Layer 2 Tunneling Protocol Version 3

First Published: May 6, 2010
Last Updated: September 02, 2010

The Layer 2 Tunneling Protocol Version 3 (L2TPv3) feature expands Cisco support of Layer 2 Virtual Private Networks (VPNs). L2TPv3 is an Internet Engineering Task Force (IETF) l2tpext working group draft that provides several enhancements to L2TP for the capability to tunnel any Layer 2 payload over L2TP. Specifically, L2TPv3 defines the L2TP protocol for tunneling Layer 2 payloads over an IP core network using Layer 2 virtual private networks (VPNs). Benefits of this feature include the following:

- L2TPv3 simplifies deployment of VPNs.
- L2TPv3 does not require Multiprotocol Label Switching (MPLS).
- L2TPv3 supports Layer 2 tunneling over IP for any payload.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the "Feature Information for L2TPv3" section on page 113.

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

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Prerequisites for Layer 2 Tunneling Protocol Version 3

- Before you configure an xconnect attachment circuit for a provider edge (PE) device (see the section "Configuring the Xconnect Attachment Circuit"), the CEF feature must be enabled. To enable CEF on an interface, use the **ip cef** or **ip cef distributed** command.
- You must configure a loopback interface on the router for originating and terminating the L2TPv3 traffic. The loopback interface must have an IP address that is reachable from the remote provider edge (PE) device at the other end of an L2TPv3 control channel.

Restrictions for Layer 2 Tunneling Protocol Version 3

Supported Port Adapters for the Cisco 7200 Series and Cisco 7500 Series Routers

The following port adapters support L2TPv3 on the Cisco 7200 series and Cisco 7500 series routers:

- Single-port Fast Ethernet 100BASE-TX
- Single-port Fast Ethernet 100BASE-FX
- Dual-port Fast Ethernet 100BASE-TX
- Dual-port Fast Ethernet 100BASE-FX
- Gigabit Ethernet port adapter
- 12-port Ethernet/2-port FE adapter
- 4-port synchronous serial port adapter
- Enhanced 4-port synchronous serial port adapter
- 8-port synchronous serial port adapter
- Single-port HSSI adapter
- Dual-port HSSI adapter
- Single-port enhanced OC-3 ATM port adapter
- 8-port multichannel E1 G.703/G.704 120-ohm interfaces
- 2-port multichannel E1 G.703/G.704 120-ohm interfaces
- 8-port multichannel T1 with integrated data service units (DSUs)
- 8-port multichannel T1 with integrated channel service units (CSUs) and DSUs
- 4-port multichannel T1 with integrated CSUs and DSUs
- 2-port multichannel T1 with integrated CSUs and DSUs
- 8-port multichannel T1/E1
- 1-port multichannel T3 interface
- 1-port multichannel E3 interface
- 2-port enhanced multichannel T3 port adapter
- Single-port T3 port adapter
- Single-port E3 port adapter
- 2-port T3 port adapter
- 2-port T3 port adapter
- Single-port Packet over SONET (PoS), single-mode, long reach
- Single-port PoS, single-mode, intermediate reach
- Single-port PoS, multimode
- Eight-port T1 ATM port adapter with inverse multiplexing over ATM (IMA)
- Eight-port E1 ATM port adapter with IMA

The following port adapters support L2TPv3 on the Cisco 7200 series routers only:

- 8-port Ethernet adapter
- 4-port Ethernet adapter

General L2TPv3 Restrictions

- CEF must be enabled for the L2TPv3 feature to function. The xconnect configuration mode is blocked until CEF is enabled. On distributed platforms, such as the Cisco 7500 series, if CEF is disabled while a session is established, the session is torn down and remains down until CEF is reenabled. To enable CEF, use the **ip cef** or **ip cef distributed** command.
- The IP local interface must be a loopback interface. Configuring any other interface with the **ip local interface** command will result in a nonoperational setting.
- The number of sessions on PPP, High-Level Data Link Control (HDLC), Ethernet, or 802.1q VLAN ports is limited by the number of interface descriptor blocks (IDBs) that the router can support. For PPP, HDLC, Ethernet, and 802.1q VLAN circuit types, an IDB is required for each circuit.

  When L2TPv3 is used to tunnel Frame Relay D channel data-link connection identifiers (DLCIs), an IDB is not required for each circuit. As a result, the memory requirements are much lower. The scalability targets for the Engineering Field Test (EFT) program are 4000 L2TP session.
- To convert an interface with Any Transport over MPLS (AToM) xconnect to L2TPv3 xconnect, remove the AToM configuration from the interface and then configure L2TPv3. Some features may not work if L2TPv3 is configured when AToM configuration is not removed properly.
- Frame Relay support includes only 10-bit DLCI addressing. The L2TPv3 feature does not support Frame Relay extended addressing.
- The interface keepalive feature is automatically disabled on the interface to which xconnect is applied, except for Frame Relay encapsulation, which is required for Local Management Interface (LMI).
- Static L2TPv3 sessions do not support Frame Relay LMI interworking.
- Static L2TPv3 sessions do not interoperate with Universal Tunnel Interface (UTI) using keepalives.
- Layer 2 fragmentation of IP packets and Intermediate System-to-Intermediate System (IS-IS) fragmentation through a static L2TPv3 session are not supported.
- Layer 3 fragmentation is not recommended because of performance degradation.
- The L2TPv3 Layer 2 (IP packet) fragmentation feature (see "Configuring the L2TPv3 Pseudowire") is not supported when the CE router is running special Layer 2 options such as Layer 2 sequencing, compression, or encryption. Examples of these options are Frame Relay compression and fragmentation or PPP compression. In these scenarios, the IP payload is not in a format that is compatible with IP fragmentation.
- The Stateful Switchover (SSO), Route Processor Redundancy (RPR) and RPR+ components of the HA functions are only supported at the coexistence level. If you attempt a switchover using SSO, RPR, or RPR+, the tunnels will fail and then eventually recover after an undetermined time duration. This includes both IPv4 and IPv6 traffic.
- Interworking is not allowed when sequencing is enabled.

Cisco 7200 Series and Cisco 7301 Specific Restrictions

- ATM port mode cell relay is only supported on the PA-A3-T3, PA-A3-E3, and PA-A3-OC-3 ATM port adapters.
- The features ATM Single Cell Relay VC Mode over L2TPv3 and ATM VP Mode Single Cell Relay over L2TPv3 are only supported on the PA-A3-T3, PA-A3-E3, and PA-A3-OC-3 ATM port adapters.

- VPI or VPI/VCI rewrite is not supported for any ATM transport mode. Both pairs of PE to CE peer routers must be configured with matching VPI and VCI values except in OAM local emulation mode. For example, if PE1 and CE1 are connected by PVC 10/100, PE2 and CE2 should also be connected by PVC 10/100.
- In OAM local emulation mode only, the VPI/VCI values used for each pair of PE to CE routers need not match. PE1 and CE1 may be configured with one VPI/VCI value, and PE2 and CE2 may be configured with a different VPI/VCI value. For example, if PE1 and CE1 are connected by PVC 10/100, PE2 and CE2 may be connected by PVC 20/200.

Cisco 7304 Specific Restrictions

- The L2TPv3 Distributed Sequencing feature in Cisco IOS Release 12.2(27)SBC is supported only on the Cisco 7304 NPE-G100.
- The Protocol Demultiplexing feature in Cisco IOS Release 12.2(27)SBC is supported only on the Cisco 7304 NPE-G100.
- On the Cisco 7304 platforms, ATM cell relay is supported only on the PA-A3-T3, PA-A3-E3, and PA-A3-OC-3 ATM port adapters. ATM cell relay is not supported on the native line cards 7300-1OC-12ATM and 7300-2OC-3ATM.

Cisco 7500 Series-Specific Restrictions

- Distributed sequencing is supported on Cisco 7500 series routers only. The **ip cef distributed** command must be configured.
- ATM port mode cell relay is supported only on the PA-A3-T3, PA-A3-E3, and PA-A3-OC-3 ATM port adapters.
- VPI or VPI/VCI rewrite is not supported for any ATM transport mode. The peer routers must be configured with matching VPI or VCI values.

Supported Shared Port Adapters for the Cisco 7600 Series Router

The following shared port adapters (SPAs) support L2TPv3 on the Cisco 7600 series routers.

Ethernet

- SPA_TYPE_ETHER_2xGE (2-port Gigabit Ethernet)
- SPA_TYPE_ETHER_2xGE_V2 (2-port Gigabit Ethernet)
- SPA_TYPE_ETHER_5xGE_V2 (5-port Gigabit Ethernet)
- SPA_TYPE_ETHER_1x10GE_V2 (single-port 10-Gigabit Ethernet)

ATM

- SPA_TYPE_KATM_2xOC3 (ATM, 2-port OC3)
- SPA_TYPE_KATM_4xOC3 (ATM, 4-port OC3)
- SPA_TYPE_KATM_1xOC12 (ATM, 1-port OC12)
- SPA_TYPE_KATM_1xOC48 (ATM, 1-port OC48)
- SPA_TYPE_CEOP_24xT1E1(CEoP 24-port T1/E1)

- SPA_TYPE_CEOP_1xOC3 (CEoP 1-port OC3)
- SPA_TYPE_CEOP_2xT3E3 (CEoP 2-port T3/E3)

Cisco 7600 Series-Specific Restrictions

On the Cisco 7600 series routers, L2TPv3 is a line card feature that was traditionally implemented only on the 7600-SIP-400 line card. In Cisco IOS Release 12.2(33)SRD, L2TPv3 is supported on the 7600-ES+20/40 line cards in the hardware, with the same capabilities (excluding the non-Ethernet interface support) and restrictions as in the 7600-SIP-400 line card. The minimum hardware requirement for enabling the L2TPv3 service on a Cisco 7600 router are an L2TPv3-aware line card (such as the 7600-SIP-400/ES+) at the Layer 2 CE-facing side and an IP interface on any line card at the IP core-facing side. A service card is not required for L2TPv3.

General Restrictions

L2TPv3 imposes the following general restrictions:

- The layer 2-facing line card must be an L2TPv3-supporting line card.
- There must be at least one distinct L2TPv3 tunnel per Layer 2-facing line card.
- Only IPv4 tunneling is supported for Layer 2 frames (configurations such as EoL2TPv3oMPLS (on the encapsulating provider edge (PE) device are not supported).

EVC/EFP Restrictions

L2TPv3 is not supported in conjunction with EVC features. L2TPv3 can coexist with EVC on the same port, meaning that while one subinterface is used to tunnel dot1q-tagged traffic over L2TP, another subinterface can be used to perform EVC features.

SVI VLAN Interfaces Restrictions

L2TPv3 is not supported on SVI VLAN interfaces.

MIB Support Restrictions

There is no L2TPv3-specific MIB support.

Layer Frame Fragmentation Restrictions

Layer 2 frame fragmentation is not supported. Even if the Layer 2 frame recovered after the L2TPv3 decapsulation exceeds the Layer 2 MTU on the CE-facing interface, the SIP-400 line card still sends the entire Layer 2 frame to the CE device. The Layer 2 frame may be dropped on the CE device because of MRU violations.

Layer 2 Virtual Private Network Interworking Restrictions

The SIP-400 line card does not support Layer 2 VPN interworking (“like to like” is the only mode supported for L2TPv3 tunneling).

Packet Sequencing Restrictions

The initial release of L2TPv3 focuses on tunneling Ethernet and ATM traffic over L2TPv3. Because of performance issues, the SIP-400 line card does not support L2TPv3 packet sequencing for Ethernet and ATM traffic. As a result, the 4-byte Layer 2-specific sublayer control word is not supported for Ethernet pseudowires. Configuring sequencing on a pseudowire will cause L2VPN traffic corruption.

By default, sequencing is disabled. However, you can configure sequencing in the pseudowire class, because the pseudowire class may be applied to pseudowires on other 7600 line cards that support sequencing. You must keep sequencing disabled when the pseudowire is handled on the SIP-400 line card.

Counters Restrictions

Per-session counters are provided by the line card. Per-tunnel counters are not provided.

Security and QoS ACLs Restrictions

The security QoS ACLs are not supported on the Layer 2 interfaces facing customer device, which means that you cannot apply ACLs to Layer 2 VPN traffic. (The Security ACL and the QoS ACL can still be applied to the IP interfaces at the core-facing side.)

DF Bit Reflection from Inner IP to Outer IP Restrictions

Traffic on ATM interfaces may have a deep stack of Layer 2 encapsulations. For example, the IP packet may be embedded first in Ethernet, then in Subnetwork Access Protocol (SNAP) and ATM Adaptation Layer 5 (AAL5). There is no guarantee that the SIP-400 line card will find the IP packet inside the AAL5 envelope. Therefore, Don't Fragment (DF) bit reflection from inner IP to outer IP is not performed for traffic on ATM interfaces.

Session Cookie

A cookie check is supported for data packets. Cookies (remote and local) can be part of the decapsulation table indexed by *session-id*.

Scalability

Up to 8000 pseudowires and 512 tunnels are supported.

Set DF Bit in Outer IP

When the **ip dfbit set** command is configured for the pseudowire, the SIP-400 line card sets the DF bit in the outer IP header during L2TPv3 encapsulation. This DF bit handling is subject to IS-IS packet fragmentation.

Set TTL in Outer IP

When the **ip ttl value** command is configured for the pseudowire, the SIP-400 line card sets the TTL value in the outer IP header during L2TPv3 encapsulation. When the TTL value is not set, the TTL value in the outer IP header is set to 254.

Layer 2-Specific Sublayer Control Word

The Layer 2-specific sublayer control word is defined in L2TPv3 RFCs solely for the purpose of packet sequencing (with the exception of AAL5 payload). On Cisco 7200 series, Cisco 7500 series, and Cisco 12000 series routers, the control word is omitted when sequencing is disabled on non-ATM AAL5 pseudowires. To interoperate with Cisco 7200 series, Cisco 7500 series, and Cisco 12000 series routers, the SIP-400 line card does not support control words on all non-AAL5 pseudowire types in the initial release.

Table 1 Layer 2 VPN over L2TPv3 Protocol Stack (without Sequencing)

L2TPv3 Packet Stack for AAL5 Payload	L2TPv3 Packet Stack for Non-AAL5 Payload
20 bytes IP header Protocol ID = 115	20 bytes IP header Protocol ID = 115

Table 1 Layer 2 VPN over L2TPv3 Protocol Stack (without Sequencing) (continued)

4 bytes session ID	4 bytes session ID
0, 4 or 8 bytes cookie	0, 4 or 8 bytes cookie
4 bytes control word	Layer 2 frame (non-AAL5
AAL5 frame	

MTU Support

MTU processing is done on the ingress path on the SIP-400 line card. The SIP-400 line card enforces Layer 2 MRU checking for every Layer 2 frame received from the CE device. All frames that fail MRU checking are dropped, and the accepted frames are entered into the L2TPv3 encapsulation process. During the process, the whole L2TPV3 packets (including outer IP) are checked again using IP MTU. The packets that pass IP MTU checking are sent to Enhanced Address Recognition Logic (EARL) for IP routing. The failed packets are sent to RP for IP fragmentation or for drop accounting and notifying.

Path MTU discovery is enabled when the **ip pmtu** command is configured for the pseudowire. This feature requires an ingress Layer 2 frame to be dropped if, after L2TPv3 encapsulation, the total packet length exceeds L2TP tunnel path MTU, and the DF bit of the IP header inside the Layer 2 frame is 1. To support this feature, the SIP-400 line card performs tunnel path MTU checking on each ingress Layer 2 frame during L2TPv3 encapsulation phase. If the total packet length after encapsulation exceeds path MTU, the SIP-400 line card forwards the original Layer 2 frame to the route processor. On receiving the Layer 2 frame, the route processor may send an Internet Control Message Protocol (ICMP) unreachable message to the source of the IP packet, depending on how deep the IP packet is embedded in the Layer 2 frame.

L2TPv3 IP packet fragmentation and reassembly is done by software on the route processor. The SIP-400 line card performs core-facing interface IP MTU checking on all packets encapsulated in L2TPv3. If the MTU checking fails, the original Layer 2 frames are sent to the route processor for IP fragmentation. Fragmented L2TPV3 IP packets received from the IP core are received by the route processor from the core facing interface by EARL. The route processor handles L2TPv3 packet reassembly and recovers the inner Layer 2 frame. The route processor also sends the Layer 2 frame to the CE-facing interface by using index-directed WAN dbus frames.

With IS-IS packet fragmentation, IS-IS packets are often padded to the maximum MTU size. L2TPv3 encapsulation increases the packet size by 28 to 36 bytes. A Layer 2 frame with an IS-IS packet embedded may exceed the tunnel path MTU after L2TPV3 encapsulation. Therefore, Layer 3 fragmentation is often needed. To support fragmentation, the SIP-400 line card searches for IS-IS packets in a Layer 2 Frame. If an IS-IS packet is found during L2TPv3 encapsulation, the SIP-400 line card clears the DF bit in the outer IP and sets IP precedence to 6. This allows the IP packet to be fragmented when traveling through the IP core.

Ethernet Attachment Circuits

The SIP-400 line card supports Ethernet over L2TPv3 in compliance with RFC4719. Two types of pseudowire are supported: Ethernet VLAN pseudowire type (0x0004) and Ethernet pseudowire type (0x0005). When xconnect is configured on an Ethernet main interface, Ethernet frames are tunneled over L2TPv3 using Ethernet port pseudowires (type 0x0005). In this mode, Ethernet frames received on the port (tagged or untagged) are delivered to the remote CE device unaltered.

When xconnect is configured on a dot1q subinterface, the tagged Ethernet frames are tunneled using an Ethernet VLAN pseudowire (type 0x0004). In this case, the pseudowire connects one Ethernet VLAN to another Ethernet VLAN. Received Ethernet VLAN frames from the CE device are tunneled over L2TPv3 unchanged. When arriving on the destination PE device, the original VLAN tag is written to use the destination VLAN ID. While doing so, the priority field in the VLAN tag is preserved.

Ethernet OAM Support

The SIP-400 line card supports service-level OAM and link-level OAM features on Ethernet interfaces.

Service-level OAM packets, also known as Connectivity Fault Management (CFM) packets, are sent using SNAP header with type 0x0126. Link-level OAM packets, also known as Link Monitoring (LM) packets are sent on Ether-Type 0x8809.

The SIP-400 line card monitors the above two types of ingress OAM frames from the CE device. When the OAM frames are found and OAM features are configured on the Ethernet interface, the OAM frames are intercepted and forwarded to the route processor. If there is no Ethernet OAM configuration, all OAM frames are tunneled in L2TPv3 as normal data frames.

ATM Attachment Circuits

The SIP-400 line card supports ATM over L2TPv3 in compliance with RFC 4454 with minor deviation. RFC 4454 defines four types of ATM pseudowire:

- ATM AAL5 SDU VCC transport (0x0002)
- ATM cell transport port mode (0x0003)
- ATM cell transport VCC mode (0x0009)
- ATM cell transport VPC mode (0x000A)

ATM cell transport port mode is not supported.

When xconnect is configured on a PVC with encapsulation AAL5, ATM AAL5 pseudowire (0x0002) is used to tunnel AAL5 frames between PE devices. The SIP-400 line card supports Layer 2 sublayer-specific control words for AAL5 pseudowire. This is the only type of pseudowire allowed to carry control words.

When xconnect is configured on PVC in AAL0 mode, an ATM cell transport VCC pseudowire (type 0x0009) is used. When xconnect is configured on PVP in AAL0 mode, an ATM cell transport VPC pseudowire (type 0x000A) is used. In both types of pseudowire, each L2TPv3 packet carries one ATM cell. Cell packing is not supported.

ATM OAM Cells

The SIP-400 line card supports ATM OAM cells operating at VP and VC levels. F4 cells operate at the VP level. They use the same VPI as the user data cells. However, they use two different reserved VCIs, as follows:

- VCI = 3 Segment OAM F4 cells
- VCI = 4 End-to-end OAM F4 cells

OAM F5 cells operate at the VC level. They use the same VPI and VCI as the user cells. To distinguish between data and OAM cells, the PTI field is used as follows:

- PTI = 100 (4) Segment OAM F5 cells processed by the next segment
- PTI =101 (5) End-to-end OAM F5 cells which are only processed by end stations terminating an ATM link

In the ingress direction (CE to PE), because of OAM emulation not supported in the 12.2(33)SRC release, all OAM cells are handled the same as data cells on the SIP-400 line card. Both segment and end-to-end OAM F4/F5 cells are tunneled over L2TPv3 to the remote PE device. They are sent transparently across the IP core in L2TPv3 tunnels.

In the egress direction (PE to CE), the SIP-400 line card sends all OAM cells to the CE device similar to sending ATM data cells.

Loopback Interface Reservation

You must reserve a loopback interface used as a source of the L2TPv3 tunnel for a particular line card to prevent it from being used across multiple line cards. These loopback interfaces host the local IP addresses used by the L2TP tunnels. A minimum of one such IP address is needed for every CE-facing line card. In most cases, you must create multiple loopback interfaces to accommodate routing protocol configuration and L2TPv3 configuration. Also, you must explicitly use the **mpls ldp router-id** command to avoid LDP router ID changes after system reload.

To reserve a loopback interface, use the **mls reserve l2tpv3 slot** *slot-number* [**processor** *processor-number*] command on the route processor in interface configuration mode.

This command binds the loopback interface to the specified slot/NP. Once configured, the loopback cannot be used to configure L2TPv3 tunnels on other LC/NPs. You must create another loopback interface in order to configure an L2TPv3 pseudowire on an interface that resides on another LC/NP.

QoS

QoS is handled on the line card. EARL does not perform QoS operations on L2TPv3 packets.

QoS at L2TPv3 Tunnel Ingress

The SIP-400 line card applies QoS to ingress traffic before doing L2TPv3 encapsulation. Given the order of traffic processing, the SIP-400 line card can support full-fledged interface/PVC level MQC on Layer 2 traffic. QoS on IP tunnel traffic is limited to ToS marking only.

The supported QoS-on-ingress Layer 2 frames are as follows.

- Classification. Ethernet interfaces: match on vlan, cos, ip dscp, ip precedence. ATM interfaces: match on atm clp
- Marking:
  - Ethernet interfaces: set cos
  - ATM interfaces: none
- Policing on both Ethernet and ATM interfaces
- Queuing on Ethernet interfaces

QoS at L2TPv3 Tunnel Egress

With egress traffic flow on the SIP-400 line card, QoS is again applied to Layer 2 traffic after L2TPv3 de-encapsulation. While the SIP-400 line card can support full-fledged Layer 2 MQC at the interface/PVC level, no QoS can be done on the IP tunnel traffic.

The supported QoS-on-egress Layer 2 frames are as follows.

- Classification:
  - Ethernet interfaces: match on vlan, cos, ip dscp, ip precedence
  - ATM interfaces: none
- Marking:
  - Ethernet interfaces: set cos, ip dscp, ip precedence
  - ATM interfaces: set atm clp
- Policing on both Ethernet and ATM interfaces
- Queuing on both Ethernet and ATM interfaces

L2TPv3 Packet ToS Marking

L2TPv3 packet ToS marking is done on the SIP-400 ingress path. There are three ways of marking the ToS field:

- Configure the **ip tos value** *value* command on each pseudowire to set the ToS field
- Configure the **ip tos reflect** command on each pseudowire to allow the inner IP ToS copied to the outer IP ToS
- By default, Layer 2 QoS is automatically reflected to outer IP ToS. For example, if the Layer 2 frame is an 802.Q frame, the 3-bit priority field in the VLAN tag is copied to the precedence bits in the outer IP ToS field

When the **ip tos reflect** command is configured, the SIP-400 line card searches for an IP header inside each received Layer 2 frame. If an IP packet is found, its ToS is copied to the outer ToS. Otherwise, the ToS value in the L2TPv3 IP header is set 0.

When neither the **ip tos value** command nor the **ip tos reflect** command is configured, the SIP-400 line card searches for a VLAN tag in each Ethernet frame. If a tag is found, the inner Layer 2 QoS is reflected to the outer IP ToS. Otherwise, the L2TPv3 IP ToS field is set 0.

Cisco 10720-Specific Restrictions

- Variable cookie size and L2TPv3 sequencing are not supported.
- Starting in Cisco IOS Release 12.0(32)SY, the L2TPv3 Layer 2 Fragmentation feature is supported on the Cisco 10720 Internet router to enable the fragmentation of IP packets to occur before data enters the pseudowire. When you enable this feature in an L2TPv3 pseudowire configuration using the **ip pmtu** command, the Don't Fragment (DF) bit in the outer Layer 2 packet header is automatically set on so that (for performance reasons) tunneled packets are not reassembled on the decapsulation router.
- The Cisco 10720 Internet router supports the reassembly only of fragmented IS-IS packets in an L2TPv3 pseudowire. IS-IS packet reassembly is performed by the Route Processor (RP) at the process level, not in the Parallel eXpress Forwarding (PXF) forwarding path.
- On the Cisco 10720 Internet router, the **uti translation** command is not migrated for xconnect service and is not supported. Although the **uti** command is supported in L2TPv3 releases, the **translation** option is lost in the migration.
- On the Cisco 10720 Internet router, although it is not required, we highly recommend that you configure a loopback interface as the IP local interface.

  You can also configure a LAN interface as the IP local interface so that the tunnel control session is tied to an operational LAN (Gigabit Ethernet or Fast Ethernet) interface or subinterface. However, in this case, the tunnel control plane is used only as long as the Gigabit Ethernet or Fast Ethernet interface is operational.

Cisco 12000 Series-Specific Restrictions

Tunnel Server Card Versus Native L2TPv3 Implementation

On the Cisco 12000 series Internet router, L2TPv3 is implemented in two different ways:

- The 1-port OC-48c/STM-16c POS/SDH line card is required as the dedicated tunnel server card (TSC) to accelerate the encapsulation and decapsulation of Layer 2 data on engine 2 (and earlier engine types) line cards in an L2TPv3 tunnel session.

- The enhanced edge capabilities of IP services engine (ISE) and engine 5 line cards do not require a tunnel server card for Layer 2 data encapsulation and decapsulation in an L2TPv3 tunnel. This is called a *native L2TPv3* session.

Note Native L2TPv3 tunnel sessions on customer-facing ISE and Engine 5 line cards can coexist with tunnel sessions that use a tunnel server card.

Different combinations of engine types are supported as customer-facing and backbone-facing line cards for encapsulation and decapsulation in L2TPv3 tunneling.

Note If you have native cards (engine 3 and engine 5) in the PE routers and the Tunnel Server Card is configured to support the non-native cards, then you must remove the TSC configuration by using the **no hw-module slot** <*number*> **mode server** command. If the TSC configuration exists in the PE router and the TSC card is removed, all the tunnels will fail.

L2TPv3 Encapsulation

When a Layer 2 packet arrives on a customer-facing interface, if the interface is bound to an L2TPv3 tunnel, L2TPv3 encapsulation is supported as follows:

- If the customer-facing line card is engine 2 or an earlier engine type, the line card forwards the packet to the tunnel server card, which performs L2TPv3 encapsulation.
- If the customer-facing line card is ISE or engine 5, the line card performs L2TPv3 encapsulation.

A backbone-facing line card of any engine type sends the packet across the service provider backbone network.

L2TPv3 Decapsulation

When an L2TPv3 packet arrives on a backbone-facing interface, L2TPv3 decapsulation is supported as follows:

- If the backbone-facing line card is non-ISE/E5 (any engine type besides ISE and Engine 5), the line card forwards the packet to the tunnel server card. The tunnel server card determines if the packet is bound to an Engine 2 (or earlier engine) or an ISE/E5 customer-facing line card.
  - If the packet is bound to an Engine 2 (or earlier engine) customer-facing line card, the TSC completes packet decapsulation and sends the Layer 2 packet to the customer-facing interface.
  - If the packet is bound to an ISE/E5 customer-facing line card, the TSC sends the packet to the line card for further decapsulation.
- If the backbone-facing line card is ISE/E5, the line card determines if the packet is bound to an Engine 2 (or earlier engine) or an ISE/E5 customer-facing line card.
  - If the packet is bound to an Engine 2 (or earlier engine) customer-facing line card, the packet is sent to the tunnel server card for further decapsulation. Afterward, the decapsulated Layer 2 packet is sent to the Engine 2 (or earlier engine) customer-facing interface.
  - If the packet is bound to an ISE/E5 customer-facing line card, the packet is sent to the ISE/E5 line card for decapsulation.

Note If no tunnel server card is installed, L2TPv3 decapsulation is not supported in the following conditions:
- The customer-facing line card is Engine 2 or an earlier engine line card.
- The customer-facing line card is ISE/E5 and the backbone-facing line card is non-ISE/5.
In these cases, packets received on the backbone-facing interface are dropped. The following warning message is logged: L2TPv3 decapsulation packet dropped.

Cisco 12000 Series Line Cards—General Restrictions

- IS-IS protocol packet fragmentation is supported only for dynamic L2TPv3 sessions.
- Hairpinning is not supported for local-to-local switching. The start and end of an L2TPv3 session must terminate on different routers linked by an IP or MPLS backbone.
- The L2TPv3 feature set is supported as follows. If a tunnel server card is:
  - Installed, and only Engine 2 or older customer-facing line cards are used, normal L2TPv3 tunnel sessions are supported with the L2TPv3 feature set described in L2TPv3 Features, page 32.
  - Is not installed and ISE/E5 backbone-facing and ISE/E5 customer-facing line cards are used, native L2TPv3 tunnel sessions are supported with the native L2TPv3 feature set described in Table 4.
  - Installed and a combination of Engine 2 or older and ISE/E5 line cards is used as customer-facing line cards, a mixed L2TPv3 tunnel session is supported with the native L2TPv3 feature set described in Table 4.
  - Installed and a ISE/E5 customer-facing and Engine 2 or older backbone-facing line cards are used, a mixed L2TPv3 tunnel session is supported with the native L2TPv3 feature set described in L2TPv3 Encapsulation and L2TPv3 Decapsulation.
- Engine 4 and Engine 4 Plus (E4+) line cards are not supported as the customer-facing line cards in an L2TPv3 tunnel session. However, Engine 4 and Engine 4+ line cards may be used to provide other services in a Layer 2 VPN.
- In a native L2TPv3 tunnel session configured on ISE/E5 interfaces, 802.1q (VLAN) is supported as an L2TPv3 payload starting in Cisco IOS Release 12.0(31)S.

Engine 2 and Earlier Engine-Specific Restrictions

- A dedicated 1-port OC-48c/STM-16c POS/SDH tunnel server card is required for L2TPv3 to function. The server card does not run Engine 2 features.
- TSC-based L2TPv3 tunnel sessions are supported only if a tunnel server card is configured.

  To configure the server card, you must enter the **ip unnumbered** command and configure the IP address on the PoS interface of the server card before you configure hardware modules. Then enter the **hw-module slot** *slot-number* **mode server** command.

  This initial configuration makes the server card IP-aware for backbones requiring an Address Resolution Protocol (ARP) to be generated by the line card. The backbone types that require this configuration are Ethernet and Spatial Reuse Protocol (SRP).

  This configuration is also a requirement for session keepalives. The interface port of the server card is automatically set to loopback internal and no keepalives when the **hw-module slot** *slot-number* **mode server** command is configured.

Note Starting in Cisco IOS Release 12.0(30)S, you must first remove all L2TPv3 xconnect attachment circuits on all Engine-2 or earlier engine customer-facing line cards before you enter the **no hw-module slot** *slot-number* **mode server** command to unconfigure a tunnel server card.

- On the tunnel server card:
  - The IP local interface must be a local loopback interface. Configuring any other interface as the IP local interface results in nonoperational sessions.
  - The IP local interface must be dedicated for the use of L2TPv3 sessions. This interface must not be shared by any other routing or tunneling protocols.
  - The maximum performance of 2.5 million packets per second (pps) is achieved only if you use transmit buffer management (TBM) ASIC ID 60F1. Other ASIC ID versions can cause the performance to be reduced by half. To determine the ASIC value of the line card, use the **execute-on slot** *slot-number* **show controller frfab bma reg | include asic** command, where *slot-number* is the slot number of the server card.
- Cover the optics of the tunnel server card because of possible interference or noise causing cyclic redundancy check (CRC) errors on the line card. These errors are caused by a framer problem in the line card.
- The aggregate performance is bound by the server card limit of 2.5 million pps.
- Because of a framer problem, the server card interfaces accounting in (packets out) are not accurate.
- Only features found in the Vanilla uCode bundle are supported on Engine 2 line cards that are associated with an L2TPv3 session and on a different interface, DLCI, or VLAN of the same line card.
- When you configure an Engine 2 feature, which is not in the Vanilla uCode bundle on an Engine 2 line card, on an interface bound to an L2TPv3 tunnel session, the Vanilla uCode is swapped out. As a result, all traffic through the L2TPv3 session stops on the Engine 2 line card. In this case, you must restore the Vanilla uCode bundle on the line card, and rebind the attachment circuit to the L2TPv3 session as described in the "Configuring the Xconnect Attachment Circuit" section on page 61.
- Configuring output Access Control Lists (ACLs) on any line card swaps out the running Engine 2 line card Vanilla uCode bundle in favor of the ACL uCode bundle. This configuration causes all traffic through the L2TPv3 session to stop on those Engine 2 line cards. If output ACLs are essential on the router, we advise you to originate all L2TPv3 sessions on Engine 0 line cards. Output ACLs do not swap out the server card uCode bundle because of the higher priority.
- Engine 2 line cards do not support Frame Relay switching and Frame Relay L2TPv3 DLCI session on the same line card.
- On Engine 2 line cards, the input Frame Relay permanent virtual circuit (PVC) counters are not updated.
- If the 8-port Fast Ethernet (Engine 1) line card is connected to a hub or switch when L2TPv3 is configured on the ingress side of one or more of its ports, duplicate packets are generated, causing the router to be flooded with packets. This restriction results from the requirement that CAM filtering is disabled when L2TPv3 is used.
- On the 3-port Gigabyte Ethernet (Engine 2) line card, performance degradation can occur if IP packets coming from a port are sent to the slow path for forwarding. This performance degradation occurs if both the following conditions are met:
  - The port has at least one 802.1q subinterface that is in an L2TPv3 session.

– The IP packet comes from the port interface itself (not 802.1q encapsulated) or from an 802.1q subinterface that is under the port interface but has no L2TPv3 session bound to it.

Edge Line Card-Specific Restrictions

The following restrictions apply to L2TPv3 sessions configured on IP Services Engine (ISE) and Engine 5 edge line cards:

- Native L2TPv3 sessions are supported only if the feature mode is configured on a customer-facing ISE/E5 line card.

  To configure the feature mode, enter the **hw-module slot** *slot-number* **np mode featur**e command. You cannot unconfigure the feature mode on a customer-facing ISE/E5 line card until all L2TPv3 xconnect attachment circuits on the line card are removed.

  A backbone-facing ISE/E5 line card can operate in any mode and no special feature mode configuration is required.

- Starting in Cisco IOS Release 12.0(31)S, 802.1q (VLAN) is supported as an L2TPv3 payload in a native L2TPv3 tunnel session configured on ISE/E5 interfaces.
- Native L2TPv3 tunnel sessions on customer-facing ISE/E5 line cards can coexist with tunnel sessions that use a tunnel server card.
- L2TPv3 encapsulation on a customer-facing ISE/E5 line card does not support the L2TPv3 Layer 2 Fragmentation feature.

  This means that if you enter the **ip pmtu** command to enable the discovery of a path maximum transmission unit (PMTU) for L2TPv3 traffic, and a customer IP packet exceeds the PMTU, IP fragmentation is not performed on the IP packet before L2TPv3 encapsulation. These packets are dropped. For more information, see the "L2TPv3 Layer 2 Fragmentation" section on page 36.

Table 2 and Table 3 show the ISE and E5 interfaces that are supported in a native L2TPv3 tunnel on:

- Customer-facing line cards (ingress encapsulation and egress decapsulation)
- Backbone-facing line cards (ingress decapsulation and egress encapsulation)

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Table 2 ISE Interfaces Supported in a Native L2TPv3 Tunnel Session

ISE Line Card	Native L2TPv3 Session on Customer-Facing Interface	Native L2TPv3 Session on Backbone-Facing Interface
4-port OC-3 POS ISE	Supported	Supported
8-port OC-3 POS ISE	Supported	Supported
16-port OC-3 POS ISE	Supported	Supported
4-port OC-12 POS ISE	Supported	Supported
1-port OC-48 POS ISE	Supported	Supported
1-port channelized OC-12 (DS1) ISE	Supported	Not supported
2.5G ISE SPA Interface Processor[1]: • 2-port T3/E3 serial SPA • 4-port T3/E3 serial SPA • 2-port channelized T3 to DS0 SPA • 4-port channelized T3 to DS0 SPA	Supported	Not supported
1-port channelized OC-48 POS ISE	Not supported	Not supported

Table 2 ISE Interfaces Supported in a Native L2TPv3 Tunnel Session (continued)

ISE Line Card	Native L2TPv3 Session on Customer-Facing Interface	Native L2TPv3 Session on Backbone-Facing Interface
4-port OC-3 ATM ISE	Supported	Supported
4-port OC-12 ATM ISE	Supported	Supported
4-port Gigabit Ethernet ISE [2]	Supported	Supported

1. For more information about the shared port adapters (SPAs) and SPA interface platforms (SIPs) supported on Cisco 12000 series routers, refer to the *Cisco 12000 Series Router SIP and SPA Hardware Installation Guide*.
2. The 4-port Gigabit Ethernet ISE line card supports VLAN membership (port-based and VLAN-based) in a native L2TPv3 tunnel session on customer-facing and backbone-facing interfaces. See VLAN for more information.

Table 3 Engine 5 Interfaces Supported in a Native L2TPv3 Tunnel Session

Engine 5 SPA	Native L2TPv3 Session on Customer-Facing Interface	Native L2TPv3 Session on Backbone-Facing Interface
1-port channelized STM-1/OC-3 to DS0	Supported	Not supported
8-port channelized T1/E1	Supported	Not supported
1-port 10-Gigabit Ethernet	Supported	Supported
5-port Gigabit Ethernet	Supported	Supported
10-port Gigabit Ethernet	Not supported	Supported
8-port Fast Ethernet	Supported	Supported
4-port OC-3/STM4 POS	Supported	Not supported
8-port OC-3/STM4 POS	Supported	Not supported
2-port OC-12/STM4 POS	Supported	Not supported
4-port OC-12/STM4 POS	Supported	Not supported
8-port OC-12/STM4 POS	Supported	Not supported
2-port OC-48/STM16 POS/RPR	Not supported	Supported
1-port OC192/STM64 POS/RPR	Not supported	Supported

Table 4 describes the L2TPv3 features supported in a native L2TPv3 tunnel session and the customer-facing ISE/E5 line cards that support each feature. Note that although native L2TPv3 sessions do not support L2TPv3 Layer 2 (IP packet) fragmentation and slow-path switching features, ATM (as a transport type) and QoS features (traffic policing and shaping) across all media types are supported.

Table 4 L2TPv3 Features Supported in a Native L2TPv3 Session

Native L2TPv3 Feature	ISE Line Cards (Customer-Facing) Supported	E5 Line Cards (Customer-Facing) Supported
Native L2TPv3 tunneling (fast-path) Supports the same L2TPv3 features that are supported by server card-based L2TPv3 tunneling, except that L2TPv3 Layer 2 (IP packet) fragmentation is not supported. For more information, see the "L2TPv3 Features" section.	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 4-port OC-3 ATM ISE 4-port OC-12 ATM ISE 4-port Gigabit Ethernet ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port T3/E3 Serial - 4-port T3/E3 Serial - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 8-port fast Ethernet - 5-port Gigabit Ethernet - 10-port Gigabit Ethernet - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS
L2TP class and pseudowire class configuration You can create an L2TP template of L2TP control channel parameters that can be inherited by different pseudowire classes configured on a PE router. You can also configure a pseudowire template of L2TPv3 session-level parameters that can be used to configure the transport Layer 2 traffic over an xconnect attachment circuit. For more information, see the sections "Configuring L2TP Control Channel Parameters" and "Configuring the L2TPv3 Pseudowire."	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 4-port OC-3 ATM ISE 4-port OC-12 ATM ISE 4-port Gigabit Ethernet ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port T3/E3 Serial - 4-port T3/E3 Serial - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 8-port Fast Ethernet - 5-port Gigabit Ethernet - 10-port Gigabit Ethernet - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS

Table 4 L2TPv3 Features Supported in a Native L2TPv3 Session (continued)

Native L2TPv3 Feature	ISE Line Cards (Customer-Facing) Supported	E5 Line Cards (Customer-Facing) Supported
L2TPv3 tunnel marking and traffic policing on the following types of ingress interfaces, when bound to a native L2TPv3 tunnel session: - 802.1q (VLAN) - ATM - Channelized - Ethernet - Frame Relay DLCIs The following conform, exceed, and violate values for the *action* argument are supported for the **police** command when QoS policies are configured on an ISE/E5 ingress interface bound to a native L2TPv3 tunnel. The **set** commands can also be used to set the IP precedence or DSCP value in the tunnel header of a L2TPv3 tunneled packet on an ingress interface. **conform-action** *actions*: **set-prec-tunnel** **set-dscp-tunnel** **transmit** **exceed-action** *actions*: **drop** **set-clp** (ATM only) **set-dscp-tunnel** **set-dscp-tunnel** and **set-clp** (ATM only) **set-dscp-tunnel** and **set-frde** (Frame Relay only) **set-frde** (Frame Relay only) **set-prec-tunnel** **set-prec-tunnel** and **set-clp** (ATM only) **set-prec-tunnel** and **set-frde** (Frame Relay only) **transmit** **violate-action** *actions*: **drop** See *"QoS: Tunnel Marking for L2TPv3 Tunnels"* for information about how to use the L2TPv3 tunnel marking and traffic policing features on Engine 2 (and earlier engine) interfaces bound to a TSC-based L2TPv3 tunnel session.	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 4-port OC-3 ATM ISE 4-port OC-12 ATM ISE 4-port Gigabit Ethernet ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port T3/E3 serial - 4-port T3/E3 serial - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 8-port Fast Ethernet - 5-port Gigabit Ethernet - 10-port Gigabit Ethernet - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS

Table 4 L2TPv3 Features Supported in a Native L2TPv3 Session (continued)

Native L2TPv3 Feature	ISE Line Cards (Customer-Facing) Supported	E5 Line Cards (Customer-Facing) Supported
Frame Relay DLCI-to-DLCI tunneling Frame Relay DLCIs are connected to create an end-to-end Frame Relay PVC. Traffic arriving on a DLCI on one interface is forwarded across an L2TPv3 tunnel to another DLCI on the other interface. For more information, see "DLCI-to-DLCI Switching" in the "Frame Relay" section.	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port T3/E3 serial - 4-port T3/E3 serial - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS - 2-port OC-48/STM16 POS/RPR
ATM single cell and packed cell relay: VC mode Each VC is mapped to a single L2TPv3 tunnel session. The following ATM cell relay modes are supported: • ATM cells arriving at an ATM interface with the specified VPI and VCI are encapsulated into a single L2TP packet (single cell relay). • ATM cells arriving at an ingress ATM interface are packed into L2TPv3 data packets and transported to the egress ATM interface (packed cell relay). For more information, see the "ATM" section.	4-port OC-3 ATM ISE 4-port OC-12 ATM ISE	Not supported
ATM single cell and packed cell relay: VP mode ATM cells arriving into a predefined PVP on the ATM interface are transported to a predefined PVP on the egress ATM interface. The following ATM cell relay modes are supported: • A single ATM cell is encapsulated into each L2TPv3 data packet (single cell relay). • Multiple ATM cells are packed into a single L2TPv3 data packet (packed cell relay). For more information, see the "ATM" section.	4-port OC-3 ATM ISE 4-port OC-12 ATM ISE	Not supported

Table 4 L2TPv3 Features Supported in a Native L2TPv3 Session (continued)

Native L2TPv3 Feature	ISE Line Cards (Customer-Facing) Supported	E5 Line Cards (Customer-Facing) Supported
ATM single cell relay and packed cell relay: Port mode ATM cells arriving at an ingress ATM interface are encapsulated into L2TPv3 data packets and transported to the egress ATM interface.The following ATM cell relay modes are supported: • A single ATM cell is encapsulated into each L2TPv3 data packet (single cell relay). • Multiple ATM cells are packed into a single L2TPv3 data packet (packed cell relay). For more information, see the "ATM" section.	4-port OC-3 ATM ISE 4-port OC-12 ATM ISE	Not supported
ATM AAL5 PVC tunneling The ATM AAL5 payload of an AAL5 PVC is mapped to a single L2TPv3 session. For more information, see "ATM AAL5" in the "ATM" section.	4-port OC-3 ATM ISE 4-port OC-12 ATM ISE	Not supported
OAM emulation mode for ATM AAL5 OAM local emulation mode for ATM AAL5 payloads is supported. Instead of being passed through the pseudowire, OAM cells are terminated and handled locally. On the L2TPv3-based pseudowire, the CE device sends an SLI message across the pseudowire to notify the peer PE node about the defect, rather than tearing down the session. For more information, see "ATM AAL5 over L2TPv3: OAM Local Emulation Mode" in the "ATM" section.	4-port OC-3 ATM ISE 4-port OC-12 ATM ISE	Not supported
OAM transparent mode for ATM AAL5 OAM transparent mode for ATM AAL5 payloads is supported. The PE routers pass OAM cells transparently across the L2TPv3 tunnel. For more information, see "ATM AAL5 over L2TPv3: OAM Transparent Mode" in the "ATM" section.	4-port OC-3 ATM ISE 4-port OC-12 ATM ISE	Not supported

Table 4 L2TPv3 Features Supported in a Native L2TPv3 Session (continued)

Native L2TPv3 Feature	ISE Line Cards (Customer-Facing) Supported	E5 Line Cards (Customer-Facing) Supported
Ethernet port-to-port tunneling Ethernet frames are tunneled through an L2TP pseudowire. For more information, see the "Ethernet" section.	4-port Gigabit Ethernet ISE	Engine 5 SPAs: - 8-port Fast Ethernet - 5-port Gigabit Ethernet - 10-port Gigabit Ethernet
VLAN-to-VLAN tunneling The following types of VLAN membership are supported in an L2TPv3 tunnel: • Port-based, in which undated Ethernet frames are received • VLAN-based, in which tagged Ethernet frames are received For more information, see the "VLAN" section.	4-port Gigabit Ethernet ISE	Engine 5 SPAs: - 8-port Fast Ethernet - 5-port Gigabit Ethernet - 10-port Gigabit Ethernet
Dual rate, 3-Color Marker for traffic policing on Frame Relay DLCIs of ingress interfaces, when bound to a native L2TPv3 tunnel session[1] The dual rate, 3-Color Marker in color-aware and color-blind modes, as defined in RFC 2698 for traffic policing, is supported on ingress ISE interfaces to classify packets. For more information, refer to "QoS: Color-Aware Policer."	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 4-port Gigabit Ethernet ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port T3/E3 serial - 4-port T3/E3 serial - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS - 2-port OC-48/STM16 POS/RPR

Table 4 L2TPv3 Features Supported in a Native L2TPv3 Session (continued)

Native L2TPv3 Feature	ISE Line Cards (Customer-Facing) Supported	E5 Line Cards (Customer-Facing) Supported
Traffic shaping on ATM and Frame Relay egress interfaces based on class map configuration is supported. Traffic shaping is supported on ATM egress interfaces for the following service categories: • Lowest priority: UBR (unspecified bit rate) • Second priority: VBR-nrt (variable bit rate nonreal-time) • Highest priority: VBR-rt (VBR real time) • Highest priority: CBR (constant bit rate) [2] For more information, see "QoSTraffic Shaping on ATM Line Cards for the Cisco 12000 Series."	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 4-port OC-3 ATM ISE 4-port OC-12 ATM ISE 4-port Gigabit Ethernet ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port clear channel T3/E3 - 4-port clear channel T3/E3 - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS - 2-port OC-48/STM16 POS/RPR
Layer 2 Virtual Private Network (L2VPN) interworking L2VPN interworking allows attachment circuits using different Layer 2 encapsulation types to be connected over an L2TPv3 pseudowire. On an ISE interface configured for L2TPv3 tunneling, the following Layer 2 encapsulations are supported: ATM AAL5 Ethernet 802.1q (VLAN) Frame Relay DLCI On an Engine 5 interface configured for L2TPv3 tunneling, the following Layer 2 encapsulations are supported: Ethernet 802.1q (VLAN) Frame Relay DLCI	4-port OC-3 POS ISE 8-port OC-3 POS ISE 16-port OC-3 POS ISE 4-port OC-12 POS ISE 1-port OC-48 POS ISE 4-port OC-3 ATM ISE 4-port OC-12 ATM ISE 4-port Gigabit Ethernet ISE 1-port channelized OC-12 (DS1) ISE ISE SPAs: - 2-port T3/E3 serial - 4-port T3/E3 serial - 2-port channelized T3 to DS0 - 4-port channelized T3 to DS0	Engine 5 SPAs: - 1-port channelized STM-1c/OC-3c to DS0 - 8-port channelized T1/E1 - 8-port Fast Ethernet - 8-port 10/100 Ethernet - 1-port 10-Gigabit Ethernet - 2-port Gigabit Ethernet - 5-port Gigabit Ethernet - 10-port Gigabit Ethernet - 4-port OC-3/STM4 POS - 8-port OC-3/STM4 POS - 2-port OC-12/STM4 POS - 4-port OC-12/STM4 POS - 8-port OC-12/STM4 POS - 2-port OC-48/STM16 POS/RPR - 1-port OC192/STM64 POS/RPR

1. Although the dual-rate, 3-Color Marker policer is not supported on ATM ISE/E5 interfaces, the ATM Forum Traffic Management Version 4.1-compliant Generic Cell Rate Algorithm (GCRA) policer is supported. The GCRA policer uses rate, peak rate, delay tolerance, and ATM maximum burst size, and supports the following options:
   - **set-dscp-tunnel**
   - **set-dscp-tunnel** and **set-clp-transmit**
   - **set-prec-tunnel**
   - **set-prec-tunnel** and **set-clp-transmit**
2. Note that VBR-rt and CBR share the same high priority shaping. ATM traffic shaping restricts traffic to the maximum rate configured on an ATM VC or PVP with due priority among the respective service categories.
   You can configure queue limits for an ATM VC or PVP. The queue limits are dual thresholds in which two different thresholds can be configured for CLP=1 cells and CLP0+1 cells. The CLP1 threshold must be lower than the queue limit threshold so that CLP=1 cells are dropped earlier than CLP=0 cells when packets start to fill the queue.

Frame Relay-Specific Restrictions

- Frame Relay per-DLCI forwarding and port-to-port trunking are mutually exclusive. L2TPv3 does not support the use of both on the same interface at the same time.
- The **xconnect** command is not supported on Frame Relay interfaces directly. For Frame Relay, xconnect is applied under the **connect** command specifying the DLCI to be used.
- Changing the encapsulation type on any interface removes any existing **xconnect** command applied to that interface.
- To use DCE or a Network-to-Network Interface (NNI) on a Frame Relay port, you must configure the **frame-relay switching** command.
- The configuration of an L2TPv3 session on a Multilink Frame Relay (MLFR) bundle interface is supported only on Cisco 12000 series 2-port channelized OC-3/STM-1 (DS1/E1) and 6-port Channelized T3 (T1) line cards. (For more information, see Binding L2TPv3 Sessions to Multilink Frame Relay Interfaces, page 45.)
- Frame Relay policing is nondistributed on the Cisco 7500 series. By configuring Frame Relay policing, you cause traffic on the affected PVCs to be sent to the RSP for processing.
- Frame Relay support is for 10-bit DLCI addresses. Frame Relay Extended Addressing is not supported.
- Multipoint DLCI is not supported.
- The keepalive is automatically disabled on interfaces that have an xconnect applied to them, except for Frame Relay encapsulation, which is a requirement for LMI.
- Static L2TPv3 sessions do not support Frame Relay LMI interworking.

VLAN-Specific Restrictions

- A PE router is responsible only for static VLAN membership entries that are manually configured on the router. Dynamic VLAN membership entries, entry aging, and membership discovery are not supported.
- Implicit tagging for VLAN membership operating on the other layers (such as at Layer 2, membership by MAC address or protocol type, at Layer 3, or membership by IP subnet) is not supported.
- Point-to-multipoint and multipoint-to-point configurations are not supported. There is a 1:1 relationship between an attachment circuit and an L2TPv3 session.

ATM VP Mode Single Cell Relay over L2TPv3 Restrictions

- The ATM VP Mode Single Cell Relay over L2TPv3 feature is supported only on the Cisco 7200 and Cisco 7500 series routers with ATM Deluxe PA-A3 interfaces.
- After the ATM VP Mode Single Cell Relay feature is configured for a virtual path connection (VPC), no other permanent virtual circuits (PVCs) are allowed for the same virtual path identifier (VPI).

ATM AAL5 SDU over L2TPv3 and Single Cell Relay VC Mode over L2TPv3 Restrictions

- The ATM AAL5 OAM Emulation over L2TPv3 feature and the ATM Single Cell Relay VC Mode over L2TPv3 feature are supported only on the Cisco 7200, Cisco 7301, Cisco 7304 NSE-100, Cisco 7304 NPE-G100, and Cisco 7500 series routers with ATM Deluxe PA-A3 interfaces.
- Sequencing is supported only for ATM adaptation layer 5 (AAL5) service data unit (SDU) frames or ATM cell relay packets. Sequencing of Operation, Administration, and Maintenance (OAM) cells is not supported.
- Sequencing is supported in CEF mode. If sequencing is enabled with dCEF, all L2TP packets that require sequence number processing are sent to the RSP module.
- L2TPv3 manual mode configuration does not support ATM alarm signaling over the pseudowire.
- The Cisco 7200 series and the Cisco 7500 series ATM driver cannot forward Resource Management (RM) OAM cells over the packet-switched network (PSN) for available bit rate (ABR) ToS. The RM cells are locally terminated.

ATM Port Mode Cell Relay over L2TPv3 Restrictions

- Port mode and virtual path (VP) or VC mode cell relay are mutually exclusive. After the ATM interface is configured for cell relay, no permanent virtual path (PVP) or PVC commands are allowed on that interface.
- ATM port mode cell relay is supported only on the PA-A3-T3, PA-A3-E3, and PA-A3-OC-3 ATM port adapters.
- ATM port mode cell relay is not supported on the PA-A3-8T1IMA and PA-A3-8E1IMA port adapters.

ATM Cell Packing over L2TPv3 Restrictions

- The ATM Cell Packing over L2TPv3 feature is supported only on PA-A3 ATM interfaces on Cisco 7200 and Cisco 7500 routers. Cell packing cannot be configured on other platforms or interface cards.
- A minimum of 2 and a maximum of 28 ATM cells can be packed into an L2TPv3 data packet.

IPv6 Protocol Demultiplexing for L2TPv3 Restrictions

- IPv6 protocol demultiplexing is supported only for Ethernet and terminated DLCI Frame Relay interfaces, PPP traffic, and HDLC traffic.
- IPv6 protocol demultiplexing is supported over non-interworking sessions.
- Frame Relay demultiplexing is supported for point-to-point or multipoint.
- FRF.12 end-to-end fragmentation is supported on the Cisco 7500 and Cisco 12000 series routers only between the CE and the PE routers.
- FRF.9 hardware payload compression is supported on the Cisco 7200 series and Cisco 7500 series routers only between the CE and the PE routers.

- FRF.9 software payload compression is supported on the Cisco 7500 series routers only between the CE and the PE routers.
- FRF.9 process switched payload compression is not supported.
- IETF encapsulation must be used with FRF.9.
- FRF.16 is supported only between the CE and the PE routers.
- HDLC restrictions for protocol demultiplexing:
  - IP must be enabled on the interface if you want to configure protocol demultiplexing using the **xconnect** command.
  - IPv6 cannot be enabled on the interface at the same time as the **xconnect** command (with or without protocol demultiplexing).
  - Payload compression is not supported.
- Cisco 12000 series router restrictions for protocol demultiplexing:
  - If a Cisco 12000 series router is acting as the PE with IPv6 protocol demultiplexing using PPP, the remote PE must also be a Cisco 12000 series router.
  - IPv6 protocol demultiplexing for Ethernet encapsulation on Engine-5 line cards is only supported with Version-2 Ethernet SPAs. It is not supported with Version-1 Ethernet SPAs.
  - IPv6 protocol demultiplexing is not supported on the SIP-400 Engine-3 line card.
- IPv6 protocol demultiplexing with PPP encapsulation must be configured in the following order to ensure a working tunnel session:
  1. Configure the IP address on the interface.
  2. Enter the encapsulation PPP command.
  3. Enter the PPP **ipv6cp id proxy** *ipv6-address* command.
  4. Enter the **xconnect** command with the **match protocol ipv6** command.

  If this configuration order is not followed, the tunnel session cannot operate until you issue a **shut/no shut** command on the protocol demultiplexing interface or do an OIR.

L2TPv3 Control Message Hashing Restrictions

- L2TPv3 control channel authentication configured with the **digest** command requires bidirectional configuration on the peer routers, and a shared secret must be configured on the communicating nodes.
- See Table 5 for a compatibility matrix of all the L2TPv3 authentication methods. For a list of the L2TPv3 authentication methods supported for your platform and release, see the "Feature Information for L2TPv3" section on page 113.

L2TPv3 Digest Secret Graceful Switchover Restrictions

- This feature works only with authentication passwords configured using the L2TPv3 Control Message Hashing feature. L2TPv3 control channel authentication passwords configured with the older, CHAP-like authentication system cannot be updated without tearing down L2TPv3 tunnels and sessions.
- In Cisco IOS Release 12.0(30)S, a maximum of two passwords can be configured simultaneously using the **digest secret** command.

Quality of Service Restrictions in L2TPv3 Tunneling

Quality of service (QoS) policies configured with the modular QoS command-line interface (MQC) are supported in L2TPv3 tunnel sessions with the following restrictions:

Frame Relay Interface (Non-ISE/E5)

- On the Cisco 7500 series with distributed CEF (dCEF), in a QoS policy applied to a Frame Relay interface configured for L2TPv3, only the MQC commands **match fr-dlci** in class-map configuration mode and **bandwidth** in policy-map configuration mode are supported. (See Configuring QoS for L2TPv3 on the Cisco 7500 Series: Example, page 102.)
- On the Cisco 12000 series, a QoS policy is supported in TSC-based L2TPv3 tunnel sessions on the Frame Relay interfaces of a 2-port channelized OC-3/STM-1 (DS1/E1) or 6-port channelized T3 (T1) line card with the following restrictions:
  - The **police** command is supported as follows:
    - Only the **transmit** option for the *action* keyword is supported with the **conform-action** command.
    - Only the **set-frde-transmit** option for the *action* keyword is supported with the **exceed-action** command.
    - Only the **drop** option for the *action* keyword is supported with the **violate-action** command.
    - Backward explicit congestion notification (BECN) and forward explicit congestion notification (FECN) configuration are not supported.
    - The type of service (ToS) byte must be configured in IP headers of tunneled Frame Relay packets when you configure the L2TPv3 pseudowire (see Configuring the L2TPv3 Pseudowire, page 58).
    - All standard restrictions for configuring QoS on Cisco 12000 series line cards apply to configuring QoS for L2TPv3 on Cisco 12000 series 2-port Channelized OC-3/STM-1 (DS1/E1) or 6-port Channelized T3 line cards.
  - On the ingress side of a Cisco 12000 series Frame Relay interface configured for TSC-based L2TPv3 tunneling:
    - Weighted random early detection (WRED) and modified deficit round robin (MDRR) configurations are not supported.
  - On the egress side of a Cisco 12000 series Frame Relay interface configured for TSC-based L2TPv3 tunneling:
    - MDRR is the only queueing strategy supported.
    - WRED is the only packet drop strategy supported.
    - MDRR is supported only in the following modes:

      —With both a low latency (priority) queue and class-default queue configured. (The low latency queue is supported only in combination with the class-default queue, and cannot be configured with normal distributed round robin (DRR) queues.)

      —Without a low latency queue configured. (In this case, only six queues are supported, including the class-default queue.)

- Egress queueing is determined according to the IP precedence values configured for classes of L2TPv3 Frame Relay traffic using the **match ip precedence** command, instead of on a per-DLCI basis.

For an example, see Configuring QoS on a Frame Relay Interface in a TSC-Based L2TPv3 Tunnel Session, page 103.

Edge Engine (ISE/E5) Interface

On the Cisco 12000 series, a QoS policy is supported in native L2TPv3 tunnel sessions on ISE/E5 interfaces (see Table 2 and Table 3 on page 16 for a list of supported line cards) with the following restrictions:

- On a Frame Relay or ATM ISE/E5 interface, traffic policing supports only the following conform, exceed, and violate values for the *action* argument of the **police** command:

  conform-action *actions*:
  set-prec-tunnel
  set-dscp-tunnel
  transmit

  exceed-action *actions*:
  drop
  set-clp (ATM only)
  set-dscp-tunnel
  set-dscp-tunnel and **set-clp** (ATM only)
  set-dscp-tunnel and **set-frde** (Frame Relay only)
  set-frde (Frame Relay only)
  set-prec-tunnel
  set-prec-tunnel and **set-clp** (ATM only)
  set-prec-tunnel and **set-frde** (Frame Relay only)
  transmit

  violate-action *actions*:
  drop

- On a Frame Relay ISE/E5 interface:
  - FECN and BECN configuration are not supported.
  - Marking the Frame Relay discard eligible (DE) bit using a MQC **set** command is not supported. To set (mark) the DE bit, use the **police exceed-action** *actions* command in policy-map configuration mode.
  - Configuring Tofab MDRR or WRED using legacy QoS (not MQC) commands is supported and is based on the tunnel precedence value.
  - Egress queueing on a Packet-over-SONET ISE/E5 interface is class-based when configured using MQC.
  - Egress queueing on a per-DLCI basis is not supported.

- On an ATM ISE/E5 interface:
  - Traffic shaping is supported on ATM egress interfaces for the following service categories:
    - Lowest priority: UBR (unspecified bit rate)
      Second priority: VBR-nrt (variable bit rate nonreal-time)
      Highest priority: VBR-rt (VBR real time)
      Highest priority: CBR (constant bit rate)
    - Note that VBR-rt and CBR share the same high-priority shaping. ATM traffic shaping restricts traffic to the maximum rate configured on an ATM VC or PVP with due priority among the respective service categories.
    - You can configure queue limits for an ATM VC or PVP. The queue limits are dual thresholds in which two different thresholds can be configured for CLP=1 cells and CLP0+1 cells. The CLP1 threshold must be lower than the queue limit threshold so that CLP=1 cells are dropped earlier than CLP=0 cells when packets start to fill the queue.
  - Although the dual-rate, 3-Color Marker policer is not supported on ATM ISE/E5 interfaces (as on Frame Relay ISE/E5 interfaces), the ATM Forum Traffic Management Version 4.1-compliant Generic Cell Rate Algorithm (GCRA) policer is supported. The GCRA policer uses rate, peak rate, delay tolerance, and ATM maximum burst size, and supports the following actions:

    set-dscp-tunnel
    set-dscp-tunnel and set-clp-transmit
    set-prec-tunnel
    set-prec-tunnel and set-clp-transmit

Protocol Demultiplexing Interface

Protocol demultiplexing requires a combination of an IP address and the **xconnect** command configured on the interface. The interface is then treated as a regular L3. To apply QoS on the Layer 2 IPv6 traffic, you must classify the IPv6 traffic into a separate class before applying any feature(s) to it.

The following match criteria are used to classify Layer 2 IPv6 traffic on a protocol demultiplexing interface:

```
class-map match-ipv6
     match protocol ipv6
```

In the absence of a class to handle Layer 2 IPv6 traffic, the service policy is not accepted on a protocol demultiplexing interface.

For detailed information about QoS configuration tasks and command syntax, refer to:

- *Cisco IOS Quality of Service Solutions Configuration Guide*
- *Cisco IOS Quality of Service Solutions Command Reference*

Information About Layer 2 Tunneling Protocol Version 3

L2TPv3 provides a method for delivering L2TP services over an IPv4 (non-UDP) backbone network. It encompasses signaling protocol as well as the packet encapsulation specification.

Migration from UTI to L2TPv3

UTI is a Cisco proprietary protocol that offers a simple high-speed transparent Layer 2-to-Layer 2 service over an IP backbone. The UTI protocol lacks the signaling capability and standards support necessary for large-scale commercial service. To begin to answer the need for a standard way to provide large-scale VPN connectivity over an IP core network, limited migration from UTI to L2TPv3 was introduced in Cisco IOS Release 12.0(21)S. The L2TPv3 feature in Cisco IOS Release 12.0(23)S introduced a more robust version of L2TPv3 to replace UTI.

As described in the section "L2TPv3 Header Description," the UTI data header is identical to the L2TPv3 header but with no sequence numbers and an 8-byte cookie. By manually configuring an L2TPv3 session using an 8-byte cookie (see the section "Manually Configuring L2TPv3 Session Parameters") and by setting the IP protocol number of outgoing data packets to 120 (as described in the section "Configuring the L2TPv3 Pseudowire"), you can ensure that a PE running L2TPv3 may interoperate with a peer PE running UTI. However, because UTI does not define a signaling plane, dynamically established L2TPv3 sessions cannot interoperate with UTI.

When a customer upgrades from a pre-L2TPv3 Cisco IOS release to a post-L2TPv3 release, an internal UTI-to-xconnect command-line interface (CLI) migration utility will automatically convert the UTI commands to xconnect and pseudowire class configuration commands without the need for any user intervention. After the CLI migration, the UTI commands that were replaced will not be available. The old-style UTI CLI is hidden from the user.

Note The UTI keepalive feature will *not* be migrated. The UTI keepalive feature will no longer be supported in post-L2TPv3 releases. You should convert to using dynamic L2TPv3 sessions to preserve the functionality provided by the UTI keepalive.

L2TPv3 Operation

L2TPv3 provides similar and enhanced services to replace the current UTI implementation, including the following features:

- Xconnect for Layer 2 tunneling through a pseudowire over an IP network

- Layer 2 VPNs for PE-to-PE router service using xconnect that supports Ethernet, 802.1q (VLAN), Frame Relay, HDLC, and PPP Layer 2 circuits, including both static (UTI-like) and dynamic (using the new L2TPv3 signaling) forwarded sessions

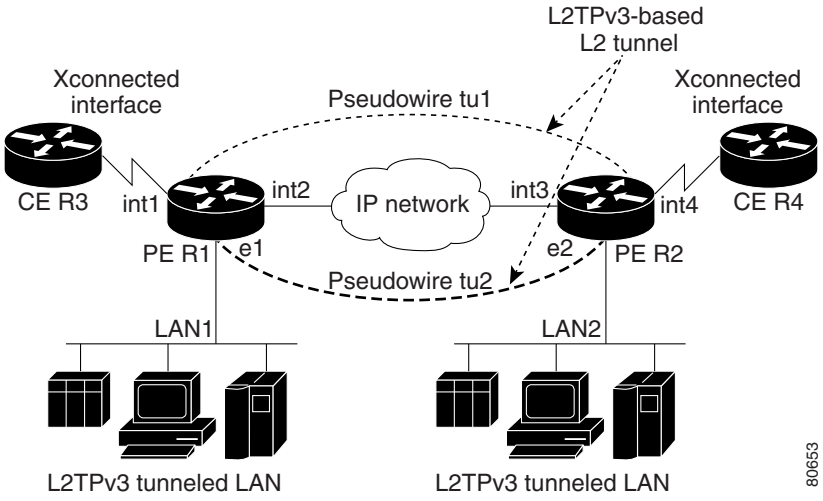
The initial Cisco IOS Release 12.0(23)S features supported only the following features:

- Layer 2 tunneling (as used in an L2TP access concentrator, or LAC) to an attachment circuit, not Layer 3 tunneling
- L2TPv3 data encapsulation directly over IP (IP protocol number 115), not using User Datagram Protocol (UDP)
- Point-to-point sessions, not point-to-multipoint or multipoint-to-point sessions
- Sessions between the same Layer 2 protocols; for example, Ethernet-to-Ethernet, VLAN-to-VLAN, but not VLAN-to-Ethernet or Frame Relay

The attachment circuit is the physical interface or subinterface attached to the pseudowire.

Figure 1 shows how the L2TPv3 feature is used for setting up VPNs using Layer 2 tunneling over an IP network. All traffic between two customer network sites is encapsulated in IP packets carrying L2TP data messages and sent across an IP network. The backbone routers of the IP network treat the traffic as any other IP traffic and need not know anything about the customer networks.

Figure 1 L2TPv3 Operation—Example



In Figure 1, the PE routers R1 and R2 provide L2TPv3 services. The R1 and R2 routers communicate with each other using a pseudowire over the IP backbone network through a path comprising the interfaces int1 and int2, the IP network, and interfaces int3 and int4.

In this example, the CE routers R3 and R4 communicate through a pair of xconnect Ethernet or VLAN interfaces using an L2TPv3 session. The L2TPv3 session tu1 is a pseudowire configured between interface int1 on R1 and interface int4 on R2. Any packet arriving on interface int1 on R1 is encapsulated and sent through the pseudowire control channel (tu1) to R2. R2 decapsulates the packet and sends it on interface int4 to R4. When R4 needs to send a packet to R3, the packet follows the same path in reverse.

Note the following features regarding L2TPv3 operation:

- All packets received on interface int1 are forwarded to R4. R3 and R4 cannot detect the intervening network.

- For Ethernet interfaces, any packet received from LAN1 by R1 on Ethernet interface e1 are encapsulated directly in IP and sent through the pseudowire session tu2 to R2 interface e2, where it is sent on LAN2.
- A VLAN on an Ethernet interface can be mapped to an L2TPv3 session.

Benefits of Using L2TPv3

L2TPv3 Simplifies Deployment of VPNs

L2TPv3 is an industry-standard Layer 2 tunneling protocol that ensures interoperability among vendors, increasing customer flexibility and service availability.

L2TPv3 Does Not Require MPLS

With L2TPv3 service providers need not deploy MPLS in the core IP backbone to set up VPNs using L2TPv3 over the IP backbone, resulting in operational savings and increased revenue.

L2TPv3 Supports Layer 2 Tunneling over IP for Any Payload

L2TPv3 provides enhancements to L2TP to support Layer 2 tunneling of any payload over an IP core network. L2TPv3 defines the base L2TP protocol as being separate from the Layer 2 payload that is tunneled.

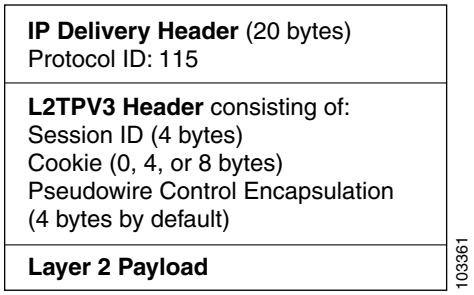
Other L2TPv3 Benefits

- L2TPv3 provides cookies for authentication.
- L2TPv3 provides session state updates and multiple sessions.
- Interworking (Ethernet-VLAN, Ethernet-QinQ, and VLAN-QinQ) is supported.

L2TPv3 Header Description

The migration from UTI to L2TPv3 also requires the standardization of the UTI header. As a result, the L2TPv3 header has the new format shown in Figure 2.

Figure 2 L2TPv3 Header Format



Each L2TPv3 packet contains an L2TPv3 header that includes a unique session ID representing one session and a variable cookie length. The L2TPv3 session ID and the Tunnel Cookie field length are assigned through the CLI. See the section "How to Configure L2TPv3" for more information on the CLI commands for L2TPv3.

Session ID

The L2TPv3 session ID is similar to the UTI session ID, and identifies the session context on the decapsulating system. For dynamic sessions, the value of the session ID is selected to optimize the context identification efficiency of the decapsulating system. A decapsulation implementation may therefore elect to support a smaller session ID bit field. In this L2TPv3 implementation, an upper value for the L2TPv3 session ID was set at 023. The L2TPv3 session ID value 0 is reserved for use by the protocol. For static sessions, the session ID is manually configured.

Note The local session ID must be unique on the decapsulating system and is restricted to the least significant ten bits.

Session Cookie

The L2TPv3 header contains a control channel cookie field that is similar to the UTI control channel key field. However, the control channel cookie field has a variable length of 0, 4, or 8 bytes according to the cookie length supported by a given platform for packet decapsulation. The control channel cookie length can be manually configured for static sessions or dynamically determined for dynamic sessions.

The variable cookie length does not present a problem when the same platform is at both ends of an L2TPv3 control channel. However, when different platforms interoperate across an L2TPv3 control channel, both platforms need to encapsulate packets with a 4-byte cookie length.

Pseudowire Control Encapsulation

The L2TPv3 pseudowire control encapsulation consists of 32 bits (4 bytes) and contains information used to sequence L2TP packets (see the section "Sequencing") and to distinguish AAL5 data and OAM cells for AAL5 SDU mode over L2TPv3. For the purposes of sequencing, only the first bit and bits 8 to 31 are relevant.

Bit 1 indicates whether the Sequence Number field, bits 8 to 31, contains a valid sequence number and is to be updated.

L2TPv3 Features

L2TPv3 provides xconnect support for Ethernet, 802.1q (VLAN), Frame Relay, HDLC, and PPP using the sessions described in the following sections:

- Static L2TPv3 Sessions (nonnegotiated, PVC-like forwarded sessions)
- Dynamic L2TPv3 Sessions (negotiated, forwarded sessions using the L2TPv3 control plane for session negotiation)

L2TPv3 also includes support for the features described in the following sections:

- Control Channel Parameters
- Sequencing

- Local Switching
- Distributed Switching
- L2TPv3 Layer 2 Fragmentation
- L2TPv3 Type of Service Marking
- Keepalive
- MTU Handling
- L2TPv3 Control Message Hashing
- L2TPv3 Control Message Rate Limiting
- L2TPv3 Digest Secret Graceful Switchover
- L2TPv3 Pseudowire
- Manual Clearing of L2TPv3 Tunnels
- L2TPv3 Tunnel Management
- L2TPv3 Protocol Demultiplexing
- Color Aware Policer on Ethernet over L2TPv3
- Site of Origin for Border Gateway Protocol VPNs
- L2TPv3 Custom Ethertype for Dot1q and QinQ Encapsulations

Control Channel Parameters

The L2TP class configuration procedure creates a template of L2TP control channel parameters that can be inherited by different pseudowire classes. L2TP control channel parameters are used in control channel authentication, keepalive messages, and control channel negotiation. In an L2TPv3 session, the same L2TP class must be specified in the pseudowire configured on the PE router at each end of the control channel. Configuring L2TP control channel parameters is optional. However, the L2TP class must be configured before it is with associated a pseudowire class (see the section "Configuring the L2TPv3 Pseudowire").

Control Channel Authentication Parameters

Two methods of control channel message authentication are available. The L2TPv3 Control Message Hashing feature introduces a more robust authentication method than the older CHAP-style L2TP control channel method of authentication. You may choose to enable both methods of authentication to ensure interoperability with peers that support only one of these methods of authentication, but this configuration will yield control of which authentication method is used to the peer PE router. Enabling both methods of authentication should be considered an interim solution to solve backward-compatibility issues during software upgrades.

The principal difference between the L2TPv3 Control Message Hashing feature and CHAP-style L2TP control channel authentication is that, instead of computing the hash over selected contents of a received control message, the L2TPv3 Control Message Hashing feature uses the entire message in the hash. In addition, instead of including the hash digest in only the SCCRP and SCCCN messages, it includes it in all messages.

Support for L2TP control channel authentication is maintained for backward compatibility. Either or both authentication methods can be enabled to allow interoperability with peers supporting only one of the authentication methods.

The following table shows a compatibility matrix for the different L2TPv3 authentication methods. PE1 is running new authentication, and the different possible authentication configurations for PE1 are shown in the first column. Each remaining column represents PE2 running software with different available authentication options, and the intersections indicate the different compatible configuration options for PE2. If any PE1/PE2 authentication configuration poses ambiguity on which method of authentication is used, the winning authentication method is indicated in bold. If both the old and new authentication methods are enabled on PE1 and PE2, both types of authentication occur.

Table 5 Compatibility Matrix for L2TPv3 Authentication Methods

PE1 Authentication Configuration	PE2 Supporting Old Authentication[1]	PE2 Supporting New Authentication[2]	PE2 Supporting Old and New Authentication[3]
None	None	None	None
		New integrity check	New integrity check
Old authentication	Old authentication	—	Old authentication
			Old authentication and new authentication
			Old authentication and new integrity check
New authentication	—	New authentication	New authentication
			Old authentication and **new authentication**
New integrity check	None	None	None
		New integrity check	New integrity check
Old and new authentication	Old authentication	New authentication	Old authentication
			New authentication
			Old and new authentication
			Old authentication and new integrity check
Old authentication and new integrity check	Old authentication	—	Old authentication
			Old authentication and new authentication
			Old authentication and new integrity check

1. Any PE software that supports only the old CHAP-like authentication system.
2. Any PE software that supports only the new message digest authentication and integrity checking authentication system, but does not understand the old CHAP-like authentication system. This type of software may be implemented by other vendors based on the latest L2TPv3 draft.
3. Any PE software that supports both the old CHAP-like authentication and the new message digest authentication and integrity checking authentication system.

Static L2TPv3 Sessions

Typically, the L2TP control plane is responsible for negotiating session parameters (such as the session ID or the cookie) to set up the session. However, some IP networks require sessions to be configured so that no signaling is required for session establishment. Therefore, you can set up static L2TPv3 sessions for a PE router by configuring fixed values for the fields in the L2TP data header. A static L2TPv3 session allows the PE to tunnel Layer 2 traffic as soon as the attachment circuit to which the session is bound comes up.

Static configuration allows sessions to be established without dynamically negotiating control connection parameters. This means that although sessions are displayed in the **show l2tun session** command output, no control channel information is displayed in the **show l2tun tunnel** command output.

Note In an L2TPv3 static session, you can still run the L2TP control channel to perform peer authentication and dead-peer detection. If the L2TP control channel cannot be established or is torn down because of a hello failure, the static session is also torn down.

When you use a static L2TPv3 session, you cannot perform circuit interworking, such as LMI, because there is no facility to exchange control messages. To perform circuit interworking, you must use a dynamic session.

Dynamic L2TPv3 Sessions

A dynamic L2TP session is established through the exchange of control messages containing attribute-value (AV) pairs. Each AV pair contains information about the nature of the Layer 2 link being forwarded: the payload type, virtual circuit (VC) ID, and so on.

Multiple L2TP sessions (one for each forwarded Layer 2 circuit) can exist between a pair of PEs, and can be maintained by a single control channel. Session IDs and cookies are dynamically generated and exchanged as part of a dynamic session setup. Information such as sequencing configuration is also exchanged. Circuit state changes (UP/DOWN) are conveyed using the set link info (SLI) message.

Sequencing

Although the correct sequence of received Layer 2 frames is guaranteed by some Layer 2 technologies (by the nature of the link, such as a serial line) or the protocol itself, forwarded Layer 2 frames may be lost, duplicated, or reordered when they traverse a network as IP packets. If the Layer 2 protocol does not provide an explicit sequencing mechanism, you can configure L2TP to sequence its data packets according to the data channel sequencing mechanism described in the L2TPv3 IETF l2tpext working group draft.

A receiver of L2TP data packets mandates sequencing through the Sequencing Required AV pair when the session is being negotiated. A sender that receives this AV pair (or that is manually configured to send sequenced packets) uses the Layer 2-specific pseudowire control encapsulation defined in L2TPv3.

You can configure L2TP to only drop out-of-order packets; you cannot configure L2TP to deliver the packets out-of-order. No reordering mechanism is available.

Interworking is not allowed when sequencing is enabled.

L2TPv3 distributed sequencing is supported on some Cisco IOS releases and platforms.

Local Switching

Local switching (from one port to another port in the same router) is supported for both static and dynamic sessions. You must configure separate IP addresses for each xconnect statement.

See the section "Configuration Examples for L2TPv3" for an example of how to configure local port switching.

Distributed Switching

Distributed CEF switching is supported for L2TP on the Cisco 7500 series routers.

Note For the Cisco 7500 series, sequencing is supported, but all L2TP packets that require sequence number processing are sent to the RSP.

L2TPv3 Layer 2 Fragmentation

Because the reassembly of fragmented packets is computationally expensive, it is desirable to avoid fragmentation issues in the service provider network. The easiest way to avoid fragmentation issues is to configure the CE routers with an path maximum transmission unit (MTU) value that is smaller than the pseudowire path MTU. However, in scenarios where this is not an option, fragmentation issues must be considered. L2TP initially supported only the following options for packet fragmentation when a packet is determined to exceed the L2TP path MTU:

- Unconditionally drop the packet
- Fragment the packet after L2TP/IP encapsulation
- Drop the packet and send an Internet Control Message Protocol (ICMP) unreachable message back to the CE router

The L2TPv3 Layer 2 Fragmentation feature introduces the ability to allow IP traffic from the CE router to be fragmented before the data enters the pseudowire, forcing the computationally expensive reassembly to occur in the CE network rather than in the service-provider network. The number of fragments that must be generated is determined based on the discovered pseudowire path MTU.

To enable the discovery of the path MTU for Layer 2 traffic, enter the **ip pmtu** command in a pseudowire class configuration (see "Configuring the L2TPv3 Pseudowire" section on page 58). On the PE router, the original Layer 2 header is then copied to each of the generated fragments, the L2TP/IP encapsulation is added, and the frames are forwarded through the L2TPv3 pseudowire.

Because the Don't Fragment (DF) bit in the Layer 2 encapsulation header is copied from the inner IP header to the encapsulation header, fragmentation of IP packets is performed on any packets received from the CE network that have a DF bit set to 0 and that exceed the L2TP path MTU in size. To prevent the reassembly of fragmented packets on the decapsulation router, you can enter the **ip dfbit set** command in the pseudowire class configuration to enable the DF bit in the outer Layer 2 header.

L2TPv3 Type of Service Marking

When Layer 2 traffic is tunneled across an IP network, information contained in the ToS bits may be transferred to the L2TP-encapsulated IP packets in one of the following ways:

- If the tunneled Layer 2 frames encapsulate IP packets themselves, it may be desirable to simply copy the ToS bytes of the inner IP packets to the outer IP packet headers. This action is known as "ToS byte reflection."

- Static ToS byte configuration. You specify the ToS byte value used by all packets sent across the pseudowire.

See the section "Configuring a Negotiated L2TPv3 Session for Local HDLC Switching: Example" for more information about how to configure ToS information.

Keepalive

The keepalive mechanism for L2TPv3 extends only to the endpoints of the tunneling protocol. L2TP has a reliable control message delivery mechanism that serves as the basis for the keepalive mechanism. The keepalive mechanism consists of an exchange of L2TP hello messages.

If a keepalive mechanism is required, the control plane is used, although it may not be used to bring up sessions. You can manually configure sessions.

In the case of static L2TPv3 sessions, a control channel between the two L2TP peers is negotiated through the exchange of start control channel request (SCCRQ), start control channel replay (SCCRP), and start control channel connected (SCCCN) control messages. The control channel is responsible only for maintaining the keepalive mechanism through the exchange of hello messages.

The interval between hello messages is configurable per control channel. If one peer detects that the other has gone down through the keepalive mechanism, it sends a StopCCN control message and then notifies all of the pseudowires to the peer about the event. This notification results in the teardown of both manually configured and dynamic sessions.

MTU Handling

It is important that you configure an MTU appropriate for a each L2TPv3 tunneled link. The configured MTU size ensures the following:

- The lengths of the tunneled Layer 2 frames fall below the MTU of the destination attachment circuit
- The tunneled packets are not fragmented, which forces the receiving PE to reassemble them

L2TPv3 handles the MTU as follows:

- The default behavior is to fragment packets that are larger than the session MTU.
- If you enable the **ip dfbit set** command in the pseudowire class, the default MTU behavior changes so that any packets that cannot fit within the tunnel MTU are dropped.
- If you enable the **ip pmtu** command in the pseudowire class, the L2TPv3 control channel participates in the path MTU discovery. When you enable this feature, the following processing is performed:
  - ICMP unreachable messages sent back to the L2TPv3 router are deciphered and the tunnel MTU is updated accordingly. To receive ICMP unreachable messages for fragmentation errors, the Don't Fragment (DF) bit in the tunnel header is set according to the DF bit value received from the CE, or statically if the **ip dfbit set** option is enabled. The tunnel MTU is periodically reset to the default value based on a periodic timer.
  - ICMP unreachable messages are sent back to the clients on the CE side. ICMP unreachable messages are sent to the CE whenever IP packets arrive on the CE-PE interface and have a packet size greater than the tunnel MTU. A Layer 2 header calculation is performed before the ICMP unreachable message is sent to the CE.

L2TPv3 Control Message Hashing

The L2TPv3 Control Message Hashing feature introduces a new and more secure authentication system that replaces the Challenge Handshake Authentication Protocol (CHAP)-like authentication system inherited from L2TPv2, which uses the Challenge and Challenge Response AV pairs in the SCCRQ, SCCRP, and SCCCN messages.

The per-message authentication introduced by the L2TPv3 Control Message Hashing feature is designed to perform a mutual authentication between L2TP nodes, check integrity of all control messages, and guard against control message spoofing and replay attacks that would otherwise be trivial to mount against the network.

Enabling the L2TPv3 Control Message Hashing feature will impact performance during control channel and session establishment, because additional digest calculation of the full message content is required for each sent and received control message. This is an expected trade-off for the additional security afforded by this feature. In addition, network congestion may occur if the receive window size is too small. If the L2TPv3 Control Message Hashing feature is enabled, message digest validation must be enabled. Message digest validation deactivates the data path received sequence number update and restricts the minimum local receive window size to 35.

The L2TPv3 Control Message Hashing feature incorporates an optional authentication or integrity check for all control messages. The new authentication method uses a computed one-way hash over the header and body of the L2TP control message, a pre-configured shared secret that must be defined on communicating L2TP nodes, and a local and remote random value exchanged using the Nonce AV pairs. Received control messages that lack any of the required security elements are dropped.

L2TPv3 control message integrity checking is a unidirectional mechanism that does not require the configuration of a shared secret. If integrity checking is enabled on the local PE router, control messages are sent with the message digest calculated without the shared secret or Nonce AV pairs, and are verified by the remote PE router. If verification fails, the remote PE router drops the control message.

L2TPv3 Control Message Rate Limiting

The L2TPv3 Control Message Rate Limiting feature was introduced to counter the possibility of a denial-of-service attack on a router running L2TPv3. The L2TPv3 Control Message Rate Limiting feature limits the rate at which SCCRQ control packets arriving at the PE that terminates the L2TPv3 tunnel can be processed. SCCRQ control packets initiate the process of bringing up the L2TPv3 tunnel and require a large amount of the control plane resources of the PE router.

On distributed platforms, most control packet filtering occurs at the line card level, and the CPU of the RP is minimally impacted even in a worst-case denial-of-service attack scenario. This feature has minimal impact on the shared bus or switching fabric, which are typically the bottleneck of a router.

No configuration is required for the L2TPv3 Control Message Rate Limiting feature. This feature automatically runs in the background in supported releases.

L2TPv3 Digest Secret Graceful Switchover

Authentication of L2TPv3 control channel messages occurs using a password that is configured on all participating peer PE routers. Before the introduction of this feature, changing this password requires removing the old password from the configuration before adding the new password, causing an interruption in L2TPv3 services. The authentication password must be updated on all peer PE routers, which are often at different physical locations. It is difficult for all peer PE routers be updated with the new password simultaneously to minimize interruptions in L2TPv3 services.

The L2TPv3 Digest Secret Graceful Switchover feature allows the password used to authenticate L2TPv3 control channel messages to be changed without tearing down established L2TPv3 tunnels. This feature works only for authentication passwords configured with the L2TPv3 Control Message Hashing feature. Authentication passwords configured with the older, CHAP-like authentication system cannot be updated without tearing down L2TPv3 tunnels.

The L2TPv3 Digest Secret Graceful Switchover feature allows two control channel passwords to be configured simultaneously, so a new control channel password can be enabled without first removing the old password. Established tunnels are rapidly updated with the new password, but continues to use the old password until it is removed from the configuration. This allows authentication to continue normally with peer PE routers that have not yet been updated to use the new password. After all peer PE routers are configured with the new password, the old password can be removed from the configuration.

During the period when both a new and an old password are configured, authentication will occur only with the new password if the attempt to authenticate using the old password fails.

L2TPv3 Pseudowire

The pseudowire class configuration procedure creates a configuration template for the pseudowire. Use this template, or class, to configure session-level parameters for L2TPv3 sessions that are used to transport attachment circuit traffic over the pseudowire.

The pseudowire configuration specifies the characteristics of the L2TPv3 signaling mechanism, including the data encapsulation type, the control protocol, sequencing, Layer 3 fragmentation, payload-specific options, and IP properties. The setting that determines if signaling is used to set up the pseudowire is also included.

For simple L2TPv3 signaling configurations on most platforms, pseudowire class configuration is optional. However, specifying a source IP address to configure a loopback interface is highly recommended. If you do not configure a loopback interface, the router will choose the best available local address, which could be any IP address configured on a core-facing interface. This configuration could prevent a control channel from being established.

On the Cisco 12000 series Internet routers, specifying a source IP address is mandatory, and you should configure a loopback interface that is dedicated for the use of L2TPv3 sessions exclusively. If you do not configure other pseudowire class configuration commands, the default values are used.

Once you specify the **encapsulation l2tpv3** command, you cannot remove it using the **no encapsulation l2tpv3** command. Nor can you change the command's setting using the **encapsulation mpls** command. Those methods result in the following error message:

```
Encapsulation changes are not allowed on an existing pw-class.
```

To remove the command, you must delete the pseudowire with the **no pseudowire-class** command. To change the type of encapsulation, remove the pseudowire with the **no pseudowire-class** command and reestablish the pseudowire and specify the new encapsulation type.

Manual Clearing of L2TPv3 Tunnels

This feature lets you clear L2TPv3 tunnels manually. Before the introduction of this feature, no provision was made to manually clear a specific L2TPv3 tunnel at will. This functionality provides users more control over an L2TPv3 network.

L2TPv3 Tunnel Management

New and enhanced commands have been introduced to facilitate managing xconnect configurations and diagnosing problems with xconnect configurations. No specific configuration tasks are associated with these commands.

For information about these Cisco IOS commands, go to the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or to the Cisco IOS Master Commands List, All Releases.

The following new and enhanced commands are introduced for tunnel management:

- Command Enhancements for L2TPv3
- Control Message Statistics and Conditional Debugging Command Enhancements

Command Enhancements for L2TPv3

This feature introduces new or enhanced commands for managing and diagnosing problems with xconnect configurations:

- **debug vpdn**—The output of this command includes authentication failure messages.
- **show l2tun session**—The **hostname** keyword option allows the peer hostname to be displayed in the output.
- **show l2tun tunnel**—The **authentication** keyword option allows the display of global information about L2TP control channel authentication attribute-value pairs (AV pairs).
- **show xconnect**—Displays xconnect-specific information, providing a sortable single point of reference for information about all xconnect configurations.
- **xconnect logging pseudowire status**—Enables syslog reporting of pseudowire status events.

Control Message Statistics and Conditional Debugging Command Enhancements

This feature introduces new commands and modifies existing commands for managing control message statistics and conditionally filtering xconnect debug messages.

For this feature, the following commands were introduced:

- **clear l2tun counters**—Clears session counters for Layer 2 tunnels.
- **clear l2tun counters tunnel l2tp**—Clears global or per-tunnel control message statistics.
- **debug condition xconnect**—Allows the conditional filtering of debug messages related to xconnect configurations (allows pseudowire conditional debugging)
- **monitor l2tun counters tunnel l2tp**—Enables or disables the collection of per-tunnel control message statistics.
- **show l2tun counters tunnel l2tp**—Displays global or per-tunnel control message statistics.

For this feature, the following command was modified:

- **show l2tun tunnel**—The **authentication** keyword was removed. The statistics previously displayed by the **show l2tun tunnel authentication** command are now displayed by the **show l2tun counters tunnel l2tp authentication** command.

L2TPv3 Protocol Demultiplexing

The Protocol Demultiplexing feature introduces the ability to provide native IPv6 support by utilizing a specialized IPv6 network to offload IPv6 traffic from the IPv4 network. IPv6 traffic is transparently tunneled to the IPv6 network using L2TPv3 pseudowires without affecting the configuration of the CE routers. IPv4 traffic is routed as usual within the IPv4 network, maintaining the existing performance and reliability of the IPv4 network.

The IPv4 PE routers must be configured to demultiplex incoming IPv6 traffic from IPv4 traffic. The PE routers facing the IPv6 network do not require IPv6 configuration. The configuration of the IPv6 network is beyond the scope of this document. For more information on configuring an IPv6 network, refer to the *Cisco IOS IPv6 Configuration Guide*.

Color Aware Policer on Ethernet over L2TPv3

The Color-Aware Policer enables a “color-aware” method of traffic policing. This feature allows you to police traffic according to the color classification of a packet. The packet color classification is based on packet matching criteria defined for two user-specified traffic classes—the conform-color class and the exceed-color class. These two traffic classes are created using the conform-color command and the metering rates are defined using the police command.

Site of Origin for Border Gateway Protocol VPNs

Site of Origin (SoO) for Border Gateway Protocol Virtual Private Networks (BGP-VPNs) is supported in Cisco IOS Release 12.0(33)S. Site of Origin (SoO) is a concept in a distributed VPN architecture that prevents routing loops in a site which is multi-homed to the VPN backbone and uses AS-OVERRIDE. The mechanism works by applying the SoO tag at the VPN entry point, the provider's edge (PE) equipment. When SoO is enabled, the PE only forwards prefixes to the customer premises equipment (CPE) when the SoO tag of the prefix does not match the SoO tag configured for the CPE.

Each site should be assigned a unique ID value, which is used as the second half of the SoO tag. These ID values used can be repeated for different customers, but not for the same customer. A “site” is considered SoO enabled if it has two or more CPEs that are connected to different PEs and includes at least one non-PE link between them.

SoO is a BGP extended community attribute used to identify when a prefix that originated from a customer site is re-advertised back into that site from a backdoor link. The following format can be used to address the SoO extended community:

<Customer-AS>:<Site-ID>

SoO can now be configured either using inbound route-maps or using the per-neighbor **neighbor soo** command. The SoO value set through the **neighbor soo** command should override the legacy inbound route-map settings when both are configured at the same time.

L2TPv3 Custom Ethertype for Dot1q and QinQ Encapsulations

The L2TPv3: Custom Ethertype for Dot1q and QinQ Encapsulation feature lets you configure an Ethertype other than 0x8100 on Gigabit Ethernet interfaces with QinQ or Dot1Q encapsulations. You can set the custom Ethertype to 0x9100, 0x9200, or 0x88A8. This allows interoperability in a multivendor Gigabit Ethernet environment.

L2TPv3 and UTI Feature Comparison

Table 6 compares L2TPv3 and UTI feature support for the Cisco 7200 and Cisco 7500 series routers.

Table 6 Comparison of L2TPv3 and UTI Feature Support

Feature	L2TPv3	UTI
Maximum number of sessions	Cisco 7200 and Cisco 7500 series:3000	Cisco 7200 and Cisco 7500 series: 1000
Tunnel cookie length	0-, 4-, or 8-byte cookies are supported for the Cisco 7200 series and the Cisco 7500 series routers.	8 bytes
Static sessions	Supported in Cisco IOS Release 12.0(21)S.	Supported
Dynamic sessions	Supported in Cisco IOS Release 12.0(23)S.	Not supported
Static ToS	Supported in Cisco IOS Release 12.0(23)S.	Supported
MQC ToS	Supported in Cisco IOS Release 12.0(27)S.	Supported
Inner IP ToS mapping	Supported on the Cisco 7200 series routers and Cisco 7500 series routers.	Not supported
802.1p mapping	Not supported.	Not supported
Keepalive	Supported in Cisco IOS Release 12.0(23)S.	Not supported
Path MTU discovery	Supported on the Cisco 7200 series and Cisco 7500 series routers.	Not supported
ICMP unreachable	Supported on the Cisco 7200 series and Cisco 7500 series routers.	Not supported
VLAN rewrite	Supported on the Cisco 7200 series and Cisco 7500 series routers in Cisco IOS Release 12.0(23)S.	Supported
VLAN and non-VLAN translation	To be supported in a future release.	Not supported
Port trunking	Supported in Cisco IOS Release 12.0(23)S.	Supported
IS-IS packet fragmentation through an L2TPv3 session	Supported on the Cisco 7200 series and Cisco 7500 series routers, and on the Cisco 10720 Internet router in Cisco IOS Release 12.0(24)S.	Not supported
L2TPv3 Layer 2 (IP packet) fragmentation through an L2TPv3 session	Supported on the Cisco 7200 series and Cisco 7500 series routers in Cisco IOS Release 12.0(24)S. Supported on the Cisco 10720 Internet router in Cisco IOS Release 12.0(32)SY.	Not supported

Table 6 Comparison of L2TPv3 and UTI Feature Support (continued)

Feature	L2TPv3	UTI
Payload sequence number checking	Supported on the Cisco 7500 series in Cisco IOS Release 12.0(28)S.	Not supported
MIB support	IfTable MIB for the attachment circuit.	IfTable MIB for the session interface.

Supported L2TPv3 Payloads

L2TPv3 supports the following Layer 2 payloads that can be included in L2TPv3 packets tunneled over the pseudowire:

- Frame Relay
- Ethernet
- VLAN
- HDLC
- PPP
- ATM
- IPv6 Protocol Demultiplexing

Note Each L2TPv3 tunneled packet includes the entire Layer 2 frame of the payloads described in this section. If sequencing is required (see the section "Sequencing"), a Layer 2-specific sublayer (see the section "Pseudowire Control Encapsulation") is included in the L2TPv3 header to provide the Sequence Number field.

Frame Relay

L2TPv3 supports the Frame Relay functionality described in the following sections:

- Port-to-Port Trunking
- DLCI-to-DLCI Switching
- PVC Status Signaling
- Sequencing
- ToS Marking
- CIR Guarantees
- Binding L2TPv3 Sessions to Multilink Frame Relay Interfaces

Port-to-Port Trunking

Port-to-port trunking is where two CE Frame Relay interfaces are connected as by a leased line (UTI raw mode). All traffic arriving on one interface is forwarded transparently across the pseudowire to the other interface.

For example, in Figure 1, if the two CE routers are connected by a virtual leased line, the PE routers transparently transport all packets between CE R3 and CE R4 over a pseudowire. PE R1 and PE R2 do not examine or change the DLCIs, and do not participate in the LMI protocol. The two CE routers are

LMI peers. There is nothing Frame Relay-specific about this service as far as the PE routers are concerned. The CE routers should be able to use any encapsulation based on HDLC framing without needing to change the provider configuration.

DLCI-to-DLCI Switching

Frame Relay DLCI-to-DLCI switching is where individual Frame Relay DLCIs are connected to create an end-to-end Frame Relay PVC. Traffic arriving on a DLCI on one interface is forwarded across the pseudowire to another DLCI on the other interface.

For example, in Figure 1, CE R3 and PE R1 are Frame Relay LMI peers; CE R4 and PE R2 are also LMI peers. You can use a different type of LMI between CE R3 and PE R1 compared to what you use between CE R4 and PE R2.

The CE devices may be a Frame Relay switch or end-user device. Each Frame Relay PVC is composed of multiple segments. The DLCI value is local to each segment and is changed as traffic is switched from segment to segment. Note that, in Figure 1, two Frame Relay PVC segments are connected by a pseudowire. Frame Relay header flags (FECN, BECN, C/R, DE) are preserved across the pseudowire.

PVC Status Signaling

PVC status signaling is propagated toward Frame Relay end users by the LMI protocol. You can configure the LMI to operate in any of the following modes:

- UNI DTE mode—PVC status is not reported, only received.
- UNI DCE mode—PVC status is reported but not received.
- NNI mode—PVC status is reported and received independently.

L2TPv3 supports all three modes.

The PVC status should be reported as ACTIVE only if the PVC is available from the reporting device to the Frame Relay end-user device. All interfaces, line protocols, and pseudowires must be operational between the reporting device and the Frame Relay end-user device.

Note that any keepalive functions on the session are independent of Frame Relay, but any state changes that are detected are fed into the PVC status reporting. For example, the L2TP control channel uses hello packets as a keepalive function. If the L2TPv3 keepalive fails, all L2TPv3 sessions are torn down. Loss of the session is notified to Frame Relay, which can then report PVCs INACTIVE to the CE devices.

For example, in Figure 1, CE R3 reports ACTIVE to PE R1 only if the PVC is available within CE R3. When CE R3 is a switch, it reports all the way to the user device in the customer network.

PE R1 reports ACTIVE to CE R3 only if the PVC is available within PE R1 and all the way to the end-user device (through PE R2 and CE R3) in the other customer VPN site.

The ACTIVE state is propagated hop-by-hop, independently in each direction, from one end of the Frame Relay network to the other end.

Sequencing

Frame Relay provides an ordered service in which packets sent to the Frame Relay network by one end-user device are delivered in order to the other end-user device. When switching is occurring over the pseudowire, packet ordering must be able to be preserved with a very high probability to closely emulate a traditional Frame Relay service. If the CE router is not using a protocol that can detect misordering itself, configuring sequence number processing may be important. For example, if the Layer 3 protocol is IP and Frame Relay is therefore used only for encapsulation, sequencing is not required. To detect

misordering, you can configure sequence number processing separately for transmission or reception. For more information about how to configure sequencing, see the section "Configuring a Negotiated L2TPv3 Session for Local HDLC Switching: Example."

ToS Marking

The ToS bytes in the IP header can be statically configured or reflected from the internal IP header. The Frame Relay discard eligible (DE) bit does not influence the ToS bytes.

CIR Guarantees

To provide committed information rate (CIR) guarantees, you can configure a queueing policy that provides bandwidth to each DLCI to the interface facing the customer network on the egress PE.

Note CIR guarantees are supported only on the Cisco 7500 series with dCEF. This support requires that the core has sufficient bandwidth to handle all CE traffic and that the congestion occurs only at the egress PE.

Binding L2TPv3 Sessions to Multilink Frame Relay Interfaces

The configuration of an L2TPv3 session on a Multilink Frame Relay (MLFR) bundle interface is supported only on Cisco 12000 series 2-port channelized OC-3/STM-1 (DS1/E1) and 6-port channelized T3 (T1) line cards.

The Multilink Frame Relay feature introduces functionality based on the Frame Relay Forum Multilink Frame Relay UNI/NNI Implementation Agreement (FRF.16). This feature provides a cost-effective way to increase bandwidth for particular applications by enabling multiple serial links to be aggregated into a single bundle of bandwidth.

For an example of how to configure L2TPv3 tunneling on a multilink Frame Relay bundle interface, see Configuring MLFR for L2TPv3 on the Cisco 12000 Series: Example, page 109.

For information about how configure and use the MLFR feature, refer to the *Multilink Frame Relay (FRF.16)* publication.

Ethernet

An Ethernet frame arriving at a PE router is simply encapsulated in its entirety with an L2TP data header. At the other end, a received L2TP data packet is stripped of its L2TP data header. The payload, an Ethernet frame, is then forwarded to the appropriate attachment circuit.

Because the L2TPv3 tunneling protocol serves essentially as a bridge, it need not examine any part of an Ethernet frame. Any Ethernet frame received on an interface is tunneled, and any L2TP-tunneled Ethernet frame is forwarded out the interface.

Note Because of the way in which L2TPv3 handles Ethernet frames, an Ethernet interface must be configured to promiscuous mode to capture all traffic received on the Ethernet segment attached to the router. All frames are tunneled through the L2TP pseudowire.

VLAN

L2TPv3 supports VLAN membership in the following ways:

- Port-based, in which undated Ethernet frames are received
- VLAN-based, in which tagged Ethernet frames are received

In L2TPv3, Ethernet xconnect supports port-based VLAN membership and the reception of tagged Ethernet frames. A tagged Ethernet frame contains a tag header (defined in 802.1Q), which is 4 bytes long and consists of a 2-byte tag protocol identifier (TPID) field and a 2-byte tag control information (TCI) field. The TPID indicates that a TCI follows. The TCI is further broken down into the following three fields:

- User priority field
- Canonical format indicator (CFI)
- A 12-bit VLAN ID (VID)

For L2TPv3, an Ethernet subinterface configured to support VLAN switching may be bound to an xconnect service so that all Ethernet traffic, tagged with a VID specified on the subinterface, is tunneled to another PE. The VLAN Ethernet frames are forwarded in their entirety. The receiving PE may rewrite the VID of the tunneled traffic to another value before forwarding the traffic onto an attachment circuit.

To successfully rewrite VLANs, it may be necessary to disable the Spanning Tree Protocol (STP). This can be done on a per-VLAN basis by using the **no spanning-tree vlan** command.

Note Because of the way in which L2TPv3 handles VLAN packets, the Ethernet interface must be configured in promiscuous mode to capture all traffic received on the Ethernet segment attached to the router. All frames are tunneled through the L2TP pseudowire.

HDLC

L2TPv3 encapsulates an HDLC frame arriving at a PE in its entirety (including the Address, Control, and Protocol fields, but not the Flag fields and the frame check sequence) with an L2TP data header.

PPP

PEs that support L2TPv3 forward PPP traffic using a “transparent pass-through” model, in which the PEs play no role in the negotiation and maintenance of the PPP link. L2TPv3 encapsulates a PPP frame arriving at a PE in its entirety (including the HDLC Address and Control fields) with an L2TP data header.

ATM

L2TPv3 can connect two isolated ATM clouds over a packet-switched network (PSN) while maintaining an end-to-end ATM Service Level Agreement (SLA). The ATM Single Cell Relay features forward one ATM cell per packet. The ATM Cell Packing over L2TPv3 features allows multiple ATM frames to be packed into a single L2TPv3 data packet. All packets are transparently forwarded over the L2TPv3 pseudowire.

Note VPI or VPI/VCI rewrite is not supported for any ATM transport mode. Both pairs of PE to CE peer routers must be configured with matching VPI or VCI values except in OAM local emulation mode. For example, if PE1 and CE1 are connected by PVC 10/100, PE2 and CE2 should also be connected by PVC 10/100.

Table 7 shows the releases that introduced support for the ATM cell relay features.

Table 7 Release Support for the ATM Cell Relay Features

Transport Type	Single Cell Relay	Packed Cell Relay
VC mode	12.0(28)S, 12.2(25)S	12.0(29)S
VP mode	12.0(25)S, 12.2(25)S	12.0(29)S
Port mode	12.0(29)S, 12.2(25)S4	12.0(29)S

ATM Single Cell Relay VC Mode over L2TPv3

The ATM Single Cell Relay VC mode over L2TPv3 feature maps one VC to a single L2TPv3 session. All ATM cells arriving at an ATM interface with the specified VPI and VCI are encapsulated into a single L2TP packet. Each ATM cell will have a 4-byte ATM cell header without Header Error Control Checksum (HEC) and a 48-byte ATM cell payload.

The ATM Single Cell Relay VC mode feature can be used to carry any type of AAL traffic over the pseudowire. It will not distinguish OAM cells from User data cells. In this mode, Performance and Security OAM cells are also transported over the pseudowire.

ATM VP Mode Single Cell Relay over L2TPv3

The ATM VP Mode Single Cell Relay over L2TPv3 feature allows cells coming into a predefined PVP on the ATM interface to be transported over an L2TPv3 pseudowire to a predefined PVP on the egress ATM interface. A single ATM cell is encapsulated into each L2TPv3 data packet.

ATM Port Mode Cell Relay over L2TPv3

The ATM Port Mode Cell Relay over L2TPv3 feature packs ATM cells arriving at an ingress ATM interface into L2TPv3 data packets and transports them to the egress ATM interface. A single ATM cell is encapsulated into each L2TPv3 data packet.

ATM Cell Packing over L2TPv3

The ATM Cell Packing over L2TPv3 feature enhances throughput and uses bandwidth more efficiently than the ATM cell relay features. Instead of a single ATM cell being packed into each L2TPv3 data packet, multiple ATM cells can be packed into a single L2TPv3 data packet. ATM cell packing is supported for Port mode, VP mode, and VC mode. Cell packing must be configured on the PE devices. No configuration is required on the CE devices.

ATM AAL5 over L2TPv3

The ATM AAL5 over L2TPv3 feature maps the AAL5 payload of an AAL5 PVC to a single L2TPv3 session. This service will transport OAM and RM cells, but does not attempt to maintain the relative order of these cells with respect to the cells that comprise the AAL5 common part convergence sublayer protocol data unit (CPCS-PDU). OAM cells that arrive during the reassembly of a single AAL5 CPCS-PDU are sent immediately over the pseudowire, followed by the AAL5 payload without the AAL5 pad and trailer bytes.

VC Class Provisioning for L2TPv3

Beginning in Cisco IOS Release 12.0(30)S, ATM AAL5 encapsulation over L2TPv3 can be configured in VC class configuration mode in addition to ATM VC configuration mode. The ability to configure ATM encapsulation parameters in VC class configuration mode provides greater control and flexibility for AAL5 encapsulation configurations.

OAM Transparent Mode

In OAM transparent mode, the PEs will pass the following OAM cells transparently across the pseudowire:

- F5 segment and end-to-end Fault Management (FM) OAM cells
- RM OAM cells, except Performance Management (PM) and Security OAM cells

Note The Cisco 7200 and the Cisco 7500 ATM driver cannot forward RM cells over the PSN for ABR ToS. The RM cells are locally terminated.

VPI or VPI/VCI rewrite is not supported for any ATM transport mode. Both pairs of PE to CE peer routers must be configured with matching VPI and VCI values except in OAM local emulation mode. For example, if PE1 and CE1 are connected by PVC 10/100, PE2 and CE2 should also be connected by PVC 10/100.

OAM Local Emulation Mode

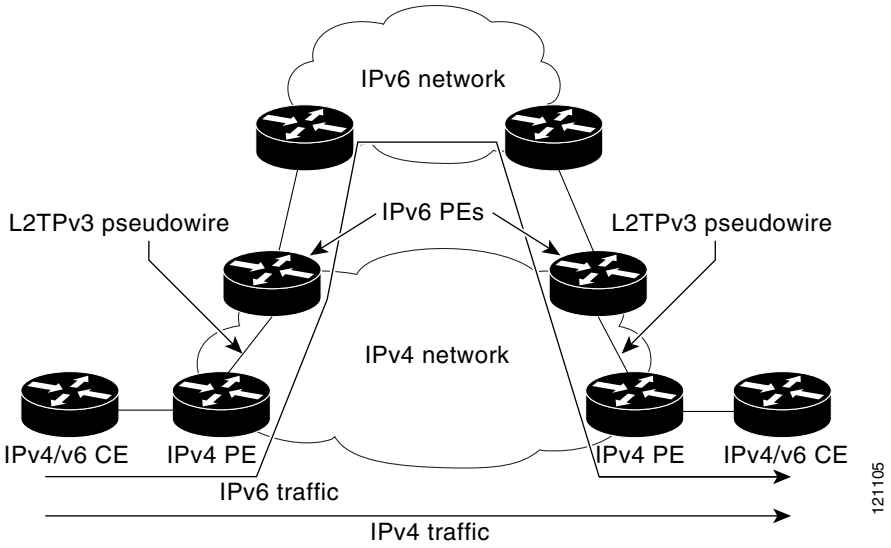
In OAM Local Emulation mode, OAM cells are not passed through the pseudowire. All F5 OAM cells are terminated and handled locally. On the L2TPv3-based pseudowire, the CE device sends an SLI message across the pseudowire to notify the peer PE node about the defect, rather than tearing down the session. The defect can occur at any point in the link between the local CE and the PE. OAM management can also be enabled on the PE node using existing OAM management configurations.

IPv6 Protocol Demultiplexing

Upgrading a service provider network to support IPv6 is a long and expensive process. As an interim solution, the Protocol Demultiplexing for L2TPv3 feature introduces the ability to provide native IPv6 support by setting up a specialized IPv6 network and offloading IPv6 traffic from the IPv4 network. IPv6 traffic is transparently tunneled to the IPv6 network using L2TPv3 pseudowires without affecting the configuration of the CE routers. IPv4 traffic is routed as usual within the IPv4 network, maintaining the existing performance and reliability of the IPv4 network.

Figure 3 shows a network deployment that offloads IPv6 traffic from the IPv4 network to a specialized IPv6 network. The PE routers demultiplex the IPv6 traffic from the IPv4 traffic. IPv6 traffic is routed to the IPv6 network over an L2TPv3 pseudowire, while IPv4 traffic is routed normally. The IPv4 PE routers must be configured to demultiplex incoming IPv6 traffic from IPv4 traffic. The PE routers facing the IPv6 network do not require IPv6 configuration.

Figure 3 Protocol Demultiplexing of IPv6 Traffic from IPv4 Traffic



Protocol demultiplexing requires supporting the combination of an IP address and an **xconnect** command configuration on the IPv4 PE interface. This combination of configurations is not allowed without enabling protocol demultiplexing, with the exception of switched Frame Relay PVCs. If no IP address is configured, the protocol demultiplexing configuration is rejected. If an IP address is configured, the **xconnect** command configuration is rejected unless protocol demultiplexing is enabled in xconnect configuration mode before exiting that mode. If an IP address is configured with an **xconnect** command configuration and protocol demultiplexing enabled, the IP address cannot be removed. To change or remove the configured IP address, the **xconnect** command configuration must first be disabled.

Table 8 shows the valid combinations of configurations.

Table 8 Valid Configuration Scenarios

Scenario	IP Address	xconnect Configuration	Protocol Demultiplexing Configuration
Routing	Yes	No	—
L2VPN	No	Yes	No
IPv6 Protocol Demultiplexing	Yes	Yes	Yes

How to Configure L2TPv3

Configuring L2TP Control Channel Parameters

After you enter L2TP class configuration mode, you can configure L2TP control channel parameters in any order. If you have multiple authentication requirements you can configure multiple sets of L2TP class control channel parameters with different L2TP class names. However, only one set of L2TP class control channel parameters can be applied to a connection between any pair of IP addresses.

Configuring L2TP Control Channel Timing Parameters

The following L2TP control channel timing parameters can be configured in L2TP class configuration mode:

- Packet size of the receive window used for the control channel
- Retransmission parameters used for control messages
- Timeout parameters used for the control channel

This task configures a set of timing control channel parameters in an L2TP class. All of the timing control channel parameter configurations are optional and may be configured in any order. If these parameters are not configured, the default values are applied.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]
4. **receive-window** *size*
5. **retransmit** {**initial retries** *initial-retries* | **retries** *retries* | **timeout** {**max** | **min**} *timeout*}
6. **timeout setup** *seconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name* for each one.
Step 4	**receive-window** *size* **Example:** `Router(config-l2tp-class)# receive-window 30`	(Optional) Configures the number of packets that can be received by the remote peer before backoff queueing occurs. • The valid values range from 1 to the upper limit the peer has for receiving packets. The default value is the upper limit.

	Command or Action	Purpose
Step 5	**retransmit** {**initial retries** *initial-retries* | **retries** *retries* | **timeout** {**max** | **min**} *timeout*} **Example:** `Router(config-l2tp-class)# retransmit retries 10`	(Optional) Configures parameters that affect the retransmission of control packets. • **initial retries**—specifies how many SCCRQs are re-sent before giving up on the session. Valid values for the *initial-retries* argument range from 1 to 1000. The default value is 2. • **retries**—specifies how many retransmission cycles occur before determining that the peer PE router does not respond. Valid values for the *retries* argument range from 1 to 1000. The default value is 15. • **timeout** {**max** | **min**}—specifies maximum and minimum retransmission intervals (in seconds) for resending control packets. Valid values for the *timeout* argument range from 1 to 8. The default maximum interval is 8; the default minimum interval is 1.
Step 6	**timeout setup** *seconds* **Example:** `Router(config-l2tp-class)# timeout setup 400`	(Optional) Configures the amount of time, in seconds, allowed to set up a control channel. • Valid values for the *seconds* argument range from 60 to 6000. The default value is 300.

Configuring L2TPv3 Control Channel Authentication Parameters

- Configuring Authentication for the L2TP Control Channel, page 52 (optional)
- Configuring L2TPv3 Control Message Hashing, page 53 (optional)
- Configuring L2TPv3 Digest Secret Graceful Switchover, page 55 (optional)

Configuring Authentication for the L2TP Control Channel

The L2TP control channel method of authentication is the older, CHAP-like authentication system inherited from L2TPv2.

The following L2TP control channel authentication parameters can be configured in L2TP class configuration mode:

- Authentication for the L2TP control channel
- Password used for L2TP control channel authentication
- Local hostname used for authenticating the control channel

This task configures a set of authentication control channel parameters in an L2TP class. All of the authentication control channel parameter configurations are optional and may be configured in any order. If these parameters are not configured, the default values are applied.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]
4. **authentication**

5. **password** [**0** | **7**] *password*
6. **hostname** *name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name* for each one.
Step 4	**authentication** **Example:** `Router(config-l2tp-class)# authentication`	(Optional) Enables authentication for the control channel between PE routers.
Step 5	**password** [**0**	**7**] *password* **Example:** `Router(config-l2tp-class)# password cisco`	(Optional) Configures the password used for control channel authentication. • [**0**	**7**]—(Optional) Specifies the input format of the shared secret. The default value is **0**. – **0**—Specifies that a plain-text secret is entered. – **7**—Specifies that an encrypted secret is entered. • *password*—Defines the shared password between peer routers.
Step 6	**hostname** *name* **Example:** `Router(config-l2tp-class)# hostname yb2`	(Optional) Specifies a hostname used to identify the router during L2TP control channel authentication. • If you do not use this command, the default hostname of the router is used.

Configuring L2TPv3 Control Message Hashing

This task configures L2TPv3 Control Message Hashing feature for an L2TP class.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]

4. **digest** [**secret** [**0** | **7**] *password*] [**hash** {**md5** | **sha**}]
5. **digest check**
6. **hidden**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name* for each one.
Step 4	**digest** [**secret** [**0** | **7**] *password*] [**hash** {**md5** | **sha**}] **Example:** `Router(config-l2tp-class)# digest secret cisco hash sha`	(Optional) Enables L2TPv3 control channel authentication or integrity checking. • **secret**—(Optional) Enables L2TPv3 control channel authentication. **Note** If the **digest** command is issued without the **secret** keyword option, L2TPv3 integrity checking is enabled. • [**0** | **7**]—Specifies the input format of the shared secret. The default value is **0**. – **0**—Specifies that a plain-text secret is entered. – **7**—Specifies that an encrypted secret is entered. • *password*—Defines the shared secret between peer routers. The value entered for the *password* argument must be in the format that matches the input format specified by the [**0** | **7**] keyword option. • **hash** {**md5** | **sha**}—(Optional) Specifies the hash function to be used in per-message digest calculations. – **md5**—Specifies HMAC-MD5 hashing. – **sha**—Specifies HMAC-SHA-1 hashing. The default hash function is **md5**.

	Command or Action	Purpose
Step 5	**digest** check **Example:** `Router(config-l2tp-class)# digest check`	(Optional) Enables the validation of the message digest in received control messages. • Validation of the message digest is enabled by default. **Note** Validation of the message digest cannot be disabled if authentication has been enabled using the **digest secret** command. If authentication has not been configured with the **digest secret** command, the digest check can be disabled to increase performance.
Step 6	**hidden** **Example:** `Router(config-l2tp-class)# hidden`	(Optional) Enables AV pair hiding when sending control messages to an L2TPv3 peer. • AV pair hiding is disabled by default. • In Cisco IOS Release 12.0(29)S and Cisco IOS Release 12.2(27)SBC, only the hiding of the cookie AV pair is supported. • If a cookie is configured in L2TP class configuration mode (see the section "Manually Configuring L2TPv3 Session Parameters"), enabling AV pair hiding causes that cookie to be sent to the peer as a hidden AV pair using the password configured with the **digest secret** command. **Note** AV pair hiding is enabled only if authentication has been enabled using the **digest secret** command, and no other authentication method is configured.

Configuring L2TPv3 Digest Secret Graceful Switchover

Perform this task to make the transition from an old L2TPv3 control channel authentication password to a new L2TPv3 control channel authentication password without disrupting established L2TPv3 tunnels.

Prerequisites

Before performing this task, you must enable control channel authentication as documented in the task "Configuring L2TPv3 Control Message Hashing."

Restrictions

This task is not compatible with authentication passwords configured with the older, CHAP-like control channel authentication system.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** *l2tp-class-name*
4. **digest [secret** [**0** | **7**] *password*] [**hash** {**md5** | **sha**}]
5. **end**
6. **show l2tun tunnel all**
7. **configure terminal**
8. **l2tp-class** [*l2tp-class-name*]
9. **no digest** [**secret** [**0** | **7**] *password* [**hash** {**md5** | **sha**}]]
10. **end**
11. **show l2tun tunnel all**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode.
Step 4	**digest** [**secret** [**0** | **7**] *password*] [**hash** {**md5** | **sha**}] **Example:** `Router(config-l2tp-class)# digest secret cisco2 hash sha`	Configures a new password to be used in L2TPv3 control channel authentication. • A maximum of two passwords may be configured at any time. **Note** Authentication will now occur using both the old and new passwords.
Step 5	**end** **Example:** `Router(config-l2tp-class)# end`	Ends your configuration session by exiting to privileged EXEC mode.

	Command or Action	Purpose
Step 6	**show l2tun tunnel all** **Example:** `Router# show l2tun tunnel all`	(Optional) Displays the current state of Layer 2 tunnels and information about configured tunnels, including local and remote Layer 2 Tunneling Protocol (L2TP) hostnames, aggregate packet counts, and control channel information. • Tunnels should be updated with the new control channel authentication password within a matter of seconds. If a tunnel does not update to show that two secrets are configured after several minutes have passed, that tunnel can be manually cleared and a defect report should be filed with the Cisco Technical Assistance Center (TAC). To manually clear an L2TPv3 tunnel, perform the task "Manually Clearing L2TPv3 Tunnels." **Note** Issue this command to determine if any tunnels are not using the new password for control channel authentication. The output displayed for each tunnel in the specified L2TP class should show that two secrets are configured.
Step 7	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 8	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name* for each one.
Step 9	**no digest** [**secret** [**0** | **7**] *password* [**hash** {**md5** | **sha**}]] **Example:** `Router(config-l2tp-class)# no digest secret cisco hash sha`	Removes the old password used in L2TPv3 control channel authentication. **Note** Do not remove the old password until all peer PE routers have been updated with the new password.
Step 10	**end** **Example:** `Router(config-l2tp-class)# end`	Ends your configuration session by exiting to privileged EXEC mode.
Step 11	**show l2tun tunnel all** **Example:** `Router# show l2tun tunnel all`	(Optional) Displays the current state of Layer 2 tunnels and information about configured tunnels, including local and remote Layer 2 Tunneling Protocol (L2TP) hostnames, aggregate packet counts, and control channel information. • Tunnels should no longer be using the old control channel authentication password. If a tunnel does not update to show that only one secret is configured after several minutes have passed, that tunnel can be manually cleared and a defect report should be filed with TAC. To manually clear an L2TPv3 tunnel, perform the task "Manually Clearing L2TPv3 Tunnels." **Note** Issue this command to ensure that all tunnels are using only the new password for control channel authentication. The output displayed for each tunnel in the specified L2TP class should show that one secret is configured.

Configuring L2TP Control Channel Maintenance Parameters

The L2TP hello packet keepalive interval control channel maintenance parameter can be configured in L2TP class configuration mode.

This task configures the interval used for hello messages in an L2TP class. This control channel parameter configuration is optional. If this parameter is not configured, the default value is applied.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]
4. **hello** *interval*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name* for each one.
Step 4	**hello** *interval* **Example:** `Router(config-l2tp-class)# hello 100`	(Optional) Specifies the exchange interval (in seconds) used between L2TP hello packets. • Valid values for the *interval* argument range from 0 to 1000. The default value is 60.

Configuring the L2TPv3 Pseudowire

Perform this task to configure the L2TPv3 pseudowire.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** [*pw-class-name*]
4. **encapsulation l2tpv3**

5. **protocol** {**l2tpv3** | **none**} [*l2tp-class-name*]
6. **ip local interface** *interface-name*
7. **ip pmtu**
8. **ip tos** {**value** *value* | **reflect**}
9. **ip dfbit set**
10. **ip ttl** *value*
11. **ip protocol** {**l2tp** | **uti** | *protocol-number*}
12. **sequencing** {**transmit** | **receive** | **both**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**pseudowire-class** [*pw-class-name*] **Example:** `Router(config)# pseudowire-class etherpw`	Enters pseudowire class configuration mode and optionally specifies the name of the L2TP pseudowire class.
Step 4	**encapsulation l2tpv3** **Example:** `Router(config-pw)# encapsulation l2tpv3`	Specifies that L2TPv3 is used as the data encapsulation method to tunnel IP traffic.
Step 5	**protocol** {**l2tpv3** | **none**}[*l2tp-class-name*] **Example:** `Router(config-pw)# protocol l2tpv3 class1`	(Optional) Specifies the L2TPv3 signaling protocol to be used to manage the pseudowires created with the control channel parameters in the specified L2TP class (see the section "Configuring L2TP Control Channel Parameters"). • If the *l2tp-class-name* argument is not specified, the default values for L2TP control channel parameters are used. The default **protocol** option is **l2tpv3**. • If you do not want to use signaling in the L2TPv3 sessions created with this pseudowire class, enter **protocol none**.

	Command or Action	Purpose
Step 6	**ip local interface** *interface-name* **Example:** `Router(config-pw)# ip local interface e0/0`	Specifies the PE router interface whose IP address is to be used as the source IP address for sending tunneled packets. • The same or a different local interface name can be used for each pseudowire classes configured between a pair of PE routers. **Note** This command must be configured for pseudowire-class configurations using L2TPv3 as the data encapsulation method.
Step 7	**ip pmtu** **Example:** `Router(config-pw)# ip pmtu`	(Optional) Enables the discovery of the path MTU for tunneled traffic and helps fragmentation. • This command enables the processing of ICMP unreachable messages that indicate fragmentation errors in the backbone network that carries L2TPv3 session traffic. Also, this command enables MTU checking for IP packets sent into the session and that have the DF bit set. Any IP packet larger than the MTU is dropped and an ICMP unreachable message is sent. MTU discovery is disabled by default. **Note** The **ip pmtu** command is not supported if you disabled signaling with the **protocol none** command in Step 5. • This command must be enabled in the pseudowire class configuration for fragmentation of IP packets before the data enters the pseudowire to occur. **Note** For fragmentation of IP packets before the data enters the pseudowire, Cisco recommends that you also enter the **ip dfbit set** command in the pseudowire class configuration. This allows the PMTU to be obtained more rapidly. **Note** When the **ip pmtu** command is enabled, the DF bit is copied from the inner IP header to the outer IP header. If no IP header is found inside the Layer 2 frame, the DF bit in the outer IP is set to 0.
Step 8	**ip tos** {**value** *value* | **reflect**} **Example:** `Router(config-pw)# ip tos reflect`	(Optional) Configures the value of the ToS byte in IP headers of tunneled packets, or reflects the ToS byte value from the inner IP header. • Valid values for the *value* argument range from 0 to 255. The default ToS byte value is 0.

	Command or Action	Purpose
Step 9	**ip dfbit set** **Example:** `Router(config-pw)# ip dfbit set`	(Optional) Configures the value of the DF bit in the outer headers of tunneled packets. • Use this command if (for performance reasons) you do not want reassembly of tunneled packets to be performed on the peer PE router. This command is disabled by default. On the Cisco 10720 Internet router and Cisco 12000 series Internet routers, the DF bit is set on by default., and the **no ip dfbit set** command is not supported.
Step 10	**ip ttl** *value* **Example:** `Router(config-pw)# ip ttl 100`	(Optional) Configures the value of the time to live (TTL) byte in the IP headers of tunneled packets. • Valid values for the *value* argument range from 1 to 255. The default TTL byte value is 255.
Step 11	**ip protocol** {**l2tp** | **uti** | *protocol-number*} **Example:** `Router(config-pw)# ip protocol l2tp`	(Optional) Configures the IP protocol to be used for tunneling packets. For backward compatibility with UTI, enter **uti** or **120**, the UTI protocol number. The default IP protocol value is **l2tp** or **115**, the L2TP protocol number.
Step 12	**sequencing** {**transmit** | **receive** | **both**} **Example:** `Router(config-pw)# sequencing both`	(Optional) Specifies the direction in which sequencing of data packets in a pseudowire is enabled: • **transmit**—Updates the Sequence Number field in the headers of data packets sent over the pseudowire according to the data encapsulation method that is used. • **receive**—Keeps the Sequence Number field in the headers of data packets received over the pseudowire. Out-of-order packets are dropped. • **both**—Enables both the **transmit** and **receive** options.

Configuring the Xconnect Attachment Circuit

This configuration procedure binds an Ethernet, 802.1q VLAN, or Frame Relay attachment circuit to an L2TPv3 pseudowire for xconnect service. The virtual circuit identifier that you configure creates the binding between a pseudowire configured on a PE router and an attachment circuit in a CE device. The virtual circuit identifier configured on the PE router at one end of the L2TPv3 control channel must also be configured on the peer PE router at the other end.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot*/*port* **Example:** `Router(config)# interface ethernet 0/0`	Specifies the interface by type (for example, Ethernet) and slot and port number, and enters interface configuration mode.

	Command or Action	Purpose
Step 4	**xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}] **Example:** `Router(config-if)# xconnect 10.0.3.201 123 pw-class vlan-xconnect`	Specifies the IP address of the peer PE router and the 32-bit virtual circuit identifier shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • At least one of the following pseudowire class parameters must be configured for the *pseudowire-parameters* argument: – **encapsulation** {**l2tpv3** [**manual**] | **mpls**}—Specifies the tunneling method used to encapsulate data in the pseudowire: • **l2tpv3**—L2TPv3 is the tunneling method to be used. • **manual**—(Optional) No signaling is to be used in the L2TPv3 control channel. This command places the router in xconnect configuration mode for manual configuration of L2TPv3 parameters for the attachment circuit. • **mpls**—MPLS is the tunneling method to be used. – **pw-class** {*pw-class-name*}—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. • The optional **encapsulation** parameter specifies the method of pseudowire tunneling used: L2TPv3 or MPLS. Enter **manual** if you do not want signaling used in the L2TPv3 control channel. The **encapsulation l2tpv3 manual** keyword combination enters xconnect configuration submode. See the section "Manually Configuring L2TPv3 Session Parameters" for the other L2TPv3 commands that you must enter to complete the configuration of the L2TPv3 control channel. If you do not enter an **encapsulation** value, the encapsulation method entered with the **password** command in the section "Configuring the Xconnect Attachment Circuit" is used. • The optional **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. Specify the pseudowire-class option if you need to configure more advanced options. **Note** You must configure either the **encapsulation** or the **pw-class** option. You may configure both options. **Note** If you select L2TPv3 as your data encapsulation method, you must specify the **pw-class** keyword. • The optional **sequencing** parameter specifies whether sequencing is required for packets that are received, sent, or both received and sent.

Manually Configuring L2TPv3 Session Parameters

When you bind an attachment circuit to an L2TPv3 pseudowire for xconnect service using the **xconnect l2tpv3 manual** command (see the section "Configuring the Xconnect Attachment Circuit") because you do not want signaling, you must then configure L2TP-specific parameters to complete the L2TPv3 control channel configuration.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **xconnect** *peer-ip-address vc-id* **encapsulation l2tpv3 manual pw-class** *pw-class-name*
5. **l2tp id** *local-session-id remote-session-id*
6. **l2tp cookie local** *size low-value* [*high-value*]
7. **l2tp cookie remote** *size low-value* [*high-value*]
8. **l2tp hello** *l2tp-class-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 0/0`	Specifies the interface by type (for example, Ethernet) and slot and port number, and enters interface configuration mode.
Step 4	**xconnect** *peer-ip-address vc-id* **encapsulation l2tpv3 manual pw-class** *pw-class-name* **Example:** `Router(config-if)# xconnect 10.0.3.201 123 encapsulation l2tpv3 manual pw-class vlan-xconnect`	Specifies the IP address of the peer PE router and the 32-bit virtual circuit identifier shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • The **encapsulation l2tpv3 manual** parameter specifies that L2TPv3 is to be used as the pseudowire tunneling method, and enters xconnect configuration mode. • The mandatory **pw-class** *pw-class-name* keyword and argument combination specifies the pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken.
Step 5	**l2tp id** *local-session-id remote-session-id* **Example:** `Router(config-if-xconn)# l2tp id 222 111`	Configures the identifiers for the local L2TPv3 session and for the remote L2TPv3 session on the peer PE router. • This command is required to complete the attachment circuit configuration and for a static L2TPv3 session configuration.

	Command or Action	Purpose
Step 6	**l2tp cookie local** *size low-value* [*high-value*] **Example:** `Router(config-if-xconn)# l2tp cookie local 4 54321`	(Optional) Specifies the value that the peer PE must include in the cookie field of incoming (received) L2TP packets. • The size of the cookie field can be 4 or 8 bytes. If you do not enter this command, no cookie value is included in the header of L2TP packets. • If you configure the cookie length in incoming packets as 8 bytes, you must specify a 4-byte high value and a 4-byte low value.
Step 7	**l2tp cookie remote** *size low-value* [*high-value*] **Example:** `Router(config-if-xconn)# l2tp cookie remote 4 12345`	(Optional) Specifies the value that the router includes in the cookie field of outgoing (sent) L2TP packets. • The size of the cookie field can be 4 or 8 bytes. If you do not enter this command, no cookie value is included in the header of L2TP packets. • If you configure the cookie length in outgoing packets as 8 bytes, you must specify a 4-byte high value and a 4-byte low value.
Step 8	**l2tp hello** *l2tp-class-name* **Example:** `Router(config-if-xconn)# l2tp hello l2tp-defaults`	(Optional) Specifies the L2TP class name to use (see the section "Configuring L2TP Control Channel Parameters") for control channel configuration parameters, including the interval to use between hello keepalive messages. **Note** This command assumes that there is no control plane to negotiate control channel parameters and that a control channel is to be used to provide keepalive support through an exchange of L2TP hello messages. By default, no hello messages are sent.

Configuring the Xconnect Attachment Circuit for ATM VP Mode Single Cell Relay over L2TPv3

The ATM VP Mode Single Cell Relay over L2TPv3 feature allows cells coming into a predefined PVP on the ATM interface to be transported over an L2TPv3 pseudowire to a predefined PVP on the egress ATM interface. This task binds a PVP to an L2TPv3 pseudowire for xconnect service.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **atm pvp** *vpi* [**l2transport**]
5. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**atm pvp** *vpi* [**l2transport**] **Example:** `Router(config-if)# atm pvp 5 l2transport`	Specifies that the PVP is dedicated to transporting ATM cells. • The **l2transport** keyword indicates that the PVP is for cell relay. After you enter this command, the router enters l2transport PVP configuration mode. This configuration mode is for Layer 2 transport only; it is not for terminated PVPs.
Step 5	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-if-atm-l2trans-pvp)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it.

Configuring the Xconnect Attachment Circuit for ATM Single Cell Relay VC Mode over L2TPv3

The ATM Single Cell Relay VC Mode over L2TPv3 feature maps one VCC to a single L2TPv3 session. All ATM cells arriving at an ATM interface with the specified VPI and VCI are encapsulated into a single L2TP packet.

The ATM Single Cell Relay VC mode feature can be used to carry any type of AAL traffic over the pseudowire. It will not distinguish OAM cells from User data cells. In this mode, PM and Security OAM cells are also transported over the pseudowire.

Perform this task to enable the ATM Single Cell Relay VC Mode over L2TPv3 feature.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **pvc** [*name*] *vpi/vci* **l2transport**
5. **encapsulation aal0**
6. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**pvc** [*name*] *vpi/vci* **l2transport** **Example:** `Router(config-if)# pvc 5/500 l2transport`	Creates or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode. • The **l2transport** keyword indicates that the PVC is for Layer 2 switched connections. After you enter this command, the router enters ATM VC configuration mode.

	Command or Action	Purpose
Step 5	**encapsulation aal0** **Example:** `Router(config-atm-vc)# encapsulation aal0`	Specifies ATM AAL0 encapsulation for the PVC.
Step 6	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-atm-vc)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.

Configuring the Xconnect Attachment Circuit for ATM Port Mode Cell Relay over L2TPv3

The ATM Port Mode Cell Relay feature packs ATM cells arriving at an ingress ATM interface into L2TPv3 data packets and transports them to the egress ATM interface. A single ATM cell is encapsulated into each L2TPv3 data packet.

Perform this task to enable the ATM Port Mode Cell Relay over L2TPv3 feature.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-if)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.

Configuring the Xconnect Attachment Circuit for ATM Cell Packing over L2TPv3

The ATM Cell Packing over L2TPv3 feature allows multiple ATM frames to be packed into a single L2TPv3 data packet. ATM cell packing can be configured for Port mode, VP mode, and VC mode. Perform one of the following tasks to configure the ATM Cell Packing over L2TPv3 feature:

- Configuring Port Mode ATM Cell Packing over L2TPv3, page 70
- Configuring VP Mode ATM Cell Packing over L2TPv3, page 71
- Configuring VC Mode ATM Cell Packing over L2TPv3, page 73

Configuring Port Mode ATM Cell Packing over L2TPv3

Perform this task to configure port mode ATM cell packing over L2TPv3.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **atm mcpt-timers** [*timeout-value-1 timeout-value-2 timeout-value-3*]
5. **cell packing** [*cells*] [**mcpt-timer** *timer*]
6. **xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**atm mcpt-timers** [*timeout-value-1 timeout-value-2 timeout-value-3*] **Example:** `Router(config-if)# atm mcpt-timers 10 100 1000`	(Optional) Sets up the cell-packing timers, which specify how long the PE router can wait for cells to be packed into an L2TPv3 packet.

	Command or Action	Purpose
Step 5	**cell-packing** [*cells*] [**mcpt-timer** *timer*] **Example:** `Router(config-if)# cell-packing 10 mcpt-timer 2`	Enables the packing of multiple ATM cells into each L2TPv3 data packet. • *cells*—(Optional) The number of cells to be packed into an L2TPv3 data packet. The default number of ATM cells to be packed is the maximum transmission unit (MTU) of the interface divided by 52. • **mcpt-timer** *timer*—(Optional) Specifies which maximum cell packing timeout (MCPT) timer to use. The MCPT timers are set using the **mcpt-timers** command. The default value is 1.
Step 6	**xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}] **Example:** `Router(config-if)# xconnect 10.0.3.201 888 encapsulation l2tpv3`	Binds an attachment circuit to a Layer 2 pseudowire and enters xconnect configuration mode.

Configuring VP Mode ATM Cell Packing over L2TPv3

Perform this task to configure VP mode ATM cell packing over L2TPv3.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **atm mcpt-timers** [*timeout-value-1 timeout-value-2 timeout-value-3*]
5. **atm pvp** *vpi* [*peak-rate*] [**l2transport**]
6. **cell packing** [*cells*] [**mcpt-timer** *timer*]
7. **xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**atm mcpt-timers** [*timeout-value-1 timeout-value-2 timeout-value-3*] **Example:** `Router(config-if)# atm mcpt-timers 10 100 1000`	(Optional) Sets up the cell-packing timers, which specify how long the PE router can wait for cells to be packed into an L2TPv3 packet.
Step 5	**atm pvp** *vpi* [*peak-rate*] [**l2transport**] **Example:** `Router(config-if)# atm pvp 10 l2transport`	Create a PVP used to multiplex (or bundle) one or more VCs.
Step 6	**cell-packing** [*cells*] [**mcpt-timer** *timer*] **Example:** `Router(config-if)# cell-packing 10 mcpt-timer 2`	Enables the packing of multiple ATM cells into each L2TPv3 data packet. • *cells*—(Optional) The number of cells to be packed into an L2TPv3 data packet. The default number of ATM cells to be packed is the MTU of the interface divided by 52. • **mcpt-timer** *timer*—(Optional) Specifies which MCPT timer to use. The MCPT timers are set using the **mcpt-timers** command. The default value is 1.
Step 7	**xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}] **Example:** `Router(config-if)# xconnect 10.0.3.201 888 encapsulation l2tpv3`	Binds an attachment circuit to a Layer 2 pseudowire and enters xconnect configuration mode.

Configuring VC Mode ATM Cell Packing over L2TPv3

Perform this task to configure VC mode ATM cell packing over L2TPv3.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **atm mcpt-timers** [*timeout-value-1 timeout-value-2 timeout-value-3*]
5. **pvc** [*name*] *vpi/vci* [**ces** | **ilmi** | **qsaal** | **smds** | **l2transport**]
6. **encapsulation aal0**
7. **cell packing** [*cells*] [**mcpt-timer** *timer*]
8. **xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**atm mcpt-timers** [*timeout-value-1 timeout-value-2 timeout-value-3*] **Example:** `Router(config-if)# atm mcpt-timers 10 100 1000`	(Optional) Sets up the cell-packing timers, which specify how long the PE router can wait for cells to be packed into an L2TPv3 packet.
Step 5	**pvc** [*name*] *vpi/vci* [**ces** | **ilmi** | **qsaal** | **smds** | **l2transport**] **Example:** `Router(config-if)# pvc 1/32 l2transport`	Creates or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode.

	Command or Action	Purpose
Step 6	**encapsulation aal0** **Example:** `Router(config-if-atm-vc)# encapsulation aal0`	Specifies ATM AAL0 encapsulation for the PVC.
Step 7	**cell-packing** [*cells*] [**mcpt-timer** *timer*] **Example:** `Router(config-if-atm-vc)# cell-packing 10 mcpt-timer 2`	Enables the packing of multiple ATM cells into each L2TPv3 data packet. • *cells*—(Optional) The number of cells to be packed into an L2TPv3 data packet. The default number of ATM cells to be packed is the MTU of the interface divided by 52. • **mcpt-timer** *timer*—(Optional) Specifies which timer to use. The mcpt timers are set using the **mcpt-timers** command. The default value is 1.
Step 8	**xconnect** *peer-ip-address vcid pseudowire-parameters* [**sequencing** {**transmit** | **receive** | **both**}] **Example:** `Router(config-if-atm-vc)# xconnect 10.0.3.201 888 encapsulation l2tpv3`	Binds an attachment circuit to a Layer 2 pseudowire and enters xconnect configuration mode.

Configuring the Xconnect Attachment Circuit for ATM AAL5 SDU Mode over L2TPv3

The ATM AAL5 SDU Mode feature maps the AAL5 payload of an AAL5 PVC to a single L2TPv3 session. This service will transport OAM and RM cells, but does not attempt to maintain the relative order of these cells with respect to the cells that comprise the AAL5 CPCS-PDU. OAM cells that arrive during the reassembly of a single AAL5 CPCS-PDU are sent immediately over the pseudowire, followed by the AAL5 SDU payload.

Beginning in Cisco IOS Release 12.0(30)S, you may choose to configure the ATM AAL5 SDU Mode feature in ATM VC configuration mode or in VC class configuration mode.

To enable the ATM AAL5 SDU Mode feature, perform one of the following tasks:

- Configuring ATM AAL5 SDU Mode over L2TPv3 in ATM VC Configuration Mode, page 75
- Configuring ATM AAL5 SDU Mode over L2TPv3 in VC Class Configuration Mode, page 76sC

Configuring ATM AAL5 SDU Mode over L2TPv3 in ATM VC Configuration Mode

Perform this task to bind a PVC to an L2TPv3 pseudowire for ATM AAL5 SDU mode xconnect service.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **pvc** [*name*] *vpi/vci* [**l2transport**]
5. **encapsulation aal5**
6. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**pvc** [*name*] *vpi/vci* [**l2transport**] **Example:** `Router(config-if)# pvc 5/500 l2transport`	Creates or assigns a name to an ATM permanent virtual circuit (PVC), specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode. • The **l2transport** keyword indicates that the PVC is for Layer 2 switched connections. After you enter this command, the router enters ATM VC configuration mode.

	Command or Action	Purpose
Step 5	**encapsulation aal5** **Example:** `Router(config-atm-vc)# encapsulation aal5`	Specifies ATM AAL5 encapsulation for the PVC.
Step 6	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-atm-vc)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** keyword binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.

Configuring ATM AAL5 SDU Mode over L2TPv3 in VC Class Configuration Mode

You can create a VC class that specifies AAL5 encapsulation and then attach the VC class to an interface, subinterface, or PVC. Perform this task to create a VC class configured for AAL5 encapsulation and attach the VC class to an interface.

Restrictions

This task requires Cisco IOS Release 12.0(30)S or a later release.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vc-class atm** *vc-class-name*
4. **encapsulation aal5**
5. **end**
6. **interface** *type slot/port*
7. **class-int** *vc-class-name*
8. **pvc** [*name*] *vpi/vci* **l2transport**
9. **xconnect** *peer-router-id vcid* **encapsulation l2tpv3**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vc-class atm** *name* **Example:** `Router(config)# vc-class atm aal5class`	Creates a VC class and enters VC class configuration mode.
Step 4	**encapsulation aal5** **Example:** `Router(config-vc-class)# encapsulation aal5`	Specifies ATM AAL5 encapsulation for the PVC.
Step 5	**end** **Example:** `Router(config-vc-class)# end`	Ends your configuration session by exiting to privileged EXEC mode.
Step 6	**interface** *type slot*/*port* **Example:** `Router(config)# interface atm 1/0`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 7	**class-int** *vc-class-name* **Example:** `Router(config-if)# class-int aal5class`	Applies a VC class on an the ATM main interface or subinterface. **Note** You can also apply a VC class to a PVC.
Step 8	**pvc** [*name*] *vpi*/*vci* **l2transport** **Example:** `Router(config-if)# pvc 1/200 l2transport`	Creates or assigns a name to an ATM permanent virtual circuit (PVC), specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode. • The **l2transport** keyword indicates that the PVC is for Layer 2 switched connections. After you enter this command, the router enters ATM VC configuration mode.
Step 9	**xconnect** *peer-router-id vcid* **encapsulation l2tpv3** **Example:** `Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation l2tpv3`	Binds the attachment circuit to a pseudowire VC.

Configuring OAM Local Emulation for ATM AAL5 over L2TPv3

If a PE router does not support the transport of OAM cells across an L2TPv3 session, you can use OAM cell emulation to locally terminate or loopback the OAM cells. You configure OAM cell emulation on both PE routers. You use the **oam-ac emulation-enable** command on both PE routers to enable OAM cell emulation.

After you enable OAM cell emulation on a router, you can configure and manage the ATM VC in the same manner as you would a terminated VC. A VC that has been configured with OAM cell emulation can send loopback cells at configured intervals toward the local CE router. The endpoint can be either of the following:

- End-to-end loopback, which sends OAM cells to the local CE router.
- Segment loopback, which responds to OAM cells to a device along the path between the PE and CE routers.

The OAM cells have the following information cells:

- Alarm indication signal (AIS)
- Remote defect indication (RDI)

These cells identify and report defects along a VC. When a physical link or interface failure occurs, intermediate nodes insert OAM AIS cells into all the downstream devices affected by the failure. When a router receives an AIS cell, it marks the ATM VC as down and sends an RDI cell to let the remote end know about the failure.

Beginning in Cisco IOS Release 12.0(30)S, you may choose to configure the OAM Local Emulation for ATM AAL5 over L2TPv3 feature in ATM VC configuration mode or in VC class configuration mode.

To enable the OAM Local Emulation for ATM AAL5 over L2TPv3 feature, perform one of the following tasks:

- Configuring OAM Local Emulation for ATM AAL5 over L2TPv3 in ATM VC Configuration Mode, page 78
- Configuring OAM Local Emulation for ATM AAL5 over L2TPv3 in VC Class Configuration Mode, page 80

Configuring OAM Local Emulation for ATM AAL5 over L2TPv3 in ATM VC Configuration Mode

Perform this task to enable the OAM Local Emulation for ATM AAL5 over L2TPv3 feature in ATM VC configuration mode.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **pvc** [*name*] *vpi/vci* [**l2transport**]
5. **encapsulation aal5**
6. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*
7. **oam-ac emulation-enable** [*ais-rate*]
8. **oam-pvc manage** [*frequency*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ATM 4/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**pvc** [*name*] *vpi/vci* [**l2transport**] **Example:** `Router(config-if)# pvc 5/500 l2transport`	Creates or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode. • The **l2transport** keyword indicates that the PVC is for Layer 2 switched connections. After you enter this command, the router enters ATM VC configuration mode.
Step 5	**encapsulation aal5** **Example:** `Router(config-atm-vc)# encapsulation aal5`	Specifies ATM AAL5 encapsulation for the PVC.
Step 6	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-atm-vc)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.

	Command or Action	Purpose
Step 7	**oam-ac emulation-enable** [*ais-rate*] **Example:** `Router(config-atm-vc)# oam-ac emulation-enable 30`	Enables OAM cell emulation on AAL5 over L2TPv3. • The **oam-ac emulation-enable** command lets you specify the rate at which AIS cells are sent. The default is one cell every second. The range is 0 to 60 seconds.
Step 8	**oam-pvc manage** [*frequency*] **Example:** `Router(config-atm-vc)# oam-pvc manage`	(Optional) Enables the PVC to generate end-to-end OAM loopback cells that verify connectivity on the virtual circuit. • The optional *frequency* argument is the interval between transmission of loopback cells and ranges from 0 to 600 seconds. The default value is 10 seconds. **Note** You can configure the **oam-pvc manage** command only after you issue the **oam-ac emulation-enable** command.

Configuring OAM Local Emulation for ATM AAL5 over L2TPv3 in VC Class Configuration Mode

This task configures OAM Cell Emulation as part of a VC class. After a VC class is configured, you can apply the VC class to an interface, a subinterface, or a VC.

When you apply a VC class to an interface, the settings in the VC class apply to all the VCs on that interface unless you specify otherwise at a lower level, such as the subinterface or VC level. For example, if you create a VC class that specifies OAM cell emulation and sets the AIS cell rate to 30 seconds and apply that VC class to an interface, every VC on that interface will use the AIS cell rate of 30 seconds. If you then enable OAM cell emulation on a single PVC and set the AIS cell rate to 15 seconds, the 15 second AIS cell rate configured at the PVC level will take precedence over the 30 second AIS cell rate configured at the interface level.

Perform this task to create a VC class configured for OAM emulation and to attach the VC class to an interface.

Restrictions

This task requires Cisco IOS Release 12.0(30)S or a later release.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vc-class atm** *name*
4. **encapsulation layer-type**
5. **oam-ac emulation-enable** [*ais-rate*]
6. **oam-pvc manage** [*frequency*]
7. **end**
8. **interface** *type slot/port*
9. **class-int** *vc-class-name*
10. **pvc** [*name*] *vpi/vci* **l2transport**
11. **xconnect** *peer-router-id vcid* **encapsulation l2tpv3**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vc-class atm** *name* **Example:** `Router(config)# vc-class atm oamclass`	Creates a VC class and enters vc-class configuration mode.
Step 4	**encapsulation** *layer-type* **Example:** `Router(config-vc-class)# encapsulation aal5`	Configures the ATM adaptation layer (AAL) and encapsulation type.
Step 5	**oam-ac emulation-enable** [*ais-rate*] **Example:** `Router(config-vc-class)# oam-ac emulation-enable 30`	Enables OAM cell emulation for AAL5 over L2TPv3. • The *ais-rate* argument lets you specify the rate at which AIS cells are sent. The default is one cell every second. The range is 0 to 60 seconds.
Step 6	**oam-pvc manage** [*frequency*] **Example:** `Router(config-vc-class)# oam-pvc manage`	(Optional) Enables the PVC to generate end-to-end OAM loopback cells that verify connectivity on the virtual circuit. • The optional *frequency* argument is the interval between transmission of loopback cells and ranges from 0 to 600 seconds. The default value is 10 seconds. **Note** You can configure the **oam-pvc manage** command only after you issue the **oam-ac emulation-enable** command.
Step 7	**end** **Example:** `Router(config-vc-class)# end`	Ends your configuration session by exiting to privileged EXEC mode.
Step 8	**interface** *type slot*/*port* **Example:** `Router(config)# interface atm1/0`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.

Step 9	**class-int** *vc-class-name* **Example:** `Router(config-if)# class-int oamclass`	Applies a VC class on an the ATM main interface or subinterface. **Note** You can also apply a VC class to a PVC.
Step 10	**pvc** [*name*] *vpi*/*vci* **l2transport** **Example:** `Router(config-if)# pvc 1/200 l2transport`	Creates or assigns a name to an ATM PVC, specifies the encapsulation type on an ATM PVC, and enters ATM VC configuration mode. • The **l2transport** keyword indicates that the PVC is for Layer 2 switched connections. After you enter this command, the router enters ATM VC configuration mode.
Step 11	**xconnect** *peer-router-id vcid* **encapsulation l2tpv3** **Example:** `Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation l2tpv3`	Binds the attachment circuit to a pseudowire VC.

Configuring Protocol Demultiplexing for L2TPv3

Configuring Protocol Demultiplexing for Ethernet Interfaces

Perform this task to configure the Protocol Demultiplexing feature on an Ethernet interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **ip address** *ip-address mask* [**secondary**]
5. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*
6. **match protocol ipv6**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 0/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 172.16.128.4`	Sets a primary or secondary IP address for an interface.
Step 5	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-if)# xconnect 10.0.3.201 888 pw-class demux`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel and enters xconnect configuration mode. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.
Step 6	**match protocol ipv6** **Example:** `Router(config-if-xconn)# match protocol ipv6`	Enables protocol demultiplexing of IPv6 traffic.

Configuring Protocol Demultiplexing for Frame Relay Interfaces

Perform this task to configure the Protocol Demultiplexing feature on a Frame Relay interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port-adapter.subinterface-number* [**multipoint | point-to-point**]
4. **ip address** *ip-address mask* [**secondary**]
5. **frame-relay interface-dlci** *dlci* [**ietf | cisco**] [**voice-cir** *cir*] [**ppp** *virtual-template-name*]
6. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*
7. **match protocol ipv6**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port-adapter.subinterface-number* [**multipoint** | **point-to-point**] **Example:** `Router(config)# interface serial 1/1.2 multipoint`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 172.16.128.4`	Sets a primary or secondary IP address for an interface.
Step 5	**frame-relay interface-dlci** *dlci* [**ietf** | **cisco**] [**voice-cir** *cir*] [**ppp** *virtual-template-name*] **Example:** `Router(config-if)# frame-relay interface-dlci 100`	Assigns a DLCI to a specified Frame Relay subinterface on the router or access server, assigns a specific PVC to a DLCI, or applies a virtual template configuration for a PPP session and enters Frame Relay DLCI interface configuration mode.

	Command or Action	Purpose
Step 6	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-fr-dlci)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel and enters xconnect configuration mode. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.
Step 7	**match protocol ipv6** **Example:** `Router(config-if-xconn)# match protocol ipv6`	Enables protocol demultiplexing of IPv6 traffic.

Configuring Protocol Demultiplexing for PPP Interfaces

Perform this task to configure the Protocol Demultiplexing feature on a Point-to-Point Protocol (PPP) interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **ip address** *ip-address mask* [**secondary**]
5. **encapsulation** *physical-interface*
6. **ppp** *interface-address*
7. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*
8. **match protocol ipv6**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface serial 0/1`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 192.167.1.1 255.255.255.252`	Sets a primary or secondary IP address for an interface.
Step 5	**encapsulation** *physical-interface* **Example:** `Router(config-if)# encapsulation ppp`	Specifies PPP encapsulation for IPv6.
Step 6	**ppp** *interface-address* **Example:** `Router(config-if)# ppp ipv6cp id proxy A8BB:CCFF:FE00:7000`	

	Command or Action	Purpose
Step 7	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-if)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel and enters xconnect configuration mode. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.
Step 8	**match protocol ipv6** **Example:** `Router(config-if-xconn)# match protocol ipv6`	Enables protocol demultiplexing of IPv6 traffic.

Configuring Protocol Demultiplexing for HDLC Interfaces

Perform this task to configure the Protocol Demultiplexing feature on a High-Level Data Link Control (HDLC) interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/port*
4. **ip address** *ip-address mask* [**secondary**]
5. **xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name*
6. **match protocol ipv6**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface** *type slot/port* **Example:** `Router(config)# interface serial 0/0`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 172.16.128.4 255.255.255.252`	Sets a primary or secondary IP address for an interface.
Step 5	**xconnect** *peer-ip-address vcid* **pw-class** *pw-class-name* **Example:** `Router(config-if)# xconnect 10.0.3.201 888 pw-class atm-xconnect`	Specifies the IP address of the peer PE router and the 32-bit VCI shared between the PE at each end of the control channel and enters xconnect configuration mode. • The peer router ID (IP address) and virtual circuit ID must be a unique combination on the router. • **pw-class** *pw-class-name*—The pseudowire class configuration from which the data encapsulation type (L2TPv3) is taken. The **pw-class** parameter binds the xconnect statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. **Note** The L2TPv3 session can also be provisioned manually. See the section "Manually Configuring L2TPv3 Session Parameters" for information about manually configuring the L2TPv3 session parameters.
Step 6	**match protocol ipv6** **Example:** `Router(config-if-xconn)# match protocol ipv6`	Enables protocol demultiplexing of IPv6 traffic.

Configuring an L2TPv3 Custom Ethertype for Dot1q and QinQ Encapsulations

The L2TPv3 Custom Ethertype for Dot1q and QinQ Encapsulations feature lets you configure an Ethertype other than 0x8100 on Gigabit Ethernet interfaces with QinQ or Dot1Q encapsulations. You can set the custom Ethertype to 0x9100, 0x9200, or 0x88A8. To define the Ethertype field type, you use the **dot1q tunneling ethertype** command.

To set a custom Ethertype, perform the steps in this section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **dot1q tunneling ethertype** {**0x88A8** | **0x9100** | **0x9200**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface gigabitethernet 1/0/0`	Specifies an interface and enters interface configuration mode.
Step 4	**dot1q tunneling ethertype** {**0x88A8** | **0x9100** | **0x9200**} **Example:** `Router(config-if)# dot1q tunneling ethertype 0x9100`	Defines the Ethertype field type used by peer devices when implementing Q-in-Q VLAN tagging.

Manually Clearing L2TPv3 Tunnels

Perform this task to manually clear a specific L2TPv3 tunnel and all the sessions in that tunnel.

SUMMARY STEPS

1. **enable**
2. **clear l2tun** {**l2tp-class** *l2tp-class-name* | **tunnel id** *tunnel-id* | **local ip** *ip-address* | **remote ip** *ip-address* | **all**}

DETAILED STEPS

Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear l2tun** {**l2tp-class** *l2tp-class-name* | **tunnel id** *tunnel-id* | **local ip** *ip-address* | **remote ip** *ip-address* | **all**} **Example:** `Router# clear l2tun tunnel id 56789`	Clears the specified L2TPv3 tunnel. (This command is not available if there are no L2TPv3 tunnel sessions configured.) • **l2tp-class** *l2tp-class-name*—All L2TPv3 tunnels with the specified L2TP class name are torn down. • **tunnel id** *tunnel-id*—The L2TPv3 tunnel with the specified tunnel ID are torn down. • **local ip** *ip-address*—All L2TPv3 tunnels with the specified local IP address are torn down. • **remote ip** *ip-address*—All L2TPv3 tunnels with the specified remote IP address are torn down. • **all**—All L2TPv3 tunnels are torn down.

Configuration Examples for L2TPv3

Note Any Internet Protocol (IP) addresses used in this document are not intended to be actual addresses. Any examples, command display output, and figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses in illustrative content is unintentional and coincidental.

Configuring a Static L2TPv3 Session for an Xconnect Ethernet Interface: Example

L2TPv3 is the only encapsulation method that supports a manually provisioned session setup. This example shows how to configure a static session configuration in which all control channel parameters are set up in advance. There is no control plane used and no negotiation phase to set up the control channel. The PE router starts sending tunneled traffic as soon as the Ethernet interface (int e0/0) comes up. The virtual circuit identifier, 123, is not used. The PE sends L2TP data packets with session ID 111 and cookie 12345. In turn, the PE expects to receive L2TP data packets with session ID 222 and cookie 54321.

```
l2tp-class l2tp-defaults
 retransmit initial retries 30
 cookie-size 8

pseudowire-class ether-pw
 encapsulation l2tpv3
 protocol none
 ip local interface Loopback0

interface Ethernet 0/0
 xconnect 10.0.3.201 123 encapsulation l2tpv3 manual pw-class ether-pw
 l2tp id 222 111
 l2tp cookie local 4 54321
 l2tp cookie remote 4 12345
 l2tp hello l2tp-defaults
```

Configuring a Negotiated L2TPv3 Session for an Xconnect VLAN Subinterface: Example

The following is a sample configuration of a dynamic L2TPv3 session for a VLAN xconnect interface. In this example, only VLAN traffic with a VLAN ID of 5 is tunneled. In the other direction, the L2TPv3 session identified by a virtual circuit identifier of 123 receives forwarded frames whose VLAN ID fields are rewritten to contain the value 5. L2TPv3 is used as both the control plane protocol and the data encapsulation.

```
l2tp-class class1
 authentication
 password secret

pseudowire-class vlan-xconnect
 encapsulation l2tpv3
 protocol l2tpv3 class1
 ip local interface Loopback0

interface Ethernet0/0.1
 encapsulation dot1Q 5
 xconnect 10.0.3.201 123 pw-class vlan-xconnect
```

Configuring a Negotiated L2TPv3 Session for Local HDLC Switching: Example

The following is a sample configuration of a dynamic L2TPv3 session for local HDLC switching. In this example, note that it is necessary to configure two different IP addresses at the endpoints of the L2TPv3 pseudowire because the virtual circuit identifier must be unique for a given IP address.

```
interface loopback 1
 ip address 10.0.0.1 255.255.255.255

interface loopback 2
 ip address 10.0.0.2 255.255.255.255

pseudowire-class loopback1
 encapsulation l2tpv3
 ip local interface loopback1

pseudowire-class loopback2
 encapsulation l2tpv3
 ip local interface loopback2

interface s0/0
 encapsulation hdlc
 xconnect 10.0.0.1 100 pw-class loopback2

interface s0/1
 encapsulation hdlc
 xconnect 10.0.0.2 100 pw-class loopback1
```

Verifying an L2TPv3 Session: Examples

To display information about current L2TPv3 sessions on a router, use the **show l2tun session brief** command:

```
Router# show l2tun session brief

L2TP Session Information Total tunnels 1 sessions 1

LocID      TunID      Peer-address    State     Username, Intf/
                                      sess/cir  Vcid, Circuit
2391726297 2382731778 6.6.6.6         est,UP    100, Gi0/2/0
```

To display detailed information about current L2TPv3 sessions on a router, use the **show l2tun session all** command:

```
Router# show l2tun session all

Session Information Total tunnels 0 sessions 1

Session id 111 is up, tunnel id 0
Call serial number is 0
Remote tunnel name is
  Internet address is 10.0.0.1
  Session is manually signalled
  Session state is established, time since change 00:06:05
    0 Packets sent, 0 received
    0 Bytes sent, 0 received
    Receive packets dropped:
      out-of-order:             0
      total:                    0
    Send packets dropped:
      exceeded session MTU:     0
      total:                    0
  Session vcid is 123
  Session Layer 2 circuit, type is ATM VPC CELL, name is ATM3/0/0:1000007
  Circuit state is UP
    Remote session id is 222, remote tunnel id 0
  DF bit off, ToS reflect disabled, ToS value 0, TTL value 255
  Session cookie information:
```

```
  local cookie, size 8 bytes, value 00 00 00 00 00 00 00 64
  remote cookie, size 8 bytes, value 00 00 00 00 00 00 00 C8
SSS switching enabled
Sequencing is off
```

Verifying an L2TP Control Channel: Examples

The L2TP control channel is used to negotiate capabilities, monitor the health of the peer PE router, and set up various components of an L2TPv3 session. To display information the L2TP control channels that are set up to other L2TP-enabled devices for all L2TP sessions on the router, use the **show l2tun tunnel** command.

```
Router# show l2tun tunnel
L2TP Tunnel Information Total tunnels 1 sessions 1

LocTunID   RemTunID   Remote Name   State  Remote Address  Sessn L2TP Class/
                                                          Count VPDN Group
2382731778 2280318174 l2tp-asr-2    est    6.6.6.6         1     l2tp_default_cl
```

To display detailed information the L2TP control channels that are set up to other L2TP-enabled devices for all L2TP sessions on the router, use the **show l2tun tunnel all** command.

```
Router# show l2tun tunnel all

Tunnel id 26515 is up, remote id is 41814, 1 active sessions
  Tunnel state is established, time since change 03:11:50
  Tunnel transport is IP (115)
  Remote tunnel name is tun1
    Internet Address 172.18.184.142, port 0
  Local tunnel name is Router
    Internet Address 172.18.184.116, port 0
  Tunnel domain is
  VPDN group for tunnel is
  0 packets sent, 0 received
  0 bytes sent, 0 received
  Control Ns 11507, Nr 11506
  Local RWS 2048 (default), Remote RWS 800
  Tunnel PMTU checking disabled
  Retransmission time 1, max 1 secondsPF
  Unsent queuesize 0, max 0
  Resend queuesize 1, max 1
  Total resends 0, ZLB ACKs sent 11505
  Current nosession queue check 0 of 5
  Retransmit time distribution: 0 0 0 0 0 0 0 0 0
  Sessions disconnected due to lack of resources 0
```

Configuring L2TPv3 Control Channel Authentication: Examples

The following example configures CHAP-style authentication of the L2TPv3 control channel:

```
l2tp-class class0
 authentication
 password cisco
```

The following example configures control channel authentication using the L2TPv3 Control Message Hashing feature:

```
l2tp-class class1
```

```
 digest secret cisco hash sha
 hidden
```

The following example configures control channel integrity checking and disables validation of the message digest using the L2TPv3 Control Message Hashing feature:

```
l2tp-class class2
 digest hash sha
 no digest check
```

The following example disables validation of the message digest using the L2TPv3 Control Message Hashing feature:

```
l2tp-class class3
 no digest check
```

Configuring L2TPv3 Digest Secret Graceful Switchover: Example

The following example uses the L2TPv3 Digest Secret Graceful Switchover feature to change the L2TP control channel authentication password for the L2TP class named class1. This example assumes that you already have an old password configured for the L2TP class named class1.

```
Router(config)# l2tp-class class1
Router(config-l2tp-class)# digest secret cisco2 hash sha
!
! Verify that all peer PE routers have been updated to use the new password before
! removing the old password.
!
Router(config-l2tp-class)# no digest secret cisco hash sha
```

Verifying L2TPv3 Digest Secret Graceful Switchover: Example

The following **show l2tun tunnel all** command output shows information about the L2TPv3 Digest Secret Graceful Switchover feature:

```
Router# show l2tun tunnel all

! The output below displays control channel password information for a tunnel which has
! been updated with the new control channel authentication password.
!
Tunnel id 12345 is up, remote id is 54321, 1 active sessions

Control message authentication is on, 2 secrets configured
Last message authenticated with first digest secret
!
! The output below displays control channel password information for a tunnel which has
! only a single control channel authentication password configured.
!
Tunnel id 23456 is up, remote id is 65432, 1 active sessions
!
Control message authentication is on, 1 secrets configured
Last message authenticated with first digest secret
!
! The output below displays control channel password information for a tunnel which is
! communicating with a peer that has only the new control channel authentication password
! configured.
!
Tunnel id 56789 is up, remote id is 98765, 1 active sessions
!
Control message authentication is on, 2 secrets configured
```

```
Last message authenticated with second digest secret
```

Configuring a Pseudowire Class for Fragmentation of IP Packets: Example

The following is a sample configuration of a pseudowire class that will allow IP traffic generated from the CE router to be fragmented before entering the pseudowire:

```
pseudowire class class1
 encapsulation l2tpv3
 ip local interface Loopback0
 ip pmtu
 ip dfbit set
```

Configuring ATM VP Mode Single Cell Relay over L2TPv3: Example

The following configuration binds a PVP to an xconnect attachment circuit to forward ATM cells over an established L2TPv3 pseudowire:

```
pw-class atm-xconnect
 encapsulation l2tpv3

interface ATM 4/1
 atm pvp 5 l2transport
 xconnect 10.0.3.201 888 pw-class atm-xconnect
```

Verifying ATM VP Mode Single Cell Relay over L2TPv3 Configuration: Example

To verify the configuration of a PVP, use the **show atm vp** command in privileged EXEC mode:

```
Router# show atm vp 5

ATM4/1/0  VPI: 5, Cell-Relay, PeakRate: 155000, CesRate: 0, DataVCs: 0,
CesVCs: 0, Status: ACTIVE

  VCD    VCI Type     InPkts  OutPkts  AAL/Encap     Status
    8      3 PVC           0        0  F4 OAM        ACTIVE
    9      4 PVC           0        0  F4 OAM        ACTIVE

TotalInPkts: 0, TotalOutPkts: 0, TotalInFast: 0, TotalOutFast: 0,
TotalBroadcasts: 0
```

Configuring ATM Single Cell Relay VC Mode over L2TPv3: Example

The following example shows how to configure the ATM Single Cell Relay VC Mode over L2TPv3 feature:

```
pw-class atm-xconnect
 encapsulation l2tpv3

interface ATM 4/1
 pvc 5/500 l2transport
  encapsulation aal0
  xconnect 10.0.3.201 888 pw-class atm-xconnect
```

Verifying ATM Single Cell Relay VC Mode over L2TPv3: Example

The following **show atm vc** command output displays information about VCC cell relay configuration:

```
Router# show atm vc

VCD/                                                 Peak   Avg/Min    Burst
Interface   Name  VPI   VCI   Type     Encaps       Kbps    Kbps       Cells         Sts
2/0         4      9    901    PVC      AAL0      149760    N/A                       UP
```

The following **show l2tun session** command output displays information about VCC cell relay configuration:

```
Router# show l2tun session all

Session Information Total tunnels 1 sessions 2
Session id 41883 is up, tunnel id 18252
Call serial number is 3211600003
Remote tunnel name is khur-l2tp
  Internet address is 10.0.0.2
  Session is L2TP signalled
  Session state is established, time since change 00:00:38
    8 Packets sent, 8 received
    416 Bytes sent, 416 received
    Receive packets dropped:
      out-of-order:             0
      total:                    0
    Send packets dropped:
      exceeded session MTU:     0
      total:                    0
  Session vcid is 124
  Session Layer 2 circuit, type is ATM VCC CELL, name is ATM2/0:9/901
  Circuit state is UP
    Remote session id is 38005, remote tunnel id 52436
  DF bit off, ToS reflect disabled, ToS value 0, TTL value 255
  No session cookie information available
  FS cached header information:
    encap size = 24 bytes
    00000000 00000000 00000000 00000000
    00000000 00000000
  Sequencing is off
```

Configuring ATM Port Mode Cell Relay over L2TPv3: Example

The following example shows how to configure the ATM Port Mode Cell Relay over L2TPv3 feature:

```
pw-class atm-xconnect
 encapsulation l2tpv3

interface atm 4/1
 xconnect 10.0.3.201 888 pw-class atm-xconnect
```

Configuring ATM Cell Packing over L2TPv3: Examples

The following examples show how to configure the ATM Cell Packing over L2TPv3 feature for Port mode, VP mode, and VC mode:

Port Mode

```
interface atm 4/1
 atm mcpt-timers 10 100 1000
 cell-packing 10 mcpt-timer 2
 xconnect 10.0.3.201 888 encapsulation l2tpv3
```

VP Mode

```
interface atm 4/1
 atm mcpt-timers 10 100 1000
 atm pvp 10 l2transport
 cell-packing 10 mcpt-timer 2
 xconnect 10.0.3.201 888 encapsulation l2tpv3
```

VC Mode

```
interface atm 4/1
 atm mcpt-timers 10 100 1000
 pvc 1/32 l2transport
  encapsulation aal0
  cell-packing 10 mcpt-timer 2
  xconnect 10.0.3.201 888 encapsulation l2tpv3
```

Configuring ATM AAL5 SDU Mode over L2TPv3: Examples

Configuring ATM AAL5 SDU Mode over L2TPv3 in ATM VC Configuration Mode

The following configuration binds a PVC to an xconnect attachment circuit to forward ATM cells over an established L2TPv3 pseudowire:

```
pw-class atm-xconnect
 encapsulation l2tpv3

interface atm 4/1
 pvc 5/500 l2transport
  encapsulation aal5
  xconnect 10.0.3.201 888 pw-class atm-xconnect
```

Configuring ATM AAL5 SDU Mode over L2TPv3 in VC-Class Configuration Mode

The following example configures ATM AAL5 over L2TPv3 in VC class configuration mode. The VC class is then applied to an interface.

```
vc-class atm aal5class
 encapsulation aal5
!
interface atm 1/0
 class-int aal5class
 pvc 1/200 l2transport
  xconnect 10.13.13.13 100 encapsulation l2tpv3
```

Verifying ATM AAL5 SDU Mode over L2TPv3 Configuration: Examples

Verifying ATM AAL5 over MPLS in ATM VC Configuration Mode

To verify the configuration of a PVC, use the **show atm vc** command in privileged EXEC mode:

```
Router# show atm vc

VCD/                                             Peak   Avg/Min    Burst
Interface   Name  VPI   VCI   Type     Encaps     Kbps    Kbps      Cells        Sts
```

```
2/0         pvc     9    900     PVC       AAL5       2400    200                    UP
2/0         4       9    901     PVC       AAL5     149760    N/A                    UP
```

The following **show l2tun session** command output displays information about ATM VC mode configurations:

```
Router# show l2tun session brief

Session Information Total tunnels 1 sessions 2
LocID      TunID      Peer-address    State        Username, Intf/
                                     sess/cir        Vcid, Circuit
41875      18252      10.0.0.2         est,UP       124, AT2/0:9/901
111           0       10.0.0.2         est,UP       123, AT2/0:9/900
```

Verifying ATM AAL5 over MPLS in VC Class Configuration Mode

To verify that ATM AAL5 over L2TPv3 is configured as part of a VC class, issue the **show atm class-links** command. The command output shows the type of encapsulation and that the VC class was applied to an interface.

```
Router# show atm class links 1/100

Displaying vc-class inheritance for ATM1/0.0, vc 1/100:
no broadcast - Not configured - using default
encapsulation aal5 - VC-class configured on main interface
.
.
.
```

Configuring OAM Local Emulation for ATM AAL5 over L2TPv3: Examples

Configuring OAM Cell Emulation for ATM AAL5 over L2TPv3 in ATM VC Configuration Mode

The following configuration binds a PVC to an xconnect attachment circuit to forward ATM AAL5 frames over an established L2TPv3 pseudowire, enables OAM local emulation, and specifies that AIS cells are sent every 30 seconds:

```
pw-class atm-xconnect
 encapsulation l2tpv3

interface ATM 4/1
 pvc 5/500 l2transport
  encapsulation aal5
  xconnect 10.0.3.201 888 pw-class atm-xconnect
  oam-ac emulation-enable 30
```

Configuring OAM Cell Emulation for ATM AAL5 over L2TPv3 in VC Class Configuration Mode

The following example configures OAM cell emulation for ATM AAL5 over L2TPv3 in VC class configuration mode. The VC class is then applied to an interface.

```
vc-class atm oamclass
 encapsulation aal5
 oam-ac emulation-enable 30
 oam-pvc manage
!
interface atm1/0
 class-int oamclass
 pvc 1/200 l2transport
  xconnect 10.13.13.13 100 encapsulation l2tpv3
```

The following example configures OAM cell emulation for ATM AAL5 over L2TPv3 in VC class configuration mode. The VC class is then applied to a PVC.

```
vc-class atm oamclass
 encapsulation aal5
 oam-ac emulation-enable 30
 oam-pvc manage
!
interface atm1/0
 pvc 1/200 l2transport
  class-vc oamclass
  xconnect 10.13.13.13 100 encapsulation l2tpv3
```

The following example configures OAM cell emulation for ATM AAL5 over L2TPv3 in VC class configuration mode. The OAM cell emulation AIS rate is set to 30 for the VC class. The VC class is then applied to an interface. One PVC is configured with OAM cell emulation at an AIS rate of 10. That PVC uses the AIS rate of 10 instead of 30.

```
vc-class atm oamclass
 encapsulation aal5
 oam-ac emulation-enable 30
 oam-pvc manage
!
interface atm1/0
 class-int oamclass
 pvc 1/200 l2transport
  oam-ac emulation-enable 10
  xconnect 10.13.13.13 100 encapsulation l2tpv3
```

Verifying OAM Local Emulation for ATM AAL5 over L2TPv3 Configuration: Examples

The following **show atm pvc** command output shows that OAM cell emulation is enabled and working on the ATM PVC:

```
Router# show atm pvc 5/500

ATM4/1/0.200: VCD: 6, VPI: 5, VCI: 500
UBR, PeakRate: 1
AAL5-LLC/SNAP, etype:0x0, Flags: 0x34000C20, VCmode: 0x0
OAM Cell Emulation: enabled, F5 End2end AIS Xmit frequency: 1 second(s)
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM Loopback status: OAM Disabled
OAM VC state: Not ManagedVerified
ILMI VC state: Not Managed
InPkts: 564, OutPkts: 560, InBytes: 19792, OutBytes: 19680
InPRoc: 0, OutPRoc: 0
InFast: 4, OutFast: 0, InAS: 560, OutAS: 560
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
Out CLP=1 Pkts: 0
OAM cells received: 26
F5 InEndloop: 0, F5 InSegloop: 0, F5 InAIS: 0, F5 InRDI: 26
OAM cells sent: 77
F5 OutEndloop: 0, F5 OutSegloop: 0, F5 OutAIS: 77, F5 OutRDI: 0
OAM cell drops: 0
Status: UP
```

Configuring Protocol Demultiplexing for L2TPv3: Examples

The following examples show how to configure the Protocol Demultiplexing feature on the IPv4 PE routers. The PE routers facing the IPv6 network do not require IPv6 configuration.

Ethernet Interface

```
interface ethernet 0/1
 ip address 172.16.128.4
 xconnect 10.0.3.201 888 pw-class demux
  match protocol ipv6
```

Frame Relay Interface

```
interface serial 1/1.1 multipoint
 ip address 172.16.128.4
 frame-relay interface-dlci 100
  xconnect 10.0.3.201 888 pw-class atm-xconnect
   match protocol ipv6
```

PPP Interface

```
interface serial 0/0
 ip address 192.167.1.1 2555.2555.2555.252
 encapsulation ppp
 ppp ipv6cp id proxy A8BB:CCFF:FE00:7000
 xconnect 75.0.0.1 1 pw-class 12tp
  match protocol ipv6
```

HDLC Interface

```
interface serial 0/0
 ip address 192.168.1.2 2555.2555.2555.252
 xconnect 75.0.0.1 1 pw-class 12tp
  match protocol ipv6
```

Manually Clearing an L2TPv3 Tunnel: Example

The following example demonstrates how to manually clear a specific L2TPv3 tunnel using the tunnel ID:

```
clear l2tun tunnel 65432
```

Configuring Frame Relay DLCI-to-DLCI Switching: Example

The following is a sample configuration for switching a Frame Relay DLCI over a pseudowire:

```
pseudowire-class fr-xconnect
 encapsulation l2tpv3
 protocol l2tpv3
 ip local interface Loopback0
 sequencing both
!
interface Serial0/0
 encapsulation frame-relay
 frame-relay intf-type dce
!
connect one Serial0/0 100 l2transport
 xconnect 10.0.3.201 555 pw-class fr-xconnect
!
```

```
connect two Serial0/0 200 l2transport
 xconnect 10.0.3.201 666 pw-class fr-xconnect
```

Configuring Frame Relay Trunking: Example

The following is a sample configuration for setting up a trunk connection for an entire serial interface over a pseudowire. All incoming packets are switched to the pseudowire regardless of content.

Note that when you configure trunking for a serial interface, the trunk connection does not require an encapsulation method. You do not, therefore, need to enter the **encapsulation frame-relay** command. Reconfiguring the default encapsulation removes all xconnect configuration settings from the interface.

```
interface Serial0/0
 xconnect 10.0.3.201 555 pw-class serial-xconnect
```

Configuring QoS for L2TPv3 on the Cisco 7500 Series: Example

The following example shows the MQC commands used on a Cisco 7500 series router to configure a CIR guarantee of 256 kbps on DLCI 100 and 512 kbps for DLCI 200 on the egress side of a Frame Relay interface that is also configured for L2TPv3 tunneling:

```
ip cef distributed
 class-map dlci100
 match fr-dlci 100
 class-map dlci200
 match fr-dlci 200
!
policy-map dlci
 class dlci100
 bandwidth 256
 class dlci200
 bandwidth 512
!
interface Serial0/0
 encapsulation frame-relay
 frame-relay interface-type dce
 service-policy output dlci
!
connect one Serial0/0 100 l2transport
 xconnect 10.0.3.201 555 encapsulation l2tpv3 pw-class mqc
!
connect two Serial0/0 200 l2transport
 xconnect 10.0.3.201 666 encapsulation l2tpv3 pw-class mqc
```

Configuring QoS for L2TPv3 on the Cisco 12000 Series: Examples

- Configuring QoS on a Frame Relay Interface in a TSC-Based L2TPv3 Tunnel Session, page 103
- Configuring Traffic Policing on an ISE/E5 Interface in a Native L2TPv3 Tunnel Session, page 104
- Configuring Tunnel Marking in a Native L2TPv3 Tunnel Session, page 106
- Configuring Traffic Shaping in a Native L2TPv3 Tunnel Session, page 107

Configuring QoS on a Frame Relay Interface in a TSC-Based L2TPv3 Tunnel Session

To apply a QoS policy for L2TPv3 to a Frame Relay interface on a Cisco 12000 series 2-port Channelized OC-3/STM-1 (DS1/E1) or 6-port Channelized T3 line card in a tunnel server card-based L2TPv3 tunnel session, you must:

- Use the **map-class frame-relay** *class-name* command in global configuration mode to apply a QoS policy to a Frame Relay class of traffic.
- Use the **frame-relay interface-dcli** *dcli-number* **switched** command (in interface configuration mode) to enter Frame Relay DLCI interface configuration mode and then the **class** command to configure a QoS policy for a Frame Relay class of traffic on the specified DLCI. You must enter a separate series of these configuration commands to configure QoS for each Frame Relay DLCI on the interface.

As shown in the following example, when you configure QoS for L2TPv3 on the ingress side of a Cisco 12000 series Frame Relay interface, you may also configure the value of the ToS byte used in IP headers of tunneled packets when you configure the L2TPv3 pseudowire (see the section "Configuring the L2TPv3 Pseudowire").

The following example shows the MQC commands and ToS byte configuration used on a Cisco 12000 series router to apply a QoS policy for DLCI 100 on the ingress side of a Frame Relay interface configured for server card-based L2TPv3 tunneling:

```
policy-map frtp-policy
 class class-default
 police cir 8000 bc 6000 pir 32000 be 4000 conform-action transmit exceed-action
set-frde-transmit violate-action drop
!
map-class frame-relay fr-map
 service-policy input frtp-policy
!
interface Serial0/1/1:0
 encapsulation frame-relay
 frame-relay interface-dlci 100 switched
   class fr-map
 connect frol2tp1 Serial0/1/1:0 100 l2transport
   xconnect 10.0.3.201 666 encapsulation l2tpv3 pw-class aaa
!
pseudowire-class aaa
encapsulation l2tpv3
 ip tos value 96
```

To apply a QoS policy for L2TPv3 to the egress side of a Frame Relay interface on a Cisco 12000 series 2-port Channelized OC-3/STM-1 (DS1/E1) or 6-port Channelized T3 line card, you must:

- Use the **match ip precedence** command in class-map configuration mode to configure the IP precedence value used to determine the egress queue for each L2TPv3 packet with a Frame Relay payload.
- Use the **random-detect** command in policy-map class configuration mode to enable a WRED drop policy for a Frame Relay traffic class that has a bandwidth guarantee. Use the **random-detect precedence** command to configure the WRED and MDRR parameters for particular IP precedence values.

The next example shows the MQC commands used on a Cisco 12000 series Internet router to apply a QoS policy with WRED/MDRR settings for specified IP precedence values to DLCI 100 on the egress side of a Frame Relay interface configured for a server card-based L2TPv3 tunnel session:

```
class-map match-all d2
 match ip precedence 2
class-map match-all d3
```

```
 match ip precedence 3
!
policy-map o
 class d2
   bandwidth percent 10
   random-detect
   random-detect precedence 1 200 packets 500 packets 1
 class d3
   bandwidth percent 10
   random-detect
   random-detect precedence 1 1 packets 2 packets 1
!
map-class frame-relay fr-map
 service-policy output o
!
interface Serial0/1/1:0
 encapsulation frame-relay
 frame-relay interface-dlci 100 switched
 class fr-map
connect frol2tp1 Serial0/1/1:0 100 l2transport
 xconnect 10.0.3.201 666 encapsulation l2tpv3 pw-class aaa
```

Configuring Traffic Policing on an ISE/E5 Interface in a Native L2TPv3 Tunnel Session

Starting in Cisco IOS Release 12.0(30)S, QoS traffic policing is supported on the following types of Edge Engine (ISE/E5) ingress interfaces bound to a native L2TPv3 tunnel session:

- ATM
- Frame Relay DLCIs

QoS traffic shaping in a native L2TPv3 tunnel session is supported on ATM ISE/E5 egress interfaces for the following service categories:

- UBR (unspecified bit rate)
- VBR-nrt (variable bit rate nonreal-time)

Traffic policing allows you to control the maximum rate of traffic sent or received on an interface and to partition a network into multiple priority levels or classes of service (CoS). The dual rate, 3-Color Marker in color-aware and color-blind modes, as defined in RFC 2698 for traffic policing, is supported on ingress ISE/E5 interfaces to classify packets.

The **police** command configures traffic policing using two rates, the committed information rate (CIR) and the peak information rate (PIR). The following conform, exceed, and violate values for the *actions* argument are supported with the **police** command in policy-map configuration mode on an ISE/E5 interface bound to an L2TPv3 tunnel session:

- **conform-action** *actions*: Actions taken on packets that conform to the CIR and PIR.
  - **set-prec-tunnel**: Sets the IP precedence value in the tunnel header of a packet encapsulated for native L2TPv3 tunneling.
  - **set-dscp-tunnel**: Sets the IP differentiated services code point (DSCP) value in the tunnel header of a packet encapsulated for native L2TPv3 tunneling.
  - **transmit**: Sends the packet with no alteration.
- **exceed-action** *actions*: Actions taken on packets that conform to the CIR but not the PIR.
  - **drop**: Drops the packet.
  - **set-clp** (ATM only): Sets the Cell Loss Priority (CLP) bit from 0 to 1 in an ATM cell encapsulated for native L2TPv3 tunneling.

  - **set-dscp-tunnel**: Sets the DSCP value in the tunnel header of a packet encapsulated for native L2TPv3 tunneling.
  - **set-dscp-tunnel** and **set-clp** (ATM only): Sets the DSCP value in the tunnel header and the CLP bit in an ATM cell encapsulated for native L2TPv3 tunneling.
  - **set-dscp-tunnel** and **set-frde** (Frame Relay only): Sets the DSCP value in the tunnel header and discard eligible (DE) bit in a Frame Relay packet encapsulated for native L2TPv3 tunneling.
  - **set-frde** (Frame Relay only): Sets the DE bit in a Frame Relay packet encapsulated for native L2TPv3 tunneling.
  - **set-prec-tunnel** and **set-clp** (ATM only): Sets the precedence value in the tunnel header and the CLP bit in an ATM cell encapsulated for native L2TPv3 tunneling.
  - **set-prec-tunnel** and **set-frde** (Frame Relay only): Sets the precedence value in the tunnel header and the Frame Relay DE bit in a Frame Relay packet encapsulated for native L2TPv3 tunneling.
  - **transmit**: Sends the packet with no alteration.
- **violate-action** *actions*: Actions taken on packets that exceed the PIR.
  - **drop**: Drops the packet.

You can configure these conform, exceed, and violate values for the *actions* argument of the **police** command in policy-map configuration mode on an ATM or Frame Relay ISE/E5 interface at the same time you use the **ip tos** command to configure the value of the ToS byte in IP headers of tunneled packets in a pseudowire class configuration applied to the interface (see the sections "Configuring the L2TPv3 Pseudowire" and "Manually Configuring L2TPv3 Session Parameters").

However, the values you configure with the **police** command on an ISE/E5 interface for native L2TPv3 tunneling take precedence over any IP ToS configuration. This means that the traffic policing you configure always rewrites the IP header of the tunnel packet and overwrites the values set by an **ip tos** command. The priority of enforcement is as follows when you use these commands simultaneously:

1. **set-prec-tunnel** or **set-dscp-tunnel** (QoS policing in native L2TPv3 tunnel)
2. **ip tos reflect**
3. **ip tos tos-value**

Note This behavior is designed. We recommend that you configure only native L2TPv3 tunnel sessions and reconfigure any ISE/E5 interfaces configured with the **ip tos** command to use the QoS policy configured for native L2TPv3 traffic policing.

The following example shows how to configure traffic policing using the dual rate, 3-Color Marker on an ISE/E5 Frame Relay interface in a native L2TPv3 tunnel session.

Note This example shows how to use the **police** command in conjunction with the **conform-color** command to specify the policing actions to be taken on packets in the conform-color class and the exceed-color class. This is called a color-aware method of policing and is described in "QoS: Color-Aware Policer." However, you can also configure color-blind traffic policing on an ISE/E5 Frame Relay interface in a native L2TPv3 tunnel session, using only the **police** command without the **conform-color** command.

```
class-map match-any match-not-frde
 match not fr-de
!
class-map match-any match-frde
```

```
 match fr-de
!
policy-map 2R3C_CA
 class class-default
  police cir 16000 bc 4470 pir 32000 be 4470
  conform-color match-not-frde exceed-color match-frde
  conform-action set-prec-tunnel-transmit 2
  exceed-action set-prec-tunnel-transmit 3
  exceed-action set-frde-transmit
  violate-action drop
```

The following example shows how to configure a QoS policy for traffic on the egress side of an ISE/E5 Frame Relay interface configured for a native L2TPv3 tunnel session.

Note that the sample output policy configured for a TSC-based L2TPv3 tunnel session in the section "Configuring QoS on a Frame Relay Interface in a TSC-Based L2TPv3 Tunnel Session" is not supported on a Frame Relay ISE/E5 interface. QoS policies on per-DLCI output traffic are not supported on ISE/E5 interfaces configured for a native L2TPv3 tunnel.

```
policy-map o
 class d2
  bandwidth percent 10
  random-detect precedence 1 200 packets 500 packets 1
 class d3
  bandwidth percent 10
  random-detect precedence 1 1 packets 2 packets 1
!
interface Serial0/1/1:0
 encapsulation frame-relay
 frame-relay interface-dlci 100 switched
  class fr-map
 service output o
```

Configuring Tunnel Marking in a Native L2TPv3 Tunnel Session

The QoS: Tunnel Marking for L2TPv3 Tunnels feature allows you to set (mark) either the IP precedence value or the differentiated services code point (DSCP) in the header of an L2TPv3 tunneled packet, using the **set-prec-tunnel** or **set-dscp-tunnel** command without configuring QoS traffic policing. Tunnel marking simplifies administrative overhead previously required to control customer bandwidth by allowing you to mark the L2TPv3 tunnel header on an ingress ISE/E5 interface.

The following example shows how to configure tunnel marking using MQC **set** commands for the default traffic class and a traffic class that matches a specified Frame Relay DE bit value:

```
class-map match-any match-frde
 match fr-de
policy-map set_prec_tun
 class match-frde
  set ip precedence tunnel 1
 class class-default
  set ip precedence tunnel 2
!
map-class frame-relay fr_100
 service-policy input set_prec_tun
```

L2TPv3 Customer-Facing ISE/E5 Interface

```
interface POS0/0
 frame-relay interface-dlci 100 switched
  class fr_100
```

Configuring Traffic Shaping in a Native L2TPv3 Tunnel Session

The following example shows how to configure traffic shaping on a Frame Relay ISE/E5 egress interface bound to a native L2TPv3 tunnel session. You can configure traffic shaping on a Frame Relay main egress interface by classifying traffic with different class maps.

Note You cannot configure per-DLCI shaping using the method shown in this example to configure traffic shaping.

To configure class-based shaping, configure the **match qos-group** and **random-detect discard-class** values according to the incoming IP precedence and DSCP values from packets received on the backbone-facing ingress interface. Use these values to define traffic classes on the customer-facing egress interface.

```
class-map match-any match_prec1
 match ip precedence 1
class-map match-any match_prec2
 match ip precedence 2
class-map match-any match_prec3
 match ip precedence 3
!
class-map match-all match_qos3
 match qos-group 3
!
class-map match-any match_qos12
 match qos-group 1
 match qos-group 2
!
policy-map customer_egress_policy
 class match_qos3
  bandwidth percent 5
  shape average 160000000
 class match_qos12
  shape average 64000000
  random-detect discard-class-based
  random-detect discard-class 1 500 packets 1000 packets
  random-detect discard-class 2 1000 packets 2000 packets
  bandwidth percent 10
 class class-default
  shape average 64000000
  queue-limit 1000 packets
  bandwidth percent 1
!
policy-map backbone_ingress_policy
 class match_prec1
  set qos-group 1
  set discard-class 1
 class match_prec2
  set qos-group 2
  set discard-class 2
 class match_prec3
  set qos-group 3
  set discard-class 3
 class class-default
  set qos-group 5
  set discard-class 5
```

L2TPv3 Customer-Facing ISE/E5 Interface

```
interface POS0/0
```

```
 service-policy output customer_egress_policy
 frame-relay interface-dlci 100 switched
  class fr_100
```

L2TPv3 Backbone-Facing ISE/E5 Interface

```
interface POS1/0
 service-policy input backbone_ingress_policy
```

Configuring a QoS Policy for Committed Information Rate Guarantees: Example

The following example shows how to configure a QoS policy that guarantees a CIR of 256 kbps on DLCI 100 and 512 kbps for DLCI 200 on a serial interface at one end of a TSC-based L2TPv3 tunnel session:

```
ip cef distributed
 class-map dlci100
 match fr-dlci 100
 class-map dlci200
 match fr-dlci 200
!
policy-map dlci
 class dlci100
 bandwidth 256
 class dlci200
 bandwidth 512
!
interface Serial 0/0
 encapsulation frame-relay
 frame-relay intf-type dce
 service-policy output dlci
!
connect one Serial 0/0 100 l2transport
 xconnect 10.0.3.201 555 encapsulation l2tpv3 pw-class mqc
!
connect two Serial 0/0 200 l2transport
 xconnect 10.0.3.201 666 encapsulation l2tpv3 pw-class mqc
```

Setting the Frame Relay DE Bit Configuration: Example

The following example shows how to configure the service policy called set-de and attach it to an output serial interface bound to a TSC-based L2TPv3 tunnel session. Note that setting the Frame Relay DE bit is not supported on a Frame Relay ISE/E5 interface bound to a native L2TPv3 tunnel session.

In this example, the class map called data evaluates all packets exiting the interface for an IP precedence value of 1. If the exiting packet has been marked with the IP precedence value of 1, the packet's DE bit is set to 1.

```
class-map data
 match qos-group 1
!
policy-map SET-DE
 class data
  set fr-de
!
interface Serial 0/0/0
 encapsulation frame-relay
 service-policy output SET-DE
!
connect fr-mpls-100 serial 0/0/0 100 l2transport
 xconnect 10.10.10.10 pw-class l2tpv3
```

Matching the Frame Relay DE Bit Configuration: Example

The following example shows how to configure the service policy called match-de and attach it to an interface bound to a TSC-based L2TPv3 tunnel session. In this example, the class map called "data" evaluates all packets entering the interface for a DE bit setting of 1. If the entering packet has been a DE bit value of 1, the packet's IP precedence value is set to 3.

```
class-map data
 match fr-de
!
policy-map MATCH-DE
 class data
  set ip precedence tunnel 3
!
ip routing
ip cef distributed
!
mpls label protocol ldp
interface Loopback0
 ip address 10.20.20.20 255.255.255.255
!
interface Ethernet1/0/0
 ip address 172.16.0.2 255.255.255.0
 tag-switching ip
!
interface Serial4/0/0
 encapsulation frame-relay
service input MATCH-DE
!
connect 100 Serial4/0/0 100 l2transport
 xconnect 10.10.10.10 100 encapsulation l2tpv3
```

The next example shows how to configure the service policy called set_prec_tunnel_from_frde and attach it to a Cisco 12000 series ISE/E5 interface bound to a native L2TPv3 tunnel session. Note that in a native L2TPv3 session, you must attach the service policy to a DLCI (in the example, DCLI 100) instead of to a main interface (as in the preceding example).

```
class-map match-any match-frde
  match fr-de
!
policy-map set_prec_tunnel_from_frde
  class match-frde
   set ip precedence tunnel 6
  class class-default
   set ip precedence tunnel 3
!
map-class frame-relay fr_100
  service-policy input set_prec_tunnel_from_frde
!
interface POS0/0
  description ISE: L2TPv3 Customer-facing interface
  frame-relay interface-dlci 100 switched
    class fr_100
```

Configuring MLFR for L2TPv3 on the Cisco 12000 Series: Example

The following example shows how to configure L2TPv3 tunneling on a multilink Frame Relay bundle interface on a Cisco 12000 series 2-port Channelized OC-3/STM-1 (DS1/E1) or 6-port Channelized T3 line card:

```
frame-relay switching
!
pseudowire-class mfr
 encapsulation l2tpv3
 ip local interface Loopback0
!
interface mfr0
 frame-relay intf-type dce
!
interface Serial0/0.1/1:11
 encapsulation frame-relay MFR0
!
interface Serial0/0.1/1:12
 encapsulation frame-relay MFR0
!
connect L2TPoMFR MFR0 100 l2transport
 xconnect 10.10.10.10 3 pw-class mfr
```

Configuring an MQC for Committed Information Rate Guarantees: Example

The following is a sample configuration of the MQC to guarantee a CIR of 256 kbps on DLCI 100 and 512 kbps for DLCI 200:

```
ip cef distributed
 class-map dlci100
 match fr-dlci 100
 class-map dlci200
 match fr-dlci 200
!
policy-map dlci
 class dlci100
 bandwidth 256
 class dlci200
 bandwidth 512
!
interface Serial0/0
 encapsulation frame-relay
 frame-relay intf-type dce
 service-policy output dlci
!
connect one Serial0/0 100 l2transport
 xconnect 10.0.3.201 555 encapsulation l2tpv3 pw-class mqc
!
connect two Serial0/0 200 l2transport
 xconnect 10.0.3.201 666 encapsulation l2tpv3 pw-class mqc
```

Configuring an L2TPv3 Custom Ethertype for Dot1q and QinQ Encapsulations: Example

The following example shows how to configure an Ethertype other than 0x8100 on Gigabit Ethernet interfaces with QinQ or Dot1Q encapsulations. In this example, the Ethertype field is set to 0x9100 on Gigabit Ethernet interface 1/0/0.

```
Router> enable
Router# configure terminal
Router(config)# interface gigabitethernet 1/0/0
Router(config-if)# dot1q tunneling ethertype 0x9100
```

Additional References

Related Documents

Related Topic	Document Title
L2TPv3	Layer 2 Tunneling Protocol Version 3 Technical Overview
L2VPN interworking	"L2VPN Interworking" chapter in the *Cisco IOS Multiprotocol Label Switching Configuration Guide*
L2VPN pseudowire switching	"L2VPN Pseudowire Switching" chapter in the *Cisco IOS Multiprotocol Label Switching Configuration Guide*
L2VPN pseudowire redundancy	"L2VPN Pseudowire Redundancy" chapter in the *Cisco IOS Wide-Area Networking Configuration Guide*
L2TP	• Layer 2 Tunnel Protocol • Layer 2 Tunneling Protocol: A Feature in Cisco IOS Software
Configuring CEF	"Part 1: Cisco Express Forwarding" in the *Cisco IOS IP Switching Configuration Guide*
MTU discovery and packet fragmentation	MTU Tuning for L2TP
Tunnel marking for L2TPv3 tunnels	QoS: Tunnel Marking for L2TPv3 Tunnels
Multilink Frame Relay over L2TPv3/AToM	Multilink Frame Relay over L2TPv3/AToM
Additional VPN commands: complete command syntax, command mode, defaults, usage guidelines, and examples	*Cisco IOS Dial Technologies Command Reference*
Additional Frame Relay commands: complete command syntax, command mode, defaults, usage guidelines and examples	*Cisco IOS Wide-Area Networking Command Reference*
UTI	Universal Transport Interface (UTI)
IPv6	*Cisco IOS IPv6 Configuration Guide*
Additional IPv6 commands: complete command syntax, command mode, defaults, usage guidelines and examples	*Cisco IOS IPv6 Command Reference*

Standards

Standard	Title
draft-ietf-l2tpext-l2tp-base-03.txt	Layer Two Tunneling Protocol (Version 3) "L2TPv3"

MIBs

MIB	MIBs Link
IfTable MIB for the attachment circuit	To locate and download MIBs for selected platforms, Cisco IOS software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 2661	*Layer Two Tunneling Protocol "L2TP"*
RFC 1321	*The MD5 Message Digest Algorithm*
RFC 2104	*HMAC-Keyed Hashing for Message Authentication*
RFC 3931	*Layer Two Tunneling Protocol Version 3 "L2TPv3"*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for L2TPv3

Table 9 lists the release history for this feature.

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

Note Table 9 lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 9 Feature Information for L2TPv3

Release	Modification
2.6.2	Support was added for the **ip pmtu** command.
Cisco IOS Release 12.0	
12.0(21)S	Initial data plane support for L2TPv3 was introduced on the Cisco 7200 series, Cisco 7500 series, Cisco 10720, and Cisco 12000 series platforms.
12.0(23)S	L2TPv3 control plane support was introduced on the Cisco 7200 series, Cisco 7500 series, Cisco 10720, and Cisco 12000 series platforms.
12.0(24)S	L2TPv3 was enhanced to support the Layer 2 Fragmentation feature (fragmentation of IP packets before they enter the pseudowire) on the Cisco 7200 series, Cisco 7500 series, and Cisco 12000 series Internet routers.
12.0(25)S	Support was added for the ATM VP Mode Single Cell Relay over L2TPv3 feature on the Cisco 7200 and Cisco 7500 series routers with ATM Deluxe PA-A3 interfaces. L2TPv3 control plane support was introduced on the Cisco 12000 series 1-port channelized OC-12 (DS3) line card.
12.0(23)S3	L2TPv3 control plane support was introduced on the Cisco 12000 series 1-port channelized OC-12 (DS3) line card.
12.0(24)S1	L2TPv3 control plane support was introduced on the Cisco 12000 series 1-port channelized OC-12 (DS3) line card.
12.0(27)S	Support was added for the following features to Cisco 12000 series 2-port channelized OC-3/STM-1 (DS1/E1) and 6-port Channelized T3 (T1) line cards: • Binding L2TPv3 sessions to Multilink Frame Relay (MLFR) interfaces • Quality of service (QoS) for Frame Relay attachment circuits

Table 9 Feature Information for L2TPv3 (continued)

12.0(28)S	Support was added for the following features on the Cisco 7200 series and Cisco 7500 series routers: • ATM AAL5 OAM Emulation over L2TPv3 • ATM Single Cell Relay VC Mode over L2TPv3 • L2TPv3 Distributed Sequencing • L2TPv3 Support for PA-A3-8T1IMA PA and PA-A3-8E1IMA Port Adapters
12.0(29)S	Support was added for the following features: • ATM Cell Packing over L2TPv3 • ATM Port Mode Cell Relay over L2TPv3 • L2TPv3 Control Message Hashing • L2TPv3 Control Message Rate Limiting • Protocol Demultiplexing for L2TPv3
12.0(30)S	Support was added for the following features to Cisco IOS Release 12.0(30)S: • L2TPv3 Digest Secret Graceful Switchover • Manual Clearing of L2TPv3 Tunnels • VC Class Provisioning for L2VPN Support was added for native L2TPv3 tunneling on IP services engine (ISE) line cards on the Cisco 12000 series Internet router.
12.0(31)S	Support was added for the following feature to Cisco IOS Release 12.0(31)S: • Layer 2 VPN (L2VPN): Syslog, SNMP Trap, and show Command Enhancements for AToM and L2TPv3 Support was added for native L2TPv3 tunneling on the following ISE line cards on the Cisco 12000 series Internet router: • 2.5G ISE SPA Interface Processor (SIP): – 2-port T3/E3 serial shared port adapter (SPA) – 4-port T3/E3 serial SPA – 2-port channelized T3 SPA – 4-port channelized T3 Serial SPA • 4-port Gigabit Ethernet ISE
12.0(31)S2	Support was added for customer-facing IP Services Engine (ISE) interfaces configured for Layer 2 local switching on a Cisco 12000 series Internet router (see *Layer 2 Local Switching*).

Table 9 Feature Information for L2TPv3 (continued)

12.0(32)SY	Support was added for Engine 5 line cards—shared port adapters (SPAs) and SPA interface processors (SIPs)—on the Cisco 12000 series Internet router, including: • Engine-5 customer-facing interfaces that are configured for local switching (see *Layer 2 Local Switching*). • Engine-5 and ISE (Engine-3) interfaces that are configured for Layer 2 VPN interworking (see *L 2VPN Interworking*). Support was added for the L2TPv3 Layer 2 fragmentation feature on the Cisco 10720 Internet router.
12.0(33)S	Support was added for the following features to Cisco IOS Release 12.0(33)S: • Protocol Demultiplexing for L2TPv3 for PPP traffic • Protocol Demultiplexing for L2TPv3 for HDLC traffic • Protocol Demultiplexing for L2TPv3 on Engine-3/Engine-5 line cards in the Cisco 12000 series platforms • Protocol Demultiplexing for L2TPv3 on Engine-3/Engine-5 line cards in the Cisco 12000 series platforms for PPP, HDLC, Ethernet, and Frame-Relay encapsulations • Color Aware Policer on Engine-3/Engine-5 line cards for Ethernet over L2TPv3 • Site of Origin for Border Gateway Protocol Virtual Private Networks (BGP-VPNs) • Control Message Statistics and Conditional Debugging Command Enhancements (including L2VPN Pseudowire Conditional Debugging)
Cisco IOS Release 12.2S	
12.2(25)S	Support was added for the following features to Cisco IOS Release 12.2(25)S: • L2TPv3: Layer 2 Tunneling Protocol • ATM AAL5 OAM Emulation over L2TPv3 • ATM Single Cell Relay VC Mode over L2TPv3 • ATM VP Mode Single Cell Relay over L2TPv3 • L2TPv3 Distributed Sequencing • L2TPv3 Layer 2 fragmentation • L2TPv3 Support for PA-A3-8T1IMA PA and PA-A3-8E1IMA Port Adapters

Table 9 Feature Information for L2TPv3 (continued)

12.2(25)S4	Support was added for the following features on the Cisco 7304 NPE-G100 and the Cisco 7304 NSE-100: • L2TPv3: Layer 2 Tunneling Protocol • ATM AAL5 OAM Emulation over L2TPv3 • ATM Port Mode Cell Relay over L2TPv3 • ATM Single Cell Relay VC Mode over L2TPv3 • ATM VP Mode Single Cell Relay over L2TPv3 • L2TPv3 Layer 2 fragmentation Support was added for this feature on the Cisco 7304 NPE-G100 only: • L2TPv3 Distributed Sequencing
Cisco IOS Release 12.2SB	
12.2(27)SBC	Support was added for the following features: • L2TPv3 Control Message Hashing • L2TPv3 Control Message Rate Limiting • Layer 2 VPN (L2VPN): Syslog, SNMP Trap, and show Command Enhancements for AToM and L2TPv3 • Protocol Demultiplexing for L2TPv3
12.2(28)SB	Support was added for Control Message Statistics and Conditional Debugging Command Enhancements (including L2VPN Pseudowire Conditional Debugging)
Cisco IOS Release 12.2SR	
12.2(33)SRC	The L2TPv3 feature was integrated into Cisco IOS Release 12.2(33)SRC and implemented on the Cisco 7600 series SPA Interface Processor-400 (SIP-400) line card.
Cisco IOS Release 12.3T	
12.3(2)T	The L2TPv3 feature was integrated into Cisco IOS Release 12.3(2)T and implemented on the Cisco 2600XM series Multiservice platforms, the Cisco 2691 Multiservice routers, the Cisco 3662 Multiservice Access platforms, the Cisco 3725 Modular Access routers, and the Cisco 3745 Modular Access routers.
Cisco IOS Release 12.4T	
12.4(11)T	Support was added for the following features: • L2TPv3 Control Message Hashing • L2TPv3 Control Message Rate Limiting • Protocol Demultiplexing for L2TPv3

Table 9 Feature Information for L2TPv3 (continued)

Cisco IOS Release 15.0S	
15.0(1)S	Support was added for the following features: • ATM AAL5 OAM Emulation over L2TPv3 • ATM Single Cell Relay VC Mode over L2TPv3 • ATM VP Mode Single Cell Relay over L2TPv3 The following commands were introduced or modified: **atm mcpt-timers**, **atm pvp**, **cell-packing**, **clear l2tun**, **clear l2tun counters**, **clear l2tun counters tunnel l2tp**, **debug atm cell-packing**, **debug condition xconnect**, **debug vpdn**, **ip pmtu**, **i l2tp cookie local**, **l2tp cookie remote**, **l2tp hello**, **l2tp id**, and **xconnect**.

Glossary

AV pairs—Attribute-value pairs.

BECN—backward explicit congestion notification. Bit set by a Frame Relay network in frames traveling in the opposite direction of frames encountering a congested path. DTE receiving frames with the BECN bit set can request that higher-level protocols take flow control action as appropriate.

CE—customer edge (Frame Relay switch or user device).

CEF—Cisco Express Forwarding. Layer 3 IP switching technology that optimizes network performance and scalability for networks with large and dynamic traffic patterns.

CIR—committed information rate. Rate at which a Frame Relay network agrees to transfer information under normal conditions, averaged over a minimum increment of time. CIR, measured in bits per second, is one of the key negotiated tariff metrics.

data-link control layer—Layer 2 in the SNA architectural model. Responsible for the transmission of data over a particular physical link. Corresponds approximately to the data link layer of the OSI model.

DCE—Data circuit-terminating equipment (ITU-T expansion). Devices and connections of a communications network that comprise the network end of the user-to-network interface.

dCEF—Distributed Cisco Express Forwarding. Type of CEF switching in which line cards (such as VIP line cards) maintain an identical copy of the FIB and adjacency tables. The line cards perform the express forwarding between port adapters; this relieves the route/switch processor of involvement in the switching operation.

DF bit—Don't Fragment bit. Bit in the IP header that can be set to indicate that the packet should not be fragmented.

DLCI—data-link connection identifier. A unique number assigned to a PVC endpoint in a Frame Relay network. Identifies a particular PVC endpoint within an access channel in a Frame Relay network and has local significance only to that channel.

DTE—Data terminal equipment. Device at the user end of a user-network interface that serves as a data source, destination, or both.

FECN—forward explicit congestion notification. Bit set by a Frame Relay network to inform DTE receiving the frame that congestion was experienced in the path from source to destination. DTE receiving frames with the FECN bit set can request that higher-level protocols take flow-control action as appropriate.

HDLC—High-Level Data Link Control. A generic link-level communications protocol developed by the International Organization for Standardization (ISO). HDLC manages synchronous, code-transparent, serial information transfer over a link connection.

ICMP—Internet Control Message Protocol. A network protocol that handles network errors and error messages.

IDB—Interface descriptor block.

IS-IS—Intermediate System-to-Intermediate System. OSI link-state hierarchical routing protocol based on DECnet Phase V routing, whereby ISs (routers) exchange routing information based on a single metric to determine network topology.

L2TP—An extension to PPP merging features of two tunneling protocols: Layer 2 Forwarding (L2F) from Cisco Systems and Point-to-Point Tunneling (PPTP) from Microsoft. L2TP is an Internet Engineering Task Force (IETF) standard endorsed by Cisco Systems, and other networking industry leaders.

L2TPv3—Draft version of L2TP that enhances functionality in RFC 2661 (L2TP).

LMI—Local Management Interface.

MPLS—Multiprotocol Label Switching. Switching method that forwards IP traffic using a label. This label instructs the routers and the switches in the network where to forward the packets based on preestablished IP routing information.

MQC—Modular quality of service command-line interface.

MTU—Maximum transmission unit. Maximum packet size, in bytes, that a particular interface can handle.

NNI—Network-to-Network Interface. ATM Forum standard that defines the interface between two ATM switches that are both located in a private network or are both located in a public network. The UNI standard defines the interface between a public switch and a private one. Also, the standard interface between two Frame Relay switches meeting the same criteria.

PE—Provider edge router providing Frame Relay over L2TPv3 functionality.

PMTU—Path MTU.

PPP—Point-to-Point Protocol. A link-layer encapsulation method for dialup or dedicated circuits. A successor to Serial Line IP (SLIP), PPP provides router-to-router and host-to-network connections over synchronous and asynchronous circuits.

PVC—permanent virtual circuit. A virtual circuit that is permanently established. A Frame Relay logical link, whose endpoints and class of service are defined by network management. Analogous to an X.25 permanent virtual circuit, a PVC consists of the originating Frame Relay network element address, originating data-link control identifier, terminating Frame Relay network element address, and termination data-link control identifier. Originating refers to the access interface from which the PVC is initiated. Terminating refers to the access interface at which the PVC stops. Many data network customers require a PVC between two points. PVCs save bandwidth associated with circuit establishment and tear down in situations where certain virtual circuits must exist all the time. Data terminating equipment with a need for continuous communication uses PVCs.

PW—Pseudowire.

SNMP—Simple Network Management Protocol. Network management protocol used almost exclusively in TCP/IP networks. SNMP provides a means to monitor and control network devices, and to manage configurations, statistics collection, performance, and security.

tunneling—Architecture that is designed to provide the services necessary to implement any standard point-to-point encapsulation scheme.

UNI—User-Network Interface.

UTI—Universal Transport Interface.

VPDN—Virtual private dialup network. A network that allows separate and autonomous protocol domains to share common access infrastructure, including modems, access servers, and ISDN routers. A VPDN enables users to configure secure networks that take advantage of ISPs that tunnel remote access traffic through the ISP cloud.

WAN—Wide-area network. Data communications network that serves users across a broad geographic area and often uses transmission devices provided by common carriers. Frame Relay, SMDS, and X.25 are examples of WANs.