Network Configuration Example

Configuring Layer 3 Cloud Data Center Tenants

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Table of Contents

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About This Document

This document describes the Cloud Data Center Solution design and architecture for multi-tenancy. This document complements the configuration guidance provided in *Example: Configuring an Advanced Layer 2 Cloud Data Center Customer Deployment* by further adding the Layer 3 Customer Deployment use case and the Combined Layer 2 and Layer 3 Customer Deployment use case scenarios. This document was validated using Junos® OS Release 12.3R6.

Cloud Data Center Overview

The cloud data center (CDC) focuses on providing data center connectivity from various external networks to services located within a multi-tenant data center. A CDC typically has more challenging business requirements than a more traditional data center that only services a single entity. Multi-tenancy requires high security, scale, and performance.

Combining the advanced routing and switching features on Juniper Networks® MX Series 3D Universal Edge Routers allows the creation of a highly secure, scalable, high-performance data center. Depending on the size of the data center, and how many tenants are required, various tiers of the data center network can be collapsed into a single tier.

This document outlines the problems and challenges with designing a multi-tenant data center, the various roles and requirements of each tier in the architecture, and an end-to-end solution architecture to solve these problems and meet crucial requirements.

Customer Use Case

Many customers are in the process of converting select points of presence (POP), sites, or subsets of their POPs or sites to cloud data center sites. These conversions are the result of investing in services, to build new revenue streams as wireline service providers have faced increased commoditization pressure. At one time, deployment of VPNs and other Internet connectivity services could generate healthy revenues and profits, but now service providers are facing increased competition which can affect their margins. For instance, smaller cloud service providers are entering the market by providing backhauling traffic across the Internet to a handful of customer remote sites or through fast pipes and VPN services that were purchased from larger service providers.

Service providers are always looking for new offerings to show value and innovation. Cloud and virtualization technologies are relatively new and have, until recently, been controlled by only a few providers who have kept their deployments confidential. As these technologies have become better understood, and new technology options are brought to market that facilitate the implementation of such cloud data centers, cloud service deployments are now less difficult to deploy.

Provisioning a Layer 3 tenant architecture design into the data center enabled by Juniper Networks helps wireline service providers embrace cloud offerings. As all of these new technology trends are coming together, wireline service providers are rapidly moving to become the next cloud and data center providers.

Solution Technical Overview

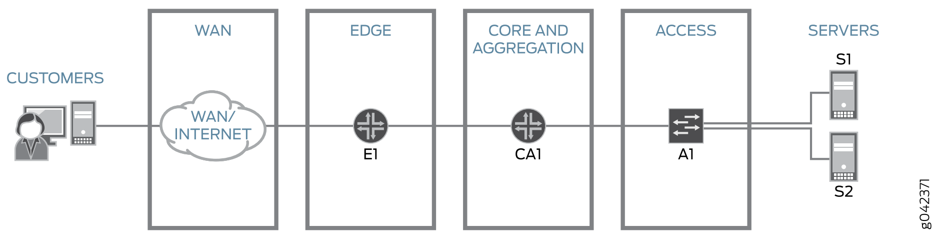
The following sections provide a general discussion around the solution provided in this document:

- End-to-End Architecture on page 2
- Functional Description on page 2

End-to-End Architecture

Cloud data center networks contain the four basic building blocks to provide transport between customers and servers. Each component of this solution is broken out into a discrete functional block as shown in Figure 1 on page 2.

Figure 1: Architectural Function Blocks



As shown in the diagram, the CDC solution provides customer access to virtual servers and is agnostic to the underlying WAN. Each customer is completely isolated from other customers in the data center.

Functional Description

Each component of the solution has a discrete set of responsibilities that must work together to create an end-to-end solution architecture. The major components in the CDC include the customers, WAN, edge router, core and aggregation router, network services, and the access switch. Depending on the requirements and deployment scenario, each component can use different features, protocols, and topologies by collapsing multiple tiers into one.

- Customers on page 2
- WAN on page 3
- Edge Router on page 3
- Core and Aggregation on page 5
- Access on page 6
- CoS Decision Points on page 7
- Layer 3 Customer Definitions on page 7

Customers

The types of customers supported in a CDC deployment can vary, depending on the deployment scenario configured. The most common customer type is a business or

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corporate customer that purchases virtual servers from a service provider. Another common customer type is an end user accessing Internet content from a workstation through a Web browser.

WAN

The role of the WAN is to provide transport from the user to the data center. How the WAN looks depends on the requirements associated with the customer deployment scenario.

- Internet on page 3
- MPLS Backbone on page 3
- Private Peering on page 3

Internet

The Internet offers various forms of data center access. This access can be as simple as accessing a public IP address on the Internet, but can include more complex access options, for example, using tunneling protocols such as GRE and IPsec to provide private IP addressing and security.

MPLS Backbone

Another common option to delivering customer access into the CDC is through the use of a customer's existing managed MPLS network. Again, the type of VPN used with this option depends on the customer's access requirements. However, the most common examples are to use Layer 2 or Layer 3 VPNs.

Private Peering

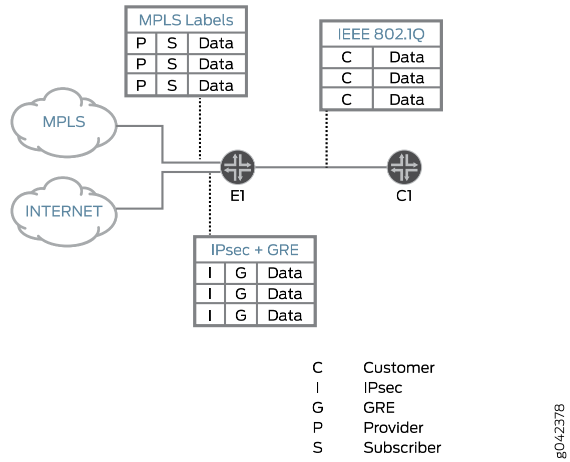
Customers with higher performance and security requirements might want to peer directly with the cloud provider. Private peering is dedicated to a single tenant where other tenant traffic does not impact the transport. This transport method also provides a trusted medium between the tenant and the service provider, typically eliminating the need for any transport encryption.

Edge Router

The edge router has the most requirements and responsibilities in a CDC solution. The primary responsibilities of the edge router are to aggregate all edge networks into the data center and to serve as the throttle point for all ingress and egress traffic for the data center.

In addition, the edge router has the unique responsibility of multiplexing and de-multiplexing customer traffic from various edge networks prior to it entering the data center. Figure 2 on page 4 shows edge router E1 accepting various edge network traffic (for example, MPLS backbone and Internet transit traffic) and mapping it to a specific customer.

Figure 2: Edge Router Multiplexing and Demultiplexing



To ensure that customer traffic is isolated and secure, the edge router must have a consistent method of mapping customer traffic from one or more edge networks into the data center.

Environments containing multiple tenants place additional requirements on the edge routers, making it unlike a traditional core router in single-tenant data center, campus network, or core network. Traditionally, the edge router is a pure Layer 3 device and does not participate in Layer 2. This means that supporting multiple tenants typically requires service providers provide both Layer 2 and Layer 3 access to customers.

Both the edge router and the core and aggregation router in a multi-tenant environment must support high-scale Layer 2. To support the high scale requirements of a multi-tenant data center, the core router must use the concept of a virtual switch to transport customer traffic. IEEE 802.1Q scales up to 4094 VLANs. A virtual switch constitutes an individual IEEE 802.1Q domain. By using multiple instances of virtual switches, the number of VLANs per physical system can then be scaled beyond the previous 4094 VLAN limit. This limitation is traditionally seen at the access layer, which now can be addressed by applying multiple virtual switch instances. In these cases the edge and customer access routers must be able to support virtual switch aggregation across multiple 802.1Q domains to provide VLAN normalization and therefore seamless connectivity to CDC access switches. Deterministic VLAN normalization is required to maintain customer isolation in a multi-tenant environment. This is detailed further in the customer design sections.

The edge and customer access routers are the throttle points for all bridged traffic. To support more than 4094 VLANs, these routers must be able to support IEEE 802.1Q bridge domains and virtual switches.

One of the drawbacks of using IEEE 802.1Q is that it requires a large number of logical interfaces. This level of scale is amplified for every network-to-network interface (NNI). For example, to support 32,000 VLANs, each NNI must support 32,000 logical interfaces. Each node in the network typically has at least three NNIs to connect any northbound or upstream inter-chassis links. This does not include southbound or downstream attached devices like access switches.

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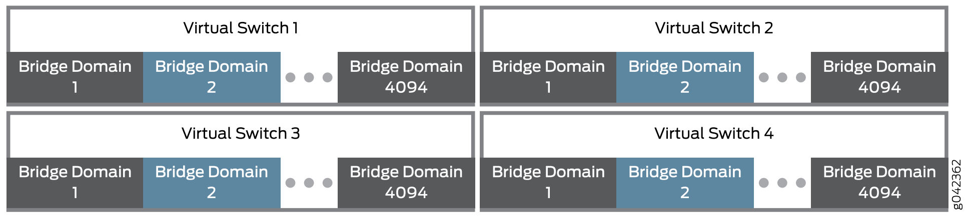
To support 20 access switches and three NNIs, each core node must support 736,000 logical interfaces, which is beyond the current 128,000 logical interface limitation as of Junos® OS Release 12.3 in a 64-bit Routing Engine. Figure 3 on page 5 shows the alternative to this limitation — using a virtual switch concept that creates a new routing instance for every 4094 bridge domains or VLANs on the core and aggregation device.

Figure 3: Bridge Domain and Virtual Switch Support



To support 32,000 VLANs, a total of eight routing instances with 4094 bridge domains each is required on the customer access routers with links to the access top-of-racks and edge devices configured as trunk ports. This method greatly reduces the number of logical interfaces required, but at the expense of using more NNIs. Virtual switches require a network port for each routing instance. In this example, of the 32,000 tenants, a total of eight network ports is required. However, the use of one NNI per 4094 bridge domains maintains deterministic performance and reduces latency. For Layer 3 customers, virtual switches on the edge are configured as per the data center, core, and/or aggregation devices, each containing 4094 bridge domains and using trunk ports.

NOTE: This is in contrast for Layer 2 customers where there is a virtual switch assigned per customer and the trunks are configured as logical interface based trunks. The detail of how the virtual switches and bridge domains are mapped at the core and edge are covered in more detail in the following sections detailing the customer or tenant design.

Core and Aggregation

In the core of the cloud data center (CDC), additional performance demands are placed on the core and aggregation routers that make up this layer, unlike the core in a single tenant data center or core network. In this design core routers only provide Layer 2 functions, as they are only providing transport across networking infrastructure only. In the high multi-tenancy design of the CDC core, the core and aggregation routers need to have the capabilities to map customer traffic into the servers and other services that reside in the access layer.

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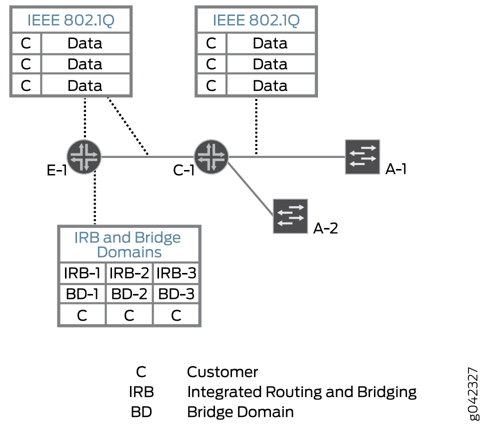
Figure 4: CDC Core and Aggregation Router Overview

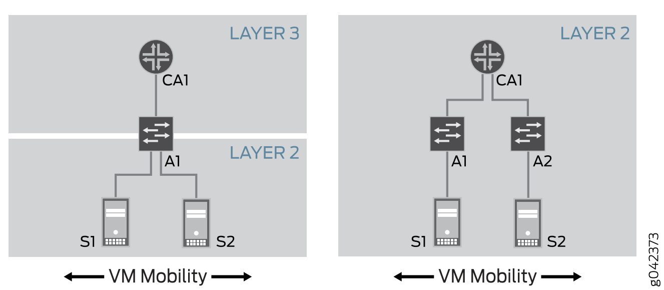


Access

The access tier terminates all server and end-host connections. Depending on the virtual machine mobility requirements, the access switch can operate at only Layer 2 or both Layer 2 and Layer 3. If virtual machine mobility is limited to a single access switch, then it is possible for the access switch to operate at both Layer 2 and Layer 3. However, if VM mobility must traverse multiple access switches, so must the broadcast domain. Figure 5 on page 6 illustrates how VM mobility impacts the access tier with regard to Layer 2 and Layer 3 boundaries. A1 shows the access switch and S1 and S2 show individual servers.

NOTE: **If the access switch is connected to the core and aggregation (CA) device using Layer 3, you cannot deliver Layer 2 VPN service to the customer.**

Figure 5: VM Mobility Options



Because of the varying customer requirements, it is recommended that you deploy the access using Layer 2. This deployment enables the customer to freely change between a Layer 2 or Layer 3 hand-off. The access switch has the fewest scaling requirements, because the majority of the scaling is managed by the core and aggregation device.

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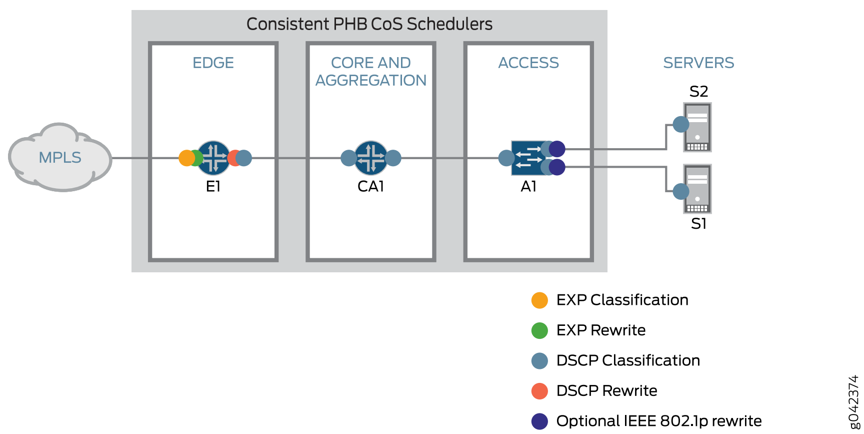
Using the recommended approach of configuring virtual switches and bridge domains, the access switch needs to only know how to handle IEEE 802.1Q (Layer 2 only) Ethernet frames.

CoS Decision Points

In a multi-tenant data center, the class-of-service (CoS) is subject to customer requirements. However, generally speaking, the network infrastructure must support two levels of service.

Figure 6 on page 7 shows the various CoS classifications and rewrites in a CDC topology. All tiers in the network should have a consistent per-hop behavior (PHB) with regard to scheduler configuration and classification. The edge router must be configured to preserve the classification between the MPLS and core networks with MPLS textual conventions and DSCP rewriting. Other routers and switches in the topology must be configured for consistent scheduling and classification of DSCP packets.

Figure 6: CDC CoS Locations



The schedulers are divided into four forwarding classes: network-control, expedited-forwarding, assured forwarding, and best-effort. This number of forwarding classes provides enough granularity to mark two levels of business applications, voice, and video traffic.

Layer 3 Customer Definitions

The Layer 3 customer tenant instances were defined as follows:

- Layer 3 was provided by the cloud provider.
- Each customer has his own Layer 3 routing instance.
- Each customer can have multiple bridge domains (VLANs).
- Each customer must be logically separate from any other customer and not be able to detect the existence of any other.

To implement these requirements, each customer was configured at the edge as a separate virtual routing and forwarding instance. This concept is shown in

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Figure 7 on page 8 where two Layer 3-only customers are each assigned two bridge domains and two IRBs accordingly.

Figure 7: Layer 3 Customer to Bridge Domains

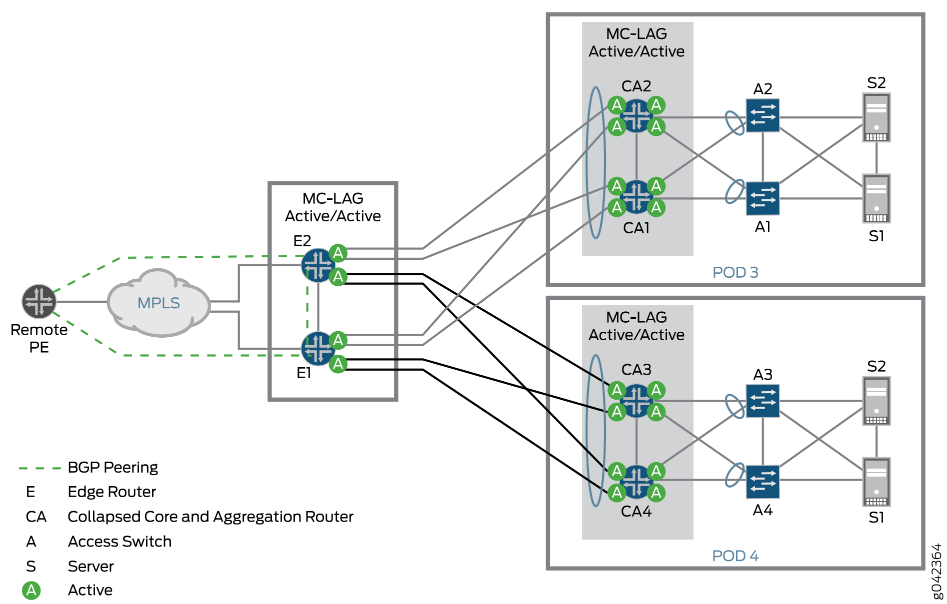
Virtual Router 1		Virtual Router 2	
irb.10	irb.20	irb.30	irb.40
Bridge Domain vlan-id 10	Bridge Domain vlan-id 20	Bridge Domain vlan-id 10	Bridge Domain vlan-id 20

g042363

The advanced Layer 3 VPN case in Figure 7 on page 8 shows multiple IRBs and bridge domains mapped to each virtual routing and forwarding (VRF) instance (mapped to a Layer 3 tenant). Thereby giving the tenant multiple environments separated from other customers using VRF instances on the Edge. The maximum number of customers here is 8000, but the number of compute environments (as defined as one per bridge domain) achievable is 32,000 if the IRBs are split across a pair of platforms, as the limiting factor in this design is the IRB scale of 16,000 per platform.

Figure 8 on page 8 provides an overview of the point of delivery topology, aggregated on the DC edge routers for Layer 3 customers. Now that VPLS is not enabled for these bridge domains, MC-LAG active/active between the core and edge can be run.

Figure 8: POD Topology Overview



This document will examine the following two methods of configuring the customers in the Layer 3 access example:

- Using trunk-style interfaces at Layer 2 to scale the VLANs in the data center and relying on Layer 3 routing separation to keep the customers separate.

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- Using logical interface style trunks (the same approach used in the layer 2 customer design), where Layer 2 separation is required for each customer using virtual-switches.

Cloud Data Center Design

Design Requirements

The following sections describe the various design requirements for this solution:

Layer 2 Connection to the Cloud Data Center

The service provider must offer Layer 2 connection capabilities to the cloud environment to enable some applications to reach other cloud assets using Layer 2, provide extension of the storage network from the customer environment to the cloud, and be able to accept a customer's virtual machine.

Layer 3 Connection to the Cloud Data Center

The cloud provider must provide Layer 3 connectivity to the cloud to enable routed connectivity between the cloud and the customer network, as well as to provide Internet access to customer cloud assets (for example, a customer webserver running in the cloud).

Cloud Infrastructure Mapping of Layer 2 and Layer 3 Customer Addresses

The cloud provider must provide Layer 2 and Layer 3 connectivity. Two possible methods of providing Layer 2 and Layer 3 connectivity are as follows:

- Extend the customer Layer 2 addressing schema and translate the Layer 2 address (that is, VLAN) at the cloud boundary. Typically, each customer gets one VLAN ID assigned in the cloud. That VLAN ID must represent that customer on that data center site and, in some cases, across data center sites. The latter implies that the unique VLAN ID must be carried over.

- Extend the customer Layer 3 addressing schema and do not translate between the customer and the cloud connection. This must be implemented in a way that enables the use of overlapping IP addresses while traffic separation occurs between tenants at the VLAN level.

High Degree of Network Investment Leverage

The data center provider must run technologies that enable active/active and multipath forwarding on the LAN and on the WAN. No interface on the path of equal cost network paths should be left unutilized or under-utilized.

Flexible and Collapsed Network Design

Network design has to be easy or flat. Within the data center, in terms of traffic and scaling, any point to any point connections should occur through the shortest and consistent length paths without throttle points. Complicated network designs cause scaling, operational, and provisioning problems. The cloud provider must be able to connect the WAN service and path instance of a customer to the compute and storage assets with maximum ease and flexibility.

The network paths of each tenant must be established across the topology with ease and should allow for easy, on-demand expansion and contraction. One of the primary reasons customers purchase cloud services is the ease in which the services can be rapidly built up or torn down as the need for the service dictates. This flexibility must be built into the network design and be supported by any technologies chosen.

High Degree of Scaling and Virtualization

The cloud data center must provide a high degree of scale, virtualization, and flexibility, to ensure that the service is profitable. The cloud business case relies on a much lower compute and storage unit cost, and profitability is achieved only when the degree of scaling and virtualization is high. Economies of scale help offer profitable services. Without this scale, the unit cost becomes too high, leaving no profit for the provider.

Compute and storage resources might have to run on servers at a certain degree of utilization and tenant VMs, or storage has to be moved from under-utilized resources to shut these down to save energy and cooling costs.

Separation of Multi-Tenant Traffic

Cloud providers must ensure that the traffic of each tenant is separated such that each tenant is unable to communicate with the other unless it occurs through the use of a firewall or other controlled mechanism. This separation alleviates cloud customer concerns surrounding security within the data center as well as between the cloud and the enterprise data center.

Building a High-Performance Data Center

The cloud operator's data center must be a high-performance data center that utilizes fast pipes to minimize delays between VMs and the storage environment. In addition, the data center must have a large number of network, server, and storage ports to satisfy any scale and profitability requirements.

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Network paths must display predictable and consistent latency, and any network or cloud performance must not depend on the location of any cloud assets.

VM Mobility

The cloud data center must allow for virtual machine (VM) mobility throughout the entire data center network to optimize compute resources and, in some cases, normalize VLAN assignments (provide VLAN translation techniques to maintain seamless access) between the customer and the provider thus giving flexibility of VLAN assignments to the cloud provider that are transparent to the customer.

VM mobility technology requires that Layer 2 paths be used within the data center. To satisfy this requirement, Layer 2 paths can reside directly on the wire or be configured in overlay mode.

VM mobility poses a new challenge to the network infrastructure. Previously, wireline networks were static, end stations that did not move. With the introduction of the cloud, and due to high scale and high utilization requirements for profitability, VMs can now move within and between data center sites. This means that Layer 2 and Layer 3 network paths, and in some cases firewall state information, can move in lockstep with the VM. In many cases, perfect (time) alignment of VM and network path migrations are difficult to achieve. To ease this migration, network designs or technologies that enable the movement of Layer 2 and Layer 3 paths, extending them with ease, are preferred. Network path extensions, in many cases, include replication of network state information between old and new locations, avoiding the occurrence of traffic interruption and application failures following the movement of the VM.

VM mobility is often necessary to optimize resource utilization within the data center. This resource optimization during VM mobility must occur without the knowledge of the customer, making network path extension and state replication abilities critical.

Programmability of Network Elements

The cloud solution infrastructure must provide a programmable means of building network paths in order to provide consistent, repeatable, and simplified automation. The high costs associated with automation and the complexity of network management are two of the more difficult items for the cloud operator to address. The value-added abilities of a cloud network infrastructure should help alleviate some of this cost and complexity.

Juniper Networks Cloud Data Center Solutions

Table 1 on page 11 outlines how the Juniper Networks Cloud Data Center (CDC) addresses the above-mentioned design requirements.

Table 1: CDC Requirements and Technology Options

Requirements	CDC Technology Options
Connection to cloud with L3	L3VPN, Internet, IPsec, GRE
Mapping of customer L2 and L3 addresses to cloud infrastructure	L2: BD, vSwitch, VLAN translations

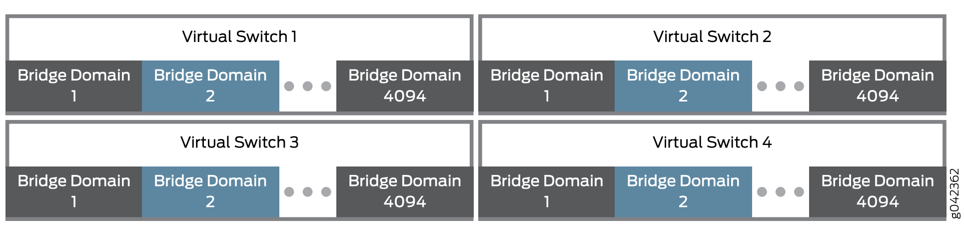
Table 1: CDC Requirements and Technology Options *(continued)*

Requirements	CDC Technology Options
High degree of (network) investment leverage (A/A, L2-L3-MP)	MC-LAG A/A, ECMP
Fast recovery from (network) failures	MC-LAG A/A, VC, FRR
Easy / flat network design	QF, VC, LAN
High degree of scaling and virtualization	>500K IPv4 /32 prefixes, 8000 L2 instances up to 4000 VPLS and 4000 VRF, 8000 VPN , 8000 VRF instances, 20,000 Bridge Domains
Separation of multi-tenant traffic	VPN, VRF, vSwitch, PVLAN, VLAN
Building high-performance data center	High-density platforms, high-density linecards, 1GE/10GE/40GE/100GE interfaces
VM mobility	VM mobility in the DC and between DC sites, VMware VM, Azure VM

Layer 3 Access Customer Using Trunk-Based Inter-Switch Links

The trunk-based approach to CDC deployment includes both benefits and trade-offs. To manage the number of logical interfaces in the system, minimizing the number of logical interfaces in the system for Layer 3 customers, VRF routing instances are used to create separation between customers. Each of these routing instances uses two integrated routing and bridging (IRB) instance routing interfaces, while bridge domain scale is achieved using virtual switches. To achieve this, virtual switch instances are configured on the core and/or aggregation devices and on the edge routers, using a one-to-one relationship, with each virtual switch containing 4094 bridge domains as shown in Figure 9 on page 12.

Figure 9: Virtual Switch to Bridge Domain Relationships



Using this configuration, each virtual switch represents a point-of-delivery (POD) of 4094 VLANs instead of a single customer. With each virtual switch containing 4094 VLANs, each aggregated Ethernet interface can be configured as a trunk for all VLANs, minimizing the total number of logical interfaces consumed to one per aggregated Ethernet interface instead of 4094.

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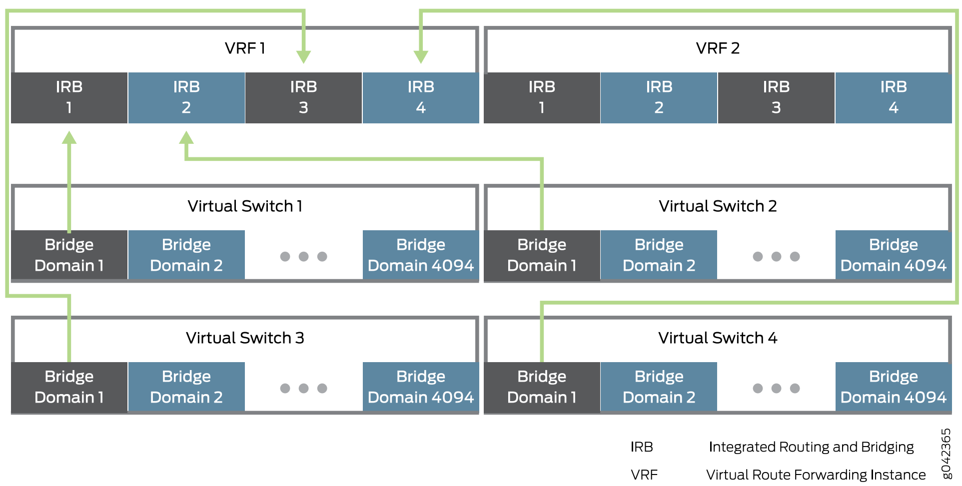
After achieving the VLAN scale necessary for the Layer 3 customers, the Layer 2 bridge domains in the virtual switching instances must be assigned to VRF instances. Each VRF is actually configured with two IRBs, each associated with a bridge domain (VLAN) from each of the virtual switches. As an example; Figure 10 on page 13 shows VRF 1 configured on the edge routers (Layer 3 Customer 1) and containing four IRBs, each IRB associated with a normalized bridge domain (1 through 4). The bridge domains (VLANs) are actually all bridge domain 1 from each of four separate virtual switches, each corresponding to a virtual switch instance on core and/or aggregation as well as edge devices.

Figure 10: IRB to Bridge Domain Mapping



In this example, abridge domain (i.e. Bridge Domain 1.... Bridge Domain 4094) is contained in each core switch within each virtual switch routing instance. Each virtual switch routing instance (customer VLAN) is denoted as 1/1 through 4/1. Similarly, Layer 3 tenant 2, tenant 3, tenant 4, and so on up to tenant 4094 will each consist of an associated VLAN from each access switch.

In this way, Layer 3 customers can be striped across the access switches and PODs to achieve the necessary eastbound-westbound traffic flow, while also avoiding logical interface consumption at the edge.

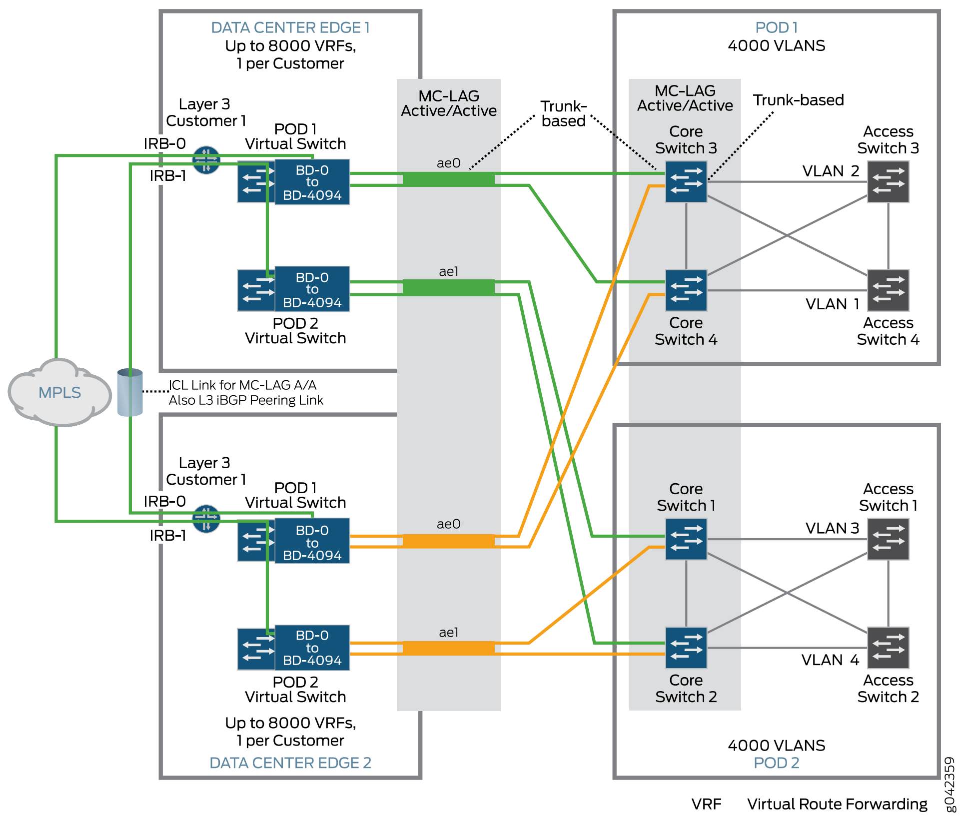
In this Layer 3 customer example, the creation of logical interfaces is avoided at the edge, only bridge domains are configured in the virtual switch, and logical interfaces are no longer explicitly configured. This configuration reduces the logical interface (IFL) load on the system, but the flexibility of assigning logical interfaces to bridge domains at the network edge is lost. Basically, this means that the cloud provider loses the ability to assign access VLAN to top-of-rack (TOR) across individual pods. This document details how to use IFL to bridge domain VLAN normalization in "Example: Configuring a Layer 3 Logical Interface-Based Cloud Data Center Customer Deployment with Inter-POD VM Mobility" on page 83.

NOTE: In the topology pictured in Figure 11 on page 14 there are no VPLS connections used in the WAN. Also, MC-LAG active/active is used here on the edge. MC-LAG active/active instances are used for all trunk-based links on the core and the edge devices. Each aggregated interface is assigned to a virtual switch instance. Therefore in this configuration all traffic flows in and out of both edge routers.

In this deployment Layer 2 virtual switch instances are used only to expand the VLAN domain in the device for scale. Each virtual switch instance will contain VLAN 1 ..... VLAN 4094. There are no logical interfaces to explicitly assign to a bridge domain, so the customer VLAN assignments will not be normalized when employing a trunk-based configuration.

Figure 11 on page 14 shows the Layer 3 customer design in more detail, but still focuses on the trunk-based design concept to reduce logical interface scale.

Figure 11: Layer 3 Customer Design –Trunk-Based Approach



This Layer 3 deployment of cloud data center tenants shows that the logical interface scale is reduced at the cost of some VLAN flexibility. This sacrifice provides higher Layer 3 tenant scale per MX series router. The MX series router has a maximum of 8,000 virtual instances (any combination of Layer 2 virtual switch or Layer 3 virtual router). By using

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this trunk-based configuration, only two virtual switch instances are consumed per POD. This frees the remaining resources for more Layer 3 virtual route instances in return.

Layer 3 Access Customer Using Logical Interface-Based Inter-Switch Links

It is possible to use logical interface-based trunks for Layer 3 customers, rather than trunk-based, for more access VLAN flexibility. In this configuration, the cloud provider has the ability to assign any logical interface VLAN to any bridge domain to any virtual switch.

This concept can be implemented in one of two ways:

- Either to maximize the separation (for increased security) for each Layer 3 customer.
- Or to maximize the scale (for increased flexibility) for each Layer 3 access customer.

The first way, shown in Figure 12 on page 16, is to configure a virtual switch and a VRF for each customer. Using this configuration, as VPLS is not configured in the WAN, provides both Layer 2 and Layer 3 separation and allows the use of MC-LAG active/active at the edge as there is no VPLS configured in the WAN. The configuration continues to use logical interface-based interfaces at the data center edge, enabling the cloud provider to assign any core or access VLAN to any customer bridge domain. This provides the most flexibility, allowing the assigning of any VLAN across PODs transparently from the point of view of the customer.

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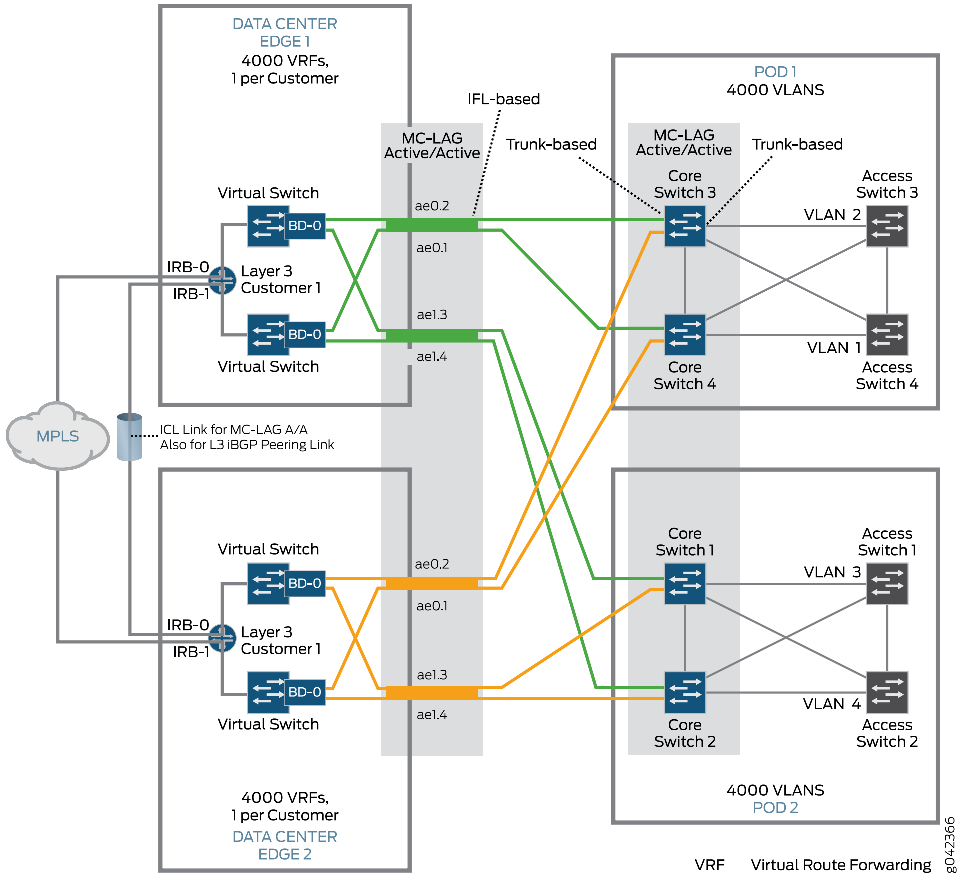
Figure 12: Layer 3 Customer Design - IFL Based with Maximized Security



The second apporach, shown in Figure 13 on page 17, is similar to the previous trunk-based example and the IFL based approach described above, in that the cloud provider can use a minimal number of virtual switches, each containing 4094 bridge domains. However, using this approach, the aggregated Ethernet links are logical interface-based (IFL). This configuration allows the same flexibility in the previous example, in that a cloud provider can assign any IFL based VLANs to any bridge domain across the core and access, but in this case there is no longer a customer specific Layer 2 or virtual switch instance.

This configuration enables the cloud provider to configure up to 8,000 VRFs (one per customer, the current system limit) but using a minimum number of virtual switch instances (as many as there are PODs), yet still maintain the flexibility of assigning any VLAN across any POD transparently from the point of view of the provider's customer. It also enables the provider to assign multiple logical interfaces to a single bridge domain, identical to the method described in Network Configuration Example: Configuring Layer 2 Cloud Data Center Tenants.

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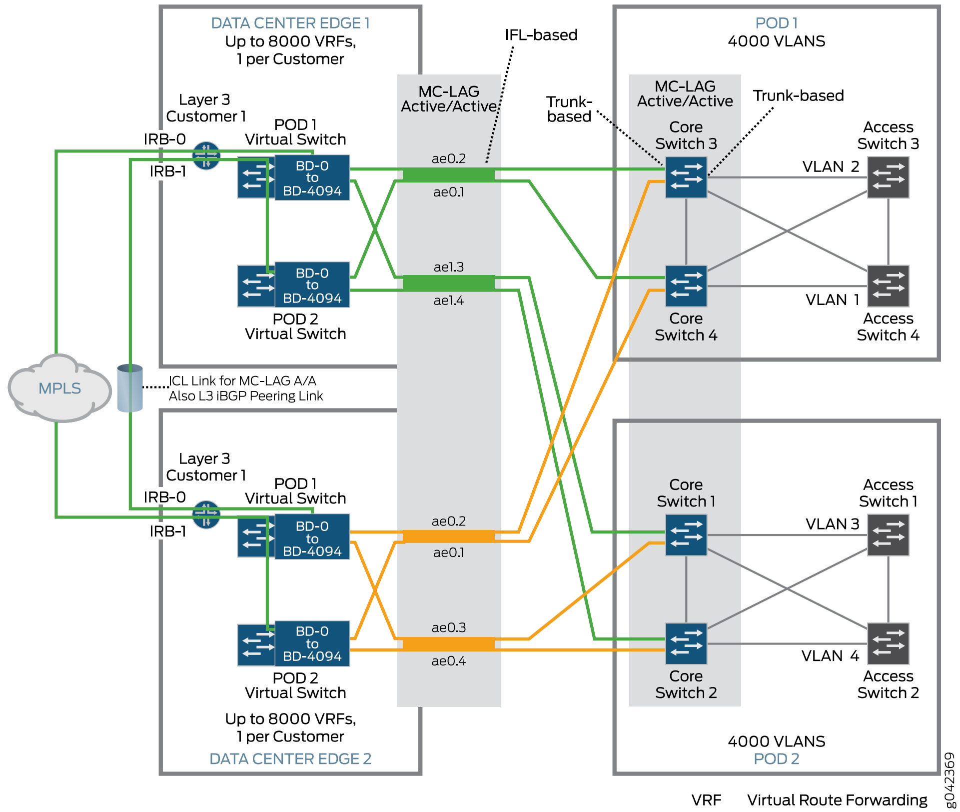
Figure 13: Layer 3 Customer Designed - IFL Based With Maximized Scale



Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment

This example details the steps required on all elements in the end-to-end configuration of the simple Layer 3 customer deployment, including the Layer 3 VPN configuration, core routers, edge routers, and class-of-service (CoS).

Table 2 on page 17 lists the various network nodes/devices, their roles in the network, and their configuration features.

Table 2: Nodes/Devices and Features

Network Node/Device Roles	Configuration Features
Remote PE Router	Interfaces: GE, XE Protocols: OSPF, OSPF3, IS-IS, BGP, RSVP, MPLS, BFD, VLAN Services: VRF, BD High Availability: GRES, NSB, NSR
MPLS Provider (P) Routers	Interfaces: GE, XE Protocols: OSPF, OSPF3, IS-IS, BFD

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Table 2: Nodes/Devices and Features *(continued)*

Network Node/Device Roles	Configuration Features
Data Center Edge Routers	Interfaces: GE, XE, AE, MC-A Protocols: OSPF, OSPF3, IS-IS, BFD, MPLS, RSVP, BGP, VLAN, PIM, ICCP, Layer 2-LEARNING, LACP Services: VRF, BD, NGMVPN, MC-LAG active/active High Availability: GRES, NSB, NSR
Data Center Core Routers	Interfaces: GE, XE,, AE, MC-AE Protocols: VLAN, ICCP, Layer 2-LEARNING, LACP Services: VIRTUAL-SWITCH, MC-LAG active/active High Availability: GRES, NSR, NSB
Top-of-Racks (TORs)	Interfaces: GE, XE, AE Protocols: VLAN, LACP Services: BD (VLANs in EX Terminology)

Figure 14 on page 19 shows a detailed test lab topology that was used for both Layer 2 and layer 3 customers.

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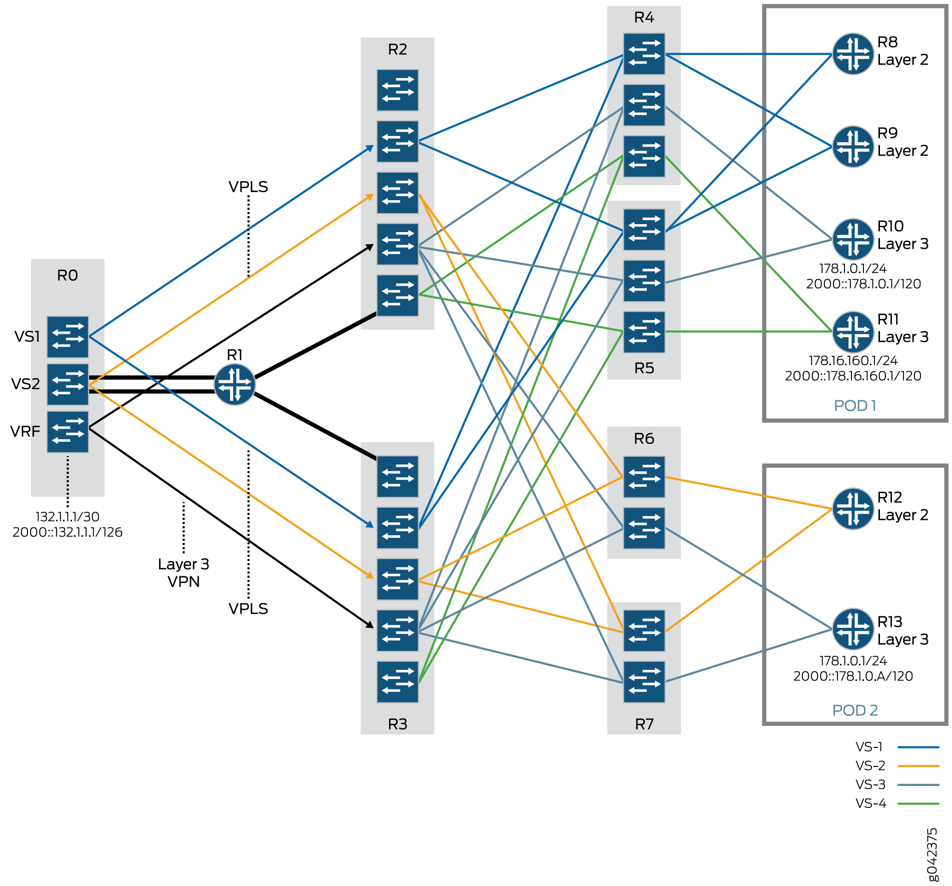
Figure 14: Detailed logical view of test lab topology (Layer 2 and Layer 3 customers)



Device R0 is the remote PE device where tenants can initiate a Layer 2 or Layer 3 connection to the data center. Device R1 is the provider (P) router in the MPLS network. Devices R2 and R3 are the provider edge (PE) routers at the data center edge. Devices R2 and R3 form a node redundancy (to alleviate issues should one of the routers go down). In addition, both routers, Device R2 and Device R3 each contain two Routing Engines (RE0 and RE1) to provide Routing Engine redundancy.

Two PODs are designed into the network. Devices R4 and R5 form the node redundancy for POD 1 that contains Devices R8, R9, R10, and R11 (all top-of-rack switches), while Devices R6 and R7 form the node redundancy for POD 2. In this design, Layer 2 is provisioned to the edge routers, Devices R2 and R3, and Layer 3 is provisioned in the Core and WAN.

The following sections explain the Layer 3 trunk-based configuration in more detail:

- Requirements on page 20
- Overview on page 23
- Configuring Routing Engine Resiliency on page 25
- Configuring Device Interfaces on page 25

Requirements

Table 3 on page 20 lists the hardware used on each node/device in this configuration.

Table 3: Node/Device Hardware

Node/Device	Hardware
Remote Provider Edge Router (R0)	Chassis: MX480 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPCE Type 2 3D EQ FPC5: MPC 3D 16x 10GE
MPLS Provider Router (R1)	Chassis: MX480 RE0: RE-S-2000 RE1: NONE FPC0: MPC 3D 16x 10GE FPC4: MPC 3D 16x 10GE FPC5: MPC Type 2 3D EQ
Data Center Edge Router (R2)	Chassis: MX480 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPC Type 2 3D EQ FPC1: MPC 3D 16x 10GE FPC2: MPC Type 2 3D EQ FPC3: MPC 3D 16x 10GE

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Table 3: Node/Device Hardware *(continued)*

Node/Device	Hardware
Data Center Edge Router (R3)	Chassis: MX960 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPC 3D 16x 10GE FPC1: MPC Type 2 3D EQ FPC2: MPC 3D 16x 10GE FPC3: MPC 3D 16x 10GE FPC4: MPC 3D 16x 10GE FPC5: MPC Type 2 3D EQ
Data Center Core Router (R4)	Chassis: MX960 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPC 3D 16x 10GE FPC2: MPC 3D 16x 10GE FPC3: MPC 3D 16x 10GE FPC4: MPC Type 2 3D EQ FPC5: MPC Type 2 3D EQ FPC7: MPC Type 2 3D EQ FPC8: MPC 3D 16x 10GE FPC9: MPC Type 2 3D EQ

Table 3: Node/Device Hardware *(continued)*

Node/Device	Hardware
Data Center Core Router (R5)	Chassis: MX960 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC1: MPC Type 2 3D EQ FPC2: MPC 3D 16x 10GE FPC4: MPC Type 2 3D EQ FPC5: MPC Type 2 3D EQ FPC7: MPC Type 2 3D EQ FPC9: MPC Type 2 3D EQ FPC10: MPC Type 2 3D EQ FPC11: MPC 3D 16x 10GE
Data Center Core Router (R6)	Chassis: MX480 RE0: RE-S-2000 RE1: NONE FPC0: DPCE 20x 1GE R EQ FPC3: MPC Type 2 3D EQ
Data Center Core Router (R7)	Chassis: MX240 RE0: RE-S-2000 RE1: RE-S-2000 FPC1: DPCE 20x 1GE R EQ
Top-of-Rack Switches (ToRs) (R8 - R12)	Chassis: EX4500-40F RE0: EX4500-40F RE1: NONE FPC0: EX4500-40F

All MX Series and EX Series devices in this example use Juniper Networks Junos® OS Release 12.3R6. Table 4 on page 23 lists the scaling values used in configuring each device.

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Table 4: Node/Device Scaling Targets

Node/Device	Targeted Feature Scale Values
Remote Provider Edge Router	Interfaces: ~25K IFL Protocols: OSPF - 8, OSPF3 - 8, IS-IS -8, BGP - 2, RSVP -4 Sessions, MPLS LSP - 2 Ingress LSPs + 2 Egress LSPs, BFD -22, VLAN -(1-4094) X 8 Services: VPLS - 4002, VRF - 4K, BD - 8012
MPLS Provider Router	Interfaces: 42 IFL Protocols: OSPF - 24, OSPF3 - 24, IS-IS - 24 , BFD - 48, RSVP LSP -4 Transit LSP
Data Center Edge Router	Interfaces: ~48630 IFL (8K IRB), AE - 8, MC-AE - 8 Protocols: OSPF - 8, OSPF3 - 8, IS-IS - 8, BFD – 23 sessions, MPLS -3 Ingress LSPs + 3 Egress LSPs, RSVP -3 Sessions, BGP - 3, VLAN -(1-4094) X 8, ICCP -1 Session Services: VPLS - 4002, VRF -4K, BD - 20200, MC-LAG active/standby - 3
Data Center Core Router	Interfaces: ~75 , AE - 8, MC-AE active/active - 8 Protocols: VLAN - (1-4094) X 8, ICCP - 1 Services: VIRTUAL-SWITCH -4
Top-of-Racks (ToRs)	Interfaces: ~10 IFL Protocols: VLAN -(1-4094) Services: BD (VLANs in EX) - (1-4094)

Before you configure the Layer 3 cloud data center customer:

- Configure the loopback interface (lo0) on each routing device.

Overview

With a baseline configuration on the routers and the IGP and BGP protocols up and running, this configuration details how to configure a virtual routing instance and any bridge domains inside the virtual switch. The VPLS protocol is enabled in the virtual switch to enable the VPLS routing instance.

In this deployment scenario, Layer 2 connectivity from the data center access is extended all the way to the data center edge by configuring virtual switches, each with 4000 bridge domains. Each bridge domain contains one IRB for integrated routing and bridging.

Each VRF is assigned two IRBs that are assigned as routing interfaces for the bridge domains from the virtual switch routing instance. A total of 2000 VRF instances are required to address the two bridge domains in the virtual switch. This means that all 4000 VRF instances are configured to manage 8000 bridge domains using two virtual switches (in this case vs3-1 and vs4-1).

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The benefits of this Layer 3 tenant design is:

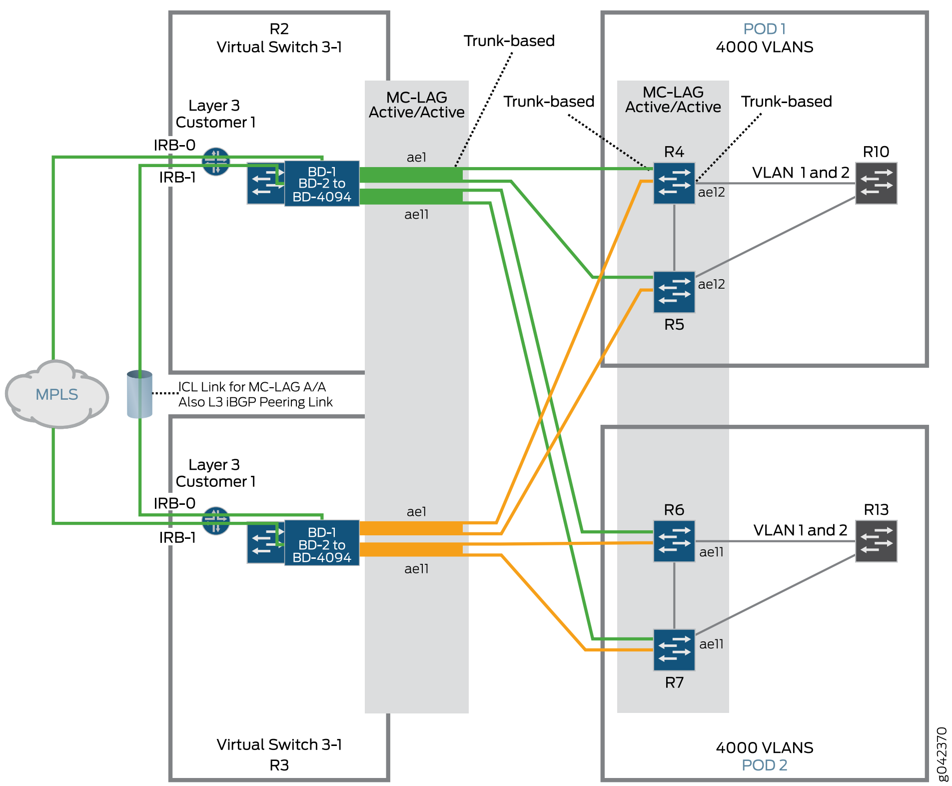
- It uses the minimum number of IFLs as trunk-based LAGs are used
- It can scale to 8000 Layer 3 Customers per MX series router pair as the minimum number of virtual switches are used (two in this example, that accommodate 4000 each).

On Device R0 (a remote PE device), routing instance vrf-1 is configured to be terminated on data center edge routers, Devices R2 and R3. These two routers contain two IRB interfaces from two bridge domains that are part of one VRF routing instance. With this configuration, each Layer 3 tenant has two computing points (bridge domains using IRB). The IRB interfaces act as customer edge interfaces in each VRF and provide connectivity to two separate bridge domains in routing instance vs3-1. In this example, the configuration for customer 1 on R2 and R3 is shown.

Topology

Figure 15 on page 24 shows the logical topology in the Simple Layer 3 Tenant deployment configuration example.

Figure 15: Simple Layer 3 (Trunk-Based) Tenant Design Topology



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Configuring Routing Engine Resiliency

Step-by-Step Procedure

Each router in the network must have chassis redundancy enabled for graceful switchover, enhanced IP to use chassis enhanced mode capabilities, and network optimization enabled to increase performance and system stability.

To enable chassis redundancy:

1. Access each router CLI.
2. Configure the master Routing Engine to switch over gracefully to a backup Routing Engine without interruption to packet forwarding.

   [edit]
   user@host# **set chassis redundancy graceful-switchover**

3. Set the router network services to enhanced IP and use enhanced mode capabilities.

   NOTE: Only MX Series router with MPCs and MS-DPCs are powered on in the chassis. Non-service DPCs do not work with enhanced network services mode options.

   [edit]
   user@host# **set chassis network-services enhanced-ip**

4. Set the router network services to network-optimization mode and enable next hop optimization.

   [edit]
   user@host# **set chassis network-optimization enable-nexthop-optimization**

Configuring Device Interfaces

The following sections define how to configure the router interfaces in this example:

- Configuring Device R2 Interfaces on page 26
- Configuring Device R3 Interfaces on page 27
- Configuring Device R4 Interfaces on page 29
- Configuring Device R5 Interfaces on page 30
- Configuring Device R6 Interfaces on page 30
- Configuring Device R7 Interfaces on page 31
- Configuring Device R10 Interfaces on page 32
- Configuring Device R13 Interfaces on page 33

Configuring Device R2 Interfaces

Step-by-Step Procedure

To configure Device R2, first configure the ICL interfaces on R2 that will connect to R3, then configure Layer 3 interfaces for Device R2:

1. Configure the ICL interface that goes to Device R3 in the instance vs3-1 interface for MCAE interfaces ae1 and ae2 on Device R2 and R3.

   ```
   [edit]
   user@R2# set interfaces xe-3/1/0 flexible-vlan-tagging
   user@R2# set interfaces xe-3/1/0 encapsulation flexible-ethernet-services
   user@R2# set interfaces xe-3/1/0 unit 0 family bridge interface-mode trunk
   user@R2# set interfaces xe-3/1/0 unit 0 family bridge vlan-id-list 1-4094
   ```

2. Configure the ICL interface that goes to Device R3 in instance vs4-1 interface for MCAE interfaces ae1 and ae2 on Devices R2 and R3.

   ```
   [edit]
   user@R2# set interfaces xe-3/2/0 flexible-vlan-tagging
   user@R2# set interfaces xe-3/2/0 encapsulation flexible-ethernet-services
   user@R2# set interfaces xe-3/2/0 unit 0 family bridge interface-mode trunk
   user@R2# set interfaces xe-3/2/0 unit 0 family bridge vlan-id-list 1-4094
   ```

   NOTE: The ICL interface link shown here is used by MC-LAG active/active.

3. Configure member links (xe-3/0/1 and xe-3/2/3) of MCAE interface ae1 on Device R2 using trunk mode.

   ```
   [edit]
   user@R2# set interfaces xe-3/0/1 gigether-options 802.3ad ae1
   user@R2# set interfaces xe-3/2/3 gigether-options 802.3ad ae1
   user@R2# set interfaces ae1 flexible-vlan-tagging
   user@R2# set interfaces ae1 unit 0 family bridge interface-mode trunk
   user@R2# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
   ```

   NOTE: Interface ae1 is the interface on Device R2 that connects to Devices R4 and R5.

4. Configure member links (xe-0/0/1 and xe-3/1/1) of MCAE interface ae2 on Device R2 using trunk mode.

   ```
   [edit]
   user@R2# set interfaces xe-3/1/1 gigether-options 802.3ad ae2
   user@R2# set interfaces xe-0/0/1 gigether-options 802.3ad ae2
   user@R2# set interfaces ae2 flexible-vlan-tagging
   user@R2# set interfaces ae2 unit 0 family bridge interface-mode trunk
   user@R2# set interfaces ae2 unit 0 family bridge vlan-id-list 1-4094
   ```

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NOTE: Interface ae2 is the interface on Device R2 that connects to Devices R6 and R7.

5. Configure Layer 3 interfaces for Device R2.

NOTE: In this example only the configuration for the Layer 3 interfaces for customer 1 is shown. In total 8000 Layer 3 customers can be provisioned per virtual switch instance, or up to 16,000 IRBs are supported.

Disable the updating of the Address Resolution Protocol (ARP) cache for gratuitous ARPs on IRB interfaces.

```
[edit]
user@R2# set interfaces irb no-gratuitous-arp-reply
```

6. Configure the IRB interfaces to not respond to gratuitous ARP requests.

```
[edit]
user@R2# set interfaces irb no-gratuitous-arp-request
```

7. Configure interface irb.0 on Device R2.

```
[edit]
user@R2# set interfaces irb unit 0 family inet address 178.1.0.252/24
user@R2# set interfaces irb unit 0 family inet6 address 2002::132.1.1.1/126
```

8. Configure interface irb.1 on Device R2.

```
[edit]
user@R2# set interfaces irb unit 1 family inet address 178.1.1.252/24
user@R2# set interfaces irb unit 1 family inet6 address 2002::132.1.1.5/126
```

Configuring Device R3 Interfaces

Step-by-Step Procedure

To configure interfaces on Device R3, first configure Layer 2 interfaces on Device R3 including the ICL and MCAE, then Configure Layer 3 (IRB) interfaces on Device R3:

1. Configure the ICL interfaces for MCAE interfaces ae1 and ae2.

```
[edit]
user@R3# set interfaces xe-2/1/1 flexible-vlan-tagging
user@R3# set interfaces xe-2/1/1 encapsulation flexible-ethernet-services
user@R3# set interfaces xe-2/1/1 unit 0 family bridge interface-mode trunk
user@R3# set interfaces xe-2/1/1 unit 0 family bridge vlan-id-list 1-4094
```

NOTE: ICL is configured on both MCAE interfaces. MC-LAG active/active is configured.

```
[edit]
user@R3# set interfaces xe-2/2/1 flexible-vlan-tagging
user@R3# set interfaces xe-2/2/1 encapsulation flexible-ethernet-services
user@R3# set interfaces xe-2/2/1 unit 0 family bridge interface-mode trunk
user@R3# set interfaces xe-2/2/1 unit 0 family bridge vlan-id-list 1-4094
```

2. Configure interfaces xe-0/2/0 and xe-0/1/3 as member links of interface ae1 on Device R3.

```
[edit]
user@R3# set interfaces xe-0/1/3 gigether-options 802.3ad ae1
user@R3# set interfaces xe-0/2/0 gigether-options 802.3ad ae1
user@R3# set interfaces ae1 flexible-vlan-tagging
user@R3# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R3# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

NOTE: The member links are configured in trunk mode.

3. Configure interfaces xe-5/0/0 and xe-0/3/1 as member links of interface ae2 on Device R3.

```
[edit]
user@R3# set interfaces xe-0/3/1 gigether-options 802.3ad ae2
user@R3# set interfaces xe-5/0/0 gigether-options 802.3ad ae2
user@R3# set interfaces ae2 flexible-vlan-tagging
user@R3# set interfaces ae2 unit 0 family bridge interface-mode trunk
user@R3# set interfaces ae2 unit 0 family bridge vlan-id-list 1-4094
```

This ae2 interface provides connectivity to Devices R6 and R7.

4. Configure Layer 3 interfaces on Device R3.

NOTE: In this example only the configuration for the Layer 3 interfaces for customer 1 is shown. In total 8000 Layer 3 customers can be provisioned per virtual switch instance, or up to 16,000 IRBs are supported.

Disable the updating of the Address Resolution Protocol (ARP) cache for gratuitous ARPs on IRB interfaces.

```
[edit]
user@R3# set interfaces irb no-gratuitous-arp-reply
```

5. Configure the IRB interfaces to not respond to gratuitous ARP requests.

```
[edit]
user@R3# set interfaces irb no-gratuitous-arp-request
```

6. Configure interface irb.0 on Device R3.

```
[edit]
user@R3#set interfaces irb unit 0 family inet address 178.1.0.252/24
user@R3#set interfaces irb unit 0 family inet6 address 2002::132.1.1.1/126
```

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7. Configure interface irb.1 on Device R3.

```
[edit]
user@R3# set interfaces irb unit 1 family inet address 178.1.1.252/24
user@R3# set interfaces irb unit 1 family inet6 address 2002::132.1.1.5/126
```

Configuring Device R4 Interfaces

Step-by-Step Procedure

To configure Layer 2 interfaces on Device R4:

1. Access the CLI for Device R4.
2. Configure the ICL interface for MCAE interfaces ae1 and ae12 on Device R4 connecting to Device R5.

   NOTE: This is the ICL link used for server-to-server communication within the POD and by MC-LAG active/active.

```
[edit]
user@R4# set interfaces xe-0/1/1 flexible-vlan-tagging
user@R4# set interfaces xe-0/1/1 encapsulation flexible-ethernet-services
user@R4# set interfaces xe-0/1/1 unit 0 family bridge interface-mode trunk
user@R4# set interfaces xe-0/1/1 unit 0 family bridge vlan-id-list 1-4094
```

3. Configure aggregation interface ae1 that connects Device R4 to the edge router, Device R2, and Device R3.

```
[edit]
user@R4# set interfaces ae1 flexible-vlan-tagging
user@R4# set interfaces ae1 encapsulation flexible-ethernet-services
user@R4# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R4# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure member links of ae1.

```
[edit]
user@R4# set interfaces xe-3/0/2 gigether-options 802.3ad ae1
user@R4# set interfaces xe-4/1/0 gigether-options 802.3ad ae1
user@R4# set interfaces ae1 flexible-vlan-tagging
user@R4# set interfaces ae1 unit 0 family bridge interface-mode trunk
```

5. Configure interface ae12, which connects Device R4 to Device R10.

```
[edit]
user@R4# set interfaces ae12 flexible-vlan-tagging
user@R4# set interfaces ae12 encapsulation flexible-ethernet-services
user@R4# set interfaces ae12 unit 0 family bridge interface-mode trunk
user@R4# set interfaces ae12 unit 0 family bridge vlan-id-list 1-4094
```

6. Configure member links of ae12.

```
[edit]
user@R4# set interfaces xe-9/0/0 gigether-options 802.3ad ae12
user@R4# set interfaces ae12 flexible-vlan-tagging
user@R4# set interfaces ae12 unit 0 family bridge interface-mode trunk
user@R4# set interfaces ae12 unit 0 family bridge vlan-id-list 1-4094
```

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Configuring Device R5 Interfaces

Step-by-Step Procedure

To configure Layer 2 interfaces on Device R5:

1. Access the CLI for Device R5.
2. Configure interface xe-1/0/0 which is connected to Device R4. This is the ICL link used for server-to-server communication within the POD and by MC-LAG (active/active).

```
[edit]
user@R5# set interfaces xe-1/0/0 flexible-vlan-tagging
user@R5# set interfaces xe-1/0/0 hold-time up 100
user@R5# set interfaces xe-1/0/0 hold-time down 10000
user@R5# set interfaces xe-1/0/0 encapsulation flexible-ethernet-services
user@R5# set interfaces xe-1/0/0 unit 0 family bridge interface-mode trunk
user@R5# set interfaces xe-1/0/0 unit 0 family bridge vlan-id-list 1-4094
```

3. Configure Interface ae1 which connects Device R5 to Devices R2 and R3.

```
[edit]
user@R5# set interfaces ae1 flexible-vlan-tagging
user@R5# set interfaces ae1 encapsulation flexible-ethernet-services
user@R5# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R5# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure the member links of ae1.

```
[edit]
user@R5# set interfaces xe-3/1/0 gigether-options 802.3ad ae1
user@R5# set interfaces xe-4/1/1 gigether-options 802.3ad ae1
user@R5# set interfaces ae1 flexible-vlan-tagging
user@R5# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R5# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

5. Configure Interface ae12, which connects Device R5 to Device R10.

```
[edit]
user@R5# set interfaces ae12 flexible-vlan-tagging
user@R5# set interfaces ae12 encapsulation flexible-ethernet-services
user@R5# set interfaces ae12 unit 0 family bridge interface-mode trunk
user@R5# set interfaces ae12 unit 0 family bridge vlan-id-list 1-4094
```

6. Configure the member links of ae12.

```
[edit]
user@R5# set interfaces xe-5/3/2 gigether-options 802.3ad ae12
user@R5# set interfaces ae12 flexible-vlan-tagging
user@R5# set interfaces ae12 unit 0 family bridge interface-mode trunk
user@R5# set interfaces ae12 unit 0 family bridge vlan-id-list 1-4094
```

Configuring Device R6 Interfaces

Step-by-Step Procedure

To configure Layer 2 interfaces on Device R6:

1. Access the CLI for Device R6.
2. Configure the ICL interface that goes to Device R7 from Device R6.

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```
[edit]
user@R6# set interfaces xe-5/2/1 flexible-vlan-tagging
user@R6# set interfaces xe-5/2/1 encapsulation flexible-ethernet-services
user@R6# set interfaces xe-5/2/1 unit 0 family bridge interface-mode trunk
user@R6# set interfaces xe-5/2/1 unit 0 family bridge vlan-id-list 1-4094
```

3. Configure interface ae1 on Device R6 which connects to Devices R2 and R3.

```
[edit]
user@R6# set interfaces ae1 flexible-vlan-tagging
user@R6# set interfaces ae1 encapsulation flexible-ethernet-services
user@R6# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R6# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure the member links of ae1.

```
[edit]
user@R6# set interfaces xe-3/1/1 gigether-options 802.3ad ae1
user@R6# set interfaces xe-3/0/1 gigether-options 802.3ad ae1
user@R6# set interfaces ae1 flexible-vlan-tagging
user@R6# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R6# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

5. Configure interface ae11 on Device R6 that goes to Device R13.

```
[edit]
user@R6# set interfaces ae11 flexible-vlan-tagging
user@R6# set interfaces ae11 encapsulation flexible-ethernet-services
user@R6# set interfaces ae11 unit 0 family bridge interface-mode trunk
user@R6# set interfaces ae11 unit 0 family bridge vlan-id-list 1-4094
```

6. Configure member links of ae11.

```
[edit]
user@R6# set interfaces xe-5/3/1 gigether-options 802.3ad ae11
user@R6# set interfaces ae11 flexible-vlan-tagging
user@R6# set interfaces ae11 unit 0 family bridge interface-mode trunk
user@R6# set interfaces ae11 unit 0 family bridge vlan-id-list 1-4094
```

Configuring Device R7 Interfaces

Step-by-Step Procedure

To configure Layer 2 interfaces on Device R7:

1. Access the CLI for Device R7.
2. Configure the ICL interface that goes to Device R6 from Device R7.

```
[edit]
user@R7# set interfaces xe-0/3/1 flexible-vlan-tagging
user@R7# set interfaces xe-0/3/1 hold-time up 100
user@R7# set interfaces xe-0/3/1 hold-time down 10000
user@R7# set interfaces xe-0/3/1 encapsulation flexible-ethernet-services
user@R7# set interfaces xe-0/3/1 unit 0 family bridge interface-mode trunk
user@R7# set interfaces xe-0/3/1 unit 0 family bridge vlan-id-list 1-4094
```

3. Configure interface ae1 on Device R7 which connects to Devices R2 and R3.

```
[edit]
user@R7# set interfaces ae1 flexible-vlan-tagging
user@R7# set interfaces ae1 encapsulation flexible-ethernet-services
```

```
user@R7# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R7# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure member links of ae1.

```
[edit]
user@R7# set interfaces xe-0/1/0 gigether-options 802.3ad ae1
user@R7# set interfaces xe-0/0/1 gigether-options 802.3ad ae1
user@R7# set interfaces ae1 flexible-vlan-tagging
user@R7# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R7# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

5. Configure interface ae11, which goes to Device R13.

```
[edit]
user@R7# set interfaces ae11 flexible-vlan-tagging
user@R7# set interfaces ae11 encapsulation flexible-ethernet-services
user@R7# set interfaces ae11 unit 0 family bridge interface-mode trunk
user@R7# set interfaces ae11 unit 0 family bridge vlan-id-list 1-4094
```

6. Configure member links of ae11.

```
[edit]
user@R7# set interfaces xe-0/2/1 gigether-options 802.3ad ae11
user@R7# set interfaces ae11 flexible-vlan-tagging
user@R7# set interfaces ae11 unit 0 family bridge interface-mode trunk
user@R7# set interfaces ae11 unit 0 family bridge vlan-id-list 1-4094
```

Configuring Device R10 Interfaces

Step-by-Step Procedure

To configure interfaces on Device R10:

1. Access the CLI for Device R10.
2. Configure the upstream interfaces towards Devices R4 and R5.

```
[edit]
user@R10# set interfaces xe-0/0/3 ether-options 802.3ad ae0
user@R10# set interfaces xe-0/0/16 ether-options 802.3ad ae0
```

3. Configure the downstream interface from Device R10 to compute resources. In this example, only a single access interface is detailed (trunk mode). This would be used when connecting to a virtual machine instance.

```
[edit]
user@R10# set interfaces ge-0/0/25 description "R10 --> Virtual Resources"
user@R10# set interfaces ge-0/0/25 unit 0 family ethernet-switching port-mode
  trunk
user@R10# set interfaces ge-0/0/25 unit 0 family ethernet-switching vlan members
  all
```

4. Configure interface ae0.

```
[edit]
user@R10# set interfaces ae0 aggregated-ether-options lacp active
user@R10# set interfaces ae0 unit 0 family ethernet-switching port-mode trunk
user@R10# set interfaces ae0 unit 0 family ethernet-switching vlan members all
```

5. Configure the VLANs.

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NOTE: Only the configuration of the VLANs used by the customer in the POD is shown. Up to 4094 VLANs are supported.

```
[edit]
user@R10# set vlans default vlan-id 4094
user@R10# set vlans vlan-1 vlan-id 1
```

Configuring Device R13 Interfaces

Step-by-Step Procedure

To configure interfaces on Device R13:

1. Access the CLI for Device R13.
2. Configure the upstream interfaces towards Devices R6 and R7.

   ```
   [edit]
   user@R13# set interfaces xe-0/0/8 ether-options 802.3ad ae0
   user@R13# set interfaces xe-0/0/10 ether-options 802.3ad ae0
   ```

3. Configure the downstream interface from Device R13 to compute resources. In this example, only a single access interface is detailed (trunk mode). This would be used when connecting to a virtual machine instance.

   ```
   [edit]
   user@R13# set interfaces ge-0/0/4 description "R13 --> Virtualized Resources"
   user@R13# set interfaces ge-0/0/4 unit 0 family ethernet-switching port-mode
     trunk
   user@R13# set interfaces ge-0/0/4 unit 0 family ethernet-switching vlan members
     all
   ```

4. Configure interface ae0.

   ```
   [edit]
   user@R13# set interfaces ae0 aggregated-ether-options lacp active
   user@R13# set interfaces ae0 unit 0 family ethernet-switching port-mode trunk
   user@R13# set interfaces ae0 unit 0 family ethernet-switching vlan members all
   ```

5. Configure the VLANs.

   NOTE: Only the configuration of the VLANs used by the customer in the POD is shown. Up to 4094 VLANs are supported.

   ```
   [edit]
   user@R13# set vlans default vlan-id 4094
   user@R13# set vlans vlan-1 vlan-id 1
   ```

Configuring MC-LAG — Link and Node Redundancy

High availability for Layer 3 tenants is achieved by having a Layer 3 VPN tunnel from the remote PE device to both Device R2 and Device R3 at the network edge. Layer 3 VPN

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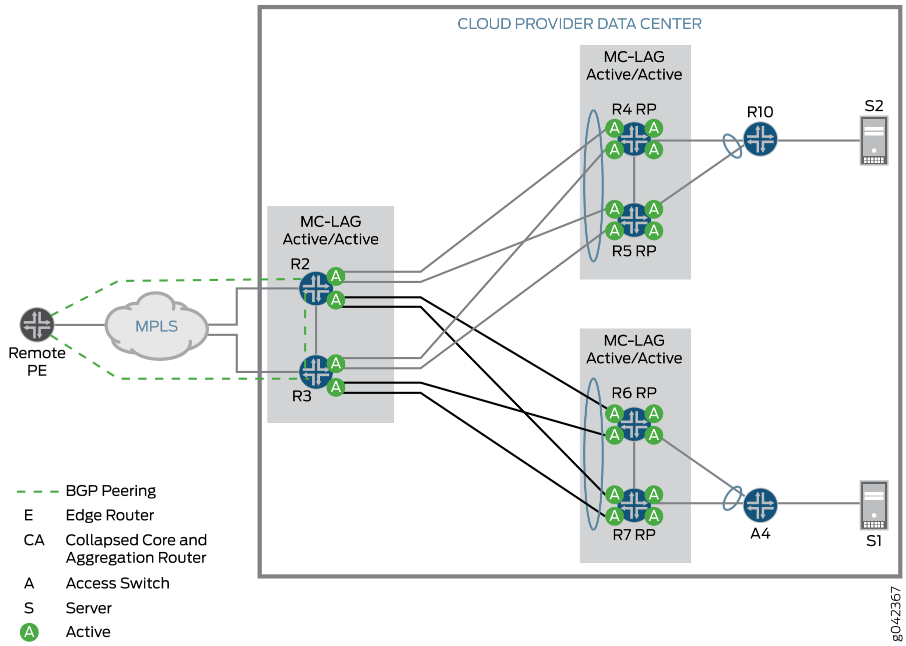
connections to both Device R2 and Device R3 always remain UP, and the traffic takes an alternate path if one of the PE devices goes down.

Figure 16 on page 34 shows the links used for configuring high availability across the topology used throughout this document.

Figure 16: Cloud Provider Data Center High Availability



High availability in the data center core is achieved by configuring MC-LAG active/active on both Device R4 and Device R5 (the core routers in POD1) and on Devices R6 and R7 (the core routers in POD2).

In addition, graceful Routing Engine switchover (GRES), nonstop routing (NSR), and nonstop bridging (NSB) are all enabled on each of the core and edge routers to ensure Routing Engine high availability.

The following sections describe how to configure MC-LAG on each device:

- Configuring MC-LAG on Device R2 on page 35
- Configuring MC-LAG on Device R3 on page 36
- Configuring MC-LAG on Device R4 on page 37
- Configuring MC-LAG on Device R5 on page 39
- Configuring MC-LAG on Device R6 on page 40
- Configuring MC-LAG on Device R7 on page 41

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Configuring MC-LAG on Device R2

Step-by-Step Procedure

To configure MC-LAG on Device R2:

1. Configure an ICCP interface.

```
[edit]
user@R2# set interfaces xe-3/0/0 gigether-options 802.3ad ae9
user@R2# set interfaces ae9 unit 0 family inet address 4.0.0.1/30
user@R2# set interfaces ae9 unit 0 family iso
user@R2# set interfaces ae9 unit 0 family inet6 address 2002::4.0.0.1/126
user@R2# set interfaces ae9 unit 0 family mpls
```

2. Configure ICCP protocol attributes on Device R2.

```
[edit]
user@R2# set protocols iccp local-ip-addr 4.0.0.1
user@R2# set protocols iccp peer 4.0.0.2 redundancy-group-id-list 1
user@R2# set protocols iccp peer 4.0.0.2 liveness-detection minimum-interval
  1000
user@R2# set protocols iccp peer 4.0.0.2 liveness-detection detection-time
  threshold 2000000
user@R2# set protocols iccp peer 4.0.0.2 liveness-detection single-hop
```

3. Configure the MCAE active/active interface on Device R2 that connects to Devices R4 and R5.

> NOTE: The protection link is as configured earlier.

```
[edit]
user@R2# set interfaces ae1 flexible-vlan-tagging
user@R2# set interfaces ae1 multi-chassis-protection 4.0.0.2 interface xe-3/1/0
user@R2# set interfaces ae1 encapsulation flexible-ethernet-services
user@R2# set interfaces ae1 aggregated-ether-options lacp active
user@R2# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@R2# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@R2# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:22
user@R2# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@R2# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 1
user@R2# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group 1
user@R2# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 0
user@R2# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@R2# set interfaces ae1 aggregated-ether-options mc-ae status-control active
user@R2# set interfaces ae1 aggregated-ether-options mc-ae events iccp-peer-down
  prefer-status-control-active
user@R2# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R2# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure the MCAE active/active interface on Device R2 that connects to Devices R6 and R7.

NOTE: The protection link is as configured earlier.

```
[edit]
user@R2# set interfaces ae2 flexible-vlan-tagging
user@R2# set interfaces ae2 multi-chassis-protection 4.0.0.2 interface xe-3/2/0
user@R2# set interfaces ae2 encapsulation flexible-ethernet-services
user@R2# set interfaces ae2 aggregated-ether-options lacp active
user@R2# set interfaces ae2 aggregated-ether-options lacp periodic fast
user@R2# set interfaces ae2 aggregated-ether-options lacp system-priority 100
user@R2# set interfaces ae2 aggregated-ether-options lacp system-id
  00:00:00:00:00:24
user@R2# set interfaces ae2 aggregated-ether-options lacp admin-key 1
user@R2# set interfaces ae2 aggregated-ether-options mc-ae mc-ae-id 2
user@R2# set interfaces ae2 aggregated-ether-options mc-ae redundancy-group
  1
user@R2# set interfaces ae2 aggregated-ether-options mc-ae chassis-id 0
user@R2# set interfaces ae2 aggregated-ether-options mc-ae mode active-active
user@R2# set interfaces ae2 aggregated-ether-options mc-ae status-control active
user@R2# set interfaces ae2 aggregated-ether-options mc-ae events iccp-peer-down
  prefer-status-control-active
user@R2# set interfaces ae2 unit 0 family bridge interface-mode trunk
user@R2# set interfaces ae2 unit 0 family bridge vlan-id-list 1-4094
```

Configuring MC-LAG on Device R3

Step-by-Step Procedure

To configure MC-LAG on Device R3:

1. Configure an ICCP interface.

```
[edit]
user@R3# set interfaces xe-2/0/1 gigether-options 802.3ad ae9
user@R3# set interfaces ae9 unit 0 family inet address 4.0.0.2/30
user@R3# set interfaces ae9 unit 0 family iso
user@R3# set interfaces ae9 unit 0 family inet6 address 2002::4.0.0.2/126
user@R3# set interfaces ae9 unit 0 family mpls
```

2. Configure ICCP protocol attributes on Device R3.

```
[edit]
user@R3# set protocols iccp local-ip-addr 4.0.0.2
user@R3# set protocols iccp peer 4.0.0.1 redundancy-group-id-list 1
user@R3# set protocols iccp peer 4.0.0.1 liveness-detection minimum-interval 1000
user@R3# set protocols iccp peer 4.0.0.1 liveness-detection detection-time threshold
  2000000
user@R3# set protocols iccp peer 4.0.0.1 liveness-detection single-hop
```

3. Configure MCAE active/active interface in Device R3 that connects to Devices R4 and R5..

NOTE: Note the protection link is as configured earlier.

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```
[edit]
user@R3# set interfaces ae1 flexible-vlan-tagging
user@R3# set interfaces ae1 multi-chassis-protection 4.0.0.1 interface xe-2/1/1
user@R3# set interfaces ae1 encapsulation flexible-ethernet-services
user@R3# set interfaces ae1 aggregated-ether-options lacp active
user@R3# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@R3# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@R3# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:22
user@R3# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@R3# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 1
user@R3# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group 1
user@R3# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 1
user@R3# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@R3# set interfaces ae1 aggregated-ether-options mc-ae status-control standby
user@R3# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R3# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure MCAE active/active interface on Device R3 that connects to Devices R6 and R7.

   NOTE: Note the protection link is as configured earlier.

```
[edit]
user@R3# set interfaces ae2 flexible-vlan-tagging
user@R3# set interfaces ae2 multi-chassis-protection 4.0.0.1 interface xe-2/2/1
user@R3# set interfaces ae2 encapsulation flexible-ethernet-services
user@R3# set interfaces ae2 aggregated-ether-options lacp active
user@R3# set interfaces ae2 aggregated-ether-options lacp periodic fast
user@R3# set interfaces ae2 aggregated-ether-options lacp system-priority 100
user@R3# set interfaces ae2 aggregated-ether-options lacp system-id
  00:00:00:00:00:23
user@R3# set interfaces ae2 aggregated-ether-options lacp admin-key 1
user@R3# set interfaces ae2 aggregated-ether-options mc-ae mc-ae-id 2
user@R3# set interfaces ae2 aggregated-ether-options mc-ae redundancy-group
  1
user@R3# set interfaces ae2 aggregated-ether-options mc-ae chassis-id 1
user@R3# set interfaces ae2 aggregated-ether-options mc-ae mode active-active
user@R3# set interfaces ae2 aggregated-ether-options mc-ae status-control standby
user@R3# set interfaces ae2 unit 0 family bridge interface-mode trunk
user@R3# set interfaces ae2 unit 0 family bridge vlan-id-list 1-4094
```

Configuring MC-LAG on Device R4

Step-by-Step Procedure

To configure MC-LAG on Device R4:

1. Configure an ICCP interface.

```
[edit]
user@R4# set interfaces xe-9/2/1 gigether-options 802.3ad ae9
user@R4# set interfaces ae9 unit 0 family inet address 4.1.0.1/30
user@R4# set interfaces ae9 unit 0 family iso
user@R4# set interfaces ae9 unit 0 family inet6 address 2002::4.1.0.1/126
```

```
user@R4# set interfaces ae9 unit 0 family mpls
```

2. Configure ICCP protocol attributes on Device R4.

```
[edit]
user@R4# set protocols iccp local-ip-addr 4.1.0.1
user@R4# set protocols iccp peer 4.1.0.2 redundancy-group-id-list 1
user@R4# set protocols iccp peer 4.1.0.2 liveness-detection minimum-interval 1000
user@R4# set protocols iccp peer 4.1.0.2 liveness-detection detection-time threshold
  2000000
user@R4# set protocols iccp peer 4.1.0.2 liveness-detection single-hop
```

3. Configure interface MC-AE1 on Device R4 that connects to data center edge routers, Devices R2 and R3.

```
[edit]
user@R4# set interfaces ae1 flexible-vlan-tagging
user@R4# set interfaces ae1 multi-chassis-protection 4.1.0.2 interface xe-0/1/1
user@R4# set interfaces ae1 encapsulation flexible-ethernet-services
user@R4# set interfaces ae1 aggregated-ether-options lacp active
user@R4# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@R4# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@R4# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:61
user@R4# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@R4# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 1
user@R4# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group
  1
user@R4# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 0
user@R4# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@R4# set interfaces ae1 aggregated-ether-options mc-ae status-control active
user@R4# set interfaces ae1 aggregated-ether-options mc-ae events iccp-peer-down
  prefer-status-control-active
user@R4# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R4# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure MCLAG active/active on ae12 on Device R4.

NOTE: This interface connects to Device R10.

```
[edit]
user@R4# set interfaces xe-9/0/0 gigether-options 802.3ad ae12
user@R4# set interfaces ae12 flexible-vlan-tagging
user@R4# set interfaces ae12 multi-chassis-protection 4.1.0.2 interface xe-0/1/1
user@R4# set interfaces ae12 encapsulation flexible-ethernet-services
user@R4# set interfaces ae12 aggregated-ether-options lacp active
user@R4# set interfaces ae12 aggregated-ether-options lacp periodic fast
user@R4# set interfaces ae12 aggregated-ether-options lacp system-priority 100
user@R4# set interfaces ae12 aggregated-ether-options lacp system-id
  00:00:00:00:00:42
user@R4# set interfaces ae12 aggregated-ether-options lacp admin-key 1
user@R4# set interfaces ae12 aggregated-ether-options mc-ae mc-ae-id 2
user@R4# set interfaces ae12 aggregated-ether-options mc-ae redundancy-group
  1
user@R4# set interfaces ae12 aggregated-ether-options mc-ae chassis-id 0
```

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```
user@R4# set interfaces ae12 aggregated-ether-options mc-ae mode active-active
user@R4# set interfaces ae12 aggregated-ether-options mc-ae status-control active
user@R4# set interfaces ae12 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
user@R4# set interfaces ae12 unit 0 family bridge filter input vs3-1
user@R4# set interfaces ae12 unit 0 family bridge interface-mode trunk
user@R4# set interfaces ae12 unit 0 family bridge vlan-id-list 1-4094
```

Configuring MC-LAG on Device R5

Step-by-Step Procedure

To configure MC-LAG on Device R5:

1. Configure an ICCP interface.

```
[edit]
user@R5# set interfaces xe-10/2/1 gigether-options 802.3ad ae9
user@R5# set interfaces ae9 unit 0 family inet address 4.1.0.2/30
user@R5# set interfaces ae9 unit 0 family iso
user@R5# set interfaces ae9 unit 0 family inet6 address 2002::4.1.0.2/126
user@R5# set interfaces ae9 unit 0 family mpls
```

2. Configure ICCP protocol attributes on Device R5

```
[edit]
user@R5# set protocols iccp local-ip-addr 4.1.0.2
user@R5# set protocols iccp peer 4.1.0.1 redundancy-group-id-list 1
user@R5# set protocols iccp peer 4.1.0.1 liveness-detection minimum-interval 1000
user@R5# set protocols iccp peer 4.1.0.1 liveness-detection detection-time threshold
  2000000
user@R5# set protocols iccp peer 4.1.0.1 liveness-detection single-hop
```

3. Configure interface MC-AE1 on Device R5 that connects to data center edge routers, Devices R2 and R3.

```
[edit]
user@R5# set interfaces ae1 flexible-vlan-tagging
user@R5# set interfaces ae1 multi-chassis-protection 4.1.0.1 interface xe-1/0/0
user@R5# set interfaces ae1 encapsulation flexible-ethernet-services
user@R5# set interfaces ae1 aggregated-ether-options lacp active
user@R5# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@R5# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@R5# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:61
user@R5# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@R5# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 1
user@R5# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group 1
user@R5# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 1
user@R5# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@R5# set interfaces ae1 aggregated-ether-options mc-ae status-control standby
user@R5# set interfaces ae1 aggregated-ether-options mc-ae events iccp-peer-down
  prefer-status-control-active
user@R5# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R5# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure MCLAG active/active configuration on aggregated interface ae12 on Device R5.

NOTE: This interface connects to Device R10.

```
[edit]
user@R5# set interfaces xe-5/3/2 gigether-options 802.3ad ae12
user@R5# set interfaces ae12 flexible-vlan-tagging
user@R5# set interfaces ae12 multi-chassis-protection 4.1.0.1 interface xe-1/0/0
user@R5# set interfaces ae12 encapsulation flexible-ethernet-services
user@R5# set interfaces ae12 aggregated-ether-options lacp active
user@R5# set interfaces ae12 aggregated-ether-options lacp periodic fast
user@R5# set interfaces ae12 aggregated-ether-options lacp system-priority 100
user@R5# set interfaces ae12 aggregated-ether-options lacp system-id
  00:00:00:00:00:42
user@R5# set interfaces ae12 aggregated-ether-options lacp admin-key 1
user@R5# set interfaces ae12 aggregated-ether-options mc-ae mc-ae-id 2
user@R5# set interfaces ae12 aggregated-ether-options mc-ae redundancy-group
  1
user@R5# set interfaces ae12 aggregated-ether-options mc-ae chassis-id 1
user@R5# set interfaces ae12 aggregated-ether-options mc-ae mode active-active
user@R5# set interfaces ae12 aggregated-ether-options mc-ae status-control
  standby
user@R5# set interfaces ae12 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
user@R5# set interfaces ae12 unit 0 family bridge interface-mode trunk
user@R5# set interfaces ae12 unit 0 family bridge vlan-id-list 1-4094
```

Configuring MC-LAG on Device R6

Step-by-Step Procedure

To configure MC-LAG on Device R6:

1. Configure an ICCP interface.

```
[edit]
user@R6# set interfaces xe-3/3/0 gigether-options 802.3ad ae9
user@R6# set interfaces ae9 unit 0 family inet address 5.1.0.1/30
user@R6# set interfaces ae9 unit 0 family iso
user@R6# set interfaces ae9 unit 0 family inet6 address 2002::5.1.0.1/126
user@R6# set interfaces ae9 unit 0 family mpls
```

2. Configure ICCP protocol attributes on Device R6.

```
[edit]
user@R6# set protocols iccp local-ip-addr 5.1.0.1
user@R6# set protocols iccp peer 5.1.0.2 redundancy-group-id-list 1
user@R6# set protocols iccp peer 5.1.0.2 liveness-detection minimum-interval 1000
user@R6# set protocols iccp peer 5.1.0.2 liveness-detection detection-time threshold
  2000000
user@R6# set protocols iccp peer 5.1.0.2 liveness-detection single-hop
```

3. Configure interface MC-AE1 on Device R6 that connects to data center edge routers, Devices R2 and R3.

```
[edit]
user@R6# set interfaces ae1 flexible-vlan-tagging
user@R6# set interfaces ae1 multi-chassis-protection 5.1.0.2 interface xe-5/2/1
```


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```
user@R6# set interfaces ae1 encapsulation flexible-ethernet-services
user@R6# set interfaces ae1 aggregated-ether-options lacp active
user@R6# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@R6# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@R6# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:61
user@R6# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@R6# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 1
user@R6# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group
  1
user@R6# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 0
user@R6# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@R6# set interfaces ae1 aggregated-ether-options mc-ae status-control active
user@R6# set interfaces ae1 aggregated-ether-options mc-ae events iccp-peer-down
  prefer-status-control-active
user@R6# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R6# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure MCLAG active/active configuration on ae11 on Device R6 . This goes toward Device R13.

```
[edit]
user@R6# set interfaces xe-5/3/1 gigether-options 802.3ad ae11
user@R6# set interfaces ae11 flexible-vlan-tagging
user@R6# set interfaces ae11 multi-chassis-protection 5.1.0.2 interface xe-5/2/1
user@R6# set interfaces ae11 encapsulation flexible-ethernet-services
user@R6# set interfaces ae11 aggregated-ether-options lacp active
user@R6# set interfaces ae11 aggregated-ether-options lacp periodic fast
user@R6# set interfaces ae11 aggregated-ether-options lacp system-priority 100
user@R6# set interfaces ae11 aggregated-ether-options lacp system-id
  00:00:00:00:00:41
user@R6# set interfaces ae11 aggregated-ether-options lacp admin-key 1
user@R6# set interfaces ae11 aggregated-ether-options mc-ae mc-ae-id 2
user@R6# set interfaces ae11 aggregated-ether-options mc-ae redundancy-group
  1
user@R6# set interfaces ae11 aggregated-ether-options mc-ae chassis-id 0
user@R6# set interfaces ae11 aggregated-ether-options mc-ae mode active-active
user@R6# set interfaces ae11 aggregated-ether-options mc-ae status-control active
user@R6# set interfaces ae11 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
user@R6# set interfaces ae11 unit 0 family bridge interface-mode trunk
user@R6# set interfaces ae11 unit 0 family bridge vlan-id-list 1-4094
```

Configuring MC-LAG on Device R7

Step-by-Step Procedure

To configure MC-LAG on Device R7:

1. Configure an ICCP interface.

```
[edit]
user@R7# set interfaces xe-0/0/3 gigether-options 802.3ad ae9
user@R7# set interfaces ae9 unit 0 family inet address 5.1.0.2/30
user@R7# set interfaces ae9 unit 0 family iso
user@R7# set interfaces ae9 unit 0 family inet6 address 2002::5.1.0.2/126
user@R7# set interfaces ae9 unit 0 family mpls
```

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2. Configure ICCP protocol attributes on Device R7.

```
[edit]
user@R7# set protocols iccp local-ip-addr 5.1.0.2
user@R7# set protocols iccp peer 5.1.0.1 redundancy-group-id-list 1
user@R7# set protocols iccp peer 5.1.0.1 liveness-detection minimum-interval 1000
user@R7# set protocols iccp peer 5.1.0.1 liveness-detection detection-time threshold
  2000000
user@R7# set protocols iccp peer 5.1.0.1 liveness-detection single-hop
```

3. Configure interface MC-AE1 on Device R7 that goes toward data center edge routers, Devices R2 and R3.

```
[edit]
user@R7# set interfaces ae1 flexible-vlan-tagging
user@R7# set interfaces ae1 multi-chassis-protection 5.1.0.1 interface xe-0/3/1
user@R7# set interfaces ae1 encapsulation flexible-ethernet-services
user@R7# set interfaces ae1 aggregated-ether-options lacp active
user@R7# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@R7# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@R7# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:61
user@R7# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@R7# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 1
user@R7# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group 1
user@R7# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 1
user@R7# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@R7# set interfaces ae1 aggregated-ether-options mc-ae status-control standby
user@R7# set interfaces ae1 aggregated-ether-options mc-ae events iccp-peer-down
  prefer-status-control-active
user@R7# set interfaces ae1 unit 0 family bridge interface-mode trunk
user@R7# set interfaces ae1 unit 0 family bridge vlan-id-list 1-4094
```

4. Configure MCLAG active/active configuration on ae11 on Device R7 which connects to Device R13.

```
[edit]
user@R7# set interfaces xe-0/2/1 gigether-options 802.3ad ae11
user@R7# set interfaces ae11 flexible-vlan-tagging
user@R7# set interfaces ae11 multi-chassis-protection 5.1.0.1 interface xe-0/3/1
user@R7# set interfaces ae11 encapsulation flexible-ethernet-services
user@R7# set interfaces ae11 aggregated-ether-options lacp active
user@R7# set interfaces ae11 aggregated-ether-options lacp periodic fast
user@R7# set interfaces ae11 aggregated-ether-options lacp system-priority 100
user@R7# set interfaces ae11 aggregated-ether-options lacp system-id
  00:00:00:00:00:41
user@R7# set interfaces ae11 aggregated-ether-options lacp admin-key 1
user@R7# set interfaces ae11 aggregated-ether-options mc-ae mc-ae-id 2
user@R7# set interfaces ae11 aggregated-ether-options mc-ae redundancy-group
  1
user@R7# set interfaces ae11 aggregated-ether-options mc-ae chassis-id 1
user@R7# set interfaces ae11 aggregated-ether-options mc-ae mode active-active
user@R7# set interfaces ae11 aggregated-ether-options mc-ae status-control
  standby
user@R7# set interfaces ae11 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
user@R7# set interfaces ae11 unit 0 family bridge interface-mode trunk
```

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```
user@R7# set interfaces ae11 unit 0 family bridge vlan-id-list 1-4094
```

Configuring IGP and BGP Protocols

Step-by-Step Procedure

In all Layer 3 data center deployment scenarios:

- OSPF is configured as the IGP on all core interfaces.
- BFD is configured to optimize convergence times during a core failure.
- MPLS and RSVP are enabled on each core interface.
- BGP is configured for inet-vpn signaling with BFD detection.

NOTE: The following is a generic configuration. Interface values are represented by an asterisk (*). Description and IP address octet variables are represented by *x* values.

To configure the IGP and BGP protocols:

1. Configure the router interfaces on all devices.

```
[edit]
user@host# set interfaces xe-*/*/* description "xxxx"
user@host# set interfaces xe-*/*/* unit 0 family inet address x.x.x.x/30
user@host# set interfaces xe-*/*/* unit 0 family mpls
```

2. Configure the OSPF protocol.

```
[edit]
user@host# set protocols ospf area 0.0.0.0 interface xe-*/*/*.0
  bfd-liveness-detection minimum-interval 500
user@host# set protocols ospf area 0.0.0.0 interface xe-*/*/*.0
  bfd-liveness-detection multiplier 3
```

3. Configure the RSVP and MPLS protocols.

```
[edit]
user@host# set protocols rsvp interface xe-*/*/*.0
user@host# set protocols mpls interface xe-*/*/*.0
user@host# set protocols mpls interface lo0.0
user@host# set protocols mpls label-switched-path <name> from <local IP>
user@host# set protocols mpls label-switched-path to-r2 to <remote IP>
```

4. Configure BGP.

```
[edit]
user@host# set protocols bgp group vpls-bgp type internal
user@host# set protocols bgp group vpls-bgp local-address x.x.x.x
user@host# set protocols bgp group vpls-bgp bfd-liveness-detection
  minimum-interval 1000
user@host# set protocols bgp group vpls-bgp bfd-liveness-detection multiplier 3
user@host# set protocols bgp group inet-vpn-bgp multipath
user@host# set protocols bgp group inet-vpn-bgp neighbor x.x.x.x family inet-vpn
  unicast
```

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user@host# **set protocols bgp group inet-vpn-bgp neighbor** *x.x.x.x* **family inet6-vpn unicast**

VRF and Virtual Switch Configuration

Configuring VRF and Virtual Switch Routing Instances on Device R2

Step-by-Step Procedure

To configure VRF and virtual switch instances:

NOTE: Only the virtual switch instance for customer vs1-1 is shown in this example. This customer is assigned two IRBs, one from each POD.

1. Configure routing instance vrf-1.

   NOTE: Only two IRBs are members of this and any customer VRF.

   [edit]
   user@R2# **set routing-instances vrf-1 instance-type vrf**
   user@R2# **set routing-instances vrf-1 interface irb.0** *This IRB from vs3-1*
   user@R2# **set routing-instances vrf-1 interface irb.1** *This IRB from vs4-1*
   user@R2# **set routing-instances vrf-1 route-distinguisher 1000:28001**
   user@R2# **set routing-instances vrf-1 vrf-target target:1000:24001**
   user@R2# **set routing-instances vrf-1 vrf-table-label**

2. Configure routing instance vs3-1, where interface xe-3/1/0 is the ICL interface that goes to Device R3 from Device R2.

   [edit]
   user@R2# **set routing-instances vs3-1 instance-type virtual-switch**
   user@R2# **set routing-instances vs3-1 interface xe-3/1/0.0**

3. Configure aggregated Ethernet interface ae1.

   Interface ae1 (and its member links) connects to Devices R4 and R5 from Device R2.

   [edit]
   user@R2# **set routing-instances vs3-1 interface ae1.0**

4. Configure bridge domains for routing instance vs3-1.

   NOTE: Only two of the possible 4094 bridge domains is shown.

   [edit]

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```
user@R2# set routing-instances vs3-1 bridge-domains bd-1 domain-type bridge
user@R2# set routing-instances vs3-1 bridge-domains bd-1 vlan-id 1
user@R2# set routing-instances vs3-1 bridge-domains bd-1 mcae-mac-synchronize
user@R2# set routing-instances vs3-1 bridge-domains bd-1 routing-interface irb.0
user@R2# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R2# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R2# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-statistics
```

5. Configure routing instance vs4-1, where interface xe-3/2/0 is the ICL interface that goes to Device R3 from Device R2.

```
[edit]
user@R2# set routing-instances vs4-1 instance-type virtual-switch
user@R2# set routing-instances vs4-1 interface xe-3/2/0.0
```

6. Configure aggregated Ethernet interface ae2 as a member of the virtual switch. Interface ae2 (and its member links) connects to Devices R6 and R7 from Device R2.

```
[edit]
user@R2# set routing-instances vs4-1 interface ae2.0
```

7. Configure bridge domains for routing instance vs4-1.

NOTE: Only two of the possible 4094 bridge-domains are shown.

```
[edit]
user@R2# set routing-instances vs4-1 bridge-domains bd-1 domain-type bridge
user@R2# set routing-instances vs4-1 bridge-domains bd-1 vlan-id 1
user@R2# set routing-instances vs4-1 bridge-domains bd-1 mcae-mac-synchronize
user@R2# set routing-instances vs4-1 bridge-domains bd-1 routing-interface irb.1
user@R2# set routing-instances vs4-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R2# set routing-instances vs4-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R2# set routing-instances vs4-1 bridge-domains bd-1 bridge-options
  mac-statistics
```

Configuring VRF and Virtual Switch Routing Instances on Device R3

Step-by-Step Procedure

To configure VRF and Virtual Switch on Device R3:

NOTE: There are only two IRBs configured in this VRF. Only customer vs1-1 is shown here.

1. Configuration of routing-instance vrf-1 on Device R3.

```
[edit]
```

```
user@R3# set routing-instances vrf-1 instance-type vrfThis IRB is from vs3-1.
user@R3# set routing-instances vrf-1 interface irb.0This IRB is from vs4-1.
user@R3# set routing-instances vrf-1 interface irb.1
user@R3# set routing-instances vrf-1 route-distinguisher 1000:32001
user@R3# set routing-instances vrf-1 vrf-target target:1000:24001
user@R3# set routing-instances vrf-1 vrf-table-label
```

2. Configure routing instance vs3-1, where interface xe-2/1/1 is the ICL interface that goes to Device R2 from Device R3.

```
[edit]
user@R3# set routing-instances vs3-1 instance-type virtual-switch
user@R3# set routing-instances vs3-1 interface xe-2/1/1.0
```

3. Configure aggregated Ethernet interface ae1. Interface ae1 (and its member links) connects to Devices R4 and R5 from Device R3.

```
[edit]
user@R3# set routing-instances vs3-1 interface ae1.0
```

4. Configure bridge domains for routing instance vs3-1.

NOTE: Only two of the possible 4094 bridge-domains are shown.

```
[edit]
user@R3# set routing-instances vs3-1 bridge-domains bd-1 domain-type bridge
user@R3# set routing-instances vs3-1 bridge-domains bd-1 vlan-id 1
user@R3# set routing-instances vs3-1 bridge-domains bd-1 mcae-mac-synchronize
user@R3# set routing-instances vs3-1 bridge-domains bd-1 routing-interface irb.0
user@R3# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R3# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R3# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-statistics
user@R3# set routing-instances vs3-1 bridge-domains bd-2 domain-type bridge
user@R3# set routing-instances vs3-1 bridge-domains bd-2 vlan-id 2
user@R3# set routing-instances vs3-1 bridge-domains bd-2 mcae-mac-synchronize
user@R3# set routing-instances vs3-1 bridge-domains bd-2 routing-interface irb.1
user@R3# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  mac-table-size 1048575
user@R3# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  interface-mac-limit 131071
user@R3# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  mac-statistics
```

5. Configure routing instance vs4-1, where interface xe-2/2/1 is the ICL interface that goes to Device R2 from Device R3.

```
[edit]
user@R3# set routing-instances vs4-1 instance-type virtual-switch
user@R3# set routing-instances vs4-1 interface xe-2/2/1.0
```

6. Configure aggregated Ethernet interface ae2 as a member of the virtual switch.

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Interface ae2 (and its member links) connects to Devices R6 and R7 from Device R3.

```
[edit]
user@R3# set routing-instances vs4-1 interface ae2.0
```

7. Configure bridge domains for routing instance vs4-1.

NOTE: Only two of the possible 4094 bridge-domains are shown.

```
[edit]
user@R3# set routing-instances vs4-1 bridge-domains bd-1 domain-type bridge
user@R3# set routing-instances vs4-1 bridge-domains bd-1 vlan-id 1
user@R3# set routing-instances vs4-1 bridge-domains bd-1 mcae-mac-synchronize
user@R3# set routing-instances vs4-1 bridge-domains bd-1 routing-interface irb.1
user@R3# set routing-instances vs4-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R3# set routing-instances vs4-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R3# set routing-instances vs4-1 bridge-domains bd-1 bridge-options
  mac-statistics
user@R3# set routing-instances vs4-1 bridge-domains bd-2 domain-type bridge
user@R3# set routing-instances vs4-1 bridge-domains bd-2 vlan-id 2
user@R3# set routing-instances vs4-1 bridge-domains bd-2 mcae-mac-synchronize
user@R3# set routing-instances vs4-1 bridge-domains bd-2 routing-interface irb.1
user@R3# set routing-instances vs4-1 bridge-domains bd-2 bridge-options
  mac-table-size 1048575
user@R3# set routing-instances vs4-1 bridge-domains bd-2 bridge-options
  interface-mac-limit 131071
user@R3# set routing-instances vs4-1 bridge-domains bd-2 bridge-options
  mac-statistics
```

Configuring Virtual Switch Routing Instances on Devices R4, R5, R6, and R7

Step-by-Step Procedure

To configure a virtual switch routing instances on Devices R4, R5, and R7:

1. Configure virtual switch routing instance vs3-1 on Device R4

NOTE: There is a virtual switch context shown in this example. The default virtual switch can also be used here, as it is assumed each POD will only have 4094 VLANs. To configure as part of the default instance, omit **routing-instance <name> prefix**. There are 4094 VLANs in this virtual switch. The bridge domains for customer 1 are shown here.

```
[edit]
user@R4# set routing-instances vs3-1 instance-type virtual-switch
user@R4# set routing-instances vs3-1 interface xe-0/1/1.0
user@R4# set routing-instances vs3-1 interface ae1.0
user@R4# set routing-instances vs3-1 interface ae12.0
user@R4# set routing-instances vs3-1 bridge-domains bd-1 domain-type bridge
```

```
user@R4# set routing-instances vs3-1 bridge-domains bd-1 vlan-id 1
user@R4# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R4# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R4# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-statistics
user@R4# set routing-instances vs3-1 bridge-domains bd-2 domain-type bridge
user@R4# set routing-instances vs3-1 bridge-domains bd-2 vlan-id 2
user@R4# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  mac-table-size 1048575
user@R4# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  interface-mac-limit 131071
user@R4# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  mac-statistics
```

2. Configure virtual switch routing instance vs3-1 on Device R5.

```
[edit]
user@R5# set routing-instances vs3-1 instance-type virtual-switch
user@R5# set routing-instances vs3-1 interface xe-1/0/0.0
user@R5# set routing-instances vs3-1 interface ae1.0
user@R5# set routing-instances vs3-1 interface ae12.0
user@R5# set routing-instances vs3-1 bridge-domains bd-1 domain-type bridge
user@R5# set routing-instances vs3-1 bridge-domains bd-1 vlan-id 1
user@R5# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R5# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R5# set routing-instances vs3-1 bridge-domains bd-1 bridge-options
  mac-statistics
user@R5# set routing-instances vs3-1 bridge-domains bd-2 domain-type bridge
user@R5# set routing-instances vs3-1 bridge-domains bd-2 vlan-id 2
user@R5# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  mac-table-size 1048575
user@R5# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  interface-mac-limit 131071
user@R5# set routing-instances vs3-1 bridge-domains bd-2 bridge-options
  mac-statistics
```

3. Configure virtual switch routing instance vs2-1 on Device R6.

```
[edit]
user@R6# set routing-instances vs2-1 instance-type virtual-switch
user@R6# set routing-instances vs2-1 interface xe-5/2/1.0
user@R6# set routing-instances vs2-1 interface ae1.0
user@R6# set routing-instances vs2-1 interface ae11.0
user@R6# set routing-instances vs2-1 bridge-domains bd-1 domain-type bridge
user@R6# set routing-instances vs2-1 bridge-domains bd-1 vlan-id 1
user@R6# set routing-instances vs2-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R6# set routing-instances vs2-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R6# set routing-instances vs2-1 bridge-domains bd-1 bridge-options
  mac-statistics
user@R6# set routing-instances vs2-1 bridge-domains bd-2 domain-type bridge
user@R6# set routing-instances vs2-1 bridge-domains bd-2 vlan-id 2
```

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```
user@R6# set routing-instances vs2-1 bridge-domains bd-2 bridge-options
  mac-table-size 1048575
user@R6# set routing-instances vs2-1 bridge-domains bd-2 bridge-options
  interface-mac-limit 131071
user@R6# set routing-instances vs2-1 bridge-domains bd-2 bridge-options
  mac-statistics
```

4. Configure virtual switch routing instance vs2-1 on Device R7.

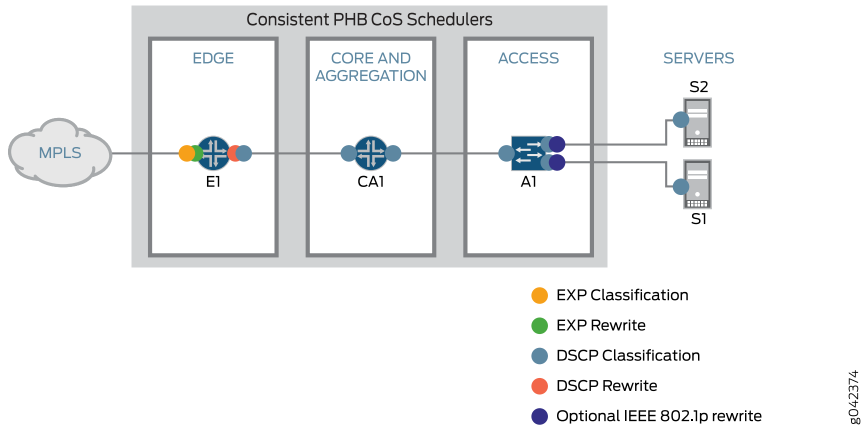
```
[edit]
user@R7# set routing-instances vs2-1 instance-type virtual-switch
user@R7# set routing-instances vs2-1 interface xe-0/3/1.0
user@R7# set routing-instances vs2-1 interface ae1.0
user@R7# set routing-instances vs2-1 interface ae11.0
user@R7# set routing-instances vs2-1 bridge-domains bd-1 domain-type bridge
user@R7# set routing-instances vs2-1 bridge-domains bd-1 vlan-id 1
user@R7# set routing-instances vs2-1 bridge-domains bd-1 bridge-options
  mac-table-size 1048575
user@R7# set routing-instances vs2-1 bridge-domains bd-1 bridge-options
  interface-mac-limit 131071
user@R7# set routing-instances vs2-1 bridge-domains bd-1 bridge-options
  mac-statistics
user@R7# set routing-instances vs2-1 bridge-domains bd-2 domain-type bridge
user@R7# set routing-instances vs2-1 bridge-domains bd-2 vlan-id 2
user@R7# set routing-instances vs2-1 bridge-domains bd-2 bridge-options
  mac-table-size 1048575
user@R7# set routing-instances vs2-1 bridge-domains bd-2 bridge-options
  interface-mac-limit 131071
user@R7# set routing-instances vs2-1 bridge-domains bd-2 bridge-options
  mac-statistics
```

Configuring Trunk-Based Layer 3 Customer Class-of-Service

As part of quality of service offered in data center edge and core routers, classifiers, rewrite rules, schedulers, forwarding classes, and drop profiles are configured as shown in this section. The attachment of the classifiers and rewrite rules to the interfaces are based on whether the traffic flowing through the interface is either made up of Layer 2 or Layer 3 data.

Figure 17 on page 50 shows the different customer CoS points.

Figure 17: Layer 3 customer CoS points



NOTE: All classifiers are marked the same on all devices where a specified classifier is used.

The following sections detail how to configure customer class-of-service.

Configuring Class-of-Service Classifiers

Step-by-Step Procedure

To configure class of service classifiers:

1. Configure EXP classifiers.

```
[edit]
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  voice loss-priority low code-points 101
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  interactive-video loss-priority low code-points 100
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  business-tier1 loss-priority low code-points 011
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  business-tier2 loss-priority low code-points 010
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  network-control loss-priority low code-points 110
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  network-control loss-priority high code-points 111
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  bulk loss-priority low code-points 000
user@host# set class-of-service classifiers exp DCN-exp-classifier forwarding-class
  bulk loss-priority high code-points 001
```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2. Configure dot1p classifiers.

```
[edit]
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class voice loss-priority low code-points 101
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class interactive-video loss-priority low code-points 100
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class business-tier1 loss-priority low code-points 011
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class business-tier2 loss-priority low code-points 010
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class network-control loss-priority low code-points 110
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class network-control loss-priority high code-points 111
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class bulk loss-priority low code-points 000
user@host# set class-of-service classifiers ieee-802.1 DCN-dot1p-classifier
  forwarding-class bulk loss-priority high code-points 001
```

3. Configure inet classifiers.

```
[edit]
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class voice loss-priority low code-points 101
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class interactive-video loss-priority low code-points 100
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class business-tier1 loss-priority low code-points 011
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class business-tier2 loss-priority low code-points 010
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class network-control loss-priority low code-points 110
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class network-control loss-priority high code-points 111
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class bulk loss-priority low code-points 000
user@host# set class-of-service classifiers inet-precedence DCN-inet
  forwarding-class bulk loss-priority high code-points 001
```

4. Configure type-of-service classifiers.

```
[edit]
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class voice loss-priority low code-points 101
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class interactive-video loss-priority low code-points 100
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class business-tier1 loss-priority low code-points 011
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class business-tier2 loss-priority low code-points 010
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class network-control loss-priority low code-points 110
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class network-control loss-priority high code-points 111
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class bulk loss-priority low code-points 000
```

```
user@host# set class-of-service classifiers inet-precedence DCN-TOS-classifier
  forwarding-class bulk loss-priority high code-points 001
```

Configuring Drop Profiles

Step-by-Step Procedure

To configure drop profiles:

1. Access the CLI of each customer-facing device.
2. Configure the drop profiles.

```
[edit]
user@host# set class-of-service drop-profiles congest-drop-low fill-level 80
  drop-probability 100
user@host# set class-of-service drop-profiles congest-drop-high fill-level 60
  drop-probability 100
```

Configuring Forwarding Classes

Step-by-Step Procedure

To configure forwarding classes:

1. Access the CLI of each customer-facing device.
2. Configure forwarding classes.

```
[edit]
user@host# set class-of-service forwarding-classes class voice queue-num 2
user@host# set class-of-service forwarding-classes class interactive-video
  queue-num 1
user@host# set class-of-service forwarding-classes class business-tier1 queue-num
  4
user@host# set class-of-service forwarding-classes class business-tier2 queue-num
  5
user@host# set class-of-service forwarding-classes class network-control
  queue-num 3
user@host# set class-of-service forwarding-classes class bulk queue-num 0
```

Configuring Rewrite Rules

Step-by-Step Procedure

To configure rewrite rules:

1. Access the CLI of each customer-facing device.
2. Configure EXP rewrite rules.

```
[edit]
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  voice loss-priority low code-point 101
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  interactive-video loss-priority low code-point 100
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  business-tier1 loss-priority low code-point 011
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  business-tier2 loss-priority low code-point 010
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  network-control loss-priority low code-point 110
```

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```
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  network-control loss-priority high code-point 111
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  bulk loss-priority low code-point 000
user@host# set class-of-service rewrite-rules exp DCN-exp-rewrite forwarding-class
  bulk loss-priority high code-point 001
```

3. Configure dot1p rewrite rules.

```
[edit]
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class voice loss-priority low code-point 101
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class interactive-video loss-priority low code-point 100
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class business-tier1 loss-priority low code-point 011
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class business-tier2 loss-priority low code-point 010
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class network-control loss-priority low code-point 110
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class network-control loss-priority high code-point 111
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class bulk loss-priority low code-point 000
user@host# set class-of-service rewrite-rules ieee-802.1 DCN-dot1p-rewrite
  forwarding-class bulk loss-priority high code-point 001
```

4. Configure type-of-service rewrite rules.

```
[edit]
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class voice loss-priority low code-point 101
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class interactive-video loss-priority low code-point 100
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class business-tier1 loss-priority low code-point 011
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class business-tier2 loss-priority low code-point 010
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class network-control loss-priority low code-point 110
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class network-control loss-priority high code-point 111
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class bulk loss-priority low code-point 000
user@host# set class-of-service rewrite-rules inet-precedence DCN-TOS-rewrite
  forwarding-class bulk loss-priority high code-point 001
```

Configuring Schedulers and Scheduler Maps

Step-by-Step Procedure

To configure class-of-service schedulers and scheduler maps:

1. Access the CLI of each customer-facing device.
2. Configure schedulers.

```
[edit]
user@host# set class-of-service schedulers voice transmit-rate percent 25
```

```
user@host# set class-of-service schedulers voice transmit-rate exact
user@host# set class-of-service schedulers voice buffer-size temporal 25k
user@host# set class-of-service schedulers voice priority high
user@host# set class-of-service schedulers interactive-video transmit-rate percent
  25
user@host# set class-of-service schedulers interactive-video transmit-rate exact
user@host# set class-of-service schedulers interactive-video buffer-size temporal
  25k
user@host# set class-of-service schedulers interactive-video priority high
user@host# set class-of-service schedulers business-tier1 transmit-rate percent
  20
user@host# set class-of-service schedulers business-tier1 buffer-size percent 20
user@host# set class-of-service schedulers business-tier1 priority medium-high
user@host# set class-of-service schedulers network-control transmit-rate percent
  5
user@host# set class-of-service schedulers network-control buffer-size percent 5
user@host# set class-of-service schedulers network-control priority high
user@host# set class-of-service schedulers bulk transmit-rate remainder
user@host# set class-of-service schedulers bulk buffer-size remainder
user@host# set class-of-service schedulers bulk priority low
user@host# set class-of-service schedulers bulk drop-profile-map loss-priority low
  protocol any drop-profile congest-drop-low
user@host# set class-of-service schedulers bulk drop-profile-map loss-priority high
  protocol any drop-profile congest-drop-high
user@host# set class-of-service schedulers business-tier2 transmit-rate percent
  20
user@host# set class-of-service schedulers business-tier2 buffer-size percent 20
user@host# set class-of-service schedulers business-tier2 priority medium-high
```

3. Configure scheduler maps.

```
[edit]
user@host# set class-of-service scheduler-maps DCN-map forwarding-class voice
  scheduler voice
user@host# set class-of-service scheduler-maps DCN-map forwarding-class
  interactive-video scheduler interactive-video
user@host# set class-of-service scheduler-maps DCN-map forwarding-class
  business-tier1 scheduler business-tier1
user@host# set class-of-service scheduler-maps DCN-map forwarding-class
  business-tier2 scheduler business-tier2
user@host# set class-of-service scheduler-maps DCN-map forwarding-class bulk
  scheduler bulk
user@host# set class-of-service scheduler-maps DCN-map forwarding-class
  network-control scheduler network-control
```

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Applying Class-of-Service Components

Step-by-Step Procedure

All classifiers are the same on all routers where a specific classifier is used. However, the attachment of classifiers and rewrite rules to routing instances or interfaces is based on whether the traffic flowing through the circuit or interface are Layer 2 or Layer 3 data packets.

When applying class-of-service components, keep the following in mind:

- All XE interfaces access the MPLS network; that is, they are either connected to the P router or to the other PE router.
- All aggregated Ethernet interfaces are attached with the dot1p classifiers and re-write rules because the packets received by the AE interfaces are VLAN tagged packets. IRB interfaces are attached with the TOS classifier and TOS rewrite rules because the packets received by these interfaces contain IPv4 header packets.

To apply customer class-of-service to various interfaces on different routers sitting at the data center edge or core:

> NOTE: Throughout this procedure, an asterisk (*) is used as a wildcard value to represent all static interface units.

1. Apply the EXP classifier to all customer routing instances.

   ```
   [edit]
   user@host# set class-of-service routing-instances vs1* classifiers exp
     DCN-exp-classifier
   user@host# set class-of-service routing-instances vs2* classifiers exp
     DCN-exp-classifier
   user@host# set class-of-service routing-instances vrf* classifiers exp
     DCN-exp-classifier
   ```

2. Apply the scheduler map, classifiers, and rewrite rules to all core-facing interfaces.

   > NOTE: All XE interfaces are the interfaces that go to the MPLS network, that is either the interface is connected to the P router, going to the other PE router, or both.

   ```
   [edit]
   user@host# set class-of-service interfaces ge-0/0/0 scheduler-map DCN-map
   user@host# set class-of-service interfaces ge-0/0/0 unit * classifiers ieee-802.1
     DCN-dot1p-classifier
   user@host# set class-of-service interfaces ge-0/0/0 unit * rewrite-rules ieee-802.1
     DCN-dot1p-rewrite
   user@host# set class-of-service interfaces xe-0/2/0 scheduler-map DCN-map
   user@host# set class-of-service interfaces xe-0/2/0 unit * classifiers ieee-802.1
     DCN-dot1p-classifier
   ```

```
user@host# set class-of-service interfaces xe-0/2/0 unit * rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces xe-0/3/1 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-0/3/1 unit * classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces xe-0/3/1 unit * rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces xe-5/0/0 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/0/0 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/0/0 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/0/1 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/0/1 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/0/1 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/0/3 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/0/3 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces xe-5/0/3 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces xe-5/1/0 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/1/0 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/1/0 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/1/1 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/1/1 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/1/1 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/1/2 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/1/2 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/1/2 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/2/1 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/2/1 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/2/1 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/3/1 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/3/1 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/3/1 unit 0 rewrite-rules exp
  DCN-exp-rewrite
user@host# set class-of-service interfaces xe-5/3/2 scheduler-map DCN-map
user@host# set class-of-service interfaces xe-5/3/2 unit 0 classifiers exp
  DCN-exp-classifier
user@host# set class-of-service interfaces xe-5/3/2 unit 0 rewrite-rules exp
  DCN-exp-rewrite
```

3. Apply the scheduler map, dot1p classifiers and rewrite rules to all LAG (AE) interfaces between core and edge and between core and access.

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NOTE: All the AE interfaces are attached with the dot1p classifiers and rewrite rules because the packets going through the AE interfaces are the VLAN tagged packets (Layer 2). The IRB interfaces are attached with the TOS classifier and TOS rewrite rules because the packets going through IRB interfaces are IPV4 header packets (Layer 3).

```
[edit]
user@host# set class-of-service interfaces ae0 scheduler-map DCN-map
user@host# set class-of-service interfaces ae0 unit * classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae0 unit * rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae1 scheduler-map DCN-map
user@host# set class-of-service interfaces ae1 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae1 unit 0 classifiers inet-precedence
  DCN-TOS-classifier deactivate class-of-service interfaces ae1 unit 0 classifiers
  inet-precedence
user@host# set class-of-service interfaces ae1 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae1 unit 0 rewrite-rules inet-precedence
  DCN-TOS-rewrite deactivate class-of-service interfaces ae1 unit 0 rewrite-rules
  inet-precedence DCN-TOS-rewrite
user@host# set class-of-service interfaces ae2 scheduler-map DCN-map
user@host# set class-of-service interfaces ae2 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae2 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae3 scheduler-map DCN-map
user@host# set class-of-service interfaces ae3 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae3 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae10 scheduler-map DCN-map
user@host# set class-of-service interfaces ae10 unit * classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae10 unit * rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae11 scheduler-map DCN-map
user@host# set class-of-service interfaces ae11 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae11 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces irb unit * classifiers inet-precedence
  DCN-TOS-classifier
user@host# set class-of-service interfaces irb unit * rewrite-rules inet-precedence
  DCN-TOS-rewrite
```

4. Apply the Class-of-Service configuration on all routers (identical configuration applied to Devices R2, R3, R4, R5, R6, and R7).

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NOTE: The IRB interfaces are attached with the TOS classifier and TOS rewrite rules because the packets that traverse this interface have IPV4 header packets (Layer 3).

```
[edit]
user@host# set class-of-service interfaces ae1 scheduler-map DCN-map
user@host# set class-of-service interfaces ae1 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae1 unit 0 classifiers inet-precedence
  DCN-TOS-classifier
user@host# set class-of-service interfaces ae1 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae1 unit 0 rewrite-rules inet-precedence
  DCN-TOS-rewrite
user@host# set class-of-service interfaces ae2 scheduler-map DCN-map
user@host# set class-of-service interfaces ae2 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae2 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces ae11 scheduler-map DCN-map
user@host# set class-of-service interfaces ae11 unit 0 classifiers ieee-802.1
  DCN-dot1p-classifier
user@host# set class-of-service interfaces ae11 unit 0 rewrite-rules ieee-802.1
  DCN-dot1p-rewrite
user@host# set class-of-service interfaces irb unit * classifiers inet-precedence
  DCN-TOS-classifier
user@host# set class-of-service interfaces irb unit * rewrite-rules inet-precedence
  DCN-TOS-rewrite
```

Verification

Confirm that the configuration is working properly.

- Verifying Aggregated Ethernet Interfaces Are UP on page 59
- Verifying the Status of ICL Interfaces on page 61
- Verifying Interfaces are Installed in VLANs on Access Switches on page 63
- Verifying Interface Connection Status on Access Switches on page 63
- Verifying LACP Status on page 64
- Verifying MCAE Active/Active Interface Status on Devices R2 and R3 on page 65
- Verifying LACP Statistics on page 67
- Verifying MCAE State on page 69
- Verifying LACP Status on MC-AE and AE Bundles on page 71
- Verifying IRB Interfaces are UP on page 73
- Verify Bridge Domain VLAN Routing Instances on page 74
- Verifying Status of Routing Instance vrf-1 on page 76
- Verifying BGP Status on page 76

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- Verifying Route Table Entries on page 78
- Verifying MAC Table Entries on page 80

Verifying Aggregated Ethernet Interfaces Are UP

Purpose Verify that aggregated Ethernet interfaces are up on all routers.

Action Verify that interface ae1 is UP on Device R2.

```
user@R2# run show interfaces terse ae1
Interface               Admin Link Proto    Local                 Remote
ae1                     up    up
ae1.0                   up    up   bridge
ae1.32767               up    up   multiservice
```

Verify that interface ae1 is UP on Device R3.

```
user@R3# run show interfaces terse ae1
Interface               Admin Link Proto    Local                 Remote
ae1                     up    up
ae1.0                   up    up   bridge
ae1.32767               up    up   multiservice
```

Verify that interface ae1 is UP on Device R4.

```
user@R4# run show interfaces terse ae1
Interface               Admin Link Proto    Local                 Remote
ae1                     up    up
ae1.0                   up    up   bridge
ae1.32767               up    up   multiservice
```

Verify that interface ae1 is UP on Device R5.

```
user@R5# run show interfaces terse ae1
Interface               Admin Link Proto    Local                 Remote
ae1                     up    up
ae1.0                   up    up   bridge
ae1.32767               up    up   multiservice
```

Verify that interface ae1 is UP on Device R6.

```
user@R6# run show interfaces terse ae1
Interface               Admin Link Proto    Local                 Remote
ae1                     up    up
ae1.0                   up    up   bridge
ae1.32767               up    up   multiservice
```

Verify that interface ae1 is UP on Device R7.

```
user@R7# run show interfaces terse ae1
Interface               Admin Link Proto    Local                 Remote
ae1                     up    up
ae1.0                   up    up   bridge
ae1.32767               up    up   multiservice
```

Verify that interface ae2 is UP on Device R2.

```
user@R2# run show interfaces terse ae2
Interface               Admin Link Proto    Local                 Remote
ae2                     up    up
ae2.0                   up    up   bridge
ae2.32767                   up    up   bridge
```

Verify that interface ae2 is UP on Device R3.

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```
user@R3# run show interfaces terse ae2
Interface               Admin Link Proto    Local                 Remote
ae2                     up    up
ae2.0                   up    up   bridge
ae2.32767                   up    up   bridge
```

Verify the status of interface ae11 on Device R6.

```
user@R6# run show interfaces terse ae11
Interface               Admin Link Proto    Local                 Remote
ae11                    up    up
ae11.0                  up    up   bridge
ae11.32767              up    up   multiservice
```

Verify the status of interface ae11 on Device R7.

```
user@R7# run show interfaces terse ae11
Interface               Admin Link Proto    Local                 Remote
ae11                    up    up
ae11.0                  up    up   bridge
ae11.32767              up    up   multiservice
```

Verify the status of interface ae12 on Device R4.

```
user@R4# run show interfaces terse ae12
Interface               Admin Link Proto    Local                 Remote
ae12                    up    up
ae12.0                  up    up   bridge
ae12.32767              up    up   multiservice
```

Verify the status of interface ae12 on Device R5.

```
user@R5# run show interfaces terse ae12
Interface               Admin Link Proto    Local                 Remote
ae12                    up    up
ae12.0                  up    up   bridge
ae12.32767              up    up   multiservice
```

Meaning All LAG interfaces throughout the topology are up and active.

Verifying the Status of ICL Interfaces

Purpose Verify that ICL interfaces are up on all routers.

Action Verify the status of the ICL interface on Device R2.

```
user@R2# run show interfaces terse xe-3/1/0
Interface               Admin Link Proto    Local                 Remote
xe-3/1/0                up    up
xe-3/1/0.0              up    up   bridge
xe-3/1/0.32767          up    up   multiservice
```

```
user@R2# run show interfaces terse xe-3/2/0
Interface               Admin Link Proto    Local                 Remote
xe-3/2/0                up    up
xe-3/2/0.0              up    up   bridge
xe-3/2/0.32767          up    up   multiservice
```

Verify the status of the ICL interface on Device R3.

```
user@R3# run show interfaces terse xe-2/1/1
Interface               Admin Link Proto    Local                 Remote
xe-2/1/1                up    up
xe-2/1/1.0              up    up   bridge
xe-2/1/1.32767          up    up   multiservice
```

```
user@R3# run show interfaces terse xe-2/2/1
Interface               Admin Link Proto    Local                 Remote
xe-2/2/1                up    up
xe-2/2/1.0              up    up   bridge
xe-2/2/1.32767          up    up   multiservice
```

Verify the status of the ICL interface on Device R4.

```
user@R4# run show interfaces terse xe-0/1/1
Interface               Admin Link Proto    Local                 Remote
xe-0/1/1                up    up
xe-0/1/1.0              up    up   bridge
xe-0/1/1.32767          up    up   multiservice
```

Verify the status of the ICL interface on Device R5.

```
user@R5# run show interfaces terse xe-1/0/0
Interface               Admin Link Proto    Local                 Remote
xe-1/0/0                up    up
xe-1/0/0.0              up    up   bridge
xe-1/0/0.32767          up    up   multiservice
```

Verify the status of the ICL Interface on Device R6.

```
user@R6# run show interfaces terse xe-5/2/1
Interface               Admin Link Proto    Local                 Remote
xe-5/2/1                up    up
xe-5/2/1.0              up    up   bridge
xe-5/2/1.32767          up    up   multiservice
```

Verify the status of the ICL interface on Device R7.

```
user@R7# run show interfaces terse xe-0/3/1
Interface               Admin Link Proto    Local                 Remote
xe-0/3/1                up    up
xe-0/3/1.0              up    up   bridge
xe-0/3/1.32767          up    up   multiservice
```

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Meaning Inter-Chassis link connections used for MC-LAG active/active data traffic are up and operational.

Verifying Interfaces are Installed in VLANs on Access Switches

Purpose Verify information about VLANs configured on bridged Ethernet interfaces.

Action Verify that interfaces are installed in VLANs on ToR Device R10.

```
user@R10# run show vlans
default        4094
                        ae0.0*, ge-0/0/25.0*
vlan-1         1
                        ae0.0*, ge-0/0/25.0*
vlan-10        10
```

Verify that interfaces are installed in VLANs on Device R13.

```
user@R13# run show vlans
Name           Tag      Interfaces
default        4094
                        ae0.0*, ge-0/0/4.0*
vlan-1         1
                        ae0.0*, ge-0/0/4.0*
```

Meaning Ensure that all VLANs for this customer are active on Devices R10 and R13.

Verifying Interface Connection Status on Access Switches

Purpose Verify that each configured interface is UP.

Action Verify that interface status of interface ae0 that connects to Devices R4 and R5 from switch R10.

```
user@R10# run show interfaces terse ae0
Interface               Admin Link Proto    Local                 Remote
ae0                     up    up
ae0.0                   up    up   eth-switch
```

Verify that interface status that goes to the virtual compute resources from switch R10.

```
user@R10# run show interfaces terse ge-0/0/25
Interface               Admin Link Proto    Local                 Remote
ge-0/0/25               up    up
ge-0/0/25.0             up    up   eth-switch
```

Verify that interface status of interface ae0 that connects to Devices R6 and R7 from switch R13.

```
user@R13# run show interfaces terse ae0
Interface               Admin Link Proto    Local                 Remote
ae0                     up    up
ae0.0                   up    up   eth-switch
```

Verify that interface status that goes to the virtual compute resources from switch R13.

```
user@R13# run show interfaces terse ge-0/0/4
Interface               Admin Link Proto    Local                 Remote
ge-0/0/4                up    up
ge-0/0/4.0              up    up   eth-switch
```

Meaning All Access VLANs are up and operational.

Verifying LACP Status

Purpose Verify Link Aggregation Control Protocol (LACP) statistics about aggregated Ethernet interfaces on all devices.

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Action Verify LACP status on Device R2 interface ae1.

```
user@R2# run show lacp statistics interfaces ae1
Aggregated interface: ae1
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-3/0/1               44778       44592            0            0
      xe-3/2/3               44649       44591            0            0
```

Verify LACP status on Device R2 interface ae2.

```
user@R2# run show lacp statistics interfaces ae2
Aggregated interface: ae11
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-0/0/1               44772       44593            0            0
      xe-3/1/1               44765       44593            0            0
```

Verify LACP status on Device R3 interface ae1.

```
user@R3# run show lacp statistics interfaces ae1
Aggregated interface: ae1
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-0/1/3              116751      116706            0            0
      xe-0/2/0              116752      116705            0            0
```

Verify LACP status on Device R2 interface ae11.

```
user@R2# run show lacp statistics interfaces ae11
Aggregated interface: ae11
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-5/0/0              116819      116770            0            0
      xe-0/3/1              116770      116759            0            0
```

Meaning LAG and LACP on Devices R2 and R3 are up and connected properly to Devices R4, R5, R6 and R7.

Verifying MCAE Active/Active Interface Status on Devices R2 and R3

Purpose Verify multichassis link aggregation interface status on all devices.

Action Verify MCAE active/active for ae1 interface status on Device R2.

```
user@R2# run show interfaces mc-ae id 1
 Member Link                  : ae1
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae1.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.0.0.2 xe-3/1/0.0 up
```

Verify MCAE active/active for ae2 interface status on Device R2

```
user@R2# run show interfaces mc-ae id 2
Member Link                  : ae2
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae2.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.0.0.2 xe-3/1/0.0 up
```

Verify MCAE active/active for ae1 interface status on Device R3.

```
user@R3# run show interfaces mc-ae id 1
Member Link                  : ae1
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae1.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.0.0.1 xe-2/1/1.0 up
```

Verify MCAE active/active for ae2 interface status on Device R4

```
user@R4# run show interfaces mc-ae id 2
Member Link                  : ae2
Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae2.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.0.0.1 xe-2/2/1.0 up
```

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Meaning All aggregated Ethernet MC-LAG instances are up.

Verifying LACP Statistics

Purpose Verify Link Aggregation Control Protocol (LACP) statistics on all devices.

Action Verify LACP statistics on interface ae1 on Device R4.

```
user@R4# run show lacp statistics interfaces ae1
Aggregated interface: ae1
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-4/1/0              417583      419802            0            0
      xe-3/0/2              410096      414256            0            0
```

Verify LACP statistics on ae12 on Device R4.

```
user@R4# run show lacp statistics interfaces ae12
Aggregated interface: ae12
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-9/0/0              421352      422115            0            0
```

Verify LACP statistics on interface ae1 on Device R5.

```
user@R5# run show lacp statistics interfaces ae1
Aggregated interface: ae1
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-4/1/1              410182      414441            0            0
      xe-3/1/0              417533      419801            0            0
```

Verify LACP statistics on ae12 on Device R5.

```
user@R5# run show lacp statistics interfaces ae12
Aggregated interface: ae12
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-5/3/2              421118      421915            0            0
```

Verify LACP statistics on ae1 on Device R6.

```
user@R6# run show lacp statistics interfaces ae1
Aggregated interface: ae1
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-3/0/1              410562      414441            0            0
      xe-3/1/1              413453      419801            0            0
```

Verify LACP statistics on ae11 on Device R6.

```
user@R6# run show lacp statistics interfaces ae11
Aggregated interface: ae11
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-5/3/1             1214585     1216944            0            0
```

Verify LACP statistics on interface ae1 on Device R7.

```
user@R7# run show lacp statistics interfaces ae1
Aggregated interface: ae1
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
      xe-0/0/1             1205312     1208261            0            0
      xe-0/1/0             1058934     1118318            0            0
```

Verify LACP statistics on ae11 on Device R7.

```
user@R7# run show lacp statistics interfaces ae11
Aggregated interface: ae11
    LACP Statistics:       LACP Rx     LACP Tx   Unknown Rx   Illegal Rx
```

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```
xe-0/2/1              1215878      1218277            0               0
```

Meaning All LACP (for link node redundancy) connections are active and operating properly for each MC-LAG.

Verifying MCAE State

Purpose Verify multi-chassis link aggregation interface status on all devices connected to ae1.

Action Verify MCAE interface MC-AE1 on Device R4.

```
user@R4# run show interfaces mc-ae id 1
Member Link                  : ae1
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae1.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.1.0.2 xe-0/1/1.0 up
```

Verify MCAE status of interface ae2 on R4.

```
user@R4# run show interfaces mc-ae id 2
Member Link                  : ae2
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae2.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.1.0.2 xe-0/1/1.0 up
```

Verify MCAE interface MC-AE1 on Device R5.

```
user@R5# run show interfaces mc-ae id 1
Member Link                  : ae1
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae1.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 4.1.0.1 xe-1/0/0.0 up
```

Verify MCAE interface MC-AE2 on Device R5.

```
user@R5# run show interfaces mc-ae id 2
Member Link                  : ae2
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae2.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
```

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```
     Peer Ip/MCP/State         : 4.1.0.1 xe-1/0/0.0 up
```

Verify MCAE interface MC-AE1 on Device R6.

```
user@R6# run show interfaces mc-ae id 1
Member Link                  : ae1
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae1.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 5.1.0.2 xe-5/2/1.0 up
```

Verify MCAE interface MC-AE1 on Device R7.

```
user@R7# run show interfaces mc-ae id 1
Member Link                  : ae1
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae1.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 5.1.0.1 xe-0/3/1.0 up
```

Verify MCAE interface MC-AE2 on Device R7.

```
user@R7# run show interfaces mc-ae id 2
Member Link                  : ae2
 Current State Machine's State: mcae active state
 Local Status                 : active
 Local State                  : up
 Peer Status                  : active
 Peer State                   : up
     Logical Interface        : ae2.0
     Topology Type            : bridge
     Local State              : up
     Peer State               : up
     Peer Ip/MCP/State        : 5.1.0.1 xe-0/3/1.0 up
```

Meaning All the MC-LAG active/active sessions are up between all peering routers connected.

Verifying LACP Status on MC-AE and AE Bundles

Purpose Verify Link Aggregation Control Protocol (LACP) information about configured aggregated Ethernet interfaces.

Action Verify LACP state on Device R4.

```
user@R4# run show lacp interfaces ae1
Aggregated interface: ae1
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-4/1/0       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-4/1/0     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/0/2       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/0/2     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:       Receive State  Transmit State          Mux State
      xe-4/1/0                 Current   Fast periodic Collecting distributing
      xe-3/0/2                 Current   Fast periodic Collecting distributing
```

```
user@R4# run show lacp interfaces ae12
Aggregated interface: ae12
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-9/0/0       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-9/0/0     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:       Receive State  Transmit State          Mux State
      xe-9/0/0                 Current   Fast periodic Collecting distributing
```

Verify LACP state on Device R5.

```
user@R5# run show lacp interfaces ae1
Aggregated interface: ae1
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-4/1/1       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-4/1/1     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/1/0       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/1/0     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:       Receive State  Transmit State          Mux State
      xe-4/1/1                 Current   Fast periodic Collecting distributing
      xe-3/1/0                 Current   Fast periodic Collecting distributing
```

```
user@R5# run show lacp interfaces ae12
Aggregated interface: ae12
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-5/3/2       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-5/3/2     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:       Receive State  Transmit State          Mux State
      xe-5/3/2                 Current   Fast periodic Collecting distributing
/0/0.0 up
```

Verify LACP state on Device R6.

```
user@R6# run show lacp interfaces ae1
Aggregated interface: ae1
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-3/0/1       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/0/1     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/1/1       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
      xe-3/1/1     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:       Receive State  Transmit State          Mux State
      xe-3/0/1                 Current   Fast periodic Collecting distributing
      xe-3/1/1                 Current   Fast periodic Collecting distributing
```

```
user@R6# run show lacp interfaces ae11
Aggregated interface: ae11
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-5/3/1       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active
```

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```
    xe-5/3/1     Partner    No     No    Yes  Yes  Yes   Yes      Fast    Active
  LACP protocol:        Receive State  Transmit State          Mux State
    xe-5/3/1                  Current   Fast periodic Collecting distributing
```

Verify LACP state on Device R7.

```
user@R7# run show lacp interfaces ae1
Aggregated interface: ae1
    LACP state:       Role    Exp    Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-0/0/1       Actor    No     No    Yes  Yes  Yes   Yes     Fast    Active
      xe-0/0/1     Partner    No     No    Yes  Yes  Yes   Yes     Fast    Active
      xe-0/1/0       Actor    No     No    Yes  Yes  Yes   Yes     Fast    Active
      xe-0/1/0     Partner    No     No    Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:        Receive State  Transmit State          Mux State
      xe-0/0/1                  Current   Fast periodic Collecting distributing
      xe-0/1/0                  Current   Fast periodic Collecting distributing
```

```
user@R7# run show lacp interfaces ae11
Aggregated interface: ae11
    LACP state:       Role    Exp    Def  Dist  Col  Syn  Aggr  Timeout  Activity
      xe-0/2/1       Actor    No     No    Yes  Yes  Yes   Yes     Fast    Active
      xe-0/2/1     Partner    No     No    Yes  Yes  Yes   Yes     Fast    Active
    LACP protocol:        Receive State  Transmit State          Mux State
      xe-0/2/1                  Current   Fast periodic Collecting distributing
```

Meaning All link state protocol between all AE bundles and MC-LAG connections are peering properly.

Verifying IRB Interfaces are UP

Purpose Verify that IRB interfaces are up on all routers.

Action Verify interfaces irb.0 is UP on Device R2.

```
user@R2# run show interfaces terse irb.0
Interface               Admin Link Proto    Local                 Remote
irb.0                   up    up   inet     178.1.0.252/24
                                   inet6    2002::8401:101/126
                                            fe80::2e6b:f5ff:fe47:ff0/64
                                   multiservice
```

Verify interface irb.1 is UP on Device R2.

```
user@R2# run show interfaces terse irb.1
Interface               Admin Link Proto    Local                 Remote
irb.1                   up    up   inet     178.1.1.252/24
                                   inet6    2002::8401:105/126
                                            fe80::2e6b:f5ff:fe47:ff0/64
                                   multiservice
```

Verify interface irb.0 is UP on Device R3.

```
user@R3# run show interfaces terse irb.0
Interface               Admin Link Proto    Local                 Remote
irb.0                   up    up   inet     178.1.0.252/24
                                   inet6    2002::8401:101/126
                                            fe80::aad0:e5ff:fef6:1ff0/64
                                   multiservice
```

Verify interface irb.1 is UP on Device R3.

```
user@R3# run show interfaces terse irb.1
Interface               Admin Link Proto    Local                 Remote
irb.1                   up    up   inet     178.1.1.252/24
                                   inet6    2002::8401:105/126
                                            fe80::aad0:e5ff:fef6:1ff0/64
                                   multiservice
```

Meaning The Layer 3 interfaces are up and active for this customer.

Verify Bridge Domain VLAN Routing Instances

Purpose Verify that bridge domain VLAN interfaces are installed in bridge domain routing instance vs3-1 on all routers.

NOTE: Devices R6 and R7 are not shown here.

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Action Verify interfaces BD-1 and BD-2 for this customer example are installed in bridge domain routing instance vs3-1 on Device R2.

```
user@R2# run show bridge domain instance vs3-1
Routing instance        Bridge domain            VLAN ID     Interfaces
vs3-1                   bd-1                     1
                                                     ae1.0
                                                     ae11.0
                                                     xe-3/1/0.0
vs3-1                   bd-2                    2
                                                     ae1.0
                                                     ae11.0
                                                     xe-3/1/0.0
```

Verify interfaces BD-1 and BD-2 for this customer example are installed in bridge domain routing instance vs3-1 on Device R3.

```
user@R3# run show bridge domain instance vs3-1
Routing instance        Bridge domain            VLAN ID     Interfaces
vs3-1                   bd-1                     1
                                                     ae1.0
                                                     ae11.0
                                                     xe-2/1/1.0
vs3-1                   bd-2                    2
                                                     ae1.0
                                                     ae11.0
                                                     xe-2/1/1.0
```

Verify interfaces BD-1 and BD-2 for this customer example are installed in bridge domain routing instance vs3-1 on Device R4.

```
user@R4# run show bridge domain instance vs3-1
Routing instance        Bridge domain            VLAN ID     Interfaces
vs3-1                   bd-1                     1
                                                     ae1.0
                                                     ae12.0
                                                     xe-0/1/1.0
vs3-1                   bd-2                    2
                                                     ae1.0
                                                     ae12.0
                                                     xe-0/1/1.0
```

Verify interfaces BD-1 and BD-2 for this customer example are installed in bridge domain routing instance vs3-1 on Device R5.

```
user@R5# run show bridge domain instance vs3-1
Routing instance        Bridge domain            VLAN ID     Interfaces
vs3-1                   bd-1                     1
                                                     ae1.0
                                                     ae12.0
                                                     xe-1/0/0.0
vs3-1                   bd-2                    2
                                                     ae1.0
                                                     ae12.0
                                                     xe-1/0/0.0
```

Meaning The bridge domains are active throughout the routing instance.

Verifying Status of Routing Instance vrf-1

Purpose Verify the status of routing instance vrf-1 for this customer example is installed on Devices R2 and R3.

Action Verify status of routing instance vrf-1 on Device R2.

```
user@R2# run show route instance vrf-1
Instance             Type    Primary RIB
Active/holddown/hidden
vrf-1                vrf
         vrf-1.inet.0                                   5/0/0
         vrf-1.inet6.0                                  7/0/0
```

Verify status of routing instance vrf-1 on Device R3.

```
user@R3# run show route instance vrf-1
Instance             Type    Primary RIB
Active/holddown/hidden
vrf-1                vrf
         vrf-1.inet.0                                   5/0/0
         vrf-1.inet6.0                                  7/0/0
```

Meaning VRF instances for this customer are active and valid in IPv4 and IPv6. This customer is isolated from other Layer 3 customers.

Verifying BGP Status

Purpose Verify BGP status on Devices R0, R2, and R3.

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Action Verify BGP summary status on Device R0.

```
user@R0# run show bgp summary
Groups: 1 Peers: 2 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
bgp.l3vpn.0
                   16000      16000          0          0          0          0
bgp.l2vpn.0
                   10506      10506          0          0          0          0
Peer                     AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
State|#Active/Received/Accepted/Damped...
10.255.32.193          1000      34364      25855       0       0  4d 4:35:55
Establ
  bgp.l3vpn.0: 8000/8000/8000/0
  bgp.l3vpn-inet6.0: 8000/8000/8000/0
  bgp.l2vpn.0: 5003/5003/5003/0
  vrf-1.inet.0: 2/2/2/0
  vrf-10.inet.0: 2/2/2/0
  vrf-100.inet.0: 2/2/2/0
  vrf-1000.inet.0: 2/2/2/0
  vrf-1001.inet.0: 2/2/2/0
  vrf-1002.inet.0: 2/2/2/0
  vrf-1003.inet.0: 2/2/2/0
  vrf-1004.inet.0: 2/2/2/0
  vrf-1005.inet.0: 2/2/2/0
  vrf-1006.inet.0: 2/2/2/0
   ---- Truncated -----
```

Verify BGP summary status on Device R2.

```
user@R2# run show bgp summary
Groups: 1 Peers: 2 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
bgp.l3vpn.0
                   12011      12011          0          0          0          0
bgp.l2vpn.0
                   10005      10005          0          0          0          0
Peer                     AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
State|#Active/Received/Accepted/Damped...
10.255.35.128          1000      13589      22553       0       0    11:54:18
Establ
  bgp.l3vpn.0: 4001/4001/4001/0
  bgp.l3vpn-inet6.0: 4001/4001/4001/0
  bgp.l2vpn.0: 4502/4502/4502/0
  vrf-1.inet.0: 1/1/1/0
```

Verify BGP summary status on Device R3.

```
user@R3# run show bgp summary
Groups: 1 Peers: 2 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
bgp.l3vpn.0
                   12011      12011          0          0          0          0
bgp.l2vpn.0
                    9505       9505          0          0          0          0
Peer                     AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
State|#Active/Received/Accepted/Damped...
10.255.32.193          1000      22825      17668       0       2    11:54:25
Establ
```

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```
bgp.l3vpn.0: 8010/8010/8010/0
bgp.l2vpn.0: 5003/5003/5003/0
vrf-1.inet.0: 2/2/2/0
```

Meaning A unique router table exists for each Layer 3 VPN instance that isolates the routes from each different tenant.

Verifying Route Table Entries

Purpose Verify route table entries for all routers.

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Action Verify the route table shows the routes in vrf-1.inet.0 on Device R0.

```
user@R0# run show route table vrf-1.inet.0
vrf-1.inet.0: 4 destinations, 6 routes (4 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
132.1.1.0/30       *[Direct/0] 4d 04:40:50
                    > via ge-0/0/0.1
132.1.1.1/32       *[Local/0] 4d 04:42:09
                      Local via ge-0/0/0.1
178.1.0.0/24       *[BGP/170] 4d 04:34:55, localpref 100, from 10.255.32.193
                      AS path: I, validation-state: unverified
                    > to 3.3.0.2 via xe-5/1/0.0, label-switched-path to-r2
                    [BGP/170] 4d 04:32:11, localpref 100, from 10.255.36.216
                      AS path: I, validation-state: unverified
                    > to 3.8.0.2 via xe-5/0/1.0, label-switched-path to-r3
178.1.1.0/24       *[BGP/170] 4d 04:34:55, localpref 100, from 10.255.32.193
                      AS path: I, validation-state: unverified
                    > to 3.3.0.2 via xe-5/1/0.0, label-switched-path to-r2
                    [BGP/170] 4d 04:32:11, localpref 100, from 10.255.36.216
                      AS path: I, validation-state: unverified
                    > to 3.8.0.2 via xe-5/0/1.0, label-switched-path to-r3
```

Verify the route table shows the routes in vrf-1.inet.0 on Device R2.

```
user@R2# run show route table vrf-1.inet.0
vrf-1.inet.0: 5 destinations, 7 routes (5 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
132.1.1.0/30       *[BGP/170] 4d 04:38:20, localpref 100, from 10.255.35.128
                      AS path: I, validation-state: unverified
                    > to 3.1.0.5 via xe-2/2/1.0, label-switched-path to-r0
178.1.0.0/24       *[Direct/0] 4d 04:36:01
                    > via irb.0
                    [BGP/170] 4d 04:32:13, localpref 100, from 10.255.36.216
                      AS path: I, validation-state: unverified
                    > to 3.4.0.5 via xe-1/3/1.0, label-switched-path to-r3
178.1.0.252/32     *[Local/0] 4d 04:48:09
                      Local via irb.0
178.1.1.0/24       *[Direct/0] 4d 04:36:01
                    > via irb.1
                    [BGP/170] 4d 04:32:13, localpref 100, from 10.255.36.216
                      AS path: I, validation-state: unverified
                    > to 3.4.0.5 via xe-1/3/1.0, label-switched-path to-r3
178.1.1.252/32     *[Local/0] 4d 04:48:09
                      Local via irb.1
```

Verify the route table shows the routes in vrf-1.inet.0 on Device R3.

```
user@R3# run show route table vrf-1.inet.0
vrf-1.inet.0: 5 destinations, 7 routes (5 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
132.1.1.0/30       *[BGP/170] 4d 04:34:09, localpref 100, from 10.255.35.128
                      AS path: I, validation-state: unverified
                    > to 3.3.0.9 via xe-3/1/2.0, label-switched-path to-r0
178.1.0.0/24       *[Direct/0] 4d 04:35:18
                    > via irb.0
                    [BGP/170] 4d 04:33:04, localpref 100, from 10.255.32.193
                      AS path: I, validation-state: unverified
                    > to 3.7.0.9 via xe-3/1/3.0, label-switched-path to-r2
178.1.0.252/32     *[Local/0] 4d 04:44:22
```

```
                           Local via irb.0
178.1.1.0/24             *[Direct/0] 4d 04:35:18
                          > via irb.1
                          [BGP/170] 4d 04:33:04, localpref 100, from 10.255.32.193
                            AS path: I, validation-state: unverified
                          > to 3.7.0.9 via xe-3/1/3.0, label-switched-path to-r2
178.1.1.252/32           *[Local/0] 4d 04:44:22
                            Local via irb.1
```

Meaning Only the routes for this Layer 3 customer, or routing instance VRF-1, are shown and isolated (as expected to be) across Devices R2, R3, and R0 (the remote PE).

Verifying MAC Table Entries

Purpose Verify MAC table entries for this customer example's bridge domain by confirming that only the MAC entries for this customer appear in their bridge domain (bd-1 and bd-2).

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Action Verify MAC table per bridge-domain bd-1 in routing instance vs3-1 on Device R2.

```
user@R2# run show bridge mac-table instance vs3-1 bridge-domain bd-1
Routing instance : vs3-1
 Bridging domain : bd-1, VLAN : 1
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:4f:c3:15:57   DR       xe-3/1/0.0
   50:20:10:00:00:01   DR       xe-3/1/0.0
   50:20:10:00:0f:ff   DR       xe-3/1/0.0
```

Verify MAC table per bridge-domain bd-2 in routing instance vs3-1 on Device R2.

```
user@R2# run show bridge mac-table instance vs3-1 bridge-domain bd-2
Routing instance : vs3-1
 Bridging domain : bd-2, VLAN : 2
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:4f:c3:15:59   DR       xe-3/1/0.0
   50:20:10:00:00:02   DR       xe-3/1/0.0
   50:20:10:00:10:00   DR       xe-3/1/0.0
```

Verify MAC table per bridge-domain bd-1 in routing instance vs3-1 on Device R3.

```
user@R3# run show bridge mac-table instance vs3-1 bridge-domain bd-1
Routing instance : vs3-1
 Bridging domain : bd-1, VLAN : 1
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:4f:c3:15:57   DL,SE    ae1.0
   50:20:10:00:00:01   DL,SE    ae1.0
   50:20:10:00:0f:ff   DL,SE    ae1.0
```

Verify MAC table per bridge-domain bd-2 in routing instance vs3-1 on Device R3.

```
user@R3# run show bridge mac-table instance vs3-1 bridge-domain bd-2
Routing instance : vs3-1
 Bridging domain : bd-2, VLAN : 2
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:4f:c3:15:59   DL,SE    ae1.0
   50:20:10:00:00:02   DL,SE    ae1.0
   50:20:10:00:10:00   DL,SE    ae1.0
```

Verify MAC table per bridge-domain bd-1 in routing instance vs3-1 on Device R4.

```
user@R4# run show bridge mac-table instance vs3-1 bridge-domain bd-1
Routing instance : vs3-1
 Bridging domain : bd-1, VLAN : 1
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   2c:6b:f5:47:0f:f0   DL,SE    ae1.0
   50:20:10:00:00:01   DL,SE    ae12.0
   50:20:10:00:0f:ff   DL,SE    ae12.0
```

Verify MAC table per bridge-domain bd-2 in routing instance vs3-1 on Device R4.

```
user@R4# run show bridge mac-table instance vs3-1 bridge-domain bd-2
```

```
Routing instance : vs3-1
 Bridging domain : bd-2, VLAN : 2
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   50:20:10:00:00:02   DL,SE    ae12.0
   50:20:10:00:10:00   DL,SE    ae12.0
```

Verify MAC table per bridge-domain bd-1 in routing instance vs3-1 on Device R5.

```
user@R5# run show bridge mac-table instance vs3-1 bridge-domain bd-1
Routing instance : vs3-1
 Bridging domain : bd-1, VLAN : 1
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:4f:c3:15:57   DL,SE    ae12.0
```

Verify MAC table per bridge-domain bd-2 in routing instance vs3-1 on Device R5.

```
user@R5# run show bridge mac-table instance vs3-1 bridge-domain bd-2
Routing instance : vs3-1
 Bridging domain : bd-2, VLAN : 2
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:4f:c3:15:59   DL,SE    ae12.0
   2c:6b:f5:47:0f:f0   DL,SE    ae1.0
```

Verify MAC table per bridge-domain bd-1 in routing instance vs2-1 on Device R6.

```
user@R6# run show bridge mac-table instance vs2-1 bridge-domain bd-1
Routing instance : vs2-1
 Bridging domain : bd-1, VLAN : 1
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:22:2d:e5:91   DR       ae11.0
   00:00:4f:c3:15:57   DR       ae1.0
   50:20:10:00:00:01   DR       ae1.0
   50:20:10:00:0f:ff   DL,SE    ae1.0
```

Verify MAC table per bridge-domain bd-2 in routing instance vs2-1 on Device R6.

```
user@R6# run show bridge mac-table instance vs2-1 bridge-domain bd-2
Routing instance : vs2-1
 Bridging domain : bd-2, VLAN : 2
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:22:2d:e5:93   DR       ae11.0
   00:00:4f:c3:15:59   DL,SE    ae1.0
   50:20:10:00:00:02   DL,SE    ae1.0
   50:20:10:00:10:00   DR       ae1.0
```

Verify MAC table per bridge-domain bd-1 in routing instance vs2-1 on Device R7.

```
user@R7# run show bridge mac-table instance vs2-1 bridge-domain bd-1
Routing instance : vs2-1
 Bridging domain : bd-1, VLAN : 1
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:22:2d:e5:91   DL,SE    ae11.0
   00:00:4f:c3:15:57   DL,SE    ae1.0
```

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```
   50:20:10:00:00:01   DL,SE    ae1.0
   50:20:10:00:0f:ff   DR       ae1.0
```

Verify MAC table per bridge-domain bd-2 in routing instance vs2-1 on Device R7.

```
user@R7# run show bridge mac-table instance vs2-1 bridge-domain bd-2
Routing instance : vs2-1
 Bridging domain : bd-2, VLAN : 2
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:22:2d:e5:93   DL,SE    ae11.0
   00:00:4f:c3:15:59   DR       ae1.0
   50:20:10:00:00:02   DR       ae1.0
   50:20:10:00:10:00   DL,SE    ae1.0
```

Meaning All associated MAC entries for this customer are isolated within BD-1 and BD-2 accordingly.

Example: Configuring a Layer 3 Logical Interface-Based Cloud Data Center Customer Deployment with Inter-POD VM Mobility

This configuration example details the Layer 3 customer design with VM Mobility (featuring VLAN normalization) described earlier in the document as the most secure approach to Layer 3 customer tenant design. In this approach, the cloud provider configures a single virtual switch instance per customer with aggregated Ethernet links configured as logical interface-based (IFL) trunks. This enables the provider to configure up to 4000 virtual switch instances and 4000 VRFs, enabling the segmentation of customers at both Layer 2 and Layer 3 to support up to 4000 customers per MX Series pair (for resiliency) of edge routers.

The following sections explain this Layer 3 configuration in more detail:

- Requirements on page 83
- Overview on page 87
- Configuring Device Interfaces on page 88
- VRF and Virtual Switch Configuration on page 95
- Verification on page 100

Requirements

Table 5 on page 84 lists the hardware used on each node/device in this configuration.

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Table 5: Node / Device Hardware

Node/Device	Hardware
Remote Provider Edge Router (R0)	Chassis: MX480 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPCE Type 2 3D EQ FPC5: MPC 3D 16x 10GE
MPLS Provider Router (R1)	Chassis: MX480 RE0: RE-S-2000 RE1: NONE FPC0: MPC 3D 16x 10GE FPC4: MPC 3D 16x 10GE FPC5: MPC Type 2 3D EQ
Data Center Edge Router (R2)	Chassis: MX480 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPC Type 2 3D EQ FPC1: MPC 3D 16x 10GE FPC2: MPC Type 2 3D EQ FPC3: MPC 3D 16x 10GE
Data Center Edge Router (R3)	Chassis: MX960 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPC 3D 16x 10GE FPC1: MPC Type 2 3D EQ FPC2: MPC 3D 16x 10GE FPC3: MPC 3D 16x 10GE FPC4: MPC 3D 16x 10GE FPC5: MPC Type 2 3D EQ

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Table 5: Node / Device Hardware *(continued)*

Node/Device	Hardware
Data Center Core Router (R4)	Chassis: MX960 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC0: MPC 3D 16x 10GE FPC2: MPC 3D 16x 10GE FPC3: MPC 3D 16x 10GE FPC4: MPC Type 2 3D EQ FPC5: MPC Type 2 3D EQ FPC7: MPC Type 2 3D EQ FPC8: MPC 3D 16x 10GE FPC9: MPC Type 2 3D EQ
Data Center Core Router (R5)	Chassis: MX960 RE0: RE-S-1800x4 RE1: RE-S-1800x4 FPC1: MPC Type 2 3D EQ FPC2: MPC 3D 16x 10GE FPC4: MPC Type 2 3D EQ FPC5: MPC Type 2 3D EQ FPC7: MPC Type 2 3D EQ FPC9: MPC Type 2 3D EQ FPC10: MPC Type 2 3D EQ FPC11: MPC 3D 16x 10GE
Data Center Core Router (R6)	Chassis: MX480 RE0: RE-S-2000 RE1: NONE FPC0: DPCE 20x 1GE R EQ FPC3: MPC Type 2 3D EQ

Table 5: Node / Device Hardware *(continued)*

Node/Device	Hardware
Data Center Core Router (R7)	Chassis: MX240 RE0: RE-S-2000 RE1: RE-S-2000 FPC1: DPCE 20x 1GE R EQ
Top of Rack Switches (ToRs) (R8 - R12)	Chassis: EX4500-40F RE0: EX4500-40F RE1: NONE FPC0: EX4500-40F

All MX Series and EX Series devices in this example use Juniper Networks Junos OS Release 12.3R6. Table 6 on page 86 lists the scaling values used in configuring each device.

Table 6: Node/Device Scaling Targets

Node/Device	Targeted Feature Scale Values
Remote Provider Edge Router	Interfaces: ~25K IFL Protocols: OSPF - 8, OSPF3 - 8, IS-IS -8, BGP - 2, RSVP -4 Sessions, MPLS LSP - 2 Ingress LSPs + 2 Egress LSPs, BFD -22, VLAN -(1-4094) X 8 Services: VPLS - 4002, VRF - 4K, BD - 8012
MPLS Provider Router	Interfaces: 42 IFL Protocols: OSPF - 24, OSPF3 - 24, IS-IS - 24 , BFD - 48, RSVP LSP -4 Transit LSP
Data Center Edge Router	Interfaces: ~48630 IFL (8K IRB), AE - 8, MC-AE - 8 Protocols: OSPF - 8, OSPF3 - 8, IS-IS - 8, BFD – 23 sessions, MPLS -3 Ingress LSPs + 3 Egress LSPs, RSVP -3 Sessions, BGP - 3, VLAN -(1-4094) X 8, ICCP -1 Session Services: VPLS - 4002, VRF -4K, BD - 20200, MC-LAG active/standby - 3
Data Center Core Router	Interfaces: ~75 , AE - 8, MC-AE active/active - 8 Protocols: VLAN - (1-4094) X 8, ICCP - 1 Services: VIRTUAL-SWITCH -4
Top-of-Racks (ToRs)	Interfaces: ~10 IFL Protocols: VLAN -(1-4094) Services: BD (VLANs in EX) - (1-4094)

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Before you configure the Layer 3 cloud data center customer:

- Configure the loopback interface (lo0) on each routing device.

Overview

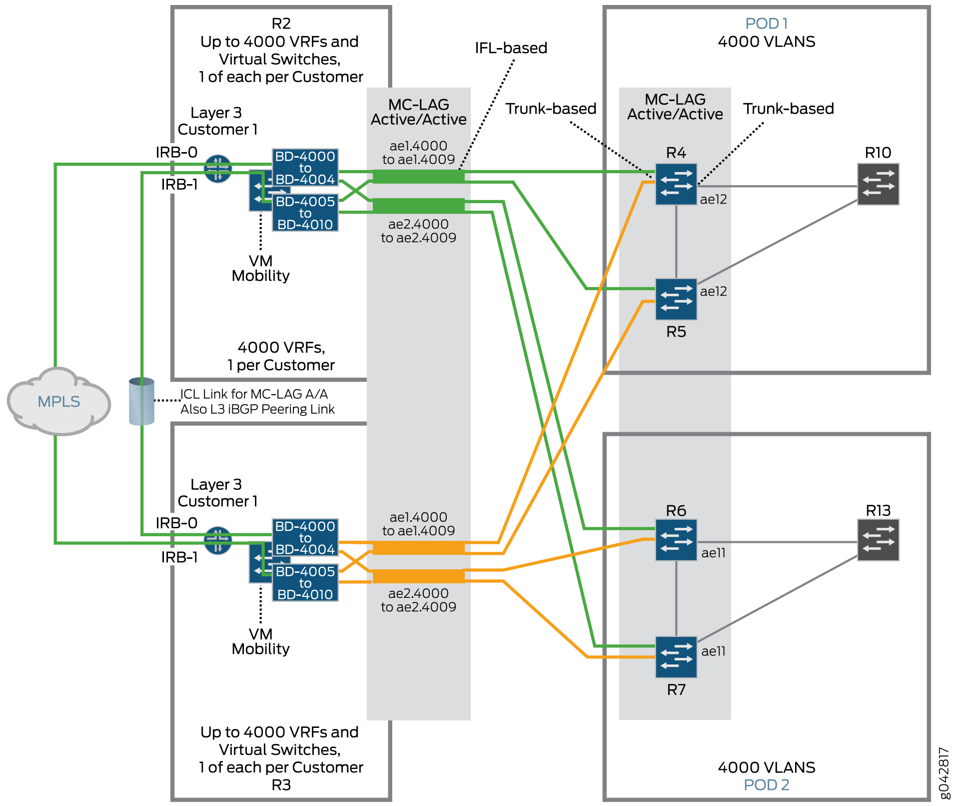
This configuration uses logical interfaces on the trunk MC-LAG interfaces at the data center edge. Any core or access VLANs can be assigned to any customer bridge domain. This approach enables the assignment of multiple logical interfaces to a single bridge domain. As mentioned previously, using logical interfaces in this configuration provides the cloud provider all of the flexibility of assigning any VLAN across all PODs transparently from the point of view of the customer.

NOTE: The configuration for this approach follows all of the same device configurations as detailed earlier in *"Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment" on page 17* the only differing configurations are with respect to Devices R2 and R3. Therefore, only the configurations for these devices will be detailed below.

Topology

Figure 18 on page 88 shows the Layer 3 logical interface-based trunk inter-POD deployment.

Figure 18: Layer 3 Test Topology - Logical Interfaced-Based Approach With Maximized Security



As noted, all device configurations have already been detailed from the trunk-based example earlier. However, the way the AE interfaces and ICL interfaces are configured on Devices R2 and R3 are modified. Additionally, the configuration of the bridge domains on both devices will now include explicit AE IFL memberships in edge bridge domains.

Configuring Device Interfaces

The following sections define how to configure the router interfaces in this configuration:

- Configuring Device R2 Interfaces on page 88
- Configuring Device R3 Interfaces on page 92

Configuring Device R2 Interfaces

Step-by-Step Procedure

To configure the interfaces on Device R2:

1. Access the CLI for Device R2.
2. Configure the ICL interface on Device R2 that connects to Device R3.

   This interface is used for inter-POD failover and is configured to carry all VLANs in the aggregated Ethernet links.

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NOTE: Each VLAN ID is explicitly configured on an IFL as opposed to the previously trunk-based bridge domain mapping from "Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment" on page 17. Only 10 access VLANs assigned to the customer in this example are shown here. Only one ICL IFL-based trunk is needed for customer traffic, as we no longer need to dedicate a LAG or an interface per virtual switch. Earlier, for redundancy, the MC-AE instances required yet another LAG itself, but now the ICL for all the MC-AE instances (in this case xe-3/1/0) provides high availability.

```
[edit]
user@host# set interfaces xe-3/1/0 flexible-vlan-tagging
user@host# set interfaces xe-3/1/0 encapsulation flexible-ethernet-services
user@host# set interfaces xe-3/1/0 unit 4000 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4000 vlan-id 4001
user@host# set interfaces xe-3/1/0 unit 4001 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4001 vlan-id 4002
user@host# set interfaces xe-3/1/0 unit 4002 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4002 vlan-id 4003
user@host# set interfaces xe-3/1/0 unit 4003 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4003 vlan-id 4004
user@host# set interfaces xe-3/1/0 unit 4004 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4004 vlan-id 4005
user@host# set interfaces xe-3/1/0 unit 4005 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4005 vlan-id 4006
user@host# set interfaces xe-3/1/0 unit 4006 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4006 vlan-id 4007
user@host# set interfaces xe-3/1/0 unit 4007 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4007 vlan-id 4008
user@host# set interfaces xe-3/1/0 unit 4008 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4008 vlan-id 4009
user@host# set interfaces xe-3/1/0 unit 4009 encapsulation vlan-bridge
user@host# set interfaces xe-3/1/0 unit 4009 vlan-id 4010
```

3. Configure the aggregated Ethernet interface on Device R2 that connects to interface ae1 on Device R4 and Device R5. This is a logical interface-based configuration for MC-LAG active/active, such that the logical interface units can be added to bridge domains in the virtual switch configuration.

NOTE: The member interfaces of these ae1 and ae2 LAG interfaces are assumed to be the same and are configured in the same way as they appear in *"Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment" on page 17* .

```
[edit]
user@host# set interfaces ae1 flexible-vlan-tagging
user@host# set interfaces ae1 multi-chassis-protection 4.0.0.2 interface xe-3/1/0
user@host# set interfaces ae1 encapsulation flexible-ethernet-services
```

```
user@host# set interfaces ae1 aggregated-ether-options lacp active
user@host# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@host# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@host# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:20
user@host# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@host# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 10
user@host# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group
  1
user@host# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 0
```

4. Configure MC-LAG as active/active.

```
[edit]
user@host# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@host# set interfaces ae1 aggregated-ether-options mc-ae status-control
  active
user@host# set interfaces ae1 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
```

5. Assign a VLAN ID to each aggregated Ethernet ae1 interface unit and protect each logical interface unit per VLAN, using the previously configured IFL-based ICL xe-3/1/0.

```
[edit]
user@host# set interfaces ae1 unit 4000 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4000 vlan-id 4001
user@host# set interfaces ae1 unit 4000 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4000
user@host# set interfaces ae1 unit 4001 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4001 vlan-id 4002
user@host# set interfaces ae1 unit 4001 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4001
user@host# set interfaces ae1 unit 4002 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4002 vlan-id 4003
user@host# set interfaces ae1 unit 4002 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4002
user@host# set interfaces ae1 unit 4003 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4003 vlan-id 4004
user@host# set interfaces ae1 unit 4003 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4003
user@host# set interfaces ae1 unit 4004 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4004 vlan-id 4005
user@host# set interfaces ae1 unit 4004 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4004
user@host# set interfaces ae1 unit 4005 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4005 vlan-id 4006
user@host# set interfaces ae1 unit 4005 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4005
user@host# set interfaces ae1 unit 4006 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4006 vlan-id 4007
user@host# set interfaces ae1 unit 4006 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4006
user@host# set interfaces ae1 unit 4007 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4007 vlan-id 4008
user@host# set interfaces ae1 unit 4007 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4007
```

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```
user@host# set interfaces ae1 unit 4008 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4008 vlan-id 4009
user@host# set interfaces ae1 unit 4008 multi-chassis-protection 4.0.0.2interface
   xe-3/1/0.4008
user@host# set interfaces ae1 unit 4009 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4009 vlan-id 4010
user@host# set interfaces ae1 unit 4009 multi-chassis-protection 4.0.0.2interface
   xe-3/1/0.4009
```

6. Configure the aggregated Ethernet interface on Device R2 that connects to interface ae2 on Device R6 and Device R7.

   This is a logical interface-based configuration for MC-LAG active/active, such that the logical interface units can be added to bridge domains in the virtual switch configuration.

```
[edit]
user@host# set interfaces ae2 flexible-vlan-tagging
user@host# set interfaces ae2 multi-chassis-protection 4.0.0.2 interface xe-3/1/0
user@host# set interfaces ae2 encapsulation flexible-ethernet-services
user@host# set interfaces ae2 aggregated-ether-options lacp active
user@host# set interfaces ae2 aggregated-ether-options lacp periodic fast
user@host# set interfaces ae2 aggregated-ether-options lacp system-priority 100
user@host# set interfaces ae2 aggregated-ether-options lacp system-id
   00:00:00:00:00:21
user@host# set interfaces ae2 aggregated-ether-options lacp admin-key 1
user@host# set interfaces ae2 aggregated-ether-options mc-ae mc-ae-id 1
user@host# set interfaces ae2 aggregated-ether-options mc-ae redundancy-group
   1
user@host# set interfaces ae2 aggregated-ether-options mc-ae chassis-id 0
user@host# set interfaces ae2 aggregated-ether-options mc-ae mode active-active
user@host# set interfaces ae2 aggregated-ether-options mc-ae status-control
   active
user@host# set interfaces ae2 aggregated-ether-options mc-ae events
   iccp-peer-down prefer-status-control-active
```

7. Assign a VLAN ID to each aggregated Ethernet ae2 interface unit and protect each logical interface unit per VLAN, using the previously configured IFL-based ICL xe-3/1/0.

```
[edit]
user@host# set interfaces ae2 unit 4000 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4000 vlan-id 4001
user@host# set interfaces ae2 unit 4000 multi-chassis-protection 4.0.0.2interface
   xe-3/1/0.4000
user@host# set interfaces ae2 unit 4001 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4001 vlan-id 4002
user@host# set interfaces ae2 unit 4001 multi-chassis-protection 4.0.0.2interface
   xe-3/1/0.4001
user@host# set interfaces ae2 unit 4002 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4002 vlan-id 4003
user@host# set interfaces ae2 unit 4002 multi-chassis-protection 4.0.0.2interface
   xe-3/1/0.4002
user@host# set interfaces ae2 unit 4003 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4003 vlan-id 4004
user@host# set interfaces ae2 unit 4003 multi-chassis-protection 4.0.0.2interface
   xe-3/1/0.4003
```

```
user@host# set interfaces ae2 unit 4004 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4004 vlan-id 4005
user@host# set interfaces ae2 unit 4004 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4004
user@host# set interfaces ae2 unit 4005 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4005 vlan-id 4006
user@host# set interfaces ae2 unit 4005 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4005
user@host# set interfaces ae2 unit 4006 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4006 vlan-id 4007
user@host# set interfaces ae2 unit 4006 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4006
user@host# set interfaces ae2 unit 4007 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4007 vlan-id 4008
user@host# set interfaces ae2 unit 4007 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4007
user@host# set interfaces ae2 unit 4008 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4008 vlan-id 4009
user@host# set interfaces ae2 unit 4008 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4008
user@host# set interfaces ae2 unit 4009 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4009 vlan-id 4010
user@host# set interfaces ae2 unit 4009 multi-chassis-protection 4.0.0.2interface
  xe-3/1/0.4009
```

Configuring Device R3 Interfaces

Step-by-Step Procedure

To configure the interfaces on Device R3:

1. Access the CLI for Device R3.
2. Configure the ICL interface on Device R3 that connects to Device R2. This interface is used for inter-POD failover and is configured to carry all VLANs in the aggregated Ethernet links.

   NOTE: Each VLAN ID is explicitly configured on an IFL as opposed to the previously trunk-based bridge-domain mapping from "Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment" on page 17. Only 10 access VLANs assigned to the customer in this example are shown here. Only one ICL IFL based trunk is needed for customer traffic, as we no longer need to dedicate a LAG or an interface per virtual-switch. Earlier, for redundancy, the MC-AE instances would require yet another LAG itself, but now the ICL for all the MC-AE instances (in this case xe-2/1/1) provides high availability.

```
[edit]
user@host# set interfaces xe-2/1/1 flexible-vlan-tagging
user@host# set interfaces xe-2/1/1 encapsulation flexible-ethernet-services
user@host# set interfaces xe-2/1/1 unit 4000 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4000 vlan-id 4001
user@host# set interfaces xe-2/1/1 unit 4001 encapsulation vlan-bridge
```


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```
user@host# set interfaces xe-2/1/1 unit 4001 vlan-id 4002
user@host# set interfaces xe-2/1/1 unit 4002 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4002 vlan-id 4003
user@host# set interfaces xe-2/1/1 unit 4003 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4003 vlan-id 4004
user@host# set interfaces xe-2/1/1 unit 4004 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4004 vlan-id 4005
user@host# set interfaces xe-2/1/1 unit 4005 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4005 vlan-id 4006
user@host# set interfaces xe-2/1/1 unit 4006 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4006 vlan-id 4007
user@host# set interfaces xe-2/1/1 unit 4007 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4007 vlan-id 4008
user@host# set interfaces xe-2/1/1 unit 4008 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4008 vlan-id 4009
user@host# set interfaces xe-2/1/1 unit 4009 encapsulation vlan-bridge
user@host# set interfaces xe-2/1/1 unit 4009 vlan-id 4010
```

3. Configure the aggregated Ethernet Interface on Device R3 that connects to the aggregated Ethernet interface ae1 on devices R4 and R5. This is logical interface-based configuration for MC-LAG active/active; the logical interface units can be added to bridge domains in the virtual switch configuration.

   NOTE: The member interfaces of these ae1 and ae2 LAG interfaces are assumed to be the same and are configured in the same way as they appear within *"Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment" on page 17* .

```
[edit]
user@host# set interfaces ae1 flexible-vlan-tagging
user@host# set interfaces ae1 multi-chassis-protection 4.0.0.2 interface xe-1/1/0
user@host# set interfaces ae1 encapsulation flexible-ethernet-services
user@host# set interfaces ae1 aggregated-ether-options lacp active
user@host# set interfaces ae1 aggregated-ether-options lacp periodic fast
user@host# set interfaces ae1 aggregated-ether-options lacp system-priority 100
user@host# set interfaces ae1 aggregated-ether-options lacp system-id
  00:00:00:00:00:20
user@host# set interfaces ae1 aggregated-ether-options lacp admin-key 1
user@host# set interfaces ae1 aggregated-ether-options mc-ae mc-ae-id 10
user@host# set interfaces ae1 aggregated-ether-options mc-ae redundancy-group
  1
user@host# set interfaces ae1 aggregated-ether-options mc-ae chassis-id 1
user@host# set interfaces ae1 aggregated-ether-options mc-ae mode active-active
user@host# set interfaces ae1 aggregated-ether-options mc-ae status-control
  active
user@host# set interfaces ae1 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
user@host# set interfaces ae1 unit 4000 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4000 vlan-id 4001
user@host# set interfaces ae1 unit 4000 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4000
user@host# set interfaces ae1 unit 4001 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4001 vlan-id 4002
```

```
user@host# set interfaces ae1 unit 4001 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4001
user@host# set interfaces ae1 unit 4002 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4002 vlan-id 4003
user@host# set interfaces ae1 unit 4002 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4002
user@host# set interfaces ae1 unit 4003 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4003 vlan-id 4004
user@host# set interfaces ae1 unit 4003 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4003
user@host# set interfaces ae1 unit 4004 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4004 vlan-id 4005
user@host# set interfaces ae1 unit 4004 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4004
user@host# set interfaces ae1 unit 4005 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4005 vlan-id 4006
user@host# set interfaces ae1 unit 4005 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4005
user@host# set interfaces ae1 unit 4006 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4006 vlan-id 4007
user@host# set interfaces ae1 unit 4006 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4006
user@host# set interfaces ae1 unit 4007 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4007 vlan-id 4008
user@host# set interfaces ae1 unit 4007 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4007
user@host# set interfaces ae1 unit 4008 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4008 vlan-id 4009
user@host# set interfaces ae1 unit 4008 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4008
user@host# set interfaces ae1 unit 4009 encapsulation vlan-bridge
user@host# set interfaces ae1 unit 4009 vlan-id 4010
user@host# set interfaces ae1 unit 4009 multi-chassis-protection 4.0.0.1 interface
  xe-1/1/0.4009
```

4. Configure the aggregated Ethernet Interface on Device R3 that connects to the aggregated Ethernet interface ae2 on Devices R6 and R7. This is a logical interface-based configuration for MC-LAG active/active; the logical interface units can be added to bridge domains in the virtual switch configuration.

```
[edit]
user@host# set interfaces ae2 flexible-vlan-tagging
user@host# set interfaces ae2 multi-chassis-protection 4.0.0.2 interface xe-2/1/1
user@host# set interfaces ae2 encapsulation flexible-ethernet-services
user@host# set interfaces ae2 aggregated-ether-options lacp active
user@host# set interfaces ae2 aggregated-ether-options lacp periodic fast
user@host# set interfaces ae2 aggregated-ether-options lacp system-priority 100
user@host# set interfaces ae2 aggregated-ether-options lacp system-id
  00:00:00:00:00:21
user@host# set interfaces ae2 aggregated-ether-options lacp admin-key 1
user@host# set interfaces ae2 aggregated-ether-options mc-ae mc-ae-id 1
user@host# set interfaces ae2 aggregated-ether-options mc-ae redundancy-group
  1
user@host# set interfaces ae2 aggregated-ether-options mc-ae chassis-id 1
user@host# set interfaces ae2 aggregated-ether-options mc-ae mode active-active
```


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```
user@host# set interfaces ae2 aggregated-ether-options mc-ae status-control
  active
user@host# set interfaces ae2 aggregated-ether-options mc-ae events
  iccp-peer-down prefer-status-control-active
user@host# set interfaces ae2 unit 4000 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4000 vlan-id 4001
user@host# set interfaces ae2 unit 4000 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4000
user@host# set interfaces ae2 unit 4001 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4001 vlan-id 4002
user@host# set interfaces ae2 unit 4001 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4001
user@host# set interfaces ae2 unit 4002 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4002 vlan-id 4003
user@host# set interfaces ae2 unit 4002 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4002
user@host# set interfaces ae2 unit 4003 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4003 vlan-id 4004
user@host# set interfaces ae2 unit 4003 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4003
user@host# set interfaces ae2 unit 4004 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4004 vlan-id 4005
user@host# set interfaces ae2 unit 4004 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4004
user@host# set interfaces ae2 unit 4005 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4005 vlan-id 4006
user@host# set interfaces ae2 unit 4005 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4005
user@host# set interfaces ae2 unit 4006 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4006 vlan-id 4007
user@host# set interfaces ae2 unit 4006 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4006
user@host# set interfaces ae2 unit 4007 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4007 vlan-id 4008
user@host# set interfaces ae2 unit 4007 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4007
user@host# set interfaces ae2 unit 4008 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4008 vlan-id 4009
user@host# set interfaces ae2 unit 4008 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4008
user@host# set interfaces ae2 unit 4009 encapsulation vlan-bridge
user@host# set interfaces ae2 unit 4009 vlan-id 4010
user@host# set interfaces ae2 unit 4009 multi-chassis-protection 4.0.0.1 interface
  xe-2/1/1.4009
```

VRF and Virtual Switch Configuration

This section describes how to configure the vm-mobility routing instance on Devices R2 and R3 for inter-POD connectivity. In this configuration, all VLANs are normalized to VLAN ID 4001 and 4002. In addition, the interfaces, each configured for a specific POD VLAN, are also all “normalized” to VLAN ID 4001 and 4002 (the bridge domains’ VLAN IDs). This configuration enables all VLANs in any of the PODs to communicate. Traffic within the same POD VLAN continues to be switched locally at the core/aggregation layer;

inter-POD traffic, or traffic that flows between access VLANs in the POD, is switched at the data center edge within the bridge domain.

- Configuring VRF and Virtual Switch on Device R2 on page 96
- Configuring VRF and Virtual Switch on Device R3 on page 98

Configuring VRF and Virtual Switch on Device R2

Step-by-Step Procedure

Configure the vm-mobility routing instance as a virtual switch with two bridge domains in Device R2 for inter-POD connectivity. This is a simple virtual switch with five logical interfaces (VLANs) from both the Device R2 POD and the Device R3 POD assigned to customer bridge domains 4001 and 4002. Each device has a routing interface assigned (irb.0 and irb.1).

To configure VRF and virtual switch on Device R2:

1. Configure the vm-mobility routing instance, its bridge domain range, and the domain type.

```
[edit]
user@host# set routing-instances vm-mobility instance-type virtual-switch
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  domain-type bridge
```

2. Configure the vm-mobility bridge domains for VLAN 4001.

```
[edit]
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  vlan-id 4001
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface xe-3/1/0.4000
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae1.4000
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae2.4000
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface xe-3/1/0.4001
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae1.4001
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae2.4001
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface xe-3/1/0.4002
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae1.4002
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae2.4002
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface xe-3/1/0.4003
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae1.4003
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae2.4003
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface xe-3/1/0.4004
```

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```
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae1.4004
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae2.4004
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  routing-interface irb.1
```

3. Configure the vm-mobility bridge domains for VLAN 4002.

```
[edit]
user@host# set routing-instances vm-mobility bridge-domains bd-4005-t0-4010
  vlan-id 4002
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4005
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4005
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4005
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4006
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4006
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4006
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4007
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4007
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4007
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4008
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4008
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4008
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4009
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4009
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4009
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  routing-interface irb.0
```

4. Configure the IRB interfaces.

```
[edit]
user@host# set interfaces irb no-gratuitous-arp-reply
user@host# set interfaces irb no-gratuitous-arp-request
user@host# set interfaces irb unit 0 family inet address 178.1.0.252/24
user@host# set interfaces irb unit 0 family inet6 address 2002::132.1.1.1/126
user@host# set interfaces irb unit 1 family inet address 178.1.1.252/24
user@host# set interfaces irb unit 1 family inet6 address 2002::132.1.1.5/126
```

5. Configure the VRF routing instance.

```
[edit]
```

user@host# **set routing-instances vrf-1 instance-type vrf**
user@host# **set routing-instances vrf-1 interface irb.0**
user@host# **set routing-instances vrf-1 interface irb.1**
user@host# **set routing-instances vrf-1 route-distinguisher 1000:28001**
user@host# **set routing-instances vrf-1 vrf-target target:1000:24001**
user@host# **set routing-instances vrf-1 vrf-table-label**

Configuring VRF and Virtual Switch on Device R3

Step-by-Step Procedure

Configure the vm-mobility routing instance as a virtual switch with two bridge domains in Device R3 for inter-POD connectivity. This is a simple virtual switch with five logical interfaces (VLANs) from both the Device R2 POD and the Device R3 POD assigned to customer bridge domains 4001 and 4002. Each device has a routing interface assigned (irb.0 and irb.1).

To configure VRF and virtual switch on Device R3:

1. Configure the vm-mobility routing instance, its bridge domain range, and the domain type.

   [edit]
   user@host# **set routing-instances vm-mobility instance-type virtual-switch**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 domain-type bridge**

2. Configure the vm-mobility bridge domains for VLAN 4001.

   [edit]
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 vlan-id 4001**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface xe-3/1/0.4000**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae1.4000**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae2.4000**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface xe-3/1/0.4001**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae1.4001**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae2.4001**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface xe-3/1/0.4002**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae1.4002**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae2.4002**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface xe-3/1/0.4003**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae1.4003**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface ae2.4003**
   user@host# **set routing-instances vm-mobility bridge-domains bd-4000-t0-4004 interface xe-3/1/0.4004**

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```
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae1.4004
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  interface ae2.4004
user@host# set routing-instances vm-mobility bridge-domains bd-4000-t0-4004
  routing-interface irb.1
```

3. Configure the vm-mobility bridge domains for VLAN 4002.

```
[edit]
user@host# set routing-instances vm-mobility bridge-domains bd-4005-t0-4010
  vlan-id 4002
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4005
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4005
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4005
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4006
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4006
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4006
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4007
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4007
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4007
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4008
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4008
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4008
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface xe-3/1/0.4009
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae1.4009
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  interface ae2.4009
user@host# set routing-instances vm-mobility bridge-domains bd-4005-to-4010
  routing-interface irb.0
```

4. Configure the IRB interfaces.

```
[edit]
user@host# set interfaces irb no-gratuitous-arp-reply
user@host# set interfaces irb no-gratuitous-arp-request
user@host# set interfaces irb unit 0 family inet address 178.1.0.252/24
user@host# set interfaces irb unit 0 family inet6 address 2002::132.1.1.1/126
user@host# set interfaces irb unit 1 family inet address 178.1.1.252/24
user@host# set interfaces irb unit 1 family inet6 address 2002::132.1.1.5/126
```

5. Configure the VRF routing instance.

```
[edit]
```

```
user@host# set routing-instances vrf-1 instance-type vrf
user@host# set routing-instances vrf-1 interface irb.0
user@host# set routing-instances vrf-1 interface irb.1
user@host# set routing-instances vrf-1 route-distinguisher 1000:28003
user@host# set routing-instances vrf-1 vrf-target target:1000:24001
user@host# set routing-instances vrf-1 vrf-table-label
```

Verification

Confirm that the configuration is working properly.

- Verifying the VM Mobility Routing Instance Configuration on page 100
- Verifying the Contents of the Bridge MAC Table on page 101
- Verifying IRB Interface Status on page 102
- Verifying Entries in Routing Table vrf-1.inet.0 on page 103

Verifying the VM Mobility Routing Instance Configuration

Purpose Verify that the vm-mobility routing instance is attached to the appropriate bridging domains.

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Action Issue the following command for Device R2:

```
user@R2# run show l2-learning instance vm-mobility
Information for routing instance and bridge domain:

Flags (DL -disable learning, SE -stats enabled,
       AD -packet action drop, LH -mac limit hit)

Inst  Logical    Routing             Bridging            Index  IRB     Flags
   BD
Type  System     Instance            Domain                     Index
   vlan
RTT   Default    vm-mobility                              4009
BD    Default    vm-mobility         bd-4000-t0-4004      8190   16346
   4001
BD    Default    vm-mobility         bd-4005-t0-4009      8191   16347
   4002
```

Issue the following command for Device R3:

```
user@R3# run show l2-learning instance vm-mobility
Information for routing instance and bridge domain:

Flags (DL -disable learning, SE -stats enabled,
       AD -packet action drop, LH -mac limit hit)

Inst  Logical    Routing             Bridging            Index  IRB     Flags
   BD
Type  System     Instance            Domain                     Index
   vlan
RTT   Default    vm-mobility                              4008
BD    Default    vm-mobility         bd-4000-t0-4004      24294  29649
   4001
BD    Default    vm-mobility         bd-4005-t0-4009      24295  29650
   4002
```

Meaning VLAN ID 4001 is mapped properly to bridge domains bd-4000 to bd-4004 and VLAN ID 4002 is mapped properly to bridge domains bd-4005 to bd-4009 in the vm-mobility routing instance. In other words, the cloud provider has successfully provisioned customer VLAN 4000 across ToR access POD VLANs 4000-4004 and customer VLAN 4001 across ToR access POD VLANs 4005-4009. This demonstrates how the provider can easily assign or move compute resources into any of the access ToR VLANs assigned to the customer VLAN/BD transparently since the default gateway (IRB) and Layer 3 addressing remain unchanged. The only modification would be to update the VLAN tag assigned to the VM or compute resource as it is moved to the updated access ToR VLAN ID.

Verifying the Contents of the Bridge MAC Table

Purpose Verify that the appropriate MAC addresses are learned and propagated in the MAC table of the VM mobilty routing instance.

Action Issue the following command for Device R2:

```
user@R2# run show bridge mac-table instance vm-mobility
MAC flags (S -static MAC, D -dynamic MAC, L -locally learned, C -Control MAC
           SE -Statistics enabled, NM -Non configured MAC, R -Remote PE MAC)

Routing instance : vm-mobility
 Bridging domain : bd-4000-to-4004, VLAN : 4001
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:d3:ff:04:45  D     ae1.4000
   00:00:d3:ff:04:47  D     ae2.4000
   a8:d0:e5:f6:1f:f0   D        lsi.1056581

MAC flags (S -static MAC, D -dynamic MAC, L -locally learned, C -Control MAC
           SE -Statistics enabled, NM -Non configured MAC, R -Remote PE MAC)

Routing instance : vm-mobility
 Bridging domain : bd-4005-to-4009, VLAN : 4002
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:d3:ff:04:46   D        ae1.4005
   00:00:d3:ff:04:48   D        ae2.4005
   a8:d0:e5:f6:1f:f0   D        lsi.1056581
```

Issue the following command for Device R3:

```
user@R3# run show bridge mac-table instance vm-mobility
MAC flags (S -static MAC, D -dynamic MAC, L -locally learned, C -Control MAC
           SE -Statistics enabled, NM -Non configured MAC, R -Remote PE MAC)

Routing instance : vm-mobility
 Bridging domain : bd-4000-to-4004, VLAN : 4001
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   00:00:d3:ff:04:45  D     lsi.1050943
   00:00:d3:ff:04:47  D     lsi.1050943

   2c:6b:f5:47:0f:f0   D        lsi.1050943

MAC flags (S -static MAC, D -dynamic MAC, L -locally learned, C -Control MAC
           SE -Statistics enabled, NM -Non configured MAC, R -Remote PE MAC)

Routing instance : vm-mobility
 Bridging domain : bd-4005-to-4009, VLAN : 4002
   MAC                 MAC      Logical          NH     RTR
   address             flags    interface        Index  ID
   2c:6b:f5:47:0f:f0   D        lsi.1050943
```

Meaning The MAC entries of the host devices in VLAN ID 4001 are mapped properly to bridge domains bd-4000 to bd-4004 and VLAN ID 4002 is mapped properly to bridge domains bd-4005 to bd-4009 in the vm-mobility routing instance.

Verifying IRB Interface Status

Purpose Verify that the IRB interfaces on are part of the bridge domains in routing instance vm-mobility and that the interfaces are in the UP state.

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Action Issue the following command for IRB interface irb.0 on Device R2:

```
user@R2# run show interfaces terse irb.0
Interface         Admin Link Proto    Local                 Remote
irb.0                up    up   inet     178.32.64.252/24
                                   inet6    2003::8401:3f81/126
                                            fe80::2e6b:f5ff:fe47:ff0/64
                                   multiservice
```

Issue the following command for IRB interface irb.1 on Device R2:

```
user@R2# run show interfaces terse irb.1
Interface         Admin Link Proto    Local                 Remote
irb.1                up    up   inet     178.32.65.252/24
                                   inet6    2003::8401:3f85/126
                                            fe80::2e6b:f5ff:fe47:ff0/64
                                   multiservice
```

Issue the following command for IRB interface irb.0 on Device R3:

```
user@R3# run show interfaces terse irb.0
Interface         Admin Link Proto    Local                 Remote
irb.0                up    up   inet     178.32.64.252/24
                                   inet6    2003::8401:3f81/126
                                            fe80::aad0:e5ff:fef6:1ff0/64
                                   multiservice
```

Issue the following command for IRB interface irb.1 on Device R3:

```
user@R3# run show interfaces terse irb.1
Interface         Admin Link Proto    Local                 Remote
irb.1                up    up   inet     178.32.65.252/24
                                   inet6    2003::8401:3f85/126
                                            fe80::aad0:e5ff:fef6:1ff0/64
                                   multiservice
```

Meaning This output shows that the IRB interfaces that are part of bridge domains in instance vm-mobility are UP. In other words, the default gateway for each customer VLAN is up.

Verifying Entries in Routing Table vrf-1.inet.0

Purpose Verify that the appropriate routing table entries appear in routing table vrf-1.inet.0.

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Action Verify that routing instance vrf-1 contains an entry for routing table vrf-1.inet.0 on Device R2.

```
user@R2# run show route instance vrf-1
Instance             Type
         Primary RIB   Active/holddown/hidden
vrf-1    vrf
         vrf-1.inet.0           9/0/0
         vrf-1.inet6.0          11/0/0
```

Verify that routing table vrf-1.inet.0 contains IRB interfaces that are part of the Layer 3 VPN instance. Confirm that the appropriate learned local and direct routes appear on Device R2.

```
user@R2# run show route table vrf-1.inet.0
vrf-1.inet.0: 9 destinations, 9 routes (9 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

132.1.1.0/30       *[BGP/170] 2d 20:04:18, localpref 100, from 10.255.35.128
                      AS path: I, validation-state: unverified
178.1.1.252/32     *[Local/0] 2d 20:08:05
                      Local via irb.1
178.32.64.0/24    *[Direct/0] 00:09:00
        > via irb.0
178.32.64.252/32   *[Local/0] 00:09:00
                      Local via irb.0
178.32.65.0/24     *[Direct/0] 00:09:00
                    > via irb.1
178.32.65.252/32  *[Local/0] 00:09:00
        Local via irb.1
```

Verify that routing instance vrf-1 contains an entry for routing table vrf-1.inet.0 on Device R3.

```
user@R3# run show route instance vrf-1
Instance             Type
         Primary RIB                                   Active/holddown/hidden
vrf-1                vrf
         vrf-1.inet.0                                  9/0/0
         vrf-1.inet6.0                                 9/0/0
```

Verify that routing table vrf-1.inet.0 contains IRB interfaces that are part of the Layer 3 VPN instance. Confirm that the appropriate learned local and direct routes appear on Device R3.

```
user@R3# run show route table vrf-1.inet.0
vrf-1.inet.0: 9 destinations, 9 routes (9 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

132.1.1.0/30       *[BGP/170] 2d 20:08:24, localpref 100, from 10.255.35.128
                      AS path: I, validation-state: unverified
                    > to 3.2.0.9 via xe-3/0/3.0, label-switched-path to-r0
178.1.1.252/32     *[Local/0] 2d 20:15:43
                      Local via irb.1
178.32.64.0/24    *[Direct/0] 00:17:52
        > via irb.0
178.32.64.252/32   *[Local/0] 00:17:52
```

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```
                              Local via irb.0
178.32.65.0/24    *[Direct/0] 00:17:52
          > via irb.1
178.32.65.252/32    *[Local/0] 00:17:52
                              Local via irb.1
```

Meaning The IRB interfaces that are part of the Layer 3 VPN instance and the local and direct routes are learned in routing table vrf-1.inet.0.

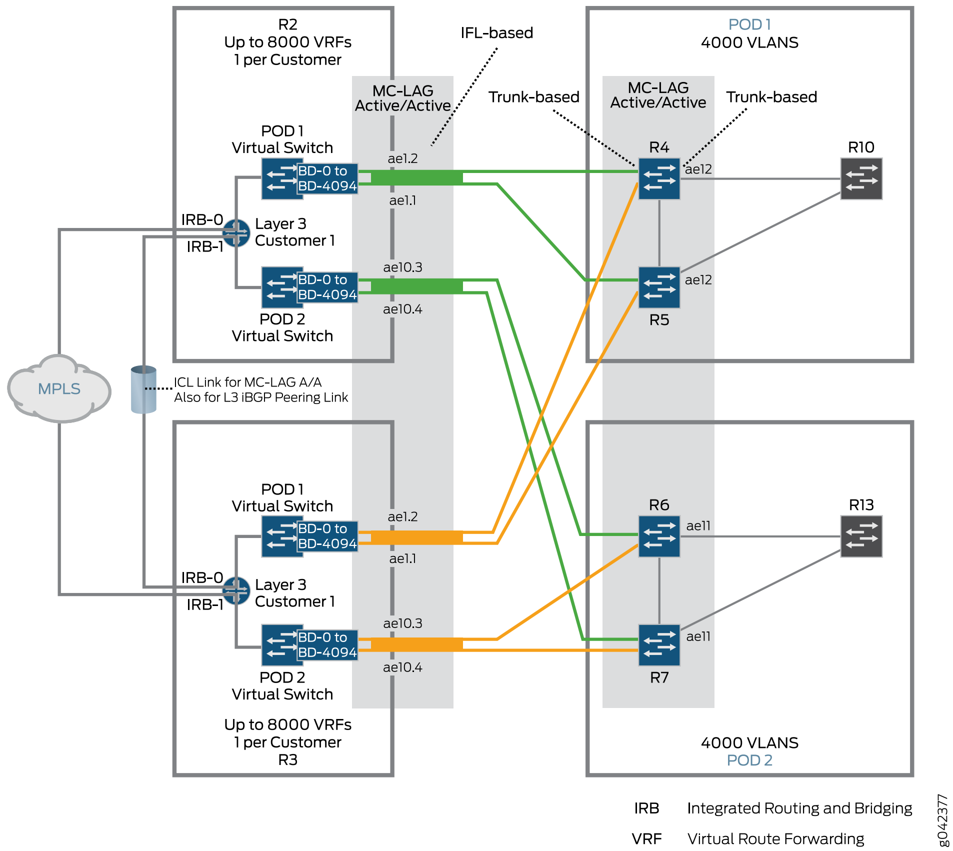
Designing a Scaled Layer 3 Logical Interface-Based Cloud Data Center Customer Deployment With Inter-POD VM Mobility

A scalable Layer 3 IFL-based approach that provides greater flexibility is an advanced approach that is similar to both "Example: Configuring a Layer 3 Logical Interface-Based Cloud Data Center Customer Deployment with Inter-POD VM Mobility" on page 83 and "Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment" on page 17 . In this approach, the cloud provider uses a minimal number of virtual switch instances (each containing 4094 bridge domains) and the trunks are configured as IFL-based. The IFL-based trunks are configured with MC-LAG active/active at the edge, as VPLS is not configured in the WAN. This approach enables the provider to configure up to the maximum system limit of 8000 VRFs (or Layer 3 customers) by using the minimum number of virtual switch instances (per POD).

Figure 19 on page 106 illustrates this deployment approach.

NOTE: The virtual switch instances contain 4094 bridge domains each.

Figure 19: Scaled Layer 3 IFL-Based Deployment Topology



This deployment approach uses IFL-based interfaces at the data center edge, thus any core or access VLAN can be assigned to a customer bridge domain. This approach allows multiple logical interfaces to be assigned to a single bridge domain, just like *Example: Configuring an Advanced Layer 2 Cloud Data Center Customer Deployment*, providing the cloud provider greater flexibility in assigning any VLAN across any POD in a way that remains completely transparent to their end customers.

Conclusion

Juniper Networks *Network Configuration Example: Configuring Layer 3 Cloud Data Center Tenants* is a comprehensively tested and validated design that provides a modular and scalable blueprint for building a robust infrastructure that is intended to meet the needs of wireline service providers facing increased pressure for more revenue generation. By leveraging the MX Series as the platform for connectivity in the cloud data center, wireline service providers can now deliver new services to their existing customer base by bridging customer WAN networks into newer cloud-based virtual services in a multi-tenant cloud data center.

Related Documentation

- Example: Configuring a Layer 3 Trunk-Based Cloud Data Center Customer Deployment on page 17

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- Example: Configuring a Layer 3 Logical Interface-Based Cloud Data Center Customer Deployment with Inter-POD VM Mobility on page 83

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