ppp iphc max-period

To set the maximum number of compressed packets that can be sent before a full header when configuring Internet Protocol Header Compression (IPHC) control options over PPP, use the **ppp iphc max-period** command in interface configuration mode. To change the configuration, use the **no** form of this command.

ppp iphc max-period *packets*

no ppp iphc max-period *packets*

Syntax Description

packets	Maximum number of compressed packets that can be sent before a full header. The range is from 1 to 65,535 packets, and the default is 256 packets.

Command Default   256 packets

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced.

Usage Guidelines   There are two types of IP header compression used over PPP: Van Jacobsen header compression, which is defined in RFC 1332, and a newer compression type described in RFC 2509. The **ppp iphc** set of commands controls parameters that pertain to the form of IPHC described in RFC 2509.

The IPHC specification allows low speed links to run more efficiently when IP headers are extremely large. IPHC supports compressed Real-Time Transport Protocol (cRTP), compressed User Datagram Protocol (cUDP), and compressed Transaction Control Protocol (cTCP).

An IPHC-enabled interface sends only changes to the header instead of sending the entire header with every packet. At the beginning of a transmission, the transmitting end (the compressor) sends a full header packet to the receiving end (the decompressor). After the initial packet is sent, the compressor sends all other packets with headers that contain only the differences between them and the original full header. The decompressor maintains a copy of the original full header and reconstructs all the other packet headers by adding the changes to them.

The header data that is different with each packet is referred to as the session state, and is identified by a session ID or connection ID.

When the decompressor receives a compressed packet, it reconstructs the packet header by adding the difference to the saved uncompressed header. Typically, IPHC enables the header to be compressed to two bytes (four bytes if UDP checksums are used).

The following fields in a packet header usually remain the same throughout a transmission:

- IP source and destination addresses
- UDP and TCP source and destination ports
- RTP synchronization source (SSRC) fields

The following fields in a packet header usually change during a transmission:

- IP packet ID
- Checksum
- Sequence number
- RTP time stamp
- RTP marker bit

The **ppp iphc max-period** command is specifically related to an IPHC frame format known as *compressed_non_TCP*. The recovery of lost compressed_non_TCP frames on lossy links is much improved by allowing more full headers to flow and by configuring less compression.

Examples   The following example shows how to increase the maximum number of compressed packets that can be sent before a full header from 256 to 512 packets when configuring IPHC control options over PPP:

```
interface Multilink1
 ip address 10.100.253.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 ip tcp header-compression iphc-format
 no ip mroute-cache
 fair-queue 64 256 1000
 no cdp enable
 ppp multilink
 ppp multilink fragment-delay 20
 ppp multilink interleave
 multilink-group 1
 ip rtp header-compression iphc-format
 ip rtp priority 16384 50 64
 ppp iphc max-header 114
 ppp iphc max-time 10
 ppp iphc max-period 512
```

Related Commands

Command	Description
ip rtp header-compression	Enables TCP, UDP, and RTP (RFC 2509) header compression.
ip tcp header-compression	Enables TCP (RFC 1332) header compression.
ppp iphc max-header	Sets the maximum size of the largest IP header that may be compressed when configuring IPHC control options over PPP.
ppp iphc max-time	Sets the maximum number of compressed packets that can be sent before a full header when configuring IPHC control options over PPP.

ppp iphc max-time

To set the maximum time allowed between full headers when configuring Internet Protocol Header Compression (IPHC) control options over PPP, use the **ppp iphc max-time** command in interface configuration mode. To change the configuration, use the **no** form of this command.

>**ppp iphc max-time** *seconds*

>**no ppp iphc max-time** *seconds*

Syntax Description

seconds	Maximum time, in seconds, allowed between full headers. The range is from 1 to 255 seconds, and the default is 5 seconds.

Command Default   5 seconds

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced.

Usage Guidelines   There are two forms of IP header compression used over PPP: Van Jacobsen header compression, which is defined in RFC 1332, and a newer form of compression described in RFC 2509. The **ppp iphc** set of commands controls parameters that pertain to the form of IPHC described in RFC 2509.

The IPHC specification allows low speed links to run more efficiently by reducing the size of IP headers as transmitted on the link. IPHC supports compressed Real-Time Transport Protocol (cRTP), compressed User Datagram Protocol (cUDP), and compressed Transaction Control Protocol (cTCP).

An IPHC-enabled interface sends only changes to the header instead of sending the entire header with every packet. At the beginning of a transmission, the transmitting end (the compressor) sends a full header packet to the receiving end (the decompressor). After the initial packet is sent, the compressor sends all other packets with headers that contain only the differences between them and the original full header. The decompressor maintains a copy of the original full header and reconstructs all the other packet headers by adding the changes to them.

The header data that is different with each packet is referred to as the session state, and is identified by a session ID or connection ID.

When the decompressor receives a compressed packet, it reconstructs the packet header by adding the difference to the saved uncompressed header. Typically, IPHC enables the header to be compressed to two bytes (four bytes if UDP checksums are used).

The following fields in a packet header usually remain the same throughout a transmission:

- IP source and destination addresses
- UDP and TCP source and destination ports
- RTP synchronization source (SSRC) fields

The following fields in a packet header usually change during a transmission:

- IP packet ID
- Checksum
- Sequence number
- RTP time stamp
- RTP marker bit

The **ppp iphc max-time** command is specifically related to an IPHC frame format known as *compressed_non_TCP*. The recovery of lost compressed_non_TCP frames on lossy links is much improved by allowing more full headers to flow and by configuring less compression.

Examples

The following example shows how to change the number of compressed packets that can be sent before a full header from the default 5 seconds to 10 seconds:

```
interface Multilink1
 ip address 10.100.253.1 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 ip tcp header-compression iphc-format
 no ip mroute-cache
 fair-queue 64 256 1000
 no cdp enable
 ppp multilink
 ppp multilink fragment-delay 20
 ppp multilink interleave
 multilink-group 1
 ip rtp header-compression iphc-format
 ip rtp priority 16384 50 64
 ppp iphc max-header 114
 ppp iphc max-time 10
 ppp iphc max-period 512
```

Related Commands

Command	Description
ip rtp header-compression	Enables TCP, UDP, and RTP (RFC 2509) header compression.
ip tcp header-compression	Enables TCP (RFC 1332) header compression.
ppp iphc max-header	Sets the maximum size of the largest IP header that may be compressed when configuring IPHC control options over PPP.
ppp iphc max-period	Sets the maximum number of compressed packets that can be sent before a full header when configuring IPHC control options over PPP.

ppp lcp delay

To configure the link control protocol (LCP) delay timer for initiating LCP negotiations after a link connects and to configure the router to discard incoming setup requests until the LCP delay timer expires, use the **ppp lcp delay** command in interface configuration mode. To disable the LCP delay timer, use the **no** form of this command.

ppp lcp delay *seconds* [*milliseconds*] [**random** *max-delay-seconds*] [**discard**]

no ppp lcp delay

Syntax Description

seconds	Delay, in seconds, before initiating LCP negotiations. Valid values for the *seconds* argument range from 0 to 255. The default value is 2 seconds.
milliseconds	(Optional) Delay, in milliseconds, before initiating LCP negotiations. Valid values for the *milliseconds* argument range from 0 to 999. The default value is 0 milliseconds.
random *max-delay-seconds*	(Optional) Specifies that a random amount of additional time will be added to the configured LCP delay timer. The additional amount of time will not exceed the number of seconds specified with the *max-delay-seconds* argument. Valid values for *max-delay-seconds* range from 1 to 255. Random delay is disabled by default.
discard	(Optional) Specifies that incoming configuration requests (CONFREQs) will be discarded until the LCP delay timer has expired. CONFREQs are not discarded by default.

Command Default   No LCP delay timer is configured.

Command Modes   Interface configuration

Command History

Release	Modification
12.1	This command was introduced.
12.2(13)T	Support for the *milliseconds* argument was added to this command.
12.3(11)YS	Support for the **random** *max-delay-seconds* and **discard** keywords and argument was added to this command.

Usage Guidelines   Configure an LCP delay timer to allow the peer device a short amount of time to send the first packet after the PPP link comes up. If the LCP delay timer expires before a CONFREQ is received from the peer, the router can initiate LCP negotiations.

The LCP delay timer is applied only to incoming connections. PPP does not delay for outbound connections or connections where PPP cannot determine a direction.

Use the **random** *max-delay-seconds* keyword and argument combination add a random amount of time to the LCP delay timer. Setting a random delay on the initiation of LCP negotiations prevents overload when many PPP links come up at the same time.

Use the **discard** keyword to specify that incoming CONFREQs should be discarded until the configured delay has expired. LCP negotiations will not be initiated until the LCP delay timer has expired.

Examples

The following example configures an LCP delay timer of 4 seconds. If a CONFREQ is not received before the LCP delay timer expires, LCP negotiations can be initiated by either peer.

```
ppp lcp delay 4
```

The following example configures an LCP delay timer that will expire at a random time between 5 and 15 seconds after the link comes up. If a CONFREQ is not received before the LCP delay timer expires, LCP negotiations can be initiated by either peer.

```
ppp lcp delay 5 random 10
```

The following example configures an LCP delay timer of 3.25 seconds and specifies that incoming CONFREQs will be discarded until the LCP delay timer has expired. After 3.25 seconds, LCP negotiations can be initiated by either peer.

```
ppp lcp delay 3 250 discard
```

The following example configures an LCP delay timer that will expire at a random time between 10 and 15 seconds after the link comes up, and specifies that incoming CONFREQs will be discarded until the LCP delay timer has expired. After the LCP delay timer expires, negotiations can be initiated by either peer.

```
ppp lcp delay 10 random 5 discard
```

ppp lcp fast-start

To allow a PPP interface to respond immediately to incoming packets once a connection is established, use the **ppp lcp fast-start** command in interface configuration mode. To specify that PPP delay before responding, use the **no** form of this command.

ppp lcp fast-start

no ppp lcp fast-start

Syntax Description   This command has no arguments or keywords.

Command Default   Command is enabled by default.

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced.

Usage Guidelines   Some systems, typically those with external modems, may have problems with slow or electrically noisy hardware. If the **no ppp lcp fast-start** command is specified, PPP starts a debounce timer and waits for it to expire before attempting to communicate with the peer system, thereby reducing the probability of a false start on the interface.

If the **no ppp lcp fast-start** command is not specified, PPP will not use a debounce timer and will respond immediately to incoming packets once a connection is made.

The default fast start enabled state should not be disabled unless there is a problem with slow or electronically noisy hardware. This setting prevents PPP from waiting for a debounce timer to expire before responding to inbound frames.

Examples   The following example disables fast start:

```
no ppp lcp fast-start
```

ppp lcp predictive

To set the PPP link control protocol (LCP) to a predictive state that reduces negotiation time by predicting responses from peers and sending expected reply and request packets in advance, use the **ppp lcp predictive** command in interface configuration mode. To disable the LCP predictive state, use the **no** form of this command.

ppp lcp predictive

no ppp lcp predictive

Syntax Description   This command has no arguments or keywords.

Command Default   The PPP LCP is not set to a predictive state.

Command Modes   Interface configuration

Command History

Release	Modification
12.2(4)T	This command was introduced.
12.2(11)T	This command was integrated into Cisco IOS Release 12.2(11)T and support was added for the Cisco AS5300, Cisco AS5400 and Cisco AS5800.

Usage Guidelines   The **ppp lcp predictive** command is useful in networks that accept connections from devices that require a reduction in the LCP negotiation cycle time. This command reduces the amount of time needed for PPP to negotiate with the peer so that connections can be made in an acceptable amount of time. The following changes to the LCP negotiation strategy make this time reduction possible:

- Send an LCP Configure-Ack packet, then send the next-level LCP Configure-Request packet before receiving acknowledgment for the PPP Configure-Request packet.

- Send an LCP Configure-Ack packet after sending LCP Configure-Reject and Configure-Nak packets for certain configuration options.

These changes can reduce connection delay by approximately 40 percent.

The **ppp lcp predictive** command is configured on group asynchronous and dialer interfaces running PPP or Multilink PPP.

Examples   The following example sets LCP and Internet Protocol Control Protocol (IPCP) to predictive states on a dialer interface:

```
!
interface dialer 1
 ip unnumbered loopback 0
 encapsulation ppp
 dialer pool 1
 dialer idle-timeout 120000
```

```
dialer enable-timeout 6
dialer-group 1
peer default ip address pool LOCAL
no cdp enable
ppp lcp predictive
ppp ipcp predictive
ppp multilink
```

Related Commands	Command	Description
	interface dialer	Defines a dialer rotary group.
	interface group-async	Creates a group interface that will serve as master, to which asynchronous interfaces can be associated as members.
	ppp ipcp predictive	Sets IPCP to a predictive state that reduces negotiation time by predicting responses from peers and sending expected reply and request packets in advance.

ppp link reorders

To set an advisory flag that indicates the serial interface may receive packets in a different order than a peer system sent them, use the **ppp link reorders** command in interface configuration mode. To turn this flag off, use the **no** form of this command.

ppp link reorders

no ppp link reorders

Syntax Description   This command has no arguments or keywords.

Command Default   Command is disabled.

Command Modes   Interface configuration

Command History

Release	Modification
12.2	This command was introduced.

Usage Guidelines   The **ppp link reorders** command indicates that a link can receive packets in a different order than the peer system sent them. This situation can be encountered with PPP tunneling mechanisms such as Layer 2 Forwarding (L2F) and the Layer 2 Transport Protocol (L2TP) that do not always enforce strictly serial delivery of frames from source to final destination. Such links can pose problems for PPP features that depend upon in-order delivery of packets, such as compression, encryption, network header compression, and Multilink PPP.

Setting this option allows some PPP systems to compensate to an extent for the nonserial delivery of packets, although this compensation can incur a performance penalty. It is not normally necessary to configure the **ppp link reorders** command. PPP automatically recognizes that the condition exists for Virtual Private Network (VPN) tunnels, and the misdelivery situation will not occur on normal serial interfaces.

Examples   The following example sets the **ppp link reorders** command advisory flag:

```
ppp link reorders
```

ppp loopback ignore

To disable PPP loopback detection, use the **ppp loopback ignore** command in interface configuration mode. To reenable PPP loopback detection (the default condition), use the **no** form of this command.

>**ppp loopback ignore**

>**no ppp loopback ignore**

Syntax Description   This command has no arguments or keywords.

Command Default   Loopback detection is enabled.

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced as **ppp ignore-loopback**.
12.2(5)T	The **ppp loopback ignore** command replaced the **ppp ignore-loopback** command.

Usage Guidelines   A circuit loopback normally indicates faulty external switching equipment or wiring errors. The PPP protocol includes a mechanism that detects when a circuit is looped back, that is, when the circuit is fed back upon itself such that the router is reading its own output on that link. A first phase of loopback detection occurs during Link Control Protocol (LCP) negotiation when the circuit is being established. A loopback condition that occurs after the connection is made (after LCP negotiation) can be detected if link keepalives are enabled. If keepalives are disabled on the link, the second phase of loopback detection is not available.

The normal operation (default) is for PPP to check for a loopback condition and terminate the connection when a loopback is detected. There are, however, some situations where it is necessary to disable loopback detection, such as during certain testing situations, or when software detects problematic peers that do not implement the PPP protocol correctly. The **ppp loopback ignore** command disables normal operation; the **no ppp loopback ignore** command restores normal operation.

Note   Loopback detection depends upon successful negotiation of the LCP Magic Number option during link establishment. Some implementations may not support this option.

Examples   The following example shows PPP loopback detection being disabled:

```
interface Serial0:15
 description "PRI D channel"
 ip unnumbered Loopback0
 encapsulation ppp
 ppp loopback ignore
```

ppp loopback ignore

Related Commands	Command	Description
	keepalive	Configures a keepalive packet that is sent at a certain time interval, and for a certain number of retries if there is no response, to keep an interface active.

ppp max-bad-auth

To configure a point-to-point interface not to reset itself immediately after an authentication failure but instead to allow a specified number of authentication retries, use the **ppp max-bad-auth** command in interface configuration mode. To reset to the default of immediate reset, use the **no** form of this command.

ppp max-bad-auth *retries*

no ppp max-bad-auth

Syntax Description

retries	Number of retries after which the interface is to reset itself. Default is 0.

Command Default   The default is 0.

Command Modes   Interface configuration

Command History

Release	Modification
11.2	This command was introduced.

Usage Guidelines   This command applies to any serial interface (asynchronous serial, synchronous serial, or ISDN) on which PPP encapsulation is enabled.

Examples   The following example sets BRI interface 0 to allow two additional retries after an initial authentication failure (for a total of three failed authentication attempts):

```
interface bri 0
 encapsulation ppp
 ppp authentication chap
 ppp max-bad-auth 3
```

Related Commands

Command	Description
exec	Allows an EXEC process on a line.

ppp max-configure

To set the maximum number of attempts to send Configure-Request packets before it is assumed that the peer is unable to respond, use the **ppp max-configure** command in interface configuration mode. To return to the default, use the **no** form of this command.

ppp max-configure *attempts*

no ppp max-configure *attempts*

Syntax Description	*attempts*	Number of attempts allowed. Must be a number from 1 to 255. Default is 10 attempts with 1 packet sent per attempt.

Command Default   10 attempts (packets) and a default retry timeout period of 2 seconds

Command Modes   Interface configuration

Command History

Release	Modification
12.2T	This command was introduced.

Usage Guidelines   The **ppp max-configure** command sets the maximum number of Configure-Request packets that will be sent for any particular control protocol and that have gone unanswered before PPP will assume that the peer is unable to respond to the packets and will cease trying to negotiate that particular control protocol.

There is generally no reason to adjust the default maximum number of Configure-Request packets sent (attempts). The number might need to be increased slightly in the unlikely event that you are connecting to a peer that is slow to start negotiations of some protocol. Because the default is 10 packets (attempts), and the default retry timeout period is 2 seconds, a slow peer would be one that takes more than 20 seconds to start protocol negotiation.

For ordinary network control protocols (NCPs), the protocol will be put in a passive state whereby PPP will accept inbound negotiation packets, thereby giving the peer a chance to attempt negotiations later on.

If the Link Control Protocol (LCP) is used, then failure to negotiate LCP implies that the link will be reset. On a dialup connection, this reset will disconnect the call. For a leased-line connection, the reset will merely result in PPP attempting to restart after a short delay.

Note   None of the supported PPP authentication protocols conform to RFC 1661-style control protocols, and the protocols are not affected by the **ppp max-configure** command. Rather, the authentication protocol commands have their own set of commands to fine-tune control.

Examples   The following example returns the maximum number of attempts to send a Configure-Request packet to the default of 10:

```
interface Serial2/0
 ip address 192.168.1.131 255.255.255.0
 encapsulation ppp
 peer default ip address pool local local_pool
 serial restart-delay 0
 no ppp max-configure
```

Related Commands

Command	Description
ppp max-failure	Sets the maximum number of attempts to send Configure-NAK packets before it is assumed the peer is not converging.
ppp max-terminate	Sets the maximum number of attempts to send a Terminate-Request packet before PPP gives up waiting for the Terminate-Ack packet and stops the protocol.
ppp timeout retry	Sets PPP timeout retry parameters.

ppp max-failure

To set the maximum number of attempts to send Configure-NAK packets before it is assumed the peer is not converging, use the **ppp max-failure** command in interface configuration mode. To return to the default, use the **no** form of this command.

ppp max-failure *attempts*

no ppp max-failure *attempts*

Syntax Description

attempts	Number of attempts allowed. Must be a number from 1 to 255. Default is 5 attempts with one packet sent per attempt.

Command Default   5 attempts

Command Modes   Interface configuration

Command History

Release	Modification
12.2T	This command was introduced.

Usage Guidelines   Unless you have reason to believe that a control protocol that is slow to converge will actually converge if given more chances, there is no reason to increase the default value of this command.

The **ppp max-failure** command sets the maximum number of successive Configure-NAK packets (attempts) that will be sent for any control protocol before PPP will assume that the peer is unwilling or incapable of converging (adapting to its own negotiation parameters), and that the negotiation parameters will never succeed.

Once the maximum limit is reached, PPP will start sending Configure-Reject packets rather than Configure-NAK packets for the offending parameters. The peer's response to this action should be to stop sending the offending parameters.

Note   None of the supported PPP authentication protocols conform to RFC 1661-style control protocols, and the protocols are not affected by the **ppp max-failure** command. Rather, the authentication protocol commands have their own set of commands to fine-tune control.

Examples   The following example returns the maximum number of attempts to send a Configure-NAK packet to the default of 5:

```
interface Serial2/0
 ip address 192.168.1.131 255.255.255.0
 encapsulation ppp
 peer default ip address pool local local_pool
 serial restart-delay 0
 no ppp max-failure
```

Related Commands	Command	Description
	ppp max-configure	Sets the maximum number of attempts to send Configure-Request packets before it is assumed that the peer is unable to respond.
	ppp max-terminate	Sets the maximum number of attempts to send a Terminate-Request packet before PPP gives up waiting for the Terminate-Ack packet and stops the protocol.
	ppp timeout retry	Sets PPP timeout retry parameters.

ppp max-terminate

To set the maximum number of attempts to send Terminate-Request packets before PPP gives up waiting for the Terminate-Ack packet and stops the protocol, use the **ppp max-terminate** command in interface configuration mode. To return to the default, use the **no** form of this command.

ppp max-terminate *attempts*

no ppp max-terminate *attempts*

Syntax Description

attempts	Number of attempts allowed. Must be a number from 1 to 255. Default is 2 attempts with 1 packet sent per attempt.

Command Default   2 attempts

Command Modes   Interface configuration

Command History

Release	Modification
12.2T	This command was introduced.

Usage Guidelines   There is little reason to change the default value of the **ppp max-terminate** command. The action of PPP sending a Terminate-Request packet is mainly a courtesy to the peer system; the protocol itself will be terminated whether or not the peer acknowledges the request. Sending the Terminate-Request packet twice makes an allowance that a single instance could be lost in transit.

When PPP wants to terminate a control protocol, it sends a Terminate-Request packet and waits for a limited time for the peer to respond with a Terminate-Ack packet. This command sets the maximum number of attempts that will be made, that is, the maximum number of Terminate-Request packets that will be sent, before PPP gives up waiting for the Terminate-Ack packet and automatically stops the protocol.

Note   None of the supported PPP authentication protocols conform to RFC 1661-style control protocols, and the protocols are not affected by the **ppp max-terminate** command. Rather, the authentication protocol commands have their own set of commands to fine-tune control.

Examples   The following example returns the maximum number of attempts to send a Terminate-Request packet to the default of 2:

```
interface Serial2/0
 ip address 192.168.1.131 255.255.255.0
 encapsulation ppp
 peer default ip address pool local local_pool
 serial restart-delay 0
 no ppp max-terminate
```

Related Commands	Command	Description
	ppp max-configure	Sets the maximum number of attempts to send Configure-Request packets before it is assumed that the peer is unable to respond.
	ppp max-failure	Sets the maximum number of attempts to send Configure-NAK packets before it is assumed the peer is not converging.
	ppp timeout retry	Sets PPP timeout retry parameters.

ppp microcode

To enable hardware (microcode) PPP framing on an asynchronous interface, use the **ppp microcode** command in interface configuration mode. To disable hardware PPP framing on an asynchronous interface, use the **no** form of this command.

ppp microcode

no ppp microcode

Syntax Description   This command has no arguments or keywords.

Command Default   Hardware PPP framing on an asynchronous interface is enabled.

Command Modes   Interface configuration (config-if)

Command History

Release	Modification
12.4	This command was introduced.

Usage Guidelines   Do not use the **no** form of this command unless instructed to do so by Cisco Technical Assistance Center (TAC) or Cisco technical support.

Examples   The following example shows how to disable the **ppp microcode** command in interface configuration mode:

```
no ppp microcode
```

Related Commands

Command	Description
async mode dedicated	Places a line into dedicated asynchronous mode using **SLIP** or PPP encapsulation.
async mode interactive	Returns a line that has been placed into dedicated asynchronous network mode to interactive mode, thereby enabling the slip and **ppp** EXEC commands.
encapsulation ppp	Sets PPP as the encapsulation method used on the specified interfaces.
ppp multilink	Enables MLP on an interface and, optionally, enables BACP and its BAP subset for dynamic bandwidth allocation.

ppp mru match

To trigger Link Control Protocol (LCP) renegotiation on a maximum receive unit (MRU) mismatch on a system acting as an L2TP network server (LNS) and thereby enforce strict matching, use the **ppp mru match** command in interface configuration mode. To remove this setting, use the **no** form of this command.

ppp mru match

no ppp mru match

Syntax Description   This command has no arguments or keywords.

Command Default   This command is disabled by default.

Command Modes   Interface configuration

Command History

Release	Modification
12.2(12)T	This command was introduced.

Usage Guidelines   This command is configured only on virtual template interfaces.

By default, the LNS does not enforce matching of the MRU value advertised by the LAC with the MRU value that the LNS would advertise. Use the **ppp mru match** command to enforce strict matching of the MRU that is advertised by the Layer 2 Tunneling Protocol (L2TP) access concentrator (LAC) with the maximum transmission unit (MTU) of the relevant virtual template interface on the LNS. A mismatch can occur because the effective MRU size for a virtual access interface is not necessarily limited to the MTU size.

This command can be useful to inform the client PPP stack of the true MRU, when that PPP implementation is capable of adapting its MTU based on LCP MRU negotiation.

Examples   The following example shows LCP renegotiation being triggered on an MRU mismatch:

```
interface Virtual-Template1
 mtu 1454
 ppp mru match
 ip unnumbered GigabitEthernet0/1
 no keepalive
 peer default ip address pool mypool
 ppp authentication pap
```

Related Commands

Command	Description
ppp mtu adaptive	Defines autonegotiation of the MTU size for PPP.

ppp ms-chap refuse

To refuse Microsoft Challenge Handshake Authentication Protocol (MS-CHAP) authentication from peers requesting it, use the **ppp ms-chap refuse** command in interface configuration mode. To allow MS-CHAP authentication, use the **no** form of this command.

ppp ms-chap refuse [**callin**]

no ppp ms-chap refuse [**callin**]

Syntax Description	callin	(Optional) Specifies that the router will refuse to answer MS-CHAP authentication challenges received from the peer, but will still require the peer to answer any MS-CHAP challenges the router sends.

Command Default This command is disabled by default.

Command Modes Interface configuration

Command History	Release	Modification
	12.2T	This command was introduced.

Usage Guidelines This command specifies that MS-CHAP authentication is disabled for all calls, meaning that all attempts by the peer to force the user to authenticate using MS-CHAP will be refused. If the **callin** keyword is used, MS-CHAP authentication is disabled for incoming calls from the peer, but will still be performed on outgoing calls to the peer.

If outbound Password Authentication Protocol (PAP) has been enabled (using the **ppp pap sent-username** command), PAP will be suggested as the authentication method in the refusal packet.

Examples The following example shows how to disable MS-CHAP authentication if a peer calls in requesting MS-CHAP authentication. The method of encapsulation on interface ISDN BRI number 0 is PPP.

```
interface bri 0
 encapsulation ppp
 ppp ms-chap refuse
```

Related Commands	Command	Description
	aaa authentication ppp	Specifies one or more AAA authentication methods for use on serial interfaces running PPP.
	ppp authentication	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication are selected on the interface.

Command	Description
ppp authentication ms-chap-v2	Creates a pool of dialup routers that all appear to be the same host when authenticating with CHAP.
ppp chap password	Enables a router calling a collection of routers that do not support this command (such as routers running older Cisco IOS software images) to configure a common CHAP secret password to use in response to challenges from an unknown peer.
ppp chap wait	Specifies that the router will not authenticate to a peer requesting CHAP authentication until after the peer has authenticated itself to the router.
ppp pap sent-username	Reenables remote PAP support for an interface and use the sent-username and password in the PAP authentication request packet to the peer.

ppp ms-chap-v2 refuse

To refuse Microsoft Challenge Handshake Authentication Protocol (MS-CHAP) version 2 authentication from peers requesting it, use the **ppp ms-chap-v2 refuse** command in interface configuration mode. To allow MS-CHAP version 2 authentication, use the **no** form of this command.

ppp ms-chap-v2 refuse [**callin**]

no ppp ms-chap-v2 refuse [**callin**]

Syntax Description	callin	(Optional) Specifies that the router will refuse to answer MS-CHAP authentication challenges received from the peer, but will still require the peer to answer any MS-CHAP challenges the router sends.

Command Default This command is disabled by default.

Command Modes Interface configuration

Command History

Release	Modification
12.2T	This command was introduced.

Usage Guidelines This command specifies that MS-CHAP version 2 authentication is disabled for all calls, meaning that all attempts by the peer to force the user to authenticate using MS-CHAP version 2 will be refused. If the **callin** keyword is used, MS-CHAP version 2 authentication is disabled for incoming calls from the peer, but will still be performed on outgoing calls to the peer.

If outbound Password Authentication Protocol (PAP) has been enabled (using the **ppp pap sent-username** command), PAP will be suggested as the authentication method in the refusal packet.

Examples The following example shows how to disable MS-CHAP version 2 authentication if a peer calls in requesting MS-CHAP version 2 authentication. The method of encapsulation on interface ISDN BRI number 0 is PPP.

```
interface bri 0
 encapsulation ppp
 ppp ms-chap-v2 refuse
```

Related Commands

Command	Description
aaa authentication ppp	Specifies one or more AAA authentication methods for use on serial interfaces running PPP.
ppp authentication	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication are selected on the interface.

Command	Description
ppp authentication ms-chap-v2	Creates a pool of dialup routers that all appear to be the same host when authenticating with CHAP.
ppp chap password	Enables a router calling a collection of routers that do not support this command (such as routers running older Cisco IOS software images) to configure a common CHAP secret password to use in response to challenges from an unknown peer.
ppp chap wait	Specifies that the router will not authenticate to a peer requesting CHAP authentication until after the peer has authenticated itself to the router.
ppp pap sent-username	Reenables remote PAP support for an interface and use the sent-username and password in the PAP authentication request packet to the peer.

ppp mtu adaptive

To allow the Layer 2 Network Server (LNS) to adapt to the Maximum Transmission Unit (MTU) size for PPP based on the value set by the customer premises equipment (CPE), use the **ppp mtu adaptive** command in interface configuration mode. To return to the default setting, use the **no** form of this command.

> **ppp mtu adaptive** [**proxy**]
>
> **no ppp mtu adaptive** [**proxy**]

Syntax Description	proxy	(Optional) Adapts the MTU to the proxy MRU, that is, the MRU negotiated by a system such as an L2TP access concentrator (LAC) that has performed Link Control Protocol (LCP) negotiation on behalf of the Cisco router and forwarded the negotiated LCP options, including the MRU.

Command Default   Automatic adaption of the MTU size for PPP is not enabled.

Command Modes   Interface configuration

Command History	Release	Modification
	12.2(7)	This command was introduced.
	12.2(13)T	This command was integrated into Cisco IOS Release 12.2(13)T. The **proxy** keyword was added.
	12.3(14)T	This command was modified. Support was added for serial interfaces when the **proxy** keyword is not used.

Usage Guidelines   By default, the Cisco IOS software will not adapt the interface MTU to the peer or proxy MRU.

> **Note**   By default, the LNS does not renegotiate Link Control Protocol (LCP). If the LNS has a different MTU defined, the call setup experiences a failure. Use the **ppp mtu adaptive** command to adjust the LNS MRU value to the CPE's negotiated value with the LAC.

Use this command on interfaces where a number of peers with different MRU settings may connect. In Cisco IOS Release 12.2(7) and later releases, this command is configured on virtual template interfaces and dialer interfaces. In Cisco IOS Release 12.3(14)T and later releases, the **ppp mtu adaptive** command *without* the **proxy** keyword can be configured on serial interfaces.

The **proxy** keyword is not typically required. It is used only as a workaround when the client PPP stack cannot correctly advertise its MRU requirements.

Examples

The following example defines autonegotiation of the MTU size on a virtual template:

```
interface Virtual-Template1
 no ip address
 no logging event link-status
 no snmp trap link-status
 ppp mtu adaptive
 ppp authentication chap callin
```

Related Commands

Command	Description
lcp renogtiation always	Allows the LNS to renegotiate the PPP LCP on dial-in calls, using L2TP or L2F.
ppp mtu match	Triggers LCP renegotiation on an MRU mismatch.

ppp multilink

To enable Multilink PPP (MLP) on an interface and, optionally, to enable Bandwidth Allocation Control Protocol (BACP) and its Bandwidth Allocation Protocol (BAP) subset for dynamic bandwidth allocation, use the **ppp multilink** command in interface configuration mode. To disable Multilink PPP or, optionally, to disable only dynamic bandwidth allocation, use the **no** form of this command.

> **ppp multilink** [**bap**]

> **no ppp multilink** [**bap** [**required**]]

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> **ppp multilink**

> **no ppp multilink**

Syntax Description		
	bap	(Optional) Specifies bandwidth allocation control negotiation and dynamic allocation of bandwidth on a link.
	required	(Optional) Enforces mandatory negotiation of BACP for the multilink bundle. The multilink bundle is disconnected if BACP is not negotiated.

Defaults This command is disabled. When BACP is enabled, the defaults are to accept calls and to set the timeout pending at 30 seconds.

Command Modes Interface configuration (config-if)

Command History	Release	Modification
	11.1	This command was introduced.
	12.0(23)SX	This command was implemented on the Cisco 10000 series router.
	12.2(16)BX	This command was implemented on the ESR–PRE2.
	12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.
	Cisco IOS XE Release 2.5	This command was integrated into Cisco IOS XE Release 2.5.

Usage Guidelines This command applies only to interfaces that use PPP encapsulation.

MLP and PPP reliable links do not work together.

When the **ppp multilink** command is used, the first channel will negotiate the appropriate Network Control Protocol (NCP) layers (such as the IP Control Protocol and IPX Control Protocol), but subsequent links will negotiate only the link control protocol and MLP. NCP layers do not get negotiated on these links, and it is normal to see these layers in a closed state.

This command with the **bap** keyword must be used before configuring any **ppp bap** commands and options. If the **bap required** option is configured and a reject of the options is received, the multilink bundle is torn down.

The **no** form of this command without the **bap** keyword disables both MLP and BACP on the interface.

The **dialer load-threshold** command enables a rotary group to bring up additional links and to add them to a multilink bundle.

Before Cisco IOS Release 11.1, the **dialer-load threshold 1** command kept a multilink bundle of any number of links connected indefinitely, and the **dialer-load threshold 2** command kept a multilink bundle of two links connected indefinitely. If you want a multilink bundle to be connected indefinitely, you must set a very high idle timer.

> **Note** By default, after changing hostnames, an MLP member link does not undergo failure recovery automatically. You must use the **ppp chap hostname** command to define the MLP bundle name on an endpoint. If this command is not configured and the hostname is changed, then a link flap will not return the link back to the bundle.

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The **ppp multilink** command has no arguments or keywords.

Examples   The following partial example shows how to configure a dialer for MLP:

```
interface Dialer0
 ip address 10.0.0.2 255.0.0.0
 encapsulation ppp
 dialer in-band
 dialer idle-timeout 500
 dialer map ip 10.0.0.1 name atlanta broadcast 81012345678901
 dialer load-threshold 30 either
 dialer-group 1
 ppp authentication chap
 ppp multilink
```

Related Commands

Command	Description
compress	Configures compression for LAPB, PPP, and HDLC encapsulations.
dialer fast-idle (interface)	Specifies the idle time before the line is disconnected.
dialer-group	Controls access by configuring an interface to belong to a specific dialing group.
dialer load-threshold	Configures bandwidth on demand by setting the maximum load before the dialer places another call to a destination.
encapsulation ppp	Enables PPP encapsulation.
ppp authentication	Enables CHAP or PAP or both, and specifies the order in which CHAP and PAP authentication is selected on the interface.
ppp bap timeout	Specifies nondefault timeout values for PPP BAP pending actions and responses.
ppp chap hostname	Enables a router calling a collection of routers that do not support this command to configure a common CHAP secret password to use in response to challenges from an unknown peer.

Command	Description
ppp multilink fragment delay	Specifies a maximum time for the transmission of a packet fragment on a MLP bundle.
ppp multilink fragment disable	Disables packet fragmentation.
ppp multilink fragmentation	Sets the maximum number of fragments a packet will be segmented into before being sent over the bundle.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp multilink interleave	Enables MLP interleaving.
ppp multilink mrru	Configures the MRRU value negotiated on an MLP bundle.
ppp multilink slippage	Defines the constraints that set the MLP reorder buffer size.
show ppp bap	Displays the configuration settings and run-time status for a multilink bundle.

ppp multilink endpoint

To override or change the default endpoint discriminator the system uses when negotiating the use of Multilink PPP (MLP) with the peer, use the **ppp multilink endpoint** command in interface configuration mode. To restore the default endpoint discriminator, use the **no** form of this command.

> **ppp multilink endpoint** {**hostname** | **ip** *ip-address* | **mac** *lan-interface* | **none** |
> **phone** *telephone-number* | **string** *char-string*}

> **no ppp multilink endpoint**

Syntax Description		
hostname	Uses the host name configured for the router. This is useful when multiple routers are using the same username to authenticate, but have different host names.
ip *ip-address*	Uses the supplied IP address.
mac *lan-interface*	Uses the specified LAN interface whose MAC address is to be used.
none	Causes negotiation of the link control protocol without requesting the endpoint discriminator option. This is useful when the router is connected to a malfunctioning peer that does not handle the endpoint discriminator option properly.
phone *telephone-number*	Uses the supplied telephone number, and accepts E.164-compliant, full international telephone numbers.
string *char-string*	Uses the supplied character string.

Command Default   The default endpoint discriminator is the globally configured host name, or the Challenge Handshake Authentication Protocol (CHAP) host name or Password Authentication Protocol (PAP) sent-username configured on the interface. See the "Usage Guidelines" for additional information.

Command Modes   Interface configuration

Command History	Release	Modification
	12.2	This command was introduced.
	12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   By default, PPP uses the same string for the endpoint discriminator that it would provide for authentication to negotiate use of MLP with the peer. The string (username) is configured for the interface with the **ppp chap hostname** or **ppp pap sent-username** command, or defaults to the globally configured host name (or stack group name, if the interface is a Stack Group Bidding Protocol, or SGBP, group member). The keywords supplied with the **ppp multilink endpoint** command allow a different endpoint discriminator to be defined. You can reset the default condition by entering the **no ppp multilink endpoint** command.

The difference between the **no ppp multilink endpoint** command and the **ppp multilink endpoint hostname** command is that for the first command, MLP supplies the name used for authentication (which may or may not be the router host name), and the second command always uses the router host name, regardless of any local authentication configuration.

Both the **hostname** and **string** keywords use the local endpoint class, the differences between them being that the **string** keyword allows you to enter a value, while the **hostname** keyword uses the configured (default) host name.

Note Do not configure the **ppp multilink endpoint** command on MLP bundle interfaces. Configure this command on each interface that will be an MLP bundle member, not on the bundle interface itself.

Refer to RFC 1990 for more information about MLP and the endpoint discriminator option.

Examples The following partial example changes the endpoint discriminator from the CHAP host named group 1 to IP address 10.1.1.4:

```
.
.
.
interface Dialer0
 ip address 10.1.1.4 255.255.255.0
 encapsulation ppp
 dialer remote-name R-name
 dialer string 23456
 dialer pool 1
 dialer-group 1
 ppp chap hostname group 1
 ppp multilink endpoint ip 10.1.1.4
.
.
.
```

Related Commands

Command	Description
multilink bundle-name	Selects a method for naming multilink bundles.
ppp chap hostname	Creates a pool of dialup routers that all appear to be the same host when authenticating with CHAP.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp pap sent-username	Reenables remote PAP support for an interface and uses the sent-username and password in the PAP authentication request packet to the peer.
sgbp member	Specifies the host name and IP address of a router or access server that is a peer member of a stack group.

ppp multilink fragment delay

To specify a maximum time for the transmission of a packet fragment on a Multilink PPP (MLP) bundle, use the **ppp multilink fragment delay** command in interface configuration mode. To reset the maximum delay to the default value, use the **no** form of this command.

ppp multilink fragment delay *milliseconds* [*microseconds*]

no ppp multilink fragment delay

Syntax Description	*milliseconds*	Maximum amount of time, in milliseconds, that should be required to transmit a fragment. Valid values range from 0 to 1000 milliseconds. The default is 30 milliseconds.
		Note If the desired delay should be in microseconds, set the *milliseconds* argument to 0 and enter a value for the *microseconds* argument.
	microseconds	(Optional) Maximum amount of time, in microseconds, that should be required to transmit a fragment. Valid values range from 1 to 999 microseconds.

Command Default The default value is 30 milliseconds if interleaving is enabled or if the bundle contains links that have differing bandwidths. See the "Usage Guidelines" for more information.

Command Modes Interface configuration

Command History	Release	Modification
	11.3	This command was introduced as **ppp multilink fragment-delay**.
	12.2	This command was changed to **ppp multilink fragment delay**.
	12.4(4)T	Support for the *microseconds* argument was added.
	12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines By default, MLP has no fragment size constraint. Packets are divided into a number of fragments based on the number of links in the bundle. The size of any fragment is unconstrained, but the maximum number of fragments is constrained by the number of links. If interleaving is enabled, if the bundle contains links that have differing bandwidths, or if a fragment delay is explicitly configured with the **ppp multilink fragment delay** command, then MLP uses a different fragmentation algorithm. In this mode, the number of fragments is unconstrained, but the size of each fragment is limited to the fragment delay value, or 30 milliseconds if the fragment delay has not been configured.

The **ppp multilink fragment delay** command is useful when packets are interleaved and traffic characteristics such as delay, jitter, and load balancing must be tightly controlled.

The **ppp multilink fragment delay** command applies only to multilink interfaces that can configure a bundle interface, including multilink interfaces, virtual templates, dialer interfaces, and ISDN BRI or PRI interfaces.

The value assigned to the *milliseconds* or *microseconds* argument is scaled by the speed at which a link can convert the time value into a byte value. If a bundle has multiple links with varying speeds, the absolute size of a fragment will differ for each link.

MLP chooses a fragment size on the basis of the maximum delay allowed. If real-time traffic requires a certain maximum bound on delay, using this command to set that maximum time can ensure that a real-time packet will get interleaved within the fragments of a large packet.

Examples   The following example configures a maximum fragment delay of 20 milliseconds:

```
ppp multilink fragment delay 20
```

The following example configures a maximum fragment delay of 500 microseconds (1/2 millisecond):

```
ppp multilink fragment delay 0 500
```

Related Commands

Command	Description
ppp multilink	Enables MLP on an interface and, optionally, enables dynamic bandwidth allocation.
ppp multilink fragment disable	Enables or suppresses packet fragmentation on an MLP bundle.
ppp multilink fragment size	Specifies the maximum packet fragment size in bytes for a MLP link.
ppp multilink fragmentation	Sets the maximum number of fragments a packet will be segmented into before being sent over the bundle.
ppp multilink interleave	Enables MLP interleaving.

ppp multilink fragment disable

To disable packet fragmentation, use the **ppp multilink fragment disable** command in interface configuration mode. To enable fragmentation, use the **no** form of this command.

ppp multilink fragment disable

no ppp multilink fragment disable

Syntax Description   This command has no arguments or keywords.

Command Default   Fragmentation is enabled.

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced as **ppp multilink fragmentation**.
12.2	The **no ppp multilink fragmentation** command was changed to **ppp multilink fragment disable**. The **no ppp multilink fragmentation** command was recognized and accepted through Cisco IOS Release 12.2.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   The **ppp multilink fragment delay** and **ppp multilink interleave** commands have precedence over the **ppp multilink fragment disable** command. Therefore, the **ppp multilink fragment disable** command has no effect if these commands are configured for a multilink interface and the following message displays:

```
Warning: 'ppp multilink fragment disable' or 'ppp multilink fragment maximum' will be
ignored, since multilink interleaving or fragment delay has been configured and have
higher precedence.
```

To completely disable fragmentation, you must do the following:

```
Router(config-if)# no ppp multilink fragment delay
Router(config-if)# no ppp multilink interleave
Router(config-if)# ppp multilink fragment disable
```

Disable multilink fragmentation using the **ppp multilink fragment disable** command if fragmentation causes performance degradation. Performance degradation due to multilink fragmentation has been observed with asynchronous member links.

Examples   The following example disables packet fragmentation:

```
ppp multilink fragment disable
```

Related Commands

Command	Description
ppp multilink fragment delay	Specifies a maximum size, in units of time, for packet fragments on an MLP bundle.
ppp multilink interleave	Enables MLP interleaving.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp multilink mrru	Configures the Maximum Receive Reconstructed Unit (MRRU) value negotiated on a Multilink PPP (MLP) bundle.

ppp multilink fragment maximum

To set the maximum number of fragments a packet will be segmented into before being sent over the bundle, use the **ppp multilink fragment maximum** command in interface configuration mode. To reset fragmentation to the default value, use the **no** form of this command.

ppp multilink fragment maximum *fragments*

no ppp multilink fragment maximum

Syntax Description

fragments	Maximum number of fragments in the range from 2 to 16.

Command Default   16 fragments

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced as **multilink max-fragments**.
12.2	This command was changed to **ppp multilink fragment maximum**. The **multilink max-fragments** command was accepted by the command line interpreter through Cisco IOS Release 12.2.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   Use the **ppp multilink fragment maximum** command to control the number of fragments into which a PPP frame may be fragmented. The **ppp multilink fragment maximum** command has been used to disable fragmentation entirely by setting the number of fragments to 1. This setting is better accomplished using the **ppp multilink fragment disable** command.

The limit set using the **ppp multilink fragment maximum** command applies only when Multilink PPP (MLP) is fragmenting packets in a mode where it is constraining the number of fragments rather than the size of the fragments. See the description about fragmentation modes in the section "Usage Guidelines" of the **ppp multilink fragment delay** command for more details.

Examples   The following example uses the **ppp multilink fragment maximum** command to fragment each frame into no more than four fragments:

```
ppp multilink fragment maximum 4
```

Related Commands

Command	Description
ppp multilink fragment delay	Specifies a maximum size, in units of time, for packet fragments on an MLP bundle.
ppp multilink fragment disable	Disables packet fragmentation.

ppp multilink fragment size

To specify the maximum packet fragment size in bytes for a Multilink PPP (MLP) link, use the **ppp multilink fragment size** command in interface configuration mode. To remove a configured fragment size limitation, use the **no** form of this command.

ppp multilink fragment size *bytes*

no ppp multilink fragment size

Syntax Description

bytes	Maximum number of bytes per fragment that will be transmitted over this link, not including link layer and multilink overhead.

Command Default   No maximum fragment size is set.

Command Modes   Interface configuration

Command History

Release	Modification
12.4(4)T	The command was introduced.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   Use the **ppp multilink fragment size** command to specify a maximum fragment size that is smaller than the size automatically computed by the value set with the **ppp multilink fragment delay** command. The **ppp multilink fragment size** command may be configured on the bundle interface or on the member links. If the command is configured on the bundle interface, the same fragment size is used by all of the links in the bundle. If it is configured in both places, the configuration on the member link takes precedence.

Examples   The following example configures a maximum fragment size of 100 bytes, not including link layer or multilink header overhead:

```
ppp multilink fragment size 100
```

Related Commands

Command	Description
ppp multilink	Enables MLP on an interface and, optionally, enables dynamic bandwidth allocation.
ppp multilink fragment delay	Specifies a maximum time for the transmission of a packet fragment on a MLP bundle.
ppp multilink fragment disable	Enables or suppresses packet fragmentation on an MLP bundle.

Command	Description
ppp multilink fragmentation	Sets the maximum number of fragments a packet will be segmented into before being sent over the bundle.
ppp multilink interleave	Enables MLP interleaving.

ppp multilink fragmentation

The **ppp multilink fragmentation** command is replaced by the **ppp multilink fragment disable** command. See the description of the **ppp multilink fragment disable** command for more information.

ppp multilink group

To restrict a physical link to join only one designated multilink group interface, use the **ppp multilink group** command in interface configuration mode. To remove this restriction, use the **no** form of this command.

> **ppp multilink group** *group-number*

> **no ppp multilink group**

Syntax Description

group-number	Multilink-group number (a nonzero number).

Command Defaults   If the **ppp multilink** command is configured on an interface, the interface can join any multilink group. If the **ppp multilink** command is not configured on an interface, the interface cannot join a multilink group.

Command Modes   Interface configuration (config-if)

Command History

Release	Modification
12.0	This command was introduced as the **multilink-group** command on the PRE1 for the Cisco10000 series router.
12.2	This command was changed to **ppp multilink group**. The **multilink-group** command is accepted by the CLI through Cisco IOS Release 12.2.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.
12.2(31)SB2	This command was implemented on the PRE3 for the Cisco10000 series router.

Usage Guidelines   When the **ppp multilink group** command is configured on an interface, the interface is restricted from joining any interface but the designated multilink group interface. If a peer at the other end of the interface tries to join a different multilink group, the connection is severed. This restriction applies when Multilink PPP (MLP) is negotiated between the local end and the peer system. The interface can still come up as a regular PPP interface.

The **ppp multilink group** command cannot be configured on an interface if the multilink group interface is not configured.

To modify the multilink group configuration on a serial interface, the existing PPP multilink group configuration must be removed from the serial interface.

When the multilink group interface is removed, the PPP multilink group configuration is removed from all the member links that have joined the specified multilink group.

The **ppp multilink group** command is primarily used with the MLP inverse multiplexer as described in the "Configuring Media-Independent PPP and Multilink PPP" chapter in the *Dial Technologies Configuration Guide*.

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The group-number option of the **ppp multilink group** command identifies the multilink group. This number must be identical to the multilink-bundle-number that you assign to a multilink interface. Valid group numbers are:

- MLP over serial-based Link Fragmentation and Interleaving (LFI)
    - 1 to 9999 (Cisco IOS Release 12.2(28)SB and later releases)
    - 1 to 2,147,483,647 (Cisco IOS Release 12.2(31)SB2 and later releases)
- Single-VC MLP over ATM-based LFI
    - 10,000 and higher
- Multi-VC MLP over ATM-based LFI
    - 1 to 9999 (Cisco IOS Release 12.2(28)SB and later releases)
    - 1 to 2,147,483,647 (Cisco IOS Release 12.2(31)SB2 and later releases)
- MLP over Frame Relay based LFI
    - 10,000 and higher

Examples

The following example shows how to configure a multilink group interface and configure a serial link to join the multilink group interface:

```
Router(config)# interface multilink 1
Router(config-if)# ip address 192.0.2.1 255.255.255.224
Router(config-if)# encapsulation ppp
Router(config-if)# exit
Router(config)# interface serial 1
Router(config-if)# encapsulation ppp
Router(config-if)# ppp multilink group 1
Router(config-if)# ppp multilink
Router(config-if)# exit
```

The following sample error message is displayed when a PPP multilink group is configured on a serial link before the multilink group interface is configured:

```
Router(config)# interface serial 2
Router(config-if)# ppp multilink group 2
% Multilink group interface does not exist. Please create a group interface first
```

The following sample error message is displayed when the multilink group configuration on a serial link is modified before the existing multilink group configuration is removed:

```
Router# show running-config interface serial4/0

Building configuration...

Current configuration : 188 bytes
!
interface Serial4/0
 no ip address
 encapsulation ppp
 ppp multilink
 ppp multilink group 1
 ppp multilink fragment size 1000
 ppp multilink mrru local 1524
 serial restart-delay 0
end
```

```
Router# configure terminal
Router(config)# interface serial4/0
Router(config-if)# ppp multilink group 4
% Link is already part of Multilink1 group interface. Please detach it from the group
interface first.
```

The following sample output displays the serial interface configuration before and after the removal of the multilink group interface:

```
Router# show running-config interface serial5/0

Building configuration...
Current configuration : 188 bytes
!
interface Serial5/0
 no ip address
 encapsulation ppp
 ppp multilink
 ppp multilink group 1
 ppp multilink fragment size 1000
 ppp multilink mrru local 1524
 serial restart-delay 0
end

Router# configure terminal
Router(config)# no interface Multilink 1
% Please 'shutdown' this interface before trying to delete it
Router(config)# interface Multilink 1
Router(config-if)# shutdown
Router(config-if)#
*Aug  2 17:35:11.825: %LINK-5-CHANGED: Interface Multilink1, changed state to
administratively down
*Aug  2 17:35:11.826: %LINEPROTO-5-UPDOWN: Line protocol on Interface Multilink1, changed
state to down
*Aug  2 17:35:11.869: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial5/0, changed
state to down
*Aug  2 17:35:11.869: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial4/0, changed
state to down
Router(config-if)# exit
Router(config)#
*Aug  2 17:35:15.908: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial5/0, changed
state to up
*Aug  2 17:35:15.908: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial4/0, changed
state to up
Router(config)# no interface Multilink1
% The multilink group configuration will be removed from all the member links.
!
Router# show running-config interface serial5/0

Building configuration...
Current configuration : 165 bytes
!
interface Serial5/0
 no ip address
 encapsulation ppp
 ppp multilink
 ppp multilink fragment size 1000
 ppp multilink mrru local 1524
 serial restart-delay 0
end
```

Related Commands

Command	Description
encapsulation ppp	Enables PPP encapsulation on a serial interface.
interface multilink	Creates a multilink bundle or enters multilink interface configuration mode.
ip address	Configures an IP address for an interface.
ppp multilink	Enables an MLP on an interface.

ppp multilink idle-link

To configure a multilink bundle so that the slowest link enters into receive-only mode when a link is added, use the **ppp multilink idle-link** command in interface configuration mode. To remove the idle link flag, use the **no** form of this command.

ppp multilink idle-link

no ppp multilink idle-link

Syntax Description   This command has no arguments or keywords.

Command Default   The idle link flag is not set.

Command Modes   Interface configuration

Command History

Release	Modification
11.3T	This command was introduced.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   When the idle link flag is enabled, Multilink PPP (MLP) places the slowest link in a bundle into an idle receive-only mode whenever the bundle has more than one link.

This mode is used for the Always On/Dynamic ISDN (AO/DI) feature, where a bundle contains one permanent slow-speed member link, which is on an X.25 circuit contained on an ISDN D channel. As additional and faster links join the MLP bundle, the D channel circuit will be idled and traffic will be confined to the faster links.

The **ppp multilink idle-link** command was intended specifically to enable the AO/DI feature. The command will work on any bundle, but normally should not be used outside the AO/DI environment.

Examples   The following example configures the interface (dialer interface 1) to add links to the MLP bundle once the traffic load on the primary link is reached:

```
interface dialer1
 ppp multilink idle-link
```

Related Commands

Command	Description
ppp multilink	Enables MLP on an interface and, optionally, enables dynamic bandwidth allocation.
ppp multilink fragment delay	Specifies a maximum time for the transmission of a packet fragment on an MLP bundle.
ppp multilink fragment disable	Disables packet fragmentation.

Command	Description
ppp multilink fragmentation	Sets the maximum number of fragments a packet will be segmented into before being sent over the bundle.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp multilink interleave	Enables MLP interleaving.

ppp multilink interleave

To enable interleaving of packets among the fragments of larger packets on a Multilink PPP (MLP) bundle, use the **ppp multilink interleave** command in interface configuration mode. To disable interleaving, use the **no** form of this command.

> **ppp multilink interleave**

> **no ppp multilink interleave**

Syntax Description This command has no arguments or keywords.

Command Default Interleaving is disabled.

Command Modes Interface configuration

Command History

Release	Modification
11.3	This command was introduced.
12.0(23)SX	This command was implemented on the Cisco 10000 series router.
12.2(4)T	This command was implemented on the Versatile Interface Processor (VIP)-enabled Cisco 7500 series routers as part of the Distributed Link Fragmentation and Interleaving (dLFI) feature. The Distributed Link Fragmentation and Interleaving feature introduced this command for ATM and Frame Relay only.
12.2(8)T	This command was implemented for leased lines on VIP-enabled Cisco 7500 series routers.
12.0(24)S	This command was implemented for leased lines on VIP-enabled Cisco 7500 series routers. This command cannot be used for ATM and Frame Relay using Cisco IOS Release 12.0S.
12.2(14)SX	This command was implemented for leased lines on the Cisco 7600 series routers and Catalyst 6500 series switches with a FlexWAN.
12.2(28)SB2	This command was integrated into Cisco IOS Release 12.2(28)SB2.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines The **ppp multilink interleave** command applies only to interfaces that can configure a bundle interface, such as virtual templates, dialer interfaces, multilink interfaces, and ISDN BRI or PRI interfaces.

Interleaving works only when the queuing mode on the bundle has been set to fair queuing (all platforms *except* the VIP-enabled Cisco 7500 series routers) or to distributed low latency queuing (dLLQ) for the VIP-enabled Cisco 7500 series routers.

On the VIP-enabled Cisco 7500 series routers, distributed Cisco Express Forwarding (dCEF) must be enabled, and dLLQ must be configured using the **priority** command in policy map configuration mode, before **ppp multilink interleave** command is used.

For all platforms except the VIP-enabled Cisco 7500 series routers, the **ppp multilink interleave** command should not be set unless weighted fair queuing (WFQ) has been configured using the default **fair-queue** command.

If interleaving is enabled when fragment delay is not configured, the default delay is 30 milliseconds. The fragment size is derived from that delay, depending on the bandwidths of the links.

Examples   The following example defines a virtual interface template that enables MLP interleaving and a maximum real-time traffic delay of 20 milliseconds, and then applies that virtual template to the MLP bundle:

```
interface virtual-template 1
 ip unnumbered ethernet 0
 ppp multilink
 ppp multilink interleave
 ppp multilink fragment delay 20
!
multilink virtual-template 1
```

The following example shows the configuration of LFI using MLP running on top of a PPP link over Frame Relay using a virtual template interface:

```
class-map voip
 match ip precedence 5
!
class-map business
 match ip precedence 3
!
policy-map llq-policy
 class voip
  priority 32
 class business
  bandwidth 32
!
policy-map shape-llq-policy
 class class-default
  shape average 80000 320 320
  service-policy llq-policy
!
policy-map input-policy
 class voip
  police 32000 1500 1500 conform-action transmit exceed-action drop
!
controller T1 5/1/0
 framing esf
 linecode b8zs
 channel-group 0 timeslots 1-2
!
interface Serial5/1/0:0
 no ip address
 encapsulation frame-relay
!
interface Serial5/1/0:0.1 point-to-point
 frame-relay interface-dlci 20 ppp Virtual-Template2
!
interface Virtual-Template2
 bandwidth 78
 ip unnumbered Loopback1
 no keepalive
 service-policy output llq-policy
 service-policy input input-policy
```

```
ppp multilink
ppp multilink fragment-delay 8
ppp multilink interleave
```

The following example shows the configuration of LFI using MLP running on top of a PPPoATM link on an ATM interface. This configuration uses a virtual template interface.

```
class-map voip
 match ip precedence 5
!
class-map business
 match ip precedence 3
!
policy-map llq-policy
 class voip
  priority 32
 class business
  bandwidth 32
!
policy-map input-policy
 class voip
  police 32000 1500 1500 conform-action transmit exceed-action drop
!
interface ATM4/0/0
 no ip address
 no atm ilmi-keepalive
!
interface ATM4/0/0.1 point-to-point
 pvc 0/34
 abr 100 80
 protocol ppp Virtual-Template4
!
interface Virtual-Template4
 bandwidth 78
 ip unnumbered Loopback1
 service-policy output llq-policy
 service-policy input input-policy
 ppp multilink
!
class-map voip
 match ip precedence 5
!
class-map business
 match ip precedence 3
!
policy-map llq-policy
 class voip
  priority 32
 class business
  bandwidth 32
!
policy-map input-policy
 class voip
  police 32000 1500 1500 conform-action transmit exceed-action drop
!
interface ATM4/0/0
 no ip address
 no atm ilmi-keepalive
!
interface ATM4/0/0.1 point-to-point
 pvc 0/34
 abr 100 80
 protocol ppp Virtual-Template4
!
```

```
interface Virtual-Template4
 bandwidth 78
 ip address 10.0.0.2 255.0.0.0
 service-policy output llq-policy
 service-policy input input-policy
 ppp multilink
 ppp multilink fragment-delay 8
 ppp multilink interleave
```

The following example shows the configuration of LFI over a leased line:

```
class-map voip
 match ip precedence 5
!
class-map business
 match ip precedence 3
!
policy-map llq-policy
 class voip
  priority 32
 class business
  bandwidth 32
!
policy-map input-policy
 class voip
  police 32000 1500 1500 conform-action transmit exceed-action drop
!
controller T1 5/1/0
 channel group 0 timeslots 1-2
!
interface multilink 2
 ip address 172.16.0.0 255.0.0.0
 keepalive 5
 bandwidth 128
 ppp multilink
 ppp multilink fragment-delay 8
 ppp multilink interleave
 service-policy output llq-policy
 service-policy input input-policy
 multilink-group 2
!
interface serial5/0/0:0
 no ip address
 encapsulation ppp
 keepalive 5
 ppp chap hostname G2
 ppp multilink
 multilink-group 2
```

The following example shows a simple leased-line interleaving configuration using a virtual access interface bundle and default WFQ:

```
multilink virtual-template 10
!
interface serial0
 no ip address
 encapsulation ppp
 ppp multilink
!
interface virtual-template10
 ip unnumbered Ethernet0
 fair-queue
 ppp multilink
 ppp multilink interleave
```

The following example shows a simple leased-line interleaving configuration using a dedicated multilink interface:

```
interface serial1
 no ip address
 encapsulation ppp
 ppp multilink
 ppp multilink-group 5
!
interface multilink5
 ip address 209.165.200.225 255.255.255.0
 fair-queue
 ppp multilink
 ppp multilink interleave
```

	Command	Description
Related Commands	**fair-queue**	Enables WFQ for an interface.
	ppp multilink fragment delay	Specifies a maximum size, in units of time, for packet fragments on an MLP bundle.
	priority	Assigns the specified priority list to an interface.
	show ppp multilink	Displays bundle information for the MLP bundles and their PPP links in the router.

ppp multilink links maximum

To limit the maximum number of links that Multilink PPP (MLP) can dial for dynamic allocation, use the **ppp multilink links maximum** command in interface configuration mode. To restore the default value, use the **no** form of this command.

ppp multilink links maximum *links*

no ppp multilink links maximum

Syntax Description	*links*	Maximum number of links. Valid values range from 1 to 255. The default is 255.

Command Default   255 links

Command Modes   Interface configuration

Command History

Release	Modification
11.3	This command was introduced as **ppp multilink max-link**.
12.2	This command was changed to **ppp multilink links maximum**. The **ppp multilink max-link** command was accepted by the command-line interpreter through Cisco IOS Release 12.2.
12.2(13)T	The range of valid values for the *links* argument was changed from 1 to 255 to 1 to 64.
12.3(8)T	The range of valid values for the *links* argument was changed from 1 to 64 to 1 to 255.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   This command affects only dial-on-demand dynamic bandwidth environments.

The value configured in the **ppp multilink links maximum** command specifies the maximum number of links allowed in a bundle. When more links than the number assigned with the **ppp multilink links maximum** command try to enter the bundle, MLP hangs up its dialer channels to reduce the number of links.

Member links that are not dialer lines are not affected by settings in the **ppp multilink links maximum** command. If a bundle contains a mix of leased and dialer links, the leased lines count against the total, but the leased lines remain as permanent member links and will do so even if the value specified for the maximum number of links is exceeded.

Use this command to fine-tune the **ppp multilink load-threshold** command settings and to prevent runaway expansion of a bundle when a low threshold is set.

Examples   The following example sets the maximum number of links to 50:

```
ppp multilink links maximum 50
```

Related Commands	Command	Description
	ppp multilink links minimum	Specifies the preferred minimum number of links in an MLP bundle.
	ppp multilink load-threshold	Enables MLP to monitor traffic load and prompt dialer capability to adjust bandwidth to fit the load.
	ppp multilink mrru	Configures the MRRU value negotiated on an MLP bundle.

ppp multilink links minimum

To specify the preferred minimum number of links in a Multilink PPP (MLP) bundle, use the **ppp multilink links minimum** command in interface configuration mode. To reset the default value, use the **no** form of this command.

ppp multilink links minimum *links* [**mandatory**]

no ppp multilink links minimum

Syntax Description	*links*	Minimum number of links. Valid values range from 0 to 255. The default is 0.
	mandatory	(Optional) Specifies that the minimum number of links configured with the *links* argument is required to establish and maintain the Network Control Protocol (NCP) for the bundle.

Command Default   0 links

Command Modes   Interface configuration

Command History	Release	Modification
	11.3	This command was introduced as **multilink min-links**.
	12.1(11b)E	The **mandatory** keyword was added to the **multilink min-links** command.
	12.2	The **multilink min-links** command was replaced by the **ppp multilink links minimum** command. The **multilink min-links** command was also accepted by the command-line interpreter in Cisco IOS Release 12.2.
	12.2(13)T	Support was added for the **mandatory** keyword, and the range of valid values for the *links* argument was changed from 0 to 255 to 0 to 64.
	12.2(14)S	This command, as modified in Cisco IOS Release 12.2(13)T, was integrated into Cisco IOS Release 12.2(14)S.
	12.2(15)B	This command, as modified in Cisco IOS Release 12.2(13)T, was integrated into Cisco IOS Release 12.2(15)B. Support was added for the Cisco 7401ASR and the Cisco 6400 series.
	12.3(8)T	The range of valid values for the *links* argument was changed from 0 to 64 to 0 to 255.
	12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines   This command affects only dial-on-demand dynamic bandwidth environments.

The value configured for the *links* argument specifies the minimum number of links that MLP will try to keep in a bundle. If a bundle contains fewer links than the number specified by the *links* argument, and there is a means to establish additional channels (for example, available dialer channels), then MLP

attempts to increase the number of links up to the specified limit. MLP attempts to dial up additional links to obtain the number specified by the *links* argument, even if the load does not exceed the load threshold.

If the **mandatory** keyword is configured, the minimum number of links specified by the *links* argument must be in the bundle. Whenever a link is added to or removed from the bundle, the number of links is checked against the specified minimum number. If the number of links in the bundle falls below the specified minimum, all NCPs will be disabled for the bundle. NCPs will be established if the number of links meets the specified minimum.

If the **dialer max-call** command is configured, MLP will not exceed its value even if the **ppp multilink links maximum** command is configured for a higher value. This restriction does not affect the number of links that you can configure; rather it affects what happens at run time.

Examples	The following example sets the minimum number of links to 12:

```
ppp multilink links minimum 12
```

The following example sets the minimum number of links to 4 and specifies that the bundle must have at least four links to establish and maintain NCPs:

```
ppp multilink links minimum 4 mandatory
```

Related Commands	Command	Description
	dialer max-call	Specifies the maximum number of calls to a remote destination that can be up at any one time for a dialer profile.
	ppp multilink links maximum	Limits the maximum number of links that MLP can dial for dynamic allocation.

ppp multilink load-threshold

To enable Multilink PPP (MLP) to monitor traffic load and prompt dialer capability to adjust bandwidth to fit the load, use the **ppp multilink load-threshold** command in interface configuration mode. To disable this function, use the **no** form of this command.

ppp multilink load-threshold *load-threshold* [**outbound** | **inbound** | **either**]

no ppp multilink load-threshold *load-threshold* [**outbound** | **inbound** | **either**]

Syntax Description	*load-threshold*	Load threshold at which to consider adding or dropping a link, expressed as a value in the range from 1 to 255. A value of 255 indicates a 100 percent load. A value of 1 is a special case indicating any load at all; MLP will add as many links as it can, ignoring the actual traffic load.
	outbound	(Optional) Only the outbound (transmit) traffic load is examined.
	inbound	(Optional) Only the inbound (receive) traffic load is examined.
	either	(Optional) Either the transmit traffic load or the receive traffic load can trigger a link addition or subtraction.

Command Default   No active dynamic bandwidth mechanisms. If a *load-threshold* argument is configured without any of the optional keywords, the link defaults to examining outbound traffic load (**outbound**).

Command Modes   Interface configuration

Command History	Release	Modification
	11.3	This command was introduced as **multilink load-threshold**.
	12.2	This command was changed to **ppp multilink load-threshold**. The **multilink load-threshold** command was accepted by the command-line interpreter through Cisco IOS Release 12.2.
	12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   The **dialer load-threshold** command is generally configured instead of the **ppp multilink load-threshold** command, and MLP inherits the values set by the **dialer load-threshold** command when a bundle configuration is taken from a dialer interface.

Use the **ppp multilink load-threshold** command for dynamic bandwidth (dial-on-demand) systems in which MLP will need to dial additional links as needed to increase the bandwidth of a connection. When the load on the bundle interface exceeds the set value, links are added. When the load on the bundle interface drops below the set value, links are dropped.

Examples   The following example sets the MLP inbound load threshold to 10:

```
ppp multilink load-threshold 10 inbound
```

Related Commands	Command	Description
	dialer load-threshold	Configures bandwidth on demand by setting the maximum load before the dialer places another call to a destination.
	ppp multilink links maximum	Limits the maximum number of links that MLP can dial for dynamic allocation.
	ppp multilink links minimum	Specifies the preferred minimum number of links in an MLP bundle.
	ppp multilink mrru	Configures the MRRU value negotiated on an MLP bundle.

ppp multilink mrru

To configure the maximum receive reconstructed unit (MRRU) value negotiated on a Multilink PPP (MLP) bundle, use the **ppp multilink mrru** command in interface configuration mode. To remove the configured MRRU, use the **no** form of this command.

ppp multilink mrru [**local** | **remote**] *mrru-value*

no ppp multilink mrru [local | remote] *mrru-value*

Syntax Description		
local	(Optional) Configures the local MRRU value.	
remote	(Optional) Configures the minimum value that the software will accept from the peer when it advertises its MRRU.	
mrru-value	MRRU value, in bytes. Valid value range is 128 to 16384.	

Command Default

The default values for the local MRRU are the value of the multilink group interface maximum transmission unit (MTU) for multilink group members, and 1524 bytes for all other interfaces.

Command Modes

Interface configuration

Command History

Release	Modification
12.3(7)T	This command was introduced.
12.0(28)S	This command was integrated into Cisco IOS Release 12.0(28)S.
12.2(27)SB	This command was integrated into Cisco IOS Release 12.2(27)SB.
12.2(28)S	This command was integrated into Cisco IOS Release 12.2(28)S.
12.2(31)SB	This command was integrated into Cisco IOS Release 12.2(31)SB.
12.2(33)SRB1	This command was integrated into Cisco IOS Release 12.2(33)SRB1.

Usage Guidelines

This command allows the MRRU value to be configured on MLP interfaces and member links. This command is useful for interfaces running an application such as IP Security (IPsec), where the addition of the IPsec header causes the packet to exceed the 1500-byte MTU of a typical IP packet.

When using a large-bundle interface MTU size, you must ensure that the individual frames-per-fragment size passed to the link interfaces is not greater than the link interface MTU setting or the peer MRRU setting. This size limit can be achieved in one of the following two ways:

- Configure the link interface MTU setting appropriately.
- Configure fragmentation such that the link MTU settings will never be violated.

When MLP is configured, several physical interfaces can constitute one logical connection to the peer. To represent the logical connection, software provides a logical interface, often called the bundle interface. This interface will have the IP address, for instance, and the MTU setting of the interface that

IP uses when it is deciding whether to fragment an IP datagram that needs to be forwarded. The physical interfaces simply forward individual MLP fragments or frames that are given to them by the bundle interface.

The result of having to decide whether to fragment a packet is that, whereas with simple PPP the interface MTU must not exceed the peer's MRRU, with MLP the MTU size of the bundle interface must not exceed the MRRU setting of the peer. The MRRU settings on both sides need not be equal, but the "must not exceed" rule just specified must be followed; otherwise a system might send several fragments that, when reconstructed as a frame, will be too large for the peer's receive buffer.

Once you configure the MRRU on the bundle interface, you enable the router to receive large reconstructed MLP frames. You may want to configure the bundle MTU so that the router can send large MLP frames, although it is not strictly necessary. The maximum recommended value for the bundle MTU is the value of the peer's MTU. The software will automatically reduce the bundle interface MTU if necessary to avoid violating the peer's MRRU.

When the bundle interface MTU is tuned to a higher number, then depending upon the fragmentation configuration, the link interface may be given larger frames to send. There are two possible solutions to this problem, as follows:

- Ensure that fragmentation is performed such that fragments are sized less than the link interface MTU (refer to the command pages for the **ppp multilink fragment disable** and **ppp multilink fragment delay** commands for more information about packet fragments).

- Configure the MTUs of the link interfaces such that they can send the larger frames.

Note Be careful when configuring MLP MRRU negotiation in a virtual private dialup network (VPDN) environment when an L2TP network server (LNS) is not running Cisco IOS Release 12.3(7)T. The software performs strict matching on the MRRU values in earlier versions of Cisco IOS software.

Examples The following example shows how to configure MRRU negotiation on a virtual template with synchronous serial interfaces. The example also applies to asynchronous serial interfaces.

```
multilink virtual-template 1
!
interface virtual-template 1
 ip address 10.13.1.1 255.255.255.0
 mtu 1600
!
interface serial 0/0
 ppp multilink
 ppp multilink mrru local 1600
 mtu 1600
!
interface serial 0/1
 ppp multilink
 ppp multilink mrru local 1600
 mtu 1600
```

The following example shows how to configure MRRU negotiation on multilink groups:

```
interface multilink 10
 ip address 10.13.1.1 255.255.255.0
 ppp multilink mrru local 1600
 mtu 1600
!
```

```
interface serial 0/0
 ppp multilink
 multilink-group 10
 mtu 1600
!
interface serial 0/1
 ppp multilink
 multilink-group 10
 mtu 1600
```

The following example shows how to configure MRRU negotiation on dialer interfaces:

Note Dialer interfaces are not supported on the Cisco 7600 series router.

```
interface dialer 1
 ip address 10.13.1.1 255.255.255.0
 encapsulation ppp
 dialer remote-name 2610-2
 dialer idle-timeout 30 inbound
 dialer string 5550101
 dialer pool 1
 dialer-group 1
 no cdp enable
 ppp multilink
 ppp multilink mrru local 1600
```

Related Commands

Command	Description
encapsulation ppp	Sets the PPP encapsulation method.
interface dialer	Defines a dialer rotary group.
mtu	Adjusts the maximum packet size or MTU size.
multilink virtual-template	Specifies a virtual template from which the specified MLP bundle interface can clone its interface parameters.
ppp multilink	Enables MLP on an interface.
ppp multilink fragment delay	Specifies a maximum time for the transmission of a packet fragment on an MLP bundle.
ppp multilink fragment disable	Disables packet fragmentation.
ppp multilink fragmentation	Sets the maximum number of fragments a packet will be segmented into before being sent over the bundle.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp multilink interleave	Enables MLP interleaving.

ppp multilink multiclass

To enable Multiclass Multilink PPP on an interface, use the **ppp multilink multiclass** command in interface configuration mode. To disable Multiclass Multilink PPP, use the **no** form of this command.

> **ppp multilink multiclass**

> **no ppp multilink multiclass**

Syntax Description   This command has no arguments or keywords.

Command Default   Multiclass Multilink PPP is disabled.

Command Modes   Interface configuration

Command History

Release	Modification
12.2(13)T	This command was introduced.
12.2(8)YN	This command was enhanced with quality of service (QoS) features for the following platforms: Cisco 1720, Cisco 1750, Cisco 1751, Cisco 1760, Cisco 2610XM through Cisco 2651XM, Cisco 3640A, Cisco 3640, and Cisco 3660.
12.3(2)T	This command was integrated into Cisco IOS Release 12.3(2)T for the following platforms: Cisco 1721, Cisco 2610 through Cisco 2651, Cisco 2610XM through Cisco 2651XM, Cisco 2691, Cisco 3620, and Cisco 3660.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines   This command applies only to interfaces that use PPP encapsulation.

Multiclass Multilink PPP and PPP reliable links do not work together.

When the **ppp multilink multiclass** command is used, the first channel will negotiate the appropriate Network Control Protocol (NCP) layers (such as the IP Control Protocol and IPX Control Protocol), but subsequent links will negotiate only the link control protocol and Multiclass Multilink PPP. NCP layers do not get negotiated. The **dialer load-threshold** command enables a rotary group to bring up additional links and to add them to a multilink bundle.

The **ppp multilink multiclass** command must be configured on each link that will be joining the bundle (that is, on member links, not on the bundle interface itself). Failure to configure this command could result in the peer refusing to allow mismatched links to join the bundle. The first link to join the bundle will determine whether Multiclass Multilink PPP is in effect for the bundle. Each subsequent link must negotiate the same Multiclass Multilink PPP parameters in order to join the bundle. In the case of PPP over ATM (PPPoA) or PPP over Frame Relay (PPPoFR), the command is entered on the virtual template.

When this command is configured (and assuming that the peer also supports and is configured for multiclass interleaving), interleaved packets are assigned sequence numbers so that they are kept in order at the receiving end. Without this command, interleaved packets are sent without multilink headers and are subject to reordering when sent over parallel links.

Examples   The following partial example shows the configuration for a dialer for Multiclass Multilink PPP; it does not show the configuration of the physical interfaces:

```
interface Dialer0
 ip address 10.0.0.2 255.0.0.0
 encapsulation ppp
 dialer in-band
 dialer idle-timeout 500
 dialer map ip 10.0.0.1 name router broadcast 81012345678901
 dialer load-threshold 30 either
 dialer-group 1
 ppp authentication chap
 ppp multilink
 ppp multilink multiclass
```

The following example shows a configuration that enables multilink PPP interleaving and Multiclass Multilink PPP on a dialer interface that controls a rotary group of BRI interfaces. This configuration permits IP packets to trigger calls.

```
interface BRI 0
 description connected into a rotary group
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI 1
 no ip address
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI 2
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI 3
 no ip address
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI 4
 encapsulation ppp
 dialer rotary-group 1
!
interface Dialer 0
 description Dialer group controlling the BRIs
 ip address 10.1.1.1 255.255.255.0
 encapsulation ppp
 dialer map ip 10.1.1.2 name router 14802616900
 dialer-group 1
 ppp authentication chap
! Enables Multilink Multiclass PPP interleaving on the dialer interface and reserves
! a special queue.
 ppp multilink
 ppp multilink multiclass
 ppp multilink interleave
 ip rtp reserve 32768 20 1000
! Keeps fragments of large packets small enough to ensure delay of 20 ms or less.
```

```
 ppp multilink fragment delay 20
dialer-list 1 protocol ip permit
```

The following example shows the configuration for defining a virtual interface template that enables Multilink PPP interleaving and a maximum real-time traffic delay of 20 milliseconds. The bundle interface will be a virtual access interface cloned from the virtual template. Multiclass Multilink PPP is then configured on a member link, Serial0.

```
interface virtual-template 1
 ip unnumbered ethernet 0
 ppp multilink
 ppp multilink interleave
 ppp multilink fragment delay 20
 ip rtp interleave 32768 20 1000
!
multilink virtual-template 1
!
interface Serial0
 encapsulation ppp
 ppp authentication chap
 ppp multilink
 ppp multilink multiclass
```

The following example shows the configuration for Multilink PPP interleaving and a maximum real-time traffic delay of 20 milliseconds on a multilink interface. Multiclass Multilink PPP is then configured on a member link, Serial1, and the member link is restricted to joining only the designated multilink group interface.

```
interface Multilink1
 ip address 10.2.3.4 255.255.255.0
 ppp multilink
 ppp multilink interleave
 ppp multilink fragment delay 20
!
interface Serial1
 encapsulation ppp
 ppp authentication chap
 ppp multilink
 ppp multilink multiclass
 ppp multilink group 1
```

The following example shows the configuration for interleaving on the bundle interface while multiclass is configured on the member links (in this case, any virtual access interfaces that are cloned from the virtual template):

```
interface Multilink1
 ip address 10.0.0.50 255.255.255.240
 fair-queue
 ppp multilink
 ppp multilink fragment-delay 10
 ppp multilink interleave
 multilink-group 2
!
interface Virtual-Template1
 no ip address
 ppp multilink
 ppp multilink multiclass
 multilink-group 2
```

	Command	Description
Related Commands	**dialer-group**	Controls access by configuring an interface to belong to a specific dialing group.
	dialer load-threshold	Configures bandwidth on demand by setting the maximum load before the dialer places another call to a destination.
	encapsulation ppp	Enables PPP encapsulation.
	ppp authentication	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication is selected on the interface.
	ppp multilink	Enables MLP on an interface.
	ppp multilink fragment-delay	Specifies a maximum size in units of time for packet fragments on a multilink PPP bundle.
	ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
	ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on a multilink PPP bundle.
	ppp multilink mrru	Configures the MRRU value negotiated on a multilink PPP bundle.
	ppp multilink multiclass local	Configure the multiclass multilink PPP multilink header format option when negotiating class of service with a peer.
	ppp multilink multiclass remote	Causes multilink to negotiate the multilink header format option if the peer requests it, and to use multiple multilink classes on transmitted packets (potentially including multilink headers on interleaved packets) if the option is negotiated.
	show ppp multilink	Displays bundle information for the multilink PPP bundles.

ppp multilink multiclass local

To configure the multiclass multilink PPP multilink header format option when negotiating class of service with a peer, use the **ppp multilink multiclass local** command in interface configuration mode. To disable a local multilink header format option, use the **no** form of the command.

> **ppp multilink multiclass local** {**request** [**initial** *init-value*] [**maximum** *max-value*] | **allow** [**maximum** *max-value*] | **forbid**}

> **no ppp multilink multiclass** {**local** {**request** [**initial** *init-value*] [**maximum** *max-value*] | **allow** [**maximum** *max-value*] | **forbid**}

Syntax Description		
	request	Signals the Link Control Protocol (LCP) to request the multilink header format (multiclass) option when the interface is negotiating with the peer.
	initial *init-value*	(Optional) The initial number of multilink classes to request, that is, the number of classes the multilink is initially prepared to accept in the receive path. The range is 1 to 16. The default is 2.
	maximum *max-value*	(Optional) The maximum number of classes that can be requested, that is, the maximum number of classes the multilink will support in the receive path. Range is 2 to 16, except on distributed platforms, where the value is limited by platform capability). The default is 16.
	allow	Causes the LCP to initially omit the multilink header format (multlink) option when negotiating with the peer, but to request the option in subsequent requests if the peer includes it in a configure-nak message.
	forbid	Causes the LCP to omit the multilink header format (multiclass) option when negotiating with the peer.

Command Default Initially omit the multilink header format option when negotiating with the peer, but request the option in a maximum of 16 subsequent requests when the peer includes it in a configure-nak message.

Command Modes Interface configuration

Command History	Release	Modification
	12.2(31)SB2	This command was introduced on the Cisco 10000 series platform.

Usage Guidelines This command applies only to interfaces that use PPP encapsulation.

Use this command paired with the **ppp multilink multiclass remote** command to configure the multiclass multilink PPP multilink header format option when negotiating with a peer. These commands extend the multiclass multilink PPP transmit logic to allow up to 16 transmit and receive classes, and up to 16 classes that can be negotiated with the peer. The **ppp multilink multiclass local** and **ppp multilink multiclass remote** commands use PPP link fragmentation and interleaving (LFI) to apply multilink headers to interleaved packets, which allows the packets to be kept in sequence when transmitted over multiple parallel links within a given multilink bundle.

MLP and PPP reliable links do not work together.

The **dialer load-threshold** command enables a rotary group to bring up additional links and to add them to a multilink bundle.

The **ppp multilink multiclass** command must be configured on each link that will be joining the bundle or on the multilink interface itself (members of the multilink group inherit any PPP configuration that is done on the multilink group master). Failure to configure this command could result in the peer refusing to allow mismatched links to join the bundle. The first link to join the bundle will determine whether multilink PPP is in effect for the bundle. Each subsequent link must negotiate the same multilink PPP parameters in order to join the bundle.

In the case of PPP over ATM (PPPoA) or PPP over Frame Relay (PPPoFR), the command is entered on the virtual template.

Effective with Cisco IOS Release 12.2(31)SB2, this command can be used only on the Cisco 10000 series platform.

Examples

The following example shows how to configure a multilink bundle for up to four receive classes and at least four transmit classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local request maximum 4
 ppp multilink multiclass remote apply minimum 4
 no cdp enable
```

The following example shows how to configure a multilink bundle to not use multiple classes but allows the peer to request the option and transmit up to four classes when needed:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local allow maximum 4
 ppp multilink multiclass remote ignore
 no cdp enable
```

The following example shows how to configure a multilink bundle to not use multiple classes, but allows the peer to request the option and inform the peer that the option is supported, allowing for up to four receive classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local request initial 1 maximum 4
 ppp multilink multiclass remote ignore
 no cdp enable
```

The following example shows how to completely disable multiclass multilink PPP, rejecting the header and declining to allow the peer to transmit multiple classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local forbid
 ppp multilink multiclass remote reject
 no cdp enable
```

Related Commands	**Command**	**Description**
	dialer-group	Controls access by configuring an interface to belong to a specific dialing group.
	dialer load-threshold	Configures bandwidth on demand by setting the maximum load before the dialer places another call to a destination.
	encapsulation ppp	Enables PPP encapsulation.
	ppp authentication	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication is selected on the interface.
	ppp multilink	Enables MLP on an interface.
	ppp multilink fragment delay	Specifies a maximum size in units of time for packet fragments on an multilink PPP bundle.
	ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
	ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on an multilink PPP bundle.
	ppp multilink mrru	Configures the MRRU value negotiated on an multilink PPP bundle.
	ppp multilink multiclass	Enables multiclass multilink PPP on an interface.
	ppp multilink multiclass remote	Causes multilink to negotiate the multilink header format option if the peer requests it, and to use multiple multilink classes on transmitted packets (potentially including multilink headers on interleaved packets) if the option is negotiated.
	show ppp multilink	Displays bundle information for the multilink PPP bundles.

ppp multilink multiclass remote

To configure the multiclass multilink PPP multilink header format option when a peer requests class of service, use the **ppp multilink multiclass remote** command in interface configuration mode. To disable a remote multilink header format option, use the **no** form of the command.

> **ppp multilink multiclass remote** {**apply** [**minimum** *min-value*] | **reject** | **ignore**}

> **no ppp multilink multiclass remote** {**apply** [**minimum** *min-value*] | **reject** | **ignore**}

Syntax Description		
	apply minimum *min-value*	Causes the multilink: • To negotiate the multilink header format option if the peer requests it and attempts to induce the peer to request the option by including it in a configure-nak message if it does not. • To use multiple multilink classes on transmitted packets (potentially including multilink headers on interleaved packets) if the option is negotiated.
	minimum *min-value*	Indicates the minimum number of classes that the peer is expected to request. This value indicates the number of classes the multilink will need in the transmit path. The range is 2 to 16 (except on distributed platforms, where the value is limited by platform capability). The default is 2.
	reject	Causes the multilink to reject the option if the peer requests it.
	ignore	Causes the multilink to acknowledge the multilink header format option if the peer requests it, but multiple classes will not be used. This is the default setting when a multiclass is not configured.

Command Default   Multilink PPP is disabled.

Command Modes   Interface configuration

Command History	Release	Modification
	12.2(31)SB2	This command was introduced on the Cisco 10000 series platform.

Usage Guidelines   This command applies only to interfaces that use PPP encapsulation.

Use this command paired with the **ppp multilink multiclass local** command to configure the multiclass multilink PPP multilink header format option when negotiating with a peer. These commands extend the multiclass multilink PPP transmit logic to allow up to 16 transmit and receive classes, and up to 16 classes that can be negotiated with the peer. The **ppp multilink multiclass local** and **ppp multilink multiclass remote** commands use PPP link fragmentation and interleaving (LFI) to apply multilink headers to interleaved packets, which allows the packets to be kept in sequence when transmitted over multiple parallel links within a given multilink bundle.

MLP and PPP reliable links do not work together.

The **dialer load-threshold** command enables a rotary group to bring up additional links and to add them to a multilink bundle.

The **ppp multilink multiclass** command must be configured on each link that will be joining the bundle or on the multilink interface itself (members of the multilink group inherit any PPP configuration that is done on the multilink group master). Failure to configure this command could result in the peer refusing to allow mismatched links to join the bundle. The first link to join the bundle will determine whether multilink PPP is in effect for the bundle. Each subsequent link must negotiate the same multilink PPP parameters in order to join the bundle.

In the case of PPP over ATM (PPPoA) or PPP over Frame Relay (PPPoFR), the command is entered on the virtual template.

Effective with Cisco IOS Release 12.2(31)SB2, this command can be used only on the Cisco 10000 series platform.

Examples

The following example shows how to configure a multilink bundle for up to four receive classes and at least four transmit classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local request maximum 4
 ppp multilink multiclass remote apply minimum 4
 no cdp enable
```

The following example shows how to configure a multilink bundle to not use multiple classes but allows the peer to request the option and transmit up to four classes when needed:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local allow maximum 4
 ppp multilink multiclass remote ignore
 no cdp enable
```

The following example shows how to configure a multilink bundle to not use multiple classes, but allows the peer to request the option and inform the peer that the option is supported, allowing for up to four receive classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local request initial 1 maximum 4
 ppp multilink multiclass remote ignore
 no cdp enable
```

The following example shows how to configure a multilink bundle to not use multiple classes, but allows the peer to request the option and inform the peer that the option is supported, allowing for up to four receive classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local request initial 1 maximum 4
 ppp multilink multiclass remote ignore
 no cdp enable
```

The following example shows how to completely disable multiclass multilink PPP, rejecting the header and declining to allow the peer to transmit multiple classes:

```
interface Multilink9
 ip address 10.0.0.161 255.255.255.240
 ppp multilink
 ppp multilink interleave
 ppp multilink group 9
 ppp multilink fragment delay 20
 ppp multilink multiclass local forbid
 ppp multilink multiclass remote reject
 no cdp enable
```

Related Commands	Command	Description
	dialer-group	Controls access by configuring an interface to belong to a specific dialing group.
	dialer load-threshold	Configures bandwidth on demand by setting the maximum load before the dialer places another call to a destination.
	encapsulation ppp	Enables PPP encapsulation.
	ppp authentication	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication is selected on the interface.
	ppp multilink	Enables MLP on an interface.
	ppp multilink fragment delay	Specifies a maximum size in units of time for packet fragments on a multilink PPP bundle.
	ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
	ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on a multilink PPP bundle.
	ppp multilink mrru	Configures the MRRU value negotiated on a multilink PPP bundle.
	ppp multilink multiclass	Enables multiclass multilink PPP on an interface.
	ppp multilink multiclass local	Configure the multiclass multilink PPP multilink header format option when negotiating class of service with a peer.
	show ppp multilink	Displays bundle information for the multilink PPP bundles.

ppp multilink ncp sequenced

To control whether Network Control Protocol (NCP) packets are sent with or without multilink headers, use the **ppp multilink ncp sequenced** command in interface configuration mode. RFC 1990 requires that compliant peer implementations be able to receive NCP packets with or without the presence of multilink headers. The **ppp multilink ncp sequenced** command provides support for those remote peers not currently compliant with RFC 1990. To disable the control of multilink headers in NCP packets, use the **no** form of this command.

ppp multilink ncp sequenced {**if-needed** | **always** | **never**}

no ppp multilink ncp sequenced

Syntax Description		
	if-needed	Specifies that NCP packets are sent with multilink headers only if your bundle has multiple links, or you have configured Link Fragmentation and Interleaving (LFI).
	always	Specifies that NCP packets are always sent with multilink headers. Use this keyword for any remote peer that requires multilink headers in NCP packet for processing.
	never	Specifies that NCP packets are never sent with multilink headers. Use this keyword for any remote peer that requires NCP packets without multilink headers for processing.

Command Default   NCP packets are sent on an if-needed basis.

Command Modes   Interface configuration

Command History

Release	Modification
12.2(31)SB2	This command was introduced.

Usage Guidelines   This command applies only to interfaces used for multilink bundles (multilink, virtual-templates, or dialer interfaces).

You must specify one keyword, unless you are using the **no** form of this command.

Some remote peers require the presence of multilink headers for NCP packet processing, while other remote peers require that NCP packets do not have multilink headers. Using the **ppp multilink ncp sequenced** command, you can control the presence of multilink headers in NCP packets.

Use this command with the **if-needed** keyword if your remote peers are RFC 1990 compliant. The **if-needed** specifies that remote peers are able to process NCP regardless of the existence of multilink headers. The **always** keyword specifies that multilink headers will always appear in all NCP packets. Use the **always** keyword for any remote peer that requires multilink headers in NCP packet for processing.

The **never** keyword specifies that multilink headers will never appear in any NCP packet. Use the **never** keyword for any remote peer that requires NCP packets without multilink headers for processing.

The **no** form of this command to disables the control of multilink headers appearing in NCP packets.

Examples

The following example shows how to configure a remote peer which is unable to process NCP packets that have multilink headers:

```
ppp multilink ncp sequenced never
```

The following example shows how to configure a remote peer which is unable to process NCP packets that do not have multilink headers:

```
ppp multilink ncp sequenced always
```

Related Commands

Command	Description
ppp multilink	Enables Multilink PPP (MLP) on an interface and, optionally, enables Bandwidth Allocation Control Protocol (BACP) and its Bandwidth Allocation Protocol (BAP) subset for dynamic bandwidth allocation.
ppp multilink interleave	Enables interleaving of packets among the fragments of larger packets on an MLP bundle.
ppp multilink fragment delay	Specifies a maximum time for the transmission of a packet fragment on an MLP bundle.
ppp multilink fragment size	Specifies the maximum packet fragment size in bytes for an MLP link.

ppp multilink slippage

To define the constraints that set the Multilink PPP (MLP) reorder buffer size, use the **ppp multilink slippage** command in interface configuration mode. To remove the restriction, use the **no** form of this command.

> **ppp multilink slippage** [**mru** *value* | **msec** *value*]

> **no ppp multilink slippage** [**mru** *value* | **msec** *value*]

Syntax Description		
mru *value*	Specifies the buffer limit is at least this many maximum receive units (MRUs) worth of data, in bytes. Valid values are 2 to 32.	
msec *value*	Specifies the buffer limit is at least this many milliseconds worth of data. Valid range is 1 to 16000.	

Defaults

The **mru** *value* default is 8 bytes.

There is no default for **msec** *value*.

Command Modes

Interface configuration

Command History

Release	Modification
12.2(13)T	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.
12.2(31)SB	This command was integrated into Cisco IOS Release 12.2(31)SB.

Usage Guidelines

The slippage constraints are interface-level configuration commands, which may be placed on any interface or configuration source ultimately providing the configuration for a multilink bundle interface like "interface Multilink" and "interface dialer."

Limits are on a "per-link" basis. For example, issuing **ppp multilink slippage mru 4** means that the total amount of data which is buffered by the bundle is 4 times the MRU times the number of links in the bundle.

The reassembly engine is also affected by the lost fragment timeout, which is configured using the **ppp timeout multilink lost-fragment** command.

The buffer limit derived from the slippage constraints implies a corresponding tolerated differential delay between the links. Since it does not make sense to be declaring a fragment lost due to a timeout when it is within the delay window defined by the slippage, the timeout will be dynamically increased as necessary so that it is never smaller than the delay value derived from the slippage parameters.

Examples   The following example shows the total amount of data buffered by the bundle is four times the MRU times the number of links in the bundle:

```
Router(config)# interface multilink 8
Router(config-if)# ip address 172.16.48.209 255.255.0.0
Router(config-if)# ppp multilink slippage mru 4

Router(config)# interface dialer8
Router(config-if)# encapsulation ppp
Router(config-if)# ip address 172.16.48.209 255.255.0.0
Router(config-if)# ppp multilink slippage mru 4
Router(config-if)# ppp multilink slippage msec 16000
```

The following example shows configuring Multilink PPP over serial interface links on a multilink group interface. In this example, there are two serial interfaces that are members of "interface multilink8". It is assumed that Serial2 interface has the bandwidth of 64kbps and Serial3 interface has the bandwidth of 128kbps. With these two serial links, interface Multilink8 will have a bandwidth equal to 64kbps plus 128kbps which equals 196 kbps or 24.5 kBps [b=bit, B=byte]. The interface Multilink8 is configured with **ppp multilink slippage msec 2000** and therefore buffers at least 2000 milliseconds worth of data (2000 ms * 24.5 kBps = 49000 bytes).

```
Router(config)# interface Multilink8
Router(config-if)# ip address 172.16.48.209 255.255.0.0
Router(config-if)# ppp multilink
Router(config-if)# ppp multilink slippage msec 2000
Router(config-if)# ppp multilink group 8

Router(config)# interface Serial2
Router(config-if)# no ip address
Router(config-if)# encapsulation ppp
Router(config-if)# ppp multilink group 8

Router(config)# interface Serial3
Router(config-if)# no ip address
Router(config-if)# encapsulation ppp
Router(config-if)# ppp multilink group 8
```

Related Commands

Command	Description
ppp multilink	Enables MLP on an interface and, optionally, enables dynamic bandwidth allocation.
ppp multilink fragment delay	Specifies a maximum time for the transmission of a packet fragment on a MLP bundle.
ppp multilink fragment disable	Disables packet fragmentation.
ppp multilink fragmentation	Sets the maximum number of fragments a packet will be segmented into before being sent over the bundle.
ppp multilink group	Restricts a physical link to joining only a designated multilink-group interface.
ppp multilink interleave	Enables MLP interleaving.
ppp multilink mrru	Configures the MRRU value negotiated on a MLP bundle.