Distributed Multilink Point-to-Point Protocol for Cisco 7500 Series Routers

Feature History

Release	Modification
12.0(3)T	The Distributed Multilink Point-to-Point Protocol (dMLPPP) feature was introduced.
12.0(9)S	The dMLPPP feature was integrated into Cisco IOS Release 12.0(9)S.
12.2(8)T	The dMLPPP feature was enhanced to include support for CBWFQ and LLQ as well as adding some MPLS support in Cisco IOS Release 12.2(8)T. For full MPLS support with dMLPPP, see: http://www.cisco.com/en/US/products/sw/iosswrel/ps1839/products_feature_guide09186a00801e7ba7.html
12.0(26)S	The dMLPPP feature was enhanced to support Multicast VPN in Cisco IOS Release 12.0(26)S.
12.3(15)	The dMLPPP feature was enhanced to support Multicast VPN in Cisco IOS Release 12.3(15).
12.4(1)	The dMLPPP feature was enhanced to support Multicast VPN in Cisco IOS Release 12.4(1).

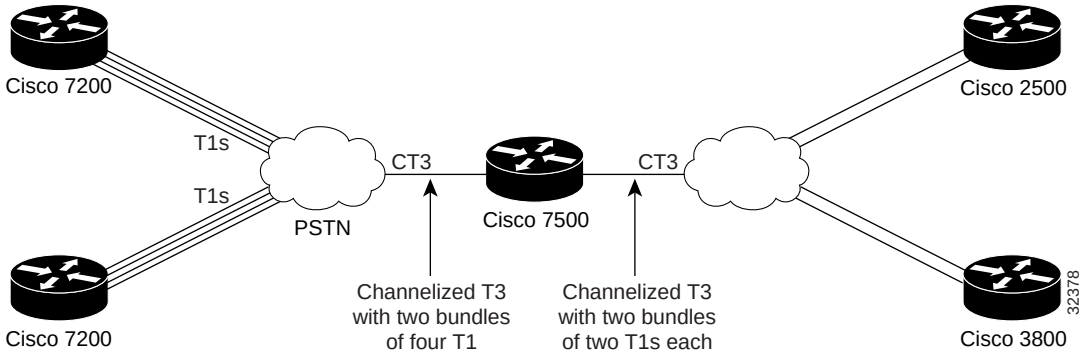
The Distributed Multilink Point-to-Point Protocol (dMLPPP) feature includes the following sections:

Feature Overview

The Distributed Multilink Point-to-Point Protocol (dMLPPP) feature allows you to combine T1/E1 lines in a Versatile Interface Processor (VIP) on a Cisco 7500 series router into a bundle that has the combined bandwidth of multiple T1/E1 lines. This is done by using a VIP MLPPP link. You choose the number of bundles and the number of T1/E1 lines in each bundle. This allows you to increase the bandwidth of your network links beyond that of a single T1/E1 line without having to purchase a T3 line. Non-distributed MLPPP can only perform limited links, with CPU utilization quickly reaching 90% with only a few T1/E1 lines running MLPPP. With distributed MLPPP, you can increase the router's total capacity. Distributed MLPPP supports bundling of fractional T1/E1 starting from DS0(64KBps) onwards.

Figure 1 shows a typical network using a VIP MLPPP link. The Cisco 7500 series router is connected to the network with a CT3 line that has been configured with VIP MLPPP to carry two bundles of four T1 lines each. Each of these bundles goes out to separate remote Cisco 7200 series routers, which each have one MLPPP bundle of four T1 lines. The Cisco 7500 series router is also connected to another CT3 line that has been configured with VIP MLPPP to carry two bundles of two T1 lines. One of these bundles goes out to a Cisco 2500 series router and the other goes out to a Cisco 3800 series router.

Figure 1 Diagram of a Typical VIP MLP Topology



As of Cisco IOS Release 12.2(8)T, Class-Based Weighted Fair Queueing and Low Latency Queueing are supported on Distributed Multilink Point-to-Point Protocol.

For more information on Distributed Class-Based Weighted Fair Queueing (dCBWFQ), see the URL:

http://www.cisco.com/en/US/products/sw/iosswrel/ps1834/products_feature_guide09186a008008058f.html

For more information on Distributed Low Latency Queueing (dLLQ), see the following URL:

http://www.cisco.com/en/US/products/sw/iosswrel/ps1834/products_feature_guide09186a00800804d0.html#xtocid48457

Benefits

The Multilink PPP Inverse Multiplexer feature is geared towards ISPs who want to have the bandwidth of multiple T1 lines with performance comparable to that of an inverse multiplexer without having to buy stand alone inverse-multiplexing equipment. A Cisco router supporting VIPs can now bundle multiple T1 lines in a CT3 or CE3 interface. This is more economical than purchasing an inverse multiplexer, and eliminates the need to configure another piece of equipment and extra shelf space.

This feature supports the CT3 or CE3 data rate without taxing the RSP and CPU by moving the data path to the VIP.

This feature also allows remote sites to purchase multiple T1 lines instead of a T3 line for additional bandwidth. This is especially useful when the remote site does not need the bandwidth of an entire T3 line.

This feature allows multilink fragmentation to be disabled, so multilink packets can be Cisco Express Forwarded (CEF) on all platforms, if fragmentation is disabled. CEF is now supported with fragmentation enabled or disabled.

Restrictions

The following restrictions apply to the Multilink PPP Inverse Multiplexer feature:

- Cisco Express Forwarding (CEF) distributed switching must be enabled.
- T1 and E1 lines cannot be mixed in a bundle.
- T1 lines in a bundle are recommended to have the same bandwidth.
- All lines in a bundle must reside on the same port adapter.
- Hardware compression is not supported.
- Encryption is not supported.
- Software compression is not recommended because CPU usage would void performance gains.
- The maximum differential delay supported is 50 ms.
- VIP CEF is limited to IP only; all other protocols are sent to the RSP.
- Fragmentation is not supported on the transmit side.

Compressed Real-Time Transport Protocol (CRTP) configurations should not be configured on the multilink interface when the following feature combination is configured:

- Link Fragmentation and Interleaving (LFI) is enabled on the multilink interface.
- The multilink bundle has more than one member link.

Note In an dLFI configuration, priority packets do not carry MLP header and sequence number. Thus MLP distributes the priority packets across all member links. As a result, packets that are compressed by CRTP may arrive out-of-order at the receiving router. This prohibits CRTP from decompressing the packet header and forces CRTP to drop the packets.

Table 1 VIP MLPPP Restrictions

Product	MLPPP Support	Maximum T1 MLPPP Bundles on a VIP[1]	Maximum T1s involved in MLPPP Configurations on a VIP	Maximum E1 MLPPP Bundles on a VIP[1]	Maximum number of E1 involved in MLPPP Configurations on a VIP
VIP2-40	Yes	4	8	3	6
VIP2-50 (2 MB SRAM)	Yes	4	8	3	6
VIP2-50 (4-8 MB SRAM)	Yes	8	16	6	12

Table 1 VIP MLPPP Restrictions (continued)

Product	MLPPP Support	Maximum T1 MLPPP Bundles on a VIP[1]	Maximum T1s involved in MLPPP Configurations on a VIP	Maximum E1 MLPPP Bundles on a VIP[1]	Maximum number of E1 involved in MLPPP Configurations on a VIP
VIP4-50	Yes	8	16	6	12
VIP4-80	Yes	20	40	16	32
VIP6-80	Yes	20	40	16	32

1. This assumes a minimum of 2 per bundle.

Table 2 VIP6-80 MLPP Restrictions

Maximum T1s per VIP Configured in MLPPP Bundles[1]	Maximum E1s per VIP Configured in MLPPP Bundles[1]
40	32
T1 Examples:	E1 Examples:
2 bundles of 20 = 40	2 bundles of 16 = 32
2 bundles of 10 and 4 bundles of 5 = 40	2 bundles of 8 and 1 bundles of 16 = 32
1 bundle of 10 and 15 bundles of 2 = 40	2 bundles of 10 and 6 bundles of 2 = 32
10 bundles of 2 = 20	10 bundles of 2 = 20

1. This limit allows for sufficient memory to allow MLPPP process to reassemble packets.

Related Documents

Cisco IOS Release 12.0 Dial Solutions Configuration Guide, Release 12.0

Cisco IOS Release 12.0 Dial Solutions Command Reference, Release 12.0

Supported Platforms

- Cisco 7500 series

Finding Support Information for Platforms and Cisco IOS Software Images

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

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

Supported Standards, MIBs, and RFCs

Standards

- No new or modified standards are supported by this feature.

MIBs

- No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

- RFC 1990, *The PPP Multilink Protocol (MP)*

Prerequisites

dCEF

- CEF distributed switching must be enabled

Port Adapters

You will need one of the following port adapters to use the Distributed MLPPP feature:

- CT3IP (Channelized T3 Interface Processor)
- PA-MC-T3
- PA-MC-2T3+
- PA-MC-E3
- PA-MC-2E1
- PA-MC-2T1
- PA-MC-4T1
- PA-MC-8T1
- PA-MC-8E1
- PA-MC-STM-1
- PA-MC-8TE1+
- PA-4T+
- PA-8T

Configuration Tasks

See the following sections for configuration tasks for the DMLPPP feature. Each task in the list is identified as either required or optional.

- Enabling Distributed CEF Switching, page 6 (required)
- Creating a Multilink Bundle, page 6 (required)
- Assigning an Interface to a Multilink Bundle, page 6 (required)
- Disabling PPP Multilink Fragmentation, page 7 (optional)
- Verifying the Configuration, page 7 (optional)

Enabling Distributed CEF Switching

In order to enable Distributed MLPPP, you must first enable Distributed CEF switching. To enable dCEF, use the **ip cef distributed** command in global configuration mode:

Command	Purpose
`Router(config)# ip cef distributed`	Enables distributed CEF switching.

Creating a Multilink Bundle

To create a multilink bundle, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface multilink` *group-number*	Enters multilink interface configuration mode.
Step 2	`Router(config-if)# ip address` *address mask*	Assigns an IP address to the multilink interface.
Step 3	`Router(config-if)# encapsulation ppp`	Enables PPP encapsulation.
Step 4	`Router(config-if)# ppp multilink`	Enables Multilink PPP.

Assigning an Interface to a Multilink Bundle

To assign an interface to a multilink bundle, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# no ip address`	Removes any specified IP address.
Step 2	`Router(config-if)# keepalive`	Sets the frequency of keepalive packets.
Step 3	`Router(config-if)# encapsulation ppp`	Enables PPP encapsulation.
Step 4	`Router(config-if)# multilink-group` *group-number*	Assigns the interface to a multilink bundle.

	Command	Purpose
Step 5	`Router(config-if)# ppp multilink`	Enables Multilink PPP.
Step 6	`Router(config-if)# ppp authentication chap`	(Optional) Enables Challenge Handshake Authentication Protocol (CHAP) authentication.

Disabling PPP Multilink Fragmentation

By default, PPP multilink fragmentation is enabled. To disable PPP multilink fragmentation, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# no ppp multilink fragmentation`	Disable PPP multilink fragmentation.

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

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

Verifying the Configuration

Use the **show ppp multilink** command to display information about the newly created multilink bundle:

```
Router# show ppp multilink

Multilink1, bundle name is group1
Bundle is Distributed
0 lost fragments, 0 reordered, 0 unassigned, sequence 0x0/0x0 rcvd/sent
0 discarded, 0 lost received, 1/255 load
Member links:4 active, 0 inactive (max not set, min not set)
 Serial1/0/0:1
 Serial1/0/0/:2
 Serial1/0/0/:3
 Serial1/0/0/:4
```

Configuration Examples

This section provides the following configuration examples:

Enabling Distributed Cisco Express Forwarding (dCEF) Example

The following example shows how to turn on dCEF in a Cisco 7500 series router:

```
ip cef distributed
```

Configuring a CT3IP Example

The following example shows how to configure the T3 controller and create four channelized interfaces:

```
controller T3 1/0/0
framing m23
cablelength 10
t1 1 timeslots 1-24
t1 2 timeslots 1-24
t1 3 timeslots 1-24
t1 4 timeslots 1-24
```

Creating a Multilink Interface Example

The following example shows how to create four multilink interfaces with distributed CEF switching and MLPPP enabled. Each of the newly created interfaces are added to a multilink bundle:

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

interface serial 1/0/0/:1
 no ip address
 encapsulation ppp
 ip route-cache distributed
 no keepalive
 ppp multilink
 multilink-group 1

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

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

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

Command Reference

This section documents new or modified commands. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command reference publications.

- **interface multilink**
- **multilink-group**
- **ppp multilink fragmentation**
- **show ppp multilink**

interface multilink

To create a multilink bundle or enter multilink interface configuration mode, use the **interface multilink** command in global configuration mode. To remove a multilink bundle, use the **no** form of this command.

interface multilink *group-name*

no interface multilink

Syntax Description

group-number	Number of the multilink bundle (a nonzero number).

Defaults

No interfaces are configured.

Command Modes

Global configuration

Command History

Release	Modification
12.0(3)T	This command was introduced.

Examples

The following example shows how to create multilink bundle 1:

```
interface multilink 1
 ip address 192.168.11.4 255.255.255.192
 encapsulation ppp
 ppp multilink
 keepalive
```

Related Commands

Command	Description
multilink-group	Designates an interface as part of a multilink leased line bundle.
ppp multilink fragmentation	Enables PPP multilink fragmentation.

multilink-group

To designate an interface as part of a multilink leased line bundle, use the **multilink-group** command in interface configuration mode. To remove an interface from a bundle, use the **no** form of this command.

multilink group *group-number*

no multilink group

Syntax Description

group-number	Number of the multilink bundle (a nonzero number).

Defaults

Disabled

Command Modes

Interface configuration

Command History

Release	Modification
12.0(3)T	This command was introduced.

Usage Guidelines

All interfaces in a multilink bundle are recommended to have the same bandwidth.

Examples

The following example shows how to designate serial interface 1 as part of multilink bundle 1:

```
interface serial 1/0/0:1
 encapsulation ppp
 multilink-group 1
 ppp multilink
 ppp authentication chap
```

Related Commands

Command	Description
interface multilink	Creates a multilink bundle or enters multilink interface configuration mode.
ppp multilink fragmentation	Enables PPP multilink fragmentation.

ppp multilink fragmentation

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

ppp multilink fragmentation

no ppp multilink fragmentation

Syntax Description

This command has no arguments or keywords.

Defaults

Enabled

Command Modes

Interface configuration

Command History

Release	Modification
12.0(3)T	This command was introduced.

Usage Guidelines

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

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

Examples

The following example shows how to disable PPP multilink fragmentation:

```
no ppp multilink fragmentation
```

Related Commands

Command	Description
interface multilink	Creates a multilink bundle or enters multilink interface configuration mode.
multilink-group	Designates an interface as part of a multilink leased line bundle.

show ppp multilink

To display information about Multilink PPP, use the **show ppp multilink** command in EXEC mode.

show ppp multilink

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values.

Command Modes

EXEC

Command History

Release	Modification
12.0(3)T	This command was introduced.

Usage Guidelines

Use this command to display information about member links of a multilink ppp group, including interfaces, bundles, lost fragments and the state of the distributed feature.

Examples

The following example shows how to displays information about a multilink group:

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

Related Commands

Command	Description
debug ppp multilink fragments	Displays information about individual multilink fragments and important multilink events.
debug ppp multilink events	Displays information about events affecting multilink groups established for Bandwidth Allocation Control Protocol (BACP.)

Glossary

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

differential delay—The amount of time that passes between the reception of two related signals that arrive on two separate carriers.

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

IMUX—Inverse multiplexer.

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

link—One of the interfaces in a bundle.

MLP—Multilink Point-to-Point Protocol. A method of splitting, recombining, and sequencing datagrams across multiple logical data links.

mux—A multiplexing device. A mux combines multiple signals for transmission over a single line. The signals are demultiplexed (separated) at the receiving end.

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

OIR—online insertion and removal. A feature that permits the addition, replacement, or removal of cards without interrupting the system power, entering console commands, or causing other software or interfaces to shut down.

PCI—Peripheral Component Interconnect. An open specification of the electrical, mechanical, and protocol features of a PCI bus. The PCI bus can operate at speeds up to 33 Mhz with a synchronous data transfer size of up to 64 data bits. The initial version of the VIP motherboard supports 25 Mhz and 32 bit transfer.

PPP—Point-to-Point Protocol. A successor to SLIP that provides router-to-router and host-to-network connections over synchronous and asynchronous circuits. PPP was designed to work with several network layer protocols (such as IP, IPX, and ARA). PPP also has built-in security mechanisms (such as CHAP and PAP). PPP relies on two protocols: LCP and NCP.

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

VIP—Versatile Interface Processor. An interface card that is used in Cisco 7000 and Cisco 7500 series routers. It can hold different port adapters to interface to various media (Ethernet, TokenRing, FDDI, Serial, ATM, etc.). The VIP supports 2 port adapters, standard packet delivery, distributed CEF and feature off-load.

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