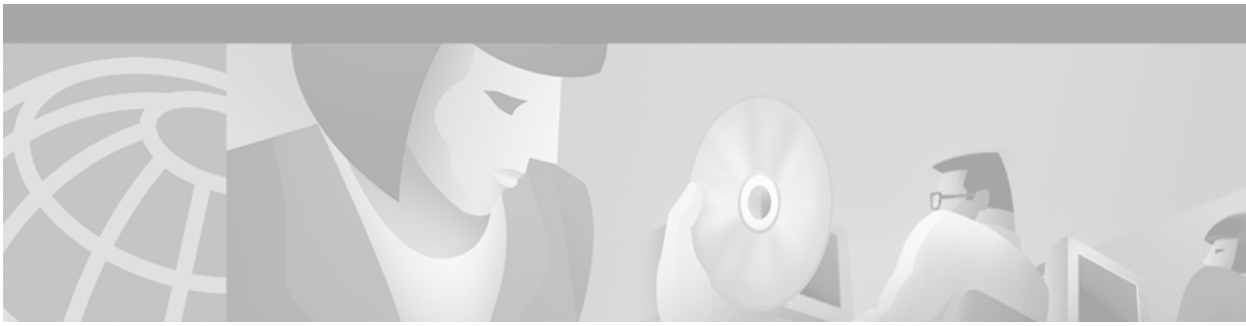

Configuring Link Fragmentation and Interleaving for Multilink PPP

The Cisco IOS Link Fragmentation and Interleaving (LFI) feature uses Multilink PPP (MLP). MLP provides a method of splitting, recombining, and sequencing datagrams across multiple logical data links. MLP allows packets to be fragmented and the fragments to be sent at the same time over multiple point-to-point links to the same remote address.

This chapter describes the tasks for configuring MLP, and it includes example configurations.

For complete conceptual information, see the section "Link Fragmentation and Interleaving for MLP" in the chapter "Link Efficiency Mechanisms Overview" in this book. To locate documentation of commands that appear in this chapter, use the command reference master index or search online.

To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter in this book.

About MLP Interleaving and Queueing for Real-Time Traffic

Interleaving on MLP allows large packets to be multilink encapsulated and fragmented into a small enough size to satisfy the delay requirements of real-time traffic; small real-time packets are not multilink encapsulated and are sent between fragments of the large packets.

The interleaving feature also provides a special transmit queue for the smaller, delay-sensitive packets, enabling them to be sent earlier than other flows.

Weighted fair queueing (WFQ) on MLP works at the packet level, not at the level of multilink fragments. Thus, if a small real-time packet gets queued behind a larger best-effort packet and no special queue has been reserved for real-time packets, the small packet will be scheduled for transmission only after all the fragments of the larger packet are scheduled for transmission.

WFQ is supported on all interfaces that support MLP, including MLP virtual access interfaces and virtual interface templates.

Fair queueing on MLP overcomes a prior restriction. Previously, fair queueing was not allowed on virtual access interfaces and virtual interface templates. Interleaving provides the delay bounds for delay-sensitive voice packets on a slow link that is used for other best-effort traffic.

Restrictions

Interleaving applies only to interfaces that can configure a multilink bundle interface. These interfaces include virtual templates, dialer interfaces, and ISDN BRI or PRI interfaces.

Multilink and fair queueing are not supported when a multilink bundle is off-loaded to a different system using Multichassis Multilink PPP (MMP). Thus, interleaving is not supported in MMP networking designs.

Note LFI on PPP over Frame Relay is not supported on Cisco IOS Release 12.1E.

Interleaving for Multilink PPP Configuration Task List

To configure MLP, perform the tasks described in the following sections. The task in the first section is required; the task in the remaining section is optional.

- Configuring MLP Interleaving (Required)
- Displaying Interleaving Statistics (Optional)
- Monitoring PPP and MLP Interfaces (Optional)

See the end of this chapter for the section "MLP and LFI Configuration Examples."

Configuring MLP Interleaving

MLP support for interleaving can be configured on virtual templates, dialer interfaces, and ISDN BRI or PRI interfaces. To configure interleaving, perform the following steps:

Step 1 Configure the dialer interface, BRI interface, PRI interface, or virtual interface template, as defined in the relevant Cisco IOS documents.

Step 2 Configure MLP and interleaving on the interface or template.

Note Fair queueing, which is enabled by default, must remain enabled on the interface.

To configure MLP and interleaving on a configured and operational interface or virtual interface template, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# ppp multilink`	Enables MLP.
Step 2	`Router(config-if)# ppp multilink interleave`	Enables real-time packet interleaving.
Step 3	`Router(config-if)# ppp multilink fragment-delay` *milliseconds*	(Optional) Configures a maximum fragment delay. If, for example, you want a voice stream to have a maximum bound on delay of 20 milliseconds (ms) and you specify 20 ms using this command, MLP will choose a fragment size based on the configured value.
Step 4	`Router(config-if)# ip rtp reserve` *lowest-UDP-port range-of-ports* [*maximum-bandwidth*]	Reserves a special queue for real-time packet flows to specified destination User Datagram Protocol (UDP) ports, allowing real-time traffic to have higher priority than other flows.
Step 5	`Router(config-if)# multilink virtual-template`	For virtual interface templates only, applies the virtual interface template to the multilink bundle. **Note** This step is not used for ISDN or dialer interfaces.

Displaying Interleaving Statistics

To display interleaving statistics, use the following command in EXEC mode:

Command	Purpose
`Router# show interfaces`	Displays statistics for all interfaces configured on the router or access server.

Monitoring PPP and MLP Interfaces

To monitor virtual interfaces, use the following command in EXEC mode:

Command	Purpose
`Router# show ppp multilink`	Displays MLP and MMP.

MLP and LFI Configuration Examples

This section provides MLP and LFI configuration examples.

For information about configuring MLP and LFI, see "Interleaving for Multilink PPP Configuration Task List" in this chapter.

The following example defines a virtual interface template that configures MLP interleaving and a maximum real-time traffic delay of 20 ms, 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
 ip rtp reserve 32768 20 1000
multilink virtual-template 1
```

The following example configures MLP interleaving on a dialer interface that controls a rotary group of BRI interfaces. This configuration permits IP packets to trigger calls.

```
interface BRI0
 description connected into a rotary group
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI1
 no ip address
 encapsulation ppp
 dialer rotary-group 1

interface BRI2
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI3
 no ip address
 encapsulation ppp
 dialer rotary-group 1
!
interface BRI4
 encapsulation ppp
 dialer rotary-group 1
!
interface Dialer0
 description Dialer group controlling the BRIs
 ip address 8.1.1.1 255.255.255.0
 encapsulation ppp
 dialer map ip 8.1.1.2 name angus 14802616900
 dialer-group 1
 ppp authentication chap
! Enables Multilink PPP interleaving on the dialer interface and reserves
! a special queue.
 ppp multilink
 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 is an example of interleaving statistics displayed using the **show interfaces** command for a particular interface on which interleaving is enabled. Interleaving data is displayed only if there are interleaves. For example, the following line shows interleaves:

```
Output queue: 315/64/164974/31191 (size/threshold/drops/interleaves)
```