Serial Interfaces

You can create the serial interface on T1 or E1, T3 or E3, SDH, or SONET interface. Each serial interface configuration differs based on the interface mode.

The channel identifier configuration differs based on the interface mode. For more information, refer serial interface supported modes.

Serial Interface Supported Modes

The serial interface name is specified as **interface serial***0/bay/port*. The zero specifies the slot number, bay specifies the bay number in the slot, and port specifies the port number in the bay.

The channel identifier varies depending on port type and supported port modes.

The following table details the values for the channel ID depending on the port modes:

Table 1: Channel Identifier Supported on T1 or E1 Interface

Mode	Interface	Serial Interface with supported Channel Identifier
T1 or E1	T1 or E1	Serial0/bay/port.1 The port value ranges from 0 to 11.

Table 2: Channel Identifier Supported on T3 or E3 Interface

Mode	Interface	Serial Interface with supported Channel Identifier
T3 or E3	T3 or E3	Serial0/bay/port.1 The port value ranges from 12 to 15.
CT3 or CE3	Channelized T3 or E3	Serial0/bay/port.<t1 number> Serial0/bay/port.<e1 number> T1 or E1 number specifies the VTG number with TUG number and T1 channels. The T1 or E1 number that is supported are as follows: • VTG 1/TUG2 1: T1 {1,8,15,22} • VTG 2/TUG2 2: T1 {2,9,16,23} • VTG 3/TUG2 3: T1 {3,10,17,24} • VTG 4/TUG2 4: T1 {4,11,18,25} • VTG 5/TUG2 5: T1 {5,12,19,26} • VTG 6/TUG2 6: T1 {6,13,20,27} • VTG 7/TUG2 7: T1 {7,14,21,28

Table 3: Channel Identifier Supported on SDH or SONET Interface

Mode	Interface Mode	Serial Interface with supported Channel Identifier
SONET or SDH	STS-3c or VC-4	Serial0/bay/port.<channel-id> For SONET, the <channel-id> is calculated based on the following formula: Channel-id = (start_sts_number − 1) x 28 + 1 For SDH, the <channel-id> is calculated based on the following formula: Channel-id = (start_aug4 − 1) x 28 x 3 + 1
SONET or SDH	T3 or E3	Serial0/bay/port.<channel-id> For SONET, the <channel-id> is calculated based on the following formula: Channel-id = (start_sts_number − 1) x 28 + 1 For SDH AU-4 mapping in TUG3 mode, the <channel-id> is calculated based on the following formula: Channel-id = (AUG 4 − 1) x 28 x 3 + (TUG 3 − 1) x 28 + (e1 − 1) x 7 + TUG 2 For SDH AU-3 mapping, the <channel-id> is calculated based on the following formula: Channel-id = (AUG 3 − 1) x 28 + (e1 − 1) x 7 + TUG 2

Mode	Interface Mode	Serial Interface with supported Channel Identifier

SONET or SDH	Concatenated Mode	For SONET, the <channel-id> is calculated based on the following formula:
		Channel-id = (start_sts_number − 1) x 28 + 1
		For SDH, the <channel-id> is calculated based on the following formula:
		Channel-id = (start_aug4 −1) x 28 x 3 + 1

SONET	VT1.5	Serial0/bay/port.<channel-id>
		<channel-id> is the channel ID calculated based on the following formula:
		Channel-id = (sts_number − 1) x 28 + (T1/E1 − 1) x 7 + VTG
		The following example describes how the channel ID is calculated for a given configuration.
		`sts-1 2`
		`mode vt-15`
		`vtg 2 t1 3 channel-group 0 timeslots 1-24`
		Inter serial interface channel-id = (2 − 1) x 28 + (3 − 1) x 7 + 2 = 44
		• VTG 1 1: T1 {1,8,15,22}
		• VTG 2 2: T1 {2,9,16,23}
		• VTG 3 3: T1 {3,10,17,24}
		• VTG 4 4: T1 {4,11,18,25}
		• VTG 5 5: T1 {5,12,19,26}
		• VTG 6 6: T1 {6,13,20,27}
		• VTG 7 7: T1 {7,14,21,28

SONET	CT3	For the CT3 mode, the <channel-id> is calculated based on the following formula: ((STS - 1) x 28) + T1

Mode	Interface Mode	Serial Interface with supported Channel Identifier
SDH	AU4-T3 or E3	For the SDH AU4-T3 or E3 mode, the <channel-id> is calculated based on the following formula: ((AU Mapping - 1) x 28 x 3) + ((TUG3 - 1) x 28) + 1
SDH	Vc11 and Vc12	T1 number with Vc11 supported: • TUG2 1: T1 {1,8,15,22} • TUG2 2: T1 {2,9,16,23} • TUG2 3: T1 {3,10,17,24} • TUG2 4: T1 {4,11,18,25} • TUG2 5: T1 {5,12,19,26} • TUG2 6: T1 {6,13,20,27} • TUG2 7: T1 {7,14,21,28 E1 number with Vc12 supported: • TUG2 1: E1 {1,8,15} • TUG2 2: E1 {2,9,16} • TUG2 3: E1 {3,10,17} • TUG2 4: E1 {4,11,18} • TUG2 5: E1 {5,12,19} • TUG2 6: E1 {6,13,20} • TUG2 7: E1 {7,14,21} **Note** Depending on the mode selected, the number of E1 changes.

Note ACL is not supported on serial interfaces.

Interworking Multiservice Gateway Support Matrix

The following table details the list of interworking multiservice gateway features supported on Cisco ASR 900 platforms.

Table 4: Interworking Multiservice Gateway Support Matrix on Cisco ASR 900 Platforms

Platform RSP	ASR900-RSP3				ASR900-RSP	
IM Type	A900-IMA3G-IMSG		A900-IMA1Z8S-CXMS		A900-IMA3G-IMSG	
Feature List	IPv4	IPv6	IPv4	IPv6	IPv4	IPv6
Interworking	Y	Y	Y	Y	Y	Y
Interworking Access Circuit Redundancy (ACR)	Y	Y	Y	Y	Y	Y
Interworking UPSR (Only HDLC)	Y	N	Y	N	N	N
L3 Termination (FR & MLFR not supported)	Y	Y	Y	Y	N	N
Interworking nXDS0	Y	N	Y	N	Y	N
Interworking nXDS0 ACR	Y	N	Y	N	Y	N
VLAN Handoff (Local connect)	Y	Y	Y	Y	N	N
VLAN Handoff (Cross connect / Xconnect)	Y	Y	Y	Y	N	N
Interworking MLPPP	Y	Y	Y	Y	Y	Y
Interworking MLPPP ACR	Y	Y	Y	Y	Y	Y
Interworking FR	Y	Y	Y	Y	Y	Y
Interworking MLFR	Y	Y	Y	Y	Y	Y

Platform RSP	ASR900-RSP3				ASR900-RSP	
Interworking FR ACR	Y	Y	Y	Y	Y	Y
Interworking MLFR ACR	Y	Y	Y	Y	Y	Y
L3 QoS (FR & MLFR not supported)	Y	N	Y	N	N	N

Y— Supported

N—Not Supported

Creating T1 or E1 Serial Interfaces on T1 or E1 Ports

Creating T1 Serial Interface

To create a channel group on a T1 interface, use the following commands:

```
router(config)#controller t1 0/2/0
router(config-controller)#channel-group 0  timeslots 1-24
```

Note For T1, the channel-group ID ranges from 0 to 23.

Creating E1 Serial Interface

To create a channel group on an E1 interface, use the following commands:

```
router(config)#controller e1 0/2/0
router(config-controller)#channel-group 0  timeslots 1-31
```

Note For E1, the channel-group ID ranges from 0 to 30.

The following example explains a channel group of number 2 with time slot 1-24 is configured on the T1 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller t1 0/2/0
router(config-controller)#channel-group  2 timeslots  1-24
router(config-controller)#end
```

Note While specifying time slot, use the complete range, for example, 1-24 for T1 and 1-31 for E1.

The following example explains a channel group of number 10 with time slot 1-31 is configured on the E1 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller e1 0/3/2
router(config-controller)#channel-group 10 timeslots 1-31
router(config-controller)#end
```

Creating T3 or E3 Serial Interfaces on T3 or E3 Ports

Configuring Mode to T3 or E3

To configure T3 mode, use the following commands:

```
router(config)#controller mediatype 0/2/12
router(config-controller)#mode t3
router(config-controller)#exit
```

To configure E3 mode, use the following commands:

```
router(config)#controller mediatype 0/2/12
router(config-controller)#mode e3
router(config-controller)#exit
```

Creating T3 Serial Interface

To create a T3 interface, use the following commands:

```
router(config)#controller t3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#exit
```

Note Use `no channel group` command to clear configured T3 channels.

Creating E3 Serial Interface

To create an E3 interface, use the following commands:

```
router(config)#controller e3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#exit
```

Note Unframed mode is not supported on E3-E1 mode.

Creating CT3 Serial Interface

To create a CT3 interface, use the following commands:

```
router(config)#controller t3 0/2/12
router(config-controller)#channelized
router(config-controller)#t1 1 channel-group 0 timeslots 1-24
router(config-controller)#t1 2 channel-group 0 timeslots 1-24
router(config-controller)#exit
```

Note While specifying time slot, ensure that you provide the complete time slot, for example 1-24 for T1 interface.

The following example explains a channel group of 0 is configured on the E3 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller e3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#end
```

The following example explains a channel group of number 0 is configured on the CT3 interface of the controller. The default encapsulation of HDLC is used.

```
router(config)#controller t3 0/2/12
router(config-controller)#no channelized
router(config-controller)#channel-group 0
router(config-controller)#end
```

Creating an E1 Serial Interface in Unframed Mode

Table 5: Feature History

Feature Name	Release Information	Description
Unframed Framing Support on an E1 and Channel STM links	Cisco IOS XE Bengaluru 17.5.1	In this release, a new framing mode unframed is supported for the 1 port OC-48/STM-16 or 4 port OC-12/OC-3 / STM-1/STM-4 + 12 port T1/E1 + 4 port T3/E3 CEM Interface Module. With the unframed mode, you can create serial interfaces under the electrical E1 mode.

Starting with Cisco IOS XE 17.5.1, you can create a channel group in the unframed mode only on the E1 interface.

To create channel group in the unframed mode, use the following commands:

```
router(config)#controller e1 0/2/0
router(config-controller)#framing unframed
router(config-controller)#channel-group channel-grp-no unframed
```

The following example explains a channel group of number 10 configured on the unframed mode of E1 interface. The default encapsulation of HDLC is used.

```
router(config)#controller e1 0/2/0
router(config-controller)#framing unframed
router(config-controller)#channel-group 10 unframed
```

Creating Serial Interfaces on SDH

Configuring Mode to SDH

To enter into SDH mode, use the following commands:

```
router(config)#controller mediatype 0/bay/port
router(config-controller)#mode sdh
router(config-controller)#exit
```

Creating SDH T3 Interface

To create an SDH T3 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode t3
router(config-ctrlr-tug3)#[no]t3 channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating SDH E3 Interface

To create an SDH E3 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode e3
router(config-ctrlr-tug3)#[no]e3  channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating SDH VC11 Interface

To create an SDH VC11 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#[no]mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode vc1x
router(config-ctrlr-tug3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#[no]t1 1  channel-group 0 timeslots 1-24
router(config-ctrlr-tug3)#exit
```

Creating SDH VC12 Interface

To create an SDH VC12 interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#[no]mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#[no]mode vc1x
router(config-ctrlr-tug3)#tug-2 1 payload vc12
router(config-ctrlr-tug2-vcx)#[no]e1 1  channel-group 0 timeslots 1-31
router(config-ctrlr-tug3)#exit
```

Creating SDH VC4-nc Interface

To create an SDH VC4-nc concatenated interface, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#rate {stm1 | stm4 | stm16}
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#[no]mode vc4
router(config-ctrlr-au4)#[no]channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating SDH T3 Interface with AUG-3 Mapping

To create an SDH T3 interface with AUG-3 AUG mapping, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#aug mapping au-3
router(config-controller)#au-3 1
router(config-ctrlr-au3)#[no]mode t3
router(config-ctrlr-au3)#[no]t3 channel-group 0
router(config-ctrlr-au3)#exit
```

Creating SDH VC11 Interface with AUG-3 Mapping

To create an SDH VC11 interface with AUG-3 AUG mapping, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#au-3 1
router(config-ctrlr-au3)#[no]mode vc1x
router(config-ctrlr-au3)#tug-2 1 payload vc11
router(config-ctrlr-tug2-vcx)#[no] t1 1 channel-group 0 timeslots 1-24
router(config-ctrlr-tug3)#exit
```

Creating SDH VC12 Interface with AUG-3 Mapping

To create an SDH VC12 interface with AUG-3 AUG mapping, use the following commands:

```
router(config)#controller sdh 0/bay/port
router(config-controller)#au-3 1
router(config-ctrlr-au3)#[no]mode vc1x
router(config-ctrlr-au3)#tug-2 1 payload vc12
router(config-ctrlr-tug2-vcx)#[no]e1 1 channel-group 0 timeslots 1-31
router(config-ctrlr-tug3)#exit
```

The following example explains SDH serial interface is configured with rate STM1 with AU-4 mapping and TUG-3 and T3 mode:

```
router(config)#controller sdh 0/3/4
router(config-controller)#rate stm1
router(config-controller)#aug mapping au-4
router(config-controller)#au-4 1
router(config-ctrlr-au4)#mode tug-3
router(config-ctrlr-au4)#tug-3 1
router(config-ctrlr-tug3)#mode t3
router(config-ctrlr-tug3)#t3  channel-group 0
router(config-ctrlr-tug3)#exit
```

Creating Serial Interfaces on SONET

Setting Controller Mode to SONET

To enter into SONET mode, use the following commands:

```
router(config)#controller mediatype 0/bay/port
router(config-controller)#mode sonet
router(config-controller)#exit
```

Creating T3 Serial Interface

To create a channel group on the T3 interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate {oc3 | oc12 | oc48}
router(config-controller)#sts-1  1
router(config-controller)#[no]mode t3
router(config-controller)#[no]t3 channel-group 0
router(config-controller)#exit
```

Creating VT1.5 Serial Interface

To create a channel group on the VT1.5 interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate oc3
router(config-controller)#sts-1  1
router(config-controller)#[no]mode vt-15
router(config-controller)#[no]vtg 1 t1 1 channel-group 0 timeslots  1-24
router(config-controller)#exit
```

Creating CT3 Serial Interface

To create a channel group on the CT3 interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate oc3
router(config-controller)#sts-1  1
router(config-controller)#[no]mode ct3
router(config-controller)#[no]t1  1 channel-group 0  timeslots 1-24
router(config-controller)#exit
```

Note While specifying time slot, ensure that you specify the complete time slot.

Creating Concatenated Mode Serial Interface

To create a channel group on the concatenated mode serial interface, use the following commands:

```
router(config)#controller sonet 0/bay/port
router(config-controller)#rate oc3
router(config-controller)#sts-1  1 - 3 mode sts-3c
router(config-controller)#channel-group 0
router(config-controller)#exit
```

The following example explains SONET interface that is configured with OC-3 rate, STS-1 as 1, and mode as T3.The serial interface is modified for PPP encapsulation.

```
router(config)#controller sonet 0/3/4
router(config-controller)#rate oc3
router(config-controller)#sts-1  1
router(config-controller)#mode t3
router(config-controller)#t3  channel-group 0
router(config-controller)#end
router(config)#interface serial 0/3/4 .1
router(config-if)#no ip address
router(config-if)# encapsulation ppp
```

Modifying Encapsulation to PPP

By default, HDLC is used for encapsulation. You can modify encapsulation to PPP on a serial interface using the `encapsulation ppp` command.

The ***channel-id*** varies based on the mode set and the circuit type. For more information, see the Serial Interface Supported Modes section.

To modify encapsulation on the serial interface, use the following commands:

```
router(config)#interface serial 0/bay/port.channel-id
router(config-if)#no ip address
router(config-if)# encapsulation ppp
```

IPv4 or IPv6 Interworking Multiservice Gateway Pseudowire over HDLC or PPP

L2VPN Interworking Multiservice Gateway

Table 6: Feature History

Feature Name	Release Information	Feature Description
CEM and IP IW Feature Parity for A900-IMA1Z8S-CXMS and A900-IMA3G-IMSG Interface Modules	Cisco IOS XE Bengaluru 17.4.1	Support for NxDS0 iMSG IPv4 and NxDS0 APS iMSG IPv4 on A900-IMA1Z8S-CXMS and A900-IMA3G-IMSG Interface Module.

Layer 2 transport over MPLS and IP already exists for like-to-like attachment circuits, such as Ethernet-to-Ethernet or PPP-to-PPP. Layer 2 Virtual Private Network (L2VPN) Interworking Multiservice Gateway (iMSG) builds on this functionality by allowing disparate attachment circuits to be connected. An iMSG function facilitates the translation between the different Layer 2 encapsulations.

L2VPN iMSG Mode

L2VPN iMSG works in IP (routed) mode that facilitates transport of IPv4 or IPv6 payload in HDLC or PPP frames to Ethernet, over an MPLS network. The configuration is supported on both A900-RSP2A-128 and A900-RSP3C-400-S . You specify the mode by issuing the **`interworking ip`** command in pseudowire-class configuration mode.

Starting with Cisco IOS XE 17.1.x release, the IPv6 iMSG is supported.

The **`interworking`** command causes the attachment circuits to be terminated locally. The **ip** keyword causes IP packets to be extracted from the attachment circuit and sent over the pseudowire. Packets with IPv4 or IPv6 payload only are transported over pseudowire.

IP Interworking Mode

The CE routers encapsulate the IP on the link between the CE router and PE router. A new VC type is used to signal the IP pseudowire in MPLS. Translation between the L2 and IP encapsulations across the pseudowire is required. Special consideration is given to the address resolution and routing protocol operation, because these operations are handled differently on different L2 encapsulations.

In routed iMSG, IP packets that are extracted from the ACs are sent over the pseudowire. The pseudowire works in the IP Layer 2 transport (VC type 0x000B) like-to-like mode. The iMSG function at the network service provider's (NSP) end performs the required adaptation that is based on the AC technology. Non-IPv4 or non-IPv6 packets are not forwarded on pseudowire. Only packets with the IPv4 or IPv6 payload are transported over the pseudowire.

The following table details on the packets that are terminated locally:

Table 7: List of Packets Locally Terminated

Protocol	Packets (Locally Terminated)	PID Number
Cisco HDLC	SLARP, LCP, or RARP	0x8035
Cisco HDLC	NCP or ARP	0x0806
PPP	LCP	0xCxxx to 0xFxxx
PPP	NCP	0x8xxx to 0xBxxx

HDLC or PPP to Ethernet IPv4 or IPv6 iMSG Pseudowire

Starting with Cisco IOS XE 16.9.1 release, the L2VPN iMSG allows you to connect disparate attachment circuits, for example, TDM and Ethernet attachment circuits.

For pseudowires operated in the IP (routed) mode, the IP packets are extracted from the attachment circuit and sent over the pseudowire.

Once IPv4 or IPv6 iMSG is configured, create a serial interface with specific channel identifier.

When a serial interface is UP, an internal label is allocated and LDP negotiation with a peer is performed for a remote label. A pseudowire is created and bound to HDLC or PPP channel. Based on the pseudowire configuration, you can permit IPv4 payload traffic with an allocated internal MPLS label.

The default encapsulation for all serial interfaces is HDLC. You can change the encapsulation to PPP. You can cross connect the attachment circuit segment with specific VC identifier and the pseudowire segment.

IPv4 or IPv6 iMSG Pseudowire Supported Modes

IPv4 or IPv6 iMSG pseudowire is supported on the following modes:

- T1 or E1
- T3 or E3
- Channelized T3 or E3 (channelized to T1 or E1)
- SDH
- SONET

Limitations of IPv4 or IPv6 iMSG Pseudowire on HDLC or PPP Serial Interfaces

The following limitations apply to IPv4 or IPv6 iMSG pseudowire on HDLC or PPP serial interfaces:

- IPv4 or IPv6 iMSG pseudowire with HDLC or PPP attachment circuit is supported only on the A900-IMA3G-IMSG variant for A900-RSP2A-128 and A900-RSP3C-400-S.
- L3 termination, bridging, and local switching on SERIAL-ACR interfaces (IPv4 and IPv6) are not supported, only L3 termination is supported on IPv4 serial interfaces.
- IPv4 or IPv6 over HDLC or PPP is not supported on Nx DS0 serial interfaces.
- T1 framing SF is not supported.

- Serial-ACR HDLC or PPP is not supported for STS-12C or VC4-4C and STS-48C or VC4-16C modes.
- HDLC or PPP is not supported for CE3 modes.
- Modifying MTU value is not supported for IPv6 iMSG pseudowire.
- Scrambling is not supported in the POS mode.
- IPv6 is not supported on RSP2 modules for Layer 3 termination on HDLC or PPP serial interfaces.

iMSG Restrictions for ASR 900 1-Port OC-192 or 8-Port Low Rate CEM 20G Bandwidth Interface Module (A900-IMA1Z8S-CXMS)

iMSG Restrictions - Cisco IOS XE Amsterdam 17.3.1 release

- MLPPP is not supported for iMSG.
- MLPPP ACR is not supported.
- nxDS0 iMSG is not supported until Cisco IOS XE Amsterdam 17.3.1.

  Starting with Cisco IOS XE Bengaluru 17.4.1, nxDS0 iMSG IPv4 is supported and.iMSG IPv6 is not supported.
- UPSR-only SONET modes such as VT1.5, STS-3C, STS-12C, and STS-48C are supported.

Bandwidth Restrictions - Cisco IOS XE Amsterdam 17.3.1 release

- Supports 2.5 G for iMSG
- iMSG supports upto STS-48c for concatenation

How to Configure IPv4 or IPv6 iMSG Pseudowire on HDLC or PPP Interface

This section provides the following information about configuring an IPv4 or IPv6 iMSG pseudowire on an HLDC or PPP interface:

- Configuring L2VPN iMSG, on page 16
- Configuring Cross-Connect Under Attachment Circuit, on page 17

Configuring L2VPN iMSG

To configure L2VPN iMSG, create a pseudowire class with the tunneling encapsulation as MPLS. The **interworking** command specifies the type of payload traffic that flows across the pseudowire tunnel. Configure pseudowire class only once on a device.

You can also configure **control-word** as an optional command.

To configure L2VPN IPv4 iMSG, use the following commands:

```
router>enable
router#configure terminal
router(config)#pseudowire-class pw-class-name
router(config-pw)#encapsulation mpls
router(config-pw)# interworking ip
router(config-pw)# control-word
```

To configure L2VPN IPv6 iMSG, use the following commands:

```
router>enable
router#configure terminal
router(config)#interface pseudowire pw-number
router(config-if)# encapsulation mpls
router(config-if)# neighbor <peer-address><vcid-value>
router(config-xconnect)# control-word include
```

Note Based on the far-end router, the control-word needs to be enabled or disabled.

The following example shows how to configure L2VPN IPv6 iMSG:

```
interface pseudowire30
 encapsulation mpls
 neighbor 10.2.2.2 30
 control-word include
```

Configuring Cross-Connect Under Attachment Circuit

The **xconnect** command binds the attachment circuit to an L2VPN pseudowire for cross connect service. The virtual circuit identifier creates the binding between a pseudowire that is configured on a PE router and an attachment circuit in a CE device.

To perform IPv4 cross connection between an AToM routed pseudowire and attachment circuit, use the following commands:

```
router(config)#interface serial 0/bay/port.channel-id
router(config-if)#xconnect ip-address vc-id pw-class atom-iw-routed
```

To perform IPv6 cross connection between pseudowire and attachment circuit, use the following commands:

```
router(config)#l2vpn xconnect context xconnect-name
router(config-xconnect)#interworking ipv6
router(config-xconnect)#member pseudowire pw-number
router(config-xconnect)#member serial 0/bay/port.channel-id
```

Verifying IPv4 or IPv6 iMSG Pseudowire over HDLC or PPP Configuration

The following **show interface serial** *0/bay/port.vc-number* command displays information about encapsulation and statistics of a serial interface.

To display configuration information on the serial interface, use the **show interface serial** command:

```
Router# show interface serial 0/5/19.8
 Serial0/5/19.8 is up, line protocol is up
  Hardware is A900RSP2A-128
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Stopped: TAGCP
  Open: IPCP, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:04, output 00:00:04, output hang never
  Last clearing of "show interface" counters 23:52:46
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     16201 packets input, 712844 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     16205 packets output, 696835 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions
 PW stats

 0 input packets ,0 output packets,
 0 input bytes, 0 output bytes, 0 input packet drop
 no alarm present
  VC 2: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
```

The **show platform software tdm-combo vc info** command helps you to identify the bay, port, STS path, T1, and channel group associated with a serial interface:

```
router#show platform software tdm-combo vc info
BAY  PORT PATH  T1      CHANNEL          VC         HWIDB
spa in bay:0 is NULL
spa in bay:1 is NULL
5    19   1      1          0        Serial0/5/19.1  1
5    19   1      8          0        Serial0/5/19.8  2
TOTAL ENTRIES :2
```

The **show running-config interface serial 0/5/19.8** command provides information about the current configuration under the serial interface 0/5/19.8:

```
router#show running-config interface serial 0/5/19.8
Building configuration...

Current configuration : 147 bytes
!
interface Serial0/5/19.8
 no ip address
 encapsulation ppp
 ppp authentication chap
 xconnect 192.168.2.6 207 encapsulation mpls pw-class ip-iw
end

BYOS-RSP3#sh xconnect all
Legend:    XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
  UP=Up       DN=Down            AD=Admin Down      IA=Inactive
  SB=Standby  HS=Hot Standby     RV=Recovering      NH=No Hardware

XC ST  Segment 1                         S1 Segment 2                         S2
------+---------------------------------+--+----------------------------------+--
UP pri   ac Se0/5/19.8(PPP)              UP mpls 192.168.2.6:207                  UP
```

The **show mpls l2transport vc 207 detail** command provides information on pseudowire corresponding to VC ID 207:

```
Local interface: Se0/5/19.8 up, line protocol up, PPP up
  Interworking type is IP
  Destination address: 192.168.2.6, VC ID: 207, VC status: up
    Output interface: Gi0/3/7, imposed label stack {16}
    Preferred path: not configured
    Default path: active
    Next hop: 209.165.202.129
  Create time: 23:31:56, last status change time: 23:31:54
    Last label FSM state change time: 23:31:56
  Signaling protocol: LDP, peer 192.168.2.6:0 up
    Targeted Hello: 192.168.2.10(LDP Id) -> 192.168.2.6, LDP is UP
    Graceful restart: configured and not enabled
    Non stop routing: not configured and not enabled
    Status TLV support (local/remote)   : enabled/supported
      LDP route watch                   : enabled
      Label/status state machine        : established, LruRru
      Last local dataplane   status rcvd: No fault
      Last BFD dataplane     status rcvd: Not sent
      Last BFD peer monitor  status rcvd: No fault
      Last local AC  circuit status rcvd: No fault
      Last local AC  circuit status sent: No fault
      Last local PW i/f circ status rcvd: No fault
      Last local LDP TLV     status sent: No fault
      Last remote LDP TLV    status rcvd: No fault
      Last remote LDP ADJ    status rcvd: No fault
    MPLS VC labels: local 512, remote 16
    Group ID: local n/a, remote 0
    MTU: local 1500, remote 1500
    Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On
  SSO Descriptor: 192.168.2.6/207, local label: 512
  Dataplane:
    SSM segment/switch IDs: 8219/8218 (used), PWID: 1
  VC statistics:
    transit packet totals: receive 0, send 0
    transit byte totals:   receive 0, send 0
    transit packet drops:  receive 0, seq error 0, send 0
```

IPv4 or IPv6 Interworking Multiservice Gateway Pseudowire over Frame Relay

Frame Relay for iMSG

Table 8: Feature History

Feature Name	Release Information	Description
Frame Relay Support for IP Interworking	Cisco IOS XE Cupertino 17.8.1	Support for frame relay encapsulation on iMSG serial interface for the following interface modules: • 1-port OC-48/STM-16 or 4-port OC-12/OC-3 / STM-1/STM-4 + 12-port T1/E1 + 4-port T3/E3 CEM interface module • ASR 900 1-port OC-192 or 8-port Low Rate CEM 20G bandwidth interface module Frame Relay being a streamlined protocol facilitates higher performance and greater efficiency.

Frame Relay is an industry-standard, switched data link layer protocol that handles multiple virtual circuits using encapsulation between connected devices.

Frame Relay provides a packet-switching data communications capability that is used across the interface between user devices (such as routers, bridges, host machines) and network equipment (such as switching nodes). User devices are often referred to as data terminal equipment (DTE), while network equipment that interfaces to DTE is often referred to as data circuit-terminating equipment (DCE). The network providing the Frame Relay interface can be either a carrier-provided public network or a network of privately owned equipment serving a single enterprise.

As an interface between user and network equipment, Frame Relay provides a means for statistically multiplexing many logical data conversations (referred to as virtual circuits) over a single physical transmission link. This contrasts with systems that use only time-division-multiplexing (TDM) techniques for supporting multiple data streams. Frame Relay's statistical multiplexing provides more flexible and efficient use of available bandwidth. It can be used without TDM techniques or on top of channels that are provided by TDM systems.

Frame relay is supported only on the RSP3 module starting with Cisco IOS XE Cupertino 17.8.x release.

Limitations of IPv4 or IPv6 iMSG Pseudowire on Frame Relay Serial Interfaces

- Subinterfaces with point-to-multipoint are not supported. Only point-to-point subinterfaces are supported.
- From release Cisco IOS XE Cupertino 17.9.1 onwards:
    - QoS on serial interface is supported.
    - On frame relay, subinterface operations (for example, shut and no shut) are not supported on HDLC and PPP serial interfaces.
    - CT3-E1 mode is not supported on HDLC and PPP serial interfaces, and you cannot enable frame relay on these interfaces.
    - Due to limitation from the Cisco series 7600 router side, the IPv6 ping fails with encapsulation as Cisco for frame relay.

      For example, consider the following scenario:

      CE1 (7600 router) FR-Encap Cisco-IPv6 <-> FR-Encap Cisco-IPv6 iMSG PE1

      The CE (7600 router) sending IETF packet (having Cisco encapsulation with the IPv6 address) with the format as 0x038E, then the expected packet format to arrive at PE side is 0x86DD.

      However, the IPv6 ping fails with encapsulation as Cisco for frame relay.
- Subinterface number and data-link connection identifier (DLCI) number should be same for local connect and cross connect.
- DTE interface type for frame relay is not supported.
- Local connect is supported with IETF only, and not with CISCO (default).
- Local connect protection is not supported.
- On frame relay subinterface, any functional and maintenance configurations (for example, shut or no shut, or DLCI) aren’t supported.
- The cross connect configuration using the **l2vpn xconnect context xconnect-name** command format isn’t supported.

Scale Supported for iMSG Pseudowire on Frame Relay Serial Interfaces

The following table describes the scale information that is applicable for serial interface (includes both main and subinterface):

Table 9: Scale Supported on iMSG Frame Relay Serial Interfaces

Interface Module/System	Scale Supported
Frame Relay Pseudowire supported per Interface Module	1000
Frame Relay Pseudowire supported per System	4000
Number of DLCI supported per interface	25

Interface Module/System	Scale Supported
Number of DLCI supported per Interface Module	1000
Number of DLCI supported per System	4000

How to Configure IPv4 or IPv6 iMSG Pseudowire on Frame Relay Serial Interface

Modifying Encapsulation to Frame Relay

By default, HDLC is used for encapsulation. You can modify encapsulation to frame relay on a serial interface using the **encapsulation frame-relay** command. You can configure the frame relay encapsulation for the interface as Cisco or IETF. The default encapsulation type for frame relay is Cisco. On the frame relay interface, you can configure interface type and Local Management Interface (LMI) type. With interface type, you can set the interface as Data Communications Equipment (DCE). Though the default option displays as Data Transmission Equipment (DTE), the DTE is not supported. The LMI types that are supported are CISCO, ANSI, and q933A, and the default value is Cisco.

The ***channel-id*** varies based on the mode set and the circuit type.

To modify encapsulation on the serial interface to frame relay, use the following commands:

```
router(config)#interface serial 0/bay/port.channel-id
router(config-if)#no ip address
router(config-if)# encapsulation frame-relay (cisco | ietf)
router(config-if)# frame-relay intf-typedce
router(config-if)# frame-relay lmi-type(cisco | ansi | q033a}
router(config-if)# end
```

Configuring Frame Relay

Configuring Frame Relay for T1 or E1 Serial Interface and Configuring Sub-interface for Serial Interface

```
controller T1 0/4/0
 threshold sd-ber 6
 threshold sf-ber 3
 framing esf
 linecode b8zs
 cablelength short 110
 channel-group 0 timeslots 1-24
 no snmp trap link-status

interface Serial0/4/0.1
 no ip address
 encapsulation frame-relay
 frame-relay lmi-type q933a

interface Serial0/4/0.1/21 point-to-point
```

Configuring Frame Relay for T3 or E3 Serial Interface and Configuring Sub-interface for Serial Interface

```
controller T3 0/4/12
 no snmp trap link-status
 threshold sd-ber 6
 threshold sf-ber 3
 no channelized
 framing c-bit
 cablelength short
 channel-group 0

interface Serial0/4/12.1
 no ip address
 encapsulation frame-relay IETF
 frame-relay lmi-type ansi

interface Serial0/4/12.1/25 point-to-point
```

Configuring Frame Relay for OCx Serial Interface and Configuring Sub-interface for Serial Interface

```
controller SONET 0/4/19
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1
  clock source internal
  mode ct3
  t3 framing c-bit
  t3 clock source internal
  t1 1 channel-group 1 timeslots 1-24
 !
 sts-1 2
  clock source internal
  mode vt-15
  vtg 1 t1 1 channel-group 2 timeslots 1-24
 !
 sts-1 3
  clock source internal
  mode t3
  t3 framing c-bit
  t3 channel-group 0
  t3 clock source internal
interface Serial0/4/19.1
 no ip address
 encapsulation frame-relay
interface Serial0/4/19.1/32 point-to-point
interface Serial0/4/19.29
 no ip address
 encapsulation frame-relay IETF
 frame-relay lmi-type ansi
interface Serial0/4/19.29/33 point-to-point
interface Serial0/4/19.57
 no ip address
 encapsulation frame-relay
 frame-relay lmi-type q933a
interface Serial0/4/19.57/34 point-to-point
```

Configuring Frame Relay for POS Serial Interface and Configuring Sub-interface for Serial Interface

```
controller SONET 0/4/18
 no snmp trap link-status
 rate OC3
 no ais-shut
 alarm-report all
 clock source internal
 !
 sts-1 1 - 3 mode sts-3c
  clock source internal
  overhead c2 207

  channel-group 0
interface Serial0/4/18.1
 no ip address
 encapsulation frame-relay
 pos report pplm
 pos report ptim
interface Serial0/4/18.1/40 point-to-point
```

Configuring Frame Relay for NxDS0 Serial Interface and Configuring Sub-interface for Serial Interface

```
controller T1 0/4/1
 threshold sd-ber 6
 threshold sf-ber 3
 framing esf
 linecode b8zs
 cablelength short 110
 channel-group 4 timeslots 1-10
 no snmp trap link-status

interface Serial0/4/1.1:4
 no ip address
 encapsulation frame-relay

interface Serial0/4/1.1:4/45 point-to-point
```

Configuring L2VPN iMSG Using Local Connect for Frame Relay

Configuring L2VPN iMSG Using IPv4 Local Connect for Frame Relay

Once you configure frame relay and subinterface for serial interface, you can configure L2VPN iMSG local connect.

```
connect <local-connect-keyword> GigabitEthernet slot/bay/port vc-number Serial
slot/bay/port.channel.id/sub-interface-number dlci-number interworking ip
```

Example

```
connect frsub21vlcv4 GigabitEthernet0/0/3 100 Serial0/2/19.1/21 21 interworking ip
```

Configuring L2VPN iMSG Using IPv6 Local Connect for Frame Relay

```
connect <local-connect-keyword> GigabitEthernet slot/bay/port vc-number Serial
slot/bay/port.channel.id/sub-interface-number dlci-number interworking ipv6
```

Example

```
connect frsub21vlcv6 GigabitEthernet0/0/3 150 Serial0/2/19.8/21 21 interworking ipv6
```

Configuring L2VPN iMSG Using Cross Connect for Frame Relay

Ensure that you create pseudowire class template before proceeding to cross connect step for IPv4 and IPv6 L2VPN.

Create Pseudowire Class Template for IPv4 and IPv6

```
pseudowire-class <pseudowire-class-name>
encapsulation mpls
interworking {ip | ipv6}
control-word
```

Example

Create Pseudowire Class Template for IPv4

```
pseudowire-class serial_test
encapsulation mpls
interworking ip
control-word
```

Create Pseudowire Class Template for IPv6

```
pseudowire-class serial_testipv6
encapsulation mpls
interworking ipv6
control-word
```

Configuring L2VPN iMSG Using IPv4 Cross Connect for Frame Relay

Once you configure frame relay and subinterface for serial interface, you can configure L2VPN iMSG cross connect.

The cross connect configuration using the **l2vpn xconnect context xconnect-name** command format is not supported. Ensure that you use the following command format to perform cross connect configuration:

```
connect <cross-connect-keyword> Serial slot/bay/port.channel.id/sub-interface-number
dlci-number  l2transport
xconnect ipv4-address vc-number encapsulation mpls pw-class pw-name
```

Example

```
connect frsub21ipv4 Serial0/2/19.43/21 21 l2transport
 xconnect 10.2.2.2 400 encapsulation mpls pw-class serial_test
```

Configuring L2VPN iMSG Using IPv6 Cross Connect for Frame Relay

```
connect <local-connect-keyword> Serial slot/bay/port.channel.id/sub-interface-number
dlci-number  l2transport
xconnect ipv4-address vc-number encapsulation mpls pw-class pw-name
```

Example

```
connect frsub21ipv6 Serial0/2/19.50/21 21 l2transport
```

```
 xconnect 10.2.2.2 450 encapsulation mpls pw-class serial_testipv6
```

Verifying IPv4 or IPv6 iMSG Pseudowire over Frame Relay Configuration

Use the following **show** commands to verify the frame relay configuration on iMSG pseudowire:

- **show interface Serial** ***<slot/bay/port.channel.id>***
- **show ip interface brief | interface** ***<slot/bay/port.channel.id>***
- **show frame-relay lmi interface Serial** ***<slot/bay/port.channel.id>***
- **show frame-relay pvc interface Serial** ***<slot/bay/port.channel.id>***
- **show xconnect all**
- **show platform software tdm-combo vc info**
- **show mpls l2transport vc <vc-id> detail**

```
Router#show ip interface brief | interface 0/4/16.28
Serial0/4/16.28        unassigned      YES unset  up                    up
Serial0/4/16.28/21     unassigned      YES unset  up                    up

Router#show interface Serial0/4/16.28
Serial0/4/16.28 is up, line protocol is up
  Hardware is A900-IMA3G-IMSG
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 252/255, txload 138/255, rxload 255/255
  Encapsulation FRAME-RELAY IETF, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0, LMI upd recvd 0
  LMI enq recvd 25, LMI stat sent  25, LMI upd sent  0, DCE LMI up
  LMI DLCI 0  LMI type is CCITT  frame relay DCE  segmentation inactive
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input 00:00:02, output 00:00:02, output hang never
  Last clearing of "show interface" counters 00:04:06
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 11661000 bits/sec, 4824731 packets/sec
  5 minute output rate 833000 bits/sec, 554183 packets/sec
     25 packets input, 375 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     1 input errors, 1 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     25 packets output, 400 bytes, 0 underruns
     Output 0 broadcasts (0 IP multicasts)
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
  no alarm present
  VC 7: timeslot(s): 1-24, Transmitter delay 0, non-inverted data

Router#show frame-relay lmi interface Serial0/4/16.28

LMI Statistics for interface Serial0/4/16.28 (Frame Relay DCE) LMI TYPE = CCITT
  Invalid Unnumbered info 0  Invalid Prot Disc 0
  Invalid dummy Call Ref 0  Invalid Msg Type 0
  Invalid Status Message 0  Invalid Lock Shift 0
  Invalid Information ID 0  Invalid Report IE Len 0
  Invalid Report Request 0  Invalid Keep IE Len 0
  Num Status Enq. Rcvd 17  Num Status msgs Sent 17
  Num Update Status Sent 0  Num St Enq. Timeouts 0


Router#show frame-relay pvc interface Serial0/4/16.28

PVC Statistics for interface Serial0/4/16.28 (Frame Relay DCE)

              Active     Inactive      Deleted       Static
  Local          0            0            0            0
  Switched       1            0            0            0
  Unused         0            0            0            0

DLCI = 21, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE = Serial0/4/16.28/21

  input pkts 0             output pkts 0            in bytes 0
  out bytes 0              dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 0          FECNs set 0              BECNs set 0
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 0           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  connected to pseudowire 10.3.3.3 vcid 700, interworking IP
  pvc create time 00:02:03, last time pvc status changed 00:01:45


Router#show xconnect all
Legend:    XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
  UP=Up       DN=Down            AD=Admin Down      IA=Inactive
  SB=Standby  HS=Hot Standby     RV=Recovering      NH=No Hardware

XC ST  Segment 1                         S1 Segment 2                         S2
------+---------------------------------+--+---------------------------------+--
UP pri   ac Se0/4/16.28/21:21(FR DLCI)   UP mpls 10.3.3.3:700                  UP



Router#show platform software tdm-combo vc info
Media:    Path:                         AUG:   Mode:         Channel:  VC:  Timeslots:
 Serial-Interface:
SONET     SONET 0/4/16.1/7/4            NONE   VT1.5         1         7    1-24
 Serial0/4/16.28
 TOTAL ENTRIES :1


Router#sh mpls l2transport vc 700 detail
Local interface: Se0/4/16.28/21 up, line protocol up, FR DLCI 21 up
  Interworking type is IP
  Destination address: 10.3.3.3, VC ID: 700, VC status: up
    Output interface: Gi0/3/0, imposed label stack {17}
    Preferred path: not configured
    Default path: active
    Next hop: 209.165.200.225
  Create time: 00:00:45, last status change time: 00:00:44
    Last label FSM state change time: 00:00:45
  Signaling protocol: LDP, peer 10.3.3.3:0 up
    Targeted Hello: 10.2.2.2(LDP Id) -> 10.3.3.3, LDP is UP
    Graceful restart: configured and not enabled
    Non stop routing: configured and enabled
    Status TLV support (local/remote)   : enabled/supported
      LDP route watch                   : enabled
      Label/status state machine        : established, LruRru
      Last local dataplane   status rcvd: No fault
      Last BFD dataplane     status rcvd: Not sent
      Last BFD peer monitor  status rcvd: No fault
      Last local AC  circuit status rcvd: No fault
      Last local AC  circuit status sent: No fault
      Last local PW i/f circ status rcvd: No fault
      Last local LDP TLV     status sent: No fault
      Last remote LDP TLV    status rcvd: No fault
      Last remote LDP ADJ    status rcvd: No fault
    MPLS VC labels: local 16, remote 17
    Group ID: local 71, remote 9
    MTU: local 1500, remote 1500
    Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On
  SSO Descriptor: 10.3.3.3/700, local label: 16
  Dataplane:
    SSM segment/switch IDs: 4103/4102 (used), PWID: 2
  VC statistics:
    transit packet totals: receive 0, send 0
    transit byte totals:   receive 0, send 0
    transit packet drops:  receive 0, seq error 0, send 0
```

Configuring Frame Relay for APS Protection

Configuring APS on Frame Relay Serial Interface and Configuring Subinterface for Serial Interface

```
controller SONET-ACR 10
 !
 sts-1 1
  mode vt-15
  vtg 1 t1 1 channel-group 1 timeslots 1-24
 !
 sts-1 2

 !
 sts-1 3

interface SERIAL-ACR10.1
 no ip address
 encapsulation frame-relay

interface SERIAL-ACR10.1/21 point-to-point
```

Configuring Frame Relay for UPSR Protection

Configuring UPSR on Frame Relay Serial Interface and Configuring Subinterface for Serial Interface

```
controller protection-group 20
 type vt1.5
 channel-group 20 timeslots 1-24
!

interface Serial-PG20.20
 no ip address
 encapsulation frame-relay
```

```
!
interface Serial-PG20.20/39 point-to-point
```

Configuring Frame Relay L2VPN iMSG for APS Protection

Configuring Frame Relay L2VPN iMSG Using Cross Connect on ACR Interface - APS

```
connect frsubacripv4 SERIAL-ACR10.1/21 21 l2transport
xconnect 10.2.2.2 402 encapsulation mpls pw-class serial_test
```

Configuring Frame Relay L2VPN iMSG for UPSR Protection

Configuring Frame Relay L2VPN iMSG Using Cross Connect on ACR Interface - UPSR

```
connect frsubupsripv4 Serial-PG20.20/39 39 l2transport
xconnect 10.2.2.2 403 encapsulation mpls pw-class serial_test
```

Verifying Frame Relay for APS Protection

```
Router#show ip interface brief | in ACR10
SERIAL-ACR10.1         unassigned      YES unset  up                    down
SERIAL-ACR10.1/21      unassigned      YES unset  down                  down


Router#show interface SERIAL-ACR10.1
SERIAL-ACR10.1 is up, line protocol is down
  Hardware is N/A
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  63, LMI stat recvd 0, LMI upd recvd 0, DTE LMI down
  LMI enq recvd 0, LMI stat sent  0, LMI upd sent  0
  LMI DLCI 1023  LMI type is CISCO  frame relay DTE
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input never, output 00:00:04, output hang never
  Last clearing of "show interface" counters 00:10:34
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     Output 0 broadcasts (0 IP multicasts)
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
  alarm present
  VC 1: timeslot(s): 1-24, Transmitter delay 0, non-inverted data


Router#show frame-relay lmi | beg SERIAL-ACR10.1
LMI Statistics for interface SERIAL-ACR10.1 (Frame Relay DTE) LMI TYPE = CISCO
  Invalid Unnumbered info 0                        Invalid Prot Disc 0
  Invalid dummy Call Ref 0                             Invalid Msg Type 0
  Invalid Status Message 0                            Invalid Lock Shift 0
  Invalid Information ID 0                              Invalid Report IE Len 0
  Invalid Report Request 0                            Invalid Keep IE Len 0
  Num Status Enq. Sent 75                            Num Status msgs Rcvd 0
  Num Update Status Rcvd 0                        Num Status Timeouts 74

Router#show platform software tdm-combo vc info  | in ACR
SONET     SONET-ACR 10.1/1/1            NONE   VT1.5         1         2    1-24
 SERIAL-ACR10.1

Router#show xconnect all | in ACR
DN pri   ac SE-ACR10.1/21:21(FR DLCI)    DN mpls 10.2.2.2:402                  DN

Router#show mpls l2transport vc 402 detail
Local interface: SE-ACR10.1/21 down, line protocol down, FR DLCI 21 down
  Interworking type is IP
  Destination address: 10.2.2.2, VC ID: 402, VC status: down
    Last error: Local peer access circuit is down
    Output interface: none, imposed label stack {}
    Preferred path: not configured
    Default path: no route
    No adjacency
  Create time: 00:09:32, last status change time: 00:09:32
    Last label FSM state change time: 00:09:32
  Signaling protocol: LDP, peer unknown
    Targeted Hello: 10.1.1.1(LDP Id) -> 10.2.2.2, LDP is DOWN, no binding
    Graceful restart: not configured and not enabled
    Non stop routing: not configured and not enabled
    Status TLV support (local/remote)   : enabled/None (no remote binding
      LDP route watch                   : enabled
      Label/status state machine        : local standby, AC-ready, LndRnd
      Last local dataplane   status rcvd: No fault
      Last BFD dataplane     status rcvd: Not sent
      Last BFD peer monitor  status rcvd: No fault
      Last local AC  circuit status rcvd: DOWN AC(rx/tx faults)
      Last local AC  circuit status sent: DOWN(not-forwarding)
      Last local PW i/f circ status rcvd: No fault
      Last local LDP TLV     status sent: No status
      Last remote LDP TLV    status rcvd: None (no remote binding)
      Last remote LDP ADJ    status rcvd: None (no remote binding)
    MPLS VC labels: local 16, remote unassigned
    Group ID: local 57, remote unknown
    MTU: local 1500, remote unknown
    Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On
  SSO Descriptor: 10.2.2.2/402, local label: 16
  Dataplane:
    SSM segment/switch IDs: 0/0 (used), PWID: 1
  VC statistics:
    transit packet totals: receive 0, send 0
    transit byte totals:   receive 0, send 0
    transit packet drops:  receive 0, seq error 0, send 0
```

Verifying Frame Relay for UPSR Protection

```
Router#show ip interface brief | in PG20
Serial-PG20.20         unassigned      YES unset  down                  down
Serial-PG20.20/39      unassigned      YES unset  down                  down
```

```
Router#show interface Serial-PG20.20
Serial-PG20.20 is down, line protocol is down
  Hardware is NCS4200-3GMS
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 128/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0, LMI upd recvd 0, DTE LMI down
  LMI enq recvd 0, LMI stat sent  0, LMI upd sent  0
  LMI DLCI 1023  LMI type is CISCO  frame relay DTE
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input never, output never, output hang never
  Last clearing of "show interface" counters 00:09:23
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     Output 0 broadcasts (0 IP multicasts)
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

```
Router#show frame-relay lmi | beg Serial-PG20.20
LMI Statistics for interface Serial-PG20.20 (Frame Relay DTE) LMI TYPE = CISCO
  Invalid Unnumbered info 0                        Invalid Prot Disc 0
  Invalid dummy Call Ref 0                             Invalid Msg Type 0
  Invalid Status Message 0                             Invalid Lock Shift 0
  Invalid Information ID 0                               Invalid Report IE Len 0
  Invalid Report Request 0                             Invalid Keep IE Len 0
  Num Status Enq. Sent 0                               Num Status msgs Rcvd 0
  Num Update Status Rcvd 0                         Num Status Timeouts 0
```

```
Router#show platform software tdm-combo vc info  | in PG
SONET     SONET 0/4/17.1/1/1            NONE   VT1.5         20        3    1-24
 Serial-PG20.20
```

```
Router#show xconnect all | in PG
DN pri   ac Se-PG20.20/39:39(FR DLCI)    DN mpls 10.2.2.2:403                  DN
```

```
Router#show mpls l2transport vc 403 detail
Local interface: Se-PG20.20/39 down, line protocol down, FR DLCI 39 down
  Interworking type is IP
  Destination address: 10.2.2.2, VC ID: 403, VC status: down
    Last error: Local peer access circuit is down
    Output interface: none, imposed label stack {}
    Preferred path: not configured
    Default path: no route
    No adjacency
  Create time: 00:09:27, last status change time: 00:09:27
    Last label FSM state change time: 00:09:27
  Signaling protocol: LDP, peer unknown
    Targeted Hello: 10.1.1.1(LDP Id) -> 10.2.2.2, LDP is DOWN, no binding
    Graceful restart: not configured and not enabled
```

```
      Non stop routing: not configured and not enabled
      Status TLV support (local/remote)   : enabled/None (no remote binding
        LDP route watch                   : enabled
        Label/status state machine        : local standby, AC-ready, LndRnd
        Last local dataplane   status rcvd: No fault
        Last BFD dataplane     status rcvd: Not sent
        Last BFD peer monitor  status rcvd: No fault
        Last local AC  circuit status rcvd: DOWN AC(rx/tx faults)
        Last local AC  circuit status sent: DOWN(not-forwarding)
        Last local PW i/f circ status rcvd: No fault
        Last local LDP TLV     status sent: No status
        Last remote LDP TLV    status rcvd: None (no remote binding)
        Last remote LDP ADJ    status rcvd: None (no remote binding)
      MPLS VC labels: local 17, remote unassigned
      Group ID: local 62, remote unknown
      MTU: local 1500, remote unknown
      Remote interface description:
    Sequencing: receive disabled, send disabled
    Control Word: On
    SSO Descriptor: 10.2.2.2/403, local label: 17
    Dataplane:
      SSM segment/switch IDs: 0/0 (used), PWID: 2
    VC statistics:
      transit packet totals: receive 0, send 0
      transit byte totals:   receive 0, send 0
      transit packet drops:  receive 0, seq error 0, send 0
```

Scenario 1–Configure L2VPN iMSG Using Local Connect for Frame Relay

Consider a cross connect scenario with the following frame relay configurations on serial interface Serial0/4/16.28:

- Frame relay encapsulation type is set to IETF
- Frame relay LMI type is set to ANSI

Configure T3 Interface

```
controller T3 0/4/12
 no snmp trap link-status
 threshold sd-ber 6
 threshold sf-ber 3
 no channelized
 framing c-bit
 cablelength short
 channel-group 0
```

Configure Serial Interface for Frame Relay and Create Sub Interface

```
interface Serial0/4/12.1
 no ip address
 encapsulation frame-relay IETF
 frame-relay lmi-type ansi
interface Serial0/4/12.1/25 point-to-point
```

Configure L2VPN iMSG Using Local Connect for Frame Relay

```
connect frsub21vlcv4 GigabitEthernet0/0/3 100 Serial0/4/12.1/25 21 interworking ip
```

Verify Frame Relay Configuration on iMSG Pseudowire

```
Router#show interface Serial0/4/12.1
Serial0/4/12.1 is up, line protocol is up
  Hardware is A900-IMA3G-IMSG
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 252/255, txload 138/255, rxload 255/255
  Encapsulation FRAME-RELAY IETF, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0, LMI upd recvd 0
  LMI enq recvd 25, LMI stat sent  25, LMI upd sent  0, DCE LMI up
  LMI DLCI 0  LMI type is CCITT  frame relay DCE  segmentation inactive
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input 00:00:02, output 00:00:02, output hang never
  Last clearing of "show interface" counters 00:04:06
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 11661000 bits/sec, 4824731 packets/sec
  5 minute output rate 833000 bits/sec, 554183 packets/sec
     25 packets input, 375 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     1 input errors, 1 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     25 packets output, 400 bytes, 0 underruns
     Output 0 broadcasts (0 IP multicasts)
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
  no alarm present
  VC 7: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
```

Scenario 2–Configure L2VPN iMSG Using Cross Connect for Frame Relay

Consider a cross connect scenario with the following frame relay configurations on serial interface Serial0/4/16.28:

- Frame relay encapsulation type is set to IETF
- Frame relay LMI type is set to q933a
- Frame relay interface type is set to DCE

Configure T1 Interface

```
controller T1 0/4/16
 threshold sd-ber 6
 threshold sf-ber 3
 framing esf
 linecode b8zs
 cablelength short 110
 channel-group 0 timeslots 1-24
 no snmp trap link-status
```

Configure Serial Interface for Frame Relay and Create Sub Interface

```
interface Serial0/4/16.28
 no ip address
 encapsulation frame-relay IETF
 ipv6 enable
 frame-relay lmi-type q933a
 frame-relay intf-type dce
interface Serial0/4/16.28/21 point-to-point
```

Create Pseudowire Class Template for IPv6

```
pseudowire-class serial_testipv6
encapsulation mpls
interworking ipv6
control-word
```

Configure L2VPN iMSG Using Cross Connect for Frame Relay

```
connect test Serial0/4/16.28/21 21 l2transport
 xconnect 10.3.3.3 700 encapsulation mpls pw-class serial_testipv6
```

Verify Frame Relay Configuration on iMSG Pseudowire

```
Router#show interface Serial0/4/16.28
Serial0/4/16.28 is up, line protocol is up
  Hardware is A900-IMA3G-IMSG
  MTU 1500 bytes, BW 1536 Kbit/sec, DLY 20000 usec,
     reliability 252/255, txload 138/255, rxload 255/255
  Encapsulation FRAME-RELAY IETF, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0, LMI upd recvd 0
  LMI enq recvd 25, LMI stat sent  25, LMI upd sent  0, DCE LMI up
  LMI DLCI 0  LMI type is CCITT  frame relay DCE  segmentation inactive
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input 00:00:02, output 00:00:02, output hang never
  Last clearing of "show interface" counters 00:04:06
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 11661000 bits/sec, 4824731 packets/sec
  5 minute output rate 833000 bits/sec, 554183 packets/sec
     25 packets input, 375 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     1 input errors, 1 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     25 packets output, 400 bytes, 0 underruns
     Output 0 broadcasts (0 IP multicasts)
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
  no alarm present
  VC 7: timeslot(s): 1-24, Transmitter delay 0, non-inverted data


Router#show frame-relay lmi interface Serial0/4/16.28

LMI Statistics for interface Serial0/4/16.28 (Frame Relay DCE) LMI TYPE = CCITT
  Invalid Unnumbered info 0  Invalid Prot Disc 0
  Invalid dummy Call Ref 0  Invalid Msg Type 0
  Invalid Status Message 0  Invalid Lock Shift 0
  Invalid Information ID 0  Invalid Report IE Len 0
  Invalid Report Request 0  Invalid Keep IE Len 0
  Num Status Enq. Rcvd 17  Num Status msgs Sent 17
  Num Update Status Sent 0  Num St Enq. Timeouts 0
```

```
Router#show xconnect all
Legend:    XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
  UP=Up       DN=Down            AD=Admin Down      IA=Inactive
  SB=Standby  HS=Hot Standby     RV=Recovering      NH=No Hardware

XC ST  Segment 1                         S1 Segment 2                         S2
------+---------------------------------+--+----------------------------------+--
UP pri   ac Se0/4/16.28/21:21(FR DLCI)   UP mpls 10.3.3.3:700                  UP
```

IPv4 Layer 3 Termination on HDLC or PPP Serial Interfaces

IPv4 Layer 3 Termination on HDLC or PPP Serial Interfaces

Starting with Cisco IOS XE 16.11.x release, you can perform IPv4 Layer 3 termination on HDLC or PPP serial interfaces for RSP3 module on the Cisco ASR 900 Series 4-Port OC3/STM-1 or 1-Port OC12/STM-4 Module (A900-IMA3G-IMSG).

IPv4 routing can be performed using standard routing protocols such as OSPF, BGP, IS-IS, EIGRP, and RIP.

A maximum of 1020 serial interfaces are supported on the Cisco RSP3 module.

This feature supports MPLS IP.

Restrictions for IPv4 Layer 3 Termination on HDLC or PPP Serial Interfaces

- Multicast and QoS features are not supported.
- Frame-relay is not supported.
- BFD is not supported on serial interfaces.
- IPv6 is not supported for layer 3 termination.

How to Configure IPv4 Layer 3 Termination on HDLC or PPP Serial Interfaces

Configuring Protocols

Configuring Routing Protocol

You should configure routing protocols such as OSPF, BGP, IS-IS, EIGRP, and RIP.

For more information on configuring IP Routing protocols, refer the respective Guides:

https://www.cisco.com/c/en/us/support/ios-nx-os-software/ios-xe-3s/products-installation-and-configuration-guides-list.html

Configuring Layer 3 VPN

To configure Layer 3 VPN, refer the MPLS Virtual Private Networks chapter in the MPLS: Layer 3 VPNs Configuration Guide.

Configuring VRF

Before configuring IPv4 Layer 3 flow on a serial interface, ensure that you have configured VRF forwarding. For more information, refer Configuring VFR.

VRF-lite is a feature that enables a service provider to support two or more VPNs, where IP addresses can be overlapped among the VPNs. VRF-lite uses input interfaces to distinguish routes for different VPNs and forms virtual packet-forwarding tables by associating one or more Layer 3 interfaces with each VRF.

With the VRF-lite feature, the router supports multiple VPN routing or forwarding instances in customer edge devices. VRF-lite allows a service provider to support two or more VPNs with overlapping IP addresses using one interface.

To configure VRF, enter the following commands:

```
router#configure terminal
router(config)#vrf definition vrf_test
router(config-vrf)#rd 1:1
router(config-vrf)#address-family ipv4
```

Once VRF is configured, ensure that you specify the Layer 3 interface to be associated with the VRF and then associate the VRF with the Layer 3 interface using the **vrf forwarding vrf-name** command. The interface can be a routed port or SVI.

To configure VRF forwarding, enter the following commands:

```
router#configure terminal
router (config-vrf)# interface interface-id
router (config-if)#vrf forwarding vrf-name
```

Configuring IPv4 Unicast Layer 3 Termination on HDLC or PPP Interfaces

You can enable or disable IPv4 Layer 3 flow on HDLC or PPP serial interfaces. You can use the **vrf forwarding <vrf name>** command optionally on the serial interface.

You can also modify the default MTU 1500 bytes optionallyusing the **mtu** command.

To enable IPv4 Layer 3 flow on a serial interface, enter the following commands:

```
router(config)#interface serial x/y/z.channel-id
router(config-if)#vrf forwarding <vrf name> (optional)
router(config-if)#ip address <ipv4 address> <mask>/<ip address>
router(config-if)#mtu <bytes>
```

To disable IPv4 Layer 3 flow on a serial interface, enter the no form of the command:

```
router(config)#interface serial x/y/z.channel-id
router(config-if)#vrf forwarding <vrf name>
router(config-if)#no ip address <ipv4 address> <mask>/<ip address>
```

```
router(config)#interface serial x/y/z.channel-id
router(config-if)#no vrf forwarding <vrf name>
```

Verifying IPv4 Layer 3 Termination on HDLC or PPP

The following **show interface serial** *0/bay/port.vc-number* command displays information about PPP encapsulation and statistics of a serial interface.

To display configuration information on the serial interface, use the **show interface serial** command:

```
Router# show interface serial 0/5/16.1
 Serial0/5/16.1 is up, line protocol is up
  Hardware is A900RSP2A-128
  Internet address is 172.16.0.1/24
  MTU 1500 bytes, BW 44210 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:03, output 00:00:02, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 76000 bits/sec, 298 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     99332 packets input, 983489 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     62 packets output, 4832 bytes, 0 underruns
     0 output errors, 0 collisions, 3 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
  no alarm present
  DSU mode 0, bandwidth 0 Kbit, scramble 0, VC 3, non-inverted data
```

QoS Support on Serial Interfaces

Table 10: Feature History

Feature Name	Release Information	Description
QoS Support on Serial Interfaces	Cisco IOS XE Cupertino 17.9.1	QoS is supported on serial interfaces. You can apply service policies on egress of L3 terminated serial interfaces with both HDLC and PPP encapsulation. By implementing QoS policies on serial interfaces you can shape, classify, or prioritize the data.

Starting with Cisco IOS XE Cupertino 17.9.1 release, you can apply QoS policy on Layer 3 terminated serial interfaces on HDLC and PPP serial interfaces for RSP3 module on the following interface modules:

- 1-port OC481/ STM-16 or 4-port OC-12/OC-3 / STM-1/STM-4 + 12-Port T1/E1 + 4-Port T3/E3 CEM (A900-IMA3G-IMSG)

- ASR 900 1-port OC-192 or 8-port low rate CEM 20G bandwidth (A900-IMA1Z8S-CXMS)

QoS support on serial interfaces offers the following:

- Egress classification—Classifies packets with qos-group
- Egress shaping—Classifies bandwidth rate
- Egress CBWFQ—Actions bandwidth, BRR or BRP, and shape
- Egress LLQ—Two-level priority and shaping
- Egress WRED—Discard-class-based
- Queue limit—In bytes and micro seconds

Creating QoS Classification

The following examples explain the QoS support on serial interfaces.

Configuring QoS class-map

QoS is supported based on precedence field of the IP header, hence 0–7 qos-groups.

```
class-map match-any qos-group0
 match qos-group 0
class-map match-any qos-group1
 match qos-group 1
class-map match-any qos-group2
 match qos-group 2
class-map match-any qos-group3
 match qos-group 3
class-map match-any qos-group4
 match qos-group 4
class-map match-any qos-group5
 match qos-group 5
class-map match-any qos-group6
 match qos-group 6
class-map match-any qos-group7
 match qos-group 7
```

Configuring QoS policy-map

```
policy-map l3egressqos-groupbrp
 class qos-group0
 class qos-group1
 class qos-group2
 class qos-group3
 class qos-group4
 class qos-group5
 class qos-group6
 class qos-group7
```

Configuring L3 Egress QoS Group

```
router(config)#interface Serial0/7/19.1
router(config-if)#service-policy output l3egressqos-groupbrp
router(config-if)#end
```

Enabling the SDM template

```
router(config)# sdm prefer enable_egr_l3vpn_cm
```

Starting with Cisco IOS XE 17.14.1 release, you must enable the **egr_l3vpn_cm** template before attaching a policy map to an interface.

For the SDM template to take effect, restart the router.

Configuring Shaping

```
policy-map l3egressqos-groupbrp
class qos-group0
             shape average 384000
class qos-group1
             shape average 384000
class qos-group2
             shape average 384000
```

Configuring Bandwidth

```
policy-map l3egressqos-groupbrp
class qos-group0
             bandwidth percent 10
class qos-group1
             bandwidth percent 10
class qos-group2
 bandwidth percent 20
```

Configuring BRP

```
policy-map l3egressqos-groupbrp
class qos-group0
             bandwidth remaining percent 10
class qos-group1
             bandwidth remaining percent 20
class qos-group2
             bandwidth remaining percent 30
```

Configuring BRR

```
policy-map l3egressqos-groupbrp
class qos-group0
             bandwidth remaining ratio 10
class qos-group1
             bandwidth remaining ratio 20
class qos-group2
 bandwidth remaining ratio 30
```

Configuring Priority

```
policy-map l3egressqos-groupbrp
class qos-group0
             priority

/* Priority Percent */
policy-map l3egressqos-groupbrp
class qos-group0
             priority percent 40
```

Configuring WRED

```
class-map match-all qos1
 match qos-group 1

policy-map egress
  class qos1
  shape average 100000000
  queue-limit 300 us
  random-detect discard-class-based
```

```
random-detect discard-class 0 100 us 200 us 100
random-detect discard-class 1 200 us 300 us 100
```

Limitation

- On serial interfaces, for Bandwidth Remaining Percent or Ratio (BRP/BRR):
  - Mixed bandwidth types aren't supported. Always configure the bandwidth command in kbps, percent, remaining percent or remaining ratio but not in mixed.
  - Priority isn't allowed with the bandwidth.
  - When the parent bandwidth is between 384 kbps to 391 kbps: You must reserve a minimum of 15% bandwidth for class-default on T1 interface.
  - When the parent bandwidth is greater than 391 kbps: You must reserve a minimum of 5% bandwidth for class-default on T1 interface.