Chapter 8
Configuring Multilink PPP

This chapter describes how to configure a Multilink Point-to-Point Protocol (PPP) interface on E-series routers.

This chapter contains the following sections:

Overview

Multilink PPP (MLPPP; also referred to as PPP Multilink, MLP, and MP) aggregates multiple physical links into a single logical bundle. More specifically, MLPPP bundles multiple link-layer channels into a single network-layer channel. Peers negotiate MLPPP during the initial phase of Link Control Protocol (LCP) option negotiation. Each router indicates that it is multilink capable by sending the multilink option as part of its initial LCP configuration request.

An MLPPP bundle can consist of multiple physical links of the same type—such as multiple asynchronous lines—or can consist of physical links of different types—such as leased synchronous lines and dial-up asynchronous lines.

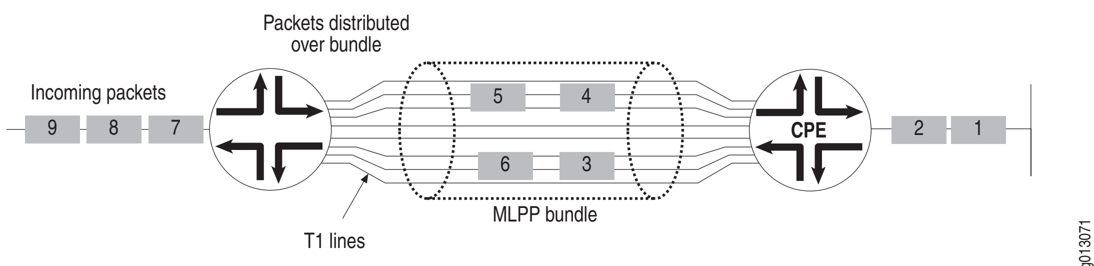
The router acts on MLPPP like another PPP Network Control Protocol (NCP). Packets received with an MLPPP header are subject to fragmentation, reassembly, and sequencing. Packets received without the MLPPP header cannot be sequenced and can be delivered only on a first-come, first-served basis.

Application

Some users need more bandwidth than a T1 or an E1 channel can provide, but cannot afford the expense or do not need the bandwidth of T3 or E3. Equal-cost multipath (ECMP) is one way to achieve the desired bandwidth. MLPPP is commonly used as an alternative to ECMP to deliver *NxT1* service. NxT1 service provides bandwidth greater than DS1 service without going up to the expense and infrastructure required for DS3 service. Cost-analysis of NxT1 versus DS3 service typically imposes a practical limit of 8xT1 service; that is, aggregation of no more than eight T1 or E1 connections into an MLPPP bundle.

The NxT1 implementation of MLPPP logically aggregates up to eight T1 or E1 connections into a single virtual connection, or bundle, to a given customer site, as shown in Figure 31.

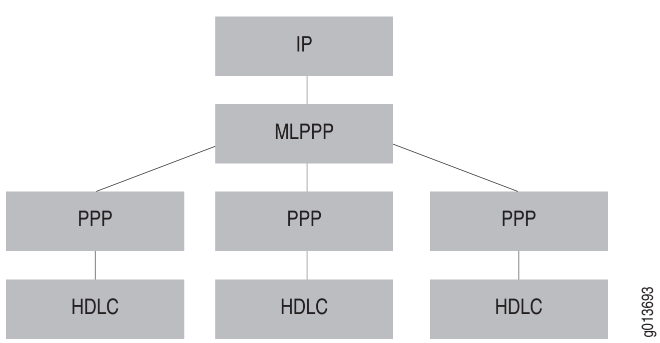
Figure 31: MLPPP Aggregation of T1 Lines into a Single Bundle



Because MLPPP aggregates multiple link-layer channels onto a single network-layer IP interface, protocol layering within the router is different than for non-multilink PPP.

Figure 32 illustrates interface stacking with MLPPP.

Figure 32: Structure of MLPPP



MLPPP LCP Extensions

Multilink PPP adds the following LCP negotiation options:

- Multilink maximum received reconstructed unit (MRRU) option—The MRRU option has two functions. First, it informs the other end of the link the maximum size of the PPP packet payload that the router can receive. Second, it informs the other end that the router supports MLPPP. When you enable multilink on your router, the router includes the MRRU option in LCP negotiation with the value set to the maximum received unit (MRU) value for PPP. If the remote system rejects this option, the local system determines that the remote system does not support multilink PPP and it terminates the link without negotiation.

NOTE: The router does not bring up a link if the MRU value received from a peer device differs from the MRRU value received from the peer.

- Short sequence number (SSN) header format option (not currently supported)—The SSN option indicates that the transmitting router wants to use a short sequence number (12 bits) in the MLPPP header rather than a long sequence number (24 bits). The router currently supports only long sequence numbers.

- Endpoint discriminator option—The endpoint discriminator option identifies the router transmitting the packet. If the receiving router determines that packets on another link have the same endpoint discriminator option, this link must be joined to that bundle. If the receiving router determines that no packets on other links have the same option, the receiving router must create a new bundle from this link.

  The endpoint discriminator is generated internally; you cannot configure it. The endpoint discriminator option is the same for all links on one end of the bundle; at the other end, all links also share a common endpoint discriminator. The two endpoint discriminators are different if the MLPPP bundle is set up between two E-series routers.

MLPPP Link Selection

By default, E-series routers use a round-robin algorithm to select the link on which to transmit data on an MLPPP interface. The round-robin link selection method applies to both best-effort packets, such as data, and non-best-effort (high-priority) packets, such as voice and video. Best-effort packets are encapsulated with an MLPPP header that contains a sequence number, whereas non-best-effort packets are encapsulated with a PPP header that does *not* contain a sequence number.

The member links in an MLPPP bundle can experience different queuing delays due to the volume of traffic transmitted on the MLPPP interface. These delays can cause packets to arrive out of order at the remote router. The effect of such delays differs for best-effort packets and non-best effort packets, as follows:

- For best-effort packets that arrive out of order from the E-series router, the remote router can use the sequence number to reorder and forward the packets in the correct order, regardless of the order in which the packets were received.
- For non-best-effort packets that arrive out of order from the E-series router, the lack of a sequence number prevents the remote router from being able to determine the correct order in which to forward the packets. This can cause problems with applications that require high-priority voice and video traffic transmitted on MLPPP interfaces to be received in the same order transmitted by the peer applications.

To ensure that the E-series router maintains the proper packet order when transmitting non-best-effort traffic, you can use the **ppp hash-link-selection** command to enable use of a hash-based algorithm to select the link on which the router transmits high-priority packets on an MLPPP interface.

When you use hash-based link selection instead of the default round-robin link selection for non-best-effort traffic, the router uses the IP source address (SA) and IP destination address (DA) of the packet as a hash to select the MLPPP member link on which to transmit the packet. Specifically, the router uses the hash algorithm to bind the transmission of all traffic between this IP SA and IP DA to the same member link in the MLPPP bundle.

If the member link selected to transmit high-priority packets becomes inoperable or is removed from the MLPPP bundle, the router must select a different link on which to transmit the packets. As a result, packets transmitted on this new link might sometimes arrive at the remote destination before the traffic sent on the previously selected member link.

You can configure hash-based MLPPP link selection in any of the following ways:

- To configure hash-based link selection for a individual MLPPP member link, issue the **ppp hash-link-selection** command from Interface Configuration mode or Subinterface Configuration mode in the context of the individual link interface. For more information, see *Configuring Static MLPPP* on page 267.
- To configure hash-based link selection for all current member links in an MLPPP bundle, issue the **ppp hash-link-selection** command from Interface Configuration mode in the context of the MLPPP bundle. Doing this has the same effect as issuing the **ppp hash-link-selection** command separately for each member link in the bundle. For more information, see *Contextual Command Differences* on page 268.
- To configure hash-based link selection for all dynamic MLPPP link interfaces created by a profile, issue the **ppp hash-link-selection** command from Profile Configuration mode. For more information, see *Configuring Dynamic MLPPP* on page 276.

For a detailed description and examples of using the **ppp hash-link-selection** command, see **ppp hash-link-selection** on page 272.

Platform Considerations

You can configure MLPPP interfaces on the following E-series routers:

- E120 router
- E320 router
- ERX-1440 router
- ERX-1410 router
- ERX-710 router
- ERX-705 router
- ERX-310 router

Module Requirements

For information about the modules that support MLPPP interfaces on ERX-14xx models, ERX-7xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support MLPPP.

For information about the modules that support MLPPP interfaces on the E120 router and the E320 router:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed module specifications.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the modules that support MLPPP.

Interface Specifiers

Some of the configuration task examples in this chapter use the *slot/port* format to specify the physical interface on which you want to configure MLPPP. However, the interface specifier format that you use depends on the type of physical interface on which you want to configure MLPPP and on the router that you are using.

For ERX-7xx models, ERX-14xx models, and ERX-310 routers, use the *slot/port* format. For example, the following command specifies an ATM interface on slot 5, port 1 of an ERX-7xx model, ERX-14xx model, or ERX-310 router.

host1(config)#**interface atm 5/1**

For E120 and E320 routers, use the *slot/adapter/port* format, which includes an identifier for the bay in which the I/O adapter (IOA) resides. In the software, adapter 0 identifies the right IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router). For example, the following command specifies a tunnel-server port on slot 3, adapter 0, port 0 of an E320 router.

host1(config)#**tunnel-server 3/0/0**

For more information about supported interface types and specifiers on E-series routers, see *Interface Types and Specifiers* in *JUNOSe Command Reference Guide, About This Guide*.

References

For more information about the MLPPP protocol and MLPPP fragmentation and reassembly, consult the following resources:

- RFC 1661—The Point-to-Point Protocol (PPP) (July 1994)
- RFC 1990—The PPP Multilink Protocol (MP) (August 1996)
- RFC 2233—The Interfaces Group MIB using SMIv2 (November 1997)

Supported MLPPP Features

The router currently supports both the static configuration of the links participating in a multilink bundle and the dynamic creation of MLPPP bundles over L2TP (only on the LNS) when the LNS detects multilink LCP option negotiation in LCP proxy data.

The following MLPPP features are available for both static and dynamic MLPPP:

- Logical aggregation of up to eight links in a bundle
- Long sequence numbers
- Authentication for interfaces with MLPPP encapsulation or for MLPPP bundles
- Monotonically increasing sequence numbers

  All packets distributed across the member links have monotonically increasing sequence numbers. This feature enables the remote system on the customer premises to perform resequencing (if the system is configured to do so).
- Round-robin packet distribution or hash-based packet distribution

  By default, E-series routers use a round-robin algorithm to handle packet distribution across the member links in a bundle for both best-effort traffic and non-best-effort traffic. The round-robin approach is used even when the member links have different line rates.

As an alternative to round-robin packet distribution for non-best-effort traffic, you can enable use of a hash-based algorithm for distribution of non-best-effort (high-priority) packets, such as voice or video. Using a hash-based packet distribution mechanism instead of the default round-robin packet distribution mechanism for non-best-effort traffic ensures that the router maintains the proper packet order when transmitting high-priority packets. For details, see *MLPPP Link Selection* on page 257.

- Forwarding of multilink traffic to L2TP tunnels

  E-series routers support dynamic MLPPP over L2TP configurations (on the L2TP network server, or LNS).

- Fragmentation and reassembly

  For details, see *Configuring MLPPP Fragmentation and Reassembly* on page 277.

- Packet resequencing for best-effort traffic, for non-best-effort traffic, and when MLPPP reassembly is enabled

  For details on how the router supports packet resequencing for best-effort traffic and non-best-effort traffic, see *MLPPP Link Selection* on page 257.

  For details on enabling MLPPP reassembly, see *Configuring MLPPP Fragmentation and Reassembly* on page 277.

You can configure bundles as follows:

- On a COCX-F3 line module and its corresponding I/O modules, you can configure:
  - Up to 8 member links from different ports in the same bundle, with the following restriction for MLPPP reassembly:
    - For a COCX-F3 line module with either a 12-port E3-12 FRAME I/O module or a 12-port CT3/T3 12 I/O module, the restriction is based on the ports on which member links in the same bundle are configured.

      A 12-port E3-12 FRAME I/O module and a 12-port CT3/T3 12 I/O module each contain 12 ports numbered 0 through 11. When MLPPP reassembly is enabled, you can configure a bundle with member links on the same port; on ports 0, 1, and 2; on ports 3, 4, and 5; on ports 6, 7, and 8; or on ports 9, 10, and 11. However, the router *cannot* properly reassemble fragments if you configure a bundle with member links that span ports in different bundles; for example, on ports 0, 1, and 4.

      When MLPPP reassembly is disabled, this restriction is not in effect; that is, member links can span ports in different bundles.
  - Up to 12 bundles

- On a cOCx/STMx line module and its corresponding I/O module, you can configure:
  - Member links from different OC3/STM1 ports in the same bundle, with the following restrictions for MLPPP reassembly:
    - For a cOCx/STMx line module with a 4-port cOC3/STM1 I/O module, the restriction is based on the ports on which member links in the same bundle are configured.

      A 4-port cOC3/STM1 I/O module contains four ports numbered 0 through 3. When MLPPP reassembly is enabled, you can configure a bundle with member links on the same port, on ports 0 and 1, or on ports 2 and 3. However, the router *cannot* properly reassemble fragments if you configure a bundle with member links that span ports in different bundles; for example, on ports 1 and 2.

      When MLPPP reassembly is disabled, this restriction is not in effect; that is, member links can span ports in different bundles.
    - For a cOCx/STMx line module with a 1-port cOC12/STM4 I/O module, the restriction is based on the STM1 (OC3) paths on which member links in the same bundle are configured.

      A 1-port cOC12/STM4 I/O module has four logical paths numbered 1 through 4. When MLPPP reassembly is enabled, you can configure a bundle with member links on the same path, on paths 1 and 2, or on paths 3 and 4. However, the router *cannot* properly reassemble fragments if you configure a bundle with member links that span paths in different bundles; that is, on paths 2 and 3.

      When MLPPP reassembly is disabled, this restriction is not in effect; for example, member links can span paths in different bundles.
  - Any combination of bundles that does not exceed the 336 available T1 channels (for example, 336 single-link T1 bundles, 42 eight-link bundles, or 41 eight-link bundles and 8 single-link bundles)
  - Any combination of bundles that does not exceed the 252 available E1 channels (for example, 252 single-link T1 bundles, 34 eight-link bundles, or 33 eight-link bundles and 8 single-link bundles)
- On a CT3/T3-F0 line module with a CT3/T3 12 I/O module, you can configure:
  - Member links from different T3 ports in the same bundle
  - Any combination of bundles that does not exceed the 336 available T1 channels (for example, 336 single-link T1 bundles, 42 eight-link bundles, or 41 eight-link bundles and 8 single-link bundles)

- On an ES2-S1 Service IOA, you can configure:
  - Up to 16,000 member links per line module, not to exceed a total of 12,000 MLPPP bundles per chassis
  - Any combination of bundles that does not exceed either of these maximums (for example, 4000 single-link bundles, 4000 two-link bundles, 4000 four-link bundles, and 2000 eight-link bundles)
- On an OCx/STMx ATM line module and its corresponding line modules, you can configure:
  - Up to 8000 member links per line module, not to exceed a total of 8000 MLPPP bundles per chassis
  - Any combination of bundles that does not exceed either of these maximums (for example, 4000 single-link bundles, 4000 two-link bundles, 2000 four-link bundles, and 1000 eight-link bundles)
- On a Service line module (SM), you can configure:
  - Up to 16,000 member links per line module, not to exceed a total of 12,000 MLPPP bundles per chassis
  - Any combination of bundles that does not exceed either of these maximums (for example, 4000 single-link bundles, 4000 two-link bundles, 4000 four-link bundles, and 2000 eight-link bundles)
- On a shared tunnel-server port configured on a GE-2 or GE-HDE line module and corresponding line modules, you can configure:
  - Up to 8000 member links per line module, not to exceed a total of 8000 MLPPP bundles per chassis
  - Any combination of bundles that does not exceed either of these maximums (for example, 4000 single-link bundles, 4000 two-link bundles, 2000 four-link bundles, and 1000 eight-link bundles)
- On a ES2-S1 GE-4 IOA that pairs with an ES2 4G LM on E120 routers and E320 routers, you can configure:
  - MLPPP bundles with one or more links per bundle for dynamic MLPPP-over-PPPoE-over-Ethernet configurations.
  - MLPPP bundles with only one link per bundle when configuring static MLPPP-over-PPPoE-over-Ethernet. When you create multilink bundles in a static MLPPP-over-PPPoE-over-Ethernet configuration, PPPoE is unable to direct the PPPoE Active Discovery Initiation (PADI) packets received from the MLPPP bundle links on the client to the appropriate (matching) links in the MLPPP bundle on the server. As a result, the connections between bundle links become crossed, and the bundle does not come up as expected. Creating MLPPP bundles with only a single link for this configuration ensures a one-to-one correspondence between a PPPoE subscriber and its associated link, and guarantees that the MLPPP bundle comes up properly.

  - MLPPP bundles with only a single link per bundle are *not* required for static MLPPP-over-PPPoE-over-Ethernet with VLAN configurations if all of the links in a bundle have the same VLAN ID that is unique across all MLPPP bundles configured on the line module.

- On all E-series ATM module combinations that support MLPPP, you can configure:

  - MLPPP bundles with one or more links per bundle for dynamic MLPPP-over-multiple PPPoE subinterfaces-over-one PPPoE major interface-over-ATM 1483 subinterface configurations.

  - MLPPP bundles with only one link per bundle when configuring static MLPPP-over-multiple PPPoE subinterfaces-over-one PPPoE major interface-over-an ATM 1483 subinterface. In this configuration, you can stack multiple PPPoE subinterfaces over a single PPPoE major interface.

  - Typically when you create ATM PVCs on an ATM module, there is a one-to-one correspondence between a PPPoE subscriber and the ATM PVC with which the subscriber is associated. However, in configurations with multiple PPPoE subinterfaces stacked over a single PPPoE major interface, crossed MLPPP bundle link connections can occur, as is the case with the ES2-S1 GE-4 IOA, and the bundle does not come up as expected. Creating MLPPP bundles with only a single link for this configuration ensures a one-to-one correspondence between a PPPoE subscriber and its associated link, and guarantees that the MLPPP bundle comes up properly.

  - MLPPP bundles with only a single link per bundle are *not* required for static MLPPP-over-multiple PPPoE subinterfaces-over-one PPPoE major interface-over-ATM 1483 subinterface configurations if all PPPoE subinterfaces stacked over the same PPPoE major interface belong to the same bundle.

NOTE: For information about the modules that support MLPPP on ERX-14xx models, ERX-7xx models, and the ERX-310 router, see *ERX Module Guide, Appendix A, Module Protocol Support*. For information about the modules that support MLPPP on the E120 router and the E320 router, see *E120 and E320 Module Guide, Appendix A, IOA Protocol Support*.

Unsupported MLPPP Features

The router does not support the following MLPPP features:

- Short sequence numbers
- Resequencing out-of-order packets in the absence of fragmentation

  Given the location in the network where the router resides, the *N*xT1 links to a customer site represent one of many places across the IP network where packets might be received out of order. For example, if the router has multiple uplinks to a core router, packets might be received out of order across these links.

  You can lose packets if you transmit layer 2 traffic on an MPLS LSP that passes over an MLPPP link bundle.

  Packets are passed along to the next protocol layer in the order that they are processed. Packet resequencing is therefore performed at the end station rather than the aggregation router. IP datagrams can be resequenced by the end station using the IP identification field.

  Layer 2 packets such as Ethernet/MPLS and ATM-AAL5/MPLS have no sequence number information and are sent in the order received. The packets are dropped if their out-of-order condition is detected by a downstream device.

  Frame Relay/MPLS packets do have a native sequence number in the header and are rejected at the end of the LSP if the MLPPP sequence number order is violated.

  To ensure that the router maintains the proper packet order when transmitting high-priority (non-best-effort) packets such as voice and video, you can use the **ppp hash-link-selection** command to enable use of a hash-based algorithm to select the link on which the router transmits high-priority packets on an MLPPP interface. For details, see *MLPPP Link Selection* on page 257.

Before You Configure Static MLPPP

Before you begin configuring static MLPPP, you must configure the physical line interfaces to be aggregated by MLPPP. See the following chapters:

- *JUNOSe Physical Layer Configuration Guide, Chapter 1, Configuring Channelized T3 Interfaces*
- *JUNOSe Physical Layer Configuration Guide, Chapter 2, Configuring T3 and E3 Interfaces*
- *JUNOSe Physical Layer Configuration Guide, Chapter 4, Configuring Channelized OCx/STMx Interfaces*

The procedures described in *Configuring Static MLPPP* on page 267 assume that a physical line interface has been configured.

Configuring Static MLPPP

Static MLPPP configuration consists of two general tasks, each with several subtasks.

To configure static MLPPP:

1. Create the member links to be aggregated into a multilink bundle.
   a. From Global Configuration mode, specify the individual interface on which you want to configure MLPPP.

      host1(config)#**interface serial 2/0:1/1**

   b. Specify MLPPP as the encapsulation method on the interface.

      host1(config-if)#**encapsulation mlppp**

   c. (Optional) Specify the keepalive timeout value for the member link interface.

      host1(config-if)#**ppp keepalive 50**

   d. (Optional) Specify the authentication method for the member link interface.

      host1(config-if)#**ppp authentication pap chap**

   e. (Optional) Enable hash-based link selection instead of the default round-robin link selection for the member link interface.

      host1(config-if)#**ppp hash-link-selection**

2. Add member links to a multilink bundle.
   a. Define the MLPPP bundle.

      host1(config)#**interface mlppp group1**

   b. Add each member link.

      host1(config-if)#**member-interface serial 2/0:1/1**

   c. Assign an IP address to the MLPPP bundle.

      host1(config-if)#**ip address 10.10.100.1 255.255.255.0**

   d. (Optional) Specify the keepalive timeout value for the MLPPP network interface (the entire MLPPP bundle).

      host1(config-if)#**ppp keepalive 50**

e. (Optional) Specify the authentication method for the MLPPP network interface (the entire MLPPP bundle).

   host1(config-if)#**ppp authentication pap chap**

f. (Optional) Enable hash-based link selection instead of the default round-robin link selection for the MLPPP network interface (the entire MLPPP bundle).

   host1(config-if)#**ppp hash-link-selection**

Configuration Example

The following commands configure three T1 lines and aggregate them into a multilink bundle named group1.

host1(config)#**interface serial 2/0:1/1**
host1(config-if)#**encapsulation mlppp**
host1(config-if)#**exit**
host1(config)#**interface serial 2/0:2/1**
host1(config-if)#**encapsulation mlppp**
host1(config-if)#**exit**
host1(config)#**interface serial 2/0:3/1**
host1(config-if)#**encapsulation mlppp**
host1(config-if)#**ppp keepalive 50**
host1(config-if)#**exit**
host1(config)#**interface mlppp group1**
host1(config-if)#**member-interface serial 2/0:1/1**
host1(config-if)#**member-interface serial 2/0:2/1**
host1(config-if)#**member-interface serial 2/0:3/1**
host1(config-if)#**ppp authentication pap chap**
host1(config-if)#**ppp hash-link-selection**
host1(config-if)#**ip address 10.10.100.1 255.255.255.0**

Contextual Command Differences

The MLPPP configuration commands have different effects depending on the interface context. If you issue an MLPPP configuration command in the context of an individual interface, the command affects only the MLPPP link interface associated with that individual interface.

For example, the following commands disable negotiation of the local magic number only for serial interface 2/0:1/1.

host1(config-if)#**member-interface serial 2/0:1/1**
host1(config-if)#**encapsulation mlppp**
host1(config-if)#**ppp magic-number disable**

If you issue an MLPPP configuration command in the context of an MLPPP bundle—the MLPPP network interface—the command affects all the member links of the bundle. This feature prevents you from having to issue MLPPP configuration commands for each member link interface.

For example, the following commands disable negotiation of the local magic number for the entire bundle, *group1*.

```
host1(config)#interface mlppp group1
host1(config-if)#member-interface serial 2/0:1/1
host1(config-if)#ip address 10.10.100.1 255.255.255.0
host1(config-if)#ppp magic-number disable
```

Any member links added to the bundle after issuing an MLPPP configuration command are not affected by the command. For example, if you add serial interface 2/0:4/1 to the *group1* bundle after you issue the **ppp magic-number disable** command, negotiation of the local magic number for this link and any member links subsequently added to the bundle is not disabled.

Configuring Authentication

Perform the following optional tasks to configure authentication on interfaces with MLPPP encapsulation or MLPPP bundles.

- Specify one or more PPP authentication types.
- Modify the length of the CHAP challenge.
- Specify the maximum number of retries.

NOTE: The JUNOSe software's PPP application accepts null usernames during PAP and CHAP authentication. When the PPP application receives an authentication request that includes a null username, PPP passes the request to AAA. To take advantage of this feature, configure your authentication server to support the use of null usernames.

ppp authentication

- Use to require authentication from the PPP peer.
- To specify the name of a virtual router (VR) to be used as the authentication VR context, use the **virtual-router** keyword. Keep the following points in mind when you use the **ppp authentication virtual-router** command:
  - When you specify a VR in the **ppp authentication** command, AAA does not query the domain map for the assigned VR context. Instead, AAA uses the VR specified in the **ppp authentication** command as the authentication VR context and issues the authentication request to the authentication server in the assigned VR context.
  - If you specify the default VR as the authentication VR context, AAA loosely binds the user to the default VR. This means that RADIUS *can override* the default VR context with a new VR context during the authentication process. When the **ppp authentication virtual-router** command specifies the default VR, AAA returns either the default VR or the VR specified by RADIUS.

  - If you specify a VR other than the default VR as the authentication VR, AAA tightly binds the user to the specified VR. This means that RADIUS *cannot override* the specified VR context with a new VR context during the authentication process. When the **ppp authentication virtual-router** command specifies a nondefault VR, AAA returns the specified VR.
- The router supports the MD5 authentication algorithm for CHAP authentication.
- Example 1—Specify PAP or CHAP as the primary authentication protocol, and the other authentication protocol as the alternative. For example, the following command specifies **pap** as the primary authentication protocol and **chap** as the alternate.

  host1(config-if)#**ppp authentication pap chap**

  The router requests the use of PAP as the authentication protocol (because it appears first in the command line). If the peer refuses to use PAP, the router requests the CHAP protocol. If the peer refuses to negotiate authentication, the router terminates the PPP session.
- Example 2—Specify a virtual router for the authentication virtual router context. This command is available in static configurations and in profiles.

  host1(config-if)#**ppp authentication virtual-router boston pap chap**
- Use the **no** version to specify that the router does not require authentication.

ppp chap-challenge-length

- Use to modify the length of the CHAP challenge by specifying the allowable minimum length and maximum length.

CAUTION: Do *not* use the **ppp chap-challenge-length** command; increasing the minimum length (from the default 16 bytes) or decreasing the maximum length (from the default 32 bytes) reduces the security of your router.

- Specify the minimum and maximum lengths in bytes in the range 8–63.
- The maximum length must be greater than or equal to the minimum length.
- Example

  host1(config-if)#**ppp chap-challenge-length 24 28**
- Use the **no** version to restore the default minimum (16 bytes) and default maximum (32 bytes).

ppp max-bad-auth

- Use to specify the maximum number of authentication retries the router allows before terminating a PPP session
- This value applies to PAP and CHAP authentication.
- The range is 0–7. The default is 0, which indicates that no retries are allowed.

- Example

  host1(config-if)#**ppp max-bad-auth 3**

- Use the **no** version to return the number of retries to the default, 0.

Configuring Other PPP Attributes

The available **ppp** command options are the same for interfaces whether they are configured with PPP or MLPPP.

encapsulation mlppp

- Use to configure MLPPP as the encapsulation method on an individual interface.
- Use this command only within the context of an individual interface. Issuing this command creates an MLPPP link interface, also referred to as an MLPPP bundle member.
- Example

  host1(config)#**interface serial 2/0:1/1**
  host1(config-if)#**encapsulation mlppp**

- Use the **no** version to disable MLPPP on an interface.

interface mlppp

- Use to create an MLPPP network interface, also known as the MLPPP bundle.
- Example

  host1(config-if)#**interface mlppp group2**

- Use the **no** version to delete the MLPPP bundle. You must first delete the IP interface, followed by deleting the bundle members (link interfaces); then you can delete the MLPPP bundle.

NOTE: RADIUS supports the inclusion of the MLPPP Bundle Name VSA [26-62] in Access-Request, Acct-Start, Acct-Stop, and Interim-Acct messages. For more information, see *JUNOSe Broadband Access Configuration Guide, Chapter 3, Configuring RADIUS Attributes*.

member-interface

- Use to add an MLPPP link interface—also known as an MLPPP bundle member—to an MLPPP bundle.
- Example

  host1(config-if)#**member-interface serial 2/0:1/1**

- Use the **no** version to remove the specified interface from the MLPPP bundle.

ppp hash-link-selection

- Use to enable use of a hash-based algorithm to select the link on which the router transmits non-best-effort (high-priority) packets, such as voice or video, on an MLPPP interface.
- Hash-based MLPPP link selection is available only for non-best-effort traffic. For best-effort traffic, the router uses a round-robin algorithm for link selection.
- Using hash-based link selection instead of the default round-robin link selection for non-best-effort traffic ensures that the router maintains the proper packet order when transmitting high-priority packets.
- When you configure hash-based link selection, the router uses the IP source address and IP destination address of the packet as a hash to select the MLPPP member link on which to transmit the packet.
- You can configure hash-based MLPPP link selection in any of the following ways:
  - To configure hash-based link selection for an individual MLPPP member link interface, issue the **ppp hash-link-selection** command from Interface Configuration mode or Subinterface Configuration mode in the context of the link interface. (See Example 1.)
  - To configure hash-based link selection for all current member links in an MLPPP bundle, issue the **ppp hash-link-selection** command from Interface Configuration mode in the context of the MLPPP bundle. (See Example 2.)
  - To configure hash-based link selection for all dynamic MLPPP link interfaces created by a profile, issue the **ppp hash-link-selection** command from Profile Configuration mode. (See Example 3.)
- Example 1—The following commands configure hash-based MLPPP link selection for an individual MLPPP member link interface.

  host1(config)#**interface atm 2/0**
  host1(config-if)#**interface atm 2/0.2**
  host1(config-subif)#**atm pvc 42 0 42 aal5snap**
  host1(config-subif)#**encapsulation mlppp**
  host1(config-subif)#**ppp hash-link-selection**

- Example 2—The following commands configure hash-based MLPPP link selection for all current member links in the MLPPP bundle (group1). Doing this has the same effect as issuing the **ppp hash-link-selection** command separately for each member link in the bundle.

  host1(config)#**interface mlppp group1**
  host1(config-if)#**ppp hash-link-selection**

- Example 3—The following commands configure hash-based MLPPP link selection for all dynamic MLPPP interfaces created by the profile named dynamicMlppp.

  host1(config)#**profile dynamicMlppp**
  host1(config-profile)#**ppp multilink enable**
  host1(config-profile)#**ppp hash-link-selection**

- Use the **no** version to restore the default round-robin algorithm for MLPPP link selection.

ppp keepalive

- Use to specify the keepalive timeout value in the range 10–64800 seconds. If issued in the context of an individual interface, the command affects only that interface. If issued in the context of an MLPPP bundle, the command affects all MLPPP link interfaces that are member links of that bundle.
- When the keepalive timer expires, the interface always sends an LCP echo request, regardless of whether the peer is silent.
- When the keepalive interval is 30 seconds (the default), a failed link is detected between 90 and 120 seconds after failure.
- Use **ppp keepalive** without a value to restore the default, 30 seconds.
- Example

  host1(config-if)#**ppp keepalive 50**

- Use the **no** version to disable keepalive.

ppp log

- Use to enable PPP packet or state machine logging on any dynamic interface that uses the profile being configured. Specify one of the following keywords:
  - **pppPacket**—Enables PPP packet logging
  - **pppStateMachine**—Enables PPP state machine logging
- Example

  host1(config-profile)#**ppp log pppPacket**

NOTE: This command is equivalent to the **log severity debug pppPacket** and **log severity debug pppStateMachine** commands.

- Use the **no** version to disable packet or state machine logging.

ppp magic-number disable

- Use to disable negotiation of the local magic number. If issued in the context of an individual interface, the command affects only that interface. If issued in the context of an MLPPP bundle, the command affects all MLPPP link interfaces that are member links of that bundle.
- Issuing this command prevents the router from detecting loopback configurations.
- Example

  host1(config-if)#**ppp magic-number disable**

- Use the **no** version to restore negotiation of the local magic number.

ppp magic-number ignore-mismatch

- Use to cause the router to ignore a mismatch of the LCP peer magic number and retain the PPP connection when the peer has not negotiated an LCP magic number.
- For more information about using this command, see *Validation of LCP Peer Magic Number* in *Chapter 7, Configuring Point-to-Point Protocol*.
- To verify configuration of LCP peer magic number validation on the router, use the **show ppp interface mlppp** command. For information, see **show ppp interface mlppp** on page 289.
- Example

  host1(config-if)#**ppp magic-number ignore-mismatch**

- Use the **no** version to restore the default behavior, in which the router terminates the PPP connection if it detects an LCP peer magic number mismatch.

ppp mru

- Use to control the negotiation of the maximum receive unit (MRU).
- Specify the number of bytes, in the range 64–65535.
- We recommend you coordinate this value with the network administrator on the other end of the line.
- If the value configured for the PPP MRU is greater than the value of the lower-layer MRU minus the PPP header length, the router logs a warning message and uses the lesser of the configured MRU value or the lower-layer MRU value minus the PPP header length to negotiate the local MRU.
- If the value configured for the PPP MRU conflicts with a similar value configured for another protocol, such as the MTU value for PPPoE, the router uses the lesser of the two values.
- If you issue the command in the context of an encapsulated MLPPP interface, it affects only that interface. If you issue the command in the context of an MLPPP bundle, it affects all member links within that bundle.
- Example

  host1(config-if)#**ppp mru 576**

- Use the **no** version to restore the default value, which causes PPP to use the lower-layer MRU minus the PPP header length as the MRU value.

ppp passive-mode

- Use to force a static or dynamic PPP interface into passive mode, for a period of one second, before LCP negotiation begins. This delay enables slow clients to start up and initiate the LCP negotiation.
- Example

  host1(config-if)#**ppp passive-mode**

- Use the **no** version to disable passive mode.

ppp peer

- Use to resolve conflicts when the system and the PPP peer system have primary and secondary DNS and WINS addresses configured with different values.
- By default, the DNS and WINS addresses configured on the system take precedence.
- Use the **ppp peer dns** or the **ppp peer wins** commands to configure the PPP peer system as the one that takes precedence. This command has no effect unless both systems have the address configured and the address is in conflict. If the PPP peer system has the address and the system does not, the peer always supplies the address regardless of how you have configured the PPP peer.
- Example

  host1(config-profile)#**ppp peer dns**

- Use the **no ppp peer dns** or the **no ppp peer wins** commands when you want the system to take precedence during setup negotiations between the system and the remote PC client. If the IP addresses passed to the system by the remote PC client differ from the ones you have configured on your system, the system returns the values that you configured as the correct values to the remote PC client.

ppp shutdown

- Use to terminate an MLPPP session.
- If you use the **ip** or **osi** keyword, disables the Internet Protocol Control Protocol (IPCP) or OSI Network Layer Control Protocol (OSINLCP) service for the MLPPP network interface (MLPPP bundle). Issue only in the context of a network interface.
- If no keywords are issued, issuing this command has the following effect:
  - If issued in the context of an individual interface, the command affects only that interface. The **ip** and **osi** keywords are not functional in this context.
  - If issued in the context of an MLPPP bundle, the command affects all MLPPP link interfaces that are member links of that bundle. The **ip** and **osi** keywords are functional only in this context.
- The **ppp shutdown** command administratively disables the interface.
- Example

  host1(config-if)#**ppp shutdown**

- If you issue the **ppp shutdown** command in the context of an MLPPP bundle, you cannot bring up an individual member link by subsequently issuing the **no ppp shutdown** command in the context of that member. You can bring up only the entire bundle; to do so, you must issue the **no ppp shutdown** command in the context of the bundle. If you add new member links while a bundle is shut down, those new members are also in the shut-down state until the entire bundle is brought up.
- Use the **no** version to restart a disabled session.

Configuring Dynamic MLPPP

You can define a profile to dynamically create MLPPP bundles over L2TP on the LNS. The profile consists of commands to define the bundle attributes, just as you would for static configuration. For more information about profiles for dynamic interfaces, see *Chapter 15, Configuring Dynamic Interfaces*.

To configure a profile for dynamic MLPPP:

1. Create a profile by assigning it a name.

   host1(config)#**profile dynmlppp**

2. Enable creation of dynamic MLPPP interfaces.

   host1(config-profile)#**ppp multilink enable**

3. Specify a virtual router to which dynamic IP interfaces created using this profile will be assigned.

   host1(config-profile)#**ip virtual-router egypt**

4. Specify an IP loopback interface with which dynamic IP interfaces created using this profile will be associated.

   host1(config-profile)#**ip unnumbered loopback 0**

5. (Optional) Set other desired PPP characteristics by using the **ppp** commands described in *Configuring Authentication* on page 269 and *Configuring Other PPP Attributes* on page 271.

ppp multilink enable

- Use in a profile to enable the creation of dynamic MLPPP interfaces.
- Example

  host1(config-profile)#**ppp multilink enable**

- Use the **no** version to cause the LNS to reject any incoming requests to create dynamic MLPPP interfaces.

profile

- Use to create a profile.
- Specify a profile name with up to 80 characters.
- Example

  host1(config)#**profile dynmlppp1**

- Use the **no** version to remove a profile.

Configuring MLPPP Fragmentation and Reassembly

You can configure MLPPP fragmentation and reassembly on a static link interface before adding the link to a bundle, or in a profile assigned to a dynamic MLPPP interface. You can also configure fragmentation and reassembly for all current member links in an MLPPP bundle.

Overview

E-series routers support fragmentation and reassembly as part of their MLPPP implementation. *Fragmentation* is the process by which a large packet is broken up into multiple smaller fragments for simultaneous transmission across multiple links of an MLPPP bundle. *Reassembly* is the process by which the destination router reassembles the fragments into the original packets.

Application

You can use MLPPP fragmentation and reassembly to reduce transmission latency. You can also use the feature to implement a packet-prioritization scheme that allows smaller, delay-sensitive packets (such as high-priority voice packets) to be interleaved with or race ahead of larger, delay-insensitive packets (such as low-priority data packets) when they are transmitted in the network.

Supported Configurations

Table 13 lists the static and dynamic MLPPP configurations on E-series routers that support fragmentation and reassembly.

Table 13: Supported Configurations for MLPPP Fragmentation and Reassembly

Static MLPPP Configurations	Dynamic MLPPP Configurations
Static MLPPP over ATM 1483 subinterfaces	Dynamic MLPPP over ATM 1483 subinterfaces
Static MLPPP over PPPoE over ATM 1483 subinterfaces	Dynamic MLPPP over PPPoE over ATM 1483 subinterfaces
Static MLPPP over serial (HDLC) interfaces	Dynamic MLPPP over serial (HDLC) interfaces
–	Dynamic MLPPP over L2TP (on the L2TP network server)

Module Requirements

For a list of the line modules and corresponding I/O modules that support MLPPP fragmentation and reassembly on ERX-7xx models, ERX-14xx models, and the ERX-310 router, see *ERX Module Guide*, *Appendix A*, *Module Protocol Support*.

For a list of the line modules and corresponding IOAs that support MLPPP fragmentation and reassembly on the E120 router and the E320 router, see *E120 and E320 Module Guide, Appendix A, IOA Protocol Support*.

Link Configuration Parameters

The parameters for MLPPP fragmentation and reassembly are configured on a per-link basis for each link interface (also known as a member link) in an MLPPP bundle.

By default, fragmentation and reassembly are disabled for MLPPP links. You can enable or disable fragmentation and reassembly for an individual link, or for all member links in a bundle, by using the **ppp fragmentation** and **ppp reassembly** commands. However, you must configure the same fragmentation setting and the same reassembly setting—enabled or disabled—for all member links in a bundle.

When you use the **ppp fragmentation** command to enable fragmentation on a link, you can optionally specify the maximum fragment size to be used on the link interface. When you use the **ppp reassembly** command to enable reassembly on a link, you can optionally specify the administrative multilink maximum received reconstructed unit (MRRU) value for the link.

Bundle Validation and Configuration Guidelines

When you configure MLPPP, the router validates that each link interface attempting to join a statically or dynamically created bundle has Link Control Protocol (LCP) parameters that are compatible with the other member links already in the bundle. This validation includes examining the parameters configured for fragmentation and reassembly on a particular link interface and verifying that these parameters are compatible with the other member links in the bundle.

To ensure that the bundle validation succeeds, make sure you observe the following configuration guidelines for MLPPP fragmentation and reassembly.

Guidelines for MLPPP Fragmentation

Use the following guidelines when you configure MLPPP fragmentation on a link interface:

- Configure the same fragmentation setting—enabled or disabled—for all member links in a bundle.
- When fragmentation is enabled, configure the same fragment size for all member links in a bundle.
- Make sure a link's fragment size does not exceed its maximum transmission unit (MTU) size.
- Do not configure both MLPPP fragmentation (with the **ppp fragmentation** command) and IP fragmentation of L2TP packets (with the **ip mtu** command) on the same interface. Instead, you must choose only one of the fragmentation configurations by setting it to the necessary value and set the other fragmentation configuration to the maximum allowable value.

Guidelines for MLPPP Reassembly

Use the following guidelines when you configure MLPPP reassembly on a link interface:

- Configure the same reassembly setting—enabled or disabled—for all member links in a bundle.
- Make sure a link's administrative MRRU is greater than or equal to the local maximum receive unit (MRU) negotiated both on that link and on other member links in the bundle.

- The local MRRU negotiated on a link must be the same as the local MRRU negotiated on the other member links in the bundle.
- The peer MRRU negotiated on a link must be the same as the peer MRRU negotiated on the other member links in the bundle.
- When reassembly is enabled, member links belonging to the same bundle can have different local MRU values.
- When reassembly is disabled, member links belonging to the same bundle must negotiate the same local MRU value.

Bundle Validation Failure

If an MLPPP link interface fails bundle validation because one or more of the preceding configuration guidelines are not met, the router's actions differ depending on whether you are using a static MLPPP configuration or a dynamic MLPPP configuration, as follows:

- For static MLPPP configurations, the router permits the failed link to join the bundle, but forces the link into a down state.
- For dynamic MLPPP configurations, the router prohibits the failed link from joining the bundle, and subsequently tears down the link.

Recovering from Bundle Validation Failure

To recover from a bundle validation failure, you must reconfigure the link interface (for static MLPPP configurations) or reconfigure the profile (for dynamic MLPPP configurations) according to the guidelines described in *Bundle Validation and Configuration Guidelines* on page 278.

Configuring Fragmentation and Reassembly for Static MLPPP

To configure fragmentation and reassembly on a static MLPPP link interface:

1. From Global Configuration mode, specify the individual link interface on which you want to configure fragmentation and reassembly.

   host1(config)#**interface serial 4/0:1/1/1/1/1**

2. Specify MLPPP as the encapsulation method on the link interface.

   host1(config-if)#**encapsulation mlppp**

3. Enable fragmentation on the link interface, and optionally specify the maximum allowable fragment size to use.

   host1(config-if)#**ppp fragmentation 128**

NOTE: You can specify the maximum fragment size for a link only when you use the **ppp fragmentation** command to enable fragmentation on that link. You cannot specify the maximum fragment size for a link when fragmentation is disabled.

---

4. Enable reassembly on the link interface, and optionally specify the administrative MRRU value to use.

   host1(config-if)#**ppp reassembly 1590**

NOTE: You can specify the administrative MRRU value for a link only when you use the **ppp reassembly** command to enable reassembly on that link. You cannot specify the administrative MRRU for a link when reassembly is disabled.

5. Exit Interface Configuration mode.

   host1(config-if)#**exit**

6. Repeat Steps 1 through 5 for each additional link interface on which you want to configure fragmentation and reassembly. For example:

   host1(config)#**interface serial 4/0:1/1/1/1/2**
   host1(config-if)#**encapsulation mlppp**
   host1(config-if)#**ppp fragmentation 128**
   host1(config-if)#**ppp reassembly 1590**
   host1(config-if)#**exit**

7. Define the MLPPP bundle.

   host1(config)#**interface mlppp group1**

8. Add each member link to the bundle.

   host1(config-if)#**member-interface serial 4/0:1/1/1/1/1**
   host1(config-if)#**member-interface serial 4/0:1/1/1/1/2**

9. Assign an IP address to the MLPPP bundle.

   host1(config-if)#**ip address 10.10.100.1 255.255.255.0**

Static MLPPP over ATM 1483 Example

The following example configures MLPPP fragmentation and reassembly for two member links in an MLPPP bundle over an ATM 1483 subinterface.

host1(config)#**interface atm 2/0**
host1(config-if)#**interface atm 2/0.2**
host1(config-subif)#**atm pvc 42 0 42 aal5snap**
host1(config-subif)#**encapsulation mlppp**
host1(config-subif)#**ppp fragmentation**
host1(config-subif)#**ppp reassembly 1400**
host1(config-subif)#**ppp authentication pap chap**
host1(config-subif)#**exit**
host1(config)#**interface atm 2/0.3**
host1(config-subif)#**atm pvc 43 0 43 aal5snap**
host1(config-subif)#**encapsulation mlppp**
host1(config-subif)#**ppp fragmentation**
host1(config-subif)#**ppp reassembly 1600**
host1(config-subif)#**ppp authentication pap chap**
host1(config-subif)#**exit**

```
host1(config)#interface mlppp client1
host1(config-if)#member-interface atm 2/0.2
host1(config-if)#member-interface atm 2/0.3
host1(config-if)#ip address 10.10.200.1 255.255.255.0
```

Configuring Fragmentation and Reassembly for Dynamic MLPPP

To configure fragmentation and reassembly for dynamic MLPPP, you must create a profile that includes commands to define the link and bundle attributes, just as you do for a static MLPPP configuration.

For more information, see:

- *Chapter 15, Configuring Dynamic Interfaces*
- *JUNOSe Broadband Access Configuration Guide, Chapter 12, Configuring an L2TP LAC*
- *JUNOSe Broadband Access Configuration Guide, Chapter 13, Configuring an L2TP LNS*

To define a profile that configures MLPPP fragmentation and reassembly for a dynamic MLPPP interface:

1. From Global Configuration mode, create a profile by assigning it a name, and access Profile Configuration mode.

   ```
   host1(config)#profile dynmlppp1
   host1(config-profile)#
   ```

2. Enable the creation of dynamic MLPPP interfaces.

   ```
   host1(config-profile)#ppp multilink enable
   ```

3. Enable fragmentation on the link interface, and optionally specify the maximum allowable fragment size to use.

   ```
   host1(config-profile)#ppp fragmentation 128
   ```

NOTE: You can specify the maximum fragment size for a link only when you use the **ppp fragmentation** command to enable fragmentation on that link. You cannot specify the maximum fragment size for a link when fragmentation is disabled.

4. Enable reassembly on the link interface, and optionally specify the administrative MRRU value to use.

   ```
   host1(config-profile)#ppp reassembly 1800
   ```

NOTE: You can specify the administrative MRRU value for a link only when you use the **ppp reassembly** command to enable reassembly on that link. You cannot specify the administrative MRRU for a link when reassembly is disabled.

5. (Optional) Specify a virtual router to which dynamic IP interfaces created with this profile will be assigned.

   host1(config-profile)#**ip virtual-router boston**

6. (Optional) Specify an IP loopback interface with which dynamic IP interfaces created with this profile will be associated.

   host1(config-profile)#**ip unnumbered loopback 0**

7. (Optional) Set other PPP characteristics as needed by using the **ppp** commands described in *Chapter 8, Configuring Multilink PPP*.

Dynamic MLPPP over PPPoE Example

The following example configures MLPPP fragmentation and reassembly for a dynamic MLPPP interface over dynamic PPPoE over an ATM 1483 subinterface.

```
host1(config)#profile dynmlppp2
host1(config-profile)#ppp multilink enable
host1(config-profile)#ppp fragmentation 128
host1(config-profile)#ppp reassembly 1800
host1(config-profile)#ip virtual-router westford
host1(config-profile)#ip unnumbered loopback 1
host1(config-profile)#pppoe sessions 9
host1(config-profile)#ppp authentication chap
host1(config-profile)#exit
host1(config)#interface atm 4/0
host1(config-if)#interface atm 4/0.1
host1(config-subif)#atm pvc 52 0 52 aal5autoconfig 0 0 0
host1(config-subif)#profile pppoe dynmlppp2
host1(config-subif)#auto-configure pppoe
```

Dynamic MLPPP over L2TP Example

The following example configures MLPPP fragmentation and reassembly for a dynamic MLPPP interface over L2TP over a Gigabit Ethernet interface.

```
host1(config)#ip router-id 193.1.1.1
host1(config)#interface loopback 0
host1(config-if)#ip address 193.1.1.1 255.255.255.0
host1(config-if)#interface gigabitEthernet 1/1
host1(config-if)#ip unnumbered loopback 0
host1(config-if)#exit
host1(config)#ip route 193.1.1.2 255.255.255.255 gigabitEthernet 1/1
host1(config)#profile l2tp-profile
host1(config-profile)#ip virtual-router default
host1(config-profile)#ip unnumbered loopback 0
host1(config-profile)#ip access-routes
host1(config-profile)#ppp authentication pap
host1(config-profile)#ppp keepalive
host1(config-profile)#ppp multilink enable
host1(config-profile)#ppp mru 1590
host1(config-profile)#ppp reassembly 1590
host1(config-profile)#ppp fragmentation 128
host1(config-profile)#pppoe session 8000
host1(config-profile)#exit
```

```
host1(config)#l2tp destination profile lac ip address 193.1.1.2
host1(config-l2tp-dest-profile)#remote host xxx.com
host1(config-l2tp-dest-profile-host)#enable proxy authenticate
host1(config-l2tp-dest-profile-host)#tunnel password welcome
host1(config-l2tp-dest-profile-host)#profile l2tp-profile
```

encapsulation mlppp

- Use to configure MLPPP as the encapsulation method on an individual interface.
- Use this command only within the context of an individual interface. Issuing this command creates an MLPPP link interface, which can be configured as a member of an MLPPP bundle.
- Example

```
host1(config)#interface serial 2/0:1/1
host1(config-if)#encapsulation mlppp
```

- Use the **no** version to disable MLPPP on an interface.

interface mlppp

- Use to create an MLPPP network interface, also known as an MLPPP bundle.
- Example

```
host1(config-if)#interface mlppp group2
```

- Use the **no** version to delete the MLPPP bundle. To delete an MLPPP bundle you must first delete the IP interface, then delete the bundle members (link interfaces), and finally delete the MLPPP bundle itself.

member-interface

- Use to add an MLPPP link interface—also known as an MLPPP bundle member—to an MLPPP bundle.
- Example

```
host1(config-if)#member-interface serial 2/0:1/1
```

- Use the **no** version to remove the specified interface from the MLPPP bundle.

ppp fragmentation

- Use to enable fragmentation on an MLPPP link interface.
- If fragmentation is enabled on the link, you can optionally specify the maximum fragment size to be used on that link, in the range 128–65535 octets.
- A link's maximum fragment size cannot exceed the MTU size on that link.
- We recommend that all member links in an MLPPP bundle be assigned the same fragment size.

- Do not configure both MLPPP fragmentation and IP fragmentation of L2TP packets (with the **ip mtu** command) on the same interface. Instead, you must choose only one of the fragmentation configurations by setting it to the necessary value and set the other fragmentation configuration to the maximum allowable value.
- Example

  host1(config-if)#**ppp fragmentation 128**

- Use the **no** version to disable fragmentation on the link and restore the default fragment size, which is the link's MTU.

ppp multilink enable

- Use in a profile to enable the creation of dynamic MLPPP interfaces.
- Example

  host1(config-profile)#**ppp multilink enable**

- Use the **no** version to reject any incoming requests to create dynamic MLPPP interfaces.

ppp reassembly

- Use to enable reassembly on an MLPPP link interface.
- If reassembly is enabled on the link, you can optionally specify the administrative MRRU for the link, in the range 64–65535 octets. The administrative MRRU is the maximum allowable size of the PPP packet payload that the router can receive.
- A link's MRRU must be greater than or equal to the local MRU on that link.
- We recommend that all member links in an MLPPP bundle be assigned the same reassembly setting: enabled or disabled.
- Example

  host1(config-if)#**ppp reassembly 1590**

- Use the **no** version to disable reassembly on the link and restore the default value, which is the local MRU on the link.

profile

- Use to create a profile for a dynamic interface.
- You specify a profile name of up to 80 characters.
- Example

  host1(config)#**profile dynmlppp1**

- Use the **no** version to remove a profile.

Configuring Fragmentation and Reassembly for MLPPP Bundles

If you issue the **ppp fragmentation** command or the **ppp reassembly** command in the context of an MLPPP bundle, the command affects all the current member links in the bundle. This enables you to issue a single command for the entire bundle instead of having to issue individual commands for each member link in the bundle.

For example, the following commands configure MLPPP fragmentation and reassembly for all member links in the bundle group1.

```
host1(config)#interface mlppp group1
host1(config-if)#ppp fragmentation 128
host1(config-if)#ppp reassembly 1590
host1(config-if)#exit
host1(config)#
```

Any member links added to the bundle after you issue an MLPPP configuration command in the bundle context are not affected by the command. For example, if you add a member link to the group1 bundle after you issue the **ppp fragmentation** or **ppp reassembly** command, MLPPP fragmentation and reassembly for this link and any member links subsequently added to the bundle is not enabled.

Monitoring MLPPP

Use the commands in this section to display information about MLPPP interfaces.

You can set a statistics baseline for MLPPP serial (member link) or bundle (multilink) interfaces using the **baseline ppp** command. Use the **delta** keyword with the **show** commands described below to display statistics with the baseline values subtracted.

After you configure multilink PPP, you can use the **show ppp interface** commands to display configuration and statistics information about MLPPP and MLPPP fragmentation and reassembly.

You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. For details, see *show Commands* in *JUNOSe System Basics Configuration Guide, Chapter 2, Command-Line Interface*.

NOTE: The E120 router and E320 router output for **monitor** and **show** commands is identical to output from other E-series routers, except that the E120 and E320 router output also includes information about the adapter identifier in the interface specifier (*slot/adapter/port*).

baseline ppp interface

- Use to set a statistics baseline for PPP interfaces—including MLPPP interfaces, either individual serial (member link) interfaces or multilink (bundle) interfaces.
- Use only the **serial** or **mlppp** keywords.
- For serial interfaces, specify the interface location in the format *slot/port:channel/subchannel* for CT3 modules.

- For MLPPP interfaces, specify the interface location as the name of the MLPPP bundle.
- The router implements the baseline by reading and storing the statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- When baselining is requested, the time since the last baseline was set is displayed in *hours:minutes:seconds* or *days/hours* format. If a baseline was not set, the following message is displayed instead:

  ```
  No baseline has been set
  ```
- Use the optional **delta** keyword with MLPPP **show** commands to specify that baselined statistics are to be shown.
- Example

  host1#**baseline ppp interface serial 2/0:1/1**
- There is no **no** version.

Sample Display Without Baseline

The following command displays PPP interface (including MLPPP interface) statistics *without* baselining:

```
host1#show ppp interface statistics

PPP interface serial 2/0:4/1 is up
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       572                 684
   errors                       0                   0
   discards                     0                   0
PPP interface serial 2/0:5/1 is up
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       572                 684
   errors                       0                   0
   discards                     0                   0
PPP interface serial 2/1:4/1 is up
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       572                 684
   errors                       0                   0
   discards                     0                   0
PPP interface serial 2/1:5/1 is up
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       572                 684
   errors                       0                   0
   discards                     0                   0
4 ppp interfaces found
```

```
PPP interface mlppp group1 is up
PPP multilink member-interface serial 2/0:1/1 is up
No baseline has been set
Interface statistics             in                  out
   packets                       0                   0
   octets                        608                 716
   errors                        0                   0
   discards                      0                   0
PPP multilink member-interface serial 2/0:2/1 is up
No baseline has been set
Interface statistics             in                  out
   packets                       0                   0
   octets                        608                 716
   errors                        0                   0
   discards                      0                   0
PPP multilink member-interface serial 2/0:3/1 is up
No baseline has been set
Interface statistics             in                  out
   packets                       0                   0
   octets                        596                 704
   errors                        0                   0
   discards                      0                   0

PPP interface mlppp group2 is up
PPP multilink member-interface serial 2/1:1/1 is up
No baseline has been set
Interface statistics             in                  out
   packets                       0                   0
   octets                        628                 740
   errors                        0                   0
   discards                      0                   0
PPP multilink member-interface serial 2/1:2/1 is up
No baseline has been set
Interface statistics             in                  out
   packets                       0                   0
   octets                        628                 740
   errors                        0                   0
   discards                      0                   0
PPP multilink member-interface serial 2/1:3/1 is up
No baseline has been set
Interface statistics             in                  out
   packets                       0                   0
   octets                        616                 728
   errors                        0                   0
   discards                      0                   0
2 mlppp interfaces found
```

Sample Display with Baseline

The following command displays PPP interface (including MLPPP interface) statistics *with* baselining:

```
host1#show ppp interface statistics delta

PPP interface serial 2/0:4/1 is up
Time since last baseline 00:00:35
Interface statistics             in                  out
   packets                       0                   0
   octets                        75                  82
   errors                        0                   0
   discards                      0                   0
PPP interface serial 2/0:5/1 is up
Time since last baseline 00:00:37
```

```
Interface statistics            in                  out
   packets                      0                   0
   octets                       87                  90
   errors                       0                   0
   discards                     0                   0
PPP interface serial 2/1:4/1 is up
Time since last baseline 00:00:39
Interface statistics            in                  out
   packets                      0                   0
   octets                       101                 112
   errors                       0                   0
   discards                     0                   0
PPP interface serial 2/1:5/1 is up
Time since last baseline 00:00:43
Interface statistics            in                  out
   packets                      0                   0
   octets                       94                  99
   errors                       0                   0
   discards                     0                   0
4 ppp interfaces found
PPP interface mlppp group1 is up
PPP multilink member-interface serial 2/0:1/1 is up
Time since last baseline 00:00:17
Interface statistics            in                  out
   packets                      0                   0
   octets                       28                  26
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface serial 2/0:2/1 is up
Time since last baseline 00:10:22

Interface statistics            in                  out
   packets                      0                   0
   octets                       102                 104
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface serial 2/0:3/1 is up
Time since last baseline 00:00:19
Interface statistics            in                  out
   packets                      0                   0
   octets                       112                 126
   errors                       0                   0
   discards                     0                   0

PPP interface mlppp group2 is up
PPP multilink member-interface serial 2/1:1/1 is up
Time since last baseline 00:00:23
Interface statistics            in                  out
   packets                      0                   0
   octets                       125                 132
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface serial 2/1:2/1 is up
Time since last baseline 00:00:25
Interface statistics            in                  out
   packets                      0                   0
   octets                       135                 138
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface serial 2/1:3/1 is up
Time since last baseline 00:00:30
```

```
Interface statistics            in                  out
   packets                      0                   0
   octets                       125                 132
   errors                       0                   0
   discards                     0                   0
2 mlppp interfaces found
```

show ppp interface mlppp

- Use to display information about MLPPP interfaces.
- You can display a great variety of information with this complex command. See the **show ppp interface** command in *Chapter 7, Configuring Point-to-Point Protocol*, for more detailed information about the display options.
- Use the **show ppp interface** command to display information about all PPP interfaces, including MLPPP interfaces.
- Field descriptions
  - PPP interface mlppp—Name and administrative status (up or down) for an MLPPP bundle
  - PPP multilink member-interface—Interface type, interface specifier, and administrative status (up or down) for an MLPPP member link
  - Network interface administrative status—Indicates whether the interface for the MLPPP bundle is administratively enabled (open), meaning that the **no ppp shutdown** command is operational, or administratively disabled (closed), meaning that the **ppp shutdown** command is operational
  - Link interface administrative status—Indicates whether the interface for the member link is administratively enabled (open), meaning that the **no ppp shutdown** command is operational, or administratively disabled (closed), meaning that the **ppp shutdown** command is operational
  - Configured network protocol—Network protocol configured on the interface
  - Fragmentation and reassembly configuration:
    - Link interface fragmentation—Indicates whether MLPPP fragmentation is enabled or disabled on the link interface
    - Link interface fragment size—MLPPP fragment size, in octets, currently in use on the link interface
    - Link interface reassembly—Indicates whether MLPPP reassembly is enabled or disabled on the link interface
    - Link interface administrative MRRU—Administrative MRRU value, in octets, currently in use on the link interface
  - Baseline status—Indicates whether a statistics baseline has been set
  - Interface statistics:
    - packets—Number of packets received (in) and sent (out) on the interface
    - octets—Number of octets received (in) and sent (out) on the interface

  - errors—Number of errors received (in) and sent (out) on the interface
  - discards—Number of packets discarded on receipt (in) or discarded before they were transmitted (out)

NOTE: For the LCP, IPCP, and OSINLCP negotiated options, the command displays a value of “none” if the option was not negotiated.

- LCP protocol configuration:
  - max-receive-unit—Controls negotiation of the local MRU option; value can be one of the following:
    - use lower layer—MRU of the layer below PPP defines the MRU to be negotiated
    - disabled—MRU option is not to be negotiated
    - a numeric value—MRU value to be negotiated
  - authentication—Controls negotiation of the local authentication option; value can be one of the following:
    - none—Do not negotiate
    - chap—Negotiate CHAP
    - pap—Negotiate PAP
    - chap/pap—Negotiate CHAP, and if it is rejected, negotiate PAP
    - pap/chap—Negotiate PAP, and if it is rejected, negotiate CHAP
  - magic-number—Controls whether the local magic number is negotiated: enabled (negotiate), or disabled (do not negotiate)
  - magic-number-mismatch—Indicates whether the router is configured to ignore the LCP peer magic number and retain the PPP connection when the peer has not negotiated an LCP magic number: ignore (ignore the peer magic number mismatch and retain the PPP connection), or reject (router terminates the PPP connection if it detects a peer magic number mismatch)
  - keepalive-timer—Rate of LCP echo requests, in seconds
  - restart-timer—Retry frequency during LCP, IPCP, and OSINLCP negotiations, in seconds
  - max-terminate—Maximum number of terminate requests
  - max-configure—Maximum number of configure requests
  - max-failure—Maximum number of configure NAKs
- LCP protocol status:
  - link-status—Indicates the overall status of LCP negotiations, including the following states: initial (idle), starting (ready to negotiate), authenticate (authenticating), and network (LCP is up)

- LCP negotiated options:
  - max-receive-unit—Negotiated maximum receive unit, in octets, for the local and remote (peer) side of the link
  - max-receive-reconstructed-unit—Negotiated maximum receive reconstructed unit, in octets, for the local and remote (peer) side of the link
  - authentication—Negotiated authentication method (none, pap, or chap) for the local and remote (peer) side of the link
  - magic-number—Negotiated magic number for the local and remote (peer) side of the link
  - pfc—Negotiated pfc (none or enabled) for the local and remote (peer) side of the link
  - acfc—Negotiated acfc (none or enabled) for the local and remote (peer) side of the link

NOTE: The command displays a value of "none" for any negotiated option parameters if the option was not negotiated.

- LCP Endpoint Discriminator options:
  - local discriminator class—Endpoint discriminator type, format, and address space for the local system
  - local endpoint discriminator—Endpoint discriminator value for the local system within the specified class
  - peer discriminator class—Endpoint discriminator type, format, and address space for the remote system
  - peer endpoint discriminator—Endpoint discriminator value for the remote system within the specified class
- LCP protocol statistics:
  - in-keepalive-requests—Number of received keepalive requests (LCP Echo Request) for the life of the interface (since either system boot or interface creation, whichever is later)
  - out-keepalive-requests—Number of transmitted keepalive requests for the life of interface
  - in-keepalive-replies—Number of received keepalive replies for the life of the interface
  - out-keepalive-replies—Number of transmitted keepalive replies for the life of the interface
  - keepalive-failures—Number of keepalive failures reported on the interface
- IPCP protocol configuration:
  - configured—IPCP is configured on this interface (true or false)
  - administrative-status—IPCP administrative status (open or closed)
  - ip-address—Address to be used for negotiation of local IP address option

- dns-precedence—Used to resolve conflicts during DNS address negotiation
- local—Local side takes precedence, and the **no ppp peer dns** command is operative
- peer—Remote side takes precedence, and the **ppp peer dns** command is operative
- wins-precedence—Used to resolve conflicts during WINS address negotiation
- local—Local side takes precedence, and the **no ppp peer wins** command is operative
- peer—Remote side takes precedence, and the **ppp peer wins** command is operative

- IPCP protocol status:
  - operational-status—IPCP operational status (up, down, not present, or not present no resources)
- IPCP negotiated options:
  - ip-address—Negotiated IP address for the local and remote (peer) side of the link
  - primary-dns-address—Negotiated primary DNS address for the local and remote (peer) side of the link
  - secondary-dns-address—Negotiated secondary DNS address for the local and remote (peer) side of the link
  - primary-wins-address—Negotiated primary WINS address for the local and remote (peer) side of the link
  - secondary-wins-address—Negotiated secondary WINS address for the local and remote (peer) side of the link

NOTE: The command displays a value of "none" for any negotiated option parameters if the option was not negotiated.

- OSINLCP protocol configuration:
  - configured—OSINLCP is configured on this interface (true or false)
  - administrative-status—OSINLCP administrative status (open or closed)
- OSINLCP protocol status:
  - operational-status—OSINLCP operational status (up, down, not present, or not present no resources)
  - terminate-reason—Reason for termination of OSINLCP service
- OSINLCP negotiated options
  - npdu-alignment—Negotiated NPDU alignment for the local and remote (peer) side of the link

- Example 1—Displays information about the MLPPP member links configured in bundle group1

```
host1#show ppp interface mlppp group1 members
PPP interface mlppp group1 is up
 PPP multilink member-interface serial 2/0:1/1 is up
 PPP multilink member-interface serial 2/0:2/1 is up
 PPP multilink member-interface serial 2/0:3/1 is up
```

- Example 2—Displays information about all MLPPP member links configured for all bundles

```
host1#show ppp interface mlppp members
PPP interface mlppp group1 is up
 PPP multilink member-interface serial 2/0:1/1 is up
 PPP multilink member-interface serial 2/0:2/1 is up
 PPP multilink member-interface serial 2/0:3/1 is up
PPP interface mlppp group2 is up
 PPP multilink member-interface serial 2/1:1/1 is up
 PPP multilink member-interface serial 2/1:2/1 is up
 PPP multilink member-interface serial 2/1:3/1 is up
PPP interface mlppp group3
 No member-interfaces found
```

- Example 3—Displays information about all MLPPP encapsulated links, regardless of whether the links are members of an MLPPP bundle

```
host1#show ppp interface mlppp links
PPP multilink interface serial 2/0:1/1 is up
PPP multilink interface serial 2/0:2/1 is up
PPP multilink interface serial 2/0:3/1 is up
PPP multilink interface serial 2/1:1/1 is up
PPP multilink interface serial 2/1:2/1 is up
PPP multilink interface serial 2/1:3/1 is up
```

- Example 4—Displays configuration information about MLPPP member links configured in bundle group1

```
host1#show ppp interface mlppp group1 config
PPP interface mlppp group1 is up
Network interface administrative status is open
Configured network protocol is IPCP
PPP multilink member-interface ATM 10/0.10 is up
Link interface administrative status is open
Link interface fragmentation is enabled
Link interface fragment size is 128
Link interface reassembly is enabled
Link interface administrative MRRU is 2000
PPP multilink member-interface ATM 10/0.11 is down (lower layer down)
Link interface administrative status is closed
Link interface fragmentation is enabled
Link interface fragment size is 128
Link interface reassembly is enabled
Link interface administrative MRRU is 2000
PPP multilink member-interface ATM 10/0.12 is down (lower layer down)
Link interface administrative status is closed
Link interface fragmentation is enabled
Link interface fragment size is 128
Link interface reassembly is enabled
Link interface administrative MRRU is 2000
PPP multilink member-interface ATM 10/0.13 is down (lower layer down)
Link interface administrative status is closed
Link interface fragmentation is enabled
```

```
Link interface fragment size is 128
Link interface reassembly is enabled
Link interface administrative MRRU is 2000
1 mlppp interfaces found
```

- Example 5—Displays statistics about all configured MLPPP member links configured in bundle group1

```
host1#show ppp interface mlppp group1 statistics
PPP interface mlppp group1 is up
PPP multilink member-interface ATM 10/0.10 is up
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       170                 690
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface ATM 10/0.11 is down (lower layer down)
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       50                  0
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface ATM 10/0.12 is down (lower layer down)
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       50                  0
   errors                       0                   0
   discards                     0                   0
PPP multilink member-interface ATM 10/0.13 is down (lower layer down)
No baseline has been set
Interface statistics            in                  out
   packets                      0                   0
   octets                       50                  0
   errors                       0                   0
   discards                     0                   0
1 mlppp interfaces found
```

- Example 6—Displays status information about the specified MLPPP bundle

```
host1#show ppp interface mlppp group1 status
PPP interface mlppp group1 is up
1 mlppp interfaces found
```

- Example 7—Shows complete configuration, statistics, and status information about the specified MLPPP bundle

```
host1#show ppp interface mlppp group1 full
PPP interface mlppp group1 is up
Network interface administrative status is open
Configured network protocol is IPCP
IPCP protocol configuration
   configured                   true
   administrative-status        open
   ip-address                   1.2.3.4
   dns-precedence               local
   wins-precedence              local
IPCP protocol status
   operational-status           up
```

```
IPCP negotiated options          local              peer
   ip-address                    1.2.3.4            6.7.8.9
   primary-dns-address           none               none
   secondary-dns-address         none               none
   primary-wins-address          none               none
   secondary-wins-address        none               none
OSINLCP protocol configuration
   configured                    false
   administrative-status         open
OSINLCP protocol status
   operational-status            not present
   terminate-reason              not configured
PPP multilink member-interface serial 2/0:1/1 is up
Link interface administrative status is open
No baseline has been set
Interface statistics             in                 out
   packets                       0                  0
   octets                        1488               1972
   errors                        0                  0
   discards                      0                  0
LCP protocol configuration
   max-receive-unit              use lower layer
   authentication                none
   magic-number                  enabled
   magic-number-mismatch         ignore
   keepalive-timer               30 seconds
   restart-timer                 3 seconds
   max-terminate                 2
   max-configure                 10
   max-failure                   5
LCP protocol status
   link-status                   network

LCP negotiated options           local              peer
   max-receive-unit              1590               1590
   max-receive-reconstructed-unit 1590              1590
   authentication                none               none
   magic-number                  0x6c079eb0         0x2c5a5798
   pfc                           none               none
   acfc                          none               none
LCP Endpoint Discriminator options
   local discriminator class     Locally Assigned Address
   local endpoint discriminator  0x313939333130303038000001b000001
   peer discriminator class      Locally Assigned Address
   peer endpoint discriminator   0x313939333130303038000001b000002
LCP protocol statistics
   in-keepalive-requests         70
   out-keepalive-requests        70
   in-keepalive-replies          70
   out-keepalive-replies         70
   keepalive-failures            0
PPP multilink member-interface serial 2/0:2/1 is up
Link interface administrative status is open
No baseline has been set
Interface statistics             in                 out
   packets                       0                  0
   octets                        1508               1996
   errors                        0                  0
   discards                      0                  0
```

```
LCP protocol configuration
   max-receive-unit              use lower layer
   authentication                none
   magic-number                  enabled
   magic-number-mismatch         ignore
   keepalive-timer               30 seconds
   restart-timer                 3 seconds
   max-terminate                 2
   max-configure                 10
   max-failure                   5
LCP protocol status
   link-status                   network
LCP negotiated options           local              peer
   max-receive-unit              1590               1590
   max-receive-reconstructed-unit 1590              1590
   authentication                none               none
   magic-number                  0x7ada4a05         0x1bb178cd
   pfc                           none               none
   acfc                          none               none

LCP Endpoint Discriminator options
   local discriminator class     Locally Assigned Address
   local endpoint discriminator  0x313939333130303038000001b000001
   peer discriminator class      Locally Assigned Address
   peer endpoint discriminator   0x313939333130303038000001b000002
LCP protocol statistics
   in-keepalive-requests         71
   out-keepalive-requests        71
   in-keepalive-replies          71
   out-keepalive-replies         71
   keepalive-failures            0
PPP multilink member-interface serial 2/0:3/1 is up
Link interface administrative status is open
No baseline has been set
Interface statistics             in                 out
   packets                       0                  0
   octets                        1568               2068
   errors                        0                  0
   discards                      0                  0
LCP protocol configuration
   max-receive-unit              use lower layer
   authentication                none
   magic-number                  enabled
   magic-number-mismatch         ignore
   keepalive-timer               30 seconds
   restart-timer                 3 seconds
   max-terminate                 2
   max-configure                 10
   max-failure                   5
LCP protocol status
   link-status                   network
LCP negotiated options           local              peer
   max-receive-unit              1590               1590
   max-receive-reconstructed-unit 1590              1590
   authentication                none               none
   magic-number                  0x31cc52e0         0x32ebdec6
   pfc                           none               none
   acfc                          none               none
LCP Endpoint Discriminator options
   local discriminator class     Locally Assigned Address
   local endpoint discriminator  0x313939333130303038000001b000001
   peer discriminator class      Locally Assigned Address
   peer endpoint discriminator   0x313939333130303038000001b000002
```

```
LCP protocol statistics
   in-keepalive-requests          74
   out-keepalive-requests         74
   in-keepalive-replies           74
   out-keepalive-replies          74
   keepalive-failures             0
1 mlppp interfaces found
```

show ppp interface summary

- Use to display a summary of all the multilinked and nonmultilinked PPP interfaces configured on the router.
- Field descriptions
  - PPP Status—Non-multilinked PPP interfaces
  - Configuration status—Indicates the configuration state of the PPP interface, IPCP, IPv6CP, OSINLCP, or MPLS
    - configured—Interface or protocol is configured
    - notConfigured—Interface or protocol is not configured
  - Administrative status—Indicates the administrative state of the PPP interface, IPCP, IPv6CP, OSINLCP, or MPLS
    - open—Interface or protocol is administratively enabled
    - closed—Interface or protocol is administratively disabled
  - Operational status (Interface)—Indicates the operational state of the PPP interface
    - up—Interface is operational
    - down—Interface is not operational because of a problem in the PPP layer
    - lowerDown—Interface is not operational because a lower layer in the protocol stack is down
    - notPresent—Interface is not operational because the hardware is unavailable
    - passive—Interface is waiting for the peer to send an LCP confReq message
    - tunnel—Interface is being redirected through a tunnel
  - Operational status (Ip, Ipv6, Osi, Mpls)—Indicates the operational state of the IPCP, IPv6CP, OSINLCP, or MPLS protocol
    - up—Protocol is operational
    - down—Protocol is not operational because of a problem in the PPP layer
    - notPresent—Protocol is not operational because it does not exist
    - noResources—Protocol is not operational because it does not exist due to a lack of resources
  - PPP Multilink Status—Multilinked PPP interfaces

- Example

```
host1#show ppp interface summary
PPP Status
Configuration status     configured notConfigured
   Interface             4000       n/a
   Ip                    4000       0
   Ipv6                  0          4000
   Osi                   0          4000
   Mpls                  0          4000
Administrative status    open       closed
   Interface             4000       0
   Ip                    4000       0
   Ipv6                  4000       0
   Osi                   4000       0
   Mpls                  4000       0
Operational status       up         down       notPresent noResources
   Interface             4000       0          0          n/a
   Ip                    4000       0          0          0
   Ipv6                  0          0          4000       0
   Osi                   0          0          4000       0
   Mpls                  0          0          4000       0
Operational status       lowerDown  passive    tunnel
   Interface             0          0          0

PPP Multilink Status
Configuration status     configured notConfigured
   Link Interface        8000       n/a
   Network Interface     2000       n/a
   Ip                    2000       0
   Ipv6                  0          2000
   Osi                   0          2000
   Mpls                  0          2000
Administrative status    open       closed
   Link Interface        8000       0
   Network Interface     2000       0
   Ip                    2000       0
   Ipv6                  2000       0
   Osi                   2000       0
   Mpls                  2000       0
Operational status       up         down       notPresent noResources
   Link Interface        8000       0          0          n/a
   Network Interface     2000       0          0          n/a
   Ip                    2000       0          0          0
   Ipv6                  0          0          2000       0
   Osi                   0          0          2000       0
   Mpls                  0          0          2000       0
Operational status       lowerDown  passive    tunnel
   Link Interface        0          0          0
   Network Interface     0          0          0
```