Network Configuration Example

Configuring Ethernet CFM Over VPLS

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Introduction

This document describes the configuration of Ethernet OAM and CFM over VPLS. It also provides step-by-step configuration examples for implementing fault monitoring, path discovery and fault verification, and fault isolation for both the customer and service provider over a VPLS and an MPLS network.

Advantages of Configuring Ethernet CFM over VPLS

Virtual Private LAN Service (VPLS) is a useful service provider offering. VPLS sites communicate with each other over IP or MPLS networks as if they were attached to the same Ethernet LAN.

Operation, Administration and Maintenance (OAM) provides instrumentation of telecommunications networks and equips the network operator with the tools to monitor, detect, and verify faults in their network infrastructure.

Ethernet OAM is specified in the IEEE 802.1ag standard. The IEEE 802.1ag standard provides for Ethernet connectivity fault management (CFM).

CFM can also be applied to VPLS. Since CFM monitors Ethernet networks at a per-service level, it can be used to monitor a VPLS instance. With VPLS CFM you can test the operation of all the network components. This is a competitive advantage for service providers deploying VPLS.

VPLS CFM can simultaneously provide OAM functions for the service provider and for the customer using the emulated Ethernet service. This allows the customer to have visibility of the end-to-end connectivity without dealing with the complexity of the MPLS core network.

The instrumentation that VPLS CFM provides reduces operational costs by simplifying network monitoring, increasing network reliability, and ensuring faster time to market for new services.

Implementing VPLS CFM improves revenue by enabling the service provider to more easily provide customers with VPLS services that include valuable OAM capabilities.

Related Documentation

- Ethernet Operations, Administration, and Maintenance on page 2
- Ethernet OAM Connectivity Fault Management on page 3
- Example: Configuring Ethernet CFM over VPLS on page 4

Ethernet Operations, Administration, and Maintenance

This topic provides an overview to help you effectively configure Ethernet Operations, Administration, and Maintenance (OAM) on a network of Juniper Networks® MX Series 3D Universal Edge Routers. For more information about configuring OAM parameters on Ethernet interfaces, see the *Junos OS Network Interfaces Library for Routing Devices*.

Ethernet OAM provides the tools that network management software and network managers can use to determine how a network of Ethernet links is functioning. Ethernet OAM should:

- Rely only on the media access control (MAC) address or virtual local area network (VLAN) identifier for troubleshooting.
- Work independently of the actual Ethernet transport and function over physical Ethernet ports, or a virtual service such as pseudowire, and so on.
- Isolate faults over a flat (or single operator) network architecture or a nested or hierarchical (or multi-provider) network.

OAM can provide simple link-level information, provide performance statistics, or track end-to-end connectivity across the network. Simple link fault management (LFM) for Ethernet links is defined in IEEE 802.3ah.

IEEE 802.1ag OAM is supported on untagged, single tagged, and stacked VLAN interfaces.

Ethernet OAM functions are implemented as:

- Fault detection and notification (provided by continuity check messages)
- Path discovery (provided by the linktrace protocol)
- Fault isolation, verification, and recovery (isolation and verification are provided by a combination of protocols, while recovery is the function of protocols such as spanning tree)

The loopback protocol used in Ethernet OAM is modeled on the standard IP ping. After a fault is detected, the loopback protocol performs fault verification and isolation under the direction of a network operator.

The loopback is performed using request and response message pairs. A unicast loopback message is generated by a maintenance endpoint (MEP), and a loopback reply is generated by the destination maintenance intermediate point (MIP) or MEP.

The target MAC address is learned by the continuity check protocol or linktrace protocol. The loopback message's packet is always forwarded to a unique port by the originating MEP, as determined by a MAC table lookup or the MEP interface MAC address.

The target MIP or MEP generates a unicast loopback reply in response to the received loopback message. The loopback message follows the same path as a data packet, and intermediate bridges simply forward the packet to the destination MIP or MEP.

Related Documentation

- Advantages of Configuring Ethernet CFM over VPLS on page 1
- Ethernet OAM Connectivity Fault Management on page 3
- Example: Configuring Ethernet CFM over VPLS on page 4
- Ethernet OAM Feature Guide for MX Series Routers
- Example: Configuring Ethernet CFM on Bridge Connections
- Example: Configuring Ethernet CFM on Physical Interfaces

Ethernet OAM Connectivity Fault Management

The most complete connectivity fault management (CFM) is defined in IEEE 802.1ag. This topic emphasizes the use of CFM in a Metro Ethernet environment.

The major features of CFM are:

- Fault monitoring using the continuity check protocol. This is a neighbor discovery and health check protocol that discovers and maintains adjacencies at the VLAN or link level.
- Path discovery and fault verification using the linktrace protocol. Similar to IP traceroute, this protocol maps the path taken to a destination MAC address through one or more bridged networks between the source and destination.
- Fault isolation using the loopback protocol. Similar to IP ping, this protocol works with the continuity check protocol during troubleshooting.

CFM partitions the service network into various administrative domains. For example, operators, providers, and customers might be part of different administrative domains.

Each administrative domain is mapped into one maintenance domain providing enough information to perform its own management, thus avoiding security breaches and making end-to-end monitoring possible. Each maintenance domain is associated with a maintenance domain level from 0 through 7. Level allocation is based on the network hierarchy, where outermost domains are assigned a higher level than the innermost domains.

Customer end points have the highest maintenance domain level. In a CFM maintenance domain, each service instance is called a maintenance association. A *maintenance association* can be thought as a full mesh of maintenance endpoints (MEPs) having similar characteristics. MEPs are active CFM entities generating and responding to CFM protocol messages.

There is also a maintenance intermediate point (MIP), which is a CFM entity similar to the MEP, but more passive (MIPs only respond to CFM messages).

MEPs can be *up MEPs* or *down MEPs*. A link can connect a MEP at level 5 to a MEP at level 7. The interface at level 5 is an up MEP (because the other end of the link is at MEP level 7), and the interface at level 7 is a down MEP (because the other end of the link is at MEP level 5).

In a Metro Ethernet network, CFM is commonly used at two levels:

- By the service provider to check the connectivity among its provider edge (PE) routers
- By the customer to check the connectivity among its customer edge (CE) routers

NOTE: The configured customer CFM level must be greater than service provider CFM level.

In many Metro Ethernet networks, CFM is used to monitor connectivity over a VPLS and bridge network.

Related Documentation

- Advantages of Configuring Ethernet CFM over VPLS on page 1
- Ethernet Operations, Administration, and Maintenance on page 2
- Example: Configuring Ethernet CFM over VPLS on page 4
- Example: Configuring Ethernet CFM on Bridge Connections
- Example: Configuring Ethernet CFM on Physical Interfaces
- Ethernet OAM Feature Guide for MX Series Routers

Example: Configuring Ethernet CFM over VPLS

This example shows how to configure Ethernet CFM over VPLS.

Requirements

This example uses the following hardware and software components:

- Two MX Series 3D Universal Edge Routers
- Junos OS Release 13.2 or later

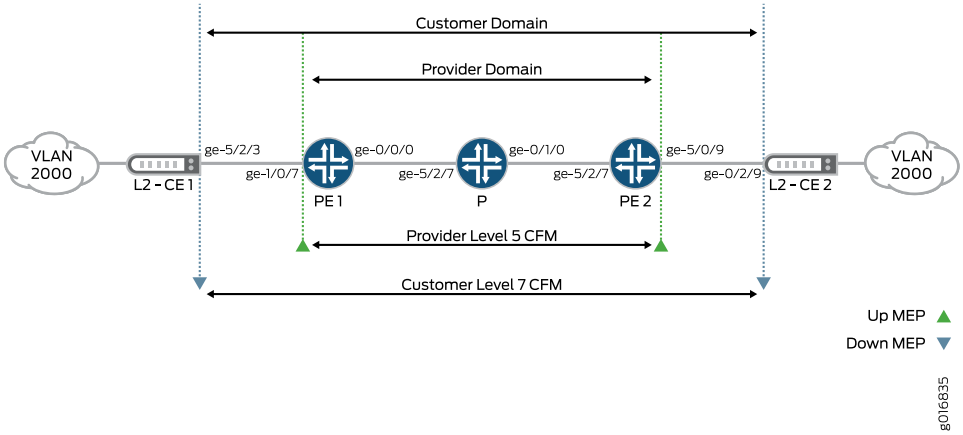
NOTE: This configuration example has been tested using the software release listed and is assumed to work on all later releases.

Overview

In this example, both the customer and service provider are running Ethernet CFM over a VPLS and an MPLS network. The network is shown in Figure 1 on page 5. The customer has configured Ethernet CFM on MX Series Routers L2-CE1 and L2-CE2. The service provider has configured Ethernet CFM on MX Series Routers PE1, P, and PE2.

Topology

Figure 1: Ethernet CFM over VPLS



Configuration

To configure CFM over VPLS, perform these tasks:

NOTE: The configurations in this example are only partial examples of complete and functional router configurations. Do not copy these configurations and use them directly on an actual system.

- Configuring Router PE1 on page 8
- Configuring Router PE2 on page 12
- Configuring Router P on page 17
- Configuring CFM on Router L2-CE1 on page 19
- Configuring CFM on Router L2-CE2 on page 20

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

On Router PE1:

```
[edit]
set chassis fpc 5 pic 0 tunnel-services bandwidth 1g
set interfaces ge-1/0/7 vlan-tagging
set interfaces ge-1/0/7 encapsulation flexible-ethernet-services
set interfaces ge-1/0/7 unit 1 encapsulation vlan-vpls
set interfaces ge-1/0/7 unit 1 vlan-id 2000
set interfaces ge-0/0/0 unit 0 family inet address 10.200.1.1/24
set interfaces ge-0/0/0 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 10.255.168.231/32 primary
```

```
set routing-instances vpls-vlan2000 instance-type vpls
set routing-instances vpls-vlan2000 interface ge-1/0/7.1
set routing-instances vpls-vlan2000 route-distinguisher 10.255.168.231:2000
set routing-instances vpls-vlan2000 vrf-target target:1000:1
set routing-instances vpls-vlan2000 protocols vpls site-range 10
set routing-instances vpls-vlan2000 protocols vpls site vlan2000-PE1 site-identifier 2
set protocols rsvp interface ge-0/0/0.0
set protocols mpls interface ge-0/0/0.0
set protocols mpls label-switched-path PE1-to-PE2 to 10.100.1.1
set protocols bgp group PE1-to-PE2
set protocols bgp group PE1-to-PE2 type internal
set protocols bgp group PE1-to-PE2 local-address 10.200.1.1
set protocols bgp group PE1-to-PE2 family l2vpn signaling
set protocols bgp group PE1-to-PE2 local-as 65000
set protocols bgp group PE1-to-PE2 neighbor 10.100.1.1
set protocols ospf traffic-engineering
set protocols ospf reference-bandwidth 4g
set protocols ospf area 0.0.0.0 interface ge-0/0/0.0
set protocols ospf area 0.0.0.0 interface lo0 passive
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 level 5
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 continuity-check interval 1s
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 100 interface ge-1/0/7.1
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 100 direction up
  auto-discovery
```

On Router PE2:

```
[edit]
set chassis fpc 5 pic 0 tunnel-services bandwidth 1g
set interfaces ge-5/0/9 vlan-tagging
set interfaces ge-5/0/9 encapsulation flexible-ethernet-services
set interfaces ge-5/0/9 unit 1 encapsulation vlan-vpls
set interfaces ge-5/0/9 unit 1 vlan-id 2000
set interfaces ge-5/2/7 unit 0 family inet address 10.100.1.1/24
set interfaces ge-5/2/7 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 10.255.168.230/32 primary
set routing-instances vpls-vlan2000 instance-type vpls
set routing-instances vpls-vlan2000 interface ge-5/0/9.1
set routing-instances vpls-vlan2000 route-distinguisher 10.255.168.230:2000
set routing-instances vpls-vlan2000 vrf-target target:1000:1
set routing-instances vpls-vlan2000 protocols vpls site-range 10
set routing-instances vpls-vlan2000 protocols vpls site vlan2000-PE2 site-identifier 1
set protocols rsvp interface ge-5/2/7.0
set protocols mpls interface ge-5/2/7.0
set protocols mpls label-switched-path PE2-to-PE1 to 10.200.1.1
set protocols bgp group PE2-to-PE1
set protocols bgp group PE2-to-PE1 type internal
set protocols bgp group PE2-to-PE1 local-address 10.100.1.1
set protocols bgp group PE2-to-PE1 family l2vpn signaling
set protocols bgp group PE2-to-PE1 local-as 65000
```



```
set protocols bgp group PE2-to-PE1 neighbor 10.200.1.1
set protocols ospf traffic-engineering
set protocols ospf reference-bandwidth 4g
set protocols ospf area 0.0.0.0 interface ge-5/2/7.0
set protocols ospf area 0.0.0.0 interface lo0 passive
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 level 5
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 continuity-check interval 1s
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 200 interface ge-5/0/9.1
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 200 direction up
  auto-discovery
```

On Router P:

```
[edit]
set interfaces ge-5/2/7 unit 0 family inet address 10.200.1.10/24
set interfaces ge-5/2/7 unit 0 family mpls
set interfaces ge-0/1/0 unit 0 family inet address 10.100.1.10/24
set interfaces ge-0/1/0 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 10.255.168.240/32
set protocols rsvp interface ge-0/1/0.0
set protocols rsvp interface ge-5/2/7.0
set protocols mpls interface ge-0/1/0.0
set protocols mpls interface ge-5/2/7.0
set protocols ospf traffic-engineering
set protocols ospf reference-bandwidth 4g
set protocols ospf area 0.0.0.0 interface ge-0/1/0.0
set protocols ospf area 0.0.0.0 interface ge-5/2/7.0
set protocols ospf area 0.0.0.0 interface lo0 passive
```

On Router L2-CE1:

```
[edit]
set interfaces ge-5/2/3 vlan-tagging
set interfaces ge-5/2/3 unit 0 vlan-id 2000
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 level 7
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 continuity-check interval 1s
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 800 interface ge-5/2/3.0
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 800 direction down
  auto-discovery
```

On Router L2-CE2:

```
[edit]
set interfaces ge-0/2/9 vlan-tagging
set interfaces ge-0/2/9 unit 0 vlan-id 2000
```

```
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 level 7
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 continuity-check interval 1s
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 700 interface ge-0/2/9.0
set protocols oam ethernet connectivity-fault-management maintenance-domain
  customer-site1 maintenance-association customer-site1 mep 700 direction down
  auto-discovery
```

Configuring Router PE1

Step-by-Step Procedure

Create the tunnel services interface, enable VLAN tagging, configure the encapsulation type, and enable the MPLS address family.

1. To create the tunnel services interface to be used for tunnel services, include the **bandwidth** statement and specify the amount of bandwidth to reserve for tunnel services in gigabits per second at the **[edit chassis fpc** *slot-number* **pic** *pic-number* **tunnel-services]** hierarchy level.

   ```
   [edit]
   user@PE1# set chassis fpc 5 pic 0 tunnel-services bandwidth 1g
   ```

2. If your network requires that each logical interface of the single physical interface on the Router PE1 to Router L2-CE1 link be configured to use a mix of different encapsulations, include the **encapsulation** statement and specify **flexible-ethernet-services** as the encapsulation type at the **[edit interfaces** *interface-name***]** hierarchy level.

   ```
   [edit]
   user@PE1# set interfaces ge-1/0/7 encapsulation flexible-ethernet-services
   ```

3. Configure VLAN tagging.

   Include the **encapsulation** statement and specify **vlan-vpls** as the encapsulation type at the **[edit interfaces** *interface-name* **unit 1]** hierarchy level.

   Include the **vlan-id** statement and specify 2000 as the VLAN ID.

   ```
   [edit]
   user@PE1# set interfaces ge-1/0/7 vlan-tagging
   user@PE1# set interfaces ge-1/0/7 unit 1 encapsulation vlan-vpls
   user@PE1# set interfaces ge-1/0/7 unit 1 vlan-id 2000
   ```

4. Configure the Gigabit Ethernet interface between Router PE1 and Router P by specifying the **inet** address family type and the **mpls** family.

   ```
   [edit]
   user@PE1# set interfaces ge-0/0/0 unit 0 family inet address 10.200.1.1/24
   user@PE1# set interfaces ge-0/0/0 unit 0 family mpls
   ```

5. Configure an IP address on the loopback logical interface.

   ```
   [edit]
   user@PE1# set interfaces lo0 unit 0 family inet address 10.255.168.231/32 primary
   ```

6. To enable a VPLS instance on Router PE1, specify the **vpls** instance type and configure a route distinguisher and a VRF target.

   The **vrf-target** statement causes default VRF import and export policies to be generated that accept and tag routes with the specified target community.

   ```
   [edit]
   user@PE1# set routing-instances vpls-vlan2000 instance-type vpls
   user@PE1# set routing-instances vpls-vlan2000 interface ge-1/0/7.1
   user@PE1# set routing-instances vpls-vlan2000 route-distinguisher
     10.255.168.231:2000
   user@PE1# set routing-instances vpls-vlan2000 vrf-target target:1000:1
   ```

7. Configure the VPLS site within the routing instance, and configure the site range and the site identifier as required by the protocol.

   ```
   [edit]
   user@PE1# set routing-instances vpls-vlan2000 protocols vpls site-range 10
   user@PE1# set routing-instances vpls-vlan2000 protocols vpls site vlan2000-PE1
     site-identifier 2
   ```

8. Configure **rsvp**.

   Enable the protocol on interface ge-0/0/0.

   ```
   [edit]
   user@PE1# set protocols rsvp interface ge-0/0/0.0
   ```

9. Configure **mpls**.

   Enable the protocol on interface ge-0/0/0, and specify the destination IP address for the label switching path between Router PE1 and Router PE2.

   ```
   [edit]
   user@PE1# set protocols mpls interface ge-0/0/0.0
   user@PE1# set protocols mpls label-switched-path PE1-to-PE2 to 10.100.1.1
   ```

10. Configure a BGP group, specify the group type, and configure an explicit neighbor.

    Specify the BGP type as internal.

    ```
    [edit]
    user@PE1# set protocols bgp group PE1-to-PE2
    user@PE1# set protocols bgp group PE1-to-PE2 type internal
    ```

    Specify the local address as the ge-0/0/0 interface IP address.

    ```
    [edit]
    user@PE1# set protocols bgp group PE1-to-PE2 local-address 10.200.1.1
    ```

    Specify the l2vpn family to indicate to the router that this is a VPLS, and specify the signaling option to configure BGP as the signaling protocol.

    ```
    [edit]
    user@PE1# set protocols bgp group PE1-to-PE2 family l2vpn signaling
    ```

    Configure an autonomous system identifier, and specify the ge-5/2/7 interface IP address of Router PE2 as the neighbor.

    ```
    [edit]
    user@PE1# set protocols bgp group PE1-to-PE2 local-as 65000
    ```

```
user@PE1# set protocols bgp group PE1-to-PE2 neighbor 10.100.1.1
```

11. Configure OSPF traffic engineering support.

    The **traffic-engineering** statement enables OSPF to advertise the label-switched path (LSP) metric in summary link-state advertisements (LSAs).

    Specify the reference bandwidth used in calculating the default interface cost.

    To specify that the routing device is directly connected to the OSPF backbone, include the **area 0.0.0.0** statement.

    Enable the protocol on the lo0.0 interface with the **passive** option.

    ```
    [edit]
    user@PE1# set protocols ospf traffic-engineering
    user@PE1# set protocols ospf reference-bandwidth 4g
    user@PE1# set protocols ospf area 0.0.0.0 interface ge-0/0/0.0
    user@PE1# set protocols ospf area 0.0.0.0 interface lo0 passive
    ```

12. Configure the CFM parameters.

    Specify the maintenance domain name and the maintenance domain level, and create a maintenance association.

    ```
    [edit ]
    user@PE1# set protocols oam ethernet connectivity-fault-management
      maintenance-domain customer-site1 level 5
    user@PE1# set protocols oam ethernet connectivity-fault-management
      maintenance-domain customer-site1 maintenance-association customer-site1
    ```

13. Enable the continuity check protocol, and specify the continuity check **interval** as 1 second.

    ```
    [edit ]
    user@PE1# set protocols oam ethernet connectivity-fault-management
      maintenance-domain customer-site1 maintenance-association customer-site1
      continuity-check interval 1s
    ```

14. Configure the maintenance association end point (MEP), and specify the **interface**, **auto-discovery**, and **direction** options.

    ```
    [edit ]
    user@PE1# set protocols oam ethernet connectivity-fault-management
      maintenance-domain customer-site1 maintenance-association customer-site1
      mep 100 interface ge-1/0/7.1
    user@PE1# set protocols oam ethernet connectivity-fault-management
      maintenance-domain customer-site1 maintenance-association customer-site1
      mep 100 direction up auto-discovery
    ```

Results From configuration mode, confirm your configuration by entering the **show chassis fpc**, **show interfaces**, **show routing-instances**, and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE1# show chassis fpc 5
pic 0 {
  tunnel-services {
    bandwidth 1g;
```



```
    }
}

user@PE1# show interfaces
ge-1/0/7 {
    vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 1 {
        encapsulation vlan-vpls;
        vlan-id 2000;
    }
}
ge-0/0/0 {
    unit 0 {
        family inet {
            address 10.200.1.1/24;
        }
        family mpls;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 10.255.168.231/32 {
                primary;
            }
        }
    }
}

user@PE1# show routing-instances
vpls-vlan2000 {
    instance-type vpls;
    interface ge-1/0/7.1;
    route-distinguisher 10.255.168.231:2000;
    vrf-target target:1000:1;
    protocols {
        vpls {
            site-range 10;
            site vlan2000-PE1 {
                site-identifier 2;
            }
        }
    }
}

user@PE1# show protocols
rsvp {
    interface ge-0/0/0.0;
}
mpls {
    label-switched-path PE1-to-PE2 {
        to 10.100.1.1;
        }
    interface ge-0/0/0.0;
}
bgp {
```

```
    group PE1-to-PE2 {
      type internal;
      local-address 10.200.1.1;
      family l2vpn {
        signaling;
      }
      local-as 65000;
      neighbor 10.100.1.1;
    }
  }
  ospf {
    traffic-engineering;
    reference-bandwidth 4g;
    area 0.0.0.0 {
      interface lo0 {
        passive;
      }
      interface ge-0/0/0.0;
    }
  }
  oam {
    ethernet {
      connectivity-fault-management {
        maintenance-domain customer-site1 {
          level 5;
          maintenance-association customer-site1 {
            continuity-check {
              interval 1s;
            }
            mep 100 {
              interface ge-1/0/7.1;
              direction up;
              auto-discovery;
            }
          }
        }
      }
    }
  }
```

Configuring Router PE2

Step-by-Step Procedure

Create the tunnel services interface, enable VLAN tagging, configure the encapsulation type, and enable the MPLS address family.

1. To create the tunnel services interface to be used for tunnel services, include the **bandwidth** statement and specify the amount of bandwidth to reserve for tunnel services in gigabits per second at the **[edit chassis fpc** *slot-number* **pic** *pic-number* **tunnel-services]** hierarchy level.

   ```
   [edit]
   user@PE2# set chassis fpc 5 pic 0 tunnel-services bandwidth 1g
   ```

2. If your network requires that each logical interface of the single physical interface on the Router PE1 to Router L2-CE1 link be configured to use a mix of different

encapsulations, include the **encapsulation** statement and specify **flexible-ethernet-services** as the encapsulation type at the **[edit interfaces *interface-name*]** hierarchy level.

```
[edit]
user@PE2# set interfaces ge-5/0/9 encapsulation flexible-ethernet-services
```

3. Configure VLAN tagging.

   Include the **encapsulation** statement and specify **vlan-vpls** as the encapsulation type at the **[edit interfaces *interface-name* unit 1]** hierarchy level.

   Include the **vlan-id** statement and specify 2000 as the VLAN ID.

```
[edit]
user@PE2# set interfaces ge-5/0/9 vlan-tagging
user@PE2# set interfaces ge-5/0/9 unit 1 encapsulation vlan-vpls
user@PE2# set interfaces ge-5/0/9 unit 1 vlan-id 2000
```

4. Configure the Gigabit Ethernet interface between Router PE2 and Router P by specifying the **inet** address family type and the **mpls** family.

```
[edit]
user@PE2# set interfaces ge-5/2/7 unit 0 family inet address 10.100.1.1/24
user@PE2# set interfaces ge-5/2/7 unit 0 family mpls
```

5. Configure an IP address on the loopback logical interface.

```
[edit]
user@PE2# set interfaces lo0 unit 0 family inet address 10.255.168.230/32 primary
```

6. To enable a VPLS instance on Router PE2, specify the **vpls** instance type, and configure a route distinguisher and a VRF target.

   The **vrf-target** statement causes default VRF import and export policies to be generated that accept and tag routes with the specified target community.

```
[edit]
user@PE2# set routing-instances vpls-vlan2000 instance-type vpls
user@PE2# set routing-instances vpls-vlan2000 interface ge-5/0/9.1
user@PE2# set routing-instances vpls-vlan2000 route-distinguisher
  10.255.168.230:2000
user@PE2# set routing-instances vpls-vlan2000 vrf-target target:1000:1
```

7. Configure the VPLS site within the routing instance, and configure the site range and the site identifier as required by the protocol.

```
[edit]
user@PE2# set routing-instances vpls-vlan2000 protocols vpls site-range 10
user@PE2# set routing-instances vpls-vlan2000 protocols vpls site vlan2000-PE2
  site-identifier 1
```

8. Configure **rsvp**.

   Enable the protocol on interface ge-5/2/7.

```
[edit]
user@PE2# set protocols rsvp interface ge-5/2/7.0
```

9. Configure **mpls**.

Enable the protocol on interface ge-5/2/7 and specify the destination IP address for the label switching path between Router PE2 and Router PE1.

```
[edit]
user@PE2# set protocols mpls interface ge-5/2/7.0
user@PE2# set protocols mpls label-switched-path PE2-to-PE1 to 10.200.1.1
```

10. Configure a BGP group, specify the group type, and configure an explicit neighbor.

    Specify the BGP type as internal.

    ```
    [edit]
    user@PE2# set protocols bgp group PE2-to-PE1
    user@PE2# set protocols bgp group PE2-to-PE1 type internal
    ```

    Specify the local address as the ge-5/2/7 interface IP address.

    ```
    [edit]
    user@PE2# set protocols bgp group PE2-to-PE1 local-address 10.100.1.1
    ```

    Specify the l2vpn family to indicate to the router that this is a VPLS, and specify the signaling option to configure BGP as the signaling protocol.

    ```
    [edit]
    user@PE2# set protocols bgp group PE2-to-PE1 family l2vpn signaling
    ```

    Configure an autonomous system identifier, and specify the ge-0/0/0 interface IP address of Router PE1 as the neighbor.

    ```
    [edit]
    user@PE2# set protocols bgp group PE2-to-PE1 local-as 65000
    user@PE1# set protocols bgp group PE2-to-PE1 neighbor 10.200.1.1
    ```

11. Configure OSPF traffic engineering support.

    The **traffic-engineering** statement enables OSPF to advertise the label-switched path (LSP) metric in summary link-state advertisements (LSAs).

    Specify the reference bandwidth used in calculating the default interface cost.

    ```
    [edit]
    user@PE2# set protocols ospf traffic-engineering
    user@PE2# set protocols ospf reference-bandwidth 4g
    ```

    To specify that the routing device is directly connected to the OSPF backbone, include the **area 0.0.0.0** statement.

    Enable the protocol on the lo0.0 interface with the **passive** option.

    ```
    [edit]
    user@PE2# set protocols ospf area 0.0.0.0 interface ge-5/2/7.0
    user@PE2# set protocols ospf area 0.0.0.0 interface lo0 passive
    ```

12. Configure the CFM parameters.

    Specify the maintenance domain name and the maintenance domain level, and create a maintenance association.

    ```
    [edit]
    user@PE2# set protocols oam ethernet connectivity-fault-management
      maintenance-domain customer-site1 level 5
    ```



```
user@PE2# set protocols oam ethernet connectivity-fault-management
  maintenance-domain customer-site1 maintenance-association customer-site1
```

13. Enable the continuity check protocol, and specify the continuity check **interval** as 1 second.

```
[edit]
user@PE2# set protocols oam ethernet connectivity-fault-management
  maintenance-domain customer-site1 maintenance-association customer-site1
  continuity-check interval 1s
```

14. Configure the maintenance association end point (MEP), and specify the **interface**, **auto-discovery**, and **direction** options.

```
[edit]
user@PE2# set protocols oam ethernet connectivity-fault-management
  maintenance-domain customer-site1 maintenance-association customer-site1
  mep 200 interface ge-5/0/9.1
user@PE2# set protocols oam ethernet connectivity-fault-management
  maintenance-domain customer-site1 maintenance-association customer-site1
  mep 200 direction up auto-discovery
```

Results From configuration mode, confirm your configuration by entering the **show chassis fpc**, **show interfaces**, **show routing-instances**, and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE2# show chassis fpc 5
pic 0 {
  tunnel-services {
    bandwidth 1g;
  }
}
```

```
user@PE2# show interfaces
ge-5/0/9 {
  vlan-tagging;
  encapsulation flexible-ethernet-services;
  unit 1 {
    encapsulation vlan-vpls;
    vlan-id 2000;
  }
}
ge-5/2/7 {
  unit 0 {
    family inet {
      address 10.100.1.1/24;
    }
    family mpls;
  }
}
lo0 {
  unit 0 {
    family inet {
      address 10.255.168.230/32 {
        primary;
```

```
        }
      }
    }
}
user@PE2# show routing-instances
vpls-vlan2000 {
    instance-type vpls;
    interface ge-5/0/9.1;
    route-distinguisher 10.255.168.230:2000;
    vrf-target target:1000:1;
    protocols {
        vpls {
            site-range 10;
            site vlan2000-PE2 {
                site-identifier 1;
            }
        }
    }
}
user@PE2# show protocols
rsvp {
    interface ge-5/2/7.0;
}
mpls {
    label-switched-path PE2-to-PE1 {
        to 10.200.1.1;
        }
    interface ge-5/2/7.0;
}
bgp {
    group PE2-to-PE1 {
        type internal;
        local-address 10.100.1.1;
        family l2vpn {
            signaling;
        }
        local-as 65000;
        neighbor 10.200.1.1;
    }
}
ospf {
    traffic-engineering;
    reference-bandwidth 4g;
    area 0.0.0.0 {
        interface lo0 {
            passive;
        }
        interface ge-5/2/7.0;
    }
}
oam {
    ethernet {
        connectivity-fault-management {
            maintenance-domain customer-site1 {
                level 5;
```

```
            maintenance-association customer-site1 {
              continuity-check {
                interval 1s;
              }
              mep 200 {
                interface ge-5/0/9.1;
                direction up;
                auto-discovery;
              }
            }
          }
        }
      }
    }
```

Configuring Router P

Step-by-Step Procedure

Configure Router P for MPLS operation. No CFM configuration is required on Router P.

1. On Router P, configure the Gigabit Ethernet interfaces to Router PE1, and specify the **inet** address family type and the **mpls** address family.

   ```
   [edit]
   user@P# set interfaces ge-5/2/7 unit 0 family inet address 10.200.1.10/24
   user@P# set interfaces ge-5/2/7 unit 0 family mpls
   ```

2. Configure the Gigabit Ethernet interfaces to Router PE2.

   Specify the **inet** address family type and the **mpls** address family.

   ```
   [edit]
   user@P# set interfaces ge-0/1/0 unit 0 family inet address 10.100.1.10/24
   user@P# set interfaces ge-0/1/0 unit 0 family mpls
   ```

   Configure the loopback interface.

   ```
   [edit]
   user@P# set interfaces lo0 unit 0 family inet address 10.255.168.240/32
   ```

3. Configure **rsvp**.

   Enable the protocol on ge-0/1/0 and ge-5/2/7.

   ```
   [edit]
   user@P# set protocols rsvp interface ge-0/1/0.0
   user@P# set protocols rsvp interface ge-5/2/7.0
   ```

4. Configure **mpls**.

   Enable the protocol on ge-0/1/0.0 and ge-5/2/7.0.

   ```
   [edit]
   user@P# set protocols mpls interface ge-0/1/0.0
   user@P# set protocols mpls interface ge-5/2/7.0
   ```

5. Configure the **ospf** routing protocol.

   Enable the protocol on the lo0.0 interface with the passive option.

   ```
   [edit]
   user@P# set protocols ospf traffic-engineering
   ```

```
user@P# set protocols ospf reference-bandwidth 4g
user@P# set protocols ospf area 0.0.0.0 interface ge-0/1/0.0
user@P# set protocols ospf area 0.0.0.0 interface ge-5/2/7.0
user@P# set protocols ospf area 0.0.0.0 interface lo0 passive
```

Results From configuration mode, confirm your configuration by entering the **show interfaces** and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@P# show interfaces
ge-5/2/7 {
  unit 0 {
    family inet {
      address 10.200.1.10/24;
    }
    family mpls;
  }
}
ge-0/1/0 {
  unit 0 {
    family inet {
      address 10.100.1.10/24;
    }
    family mpls;
  }
}
lo0 {
  unit 0 {
  family inet {
    address 10.255.168.240/32 ;
  }
}
```

```
user@P# show protocols
rsvp {
  interface ge-0/1/0.0;
  interface ge-5/2/7.0;
}
mpls {
  interface ge-0/1/0.0;
  interface ge-5/2/7.0;
}
ospf {
  traffic-engineering;
  reference-bandwidth 4g;
  area 0.0.0.0 {
    interface lo0 {
      passive;
    }
    interface ge-0/1/0.0;
    interface ge-5/2/7.0;
  }
}
```

Configuring CFM on Router L2-CE1

Step-by-Step Procedure

To configure CFM on Router L2-CE1:

1. Configure **vlan-tagging** on the Gigabit Ethernet interface with Router PE1, and specify the **vlan-ID**.

   ```
   [edit]
   user@L2-CE1# set interfaces ge-5/2/3 vlan-tagging
   user@L2-CE1# set interfaces ge-5/2/3 unit 0 vlan-id 2000
   ```

2. Configure the CFM parameters at the **[edit protocols oam]** hierarchy level.

   Specify the maintenance domain name and the maintenance domain level, and create a maintenance association.

   ```
   [edit]
   user@L2-CE1# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 level 7
   user@L2-CE1# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
   ```

3. Enable the continuity check protocol, and specify the continuity check **interval** as 1 second.

   ```
   [edit]
   user@L2-CE1# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
     continuity-check interval 1s
   ```

4. Configure the maintenance association end point (MEP), and specify the **interface**, **auto-discovery**, and **direction** options.

   ```
   [edit]
   user@L2-CE1# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
     mep 800 interface ge-5/2/3.0
   user@L2-CE1# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
     mep 800 direction down auto-discovery
   ```

Results

From configuration mode, confirm your configuration by entering the **show interfaces** and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@L2-CE1# show interfaces
ge-5/2/3 {
  vlan-tagging;
  unit 0 {
    vlan-id 2000;
  }
}
```

```
user@L2-CE1# show protocols
oam {
  ethernet {
    connectivity-fault-management {
```

```
        maintenance-domain customer-site1 {
          level 7;
          maintenance-association customer-site1 {
            continuity-check {
              interval 1s;
            }
            mep 800 {
              interface ge-5/2/3.0;
              direction down;
              auto-discovery;
            }
          }
        }
      }
    }
  }
```

Configuring CFM on Router L2-CE2

Step-by-Step Procedure

To configure CFM on Router L2-CE2:

1. Configure **vlan-tagging** on the Gigabit Ethernet interface to Router PE2, and specify the **vlan-ID**.

   ```
   [edit]
   user@L2-CE2# set interfaces ge-0/2/9 vlan-tagging
   user@L2-CE2# set interfaces ge-0/2/9 unit 0 vlan-id 2000
   ```

2. At the **[edit protocols oam]** hierarchy level, configure the CFM parameters.

   Specify the maintenance domain name and the maintenance domain level, and create a maintenance association.

   ```
   [edit]
   user@L2-CE2# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 level 7
   user@L2-CE2# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
   ```

3. Enable the continuity check protocol, and specify the continuity check **interval** as 1 second.

   ```
   [edit]
   user@L2-CE2# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
     continuity-check interval 1s
   ```

4. Configure the maintenance association end point (MEP), and specify the **interface**, **auto-discovery**, and **direction** options.

   ```
   [edit]
   user@L2-CE2# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
     mep 700 interface ge-0/2/9.0
   user@L2-CE2# set protocols oam ethernet connectivity-fault-management
     maintenance-domain customer-site1 maintenance-association customer-site1
     mep 700 direction down auto-discovery
   ```

Results From configuration mode, confirm your configuration by entering the **show interfaces** and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@L2-CE2# show interfaces
ge-0/2/9 {
  vlan-tagging;
    unit 0 {
      vlan-id 2000;
    }
}
```

```
user@L2-CE2# show protocols
oam {
  ethernet {
    connectivity-fault-management {
      maintenance-domain customer -site1 {
        level 7;
        maintenance-association customer-site1 {
          continuity-check {
            interval 1s;
          }
          mep 700 {
            interface ge-0/2/9.0;
            direction down;
            auto-discovery;
          }
        }
      }
    }
  }
}
```

Verification

Verifying That OAM CFM Has Been Configured Properly

Purpose Verify that OAM CFM has been configured properly.

Action Use the **show oam ethernet connectivity-fault-management interfaces detail** command:

```
user@PE1# show oam ethernet connectivity-fault-management interfaces detail
```

```
Interface name: ge-2/1/7.1 , Interface status: Active, Link status: Up
  Maintenance domain name: customer-site1, Format: string, Level: 5, MD Index: 1

    Maintenance association name: customer-site1, Format: string, MA Index: 1
    Continuity-check status: enabled, Interval: 1s, Loss-threshold: 3 frames
    Interface status TLV: none, Port status TLV: none
    Connection Protection TLV: no
    MEP identifier: 200, Direction: up, MAC address: 00:21:59:0f:35:d6
    MEP status: running
    Defects:
      Remote MEP not receiving CCM                 : no
      Erroneous CCM received                       : no
      Cross-connect CCM received                   : no
```

```
    RDI sent by some MEP                          : no
    Some remote MEP's MAC in error state          : no
  Statistics:
    CCMs sent                                     : 0
    CCMs received out of sequence                 : 0
    LBMs sent                                     : 0
    Valid in-order LBRs received                  : 0
    Valid out-of-order LBRs received              : 0
    LBRs received with corrupted data             : 0
    LBRs sent                                     : 0
    LTMs sent                                     : 0
    LTMs received                                 : 0
    LTRs sent                                     : 0
    LTRs received                                 : 0
    Sequence number of next LTM request           : 0
    1DMs sent                                     : 0
    Valid 1DMs received                           : 0
    Invalid 1DMs received                         : 0
    Out of sync 1DMs received                     : 0
    DMMs sent                                     : 0
    Valid DMMs received                           : 0
    Invalid DMMs received                         : 0
    DMRs sent                                     : 0
    Valid DMRs received                           : 0
    Invalid DMRs received                         : 0
    LMMs sent                                     : 0
    Valid LMMs received                           : 0
    Invalid LMMs received                         : 0
    LMRs sent                                     : 0
    Valid LMRs received                           : 0
    Invalid LMRs received                         : 0
    SLMs sent                                     : 0
    Valid SLMs received                           : 0
    Invalid SLMs received                         : 0
    SLRs sent                                     : 0
    Valid SLRs received                           : 0
    Invalid SLRs received                         : 0
```

Meaning When the output displays that continuity-check status is **enabled** and displays details of the remote MEP, it means that CFM has been configured properly.

Related Documentation

- Advantages of Configuring Ethernet CFM over VPLS on page 1
- Ethernet Operations, Administration, and Maintenance on page 2
- Ethernet OAM Connectivity Fault Management on page 3
- Example: Configuring Ethernet CFM on Bridge Connections
- Example: Configuring Ethernet CFM on Physical Interfaces
- Ethernet OAM Feature Guide for MX Series Routers