



MPLS-Multilink PPP Support

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The MPLS--Multilink PPP Support feature ensures that MPLS Layer 3 Virtual Private Networks (VPNs) with quality of service (QoS) can be enabled for bundled links. This feature supports Multiprotocol Label Switching (MPLS) over Multilink PPP (MLP) links in the edge (provider edge [PE]-to-customer edge [CE]) or in the MPLS core (PE-to-PE and PE-to-provider router [P]).

Service providers that use relatively low-speed links can use MLP to spread traffic across them in their MPLS networks. Link fragmentation and interleaving (LFI) should be deployed in the CE-to-PE link for efficiency, where traffic uses a lower link bandwidth (less than 768 kbps).

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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for MPLS--Multilink PPP Support

The MPLS--Multilink PPP Support feature requires the following:



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- Cisco Express Forwarding or distributed Cisco Express Forwarding enabled
- MPLS enabled on PE and P routers
- Cisco Express Forwarding switching enabled on the interface with the **ip route-cache cef** command

The first table below lists the required port adapters and processors for the MPLS--Multilink PPP Support feature on the Cisco 7200 series routers. The second table below lists the required port adapters and processors for the MPLS--Multilink PPP Support feature on the Cisco 7500 series routers.

Table 1 *Required Cisco 7200 Port Adapters and Processors for MPLS--Multilink PPP Support*

Port Adapter	Processor
PA-4T+	Network processing engine models
PA-8T	<ul style="list-style-type: none"> • NPE-400
Channelized adapters	<ul style="list-style-type: none"> • NPE-G1 • NSE-1
<ul style="list-style-type: none"> • PA-MC-2E1/120 • PA-MC-2T1 • PA-MC-2T3+ • PA-MC-4T1 • PA-MC-8E1/120 • PA-MC-8T1 • PA-MC-E3 • PA-MC-STM-1MM • PA-MC-STM-1SMI • PA-MC-T3 • PA-MC-8TE1+ 	

Table 2 *Required Cisco 7500 Port Adapters and Processors for MPLS--Multilink PPP Support*

Port Adapter	Processor
PA-4T+	Route Switch Processors
PA-8T	<ul style="list-style-type: none"> • RSP16
Channelized adapters	<ul style="list-style-type: none"> • RSP8 • RSP4+
<ul style="list-style-type: none"> • PA-MC-2E1/120 • PA-MC-2T1 • PA-MC-2T3+ • PA-MC-4T1 • PA-MC-8E1/120 • PA-MC-8T1 • PA-MC-E3 • PA-MC-STM-1MM • PA-MC-STM-1SMI • PA-MC-T3 • PA-MC-8TE1+ 	Versatile interface processors <ul style="list-style-type: none"> • VIP4-50 • VIP4-80 • VIP6-80

Restrictions for MPLS--Multilink PPP Support

The MPLS--Multilink PPP Support feature is limited by platform-specific restrictions that apply to the use of MLP and distributed MLP (dMLP).

For restrictions that apply to dMLP on the Cisco 7500 routers, see the Distributed Multilink Point-to-Point Protocol for Cisco 7500 Series Routers feature module.

Information About MPLS--Multilink PPP Support

- [MPLS Features Supported for Multilink PPP, page 3](#)
- [MPLS--Multilink PPP Support and PE-to-CE Links, page 5](#)
- [MPLS--Multilink PPP Support and Core Links, page 6](#)
- [MPLS--Multilink PPP Support in a CSC Network, page 6](#)
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MPLS Features Supported for Multilink PPP

The following topics provide information about MPLS features supported for MLP:

- [MPLS Layer 3 Virtual Private Network Features Supported for Multilink PPP, page 3](#)
- [MPLS Quality of Service Features Supported for Multilink PPP, page 4](#)

MPLS Layer 3 Virtual Private Network Features Supported for Multilink PPP

The table below lists MPLS Layer 3 VPN features supported for MLP and indicates if the feature is supported on CE-to-PE links, PE-to-P links, and Carrier Supporting Carrier (CSC) CE-to-PE links.

Table 3 *MPLS Layer 3 VPN Features Supported for MLP*

MPLS L3 VPN Feature	CE-to-PE Links	PE-to-P Links	CSC CE-to-PE Links
Static routes	Supported	-- ¹	--
External Border Gateway Protocol (eBGP)	Supported	Not applicable to this configuration	Supported
Intermediate System-to-Intermediate System (IS-IS)	--	Supported	--
Open Shortest Path first (OSPF)	Supported	Supported	--

¹ An em dash (--) indicates that the configuration is not supported.

MPLS L3 VPN Feature	CE-to-PE Links	PE-to-P Links	CSC CE-to-PE Links
Enhanced Interior Gateway Routing Protocol (EIGRP)	Supported	Supported	--
Interprovider (Inter-AS) VPNs (with Label Distribution Protocol [LDP])	Not applicable to this configuration	Supported (MLP between Autonomous System Border routers {ASBRs})	Not applicable to this configuration
Inter-AS VPNs with IPv4 Label Distribution	Not applicable to this configuration	Supported (MLP between ASBRs)	Not applicable to this configuration
CSC VPNs (with LDP)	--	Not applicable to this configuration	Supported
CSC VPNs with IPv4 label distribution	Supported	Not applicable to this configuration	Supported
External and internal BGP (eBGP) Multipath	--	--	Not applicable to this configuration
Internal BGP (iBGP) Multipath	Not applicable to this configuration	--	Not applicable to this configuration
eBGP Multipath	--	--	--

MPLS Quality of Service Features Supported for Multilink PPP

The table below lists the MPLS QoS features supported for MLP and indicates if the feature is supported on CE-to-PE links, PE-to-P links, and CSC-CE-to-CSC-PE links.

Table 4 MPLS QoS Features Supported for MLP

MPLS QoS Feature	CE-to-PE Links	PE-to-P Links	CSC-CE-to-PE Links
Default copy of IP Precedence to EXP bits and the reverse	Supported	-- ²	--
Set MPLS EXP bits using the modular QoS Command-Line Interface (MQC)	Supported	Supported	Supported
Matching on MPLS EXP using MQC	Supported	Supported	Supported

² An em dash (--) indicates that the configuration is not supported.

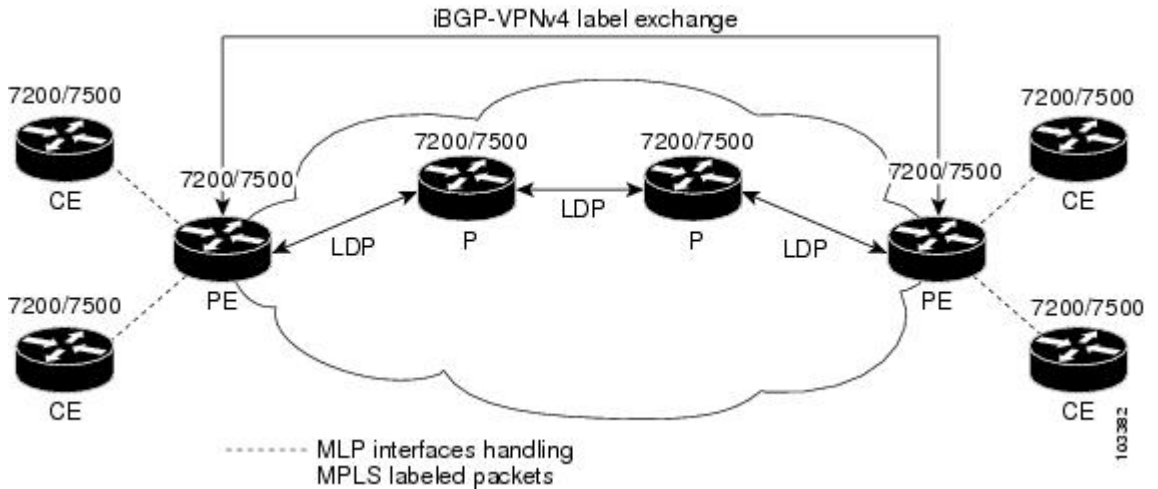
MPLS QoS Feature	CE-to-PE Links	PE-to-P Links	CSC-CE-to-PE Links
Low Latency Queueing (LLQ)/ Class-Based Weighted Fair Queueing (CBWFQ) support	Supported	Supported	Supported
Weighted Random Early Detection (WRED) based on EXP bits using MQC	Supported	Supported	Supported
Policer with EXP bit-marking using MQC-3 action	Supported	Supported	Supported
Support for EXP bits in MPLS accounting	Supported	Supported	Supported

MPLS--Multilink PPP Support and PE-to-CE Links

The figure below shows a typical MPLS network in which the PE router is responsible for label imposition (at ingress) and disposition (at egress) of the MPLS traffic.

In this topology, MLP is deployed on the PE-to-CE links. The VPN routing and forwarding instance (VRF) interface is in a multilink bundle. There is no MPLS interaction with MLP; all packets coming into the MLP bundle are IP packets.

Figure 1 *MLP and Traditional PE-to-CE Links*



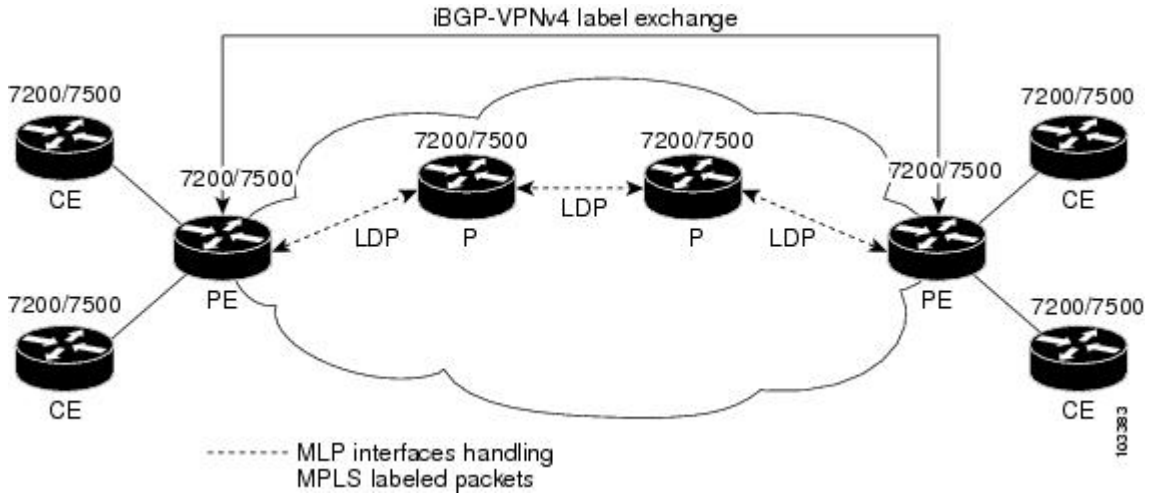
The PE-to-CE routing protocols that are supported for the MPLS--Multilink PPP Support feature are eBGP, OSPF, and EIGRP. Static routes are also supported between the CE and PE routers.

QoS features that are supported for the MPLS--Multilink PPP Support feature on CE-to-PE links are LFI, compressed Real-Time Transport Protocol (cRTP), policing, marking, and classification.

MPLS--Multilink PPP Support and Core Links

The figure below shows a sample topology in which MPLS is deployed over MLP on PE-to-P and P-to-P links. Enabling MPLS on MLP for PE-to-P links is similar to enabling MPLS on MLP for P-to-P links.

Figure 2 *MLP on PE-to-P and P-to-P Links*



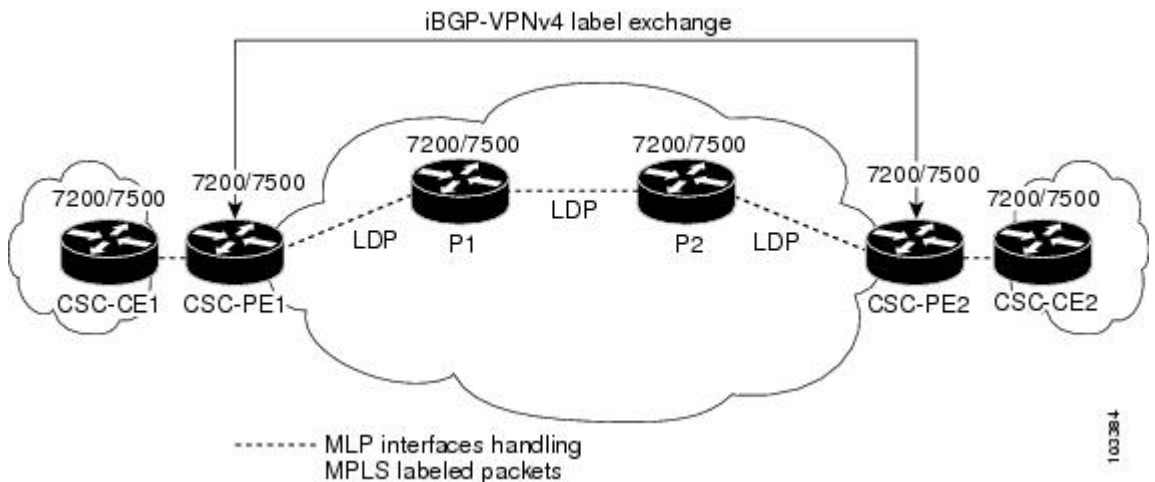
You employ MLP in the PE-to-P or P-to-P links primarily so that you can reduce the number of Interior Gateway Protocol (IGP) adjacencies and facilitate the load sharing of traffic.

In addition to requiring MLP on the PE-to-P links, the MPLS--Multilink PPP Support feature requires the configuration of an IGP routing protocol and LDP.

MPLS--Multilink PPP Support in a CSC Network

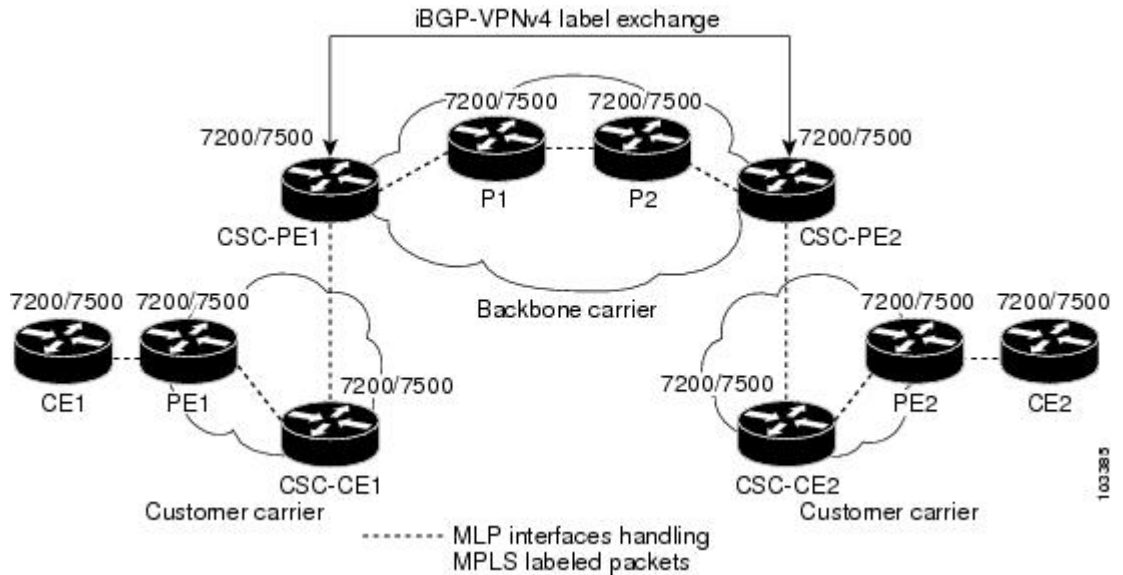
The figure below shows a typical MPLS VPN CSC network where MLP is configured on the CSC-CE-to-CSC-PE links.

Figure 3 *MLP on CSC-CE-to-CSC-PE Links with MPLS VPN Carrier Supporting Carrier*



The MPLS--Multilink PPP Support feature supports MLP between CSC-CE and CSC-PE links with LDP or with EBGp IPv4 label distribution. This feature also supports LFI for an MPLS VPN CSC configuration. The figure below shows all MLP links that this feature supports for CSC configurations.

Figure 4 *MLP Supported Links with MPLS VPN Carrier Supporting Carrier*

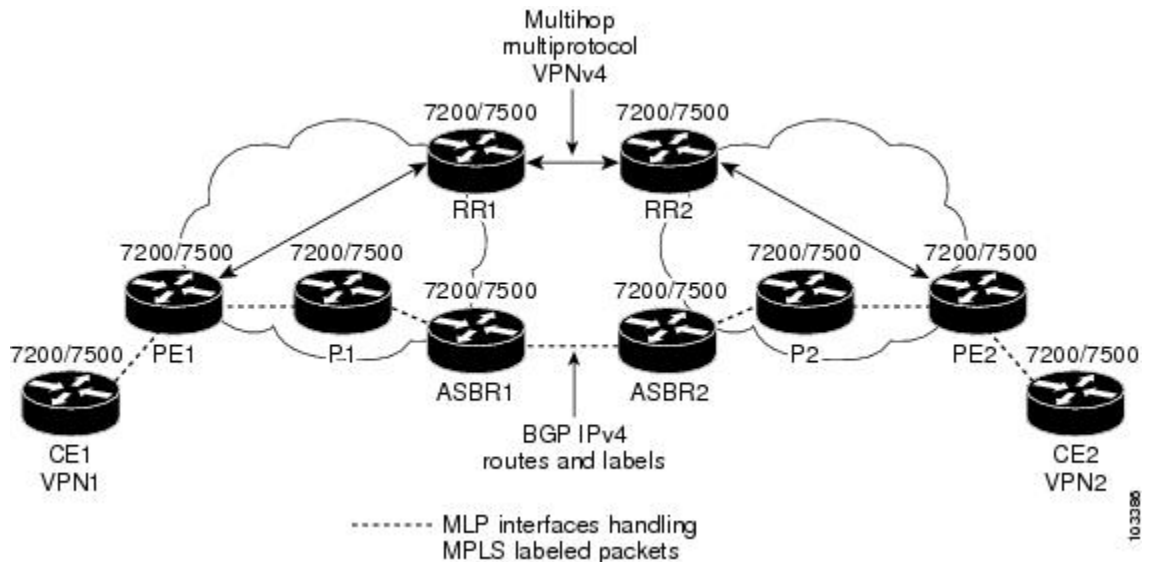


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MPLS--Multilink PPP Support in an Interautonomous System

The figure below shows a typical MPLS VPN interautonomous system (Inter-AS) network where MLP is configured on the PE-to-CE links.

Figure 5 *MLP on ASBR-to-PE Links in an MPLS VPN Inter-AS Network*



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The MPLS--Multilink PPP Support feature supports MLP between ASBR links for Inter-AS VPNs with LDP and with eBGP IPv4 label distribution.

How to Configure MPLS--Multilink PPP Support

Service providers that use relatively low-speed links can use MLP to spread traffic across them in their MPLS networks. LFI should be deployed in the CE-to-PE link for efficiency, where traffic uses lower link bandwidth (less than 768 kbps). The MPLS--Multilink PPP Support feature can reduce the number of IGP adjacencies and facilitate load sharing of traffic.

The tasks in this section can be performed on CE-to-PE links, PE-to-P links, P-to-P links, and CSC-CE-to-CSC-PE links.

- [Enabling Cisco Express Forwarding or Distributed Cisco Express Forwarding Switching](#), page 8
- [Creating a Multilink Bundle](#), page 10
- [Assigning an Interface to a Multilink Bundle](#), page 11
- [Disabling PPP Multilink Fragmentation](#), page 15
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Enabling Cisco Express Forwarding or Distributed Cisco Express Forwarding Switching

Perform the following task to enable Cisco Express Forwarding or distributed Cisco Express Forwarding switching.

Multilink PPP requires the configuration of standard Cisco Express Forwarding. Distributed MLP (dMLP) requires the configuration of distributed Cisco Express Forwarding.

Cisco Express Forwarding is enabled by default on most Cisco platforms running Cisco IOS software Release 12.0 or a later release. To find out if Cisco Express Forwarding is enabled on your platform, enter the `show ip cef` command. If Cisco Express Forwarding is enabled, you receive output that looks like this:

```
Router# show ip cef
Prefix          Next Hop          Interface
10.2.61.8/24    192.168.100.1    FastEthernet1/0/0
                192.168.101.1    FastEthernet6/1
```

If Cisco Express Forwarding is not enabled on your platform, the output for the `show ip cef` command looks like this:

```
Router# show ip cef
%CEF not running
```

Distributed Cisco Express Forwarding is enabled by default on devices such as the Catalyst 6500 series switch, the Cisco 7500 series router, and the Cisco 12000 series Internet router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
 - **ip cef**
 -
 - **ip cef distributed**
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
Step 3	<p>Do one of the following:</p> <ul style="list-style-type: none"> • ip cef • • ip cef distributed <p>Example:</p> <pre>Router(config)# ip cef</pre> <p>Example:</p> <pre>Router(config)# ip cef distributed</pre>	<p>Enables standard Cisco Express Forwarding switching.</p> <p>or</p> <p>Enables distributed Cisco Express Forwarding switching.</p>

	Command or Action	Purpose
Step 4	exit Example: Router(config)# exit	Exits to privileged EXEC mode.

Creating a Multilink Bundle

Perform this task to create a multilink bundle for the MPLS--Multilink PPP Support feature. This can reduce the number of IGP adjacencies and facilitate load sharing of traffic.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface multilink** *group-number*
4. **ip address** *address mask* [**secondary**]
5. **encapsulation** *encapsulation-type*
6. **ppp multilink**
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface multilink <i>group-number</i> Example: Router(config)# interface multilink 1	Creates a multilink bundle or enters multilink interface configuration mode. <ul style="list-style-type: none"> • The <i>group-number</i> argument is the number of the multilink bundle (a nonzero number).

Command or Action	Purpose
<p>Step 4 <code>ip address <i>address mask</i> [secondary]</code></p> <p>Example:</p> <pre>Router(config-if)# ip address <i>address mask</i></pre>	<p>Sets a primary or secondary IP address for an interface.</p> <ul style="list-style-type: none"> The <i>address</i> argument is the IP address. The <i>mask</i> argument is the mask for the associated IP subnet. The secondary keyword specifies that the configured address is a secondary IP address. If this keyword is omitted, the configured address is the primary IP address. <p>This command is used to assign an IP address to the multilink interface.</p>
<p>Step 5 <code>encapsulation <i>encapsulation-type</i></code></p> <p>Example:</p> <pre>Router(config-if)# encapsulation ppp</pre>	<p>Sets the encapsulation method used by the interface.</p> <ul style="list-style-type: none"> The <i>encapsulation-type</i> argument specifies the encapsulation type. The keyword ppp enables PPP encapsulation.
<p>Step 6 <code>ppp multilink</code></p> <p>Example:</p> <pre>Router(config-if)# ppp multilink</pre>	<p>Enables MLP on an interface.</p>
<p>Step 7 <code>end</code></p> <p>Example:</p> <pre>Router(config-if)# end</pre>	<p>Exits to privileged EXEC mode.</p>

Assigning an Interface to a Multilink Bundle

Perform this task to assign an interface to a multilink bundle for the MPLS--Multilink PPP Support feature.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **controller** {*t1* | *e1*} *slot / port*
4. **channel-group** *channel-number timeslots range*
5. **exit**
6. **interface serial** *slot / port : channel-group*
7. **ip route-cache** [*cef* | **distributed**]
8. **no ip address**
9. **keepalive** [*period* [*retries*]]
10. **encapsulation** *encapsulation-type*
11. **multilink-group** *group-number*
12. **ppp multilink**
13. **ppp authentication chap**
14. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	controller { <i>t1</i> <i>e1</i> } <i>slot / port</i> Example: Router# controller t1 1/3	Configures a T1 or E1 controller and enters controller configuration mode. <ul style="list-style-type: none"> • The t1 keyword indicates a T1 line card. • The e1 keyword indicates an E1 line card. • The <i>slot / port</i> arguments are the backplane slot number and port number on the interface. Refer to your hardware installation manual for the specific slot numbers and port numbers.

	Command or Action	Purpose
Step 4	<p>channel-group <i>channel-number</i> timeslots <i>range</i></p> <p>Example:</p> <pre>Router(config-controller)# channel-group 1 timeslots 1</pre>	<p>Defines the time slots that belong to each T1 or E1 circuit.</p> <ul style="list-style-type: none"> The <i>channel-number</i> argument is the channel-group number. When a T1 data line is configured, channel-group numbers can be values from 0 to 23. When an E1 data line is configured, channel-group numbers can be values from 0 to 30. The timeslots <i>range</i> keyword-argument pair specifies one or more time slots or ranges of time slots belonging to the channel group. The first time slot is numbered 1. For a T1 controller, the time slot range is from 1 to 24. For an E1 controller, the time slot range is from 1 to 31. You can specify a time slot range (for example, 1-29), individual time slots separated by commas (for example 1, 3, 5), or a combination of the two (for example 1-14, 15, 17-31).
Step 5	<p>exit</p> <p>Example:</p> <pre>Router(config-controller)# exit</pre>	<p>Exits to global configuration mode.</p>
Step 6	<p>interface serial <i>slot / port</i> : <i>channel-group</i></p> <p>Example:</p> <pre>Router(config)# interface serial 1/0:1</pre>	<p>Configures a serial interface for a Cisco 7500 series router with channelized T1 or E1 and enters interface configuration mode.</p> <ul style="list-style-type: none"> The <i>slot</i> argument indicates the slot number. Refer to the appropriate hardware manual for slot and port information. The <i>/port</i> argument indicates the port number. Refer to the appropriate hardware manual for slot and port information. The <i>:channel-group</i> argument indicates the channel group number. Cisco 7500 series routers specify the channel group number in the range of 0 to 4 defined with the channel-groupcontroller configuration command.
Step 7	<p>ip route-cache [cef distributed]</p> <p>Example:</p> <pre>Router(config-if)# ip route- cache cef</pre>	<p>Controls the use of switching methods for forwarding IP packets</p> <ul style="list-style-type: none"> The cef keyword enables Cisco Express Forwarding operation on an interface after Cisco Express Forwarding operation was disabled. The distributed keyword enables distributed switching on the interface.
Step 8	<p>no ip address</p> <p>Example:</p> <pre>Router(config-if)# no ip address</pre>	<p>Removes any specified IP address.</p>

Command or Action	Purpose
<p>Step 9 keepalive [<i>period</i> [<i>retries</i>]]</p> <p>Example:</p> <pre>Router(config-if)# keepalive</pre>	<p>Enables keepalive packets and specifies the number of times that the Cisco IOS software tries to send keepalive packets without a response before bringing down the interface or before bringing the tunnel protocol down for a specific interface.</p> <ul style="list-style-type: none"> • The <i>period</i> argument is an integer value, in seconds, greater than 0. The default is 10. • The <i>retries</i> argument specifies the number of times that the device will continue to send keepalive packets without response before bringing the interface down. Enter an integer value greater than 1 and less than 255. If you do not enter a value, the value that was previously set is used; if no value was specified previously, the default of 5 is used. <p>If you are using this command with a tunnel interface, the command specifies the number of times that the device will continue to send keepalive packets without response before bringing the tunnel interface protocol down.</p>
<p>Step 10 encapsulation <i>encapsulation-type</i></p> <p>Example:</p> <pre>Router(config-if)# encapsulation ppp</pre>	<p>Sets the encapsulation method used by the interface.</p> <ul style="list-style-type: none"> • The <i>encapsulation-type</i> argument specifies the encapsulation type. The keyword ppp enables PPP encapsulation.
<p>Step 11 multilink-group <i>group-number</i></p> <p>Example:</p> <pre>Router(config-if)# multilink- group 1</pre>	<p>Designates an interface as part of a multilink leased line bundle.</p> <ul style="list-style-type: none"> • The <i>group-number</i> argument is the number of the multilink bundle (a nonzero number).
<p>Step 12 ppp multilink</p> <p>Example:</p> <pre>Router(config-if)# ppp multilink</pre>	<p>Enables MLP on an interface.</p>
<p>Step 13 ppp authentication chap</p> <p>Example:</p> <pre>Router(config-if)# ppp authentication chap</pre>	<p>(Optional) Enables Challenge Handshake Authentication Protocol (CHAP) authentication on a serial interface.</p>

Command or Action	Purpose
Step 14 end Example: Router(config-if)# end	Exits to privileged EXEC mode.

Disabling PPP Multilink Fragmentation

Perform this task to disable PPP multilink fragmentation. PPP multilink fragmentation is enabled by default.

Enabling fragmentation reduces the delay latency among bundle links, but adds some load to the CPU. Disabling fragmentation might produce better throughput.

If your data traffic is consistently of a similar size, we recommend disabling fragmentation. In this case, the benefits of fragmentation can be outweighed by the added load on the CPU.

SUMMARY STEPS

1. enable
2. configure terminal
3. interface *type number*
4. ppp multilink fragmentation disable
5. end

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.

Command or Action	Purpose
<p>Step 3 <code>interface type number</code></p> <p>Example:</p> <pre>Router(config)# interface serial 1/0/0</pre>	<p>Configures an interface type and enters interface configuration mode.</p> <ul style="list-style-type: none"> The <i>type</i> argument indicates the type of interface to be configured. The <i>number</i> argument specifies the port, connector, or interface card number. The numbers are assigned at the factory at the time of installation or when the interface is added to a system, and can be displayed with the show interfaces command.
<p>Step 4 <code>ppp multilink fragmentation disable</code></p> <p>Example:</p> <pre>Router(config-if)# ppp multilink fragmentation disable</pre>	<p>Disables packet fragmentation.</p>
<p>Step 5 <code>end</code></p> <p>Example:</p> <pre>Router(config-if)# end</pre>	<p>Exits to privileged EXEC mode.</p>

Verifying the Multilink PPP Configuration

SUMMARY STEPS

1. `enable`
2. `show ip interface brief`
3. `show ppp multilink`
4. `show ppp multilink interface interface-bundle`
5. `show interface interface-name interface-number`
6. `show mpls forwarding-table`
7. `exit`

DETAILED STEPS

- Step 1** `enable`
Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

- Step 2** `show ip interface brief`

Use this command to verify logical and physical MLP interfaces. For example:

Example:

```
Router# show ip interface brief
Locolrface          IP-Address      OK? Method Status  Prot
FastEthernet1/0/0   10.3.62.106    YES NVRAM  up      up
FastEthernet0/0/1   unassigned      YES NVRAM  administratively down down
FastEthernet0/0/0   unassigned      YES NVRAM  administratively down down
FastEthernet0/0/1   unassigned      YES NVRAM  administratively down down
FastEthernet0/0/2   unassigned      YES NVRAM  administratively down down
FastEthernet0/1/0   unassigned      YES NVRAM  administratively down down
FastEthernet0/1/1   unassigned      YES NVRAM  administratively down down
FastEthernet0/1/2   unassigned      YES NVRAM  administratively down down
FastEthernet1/2/0   unassigned      YES NVRAM  administratively down down
FastEthernet1/0/1   unassigned      YES NVRAM  administratively down down
FastEthernet1/1/0   unassigned      YES NVRAM  administratively down down
FastEthernet1/1/1   unassigned      YES NVRAM  administratively down down
FastEthernet1/1/2   unassigned      YES NVRAM  administratively down down
Serial1/1/0:1       unassigned      YES NVRAM  administratively down down
Serial1/1/0:2       unassigned      YES NVRAM  administratively down down
Serial1/1/1:1       unassigned      YES NVRAM  up       up
Serial1/1/1:2       unassigned      YES NVRAM  up       down
Serial1/1/3:1       unassigned      YES NVRAM  up       up
Serial1/1/3:2       unassigned      YES NVRAM  up       up
Multilink6          10.30.0.2       YES NVRAM  up       up
Multilink8          unassigned      YES NVRAM  administratively down down
Multilink10         10.34.0.2       YES NVRAM  up       up
Loopback0           10.0.0.1        YES NVRAM  up       up
```

Step 3 **show ppp multilink**

Use this command to verify that you have created a multilink bundle. For example:

Example:

```
Router# show ppp multilink
Multilink1, bundle name is group 1
  Bundle is Distributed
  0 lost fragments, 0 reordered, 0 unassigned, sequence 0x0/0x0 rcvd/sent
  0 discarded, 0 lost received, 1/255 load
  Member links: 4 active, 0 inactive (max no set, min not set)
  Serial1/0/0/:1
  Serial1/0/0/:2
  Serial1/0/0/:3
  Serial1/0/0/:4
```

Step 4 **show ppp multilink interface interface-bundle**

Use this command to display information about a specific MLP interface. For example:

Example:

```
Router# show ppp multilink interface multilink6
Multilink6, bundle name is router
  Bundle up for 00:42:46, 1/255 load
  Receive buffer limit 24384 bytes, frag timeout 1524 ms
  Bundle is Distributed
  0/0 fragments/bytes in reassembly list
  1 lost fragments, 48 reordered
  0/0 discarded fragments/bytes, 0 lost received
  0x4D7 received sequence, 0x0 sent sequence
  Member links: 2 active, 0 inactive (max not set, min not set)
  Sel/1/3:1, since 00:42:46, 240 weight, 232 frag size
  Sel/1/3:2, since 00:42:46, 240 weight, 232 frag size
```

Step 5 **show interface interface-name interface-number**

Use this command to display information about serial interfaces in your configuration. For example:

Example:

```
Router# show interface serial 1/1/3:1
Serial1/1/3:1 is up, line protocol is up
Hardware is Multichannel T1
MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, LCP Open, multilink Open, crc 16, Data non-inverted
Last input 00:00:01, output 00:00:01, output hang never
Last clearing of "show interface" counters 00:47:13
Input queue: 0/75/0/0 (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
    722 packets input, 54323 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    697 packets output, 51888 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 output buffer failures, 0 output buffers swapped out
    1 carrier transitions no alarm present
Timeslot(s) Used:1, subrate: 64Kb/s, transmit delay is 0 flags
Transmit queue length 25
Router# show interface serial 1/1/3:2
Serial1/1/3:2 is up, line protocol is up
Hardware is Multichannel T1
MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, LCP Open, multilink Open, crc 16, Data non-inverted
Last input 00:00:03, output 00:00:03, output hang never
Last clearing of "show interface" counters 00:47:16
Input queue: 0/75/0/0 (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
    725 packets input, 54618 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    693 packets output, 53180 bytes, 0 underruns
    0 output errors, 0 collisions, 1 interface resets
    0 output buffer failures, 0 output buffers swapped out
    1 carrier transitions no alarm present
Timeslot(s) Used:2, subrate: 64Kb/s, transmit delay is 0 flags
Transmit queue length 26
```

You can also use the **show interface** command to display information about the multilink interface:

Example:

```
Router# show interface multilink6
Multilink6 is up, line protocol is up
Hardware is multilink group interface
Internet address is 10.30.0.2/8
MTU 1500 bytes, BW 128 Kbit, DLY 100000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, LCP Open, multilink Open
Open: CDPCP, IPCP, TAGCP, loopback not set
DTR is pulsed for 2 seconds on reset
Last input 00:00:00, output never, output hang never
Last clearing of "show interface" counters 00:48:43
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/40 (size/max)
```

```

30 second input rate 0 bits/sec, 0 packets/sec
30 second output rate 0 bits/sec, 0 packets/sec
  1340 packets input, 102245 bytes, 0 no buffer
  Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  1283 packets output, 101350 bytes, 0 underruns
  0 output errors, 0 collisions, 1 interface resets
  0 output buffer failures, 0 output buffers swapped out
  0 carrier transitions

```

Step 6**show mpls forwarding-table**

Use this command to display contents of the MPLS Label Forwarding Information Base (LFIB) and look for information on multilink interfaces associated with a point2point next hop. For example:

Example:

```

Router# show mpls forwarding-table
Local  Outgoing  Prefix          Bytes tag  Outgoing     Next Hop
tag    tag or VC  or Tunnel Id   switched  interface
16     Untagged  10.30.0.1/32   0         Mu6          point2point
17     Pop tag    10.0.0.3/32    0         Mu6          point2point
18     Untagged  10.0.0.9/32[V] 0         Mu10         point2point
19     Untagged  10.0.0.11/32[V] 6890      Mu10         point2point
20     Untagged  10.32.0.0/8[V] 530       Mu10         point2point
21     Aggregate 10.34.0.0/8[V] 0
22     Untagged  10.34.0.1/32[V] 0         Mu10         point2point

```

Use the **show ip bgp vpnv4** command to display VPN address information from the Border Gateway Protocol (BGP) table:

Example:

```

Router# show ip bgp vpnv4 all summary
BGP router identifier 10.0.0.1, local AS number 100
BGP table version is 21, main routing table version 21
10 network entries using 1210 bytes of memory
10 path entries using 640 bytes of memory
2 BGP path attribute entries using 120 bytes of memory
1 BGP extended community entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1994 total bytes of memory
BGP activity 10/0 prefixes, 10/0 paths, scan interval 5 secs
10.0.0.3 4 100 MsgRc52 MsgSe52 TblV21 0 0 00:46:35 State/P5xRcd

```

Step 7**exit**

Use this command to exit to user EXEC mode. For example:

Example:

```

Router# exit
Router>

```

Configuration Examples for MPLS--Multilink PPP Support

- [Sample MPLS--Multilink PPP Support Configurations, page 20](#)

- [Enabling Cisco Express Forwarding or Distributed Cisco Express Forwarding Example, page 22](#)
- [Creating a Multilink Bundle Example, page 22](#)
- [Assigning an Interface to a Multilink Bundle Example, page 23](#)

Sample MPLS--Multilink PPP Support Configurations

The following examples show sample configurations for MLP on a Cisco 7200 router, on a Cisco 7500 router, and on a CSC network. The configuration of MLP on an interface is the same for PE-to-CE links, PE-to-P links, and P-to-P links.

- [Sample Multilink PPP Configuration on Cisco 7200 Series Router, page 20](#)
- [Sample Multilink PPP Configuration for Cisco 7500 Series Router, page 20](#)
- [Sample Multilink PPP Configuration on an MPLS CSC PE Router, page 21](#)

Sample Multilink PPP Configuration on Cisco 7200 Series Router

Following is a sample configuration of a Cisco 7200 router, which is connected with a T1 line card and configured with an MPLS Multilink PPP interface:

```

controller T1 1/3
  framing esf
  clock source internal
  linecode b8zs
  channel-group 1 timeslots 1
  channel-group 2 timeslots 2
  no yellow generation
  no yellow detection
!
interface Multilink6
  ip address 10.37.0.1 255.0.0.0
  ppp multilink interleave
  tag-switching ip
  load-interval 30
  multilink-group 6
!
interface Serial1/3:1
  encapsulation ppp
  no ip address
  ppp multilink
  tx-queue-limit 26
  multilink-group 6
  peer neighbor-route
!
interface Serial1/3:2
  encapsulation ppp
  no ip address
  ppp multilink
  tx-queue-limit 26
  multilink-group 6
  peer neighbor-route

```

Sample Multilink PPP Configuration for Cisco 7500 Series Router

Following is a sample configuration of a Cisco 7500 router, which is connected with a T1 line card and configured with an MPLS Multilink PPP interface:

```

controller T1 1/1/3
  framing esf
  clock source internal
  linecode b8zs
  channel-group 1 timeslots 1

```

```

channel-group 2 timeslots 2
no yellow generation
no yellow detection
!
interface Multilink6
ip address 10.37.0.2 255.0.0.0
ppp multilink interleave
tag-switching ip
load-interval 30
multilink-group 6
!
interface Serial1/1/3:1
encapsulation ppp
no ip address
ppp multilink
tx-queue-limit 26
multilink-group 6
peer neighbor-route
!
interface Serial1/1/3:2
encapsulation ppp
no ip address
ppp multilink
tx-queue-limit 26
multilink-group 6
peer neighbor-route

```

Sample Multilink PPP Configuration on an MPLS CSC PE Router

Following is a sample configuration for an MPLS CSC PE router. An EBGP session is configured between the PE and CE routers.

```

PE-Router# show running-config interface Serial1/0:1
Building configuration...
!
mpls label protocol ldp
ip cef
ip vrf vpn2
rd 200:1
route-target export 200:1
route-target import 200:1
!
controller T1 1/0
framing esf
clock source internal
linecode b8zs
channel-group 1 timeslots 1
channel-group 2 timeslots 2
no yellow generation
no yellow detection
!
interface Serial1/0:1
no ip address
encapsulation ppp
tx-ring-limit 26
ppp multilink
ppp multilink group 1
!
interface Serial1/0:2
no ip address
encapsulation ppp
tx-ring-limit 26
ppp multilink
ppp multilink group 1
!
interface Multilink1
ip vrf forwarding vpn2
ip address 10.35.0.2 255.0.0.0
no peer neighbor-route
load-interval 30
ppp multilink

```

```

ppp multilink interleave
ppp multilink group 1
!
!
router ospf 200
log-adjacency-changes
auto-cost reference-bandwidth 1000
redistribute connected subnets
passive-interface Multilink1
network 10.0.0.7 0.0.0.0 area 200
network 10.31.0.0 0.255.255.255 area 200
!
!
router bgp 200
no bgp default ipv4-unicast
bgp log-neighbor-changes
neighbor 10.0.0.11 remote-as 200
neighbor 10.0.0.11 update-source Loopback0
!
address-family vpnv4
neighbor 10.0.0.11 activate
neighbor 10.0.0.11 send-community extended
bgp scan-time import 5
exit-address-family
!
address-family ipv4 vrf vpn2
redistribute connected
neighbor 10.35.0.1 remote-as 300
neighbor 10.35.0.1 activate
neighbor 10.35.0.1 as-override
neighbor 10.35.0.1 advertisement-interval 5
no auto-summary
no synchronization
exit-address-family

```

Enabling Cisco Express Forwarding or Distributed Cisco Express Forwarding Example

The following example shows how to enable Cisco Express Forwarding for MLP configurations:

```

enable
configure terminal
ip cef

```

The following example shows how to enable distributed Cisco Express Forwarding for dMLP configurations:

```

enable
configure terminal
ip cef distribute

```

Creating a Multilink Bundle Example

The following example shows how to create a multilink bundle for the MPLS--Multilink PPP Support feature:

```

interface multilink 1
ip address 10.0.0.0 10.255.255.255
encapsulation ppp
ppp chap hostname group 1
ppp multilink
multilink-group 1

```

Assigning an Interface to a Multilink Bundle Example

The following example shows how to create four multilink interfaces with distributed Cisco Express Forwarding switching and MLP enabled. Each of the newly created interfaces is added to a multilink bundle.

```
interface multilink1
 ip address 10.0.0.0 10.255.255.255
 ppp chap hostname group 1
 ppp multilink
 multilink-group 1

interface serial 1/0/0:1
 no ip address
 encapsulation ppp
 ip route-cache distributed
 no keepalive
 ppp multilink
 multilink-group 1
interface serial 1/0/0:2
 no ip address
 encapsulation ppp
 ip route-cache distributed
 no keepalive
 ppp chap hostname group 1
 ppp multilink
 multilink-group 1
interface serial 1/0/0:3
 no ip address
 encapsulation ppp
 ip route-cache distributed
 no keepalive
 ppp chap hostname group 1
 ppp multilink
 multilink-group 1
interface serial 1/0/0:4
 no ip address
 encapsulation ppp
 ip route-cache distributed
 no keepalive
 ppp chap hostname group 1
 ppp multilink
 multilink-group
```

Additional References

The following sections provide references related to the MPLS--Multilink PPP Support feature:

Related Documents

Related Topic	Document Title
Configuration tasks for Distributed MLP for Cisco 7500 series routers	Distributed Multilink Point-to-Point Protocol for Cisco 7500 Series Routers
Configuration tasks for media-independent PPP and Multilink PPP	Configuring Media-Independent PPP and Multilink PPP
Configuration tasks for MPLS DiffServ tunneling modes	MPLS DiffServ Tunneling Modes

Related Topic	Document Title
Configuration tasks for the MPLS QoS multi-VC mode feature	“Configuring MPLS” chapter , Cisco IOS Multiprotocol Label Switching Configuration Guide, Release 12.4
Configuration tasks for MPLS VPNs	“MPLS Virtual Private Networks” chapter , Cisco IOS Multiprotocol Label Switching Configuration Guide, Release 12.4
Configuration tasks for MPLS VPN CSC	“MPLS Virtual Private Networks” chapter , Cisco IOS Multiprotocol Label Switching Configuration Guide, Release 12.4
Configuration tasks for MPLS VPN CSC with IPv4 BGP label distribution	“MPLS Virtual Private Networks” chapter , Cisco IOS Multiprotocol Label Switching Configuration Guide, Release 12.4
Configuration tasks for MPLS VPN Inter-AS with IPv4 BGP label distribution	“MPLS Virtual Private Networks” chapter , Cisco IOS Multiprotocol Label Switching Configuration Guide, Release 12.4

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 1990	<i>The PPP Multilink Protocol (MP)</i>

Technical Assistance

Description	Link
The Technical Support & Documentation website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Command Reference

This feature uses no new or modified commands.

Feature Information for MPLS--Multilink PPP Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 5 **Feature Information for MPLS--Multilink PPP Support**

Feature Name	Releases	Feature Information
MPLS--Multilink PPP Support	12.2(8)T 12.2(15)T1012.3(5a) 12.3(7)T 12.2(28)SB 12.4(20)T	<p>The MPLS--Multilink PPP Support feature ensures that MPLS Layer 3 Virtual Private Networks (VPNs) with quality of service (QoS) can be enabled for bundled links. This feature supports Multiprotocol Label Switching (MPLS) over Multilink PPP (MLP) links in the edge (provider edge [PE]-to-customer edge [CE]) or in the MPLS core (PE-to-PE and PE-to-provider router [P]).</p> <p>Service providers that use relatively low-speed links can use MLP to spread traffic across them in their MPLS networks. Link fragmentation and interleaving (LFI) should be deployed in the CE-to-PE link for efficiency, where traffic uses a lower link bandwidth (less than 768 kbps).</p> <p>In 12.2(8)T, MLP support on CE-to-PE links was introduced.</p> <p>In 12.2(15)T10 and 12.3(5a), MLP support for MPLS networks was extended to PE-to-P links, PE-to-PE links, Carrier Supporting Carrier (CSC) CSC-CE-to-CSC-PE links, and interautonomous system (Inter-AS) PE-to-PE links.</p> <p>In 12.3(7)T, the feature was integrated into the Cisco IOS 12.3T release.</p> <p>In 12.2(28)SB, the feature was integrated into the Cisco IOS 12.2SB release.</p> <p>In 12.4(20)T, the feature was integrated into the Cisco IOS 12.4T release.</p>

Glossary

bundle --A group of interfaces connected by parallel links between two systems that have agreed to use Multilink PPP (MLP) over those links.

CBWFQ --class-based weighted fair queueing. A queueing option that extends the standard Weighted Fair Queueing (WFQ) functionality to provide support for user-defined traffic classes.

Cisco Express Forwarding --A proprietary form of switching that optimizes network performance and scalability for networks with large and dynamic traffic patterns, such as the Internet, and for networks characterized by intensive web-based applications or interactive sessions. Although you can use Cisco Express Forwarding in any part of a network, it is designed for high-performance, highly resilient Layer 3 IP backbone switching.

EIGRP --Enhanced Interior Gateway Routing Protocol. An advanced version of the Interior Gateway Routing Protocol (IGRP) developed by Cisco. It provides superior convergence properties and operating efficiency, and combines the advantages of link-state protocols with those of distance vector protocols.

IGP --Interior Gateway Protocol. An Internet protocol used to exchange routing information within an autonomous system. Examples of common Internet IGPs include Interior Gateway Routing Protocol (IGRP), Open Shortest Path First (OSPF), and Routing Information Protocol (RIP).

IGRP --Interior Gateway Routing Protocol. An Interior Gateway Protocol (IGP) developed by Cisco to address the issues associated with routing in large, heterogeneous networks. Compare with Enhanced Interior Gateway Routing Protocol (EIGRP).

IS-IS --Intermediate System-to-Intermediate System. An Open Systems Interconnection (OSI) link-state hierarchical routing protocol, based on DECnet Phase V routing, in which IS-IS routers exchange routing information based on a single metric to determine network topology.

LCP --Link Control Protocol. A protocol that establishes, configures, and tests data link connections for use by PPP.

LFI --link fragmentation and interleaving. The Cisco IOS XE LFI feature reduces delay on slower-speed links by breaking up large datagrams and interleaving low-delay traffic packets with the smaller packets resulting from the fragmented datagram. LFI allows reserve queues to be set up so that Real-Time Protocol (RTP) streams can be mapped into a higher priority queue in the configured weighted fair queue set.

link --One of the interfaces in a bundle.

LLQ --low latency queueing. A quality of service QoS queueing feature that provides a strict priority queue (PQ) for voice traffic and weighted fair queues for other classes of traffic. It is also called priority queueing/class-based weighted fair queueing (PQ/CBWFQ).

MLP --Multilink PPP. A method of splitting, recombining, and sequencing datagrams across multiple logical links. The use of MLP increases throughput between two sites by grouping interfaces and then load balancing packets over the grouped interfaces (called a bundle). Splitting packets at one end, sending them over the bundled interfaces, and recombining them at the other end achieves load balancing.

MQC --Modular QoS CLI. MQC is a CLI structure that allows users to create traffic polices and attach these polices to interfaces. MQC allows users to specify a traffic class independently of QoS policies.

NCP --Network Control Protocol. A series of protocols for establishing and configuring different network layer protocols (such as for AppleTalk) over PPP.

OSPF --Open Shortest Path First. A link-state, hierarchical Interior Gateway Protocol (IGP) routing algorithm proposed as a successor to Routing Information Protocol (RIP) in the Internet community. OSPF features include least-cost routing, multipath routing, and load balancing. OSPF was derived from an early version of the IS-IS protocol.

PPP --Point-to-Point Protocol. A successor to the Serial Line Interface Protocol (SLIP) that provides router-to-router and host-to-network connections over synchronous and asynchronous circuits. PPP works with several network layer protocols (such as IP, Internetwork Packet Exchange [IPX], and AppleTalk Remote Access [ARA]). PPP also has built-in security mechanisms (such as Challenge Handshake Authentication Protocol [CHAP] and Password Authentication Protocol [PAP]). PPP relies on two protocols: Link Control Protocol (LCP) and Network Control Protocol (NCP).

RIP --Routing Information Protocol. A version of Interior Gateway Protocol (IGP) that is supplied with UNIX Berkeley Standard Distribution (BSD) systems. Routing Information Protocol (RIP) is the most common IGP in the Internet. It uses hop count as a routing metric.

Virtual Bundle Interface --An interface that represents the master link of a bundle. It is not tied to any physical interface. Data going over the bundle is transmitted and received through the master link.

WFQ --weighted fair queueing. A congestion management algorithm that identifies conversations (in the form of traffic streams), separates packets that belong to each conversation, and ensures that capacity is shared fairly among the individual conversations. WFQ is an automatic way of stabilizing network behavior during congestion and results in improved performance and reduced retransmission.

WRED --weighted random early detection. A queueing method that ensures that high-precedence traffic has lower loss rates than other traffic during times of congestion.

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