Layer 2 Tunneling Protocol Version 3

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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 Layer-2 Tunneling Protocol Version 3" section on page 43.

Use Cisco Feature Navigator to find information about platform support and Cisco 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 "Configuring the Xconnect Attachment Circuit" section on page 29), the CEF feature must be enabled. To enable CEF on an interface, use the **ip cef** 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

- General L2TPv3 Restrictions
- VLAN-Specific Restrictions
- IPv6 Protocol Demultiplexing for L2TPv3 Restrictions
- L2TPv3 Control Message Hashing Restrictions
- L2TPv3 Digest Secret Graceful Switchover Restrictions
- Quality of Service Restrictions in L2TPv3 Tunneling

General L2TPv3 Restrictions

- Cisco Express Forwarding (CEF) must be enabled for the L2TPv3 feature to function. The xconnect configuration mode is blocked until CEF is enabled. To enable CEF, use the **ip cef** 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 Ethernet or VLAN ports is limited by the number of interface descriptor blocks (IDBs) that the router can support. For Ethernet and VLANVLAN circuit types, an IDB is required for each circuit.
- 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.
- Layer 2 fragmentation of IP packets and Intermediate System-to-Intermediate System (IS-IS) fragmentation are not supported.
- Layer 3 fragmentation is not recommended because of performance degradation.
- Only Ethernet, HDLC, and VLAN (802.1Q, QinQ, and QinAny) attachment circuits are supported.
- Interworking is not allowed when sequencing is enabled.
- Stateful Switchover (SSO) is not supported for L2TPv3 sessions. Instead, L2TPv3 functions in a HA (high availability) coexistence mode. This means that all sessions are lost during an RP (route processor) switchover, but will then be re-established.

- Convergence at bootup or RP switchover takes a significant amount of time depending on the number of configured session.

Supported Shared Port Adapters for Cisco ASR 1000 Series Routers

The following shared port adapters (SPAs) support L2TPv3 on the Cisco ASR 1000 series routers.

- SPA-4X1FE-TX-V2 (4-Port 10BASE-T/100BASE-TX Fast Ethernet)
- SPA-8X1FE-TX-V2 (8-Port 10BASE-T/100BASE-TX Fast Ethernet)
- SPA-2X1GE-V2 (2-port Gigabit Ethernet)
- SPA-5X1GE-V2 (5-port Gigabit Ethernet)
- SPA-8X1GE-V2 (8-port Gigabit Ethernet)
- SPA-10XGE-V2 (10-port Gigabit Ethernet)
- SPA-1X10GE-L-V2 (1-port Gigabit Ethernet)

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.

IPv6 Protocol Demultiplexing for L2TPv3 Restrictions

- IPv6 protocol demultiplexing is supported only for Ethernet traffic.
- IPv6 protocol demultiplexing is supported over noninterworking sessions.

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 2 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 Layer-2 Tunneling Protocol Version 3" section on page 43.

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.

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:

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 the signaling protocol as well as the packet encapsulation specification.

Performance Impact of L2TPv3 on Cisco ASR 1000 Series Routers

L2TPv3 supports the following maximum numbers of attachment circuits and tunnels.

- First-generation Cisco ASR 1000 Series Route Processor (RP1) with Embedded Services Processor 10 (ESP10):
  - Attachment circuits for Ethernet: 8000 per system in a typical user environment. This includes 4000 per port and 8000 per SPA

  - L2TPv3 tunnels: 1000 (in a typical user environment) and 2000 (maximum)
- Second-generation Cisco ASR 1000 Series Route Processor (RP2) with Embedded Services Processor 20 (ESP20):
  - Attachment circuits for Ethernet: 16,000 per system in a typical user environment. This includes 4000 per port and 8000 per SPA
  - L2TPv3 tunnels: 2000 (in a typical user environment) and 4000 (maximum)

L2TPv3 Operation

L2TPv3 includes 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 and VLAN, including both static and dynamic (using the new L2TPv3 signaling) forwarded sessions

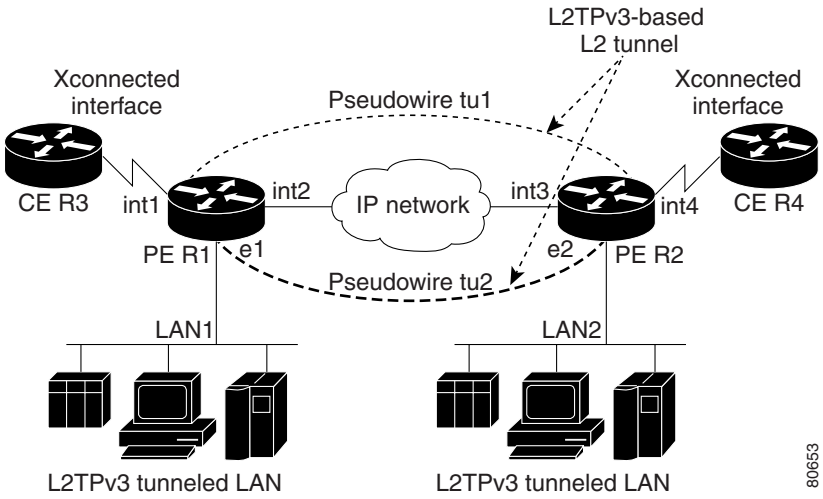
The initial Cisco IOS features supported only the following features:

- 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

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



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.

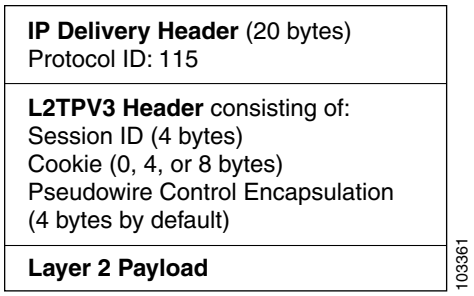
Other L2TPv3 Benefits

- 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 L2TPv3 header has the 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 "How to Configure Layer 2 Tunneling Protocol Version 3" section on page 17 for more information on the CLI commands for L2TPv3.

Session ID

The L2TPv3 session ID 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. 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 "Sequencing" section on page 11). 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 and VLAN 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 supports the following features:

- Ethernet over L2TPv3
- Sequencing
- L2TPv3 Type of Service Marking
- Keepalive
- MTU Handling
- L2TPv3 Control Message Hashing
- L2TPv3 Control Message Rate Limiting
- L2TPv3 Digest Secret Graceful Switchover
- Manual Clearing of L2TPv3 Tunnels
- L2TPv3 Tunnel Management
- L2TPv3 Protocol Demultiplexing
- L2TPv3 Custom Ethertype for Dot1q and QinQ Encapsulations
- HDLC over L2TPv3

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.

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 "Configuring the L2TPv3 Pseudowire" section on page 26).

L2TPv3 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.

Table 1 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 1 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 New integrity check	None 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 New integrity check	None 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.

Ethernet over L2TPv3

The Ethernet over L2TPv3 feature provides support for Ethernet-based Layer 2 payload tunneling over IP core networks, using L2TPv3.

The Ethernet over L2TPv3 feature supports the following like-to-like switching modes.

- Ethernet port mode
- Ethernet VLAN mode
- Ethernet VLAN mode with VLAN rewrite
- Ethernet QinQ and QinAny mode

Note The QinQ over L2TPv3 support feature includes QinAny over L2TPv3, which has a fixed outer VLAN tag and a variable inner VLAN tag.

The Ethernet over L2TPv3 feature supports the following types of internetworking.

- Ethernet port to VLAN (routed)
- Ethernet port to VLAN (bridged)
- QinQ to Ethernet VLAN or Port Interworking (routed)
- QinQ to Ethernet VLAN or Port Interworking (bridged)

Note QinAny Interworking is not a valid configuration because the inner VLAN tag is undetermined.

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 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.

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.

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 preconfigured 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.

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.

You may choose to configure control channel authentication or control message integrity checking. Control channel authentication requires participation by both peers, and a shared secret must be configured on both routers. Control message integrity check is unidirectional, and requires configuration on only one of the peers.

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.

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, 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.

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:

- Syslog, SNMP Trap, and show Command Enhancements for L2TPv3

Syslog, SNMP Trap, and show 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.

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*.

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.

HDLC over L2TPv3

HDLC for Layer 2 Data Encapsulation provides encapsulation of port-to-port Layer 2 traffic. All HDLC traffic including IPv4, IPv6 and non-IP packet (like IS-IS) are tunneled over L2TPv3. HDLC does not support interworking mode.

Note L2TPv3 supports IPv4 tunnel only for HDLC. The IPv4 tunnel supports IPv4 and IPv6 packets.

Supported L2TPv3 Payloads

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

- Ethernet
- VLAN
- 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.

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.

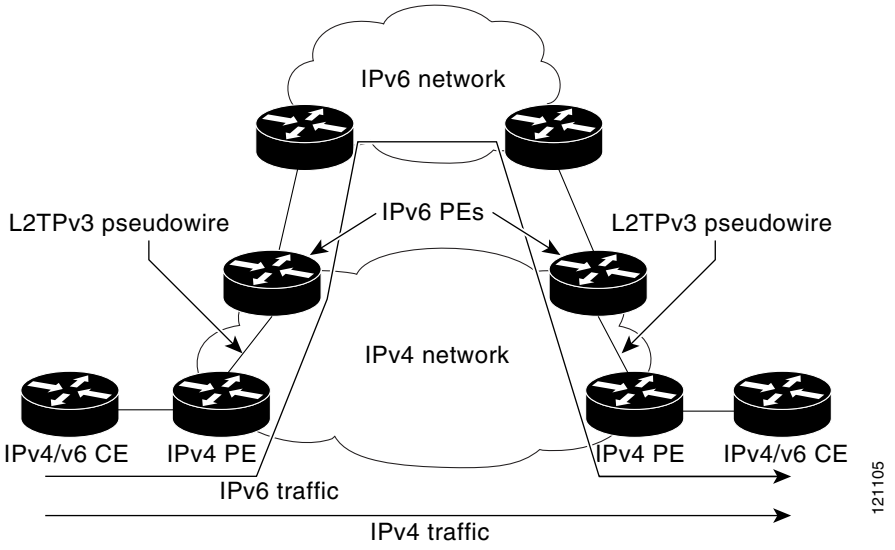
Note Because of the way in which L2TPv3 handles VLAN packets, the Ethernet interface must be configured in promiscuous mode to capture all traffic received on the Ethernet segment attached to the router. All frames are tunneled through the L2TP pseudowire.

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. 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 2 shows the valid combinations of configurations.

Table 2 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 Layer 2 Tunneling Protocol Version 3

- Configuring L2TP Control Channel Parameters, page 18 (optional)
- Configuring the L2TPv3 Pseudowire, page 26 (required)

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. **retransmit** {**initial retries** *initial-retries* | **retries** *retries* | **timeout** {**max** | **min**} *timeout*}
5. **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, to configure multiple L2TP classes, you must specify a unique *l2tp-class-name* for each one.
Step 4	**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 5	**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 19 (optional)
- Configuring L2TPv3 Control Message Hashing, page 21 (optional)
- Configuring L2TPv3 Digest Secret Graceful Switchover, page 23 (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, 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.

	Command or Action	Purpose
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, to configure multiple L2TP classes, you must specify a unique *l2tp-class-name* for each one.

	Command or Action	Purpose
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**.
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. • Only the hiding of the cookie AV pair is supported. • If a cookie is configured in L2TP class configuration mode (see the "Manually Configuring L2TPv3 Session Parameters" section on page 30), 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.

	Command or Action	Purpose
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.
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, the 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, 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.

	Command or Action	Purpose
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.

	Command or Action	Purpose
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, 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** | *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.

	Command or Action	Purpose
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 "Configuring L2TP Control Channel Parameters" section on page 18). • 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**.
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.

	Command or Action	Purpose
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.
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.
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.

	Command or Action	Purpose
Step 11	**ip protocol** {**l2tp** | *protocol-number*} **Example:** `Router(config-pw)# ip protocol l2tp`	(Optional) Configures the IP protocol to be used for tunneling packets.
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 or VLAN 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 "Manually Configuring L2TPv3 Session Parameters" section on page 30 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 "Configuring the Xconnect Attachment Circuit" section on page 29 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 "Configuring the Xconnect Attachment Circuit" section on page 29) 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 "Configuring L2TP Control Channel Parameters" section on page 18) 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 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 "Manually Configuring L2TPv3 Session Parameters" section on page 30 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 Layer 2 Tunneling Protocol Version 3

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.

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

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
```

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

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
```

Example: Verifying an L2TPv3 Session

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

L2TP Session Information Total tunnels 1 sessions 1

Session id 2391726297 is up, logical session id 36272, tunnel id 2382731778
  Remote session id is 193836624, remote tunnel id 2280318174
  Locally initiated session
  Unique ID is 12
Session Layer 2 circuit, type is Ethernet, name is GigabitEthernet0/2/0
  Session vcid is 100
  Circuit state is UP
    Local circuit state is UP
    Remote circuit state is UP
Call serial number is 98300002
Remote tunnel name is l2tp-asr-2
  Internet address is 6.6.6.6
Local tunnel name is l2tp-asr-1
  Internet address is 3.3.3.3
IP protocol 115
  Session is L2TP signaled
  Session state is established, time since change 00:05:25
    94 Packets sent, 58 received
    9690 Bytes sent, 5642 received
  Last clearing of counters never
  Counters, ignoring last clear:
    94 Packets sent, 58 received
    9690 Bytes sent, 5642 received
    Receive packets dropped:
      out-of-order:             0
      other:                    0
      total:                    0
Send packets dropped:
      exceeded session MTU:     0
      other:                    0
      total:                    0
  DF bit off, ToS reflect disabled, ToS value 0, TTL value 255
  Sending UDP checksums are disabled
  Received UDP checksums are verified
  No session cookie information available
  FS cached header information:
    encap size = 24 bytes
    45000014 00000000 ff73a965 03030303
    06060606 0b8db650
  Sequencing is off
  Conditional debugging is disabled
  SSM switch id is 4101, SSM segment id is 12294
```

Example: Verifying an L2TP Control Channel

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

L2TP Tunnel Information Total tunnels 1 sessions 1

Tunnel id 2382731778 is up, remote id is 2280318174, 1 active sessions
  Locally initiated tunnel
  Tunnel state is established, time since change 00:02:59
  Tunnel transport is IP  (115)
  Remote tunnel name is l2tp-asr-2
    Internet Address 6.6.6.6, port 0
  Local tunnel name is l2tp-asr-1
    Internet Address 3.3.3.3, port 0
  L2TP class for tunnel is l2tp_default_class
  Counters, taking last clear into account:
    54 packets sent, 35 received
    5676 bytes sent, 3442 received
  Last clearing of counters never
  Counters, ignoring last clear:
    54 packets sent, 35 received
    5676 bytes sent, 3442 received
Control Ns 5, Nr 4
  Local RWS 1024 (default), Remote RWS 1024
  Control channel Congestion Control is disabled
  Tunnel PMTU checking disabled
  Retransmission time 1, max 1 seconds
  Unsent queuesize 0, max 0
  Resend queuesize 0, max 2
  Total resends 0, ZLB ACKs sent 2
  Total out-of-order dropped pkts 0
  Total out-of-order reorder pkts 0
  Total peer authentication failures 0
  Current no session pak queue check 0 of 5
  Retransmit time distribution: 0 0 0 0 0 0 0 0 0 0
  Control message authentication is disabled
```

Example: Configuring L2TPv3 Control Channel Authentication

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
```

Example: Configuring L2TPv3 Digest Secret Graceful Switchover

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
```

Example: Verifying L2TPv3 Digest Secret Graceful Switchover

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
```

Example: Configuring a Pseudowire Class for Fragmentation of IP Packets

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
```

Example: Configuring Protocol Demultiplexing for L2TPv3

The following example 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.

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

Example: Manually Clearing an L2TPv3 Tunnel

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

```
clear l2tun tunnel 65432
```

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

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
```

Example: Configuring an L2TPv3 HDLC Like-to-like Layer 2 Transport

- Example: Configuring an L2TPv3 HDLC Like-to-like Layer 2 Transport on Dynamic Mode
- Example: Configuring an L2TPv3 HDLC Like-to-like Layer 2 Transport on Static Mode

Example: Configuring an L2TPv3 HDLC Like-to-like Layer 2 Transport on Dynamic Mode

The following example shows how to configure xconnect on a serial interface with HDLC encapsulation on a dynamic mode. The dynamic mode uses L2TPv3 signaling in control channel to set up the L2TPv3 tunnel.

```
pseudowire-class 774
 encapsulation l2tpv3
 protocol l2tpv3
 ip local interface GigabitEthernet0/0/1.774
!
interface Serial0/2/0:0
 no ip address
 xconnect 4.4.4.4 200 pw-class 774
```

Example: Configuring an L2TPv3 HDLC Like-to-like Layer 2 Transport on Static Mode

The following example shows how to configure xconnect on a serial interface with HDLC encapsulation on a static mode. The static mode is used to not enable signaling in the L2TPv3 control channel. Since signaling is not enabled, you must specify the manual option in xconnect and configure the L2TP-specific parameters to complete the L2TPv3 control channel configuration.

```
pseudowire-class pe1-ether-pw
 encapsulation l2tpv3
 protocol none
 ip local interface Loopback1
!
interface Serial0/2/0:0
 no ip address
 xconnect 2.2.2.2 50 encapsulation l2tpv3 manual pw-class pe1-ether-pw
  l2tp id 111 111
  l2tp cookie local 4 54321
  l2tp cookie remote 4 12345
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
Wide area networking commands	*Cisco IOS Wide-Area Networking Command Reference*
VPN commands	*Cisco IOS Dial Technologies Command Reference*
IPv6 configuration tasks	*IPv6 Configuration Guide, Cisco IOS XE Release 3S*
IPv6 commands	*Cisco IOS IPv6 Command Reference*
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*

Related Topic	Document Title
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*

Standards

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

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Layer-2 Tunneling Protocol Version 3

Table 3 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 3 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 3 Feature Information for Layer-2 Tunneling Protocol Version 3

Feature Name	Releases	Feature Information
Layer 2 Tunneling Protocol Version 3	XE 2.6 XE 2.6.2 XE 3.3S	The Layer 2 Tunneling Protocol Version 3 (L2TPv3) feature expands Cisco support of Layer 2 Virtual Private Networks (VPNs). In Cisco IOS XE Release 2.6, the following features were added: • Ethernet over L2TPv3 • Layer 2 VPN (L2VPN): Syslog, SNMP Trap, and show Command Enhancements for AToM and L2TPv3 • L2TPv3 Control Message Hashing • L2TPv3 Control Message Rate Limiting • L2TPv3 Digest Secret Graceful Switchover • Protocol Demultiplexing for L2TPv3 • L2TPv3: Custom Ethertype for Dot1q and QinQ Encapsulation In Cisco IOS XE Release 2.6.2, support was added for the **ip pmtu** command. In Cisco IOS XE Release 3.3S, support for HDLC over L2TPv3 was added. The following sections provide information about this feature: • Information About Layer 2 Tunneling Protocol Version 3, page 4 • How to Configure Layer 2 Tunneling Protocol Version 3, page 17 The following commands were introduced or modified: **clear l2tun, debug vpdn, ip pmtu, l2tp cookie local, l2tp cookie remote, l2tp hello, l2tp id,** and **xconnect.**

Glossary

AV pairs—attribute-value pairs.

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

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.

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

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

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

IDB—interface descriptor block.

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.

PMTU—path MTU.

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.

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. SMDS, and X.25 are examples of WANs.