prefix Incoming Service Egress Status
Rx Packets Rx Bytes
Label Label VRF
-----
static n/a exp-null - default operational
33 44
BGP n/a imp-null 2001 vrf-blue operational
22 33
Transit Bindings:
Origin Prefix Incoming Egress Egress Nextthop
Outgoing Status Rx Packets Rx Bytes
Tx Packets Tx Bytes
Label Interface VRF Address Label
-----
LDP 4.4.4.4/32 2002 1/1/6 default
192.168.10.2 3002 operational 11
22 22 33

```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

show mpls label-range static-lsp

```
show mpls label-range static-lsp
```

Description

Shows the range of MPLS labels allocated for use in static LSP bindings and the range of labels currently used by static LSP bindings.

Examples

Showing the range and usage of static LSp labels on the switch:

```
switch# show mpls label-range static-lsp

Static LSP Labels

Allocated : 16-100
In use    : 16-30,35
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Operators or Administrators or local user group members with execution rights for this command. Operators can execute this command from the operator context (>) only.

show mpls ldp bindings

```
show mpls ldp bindings
```

Description

Shows information about all MPLS LDP bindings.

Examples

Showing information about MPLS LDP bindings:

```
switch# show mpls ldp bindings

10.10.2.0/24
  local binding: label: imp-null
  remote binding: lsr:10.255.255.255:0, label:16
  remote binding: lsr:10.256.256.256:0, label: exp-null
10.10.3.0/24
  local binding: label:20
  remote binding: lsr:10.256.256.256:0, label:22
5.43.9.98/32
```

```
local binding: label:21
No remote binding
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

show mpls ldp discovery

```
show mpls ldp discovery [<IP-ADDR>]
no syntax
```

Description

Shows information about discovered LDP peers.

Parameter	Description
<IP-ADDR>	Specifies the peer MPLS LDP router ID in x.x.x.x format, where x is a decimal value from 0 to 255.

Examples

Showing information about discovered LDP peers:

```
switch# show mpls ldp discovery
Local LDP Identifier: 10.44.44.44:0
Discovery Sources:
  Interfaces:
    1/1/1 : recv
      LDP Id: 10.33.33.33:0, Transport address: 10.33.33.33
      Path vector limit: 10
      Distribution type: Downstream-on-demand
      Adjacency type: Link
      Hold time: 15 sec (local: 15 sec, peer: 15 sec, remaining: 10s)
      BFD status: Activating
    1/1/2 : recv
      LDP Id: 10.33.33.34:0, Transport address: 10.33.33.33
      Path vector limit: 10
      Distribution type: Downstream-unsolicited
      Adjacency type: Targeted
      Hold time: 15 sec (local: 15 sec, peer: 15 sec, remaining: 10s)
      BFD status: Active
```

```

Local LDP Identifier: 10.44.44.44:2
Discovery Sources:
  Interfaces:
    1/1/3 : recv
      LDP Id: 10.33.38.33:0, Transport address: 10.43.33.33
      Path vector limit: 10
      Distribution type: Downstream-unsolicited
      Adjacency type: Link
      Hold time: 15 sec (local: 15 sec, peer: 15 sec, remaining: 10s)
      BFD status: Active

```

Showing information about a specific LDP peer:

```

switch# show mpls ldp discovery 10.33.33.34
Local LDP Identifier: 10.44.44.44:0
Discovery Sources:
  Interfaces:
    1/1/2 : recv
      LDP Id: 10.33.33.34:0, Transport address: 10.33.33.33
      Path vector limit: 10
      Distribution type: Downstream-unsolicited
      Adjacency type: Targeted
      Hold time: 15 sec (local: 15 sec, peer: 15 sec, remaining: 10s)
      BFD status: Active

```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

show mpls ldp graceful-restart

```
show mpls ldp graceful-restart
```

Description

Shows graceful restart parameters and status.

Examples

Showing graceful restart parameters and status when graceful restart is not configured:

```
switch# show mpls ldp graceful-restart
```

```

Max recovery time           : 50 sec
Neighbor liveness time     : 50 sec
Forwarding holding time    : 70 sec
Number of graceful restart events : 7
Graceful restart in progress : true
Forwarding holding time remaining : 300 sec
Current graceful restart status : in-progress
Graceful restart exit history (last 5) : complete, complete, complete, cancelled, cancelled

```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.10	Command introduced.

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

show mpls ldp neighbor

```
show mpls ldp neighbor
```

Description

Shows information about LDP neighbors in the current session(s). The reconnect and recovery time are the times advertised by the peer device.

Examples

Showing LDP neighbors:

```

switch# show mpls ldp neighbor
Local LDP Identifier: 10.44.44.44:0, Peer LDP Identifier: 10.22.22.22:0
  TCP connection: 10.22.22.22:646 - 10.33.33.33:65530
  Graceful Restart: No
  Session Holdtime: 180 sec
  State: Operational; Msgs sent/rcvd: 46/43
  Up time: 00:31:21
  LDP Discovery Sources: 1/1/1
  Addresses bound to this peer:
    10.22.22.22 10.10.2.1

```

Showing LDP neighbors when graceful restart has been configured:

```

switch# show mpls ldp neighbor
Local LDP Identifier: 1.1.1.1:0, Peer LDP Identifier: 11.1.1.2:0
  Graceful Restart: Yes

```

```
Peer Reconnect Time: 120 sec
Peer Recovery Time: 300 sec
Session Holdtime: 40 sec
Up time: 00:02:59
State: operational
LDP Discovery Sources: 1/1/32
Addresses bound to this peer:
    11.1.1.2 12.1.1.1 2.2.2.2
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	Operator (>) or Manager (#)	Administrators or local user group members with execution rights for this command.

static-lsp

```
static-lsp
no static-lsp
```

Description

Configures MPLS static Label Switched Paths (LSP).

The **no** form of this command removes all static LSP configurations including label range allocation and static LSP binding.

Examples

Configuring MPLS static LSP:

```
switch(config-mpls) # static-lsp
```

Removing MPLS static LSP configuration:

```
switch(config-mpls) # no static-lsp
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.09	Command introduced

Command Information

Platforms	Command context	Authority
6400 8360	config-mpls	Administrators or local user group members with execution rights for this command.

traceroute mpls

```
traceroute mpls ipv4 <IP-ADDR/MASK> [source <IP-ADDR> | destination <IP-ADDR> | ttl <HOPS> | timeout <TIME> | fec-type ldp]
```

Description

Send LSP ping packets on the MPLS network and display the responses all intermediate routers as well as the destination host. Use this command as a debugging and analytics tool to verify connectivity within the MPLS networks.

Parameter	Description
ipv4 <IP-ADDR/MASK>	Specifies the IP address and netmask of the remote subnet to traceroute.
source <IP-ADDR>	Specifies the source IPv4 address for the request packet.
destination <IP-ADDR>	Specifies the destination IPv4 address for the request packet
ttl <HOPS>	Specifies the max number of hops a packet can take en route to its destination. Range: 1-255. Default: 255.
timeout <SECONDS>	Specifies the number of seconds after which a packet is considered dropped. Range: 1-60 seconds. Default: 2.
fec-type ldp	Selects the target Forward Equivalence Class (FEC) type. The only supported option is the default value of ldp.

Example

Successfully tracing the route a target with IP address 1.1.4.1/32 with a maximum TTL of 3 hops and a 3 second timeout:

```
switch# traceroute mpls ipv4 1.1.4.1/32 ttl 3 timeout 3
Tracing MPLS Label Switched Path to 1.1.4.1/32 from source 10.0.0.2,
timeout is 3 seconds and ttl is 3

Codes: '!' - success, 'Q' - request not sent, '.' - timeout, 'N' - no label entry,
'R' - transit router, 'D' - DS Map mismatch, 'F' - no FEC mapping,
'M' - malformed request, 'T' - unsupported tlvs, 'Z' - return code 0

Type escape sequence to abort.
 0 10.0.0.2 MRU 1500 [Labels: 17]
R 1 10.0.0.1 MRU 1500 [Labels: explicit-null] 10 ms
! 2 10.0.1.2 1 ms
```

Command History

Release	Modification
10.11	Support for the 6400 Series Switch added.
10.10	Command introduced

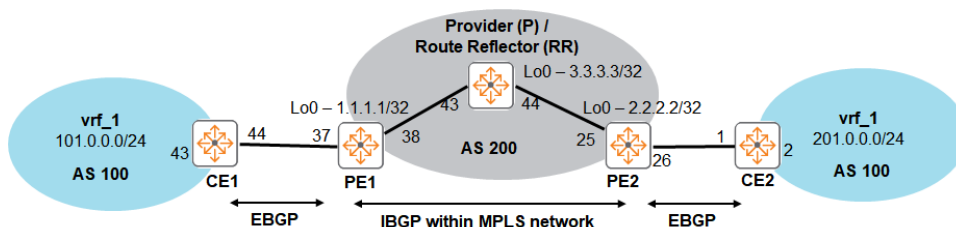
Command Information

Platforms	Command context	Authority
6400 8360	Manager (#)	Administrators or local user group members with execution rights for this command.

The following is recommended prior to beginning the troubleshooting process:

- Have a topology diagram ready
- Ensure IPs, interface, and AS details are included
- Check physical cabling and generate `show tech` when opening a TAC case
- Check network:
 - Run **show LLDP neighbor**
 - Ensure unicast network works using ping and traceroute between loopbacks and interfaces
 - Fix any issues found

The figure below provides an example:



Mirror traffic and packet capture if required:

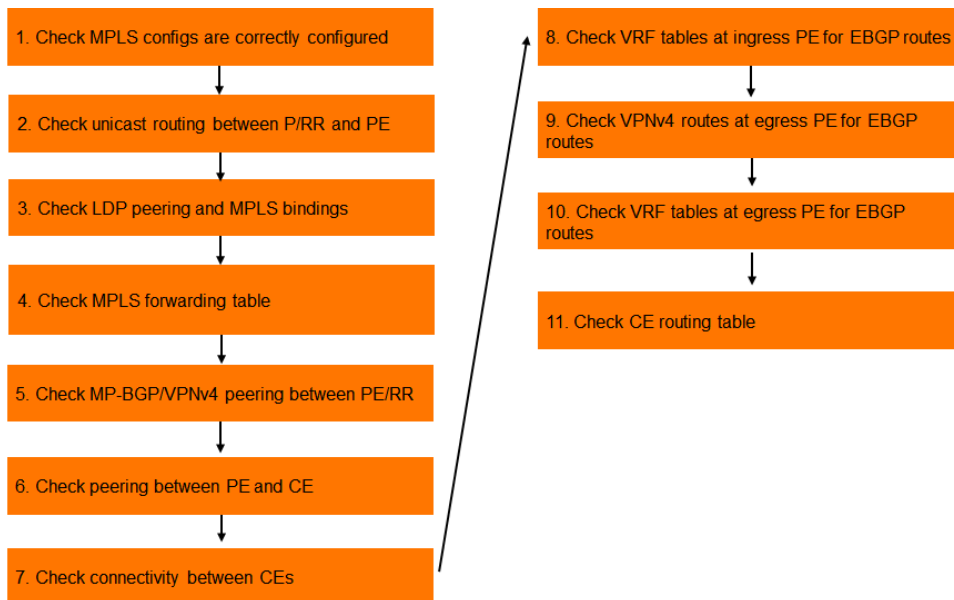
```
mirror session 1
  enable
  destination interface 1/1/40
  source interface 1/1/51 both
```

If requested by TAC engineer:

```
diagnostics
diag-dump mpls basic

debug mpls all
sh debug buffer
no debug all
```

The recommended MPLS troubleshooting flow is provided in the diagram below.



Troubleshooting steps

Follow the process outlines below to troubleshoot MPLS-related issues:

Step 1: Verify that MPLS configurations are correct

Refer to the [Use cases](#) section for CE, PE and P sample configurations.

Step 2: Check unicast routing between P/RR and PE

On PE, verify loopbacks from remote P and PE have been learned. If not seen, verify that OSPF is enabled and advertising loopbacks on remote P and PE:

```

PE1# show ip route

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
               R - RIP, B - BGP, O - OSPF
Type Codes:   E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
               IA - OSPF internal area, E1 - OSPF external type 1
               E2 - OSPF external type 2

VRF: default

Prefix      Nextthop      Interface      VRF (egress)      Origin/
Distance/   Age
-----
1.1.1.1/32   -              loopback0      -                  L              [0/0]
2.2.2.2/32   30.0.0.2      1/1/38         -                  O
[110/20]     00h:12m:32s
3.3.3.3/32   30.0.0.2      1/1/38         -                  O
[110/10]     00h:12m:52s
  
```

```

30.0.0.0/24      -          1/1/38      -          C          [0/0]
-
30.0.0.1/32     -          1/1/38      -          L          [0/0]
-
30.1.0.0/24     30.0.0.2   1/1/38      -          O
[110/20]       00h:12m:52s

Total Route Count : 6

```

Step 3: Check LDP peering and MPLS bindings

Verify LDP neighbor is up:

```

PE1# show mpls ldp neighbor
Local LDP Identifier: 1.1.1.1:0, Peer LDP Identifier: 3.3.3.3:0
  Graceful Restart: No
  Session Holdtime: 40 sec
  Up time: 00:13:49
  State: operational
  LDP Discovery Sources: 1/1/38
  Addresses bound to this peer:
    3.3.3.3 30.0.0.2 30.1.0.1

```

Verify labels and MPLS bindings for remote P and PE exist:

```

PE1# show mpls ldp bindings
30.1.0.1/32
  No local binding
  remote binding: lsr:3.3.3.3:0 label: exp-null
1.1.1.1/32
  local binding: label: exp-null
  remote binding: lsr:3.3.3.3:0 label:16
30.0.0.1/32
  local binding: label: exp-null
  No remote binding
30.0.0.2/32
  No local binding
  remote binding: lsr:3.3.3.3:0 label: exp-null
3.3.3.3/32
  local binding: label: 17
  remote binding: lsr:3.3.3.3:0 label: exp-null
2.2.2.2/32
  local binding: label: 18
  remote binding: lsr:3.3.3.3:0 label:17

```

If the bolded examples are not seen, verify that remote PE has LDP established.

Step 4: Check MPLS forwarding table

Verify nexthop, labels, and routes exist for remote VPNv4 (outgoing label 18) and PE (outgoing label 17):

```

PE1# show mpls forwarding

MPLS Bindings

Entry Bindings   : 4

```

```

Exit Bindings      : 3
Transit Bindings  : 2

Entry Bindings:
Origin Prefix      Ingress  Nexthop  Outgoing  Egress   Egress   Status
                   VRF       Address  Label     Interface VRF
-----
LDP  2.2.2.2/32    default  30.0.0.2  17        1/1/38   default
operational
LDP  3.3.3.3/32    default  30.0.0.2  exp-null  1/1/38   default
operational
BGP  20.2.0.0/24   vrf_1    2.2.2.2   18        1/1/38   default
operational
BGP  201.0.0.0/24  vrf_1    2.2.2.2   18        1/1/38   default
operational

Exit Bindings:
Origin  Prefix      Incoming  Service  Egress   Status
Label   Label      Label     Label    VRF
-----
static  n/a          exp-null  -        default  operational
BGP     n/a          imp-null  16       vrf_1    operational
static  n/a          7         -        default  operational

```

Step 5: Check MP-BGP VPNv4 peering between PE/RR

Verify that MP-BGP VPNv4 peering is established. If it's down, verify and fix network reachability between source and destination peering IPs.

```

PE1# show bgp vpnv4 un neighbors
Codes: ^ Inherited from peer-group

VRF : default

BGP Neighbor 3.3.3.3 (Internal)
  Description      :
  Peer-group       :

  Remote Router Id : 3.3.3.3           Local Router Id  : 1.1.1.1
  Remote AS        : 200             Local AS         : 200
  Remote Port      : 43923          Local Port       : 179
  State            : Established   Admin Status    : Up
  Conn. Established : 2              Conn. Dropped   : 1
  Passive          : No              Update-Source   : loopback0

```

Step 6: Check peering between PE and CE

Verify EBGP peering to CE on the PE

```

PE1# show bgp vrf vrf_1 ipv4 unicast neighbors
Codes: ^ Inherited from peer-group

VRF : vrf_1

```

```

BGP Neighbor 20.1.0.1 (External)
  Description      :
  Peer-group      :

  Remote Router Id   : 20.1.0.1           Local Router Id   : 20.1.0.2
  Remote AS         : 100                 Local AS         : 200
  Remote Port       : 51588              Local Port       : 179
  State            : Established       Admin Status     : Up
  Conn. Established : 1                   Conn. Dropped    : 0
  Passive          : No                   Update-Source    :
  Cfg. Hold Time   : 180                 Cfg. Keep Alive  : 60
  Neg. Hold Time   : 180                 Neg. Keep Alive  : 60
  Up/Down Time     : 00h:20m:28s        Connect-Retry Time : 120
  Local-AS Prepend : No                   Alt. Local-AS    : 0
  BFD              : Disabled
  Password         :
  Last Err Sent    : Cease
  Last SubErr Sent : Administrative Shutdown
  Last Err Rcvd   : No Error
  Last SubErr Rcvd : No Error

```

Step 7: Check connectivity between PEs and between CEs

Ping from CE to remote CE WAN and LAN to verify MPLS L3 VPN connectivity:

```

CE1# ping 20.2.0.2
PING 20.2.0.2 (20.2.0.2) 100(128) bytes of data.
108 bytes from 20.2.0.2: icmp_seq=1 ttl=61 time=0.307 ms
108 bytes from 20.2.0.2: icmp_seq=2 ttl=61 time=0.328 ms
108 bytes from 20.2.0.2: icmp_seq=3 ttl=61 time=0.340 ms
108 bytes from 20.2.0.2: icmp_seq=4 ttl=61 time=0.335 ms
108 bytes from 20.2.0.2: icmp_seq=5 ttl=61 time=0.354 ms

```

Traceroute from CE to remote CE to verify the hop information over MPLS L3 VPN:

```

CE1# traceroute 20.2.0.2
traceroute to 20.2.0.2 (20.2.0.2), 1 hops min, 30 hops max, 3 sec. timeout, 3
probes
 1  20.1.0.2  0.177ms  0.121ms  0.087ms
 2  30.0.0.2  0.233ms  0.120ms  0.122ms
 3  30.1.0.2  0.260ms  0.123ms  0.125ms
 4  20.2.0.2  0.189ms  0.149ms  0.144ms

```

Ping from PE to remote PE to verify MPLS L3 VPN connectivity:

```

PE1# ping 20.2.0.1 vrf vrf_1
PING 20.2.0.1 (20.2.0.1) 100(128) bytes of data.
108 bytes from 20.2.0.1: icmp_seq=1 ttl=60 time=0.334 ms
108 bytes from 20.2.0.1: icmp_seq=2 ttl=60 time=0.279 ms
108 bytes from 20.2.0.1: icmp_seq=3 ttl=60 time=0.280 ms
108 bytes from 20.2.0.1: icmp_seq=4 ttl=60 time=0.315 ms
108 bytes from 20.2.0.1: icmp_seq=5 ttl=60 time=0.291 ms

--- 20.2.0.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4091ms
rtt min/avg/max/mdev = 0.279/0.299/0.334/0.021 ms

```

Traceroute from PE to remote PE to verify hop information over MPLS L3 VPN:

```
PE1# traceroute 20.2.0.1 vrf vrf_1
traceroute to 20.2.0.1 (20.2.0.1), 1 hops min, 30 hops max, 3 sec. timeout, 3
probes
 1  30.0.0.2  0.224ms  0.156ms  0.158ms
 2  30.1.0.2  0.186ms  0.138ms  0.136ms
 3  20.2.0.1  0.160ms  0.147ms  0.127ms
```

Step 8: Check VRF tables at ingress PE for EBGp routes

On ingress PE, verify that routes from both the connected CE and remote PE are learned. If the expected route is not learned, check if the CE and remote PE are learning and advertising routes. In the example below, 20.2.0.0/24 is the route from the remote PE and 101.0.0.0/24 is the route from the directly connected CE:

```
PE1# show ip rib vrf vrf_1

Displaying ipv4 routes in RIB

Origin Codes: R - RIP, O - OSPFv2, B - BGP
               C - connected, S - static, L - local
Type Codes:   E - External BGP, I - Internal BGP
               IA - OSPF inter area, ia - OSPF intra area
               E1 - OSPF external type 1, E2 - OSPF external type 2
               EV - BGP EVPN, V - BGP VPN
* indicates selected for forwarding

VRF: vrf_1

Prefix          Nexthop          Interface          VRF (egress)  Origin/
Distance/      Age
-----
*20.1.0.0/24    -                1/1/37             -              C          [0/0]
-
*20.1.0.2/32    -                1/1/37             -              L          [0/0]
-
*20.2.0.0/24    2.2.2.2         -                  -              B/V
[200/0]         00h:24m:27s
*101.0.0.0/24   20.1.0.1        -                  -              B/E          [20/0]
00h:14m:53s
*201.0.0.0/24   2.2.2.2         -                  -              B/V
[200/0]         00h:14m:50s

Total Route Count : 5
```

```
PE1# show ip route vrf vrf_1

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
               R - RIP, B - BGP, O - OSPF
Type Codes:   E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
               IA - OSPF internal area, E1 - OSPF external type 1
               E2 - OSPF external type 2
```

```

VRF: vrf_1

Prefix          NextHop      Interface    VRF (egress)  Origin/
Distance/      Age
-----
20.1.0.0/24    -            1/1/37      -              C          [0/0]
-
20.1.0.2/32    -            1/1/37      -              L          [0/0]
-
20.2.0.0/24    2.2.2.2    1/1/38    default        B/V       [200/0]
00h:26m:51s
101.0.0.0/24  20.1.0.1   1/1/37    -              B/E       [20/0]
00h:11m:42s
201.0.0.0/24   2.2.2.2     1/1/38     default        B/V       [200/0]
00h:11m:42s

Total Route Count : 5

```

Step 9: Check VPNv4 routes at egress PE for EBGp routes

Verify CE LAN routes appear in the output:

```

PE2# show bgp vpnv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete

VRF : default
Local Router-ID 2.2.2.2

      Network          NextHop      Metric    LocPrf    Weight Path
Route Distinguisher: 1:1
*>i 20.1.0.0/24        1.1.1.1      0          100       0        ?
Route Distinguisher: 1:2
*> 20.2.0.0/24        0.0.0.0      0          100       0        ?
Route Distinguisher: 1:1
*>i 101.0.0.0/24      1.1.1.1      0          100       0        100 i
Route Distinguisher: 1:2
*> 201.0.0.0/24      0.0.0.0      0          100       0        100 i
Total number of entries 4

```

Step 10: Check VRF tables at egress PE for EBGp routes

Verify CE LAN routes appear in the output:

```

PE2# show ip rib vrf vrf_1

Displaying ipv4 routes in RIB

Origin Codes: R - RIP, O - OSPFv2, B - BGP
               C - connected, S - static, L - local
Type Codes:   E - External BGP, I - Internal BGP

```

```

        IA - OSPF inter area, ia - OSPF intra area
        E1 - OSPF external type 1, E2 - OSPF external type 2
        EV - BGP EVPN, V - BGP VPN
* indicates selected for forwarding

VRF: vrf_1

Prefix          Nexthop          Interface          VRF(egress)  Origin/
Distance/      Age
-----
*20.1.0.0/24    1.1.1.1          -                  -             B/V
[200/0]        00h:23m:48s
*20.2.0.0/24    -                 1/1/26            -             C             [0/0]
-
*20.2.0.1/32    -                 1/1/26            -             L             [0/0]
-
*101.0.0.0/24  1.1.1.1         -                  -             B/V
[200/0]        00h:14m:14s
*201.0.0.0/24  20.2.0.2       -                  -             B/E             [20/0]
00h:14m:12s

Total Route Count : 5

```

```

PE2# show ip route vrf vrf_1

Displaying ipv4 routes selected for forwarding

Origin Codes: C - connected, S - static, L - local
               R - RIP, B - BGP, O - OSPF
Type Codes:   E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
               IA - OSPF internal area, E1 - OSPF external type 1
               E2 - OSPF external type 2

VRF: vrf_1

Prefix          Nexthop          Interface          VRF(egress)  Origin/
Distance/      Age
-----
20.1.0.0/24    1.1.1.1          1/1/25            default       B/V
[200/0]        00h:21m:20s
20.2.0.0/24    -                 1/1/26            -             C
[0/0]         -
20.2.0.1/32    -                 1/1/26            -             L
[0/0]         -
101.0.0.0/24  1.1.1.1         1/1/25            default       B/V
[200/0]        00h:11m:46s
201.0.0.0/24  20.2.0.2       1/1/26            -             B/E
[20/0]        00h:11m:44s

Total Route Count : 5

```

Step 11: Check CE routing table

Check routes on CE and verify that remote CE routes have been learned. In the output below, 20.2.0.0/24 is the remote CE WAN subnet and 201.0.0.0/24 is the remote CE LAN subnet:

```
CE1# show ip route
```

```
Displaying ipv4 routes selected for forwarding
```

```
Origin Codes: C - connected, S - static, L - local
```

```
R - RIP, B - BGP, O - OSPF
```

```
Type Codes: E - External BGP, I - Internal BGP, V - VPN, EV - EVPN
```

```
IA - OSPF internal area, E1 - OSPF external type 1
```

```
E2 - OSPF external type 2
```

```
VRF: default
```

Prefix Distance/ Age	Nexthop	Interface	VRF(egress)	Origin/ Type	Metric
20.0.0.0/24 [0/0]	-	1/1/43	-	C	
20.0.0.2/32 [0/0]	-	1/1/43	-	L	
20.1.0.0/24 [0/0]	-	1/1/44	-	C	
20.1.0.1/32 [0/0]	-	1/1/44	-	L	
20.2.0.0/24 [20/0]	20.1.0.2 00h:13m:15s	1/1/44	-	B/E	
101.0.0.0/24 [200/0]	20.0.0.1 00h:01m:10s	1/1/43	-	B/I	
101.0.1.0/24 [200/0]	20.0.0.1 00h:01m:10s	1/1/43	-	B/I	
101.0.2.0/24 [200/0]	20.0.0.1 00h:01m:10s	1/1/43	-	B/I	
101.0.3.0/24 [200/0]	20.0.0.1 00h:01m:10s	1/1/43	-	B/I	
101.0.4.0/24 [200/0]	20.0.0.1 00h:01m:12s	1/1/43	-	B/I	
201.0.0.0/24 [20/0]	20.1.0.2 00h:01m:12s	1/1/44	-	B/E	
201.0.1.0/24 [20/0]	20.1.0.2 00h:01m:12s	1/1/44	-	B/E	
201.0.2.0/24 [20/0]	20.1.0.2 00h:01m:12s	1/1/44	-	B/E	
201.0.3.0/24 [20/0]	20.1.0.2 00h:01m:12s	1/1/44	-	B/E	
201.0.4.0/24 [20/0]	20.1.0.2 00h:01m:12s	1/1/44	-	B/E	

```
Total Route Count : 15
```

Caveats and limitations

- It is recommended to configure Jumbo frame support on all MPLS-enabled interfaces to avoid any unexpected network drops, as fragmentation on MPLS frames is not possible.
- For site connectivity redundancy, two standalone Provider Edge (PE) devices connected to the Customer Edge (CE) device at the site must be used, and not two PE devices in the VSX mode.
- ICMP Ping/Traceroute with ip-options are not supported over an L3VPN.

- MPLS/LDP - config restore using a checkpoint is not supported. Performing this action may lead to VPNV4 neighbor struck in a **bgp idle** state with a **cease/connection rejected** error.
- MPLS is supported on Core-Spine and Aggregation-Leaf profiles only.
- Dual IGP paths on MPLS core (that is, between PE to P) supported only in Active Standby.
- Route-map, ORF, aggregate-address, add-path capability, carrying MED are not supported with VPNV4 neighbours.
- MPLS is not supported on sub-interfaces or split-ports
- This feature provides explicit-null support only. Any 3rd party PE will need to be configured with Explicit-null for proper forwarding.
- Static LSP must be used in single label forwarding deployments and LDP/BGP configurations must be used for all L3VPN deployments.
- While using site connectivity redundancy, the same RD must be configured on both stand-alone PE devices to provide BGP best path selection.
- On leaving the MPLS core, the MPLS QoS EXP bit is copied to both the Ethernet and IP header at the Label Edge Router (LER). This is required at the egress LER to keep the CoS value same as ingress.

Frequently asked questions

1. Can L2 subnets be extended across an MPLS L3 VPN network?

No, only L3 routing between CEs is supported across MPLS L3 VPN network. VXLAN can be used on CEs to provide L2 subnet stretching over the MPLS L3 VPN network.

2. Is multicast and IPv6 routing and supported across an MPLS L3 VPN network with 10.09?

No, 10.09 MPLS L3 VPN only supports IPv4 unicast routing. VXLAN can be used on CEs to provide multicast and IPv6 routing over the MPLS L3 VPN network.

3. Is VSX required on PEs for high availability?

VSX is not required on PEs as L3 routing across 2 standalone PEs (from a dual homed CE) provides PE redundancy.

4. How does the L3VPN solution enable site redundancy?

Site redundancy can be achieved using dual standalone PE devices connected to the site CE device that requires redundancy instead of using the PE devices in VSX mode. In order to ensure optimal best path selection, BGP configurations should implemented as explained in the examples above with same RD configurations on both PE devices.

5. Are non-L3VPN forwarding deployments supported?

Non-L3VPN forwarding deployments are supported with static LSP. Please refer to the [lsp label imposition](#) command for configuration details. LDP/BGP need to be configured on devices as explained in the examples above for all L3VPN deployments.

6. Why is BGP peer establishment failing with a non-HPE Aruba Networking device as PE and HPE Aruba Networking P device as a router?

It is important to make sure that explicit-null is correctly configured on the non-HPE Aruba Networking PE device for forwarding between the HPE Aruba Networking P device and non-HPE Aruba Networking

PE device. The HPE Aruba Networking P device requires proper explicit-null configuration for LDP label distribution. This enables BGP session establishment through the MPLS core.

7. Why is BGP peer establishment causing intermittent flaps in the MPLS domain?

Make sure that all interfaces that are enabled for MPLS are also configured to support jumbo frames. If MPLS-enabled interfaces do not support jumbo frames it's possible that the BGP route exchanges could be bigger than the configured MTU. Configuring jumbo frame support across the MPLS domain will prevent any traffic interruptions due to BGP session flaps.

8. Are IP/ICMP Ping IP options and dual homing supported with MPLS?

Packets over MPLS with IP options will get dropped. Ping or traceroute over MPLS paths on a dual-home network will fail and packets would be dropped.

Accessing HPE Aruba Networking Support

HPE Aruba Networking Support Services	https://www.hpe.com/us/en/networking/hpe-aruba-networking-support-services.html
AOS-CX Switch Software Documentation Portal	https://arubanetworking.hpe.com/techdocs/AOS-CX/help_portal/Content/home.htm
HPE Aruba Networking Support Portal	https://networkingsupport.hpe.com/home
North America telephone	1-800-943-4526 (US & Canada Toll-Free Number) +1-650-750-0350 (Backup—Toll Number)
International telephone	https://www.hpe.com/psnow/doc/a50011948enw

Be sure to collect the following information before contacting Support:

- Technical support registration number (if applicable)
- Product name, model or version, and serial number
- Operating system name and version
- Firmware version
- Error messages
- Product-specific reports and logs
- Add-on products or components
- Third-party products or components

Other useful sites

Other websites that can be used to find information:

HPE Aruba Networking Developer Hub	https://developer.arubanetworks.com/hpe-aruba-networking-aoscx/docs/about
Airheads social forums and Knowledge Base	https://community.arubanetworks.com/
AOS-CX Software Technical Update channel on YouTube.	Videos on new features introduced in this release: https://www.youtube.com/playlist?list=PLsYGHuNuBZcbWPEjjHuVMqP-Q_UL3CskS

HPE Aruba Networking Hardware Documentation and Translations Portal	https://arubanetworking.hpe.com/techdocs/hardware/DocumentationPortal/Content/home.htm
HPE Aruba Networking software	https://networkingsupport.hpe.com/downloads
Software licensing and Feature Packs	https://licensemanagement.hpe.com/
End-of-Life information	https://networkingsupport.hpe.com/end-of-life

Accessing Updates

You can access updates from the HPE Aruba Networking Support Portal at <https://networkingsupport.hpe.com>.

Some software products provide a mechanism for accessing software updates through the product interface. Review your product documentation to identify the recommended software update method.

To subscribe to eNewsletters and alerts:

<https://networkingsupport.hpe.com/notifications/subscriptions> (requires an active HPE Aruba Networking Support Portal account to manage subscriptions). Security notices are viewable without an HPE Aruba Networking Support Portal account.

Warranty Information

To view warranty information for your product, go to <https://www.arubanetworks.com/support-services/product-warranties/>.

Regulatory Information

To view the regulatory information for your product, view the *Safety and Compliance Information for Server, Storage, Power, Networking, and Rack Products*, available at <https://www.hpe.com/support/Safety-Compliance-EnterpriseProducts>

Additional regulatory information

HPE Aruba Networking is committed to providing our customers with information about the chemical substances in our products as needed to comply with legal requirements, environmental data (company programs, product recycling, energy efficiency), and safety information and compliance data, (RoHS and WEEE). For more information, see <https://www.arubanetworks.com/company/about-us/environmental-citizenship/>.

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docsfeedback-switching@hpe.com). When submitting your feedback, include the document title, part number, edition, and publication date located on the front cover of the document. For online help content, include the product name, product version, help edition, and publication date located on the legal notices page.