Configuring MLPPP

The Multilink Point-to-Point (MLPPP) feature provides load balancing functionality over multiple WAN links, while providing multivendor interoperability, packet fragmentation and proper sequencing, and load calculation on both inbound and outbound traffic.

Note To get information on the basic configuration of MLPPP, see http://www.cisco.com/en/US/docs/ios/12_2/dial/configuration/guide/dafppp.html.

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 for MLPPP, on page 19.

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

Prerequisites

- Cisco IOS Release 15.2(2)SNI or a later release that supports the Multiprotocol Label Switching (MPLS) over MLPPP feature must be installed previously on the Cisco ASR 901 Series Aggregation Services Router.
- Cisco Express Forwarding (CEF) or distributed Cisco Express Forwarding (dCEF) should be enabled.

- MPLS should enabled on PE and P routers.
- Before enabling MPLS over MLPPP link, configure the following commands:
  - mpls label protocol ldp
  - mpls ip (configure this command over MLPPP link where IP address has been enabled)

Restrictions

- TE-FRR/LFA FRR feature is not supported on the MLPPP interface.
- Virtual Routing and Forwarding (VRF) configuration is not supported on the MLPPP interface.
- You need to shut down and bring up the MLPP interface for the following conditions:
  - On the fly fragmentation enable or disable
  - On the fly changes to the fragment size
  - Link fragmentation interleave
  - Enabling multiclass
- If the CPU command is modified when IS-IS is configured, you should remove and re-apply the service-policy in MLPPP.
- For MLPPP, you can use only up to 1500 maximum transmission unit (MTU) for control plane traffic from the router. Traffic drop is observed while sending ICMP packets over 1500 MTU with Do not Fragment (DF) bits.
- For data-plane traffic, the MTU configuration has no impact. Though you can configure Multilink Maximum Received Reconstructed Unit (MRRU) to any value, it does not serve any purpose to configure it above 1536, as MTU is hardcoded to 1536.
- For MPLS backbone, you can use only up to 1492 MTU with DF bit set, which results in 1492 MTU and 2 MPLS headers with DF. ICMP traffic drop is observed for anything beyond this.

MLPPP Optimization Features

The Cisco ASR 901 supports several features that improve the performance of Multilink Point-to-Point Protocol (MLPPP) connections and related applications such as IP over MLPPP. Some important features are given below:

Distributed Multilink Point-to-Point Protocol Offload

Distributed Multilink Point-to-Point Protocol (dMLPPP) allows you to combine T1 or E1 connections into a bundle that has the combined bandwidth of all of the connections in the bundle, providing improved capacity and CPU utilization over MLPPP. The dMLPPP offload feature improves the performance for traffic in dMLPPP applications such as IP over MLPPP by shifting processing of this traffic from the main CPU to the network processor.

The Cisco ASR 901 supports one serial links per T1/E1 connection and up to 16 MLPPP bundles. You can use the fixed T1/E1 ports to create up to 16 MLPPP links.

The Cisco ASR 901 implementation of multilink (dMLPPP) uses interleaving to allow short, delay-sensitive packets to be transmitted within a predictable amount of time. Interleaving allows the Cisco ASR 901 to interrupt the transmission of delay-insensitive packets in order to transmit delay-sensitive packets. You can

also adjust the responsiveness of the Cisco ASR 901 to delay-sensitive traffic by adjusting the maximum fragment size; this value determines the maximum delay that a delay-sensitive packet can encounter while the Cisco ASR 901 transmits queued fragments of delay-insensitive traffic.

Multiclass MLPPP

The Cisco ASR 901 implementation of dMLPPP also supports Multiclass MLPPP. Multiclass MLPPP is an extension to MLPPP functionality that allows you to divide traffic passing over a multilink bundle into several independently sequenced streams or classes. Each multiclass MLPPP class has a unique sequence number, and the receiving network peer processes each stream independently. The multiclass MLPPP standard is defined in RFC 2686.

The Cisco ASR 901 supports the following multiclass MLPPP classes:

- Class 0- Data traffic that is subject to normal MLPPP fragmentation. Appropriate for non-delay-sensitive traffic.
- Class 1- Data traffic that can be interleaved but not fragmented. Appropriate for delay-sensitive traffic such as voice.

You can use the QoS configuration to classify the LLQ traffic inorder to prioritize the Class 1 traffic and bandwidth queues for Class 0 traffic to guarantee bandwidth when multiclass multilink PPP (MCMP) is enabled.

Note By default, Multiclass MLPPP is enabled with two classes. Maximum number of classes supported is also two.

Note The Cisco ASR 901 does not support some PPP and MLPPP options when the bundle is offloaded to the network processor; you can retain these options by disabling MLPPP and IPHC offloading for a given bundle. For more information, see MLPPP Offload, on page 12.

Note The output for the **show ppp multilink** command for an offloaded MLPPP bundle differs from the output for a non-offloaded bundle.

MPLS over MLPPP

The Multiprotocol Label Switching (MPLS) support over Multilink PPP feature allows you to use labeled switch paths (LSPs) over MLPPP links. In a network with Ethernet and MLPPP connections, this feature supports MPLS over MLPPP links in the edge (PE-to-CE) or in the MPLS core (PE-to-PE and PE-to-P) or at the end of MPLS labeled path (CE-to-PE) as PE router.

Note QoS is not supported for MPLS over MLPPP.

This section contains the following topics:

MPLS Features Supported for MLPPP

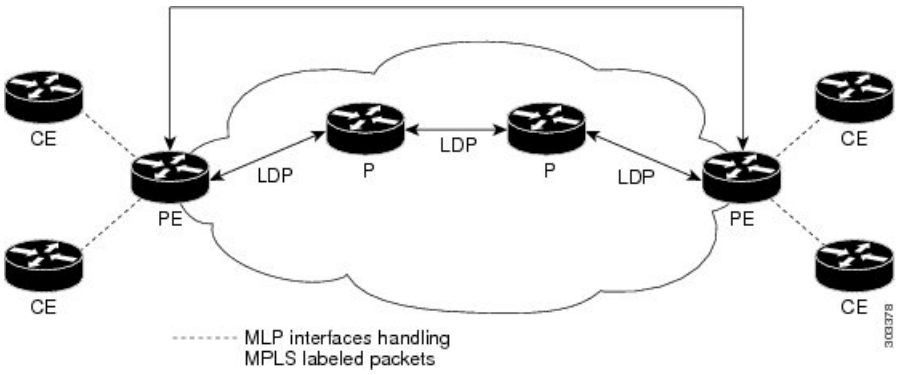
The following features are supported.

- MPLS Label imposition (LER)
- MPLS Label switching (LSR)
- MPLS VPN (L3VPN): User-Network Interface (UNI) on which virtual routing and forwarding (VRF) is configured should be switch virtual interface (SVI) on Gigabit interfaces and Network-to-Network Interface(NNI) can be MLPPP link
- Routing Protocols – ISIS/OSPF/BGP on MLPPP
- Label Distribution Protocol (LDP) as MPLS label protocol
- Equal Cost Multipath (ECMP) support on MLPPP links for IP to Tag (LER cases)

MPLS over MLPPP on PE-to-CE Links

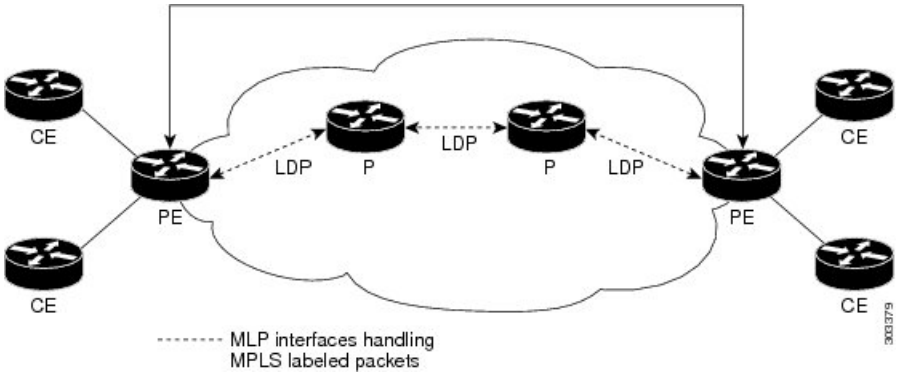
The following figure shows a typical MPLS network in which the PE router is responsible for label imposition (at ingress) and disposition (at egress) of the MPLS traffic.

In this topology, MLPPP is deployed on the PE-to-CE links.



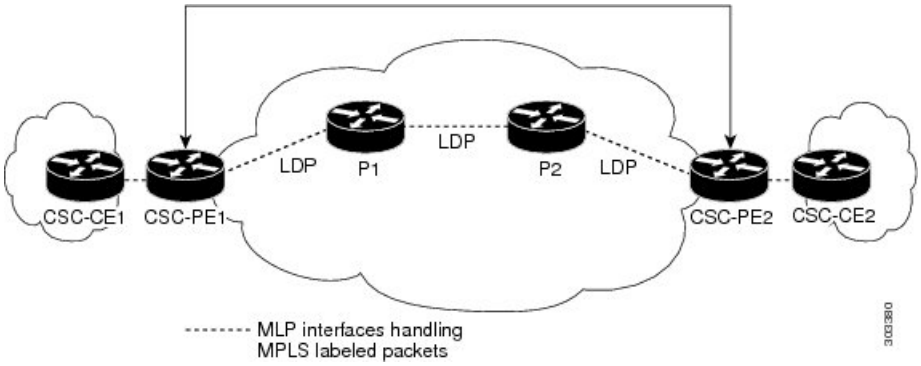
MPLS over MLPPP on Core Links

The following figure 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.



MPLS over MLPPP on CE to PE Links

The following figure shows a sample topology in which MPLS is deployed over MLPPP between CE and PE links with LDP.



Configuring MLPPP Backhaul

To configure an MLPPP backhaul, complete the following tasks:

Configuring the Card Type, E1 and T1 Controllers

For information on configuring the card type, E1 and T1 controllers, see Chapter 18, Configuring T1/E1 Controllers .

Configuring a Multilink Backhaul Interface

A multilink interface is a virtual interface that represents a multilink PPP bundle. The multilink interface coordinates the configuration of the bundled link, and presents a single object for the aggregate links. However, the individual PPP links that are aggregated must also be configured. Therefore, to enable multilink PPP on multiple serial interfaces, you first need to set up the multilink interface, and then configure each of the serial interfaces and add them to the same multilink interface.

Note In the following procedure, press the Return key after each step unless otherwise noted. At any time, you can exit the privileged level and return to the user level by entering disable at the Router# prompt.

The Cisco ASR 901 router can support up to 16 E1/T1 connections through the multilink interface, ranging from 16 bundles of one E1/T1 each to a single bundle containing 12 E1/T1 bundles.

Complete the following tasks to configure a multilink backhaul interface.

Creating a Multilink Bundle

Complete the following steps to create a multilink bundle:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables the privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters the global configuration mode.
Step 3	**interface multilink** *group-number* **Example:** `Router(config)# interface multilink5`	Creates a multilink bundle and enters the interface configuration mode: • *group-number*—Number of the multilink bundle. The example creates a multilink bundle 5. To remove a multilink bundle, use the no form of this command.
Step 4	**ipaddress** *address subnet mask* **Example:** `Router(config-if)# ip address 10.10.10.2 255.255.255.0`	Assigns an IP address to the multilink interface. • *address*— IP address. • *subnet mask*—Network mask of IP address. The example configures an IP address and subnet mask.
Step 5	**exit** **Example:** `Router(config-if)# exit`	Exits the configuration mode.

Configuring MRRU

You should configure the local maximum received reconstructed unit (MRRU) of the multilink bundle to a value greater than or equal to 1508 bytes(or equal to the maximum packet length expected on the bundle at any point in time). The maximum MTU supported on the Cisco ASR 901 router is 1536, and MTU drops occur when the packet length is more than 1536.

Complete the following steps to configure MRRU:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Router> enable`	
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface multilink** *multilink-bundle-number* **Example:** `Router(config)# interface multilink 1`	Creates a multilink bundle and enters the multilink interface configuration mode to configure the multilink bundle. • *multilink-bundle-number*—Number of the multilink bundle. The range is from 1 to 65535.
Step 4	**ppp multilink mrru local** *bytes* **Example:** `Router(config-if)# ppp multilink mrru local 1536`	Configures the MRRU value negotiated on a Multilink PPP bundle. • **local**—Configures the local MRRU value. • *bytes*—MRRU value, in bytes. Valid value range is 128 to 16384.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits configuration mode.

Configuring PFC and ACFC

Protocol-Field-Compression (PFC) and Address-and-Control-Field-Compression (AFC) are PPP compression methods defined in RFCs 1661 and 1662. PFC allows for compression of the PPP Protocol field; ACFC allows for compression of the PPP Data Link Layer Address and Control fields.

Follow these steps to configure PFC and ACFC handling during PPP negotiation to be configured. By default, PFC/ACFC handling is not enabled.

Note The recommended PFC and ACFC handling in the Cisco ASR 901 router is: acfc local request, acfc remote apply, pfc local request, and pfc remote apply.

Configuring PFC

Complete the following steps to configure PFC handling during PPP negotiation:

Procedure

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface multilink** *group-number* **Example:** `Router(config)# interface multilink5`	Creates a multilink bundle and enters the interface configuration mode: • *group-number*—Number of the multilink bundle. The example creates a multilink bundle 5. To remove a multilink bundle, use the no form of this command.
Step 4	**ppp pfc local** {**request** | **forbid**} **Example:** `Router(config-if)# ppp pfc local request`	Configures how the router handles PFC in its outbound configuration requests, use the **ppp pfc local** command. The syntax is as follows: • **request**—The PFC option is included in outbound configuration requests. • **forbid**—The PFC option is not sent in outbound configuration requests, and requests from a remote peer to add the PFC option are not accepted. The example shows how to create a method for the router to manage PFC.
Step 5	**ppp pfc remote** {**apply** | **reject** | **ignore**} **Example:** `Router(config-if)# ppp pfc remote apply`	Specifies how the router manages the PFC option in configuration requests received from a remote peer. The syntax is as follows: • **apply**—Specifies that PFC options are accepted and PFC may be performed on frames sent to the remote peer. • **reject**—Specifies that PFC options are explicitly ignored. • **ignore**—Specifies that PFC options are accepted, but PFC is not performed on frames sent to the remote peer. The example shows how to allow PFC options to be accepted.
Step 6	**exit** **Example:**	Exits configuration mode.

	Command or Action	Purpose
	`Router(config)# exit`	

Configuring ACFC

Complete the following steps to configure ACFC handling during PPP negotiation:

Procedure

	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	**interface multilink** *group-number* **Example:** `Router(config)# interface multilink 5`	Creates a multilink bundle and enter the interface configuration mode: • *group-number*—Number of the multilink bundle. The example creates a multilink bundle 5. To remove a multilink bundle, use the no form of this command.
Step 4	**ppp acfc local** {*request* | *forbid*} **Example:** `Router(config-if)# ppp acfc local request`	Specifies how the router handles ACFC in outbound configuration requests. The syntax is as follows: • *request*—Specifies that the ACFC option is included in outbound configuration requests. • *forbid*—Specifies that the ACFC option is not sent in outbound configuration requests, and requests from a remote peer to add the ACFC option are not accepted.
Step 5	**ppp acfc remote** {*apply* | *reject* | *ignore*} **Example:** `Router(config-if)# ppp acfc remote apply`	Specifies how the router handles the ACFC option in configuration requests received from a remote peer. The syntax is as follows: • *apply*—ACFC options are accepted and ACFC may be performed on frames sent to the remote peer. • *reject*—ACFC options are explicitly ignored.

	Command or Action	Purpose
		• *ignore*—ACFC options are accepted, but ACFC is not performed on frames sent to the remote peer. The example allows ACFC options to be accepted.
Step 6	**exit** **Example:** `Router(config)# exit`	Exit configuration mode.

Enabling Multilink and Identifying the Multilink Interface

Complete the following steps to enable multilink and identify the multilink interface:

Note If you modify parameters for an MLPPP bundle while it is active, the changes do not take effect until the Cisco ASR 901 renegotiates the bundle connection.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables the privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters the global configuration mode.
Step 3	**interface multilink** *group-number* **Example:** `Router(config-if)# interface multilink 5`	Creates the multilink group interface corresponding to the specified group number. This command enables the following commands under the interface multilink group number: **a. keepalive** **b. ppp multilink group** *group-number* where *group-number* is the Multilink group number. The example restricts (identifies) the multilink interface that can be negotiated to multilink interface 5.

	Command or Action	Purpose
Step 4	**keepalive** [*period*[*retries*]] **Example:** `Router(config-if)# keepalive 1 5`	Enables keepalive packets on the interface and specifies the number of times the keepalive packets are sent without a response before the router disables the interface. The syntax is as follows: • *period*—(Optional) Integer value in seconds greater than 0. The default is 10. Using 0 disables the keepalive option. • *retries*—(Optional) Specifies the number of times that the device will continue to send keepalive packets without response before bringing the interface down. Integer value greater than 1 and less than 255. If omitted, the value that was previously set is used; if no value was specified previously, the default of 5 is used.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits the configuration mode.

Configuring a Serial Interface as a Member Link of a MLPPP Group

Complete the following steps to configure a serial interface as a member link of a MLPPP group:

Procedure

	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	**interface serial slot/port:** *channel-group-number* **Example:** `Router(config-if)# interface serial 0/5:5`	Identifies and accesses the serial interface on the specified slot and port. • *channel-group-number*—The number to identify the channel group. The valid range is from 0–30 for E1 controllers and 0–23 for T1 controllers.

	Command or Action	Purpose
Step 4	**encapsulation ppp** **Example:** `Router(config-if)# encapsulation ppp`	Enables PPP encapsulation on the serial interface.
Step 5	**ppp multilink** **Example:** `Router(config-if)# ppp multilink`	Enables multilink PPP on the serial interface.
Step 6	**ppp multilink group** *group-number* **Example:** `Router(config-if)# ppp multilink group 5`	Configures the serial interface as a member link to the multilink interface identified by the group-number. • *group-number* —Multilink group number. The example identifies the multilink interface to which the serial interface should be bound to as a member-link.
Step 7	**exit** **Example:** `Router(config)# exit`	Exits configuration mode.

MLPPP Offload

By default, the Cisco ASR 901 router offloads processing for distributed MLPPP (dMLPPP) to the network processor for improved performance. However, the Cisco ASR 901 does not support some dMLPPP settings on offloaded bundles. The Cisco ASR 901 does not support the following options on offloaded dMLPPP bundles:

- **ppp multilink idle-link**
- **ppp multilink queue depth**
- **ppp multilink fragment maximum**
- **ppp multilink slippage**
- **ppp timeout multilink lost-fragment**

Note If you have a bundle that requires the use of these options, contact Cisco support for assistance.

Configuring Additional MLPPP Settings

You can perform a variety of other configurations on an MLPPP bundle, including the following:

- Modifying the maximum fragment size
- Modifying fragmentation settings
- Enabling or disabling fragmentation

- Enabling or disabling interleaving
- Configuring multiclass MLPPP

Note For more information about configuring MLPPP, see the Dial Configuration Guide, Cisco IOS Release 15.0S .

Configuring MPLS over the MLPPP on a Serial Interface

Complete the following steps to configure MPLS over the MLPPP link on a serial interface:

Procedure

	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	**interface serial** *slot/port:time-slot* **Example:** `Router(config-if)# interface Serial0/0:0`	Specifies a serial interface created on a channelized E1 or channelized T1 controller: • *slot*—Slot number where the channelized E1 or T1 controller is located. • *port*—Port number where the channelized E1 or T1 controller is located. • *time-slot* —For ISDN, the D channel time slot, which is the :23 channel for channelized T1 and the :15 channel for channelized E1. PRI time slots are in the range from 0 to 23 for channelized T1 and in the range from 0 to 30 for channelized E1.
Step 4	**no ip address** **Example:** `Router(config-if)# no ip address`	Disabled IP address processing.
Step 5	**encapsulation** *encapsulation-type* **Example:** `Router(config-if)# encapsulation ppp`	Configures the encapsulation method used by the interface. • *encapsulation-type*—Encapsulation type.

	Command or Action	Purpose
Step 6	**ppp multilink** **Example:** `Router(config-if)# ppp multilink`	Enables Multilink PPP on an interface .
Step 7	**ppp multilink group** *group-number* **Example:** `Router(config-if)# ppp multilink group 2`	Restricts a physical link to join only one designated multilink group interface. • *group-number*—Multilink-group number (a non-zero number).
Step 8	**exit** **Example:** `Router(config)# exit`	Exits interface configuration mode.

Configuring MPLS over MLPPP for OSPF

Complete the following steps to configure MPLS over the MLPPP link for OSPF:

Procedure

	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	**interface multilink** *group-number* **Example:** `Router(config)# interface multilink 2`	Creates the multilink group interface corresponding to the specified group number, and enters the interface configuration mode. • *group-number* —Multilink group number.
Step 4	**ip address** *ip-address* [*subnet mask*] **Example:** `Router(config-if)# ip address 11.11.11.2 255.255.255.0`	Assigns an IP address to the multilink interface. • *ip-address*—IP address. • *subnet mask*—Network mask of IP address.
Step 5	**ip ospf** *process-id* **area** *area-id*	Enables OSPF on an interface.

	Command or Action	Purpose
	Example: `Router(config-if)# ip ospf 10 area 0`	• *process-id*—A decimal value in the range from 1 to 65535. • *area-id*—A decimal value in the range from 0 to 4294967295, or an IP address.
Step 6	**ip ospf authentication null** **Example:** `Router(config-if)# ip ospf authentication null`	Specifies the authentication type for an interface. • **null** —No authentication is used. Useful for overriding password or message-digest authentication if configured for an area.
Step 7	**mpls ip** **Example:** `Router(config-if)# mpls ip`	Enables MPLS forwarding of IPv4 packets along normally routed paths for a particular interface.
Step 8	**no keepalive** **Example:** `Router(config-if)# no keepalive`	Disables keepalive packets.
Step 9	**ppp pfc local request** **Example:** `Router(config-if)# ppp pfc local request`	Configures protocol field compression (PFC) in configuration requests.
Step 10	**ppp pfc remote apply** **Example:** `Router(config-if)# ppp pfc remote apply`	Configures how the PFC option in configuration requests is received from a remote peer.
Step 11	**ppp multilink** **Example:** `Router(config-if)# ppp multilink`	Enables Multilink PPP on an interface.
Step 12	**ppp multilink group** *group-number* **Example:** `Router(config-if)# ppp multilink group 2`	Restricts a physical link to join only one designated multilink group interface. • *group-number* —Multilink-group number (a nonzero number).
Step 13	**ppp multilink endpoint string** *char-string* **Example:**	Restricts a physical link to join only one designated multilink group interface. • *char-string*—Character string.

	Command or Action	Purpose
	`Router(config-if)# ppp multilink endpoint string 22`	
Step 14	**exit** **Example:** `Router(config)# exit`	Exits interface configuration mode.
Step 15	**router ospf** *process-id* [**vrf** *vrf-name*] **Example:** `Router(config)# router ospf 1234`	Configures an OSPF routing process and enters the router configuration mode. • *process-id* — Internally used identification parameter for an OSPF routing process. It is locally assigned and can be any positive integer. A unique value is assigned for each OSPF routing process.
Step 16	**network** *ip-address wildcard-mask* **area** *area-id* **Example:** `Router(config-router)# network 6.6.6.6 0.0.0.0 area 2`	Configures the interfaces on which OSPF runs and to define the area ID for those interfaces. • *ip-address*—IP address. • *wildcard-mask* —IP-address-type mask that includes optional bits. • *area-id*—Area that is to be associated with the OSPF address range. It can be specified as either a decimal value or as an IP address. If you intend to associate areas with IP subnets, you can specify a subnet address as the value of the area-id argument. **Note** Repeat this step to configure different interfaces on which OSPF runs, and to define the area ID for those interfaces.
Step 17	**exit** **Example:** `Router(config-router)# exit`	Exits the router configuration mode.

Configuration Examples for MPLS over MLPPP

The following example shows a sample configuration of MPLS over MLPPP for OSPF.

```
Building configuration...
Current configuration : 234 bytes
!
interface Multilink2
```

```
ip address 11.11.11.2 255.255.255.0
ip ospf 1234 area 0
ip ospf authentication null
mpls ip
no keepalive
ppp pfc local request
ppp pfc remote apply
ppp multilink
ppp multilink group 2
ppp multilink endpoint string 22
router ospf 1234
network 6.6.6.6 0.0.0.0 area 2
network 11.11.11.0 0.0.0.255 area 0
network 12.12.12.0 0.0.0.255 area 2
```

The following example shows a sample configuration of MPLS over MLPPP for a Serial Interface.

```
Building configuration...
Current configuration : 101 bytes
!
interface Serial0/0:0
no ip address
encapsulation ppp
ppp multilink
ppp multilink group 2
```

The following example shows a sample configuration of MCMP enabled in MLPPP with classification based on DSCP

```
Configuring the class-map to match on priority queue (DSCP EF). When Priority percent is
configured, it expedites the Class 1 traffic.
class-map match-any DSCP_EF
match ip dscp ef
policy-map BCP_MLPPP
class  DSCP_EF
  priority percent 10
class class-default
  bandwidth percent 5
```

Verifying MPLS over MLPPP Configuration

To verify the configuration of MPLS over MLPPP, use the **following** commands as shown in the examples below:

```
Router# ping mpls ipv4 6.6.6.6/32
Sending 5, 100-byte MPLS Echos to 6.6.6.6/32,
     timeout is 2 seconds, send interval is 0 msec:
Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
  'L' - labeled output interface, 'B' - unlabeled output interface,
  'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
  'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
  'P' - no rx intf label prot, 'p' - premature termination of LSP,
  'R' - transit router, 'I' - unknown upstream index,
  'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
  'X' - unknown return code, 'x' - return code 0
Type escape sequence to abort.
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8 ms
Total Time Elapsed 40 ms
Router# show mpls ldp bindings 6.6.6.6 32
```

```
lib entry: 6.6.6.6/32, rev 8
        local binding:  label: 17
        remote binding: lsr: 6.6.6.6:0, label: imp-null


Router# traceroute mpls ipv4 6.6.6.6/32
Tracing MPLS Label Switched Path to 6.6.6.6/32, timeout is 2 seconds
Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
  'L' - labeled output interface, 'B' - unlabeled output interface,
  'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
  'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
  'P' - no rx intf label prot, 'p' - premature termination of LSP,
  'R' - transit router, 'I' - unknown upstream index,
  'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
  'X' - unknown return code, 'x' - return code 0
Type escape sequence to abort.
  0 11.11.11.1 MRU 1500 [Labels: implicit-null Exp: 0]
! 1 11.11.11.2 4 ms
```

Additional References

The following sections provide references related to MLPPP feature.

Related Documents

Related Topic	Document Title
Cisco IOS Commands	Cisco IOS Master Commands List, All Releases
Cisco ASR 901 Commands	Cisco ASR 901 Series Aggregation Services Router Command Reference
Cisco IOS Dial Technologies Configuration Guide	http://www.cisco.com/en/US/docs/ios/12_2/dial/configuration/guide/dafppp.html Configuring Media-Independent PPP and Multilink PPP
MPLS over MLPPP	MPLS—Multilink PPP Support

Standards

Standard	Title
None	—

MIBs

MIB	MIBs Link
None	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

RFC	Title
None	—

Technical Assistance

Description	Link
The Cisco Technical Support 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

Feature Information for MLPPP

Table 1: Feature Information for MLPPP, on page 19 lists the features in this module and provides links to specific configuration information.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn . An account on Cisco.com is not required.

Note Table 1: Feature Information for MLPPP, on page 19 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.

Table 1: Feature Information for MLPPP

Feature Name	Releases	Feature Information
MPLS over MLPPP	15.2(2)SNI	This feature was introduced on the Cisco ASR 901 routers. The following sections provide information about this feature: