



MPLS—Multilink PPP Support

The Multiprotocol Label Switching (MPLS)—Multilink Point-to-Point Protocol (MLPPP) 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 MPLS over MLPPP 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 MLPPP to spread traffic across multiple low-speed links in their MPLS networks. Link Fragmentation and Interleaving (LFI) should be deployed in the CE-to-PE link for efficiency, where you use smaller link bandwidths (less than 768 kbps).

Feature History for MPLS—Multilink PPP Support

Release	Modification
12.2(8)T	MLPPP support on CE-to-PE links was introduced.
12.2(15)T10, 12.3(5a)	MLPPP support for MPLS networks was extended to PE-to-P links, PE-to-PE links, Carrier Supporting Carrier (CSC) CE-to-PE links, and interautonomous system (Inter-AS) PE-to-PE links.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

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Prerequisites for MPLS—Multilink PPP Support

MPLS—Multilink PPP Support requires the following:

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

[Table 1](#) lists the required port adapters and processors for MPLS—Multilink PPP Support on the Cisco 7200 series routers. [Table 2](#) lists the required port adapters and processors for MPLS—Multilink PPP Support 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 has no restrictions, except for platform-specific restrictions that apply to the use of MLPPP and Distributed MLPPP (dMLPPP).

For restrictions that apply to dMLPPP 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

This section contains information that you need to use the MPLS—Multilink PPP Support feature:

- [MPLS Features Supported for Multilink PPP, page 4](#)
- [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 7](#)
- [MPLS—Multilink PPP Support in an Inter autonomous System, page 8](#)

MPLS Features Supported for Multilink PPP

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

- [MPLS Layer 3 Virtual Private Network Features Supported for Multilink PPP, page 4](#)
- [MPLS Quality of Service Features Supported for Multilink PPP, page 5](#)

MPLS Layer 3 Virtual Private Network Features Supported for Multilink PPP

Table 3 lists MPLS Layer 3 VPN features supported for MLPPP 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 MLPPP

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	—
Enhanced Interior Gateway Routing Protocol (EIGRP)	Supported	Supported	—
Interprovider (InterAS) VPNs (with LDP)	Not applicable to this configuration	Supported (MLPPP between ASBRs)	Not applicable to this configuration
InterAS VPNs with IPv4 Label Distribution	Not applicable to this configuration	Supported (MLPPP between autonomous system border routers [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
eiBGP Multipath	—	—	Not applicable to this configuration
iBGP Multipath	Not applicable to this configuration	—	Not applicable to this configuration
eBGP Multipath	—	—	—

1. An em dash (—) indicates that the configuration is not supported in this release.

MPLS Quality of Service Features Supported for Multilink PPP

Table 4 lists the MPLS quality of service (QoS) features supported for MLPPP 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 4 *MPLS QoS Features Supported for MLPPP*

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	— ¹	—
Set MPLS EXP bits using modular QoS CLI (MQC)	Supported	Supported	Supported
Matching on MPLS EXP using MQC	Supported	Supported	Supported
LLQ/CBWFQ support	Supported	Supported	Supported
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

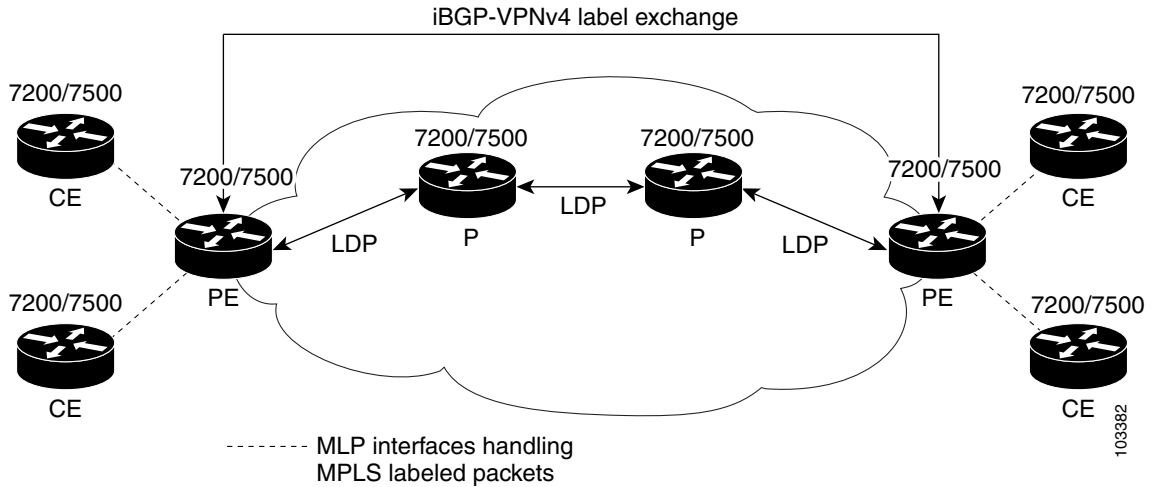
1. An em dash (—) indicates that the configuration is not supported in this release.

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

Figure 1 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, MLPPP is deployed on the PE-to-CE links. The VPN routing/forwarding instance (VRF) interface is in a multilink bundle. There is no MPLS interaction with MLPPP; all packets coming into the MLPPP bundle are IP packets.

Figure 1 MLPPP and Traditional PE-to-CE Links



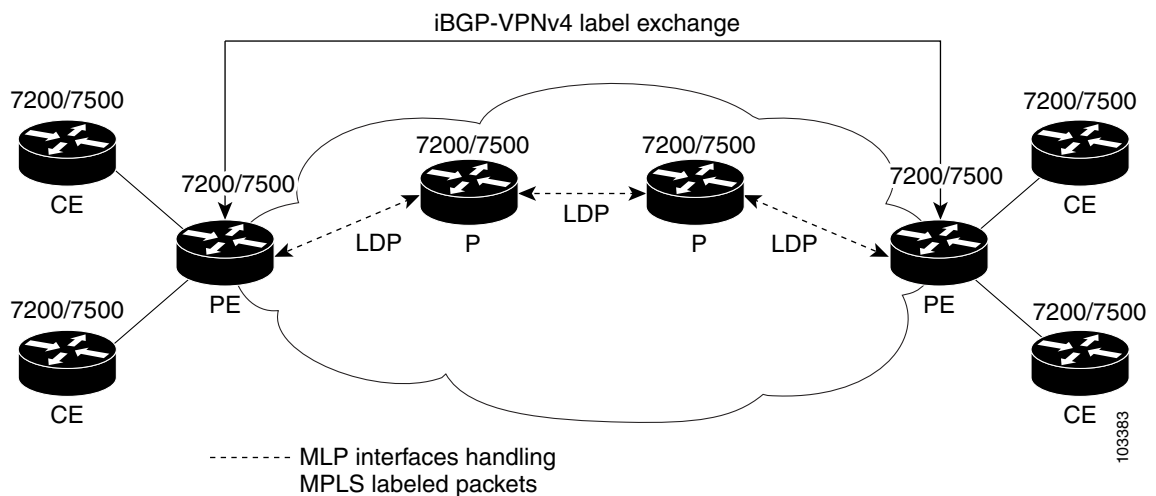
The PE-to-CE routing protocols that are supported for the MPLS—Multilink PPP Support feature include EBGP, OSPF, and EIGRP. Static routes are also supported between the CE and PE routers.

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

MPLS—Multilink PPP Support and Core Links

Figure 2 shows a sample topology in which MPLS is deployed over MLPPP on PE-to-P and P-to-P links. Enabling MPLS on MLPPP for PE-to-P links is similar to enabling MPLS on MLPPP for P-to-P links.

Figure 2 MLPPP on PE-to-P Core Links



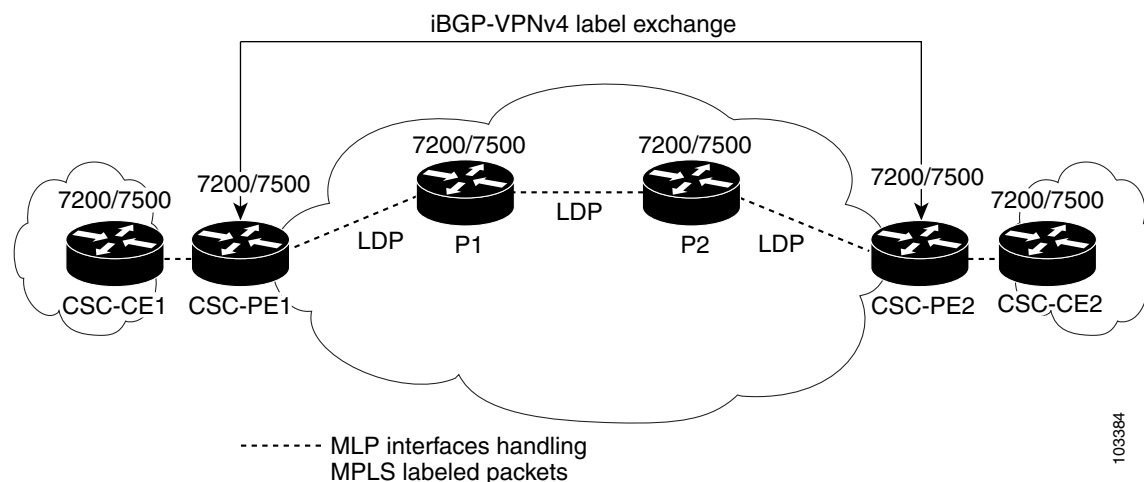
You employ MLPPP in the PE-to-P or P-to-P links primarily so that you can reduce the number of Interior Gateway Protocol (IGP) adjacencies and facilitate the load sharing of traffic.

In addition to MLPPP on the PE-to-P links, the MPLS—Multilink PPP Support feature requires the configuration of an IGP routing protocol and Label Distribution Protocol (LDP).

MPLS—Multilink PPP Support in a CSC Network

Figure 3 shows a typical MPLS VPN CSC network where MLPPP is configured on the CSC-CE-to-CSC-PE links.

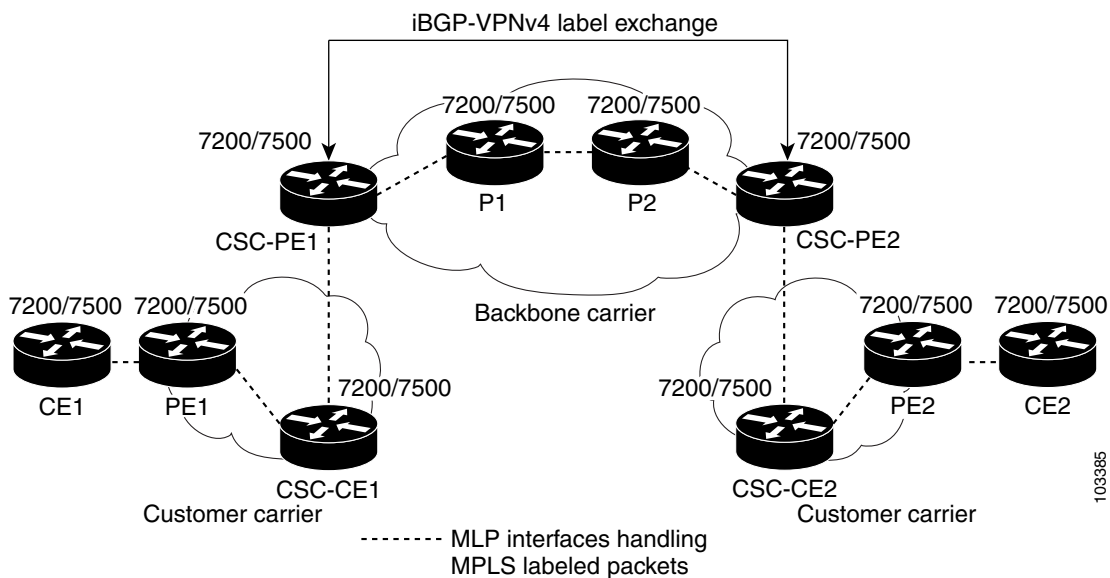
Figure 3 MLPPP on CSC-CE-to-CSC-PE Links with MPLS VPN Carrier Supporting Carrier



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The MPLS—Multilink PPP Support feature supports MLPPP 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. Figure 4 shows all MLPPP links that this feature supports for CSC configurations.

Figure 4 MLPPP Supported Links with MPLS VPN Carrier Supporting Carrier

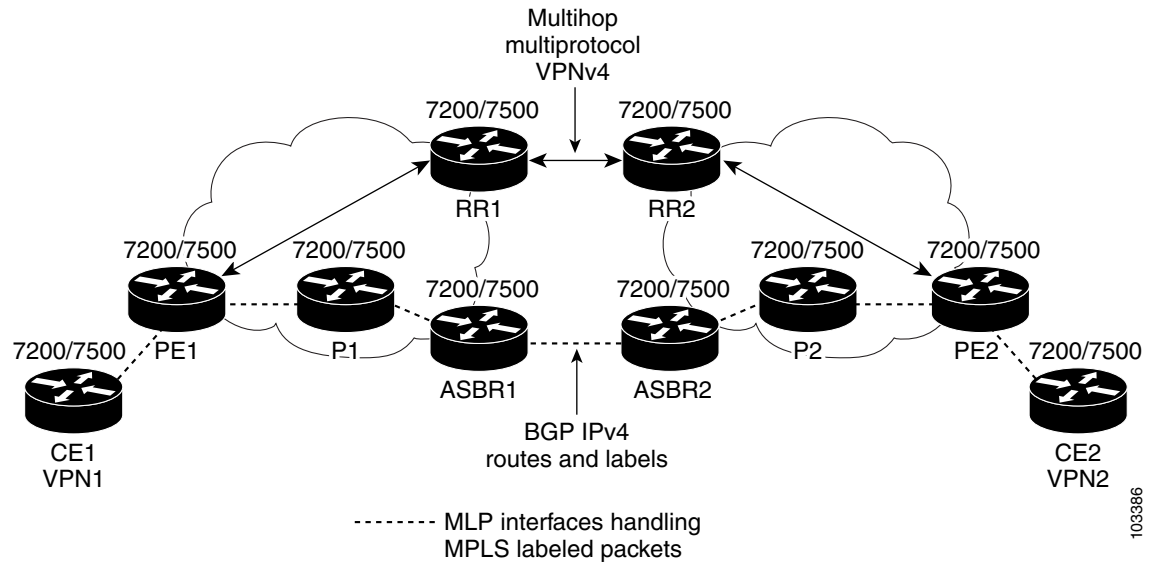


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MPLS—Multilink PPP Support in an Interautonomous System

Figure 5 shows a typical MPLS VPN Interautonomous System (Inter-AS) network where MLPPP is configured on the PE-to-CE links.

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



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

How to Configure MPLS—Multilink PPP Support

This section contains the following procedures for configuring the MPLS—Multilink PPP Support feature:

- [Enabling CEF or Distributed CEF Switching, page 9](#) (required)
- [Creating a Multilink Bundle, page 10](#) (required)
- [Assigning an Interface to a Multilink Bundle, page 11](#) (required)
- [Disabling PPP Multilink Fragmentation, page 17](#) (optional)
- [Verifying the Multilink PPP Configuration, page 18](#) (optional)

Enabling CEF or Distributed CEF Switching

Perform the following task to enable CEF or distributed CEF (dCEF) switching.

Prerequisites

Multilink PPP requires the configuration of standard CEF. Distributed MLPPP (dMLPPP) requires the configuration of dCEF.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef** or **ip cef distributed**
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ip cef or ip cef distributed Example: Router(config)# ip cef OR Router(config)# ip cef distributed	Enables standard CEF switching. or Enables distributed CEF switching.
Step 4	exit Example: Router(config)# exit	Exits to privileged EXEC mode.

Creating a Multilink Bundle

Perform this task to create a multilink bundle.

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).
Step 4	ip address <i>address mask</i> [secondary] Example: Router(config-if)# ip address <i>address mask</i>	Sets a primary or secondary IP address for an interface. <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>
Step 5	encapsulation <i>encapsulation-type</i> Example: Router(config-if)# encapsulation ppp	Sets the encapsulation method used by the interface. <ul style="list-style-type: none"> • The <i>encapsulation-type</i> argument specifies the encapsulation type. The keyword ppp enables PPP encapsulation.

	Command or Action	Purpose
Step 6	<code>ppp multilink</code> Example: Router(config-if)# ppp multilink	Enables Multilink PPP (MLPPP) on an interface.
Step 7	<code>end</code> Example: Router(config)# end	Exits to privileged EXEC mode.

Assigning an Interface to a Multilink Bundle

Perform this task to assign an interface to a multilink bundle.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `controller {t1 | e1} slot/port`
4. `channel-group channel-number timeslots range`
5. `exit`
6. `interface slot/port: channel-number`
7. `ip route-cache cef`
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	<p><code>enable</code></p> <p>Example: Router> <code>enable</code></p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<p><code>configure terminal</code></p> <p>Example: Router# <code>configure terminal</code></p>	<p>Enters global configuration mode.</p>
Step 3	<p><code>controller {t1 e1} slot/port</code></p> <p>Example: Router# <code>controller t1 1/3</code></p>	<p>Configures a T1 or E1 controller and enters controller configuration mode.</p> <ul style="list-style-type: none"> The <code>t1</code> keyword indicates a T1 line card. The <code>e1</code> keyword indicates an E1 line card. The <code>slot/port</code> 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.
Step 4	<p><code>channel-group channel-number timeslots range</code></p> <p>Example: Router(config-controller)# <code>channel-group 1 timeslots 1</code></p>	<p>Defines the time slots that belong to each T1 or E1 circuit.</p> <ul style="list-style-type: none"> The <code>channel-number</code> 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 <code>timeslots range</code> 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><code>exit</code></p> <p>Example: Router(config-controller)# <code>exit</code></p>	<p>Exits to global configuration mode.</p>

	Command or Action	Purpose
Step 6	<p>interface <i>slot/port: channel-number</i></p> <p>Example: Router(config)# interface serial 1/0:1</p>	<p>Configures an interface type and enters interface configuration mode.</p> <ul style="list-style-type: none"> The <i>slot</i> argument indicates 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-number</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-group controller configuration command.
Step 7	<p>ip route-cache cef</p> <p>Example: Router(config-if)# ip route-cache cef</p>	<p>Enables CEF operation on an interface after CEF operation was disabled.</p>
Step 8	<p>no ip address</p> <p>Example: Router(config-if)# no ip address</p>	<p>Removes any specified IP address.</p>
Step 9	<p>keepalive [<i>period</i> [<i>retries</i>]]</p> <p>Example: Router(config-if)# keepalive</p>	<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, specifies the number of times that the device will continue to send keepalive packets without response before bringing the tunnel interface protocol down.</p>
Step 10	<p>encapsulation <i>encapsulation-type</i></p> <p>Example: Router(config-if)# encapsulation ppp</p>	<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.

	Command or Action	Purpose
Step 11	<code>multilink-group group-number</code> Example: Router(config-if)# multilink-group 1	Designates an interface as part of a multilink leased line bundle. • The <i>group-number</i> argument is the number of the multilink bundle (a nonzero number).
Step 12	<code>ppp multilink</code> Example: Router(config-if)# ppp multilink	Enables MLPPP on an interface.
Step 13	<code>ppp authentication chap</code> Example: Router(config-if)# ppp authentication chap	(Optional) Enables Challenge Handshake Authentication Protocol (CHAP) authentication on a serial interface.
Step 14	<code>end</code> Example: Router(config)# end	Exits to privileged EXEC mode.

Troubleshooting Tips

You can verify logical and physical MLPPP interfaces by the use of the **show ip interface brief** command:

```
Router# show ip interface brief
```

```

Locolrface          IP-Address      OK? Method Status      Prot
Ethernet0/0/0      3.3.62.106     YES NVRAM  up          up

Ethernet0/0/1      unassigned     YES NVRAM  administratively down down
Ethernet0/0/2      unassigned     YES NVRAM  administratively down down
Ethernet0/0/3      unassigned     YES NVRAM  administratively down down
Ethernet0/0/4      unassigned     YES NVRAM  administratively down down
Ethernet0/0/5      unassigned     YES NVRAM  administratively down down
Ethernet0/0/6      unassigned     YES NVRAM  administratively down down
Ethernet0/0/7      unassigned     YES NVRAM  administratively down down
Ethernet0/1/0      unassigned     YES NVRAM  administratively down down
Ethernet0/1/1      unassigned     YES NVRAM  administratively down down
Ethernet0/1/2      unassigned     YES NVRAM  administratively down down
Ethernet0/1/3      unassigned     YES NVRAM  administratively down down
Ethernet0/1/4      unassigned     YES NVRAM  administratively down down
Ethernet0/1/5      unassigned     YES NVRAM  administratively down down
Ethernet0/1/6      unassigned     YES NVRAM  administratively down down
Ethernet0/1/7      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         30.0.0.2       YES NVRAM  up          up

```

```

Multilink8          unassigned      YES NVRAM  administratively down down
Multilink10         34.0.0.2       YES NVRAM  up          up

Loopback0           10.0.0.1       YES NVRAM  up          up

```

You can use the **show ppp multilink** command to display information about a specific MLPPP interface:

```

Router# show ppp multilink interface multilink 6

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)
  Se1/1/3:1, since 00:42:46, 240 weight, 232 frag size
  Se1/1/3:2, since 00:42:46, 240 weight, 232 frag size

dLFI statistics:
      DLFI Packets   Pkts In   Chars In   Pkts Out   Chars Out
      Fragmented           86    13072           86    12857
      UnFragmented       1144    85502          1091    82208
      Reassembled        1187    98230          1134    94721

      Reassembly Drops           0
      Fragmentation Drops        0
      Out of Seq Frags           1

```


Note

On Cisco 7500 routers, dLFI statistics are displayed only if LFI is enabled on a distributed MLPPP interface.

You can use the **show interface** command to display information about serial interfaces in your configuration:

```

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:

```

Router# show interface multilink 6
Multilink6 is up, line protocol is up
  Hardware is multilink group interface
  Internet address is 30.0.0.2/8
  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

```

Use the **show mpls forwarding-table** command to view contents of the MPLS label forwarding information base (LFIB):

```

Router# show mpls forwarding-table

Local  Outgoing  Prefix          Bytes tag  Outgoing  Next Hop
tag    tag or VC  or Tunnel Id    switched  interface
16     Untagged  30.0.0.1/32     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  32.0.0.0/8[V]  530       Mu10      point2point
21     Aggregate 34.0.0.0/8[V]  0         Mu10
22     Untagged  34.0.0.1/32[V]  0         Mu10      point2point

```

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

```
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
```

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.

Distributed MLPPP over MPLS does not support fragmentation of the packets, unless you enable LFI on the MLPPP interface using the following commands:

```
Router(config)# interface multilink group-number
Router(config-if)# ppp multilink interleave
Router(config-if)# ppp multilink fragment-delay delay in msec
```

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.
Step 3	interface <i>type number</i> Example: Router(config)# interface serial 1/0	Configures an interface type and enters interface configuration mode. <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.
Step 4	ppp multilink fragmentation disable Example: Router(config-if)# ppp multilink fragmentation disable	Disables packet fragmentation.
Step 5	end Example: Router(config)# end	Exits to privileged EXEC mode.

Verifying the Multilink PPP Configuration

Perform the following task to verify the Multilink PPP configuration.

SUMMARY STEPS

- enable
- show ppp multilink
- disable

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	show ppp multilink Example: Router# show ppp multilink	Displays information about Multilink PPP.
Step 3	disable Example: Router# disable	Exits to user EXEC mode.

Examples

The following example shows sample output from a **show ppp multilink** command:

```
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
```

Configuration Examples for MPLS—Multilink PPP Support

The following are configuration examples for the MPLS—Multilink PPP Support feature:

- [Sample MPLS—Multilink PPP Support Configurations, page 20](#)
- [Enabling CEF or Distributed CEF: Example, page 23](#)
- [Creating a Multilink Bundle: Example, page 23](#)
- [Assigning an Interface to a Multilink Bundle: Example, page 23](#)

Sample MPLS—Multilink PPP Support Configurations

The following examples show sample configurations for MLPPP on a Cisco 7200 router, a Cisco 7500 router, and on a CSC network. The configuration of MLPPP 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 21](#)
- [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 37.0.0.1 255.0.0.0
  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 37.0.0.2 255.0.0.0
  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 35.0.0.2 255.0.0.0
  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 31.0.0.0 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 35.0.0.1 remote-as 300
  neighbor 35.0.0.1 activate
  neighbor 35.0.0.1 as-override
  neighbor 35.0.0.1 advertisement-interval 5
  no auto-summary
  no synchronization
  exit-address-family

```

Enabling CEF or Distributed CEF: Example

The following example shows how to enable CEF for MLPPP configurations:

```
Router> enable
Router# configure terminal
Router(config)# ip cef
```

The following example shows how to enable dCEF for dMLPPP configurations:

```
Router> enable
Router# configure terminal
Router(config)# ip cef distribute
```

Creating a Multilink Bundle: Example

The following example shows how to create 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
```

Assigning an Interface to a Multilink Bundle: Example

The following example shows how to create four multilink interfaces with distributed CEF switching and MLPPP 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, page 24](#)
- [Standards, page 24](#)
- [MIBs, page 25](#)
- [RFCs, page 25](#)
- [Technical Assistance, page 25](#)

Related Documents

Related Topic	Document Title
Configuration tasks for Distributed MLPPP 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 the Diff-Serv-aware MPLS Traffic Engineering feature	Diff-Serv-aware MPLS Traffic Engineering (DS-TE)
Configuration tasks for the MPLS QoS multi-VC mode feature	MPLS QoS Multi-VC Mode for PA-A3
Configuration tasks for MPLS VPNs	MPLS Virtual Private Networks (VPNs)
Configuration tasks for MPLS VPN CSC	MPLS VPN Carrier Supporting Carrier
Configuration tasks for MPLS VPN CSC with IPv4 BGP label distribution	MPLS VPN—Carrier Supporting Carrier—IPv4 BGP Label Distribution
Configuration tasks for MPLS VPN Inter-AS with IPv4 BGP label distribution	MPLS VPN—Inter-AS—IPv4 BGP Label Distribution

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
Technical Assistance Center (TAC) home page, containing 30,000 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/public/support/tac/home.shtml

Glossary

bundle—A group of interfaces connected by parallel links between two systems that have agreed to do MLPPP over those links.

CBWFQ—class-based weighted fair queuing. A queuing option that extends the standard WFQ functionality to provide support for user-defined traffic classes.

CEF—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 CEF 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 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 IGRP, OSPF, and RIP.

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

IS-IS—Intermediate System-to-Intermediate System. An OSI link-state hierarchical routing protocol, based on DECnet Phase V routing, in which ISs (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 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 queuing. A QoS queuing 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).

MLPPP—Multilink Point-to-Point Protocol. A method of splitting, recombining, and sequencing datagrams across multiple logical links. The use of MLPPP 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 IGP routing algorithm proposed as a successor to 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, IPX, and ARA). PPP also has built-in security mechanisms (such as CHAP and PAP). PPP relies on two protocols: LCP and NCP.

RIP—Routing Information Protocol. A version of IGP that is supplied with UNIX BSD systems. RIP is the most common IGP in the Internet. It uses hop count as a routing metric.

RSP—Route Switch Processor. A processor module used in the Cisco 7500 series routers that integrates the functions of the Route Processor and the Switch Processor. The former contains the CPU, system software, and most of the router's memory components; the latter is a processor module that acts as the administrator for all Cisco Extended Bus activities.

VIP—Versatile Interface Processor. An interface card that is used in Cisco 7000 and Cisco 7500 series routers. It can hold different port adapters for interfaces to various media (Ethernet, Token Ring, FDDI, ATM, and so on). The VIP supports two port adapters, standard packet delivery, distributed CEF, and feature off-load.

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 queuing. 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 queuing method that ensures that high-precedence traffic has lower loss rates than other traffic during times of congestion.

**Note**

Refer to the Cisco *Dictionary of Internetworking Terms and Acronyms* for terms not included in this glossary.

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