VPDN Configuration Guide, Cisco IOS Release 15M&T

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CHAPTER 1

VPDN Technology Overview

Virtual private dial-up networks (VPDNs) securely carry private data over a public network, allowing remote users to access a private network over a shared infrastructure such as the Internet. VPDNs maintain the same security and management policies as a private network, while providing a cost-effective method for point-to-point connections between remote users and a central network.

Information About VPDNs

Overview of VPDN Technology

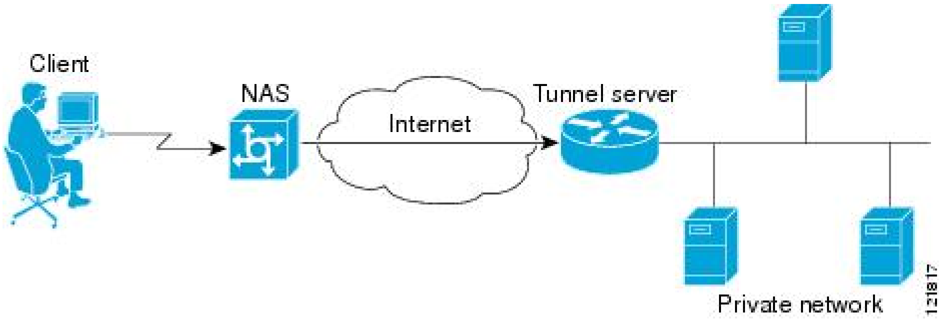
VPDNs extend private network dial-in services to remote users. VPDNs use Layer 2 tunneling technologies to create virtual point-to-point connections between remote clients and a private network. VPDNs maintain the same security and management policies as a private network, while providing a cost-effective method for point-to-point connections between remote users and a central network.

Instead of connecting directly to the remote private network, VPDN users connect to a nearby access server, which is often located at an Internet service provider (ISP) local point of presence (POP). Data is securely forwarded from the access server to the private network over the Internet, providing a cost-effective method of communication between remote clients and the private network.

A benefit of VPDNs is the way they delegate responsibilities for the network. The customer can outsource responsibility for the information technology (IT) infrastructure to an ISP that maintains the modems that the remote users dial in to, the access servers, and the internetworking expertise. The customer is then responsible only for authenticating users and maintaining the private network.

The figure below shows a basic VPDN network deployment.

Figure 1: Basic VPDN Network Deployment



A PPP client dials in to an ISP access server, called the Network Access Server (NAS). The NAS determines whether it should forward that PPP session on to the router or access server that serves as the point of contact for the private network, the tunnel server. The tunnel server authenticates the user and initiates PPP negotiations. Once PPP setup is complete, all frames that are sent between the client and the tunnel server pass through the NAS.

VPDNs can use these tunneling protocols to tunnel link-level frames:

- Layer 2 Tunneling Protocol (L2TP)
- Layer 2 Tunneling Protocol Version 3 (L2TPv3)
- Layer 2 Forwarding (L2F)
- Point-to-Point Tunneling Protocol (PPTP)

Using one of these protocols, a tunnel is established between the NAS or client and the tunnel server, providing secure data transport over a shared infrastructure such as the Internet.

Note VPDNs on the Cisco ASR 1000 Series Aggregation Services Routers can use only the Layer 2 Tunneling Protocol (L2TP) or the Layer 2 Tunneling Protocol Version 3 (L2TPv3) to tunnel link-level frames.

VPDN Terminology

VPDN Hardware Devices

Generally three devices are involved in VPDN tunneling. Two of these devices function as tunnel endpoints--one device initiates the VPDN tunnel, and the other device terminates the VPDN tunnel. Depending on the tunneling architecture, different types of devices can act as the local tunnel endpoint.

As new tunneling protocols have been developed for VPDNs, protocol-specific terminology has been created to describe some of the devices that participate in VPDN tunneling. However, these devices perform the same basic functions no matter what tunneling protocol is being used. For the sake of clarity we will use this generic terminology to refer to VPDN devices throughout this documentation:

- Client--The client device can be the PC of a dial-in user, or a router attached to a local network. In client-initiated VPDN tunneling scenarios, the client device acts as a tunnel endpoint.
- NAS--The network access server (NAS) is typically a device maintained by an ISP that provides VPDN services for its customers. The NAS is the local point of contact for the client device. Establishing a connection between the NAS and the client will referred to as *receiving a calll* or *placing a calll*, depending on whether a dial-in or dial-out scenario is being discussed. Depending on the tunneling architecture, the NAS functions as follows:
  - For NAS-initiated VPDN tunneling scenarios and dial-out VPDN tunneling scenarios, the NAS functions as a tunnel endpoint. The NAS initiates dial-in VPDN tunnels and terminates dial-out VPDN tunnels. The Cisco ASR 1000 Series Aggregation Services Routers support dial-in only.
  - For client-initiated VPDN tunneling scenarios, the NAS does not function as a a tunnel endpoint; it simply provides Internet connectivity.
- Tunnel server--The tunnel server is typically maintained by the customer and is the contact point for the remote private network. The tunnel server terminates dial-in VPDN tunnels and initiates dial-out VPDN tunnels.
- Tunnel server--The tunnel server is typically maintained by the customer and is the contact point for the remote private network. The tunnel server terminates dial-in VPDN tunnels and initiates dial-out VPDN tunnels.
- Tunnel switch--A tunnel switch is a device configured to perform multihop VPDN tunneling. A tunnel switch acts as both a NAS and a tunnel server. The tunnel switch terminates incoming VPDN tunnels and initiates the outgoing VPDN tunnels that will carry data on to the next hop.

Although technically a tunnel switch is a tunnel endpoint for both the incoming tunnel and the outgoing tunnel, for the sake of simplicity the tunnel endpoints in a multihop deployment are considered to be the device that initiates the first tunnel and the device that terminates the final tunnel of the multihop path.

The table below lists the generic terms and the corresponding technology-specific terms that are sometimes used to describe the NAS and the tunnel server.

Table 1: VPDN Hardware Terminology

Generic Term	L2F Term	L2TP Term	PPTP Term
NAS	NAS	L2TP access concentrator (LAC)	PPTP access concentrator (PAC)
Tunnel server	Home gateway	L2TP network server (LNS)	PPTP network server (PNS)

Note The Cisco ASR 1000 Series Aggregation Services Routers support only L2TP.

VPDN Tunnels

A VPDN tunnel exists between the two tunnel endpoints. The tunnel consists of a control connection and zero or more Layer 2 sessions. The tunnel carries encapsulated PPP datagrams and control messages between the tunnel endpoints. Multiple VPDN sessions can use the same VPDN tunnel.

VPDN Sessions

A VPDN session is created between the tunnel endpoints when an end-to-end PPP connection is established between a client and the tunnel server. Datagrams related to the PPP connection are sent over the tunnel. There is a one-to-one relationship between an established session and the associated call. Multiple VPDN sessions can use the same VPDN tunnel.

VPDN Architectures

Client-Initiated Dial-In VPDN Tunneling

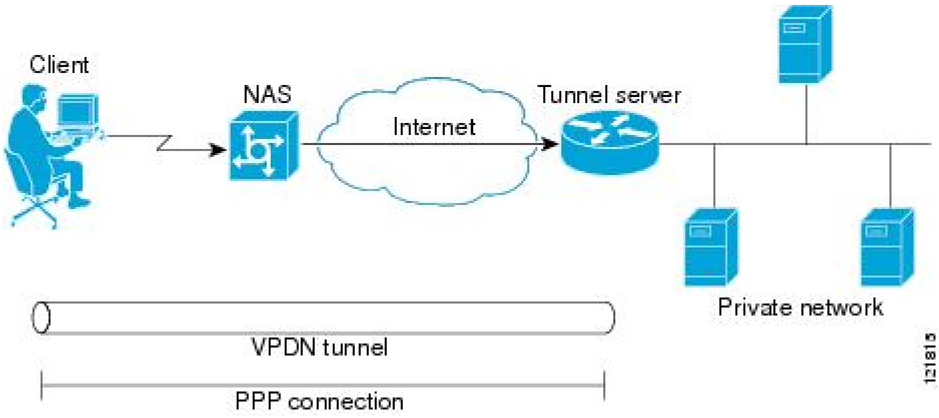
Client-initiated dial-in VPDN tunneling is also known as voluntary tunneling. In a client-initiated dial-in VPDN tunneling scenario, the client device initiates a Layer 2 tunnel to the tunnel server, and the NAS does not participate in tunnel negotiation or establishment. In this scenario, the NAS is not a tunnel endpoint; it simply provides Internet connectivity. The client device must be configured to initiate the tunnel.

The main advantage of client-initiated VPDN tunneling is that it secures the connection between the client and the ISP NAS. However, client-initiated VPDNs are not as scalable and are more complex than NAS-initiated VPDNs.

Client-initiated VPDN tunneling can use the L2TP protocol or the L2TPv3 protocol if the client device is a router. If the client device is a PC, only the PPTP protocol is supported.

The figure below shows a client-initiated VPDN tunneling scenario.

Figure 2: Client-Initiated Dial-In VPDN Scenario



For further information about client-initiated tunneling deployments, see the “Configuring Client-Initiated Dial-In VPDN Tunneling” module.

Before configuring a client-initiated dial-in VPDN tunneling deployment, you must complete the required tasks in the "Configuring AAA for VPDNs" module.

NAS-Initiated Dial-In VPDN Tunneling

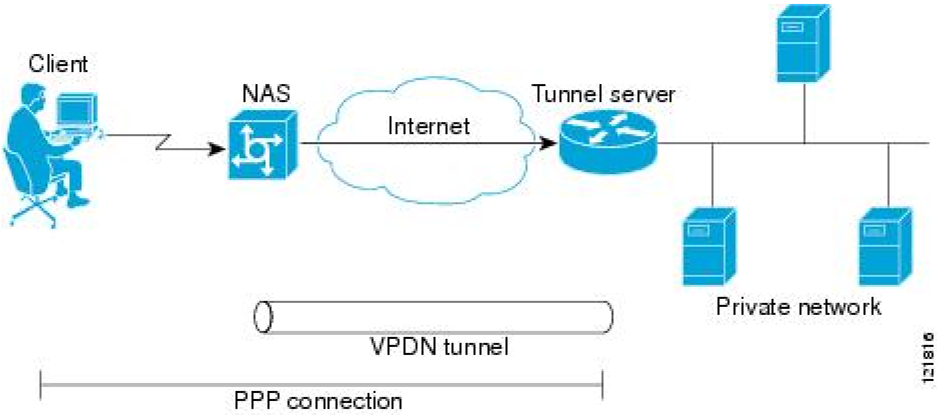
NAS-initiated dial-in VPDN tunneling is also known as compulsory tunneling. In a NAS-initiated dial-in VPDN tunneling scenario, the client dials in to the NAS through a medium that supports PPP. If the connection from the client to the ISP NAS is over a medium that is considered secure, such as digital subscriber line (DSL), ISDN, or the public switched telephone network (PSTN), the client can choose not to provide additional security. The PPP session is securely tunneled from the NAS to the tunnel server without any special knowledge or interaction required from the client.

NAS-initiated VPDN tunneling can be configured with the L2TP or L2F protocol.

Note The Cisco ASR 1000 Series Aggregation Services Routers support only L2TP.

The figure below shows a NAS-initiated dial-in tunneling scenario.

Figure 3: NAS-Initiated Dial-In VPDN Scenario



For further information about NAS-initiated tunneling deployments, see the Configuring NAS-Initiated Dial-In VPDN Tunneling module.

Before configuring a NAS-initiated dial-in VPDN tunneling deployment, you must complete the required tasks in the Configuring AAA for VPDNs module.

Dial-Out VPDN Tunneling

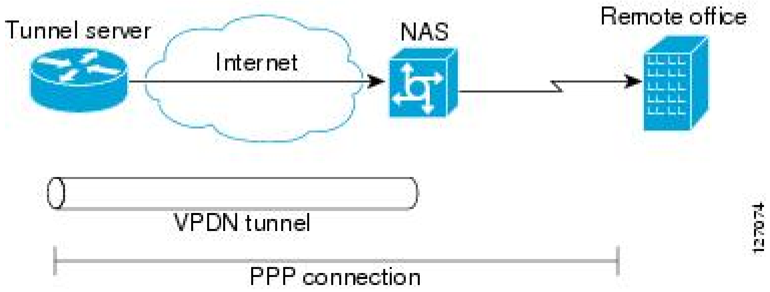
Dial-out VPDN deployments allow the tunnel server to tunnel outbound calls to the NAS. Dial-out VPDNs allow a centralized network to efficiently and inexpensively establish virtual point-to-point connections with any number of remote offices.

Dial-out VPDN tunneling can be configured only with the L2TP protocol.

Note Cisco routers can carry both dial-in and dial-out calls in the same L2TP tunnel.

A dial-out VPDN tunneling scenario is shown in the figure below.

Figure 4: Dial-Out VPDN Scenario



For further information about dial-out VPDN tunneling deployments, see the Configuring Additional VPDN Features module.

Before configuring a dial-out VPDN tunneling deployment, you must complete the required tasks in the Configuring AAA for VPDNs module.

Multihop VPDN Tunneling

Multihop VPDN is a specialized VPDN configuration that allows packets to pass through multiple tunnels. Ordinarily, packets are not allowed to pass through more than one tunnel. In a multihop tunneling deployment, the VPDN tunnel is terminated after each hop and a new tunnel is initiated to the next hop destination. A maximum of four hops is supported.

Multihop VPDN is required for the scenarios described in these sections:

VPDN Tunneling to an MMP Stack Group

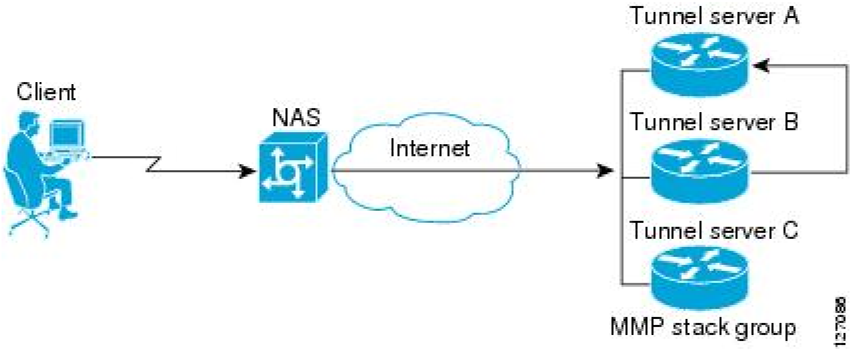
Multihop VPDN is required when the private network uses Mutlichassis Multilink PPP (MMP) with multiple tunnel servers in a stack group. Stack group configurations require the ability to establish Layer 2 tunnels between participating hardware devices. If the incoming data is delivered to the stack group over a VPDN tunnel, multihop VPDN is required for the stack group to function.

Multihop VPDN tunneling with MMP can be configured using the L2TP or L2F protocol.

Note The Cisco ASR 1000 Aggregation Services Routers support only L2TP.

The figure below shows a network scenario using a multihop VPDN with an MMP deployment.

Figure 5: MMP Using Multihop VPDN



For further information about configuring multihop VPDN for MMP deployments, see the Configuring Multihop VPDN module.

Before configuring a multihop VPDN for MMP deployment, you must configure MMP and you must complete the required tasks in the Configuring AAA for VPDNs module.

Tunnel Switching VPDNs

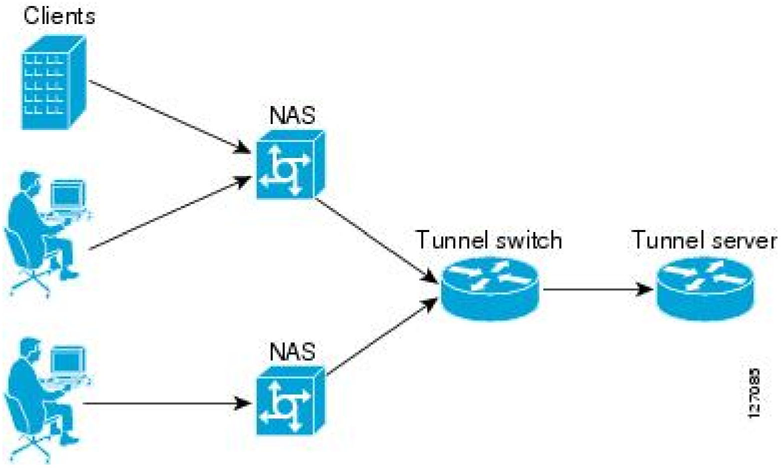
Multihop VPDN can be used to configure a router as a tunnel switch. A tunnel switch is a device that is configured as both a NAS and a tunnel server. A tunnel switch is able to receive packets from an incoming VPDN tunnel and send them out over an outgoing VPDN tunnel. Tunnel switch configurations can be used between ISPs to provide wholesale VPDN services.

Multihop tunnel switching can be configured using the L2TP, L2F, or PPTP protocol.

Note The Cisco ASR 1000 Aggregation Services Routers support only L2TP.

The figure below shows a network scenario using a tunnel switching deployment.

Figure 6: Tunnel Switching Using Multihop VPDN



For further information about multihop tunnel switching deployments, see the Configuring Multihop VPDN module.

Before configuring a multihop tunnel switching deployment, you must complete the required tasks in the Configuring AAA for VPDNs module.

VPDN Tunneling Protocols

VPDNs use Layer 2 protocols to tunnel the link layer of high-level protocols (for example, PPP frames or asynchronous High-Level Data Link Control (HDLC). ISPs configure their NAS to receive calls from users and to forward the calls to the customer tunnel server.

Usually, the ISP maintains only information about the customer tunnel server. The customer maintains the users' IP addresses, routing, and other user database functions. Administration between the ISP and the tunnel server is reduced to IP connectivity.

This section contains information on these Layer 2 protocols that can be used for VPDN tunneling:

Note Effective with Cisco Release 12.4(11)T, the L2F protocol is not available in Cisco IOS software.

L2TP

L2TP is an Internet Engineering Task Force (IETF) standard that combines the best features of the two older tunneling protocols: Cisco L2F and Microsoft PPTP.

L2TP offers the same full-range spectrum of features as L2F, but offers additional functionality. An L2TP-capable tunnel server will work with an existing L2F NAS and will concurrently support upgraded components running L2TP. Tunnel servers do not require reconfiguration each time an individual NAS is upgraded from L2F to L2TP. The table below compares L2F and L2TP feature components.

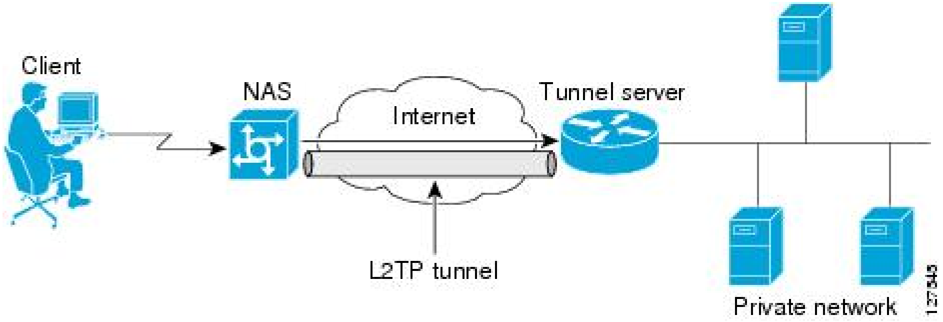
Table 2: L2F and L2TP Feature Comparison

Function	L2F	L2TP
Flow Control	No	Yes
Attribute-value (AV) pair hiding	No	Yes
Tunnel server load sharing	Yes	Yes
Tunnel server stacking/multihop support	Yes	Yes
Tunnel server primary and secondary backup	Yes	Yes
Domain Name System (DNS) name support	Yes	Yes
Domain name flexibility	Yes	Yes
Idle and absolute timeout	Yes	Yes
Multilink PPP support	Yes	Yes
Multichassis Multilink PPP support	Yes	Yes
Security	• All security benefits of PPP, including multiple per-user authentication options: • Challenge Handshake Authentication Protocol (CHAP) • Microsoft CHAP (MS-CHAP) • Password Authentication Protocol (PAP) • Tunnel authentication mandatory	• All security benefits of PPP, including multiple per-user authentication options: • CHAP • MS-CHAP • PAP • Tunnel authentication optional

Traditional dialup networking services support only registered IP addresses, which limits the types of applications that are implemented over VPDNs. L2TP supports multiple protocols and unregistered and privately administered IP addresses. This allows the existing access infrastructure--such as the Internet, modems, access servers, and ISDN terminal adapters (TAs)--to be used. It also allows customers to outsource dial-out support, thus reducing overhead for hardware maintenance costs and 800 number fees, and allows them to concentrate corporate gateway resources.

The figure below shows the basic L2TP architecture in a typical dial-in environment.

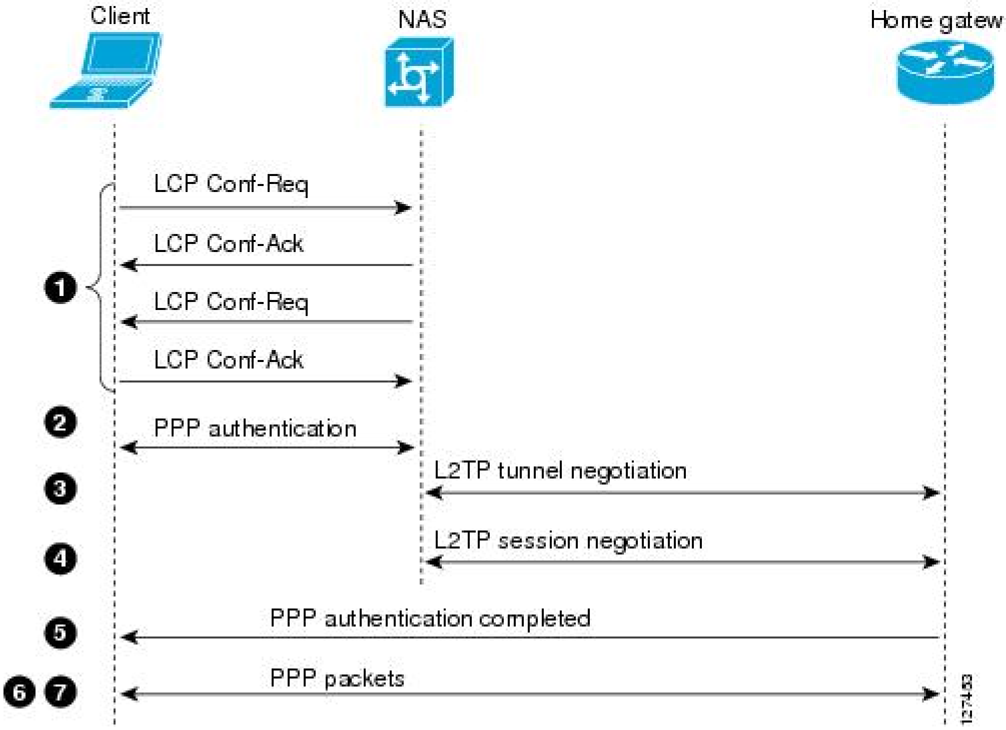
Figure 7: L2TP Architecture



Using L2TP tunneling, an ISP or other access service can create a virtual tunnel to link remote sites or remote users with corporate home networks. The NAS located at the POP of the ISP exchanges PPP messages with remote users and communicates by way of L2TP requests and responses with the private network tunnel server to set up tunnels. L2TP passes protocol-level packets through the virtual tunnel between endpoints of a point-to-point connection. Frames from remote users are accepted by the ISP NAS, stripped of any linked framing or transparency bytes, encapsulated in L2TP, and forwarded over the appropriate tunnel. The private network tunnel server accepts these L2TP frames, strips the L2TP encapsulation, and processes the incoming frames for the appropriate interface.

The figure below depicts the events that occur during establishment of a NAS-initiated dial-in L2TP connection.

Figure 8: L2TP Protocol Negotiation Events



The following describes the sequence of events shown in the figure above and is keyed to the figure:

1 The remote user initiates a PPP connection to the ISP NAS using a medium that supports PPP such as the analog telephone system. The NAS accepts the connection, the PPP link is established, and Link Control Protocol (LCP) is negotiated.

2 After the end user and NAS negotiate LCP, the NAS partially authenticates the end user with CHAP or PAP. The username, domain name, or Dialed Number Information Service (DNIS) is used to determine whether the user is a VPDN client. If the user is not a VPDN client, authentication continues, and the client will access the Internet or other contacted service. If the username is a VPDN client, the mapping will name a specific endpoint (the tunnel server).

3 The tunnel endpoints, the NAS and the tunnel server, authenticate each other before any tunnel or session establishment is attempted. Alternatively, the tunnel server can accept tunnel creation without any tunnel authentication of the NAS. The NAS and the tunnel server exchange control messages to negotiate tunnel establishment.

4 Once the tunnel exists, an L2TP session is created for the end user. The NAS and the tunnel server exchange call messages to negotiate session establishment.

5 The NAS will propagate the negotiated LCP options and the partially authenticated CHAP or PAP information to the tunnel server. The tunnel server will funnel the negotiated options and authentication information directly to the virtual access interface, allowing authentication to be completed. If the options configured in the virtual template interface do not match the options negotiated with the NAS, the connection will fail and a disconnect notification will be sent to the NAS.

6 PPP packets are exchanged between the dial-in client and the remote tunnel server as if no intermediary device (the NAS) is involved.

Subsequent PPP incoming sessions (designated for the same tunnel server) do not repeat the L2TP tunnel negotiation because the L2TP tunnel is already open.

L2TPv3

L2TPv3 is an enhanced version of L2TP with the capability to tunnel any Layer 2 payload. L2TPv3 defines the L2TP protocol for tunneling Layer 2 payloads over an IP core network using Layer 2 Virtual Private Networks (VPNs).

In VPDN deployments, L2TPv3 can be used to establish a client-initiated tunnel from a local router to the remote customer network over an emulated circuit known as a pseudowire. There is one pseudowire associated with each L2TPv3 session.

Rather than using a VPDN group configuration, L2TPv3 uses an L2TP class configuration that is associated with the pseudowire. L2TPv3 pseudowires can also be used to establish L2TP tunnels by configuring an L2TP class on the local device and an accept-dialin VPDN group on the customer network.

For detailed information about the L2TPv3 protocol, see the Additional References section.

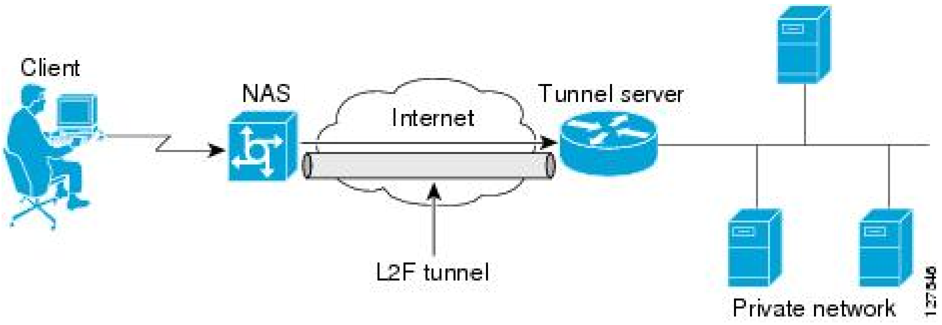
L2F

L2F is an older tunneling protocol, but still offers a wide range of useful features. L2F, on page 12 offers a comparison of L2F and L2TP feature components.

Note Effective with Cisco Release 12.4(11)T, the L2F protocol is not available in Cisco IOS software.

The figure below shows the basic L2F architecture in a typical dial-in environment.

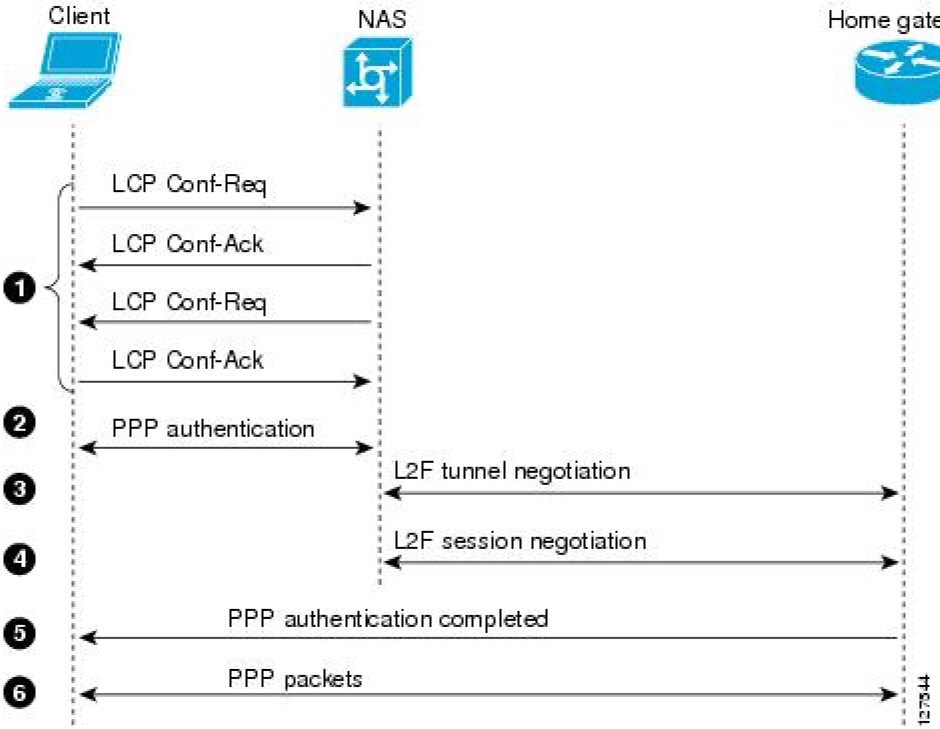
Figure 9: L2F Architecture



Using L2F tunneling, an ISP or other access service can create a virtual tunnel to link remote sites or remote users with the corporate home network. The NAS located at the POP of the ISP exchanges PPP messages with remote users and communicates by way of L2F requests and responses with the private network tunnel server to set up tunnels. L2F passes protocol-level packets through the virtual tunnel between endpoints of a point-to-point connection. Frames from remote users are accepted by the ISP NAS, stripped of any linked framing or transparency bytes, encapsulated in L2F, and forwarded over the appropriate tunnel. The private network tunnel server accepts these L2F frames, strips the L2F encapsulation, and processes the incoming frames for the appropriate interface.

The figure below depicts the events that occur during establishment of a NAS-initiated dial-in L2F connection.

Figure 10: L2F Protocol Negotiation Events



The following describes the sequence of events shown in the figure above and is keyed to the figure:

1 The remote user initiates a PPP connection to the ISP NAS using a medium that supports PPP such as the analog telephone system. The NAS accepts the connection, the PPP link is established, and LCP is negotiated.

2 The NAS begins PPP authentication by sending a CHAP challenge to the client. The client replies with a CHAP response.

3 When the NAS receives the CHAP response, either the phone number from which the user dialed in (when using DNIS-based authentication) or the user domain name (when using authentication based on domain name) matches a configuration on either the NAS or its authentication, authorization, and accounting (AAA) server. The NAS and the tunnel server exchange L2F control packets, opening the L2F tunnel.

4 Once the L2F tunnel is open, the NAS and tunnel server exchange L2F session packets. The NAS sends the tunnel server client information from the LCP negotiation, the CHAP challenge, and the CHAP response. The tunnel server creates a virtual access interface for the client and responds to the NAS, opening the L2F session.

5 The tunnel server authenticates the CHAP challenge and response (using either local or remote AAA) and sends a CHAP Auth-OK packet to the client. This completes the three-way CHAP authentication.

6 When the client receives the CHAP Auth-OK packet, it can send PPP encapsulated packets to the tunnel server. The client and the tunnel server can now exchange PPP encapsulated packets. The NAS acts as a transparent PPP frame forwarder.

Subsequent PPP incoming sessions (designated for the same tunnel server) do not repeat the L2F tunnel negotiation because the L2F tunnel is already open.

PPTP

PPTP is a network protocol that enables the secure transfer of data from a remote client to a private enterprise server by creating a VPDN across TCP/IP-based data networks. PPTP supports on-demand, multiprotocol, virtual private networking over public networks, such as the Internet.

Cisco supports only client-initiated VPDNs using PPTP. Only the client and the tunnel server need to be configured for VPDN. The client first establishes basic connectivity by dialing in to an ISP NAS. Once the PPP session has been established, the client initiates a PPTP tunnel to the tunnel server.

Microsoft Point-to-Point Encryption (MPPE), an encryption technology developed by Microsoft to encrypt point-to-point links, can be used to encrypt PPTP VPDNs. It encrypts the entire session from the client to the tunnel server.

The following describes the protocol negotiation events that establish a client-initiated PPTP tunnel:

1. The client dials in to the ISP NAS and establishes a PPP session.
2. The client establishes a TCP connection with the tunnel server.
3. The tunnel server accepts the TCP connection.
4. The client sends a PPTP Start Control Connection Request (SCCRQ) message to the tunnel server.
5. The tunnel server establishes a new PPTP tunnel and replies with a Start Control Connection Reply (SCCRP) message.
6. The client initiates the session by sending an Outgoing Call Request (OCRQ) message to the tunnel server.
7. The tunnel server creates a virtual access interface.
8. The tunnel server replies with an Outgoing Call Reply (OCRP) message.

VPDN Group Configuration Modes

Many VPDN configuration tasks are performed within a VPDN group. A VPDN group can be configured to function either as a NAS VPDN group or as a tunnel server VPDN group, but not as both. However, an individual router can be configured with both a NAS VPDN group and a tunnel server VPDN group.

You can configure a VPDN group as a specific type of VPDN group by issuing at least one of the commands listed in the table below:

- Tunnel server VPDN groups can be configured to accept dial-in calls, request dial-out calls, or both.
- NAS VPDN groups can be configured to request dial-in calls, accept dial-out calls, or both.

Table 3: VPDN Subgroup Configuration Modes

VPDN Group Type	Command	Command Mode	Command Mode Prompt
tunnel server	**accept-dialin**	VPDN accept-dialin configuration	Router(config-vpdn-acc-in)#
tunnel server	**request-dialout**	VPDN request-dialout configuration	Router(config-vpdn-req-ou)#
NAS	**request-dialin**	VPDN request-dialin configuration	Router(config-vpdn-req-in)#
NAS	**accept-dialout**	VPDN accept-dialout configuration	Router(config-vpdn-acc-ou)#

Many of the commands required to properly configure VPDN tunneling are issued in one of the VPDN subgroup configuration modes shown in the table above. Removing the VPDN subgroup command configuration will remove all subordinate VPDN subgroup configuration commands as well.

Where to Go Next

Once you have identified the VPDN architecture that you want to configure and the tunneling protocol that you will use, you should perform the required tasks in the Configuring AAA for VPDNs module.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
Information about Multichassis Multilink PPP	Implementing Multichassis Multilink PPP module
Technical support documentation for L2TP	*Layer 2 Tunnel Protocol (L2TP)*
Technical support documentation for PPTP	*Point to Point Tunneling Protocol (PPTP)*
Technical support documentation for VPDNs	*Virtual Private Dial-Up Network (VPDN)*
Dial Technologies commands: complete command syntax, command mode, defaults, usage guidelines, and examples	*Cisco IOS Dial Technologies Command Reference*

Related Topic	Document Title
Information on L2TPv3	L2TPv3: Layer 2 Tunnel Protocol Version 3 module

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
• CISCO-VPDN-MGMT-MIB • CISCO-VPDN-MGMT-EXT-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 2341	Cisco Layer Two Forwarding (Protocol) L2F
RFC 2637	Point-to-Point Tunneling Protocol (PPTP)
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

CHAPTER 2

Configuring AAA for VPDNs

This module describes how to configure authentication, authorization, and accounting (AAA) for virtual private dialup networks (VPDNs).

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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 table at the end of this module.

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

Prerequisites for Configuring AAA for VPDNs

- Before configuring AAA for VPDNs, you should understand the concepts in the *VPDN Technology Overview* module.
- You must identify the VPDN architecture you plan to implement.
- You must identify the tunneling protocol you will use.

- If you plan to configure remote AAA, you should understand the concepts in the Authentication, Authorization, and Accounting (AAA) and Security Server Protocols modules.
- If you plan to configure Layer 2 Tunneling Protocol (L2TP) Forwarding of Point-to-Point over Ethernet (PPPoE) Tagging Information, it is recommended that you be familiar with RFC 2516 and DSL Forum TR-101 before configuring this feature.
- If you plan to configure L2TP Domain Screening, you must configure the L2TP access concentrator (LAC) to request authentication of a complete username before making a forwarding decision for dial-in L2TP. In other words, the LAC preauthenticates *username@domain* to find the correct L2TP tunnel for the user session.
- You can configure VPDN preauthentication to occur globally or per VPDN group. For global VPDN preauthentication, authentication and authorization should be done using an authentication server. For per-VPDN group-level preauthentication, authentication and authorization should be done locally.

Information About Configuring AAA for VPDNs

VPDN Tunnel Authorization Search Order

When a call to a network access server (NAS) is to be tunneled to a tunnel server, the NAS must identify which tunnel server to forward the call to. The router can authorize users and select the outgoing tunnel based on the domain portion of the username, the Dialed Number Identification Service (DNIS) number, the multihop hostname, or any combination of these three parameters in a specified order. The default search order for VPDN tunnel authorization is to first search by DNIS, then by domain.

These sections contain information on VPDN tunnel lookup criteria:

VPDN Tunnel Lookup Based on Domain Name

When a NAS is configured to forward VPDN calls on the basis of the user domain name, the user must use a username of the form *username@domain*. The NAS then compares the user domain name to the domain names it is configured to search for. When the NAS finds a match, it forwards the user call to the proper tunnel server.

VPDN Tunnel Lookup Based on L2TP Domain Screening

You can modify the domain portion of the username seamlessly when you enter into a virtual private network (VPN) service. The L2TP Domain Screening feature ensures that the appropriate domain has been screened before access is allowed to an L2TP tunnel for the user session.

For additional information on configuring L2TP Domain Screening tunnel authentication into a VPN, refer to the L2TP Domain Screening, on page 19.

VPDN Tunnel Lookup Based on DNIS Information

When a NAS is configured to forward VPDN calls on the basis of the user DNIS information, the NAS identifies the user DNIS information, which is provided on ISDN lines, and then forwards the call to the proper tunnel server.

The ability to select a tunnel on the basis of DNIS information provides additional flexibility to network service providers that offer VPDN services and to the companies that use the services. Instead of using only the domain name for tunnel selection, the NAS can use dialed number information for tunnel selection.

With this feature, a company--which might have only one domain name--can provide multiple specific phone numbers for users to dial in to the NAS at the service provider point of presence (POP). The service provider can select the tunnel to the appropriate services or portion of the company network on the basis of the dialed number.

VPDN Tunnel Lookup Based on Both Domain Name and DNIS Information

When a service provider has multiple AAA servers configured, VPDN tunnel authorization searches based on domain name can be time consuming and might cause the client session to time out.

To provide more flexibility, service providers can configure the NAS to perform tunnel authorization searches by domain name only, by DNIS only, or by both in a specified order.

VPDN Tunnel Lookup Based on the Multihop Hostname

If a device will function as a multihop tunnel switch, tunnel authorization searches can be performed based on the multihop hostname. Configuring a multihop hostname on a tunnel switch allows authorization searches to be based on the identity of the peer device that initiated the tunnel. The multihop hostname can be the hostname of the remote peer that initiated the ingress tunnel, or the tunnel ID associated with the ingress tunnel.

A multihop tunnel switch can be configured to perform authorization searches by multihop hostname only, by domain name only, by DNIS only, or by any combination of these searches in a specified order.

L2TP Domain Screening

The L2TP Domain Screening feature provides a flexible mechanism for controlling session access to an L2TP tunnel. This feature provides the ability to modify the domain portion of the username seamlessly when a subscriber enters into a virtual private network (VPN) service. The L2TP Domain Screening feature allows per-user L2TP tunnel setup by combining these features:

- User preauthentication using the **vpdn authen-before-forward** command
- Modifying the domain portion of the username using the **vpn service** command to bind an incoming session to a certain L2TP tunnel

These two commands work together in the L2TP Domain Screening feature to make sure that the appropriate domain has been screened before access is allowed to an L2TP tunnel for the user session.

You can modify the domain portion of the username seamlessly when you enter into a VPN service. The L2TP Domain Screening, Rules Based feature allows per-user L2TP tunnel setup by creating customized Policy Manager match rules. For more information on the L2TP Domain Screening, Rules Based, see the L2TP Domain Screening Rules Based, on page 20.

L2TP Tunnel Authentication

The general process flow for tunnel authentication begins when the vpdn authen-before-forward process is called if necessary to authenticate the username and domain name to find the correct L2TP tunnel for the session. If no authentication is required, the tunnel match for the domain name is found for the session. In either case, the original username with the original domain is used for session authentication at the L2TP network server (LNS).

For instances with the VPN service applied to the configuration. Just as before, if the vpdn authen-before-forward process determines that the session must be locally authenticated before being placed into the correct tunnel, authentication proceeds as normal. However, with the vpn service statement applied, the session is placed into the appropriate tunnel for the VPN domain.

The full VPN service application flow. If local authentication at the LAC is required and a VPN service is configured, a local authentication is done with the username provided and the domain of the VPN service provider. This step returns the necessary L2TP tunnel for this VPN session. If VPN service is not configured, local authentication is provided on the username and domain name provided by the subscriber.

If the session does not require local authentication but there is a configured VPN service, the session is placed into the L2TP tunnel for the VPN service provider. Otherwise, the session will be placed into the tunnel for the specified domain name.

In any of these scenarios, the username and domain name for the subscriber session stay the same at the L2TP network server (LNS). This allows a wholesale provider to dedicate a service provider for providing all VPN services to its subscribers without the need for complex configuration for each VPN.

The **vpn service** command binds a physical incoming interface to a certain tunnel. The result is that no matter what username or domain is presented, the user is always forwarded to the specified tunnel configured by the **vpn service** command.

L2TP Domain Screening Rules Based

You can modify the domain portion of the username seamlessly when you enter into a VPN service. The L2TP Domain Screening, Rules Based feature allows per-user L2TP tunnel setup by creating customized Policy Manager match rules. The L2TP Domain Screening, Rules Based feature allows you to construct rules to customize specific policy behavior. You can use the following commands to construct specific policy behavior.

- Collect and cache the unauthenticated user name using the **set variable** command
- Replace the domain portion of the cached username using the **substitute** command and authenticate using the new altered domain name
- Authenticate the name specified using the **authenticate** command and send the authenticated name to policy manager

These commands work together in the L2TP Domain Screening, Rules Based feature to make sure that the appropriate domain has been screened before access is allowed to an L2TP tunnel for the user session.

Per-User VPDN AAA

If remote AAA is used for VPDN, the NAS that receives the call from a user forwards information about that user to its remote AAA server. With basic VPDN, the NAS sends the user domain name when performing authentication based on domain name or the telephone number the user dialed in from when performing authentication based on DNIS.

When per-user VPDN is configured, the entire structured username is sent to a RADIUS AAA server the first time the router contacts the AAA server. This enables the software to customize tunnel attributes for individual users that use a common domain name or DNIS.

Without VPDN per-user configuration, the software sends only the domain name or DNIS to determine VPDN tunnel attribute information. Then, if no VPDN tunnel attributes are returned, the software sends the entire username string.

VPDN Authorization for Directed Request Users

Directed requests allow users logging in to a NAS to select a RADIUS server for authorization. With directed requests enabled, only the portion of the username before the "@" symbol is sent to the host specified after the "@" symbol. Using directed requests, authorization requests can be directed to any of the configured servers, and only the username is sent to the specified server.

Domain Name Prefix and Suffix Stripping

When a user connects to a NAS configured to use a remote server for AAA, the NAS forwards the username to the remote AAA server. Some RADIUS or TACACS+ servers require the username to be in a particular format, which might be different from the format of the full username. For example, the remote AAA server might require the username to be in the format user@domain.com, but the full username could be prefix/user@domain.com@suffix. Configuring domain name stripping allows the NAS to strip incompatible portions from the full username before forwarding the reformatted username to the remote AAA server.

The NAS can be configured to perform in these ways:

- Strip generic suffixes from the full username using the suffix delimiter character @. Any portion of the full username that follows the first delimiter that is parsed will be stripped.
- Use a different character or set of characters as the suffix delimiter.
- Strip both suffixes and prefixes from the full username. The NAS can also be configured to strip only specified suffixes instead of performing generic suffix stripping.

VPDN Tunnel Authentication

VPDN tunnel authentication enables routers to authenticate the other tunnel endpoint before establishing a VPDN tunnel. VPDN tunnel authentication is optional for L2TP tunnels.

For additional information on configuring VPDN tunnel authentication for client-initiated VPDN tunneling deployments, see the "Configuring VPDN Tunnel Authentication" section.

VPDN tunnel authentication can be performed in these ways:

- Using local AAA on both the NAS and the tunnel server
- Using a remote RADIUS AAA server on the NAS and local AAA on the tunnel server
- Using a remote TACACS+ AAA server on the NAS and local AAA on the tunnel server

For L2TP tunnels only, a remote RADIUS AAA server can be used to perform VPDN tunnel authentication on the VPDN tunnel terminator as follows:

- Using a remote RADIUS AAA server on the tunnel server for dial-in VPDNs
- Using a remote RADIUS AAA server on the NAS for dial-out VPDNs

For detailed information on configuring remote RADIUS or TACACS+ servers, see the "Additional References section."

RADIUS Tunnel Accounting for L2TP VPDNs

RADIUS tunnel accounting for VPDNs is supported by RFC 2867, which introduces six new RADIUS accounting types. Without RADIUS tunnel accounting support, VPDN with network accounting will not report all possible attributes to the accounting record file. RADIUS tunnel accounting support allows users to determine tunnel-link status changes. Because all possible attributes can be displayed, users can better verify accounting records with their Internet service providers (ISPs).

Enabling tunnel type accounting records allows the router to send tunnel and tunnel-link accounting records to the RADIUS server. The two types of accounting records allow the identification of VPDN tunneling events as described next.

Tunnel-Type Accounting Records

AAA sends Tunnel-Start, Tunnel-Stop, or Tunnel-Reject accounting records to the RADIUS server to identify these events:

- A VPDN tunnel is brought up or destroyed.
- A request to create a VPDN tunnel is rejected.

Tunnel-Link-Type Accounting Records

AAA sends Tunnel-Link-Start, Tunnel-Link-Stop, or Tunnel-Link-Reject accounting records to the RADIUS server to identify these events:

- A user session within a VPDN tunnel is brought up or brought down.
- A user session create request is rejected.

Suppressing EXEC Accounting Record

You can suppress an EXEC accounting record when you configure autoselection during login for the dial-in clients. Normally when you configure autoselection during-login, two accounting start and stop records (one for the EXEC_service and the other for FRAMED_service) are sent if PPP is autoselected for the user. Though it is the expected behavior, it can lead to additional billing on the server. Use the **aaa accounting nested suppress stop** command to prevent the generation of EXEC-stop accounting records.

VPDN-Specific Remote RADIUS AAA Server Configurations

The RADIUS attributes are specific to VPDN configurations. For detailed information on configuring remote RADIUS or TACACS+ servers, see the Additional References section.

VPDN-specific RADIUS attributes provide this functionality:

- Tunnel server load balancing and failover--The NAS remote RADIUS AAA server can be configured to forward the NAS information about tunnel server priorities.
- DNS name support--The NAS AAA server can be configured to resolve Domain Name System (DNS) names and translate them into IP addresses.
- Tunnel assignments--The NAS AAA server can be configured to group users from different per-user or domain RADIUS profiles into the same active VPDN tunnel when the tunnel type and tunnel endpoint are identical.
- L2TP tunnel connection speed labeling--The NAS AAA server can be configured to perform an authentication check based on the user's connection speed.
- Authentication names for NAS-initiated tunnels--The NAS AAA server can be configured with authentication names other than the default names for the NAS and the NAS AAA server.

L2TP Tunnel Server Load Balancing and Failover Using the RADIUS Tunnel Preference Attribute

In a multivendor network environment, using a VSA on a RADIUS server can cause interoperability issues among NASs manufactured by different vendors. Even though some RADIUS server implementations can send VSAs that the requesting NAS can understand, the user still must maintain different VSAs for the same purpose in a single-service profile.

A consensus regarding the tunnel attributes that are to be used in a multivendor network environment is defined in RFC 2868. In RFC 2868, Tunnel-Server-Endpoint specifies the address to which the NAS should initiate a new session. If multiple Tunnel-Server-Endpoint attributes are defined in one tagged attribute group, they are interpreted as equal-cost load-balancing tunnel servers.

The Tunnel-Preference attribute defined in RFC 2868 can be used to form load balancing and failover tunnel server groups. When the Tunnel-Preference values of different tagged attribute groups are the same, the Tunnel-Server-Endpoint of those attribute groups is considered to have the same priority unless otherwise specified. When the Tunnel-Preference values of some attribute groups are higher (they have a lower preference) than other attribute groups, their Tunnel-Server-Endpoint attributes will have higher priority values. When an attribute group has a higher priority value, that attribute group will be used for failover in case the attribute groups with lower priority values are unavailable for the connections.

Note Support for the Tunnel-Preference attribute was introduced on Cisco access server platforms in Cisco IOS Release 12.2(11)T.

The RADIUS Tunnel-Preference attribute is useful for large multivendor networks that use VPDN Layer 2 tunnels over WAN links such as ATM and Ethernet. The NAS uses tunnel profiles downloaded from the RADIUS server to establish load balancing and failover priorities for VPDN Layer 2 tunnels. The Point-to-Point over Ethernet (PPPoE) protocol is used as the client to generate PPP sessions.

When multiple tunnel servers of the same priority are configured, the NAS will select the tunnel server with the lowest number of active sessions. If several tunnel servers have the same number of active sessions, the NAS must use a tie-breaking mechanism to determine which to select.

The NAS uses a round-robin selection as the tie-breaking mechanism. Because each NAS is aware only of its own session load, multiple NASs using the same round-robin algorithm might unevenly distribute sessions across the tunnel servers (session bunching). Each NAS selects the same tunnel server in the case of a tie because the round-robin tie-breaking mechanism always resolves to the same tunnel server. Session bunching is especially prominent when there is a very low number of sessions on each NAS.

The NAS uses a new tie-breaking algorithm. A random selection is made among all peer tunnel servers carrying the same session load. This improved algorithm results in a more even distribution of sessions across tunnel servers, reducing the occurrence of session bunching.

Shell-Based Authentication of VPDN Users

The NAS and tunnel server can be configured to perform shell-based authentication of VPDN users. Shell-based authentication of VPDN users provides terminal services (shell login or exec login) for VPDN users to support rollout of wholesale dial networks. Authentication of users occurs via shell or exec login at the NAS before PPP starts and the tunnel is established.

A character-mode login dialog is provided before PPP starts, and the login dialog supports schemes such as token-card synchronization and initialization, challenge-based password, and so on. After a user is authenticated in this way, the connection changes from character mode to PPP mode to connect the user to the desired destination. The AAA server that authenticates the login user can be selected based on the dialed DNIS or the domain-name part of the username.

VPDN profiles can be kept by a Resource Pool Manager Server (RPMS), RADIUS-based AAA server, or on the NAS.

Enabling shell-based authentication of VPDN users provides these capabilities:

- Authentication of a dial-in user session occurs at the NAS before PPP is started or a tunnel is established. If authentication fails, the user session can be terminated before tunneling resources are used.
- Authentication of a PPP user can be performed using authentication methods other than CHAP and Password Authentication Protocol (PAP). A character-mode login dialog such as username/password or username/challenge/password, Secure ID, or Safeword can be used. PPP authentication data is preconfigured or entered before PPP starts. Authentication is completed without any further input from the user.

For the NAS to perform shell-based VPDN authentication, it must be configured for AAA, PPP must be configured to bypass authentication, and DNIS must be enabled.

L2TP Forwarding of PPPoE Tagging Information

The L2TP Forwarding of PPPoE Tag Information feature allows you to transfer DSL line information from the L2TP access concentrator (LAC) to the L2TP network server (LNS). For example, the LAC transports the actual-rate-up and the actual-rate-down PPPoE tag information to the LNS, which learns about the actual PPPoE transfer speeds that are negotiated by the customer premise equipment (CPE) and the digital subscriber line access multiplexer (DSLAM). The DSLAM inserts the PPPoE tag values for the rate up and the rate down and signals this information during PPPoE establishment with the LAC, which in turn, sends this information to the LNS.

By using the L2TP Forwarding of PPPoE Tag Information feature, you can also override the nas-port-id, or calling-station-id VSAs, or both, on the LNS with the Circuit-ID and Remote-ID VSA respectively.

When you configure the **dsl-line-info-forwarding** command in VPDN group or VPDN-template configuration mode, and when the LNS receives one of the specified AV pairs, the LNS sends a matching VSA to the RADIUS server as a AAA request. The associated AAA attributes are:

- AAA_CIRCUIT_ID (RADIUS attribute 87)
- AAA_REMOTE_ID (RADIUS attribute 31)

- DSL Sync Rate VSAs

Enter the **radius-server attribute 87 circuit-id** command to override the nas-port-id with the CIRCUIT_ID VSA. Enter the **radius-server attribute 31 remote-id** command to override the calling-station-id with the REMOTE_ID VSA.

In accordance with DSL Forum 2004-71, the DSL uses the Vendor Specific tag for line identification. The first two octets (TAG_TYPE) are PPPOE_TAG_VENDSPEC (0x0105). The next two octets (TAG_LENGTH) contain the total length including Suboptions, Suboption-lengths, and Tag-values. The first four octets of the TAG_VALUE contain the vendor ID. The next octet contains suboption for Agent Remote ID (0x02). Following octet contains total length of Suboption-tag in bytes.

The maximum length for the Remote-ID tag is 63 bytes. The Remote-ID tag contains an operator administered string that uniquely identifies the subscriber on the associated DSL line. The Remote-ID tag can be a phone number, an e-mail address, a billing account number, or any other string that can be used by service providers as a tracking mechanism.

If the discovery frame has the suboption 0x01, it indicates the presence of the Circuit-ID tag. A single frame supports Circuit-ID, Remote-ID, or both. If Circuit-ID is present in the same frame, it sends to the RADIUS server through the Nas-Port-ID attribute.

The following example shows an access and accounting request sent to the RADIUS server with remote-ID tag and DSL-Sync-Rate tags:

```
01:24:52: RADIUS/ENCODE: Best Local IP-Address 10.0.73.20 for Radius-Server 128.107.164.254
01:24:52: RADIUS(00000011): Send Access-Request to 192.107.164.254:1645 id 1645/3, len 391
01:24:52: RADIUS:  authenticator 3B 49 F5 7D 8A 6F A4 D7 - 57 99 E6 60 A9 D0 C7 B9
01:24:52: RADIUS:  Vendor, Cisco       [26]  41
01:24:52: RADIUS:   Cisco AVpair       [1]   35  "client-mac-address=0090.bf06.c81c"
01:24:52: RADIUS:  Vendor, Cisco       [26]  39
01:24:52: RADIUS:   Cisco AVpair       [1]   33  "actual-data-rate-upstream=20480"
01:24:52: RADIUS:  Vendor, Cisco       [26]  39
01:24:52: RADIUS:   Cisco AVpair       [1]   33  "actual-data-rate-downstream=512"
01:24:52: RADIUS:  Vendor, Cisco       [26]  39
01:24:52: RADIUS:   Cisco AVpair       [1]   33  "minimum-data-rate-upstream=1024"
01:24:52: RADIUS:  Framed-Protocol     [7]   6   PPP                       [1]
01:24:52: RADIUS:  User-Name           [1]   16  "pshroff-client"
01:24:52: RADIUS:  CHAP-Password       [3]   19  *
01:24:52: RADIUS:  NAS-Port-Type       [61]  6   Ethernet                  [15]
01:24:52: RADIUS:  Vendor, Cisco       [26]  46
01:24:52: RADIUS:   Cisco AVpair       [1]   40  "circuit-id-tag=Ethernet1/0.1:ababababa"
01:24:52: RADIUS:  Vendor, Cisco       [26]  36
01:24:52: RADIUS:   Cisco AVpair       [1]   30  "remote-id-tag=0090.bf06.c81c"
01:24:52: RADIUS:  NAS-Port            [5]   6   268435486
01:24:52: RADIUS:  NAS-Port-Id         [87]  25  "Ethernet1/0.1:ababababa"
01:24:52: RADIUS:  Vendor, Cisco       [26]  41
01:24:52: RADIUS:   Cisco AVpair       [1]   35  "client-mac-address=0090.bf06.c81c"
01:24:52: RADIUS:  Service-Type        [6]   6   Framed                    [2]
01:24:52: RADIUS:  NAS-IP-Address      [4]   6   10.0.73.20
01:24:55: RADIUS(00000011): Send Accounting-Request to 192.107.164.254:1646 id 1646/4, len
 495
01:24:55: RADIUS:  authenticator 22 6F B2 F3 88 B1 03 91 - 4A 70 53 BD 44 A6 A6 0F
01:24:55: RADIUS:  Acct-Session-Id     [44]  19  "1/0/0/30_00000008"
01:24:55: RADIUS:  Vendor, Cisco       [26]  39
01:24:55: RADIUS:   Cisco AVpair       [1]   33  "actual-data-rate-upstream=20480"
01:24:55: RADIUS:  Vendor, Cisco       [26]  39
01:24:55: RADIUS:   Cisco AVpair       [1]   33  "actual-data-rate-downstream=512"
01:24:55: RADIUS:  Vendor, Cisco       [26]  39
01:24:55: RADIUS:   Cisco AVpair       [1]   33  "minimum-data-rate-upstream=1024"
01:24:55: RADIUS:  Vendor, Cisco       [26]  49
01:24:55: RADIUS:   Cisco AVpair      [1]   43  "minimum-data-rate-downstream-low-power=32"
01:24:55: RADIUS:  Vendor, Cisco       [26]  46
01:24:55: RADIUS:   Cisco AVpair       [1]   40  "maximum-interleaving-delay-upstream=64"
01:24:55: RADIUS:  Framed-Protocol     [7]   6   PPP                       [1]
01:24:55: RADIUS:  User-Name           [1]   16  "pshroff-client"
01:24:55: RADIUS:  Vendor, Cisco       [26]  32
```

```
01:24:55: RADIUS:   Cisco AVpair       [1]   26  "connect-progress=Call Up"
01:24:55: RADIUS:  Acct-Authentic      [45]  6   RADIUS                     [1]
01:24:55: RADIUS:  Acct-Status-Type    [40]  6   Start                      [1]
01:24:55: RADIUS:  NAS-Port-Type       [61]  6   Ethernet                   [15]
01:24:55: RADIUS:  Vendor, Cisco       [26]  46
01:24:55: RADIUS:   Cisco AVpair       [1]   40  "circuit-id-tag=Ethernet1/0.1:abababababa"
01:24:55: RADIUS:  Vendor, Cisco       [26]  36
01:24:55: RADIUS:   Cisco AVpair       [1]   30  "remote-id-tag=0090.bf06.c81c"
01:24:55: RADIUS:  NAS-Port            [5]   6   268435486
01:24:55: RADIUS:  NAS-Port-Id         [87]  25  "Ethernet1/0.1:abababababa"
01:24:55: RADIUS:  Vendor, Cisco       [26]  41
01:24:55: RADIUS:   Cisco AVpair       [1]   35  "client-mac-address=0090.bf06.c81c"
01:24:55: RADIUS:  Service-Type        [6]   6   Framed                     [2]
01:24:55: RADIUS:  NAS-IP-Address      [4]   6   10.0.73.20
01:24:55: RADIUS:  Acct-Delay-Time     [41]  6   0
01:24:57: RADIUS: Received from id 1646/4 192.107.164.254:1646, Accounting-response, len
20
```

The LAC sends the indicated AV pairs containing the DSL line information to the LNS, which sends them through AAA to the RADIUS server. The RADIUS server uses the DSL line identification when processing AAA requests.

Note The LNS must reply with the same attribute-value pairs (AVPs) that it receives from the LAC. For example, if the LAC sends only Cisco AVPs, the LNS must reply with Cisco AVPs and no others.

Note Configuring two-way CHAP authentication on a forwarded PPP session is not supported, except when you configure the **ppp direction callin** command on the LAC PPPoE to override the default direction of the PPP connection. This causes the LAC to forward the call instead of responding to the peer (client) challenge. The LNS is held in the authentication phase until the client times out and resends the challenge, which, because the call has been forwarded, is handled by the LNS. Authentication then proceeds.

If you plan to configure L2TP Forwarding of PPPoE Tagging Information, it is recommended that you be familiar with RFC 2516 and DSL Forum TR-101 before configuring this feature.

DSL Sync-Rate VSAs

The DSL uses PPPoE Vendor Specific tags for Sync-Rate tag information. DSL Sync-Rates are encoded as 32-bit binary values, describing the rate in Kbps. The tag length is 4 bytes. The table below shows the mandatory DSL Sync-Rate tags and their associated RADIUS VSA.

Table 4: Required DSL Sync-Rate Tags

DSL Line Information	RADIUS VSA	Description
DSL Line Actual-Data-Rate-Upstream AVP	AAA_AT_ACTUAL_RATE_UP	Actual data rate upstream in kbps.
DSL Line Actual-Data-Rate-Downstream AVP	AAA_AT_ACTUAL_RATE_DOWN	Actual data rate downstream in kbps.
DSL Line Minimum-Data-Rate-Upstream AVP	AAA_AT_MIN_RATE_UP	Minimum data rate upstream in kbps.

DSL Line Information	RADIUS VSA	Description
DSL Line Minimum-Data-Rate-Downstream AVP	AAA_AT_MIN_RATE_DOWN	Minimum data rate downstream in kbps.

PADI/PADR frames might contain an optional DSL Sync-Rate tag. The table below shows DSL line information and their associated RADIUS VSA for the optional DSL Sync-Rate tags.

Table 5: Optional DSL Sync-Rate Tags

DSL Line Information	RADIUS VSA	Description
DSL Line Attainable-Data-Rate-Upstream AVP	AAA_AT_ATTAINABLE_RATE_UP	Attainable data rate upstream in kbps.
DSL Line Attainable-Data-Rate-Downstream AVP	AAA_AT_ATTAINABLE_RATE_DOWN	Attainable data rate downstream in kbps.
DSL Line Maximum-Data-Rate-Upstream AVP	AAA_AT_MAX_RATE_UP	Maximum data rate upstream in kbps.
DSL Line Maximum-Data-Rate-Downstream AVP	AAA_AT_MAX_RATE_DOWN	Maximum data rate downstream in kbps.
DSL Line Minimum-Data-Rate-Upstream -Low-Power AVP	AAA_AT_MIN_RATE_UP_LOW_POWER	Minimum data rate upstream in low power state in kbps.
DSL Line Minimum-Data-Rate-Downstream -Low-Power AVP	AAA_AT_MIN_RATE_DOWN_LOW_POWER	Minimum data rate downstream in low power state in kbps.
DSL Line Maximum-Interleaving-Delay-UpStream AVP	AAA_AT_MAX_INTER_DELAY_UP	Maximum interleaving delay upstream in ms.
DSL Line Maximum-Interleaving-Delay-DownStream AVP	AAA_AT_MAX_INTER_DELAY_DOWN	Maximum interleaving delay downstream in ms.
DSL Line Actual-Interleaving-Delay-Upstream AVP	AAA_AT_ACTUAL_INTER_DELAY_UP	Actual interleaving delay upstream in kbps.
DSL Line Actual-Interleaving-Delay-Downstream AVP	AAA_AT_ACTUAL_INTER_DELAY_DOWN	Actual interleaving delay downstream in kbps.
DSL Access Line IWF-Session AVP	AAA_AT_IWF_TAG	Indicates if an Interworking Function has been performed with respect to the session of the subscriber.

LNS Address Checking

Benefits of LNS Address Checking

The LNS Address Checking feature allows a LAC to check the IP address of the LNS sending traffic to it during the setup of an L2TP tunnel, thus providing a check for uplink and downlink traffic arriving from different interfaces.

The benefit of the LNS Address Checking feature is avoiding the loss of revenue from users sending back traffic through an alternate network.

LNS Address Checking Using a RADIUS Server

Use the Cisco attribute-value pair (AVP), downloaded from a RADIUS server during authentication, to enable IP address checking at the LAC.

The Cisco AVP is:

l2tp-security-ip-address-check=yes

The following RADIUS profile example shows the LNS address checking enabled:

```
example.com Password="example"
Service-Type=Outbound
Cisco-Avpair="vpdn:tunnel-id=tunnel"
Cisco-Avpair="vpdn:tunnel-type=l2tp"
Cisco-Avpair=":ip-address=10.10.10.1"
Cisco-Avpair="vpdn:l2tp-tunnel-password=example"
Cisco-Avpair="vpdn:l2tp-security-ip-address-check=yes"
```

Debugging Dropped Control Packets

Use the LNS Address Checking feature to help troubleshoot dropped control packets. If you configure the **debug vpdn 12x-error** command, informational messages display for each control packet that is dropped in the following format:

```
Tnl <tunnel-ID>
 L2TP: Drop <L2TP-packet-name>
 from y.y.y.y (attempted) x.x.x.x
```

Modified LNS Dead-Cache Handling

The Modified LNS Dead-Cache Handling feature allows you to display and clear (restart) any Layer 2 Tunnel Protocol (L2TP) Network Server (LNS) entry in a dead-cache (DOWN) state. You can use this feature to generate a Simple Network Management Protocol (SNMP) or system message log (syslog) event when an LNS enters or exits a dead-cache state. Once an LNS exits the dead-cache state, the LNS is able to establish new sessions.

Prior to Cisco IOS Release 12.2(31)ZV, networks could not identify the status of a Load Sharing Group (LSG) on a LAC. As a result, it was not possible to know if an LNS is not responding (dead-cache state). An LNS in a dead-cache state causes an LSG to reject a call from an LAC.

Networks also have no method of logging, either though a syslog or SNMP event, when an LNS enters, or is cleared from a dead-cache state.

The Modified LNS Dead-Cache Handling feature allows you to view (identify) and clear (restart) one or more LNS entries in a dead-cache (DOWN) state, and generate either a syslog or SNMP event when an LNS exits or enters a dead-cache state. Once an LNS clears a dead-cache state, the LNS is active and available for new call-session establishments.

How to Configure AAA for VPDNs

Enabling VPDN on the NAS and the Tunnel Server

Before performing any VPDN configuration tasks, you must enable VPDN on the NAS and the tunnel server. If you are deploying a multihop VPDN tunnel switching architecture, VPDN must be enabled on the tunnel switch as well.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn enable**

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	**vpdn enable** **Example:** `Router(config)# vpdn enable`	Enables VPDN on the router.

Configuring the VPDN Tunnel Authorization Search Order

Perform this task on the NAS or the tunnel switch to configure the VPDN tunnel authorization search order if you prefer to use an order other than the default order. The default search order for VPDN tunnel authorization is to first search by DNIS, then by domain.

Before You Begin

You must perform the task in the "Enabling VPDN on the NAS and the Tunnel Server" section.

Note Tunnel authorization searches based on the multihop hostname are supported only for multihop tunnel switching deployments.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn search-order** {**dnis** [**domain**] [**multihop-hostname**] | **domain** [**dnis**] [**multihop-hostname**] | **multihop-hostname** [**dnis**] [**domain**]}

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	**vpdn search-order** {**dnis** [**domain**] [**multihop-hostname**] | **domain** [**dnis**] [**multihop-hostname**] | **multihop-hostname** [**dnis**] [**domain**]}
	Example:
	`Router(config)# vpdn search-order domain dnis`
		Specifies how the service provider NAS or tunnel switch is to perform VPDN tunnel authorization searches.
		• At least one search parameter keyword must be specified. You can specify multiple search parameter keywords in any order to define the desired order in which searches will be performed.
		Note The **multihop-hostname** keyword is used only on a device configured as a tunnel switch.

Configuring L2TP Domain Screening

To configure L2TP Domain Screening, enable VPN service and VPDN preauthentication on the LAC. You can enable VPDN preauthentication globally or for specific VPDN groups.

This section contains these procedures:

Configuring L2TP Domain Screening with Global Preauthentication

To configure L2TP Domain Screening with global preauthentication, enable VPN service and enable VPDN preauthorization globally. RADIUS authentication and authorization are required for per-user tunnels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa new-model**
4. **aaa authentication ppp** {**default** | *list-name*} *method1* [*method2...*]
5. **aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} *method1* [*method2...*]
6. **radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*]
7. **radius-server key** {**0** *string* | **7** *string* | *string*}
8. **vpdn enable**
9. **vpdn authen-before-forward**
10. **interface atm** *interface-number*
11. **ip address** *ip-address mask*
12. **pvc** *vpi* / *vci*
13. **encapsulation aal5snap**
14. **protocol pppoe**
15. **vpn service** *domain-name* [**replace-authen-domain**]
16. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**aaa new-model** **Example:** `Router(config)# aaa new-model`	Enables the authentication, authorization, and accounting (AAA) access control system.
Step 4	**aaa authentication ppp** {**default** | *list-name*} *method1* [*method2...*] **Example:** `Router(config)# aaa authentication ppp default group radius`	Specifies the use of RADIUS authentication for PPP authentication.
Step 5	**aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} *method1* [*method2...*] **Example:** `Router(config)# aaa authorization network default group radius`	Specifies that authorization be run for all network-related service requests and uses **group radius** as the default method for authorization. This command is required for the AAA server to provide VPDN attributes.
Step 6	**radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*] **Example:** `Router(config)# radius-server host 10.1.10.1 auth-port 1645 acct-port 1646`	Specifies the AAA server that will supply the network access server or L2TP access concentrator (LAC) with the VPDN attributes for the user.

Step 7	**radius-server key** {**0** *string* | **7** *string* | *string*}
	Example:
	`Router(config)# radius-server key cisco`
		Sets the authentication and encryption key for all RADIUS communications between the router and the RADIUS daemon.

Step 8	**vpdn enable** **Example:** `Router(config)# vpdn enable`	Enables virtual private dialup networking on the router and informs the router to look for tunnel definitions in a local database or on a remote authorization server (home gateway), if one is present.

	Command or Action	Purpose
Step 9	**vpdn authen-before-forward** **Example:** `Router(config)# vpdn authen-before-forward`	Enables authentication of all dial-in L2TP sessions before the sessions are forwarded to the tunnel server (global preauthentication).
Step 10	**interface atm** *interface-number* **Example:** `Router(config)# interface atm 4/0`	Defines an ATM interface.
Step 11	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.0.0.2 255.255.0.0`	Sets the primary IP address for this interface.
Step 12	**pvc** *vpi* **/** *vci* **Example:** `Router(config-if)# pvc 1/20`	Enters ATM VC configuration mode for the interface identified by this virtual path identifier/virtual channel identifier pair.
Step 13	**encapsulation aal5snap** **Example:** `Router(config-if-atm-vc)# encapsulation aal5snap`	Configures the encapsulation type for this PVC range. The global default encapsulation option is **aal5snap**.
Step 14	**protocol pppoe** **Example:** `Router(config-if-atm-vc)# protocol pppoe`	Enables PPP over Ethernet sessions for this PVC.
Step 15	**vpn service** *domain-name* [**replace-authen-domain**] **Example:** `Router(config-if-atm-vc)# vpn service example.com replace-authen-domain`	Replaces the domain field with the domain name during preauthentication.

Step 16	**end**
	Example:
	`Router(config-if-atm-vc)# end`
		Ends the current configuration session and returns to privileged EXEC mode.

Configuring L2TP Domain Screening with per-VPDN Group Preauthentication

To configure L2TP Domain Screening with per-VPDN group preauthentication, enable VPN service and enable VPDN preauthentication by specific VPDN group.

Note

- The **show running-config** command does not display the configured domain name and virtual template, unless you configure the **protocol l2tp** command.
- When you unconfigure the **protocol l2tp** command, the configured domain name and virtual template are automatically removed. When you reconfigure the **protocol l2tp** command, the domain name and virtual template need to be explicitly added again.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa new-model**
4. **aaa authentication ppp** {**default** | *list-name*} *method1* [*method2...*]
5. **aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} *method1* [*method2...*]
6. **vpdn enable**
7. **vpdn-group** *name*
8. **request-dialin**
9. **protocol l2tp**
10. **domain** *domain-name*
11. **exit**
12. **authen-before-forward**
13. **initiate-to ip** *ip-address*
14. **end**
15. **configure terminal**
16. **interface atm** *interface-number*
17. **ip address** *ip-address mask*
18. **pvc** *vpi* **/** *vci*
19. **encapsulation aal5snap**
20. **protocol pppoe**
21. **vpn service** *domain-name* [**replace-authen-domain**]
22. **end**

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	**aaa new-model** **Example:** `Router(config)# aaa new-model`	Enables the AAA access control system.
Step 4	**aaa authentication ppp** {**default** | *list-name*} *method1* [*method2...*] **Example:** `Router(config)# aaa authentication ppp default local`	Specifies the use of local authentication for PPP authentication.
Step 5	**aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} *method1* [*method2...*] **Example:** `Router(config)# aaa authorization network default local`	Specifies that authorization be run for all network-related service requests and uses local authentication as the default method for authorization. This command is required for the AAA server to provide VPDN attributes.
Step 6	**vpdn enable** **Example:** `Router(config)# vpdn enable`	Enables virtual private dialup networking on the router and informs the router to look for tunnel definitions in a local database or on a remote authorization server (home gateway), if one is present.
Step 7	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group l2tp`	Creates a VPDN group and enters VPDN group configuration mode.

	Command or Action	Purpose
Step 8	**request-dialin** **Example:** `Router(config-vpdn)# request-dialin`	Configures the VPDN group to request an L2TP dial-in tunnel.
Step 9	**protocol l2tp** **Example:** `Router(config-vpdn-req-in)# protocol l2tp`	Specifies the tunneling protocol to be used by the VPDN group.
Step 10	**domain** *domain-name* **Example:** `Router(config-vpdn-req-in)# domain example.com`	Specifies the domain name of users that will be forwarded to the tunnel server.
Step 11	**exit** **Example:** `Router(config-vpdn-req-in)# exit`	Returns to VPDN configuration mode.
Step 12	**authen-before-forward** **Example:** `Router(config-vpdn)# authen-before-forward`	Enables authentication of dial-in L2TP sessions associated with this VPDN group before the sessions are forwarded to the tunnel server (per-VPDN group preauthentication).
Step 13	**initiate-to ip** *ip-address* **Example:** `Router(config-vpdn)# initiate-to ip 10.2.2.2`	Specifies an IP address to be used for L2TP tunneling.

Step 14	**end**
	Example:
	`Router(config-vpdn)# end`
		Returns to privileged EXEC mode.

Step 15	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 16	**interface atm** *interface-number* **Example:** `Router(config)# interface atm 4/0`	Defines an ATM interface.
Step 17	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.0.0.2 255.255.0.0`	Sets the primary IP address for this interface.
Step 18	**pvc** *vpi* / *vci* **Example:** `Router(config-if)# pvc 1/20`	Enters ATM VC configuration mode for the interface identified by this virtual path identifier/virtual channel identifier pair.
Step 19	**encapsulation aal5snap** **Example:** `Router(config-if-atm-vc)# encapsulation aal5snap`	Configures the encapsulation type for this PVC range. The global default encapsulation option is **aal5snap**.
Step 20	**protocol pppoe** **Example:** `Router(config-if-atm-vc)# protocol pppoe`	Enables PPP over Ethernet sessions for this PVC.
Step 21	**vpn service** *domain-name* [**replace-authen-domain**] **Example:** `Router(config-if-atm-vc)# vpn service example.com replace-authen-domain`	Replaces the domain field with the domain name during preauthentication.

Step 22	**end**
	Example:
	`Router(config-if-atm-vc)# end`
		Ends the current configuration session and returns to privileged EXEC mode.

Configuring L2TP Domain Screening Rules Based

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** [**type** {**stack** | **access-control** | **port-filter** | **queue-threshold** | **logging** *log-policy*}] *policy-map-name*
4. **class-map** [**type** {**stack** | **access-control** | **port-filter** | **queue-threshold** | **logging** *log class*}] [**match-all** | **match-any**] *class-map-name*
5. *action-number* **collect** [**aaa list** *list-name*] **identifier** {**authen-status** | **authenticated-domain** | **authenticated-username** | **dnis** | **media** | **mlp-negotiated** | **nas-port** | **no-username** | **protocol** | **service-name** | **source-ip-address** | **timer** | **tunnel-name** | **unauthenticated-domain** | **unauthenticated-username**}
6. *action-number* **set** [*variable-name*] [**identifier**] [*type*]
7. *action-number* **substitute** [*variable-name*] [*matching-pattern*] [*rewrite-pattern*]
8. *action-number* **authenticate aaa list** *list-name*
9. **exit**

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	**policy-map** [**type** {**stack** | **access-control** | **port-filter** | **queue-threshold** | **logging** *log-policy*}] *policy-map-name* **Example:** `Router(config)# policy-map type control start-up-ppp`	Creates or modifies a control policy map, which is used to define a control policy.
Step 4	**class-map** [**type** {**stack** | **access-control** | **port-filter** | **queue-threshold** | **logging** *log class*}] [**match-all** | **match-any**] *class-map-name*	Specifies a control class for which actions can be configured. • A policy rule for which the control class is **always** will always be treated as the lowest priority rule within the control policy map.

	Command or Action	Purpose
	Example: `Router(config-control-policymap)# class type control always event session-start`	

Step 5	*action-number* **collect** [**aaa list** *list-name*] **identifier** {**authen-status** | **authenticated-domain** | **authenticated-username** | **dnis** | **media** | **mlp-negotiated** | **nas-port** | **no-username** | **protocol** | **service-name** | **source-ip-address** | **timer** | **tunnel-name** | **unauthenticated-domain** | **unauthenticated-username**}
	Example:
	`Router(config-control-policymap-class-control)# 1 collect identifier unauthenticated-username`
		(Optional) Collects the specified subscriber identifier from the access protocol.

Step 6	*action-number* **set** [*variable-name*] [**identifier]** [*type*] **Example:** `Router(config-control-policymap-class-control)# 2 set NAME identifier unauthenticated-username`	Creates a temporary memory space to hold values received by policy manager on the identifier type.
Step 7	*action-number* **substitute** [*variable-name*] [*matching-pattern*] [*rewrite-pattern*] **Example:** `Router(config-control-policymap-class-control)# 3 substitute NEWNAME`	Matches the contents of *variable-name*using *matching-pattern*and perform the substitution defined in *rewrite-pattern.*
Step 8	*action-number* **authenticate aaa list** *list-name* **Example:** `Router(config-control-policymap-class-control)# 1 authenticate aaa list LIST1`	Initiates an authentication request using the contents of *variable-name* instead of the default unauthenticated-username.
Step 9	**exit** **Example:** `Router(config-control-policymap-class-control)# exit`	Exits the current configuration mode.

Configuring per-User VPDN on the NAS

Per-user VPDN can be configured globally, or for individual VPDN groups. The VPDN group configuration will take precedence over the global configuration.

Perform one of these tasks on the NAS to configure per-user VPDN:

Prerequisites

The NAS remote RADIUS server must be configured for AAA. See the "Additional References" section.

Restrictions

- Per-user VPDN configuration supports only RADIUS as the AAA protocol.
- This task is compatible only with NAS-initiated dial-in VPDN scenarios.

Configuring Global per-User VPDN

Configuring per-user VPDN on a NAS causes the NAS to send the entire structured username of the user to a RADIUS AAA server the first time the NAS contacts the AAA server. Per-user VPDN can be configured globally, or for individual VPDN groups. Configuring per-user VPDN globally will apply per-user VPDN to all request-dialin VPDN groups configured on the NAS.

Perform this task on the NAS to configure global per-user VPDN.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn authen-before-forward**

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	**vpdn authen-before-forward** **Example:** `Router(config)# vpdn authen-before-forward`	Configures a NAS to request authentication of a complete username before making a forwarding decision for dial-in tunnels.

Configuring per-User VPDN for a VPDN Group

Configuring per-user VPDN on a NAS causes the NAS to send the entire structured username of the user to a RADIUS AAA server the first time the NAS contacts the AAA server. Per-user VPDN can be configured globally, or for individual VPDN groups. Configuring per-user VPDN at the VPDN group level will apply per-user VPDN only to calls associated with that specific VPDN group.

Perform this task on the NAS to configure per-user VPDN for a specific VPDN group.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **request-dialin**
5. **protocol** {**l2f** | **l2tp** | **any**}
6. **exit**
7. **authen-before-forward**

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**request-dialin** **Example:** `Router(config-vpdn)# request-dialin`	Configures a NAS to request the establishment of an L2F or L2TP tunnel to a tunnel server, creates a request-dialin VPDN subgroup, and enters VPDN request dial-in subgroup configuration mode.

Step 5	**protocol** {**l2f** | **l2tp** | **any**}
	Example:
	`Router(config-vpdn-req-in)# protocol l2tp`
		Specifies the Layer 2 protocol that the VPDN group will use.
		• L2TP and L2F are the only valid tunneling protocols for dial-in VPDNs. The **any** keyword can be used to specify that both L2TP and L2F tunnels can be established.

Step 6	**exit** **Example:** `Router(config-vpdn-req-in)# exit`	Exits to VPDN group configuration mode.
Step 7	**authen-before-forward** **Example:** `Router(config-vpdn)# authen-before-forward`	Configures a NAS to request authentication of a complete username before making a forwarding decision for dial-in L2TP or L2F tunnels belonging to a VPDN group.

Configuring AAA on the NAS and the Tunnel Server

For NAS-initiated dial-in VPDN tunneling and L2TP dial-out tunneling deployments, perform this task on the NAS and the tunnel server.

For client-initiated dial-in VPDN tunneling, perform this task on the tunnel server.

Before You Begin

- You must perform the task in the Enabling VPDN on the NAS and the Tunnel Server, on page 29.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa new-model**
4. **aaa authentication login** {**default** | *list-name*} *method1* [*method2...*]
5. **aaa authentication ppp** {**default** | *list-name*} *method1* [*method2...*]
6. **aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method1* [*method2...*]]
7. **vpdn aaa attribute** {**nas-ip-address**{**vpdn-nas** | **vpdn-tunnel-client**} | **nas-port** {**physical-channel-id** | **vpdn-nas**}}

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	**aaa new-model** **Example:** `Router(config)# aaa new model`	Enables the AAA access control model.
Step 4	**aaa authentication login** {**default** | *list-name*} *method1* [*method2...*] **Example:** `Router(config)# aaa authentication login default local`	Sets AAA authentication at login.
Step 5	**aaa authentication ppp** {**default** | *list-name*} *method1* [*method2...*] **Example:** `Router(config)# aaa authentication ppp default radius`	Specifies one or more AAA authentication methods for use on serial interfaces that are running PPP. **Note** This command must be configured with the **if-needed** option for the *method1*argument if you are configuring shell-based authentication for VPDNs. This configures PPP to bypass user authentication if the user has been authenticated at the login prompt.

	Command or Action	Purpose
Step 6	**aaa authorization** {**network** | **exec** | **commands** *level* | **reverse-access** | **configuration**} {**default** | *list-name*} [*method1* [*method2*...]] **Example:** `Router(config)# aaa authorization network default radius`	Sets parameters that restrict user access to a network.

Step 7	**vpdn aaa attribute** {**nas-ip-address**{**vpdn-nas** | **vpdn-tunnel-client**} | **nas-port** {**physical-channel-id** | **vpdn-nas**}}
	Example:
	`Router(config)# vpdn aaa attribute nas-ip-address vpdn-nas`
		(Optional) Enables AAA attributes related to a VPDN that will be reported to the AAA server in accounting records.
		Note Configure this command only on the tunnel server when remote AAA accounting will be enabled on the NAS.

Configuring Remote AAA for VPDNs

A remote RADIUS or TACACS+ AAA server can be used for tunnel authentication. For detailed information on configuring remote RADIUS or TACACS+ servers, see the "Additional References" section.

Remote AAA authentication can be configured on the NAS or the tunnel server in these ways:

Dial-In Configurations

- The NAS can be configured to use a remote AAA server.
- The tunnel server, functioning as the tunnel terminator, can be configured to use a remote AAA server for L2TP tunnels only.

Dial-Out Configurations

- The NAS, functioning as the tunnel terminator, can be configured to use a remote AAA server for L2TP tunnels only.

Perform one of these tasks to configure remote AAA for VPDNs:

Configuring the NAS for Remote AAA for Dial-In VPDNs

Perform this task to configure the NAS to use a remote RADIUS or TACACS+ server for tunnel authentication. This task applies only to dial-in VPDN configurations.

Before You Begin

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*] [**alias** {*hostname* | *ip-address*}]
   - **tacacs-server host** {*host-name* | *host-ip-address*} [**key** *string*] [**nat**] [**port** [*integer*]] [**single-connection**] [**timeout** [*integer*]]
4. Do one of the following:
   - **aaa group server radius** *group-name*
   - **aaa group server tacacs+** *group-name*
5. Do one of the following:
   - **server** *ip-address* [**auth-port** *port-number*] [**acct-port** *port-number*]
   - **server** *ip-address*

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	Do one of the following: • **radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*] [**alias** {*hostname* | *ip-address*}] • **tacacs-server host** {*host-name* | *host-ip-address*} [**key** *string*] [**nat**] [**port** [*integer*]] [**single-connection**] [**timeout** [*integer*]]	Specifies a RADIUS server host. **Note** This command is required if you will be performing the task in the Configuring the NAS for Shell-Based Authentication of VPDN Users section. or Specifies a TACACS+ host.

	Command or Action	Purpose

	Example:
	`Router(config)# radius-server host 10.1.1.1`
	Example:
	`Router(config)# tacacs-server host 10.2.2.2`	

Step 4	Do one of the following:
	• **aaa group server radius** *group-name*
	• **aaa group server tacacs+** *group-name*
	Example:
	`Router(config)# aaa group server radius group1`
	Example:
	`Router(config)# aaa group server tacacs+ group7`
		(Optional) Groups different RADIUS server hosts into distinct lists and distinct methods and enters RADIUS server group configuration mode.
		or
		(Optional) Groups different TACACS+ server hosts into distinct lists and distinct methods and enters RADIUS server group configuration mode.

Step 5	Do one of the following:
	• **server** *ip-address* [**auth-port** *port-number*] [**acct-port** *port-number*]
	• **server** *ip-address*
	Example:
	`Router(config-sg-radius)# server 10.1.1.1 auth-port 1000 acct-port 1646`
	Example:
	`Router(config-sg-radius)# server 10.2.2.2`
		(Optional) Configures the IP address of the RADIUS server for the group server.
		or
		(Optional) Configures the IP address of the TACACS+ server for the group server.
		Note Perform this step multiple times to configure multiple RADIUS or TACACS+ servers as part of the server group.

What to Do Next

You must perform the process in the Configuring VPDN Tunnel Authentication, on page 63.

Configuring the Tunnel Terminator for Remote RADIUS AAA for L2TP Tunnels

You can configure the device that terminates the L2TP VPDN tunnel to perform remote RADIUS AAA. Without this functionality, the tunnel terminator can only perform L2TP authentication locally. Local authentication requires that data about the corresponding tunnel endpoint be configured within a VPDN group. This mechanism does not scale well because the information stored in the VPDN groups on each device must be updated independently.

Remote RADIUS authentication allows users to store configurations on the RADIUS server, avoiding the need to store information locally. New information can be added to the RADIUS server as needed, and a group of tunnel terminators can access a common database on the RADIUS server.

Perform this task to configure remote RADIUS AAA for L2TP tunnels on the tunnel terminator. This task can be performed on the tunnel server for dial-in VPDN tunnels, or on the NAS for dial-out VPDN tunnels.

Before You Begin

- The remote RADIUS AAA server must be configured. For more information on configuring remote RADIUS AAA servers, see the "Additional References" section.
- AAA must be enabled. To enable AAA, perform the task in the "Configuring AAA on the NAS and the Tunnel Server" section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*] [**alias** {*hostname* | *ip-address*}]
4. **aaa group server radius** *group-name*
5. **server** *ip-address* [**auth-port** *port-number*] [**acct-port** *port-number*]
6. **exit**
7. **vpdn tunnel authorization network** {*list-name* | **default**}
8. **vpdn tunnel authorization virtual-template** *vtemplate-number*
9. **vpdn tunnel authorization password** *password*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*] [**alias** {*hostname* | *ip-address*}] **Example:** `Router(config)# radius-server host 10.1.1.1`	Specifies a RADIUS server host.
Step 4	**aaa group server radius** *group-name* **Example:** `Router(config)# aaa group server radius group1`	Groups different RADIUS server hosts into distinct lists and distinct methods and enters RADIUS server group configuration mode.
Step 5	**server** *ip-address* [**auth-port** *port-number*] [**acct-port** *port-number*] **Example:** `Router(config-sg-radius)# server 10.1.1.1 auth-port 1000 acct-port 1646`	Configures the IP address of the RADIUS server for the group server. **Note** Perform this step multiple times to configure multiple RADIUS or TACACS+ servers as part of the server group.
Step 6	**exit** **Example:** `Router(config-sg-radius)# exit`	Exits RADIUS server group configuration mode.
Step 7	**vpdn tunnel authorization network** {*list-name* | **default**} **Example:** `Router(config)# vpdn tunnel authorization network default`	Specifies the AAA authorization method list that will be used for remote tunnel hostname-based authorization. • If the *list-name* argument was specified in the **aaa authorization** command, you must use that list name. • If the default keyword was specified in the **aaa authorization** command, you must use that keyword.
Step 8	**vpdn tunnel authorization virtual-template** *vtemplate-number* **Example:** `Router(config)# vpdn tunnel authorization virtual-template 3`	(Optional) Selects the default virtual template from which to clone virtual access interfaces.

	Command or Action	Purpose
Step 9	**vpdn tunnel authorization password** *password* **Example:** `Router(config)# vpdn tunnel authorization password my-secret`	(Optional) Configures a false password for the RADIUS authorization request to retrieve the tunnel configuration that is based on the remote tunnel hostname. **Note** If this command is not enabled, the password will always be "cisco."

What to Do Next

You must perform these tasks in these sections:

- Configuring VPDN Tunnel Authentication
- Configuring Authentication of L2TP Tunnels at the Tunnel Terminator Remote RADIUS AAA Server

Verifying and Troubleshooting Remote AAA Configurations

Verifying that the VPDN Tunnel Is Up

SUMMARY STEPS

1. **enable**
2. **show vpdn tunnel**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show vpdn tunnel**

Enter this command to display information about active VPDN tunnels. At least one tunnel and one session must be set up.

Example:

```
Router# show vpdn tunnel
L2TP Tunnel and Session Information Total tunnels 1 sessions 1
LocID RemID Remote   Name   State  Remote Address  Port  Sessions VPDN Group
4571  61568 csidtw13        est    10.0.195.4      1701  1        ?
```

```
LocID RemID TunID Intf          Username               State  Last Chg
4     11    4571  Vi4.1         csidtw9@cisco.com       est    00:02:29
%No active PPPoE tunnels
```

Verifying the Remote RADIUS AAA Server Configuration

Perform this task to verify that the remote AAA authorization server is configured on the tunnel endpoint and that the tunnel endpoint can receive attributes 90 and 69 from the RADIUS server.

In this example the steps are performed on the tunnel server, which is performing remote RADIUS AAA as a tunnel terminator. These steps can also be performed on the NAS when remote RADIUS AAA is being performed on the NAS as a tunnel initiator for dial-in VPDNs or as a tunnel terminator for dial-out VPDNs.

SUMMARY STEPS

1. **enable**
2. **debug radius**
3. **show logging**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **debug radius**

Enter this command on the tunnel server to display RADIUS debugging messages.

Example:

```
Router# debug radius
```

Step 3 **show logging**

Enter this command on the tunnel server to display the contents of the standard system logging message buffer. Ensure that "access-accept" is in the output and that attributes 90 and 69 can be seen in the RADIUS reply, as shown in bold.

Example:

```
Router# show logging
00:32:56: RADIUS: Received from id 21645/5 172.19.192.50:1645, Access-Accept
, len 81
00:32:56: RADIUS:  authenticator 73 2B 1B C2 33 71 93 19 - 62 AC 3E BE 0D 13 14 85
00:32:56: RADIUS:  Service-Type        [6]   6   Outbound                 [5]
00:32:56: RADIUS:  Tunnel-Type         [64]  6   00:L2TP                  [3]
00:32:56: RADIUS:  Tunnel-Medium-Type  [65]  6   00:IPv4                  [1]
00:32:56: RADIUS:  Tunnel-Client-Auth-I[90]
```

```
  6   00:"csidtw13"
00:32:56: RADIUS:  Tunnel-Password     [69]
 8   *
00:32:56: RADIUS:  Vendor, Cisco       [26]  29
00:32:56: RADIUS:   Cisco AVpair       [1]   23  "vpdn:vpdn-vtemplate=1"
```

Verifying the Remote TACACS+ AAA Server Configuration on the NAS

Perform this task on the NAS to verify that the remote TACACS+ AAA server is properly configured.

Before You Begin

Enable these debug commands before performing this task:

- **debug aaa accounting** --Displays information on accountable events as they occur.
- **debug aaa authentication** --Displays information on AAA TACACS+ authentication.
- **debug aaa authorization** --Displays information on AAA TACACS+ authorization.
- **debug tacacs** --Displays information associated with TACACS+.
- **debug vpdn error** --Displays information about Layer 2 protocol-independent errors that occur.
- **debug vpdn events** --Displays information about Layer 2 protocol-independent events that are part of normal tunnel establishment or shutdown.
- **debug vpdn l2x-errors** --Displays information about Layer 2 protocol-specific errors that are part of normal PPP tunnel establishment or shutdown.
- **debug vpdn l2x-events** --Displays information about Layer 2 protocol-specific events that are part of normal PPP tunnel establishment or shutdown.
- **debug vpdn l2x-packets** --Displays information about Layer 2 protocol-specific
- **debug vtemplate** --Displays cloning information for a virtual access interface from the time it is cloned from a virtual template to the time the virtual access interface comes down when the call ends.

SUMMARY STEPS

1. **enable**
2. **show debugging**
3. Examine the debug output.

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show debugging**

Enter this command to display information about the types of debugging that are enabled for your router.

Example:

```
Router# show debugging
General OS:
AAA Authentication debugging is on
AAA Authorization debugging is on
AAA Accounting debugging is on
VPN:
L2X protocol events debugging is on
L2X protocol errors debugging is on
VPDN events debugging is on
VPDN errors debugging is on
VTEMPLATE:
Virtual Template debugging is on
!
```

Step 3 Examine the debug output.

The following example shows complete debug output from the NAS for successful VPDN tunnel establishment using remote TACACS+ AAA authentication at the NAS:

Example:

```
Jan 30 12:17:09: As1 AAA/AUTHOR/FSM: (0): LCP succeeds trivially
20:03:18: %LINK-3-UPDOWN: Interface Async1, changed state to up
Jan 30 12:17:09: As1 VPDN: Looking for tunnel -- rtp.cisco.com --
Jan 30 12:17:09: AAA: parse name=Async1 idb type=10 tty=1
Jan 30 12:17:09: AAA: name=Async1 flags=0x11 type=4 shelf=0 slot=0 adapter=0
port=1 channel=0
Jan 30 12:17:09: AAA/AUTHEN: create_user (0x278B90) user='rtp.cisco.com'
ruser=''
port='Async1' rem_addr='' authen_type=NONE service=LOGIN priv=0
Jan 30 12:17:09: AAA/AUTHOR/VPDN (898425447): Port='Async1' list='default'
service=NET
Jan 30 12:17:09: AAA/AUTHOR/VPDN: (898425447) user='rtp.cisco.com'
Jan 30 12:17:09: AAA/AUTHOR/VPDN: (898425447) send AV service=ppp
Jan 30 12:17:09: AAA/AUTHOR/VPDN: (898425447) send AV protocol=vpdn
Jan 30 12:17:09: AAA/AUTHOR/VPDN (898425447) found list "default"
Jan 30 12:17:09: AAA/AUTHOR/VPDN: (898425447) Method=TACACS+
Jan 30 12:17:09: AAA/AUTHOR/TAC+: (898425447): user=rtp.cisco.com
Jan 30 12:17:09: AAA/AUTHOR/TAC+: (898425447): send AV service=ppp
Jan 30 12:17:09: AAA/AUTHOR/TAC+: (898425447): send AV protocol=vpdn
Jan 30 12:17:09: TAC+: (898425447): received author response status = PASS_ADD
Jan 30 12:17:09: AAA/AUTHOR (898425447): Post authorization status = PASS_ADD
Jan 30 12:17:09: AAA/AUTHOR/VPDN: Processing AV service=ppp
Jan 30 12:17:09: AAA/AUTHOR/VPDN: Processing AV protocol=vpdn
Jan 30 12:17:09: AAA/AUTHOR/VPDN: Processing AV tunnel-type=l2tp
Jan 30 12:17:09: AAA/AUTHOR/VPDN: Processing AV tunnel-id=rtp_tunnel
Jan 30 12:17:09: AAA/AUTHOR/VPDN: Processing AV ip-addresses=10.31.1.56
Jan 30 12:17:09: As1 VPDN: Get tunnel info for rtp.cisco.com with NAS
rtp_tunnel, IP 10.31.1.56
Jan 30 12:17:09: AAA/AUTHEN: free_user (0x278B90) user='rtp.cisco.com' ruser=''
port='Async1' rem_addr='' authen_type=NONE service=LOGIN priv=0
Jan 30 12:17:09: As1 VPDN: Forward to address 10.31.1.56
Jan 30 12:17:09: As1 VPDN: Forwarding...
Jan 30 12:17:09: AAA: parse name=Async1 idb type=10 tty=1
Jan 30 12:17:09: AAA: name=Async1 flags=0x11 type=4 shelf=0 slot=0 adapter=0
port=1 channel=0
```

```
Jan 30 12:17:09: AAA/AUTHEN: create_user (0x22CDEC) user='user1@rtp.cisco.com'
ruser='' port='Async1' rem_addr='async' authen_type=CHAP
service=PPP priv=1
Jan 30 12:17:09: As1 VPDN: Bind interface direction=1
Jan 30 12:17:09: Tnl/Cl 74/1 L2TP: Session FS enabled
Jan 30 12:17:09: Tnl/Cl 74/1 L2TP: Session state change from idle to
wait-for-tunnel
Jan 30 12:17:09: As1 74/1 L2TP: Create session
Jan 30 12:17:09: Tnl 74 L2TP: SM State idle
Jan 30 12:17:09: Tnl 74 L2TP: O SCCRQ
Jan 30 12:17:09: Tnl 74 L2TP: Tunnel state change from idle to wait-ctl-reply
Jan 30 12:17:09: Tnl 74 L2TP: SM State wait-ctl-reply
Jan 30 12:17:09: As1 VPDN: user1@rtp.cisco.com is forwarded
Jan 30 12:17:10: Tnl 74 L2TP: I SCCRP from ABCDE
Jan 30 12:17:10: Tnl 74 L2TP: Got a challenge from remote peer, ABCDE
Jan 30 12:17:10: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:10: AAA/AUTHEN: create_user (0x23232C) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:10: AAA/AUTHEN/START (1598999635): port='' list='default'
action=SENDAUTH service=PPP
Jan 30 12:17:10: AAA/AUTHEN/START (1598999635): found list default
Jan 30 12:17:10: AAA/AUTHEN (1598999635): status = UNKNOWN
Jan 30 12:17:10: AAA/AUTHEN/START (1598999635): Method=TACACS+
Jan 30 12:17:10: TAC+: send AUTHEN/START packet ver=193 id=1598999635
Jan 30 12:17:10: TAC+: ver=192 id=1598999635 received AUTHEN status = ERROR
Jan 30 12:17:10: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:10: AAA/AUTHEN: create_user (0x232470) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:10: TAC+: ver=192 id=3400389836 received AUTHEN status = PASS
Jan 30 12:17:10: AAA/AUTHEN: free_user (0x232470) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:10: AAA/AUTHEN (1598999635): status = PASS
Jan 30 12:17:10: AAA/AUTHEN: free_user (0x23232C) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:10: Tnl 74 L2TP: Got a response from remote peer, ABCDE
Jan 30 12:17:10: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:10: AAA/AUTHEN: create_user (0x22FBA4) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:10: AAA/AUTHEN/START (2964849625): port='' list='default'
action=SENDAUTH service=PPP
Jan 30 12:17:10: AAA/AUTHEN/START (2964849625): found list default
Jan 30 12:17:10: AAA/AUTHEN (2964849625): status = UNKNOWN
Jan 30 12:17:10: AAA/AUTHEN/START (2964849625): Method=TACACS+
Jan 30 12:17:10: TAC+: send AUTHEN/START packet ver=193 id=2964849625
20:03:20: %LINEPROTO-5-UPDOWN: Line protocol on Interface Async1,
changed state to up
Jan 30 12:17:11: TAC+: ver=192 id=2964849625 received AUTHEN status = ERROR
Jan 30 12:17:11: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:11: AAA/AUTHEN: create_user (0x22FC8C) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:11: As1 74/1 L2TP: Discarding data packet because tunnel
is not open
Jan 30 12:17:11: As1 74/1 L2TP: Discarding data packet because tunnel
is not open
Jan 30 12:17:11: TAC+: ver=192 id=1474818051 received AUTHEN status = PASS
Jan 30 12:17:11: AAA/AUTHEN: free_user (0x22FC8C) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:11: AAA/AUTHEN (2964849625): status = PASS
Jan 30 12:17:11: AAA/AUTHEN: free_user (0x22FBA4) user='rtp_tunnel'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:11: Tnl 74 L2TP: Tunnel Authentication success
Jan 30 12:17:11: Tnl 74 L2TP: Tunnel state change from wait-ctl-reply to
established
```

```
Jan 30 12:17:11: Tnl 74 L2TP: O SCCCN to ABCDE tnlid 56
Jan 30 12:17:11: Tnl 74 L2TP: SM State established
Jan 30 12:17:11: As1 74/1 L2TP: O ICRQ to ABCDE 56/0
Jan 30 12:17:11: As1 74/1 L2TP: Session state change from wait-for-tunnel
to wait-reply
Jan 30 12:17:11: Tnl 74 L2TP: Dropping old CM, Ns 0, expected 1
Jan 30 12:17:11: As1 74/1 L2TP: O ICCN to ABCDE 56/1
Jan 30 12:17:11: As1 74/1 L2TP: Session state change from wait-reply to
established
```

Verifying the Remote TACACS+ AAA Server Configuration on the Tunnel Server

Perform this task on the tunnel server to verify that the remote TACACS+ AAA server is properly configured.

Before You Begin

Enable these debug commands before performing this task:

- **debug aaa authentication** --Displays information on AAA authentication.
- **debug aaa authorization** --Displays information on AAA authorization.
- **debug aaa accounting** --Displays information on accountable events as they occur. The information displayed by this command is independent of the accounting protocol used to transfer the accounting information to a server.
- **debug tacacs+** --Displays detailed debugging information associated with TACACS+.
- **debug vtemplate** --Displays cloning information for a virtual access interface from the time it is cloned from a virtual template to the time the virtual access interface comes down when the call ends.
- **debug vpdn error** --Displays errors that prevent a PPP tunnel from being established or errors that cause an established tunnel to be closed.
- **debug vpdn events** --Displays messages about events that are part of normal PPP tunnel establishment or shutdown.
- **debug vpdn l2x-errors** --Displays messages about events that are part of normal PPP tunnel establishment or shutdown.
- **debug vpdn l2x-events** --Displays messages about events that are part of normal PPP tunnel establishment or shutdown for Layer 2.

SUMMARY STEPS

1. **enable**
2. **show debugging**
3. Examine the debug output.

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show debugging**

Enter this command to display information about the types of debugging that are enabled for your router.

Example:

```
Router# show debugging
General OS:
AAA Authentication debugging is on
AAA Authorization debugging is on
AAA Accounting debugging is on
VPN:
L2X protocol events debugging is on
L2X protocol errors debugging is on
VPDN events debugging is on
VPDN errors debugging is on
VTEMPLATE:
Virtual Template debugging is on
```

Step 3 Examine the debug output.

The following example shows complete debug output from the tunnel server for successful VPDN tunnel establishment using remote TACACS+ AAA authentication at the NAS:

Example:

```
Jan 30 12:17:09: L2TP: I SCCRQ from rtp_tunnel tnl 74
Jan 30 12:17:09: Tnl 56 L2TP: New tunnel created for remote
rtp_tunnel, address 10.31.1.144
Jan 30 12:17:09: Tnl 56 L2TP: Got a challenge in SCCRQ, rtp_tunnel
Jan 30 12:17:09: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:09: AAA/AUTHEN: create_user (0x21F6D0) user='ABCDE'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:09: AAA/AUTHEN/START (3194595626): port='' list='default'
action=SENDAUTH service=PPP
Jan 30 12:17:09: AAA/AUTHEN/START (3194595626): found list default
Jan 30 12:17:09: AAA/AUTHEN (3194595626): status = UNKNOWN
Jan 30 12:17:09: AAA/AUTHEN/START (3194595626): Method=TACACS+
Jan 30 12:17:09: TAC+: send AUTHEN/START packet ver=193 id=3194595626
Jan 30 12:17:09: TAC+: ver=192 id=3194595626 received AUTHEN status = ERROR
Jan 30 12:17:09: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:09: AAA/AUTHEN: create_user (0x2281AC) user='ABCDE'
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:09: TAC+: ver=192 id=3639011179 received AUTHEN status = PASS
Jan 30 12:17:09: AAA/AUTHEN: free_user (0x2281AC) user='ABCDE' ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:09: AAA/AUTHEN (3194595626): status = PASS
Jan 30 12:17:09: AAA/AUTHEN: free_user (0x21F6D0) user='ABCDE' ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:09: Tnl 56 L2TP: O SCCRP to rtp_tunnel tnlid 74
Jan 30 12:17:09: Tnl 56 L2TP: Tunnel state change from idle to
wait-ctl-reply
Jan 30 12:17:10: Tnl 56 L2TP: O Resend SCCRP, flg TLF, ver 2, len 152,
tnl 74, cl 0, ns 0, nr 1
Jan 30 12:17:10: Tnl 56 L2TP: I SCCCN from rtp_tunnel tnl 74
Jan 30 12:17:10: Tnl 56 L2TP: Got a Challenge Response in SCCCN from rtp_tunnel
Jan 30 12:17:10: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:10: AAA/AUTHEN: create_user (0x227F3C) user='ABCDE'
```

```
ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:10: AAA/AUTHEN/STARTTranslating "rtp.cisco.com"
(4117701992): port='' list='default' action=SENDAUTH service=PPP
Jan 30 12:17:10: AAA/AUTHEN/START (4117701992): found list default
Jan 30 12:17:10: AAA/AUTHEN (4117701992): status = UNKNOWN
Jan 30 12:17:10: AAA/AUTHEN/START (4117701992): Method=TACACS+
Jan 30 12:17:10: TAC+: send AUTHEN/START packet ver=193 id=4117701992
Jan 30 12:17:11: TAC+: ver=192 id=4117701992 received AUTHEN status = ERROR
Jan 30 12:17:11: AAA: parse name= idb type=-1 tty=-1
Jan 30 12:17:11: AAA/AUTHEN: create_user (0x228E68) user='ABCDE' ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:11: TAC+: ver=192 id=2827432721 received AUTHEN status = PASS
Jan 30 12:17:11: AAA/AUTHEN: free_user (0x228E68) user='ABCDE' ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:11: AAA/AUTHEN (4117701992): status = PASS
Jan 30 12:17:11: AAA/AUTHEN: free_user (0x227F3C) user='ABCDE' ruser='' port=''
rem_addr='' authen_type=CHAP service=PPP priv=1
Jan 30 12:17:11: Tnl 56 L2TP: Tunnel Authentication success
Jan 30 12:17:11: Tnl 56 L2TP: Tunnel state change from wait-ctl-reply
to established
Jan 30 12:17:11: Tnl 56 L2TP: SM State established
Jan 30 12:17:11: Tnl 56 L2TP: I ICRQ from rtp_tunnel tnl 74
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: Session FS enabled
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: Session state change from idle to
wait-for-tunnel
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: New session created
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: O ICRP to rtp_tunnel 74/1
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: Session state change from wait-for-tunnel
to wait-connect
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: I ICCN from rtp_tunnel tnl 74, cl 1
Jan 30 12:17:11: Tnl/Cl 56/1 L2TP: Session state change from wait-connect
to established
Jan 30 12:17:11: Vi1 VTEMPLATE: Reuse Vi1, recycle queue size 0
Jan 30 12:17:11: Vi1 VTEMPLATE: Hardware address 00e0.1e68.942c
Jan 30 12:17:11: Vi1 VPDN: Virtual interface created for user1@rtp.cisco.com
Jan 30 12:17:11: Vi1 VPDN: Set to Async interface
Jan 30 12:17:11: Vi1 VPDN: Clone from Vtemplate 1 filterPPP=0 blocking
Jan 30 12:17:11: Vi1 VTEMPLATE: Has a new cloneblk vtemplate, now it has vtemplate
Jan 30 12:17:11: Vi1 VTEMPLATE: ************ CLONE VACCESS1 ****************
Jan 30 12:17:11: Vi1 VTEMPLATE: Clone from Virtual-Template1
```

Verifying L2TP Tunnel Establishment PPP Negotiations and Authentication with the Remote Client

Perform this task to verify that the L2TP tunnel has been established and that the tunnel server can perform PPP negotiation and authentication with the remote client.

In this example the steps are performed on the tunnel server, which is performing remote AAA as a tunnel terminator. These steps can also be performed on the NAS when remote AAA is being performed on the NAS as a tunnel initiator for dial-in VPDNs or as a tunnel terminator for dial-out VPDNs.

SUMMARY STEPS

1. **enable**
2. **debug ppp negotiation**
3. **debug ppp authentication**
4. **show logging**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **debug ppp negotiation**

Enter this command on the tunnel server to display PPP negotiation debugging messages.

Example:

```
Router# debug ppp negotiation
```

Step 3 **debug ppp authentication**

Enter this command on the tunnel server to display PPP authentication debugging messages.

Example:

```
Router# debug ppp authentication
```

Step 4 **show logging**

Enter this command on the tunnel server to display the contents of the standard system logging message buffer. Observe that the tunnel server receives a PPP Challenge Handshake Authentication Protocol (CHAP) challenge and then sends a PPP CHAP "SUCCESS" to the client.

Example:

```
00:38:50: ppp3 PPP: Received LOGIN Response from AAA = PASS
00:38:50: ppp3 PPP: Phase is FORWARDING, Attempting Forward
00:38:50: Vi4.1  Tnl/Sn4571/4 L2TP: Session state change from wait-for-service-selection to established
00:38:50: Vi4.1 PPP: Phase is AUTHENTICATING, Authenticated User
00:38:50: Vi4.1 CHAP: O SUCCESS id 1 len 4
```

After PPP authentication is successful, observe from the debug output that PPP negotiation has started, that the tunnel server has received Link Control Protocol (LCP) IP Control Protocol (IPCP) packets, and that negotiation is successful.

Example:

```
00:38:50: Vi4.1 IPCP: State is Open
00:38:50: Vi4.1 IPCP: Install route to 10.1.1.4
```

Configuring Directed Request Authorization of VPDN Users

Directed request authorization of VPDN users can be configured on the NAS or on the tunnel server. The directed request configuration is performed on the device that ultimately performs the authentication. Directed requests are most commonly configured on the tunnel server.

Perform one of these tasks to enable directed request authorization of VPDN users.

Configuring Directed Request Authorization of VPDN Users on the Tunnel Server

Perform this task on the tunnel server to configure directed request authorization of VPDN users when the tunnel server performs authentication.

Before You Begin

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip host** {*name* | **t** *modem-telephone-number*} [*tcp-port-number*] *address1* [*address2...address8*]
4. Do one of the following:
   - **radius-server directed-request** [**restricted**]
   - **tacacs-server directed-request** [**restricted**] [**no-truncate**]
5. **vpdn authorize directed-request**

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	**ip host** {*name* | **t** *modem-telephone-number*} [*tcp-port-number*] *address1* [*address2...address8*] **Example:** `Router(config)# ip host example.com 10.3.3.3`	Specifies or modifies the hostname for the network server. **Note** The IP address specified with the **ip host** command must match the IP address you configured with the **radius-server host**or **tacacs-server host** command when performing the task in the Configuring Remote AAA for VPDNs, on page 44.
Step 4	Do one of the following: • **radius-server directed-request** [**restricted**] • **tacacs-server directed-request** [**restricted**] [**no-truncate**]	Allows users logging in to a NAS to select a RADIUS server for authentication. or Allows users logging in to a NAS to select a TACACS+ server for authentication.

	Command or Action	Purpose

	Example:
	`Router(config)# radius-server directed-request`
	Example:
	`Router(config)# tacacs-server directed-request`	

Step 5	**vpdn authorize directed-request** **Example:** `Router(config)# vpdn authorize directed-request`	Enables VPDN authorization for directed request users.

What to Do Next

You must perform the process in the Configuring VPDN Tunnel Authentication, on page 63.

Configuring Directed Request Authorization of VPDN Users on the NAS

Perform this task on the NAS to configure directed request authorization of VPDN users when the NAS performs authentication.

Before You Begin

You must perform the task in the "Remote AAA for VPDNs" section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip host** {*name* | **t** *modem-telephone-number*} [*tcp-port-number*] *address1* [*address2...address8*]
4. Do one of the following:
    - **radius-server directed-request** [**restricted**]
    - **tacacs-server directed-request** [**restricted**] [**no-truncate**]
5. **vpdn authorize directed-request**

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	**ip host** {*name* | **t** *modem-telephone-number*} [*tcp-port-number*] *address1* [*address2...address8*] **Example:** `Router(config)# ip host example.com 10.3.3.3`	Specifies or modifies the hostname for the network server. **Note** The IP address specified with the **ip host** command must match the IP address you configured with the **radius-server host** or **tacacs-server host** command when performing the task in the Configuring Remote AAA for VPDNs, on page 44.

Step 4	Do one of the following:
	• **radius-server directed-request** [**restricted**]
	• **tacacs-server directed-request** [**restricted**] [**no-truncate**]
	Example:
	`Router(config)# radius-server directed-request`
	Example:
	`Router(config)# tacacs-server directed-request`
		Allows users logging in to a NAS to select a RADIUS server for authentication.
		or
		Allows users logging in to a NAS to select a TACACS+ server for authentication.

Step 5	**vpdn authorize directed-request** **Example:** `Router(config)# vpdn authorize directed-request`	Enables VPDN authorization for directed request users.

What to Do Next

You must perform the process in the Configuring VPDN Tunnel Authentication, on page 63.

Configuring Domain Name Prefix and Suffix Stripping

A single set of stripping rules can be configured globally. An independent set of stripping rules can be configured for each virtual private network (VPN) routing and forwarding (VRF) instance.

Global stripping rules are applied to all usernames, and per-VRF rules are applied only to usernames associated with the specified VRF. If a per-VRF rule is configured, it will take precedence over the global rule for usernames associated with that VRF.

Perform this task on the NAS to configure a set of global or per-VRF stripping rules.

Before You Begin

- You must be running Cisco IOS 12.2(13)T or a later release to configure generic suffix stripping using the suffix delimiter @ for usernames forwarded to a remote RADIUS AAA server.
- You must be running Cisco IOS 12.3(4)T or a later release to configure a suffix delimiter or a set of suffix delimiters for usernames forwarded to a remote RADIUS AAA server.
- You must be running Cisco IOS 12.4(4)T or a later release to configure suffix stripping for usernames forwarded to a remote TACACS+ AAA server.
- You must be running Cisco IOS 12.4(4)T or a later release to configure prefix stripping or per-suffix stripping.
- AAA must be enabled on the NAS. Perform the task in the Configuring AAA on the NAS and the Tunnel Server, on page 42.
- You must understand the usage guidelines for the **radius-server domain-stripping** command as described in the VPDN command reference.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
    - **radius-server domain-stripping** [**right-to-left**] [**prefix-delimiter** *character* [*character2*...*character7*]] [**delimiter** *character* [*character2*...*character7*]] [**vrf** *vrf-name*]
    - **tacacs-server domain-stripping** [**right-to-left**] [**prefix-delimiter** *character* [*character2*...*character7*]] [**delimiter** *character* [*character2*...*character7*]] [**vrf** *vrf-name*]
4. Do one of the following:
    - **radius-server domain-stripping strip-suffix** *suffix* [**vrf** *vrf-name*]
    - **tacacs-server domain-stripping strip-suffix** *suffix* [**vrf** *vrf-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	Do one of the following:
	- **radius-server domain-stripping** [**right-to-left**] [**prefix-delimiter** *character* [*character2*...*character7*]] [**delimiter** *character* [*character2*...*character7*]] [**vrf** *vrf-name*]
	- **tacacs-server domain-stripping** [**right-to-left**] [**prefix-delimiter** *character* [*character2*...*character7*]] [**delimiter** *character* [*character2*...*character7*]] [**vrf** *vrf-name*]
	Example:
	`Router(config)# radius-server domain-stripping prefix-delimiter #%&\\ delimiter @/`
	Example:
	`Router(config)# tacacs-server domain-stripping prefix-delimiter %\$ vrf myvrf`
		(Optional) Configures a router to strip suffixes, or both suffixes and prefixes, from the username before forwarding the username to the RADIUS server.
		or
		(Optional) Configures a router to strip suffixes, or both suffixes and prefixes, from the username before forwarding the username to the TACACS+ server.
		- **right-to-left** --Configures the router to parse the username for a delimiter from right to left, rather than in the default direction of left to right. The prefix or suffix will be stripped at the first valid delimiter character detected by the router. Changing the direction that the router parses the username will control the portion of the username that is stripped if multiple valid delimiters are present.
		Note Only one parse direction can be configured per set of global or per-VRF rules. The router cannot be configured to parse for prefixes in one direction, and parse for suffixes in the other direction.
		- **prefix-delimiter** *character* [*character2*...*character7*]--Enables prefix stripping and specifies the character or characters that will be recognized as a prefix delimiter. Valid values for the *character* argument are @, /, $, %, \, #, and -. Multiple characters can be entered without intervening spaces. Up to seven characters can be defined as prefix delimiters, which is the maximum number of valid characters. If a \ is entered as the final or only value for the *character* argument, it must be entered as \\.
		Note Enabling prefix stripping will automatically enable suffix stripping using the default suffix delimiter @, unless a different suffix delimiter is configured using the **delimiter** *character* keyword and argument.
		- **delimiter** *character* [*character2*...*character7*]--Specifies the character or characters that will be recognized as a suffix delimiter. Valid values for the *character* argument are @, /, $, %, \, #, and -. Multiple characters can be entered without intervening spaces. Up to seven characters can be defined as prefix delimiters, which is the maximum number of valid characters. If a \ is entered as the final or only value for the *character* argument, it must be entered as \\.

	Command or Action	Purpose
		- **vrf** *vrf-name* --Restricts the stripping configuration to a VRF instance. The *vrf-name*argument specifies the name of a configured VRF.

Step 4	Do one of the following:
	- **radius-server domain-stripping strip-suffix** *suffix* [**vrf** *vrf-name*]
	- **tacacs-server domain-stripping strip-suffix** *suffix* [**vrf** *vrf-name*]
	Example:
	`Router(config)# radius-server domain-stripping strip-suffix cisco.com`
	Example:
	`Router(config)# tacacs-server domain-stripping strip-suffix cisco.net vrf myvrf`
		(Optional) Configures a router to strip a specific suffix from the username before forwarding the username to the RADIUS server.
		or
		(Optional) Configures a router to strip a specific suffix from the username before forwarding the username to the TACACS+ server.
		- **strip-suffix** *suffix* --Enables per-suffix stripping and specifies the string that must be matched for the suffix to be stripped.
		Note Both the suffix delimiter and the suffix must match for the suffix to be stripped from the full username. The default suffix delimiter of @ will be used if you do not specify a different suffix delimiter or set of suffix delimiters in Configuring Domain Name Prefix and Suffix Stripping.
		- **vrf** *vrf-name* --Restricts the per-suffix stripping configuration to a VRF instance. The *vrf-name*argument specifies the name of a VRF.
		Note You can configure a single ruleset to strip multiple specific suffixes by performing this step multiple times.

What to Do Next

You must perform the process in the Configuring VPDN Tunnel Authentication, on page 63.

Configuring VPDN Tunnel Authentication

VPDN tunnel authentication enables routers to authenticate the other tunnel endpoint before establishing a VPDN tunnel. VPDN tunnel authentication is required for L2F tunnels; it is optional but highly recommended for L2TP, L2TPv3, and PPTP tunnels.

By default, the router will use the hostname as the tunnel name in VPDN tunnel authentication. If a local name is configured under a VPDN group, the router will use the local name when negotiating authentication for tunnels belonging to that VPDN group.

For NAS-initiated VPDN deployments and dial-out VPDN deployments, tunnel authentication requires that a single shared secret be configured on both the NAS and the tunnel server. The password can be configured using the hostname or local name for L2F tunnels. For L2TP tunnels, the password can be configured using the hostname, the local name, or the L2TP tunnel password.

For client-initiated VPDN tunneling deployments, tunnel authentication requires that a single shared secret be configured on both the client and the tunnel server. The available authentication configuration options depend on the tunneling protocol being used.

For L2TPv3 client-initiated VPDN tunnels, the shared secret can be configured on the local peer router and the tunnel server in either of these ways:

- In an L2TP class configuration. Perform the task Configuring L2TP Control Channel Authentication Parameters.
- Using the hostname of the router as described in the process documented in this section.

For L2TP client-initiated VPDN tunnels, the shared secret can be configured on the tunnel server using the hostname, the local name, or the L2TP tunnel password as described the process documented in this section. The shared secret can be configured on the local peer router in either of these ways:

- In an L2TP class configuration. Perform the task Configuring L2TP Control Channel Authentication Parameters. Using the hostname of the router as described in the process documented in this section.

For PPTP client-initiated VPDN tunnels, authentication parameters can be configured using the hostname or the local name as described in the process documented in this section.

Note If you plan to implement shell-based authentication of VPDN users, it is highly recommended that a separate VPDN group with a distinct local name be created on the tunnel server for users that are authenticated using terminal services, so that only exec VPDN sessions are accepted without authentication.

To configure VPDN tunnel authentication, you must perform one of the following tasks on the NAS and the tunnel server as required. You need not choose the same method to configure the secret on the NAS and the tunnel server. However, the configured password must be the same on both devices.

VPDN tunnel authentication is optional for L2TP tunnels. Perform the following task on the NAS and the tunnel server if you want to disable VPDN tunnel authentication:

Prerequisites

AAA must be enabled. See the Configuring AAA on the NAS and the Tunnel Server section.

Configuring VPDN Tunnel Authentication Using the Hostname

Perform this task on the NAS or tunnel server to configure VPDN tunnel authentication using the hostname.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **hostname** *name*
4. **username** *name* **password** *secret*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**hostname** *name* **Example:** `Router(config)# hostname tunnelserver12`	Specifies or modifies the hostname for the network server.
Step 4	**username** *name* **password** *secret* **Example:** `Router(config)# username nas4 password mysecret`	Establishes a username-based authentication system. • The specified username must be the name of the remote router. • The secret password must be the same on both routers.

What to Do Next

- Once you have configured a secret password on one tunnel endpoint, you must configure the same tunnel secret on the corresponding tunnel endpoint.
- If you are configuring shell-based authentication of VPDN tunnels, you must perform the task in the Configuring the NAS for Shell-Based Authentication of VPDN Users, on page 83.

Configuring VPDN Tunnel Authentication Using the Local Name

Perform this task on the NAS or tunnel server to configure VPDN tunnel authentication using the local name.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **local name** *host-name*
5. **exit**
6. **username** *name* **password** *secret*

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group mygroup`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**local name** *host-name* **Example:** `Router(config-vpdn)# local name tunnelserver2`	Specifies a local hostname that the tunnel will use to identify itself.
Step 5	**exit** **Example:** `Router(config-vpdn)# exit`	Exits VPDN group configuration mode.
Step 6	**username** *name* **password** *secret* **Example:** `Router(config)# username nas7 password mysecret`	Establishes a username-based authentication system. • The specified username must be the name of the remote router. • The secret password must be the same on both routers.

What to Do Next

- Once you have configured a secret password on one tunnel endpoint, you must configure the same tunnel secret on the corresponding tunnel endpoint.
- If you are configuring shell-based authentication of VPDN tunnels, you must perform the task in the Configuring the NAS for Shell-Based Authentication of VPDN Users, on page 83.

Configuring VPDN Tunnel Authentication Using the L2TP Tunnel Password

Perform this task on the NAS or tunnel server to configure VPDN tunnel authentication using the L2TP tunnel password. This task can be used only for VPDN tunnel authentication of L2TP tunnels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **l2tp tunnel password** *password*
5. **local name** *host-name*
6. **exit**
7. **username** *name* **password** *secret*

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group mygroup`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**l2tp tunnel password** *password* **Example:** `Router(config-vpdn)# l2tp tunnel password mysecret`	Sets the password that the router will use to authenticate the tunnel.
Step 5	**local name** *host-name* **Example:** `Router(config-vpdn)# local name tunnelserver2`	(Optional) Specifies a local hostname that the tunnel will use to identify itself. • You must perform this step if the remote router does not use the L2TP tunnel password.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Router(config-vpdn)# exit`	(Optional) Exits VPDN group configuration mode. • You must perform this step only if the remote router does not use the L2TP tunnel password method of VPDN tunnel authentication.
Step 7	**username** *name* **password** *secret* **Example:** `Router(config)# username nas64 password mysecret`	(Optional) Establishes a username-based authentication system. • You need to perform this step only if the remote router does not use the L2TP tunnel password method of VPDN tunnel authentication. • The specified username must be the name of the remote router. • The password must be the same on both routers.

What to Do Next

- Once you have configured a secret password on one tunnel endpoint, you must configure the same tunnel secret on the corresponding tunnel endpoint.
- If you are configuring shell-based authentication of VPDN tunnels, you must perform the task in the Configuring the NAS for Shell-Based Authentication of VPDN Users, on page 83.

Disabling VPDN Tunnel Authentication for L2TP Tunnels

Perform this task to disable VPDN tunnel authentication for L2TP tunnels. You must perform this task on both the NAS and the tunnel server to disable VPDN tunnel authentication.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **no l2tp tunnel authentication**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group mygroup`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**no l2tp tunnel authentication** **Example:** `Router(config-vpdn)# no l2tp tunnel authentication`	Disables L2TP tunnel authentication.

What to Do Next

- If you are configuring shell-based authentication of VPDN tunnels, you must perform the task in the Configuring the NAS for Shell-Based Authentication of VPDN Users, on page 83.

Configuring RADIUS Tunnel Accounting for L2TP VPDNs

The new RADIUS tunnel accounting types are used with the RADIUS accounting attribute Acct-Status-Type (attribute 40), which indicates whether an accounting request marks the beginning of user service (start) or the end (stop).

Perform this task to configure a NAS or tunnel server to send tunnel and tunnel-link accounting records to the remote RADIUS server.

Before You Begin

- You must perform the tasks in the Configuring AAA on the NAS and the Tunnel Server, on page 42.
- You must configure the router to use a remote RADIUS AAA server as described in the Configuring Remote AAA for VPDNs, on page 44.
- You must perform the tasks in the "Configuring VPDN Tunnel Authentication" section.

Note RADIUS tunnel accounting is supported only for VPDNs using the L2TP protocol.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa accounting network default** | *list-name*} {**start-stop** | **stop-only** | **wait-start** | **none group** *groupname*
4. **vpdn tunnel accounting network** *list-name*
5. **vpdn session accounting network** *list-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	**aaa accounting network default** | *list-name*} {**start-stop** | **stop-only** | **wait-start** | **none group** *groupname* **Example:** `Router(config)# aaa accounting network list1 start-stop group radius`	Enables network accounting. • **default** --If the default network accounting method-list is configured and no additional accounting configurations are enabled on the interface, network accounting is enabled by default. If either the **vpdn session accounting network** command or the **vpdn tunnel accounting network** command is linked to the **default** method-list, all tunnel and tunnel-link accounting records are enabled for those sessions. • *list-name* --The *list-name*defined in the **aaa accounting** command must be the same as the *list-name* defined in the VPDN command; otherwise, accounting will not occur.
Step 4	**vpdn tunnel accounting network** *list-name* **Example:** `Router(config)# vpdn tunnel accounting network list1`	Enables Tunnel-Start, Tunnel-Stop, and Tunnel-Reject accounting records. • *list-name* --The *list-name* must match the *list-name* defined in the **aaa accounting**command; otherwise, network accounting will not occur.

	Command or Action	Purpose
Step 5	**vpdn session accounting network** *list-name* **Example:** `Router(config)# vpdn session accounting network list1`	Enables Tunnel-Link-Start, Tunnel-Link-Stop, and Tunnel-Link-Reject accounting records. • *list-name* --The *list-name* must match the *list-name* defined in the **aaa accounting** command; otherwise, network accounting will not occur.

Configuring Suppression of EXEC Records

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa accounting nested suppress stop**

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	**aaa accounting nested suppress stop** **Example:** `Router(config)# aaa accounting nested suppress stop`	Stops the generation of EXEC-stop accounting records.

Configuring Authentication of L2TP Tunnels at the Tunnel Terminator Remote RADIUS AAA Server

For L2TP tunnels, you can configure the device that terminates the VPDN tunnel to perform remote RADIUS AAA. A remote RADIUS AAA server can be used to perform VPDN tunnel authentication on the tunnel terminator as follows:

- Using a remote RADIUS AAA server on the tunnel server for dial-in VPDNs
- Using a remote RADIUS AAA server on the NAS for dial-out VPDNs

Perform this task on the remote RADIUS AAA server to configure the RADIUS server to authenticate VPDN tunnels at the device that terminates the tunnel.

Before You Begin

- The RADIUS server must be configured for AAA. For more information on configuring remote RADIUS AAA servers, see the "Additional References" section.
- The service type in the RADIUS user profile for the tunnel initiator should always be set to "Outbound."

Note This task applies only when the device that terminates the VPDN tunnel is performing remote RADIUS AAA. To configure the tunnel terminator to perform remote RADIUS AAA, perform the task in the "Configuring the Tunnel Terminator for Remote RADIUS AAA for L2TP Tunnels" section.

SUMMARY STEPS

1. **service type =** *Outbound*
2. **tunnel-type =** *protocol*
3. **Cisco:Cisco-Avpair = vpdn:dout-dialer =** *NAS-dialer-number*
4. **Cisco:Cisco-Avpair = vpdn:vpdn-vtemplate =** *vtemplate-number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**service type =** *Outbound* **Example:** `service type = Outbound`	Specifies the service type.
Step 2	**tunnel-type =** *protocol* **Example:** `tunnel-type = l2tp`	Specifies the tunneling protocol. **Note** L2TP is the only valid protocol for this task.

	Command or Action	Purpose
Step 3	**Cisco:Cisco-Avpair = vpdn:dout-dialer =** *NAS-dialer-number* **Example:** `Cisco:Cisco-Avpair = vpdn:dout-dialer = 2`	Specifies which dialer to use on the NAS for dial-out configuration. **Note** Perform this step only for dial-out configurations.
Step 4	**Cisco:Cisco-Avpair = vpdn:vpdn-vtemplate =** *vtemplate-number* **Example:** `Cisco:Cisco-Avpair = vpdn:vpdn-vtemplate = 1`	Specifies the virtual template number to use on the tunnel server for dial-in configuration. **Note** Perform this step only for dial-in configurations. **Note** This configuration is optional if the **vpdn tunnel authorization virtual-template** command is used in the task in the Configuring the Tunnel Terminator for Remote RADIUS AAA for L2TP Tunnels, on page 47.

Configuring DNS Name Support on the NAS Remote RADIUS AAA Server

NAS remote AAA servers can resolve DNS names and translate them into IP addresses. The server will first look up the name in its name cache. If the name is not in the name cache, the server will resolve the name by using a DNS server.

Perform this task on the NAS remote RADIUS AAA server.

Before You Begin

The RADIUS server must be configured for AAA.

SUMMARY STEPS

1. **l2tp-tunnel-password =** *password*
2. **tunnel-type =** *protocol*
3. **ip-addresses =** *DNS-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**l2tp-tunnel-password =** *password* **Example:** `l2tp-tunnel-password = cisco123`	Specifies the password for the VPDN tunnel.

	Command or Action	Purpose
Step 2	**tunnel-type =** *protocol* **Example:** `tunnel-type = l2tp`	Specifies the tunneling protocol.
Step 3	**ip-addresses =** *DNS-name* **Example:** `ip-addresses = cisco`	Instructs the RADIUS server to resolve the DNS name and tunnel calls to the appropriate IP address.

Configuring L2TP Tunnel Server Load Balancing and Failover on the NAS Remote RADIUS AAA Server

Perform one of the tasks on the NAS remote RADIUS AAA server to configure tunnel server load balancing and failover. For release prior to Cisco IOS Release 12.2(4)T, perform the Cisco proprietary VSA task. For Cisco IOS Release 12.2(4)T and later releases, perform the RADIUS tunnel preference attribute task:

Configuring L2TP Tunnel Server Load Balancing and Failover Using the Cisco Proprietary VSA

Until Cisco IOS Release 12.2(4)T, load balancing and failover functionality for L2TP tunnel servers was provided by the Cisco proprietary Vendor Specific Attribute (VSA). A specially formatted string would be transported within a Cisco VSA “vpdn:ip-addresses” string from the RADIUS server to a NAS for the purpose of tunnel server load balancing and failover. For example, 10.0.0.1 10.0.0.2 10.0.0.3/10.0.0.4 10.0.0.5 would be interpreted as IP addresses 10.0.0.1, 10.0.0.2, and 10.0.0.3 for the first group for load balancing. New sessions are projected to these three addresses based on the least-load-first algorithm. This algorithm uses its local knowledge to select a tunnel server that has the least load to initiate the new session. In this example, the addresses 10.0.0.4 and 10.0.0.5 in the second group have a lower priority and are applicable only when all tunnel servers specified in the first group fail to respond to the new connection request, thereby making 10.0.0.4 and 10.0.0.5 the failover addresses.

Perform this task on the NAS remote RADIUS server to assign tunnel server priorities for load balancing and failover.

Prerequisites

Perform this task on the NAS remote RADIUS server to assign tunnel server priorities for load balancing and failover.

Before You Begin

- The RADIUS server must be configured for AAA.

SUMMARY STEPS

1. **ip-addresses** = {*ip-address* | *dns-name*} {**,** | **/**} {*ip-address* | *dns-name*} {**,**| **/**} [*ip-address* | *dns-name*]....

DETAILED STEPS

	Command or Action	Purpose
Step 1	**ip-addresses** = {*ip-address* | *dns-name*} {**,** | **/**} {*ip-address* | *dns-name*} {**,**| **/**} [*ip-address* | *dns-name*].... **Example:** `ip-addresses = 172.16.171.11, 172.16.171.12, 172.16.171.13/mydomain`	Configures the IP addresses of the tunnel servers that the load will be balanced over. • Separating the IP addresses with a spaces or a comma specifies that the load will be equally balanced over the tunnel servers. • Using a slash to separate IP addresses specifies that the IP addresses after the slash will be contacted only if the other specified tunnel servers are unavailable. • A DNS name can be used in place of an IP address.

Configuring L2TP Tunnel Server Load Balancing and Failover Using the RADIUS Tunnel Preference Attribute

Perform this task on the NAS remote RADIUS server to assign a priority value to each tunnel server for load balancing and failover.

Before You Begin

- The NAS must be running Cisco IOS Release 12.2(4)T or a later release.
- On Cisco access server platforms, you must be running Cisco IOS Release 12.2(11)T or a later release.
- The RADIUS server must be configured for AAA.

Note

- Dial-out VPDN deployments are not supported.
- The maximum number of tunnel servers allowed in the network is 1550, which is 50 per tagged attribute group with a limit of 31 tags.
- This feature requires a RADIUS server implementation that supports RFC 2868.

SUMMARY STEPS

1. **Tunnel-Server-Endpoint = :** *tag* **: "** *ip-address* **",**
2. **Tunnel-Preference = :** *priority* **:** *tag* **,**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**Tunnel-Server-Endpoint = :** *tag* **: "** *ip-address* **",** **Example:** `Tunnel-Server-Endpoint = :0:"10.1.1.1",`	Specifies the IP address of a tunnel server.
Step 2	**Tunnel-Preference = :** *priority* **:** *tag* **,** **Example:** `Tunnel-Preference = :0:1,`	Specifies the priority of the tunnel server for load balancing and failover. • A lower value for the *priority* argument gives a higher priority to the tunnel server.

Configuring Tunnel Assignments on the NAS Remote RADIUS AAA Server

Tunnel assignments allow the grouping of users from different per-user or domain RADIUS profiles into the same active tunnel. This functionality prevents the establishment of duplicate tunnels when the tunnel type, tunnel endpoints, and tunnel assignment ID are identical.

Perform this task on the NAS remote RADIUS AAA server for each user and domain that you want to group into the same tunnel.

Before You Begin

The RADIUS server must be configured for AAA.

SUMMARY STEPS

1. Do one of the following:
   - *user* @ *domain.com* **Password = "** *secret* **" Service-Type = Outbound**
   - *user.domain.com* **Password = "** *secret* **" Service-Type = Outbound**
2. **tunnel-type =** *protocol*
3. **tunnel-server-endpoint =** *ip-address*
4. **tunnel-assignment-id =** *name*

DETAILED STEPS

	Command or Action	Purpose

Step 1	Do one of the following:
	• *user* @ *domain.com* **Password =** " *secret* " **Service-Type = Outbound**
	• *user.domain.com* **Password =** " *secret* " **Service-Type = Outbound**
	Example:
	`user@cisco.com Password = "cisco" Service-Type = Outbound`
	Example:
	`user.cisco.com Password = "cisco" Service-Type = Outbound`
		Specifies the user or domain, the tunnel password, and the service type.

Step 2	**tunnel-type =** *protocol* **Example:** `tunnel-type = l2tp`	Specifies the tunneling protocol used. • The tunnel type must be identical for users to be grouped into the same tunnel.
Step 3	**tunnel-server-endpoint =** *ip-address* **Example:** `tunnel-server-endpoint = 10.1.1.1`	Specifies the IP address of the tunnel server that calls from the specified user or domain are tunneled to. • The tunnel server endpoint must be identical for users to be grouped into the same tunnel.
Step 4	**tunnel-assignment-id =** *name* **Example:** `tunnel-assignment-id = group1`	Specifies the tunnel ID that calls from the specified user or domain are assigned. • The tunnel assignment ID must be identical for users to be grouped into the same tunnel.

Configuring L2TP Tunnel Connection Speed Labeling on the Remote ARS RADIUS AAA Server and the Tunnel Server

Tunnel connection speed labeling allows L2TP sessions to be accepted or denied based on the allowed connection speed that is configured on the Cisco Access Registrar (ARS) RADIUS server for that user. The administrator can configure an ARS RADIUS server to authorize users based on their Service Level Agreement (SLA). Tunnel connection speed information is forwarded to the ARS RADIUS server by default.

Perform these tasks to configure tunnel connection speed labeling:

Restrictions

- This feature can be used only with the ARS RADIUS server.
- This feature can be used only with the L2TP tunneling protocol.

Configuring User Profiles on the ARS RADIUS Server for L2TP Tunnel Connection Speed Labeling

By default, the L2TP tunnel server will forward connection speed information to the AR RADIUS server for authentication. For the AR RADIUS server to perform authentication based on tunnel connection speed information, the user profiles on the ARS RADIUS server must be configured with the allowed connection speed.

Perform this task on the ARS RADIUS server to configure connection speed information in user profiles.

Before You Begin

- The ARS RADIUS server must be configured for AAA. For more information on configuring remote RADIUS AAA servers, see the "Additional References."

SUMMARY STEPS

1. *user* **@** *example* **.** *com*
2. **userdefined 1 = [TX:** *speed* [**-** *maxspeed*]] [**:**] [**RX:** *speed*[**-** *maxspeed*]]

DETAILED STEPS

	Command or Action	Purpose
Step 1	*user* **@** *example* **.** *com* **Example:** `user@example.com`	Specifies the user that the profile is for.
Step 2	**userdefined 1 = [TX:** *speed* [**-** *maxspeed*]] [**:**] [**RX:** *speed*[**-** *maxspeed*]] **Example:** `userdefined1 = TX:102400000:RX:96000000-200000000`	Specifies the allowable transmission and receiving connection speeds. • A range of connection speeds can be specified. • If no connection speed is specified, any speed will be allowed.

What to Do Next

- If the inclusion of RADIUS attribute 77 in authentication requests has previously been disabled on the tunnel server, you must perform the task in the Configuring L2TP Tunnel Connection Speed Labeling on the Tunnel Server, on page 80.

Disabling L2TP Tunnel Connection Speed Labeling on the Tunnel Server

By default, the L2TP tunnel server will forward connection speed information to the RADIUS server for authentication. To disable authentication based on connection speeds, you must choose to not include RADIUS attribute 77 in the access request.

Perform this task on the tunnel server to disable authentication based on connection speeds.

Before You Begin

- You must first perform the tasks in the Configuring AAA on the NAS and the Tunnel Server, on page 42 and the Configuring VPDN Tunnel Authentication, on page 63.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no radius-server attribute 77 include-in-access-req**

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	**no radius-server attribute 77 include-in-access-req** **Example:** `Router(config)# no radius-server attribute 77 include-in-access-req`	Disables the sending of connection speed information to the RADIUS server in the access request.

Configuring L2TP Tunnel Connection Speed Labeling on the Tunnel Server

Perform this task on the L2TP tunnel server to enable authentication based on connection speeds if it has been previously disabled.

Before You Begin

- You must first perform the tasks in the Configuring AAA on the NAS and the Tunnel Server section and the Configuring VPDN Tunnel Authentication section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **radius-server attribute 77 include-in-access-req**

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	**radius-server attribute 77 include-in-access-req** **Example:** `Router(config)# radius-server attribute 77 include-in-access-req`	Sends connection speed information to the RADIUS server in the access request. **Note** The **radius-server attribute 77 include-in-access-req** command is enabled by default. You need to perform this task only if you have previously disabled the **radius-server attribute 77 include-in-access-req** command. **Note** When the **radius-server attribute 77 include-in-access-req** command is enabled, it is not visible in NVGEN. This is because the **radius-server attribute 77 include-in-access-req** command is enabled by default.

Configuring L2TP Tunnel Connection Speed Labeling for a Tunnel Switch

Perform this task on the tunnel switch to enable L2TP tunnel connection speed labeling for a tunnel switch node. This configuration allows the access request to be sent to the RADIUS server before the tunnel switch forwards the session to the next hop.

Before You Begin

- You must first perform the tasks in the Configuring AAA on the NAS and the Tunnel Server, on page 42 and the Configuring VPDN Tunnel Authentication, on page 63.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn authen-before-forward**

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	**vpdn authen-before-forward** **Example:** `Router(config)# vpdn authen-before-forward`	Requests authentication and authorization of an L2TP tunnel before it is forwarded to the tunnel server.

Configuring Secure Tunnel Authentication Names on the NAS Remote RADIUS AAA Server

The NAS AAA server can be configured with authentication names other than the default names for the NAS and the NAS AAA server, providing a higher level of security during VPDN tunnel establishment.

RADIUS tunnel authentication name attributes allows you to specify a name other than the default name for the tunnel initiator and for the tunnel terminator. These authentication names are specified using RADIUS tunnel attributes 90 and 91.

Perform this task on the remote RADIUS AAA server. This task applies to NAS-initiated tunnels using either L2TP or L2F.

Before You Begin

- The RADIUS server must be configured for AAA.
- The NAS must be able to recognize RADIUS attributes 90 and 91.
- The RADIUS server must support tagged attributes to use RADIUS tunnel attributes 90 and 91. Tagged attributes are defined in RFC 2868, *RADIUS Tunnel Authentication Attributes* .

SUMMARY STEPS

1. Do one of the following:
   - *user @ example.com* **Password = "** *secret* **" Service-Type = Outbound**
   - *user.example.com* **Password = "** *secret* **" Service-Type = Outbound**
2. **tunnel-client-auth-id** = {**:1** | **:2**}**: "** *NAS-name* **"**
3. **tunnel-server-auth-id** = {**:1** | **:2**}**: "** *tunnel-server-name* **"**

DETAILED STEPS

	Command or Action	Purpose

Step 1	Do one of the following:
	• *user @ example.com* **Password = "** *secret* **" Service-Type = Outbound**
	• *user.example.com* **Password = "** *secret* **" Service-Type = Outbound**
	Example:
	`user@cisco.com Password = "cisco" Service-Type = Outbound`
	Example:
	`user.cisco.com Password = "cisco" Service-Type = Outbound`
		Specifies the user or domain, the tunnel password, and the service type.

	Command or Action	Purpose
Step 2	**tunnel-client-auth-id = {:1 | :2}: "** *NAS-name* **"** **Example:** `tunnel-client-auth-id = :2:NAS36`	Specifies the name used by the NAS when it authenticates tunnel setup with the tunnel server. • **:1** --Specifies L2F tunnels. • **:2** --Specifies L2TP tunnels.
Step 3	**tunnel-server-auth-id = {:1 | :2}: "** *tunnel-server-name* **"** **Example:** `tunnel-server-auth-id = :2:TS14`	Specifies the name used by the tunnel server when it authenticates tunnel setup with the NAS. • **:1** --Specifies L2F tunnels. • **:2** --Specifies L2TP tunnels.

Configuring the NAS for Shell-Based Authentication of VPDN Users

Shell-based authentication of VPDN users provides terminal services (shell login or exec login) for VPDN users. With shell-based authentication enabled, when clients dial in to the NAS, authentication occurs in character mode. Once authentication is complete, PPP starts and a tunnel is established based on either DNIS or domain.

Perform this task to configure the NAS for shell-based authentication of VPDN users.

Before You Begin

- The dialup line interface can be configured with the **autoselect during-login** command to allow smooth login terminal services.
- The dialup line interface can be configured with the **autocommand ppp** command. This denies the PPP user access to the exec shell, but allows entry to tunneled PPP.
- RPMS can be configured.
- Multilink PPP (MLP) can be configured.
- You must perform the task in the Configuring AAA on the NAS and the Tunnel Server section.
- You must perform the task in the Configuring the NAS for Remote AAA for Dial-In VPDNs section.
- You must perform the task in the Configuring VPDN Tunnel Authentication section. It is highly recommended that a separate VPDN group with a distinct local name be created on the tunnel server for users that are authenticated using terminal services, so that only the exec VPDN sessions are accepted without authentication.
- The remote RADIUS server must be configured for AAA. For detailed information about configuring remote RADIUS servers, see the Additional References section.
- For increased security, it is recommended that you provide additional protection of the L2TP tunnel using L2TP security. For information on configuring L2TP security, see the Configuring Additional VPDN Features module

- To use the **aaa dnis map authentication group** aaa-server-group configuration command, you must first enable AAA, define a AAA server group, and enable DNIS mapping.

Note

- Per-user virtual profiles on the tunnel server are not supported.
- Callback is not supported.
- Only those login schemes supported by the NAS exec login features are supported.
- If VPDN fails to be established (for example, Resource Pool Manager Server (RPMS) denies the session), the dialup call is terminated. An exec PPP session is not terminated locally on the NAS if the desired VPDN session fails to be established because the user was presumed authenticated by an AAA server at the remote enterprise.
- Although an exec VPDN tunnel server accepts a tunneled PPP session without authenticating the PPP clients, the tunnel itself must be mutually authenticated by both the NAS and the tunnel server. To further reduce security risks, create a separate VPDN group with a distinct local name on the tunnel server so that only the exec VPDN sessions are accepted without authentication.
- If a DNIS is mapped to a AAA server, the DNIS should also be mapped to a corresponding tunnel server in the VPDN configuration.
- The AAA server and the tunnel server, both of which can be mapped to by either a DNIS or domain name, must belong to the same enterprise and must be accessible to the NAS.
- When configuring AAA authentication at login, do not use “local” as a value for the *method-name*argument of the **aaa authentication login** command. Specifying “local” as a *method-name*would allow an end user to tunnel to a remote tunnel server after local authentication.
- The AAA server group mapped to by the DNIS is intended to authenticate users that are to be connected to the tunnel server network, and thus must not be used for authenticating local users.
- The **ppp dnis** command must not be used on the exec VPDN dialup interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa dnis map enable**
4. **aaa dnis map** *dnis-number* **authentication login group** *server-group-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**aaa dnis map enable** **Example:** `Router(config)# aaa dnis map enable`	Enables DNIS mapping for locating a AAA server.
Step 4	**aaa dnis map** *dnis-number* **authentication login group** *server-group-name* **Example:** `Router(config)# aaa dnis map 7777 authentication login group EXEC-VPDN-login-servers`	Maps a DNIS number to a particular authentication server group (this server group is used for AAA authentication).

Configuring L2TP Forwarding of PPPoE Tagging Information

Configuring L2TP Forwarding of the PPPoE Tagging Information

On the LAC, perform these steps to configure L2TP Forwarding of PPPoE Tagging Information to populate the circuit-id tag in the nas-port-id attribute and the remote-id tag in the calling-station-id attribute on the LNS.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **dsl-line-info-forwarding**
5. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group pppoe-group`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**dsl-line-info-forwarding** **Example:** `Router(config-vpdn)# dsl-line-info-forwarding`	Enables the processing of the received PPPoE Vendor-Specific tag in the PADR packet, and sends a matching VSA to the AAA server in RADIUS access and accounting requests.
Step 5	**exit** **Example:** `Router(config-vpdn)# exit`	Exits VPDN group configuration mode.

Overriding L2TP Forwarding of PPPoE Tag Information

You can configure the L2TP Forwarding of PPPoE Tagging Information feature to override the following VSA:

Overriding nas-port VSA with circuit-id

To override the population of the circuit-id tag in the nas-port-id attribute on the LNS, perform these steps on the LNS.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **radius-server attribute 87 circuit-id**
4. **exit**

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	**radius-server attribute 87 circuit-id** **Example:** `Router(config)# radius-server attribute 87 circuit-id`	Overrides the NAS-Port-Id attribute with the Circuit-ID attribute in RADIUS access and accounting requests.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits the current mode.

Overriding calling-station-id VSA with remote-id

To override the calling-station-id VSA with the remote-id on the LNS, perform these steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **radius-server attribute 31 remote-id**
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router # configure terminal`	Enters global configuration mode.
Step 3	**radius-server attribute 31 remote-id** **Example:** `Router(config)# radius-server attribute 31 remote-id`	Overrides the calling-station-id attribute with Remote-ID attribute in RADIUS access and accounting requests.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits the current mode.

Removing L2TP Forwarding of PPPoE Tag Information

Outgoing PADO and PADS packets will have the DSLAM-inserted Vendor-Specific Line-Id tag, and DSLAM must strip the Circuit-Id tag from the packets. If the DSLAM cannot strip the tag, the BRAS must remove it before sending out the packets. This task is accomplished through configuration of the **vendor-tag remote-id strip** command under BBA group configuration mode.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **bba-group pppoe** *group-name*
4. **vendor-tag remote-id strip**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**bba-group pppoe** *group-name* **Example:** `Router(config)# bba-group pppoe pppoe-group`	Defines a PPPoE profile and enters BBA group configuration mode.
Step 4	**vendor-tag remote-id strip** **Example:** `Router(config-bba-group)# vendor-tag remote-id strip`	Enables the BRAS to strip off incoming Vendor-Specific Remote-Id tags from outgoing PADO and PADS packets.

Displaying the Session Activity Log

When the **radius-server attribute nas-port format d** global configuration command is added to the PPPoE Circuit-Id Tag Processing feature configuration on the BRAS (see the Examples Configuring the VPDN Tunnel Authorization Search Order, on page 96 for an example), the report from the **debug radius** privileged EXEC command will include information about the incoming access interface, where discovery frames are received, and about the session being established in PPPoE extended NAS-Port format (format d).

SUMMARY STEPS

1. Enable the **debug radius** command to display a report of session activity. In the example shown in this section:

DETAILED STEPS

Enable the **debug radius** command to display a report of session activity. In the example shown in this section:

- The acct_session_id is 79 or 4F in hexadecimal format.
- In the message *Acct-session-id pre-pended with Nas Port = 0/0/0/200*, the interface on which the PPPoE discovery frames arrived is FastEthernet0/0.200. The 0/0/0 is Cisco format for slot/subslot/port.
- The Acct-Session-Id vendor-specific attribute 44 contains the string *0/0/0/200_0000004F*, which is a combination of the ingress interface and the session identifier.

Note Strings of interest in the **debug radius** output log are presented in bold text for purpose of example only.

Example:

```
Router# debug radius
02:10:49: RADIUS(0000003F): Config NAS IP: 0.0.0.0
02:10:49: RADIUS/ENCODE(0000003F): acct_session_id: 79
02:10:49: RADIUS(0000003F): sending
02:10:49: RADIUS/ENCODE: Best Local IP-Address 10.0.58.141 for Radius-Server 172.20.164.143
02:10:49: RADIUS(0000003F): Send Access-Request to 172.20.164.143:1645 id 1645/65, len 98
02:10:49: RADIUS:  authenticator 1C 9E B0 A2 82 51 C1 79 - FE 24 F4 D1 2F 84 F5 79
02:10:49: RADIUS:  Framed-Protocol     [7]   6 PPP                       [1]
02:10:49: RADIUS:  User-Name           [1]   7   "peer1"
02:10:49: RADIUS:  CHAP-Password       [3]   19  *
02:10:49: RADIUS:  NAS-Port-Type       [61]  6 Ethernet                  [15]
02:10:49: RADIUS:  NAS-Port            [5]   6   200
02:10:49: RADIUS:  NAS-Port-Id         [87]  22  "FastEthernet6/0.200:"
02:10:49: RADIUS:  Service-Type        [6]   6 Framed                    [2]
02:10:49: RADIUS:  NAS-IP-Address      [4]   6   10.0.58.141
02:10:49: RADIUS: Received from id 1645/65 172.20.164.143:1645, Access-Accept, len 32 02:10:49:
RADIUS:  authenticator 06 45 84 1B 27 1F A5 C3 - C3 C9 69 6E B9 C0 6F 94
02:10:49: RADIUS:  Service-Type        [6]   6 Framed                    [2]
02:10:49: RADIUS:  Framed-Protocol     [7]   6 PPP                       [1]
02:10:49: RADIUS(0000003F): Received from id 1645/65
02:10:49: [62]PPPoE 65: State LCP_NEGOTIATION    Event PPP_LOCAL
02:10:49: PPPoE 65/SB: Sent vtemplate request on base Vi2
02:10:49: [62]PPPoE 65: State VACCESS_REQUESTED    Event VA_RESP
02:10:49: [62]PPPoE 65: Vi2.1 interface obtained
02:10:49: [62]PPPoE 65: State PTA_BINDING    Event STAT_BIND
02:10:49: [62]PPPoE 65: data path set to Virtual Acess
02:10:49: [62]PPPoE 65: Connected PTA
02:10:49: [62]PPPoE 65: AAA get dynamic attrs
02:10:49: [62]PPPoE 65: AAA get dynamic attrs
02:10:49: RADIUS/ENCODE(0000003F):Orig. component type = PPoE
02:10:49: RADIUS/ENCODE(0000003F): Acct-session-id pre-pended with Nas Port = 0/0/0/200
02:10:49: RADIUS(0000003F): Config NAS IP: 0.0.0.0
02:10:49: RADIUS(0000003F): sending
02:10:49: RADIUS/ENCODE: Best Local IP-Address 10.0.58.141 for Radius-Server 172.20.164.143
02:10:49: RADIUS(0000003F): Send Accounting-Request to 172.20.164.143:1646 id 1 646/42, len 117
02:10:49: RADIUS:  authenticator 57 24 38 1A A3 09 62 42 - 55 2F 41 71 38 E1 CC 24
02:10:49: RADIUS:  Acct-Session-Id     [44]  20  "0/0/0/200_0000004F"
02:10:49: RADIUS:  Framed-Protocol     [7]   6 PPP                       [1]
02:10:49: RADIUS:  User-Name           [1]   7   "peer1"
02:10:49: RADIUS:  Acct-Authentic      [45]  6 RADIUS                    [1]
02:10:49: RADIUS:  Acct-Status-Type    [40]  6 Start                     [1]
02:10:49: RADIUS:  NAS-Port-Type       [61]  6 Ethernet                  [15]
02:10:49: RADIUS:  NAS-Port            [5]   6   200
02:10:49: RADIUS:  NAS-Port-Id         [87]  22  "FastEthernet6/0.200:"
02:10:49: RADIUS:  Service-Type        [6]   6 Framed                    [2]
02:10:49: RADIUS:  NAS-IP-Address      [4]   6   10.0.58.141
02:10:49: RADIUS:  Acct-Delay-Time     [41]  6   0
02:10:49: RADIUS: Received from id 1646/42 172.20.164.143:1646, Accounting-resp onse, len 20
02:10:49: RADIUS:  authenticator 34 84 7E B2 F4 40 B2 7C - C5 B2 4E 98 78 03 8B C0
```

Configuring LNS Address Checking

To allow a LAC to check the IP address of the LNS sending traffic to it during the setup of an L2TP tunnel, thus providing a check for uplink and downlink traffic arriving from different interfaces, follow this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn enable**
4. **vpdn-group** *name*
5. **l2tp security ip address-check**
6. **exit**

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	**vpdn enable** **Example:** `Router(config)# vpdn enable`	Enables virtual private dialup networking on the router and informs the router to look for tunnel definitions in a local database or on a remote authorization server (home gateway), if one is present.
Step 4	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group example`	Creates a VPDN group and enters VPDN group configuration mode.
Step 5	**l2tp security ip address-check** **Example:** `Router(config-vpdn)# l2tp security ip address-check`	Configures the LNS to compare the IP addresses contained in the inbound and outbound message to ensure they are identical. If the IP addresses to not match, the L2TP tunnel is not established.
Step 6	**exit** **Example:** `Router(config-vpdn)# exit`	Exits VPDN group configuration mode.

Configuring Modified LNS Dead-Cache Handling

Identifying an LNS in a Dead-Cache State

With the Modified LNS Dead-Cache Handling feature, you can use the **show vpdn dead-cache** command to display the status of an LNS in an LSG on a LAC and determine if an LNS is not responding (dead-cache state). The **show vpdn dead-cache** command displays the IP address of the nonresponding LNS, and a time entry showing how long the LNS has been down.

This procedure shows how to use the **show vpdn dead-cache** command to display the status of an LNS to determine if it is in a dead-cache state. An LNS in a dead-cache state cannot establish new sessions or calls.

SUMMARY STEPS

1. **enable**
2. **show vpdn dead-cache** {**group** *name* | **all**}
3. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

Step 2	**show vpdn dead-cache** {**group** *name* | **all**}
	Example:
	`Router# show vpdn dead-cache all`
		Displays the status of any LNS in a dead-cache state, including how long the entry has been in the dead-cache state.

Step 3	**exit** **Example:** `Router# exit`	Exits privileged EXEC mode.

Clearing an LNS in a Dead-Cache State

With the Modified LNS Dead-Cache Handling feature, you can use the **clear vpdn dead-cache** command to clear an LNS entry in the dead-cache based on the IP address of the LNS, clear all LNS dead-cache states in a VPDN group, or clear all dead-cache LNS entries. If you clear an LNS based on its IP address, and the LNS is associated with more than one VPDN group, the LNS is cleared in all the associated VPDN groups.

This procedure shows how to clear an LNS in a dead-cache state. Once an entry clears from the dead-cache state, the entry is available for new session establishments and calls.

Before You Begin

Perform this procedure on the LAC.

SUMMARY STEPS

1. **enable**
2. **clear vpdn dead-cache** {**group** *name* | **ip-address** *ip-address* | **all**}
3. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

Step 2	**clear vpdn dead-cache** {**group** *name* | **ip-address** *ip-address* | **all**}
	Example:
	`Router# clear vpdn dead-cache ip-address 10.10.10.1`
		Clears the designated LNS from the dead-cache state.

Step 3	**exit** **Example:** `Router# exit`	Exits privileged EXEC mode.

Generating an SNMP Event for a Dead-Cache Entry

If you are a manager responsible for a large number of devices, and each device has a large number of objects, it is impractical for you to poll or request information from every object on every device. SNMP trap-directed notification alerts you without solicitation, by sending a message known as a trap of the event. After you receive the event, you can display it and can choose to take an appropriate action based on the event.

To generate an SNMP event when an LNS exits or enters the dead-cache state, follow this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server enable traps vpdn dead-cache**
4. **exit**

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	**snmp-server enable traps vpdn dead-cache** **Example:** `Router(config)# snmp-server enable traps vpdn dead-cache`	Enables the generation of an SNMP event whenever an LNS enters or exits the dead-cache state.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.

Generating a Syslog Event for a Dead-Cache Entry

To view a syslog event when an LNS is added, deleted, or cleared from a dead-cache state, configure the **vpdn logging dead-cache** command. You can use syslog events to help troubleshoot networks.

The table below summarizes the syslog messages generated by using the **vpdn logging dead-cache** command.

Table 6: VPDN Logging Dead-Cache Events

Syslog Message	Description
MM:DD:hh:mm:ss %VPDN-6-VPDN_DEADCACHE_EVENT: LSG dead cache entry <ip-address> added	Added--An entry in the LSG table enters DOWN status, which marks it a dead-cache entry.

Syslog Message	Description
MM:DD:hh:mm:ss %VPDN-6-VPDN_DEADCACHE_EVENT: LSG dead cache entry <ip-address> deleted	Deleted--An entry in the LSG table is removed from DOWN status, which deletes its dead-cache entry from the table.
MM:DD:hh:mm:ss %VPDN-6-VPDN_DEADCACHE_EVENT: LSG dead cache entry <ip-address> cleared	Cleared--An entry in the LSG table is manually cleared.

To generate a syslog event when an LNS enters or exits the dead-cache state, follow this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn logging dead-cache**
4. **exit**

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	**vpdn logging dead-cache** **Example:** `Router(config)# vpdn logging dead-cache`	Enables the generation of a syslog event when an LNS enters or exits the dead-cache state.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.

Configuration Examples for AAA for VPDNs

Examples Configuring the VPDN Tunnel Authorization Search Order

The following configuration example enables VPDN and configures a tunnel authorization search order that will be used instead of the default search order of DNIS number, then domain.

```
vpdn enable
vpdn search-order domain dnis
```

The following example enables VPDN and multihop, and configures a tunnel authorization search order of multihop hostname first, then domain, then DNIS number. This configuration is used only on a tunnel switch.

```
vpdn enable
vpdn multihop
vpdn search-order multihop-hostname domain dnis
```

Example Configuring L2TP Domain Screening Rules Based

The following example shows a policy map configuration for L2TP domain screening, rules based:

```
policy-map type control REPLACE_WITH_example.com
 class type control always event session-start
  1 collect identifier unauthenticated-username
  2 set NEWNAME identifier unauthenticated-username
  3 substitute NEWNAME “(.*@).*” “\1example.com”
  4 authenticate variable NEWNAME aaa list EXAMPLE
  5 service-policy type service name example
policy-map type service abc
 service vpdn group 1
bba-group pppoe global
 virtual-template 1
!
interface Virtual-Template1
 service-policy type control REPLACE_WITH_example.com
```

Examples Configuring per-User VPDN on the NAS

The following example enables VPDN and configures global per-user VPDN on the NAS for all dial-in VPDN tunnels. The first time the NAS contacts the remote RADIUS AAA server, the entire structured username will be sent rather than just the domain name or DNIS number.

```
vpdn enable
vpdn authen-before-forward
```

The following example enables VPDN and configures per-user VPDN on the NAS for dial-in VPDN tunnels belonging to the VPDN group named cisco1. The first time the NAS contacts the remote RADIUS AAA server, the entire structured username will be sent rather than just the domain name or DNIS number.

```
vpdn enable
vpdn-group cisco1
 request-dialin
  protocol l2tp
  exit
 authen-before-forward
```

Examples Configuring AAA on the NAS and the Tunnel Server

The following example enables VPDN and local authentication and authorization on the NAS or the tunnel server:

```
vpdn enable
!
aaa new-model
aaa authentication login default local
aaa authentication ppp default local
aaa authorization network default local
```

The following examples enables VPDN and configures the NAS and the tunnel server for dial-in VPDN tunnels when remote RADIUS AAA authentication occurs at the NAS:

NAS Configuration

```
vpdn enable
!
aaa new-model
aaa authentication login default radius
aaa authentication ppp default radius
aaa authorization network default radius
aaa accounting network default start-stop radius
radius-server host 10.1.1.1 auth-port 1939 acct-port 1443
vpdn aaa untagged
```

Tunnel Server Configuration

```
vpdn enable
!
aaa new-model
aaa authentication login default radius
aaa authentication ppp default radius
aaa authorization network default radius
aaa accounting network default start-stop radius
vpdn aaa attribute nas-ip-address vpdn-nas
vpdn aaa untagged
```

The Basic TACACS+ Configuration Example document provides a basic configuration of TACACS+ for user dialup authentication to a NAS.

Examples Configuring Remote AAA for VPDNs on the L2TP Tunnel Terminator

The following example enables VPDN and configures the NAS and the tunnel server for dial-in VPDN tunnels with remote RADIUS AAA authentication occurring at the tunnel server. A sample RADIUS user profile for the remote RADIUS AAA server is also shown.

NAS Configuration

```
vpdn enable
!
aaa new-model
aaa authentication login default radius
aaa authentication ppp default radius
aaa authorization network default radius
aaa accounting network default start-stop radius
radius-server host 10.1.1.1 auth-port 1939 acct-port 1443
vpdn aaa untagged
```

Tunnel Server Configuration

```
vpdn enable
!
aaa new-model
aaa authentication login default radius
aaa authentication ppp default radius
aaa authorization network default mymethodlist group myvpdngroup
radius-server host 10.2.2.2 auth-port 1939 acct-port 1443
aaa group server radius myvpdngroup
 server 10.2.2.2 auth-port 1939 acct-port 1443
!
vpdn tunnel authorization network mymethodlist
vpdn tunnel authorization virtual-template 1
```

RADIUS User Profile

```
csidtw13  Password = "cisco"
        Service-Type = Outbound,
        Tunnel-Type = :0:L2TP,
        Tunnel-Medium-Type = :0:IP,
        Tunnel-Client-Auth-ID = :0:"csidtw13",
        Tunnel-Password = :0:"cisco"
        Cisco:Cisco-Avpair = "vpdn:vpdn-vtemplate=1"
```

Examples Configuring Directed Request Authorization of VPDN Users

The following example enables VPDN and configures remote RADIUS AAA with VPDN authentication of directed request users on the tunnel server:

```
vpdn enable
!
aaa new-model
aaa authentication login default radius
aaa authentication ppp default radius
aaa authorization network default mymethodlist group myvpdngroup
radius-server host 10.3.3.3 auth-port 1939 acct-port 1443
aaa group server radius myvpdngroup
 server 10.3.3.3 auth-port 1939 acct-port 1443
!
ip host example.com 10.3.3.3
radius-server directed-request
vpdn authorize directed-request
```

The following example enables VPDN and configures per-user VPDN, remote TACACS+ AAA, and VPDN authentication of directed request users on the NAS:

```
vpdn enable
vpdn-group 1
 request-dialin
  protocol l2tp
  domain example.com
!
 initiate-to 10.3.3.3
 local name local1
 authen-before-forward
!
aaa new-model
aaa authentication login default tacacs
aaa authentication ppp default tacacs
aaa authorization network default mymethod group mygroup
radius-server host 10.4.4.4 auth-port 1201 acct-port 1450
aaa group server tacacs mygroup
 server 10.3.3.3 auth-port 1201 acct-port 1450
!
```

```
ip host example.com 10.3.3.3
radius-server directed-request
vpdn authorize directed-request
```

Examples Configuring Domain Name Prefix and Suffix Stripping

The following example configures the router to parse the username from right to left and sets the valid suffix delimiter characters as @, \, and $. If the full username is cisco/user@cisco.com$cisco.net, the username */user@cisco.com* will be forwarded to the RADIUS server because the $ character is the first valid delimiter encountered by the NAS when parsing the username from right to left.

```
radius-server domain-stripping right-to-left delimiter @\$
```

The following example configures the router to strip the domain name from usernames only for users associated with the VRF instance named abc. The default suffix delimiter @ will be used for generic suffix stripping.

```
radius-server domain-stripping vrf abc
```

The following example enables prefix stripping using the character / as the prefix delimiter. The default suffix delimiter character @ will be used for generic suffix stripping. If the full username is cisco/user@cisco.com, the username *user* will be forwarded to the TACACS+ server.

```
tacacs-server domain-stripping prefix-delimiter /
```

The following example enables prefix stripping, specifies the character / as the prefix delimiter, and specifies the character # as the suffix delimiter. If the full username is cisco/user@cisco.com#cisco.net, the username *user@cisco.com* will be forwarded to the RADIUS server.

```
radius-server domain-stripping prefix-delimiter / delimiter #
```

The following example enables prefix stripping, configures the character / as the prefix delimiter, configures the characters $, @, and # as suffix delimiters, and configures per-suffix stripping of the suffix cisco.com. If the full username is cisco/user@cisco.com, the username *user* will be forwarded to the TACACS+ server. If the full username is cisco/user@cisco.com#cisco.com, the username “user@cisco.com” will be forwarded.

```
tacacs-server domain-stripping prefix-delimiter / delimiter $@#
tacacs-server domain-stripping strip-suffix cisco.com
```

The following example configures the router to parse the username from right to left and enables suffix stripping for usernames with the suffix cisco.com. If the full username is cisco/user@cisco.net@cisco.com, the username *cisco/user@cisco.net* will be forwarded to the RADIUS server. If the full username is cisco/user@cisco.com@cisco.net, the full username will be forwarded.

```
radius-server domain-stripping right-to-left
radius-server domain-stripping strip-suffix cisco.com
```

The following example configures a set of global stripping rules that will strip the suffix cisco.com using the delimiter @, and a different set of stripping rules for usernames associated with the VRF named myvrf:

```
radius-server domain-stripping strip-suffix cisco.com
!
radius-server domain-stripping prefix-delimiter # vrf myvrf
radius-server domain-stripping strip-suffix cisco.net vrf myvrf
```

Examples Configuring VPDN Tunnel Authentication

The following example configures VPDN tunnel authentication using the hostname on a NAS and the local name on the tunnel server. Note that the secret password configured for each device matches.

NAS Configuration

```
hostname NAS1
username tunnelserver1 password supersecret
```

Tunnel Server Configuration

```
vpdn-group 1
 local name tunnelserver1
 exit
username NAS1 password supersecret
```

The following example configures VPDN tunnel authentication using the local name on the NAS and the L2TP tunnel password on the tunnel server. Note that the secret password configured for each device matches.

NAS Configuration

```
vpdn-group 2
 local name NAS6
!
username tunnelserver12 password verysecret
```

Tunnel Server Configuration

```
vpdn-group 4
 l2tp tunnel password verysecret
 local name tunnelserver12
 exit
username NAS6 password verysecret
```

The following example configures VPDN tunnel authentication using the L2TP tunnel password on both the NAS and the tunnel server. Note that the secret password configured for each device matches.

NAS Configuration

```
vpdn-group l2tp
 l2tp tunnel password rathersecret
```

Tunnel Server Configuration

```
vpdn-group 46
 l2tp tunnel password rathersecret
```

Examples Configuring L2TP Domain Screening

Examples Configuring L2TP Domain Screening with Global Preauthentication

Global preauthentication for L2TP domain screening requires RADIUS authentication and authorization. Each user must have a RADIUS user profile that enables per-user L2TP tunneling.

The following example shows a user profile for user-1@example.net; the IP address in the profile is the LNS interface connected to the LAC.

```
[ /Radius/UserLists/Default/user-1@example.net ]
    Name = user_1@example1.net
    Description = TEST
    Password = <encrypted>
    Enabled = TRUE
cisco-avpair = vpdn:tunnel-type=l2tp
    cisco-avpair = vpdn:l2tp-tunnel-password=tunnel
    cisco-avpair = vpdn:l2tp-hello-interval=60
    cisco-avpair = vpdn:ip-addresses=10.1.1.1
    cisco-avpair = vpdn:tunnel-id=LAC1-1
    Framed-protocol = PPP
    Service-Type = Outbound
```

The following partial sample configuration shows the L2TP Domain Screening feature with global preauthentication.

```
Router# show running-config
!
.
.
.
hostname esr1-client
.
.
.
aaa new-model
!
aaa authentication login mylist enable line
aaa authentication ppp default group radius
aaa authorization network default group radius
!
aaa nas port extended
aaa session-id common
ip subnet-zero
no ip gratuitous-arps
ip host example-2 10.0.0.253
!
vpdn enable
vpdn authen-before-forward
vpdn ip udp ignore checksum
vpdn search-order domain
!
vpdn-group 1
 accept-dialin
 protocol pppoe
 virtual-template 1
pppoe limit per-mac 2
pppoe limit per-vc 2
pppoe limit per-vlan 2
pppoe limit max-sessions 2
!
ppp hold-queue 80000
no virtual-template snmp
!
.
.
.
!
interface Loopback1
 no ip address
!
interface FastEthernet0/0/0
 ip address 10.5.11.7 255.255.0.0
 speed 100
 full-duplex
 hold-queue 4096 in
 hold-queue 4096 out
!
interface GigabitEthernet1/0/0
 no ip address
 negotiation auto
!
!
interface ATM4/0/0.101 multipoint
 atm pppatm passive
 range pvc 52/101 52/101
 encapsulation aal5autoppp Virtual-Template1
!
 pvc-in-range 52/101
 vpn service znet.net1 replace-authen-domain
!
!
interface ATM5/0/0
 no ip address
 no ip mroute-cache
 no atm pxf queuing
 atm clock INTERNAL
 no atm auto-configuration
 no atm ilmi-keepalive
 no atm address-registration
 no atm ilmi-enable
!
interface ATM5/0/0.101 multipoint
 atm pppatm passive
 range pvc 51/101 51/101
 encapsulation aal5autoppp Virtual-Template1
 !
  pvc-in-range 51/101
vpn service znet.net1 replace-authen-domain
 !
!
.
.
.
radius-server attribute nas-port format d
radius-server host 10.5.6.100 auth-port 1645 acct-port 1646
radius-server retransmit 4
radius-server timeout 15
radius-server key cisco
!
control-plane
!
call admission limit 90
!
.
.
.
!
end
```

Example Configuring L2TP Domain Screening with per-VPDN Group Preauthentication

The following partial sample configuration shows the L2TP Domain Screening feature with per-VPDN group preauthentication.

```
Router# show running-config
!
.
.
.
hostname esr1-client
.
.
.
aaa new-model
!
!
aaa authentication login mylist enable line
aaa authentication ppp default local
aaa authorization network default local
!
aaa nas port extended
aaa session-id common
ip subnet-zero
```

```
no ip gratuitous-arps
ip host example-2 10.0.0.253
!
!
vpdn enable
vpdn ip udp ignore checksum
vpdn search-order domain
!
vpdn-group 1
 accept-dialin
 protocol pppoe
 virtual-template 1
 pppoe limit per-mac 2
 pppoe limit per-vc 2
 pppoe limit per-vlan 2
 pppoe limit max-sessions 2
!
!
vpdn-group LAC_1
 request-dialin
 protocol l2tp
 domain znet.net1
 initiate-to ip 10.1.1.1
 local name LAC1-1
 authen-before-forward
 l2tp tunnel password 0 tunnel
!
ppp hold-queue 80000
no virtual-template snmp
username LAC1-1 nopassword
username LNS1-1 nopassword
username user-1-1@znet.net1 password 0 sanfran_1_1
.
.
.
!
interface ATM4/0/0.101 multipoint
 atm pppatm passive
 range pvc 52/101 52/101
 encapsulation aal5autoppp Virtual-Template1
!
 pvc-in-range 52/101
 vpn service znet.net1 replace-authen-domain
 !
!
interface ATM5/0/0
 no ip address
 no ip mroute-cache
 no atm pxf queuing
 atm clock INTERNAL
 no atm auto-configuration
 no atm ilmi-keepalive
 no atm address-registration
 no atm ilmi-enable
!
interface ATM5/0/0.101 multipoint
 atm pppatm passive
 range pvc 51/101 51/101
 encapsulation aal5autoppp Virtual-Template1
 !
 pvc-in-range 51/101
 vpn service znet.net1 replace-authen-domain
 !
.
.
.
radius-server attribute nas-port format d
!
control-plane
!
call admission limit 90
!
.
```

```
.
.
end
```

Example Configuring RADIUS Tunnel Accounting on a NAS

The following example configures a NAS for remote AAA, configures a dial-in VPDN deployment, and enables the sending of tunnel and tunnel-link accounting records to the RADIUS server:

```
aaa new-model
!
aaa authentication ppp default group radius
aaa authorization network default local
aaa accounting network m1 start-stop group radius
aaa accounting network m2 stop-only group radius
aaa session-id common
enable secret 5 $1$IDjH$iL7puCja1RMlyOM.JAeuf/
enable password secret
!
username ISP-LAC password 0 tunnelpass
!
resource-pool disable
!
ip subnet-zero
ip cef
no ip domain-lookup
ip host myhost 172.16.1.129
!
vpdn enable
vpdn tunnel accounting network m1
vpdn session accounting network m1
vpdn search-order domain dnis
!
vpdn-group 1
 request-dialin
 protocol l2tp
 domain cisco.com
 initiate-to ip 10.1.26.71
 local name ISP-LAC
!
isdn switch-type primary-5ess
!
fax interface-type fax-mail
mta receive maximum-recipients 0
!
controller T1 7/4
 framing esf
 linecode b8zs
 pri-group timeslots 1-24
!
interface GigabitEthernet0/0/0
 ip address 10.1.27.74 255.255.255.0
 no ip mroute-cache
 duplex half
 speed auto
 no cdp enable
!
interface GigabitEthernet0/1/0
 no ip address
 no ip mroute-cache
 shutdown
 duplex auto
 speed auto
 no cdp enable
!
interface Serial7/4:23
 ip address 10.0.0.2 255.255.255.0
 encapsulation ppp
 dialer string 2000
 dialer-group 1
 isdn switch-type primary-5ess
 ppp authentication chap
!
interface Group-Async0
 no ip address
 shutdown
 group-range 1/00 3/107
!
ip default-gateway 10.1.27.254
ip classless
ip route 0.0.0.0 0.0.0.0 10.1.27.254
no ip http server
ip pim bidir-enable
!
dialer-list 1 protocol ip permit
no cdp run
!
radius-server host 172.19.192.26 auth-port 1645 acct-port 1646 key rad123
radius-server retransmit 3
call rsvp-sync
```

Example Configuring RADIUS Tunnel Accounting on a Tunnel Server

The following example configures a tunnel server for remote AAA, configures a dial-in VPDN deployment, and enables the sending of tunnel and tunnel-link accounting records to the RADIUS server:

```
aaa new-model
!
aaa accounting network m1 start-stop group radius
aaa accounting network m2 stop-only group radius
aaa session-id common
enable secret 5 $1$ftf.$wE6Q5Yv6hmQiwL9pizPCg1
!
username ENT_LNS password 0 tunnelpass
username user1@cisco.com password 0 lab
username user2@cisco.com password 0 lab
!
spe 1/0 1/7
 firmware location system:/ucode/mica_port_firmware
!
spe 2/0 2/9
 firmware location system:/ucode/mica_port_firmware
!
resource-pool disable
clock timezone est 2
!
ip subnet-zero
no ip domain-lookup
ip host CALLGEN-SECURITY-V2 10.24.80.28 10.47.0.0
ip host myhost 172.16.1.129
!
vpdn enable
vpdn tunnel accounting network m1
vpdn session accounting network m1
!
vpdn-group 1
accept-dialin
 protocol l2tp
 virtual-template 1
 terminate-from hostname ISP_NAS
 local name ENT_TS
!
isdn switch-type primary-5ess
!
fax interface-type modem
mta receive maximum-recipients 0
!
interface Loopback0
```

```
 ip address 10.0.0.101 255.255.255.0
!
interface Loopback1
 ip address 10.0.0.201 255.255.255.0
!
interface Ethernet0
 ip address 10.1.26.71 255.255.255.0
 no ip mroute-cache
 no cdp enable
!
interface Virtual-Template1
 ip unnumbered Loopback0
 peer default ip address pool vpdn-pool1
 ppp authentication chap
!
interface Virtual-Template2
 ip unnumbered Loopback1
 peer default ip address pool vpdn-pool2
 ppp authentication chap
!
interface FastEthernet0
 no ip address
 no ip mroute-cache
 shutdown
 duplex auto
speed auto
 no cdp enable
!
ip local pool vpdn-pool1 10.0.0.2 10.0.0.200
ip local pool vpdn-pool2 10.0.0.1 10.0.0.100
ip default-gateway 10.1.26.254
ip classless
ip route 0.0.0.0 0.0.0.0 10.1.26.254
ip route 10.1.1.2 255.255.255.255 10.1.26.254
no ip http server
ip pim bidir-enable
!
dialer-list 1 protocol ip permit
no cdp run
!
radius-server host 172.16.192.80 auth-port 1645 acct-port 1646 key rad123
radius-server retransmit 3
call rsvp-sync
```

Example Configuring DNS Name Support on the NAS Remote RADIUS AAA Server

The following AV pair instructs the RADIUS server to resolve the DNS name cisco and tunnel calls to the appropriate IP addresses:

```
9,1="vpdn:ip-addresses = cisco"
```

Examples Configuring L2TP Tunnel Server Load Balancing and Failover Using the Cisco Proprietary VSA

The following example shows a RADIUS profile that will equally balance the load between three tunnel servers:

```
user = cisco.com
profile_id = 29
profile_cycle = 7
radius=Cisco
```

```
check_items=
2=cisco
reply_attributes= {
9,1="vpdn:l2tp-tunnel-password=cisco123"
9,1="vpdn:tunnel-type=l2tp"
9,1="vpdn:ip-addresses=172.16.171.11 172.16.171.12 172.16.171.13"
9,1="vpdn:tunnel-id=tunnel"
}
}
}
```

The following example shows a RADIUS profile that will equally balance calls between 172.16.171.11 and 172.16.171.12. If both of those tunnel servers are unavailable, the RADIUS server will tunnel calls to 172.16.171.13.

```
user = cisco.com
profile_id = 29
profile_cycle = 7
radius=Cisco
check_items=
2=cisco
reply_attributes= {
9,1="vpdn:l2tp-tunnel-password=cisco123"
9,1="vpdn:tunnel-type=l2tp"
9,1="vpdn:ip-addresses=172.16.171.11 172.16.171.12/172.16.171.13"
9,1="vpdn:tunnel-id=tunnel"
}
```

Example Configuring L2TP Tunnel Server Load Balancing and Failover using the RADIUS Tunnel Preference Attribute

The following RADIUS configuration specifies four tunnel server profiles with different priority values specified in the Tunnel-Preference attribute field. The NAS will preferentially initiate L2TP tunnels to the tunnel server with the lowest configured priority value. If two tunnel server profiles have the same priority value configured, they will be considered equal and load balancing will occur between them.

```
net3 Password = "cisco" Service-Type = Outbound
        Tunnel-Type = :0:L2TP,
        Tunnel-Medium-Type = :0:IP,
        Tunnel-Server-Endpoint = :0:"10.1.3.1",
        Tunnel-Assignment-Id = :0:"1",
        Tunnel-Preference = :0:1,
        Tunnel-Password = :0:"secret"
        Tunnel-Type = :1:L2TP,
        Tunnel-Medium-Type = :1:IP,
        Tunnel-Server-Endpoint = :1:"10.1.5.1",
        Tunnel-Assignment-Id = :1:"1",
        Tunnel-Preference = :1:1,
        Tunnel-Password = :1:"secret"
        Tunnel-Type = :2:L2TP,
        Tunnel-Medium-Type = :2:IP,
        Tunnel-Server-Endpoint = :2:"10.1.4.1",
        Tunnel-Assignment-Id = :2:"1",
        Tunnel-Preference = :2:1,
        Tunnel-Password = :2:"secret"
        Tunnel-Type = :3:L2TP,
        Tunnel-Medium-Type = :3:IP,
        Tunnel-Server-Endpoint = :3:"10.1.6.1",
        Tunnel-Assignment-Id = :3:"1",
        Tunnel-Preference = :3:1,
        Tunnel-Password = :3:"secret"
```

Examples Configuring Tunnel Assignments on the NAS RADIUS AAA Server

The following examples configure the RADIUS server to group sessions in a tunnel:

Per-User Configuration

```
user@cisco.com Password = "cisco" Service-Type = Outbound,
       tunnel-type = :1:L2TP,
       tunnel-server-endpoint = :1:"10.14.10.54",
       tunnel-assignment-Id = :1:"router"
client@cisco.com Password = "cisco" Service-Type = Outbound,
       tunnel-type = :1:L2TP,
       tunnel-server-endpoint = :1:"10.14.10.54",
       tunnel-assignment-Id = :1:"router"
```

Domain Configuration

```
eng.cisco.com Password = "cisco" Service-Type = Outbound,
        tunnel-type = :1:L2TP,
        tunnel-server-endpoint = :1:"10.14.10.54",
        tunnel-assignment-Id = :1:"router"
sales.cisco.com Password = "cisco" Service-Type = Outbound,
        tunnel-type = :1:L2TP,
        tunnel-server-endpoint = :1:"10.14.10.54",
        tunnel-assignment-Id = :1:"router"
```

Examples Configuring L2TP Tunnel Connection Speed Labeling

The following example shows an ARS RADIUS server profile configuration for three users of the service cisco.com. Each user has a different configuration for allowable connection speeds.

```
#    cisco.com/
#        Name = cisco.com
#        Description = Domain
#        Password = <encrypted>
#        AllowNullPassword = FALSE
#        Enabled = TRUE
#        Group~ =
#        BaseProfile~ =
#        AuthenticationScript~ =
#        AuthorizationScript~ =
#        UserDefined1 =
#        Attributes/
#            cisco-avpair = vpdn:tunnel-id=aaa_lac
#            cisco-avpair = vpdn:tunnel-type=l2tp
#            cisco-avpair = vpdn:ip-addresses=10.1.1.3
#            cisco-avpair = vpdn:l2tp-tunnel-password=lab
#            service-type = outbound
#        CheckItems/
#    Euser1@cisco.com/
#        Name = Euser1@cisco.com
#        Description = PPPoE-Only-Tx-Accept
#        Password = <encrypted>
#        AllowNullPassword = FALSE
#        Enabled = TRUE
#        Group~ =
#        BaseProfile~ =
#        AuthenticationScript~ =
#        AuthorizationScript~ =
#        UserDefined1 = TX:102400000
#        Attributes/
#        CheckItems/
```

```
#
#    Euser11@cisco.com/
#        Name = Euser11@cisco.com
#        Description = PPPoE-Range-RX-Accept
#        Password = <encrypted>
#        AllowNullPassword = FALSE
#        Enabled = TRUE
#        Group~ =
#        BaseProfile~ =
#        AuthenticationScript~ =
#        AuthorizationScript~ =
#        UserDefined1 = RX:96000000-200000000
#        Attributes/
#        CheckItems/
#
#    Euser8@cisco.com/
#        Name = Euser8@cisco.com
#        Description = PPPoE-Both-TXRX-Reject
#        Password = <encrypted>
#        AllowNullPassword = FALSE
#        Enabled = TRUE
#        Group~ =
#        BaseProfile~ =
#        AuthenticationScript~ =
#        AuthorizationScript~ =
#        UserDefined1 = TX:5600000:RX:64000000
#        Attributes/
#        CheckItems/
```

The following example configures the .tcl script to be the OutgoingScript of the service that has been created:

```
Name = check-info
Description =
Type = local
IncomingScript~ =
OutgoingScript~ = checkConnect-Info
OutagePolicy~ = RejectAll
OutageScript~ =
UserList = dialin-users
```

Connection speed information is forwarded by the tunnel server to the RADIUS AAA server for authentication by default. The following example disables the forwarding of connection speed information to the RADIUS AAA server:

```
Router(config)# no radius-server attribute 77 include-in-access-req
```

The following example enables the forwarding of connection speed information to the RADIUS AAA server from the tunnel server if it has been previously disabled:

```
Router(config)# radius-server attribute 77 include-in-access-req
```

The following example enables the forwarding of connection speed information to the RADIUS AAA server from a tunnel switch before the session is forwarded to the next hop:

```
Router(config)# vpdn authen-before-forward
```

Example Configuring Secure Authentication Names

The following is an example of a RADIUS user profile that includes RADIUS tunneling attributes 90 and 91. This entry supports two tunnels, one for L2F and the other for L2TP. The tag entries with :1 support L2F tunnels, and the tag entries with :2 support L2TP tunnels.

```
cisco.com Password = "cisco", Service-Type = Outbound
Service-Type = Outbound,
Tunnel-Type = :1:L2F,
Tunnel-Medium-Type = :1:IP,
Tunnel-Client-Endpoint = :1:"10.0.0.2",
Tunnel-Server-Endpoint = :1:"10.0.0.3",
Tunnel-Client-Auth-Id = :1:"l2f-cli-auth-id",
Tunnel-Server-Auth-Id = :1:"l2f-svr-auth-id",
Tunnel-Assignment-Id = :1:"l2f-assignment-id",
Cisco-Avpair = "vpdn:nas-password=l2f-cli-pass",
Cisco-Avpair = "vpdn:gw-password=l2f-svr-pass",
Tunnel-Preference = :1:1,
Tunnel-Type = :2:L2TP,
Tunnel-Medium-Type = :2:IP,
Tunnel-Client-Endpoint = :2:"10.0.0.2",
Tunnel-Server-Endpoint = :2:"10.0.0.3",
Tunnel-Client-Auth-Id = :2:"l2tp-cli-auth-id",
Tunnel-Server-Auth-Id = :2:"l2tp-svr-auth-id",
Tunnel-Assignment-Id = :2:"l2tp-assignment-id",
Cisco-Avpair = "vpdn:l2tp-tunnel-password=l2tp-tnl-pass",
Tunnel-Preference = :2:2
```

Examples Configuring Shell-Based Authentication of VPDN Users

The following example configures dial-in lines 1 through 8 on the NAS to support shell-based authentication of VPDN users:

```
line 1 8
!assuming all logins on lines 1-8 is to be authenticated at 172.69.71.85
  login authentication ExceVPDN-Login
  autoselect during-login
  autocommand ppp
  modem InOut
  transport input all
  transport output none
  stopbits 1
  speed 115200
```

The following example configures a NAS for shell-based authentication of VPDN users based on DNIS information:

```
vpdn enable
vpdn search-order dnis
!
aaa new-model
aaa authentication login Exec-VPDN-login group Exec-VPDN-Login-Servers
aaa authentication ppp Exec-VPDN-ppp if-needed group Exec-VPDN-Login-Servers
aaa authorization network default group Exec-VPDN-Login-Servers
aaa authorization network no_author none
!
!The following configuration creates a RADIUS server group named Exec-VPDN-Login Servers.
radius-server host 172.69.69.72 auth-port 1645 acct-port 1646
aaa group server radius Exec-VPDN-Login-Servers
 server 171.69.69.72 auth-port 1645 acct-port 1646
!
!The following configuration maps DNIS 7777 to the RADIUS server group named !Exec-VPDN-Login
 Servers. Authentication requests from users at DNIS 7777 will be !forwarded to the RADIUS
 server at 10.1.10.1.
aaa dnis map enable
aaa dnis map 7777 authentication ppp group ExecVPDN-Login-Servers
aaa dnis map 7777 authentication login group ExecVPDN-Login-Servers
```

The following example uses the global RADIUS server definition list for PPP authentication on the NAS if authentication is needed:

```
aaa authentication ppp ExecVPDN-ppp if-needed group radius
!PPP config for line 1
int async 1
ip unnumbered e0
encap ppp
```

```
async mode interactive
ppp authentication pap ExecVPDN-ppp
```

The following example configures the tunnel server to accept VPDN tunnels without performing PPP authentication:

```
vpdn-group 1
  accept-dialin
  protocol l2tp
  virtual-template 1
  terminate-from hostname host1_no_authen
  l2tp tunnel authentication
  l2tp password no_authen_secret
  local name host2_no_authen
!
interface Virtual-Template1
  ip unnumbered Ethernet0/0
  no keepalive
  ppp authorization no_author
!
```

The following example configures the tunnel server to accept VPDN tunnels with PPP authentication enabled:

```
vpdn-group 2
  accept-dialin
  protocol l2tp
  virtual-template 2
  terminate-from hostname authen_on
  l2tp tunnel authentication
  l2tp password no_authen_secret
  local name host2_autne_on
!
interface Virtual-Template1
  ip unnumbered Ethernet0/0
  no keepalive
  ppp authentication pap
```

Examples Configuring LNS Address Checking

The following shows an example configuration for the client router.

```
hostname Client
!
enable password example
!
no aaa new-model
!
vpdn enable
!
bba-group pppoe 1
 virtual-template 1
!
interface <interface toward LAC>
 pppoe enable group 1
!
interface Virtual-Template 1
 ip unnumbered <interface>
 ppp pap sent-username@example.com
!
end
```

The following shows an example configuration for the LAC.

```
hostname LAC
!
enable password example
!
no aaa new-model
!
```

```
vpdn enable
!
vpdn-group 1
 request-dialin
 protocol l2tp
 domain example.com
 initiate-to ip <lns 1 IP address>
 l2tp tunnel password 0 example
!
bba-group pppoe 1
 virtual-template 1
!
interface Virtual-Template 1
 no ip address
 ppp authentication pap
!
interface <interface>
 pppoe enable group 1
!
end
```

The following shows an example configuration for the LNS 1.

```
hostname LNS1
!
enable password example
!
aaa authentication ppp default local
!
vpdn enable
!
vpdn-group 1
!Default L2TP VPDN group
 accept-dialin
 protocol l2tp
 virtual-template 1
 l2tp tunnel password 0 example
!
vpdn-group 2
 request-dialin
 protocol l2tp
 domain example.com
 initiate-to ip <lns 2 IP address>
 l2tp tunnel password 0 example
!
interface Virtual-Template 1
 ip unnumbered <interface>
 ppp authentication pap
!
end
```

Examples Configuring Modified LNS Dead-Cache Handling

The following show an example configuration from the **show vpdn dead-cache all** command:

```
Router> enable
Router# show vpdn dead-cache all
vpdn-group     ip address     down time
exampleA     192.168.2.2     00:10:23
exampleB     192.168.4.2     00:10:16
exampleB     192.168.4.3     00:10:15
exampleB     192.168.4.4     00:10:12
```

The following shows an example configuration to clear an LNS, based on its IP address, from the dead-cache state:

```
Router# clear vpdn dead-cache ip-address 192.168.4.4
Router#
```

```
*Sept. 30 22:58:32 %VPDN-6-VPDN_DEADCACHE_CHANGE: LSG dead cache entry 192.168.4.4 cleared
LAC# show vpdn dead-cache all
vpdn-group     ip address     down time
exampleA     192.168.2.2     00:10:28
exampleB     192.168.4.2     00:10:21
exampleB     192.168.4.3     00:10:20
```

The following shows an example configuration to clear an LNS group from the dead-cache state:

```
Router# clear vpdn dead-cache group exampleB
Router#
*Sept. 30 22:58:32 %VPDN-6-VPDN_DEADCACHE_CHANGE: LSG dead cache entry 192.168.4.2 cleared
*Sept. 30 22:58:32 %VPDN-6-VPDN_DEADCACHE_CHANGE: LSG dead cache entry 192.168.4.3 cleared
Router# show vpdn dead-cache all
vpdn-group     ip address     down time
exampleA     192.168.2.2     00:10:31
```

Where to Go Next

Depending on the type of VPDN deployment you are configuring, you should perform the tasks in one of these modules:

- To configure a client-initiated tunneling deployment, proceed to the Configuring Client-Initiated Dial-In VPDN Tunneling module.
- To configure a NAS-initiated tunneling deployment, proceed to the Configuring NAS-Initiated Dial-In VPDN Tunneling module.
- To configure a dial-out VPDN tunneling deployment, proceed to the Configuring Additional VPDN Features module.
- To configure a multihop MMP or multihop tunnel switching VPDN deployment, proceed to the Configuring Multihop VPDN module.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
VPDN technology overview	VPDN Technology Overview module
Information about configuring AAA	Authentication, Authorization, and Accounting (AAA) module
Layer 2 Tunnel Protocol	*Layer 2 Tunnel Protocol*
Information about configuring RADIUS and TACACS	Security Server Protocols module

Related Topic	Document Title
Security commands	*Cisco IOS Security Command Reference*
Information about RPMS	Configuring Resource Pool Management module
Dial Technologies commands	*Cisco IOS Dial Technologies Command Reference*

Standards

Standard	Title
DSL Forum 2004-72	--

MIBs

MIB	MIBs Link
• CISCO-VPDN-MGMT-MIB • CISCO-VPDN-MGMT-EXT-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 2516	A Method for Transmitting PPP Over Ethernet (PPPoE)
RFC 2867	*RADIUS Accounting Modifications for Tunnel Protocol Support*
RFC 2868	*RADIUS Tunnel Authentication Attributes*

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 AAA for VPDNs

The following table provides release information about the feature or features described in this module. This table 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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 7: Feature Information for AAA for VPDNs

Feature Name	Releases	Feature Information
Configurable Domain Name Prefix and Suffix Stripping	12.3(4)T 12.2(33)SRE	This feature allows the NAS to be configured to strip prefixes, suffixes, or both from the full username. The reformatted username is then forwarded to the remote AAA server. The following commands were introduced or modified by this feature: **radius-server domain-stripping**, **tacacs-server domain-stripping**.
Suppressing EXEC Accounting Record	12.4(11)T 12.2(33)SRE	This feature suppresses EXEC accounting records when you configure autoselection during-login for the dial-in clients. The following command was introduced or modified by this feature: **aaa accounting nested**.

Feature Name	Releases	Feature Information
L2TP Domain Screening, Rules Based	12.2(31)SB2	This feature allows per-user L2TP tunnel setup by creating customized Policy Manager match rules. The L2TP Domain Screening, Rules Based feature allows per-user L2TP tunnel setup by creating customized Policy Manager match rules by combining these features: • Create a temporary memory to hold the value of identifier types received by policy manager, using the **set variable** command in configuration-control-policymap-class mode • Match the contents, stored in temporary memory of identifier types received by policy manager, against a specified *matching-pattern*and perform the substitution defined in *rewrite-pattern*, using the **substitute** command in configuration-control-policymap-class mode • Authenticate a request for an Intelligent Service Gateway (ISG) subscriber session, using the **authenticate** command in control policy-map class configuration mode These three commands work together to allows you to construct rules to customize specific policy behavior to allow an L2TP tunnel setup by creating customized Policy Manager match rules.

Feature Name	Releases	Feature Information
L2TP Tunnel Selection Load Balancing with Random Algorithm	12.2(31)SB2	This feature allows the NAS to use a new tie-breaking algorithm and is transparent to any user. A random selection is made among all peer tunnel servers carrying the same session load. This improved algorithm results in a more even distribution of sessions across tunnel servers, reducing the occurrence of session bunching.
L2TP Domain Screening	12.2(28)SB	This feature introduces the ability to modify the domain portion of the username seamlessly when you enter into a virtual private network (VPN) service. The L2TP Domain Screening feature allows per-user L2TP tunnel setup by combining these features: • User preauthentication using the **vpdn authen-before-forward** command • Modifying the domain portion of the username using the **vpn service** command to bind an incoming session to a certain L2TP tunnel These two commands work together to make sure that the appropriate domain has been screened before access is allowed to an L2TP tunnel for the user session.
L2TP Tunnel Connection Speed Labeling	12.3(4)T	This feature introduces the ability to accept or deny an L2TP session based on the allowed connection speed that is configured on the Cisco ARS RADIUS server for that user. The RADIUS server can authorize users based on their SLA. No commands were introduced or modified by this feature.

Feature Name	Releases	Feature Information
LNS Address Checking	12.2(34)SB 12.2(33)XNE	This feature allows an LAC, which is receiving data from a LNS, to check the IP address of the LNS prior to establishing an L2TP tunnel. The following command was introduced by this feature: **l2tp security ip address-check.**
Modified LNS Dead-Cache Handling	12.2(34)SB	This feature displays and clears (restarts) any LNS entry in a dead-cache (DOWN) state. The following commands were introduced by this feature: **clear vpdn dead-cache**, **show vpdn dead-cache**. The following commands were modified by this feature: **snmp-server enable traps**, **vpdn logging**.
RADIUS Attribute 82: Tunnel Assignment ID	12.2(4)T	This feature allows the L2TP NAS to group users from different per-user or domain RADIUS profiles into the same active tunnel if the tunnel endpoints, tunnel type, and Tunnel-Assignment-ID are identical. No commands were introduced or modified by this feature.
RADIUS Tunnel Attribute Extensions	12.2(13)T	This feature introduces RADIUS attribute 90 and RADIUS attribute 91. Both attributes help support the provision of compulsory tunneling in VPDNs by allowing the user to specify authentication names for the NAS and the RADIUS server. No commands were introduced or modified by this feature.

Feature Name	Releases	Feature Information
RADIUS Tunnel Preference for Load Balancing and Fail-Over	12.2(4)T 12.2(11)T	This feature provides industry-standard load balancing and failover functionality for multi-vendor networks. Support for Cisco access server platforms was introduced in Cisco IOS Release 12.2(11)T.
RFC-2867 RADIUS Tunnel Accounting	12.3(4)T	This feature introduces six new RADIUS accounting types that are used with the RADIUS accounting attribute Acct-Status-Type (attribute 40), which indicates whether an accounting request marks the beginning of user service (start) or the end (stop). The following commands were introduced or modified by this feature: **aaa accounting**, **vpdn session accounting network**, **vpdn tunnel accounting network**.
Shell-Based Authentication of VPDN Users	12.2(2)T	This feature provides terminal services for VPDN users to support rollout of wholesale dial networks. The following command was modified by this feature: **aaa dnis map authentication group**.
Tunnel Authentication via RADIUS on Tunnel Terminator	12.3(4)T	This feature allows the L2TP tunnel server to perform remote authentication and authorization with RADIUS on incoming L2TP NAS dial-in connection requests. This feature also allows the L2TP NAS to perform remote authentication and authorization with RADIUS on incoming L2TP tunnel server dial-out connection requests. The following commands were introduced by this feature: **vpdn tunnel authorization network**, **vpdn tunnel authorization password**, **vpdn tunnel authorization virtual-template**.

CHAPTER 3

Configuring NAS-Initiated Dial-In VPDN Tunneling

Network access server (NAS)-initiated dial-in tunneling provides secure tunneling of a PPP session from a NAS to a tunnel server without any special knowledge or interaction required from the client.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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 table at the end of this module.

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

Prerequisites for Configuring NAS-Initiated Dial-In VPDN Tunneling

- Before performing the tasks documented in this module, you must perform the required tasks in the Configuring AAA for VPDNs module.

- The NAS should be configured to receive incoming calls from clients using ISDN, the Public Switched Telephone Network (PSTN), Digital Subscriber Line (DSL), or cable modem .

Information About NAS-Initiated Dial-In VPDN Tunneling

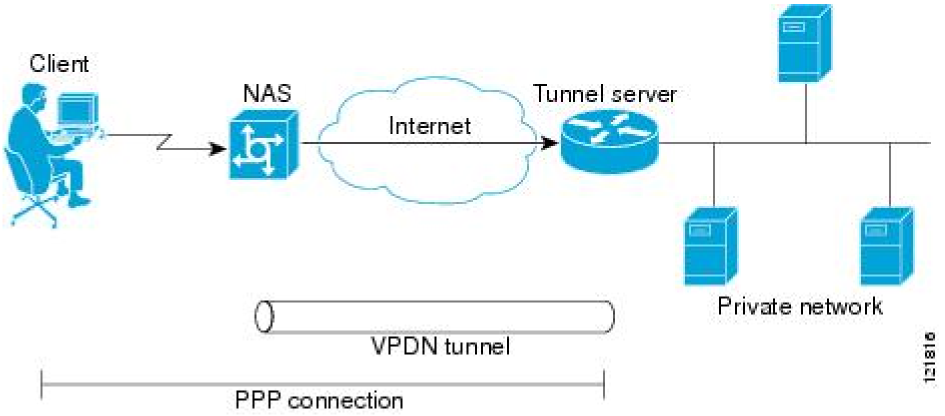
NAS-Initiated Dial-in VPDN Tunneling

NAS-initiated dial-in VPDN tunneling is also known as compulsory tunneling. In NAS-initiated dial-in VPDN tunneling, the client dials in to the NAS through a medium that supports PPP. If the connection from the client to the Internet service provider (ISP) NAS is over a medium that is considered secure, such as DSL, ISDN, or the PSTN, the client might choose not to provide additional security. The PPP session is securely tunneled from the NAS to the tunnel server without any special knowledge or interaction required from the client. NAS-initiated dial-in VPDN tunnels can use either the Layer 2 Tunneling Protocol (L2TP) or the Layer 2 Forwarding (L2F) protocol.

Note The Cisco ASR 1000 Series Aggregation Services Routers support only L2TP.

A NAS-initiated dial-in tunneling scenario is shown in the figure below.

Figure 11: NAS-Initiated Dial-In VPDN Scenario



L2TP Calling Station ID Suppression

In a NAS-initiated dial-in L2TP tunneling scenario, when the NAS connects to a tunnel server it transfers numerous attribute-value (AV) pairs as part of the session setup process. One of these AV pairs is L2TP AV pair 22, the Calling Number ID. The Calling Number ID AV pair includes the calling station ID of the originator of the session, which can be the phone number of the originator, the Logical Line ID (LLID) used to make the connection on the LAC, or the MAC address of the PC connecting to the network. This information can be considered sensitive in cases where the NAS and tunnel server are being managed by different entities. Depending on the security requirements of the NAS or end users, it might be desirable for the NAS to suppress part or all of the calling station ID.

Parts of the calling station ID can be masked, or the calling station ID can be removed completely. Calling station ID suppression can be configured globally on the NAS, for individual VPDN groups on the NAS, or on the remote RADIUS server if one is configured.

L2TP Failover

If a NAS fails to contact its peer during L2TP tunnel establishment, it can fail over to another configured tunnel server and attempt tunnel establishment with that device.

Failover can occur in these scenarios:

- If the router sends a Start Control Connection Request (SCCRQ) a number of times and receives no response from the peer
- If the router receives a Stop Control Connection Notification (StopCCN) from its peer
- If the router receives a Call Disconnect Notify (CDN) message from its peer

In both the StopCCN control message and the CDN control message, a Result Code AV pair is included, which indicates the reason for tunnel or session termination, respectively. This AV pair might also include an optional Error Code, which further describes the nature of the termination. The various Result Code and Error Code values have been standardized in RFC 2661. Failover will occur if the combination of Result Code and Error Code values as defined in the table below is received from the peer.

Table 8: Defined Result and Error Codes from RFC 2661

Control Message	Result Code	Error Code
StopCCN, CDN	2: General error, see Error Code.	4: Insufficient resources to handle this operation now. 6: A generic vendor-specific error occurred.[1] 7: Try another. 9: Try another directed.
CDN	4: Temporary lack of resources.	--

[1] For failover, this error code would be accompanied by a vendor-specific error AVP in the error message--in this case containing the Cisco vendor code (SMI_CISCO_ENTERPRISE_CODE) and a Cisco error code (L2TP_VENDOR_ERROR_SLIMIT).

When one of the three scenarios occurs, the router marks the peer IP address as busy for 60 seconds by default. During that time no attempt is made to establish a session or tunnel with the peer. The router selects an alternate peer to contact if one is configured. If a tunnel already exists to the alternate peer, new sessions are brought up in the existing tunnel. Otherwise, the router begins negotiations to establish a tunnel to the alternate peer.

How to Configure NAS-Initiated Dial-In VPDN Tunneling

Configuring the NAS to Request Dial-In VPDN Tunnels

The NAS must be configured to request tunnel establishment with the remote tunnel server. Perform this task on the NAS to configure a VPDN request dial-in subgroup and the IP address of the tunnel server that will be the other endpoint of the VPDN tunnel.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **request-dialin**
6. **protocol** {**any** | **l2f** | **l2tp**}
7. Do one of the following:
    - **domain** *domain-name*
    - **dnis** {*dnis-number* | *dnis-group-name*}
8. **exit**
9. **initiate-to ip** *ip-address* [**limit** *limit-number*] [**priority** *priority-number*]
10. **l2f ignore-mid-sequence**

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.

	Command or Action	Purpose
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description myvpdngroup`	(Optional) Adds a description to a VPDN group.
Step 5	**request-dialin** **Example:** `Router(config-vpdn)# request-dialin`	Configures a NAS to request the establishment of an L2F or L2TP tunnel to a tunnel server, creates a request-dialin VPDN subgroup, and enters VPDN request dial-in subgroup configuration mode.

Step 6	**protocol** {**any** | **l2f** | **l2tp**}
	Example:
	`Router(config-vpdn-req-in)# protocol l2tp`
		Specifies the Layer 2 protocol that the VPDN group will use.
		• The **any** keyword can be used to specify that both L2TP and L2F tunnels can be established.

Step 7	Do one of the following:
	• **domain** *domain-name*
	• **dnis** {*dnis-number* | *dnis-group-name*}
	Example:
	`Router(config-vpdn-req-in)# domain example.com`
	Example:
	`Router(config-vpdn-req-in)# dnis 5687`
		Requests that PPP calls from a specific domain name be tunneled.
		or
		Requests that PPP calls from a specific Dialed Number Identification Service (DNIS) number or DNIS group be tunneled.

Step 8	**exit** **Example:** `Router(config-vpdn-req-in)# exit`	Exits to VPDN group configuration mode.
Step 9	**initiate-to ip** *ip-address* [**limit** *limit-number*] [**priority** *priority-number*] **Example:** `Router(config-vpdn)# initiate-to ip 10.1.1.1 limit 12`	Specifies an IP address that will be used for Layer 2 tunneling. • Beginning in Cisco IOS Release 12.2(15)T, the following options are available for this command: • **limit**--Maximum number of connections that can be made to this IP address. • **priority**--Priority for this IP address.

	Command or Action	Purpose
		Note The **priority** keyword is typically not configured on a NAS. Information used for load balancing and failover is configured on a remote authentication, authorization, and accounting (AAA) server instead. • Multiple tunnel servers can be configured on the NAS by configuring multiple initiate-to commands.
Step 10	**l2f ignore-mid-sequence** **Example:** `Router(config-vpdn)# l2f ignore-mid-sequence`	(Optional) Ignores multiplex ID (MID) sequence numbers for sessions in an L2F tunnel. • This command is available only if the **protocol l2f** or **protocol any** command has been configured in the VPDN subgroup. • This command is not required for Cisco-to-Cisco tunnel endpoints, and is required only if MID sequence numbering is not supported by a third-party hardware vendor.

What to Do Next

You must perform the task in the Configuring the Tunnel Server to Accept Dial-In VPDN Tunnels, on page 126.

Configuring the Tunnel Server to Accept Dial-In VPDN Tunnels

The tunnel server must be configured to accept tunnel requests from the remote NAS. Perform this task on the tunnel server to create a VPDN accept dial-in subgroup and to configure the tunnel server to accept tunnels from the NAS that will be the other endpoint of the VPDN tunnel. To configure the tunnel server to accept tunnels from multiple NASs, you must perform this task for each NAS.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **accept-dialin**
6. **protocol** {**any** | **l2f** | **l2tp**}
7. **virtual-template** *number*
8. **exit**
9. **terminate-from hostname** *host-name*
10. **lcp renegotiation** {**always** | **on-mismatch**}
11. **force-local-chap**

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description myvpdngroup`	(Optional) Adds a description to a VPDN group.
Step 5	**accept-dialin** **Example:** `Router(config-vpdn)# accept-dialin`	Configures a tunnel server to accept requests from a NAS to establish an L2F or L2TP tunnel, creates an accept-dialin VPDN subgroup, and enters VPDN accept dial-in subgroup configuration mode.
Step 6	**protocol** {**any** | **l2f** | **l2tp**}	Specifies the Layer 2 protocol that the VPDN group will use.

	Command or Action	Purpose
	Example: `Router(config-vpdn-acc-in)# protocol l2tp`	• The **any** keyword can be used to specify that both L2TP and L2F tunnels can be established.
Step 7	**virtual-template** *number* **Example:** `Router(config-vpdn-acc-in)# virtual-template 1`	Specifies which virtual template will be used to clone virtual access interfaces.
Step 8	**exit** **Example:** `Router(config-vpdn-acc-in)# exit`	Exits to VPDN group configuration mode.
Step 9	**terminate-from hostname** *host-name* **Example:** `Router(config-vpdn)# terminate-from hostname NAS12`	Specifies the hostname of the remote NAS that will be required when accepting a VPDN tunnel.

Step 10	**lcp renegotiation** {**always** | **on-mismatch**}
	Example:
	`Router(config-vpdn)# lcp renegotiation always`
		(Optional) Allows the tunnel server to renegotiate the PPP Link Control Protocol (LCP) on dial-in calls using L2TP or L2F.
		• This command is useful for a tunnel server that tunnels to a non-Cisco NAS, where the NAS might negotiate a different set of LCP options than what the tunnel server expects.

Step 11	**force-local-chap** **Example:** `Router(config-vpdn)# force-local-chap`	(Optional) Forces the tunnel server to reauthenticate the client. • Enabling this command forces the tunnel server to reauthenticate the client in addition to the proxy authentication that occurs at the NAS. **Note** This command will function only if Challenge Handshake Authentication Protocol (CHAP) authentication is enabled for PPP using the **ppp authentication chap** command in the virtual template configured on the tunnel server.

What to Do Next

You must perform the task in the Configuring the Virtual Template on the Tunnel Server, on page 129.

Configuring the Virtual Template on the Tunnel Server

When a request to establish a tunnel is received by the tunnel server, the tunnel server must create a virtual access interface. The virtual access interface is cloned from a virtual template interface, used, and then freed when no longer needed. The virtual template interface is a logical entity that is not tied to any physical interface.

Perform this task on the tunnel server to configure a basic virtual template .

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface virtual-template** *number*
4. **ip unnumbered** *type number*
5. **ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**]
6. **peer default ip address** {*ip-address*| **dhcp-pool** | **dhcp** | **pool** [*pool-name*]}
7. **encapsulation** *encapsulation-type*

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 virtual-template** *number* **Example:** `Router(config)# interface virtual-template 1`	Enters interface configuration mode and creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 4	**ip unnumbered** *type number* **Example:** `Router(config-if)# ip unnumbered FastEthernet 0/0`	Enables IP processing on a serial interface without assigning an explicit IP address to the interface. **Note** Configuring the **ip address** command within a virtual template is not recommended. Configuring a specific IP address in a virtual template can result in the establishment of erroneous routes and the loss of IP packets.

	Command or Action	Purpose
Step 5	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**] **Example:** `Router(config-if)# ppp authentication chap`	Enables at least one PPP authentication protocol and specifies the order in which the protocols are selected on the interface.
Step 6	**peer default ip address** {*ip-address*| **dhcp-pool** | **dhcp** | **pool** [*pool-name*]} **Example:** `Router(config-if)# peer default ip address pool mypool`	Specifies an IP address, an address from a specific IP address pool, or an address from the Dynamic Host Configuration Protocol (DHCP) mechanism to be returned to a remote peer connecting to this interface.
Step 7	**encapsulation** *encapsulation-type* **Example:** `Router(config-if)# encapsulation ppp`	Sets the encapsulation method used by the interface.

Verifying a NAS-Initiated VPDN Configuration

Verifying and Troubleshooting Tunnel Establishment Between the NAS and the Tunnel Server

Perform this task to verify that a tunnel between the NAS and the tunnel server has been established, and to troubleshoot problems with tunnel establishment.

SUMMARY STEPS

1. **enable**
2. **show vpdn tunnel all**
3. **ping** *ip-address*
4. **debug vpdn event**
5. **debug vpdn errors**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show vpdn tunnel all**

Enter this command to display details about all active VPDN tunnels. This example shows output from a tunnel server with a single active L2F tunnel:

Example:

```
Router# show vpdn tunnel all

% No active L2TP tunnels
L2F Tunnel
NAS name: ISP-NAS
NAS CLID: 36
NAS IP address 172.22.66.23
Gateway name: ENT-TS
Gateway CLID: 1
Gateway IP address 172.22.66.25
State: open
Packets out: 52
Bytes out: 1799
Packets in: 100
Bytes in: 7143
```

If no active tunnels have been established with the NAS, proceed with the following steps to troubleshoot the problem.

Step 3 **ping** *ip-address*

Enter this command to ping the NAS. The following output shows the result of a successful ping from the tunnel server to the NAS:

Example:

```
Router# ping 172.22.66.25

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 128/132/152 ms
```

If the tunnel server is unable to ping the NAS, there might be a problem with the routing path between the devices, or the NAS might not be functional.

Step 4 **debug vpdn event**

Enter this command to display the VPDN events that occur during tunnel establishment .

The following output from the tunnel server shows normal VPDN tunnel establishment for an L2F tunnel:

Example:

```
Router# debug vpdn event
L2F: Chap authentication succeeded for nas1.
Virtual-Access3 VPN Virtual interface created for user6@cisco.com
Virtual-Access3 VPN Set to Async interface
Virtual-Access3 VPN Clone from Vtemplate 1 block=1 filterPPP=0
%LINK-3-UPDOWN: Interface Virtual-Access3, changed state to up
Virtual-Access3 VPN Bind interface direction=2
Virtual-Access3 VPN PPP LCP accepted sent & rcv CONFACK
%LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access3, changed state to up
```

The following output from the tunnel server shows normal VPDN tunnel establishment for an L2TP tunnel:

Example:

```
Router# debug vpdn event
20:19:17: L2TP: I SCCRQ from ts1 tnl 8
20:19:17: L2X: Never heard of ts1
20:19:17: Tnl 7 L2TP: New tunnel created for remote ts1, address 172.21.9.4
20:19:17: Tnl 7 L2TP: Got a challenge in SCCRQ, ts1
20:19:17: Tnl 7 L2TP: Tunnel state change from idle to wait-ctl-reply
20:19:17: Tnl 7 L2TP: Got a Challenge Response in SCCCN from ts1
20:19:17: Tnl 7 L2TP: Tunnel Authentication success
20:19:17: Tnl 7 L2TP: Tunnel state change from wait-ctl-reply to established
20:19:17: Tnl 7 L2TP: SM State established
20:19:17: Tnl/Cl 7/1 L2TP: Session FS enabled
20:19:17: Tnl/Cl 7/1 L2TP: Session state change from idle to wait-for-tunnel
20:19:17: Tnl/Cl 7/1 L2TP: New session created
20:19:17: Tnl/Cl 7/1 L2TP: O ICRP to ts1 8/1
20:19:17: Tnl/Cl 7/1 L2TP: Session state change from wait-for-tunnel to wait-connect
20:19:17: Tnl/Cl 7/1 L2TP: Session state change from wait-connect to established
20:19:17: Vi1 VPDN: Virtual interface created for bum1@cisco.com
20:19:17: Vi1 VPDN: Set to Async interface
20:19:17: Vi1 VPDN: Clone from Vtemplate 1 filterPPP=0 blocking
20:19:18: %LINK-3-UPDOWN: Interface Virtual-Access1, changed state to up
20:19:18: Vi1 VPDN: Bind interface direction=2
20:19:18: Vi1 VPDN: PPP LCP accepting rcv CONFACK
20:19:19: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access1, changed state to up
```

Step 5 **debug vpdn errors**

Enter this command to display error messages that are generated during tunnel establishment. The following output from the NAS shows an authentication failure during tunnel establishment.

Example:

```
Router# debug vpdn errors
%LINEPROTO-5-UPDOWN: Line protocol on Interface Async1, changed state to down
%LINK-5-CHANGED: Interface Async1, changed state to reset
%LINK-3-UPDOWN: Interface Async1, changed state to down
%LINK-3-UPDOWN: Interface Async1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Async1, changed state to up
VPDN tunnel management packet failed to authenticate
VPDN tunnel management packet failed to authenticate
```

If an authentication failure occurs, verify that both the NAS and the tunnel server are configured with the same secret password.

Verifying the Connection Between the Client and the NAS

Perform this task to verify the connection between the dial-in client and the NAS.

SUMMARY STEPS

1. Dial in to the NAS from a client PC.
2. **enable**
3. **show caller user** *user*
4. **show interfaces virtual-access** *number*
5. **show vpdn session**

DETAILED STEPS

Step 1 Dial in to the NAS from a client PC.

Ensure that the client PC is able to connect to the NAS by establishing a dial-in connection. As the call comes into the NAS, a LINK-3-UPDOWN message automatically appears on the NAS terminal screen. In the following example, the call comes into the NAS on asynchronous interface 14:

Example:

```
*Jan  1 21:22:18.410: %LINK-3-UPDOWN: Interface Async14, changed state to up
```

Note No **debug** commands are turned on to display this log message. This message should be displayed within 30 seconds after the client first sends the call.

If this message is not displayed by the NAS, there is a problem with the dial-in configuration.

Step 2 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 3 **show caller user** *user*

Enter this command on the tunnel server to verify that the client received an IP address. The following example shows that user3 is using IP address 172.30.2.1.

Example:

```
Router# show caller user user3@cisco.com
  User: user3@cisco.com, line Vi1, service PPP L2F, active 00:01:35
  PPP: LCP Open, CHAP (<- AAA), IPCP
  IP: Local 172.22.66.25, remote 172.30.2.1
  VPDN: NAS ISP-NAS, MID 1, MID open
        HGW  ENT-TS, NAS CLID 36, HGW CLID 1, tunnel open
  Counts: 105 packets input, 8979 bytes, 0 no buffer
          0 input errors, 0 CRC, 0 frame, 0 overrun
          18 packets output, 295 bytes, 0 underruns
          0 output errors, 0 collisions, 0 interface resets
```

If an incorrect IP address or no IP address is displayed, there is a problem with IP addresses assignment. Verify the configuration of the **peer default ip address** command in the virtual template on the tunnel server.

Step 4 **show interfaces virtual-access** *number*

Enter this command to verify that the interface is up, that LCP is open, and that no errors are reported. The following output shows a functional interface:

Example:

```
Router# show interfaces virtual-access 1
Virtual-Access1 is up, line protocol is up
  Hardware is Virtual Access interface
  Interface is unnumbered. Using address of FastEthernet0/0 (172.22.66.25)
  MTU 1500 bytes, BW 115 Kbit, DLY 100000 usec,
     reliablility 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set, keepalive set (10 sec)
  DTR is pulsed for 5 seconds on reset
  LCP Open
  Open: IPCP
  Last input 00:00:02, output never, output hang never
  Last clearing of "show interface" counters 3d00h
  Queueing strategy: fifo
  Output queue 1/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     114 packets input, 9563 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     27 packets output, 864 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

The virtual access interface is up and the line protocol is up, showing that virtual interface establishment was successful.

Step 5 **show vpdn session**

Enter this command on the tunnel server to verify that there are active VPDN sessions. This example shows output from a tunnel server with several active L2F and L2TP tunnels.

Example:

```
Router# show vpdn session

L2TP Session Information Total tunnels 1 sessions 4
LocID RemID TunID Intf          Username             State    Last Chg Uniq ID
4     691   13695 Se0/0         nobody2@cisco.com        est    00:06:00  4
5     692   13695 SSS Circuit   nobody1@cisco.com        est    00:01:43  8
6     693   13695 SSS Circuit   nobody1@cisco.com        est    00:01:43  9
3     690   13695 SSS Circuit   nobody3@cisco.com        est    2d21h     3
L2F Session Information Total tunnels 1 sessions 2
 CLID   MID    Username                   Intf          State   Uniq ID
 1      2      nobody@cisco.com              SSS Circuit   open    10
 1      3      nobody@cisco.com              SSS Circuit   open    11
```

If there is no session established for the client, you should perform the troubleshooting steps in the Verifying and Troubleshooting Tunnel Establishment Between the NAS and the Tunnel Server, on page 130.

Configuring L2TP Calling Station ID Suppression

Calling station ID suppression can be configured globally on the NAS, for individual VPDN groups on the NAS, or on the remote RADIUS server if one is configured.

The order of precedence for L2TP calling station ID suppression configurations is as follows:

- A RADIUS server configuration will take precedence over any configuration on the NAS.

- A VPDN group configuration will take precedence over a global configuration for calls associated with that VPDN group.
- A global configuration will be applied if no other method is configured.

Perform one or more of the following tasks to configure L2TP calling station ID suppression:

Prerequisites for Configuring L2TP Calling Station ID Suppression

- You must configure the NAS and the tunnel server to use the L2TP protocol when performing the tasks in the Configuring the NAS to Request Dial-In VPDN Tunnels section and the Configuring the Tunnel Server to Accept Dial-In VPDN Tunnels section.
- You must configure the NAS to tunnel calls based on the domain name when performing the task in the Configuring the NAS to Request Dial-In VPDN Tunnels section.
- You must configure the VPDN search order to use the domain name when performing the task in the Configuring the VPDN Tunnel Authorization Search Order section of the Configuring AAA for VPDNs module.

Configuring Global L2TP Calling Station ID Suppression on the NAS

The calling station ID information included in L2TP AV pair 22 can be removed or masked for every L2TP session established on the router if you configure L2TP calling station ID suppression globally. This configuration is compatible with either local or remote authorization.

Perform this task on the NAS to configure global L2TP calling station ID suppression.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn l2tp attribute clid mask-method** {**right** *mask-character characters* | **remove**} [**match** *match-string*]

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	**vpdn l2tp attribute clid mask-method** {**right** *mask-character characters* | **remove**} [**match** *match-string*] **Example:** `Router(config)# vpdn l2tp attribute clid mask-method right # 6 match %321`	Configures a NAS to suppress L2TP calling station IDs globally on the router. • **right** *mask-character characters* --Masks the calling station ID starting from the right end, using the specified *mask-character* to replace the defined number of *characters*. The *mask-character* must be a printable character. • **remove** --Removes the entire calling station ID. • **match** *match-string* --Removes or masks the calling station ID only when the username contains the specified *match-string*.

Configuring L2TP Calling Station ID Suppression for a VPDN Group on the NAS

The calling station ID information included in L2TP AV pair 22 can be removed or masked for calls associated with a specific VPDN group. This configuration is compatible with local authorization configurations.

Perform this task on the NAS to configure L2TP calling station ID suppression for calls associated with a particular VPDN group when using local authorization.

Before You Begin

- You must configure the NAS and the tunnel server for local authorization when performing the task in the Configuring AAA on the NAS and the Tunnel Server section of the Configuring AAA for VPDNs module.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **l2tp attribute clid mask-method** {**right** *mask-character characters*| **remove**} [**match** *match-string*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group L2TP`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**l2tp attribute clid mask-method** {**right** *mask-character characters*| **remove**} [**match** *match-string*] **Example:** `Router (config-vpdn)# l2tp attribute clid mask-method remove`	Configures a NAS to suppress L2TP calling station IDs for sessions associated with a VPDN group or VPDN template. • **right** *mask-character characters* --Masks the calling station ID starting from the right end, using the specified *mask-character* to replace the defined number of *characters*. The *mask-character* must be a printable character. • **remove** --Removes the entire calling station ID. • **match** *match-string* --Removes or masks the calling station ID only when the username contains the specified *match-string*.

Configuring L2TP Calling Station ID Suppression on the NAS Remote RADIUS Server

L2TP calling station ID suppression can be configured directly on the NAS, or in the RADIUS user profile. Configuring L2TP calling station ID suppression in the RADIUS user profile allows the configuration to be propagated to multiple NASs without having to configure each one.

Perform this task on the RADIUS server to configure a user profile that will allow the RADIUS server to instruct NASs to remove or mask the L2TP calling station ID.

Before You Begin

- The NAS must be configured for remote RADIUS AAA. Perform the tasks for configuring AAA on the NAS and the tunnel server, and configuring remote AAA for VPDNs as described in the Configuring AAA for VPDNs module.
- The RADIUS server must be configured for AAA.

SUMMARY STEPS

1. **Cisco-Avpair = vpdn:l2tp-tunnel-password=** *secret*
2. **Cisco-Avpair = vpdn:tunnel-type= l2tp**
3. **Cisco-Avpair = vpdn:tunnel-id=** *name*
4. **Cisco-Avpair = vpdn:ip-address=** *address*
5. **Cisco-Avpair = vpdn:l2tp-clid-mask-method=** {**right:** *character* **:** *characters* | **remove**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**Cisco-Avpair = vpdn:l2tp-tunnel-password=** *secret* **Example:** `Cisco-Avpair = vpdn:l2tp-tunnel-password=cisco`	Specifies the L2TP tunnel password in the RADIUS user profile.
Step 2	**Cisco-Avpair = vpdn:tunnel-type= l2tp** **Example:** `Cisco-Avpair = vpdn:tunnel-type=l2tp`	Specifies L2TP as the tunneling protocol in the RADIUS user profile.
Step 3	**Cisco-Avpair = vpdn:tunnel-id=** *name* **Example:** `Cisco-Avpair = vpdn:tunnel-id=test`	Specifies the tunnel ID in the RADIUS user profile.
Step 4	**Cisco-Avpair = vpdn:ip-address=** *address* **Example:** `Cisco-Avpair = vpdn:ip-address=172.16.9.9`	Specifies the NAS IP address in the RADIUS user profile.

Step 5	**Cisco-Avpair = vpdn:l2tp-clid-mask-method=** {**right:** *character* **:** *characters* | **remove**}
	Example:
	`Cisco-Avpair = vpdn:l2tp-clid-mask-method= right:#:5`
		Specifies L2TP calling station ID suppression parameters in the RADIUS user profile.
		• **right** --Masks the calling station ID starting from the right side, using the specified *mask-character* to replace the defined number of *characters*.
		• **remove** --Removes the entire calling station ID.

Configuration Examples for NAS-Initiated Dial-In VPDN Tunneling

Example Configuring the NAS for Dial-In VPDNs

The following example configures a NAS named ISP-NAS to tunnel PPP calls to a tunnel server named ENT-TS using L2TP and local authentication and authorization:

```
! Enable AAA authentication and authorization with RADIUS as the default method
aaa new-model
aaa authentication ppp default radius
aaa authorization network default radius
!
! Configure the VPDN tunnel authentication password using the local name
username ISP-NAS password 7 tunnelme
username ENT-TS password 7 tunnelme
!
vpdn enable
!
! Configure VPN to first search on the client domain name and then on the DNIS
vpdn search-order domain dnis
!
! Allow a maximum of 10 simultaneous VPDN sessions
vpdn session-limit 10
!
! Configure the NAS to initiate VPDN dial-in sessions to the tunnel server
vpdn-group 1
 request-dialin
 protocol l2tp
 domain cisco.com
!
 initiate-to ip 172.22.66.25
 local name ISP-NAS
!
! Specifies the RADIUS server IP address, authorization port, and accounting port
radius-server host 172.22.66.16 auth-port 1645 acct-port 1646
!
! Specifies the authentication key to be used with the RADIUS server
radius-server key cisco
!
```

Example Configuring the Tunnel Server for Dial-in VPDNs

The following example show a tunnel server named ENT-TS configured to accept L2TP tunnels from a NAS named ISP-NAS using local authentication and authorization:

```
! Configure AAA to first use the local database and then contact the RADIUS server for
! PPP authentication
aaa new-model
aaa authentication ppp default local radius
!
! Configure AAA network authorization and accounting by using the RADIUS server
aaa authorization network default radius
aaa accounting network default start-stop radius
!
! Configure the VPDN tunnel authentication password using the local name
username ISP-NAS password 7 tunnelme
username ENT-TS password 7 tunnelme
!
```

```
vpdn enable
!
! Configure the tunnel server to accept dial-in sessions from the NAS
vpdn-group 1
 accept-dialin
 protocol l2tp
 virtual-template 1
!
 terminate-from hostname ISP-NAS
 local name ENT-TS
 force-local-chap
!
! Configure the virtual template
interface Virtual-Template1
  gigabitethernet0/0/0
 ppp authentication chap
 peer default ip address pool default
 encapsulation ppp
!
! Specifies the RADIUS server IP address, authorization port, and accounting port
radius-server host 172.22.66.13 auth-port 1645 acct-port 1646
!
! Specifies the authentication key to be used with the RADIUS server
radius-server key cisco
```

Example L2TP Calling Station ID Suppression with Local Authorization

The following example configures a NAS for PPP over Gigabit Ethernet over virtual LAN (PPPoEoVLAN). The NAS obtains a calling station ID from LLID NAS port preauthorization through RADIUS. The calling station ID will be removed from AV pair 22 for tunnels associated with the VPDN group named L2TP if the string #184 is included in the username.

```
hostname LAC
!
enable secret 5 $1$8qtb$MHcYeW2kn8VNYgz932eXl.
enable password lab
!
aaa new-model
!
aaa group server radius LLID-Radius
 server 192.168.1.5 auth-port 1645 acct-port 1646
!
aaa group server radius LAC-Radius
 server 192.168.1.6 auth-port 1645 acct-port 1646
!
aaa authentication ppp default local
aaa authorization network default local
aaa authorization network LLID group LLID-Radius
aaa accounting network default start-stop group LAC-Radius
aaa nas port extended
aaa session-id common
!
ip subnet-zero
ip cef
no ip domain lookup
!
vpdn enable
vpdn search-order domain
!
vpdn-group L2TP
 request-dialin
 protocol l2tp
 domain cisco.com
 domain cisco.com#184
!
 initiate-to ip 192.168.1.4
 local name test
 l2tp tunnel password 0 cisco
 l2tp attribute clid mask-method remove match #184
!
bba-group ppoe 2
 virtual-template 1
 nas-port format d 2/2/4
!
subscriber access pppoe pre-authorize nas-port-id LLID send username
!
interface Loopback0
 no ip address
!
interface Loopback1
 ip address 10.1.1.1 255.255.255.0
!
interface gigabitethernet0/0/0
 ip address 192.168.1.3 255.255.255.0
 no cdp enable
!
interface gigabitethernet0/0/0.20
 encapsulation dot1Q 1024
 no snmp trap link-status
 ppoe enable group 2
 pppoe max-sessions 200
 no cdp enable
!
interface gigabitethernet1/0/0
 ip address 10.1.1.10 255.255.255.0
 no cdp enable
!
interface Serial2/0/0
no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/0/0
 no ip address
 shutdown
 serial restart-delay 0
!
interface Virtual-Template1
 ip unnumbered gigabitethernet1/0/0
 ip mroute-cache
 no peer default ip address
 ppp authentication pap
!
ip classless
ip route 0.0.0.0 0.0.0.0 gigabitethernet0/0/0
ip route 10.0.0.0 255.0.0.0 gigabitethernet1/0/0
!
no ip http server
!
radius-server attribute 69 clear
radius-server host 192.168.1.5 auth-port 1645 acct-port 1646
radius-server host 192.168.1.6 auth-port 1645 acct-port 1646
radius-server domain-stripping delimiter #
radius-server key cisco
radius-server vsa send accounting
radius-server vsa send authentication
!
control-plane
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 password lab
```

Example L2TP Calling Station ID Suppression with RADIUS Authorization

The following example configures a NAS for PPPoEoVLAN. The NAS obtains a calling station ID from LLID NAS port preauthorization through RADIUS. The RADIUS user profile specifies that the calling station ID should be masked by replacing the rightmost six characters with the character X.

NAS Configuration

```
hostname LAC
!
enable secret 5 $1$8qtb$MHcYeW2kn8VNYgz932eXl.
enable password lab
!
aaa new-model
!
aaa group server radius LLID-Radius
 server 192.168.1.5 auth-port 1645 acct-port 1646
!
aaa group server radius LAC-Radius
 server 192.168.1.6 auth-port 1645 acct-port 1646
!
aaa authentication ppp default local
aaa authorization network default group LAC-Radius
aaa authorization network LLID group LLID-Radius
aaa accounting network default start-stop group LAC-Radius
aaa nas port extended
aaa session-id common
!
ip subnet-zero
ip cef
no ip domain lookup
!
vpdn enable
vpdn search-order domain
!
bba-group ppoe 2
 virtual-template 1
 nas-port format d 2/2/4
!
subscriber access pppoe pre-authorize nas-port-id LLID send username
!
interface Loopback0
 no ip address
!
interface Loopback1
 ip address 10.1.1.1 255.255.255.0
!
interface gigabitethernet0/0/0
 ip address 192.168.1.3 255.255.255.0
 no cdp enable
!
interface gigabitethernet0/0/0.20
 encapsulation dot1Q 1024
 no snmp trap link-status
 pppoe enable group 2
 pppoe max-sessions 200
 no cdp enable
!
interface gigabitethernet1/0/0
 ip address 10.1.1.10 255.255.255.0
 no cdp enable
!
interface Serial2/0/0
no ip address
 shutdown
 serial restart-delay 0
!
```

```
interface Serial3/0/0
 no ip address
 shutdown
 serial restart-delay 0
!
interface Virtual-Template1
 ip unnumbered gigabitethernet1/0/0
 ip mroute-cache
 no peer default ip address
 ppp authentication pap
!
ip classless
ip route 0.0.0.0 0.0.0.0 gigabitethernet0/0/0
ip route 10.0.0.0 255.0.0.0 gigabitethernet1/0/0
!
no ip http server
!
radius-server attribute 69 clear
radius-server host 192.168.1.5 auth-port 1645 acct-port 1646
radius-server host 192.168.1.6 auth-port 1645 acct-port 1646
radius-server domain-stripping delimiter #
radius-server key cisco
radius-server vsa send accounting
radius-server vsa send authentication
!
control-plane
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 password lab
```

RADIUS User Profile Configuration

```
Cisco-Avpair = vpdn:l2tp-tunnel-password=cisco
Cisco-Avpair = vpdn:tunnel-type=l2tp
Cisco-Avpair = vpdn:tunnel-id=test
Cisco-Avpair = vpdn:ip-address=192.168.1.4
Cisco-Avpair = vpdn:l2tp-clid-mask-method=right:X:6
```

Where to Go Next

You can perform any of the relevant optional tasks in the Configuring Additional VPDN Features and in the VPDN Tunnel Management modules.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
VPDN technology overview	VPDN Technology Overview module
Information about virtual templates	Configuring Virtual Template Interfaces module

Related Topic	Document Title
Dial Technologies commands	*Cisco IOS Dial Technologies Command Reference*
Technical support documentation for L2TP	*Layer 2 Tunnel Protocol (L2TP)*
Technical support documentation for VPDNs	*Virtual Private Dial-Up Network (VPDN)*

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
• CISCO-VPDN-MGMT-MIB • CISCO-VPDN-MGMT-EXT-MIB	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 2341	Cisco Layer Two Forwarding (Protocol) L2F
RFC 2661	*Layer Two Tunneling Protocol L2TP*

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 NAS-Initiated Dial-In VPDN Tunneling

The following table provides release information about the feature or features described in this module. This table 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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 9: Feature Information for NAS-Initiated Dial-In VPDN Tunneling

Feature Name	Software Releases	Feature Configuration Information
L2TP Calling Station ID Suppression	12.2(31)SB2	This feature allows the NAS to suppress part or all of the calling station ID from the NAS in the L2TP AV pair 22, the Calling Number ID. Calling station ID suppression can be configured globally on the router, for individual VPDN groups on the router, or on the remote RADIUS server if one is configured. The following commands were introduced by this feature: **l2tp attribute clid mask-method**, **vpdn l2tp attribute clid mask-method**.
L2TP Extended Failover	12.2(13)T 12.2(28)SB	This feature extends L2TP failover to occur if, during tunnel establishment, a router receives a StopCCN message from its peer, or during session establishment a router receives a CDN message from its peer. In either case, the router selects an alternate peer to contact. No commands were introduced or modified by this feature.

CHAPTER 4

Configuring Client-Initiated Dial-In VPDN Tunneling

Client-initiated dial-in virtual private dialup networking (VPDN) tunneling deployments allow remote users to access a private network over a shared infrastructure with end-to-end protection of private data. Client-initiated VPDN tunneling does not require additional security to protect data between the client and the Internet service provider (ISP) network access server (NAS).

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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 table at the end of this module.

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

Prerequisites for Client-Initiated VPDN Tunneling

- If the client device is a PC, appropriate Virtual Private Network (VPN) software must be installed and configured. For information on installing and configuring client VPN software, refer to the instructions provided with the VPN software package.
- The NAS should be configured to receive incoming calls from clients using ISDN, the public switched telephone network (PSTN), digital subscriber line (DSL), or cable modem.
- The interface between the NAS and the tunnel server must be configured for PPP.
- Before performing the tasks documented in this module, you must perform the required tasks in the Configuring AAA for VPDNs module.

Restrictions for Client-Initiated VPDN Tunneling

- The Layer 2 Forwarding (L2F) protocol is not supported.
- Layer 2 Tunneling Protocol (L2TP) and L2TP Version 3 (L2TPv3) protocols are supported only for tunnels initiated by a client router.
- The Point-to-Point Tunneling Protocol (PPTP) is supported only for tunnels initiated by a client PC running appropriate VPN software.

Information About Client-Initiated VPDN Tunneling

Client-Initiated VPDN Tunneling

Client-initiated dial-in VPDN tunneling is also known as voluntary tunneling. In a client-initiated dial-in VPDN scenario, the client device initiates a Layer 2 tunnel to the tunnel server, and the NAS does not participate in tunnel negotiation or establishment. In this scenario the NAS is not a tunnel endpoint, it simply provides internet connectivity.

The client can be either of these devices:

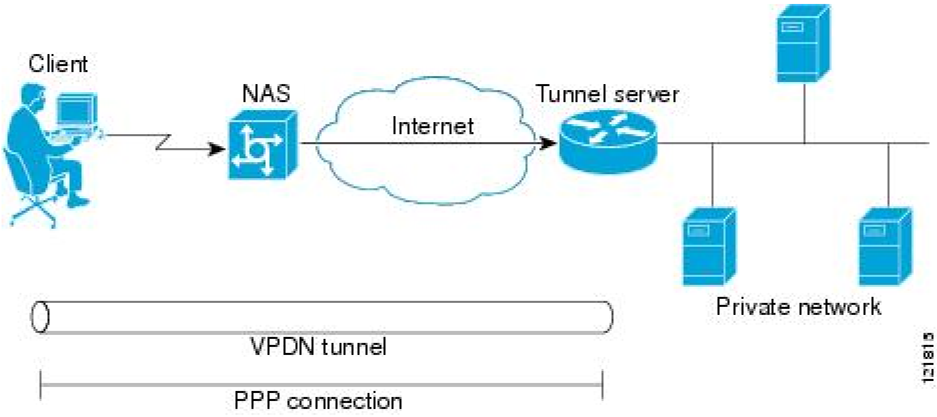
- A properly configured router attached to a client network using either L2TP or L2TPv3.
- A PC that is running appropriate VPN client software using PPTP.

Client-initiated VPDN tunneling provides end-to-end security for the connection from the client to the tunnel server. Unlike NAS-initiated VPDN scenarios, no additional security is required to protect the connection between the client device and the NAS.

The figure below depicts a generic client-initiated VPDN tunneling scenario. The local device, which can be either a client PC or a client router, connects to the NAS through a medium that supports PPP. The client can initiate a VPDN tunnel to the tunnel server using either the PPTP, L2TP, or L2TPv3 protocol. The type of

Layer 2 tunnel that is established is dependent on the configuration of both the client device and remote tunnel server.

Figure 12: Client-Initiated Tunneling



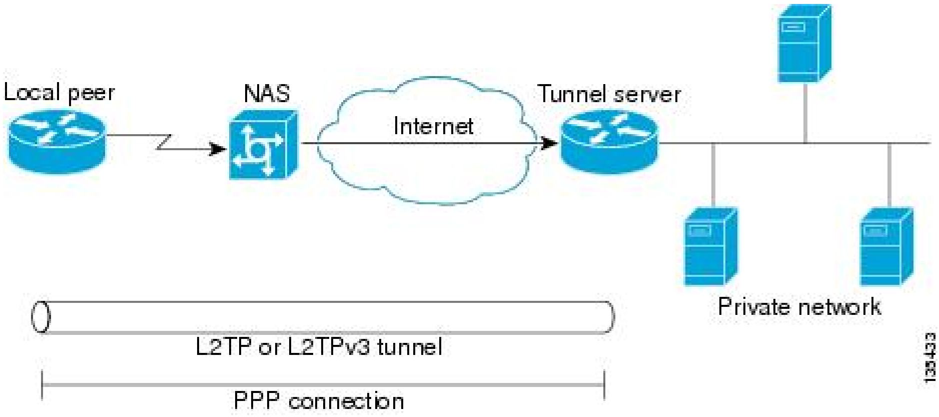
Client-Initiated VPDN Tunneling Using the L2TP or L2TPv3 Protocol

Client-initiated tunnels using the L2TP or L2TPv3 protocol must be initiated by a router configured as the local peer. The L2TP and L2TPv3 protocols are not supported for client-initiated tunnels from a client PC.

In the client-initiated tunneling scenario depicted in the figure below, the local peer connects to the NAS through a medium that supports PPP, such as a dialup modem, DSL, ISDN, or cable modem. The PPP interface adds Layer 2 encapsulation to Layer 3 packets, allowing them to be sent to the tunnel server over an L2TP or L2TPv3 tunnel.

The client can initiate a VPDN tunnel to the tunnel server using either the L2TP or L2TPv3 protocol. The type of Layer 2 tunnel that is established is dependent on the configuration of both the local peer and remote tunnel server. The local and remote peers must be configured to establish the same type of tunnel.

Figure 13: L2TP or L2TPv3 Client-Initiated Tunneling

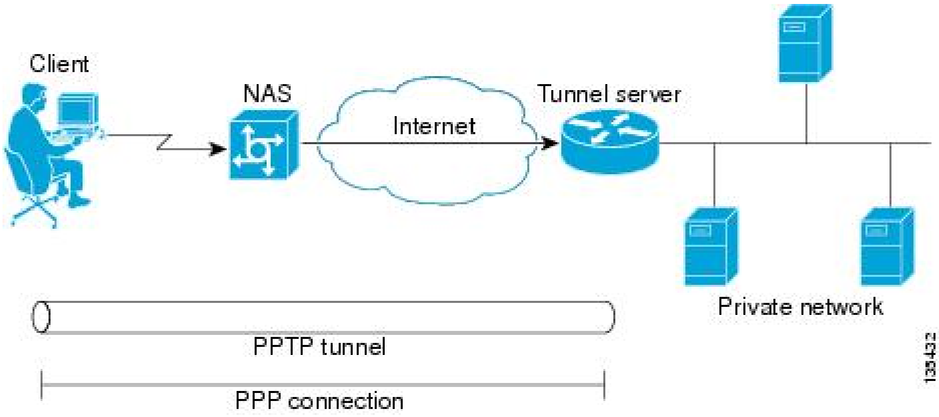


Client-Initiated VPDN Tunneling Using the PPTP Protocol

Client-initiated tunnels using the PPTP protocol must be initiated by a client PC configured with appropriate VPN client software. The client must manage the software that initiates the tunnel on the PC. The PPTP protocol is not supported for client-initiated tunnels from a local peer router.

In the client-initiated tunneling scenario depicted in the figure below, the client PC connects to the NAS through a medium that supports PPP, such as a dialup modem, DSL, ISDN, or cable modem. The client can initiate a VPDN tunnel to the tunnel server using the PPTP protocol.

Figure 14: PPTP Client-Initiated Tunneling



PPTP uses an enhanced Generic Routing Encapsulation (GRE) mechanism to provide a flow- and congestion-controlled encapsulated datagram service for carrying PPP packets.

These sections contain information about PPTP features:

MPPE Encryption of PPTP Tunnels

Microsoft Point-to-Point Encryption (MPPE) can be used to encrypt PPTP VPDN tunnels. MPPE encrypts the entire session from the client to the tunnel server.

MPPE is an encryption technology developed by Microsoft to encrypt point-to-point links. These connections can be over a dialup line or over a VPDN tunnel. MPPE works is a feature of Microsoft Point-to-Point Compression (MPPC).

MPPC is a scheme used to compress PPP packets between Cisco and Microsoft client devices. The MPPC algorithm is designed to optimize bandwidth utilization in order to support multiple simultaneous connections.

MPPE is negotiated using bits in the MPPC option within the Compression Control Protocol (CCP) MPPC configuration option (CCP configuration option number 18).

MPPE uses the RC4 algorithm with either 40- or 128-bit keys. All keys are derived from the cleartext authentication password of the user. RC4 is stream cipher; therefore, the sizes of the encrypted and decrypted frames are the same size as the original frame. The Cisco implementation of MPPE is fully interoperable with that of Microsoft and uses all available options, including stateless mode (sometimes referred to as historyless mode). Stateless mode can increase throughput in lossy environments such as VPDNs, because neither side needs to send CCP Resets Requests to synchronize encryption contexts when packets are lost.

Two modes of MPPE encryption are available:

- Stateful MPPE encryption--Stateful encryption provides the best performance but might be adversely affected by networks that experience substantial packet loss. Because of the way that the RC4 tables are reinitialized during stateful synchronization, it is possible that two packets might be encrypted using the same key. For this reason, stateful encryption might not be appropriate for lossy network environments (such as Layer 2 tunnels on the Internet). If you configure stateful encryption, the PPTP flow control alarm is automatically enabled.
- Stateless MPPE encryption--Stateless encryption provides a lower level of performance, but will be more reliable in a lossy network environment. Stateless mode is sometimes referred to as historyless mode. The PPTP flow control alarm is automatically disabled when stateless encryption is being used.

PPTP Flow Control Alarm

The PPTP flow control alarm indicates when congestion or lost packets are detected. When the flow control alarm goes off, PPTP reduces volatility and additional control traffic by falling back from a stateful to a stateless encryption mode for the MPPE session.

How to Configure Client-Initiated VPDN Tunneling

Configuring Client-Initiated Tunneling Using the L2TP or L2TPv3 Protocol

Prerequisites

- This procedure requires Cisco IOS Release 12.3(2)T or a later release on both the local peer and the tunnel server for L2TPv3 tunneling configurations.
- This procedure requires Cisco IOS Release 12.3(2)T or a later release on the local peer for L2TP tunneling configurations.
- Cisco Express Forwarding must be enabled.

Restrictions

- PPP is the only encapsulation method supported.
- PPTP tunneling is not supported.
- Session establishment cannot be triggered by interesting traffic.
- Failover is not supported with the L2TP peer.
- L2TP redirect is not supported.

Configuring L2TP or L2TPv3 Client-Initiated VPDN Tunneling on the Local Peer

Perform this task to configure the local peer to initiate VPDN tunnels to the tunnel server. This task applies to both L2TP and L2TPv3 configurations.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]
4. **exit**
5. **pseudowire-class** [*pw-class-name*]
6. **exit**
7. **interface virtual-ppp** *number*
8. **ip unnumbered** *interface-type interface-number*
9. **ppp authentication** *protocol1* [*protocol2*...] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**]
10. **ppp chap hostname** [*hostname*]
11. **pseudowire** *peer-ip-address vcid* **pw-class** *pw-class-name* [**sequencing** {**transmit** | **receive** | **both**}]
12. **exit**
13. **ip route** *prefix mask* {*ip-address*| *interface-type interface-number* [*ip-address*]} [**distance**] [**name**] [**permanent**] [**tag** *tag*]

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 l2tpclass2`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name*for each one. • You can configure L2TP control channel parameters in L2TP class configuration mode. See the Configuring L2TP Control Channel Parameters, on page 160 for more information.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config-l2tp-class)# exit`	Exits L2TP class configuration mode.
Step 5	**pseudowire-class** [*pw-class-name*] **Example:** `Router(config)# pseudowire-class pwclass2`	Enters pseudowire class configuration mode and optionally specifies the name of the L2TP pseudowire class.
Step 6	**exit** **Example:** `Router(config-pw)# exit`	Exits pseudowire class configuration mode.
Step 7	**interface virtual-ppp** *number* **Example:** `Router(config)# interface virtual-ppp 2`	Enters interface configuration mode and assigns a virtual-PPP interface number.
Step 8	**ip unnumbered** *interface-type interface-number* **Example:** `Router(config-if)# ip unnumbered loopback 1`	Enables IP processing on an interface without assigning an explicit IP address to the interface.
Step 9	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] **Example:** `Router(config-if)# ppp authentication chap`	Enables Challenge Handshake Authentication Protocol (CHAP) or Password Authentication Protocol (PAP) or both and specifies the order in which CHAP and PAP authentication is selected on the interface.
Step 10	**ppp chap hostname** [*hostname*] **Example:** `Router(config-if)# ppp chap hostname peer2`	Creates a pool of dialup routers that all appear to be the same host when authenticating with CHAP.
Step 11	**pseudowire** *peer-ip-address vcid* **pw-class** *pw-class-name* [**sequencing** {**transmit** | **receive** | **both**}]	Specifies the IP address of the tunnel server and the 32-bit virtual circuit identifier (VCID) shared between the devices at each end of the control channel.

	Command or Action	Purpose
	Example: `Router(config-if)# pseudowire 172.16.32.24 10 pw-class pwclass2`	• *peer-ip-address vcid* --The tunnel server IP address and VCID must be a unique combination on the router. **Note** For L2TPv3 tunnels, the VCID configured on the local peer must match the VCID configured on the tunnel server. • **pw-class** *pw-class-name* --The pseudowire class configuration from which the data encapsulation type will be taken.The **pw-class** keyword binds the pseudowire statement to a specific pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. • **sequencing** --The optional **sequencing** keyword specifies whether sequencing is required for packets that are received, sent, or both received and sent. **Note** If the network between the tunnel endpoints is unreliable, packets might be delivered out of order. Enabling sequencing can reduce the number of dropped packets and network latency.
Step 12	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode.
Step 13	**ip route** *prefix mask* {*ip-address*| *interface-type interface-number* [*ip-address*]} [**distance**] [**name**] [**permanent**] [**tag** *tag*] **Example:** `Router(config)# ip route 10.20.20.0 255.255.255.0 virtual-PPP 1`	Establishes static routes.

What to Do Next

You must perform one of these tasks depending on the tunneling protocol you are configuring:

- Configuring Client-Initiated Tunneling on the Tunnel Server for L2TP Tunnels
- Configuring Client-Initiated Tunneling on the Tunnel Server for L2TPv3 Tunnels

Configuring Client-Initiated Tunneling on the Tunnel Server for L2TP Tunnels

When a request to establish an L2TP tunnel is received by the tunnel server, the tunnel server must create a virtual access interface. The virtual access interface is cloned from a virtual template interface, used, and then freed when no longer needed. The virtual template interface is a logical entity that is not tied to any physical interface. The tunnel server must be configured to terminate VPDN tunnels.

Perform this task to configure the tunnel server to terminate client-initiated L2TP tunnels and to configure a basic virtual template.

Before You Begin

- You must perform the required tasks in the Configuring AAA for VPDNs module.
- The same tunneling protocol must be configured on the tunnel server and the local peer device. For L2TP tunnels, the tunneling protocol is configured in a VPDN group on the tunnel server. On the local peer, the tunneling protocol is configured in a pseudowire class.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **accept-dialin**
6. **protocol l2tp**
7. **virtual-template** *template-number*
8. **exit**
9. **terminate-from hostname** *hostname*
10. **exit**
11. **interface virtual-template** *number*
12. **ip unnumbered** *interface-type interface-number*
13. **ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**]
14. **ppp chap hostname** [*hostname*]

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn group vpdngroup1`	Enters VPDN group configuration mode and associates a VPDN group to a customer or VPDN profile.
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description clientl2tp`	(Optional) Adds a description to a VPDN group.
Step 5	**accept-dialin** **Example:** `Router(config-vpdn)# accept-dialin`	Enters VPDN accept-dialin configuration mode, configures the tunnel server to accept tunneled PPP connections, and creates an accept-dialin VPDN subgroup.
Step 6	**protocol l2tp** **Example:** `Router(config-vpdn-acc-in)# protocol l2tp`	Specifies the Layer 2 protocol that the VPDN subgroup will use.
Step 7	**virtual-template** *template-number* **Example:** `Router(config-vpdn-acc-in)# virtual-template 1`	Specifies which virtual template will be used to clone virtual access interfaces.
Step 8	**exit** **Example:** `Router(config-vpdn-acc-in)# exit`	Exits VPDN accept-dialin configuration mode.
Step 9	**terminate-from hostname** *hostname* **Example:** `Router(config-vpdn)# terminate-from hostname peer1`	Specifies the hostname of the remote LAC or LNS that will be required when accepting a VPDN tunnel.
Step 10	**exit** **Example:** `Router(config-vpdn)# exit`	Exits VPDN group configuration mode.

	Command or Action	Purpose
Step 11	**interface virtual-template** *number* **Example:** `Router(config)# interface virtual-template 1`	Enters interface configuration mode and creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 12	**ip unnumbered** *interface-type* *interface-number* **Example:** `Router(config-if)# ip unnumbered loopback 1`	Enables IP processing on an interface without assigning an explicit IP address to the interface.
Step 13	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] **Example:** `Router(config-if)# ppp authentication chap`	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication is selected on the interface.
Step 14	**ppp chap hostname** [*hostname*] **Example:** `Router(config-if)# ppp chap hostname peer2`	Creates a pool of dialup routers that all appear to be the same host when authenticating with CHAP.

What to Do Next

You must perform the task in the Configuring the Pseudowire, on page 165.

Configuring Client-Initiated Tunneling on the Tunnel Server for L2TPv3 Tunnels

The tunnel server must be configured to terminate VPDN tunnels. The same tunneling protocol must be configured on the tunnel server and the local peer device. For L2TPv3 tunnels, the tunneling protocol is configured in a pseudowire class on both the tunnel server and the local peer.

Perform this task to configure the tunnel server to terminate client-initiated L2TPv3 tunnels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]
4. **exit**
5. **pseudowire-class** [*pw-class-name*]
6. **exit**
7. **interface virtual-ppp** *number*
8. **ip unnumbered** *interface-type interface-number*
9. **ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**]
10. **ppp chap hostname** [*hostname*]
11. **pseudowire** *peer-ip-address vcid* **pw-class** *pw-class-name* [**sequencing** {**transmit** | **receive** | **both**}]
12. **exit**
13. **ip route** *prefix mask* {*ip-address*| *interface-type interface-number* [*ip-address*]} [**distance**] [**name**] [**permanent**] [**tag** *tag*]

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 l2tpclass2`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name*for each one. • You can configure L2TP control channel parameters in L2TP class configuration mode. See the Configuring L2TP Control Channel Parameters, on page 160.
Step 4	**exit** **Example:** `Router(config-l2tp-class)# exit`	Exits L2TP class configuration mode.

	Command or Action	Purpose
Step 5	**pseudowire-class** [*pw-class-name*] **Example:** `Router(config)# pseudowire-class pwclass2`	Enters pseudowire class configuration mode and optionally specifies the name of the L2TP pseudowire class.
Step 6	**exit** **Example:** `Router(config-pw)# exit`	Exits pseudowire class configuration mode.
Step 7	**interface virtual-ppp** *number* **Example:** `Router(config)# interface virtual-ppp 2`	Enters interface configuration mode and assigns a virtual-PPP interface number.
Step 8	**ip unnumbered** *interface-type interface-number* **Example:** `Router(config-if)# ip unnumbered loopback 1`	Enables IP processing on an interface without assigning an explicit IP address to the interface.
Step 9	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] **Example:** `Router(config-if)# ppp authentication chap`	Enables CHAP or PAP or both and specifies the order in which CHAP and PAP authentication is selected on the interface.
Step 10	**ppp chap hostname** [*hostname*] **Example:** `Router(config-if)# ppp chap hostname peer2`	Creates a pool of dialup routers that all appear to be the same host when authenticating with CHAP.
Step 11	**pseudowire** *peer-ip-address vcid* **pw-class** *pw-class-name* [**sequencing** {**transmit** | **receive** | **both**}] **Example:** `Router(config-if)# pseudowire 172.16.32.24 10 pw-class pwclass2`	Specifies the IP address of the local peer and the 32-bit VCID shared between the local peer and the tunnel server. • *peer-ip-address vcid* --The peer router IP address and VCID must be a unique combination on the router. **Note** The VCID configured on the tunnel server must match the VCID configured on the local peer. • **pw-class** *pw-class-name* --The pseudowire class configuration from which the data encapsulation type will be taken.The **pw-class** keyword binds the pseudowire statement to a specific

	Command or Action	Purpose
		pseudowire class. The pseudowire class then serves as the template configuration for all attachment circuits bound to it. • **sequencing** --The optional **sequencing** keyword specifies whether sequencing is required for packets that are received, sent, or both received and sent. **Note** If the network between the tunnel endpoints is unreliable, packets might be delivered out of order. Enabling sequencing can reduce the number of dropped packets and network latency.
Step 12	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode.
Step 13	**ip route** *prefix mask* {*ip-address*| *interface-type interface-number* [*ip-address*]} [**distance**] [**name**] [**permanent**] [**tag** *tag*] **Example:** `Router(config)# ip route 10.20.20.0 255.255.255.0 Virtual-PPP 1`	Establishes static routes.

What to Do Next

You must perform the task in the Configuring the Pseudowire, on page 165.

Configuring L2TP 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. Configuring L2TP control channel parameters is optional.

The three groups of L2TP control channel parameters that you can configure for an L2TP class are described in these sections:

After the router enters 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.

Prerequisites

L2TP Tunnels

For L2TP, the L2TP class is configured only on the local peer. An L2TP class was defined for the local peer in the Configuring L2TP or L2TPv3 Client-Initiated VPDN Tunneling on the Local Peer, on page 152."

L2TPv3 Tunnels

For L2TPv3, an L2TP class must be configured on both the local peer and the tunnel server. An L2TP class was defined for the local peer in the Configuring L2TP or L2TPv3 Client-Initiated VPDN Tunneling on the Local Peer, on page 152. An L2TP class was defined for the tunnel server in the Configuring Client-Initiated Tunneling on the Tunnel Server for L2TPv3 Tunnels, on page 157.

Configuring L2TP Control Channel Timing Parameters

These 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

Perform this task to configure a set of timing control channel parameters for an L2TP class. All of the timing control channel parameter configurations are optional and can be configured in any order. If these parameters are not configured, the default values are applied.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

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

Step 5	**retransmit** {**initial retries** *initial-retries* | **retries** *retries*| **timeout** {**max** | **min**} *timeout*}
	Example:
	`Router(config-l2tp-class)# retransmit retries 10`
		(Optional) Configures parameters that affect the retransmission of control packets.
		• **initial retries** --Specifies how many start control channel requests (SCCRQs) are re-sent before the device gives 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 the device determines that the peer router does not respond. Valid values for the *retries* argument range from 1 to 1000. The default value is 15.
		• **timeout** {**max** | **min**}--Specifies maximum and minimum retransmission intervals (in seconds) for resending control packets. Valid values for the *timeout* argument range from 1 to 8. The default maximum interval is 8; the default minimum interval is 1.

Step 6	**timeout setup** *seconds*
	Example:
	`Router(config-l2tp-class)#`
	`timeout setup 400`
		(Optional) Configures the amount of time, in seconds, allowed for setting up a control channel.
		• Valid values for the *seconds* argument range from 60 to 6000. The default value is 300.

What to Do Next

You must perform the task in the Configuring the Pseudowire, on page 165.

Configuring L2TP Control Channel Authentication Parameters

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

- Authentication for the L2TP control channel
- Local hostname used for authenticating the control channel
- Hiding the attribute-value (AV) pairs in outgoing control messages
- Password used for control channel authentication and AV pair hiding

Perform this task to configure a set of authentication control channel parameters for an L2TP class. All of the authentication control channel parameter configurations are optional and can be configured in any order. If these parameters are not configured, the default values will be applied.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp-class** [*l2tp-class-name*]
4. **authentication**
5. **hostname** *name*
6. **hidden**
7. **password** [*encryption-type*] *password*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name*for each one.

	Command or Action	Purpose
Step 4	**authentication** **Example:** `Router(config-l2tp-class)# authentication`	(Optional) Enables authentication for the control channel between PE routers. • Authentication is enabled by default.
Step 5	**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.

Step 6	**hidden**
	Example:
	`Router(config-l2tp-class)#`
	`hidden`
		(Optional) Hides the AV pairs in control messages.
		• AV pairs are not hidden by default.

Step 7	**password** [*encryption-type*] *password*
	Example:
	`Router(config-l2tp-class)#`
	`password tunnel2`
		(Optional) Configures the password used for control channel authentication.
		• The valid values for the optional encryption type range from 0 to 7. If you do not use this command to specify a password, the password associated with the remote peer PE is taken from the value entered with the **username password** *value* global configuration command.
		Note The password configured on the local peer must match the password configured on the tunnel server.

What to Do Next

You must perform the task in the Configuring the Pseudowire, on page 165.

Configuring L2TP Control Channel Maintenance Parameters

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

Perform this task to configure the interval used for hello messages for an L2TP class. This control channel parameter configuration is optional. If this parameter is not configured, the default value will be applied.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp-class** [*l2tp-class-name*] **Example:** `Router(config)# l2tp-class class1`	Specifies the L2TP class name and enters L2TP class configuration mode. • The *l2tp-class-name* argument is optional. However, if you want to configure multiple L2TP classes you must specify a unique *l2tp-class-name*for each one.

Step 4	**hello** *interval*
	Example:
	`Router(config-l2tp-class)#`
	`hello 100`
		(Optional) Specifies the exchange interval (in seconds) used between L2TP hello packets.
		• Valid values for the *interval* argument range from 0 to 1000. The default value is 60.

What to Do Next

You must perform the task in the Configuring the Pseudowire, on page 165.

Configuring the Pseudowire

The pseudowire class configuration procedure creates a configuration template for the pseudowire. You use this template, or class, to configure session-level parameters for L2TP or L2TPv3 sessions that will be used to transport attachment circuit traffic over the pseudowire.

The pseudowire configuration specifies the characteristics of the L2TP or L2TPv3 signaling mechanism, including the data encapsulation type, the control protocol, sequencing, fragmentation, payload-specific options, and IP properties. The setting that determines if signaling is used to set up the pseudowire is also included.

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. This configuration could prevent a control channel from being established.

If you do not configure the optional pseudowire class configuration commands, the default values are used.

Before You Begin

L2TP Tunnels

For L2TP, the pseudowire class is configured only on the local peer. A pseudowire class was defined for the local peer in the task Configuring L2TP or L2TPv3 Client-Initiated VPDN Tunneling on the Local Peer, on page 152.

L2TPv3 Tunnels

For L2TPv3, the pseudowire class must be configured on both the local peer and the tunnel server. A pseudowire class was defined for the local peer in the task Configuring L2TP or L2TPv3 Client-Initiated VPDN Tunneling on the Local Peer, on page 152. A pseudowire class was defined for the tunnel server in the task Configuring Client-Initiated Tunneling on the Tunnel Server for L2TPv3 Tunnels, on page 157.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** [*pw-class-name*]
4. **encapsulation** {**l2tpv2** | **l2tpv3**}
5. **protocol** {**l2tpv2** | **l2tpv3**} [*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. **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.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**pseudowire-class** [*pw-class-name*] **Example:** `Router(config)# pseudowire-class etherpw`	Enters pseudowire class configuration mode and optionally specifies the name of the L2TP pseudowire class.

Step 4	**encapsulation** {**l2tpv2** | **l2tpv3**}
	Example:
	`Router(config-pw)# encapsulation l2tpv3`
		Specifies the data encapsulation method used to tunnel IP traffic.
		• **l2tpv2** --L2TP is the tunneling method to be used to encapsulate data in the pseudowire.
		• **l2tpv3** --L2TPv3 is the tunneling method to be used to encapsulate data in the pseudowire.

Step 5	**protocol** {**l2tpv2** | **l2tpv3**} [*l2tp-class-name*]
	Example:
	`Router(config-pw)#`
	`protocol l2tpv3 class1`
		Specifies the Layer 2 signaling protocol to be used to manage the pseudowires created with the control channel parameters in the specified L2TP class.
		• **l2tpv2** --Specifies L2TP as the signaling protocol to be used.
		• **l2tpv3** --Specifies L2TPv3 as the signaling protocol to be used.
		• *l2tp-class-name* --(Optional) The name of the L2TP class configuration to be used for pseudowires set up from the pseudowire class.
		Note If the *l2tp-class-name* argument is not specified, the default values for L2TP control channel parameters will be used.

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.
		• Use the same local interface name for all pseudowire classes configured between a pair of PE routers.
		Note This command must be configured for pseudowire class configurations using L2TPv3 as the data encapsulation method.

Step 7	**ip pmtu**
	Example:
	`Router(config-pw)#`
	`ip pmtu`
		(Optional) Enables the discovery of the path maximum transmission unit (PMTU) for tunneled traffic.
		• This command enables the processing of Internet Control Message Protocol (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 Don’t Fragment (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.

	Command or Action	Purpose
		• 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, we recommend that you also enable the **ip dfbit set** command in the pseudowire class configuration. This allows the PMTU to be obtained more rapidly.

Step 8	**ip tos** {**value** *value* | **reflect**}
	Example:
	`Router(config-pw)# ip tos reflect`
		(Optional) Configures the value of the type of service (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.

Step 11	**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.
		Note If the network between the tunnel endpoints is unreliable, packets might be delivered out of order. Enabling sequencing can reduce the number of dropped packets and network latency.

Verifying an L2TP Control Channel

Perform this task to display detailed information about the L2TP control channels that are set up to other L2TP-enabled devices for all L2TP sessions on the router.

SUMMARY STEPS

1. **enable**
2. **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	**show l2tun tunnel all** **Example:** `Router# show l2tun tunnel all`	Displays the current state of Layer 2 tunnels and information about configured tunnels, including local and remote L2TP hostnames, aggregate packet counts, and control channel information.

Configuring Client-Initiated VPDN Tunneling Using the PPTP Protocol

Prerequisites for Configuring Client-Initiated VPDN Tunneling Using the PPTP Protocol

The client PC must be configured with appropriate VPN client software.

Restrictions for Configuring Client-Initiated VPDN Tunneling Using the PPTP Protocol

- Only Cisco Express Forwarding and process switching are supported. Regular fast switching is not supported.
- PPTP does not support multilink.
- VPDN multihop is not supported.
- Because all PPTP signaling is over TCP, TCP configurations will affect PPTP performance in large-scale environments.
- MPPE is not supported with TACACS.
- Windows clients must use Microsoft Challenge Handshake Authentication Protocol (MS-CHAP) authentication in order for MPPE to work.
- If you are performing mutual authentication with MS-CHAP and MPPE, both sides of the tunnel must use the same password.

- To use MPPE with authentication, authorization, and accounting (AAA), you must use a RADIUS server that supports the Microsoft vendor specific attribute for MPPE-KEYS. CiscoSecure NT supports MPPE beginning with release 2.6. CiscoSecure UNIX does not support MPPE.

Configuring the Tunnel Server to Accept PPTP Tunnels

The tunnel server must be configured to terminate PPTP tunnels.

Perform this task to configure the tunnel server to accept tunneled PPPTP connections from a client.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **accept-dialin**
5. **protocol pptp**
6. **virtual-template** *template-number*

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group or associates a VPDN group to a customer or VPDN profile and enters VPDN group configuration mode.
Step 4	**accept-dialin** **Example:** `Router(config-vpdn)# accept-dialin`	Creates an accept dial-in VPDN subgroup that configures a tunnel server to accept requests from a NAS to tunnel dial-in calls, and enters accept dial-in VPDN subgroup configuration mode.

	Command or Action	Purpose
Step 5	**protocol pptp** **Example:** `Router(config-vpdn-acc-in)# protocol pptp`	Specifies the Layer 2 protocol that the VPDN group will use.
Step 6	**virtual-template** *template-number* **Example:** `Router(config-vpdn-acc-in)# virtual-template 1`	Specifies which virtual template will be used to clone virtual access interfaces.

What to Do Next

You must perform the task in the Configuring the Virtual Template on the Tunnel Server, on page 171.

Configuring the Virtual Template on the Tunnel Server

When a request to establish a tunnel is received by the tunnel server, the tunnel server must create a virtual access interface. The virtual access interface is cloned from a virtual template interface, used, and then freed when no longer needed. The virtual template interface is a logical entity that is not tied to any physical interface.

Perform this task on the tunnel server to configure a basic virtual template.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface virtual-template** *number*
4. **ip unnumbered** *type number*
5. **ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**]
6. **peer default ip address** {*ip-address*| **dhcp-pool** | **dhcp** | **pool** [*pool-name*]}
7. **encapsulation** *encapsulation-type*
8. **ppp encrypt mppe** {**auto** | **40** | **128**} [**passive** | **required**] [**stateful**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface virtual-template** *number* **Example:** `Router(config)# interface virtual-template 1`	Enters interface configuration mode and creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 4	**ip unnumbered** *type number* **Example:** `Router(config-if)# ip unnumbered FastEthernet 0/0`	Enables IP processing on a serial interface without assigning an explicit IP address to the interface. **Note** Configuring the **ip address** command within a virtual template is not recommended. Configuring a specific IP address in a virtual template can result in the establishment of erroneous routes and the loss of IP packets.
Step 5	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**] **Example:** `Router(config-if)# ppp authentication chap`	Enables at least one PPP authentication protocol and specifies the order in which the protocols are selected on the interface.
Step 6	**peer default ip address** {*ip-address*| **dhcp-pool** | **dhcp** | **pool** [*pool-name*]} **Example:** `Router(config-if)# peer default ip address pool mypool`	Specifies an IP address, an address from a specific IP address pool, or an address from the Dynamic Host Configuration Protocol (DHCP) mechanism to be returned to a remote peer connecting to this interface.
Step 7	**encapsulation** *encapsulation-type* **Example:** `Router(config-if)# encapsulation ppp`	Sets the encapsulation method used by the interface.
Step 8	**ppp encrypt mppe** {**auto** | **40** | **128**} [**passive** | **required**] [**stateful**]	(Optional) Enable MPPE encryption on the virtual template. • **passive** --The tunnel server will not offer MPPE encryption, but will negotiate if the other tunnel endpoint requests encryption.

	Command or Action	Purpose
	Example: `Router(config-if)# ppp encrypt mppe auto required`	• **required** --MPPE must be negotiated, or the connection will be terminated. • **stateful** --MPPE will negotiate only stateful encryption. If the **stateful** keyword is not used, MPPE will first attempt to negotiate stateless encryption, but will allow stateful encryption if the other tunnel endpoint requests the stateful mode.

Configuring MPPE on the ISA Card

Using the Industry-Standard Architecture (ISA) card to offload MPPE from the Route Processor will improve performance in large-scale environments.

Perform this optional task to offload MPPE encryption from the tunnel server processor to the ISA card.

Note An ISA card must be installed on the tunnel server.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **controller isa** *slot* / *port*
4. **encryption mppe**

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	**controller isa** *slot* / *port* **Example:** `Router(config)# controller isa 5/0`	Enters controller configuration mode on the ISA card.
Step 4	**encryption mppe** **Example:** `Router(config-controller)# encryption mppe`	Enables MPPE encryption on an ISA card.

What to Do Next

You must reboot your router for the configuration of the **encryption mppe** command to take effect.

Tuning PPTP

You can configure PPTP control options to tune the performance of your PPTP deployment. All of the PPTP tuning configuration commands are optional and can be configured in any order. If these parameters are not configured, the default values are applied.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **pptp flow-control receive-window** *packets*
5. **pptp flow-control static-rtt** *timeout-interval*
6. **pptp tunnel echo** *seconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn group pptp1`	Enters VPDN group configuration mode and associates a VPDN group to a customer or VPDN profile.
Step 4	**pptp flow-control receive-window** *packets* **Example:** `Router(config-vpdn)# pptp flow-control receive-window 20`	Specifies how many packets the client can send before it must wait for the acknowledgment from the tunnel server.
Step 5	**pptp flow-control static-rtt** *timeout-interval* **Example:** `Router(config-vpdn)# pptp flow-control static-rtt 2000`	Specifies the timeout interval of the tunnel server between sending a packet to the client and receiving a response. **Note** If the configured timeout interval elapses with no response, the flow control alarm will be triggered.
Step 6	**pptp tunnel echo** *seconds* **Example:** `Router(config-vpdn)# pptp tunnel echo 90`	Specifies the period of idle time on the tunnel that will trigger an echo message from the tunnel server to the client.

Verifying a PPTP Client-Initiated VPDN Configuration

Perform this task to verify that a PPTP client-initiated VPDN configuration functions properly.

SUMMARY STEPS

1. Dial in to the NAS from a client PC.
2. From the client PC, establish a PPTP connection to the tunnel server using the VPN client software.
3. From the client, ping the remote network.
4. **enable**
5. **show vpdn**
6. **show vpdn session all**
7. **show ppp mppe virtual-access** *number*

DETAILED STEPS

Step 1 Dial in to the NAS from a client PC.

Ensure that the client PC is able to connect to the NAS by establishing a dial-in connection. As the call comes in to the NAS, a LINK-3-UPDOWN message automatically appears on the NAS terminal screen. In the following example, the call comes into the NAS on asynchronous interface 14:

Example:

```
*Jan  1 21:22:18.410: %LINK-3-UPDOWN: Interface Async14, changed state to up
```

Note No **debug** commands are turned on to display this log message. This message should be displayed within 30 seconds after the client first sends the call.

If this message is not displayed by the NAS, there is a problem with the dial-in configuration.

Step 2 From the client PC, establish a PPTP connection to the tunnel server using the VPN client software.

Step 3 From the client, ping the remote network.

From the client desktop:

a) Click **Start**.
b) Choose **Run**.
c) Enter **ping** *remote-ip-address* .
d) Click **OK**.
e) Look at the terminal screen and verify that the remote network is sending ping reply packets to the client.

Step 4 **enable**

Enter this command on the tunnel server to enter privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 5 **show vpdn**

Enter this command on the tunnel server to display information about active tunnels and message identifiers. Verify that the client has established a PPTP session.

Example:

```
Router# show vpdn
% No active L2TP tunnels
% No active L2F tunnels
PPTP Tunnel and Session Information (Total tunnels=1 sessions=1)
LocID RemID Remote Name     State    Remote Address  Port  Sessions
13    13    10.1.2.41       estabd   10.1.2.41       1136  1
LocID RemID TunID Intf    Username      State   Last Chg
13    0     13    Vi3                   estabd  000030
```

Step 6 **show vpdn session all**

Enter this command for more detailed information about the VPDN session. The last line of output from the **show vpdn session all** command indicates the current status of the flow control alarm.

Example:

```
Router# show vpdn session all
% No active L2TP tunnels
% No active L2F tunnels
PPTP Session Information (Total tunnels=1 sessions=1)
Call id 13 is up on tunnel id 13
Remote tunnel name is 10.1.2.41
 Internet Address is 10.1.2.41
 Session username is unknown, state is estabd
 Time since change 000106, interface Vi3
 Remote call id is 0
 10 packets sent, 10 received, 332 bytes sent, 448 received
 Ss 11, Sr 10, Remote Nr 10, peer RWS 16
 0 out of order packets
 Flow alarm is clear.
```

Step 7 **show ppp mppe virtual-access** *number*

Enter this command to display MPPE information for the virtual access interface:

Example:

```
Router# show ppp mppe virtual-access 3
Interface Virtual-Access3 (current connection)
  Hardware (ISA5/1, flow_id=13) encryption, 40 bit encryption, Stateless mode
  packets encrypted = 0        packets decrypted  = 1
  sent CCP resets   = 0        receive CCP resets = 0
  next tx coherency = 0        next rx coherency  = 0
  tx key changes    = 0        rx key changes     = 0
  rx pkt dropped    = 0        rx out of order pkt= 0
  rx missed packets = 0
```

To display changed information, reissue the command:

Example:

```
Router# show ppp mppe virtual-access 3
Interface Virtual-Access3 (current connection)
  Hardware (ISA5/1, flow_id=13) encryption, 40 bit encryption, Stateless mode
  packets encrypted = 0        packets decrypted  = 1
  sent CCP resets   = 0        receive CCP resets = 0
  next tx coherency = 0        next rx coherency  = 0
  tx key changes    = 0        rx key changes     = 1
  rx pkt dropped    = 0        rx out of order pkt= 0
```

rx missed packets = 0

Configuration Examples for Client-Initiated VPDN Tunneling

Example Configuring L2TP Client-Initiated Tunneling

The following example configures L2TP client-initiated tunneling on the local peer and the tunnel server. This configuration is for L2TP tunnels.

Local Peer Configuration

```
l2tp-class l2tpclass1
!
pseudowire-class pwclass1
 encapsulation l2tpv2
 protocol l2tpv2 l2tpclass1
 ip local interface ethernet0/0
!
interface virtual-ppp 1
 ip unnumbered loopback1
 ppp authentication chap
 ppp chap hostname peer1
 pseudowire 172.24.13.196 10 pw-class pwclass1
!
ip route 10.10.10.0 255.255.255.0 virtual-PPP 1
```

Tunnel Server Configuration

```
vpdn-group l2tpgroup1
 accept-dialin
  protocol l2tp
  virtual-template 1
 terminate-from hostname peer1
!
interface virtual-template 1
 ip unnumbered loopback 1
 ppp authentication chap
 ppp chap hostname peer2
```

Example Configuring L2TPv3 Client-Initiated Tunneling

The following example configures L2TP client-initiated tunneling on the local peer and tunnel server. This configuration is for L2TPv3 tunnels.

Local Peer Configuration

```
l2tp-class l2tpclass1
!
pseudowire-class pwclass1
 encapsulation l2tpv3
 protocol l2tpv3 l2tpclass1
 ip local interface ethernet0/0
!
interface virtual-ppp 1
 ip unnumbered loopback1
 ppp authentication chap
 ppp chap hostname peer1
 pseudowire 172.24.13.196 15 pw-class pwclass1
!
ip route 10.10.10.0 255.255.255.0 virtual-PPP 1
```

Tunnel Server Configuration

```
l2tp-class l2tpclass2
!
pseudowire-class pwclass2
 encapsulation l2tpv3
 protocol l2tpv3 l2tpclass2
 ip local interface ethernet0/1
!
interface virtual-ppp 2
 ip unnumbered loopback 1
 ppp authentication chap
 ppp chap hostname peer2
 pseudowire 172.16.32.24 15 pw-class pwclass2
!
ip route 10.20.20.0 255.255.255.0 virtual-PPP 1
```

Example Verifying an L2TP Control Channel

The following output displays detailed information the L2TP control channels that are set up to other L2TP-enabled devices for all L2TP sessions on the router:

```
Router# show l2tun session all
Session Information Total tunnels 0 sessions 1
Session id 111 is up, tunnel id 0
Call serial number is 0
Remote tunnel name is
  Internet address is 2.0.0.1
  Session is manually signalled
  Session state is established, time since change 00:06:05
    0 Packets sent, 0 received
    0 Bytes sent, 0 received
    Receive packets dropped:
      out-of-order:             0
      total:                    0
    Send packets dropped:
      exceeded session MTU:     0
      total:                    0
  Session vcid is 123
Session Layer 2 circuit, type is ATM VPC CELL, name is ATM3/0/0:1000007
Circuit state is UP
    Remote session id is 222, remote tunnel id 0
  DF bit off, ToS reflect disabled, ToS value 0, TTL value 255
  Session cookie information:
    local cookie, size 8 bytes, value 00 00 00 00 00 00 00 64
    remote cookie, size 8 bytes, value 00 00 00 00 00 00 00 C8
  SSS switching enabled
Sequencing is off
```

Example Configuring Client-Initiated VPDN Tunneling Using PPTP

The following example shows the configuration of a tunnel server for client-initiated VPDN tunneling with the PPTP protocol using an ISA card to perform stateless MPPE encryption:

```
vpdn-group pptp1
accept-dialin
  protocol pptp
  virtual-template 1
 local name cisco_pns
!
interface virtual-template 1
 ip unnumbered FastEthernet 0/0
 peer default ip address pool mypool
 encapsulation ppp
 ppp authentication ms-chap
 ppp encrypt mppe auto
!
controller ISA 5/0
 encryption mppe
```

Where to Go Next

You can perform any of the relevant optional tasks in the Configuring Additional VPDN Features and in the VPDN Tunnel Management modules.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
VPDN technology overview	VPDN Technology Overview module
Information about virtual templates	Configuring Virtual Template Interfaces module
Dial Technologies commands	*Cisco IOS Dial Technologies Command Reference*
Technical support documentation for L2TP	*Layer 2 Tunnel Protocol (L2TP)*
Technical support documentation for PPTP	*Point to Point Tunneling Protocol (PPTP)*
Technical support documentation for VPDNs	*Virtual Private Dial-Up Network (VPDN)*

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
• CISCO-VPDN-MGMT-MIB • CISCO-VPDN-MGMT-EXT-MIB	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 2637	Point-to-Point Tunneling Protocol (PPTP)
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 Client-Initiated VPDN Tunneling

The following table provides release information about the feature or features described in this module. This table 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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 10: Feature Information for Client-Initiated VPDN Tunneling

Feature Name	Software Releases	Feature Configuration Information
L2TP Client-Initiated Tunneling	12.3(2)T	This feature introduces the ability to establish client-initiated L2TP tunnels. The client can initiate an L2TP or L2TPv3 tunnel to the tunnel server without the intermediate NAS participating in tunnel negotiation or establishment. The following commands were introduced or modified by this feature: **authentication** (L2TP), **encapsulation** (L2TP), **hello**, **hidden**, **hostname** (L2TP), **interface virtual-ppp**, **ip dfbit set**, **ip local interface**, **ip pmtu**, **ip protocol**, **ip tos** (L2TP), **ip ttl**, **l2tp-class**, **password** (L2TP), **protocol** (L2TP), **pseudowire**, **pseudowire-class**, **receive-window**, **retransmit**, **sequencing**, **timeout setup**.

CHAPTER 5

Configuring Multihop VPDN

Multihop virtual private dialup networking (VPDN) is a specialized VPDN configuration that allows packets to pass through multiple tunnels. Ordinarily, packets are not allowed to pass through more than one tunnel. In a multihop deployment, the VPDN tunnel is terminated after each hop and a new tunnel is initiated to the next hop destination.

Multihop VPDN deployments are required when the remote private network uses Multichassis Multilink PPP (MMP) with multiple tunnel servers in a stack group.

Multihop VPDN deployments can also be used to configure a device as a tunnel switch. A tunnel switch acts as both a network access server (NAS) and a tunnel server, able to receive packets from an incoming VPDN tunnel and send them out over an outgoing VPDN tunnel. Tunnel switch configurations can be used between Internet service providers (ISPs) to provide wholesale VPDN services.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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 table at the end of this module.

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

Prerequisites for Multihop VPDN

Before you configure multihop VPDN, a VPDN deployment must be configured. For more information about VPDN deployments that are compatible with multihop VPDN scenarios, see the Configuring an MMP Stack Group for Multihop VPDN, on page 188 or the Configuring a Multihop Tunnel Switch, on page 196.

Information About Multihop VPDN

Using Multihop VPDN with an MMP Stack Group

Multihop VPDN is required when a VPDN tunnel delivers Multilink PPP (MLP) data to a private network that uses an MMP stack group.

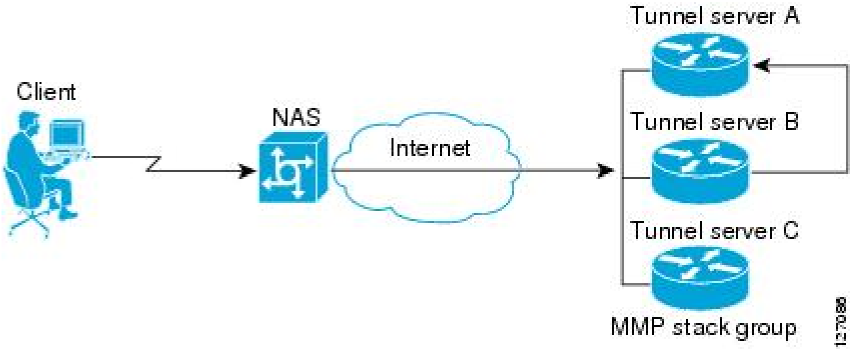
MLP provides the capability of splitting and recombining packets to a single end system across a logical pipe (also called a bundle) formed by multiple links.

MMP deployments link multiple tunnel servers in a stack group. Different members of a stack group can terminate MLP links from the same source. Stack group tunnel servers must establish Layer 2 tunnels between each other so that MLP packets from a single host can be properly recombined. If the incoming MLP data is delivered to the stack group over a VPDN tunnel, multihop VPDN is required for the stack group to function.

MMP using multihop VPDN can use only the Layer 2 Tunnel Protocol (L2TP) or Layer 2 Forwarding (L2F) protocol on the NAS and the stack group members.

The figure below shows a network scenario using a multihop VPDN with a MMP deployment.

Figure 15: MMP Using Multihop VPDN



Data from the client is tunneled from the NAS to a stack group member using either L2TP or L2F. If the client is using MLP, multiple data links can terminate on different stack members. Stack group bidding protocol (SGBP) is used to determine which stack member is the MLP bundle owner. Tunnel servers that receive calls belonging to a bundle owned by a different stack group member will forward those calls to the owner using an L2TP or L2F tunnel. Because the data must traverse two VPDN tunnels in this scenario, multihop VPDN must be enabled.

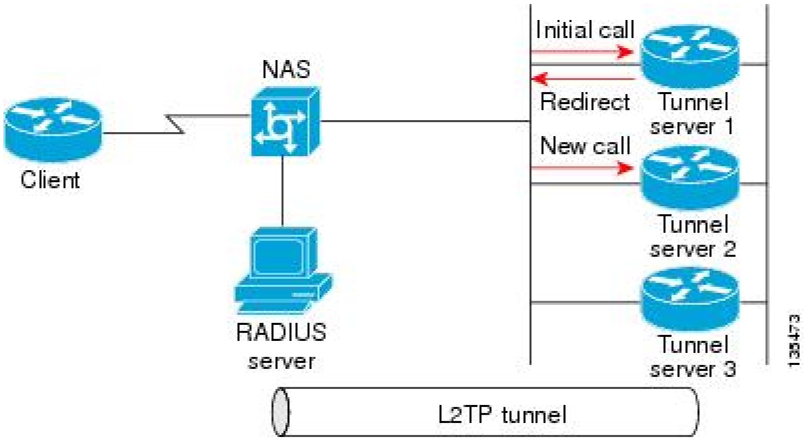
L2TP Redirect for MMP Multihop Deployments

In a traditional MMP deployment, the stack group tunnel servers use L2TP or L2F tunnels to deliver MLP links to the bundle owner. This architecture does not easily scale beyond a few routers per tunnel server stack, and inherently adds hops and latency variations between links in a bundle.

Enabling L2TP redirect allows a stack group member to send a redirect message to the NAS if it receives a link that is owned by another stack group member. L2TP redirect increases the scalability of MMP deployments, load balances sessions across the stack group tunnel servers, and smooths traffic as all links in a multilink bundle experience the same delay and latency.

The figure below shows a network scenario using L2TP redirect for an MMP deployment.

Figure 16: L2TP Redirect Scenario



When tunnel server 1 answers the initial call, SGBP bidding is performed by all stack group members to determine which device owns the call. If the call is owned by a different tunnel server, such as tunnel server 2, the call must be passed from tunnel server 1 to the owner.

In a traditional multihop SGBP deployment, tunnel server 1 would establish an L2F or L2TP tunnel to to tunnel server 2 and forward the call over that tunnel.

With L2TP redirect enabled, instead of establishing a new tunnel to tunnel server 2, tunnel server 1 sends a redirect message to the NAS informing it that tunnel server 2 actually owns the call. The NAS then tears down the initial connection to tunnel server 1 and establishes a new L2TP tunnel directly to tunnel server 2.

How L2TP Redirect Works

In a traditional SGBP multihop VPDN deployment, if a stack group member receives a call that belongs to a different stack group member, it forwards the call to the bundle owner over an L2TP or L2F tunnel. When L2TP redirect is configured, instead of forwarding the call to the bundle owner the stack group member will send a redirect message to the NAS. The redirect message includes the IP address or redirect identifier of the bundle owner. The NAS will terminate the initial connection, and initiate a new connection directly to the bundle owner.

For L2TP redirect to function, it must be enabled on both the NAS and the stack group tunnel servers. If the NAS is not configured for L2TP redirect, the tunnel server will forward the call to the bundle owner using traditional multihop technology. This maintains interoperability with non-Cisco devices and Cisco devices running older versions of Cisco IOS software.

In order to redirect the call, the NAS must perform redirect authorization for the bundle owner. If a redirect identifier has been configured on the bundle owner, the NAS uses that identifier to get redirect authorization information. Otherwise, the IP address of the bundle owner must be configured on the NAS.

Number of Redirect Attempts on the NAS

In some cases, a stack group member other than the device that answers the first call from a particular MLP bundle might win the SGBP bid for that call. The call will be redirected to the winning device, but because the call is again the first call from that MLP bundle, another SGBP bid will be triggered. In some rare instances this behavior might result in the initial call being passed from one stack group member to another as different devices win the bid each time.

By default, the NAS will redirect a particular call only three times, preventing excessive redirects. The number of redirect attempts the NAS will make can be configured to meet the needs of a particular network deployment. Once the NAS has redirected a call the configured number of times it will refuse further redirection requests, and traditional multihop forwarding will occur on the stack group.

Load Balancing Calls Using L2TP Redirect

Enabling L2TP redirect allows load balancing of calls to be performed by the stack group rather than the NAS. The stack group tunnel servers bid for each link that comes in, and those tunnel servers with the lightest load will win the bid and become the bundle owner. The managing of bids in this manner results in an even load distribution of sessions among a stack of tunnel servers.

L2TP redirect can also be used to load balance all L2TP PPP calls (not just MLP calls) across a stack group. All the NASs for a particular domain can point to a primary contact tunnel server. This primary tunnel server must have SGBP and the **sgbp ppp-forward** command configured to force it to issue a mastership query to the stack group for every PPP link. As when performing MLP load balancing, the stack group tunnel servers bid for each link that comes in, and those tunnel servers with the lightest load will win the bids. The primary tunnel server might not actually terminate any sessions; it might simply issue the mastership query, collects the bids, choose the highest one, and redirect the originating NAS to that tunnel server.

Redirect Identifier

The redirect identifier is an optional configuration that simplifies the task of configuring NASs to perform L2TP redirects. If the redirect identifier is not configured, the IP address of every tunnel server in the stack group must be configured with the **initiate-to** command on each NAS.

The redirect identifier allows new stack group members to be added without the need to update the NAS configuration with their IP addresses. With the redirect identifier configured, a new stack group member can be added and given the same redirect identifier as the rest of the stack group. If stack group members have different authorization information, unique redirect identifiers must be configured.

The redirect identifier can also be configured on a remote RADIUS server, rather than directly on the NAS. The RADIUS server can update multiple NASs with the redirect identifier information, avoiding the requirement to configure the redirect identifier on each NAS.

Redirect Source

The redirect source is an optional configuration that allows a stack group member to advertise a public IP address for L2TP redirection, rather than the IP address used for SGBP bidding. Often a stack group will use private IP addresses for stack group bidding, and these IP addresses will not be reachable by the NAS. Configuring a public IP address as the redirect source allows a stack group member to inform the NAS of the reachable IP address of another stack group member in the redirect request.

Tunnel Switching Using Multihop VPDN

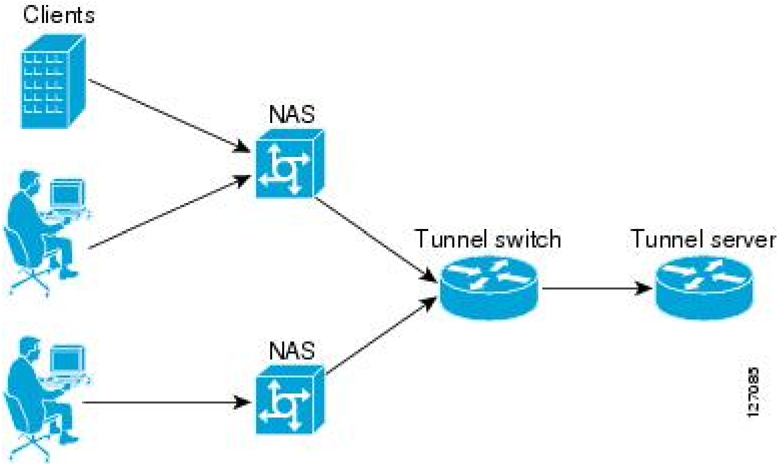
Multihop VPDN can be used to configure a device as a tunnel switch. A tunnel switch acts as both a NAS and a tunnel server, receiving packets from an incoming VPDN tunnel and sending them out over an outgoing VPDN tunnel. Tunnel switch configurations can be used between ISPs to provide wholesale VPDN services. A VPDN tunnel switch can forward L2TP, L2F, or Point-to-Point Tunneling Protocol (PPTP) sessions.

In an L2TP or L2F tunnel switching deployment, the tunnel endpoints are considered the originating NAS and the terminating tunnel server. The tunnel switch is not considered a tunnel endpoint.

In a PPTP tunnel switching deployment, the tunnel endpoints are considered the originating client device and the terminating tunnel server. The tunnel switch is not considered a tunnel endpoint.

The figure below shows a network scenario using a basic L2TP tunnel switching deployment.

Figure 17: Tunnel Switching Using Multihop VPDN



The tunnel switch can be configured to terminate incoming VPDN tunnels from multiple devices, and to initiate outgoing VPDN tunnels to one or more tunnel servers.

The Subscriber Service Switch (SSS) framework is supported for VPDN tunnel switching. SSS supports additional Layer 2 protocols, including PPP over Ethernet (PPPoE), PPP over ATM (PPPoA), and generic routing encapsulation (GRE). Configuring SSS for VPDN tunnel switching is optional. SSS profiles increase the scalability of tunnel switching configurations, particularly in multiprotocol environments.

How to Configure Multihop VPDN

Configuring an MMP Stack Group for Multihop VPDN

Multihop VPDN is required when a VPDN tunnel delivers MLP data to a private network that uses a MMP stack group.

Perform this task on each of the stack group tunnel servers to enable multihop VPDN.

Before You Begin

- MMP must be enabled, and a stack group must be configured.
- The NAS must be configured to initiate L2TP or L2F VPDN tunnels. For information on configuring the NAS to initiate L2TP or L2F VPDN tunnels, see the Configuring NAS-Initiated Dial-In Tunneling module.
- The stack group tunnel servers must be configured to accept incoming L2TP or L2F VPDN tunnels. For information on configuring the stack group tunnel servers to accept incoming L2TP or L2F VPDN tunnels, see the Configuring NAS-Initiated Dial-In Tunneling module.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn multihop**

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	**vpdn multihop** **Example:** `Router(config)# vpdn multihop`	Enables VPDN multihop.

Configuring L2TP Redirect for MMP VPDNs

Enabling L2TP redirect allows a tunnel server in a stack group to send a redirect message to the NAS if it receives a link that belongs to another tunnel server in the stack group. L2TP redirect increases the scalability of MMP deployments. Because all links in a multilink bundle will travel directly to the bundle master after redirection they will experience the same delays and latency, resulting in smoother traffic.

L2TP redirect can be used to load balance both MLP and PPP calls across a stack group.

Perform these tasks to configure L2TP redirect:

Prerequisites for Configuring L2TP Redirect

- The NAS and tunnel servers must be Cisco equipment.
- MMP must be enabled, and a stack group must be configured.
- The NAS and the stack group tunnel servers must be configured for L2TP VPDN tunneling. For configuration information, see the Configuring NAS-Initiated Dial-In VPDN Tunneling module.
- Multihop VPDN must be enabled on the stack group members. To enable multihop VPDN on the stack group, perform the task in the Configuring an MMP Stack Group for Multihop VPDN section.

Restrictions for Configuring L2TP Redirect

- Only the L2TP tunneling protocol is supported.
- L2TP redirect capability is supported only for stack group deployments.

Enabling L2TP Redirect

For the redirection of calls to occur, L2TP redirect must be enabled on the NAS and on each participating tunnel server.

Perform this task to enable L2TP redirect on all participating devices and to optionally set the number of allowed redirect attempts on the NAS.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn redirect**
4. **vpdn redirect attempts** *number-of-attempts*

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	**vpdn redirect** **Example:** `Router(config)# vpdn redirect`	Enables L2TP redirect functionality on a NAS or tunnel server.
Step 4	**vpdn redirect attempts** *number-of-attempts* **Example:** `Router(config)# vpdn redirect attempts 5`	(Optional) Restricts the number of redirect attempts possible for a given L2TP call on the NAS. • *number-of-attempts* --The number of redirect attempts. Valid values range from 1 to 20. The default value is 3. • If you do not issue this command, the default value for *number-of-attempts* will be applied. **Note** This command is used only on the NAS.

What to Do Next

You must perform the task in the Enabling Multihop VPDN on the NAS section.

Enabling Multihop VPDN on the NAS

Because redirected packets will pass through multiple VPDN tunnels, multihop must be enabled on the NAS for L2TP redirect to function.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn multihop**

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	**vpdn multihop** **Example:** `Router(config)# vpdn multihop`	Enables VPDN multihop on the NAS.

Configuring the Redirect Identifier on the NAS

The L2TP redirect identifier is an optional configuration that simplifies the task of configuring the NAS for L2TP redirect. The redirect identifier can be configured directly on the NAS, or on the remote RADIUS server. Configuring the redirect identifier on the remote RADIUS server allows it to be propagated to multiple NASs without having to configure each NAS directly.

Perform this task to configure the redirect identifier directly on the NAS.

To configure the redirect identifier on the RADIUS server, perform the task in the Configuring the Redirect Identifier on the RADIUS Server, on page 192 instead.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **redirect identifier** *identifier-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and to enters VPDN group configuration mode.
Step 4	**redirect identifier** *identifier-name* **Example:** `Router(config-vpdn)# redirect identifier stack1`	Configures a VPDN redirect identifier to use for L2TP call redirection on a NAS. **Note** The redirect identifier configured on the NAS must match the redirect identifier configured on the stack group tunnel servers. **Note** If stack group members have different authorization information, unique redirect identifiers must be configured for each.

What to Do Next

You must perform the task in the Configuring the Redirect Identifier on the Stack Group Tunnel Servers, on page 193.

Configuring the Redirect Identifier on the RADIUS Server

The L2TP redirect identifier is an optional configuration that simplifies the task of configuring the NAS for L2TP redirect. The redirect identifier can be configured directly on the NAS, or on the remote RADIUS server. Configuring the redirect identifier on the remote RADIUS server allows it to be propagated to multiple NASs without having to configure each one.

Perform this task to configure the redirect identifier in the RADIUS server profile.

To configure the redirect identifier directly on a NAS, perform the task in the“Configuring the Redirect Identifier on the NAS, on page 191 instead.

SUMMARY STEPS

1. **:0:" vpdn:vpdn-redirect-id =** *identifier-name* **"**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**:0:" vpdn:vpdn-redirect-id =** *identifier-name* **"** **Example:** `:0:"vpdn:vpdn-redirect-id = stack1"`	Configures the redirect identifier in the RADIUS profile. • To avoid having to configure multiple NASs, update the RADIUS profile so that the RADIUS server automatically updates the configurations of the multiple NASs. • Refer to your vendor-specific RADIUS configuration documentation for specific instructions on updating the RADIUS profile. **Note** The redirect identifier configured in the RADIUS profile must match the redirect identifier configured on the stack group tunnel servers. **Note** If stack group members have different authorization information, unique redirect identifiers must be configured for each.

What to Do Next

You must perform the task in the Configuring the Redirect Identifier on the Stack Group Tunnel Servers, on page 193.

Configuring the Redirect Identifier on the Stack Group Tunnel Servers

The redirect identifier is an optional configuration that simplifies the task of configuring the NAS for L2TP redirect. The redirect identifier must be configured on each member of the stack group.

Perform this task on each stack group tunnel server to configure the redirect identifier.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn redirect identifier** *identifier-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn redirect identifier** *identifier-name* **Example:** `Router(config)# vpdn redirect identifier stack1`	Configures a VPDN redirect identifier to use for L2TP call redirection on a stack group tunnel server. **Note** The redirect identifier configured on the stack group members must match the redirect identifier configured on the NAS or in the RADIUS profile. **Note** If stack group members have different authorization information, unique redirect identifiers must be configured for each.

Configuring the Redirect Source on the Stack Group Tunnel Servers

The redirect source is an optional configuration that allows a stack group member to advertise a public IP address for L2TP redirect, rather than the default IP address. The default IP address is that used for SGBP bidding. If your stack group uses private IP addresses for SGBP bidding, you must configure the redirect source for each tunnel server in the stack. Otherwise the NAS will be redirected to the default IP address, which will be unreachable.

Perform this task on each stack group tunnel server to configure the redirect source.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn redirect source** *redirect-ip-address*

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	**vpdn redirect source** *redirect-ip-address* **Example:** `Router(config)# vpdn redirect source 10.1.1.1`	Configures the public redirect IP address of a tunnel server.

Monitoring L2TP Redirect Configurations

The number of L2TP sessions that were redirected or forwarded using traditional multihop technology can be monitored. Statistics are maintained on both the NAS and the tunnel servers.

Perform this task on the NAS or a tunnel server to examine L2TP redirect statistics.

SUMMARY STEPS

1. **enable**
2. **show vpdn redirect**
3. **clear vpdn redirect**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show vpdn redirect**

Enter this command to display statistics for all L2TP call redirects and forwards. The display shown in this example is from a tunnel server that redirected four calls using L2TP redirect, and forwarded two calls using traditional multihop VPDN.

Example:

```
Router# show vpdn redirect
‘vpdn redirection enabled’
‘sessions redirected as access concentrator: 4’
‘sessions redirected as network server: 0’
‘sessions forwarded: 2’
```

Step 3 **clear vpdn redirect**

Enter this command to clear the counters for the **show vpdn redirect** command.

Example:

```
Router# clear vpdn redirect
```

Configuring a Multihop Tunnel Switch

Multihop VPDN can be used to configure a device as a tunnel switch. A tunnel switch acts as both a NAS and a tunnel server, and must be configured with both a NAS VPDN group and a tunnel server VPDN group.

Tunnel switching using the SSS infrastructure is supported. SSS allows L2TP, L2F, PPTP, PPPoE, PPPoA, GRE, and general packet radio service (GPRS) sessions to be switched over virtual links using a tunnel switch. SSS configurations are not required for tunnel switching data over L2TP, L2F, or PPTP tunnels, but SSS increases the scalability of tunnel switching deployments .

A multihop VPDN tunnel switch can be configured to forward L2TP, L2F, or PPTP tunnels.

Perform these tasks to configure a device as a multihop VPDN tunnel switch:

Prerequisites for Configuring a Multihop Tunnel Switch

- The tunnel endpoints must be configured for VPDN tunneling as described in the Configuring Client-Initiated Dial-In VPDN Tunneling or in the Configuring NAS-Initiated Dial-IN VPDN Tunneling module.
- If you want to perform VPDN tunnel authorization searches based on the multihop hostname, you must configure the search to use the multihop hostname as described in the Configuring the VPDN Tunnel Authorization Search Order section of the Configuring AAA for VPDNs module.

Restrictions for Configuring a Multihop Tunnel Switch

Tunnel switching based on dialed number identification service (DNIS) numbers or multihop hostnames is supported only in Cisco IOS Release 12.2(13)T and later releases.

Enabling Multihop VPDN on the Tunnel Switch

In tunnel switching deployments, packets must traverse multiple tunnels. Multihop VPDN must be enabled on the tunnel switch for the deployment to function.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn multihop**

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	**vpdn multihop** **Example:** `Router(config)# vpdn multihop`	Enables VPDN multihop.

What to Do Next

You must perform the task in the Configuring the Multihop Tunnel Switch to Terminate Incoming VPDN Tunnels, on page 197.

Configuring the Multihop Tunnel Switch to Terminate Incoming VPDN Tunnels

A tunnel switch must be configured as a tunnel server, allowing it to terminate incoming VPDN tunnels. You can configure a tunnel switch to terminate tunnels from multiple devices.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **accept-dialin**
6. **protocol** {**any** | **l2f** | **l2tp** | **pptp**}
7. **virtual-template** *number*
8. **exit**
9. **terminate-from hostname** *host-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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and to enters VPDN group configuration mode.
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description myvpdngroup`	(Optional) Adds a description to a VPDN group.
Step 5	**accept-dialin** **Example:** `Router(config-vpdn)# accept-dialin`	Configures a tunnel switch to accept requests from a NAS to establish a tunnel, creates an accept-dialin VPDN subgroup, and enters VPDN accept dial-in subgroup configuration mode.

Step 6	**protocol** {**any** | **l2f** | **l2tp** | **pptp**}
	Example:
	`Router(config-vpdn-acc-in)# protocol l2tp`
		Specifies the Layer 2 protocol that the VPDN group will use.
		• The **any** keyword can be used to specify that L2TP, L2F, and PPTP tunnels can be switched.

Step 7	**virtual-template** *number* **Example:** `Router(config-vpdn-acc-in)# virtual-template 1`	(Optional) Specifies which virtual template will be used to clone virtual access interfaces. This step is not required if the virtual access interface is not going to be cloned when a user connects.
Step 8	**exit** **Example:** `Router(config-vpdn-acc-in)# exit`	Exits to VPDN group configuration mode.

	Command or Action	Purpose
Step 9	**terminate-from hostname** *host-name* **Example:** `Router(config-vpdn)# terminate-from hostname NAS12`	Specifies the hostname of the remote NAS that will be required when accepting a VPDN tunnel.

What to Do Next

You must perform the task in the Configuring the Multihop Tunnel Switch to Initiate Outgoing VPDN Tunnels, on page 199.

Configuring the Multihop Tunnel Switch to Initiate Outgoing VPDN Tunnels

A tunnel switch must be configured as a NAS, allowing it to initiate outgoing VPDN tunnels. You can configure a tunnel switch to initiate tunnels to multiple devices.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **request-dialin**
6. **protocol** {**any** | **l2f** | **l2tp** | **pptp**}
7. Do one of the following:
   - **domain** *domain-name*
   - **dnis** {*dnis-number* | *dnis-group-name*}
   - **multihop-hostname** *ingress-tunnel-name*
8. **exit**
9. **initiate-to ip** *ip-address* [**limit** *limit-number*] [**priority** *priority-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description myvpdngroup`	(Optional) Adds a description to a VPDN group.
Step 5	**request-dialin** **Example:** `Router(config-vpdn)# request-dialin`	Configures a tunnel switch to request the establishment of a tunnel to a tunnel server, creates a request-dialin VPDN subgroup, and enters VPDN request dial-in subgroup configuration mode.

Step 6	**protocol** {**any** | **l2f** | **l2tp** | **pptp**}
	Example:
	`Router(config-vpdn-req-in)# protocol l2tp`
		Specifies the Layer 2 protocol that the VPDN group will use.
		• The **any** keyword can be used to specify that L2TP, L2F, and PPTP tunnels can be switched.

Step 7	Do one of the following: • **domain** *domain-name* • **dnis** {*dnis-number* | *dnis-group-name*} • **multihop-hostname** *ingress-tunnel-name* **Example:** `Router(config-vpdn-req-in)# domain company.com`	Requests that PPP calls from a specific domain name be tunneled. or Requests that PPP calls from a specific DNIS number or DNIS group be tunneled. or Enables the tunnel switch to initiate a tunnel based on the NAS host name or the ingress tunnel ID. **Note** If you use the **multihop-hostname** command to configure your tunnel switch, you must configure **vpdn search-order** command with the **multihop-hostname** keyword. For more information on configuring the VPDN tunnel authorization search order, see the “Configuring AAA for VPDNs” module.

	Command or Action	Purpose

	Example:
	`Router(config-vpdn-req-in)# dnis 5687`
	Example:
	`Router(config-vpdn-req-in)# multihop-hostname nas1`	

Step 8	**exit** **Example:** `Router(config-vpdn-req-in)# exit`	Exits to VPDN group configuration mode.
Step 9	**initiate-to ip** *ip-address* [**limit** *limit-number*] [**priority** *priority-number*] **Example:** `Router(config-vpdn)# initiate-to ip 10.1.1.1 limit 12`	Specifies an IP address that will be used for Layer 2 tunneling. • These options are available for this command: • **limit**--Maximum number of connections that can be made to this IP address. • **priority**--Priority for this IP address. **Note** The **priority** keyword is typically not configured on a tunnel switch. Information used for load balancing and failover is configured on a remote authentication, authorization, and accounting (AAA) server instead. For configuration information, see the “Configuring L2TP Tunnel Server Load Balancing and Failover on the NAS Remote RADIUS AAA Server” section in the “Configuring AAA for VPDNs” module. • Multiple tunnel servers can be configured on the tunnel switch by configuring multiple **initiate-to** commands.

Configuration Examples for Multihop VPDN

Example Configuring Multihop VPDN on an MMP Stack Group

The following example configures a stack group and a NAS for dial-in L2F VPDN tunneling with multihop VPDN enabled:

Tunnel Server A Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop VPDN
vpdn multihop
!
!Configure the tunnel server to accept L2F tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2f
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelserverb 10.1.1.2
sgbp member tunnelserverc 10.1.1.3
```

Tunnel Server B Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop VPDN
vpdn multihop
!
!Configure the tunnel server to accept L2F tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2f
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelservera 10.1.1.1
sgbp member tunnelserverc 10.1.1.3
```

Tunnel Server C Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop VPDN
vpdn multihop
!
!Configure the tunnel server to accept L2F tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2f
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelservera 10.1.1.1
sgbp member tunnelserverb 10.1.1.2
```

NAS Configuration

```
!Enable VPDN
vpdn enable
!
!Configure the NAS to initiate L2TP tunnels
vpdn-group group1
 request-dialin
  protocol l2tp
  domain cisco.com
!
!Configure the NAS with the IP address of each tunnel server in the stack group
 initiate-to ip 10.1.1.1
 initiate-to ip 10.1.1.2
 initiate-to ip 10.1.1.3
```

Example Configuring L2TP Redirect

The following example configures a stack group and a NAS for dial-in L2TP VPDN tunneling and enables basic L2TP redirect:

Tunnel Server A Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelserverb 10.1.1.2
sgbp member tunnelserverc 10.1.1.3
```

Tunnel Server B Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelservera 10.1.1.1
sgbp member tunnelserverc 10.1.1.3
```

Tunnel Server C Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelservera 10.1.1.1
sgbp member tunnelserverb 10.1.1.2
```

NAS Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop VPDN
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the NAS to initiate L2TP tunnels
vpdn-group group1
 request-dialin
  protocol l2tp
  domain cisco.com
!
!Configure the NAS with the IP address of each tunnel server in the stack group
 initiate-to ip 10.1.1.1
 initiate-to ip 10.1.1.2
 initiate-to ip 10.1.1.3
```

Example Configuring L2TP Redirect with a Redirect Identifier

The following example configures the NAS and stack group tunnel servers for L2TP redirect using a redirect identifier:

Tunnel Server A Configuration

```
!Enable VPDN
```

```
vpdn enable
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelserverb 10.1.1.2
sgbp member tunnelserverc 10.1.1.3
!
!Configure the redirect identifier
vpdn redirect identifier stack1
```

Tunnel Server B Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels from the NAS
vpdn-group group1
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelservera 10.1.1.1
sgbp member tunnelserverc 10.1.1.3
!
!Configure the redirect identifier
vpdn redirect identifier stack1
```

Tunnel Server C Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels from the NAS
vpdn-group group1
```

```
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group mystack
sgbp member tunnelservera 10.1.1.1
sgbp member tunnelserverb 10.1.1.2
!
!Configure the redirect identifier
vpdn redirect identifier stack1
```

NAS Configuration

```
!Enable VPDN
vpdn enable
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the NAS to initiate L2TP tunnels
vpdn-group group1
 request-dialin
  protocol l2tp
  domain cisco.com
!
!Configure the NAS with the redirect identifier
 redirect identifier stack1
```

Example Configuring Redirect Identifiers on the RADIUS Server

The following example shows the RADIUS server profile configured with three unique redirect identifiers for stack group members with unique authentication requirements. Each stack group member must be configured with the corresponding unique redirect identifier. When the NAS receives a redirect request containing the redirect identifier of the owner of the call, it can look up the proper authentication information in the RADIUS profile associated with that redirect identifier.

```
cisco.com Password = "cisco"
       Tunnel-Type = :0:L2TP,
       Tunnel-Medium-Type = :0:IP,
       Tunnel-Server-Endpoint = :0:"10.1.1.1",
       Cisco:Cisco-Avpair = :0:"vpdn:vpdn-redirect-id=ts1",
       Tunnel-Type = :1:L2TP,
       Tunnel-Medium-Type = :1:IP,
       Tunnel-Server-Endpoint = :1:"10.1.1.2",
       Cisco:Cisco-Avpair = :1:"vpdn:vpdn-redirect-id=ts2"
       Tunnel-Type = :2:L2TP,
       Tunnel-Medium-Type = :1:IP,
       Tunnel-Server-Endpoint = :1:"10.1.1.3",
       Cisco:Cisco-Avpair = :1:"vpdn:vpdn-redirect-id=ts3"
```

Example Configuring the Redirect Source on a Stack Group Tunnel Server

The following example configures one member of a stack group to accept dial-in L2TP VPDN tunnels and enables L2TP redirect using a redirect source IP address:

```
!Enable VPDN
vpdn enable
```

```
!
!Enable multihop to ensure interoperability with devices that are not capable of !performing
 L2TP redirect.
vpdn multihop
!
!Enable L2TP redirect
vpdn redirect
!
!Configure the tunnel server to accept L2TP tunnels
vpdn-group group1
 accept-dialin
  protocol l2tp
  virtual-template 1
  exit
 terminate-from 172.18.32.139
!
!Configure the tunnel server as a stack group member
username user1 password mypassword
sgbp group stack1
sgbp member tunnelserverb 10.1.1.2
sgbp member tunnelserverc 10.1.1.3
!
!Configure the redirect source
vpdn redirect source 172.23.1.1
```

Example Configuring Multihop VPDN Tunnel Switching

The following example configures a NAS, tunnel switch, and tunnel server to establish a multihop VPDN tunnel using L2TP:

NAS Configuration

```
! Configure the NAS to initiate VPDN dial-in sessions to the tunnel switch
vpdn-group 1
 request-dialin
  protocol l2tp
  domain cisco.com
!
 initiate-to ip 172.22.66.25
 local name ISP-NAS
```

Tunnel Switch Configuration

```
!Enable VPDN
vpdn enable
!
!Enable multihop
vpdn multihop

!

! Configure the tunnel switch to use the multihop hostname in the authentication search.

 vpdn search-order multihop-hostname domain dnis

!

! Configure the tunnel switch to accept dial-in sessions from the NAS
vpdn-group tunnelin
 accept-dialin
  protocol l2tp
  virtual-template 1
!
 terminate-from hostname ISP-NAS
 local name ISP-Sw
!
```

```
! Configure the tunnel switch to initiate VPDN dial-in sessions to the tunnel server
vpdn-group tunnelout
 request-dialin
  protocol l2tp
  multihop-hostname ISP-NAS
!
 initiate-to ip 10.2.2.2
 local name ISP-Sw
```

Tunnel Server Configuration

```
! Configure the tunnel server to accept dial-in sessions from the NAS
vpdn-group 1
 accept-dialin
  protocol l2tp
  virtual-template 1
!
 terminate-from hostname ISP-Sw
 local name ENT-TS
```

Where to Go Next

You can perform any of the relevant optional tasks in the Configuring Additional VPDN Features and in the VPDN Tunnel Management modules.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
VPDN technology overview	VPDN Technology Overview module
Information about Multichassis Multilink PPP	Implementing Multichassis Multilink PPP module
Information about virtual templates	Configuring Virtual Template Interfaces module
Dial Technologies commands	*Cisco IOS Dial Technologies Command Reference*
Information about SSS	Configuring a Cisco Subscriber Service Switch Policy module
Broadband access aggregation and DSL command: complete command syntax, command mode, defaults, usage guidelines, and examples	*Cisco IOS Broadband Access Aggregation and DSL Command Reference*

Standards

Standard	Title
None	--

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 2341	Cisco Layer Two Forwarding (Protocol) L2F
RFC 2661	*Layer Two Tunneling Protocol L2TP*

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 Multihop VPDN

The following table provides release information about the feature or features described in this module. This table 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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 11: Feature Information for Multihop VPDN

Feature Name	Software Releases	Feature Configuration Information
L2TP Redirect	12.2(13)T	This feature allows a tunnel server participating in SGBP to send a redirect message to the NAS if another stack group member wins the SGBP bid. The NAS will then reinitiate the call to the newly redirected tunnel server. The following commands were introduced by this feature: **clear vpdn redirect**, **show vpdn redirect**, **vpdn redirect**, **vpdn redirect attempts**, **vpdn redirect identifier**, **vpdn redirect source**.
Subscriber Service Switch	12.2(13)T	This feature provides flexibility on where and how many subscribers are connected to available services and how those services are defined. The primary focus of SSS is to direct PPP from one point to another using a Layer 2 subscriber policy. The policy will manage tunneling of PPP in a policy-based bridging fashion. The following VPDN commands were introduced or modified by this feature: **multihop-hostname**, **vpdn search-order**.
VPDN Multihop by DNIS	12.2(13)T	This feature allows DNIS-based multihop capability for VPDNs. The following commands were introduced or modified by this feature: **vpdn multihop**, **vpdn search-order**.

CHAPTER 6

Configuring Additional VPDN Features

This module documents concepts and tasks associated with configuring the following additional virtual private dialup network (VPDN) features:

- The following optional feature can be configured in isolation, or in combination with a dial-in VPDN deployment:
  - L2TP dial-out VPDNs
- The following optional features are used in combination with a VPDN deployment, and require that a VPDN deployment is first configured:
  - L2TP Security for the Protection of VPDN Tunnels
  - VPDN Template
  - VPDN Source IP Address
  - VRF-Aware VPDN Tunnels
  - MTU Tuning for L2TP VPDN Tunnels
  - QoS for VPDN Tunnels
  - VPDN Group Selection

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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 table at the end of this module.

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

Information About Configuring Additional VPDN Features

L2TP Dial-Out VPDNs

Dial-out VPDN configurations allow the tunnel server to tunnel outbound calls to the network access server (NAS). The NAS must establish a connection with the remote destination using a medium that supports PPP. Dial-out VPDNs allow a centralized network to efficiently and inexpensively establish virtual point-to-point connections with any number of remote offices.

Dial-out VPDNs are supported with only Layer 2 Tunnel Protocol (L2TP). Cisco routers can carry both dial-in and dial-out calls in the same L2TP tunnel.

In an L2TP dial-out deployment, the tunnel server receives PPP packets from it’s local network to send to a remote network or device. The tunnel server initiates establishment of an L2TP tunnel with the NAS, and the NAS terminates the tunnel. The NAS must then establish a connection to the client.

L2TP Dial-Out Connection Establishment

This sequence of events occurs during session establishment:

1. The tunnel server receives PPP packets and forwards them to its dialer interface. The dialer interface can be either a dialer profile dialer pool or dial-on-demand routing (DDR) rotary group. The dialer issues a dial call request to the VPDN group, and the tunnel server creates a virtual access interface. If the dialer is a dialer profile, this interface becomes a member of the dial pool. If the dialer is DDR, the interface becomes a member of the rotary group. The VPDN group creates a VPDN session for this connection and sets it in the pending state.
2. The tunnel server and NAS establish an L2TP tunnel (unless a tunnel is already open) by exchanging Start Control Connection Request (SCCRQ) and Start Control Connection Reply (SCCRP) messages.
3. The tunnel server sends an Outgoing Call Request (OCRQ) packet to the NAS, which checks if it has a dial resource available. If the resource is available, the NAS responds to the tunnel server with an Outgoing Call Reply (OCRP) packet. If the resource is not available, the NAS responds with a Call Disconnect Notification (CDN) packet, and the session is terminated.
4. If the NAS has an available resource, it creates a VPDN session and sets it in the pending state.
5. The NAS then initiates a call to the PPP client. When the NAS call connects to the PPP client, the NAS binds the call interface to the appropriate VPDN session.

6 The NAS sends an Outgoing Call Connected (OCCN) packet to the tunnel server. The tunnel server binds the call to the appropriate VPDN session and then brings the virtual access interface up.

7 The dialer on the tunnel server and the PPP client can now exchange PPP packets. The NAS acts as a transparent packet forwarder.

If the dialer interface is a DDR and a virtual profile is configured, the PPP endpoint is the tunnel server virtual access interface, not the dialer. All Layer 3 routes point to this interface instead of to the dialer.

L2TP Dial-Out Load Balancing and Redundancy

In Cisco IOS software prior to Release 12.2(15)T or 12.2(28)SB, load balancing and redundancy for dial-out VPDNs could be configured only with L2TP large-scale dial-out (LSDO) using Stack Group Bidding Protocol (SGBP). This method of load balancing and redundancy requires that the primary NAS is up and running for dial-out to take place, because the IP address of only that NAS is configured on the tunnel server. When the primary NAS is down, no dial-out can take place. When the primary NAS is up, the NAS determines among itself and the secondary NASs which NAS has the least congestion, and then inform the tunnel server to use the selected NAS for dial-out. Because the tunnel server cannot contact any other NASs when the primary NAS is down, failover is not supported for dial-out calls by this mechanism .

The ability to configure a tunnel server with the IP addresses of multiple NASs was introduced in Cisco IOS Release 12.2(15)T and Cisco IOS Release 12.2(28)SB. Load balancing, redundancy, and failover can all be controlled by assigning each NAS the desired priority settings on the tunnel server. Load balancing occurs between NASs with identical priority settings. When NASs are assigned different priority settings, if the NAS with the highest priority goes down the tunnel server will fail over to a lower priority NAS.

L2TP Security for the Protection of VPDN Tunnels

L2TP security provides enhanced security for tunneled PPP frames by allowing the robust security features of IP Security (IPSec) to protect the L2TP VPDN tunnel and the PPP sessions within the tunnel. Without L2TP security, only a one-time, optional mutual authentication is performed during tunnel setup, with no authentication of subsequent data packets or control messages.

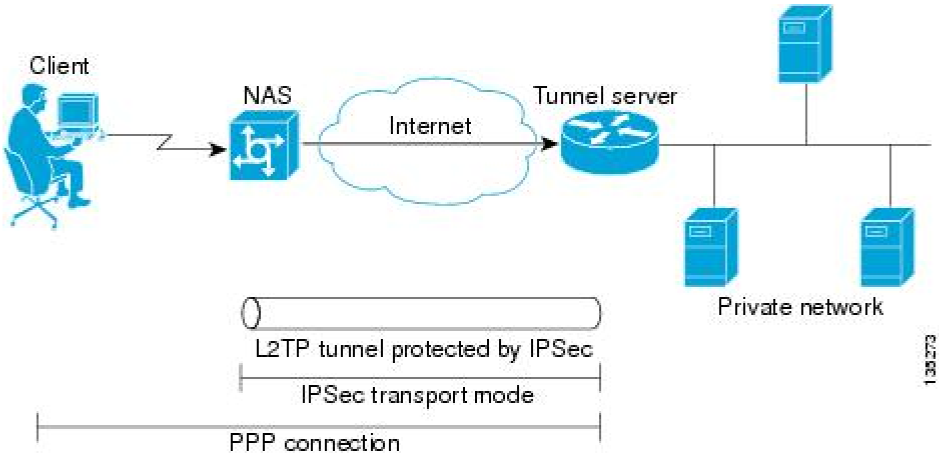
The deployment of Microsoft Windows 2000 demands the integration of IPSec with L2TP because this is the default VPDN networking scenario. This integration of protocols is also used for LAN-to-LAN VPDN connections in Microsoft Windows 2000. L2TP security provides integration of IPSec with L2TP in a solution that is scalable to large networks with minimal configuration.

The enhanced protection provided by L2TP security increases the integrity and confidentiality of tunneled PPP sessions within a standardized, well-deployed Layer 2 tunneling solution. The security features of IPSec and Internet Key Exchange (IKE) include confidentiality, integrity checking, replay protection, authentication, and key management. Traditional routing protocols such as Routing Information Protocol (RIP), Open Shortest Path First (OSPF), and Interior Gateway Routing Protocol (IGRP) will run transparently because a real PPP interface is associated with the secure tunnel. Additional benefits include built in keepalives and standardized interfaces for user authentication and accounting to authentication, authorization, and accounting (AAA) servers, interface statistics, standardized MIBs, and multiprotocol support.

L2TP Security with NAS-Initiated VPDN Tunnels

L2TP security can be configured to protect VPDN tunnels between the NAS and the tunnel server in NAS-initiated VPDN deployments. A NAS-initiated tunneling scenario with L2TP security protection is depicted in the figure below.

Figure 18: L2TP Security for a NAS-Initiated Tunneling Scenario

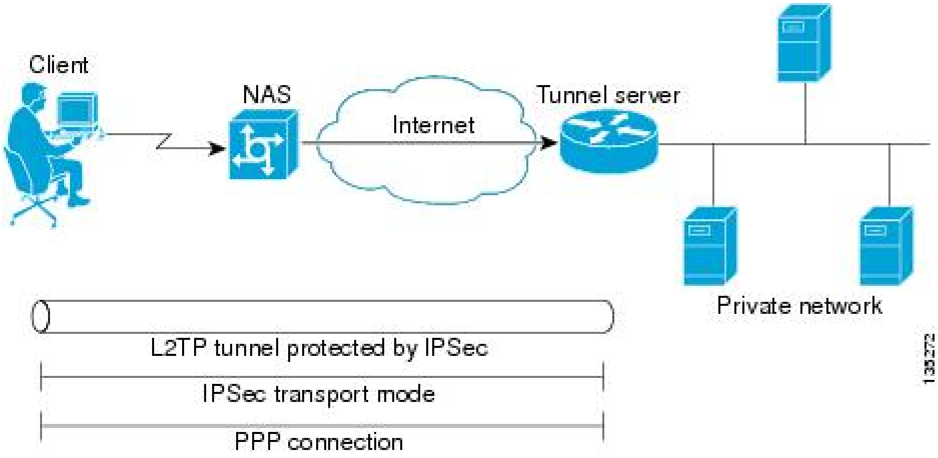


The client connects to the NAS through a medium that supports PPP, such as a dialup modem, digital subscriber line (DSL), ISDN, or a cable modem. If the connection from the client to the NAS is considered secure--such as a modem, ISDN, or a DSL connection--the client might choose not to provide additional security. The PPP session is securely tunneled from the NAS to the tunnel server without any required knowledge or interaction by the client. L2TP security protects the L2TP tunnel between the NAS and the tunnel server with IPSec.

L2TP Security with Client-Initiated VPDN Tunnels

L2TP security can be configured to protect VPDN tunnels between the client and the tunnel server in client-initiated VPDN deployments. A client-initiated tunneling scenario with L2TP security protection is depicted in the figure below.

Figure 19: L2TP Security for a Client-Initiated Tunneling Scenario



The client initiates an L2TP tunnel to the tunnel server without the intermediate NAS participating in tunnel negotiation or establishment. The client must manage the software that initiates the tunnel. Microsoft Windows 2000 supports this VPDN scenario. In this scenario, extended services processor (ESP) with authentication must always be used. L2TP security protects the L2TP tunnel between the client and the tunnel server with IPSec.

VPDN Template

A VPDN template can be configured with global default values that will supersede the system default values. These global default values are applied to all VPDN groups, unless specific values are configured for individual VPDN groups.

Multiple named VPDN templates can be configured in addition to a single global (unnamed) VPDN template. A VPDN group can be associated with only one VPDN template.

Values configured in the global VPDN template are applied to all VPDN groups by default. A VPDN group can be disassociated from the global VPDN template, or associated with a named VPDN template. Associating a VPDN group with a named VPDN template automatically disassociates it from the global VPDN template.

The default hierarchy for the application of VPDN parameters to a VPDN group is as follows:

- VPDN parameters configured for the individual VPDN group are always applied to that VPDN group.
- VPDN parameters configured in the associated VPDN template are applied for any settings not specified in the individual VPDN group configuration.
- System default settings for VPDN parameters are applied for any settings not configured in the individual VPDN group or the associated VPDN template.

Individual VPDN groups can be disassociated from the associated VPDN template if desired, allowing the system default settings to be used for any parameters not configured in that individual VPDN group.

VPDN Source IP Address

A tunnel endpoint can be configured with a source IP address that is different from the IP address used to open the VPDN tunnel. When a source IP address is configured on a tunnel endpoint, the router will generate VPDN packets labeled with the configured source IP address. A source IP address might need to be configured if the tunnel endpoints are managed by different companies and addressing requirements necessitate that a particular IP address be used.

The source IP address can be configured globally, or for an individual VPDN group. The VPDN group configuration will take precedence over the global configuration.

VRF-Aware VPDN Tunnels

Prior to Cisco IOS Release 12.2(15)T or Cisco IOS Release 12.2(28)SB, you had to specify IP addresses from the global routing table for the endpoints of a VPDN tunnel. VRF-aware VPDN tunnels provide support for VPDN tunnels that terminate on a Virtual Private Network (VPN) routing and forwarding instance (VRF) by allowing you to use IP addresses from a VRF routing table.

VRF-aware VPDN tunnels enhance the support of VPDN tunnels by allowing VPDN tunnels to start outside a Multiprotocol Label Switching (MPLS) VPN and terminate within the MPLS VPN and have overlapping IP addresses. For example, this feature allows you to use a VRF address from a customer VRF as the destination address.

Beginning with Cisco IOS Release 12.2(33)SB, the VRF-Aware VPDN Tunnels feature adds supports for L2TP on the LNS. Cisco IOS Release 12.2(33)SB allows the initiation and termination of tunnels in a VRF instance on the Cisco 10000 series router in both an LNS and Layer 2 Access Concentrator (LAC) environment.

You can use VRF-aware VPDN tunnels with multihop, dial-in, and dial-out VPDN tunneling scenarios. In a multihop scenario, this feature is sometimes referred to as VRF-aware VPDN multihop.

MTU Tuning for L2TP VPDN Tunnels

Fragmentation and reassembly of packets is done at the process level in the software. When a tunnel server is aggregating large numbers of sessions and traffic flows, process switching can dramatically reduce performance. For this reason, it is highly desirable to reduce or eliminate the need for packet fragmentation and reassembly in a VPDN deployment, and instead move the burden of any required packet reassembly to the client devices.

Packets are fragmented when they attempt to pass through an egress interface with a maximum transmission unit (MTU) that is smaller than the size of the packet. By default, the MTU of most interface is 1500 bytes. Because of this default MTU size, TCP segments are created with a default payload of 1460 bytes, allowing room for the 40 byte TCP/IP header. Because L2TP encapsulation adds 40 bytes of header information, tunneled packets will exceed the MTU of an interface if MTU tuning is not performed.

In order to reach its final destination, a packet might traverse multiple egress interfaces. The path MTU is defined as the smallest MTU of all of the interfaces that the packet must pass through.

A number of different methods are available to perform MTU tuning. Their end goal is to prevent fragmentation of packets after they have been encapsulated for tunneling. These methods take advantage of distinct mechanisms to accomplish this, as described in these sections:

MTU Tuning Using IP MTU Adjustments

The IP MTU configuration controls the maximum size of a packet allowed to be encapsulated by a Layer 2 protocol. The IP MTU of an interface can be manually lowered to compensate for the size of the L2TP header if the path MTU is known.

A router can also be configured to automatically adjust the IP MTU of an interface to compensate for the size of the L2TP header. The automatic adjustment corrects for the size of the L2TP header based on the MTU of the egress interface of that device. This configuration is effective only in preventing fragmentation when the MTU of that interface is the same as the path MTU.

MTU Tuning Using Path MTU Discovery

If the path MTU between the NAS and the tunnel server is unknown, or if it changes, path MTU discovery (PMTUD) can be used to perform MTU tuning. PMTUD uses the Don't Fragment (DF) bit in the IP header to dynamically discover the smallest MTU among all the interfaces along a routing path.

The source host initially assumes that the path MTU is the known MTU of the first egress interface, and sends all packets on that path with the DF bit in the IP header set. If any of the packets are too large to be forwarded without fragmentation by the interface of a device along the path, that device will discard the packet and return an Internet Control Message Protocol (ICMP) Destination Unreachable message to the source host. The ICMP Destination Unreachable message includes code 4, which means *fragmentation needed and DF set*, and indicates the IP MTU of the interface that was unable to forward the packet without fragmentation. This information allows the source host to reduce the size of the packet before retransmission to allow it to fit through that interface.

Enabling PMTUD makes VPDN deployments vulnerable to Denial of Service (DoS) attacks that use crafted ICMP messages to set a connection’s path MTU to an impractically low value. This will cause higher layer protocols to time out because of a very low throughput, even though the connection is still in the established state. This type of attack is classified as a throughput-reduction attack. For more information on throughput-reduction attacks against L2TP VPDN deployments, see the "Additional References" section.

To protect against a throughput-reduction attack, a range of acceptable values for the path MTU can be specified. If the device receives an ICMP code 4 message that advertises a next-hop path MTU that falls outside the configured size range, the device will ignore the message.

PMTUD can be unreliable and might fail when performed over the Internet because some routers or firewalls are configured to filter out all ICMP messages. When the source host does not receive an ICMP destination unreachable message from a device that is unable to forward a packet without fragmentation, it will not know to reduce the packet size. The source host will continue to retransmit the same large packet. Because the DF bit is set, these packets will be continually dropped because they exceed the path MTU, and the connection will stop responding.

MTU Tuning Using TCP MSS Advertising

Because PMTUD can be unreliable, an alternate method of performing MTU tuning was introduced. This method of MTU tuning takes advantage of TCP Maximum Segment Size (MSS) advertisements in the incoming and outgoing synchronize (SYN) packets sent by the end hosts.

The TCP MSS defines the maximum amount of data that a host is willing to accept in a single TCP/IP datagram. The MSS value is sent as a TCP header option only in TCP SYN segments. Each side of a TCP connection reports its MSS value to the other side. The sending host is required to limit the size of data in a single TCP segment to a value less than or equal to the MSS reported by the receiving host.

If you configure a lower TCP MSS than the usual default of 1460, the size of TCP segments will be reduced to compensate for the information added by the L2TP header.

MTU Tuning Using PPP MRU Advertising

Another option for reducing fragmentation in an L2TP VPDN network requires that Maximum Receive Unit (MRU) negotiation is supported by the PPP client. One known client which supports MRU negotiations is the Windows XP PPP client. Unfortunately, other commonly deployed PPP clients do not adhere to the advertised PPP MRU as they should. To determine if your PPP client properly responds to the advertised PPP MRU, see the PPP client documentation.

PPP MRU allows a peer to advertise its maximum receive unit, which is derived from the MTU configuration on the virtual template interface. A device will not process a PPP frame with a payload larger than its advertised MRU. The Cisco PPP implementation uses the MTU of the interface as the advertised MRU value during PPP negotiations.

The MTU of a virtual template interface can be manually lowered to compensate for the size of the L2TP header. If the PPP peer listens to the MRU advertised during PPP negotiation, it will adjust its MTU (and indirectly its IP MTU) for that PPP link. This in turn will modify the TCP MSS that the peer advertises when opening up TCP connections.

Because the default MTU for an interface is 1500 bytes, the default MRU is 1500 bytes. Setting the MTU of an interface to 1460 changes the advertised MRU to 1460. This configuration would tell the peer to allow room for a 40-byte L2TP header.

One issue with lowering the MTU on the virtual-template interface is that the IP MTU is automatically lowered as well. It is not possible to configure an IP MTU greater than the MTU on a virtual template interface. This can be an issue if there is a mixture of peer devices that do and do not adjust their MTU based on the advertised MRU. The clients that are unable to listen to MRU advertisements and adjust accordingly will continue to send full-sized packets to the peer. Packets that are larger than the lowered IP MTU, yet smaller than the normal default IP MTU, will be forced to fragment. For example, an L2TP packet that is 1490 bytes would normally be transmitted without fragmentation. If the MTU has been lowered to 1460 bytes, this packet will be unnecessarily fragmented. In this situation, it would be optimal to advertise a lower MRU to those clients that are capable of listening and adjusting, yet still allow full-sized packets for those clients that are unable to adjust.

Clients that ignore the advertised MRU might experience the PMTUD problems described in the MTU Tuning Using IP MTU Adjustments, on page 217. PMTUD can be turned off by clearing the DF bit on the inner IP packet.

QoS for VPDN Tunnels

Quality of service (QoS) packet classification features provide the capability to partition network traffic into multiple priority levels or classes of service. Packet classifications provide the information required to coordinate QoS from end to end within and between networks. Packet classifications are used by other QoS features to assign the appropriate traffic handling policies, including congestion management, bandwidth allocation, and delay bounds for each traffic class.

Packets can be marked for end-to-end QoS using the type of service (ToS) byte in the IP header. The first three bits of the ToS byte are used for IP precedence settings. Four of the remaining five bits are used to set the ToS. The remaining bit of the ToS byte is unassigned.

In a VPDN deployment, IP packets might be classified by an external source such as the customer network or a downstream client. By default, a tunnel endpoint will set the ToS byte in the Layer 2 header to zero, specifying normal service. Depending on the VPDN deployment, you can choose to configure your VPDN network to do one of the following in regard to QoS classifications:

- Ignore existing QoS classifications by leaving the default configuration in place.
- Preserve existing QoS classifications by configuring the tunnel endpoint to copy the ToS byte from the IP header to the Layer 2 header.
- Configure QoS classifications specific to your VPDN network.

These sections provide additional information on QoS options for VPDN deployments:

QoS Classification Preservation

When Layer 2 packets are created the ToS byte value is set to zero by default, indicating normal service. This setting ignores the values of the ToS byte of the encapsulated IP packets that are being tunneled. The tunnel server can be configured to copy the contents of the ToS field of the inner IP packets to the ToS byte of the Layer 2 header. Copying the ToS field from the IP header to the Layer 2 header preserves end-to-end QoS for tunneled packets.

IP Precedence for VPDN Tunnels

IP precedence settings mark the class of service (CoS) for a packet. The three precedence bits in the ToS field of the IP header can be used to define up to six classes of service. If you choose to manually configure a specific IP precedence value for Layer 2 packets, QoS will not be preserved end-to-end across the tunnel.

ToS Classification for VPDN Tunnels

The ToS bits mark the ToS classification for a packet. Each of the four bits controls a particular aspect of the ToS--reliability, throughput, delay, and cost. If you choose to manually configure a specific ToS value for Layer 2 packets, QoS will not be preserved end-to-end across the tunnel.

VPDN Group Selection

The VPDN Group Selection feature allows configuration of multiple VPDN tunnels, between a LAC and LNS, with different VPDN group configurations. Prior to Cisco IOS 12.4(20)T, a Service Provider (SP) can only control the establishment of a VPDN-group tunnel to an LNS based on the LAC hostname. VPDN tunnels, from a LAC with a particular hostname, can be established only to one VPDN group.

The VPDN Group Selection feature introduces two new keys that allow an LNS to connect to multiple VPDN tunnels from the same LAC, and to bind to different VPDN groups that use a different VPDN template for customized configurations. These keys are:

- Destination IP address the L2TP Start-Control-Connection-Request (SCCRQ) was received on
- The virtual routing and forwarding (VRF) instance the SCCRQ was received on

The VPDN Group Selection feature allows the LAC to build VPDN tunnels to either different IP addresses or different VRFs.

Benefits of VPDN Group Selection

The VPDN Group Selection feature allows SPs to support multiple VPDN groups or tunnels between a LAC and LNS by using the new VPDN group selection keys destination IP address or VRF ID, in addition to the previously supported hostname selection key. Prior to Cisco IOS Release 12.4(20)T, the key to select the VPDN group was only the LAC hostname, preventing the use of separate VPDN groups for each tunnel. Beginning with Cisco IOS Release 12.4(20)T, the VPDN Group Selection feature enables SPs to provide customize configurations for each VPDN tunnel.

How to Configure Additional VPDN Features

Configuring a Dial-Out L2TP VPDN

Configuring a dial-out VPDN enables a tunnel server to send outbound calls over a VPDN tunnel using L2TP as the tunneling protocol. Dial-out VPDN configuration allows a centralized network to efficiently and inexpensively establish a virtual point-to-point connection with any number of remote offices.

Cisco routers can carry both dial-in and dial-out calls in the same L2TP tunnels.

These tasks must be completed to configure a dial-out L2TP VPDN:

Prerequisites for Configuring a Dial-Out L2TP VPDN

Complete the required tasks in the Configuring AAA for VPDNs module.

Restrictions for Configuring a Dial-Out L2TP VPDN

- L2TP is the only Layer 2 protocol that can be used to tunnel dial-out VPDNs.
- Large-scale dial-out, Bandwidth Allocation Protocol (BAP), and Dialer Watch are not supported with dial-out VPDNs.
- When you configure the tunnel server to dial-out to multiple NASs, because each NAS is configured using the same VPDN group, all of the NASs must have the same tunnel configuration settings (the same L2TP tunnel password, for example).

Configuring the Tunnel Server to Request Dial-Out

The tunnel server must be configured to request the establishment of a VPDN tunnel with the NAS when it is directed to tunnel outbound PPP data. The VPDN group is linked to the dialer profile by the dialer pool number.

Perform this task to configure the tunnel server to request the establishment of a dial-out VPDN tunnel and to specify the dialer rotary group or dialer pool that can issue dial requests to the VPDN group.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **request-dialout**
6. **protocol l2tp**
7. **pool-member** *pool-number*
8. **exit**
9. **initiate-to ip** *ip-address* [**limit** *limit-number*] [**priority** *priority-number*]

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description myvpdngroup`	(Optional) Adds a description to a VPDN group.
Step 5	**request-dialout** **Example:** `Router(config-vpdn)# request-dialout`	Creates a request dial-out VPDN subgroup that configures a tunnel server to request the establishment of dial-out L2TP tunnels to a NAS and enters request dial-out VPDN subgroup configuration mode.

	Command or Action	Purpose
Step 6	**protocol l2tp** **Example:** `Router(config-vpdn-req-ou)# protocol l2tp`	Specifies L2TP as the Layer 2 protocol that the VPDN group will use.
Step 7	**pool-member** *pool-number* **Example:** `Router(config-vpdn-req-ou)# pool-member 1`	Assigns a request-dialout VPDN group to a dialer pool.
Step 8	**exit** **Example:** `Router(config-vpdn-req-ou)# exit`	Exits request dial-out VPDN subgroup configuration mode.
Step 9	**initiate-to ip** *ip-address* [**limit** *limit-number*] [**priority** *priority-number*] **Example:** `Router(config-vpdn)# initiate-to ip 10.0.58.201 limit 5 priority 1`	Specifies the IP address that will be used for Layer 2 tunneling. • Beginning in Cisco IOS Release 12.2(15)T and Cisco IOS Release 12.2(28)SB, these options are available for this command: • **limit**--Maximum number of connections that can be made to this IP address. • **priority**--Priority for this IP address (1 is the highest). **Note** Beginning in Cisco IOS Release 12.2(15)T and Cisco IOS Release 12.2(28)SB, multiple **initiate-to** commands can be entered to configure the tunnel server to contact multiple NASs. The tunnel server can also be configured to provide load balancing and redundancy for failover using the **initiate-to** command; see the examples in the Example Configuring L2TP Dial-Out Load Balancing, on page 261.

What to Do Next

You must perform the task in the Configuring the Dialer on the NAS, on page 227 .

Configuring the Dialer on the Tunnel Server

A request to tunnel outbound data from the tunnel server must be associated with a dialer profile. A dialer profile must be configured for each dial-out destination.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface dialer** *dialer-rotary-group-number*
4. **ip address** *ip-address mask* [**secondary**]
5. **encapsulation ppp**
6. **dialer remote-name** *user-name*
7. **dialer-string** *dial-string*
8. **dialer vpdn**
9. **dialer pool** *number*
10. **dialer-group** *group-number*
11. **ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**]

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 dialer** *dialer-rotary-group-number* **Example:** `Router(config)# interface dialer 1`	Defines a dialer rotary group and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 10.1.1.1 255.255.255.0`	Sets a primary or secondary IP address for an interface.
Step 5	**encapsulation ppp** **Example:** `Router(config-if)# encapsulation ppp`	Sets PPP as the encapsulation method used by the interface.

	Command or Action	Purpose
Step 6	**dialer remote-name** *user-name* **Example:** `Router(config-if)# dialer remote-name router22`	Specifies the authentication name of the remote router on the destination subnetwork for a dialer interface.
Step 7	**dialer-string** *dial-string* **Example:** `Router(config-if)# dialer-string 5550100`	Specifies the string (telephone number) to be called for interfaces calling a single site.
Step 8	**dialer vpdn** **Example:** `Router(config-if)# dialer vpdn`	Enables a dialer profile or DDR dialer to use L2TP dial-out.
Step 9	**dialer pool** *number* **Example:** `Router(config-if)# dialer-pool 1`	Specifies, for a dialer interface, which dialing pool to use to connect to a specific destination subnetwork. **Note** The value used for the *number* argument must match the value configured for the **pool-member** *pool-number* command in the VPDN group configuration.
Step 10	**dialer-group** *group-number* **Example:** `Router(config-if)# dialer-group 1`	Controls access by configuring an interface to belong to a specific dialing group.
Step 11	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**] **Example:** `Router(config-if)# ppp authentication chap`	Enables at least one PPP authentication protocol and specifies the order in which the protocols are selected on the interface.

What to Do Next

You must perform the task in the Configuring the NAS to Accept Dial-Out, on page 225 .

Configuring the NAS to Accept Dial-Out

The NAS must be configured to accept outbound tunnels from the tunnel server, and to initiate PPP calls to the destination client. Outbound calls will be placed using the dialer interface specified in the VPDN group configuration.

Perform this task to configure the NAS to accept tunneled dial-out connections from the tunnel server. If multiple NASs are configured on the tunnel server, perform this task on each NAS.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **description** *string*
5. **accept-dialout**
6. **protocol l2tp**
7. **dialer** *dialer-interface*
8. **exit**
9. **terminate-from hostname** *hostname*
10. **l2tp tunnel bearer capabilities** {**none** | **digital** | **analog** | **all**}
11. **l2tp tunnel framing capabilities** {**none** | **synchronous** | **asynchronous** | **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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.

	Command or Action	Purpose
Step 4	**description** *string* **Example:** `Router(config-vpdn)# description myvpdngroup`	(Optional) Adds a description to a VPDN group.
Step 5	**accept-dialout** **Example:** `Router(config-vpdn)# accept-dialout`	Creates an accept dial-out VPDN subgroup that configures a NAS to accept requests from a tunnel server to tunnel L2TP dial-out calls and enters accept dial-out VPDN subgroup configuration mode.
Step 6	**protocol l2tp** **Example:** `Router(config-vpdn-acc-ou)# protocol l2tp`	Specifies L2TP as the Layer 2 protocol that the VPDN group will use.
Step 7	**dialer** *dialer-interface* **Example:** `Router(config-vpdn-acc-ou)# dialer 2`	Specifies the dialer interface that an accept-dialout VPDN subgroup will use to dial out calls.
Step 8	**exit** **Example:** `Router(config-vpdn-acc-ou)# exit`	Exits accept dial-out VPDN subgroup configuration mode.
Step 9	**terminate-from hostname** *hostname* **Example:** `Router(config-vpdn)# terminate-from hostname tunnelserver32`	Specifies the hostname of the remote NAS or tunnel server that will be required when accepting a VPDN tunnel.
Step 10	**l2tp tunnel bearer capabilities** {**none** | **digital** | **analog** | **all**} **Example:** `Router(config-vpdn)# l2tp tunnel bearer capabilities digital`	(Optional) Sets the bearer-capability value used by the Cisco router. • When an accept dial-out VPDN subgroup is configured, the default value for this command is **all**. To ensure compatibility with some non-Cisco routers, you might be required to override the default bearer-capability value.
Step 11	**l2tp tunnel framing capabilities** {**none** | **synchronous** | **asynchronous** | **all**}	(Optional) Sets the framing-capability value used by the Cisco router.

	Command or Action	Purpose
	Example: `Router(config-vpdn)# l2tp tunnel framing capabilities synchronous`	• When an accept dial-out VPDN subgroup is configured, the default value for this command is **all**. To ensure compatibility with some non-Cisco routers, you might be required to override the default framing-capability value.

What to Do Next

You must perform the task in the Configuring the Dialer on the NAS, on page 227 .

Configuring the Dialer on the NAS

When the NAS receives outbound data from the tunnel server, it must initiate a PPP call to the destination client. The dialer used to initiate calls is specified in the VPDN group configuration, and must match the dialer rotary group number.

Perform this task to configure the dialer on the NAS for dial-out VPDN.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface dialer** *dialer-rotary-group-number*
4. **ip unnumbered** *interface-type interface-number*
5. **encapsulation ppp**
6. **dialer in-band**
7. **dialer aaa** [**suffix** *string*] [**password** *string*]
8. **dialer-group** *group-number*
9. **ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface dialer** *dialer-rotary-group-number* **Example:** `Router(config)# interface dialer 3`	Defines a dialer rotary group and enters interface configuration mode. **Note** The value configured for the *dialer-rotary-group-number* argument must match the value configured for the **dialer** *dialer-interface* command in the VPDN group configuration.
Step 4	**ip unnumbered** *interface-type interface-number* **Example:** `Router(config-if)# ip unnumbered serial 1`	Enables IP processing on a serial interface without assigning an explicit IP address to the interface.
Step 5	**encapsulation ppp** **Example:** `Router(config-if)# encapsulation ppp`	Sets PPP as the encapsulation method used by the interface.
Step 6	**dialer in-band** **Example:** `Router(config-if)# dialer in-band`	Specifies that DDR is to be supported.
Step 7	**dialer aaa** [**suffix** *string*] [**password** *string*] **Example:** `Router(config-if)# dialer aaa`	Allows a dialer to access the AAA server for dialing information.
Step 8	**dialer-group** *group-number* **Example:** `Router(config-if)# dialer-group 3`	Controls access by configuring an interface to belong to a specific dialing group.
Step 9	**ppp authentication** *protocol1* [*protocol2...*] [**if-needed**] [*list-name* | **default**] [**callin**] [**one-time**] [**optional**] **Example:** `Router(config-if)# ppp authentication chap`	Enables at least one PPP authentication protocol and specifies the order in which the protocols are selected on the interface.

Configuring L2TP Security for VPDN Tunnels

L2TP security provides enhanced security for tunneled PPP frames between the NAS and the tunnel server, increasing the integrity and confidentiality of tunneled PPP sessions within a standardized, well-deployed Layer 2 tunneling solution. The security features of IPSec and IKE include confidentiality, integrity checking, replay protection, authentication, and key management. Additional benefits include built-in keepalives and standardized interfaces for user authentication and accounting to AAA servers, interface statistics, standardized MIBs, and multiprotocol support.

L2TP security can be configured for both NAS-initiated L2TP tunneling scenarios and client-initiated L2TP tunneling scenarios.

To configure L2TP security for VPDN tunnels, perform these tasks:

Prerequisites for L2TP Security

- You must perform the required tasks in the Configuring AAA for VPDNs module.
- The interface between the NAS and tunnel server must support IPSec. For more information on configuring IPSec, see the Additional References section.

NAS-Initiated Tunnels

- For NAS-initiated tunneling scenarios, you must perform the required tasks in the Configuring NAS-Initiated Dial-In VPDN Tunneling module.

Client-Initiated Tunnels

- For client-initiated tunneling scenarios, you must perform the required tasks in the Configuring Client-Initiated Dial-In VPDN Tunneling module.
- The interface between the client and the NAS must support PPP.
- The client software must support L2TP and IPSec. This is the default VPDN networking scenario in Microsoft Windows 2000.

Configuring IPSec Protection of an L2TP Tunnel

- For NAS-initiated L2TP tunnels, this task must be performed on both the NAS and the tunnel server.
- For client-initiated L2TP tunnels, this task must be performed on the tunnel server.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **l2tp security crypto-profile** *profile-name* [**keep-sa**]

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**l2tp security crypto-profile** *profile-name* [**keep-sa**] **Example:** `Router(config-vpdn)# l2tp security crypto-profile l2tp keep-sa`	Enables the VPDN group to be protected by IPSec.

What to Do Next

You must perform the task in the Creating the Security Profile, on page 230.

Creating the Security Profile

A security profile must be configured to provide IPSec protection of L2TP tunnels. For NAS-initiated L2TP tunnels, this task must be performed on both the NAS and the tunnel server. For client-initiated L2TP tunnels, this task must be performed on the tunnel server.

Before You Begin

- To create an IKE policy and a crypto profile configuration associated with the VPDN group, you must first configure phase 1 Internet Security Association and Key Management Protocol (ISAKMP) policy and an IPSec transform set. For information on configuring phase 1 ISAKMP policies and IPSec transform sets, see the Additional References section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **crypto map** *map-name seq-num* [**ipsec-isakmp**] [**dynamic** *dynamic-map-name*] [**discover**] [**profile** *profile-name*]
4. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
5. **exit**
6. **interface** *type number*
7. **crypto-map** *map-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	**crypto map** *map-name seq-num* [**ipsec-isakmp**] [**dynamic** *dynamic-map-name*] [**discover**] [**profile** *profile-name*] **Example:** `Router(config)# crypto map l2tpsec 10 ipsec-isakmp profile l2tp`	Enters crypto map configuration mode, creates or modifies a crypto map entry, or creates a crypto profile that provides a template for configuration of dynamically created crypto maps. **Note** The **set peer** and **match address** commands are ignored by crypto profiles and should not be configured in the crypto map definition.
Step 4	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*] **Example:** `Router(config-crypto-map)# set transform-set esp-des-sha-transport`	Specifies which transform sets can be used with the crypto map entry.

	Command or Action	Purpose
Step 5	**exit** **Example:** `Router(config-crypto-map)# exit`	Exits crypto map configuration mode.
Step 6	**interface** *type number* **Example:** `Router(config)# interface fastethernet 0/0`	Configures an interface type and enters interface configuration mode.
Step 7	**crypto-map** *map-name* **Example:** `Router(config-if)# crypto map l2tpsec`	Applies a previously defined crypto map set to an interface.

Verifying IPSec Protection of L2TP VPDN Tunnels

Verifying Establishment of the Crypto Socket

Perform this task on the NAS or the tunnel server to verify that the crypto socket is created and activated in response to VPDN tunneling events.

SUMMARY STEPS

1. **enable**
2. **debug crypto socket**
3. **debug vpdn l2x-events**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **debug crypto socket**

Enter this command to turn on debug messages for socket messages:

Example:

```
Router# debug crypto socket
```

Step 3 **debug vpdn l2x-events**

Enter this command to turn on debug messages for protocol-specific VPDN tunneling events. Examine the debug messages to verify that the socket is created and moved to the active state in response to L2TP tunnel events. The example shows debug output from successful crypto socket creation and activation:

Example:

```
Router# debug vpdn l2x-events
*Mar  1 00:56:46.959:CRYPTO_SS(L2X Security):Passive open, socket info:local 10.0.0.13/1701, remote
 10.0.0.12/1701, prot 17, ifc Fa0/0
*Mar  1 00:56:47.291:L2TP:I SCCRQ from user02 tnl 5107
*Mar  1 00:56:47.295:L2X:Requested security for socket, UDP socket info:local 10.0.0.13(1701), remote
 10.0.0.12(1701)
*Mar  1 00:56:47.295:Tnl 13582 L2TP:Got a challenge in SCCRQ, user02
*Mar  1 00:56:47.295:Tnl 13582 L2TP:New tunnel created for remote user02, address 10.0.0.12
*Mar  1 00:56:47.295:Tnl 13582 L2TP:O SCCRP  to user02 tnlid 5107
*Mar  1 00:56:47.295:Tnl 13582 L2TP:Control channel retransmit delay set to 1 seconds
*Mar  1 00:56:47.299:Tnl 13582 L2TP:Tunnel state change from idle to wait-ctl-reply
*Mar  1 00:56:47.299:CRYPTO_SS(L2X Security):Completed binding of application to socket
```

Verifying the Crypto Map Configuration

Perform this task to verify that the crypto map was dynamically created for the L2TP tunnel.

SUMMARY STEPS

1. **enable**
2. **show crypto map** [**interface** *interface* | **tag** *map-name*]

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show crypto map** [**interface** *interface* | **tag** *map-name*]

Enter this command to display information about a crypto map. Ensure that the proper interface is using the correct crypto map. The following example displays output for the crypto map with the name l2tpsec and shows that it is being used by the FastEthernet 0/0 interface:

Example:

```
Router# show crypto map tag l2tpsec
Crypto Map "l2tpsec" 10 ipsec-isakmp
        No matching address list set.
        Current peer:0.0.0.0
        Security association lifetime:4608000 kilobytes/3600 seconds
        PFS (Y/N):N
        Transform sets={ esp, }
Crypto Map "l2tpsec" 20 ipsec-isakmp
        Peer = 10.0.0.13
        Extended IP access list
            access-list  permit udp host 10.0.0.12 port = 1701 host 10.0.0.13 port = 1701
        Current peer:10.0.0.13
        Security association lifetime:4608000 kilobytes/3600 seconds
        PFS (Y/N):N
        Transform sets={ esp, }
!The output below shows that the interface FastEthernet0/0 is uing the crypto map named !l2tpsec.
        Interfaces using crypto map l2tpsec:
                FastEthernet0/0
```

Verifying Encryption and Decryption of L2TP Packets

Perform this task to verify that L2TP packets are being encrypted and decrypted.

SUMMARY STEPS

1. **enable**
2. **show crypto engine connections active**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **show crypto engine connections active**

Enter this command to display information about active crypto engine connections. The number of encryption and decryption events are displayed.

Example:

```
Router# show crypto engine connections active

  ID Interface       IP-Address      State  Algorithm           Encrypt  Decrypt
   1 FastEthernet0/0 10.0.0.13       set    HMAC_SHA+DES_56_CB        0        0
```

```
2000 FastEthernet0/0 10.0.0.13       set    HMAC_SHA+DES_56_CB        0        62
2001 FastEthernet0/0 10.0.0.13       set    HMAC_SHA+DES_56_CB       64         0
```

Creating a VPDN Template

Perform this task on the NAS or the tunnel server to create a VPDN template. If you remove a named VPDN template configuration, all VPDN groups that were associated with it will automatically be associated with the global VPDN template.

Before You Begin

- You must be running Cisco IOS Release 12.2(8)T, Cisco IOS Release 12.2(28)SB, or a later release to configure a VPDN template.
- You must be running Cisco IOS Release 12.2(13)T, Cisco IOS Release 12.2(28)SB, or a later release to configure named VPDN templates.

Note

- An L2TP or Layer 2 Forwarding Protocol (L2F) tunnel must be established for the VPDN template settings to be used. Once a tunnel has been established, changes in the VPDN template settings will not have an effect on the tunnel until it is brought down and reestablished.
- Effective with Cisco Release 12.4(11)T, the L2F protocol was removed in Cisco IOS software.
- Not all commands that are available for configuring a VPDN group can be used to configure a VPDN template. For a list of the commands that can be used in VPDN template configuration mode, use the **?** command in VPDN template configuration mode.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-template** [*name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-template** [*name*] **Example:** `Router(config)# vpdn-template l2tp`	Creates a VPDN template and enters VPDN template configuration mode.

Associating a VPDN Group with a VPDN Template

VPDN groups are associated with the global VPDN template by default. Individual VPDN groups can be associated with a named VPDN template instead. Associating a VPDN group with a named VPDN template disassociates the VPDN group from the global VPDN template.

Perform this task on the NAS or the tunnel server to associate a specific VPDN group with a named VPDN template, or to reassociate a VPDN group with the global VPDN template if it has been previously disassociated from the global VPDN template.

Before You Begin

- Create and enable the VPDN template. For details, see the "Creating a VPDN Template" section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **source vpdn-template** [*name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group l2tp`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**source vpdn-template** [*name*] **Example:** `Router(config-vpdn)# source vpdn-template l2tp`	Associates a VPDN group with a VPDN template. • VPDN groups are associated with the unnamed VPDN template by default. • If you have disassociated a VPDN group from the VPDN template using the **no source vpdn-template** command, you can reassociate it by issuing the **source vpdn-template** command. • Associating a VPDN group with a named VPDN template disassociates it from the global VPDN template.

Disassociating a VPDN Group from the VPDN Template

Individual VPDN groups can be disassociated from the VPDN template if desired, allowing the system default settings to be used for any parameters not configured in the individual VPDN group.

Perform this task on the NAS or the tunnel server to disassociate a specific VPDN group from any VPDN template.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **no source vpdn-template** [*name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group l2tp`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**no source vpdn-template** [*name*] **Example:** `Router(config-vpdn)# no source vpdn-template l2tp`	Configures an individual VPDN group to use system default settings rather than the VPDN template settings for all unspecified parameters. • VPDN groups are associated with the unnamed VPDN template by default. Use the **no source vpdn-template** command to disassociate a VPDN group from its associated VPDN template. • If you have disassociated a VPDN group from the VPDN template using the **no source vpdn-template** command, you can reassociate it by issuing the **source vpdn-template** command.

Configuring the VPDN Source IP Address

Perform one of these tasks to configure a source IP address on a NAS or a tunnel server:

Configuring the Global VPDN Source IP Address

You can configure a single global source IP address on a device. If a source IP address is configured for a VPDN group, the global source IP address will not be used for tunnels belonging to that VPDN group.

Perform this task on a tunnel endpoint to configure the global source IP address.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn source-ip** *ip-address*

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	**vpdn source-ip** *ip-address* **Example:** `Router(config)# vpdn source-ip 10.1.1.1`	Globally specifies an IP address that is different from the physical IP address used to open a VPDN tunnel.

Configuring the Source IP Address for a VPDN Group

You can configure a source IP address for a specific VPDN group. If a source IP address is configured for a VPDN group, the global source IP address will not be used for tunnels belonging to that VPDN group.

Perform this task on a tunnel endpoint to configure a source IP address for a specific VPDN group.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **source-ip** *ip-address*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**source-ip** *ip-address* **Example:** `Router(config-vpdn)# source-ip 10.1.1.1`	Specifies an IP address that is different from the physical IP address used to open a VPDN tunnel for the tunnels associated with a VPDN group.

Configuring VRF-Aware VPDN Tunneling

VRF-aware VPDN tunneling can be configured locally on a NAS, tunnel server, or multihop tunnel switch, or it can be configured in the remote RADIUS server profile. Configuring VRF-aware VPDN tunneling in the RADIUS server profile will propagate the configuration only to a NAS or multihop tunnel switch. To configure VRF-aware VPDN tunnels on a tunnel server, you must configure the tunnel server locally.

Perform one of these tasks to configure a VRF-aware VPDN tunnel:

Configuring VRF-Aware VPDN Tunneling Locally

VRF-aware VPDN tunneling can be configured locally on a NAS, a tunnel server, or a multihop tunnel switch. Configuring VRF-aware VPDN tunneling on a device specifies that the tunnel endpoint IP addresses configured for that VPDN group belong to the specified VRF routing table rather than the global routing table.

Perform this task on the multihop tunnel switch, the NAS, or the tunnel server to configure a VPDN tunnel to belong to a VRF.

Before You Begin

- A multihop, dial-in, or dial-out L2TP VPDN tunneling deployment must be configured.
- The source IP address and the destination IP address configured in the L2TP VPDN group must exist in the specified VPN.
- Because VRFs use Cisco Express Forwarding, you must configure Cisco Express Forwarding before performing this task.

Note L2TP is the only tunneling protocol supported for VRF-aware VPDN tunneling.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **vpn** {**vrf** *vrf-name* | **id** *vpn-id*}

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group mygroup`	Creates a VPDN group and enters VPDN group configuration mode.

Step 4	**vpn** {**vrf** *vrf-name* | **id** *vpn-id*}
	Example:
	`Router(config-vpdn)# vpn vrf myvrf`
		Specifies that the source and destination IP addresses of a given VPDN group belong to a specified VRF instance.
		• **vrf** *vrf-name* --Specifies the VRF instance by the VRF name.
		• **id** *vpn-id* --Specifies the VRF instance by the VPN ID.

Configuring VRF-Aware VPDN Tunneling on the Remote RADIUS AAA Server

VRF-aware VPDN tunneling can be configured in the remote RADIUS server profile. Configuring VRF-aware VPDN tunneling on a device specifies that the tunnel endpoint IP addresses configured for that VPDN group belong to the specified VRF routing table rather than the global routing table.

Configuring VRF-aware VPDN tunneling in the RADIUS server profile will propagate the configuration only to a NAS or multihop tunnel switch. To configure VRF-aware VPDN tunnels on a tunnel server, you must configure the tunnel server locally by performing the task in the Configuring VRF-Aware VPDN Tunneling Locally section.

Perform this task on the remote RADIUS server. The tunnel attributes configured in the RADIUS server profile will be propagated to the NAS or multihop tunnel switch.

Before You Begin

- A multihop, dial-in, or dial-out L2TP VPDN tunneling deployment must be configured.
- The source IP address and the destination IP address configured in the L2TP VPDN group must exist in the specified VPN.
- Because VRFs use Cisco Express Forwarding, you must configure Cisco Express Forwarding before performing this task.
- The NAS or tunnel switch must be configured for remote RADIUS AAA. Perform the tasks in the Configuring AAA on the NAS and the Tunnel Server and Configuring Remote AAA for VPDNs sections in the Configuring AAA for VPDNs module to configure the NAS for remote RADIUS AAA.
- The RADIUS server must be configured for AAA.

Note L2TP is the only tunneling protocol supported for VRF-aware VPDN tunneling.

SUMMARY STEPS

1. **Cisco-Avpair = vpdn:tunnel-id=** *name*
2. **Cisco-Avpair = vpdn:tunnel-type= l2tp**
3. **Cisco-Avpair = vpdn:vpn-vrf=** *vrf-name*
4. **Cisco-Avpair = vpdn:l2tp-tunnel-password=** *secret*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**Cisco-Avpair = vpdn:tunnel-id=** *name* **Example:** `Cisco-Avpair = vpdn:tunnel-id=test`	Specifies the tunnel ID in the RADIUS user profile.
Step 2	**Cisco-Avpair = vpdn:tunnel-type= l2tp** **Example:** `Cisco-Avpair = vpdn:tunnel-type=l2tp`	Specifies L2TP as the tunneling protocol in the RADIUS user profile.

	Command or Action	Purpose

Step 3	**Cisco-Avpair = vpdn:vpn-vrf=** *vrf-name*
	Example:
	`or`
	Example:
	Cisco-Avpair = vpdn:vpn-id= *vpn-id*
	Example:
	`Cisco-Avpair = vpdn:vpn-vrf=myvrf`
	Example:
	`or`
	Example:
	`Cisco-Avpair = vpdn:vpn-id=A1:3F6C`
		Specifies the VRF instance that the VPDN tunnel should be associated with using the VRF name in the RADIUS user profile.
		or
		Specifies the VRF instance that the VPDN tunnel should be associated with using the VPN ID in the RADIUS user profile.

Step 4	**Cisco-Avpair = vpdn:l2tp-tunnel-password=** *secret* **Example:** `Cisco-Avpair = vpdn:l2tp-tunnel-password=cisco`	Specifies the L2TP tunnel password in the RADIUS user profile.

Performing MTU Tuning for L2TP VPDNs

MTU tuning reduces or prevents packet fragmentation and reassembly of L2TP packets in a VPDN deployment. Because the tunnel server is typically the device that aggregates large numbers of sessions and traffic flows in a VPDN deployment, the performance impact of the process switching required for packet fragmentation and reassembly is most dramatic, and least desirable, on this device.

A number of different methods are available to perform MTU tuning. The goal is to prevent fragmentation of packets after they have been encapsulated for tunneling. The most reliable method of MTU tuning is manually configuring the advertised TCP MSS.

Perform one of these tasks to perform MTU tuning:

Manually Configuring the IP MTU for VPDN Deployments

One method for reducing the amount of fragmentation of tunneled packets is to manually configure the IP MTU to the largest IP packet size that will not exceed the path MTU between the NAS and the tunnel server once the full Layer 2 header is added to the packet.

Perform this task on the tunnel server to lower the IP MTU manually.

Before You Begin

- An L2TP VPDN deployment must be configured.
- The path MTU between the NAS and the tunnel server should be known.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface virtual-template** *number*
4. **ip mtu** *bytes*

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 virtual-template** *number* **Example:** `Router(config)# interface virtual-template 1`	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces and enters interface configuration mode.
Step 4	**ip mtu** *bytes* **Example:** `Router(config-if)# ip mtu 1460`	Sets the MTU size of IP packets sent on an interface. **Note** Because Layer 2 headers are 40 bytes, the recommended value for the *bytes* argument is 1460.

Enabling Automatic Adjustment of the IP MTU for VPDN Deployments

A tunnel server can be configured to automatically adjust the IP MTU of an interface to compensate for the size of the Layer 2 header. The automatic adjustment corrects for the size of the Layer 2 header based on the MTU of the egress interface of that device. This configuration is effective in preventing fragmentation only when the MTU of that interface is the same as that of the path MTU.

Perform this task on the tunnel server to enable automatic adjustment of the IP MTU.

Before You Begin

- A VPDN deployment must be configured.
- You must be running Cisco IOS Release 12.2(3), Cisco IOS Release 12.2(4)T, or a later release to control automatic adjustment of the IP MTU.

Note

- Automatic adjustment of the IP MTU was introduced in Cisco IOS Release 12.1(5)T, and is enabled by default. No mechanism is available to disable it in releases prior to Cisco IOS Release 12.2(3) and 12.2(4)T.
- The **ip mtu adjust** command was introduced in Cisco IOS Release 12.2(3) and 12.2(4)T. The **no** form of this command can be used to disable automatic adjustment of the IP MTU.
- In Cisco IOS Release 12.2(6) and 12.2(8)T, the default was changed so that automatic adjustment of the IP MTU is disabled.
- The IP MTU is automatically adjusted only if there is no IP MTU configured manually on the virtual template interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **ip mtu adjust**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**ip mtu adjust** **Example:** `Router(config-vpdn)# ip mtu adjust`	Enables automatic adjustment of the IP MTU on a virtual access interface.

Enabling Path MTU Discovery for VPDNs

If the path MTU between the NAS and the tunnel server is variable or unknown, PMTUD can be enabled for VPDNs. PMTUD uses the DF bit in the IP header to dynamically discover the smallest MTU among all the interfaces along a routing path.

When PMTUD is enabled, VPDN deployments are vulnerable to DoS attacks that use crafted ICMP messages to set a connection’s path MTU to an impractically low value. This will cause higher layer protocols to time out because of a very low throughput, even though the connection is still in the established state. This type of attack is classified as a throughput-reduction attack.

To protect against a throughput-reduction attack, configure a range of acceptable values for the path MTU. If the device receives an ICMP message that advertises a next-hop path MTU that falls outside the configured size range, the device will ignore the message. For more information on throughput-reduction attacks and for information on detecting a PMTUD attack on an L2TP VPDN deployment, see the “Additional References” section.

PMTUD might fail when performed over the Internet because some routers or firewalls are configured to filter out all ICMP messages. When the source host does not receive an ICMP Destination Unreachable message from a device that is unable to forward a packet without fragmentation, it will not know to reduce the packet size. The source host will continue to retransmit the same large packet. Because the DF bit is set, these packets will be continually dropped because they exceed the path MTU, and the connection will stop responding entirely.

Perform this task on the tunnel server to enable PMTUD and to protect the L2TP VPDN deployment against throughput-reduction DoS attacks.

Before You Begin

- A VPDN deployment must be configured.
- You must be running Cisco IOS Release 12.2(4)T or a later release.

- You must be running Cisco IOS Release 12.2(11)T or a later release on the Cisco 1760 modular access router, the Cisco AS5300 series universal gateways, the Cisco AS5400 series universal gateways, and the Cisco AS5800 series universal gateways.
- To protect against a DoS throughput-reduction attack, you must be running a version of Cisco IOS software that supports the **vpdn pmtu** command. These maintenance releases of Cisco IOS software support the **vpdn pmtu** command:
  - Cisco IOS Release 12.3(25) and later releases
  - Cisco IOS Release 12.3(14)T and later releases
  - Cisco IOS Release 12.2(28)SB and later releases

Note Some software releases remain vulnerable to throughput-reduction DoS attacks when PMTUD is enabled. The only way to protect against DoS attacks when running these versions of the Cisco IOS software is to disable PMTUD.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **ip pmtu**
5. **exit**
6. **vpdn pmtu maximum** *bytes*
7. **vpdn pmtu minimum** *bytes*

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**ip pmtu** **Example:** `Router(config-vpdn)# ip pmtu`	Enables the discovery of a path MTU for Layer 2 traffic.
Step 5	**exit** **Example:** `Router(config-vpdn)# exit`	Exits VPDN group configuration mode.
Step 6	**vpdn pmtu maximum** *bytes* **Example:** `Router(config)# vpdn pmtu maximum 1460`	Manually configures the maximum allowed path MTU size, in bytes, for an L2TP VPDN.
Step 7	**vpdn pmtu minimum** *bytes* **Example:** `Router(config)# vpdn pmtu minimum 576`	Manually configures the minimum allowed path MTU size, in bytes, for an L2TP VPDN.

Manually Configuring the Advertised TCP MSS

Manually configuring a lower value for the advertised TCP MSS reduces the size of IP packets created by TCP at the transport layer, reducing or eliminating the amount of packet fragmentation that will occur in a VPDN deployment.

The default advertised TCP MSS is 1460, which allows room for the 40-byte TCP/IP header. To prevent packet fragmentation over a tunnel, additionally reduce the TCP MSS to provide space for the Layer 2 encapsulation header.

Perform this task on the tunnel server to manually lower the TCP MSS.

Before You Begin

A VPDN deployment must be configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface virtual-template** *number*
4. **ip tcp adjust-mss** *bytes*

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 virtual-template** *number* **Example:** `Router(config)# interface virtual-template 1`	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces and enters interface configuration mode.
Step 4	**ip tcp adjust-mss** *bytes* **Example:** `Router(config-if)# ip tcp adjust-mss 1420`	Adjusts the MSS value of TCP SYN packets going through a router. **Note** Because Layer 2 headers are 40 bytes, the recommended value for the *bytes* argument is 1420.

Configuring MRU Advertising

You can manually configure a lower MTU on the virtual template interface to compensate for the size of the Layer 2 header. The MTU of the interface is advertised to PPP peers as the MRU. If the peer is running a PPP client that is capable of listening to this advertisement, it can adjust its MTU (and indirectly its IP MTU) for that PPP link. This in turn modifies the TCP MSS that the peer advertises when opening up TCP connections.

Because the default MTU for an interface is 1500 bytes, the default MRU is 1500 bytes. Setting the MTU of an interface to 1460 changes the advertised MRU to 1460. This configuration would tell the peer to allow room for a 40-byte Layer 2 header.

Perform this task on the tunnel server to manually lower the MTU of the virtual template interface.

Before You Begin

A VPDN deployment must be configured.

Note

- MRU negotiation must be supported on the PPP client. One known client that supports MRU negotiations is the Windows XP PPP client. Other commonly deployed PPP clients do not adhere to the advertised PPP MRU as they should. To determine if your PPP client properly responds to the advertised PPP MRU, see the PPP client documentation.
- Changing the MTU value for an interface with the **mtu** command can affect the value of the **ip mtu** command. The value specified with the **ip mtu** command must not be greater than the value specified with the **mtu** command. If you change the value for the **mtu** command and the new value would result in an **ip mtu** value that is higher than the new **mtu** value, the **ip mtu** value automatically changes to match the new value configured with the **mtu** command. Changing the value of the **ip mtu** commands has no effect on the value of the **mtu** command.
- If proxy Link Control Protocol (LCP) is running, LCP renegotiation must take place because the MRU option is set during LCP negotiations. To force LCP renegotiation, configure the **lcp renegotiation** command for the VPDN group.
- If the MTU is manually lowered for a tunnel server that communicates with a mixture of devices that do and do not listen to MRU advertising, those devices that do not listen might encounter the PMTUD issues discussed in the "Enabling Path MTU Discovery for VPDNs" section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface virtual-template** *number*
4. **mtu** *bytes*
5. **exit**
6. **vpdn-group** *name*
7. **lcp renegotiation** {**always** | **on-mismatch**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface virtual-template** *number* **Example:** `Router(config)# interface virtual-template 1`	Creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces and enters interface configuration mode.
Step 4	**mtu** *bytes* **Example:** `Router(config-if)# mtu 1460`	Adjusts the maximum packet size or MTU size. **Note** Because Layer 2 headers are 40 bytes, the recommended value for the *bytes* argument is 1460.
Step 5	**exit** **Example:** `Router(config-if)# exit`	(Optional) Exits interface configuration mode.
Step 6	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	(Optional) Creates a VPDN group and enters VPDN group configuration mode.

Step 7	**lcp renegotiation** {**always** | **on-mismatch**}
	Example:
	`Router(config-vpdn)# lcp renegotiation always`
		(Optional) Allows the tunnel server to renegotiate the PPP LCP on dial-in calls.

Configuring VPDN Group Selection

Configuring VPDN Group Selection Based on a Hostname

Use these steps to display the status of an LNS to determine if it is active.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **accept-dialin**
5. **protocol l2tp**
6. **terminate-from hostname** *hostname*
7. **exit**

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**accept-dialin** **Example:** `Router(config-vpdn)# accept-dialin`	Creates a VPDN accept dialin group that configures a tunnel server to accept requests from a network access server (NAS) to tunnel dialin calls, and enters accept dialin VPDN subgroup configuration mode.
Step 5	**protocol l2tp** **Example:** `Router(config-vpdn-acc-in)# protocol l2tp`	Specifies the tunneling protocol that a VPDN subgroup will use.
Step 6	**terminate-from hostname** *hostname* **Example:** `Router(config-vpdn-acc-in)# terminate-from hostname example`	Specify the hostname of the remote LAC or LNS that will be required when accepting a VPDN tunnel.

	Command or Action	Purpose
Step 7	**exit** **Example:** `Router(config-vpdn-acc-in)# exit`	Exits VPDN accept dialin group configuration mode.

Configuring VPDN Group Selection Based on a Source IP Address

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **accept-dialin**
5. **protocol l2tp**
6. **source-ip** *ip-address*
7. **exit**

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.

	Command or Action	Purpose
Step 4	**accept-dialin** **Example:** `Router(config-vpdn)# accept dialin`	Creates a VPDN accept dialin group that configures a tunnel server to accept requests from a network access server (NAS) to tunnel dialin calls, and enters accept dial-in VPDN subgroup configuration mode.
Step 5	**protocol l2tp** **Example:** `Router(config-vpdn-acc-in)# protocol l2tp`	Specifies the tunneling protocol that a VPDN subgroup will use.
Step 6	**source-ip** *ip-address* **Example:** `Router(config-vpdn-acc-in)# source-ip 10.10.10.1`	Specifies a source IP addresses to which to map the destination IP addresses in subscriber traffic.
Step 7	**exit** **Example:** `Router(config-vpdn-acc-in)# exit`	Exits a VPDN accept dialin group configuration mode.

Configuring VPDN Group Selection Based on VRF

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **accept-dialin**
5. **protocol l2tp**
6. **vpn vrf** *vrf-name*
7. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**accept-dialin** **Example:** `Router(config-vpdn)# accept dialin`	Creates a VPDN accept dialin group that configures a tunnel server to accept requests from a network access server (NAS) to tunnel dialin calls, and enters accept dial-in VPDN subgroup configuration mode.
Step 5	**protocol l2tp** **Example:** `Router(config-vpdn-acc-in)# protocol l2tp`	Specifies the tunneling protocol that a VPDN subgroup will use.
Step 6	**vpn vrf** *vrf-name* **Example:** `Router(config-vpdn-acc-in)# vpn vrf myvrf`	Specifies that the source and destination IP addresses of a given VPDN group belong to a specified Virtual Private Network (VPN) routing and VRF instance. • **vrf** *vrf-name* --Specifies the VRF instance by the VRF name.
Step 7	**exit** **Example:** `Router(config)# exit`	Exits accept dialin VPDN subgroup mode.

Displaying VPDN Group Selections

SUMMARY STEPS

1. **enable**
2. **show vpdn group-select**
3. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show vpdn group-select** **Example:** `Router> show vpdn group-select`	Displays the information for the selected VPDN group.
Step 3	**exit** **Example:** `Router> exit`	Exits global configuration mode.

Configuring QoS Packet Classifications for VPDNs

Depending on the VPDN deployment, instead of using the default setting you can choose to configure your VPDN network to preserve QoS end to end by copying the contents of the ToS byte from the IP header to the Layer 2 header, or to manually configure custom packet classifications for the VPDN network.

QoS configurations are generally required only on the tunnel server, the device that must manage and prioritize large volumes of outbound traffic.

Perform this task if you choose to preserve end-to-end QoS:

Perform either or both of these tasks to manually configure custom packet classifications for your VPDN deployment:

Configuring Preservation of QoS Classifications in the ToS Byte

When Layer 2 packets are created the ToS byte value is set to zero by default, indicating normal service. This setting ignores the values of the ToS byte of the encapsulated IP packets that are being tunneled. The tunnel server can be configured to copy the contents of the ToS field of the inner IP packets to the ToS byte of the Layer 2 header. Copying the ToS field from the IP header to the Layer 2 header preserves end-to-end QoS for tunneled packets.

Perform this task to configure a tunnel server to copy the ToS byte from the IP packet to the Layer 2 header.

Before You Begin

A VPDN deployment must be configured.

Note

- The tunneled link must carry IP packets for the ToS field to be preserved.
- Proxy PPP dial-in is not supported.
- The tunneled link must carry IP for the ToS field to be preserved. The encapsulated payload of Multilink PPP (MLP) connections is not IP, therefore this task has no effect when MLP is tunneled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **ip tos reflect**

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.

	Command or Action	Purpose
Step 4	**ip tos reflect** **Example:** `Router(config-vpdn)# ip tos reflect`	Configures a VPDN group to copy the ToS byte value of IP packet to the Layer 2 header.

Manually Configuring the IP Precedence for VPDNs

IP precedence bits of the ToS byte can be manually configured to set a CoS for Layer 2 packets. If you choose to manually configure a specific IP precedence value for Layer 2 packets, QoS will not be preserved end to end across the tunnel.

Perform this task on the tunnel server to manually configure a CoS for Layer 2 packets.

Before You Begin

A VPDN deployment must be configured.

Note Manual configuration of an IP precedence value will override the configuration of the **ip tos reflect** command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **ip precedence** [*number* | *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.

	Command or Action	Purpose
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**ip precedence** [*number* | *name*] **Example:** `Router(config-vpdn)# ip precedence 1`	Sets the precedence value in the VPDN Layer 2 encapsulation header.

Manually Configuring the ToS for VPDN Sessions

The ToS bits can be manually configured to mark the ToS of a packet. If you choose to manually configure a specific ToS value for Layer 2 packets, QoS will not be preserved end-to-end across the tunnel.

Perform this task on the tunnel server to manually configure a CoS for Layer 2 packets.

Before You Begin

A VPDN deployment must be configured.

Note Manual configuration of a ToS value will override the configuration of the **ip tos reflect** command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **ip tos** {*tos-bit-value* | **max-reliability** | **max-throughput** | **min-delay** | **min-monetary-cost** | **normal**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.

Step 4	**ip tos** {*tos-bit-value* | **max-reliability** | **max-throughput** | **min-delay** | **min-monetary-cost** | **normal**}
	Example:
	`Router(config-vpdn)# ip tos 9`
		Sets the ToS bits in the VPDN Layer 2 encapsulation header.

Configuration Examples for Additional VPDN Features

Examples Configuring a Basic Dial-Out VPDN

The following example enables VPDN, configures a tunnel server to request dial-out VPDN tunnels for outbound PPP calls, and configures the dialer interface to place outbound calls using the VPDN tunnel:

```
vpdn enable
vpdn-group out
 request-dialout
 protocol l2tp
 pool-member 1
!
 initiate-to ip 10.10.10.1

 local name tunnelserver32

!
interface dialer 1
 ip address 10.1.1.1 255.255.0
 encapsulation ppp
 dialer remote-name router22
 dialer string 5550100
 dialer vpdn
 dialer pool 1
 dialer-group 1
 ppp authentication chap
```

The following example enables VPDN, configures a NAS to accept dial-out VPDN tunnel requests, and configures a dialer interface on the NAS to place outbound calls to the PPP client:

```
vpdn enable
```

```
vpdn-group 1
 accept-dialout
 protocol l2tp

 dialer 3

!

 terminate-from hostname tunnelserver32

!

interface dialer 3

 ip unnumbered Ethernet0

 encapsulation ppp

 dialer in-band

 dialer aaa

 dialer-group 3

 ppp authentication chap
```

Example Configuring L2TP Dial-Out Load Balancing

The following example configures a preexisting dial-out VPDN group on a tunnel server to load balance calls across multiple NASs. Calls will be load balanced between the NASs because the same priority value has been assigned to each NAS with the **initiate-to** command:

```
vpdn-group 1
 initiate-to ip 10.0.58.201 priority 10
 initiate-to ip 10.0.58.205 priority 10
 initiate-to ip 10.0.58.207 priority 10
 initiate-to ip 10.0.58.209 priority 10
```

Example Configuring L2TP Dial-Out Failover Redundancy

The following example configures a preexisting dial-out VPDN group on a tunnel server for failover between multiple NASs. If the NAS with the highest priority goes down, the tunnel server will fail over to a NAS with a lower priority. The highest priority value you can assign is 1.

```
vpdn-group 1
 initiate-to ip 10.0.58.201 priority 1
 initiate-to ip 10.0.58.205 priority 10
 initiate-to ip 10.0.58.209 priority 15
```

Example L2TP Dial-Out Failover Redundancy with Tunnel Timers

The following example configures a preexisting dial-out VPDN group on a tunnel server for failover using custom L2TP tunnel timers. The tunnel server is configured to retry to connect to a NAS five times, with a minimum wait of 10 seconds between attempts. If the tunnel server is not able to connect to the highest priority NAS after the specified number of retries, failover to the next highest priority NAS will occur. The tunnel server will not attempt to recontact the highest priority NAS until 420 seconds have passed.

```
vpdn-group 1
```

```
 initiate-to ip 10.0.58.201 priority 1
 initiate-to ip 10.0.58.207 priority 50
 initiate-to ip 10.0.58.205 priority 100
 l2tp tunnel retransmit initial retries 5
 l2tp tunnel retransmit initial timeout min 10
 l2tp tunnel busy timeout 420
```

Example Configuring IPSec Protection of a NAS-Initiated L2TP Tunnel

The following example configures IPSec protection of L2TP tunnels on the NAS and the tunnel server for a NAS-initiated tunneling scenario:

NAS Configuration

```
! Passwords for the L2TP tunnel authentication
username NAS password 0 cisco
username TS1 password 0 cisco
!
! VPDN configuration to tunnel users with the domain cisco.com to the LNS. This !
configuration has l2tp tunnel authentication enabled.
!
vpdn enable
vpdn-group 1
 request-dialin
 protocol l2tp
 domain cisco.com
!
 initiate-to ip 10.0.0.13
 local name NAS
 l2tp security crypto-profile l2tp keep-sa
 l2tp tunnel password cisco
!
crypto isakmp policy 1
 authentication pre-share
!
crypto isakmp key cisco address 10.0.0.13
!
crypto ipsec transform-set esp-des-sha-transport esp-des esp-sha-hmac
 mode transport
!
! Crypto profile configuration which is bound to the vpdn-group shown above
crypto map l2tpsec 10 ipsec-isakmp profile l2tp
 set transform-set esp-des-sha-transport
!
interface FastEthernet0/0
 ip address 10.0.0.12 255.255.255.0
 crypto map l2tpsec
```

Tunnel Server Configuration

```
! PPP client username and password needed for CHAP authentication
username userSerial10@cisco.com password 0 cisco
!
! Passwords for the L2TP tunnel authentication
username NAS password 0 cisco
username TS1 password 0 cisco
!
! Using address pool to assign client an IP address
ip address-pool local
!
! VPDN configuration
vpdn enable
vpdn-group 1
 accept-dialin
 protocol any
 virtual-template 1
```

```
!
 terminate-from hostname NAS
 lcp renegotiation on-mismatch
 l2tp security crypto-profile l2tp keep-sa
!
crypto isakmp policy 1
 authentication pre-share
crypto isakmp key cisco address 10.0.0.12
!
crypto ipsec transform-set esp-des-sha-transport esp-des esp-sha-hmac
 mode transport
!
crypto map l2tpsec 10 ipsec-isakmp profile l2tp
 set transform-set esp-des-sha-transport
!
interface FastEthernet0/0
 ip address 10.0.0.13 255.255.255.0
 speed 10
 half-duplex
 crypto map l2tpsec
```

Example Configuring IPSec Protection of a Client-Initiated L2TP Tunnel

The following example configures IPSec protection of L2TP tunnels on the tunnel server for a client-initiated tunneling scenario:

```
! PPP client username and password needed for CHAP authentication
username userSerial10@cisco.com password 0 cisco
! Passwords for the L2TP tunnel authentication.
username NAS password 0 cisco
username TS1 password 0 cisco
!
! Using address pool to assign client an IP address
ip address-pool local
!
! VPDN configuration
vpdn enable
vpdn-group dial-in
 accept-dialin
 protocol l2tp
 virtual-template 1
!
 l2tp security crypto-profile l2tp
 no l2tp tunnel authentication
ip pmtu
!
crypto ipsec transform-set esp-des-sha-transport esp-des esp-sha-hmac
 mode transport
!
crypto map l2tpsec 10 ipsec-isakmp profile l2tp
 set transform-set esp-des-sha-transport
 set security-association lifetime seconds 120
!
interface FastEthernet0/0
 ip address 10.0.0.13 255.255.255.0
 speed 10
 half-duplex
 crypto map l2tpsec
```

Example Configuring a Global VPDN Template

The following example configures two VPDN parameters in the unnamed global VPDN template:

```
vpdn-template
```

```
 local name host43
 ip tos reflect
```

Example Configuring a Named VPDN Template

The following example configures two VPDN parameters in a VPDN template named l2tp. The named VPDN template is associated with the VPDN group named l2tp_tunnels.

```
vpdn-template l2tp
 l2tp tunnel busy timeout 65
 l2tp tunnel password tunnel4me
!
vpdn-group l2tp_tunnels
 source vpdn-template l2tp_tunnels
```

Example Disassociating a VPDN Group from the VPDN Template

The following example disassociates the VPDN group named l2tp from the VPDN template. The system default settings will be used for all VPDN parameters that are not specified in the VPDN group configuration.

```
vpdn-group l2tp
 no source vpdn-template
```

Example Configuring a Global VPDN Source IP Address

The following example configures a global source IP address. This source IP address will be used for all tunnels established on the router unless a specific source IP address is configured for a VPDN group.

```
vpdn source-ip 10.1.1.1
```

Example Configuring a Source IP Address for a VPDN Group

The following example configures a source IP address for tunnels associated with the VPDN group named tunneling. This source IP address will override any configured global source IP address for tunnels associated with this VPDN group.

```
vpdn-group tunneling
 source-ip 10.1.1.2
```

Example Configuring VRF-Aware VPDN Tunnels Locally

The following example configures a multihop tunnel switch to connect a NAS to a remote tunnel server within a VRF:

NAS

```
interface loopback 0
 ip address 172.16.45.6 255.255.255.255
!
vpdn enable
```

```
vpdn-group group1
 request-dialin
 protocol l2tp
 domain cisco.com
!
 initiate-to 10.10.104.9
 local name nas32
 source-ip 172.16.45.6
 l2tp tunnel password secret1
```

Multihop Tunnel Switch

```
ip vrf cisco-vrf
 vpn id A1:3F6C
!
interface loopback 0
 ip address 10.10.104.22 255.255.255.255
!
interface loopback 40
 ip vrf forwarding cisco-vrf
 ip address 172.16.40.241 255.255.255.255
!
vpdn enable
vpdn multihop
!
vpdn-group mhopin
 accept-dialin
 protocol l2tp
 virtual-template 4
!
 terminate-from hostname nas32
 source-ip 10.10.104.9
 l2tp tunnel password secret1
!
vpdn-group mhopout
 request-dialin
 protocol l2tp
 domain cisco.com
!
 vpn vrf cisco-vrf
 initiate-to ip 172.16.45.6
 source-ip 172.16.40.241
 local name multihop-tsw25
 l2tp tunnel password secret2
```

Tunnel Server

```
interface loopback 0
 ip address 172.16.45.6 255.255.255.255
!
vpdn enable
vpdn-group cisco
 accept-dialin
 protocol l2tp
 virtual-template 1
!
 terminate-from hostname multihop-tsw25
 source-ip 172.16.45.6
 local name ts-12
 l2tp tunnel password secret2
```

Examples Configuring VRF-Aware VPDN Tunnels on the Remote RADIUS AAA Server

The following examples configure VRF-aware VPDN tunnels for a service provider network. The AAA RADIUS server user profile defines VPDN tunnel attributes, which can propagate to multiple NASs or tunnel switches.

RADIUS User Profile--VRF Name

The following example specifies that the source and destination IP addresses belong to the VPN named vpn-first:

```
cisco.com Password = "secret"
      Service-Type = Outbound-User,
      cisco-avpair = "vpdn:tunnel-id=LAC",
      cisco-avpair = "vpdn:tunnel-type=l2tp",
      cisco-avpair = "vpdn:ip-addresses=10.0.0.1",
      cisco-avpair = "vpdn:source-ip=10.0.0.9",
      cisco-avpair = "vpdn:vpn-vrf=vpn-first"
      cisco-avpair = "vpdn:l2tp-tunnel-password=supersecret"
```

RADIUS User Profile--VRF ID

The following example specifies that the source and destination IP addresses belong to the VPN with the ID A1:3F6C:

```
cisco.com Password = "secret"
      Service-Type = Outbound-User,
      cisco-avpair = "vpdn:tunnel-id=LAC",
      cisco-avpair = "vpdn:tunnel-type=l2tp",
      cisco-avpair = "vpdn:ip-addresses=10.0.0.1",
      cisco-avpair = "vpdn:source-ip=10.0.0.9",
      cisco-avpair = "vpdn:vpn-id=A1:3F6C"
      cisco-avpair = "vpdn:l2tp-tunnel-password=supersecret"
```

Example Manually Configuring the IP MTU for VPDN Deployments

The following example manually configures an IP MTU of 1460 bytes for all tunnels that use the virtual-template named 1:

```
interface virtual-template 1
 ip mtu 1460
```

Example Enabling Automatic Adjustment of the IP MTU for VPDN Deployments

The following example configures tunnels associated with the VPDN group named tunneler to automatically adjust the IP MTU based on the MTU of the egress interface of the device:

```
vpdn-group tunneler
 ip mtu adjust
```

Example Enabling Path MTU Discovery for VPDNs

The following example enables PMTUD for the VPDN group named tunnelme and configures the device to accept path MTU values ranging from 576 to 1460 bytes. The device will ignore code 4 ICMP messages that specify a path MTU outside of this range.

```
vpdn-group tunnelme
ip pmtu
!
vpdn pmtu maximum 1460
vpdn pmtu minimum 576
```

Example Manually Configuring the Advertised TCP MSS

The following example manually configures a TCP MSS of 1420 bytes for all tunnels that use the virtual template named 2:

```
interface virtual-template 2
 ip tcp adjust-mss 1420
```

Example Configuring MRU Advertising

The following example manually configures an MTU of 1460 bytes for all tunnels that use the virtual template named 3. The VPDN group named mytunnels is configured to perform LCP renegotiation because it uses proxy LCP.

```
interface virtual-template 3
 mtu 1460
!
vpdn-group mytunnels
 lcp renegotiation always
```

Example Configuring Preservation of QoS Classifications in the ToS Byte

The following example configures preservation of the IP ToS field for an existing VPDN group named out1:

```
vpdn-group out1
 ip tos reflect
```

Example Manually Configuring the IP Precedence for VPDNs

The following example manually configures an IP precedence value for an existing VPDN group named out2:

```
vpdn-group out2
 ip precedence priority
```

Example Manually Configuring the ToS for VPDN Sessions

The following example manually configures a ToS classification for an existing VPDN group named out3:

```
vpdn-group out3
 ip tos 9
```

Configuration Examples for VPDN Group Selection

Example Configuring VPDN Group Selection Based on Hostname

The following example configuration shows a LAC-1 building a VPDN tunnel to an LNS, and the LNS would terminating the session on vpdn-group 1:

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
```

Example Configuring VPDN Group Selection Based on an IP Address

The following example configuration shows a LAC-1/LAC-2 building a VPDN tunnel to IP address 10.10.10.1, and the LNS terminating the session on vpdn-group 1. If an LAC-1/LAC-2 builds a VPDN tunnel to IP address 10.10.10.2, the LNS terminates the session on vpdn-group 2. Any source IP address match is optional.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# source-ip 10.10.10.1
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# exit
Router(config)# vpdn-group 2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# source-ip 10.10.10.2
```

Example Configuring VPDN Group Selection Based on VRF

The following example configuration shows a LAC sending a SCCRQ on service-A, and the LNS terminating the tunnel on vpdn-group 1. When an LAC sends a SCCRQ on service-B, the LNS would terminate the tunnel on vpdn-group 2.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-A
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# vpdn-group 2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-B
```

Example Configuring VPDN Group Selection Based on a Hostname and IP Address

The following example configuration shows a LAC-1 building a VPDN tunnel to IP address 10.10.10.1, and the LNS terminating the session on vpdn-group 1. If LAC-1 builds a VPDN tunnel to IP address 10.10.10.2, the LNS terminates the session on vpdn-group 2. If LAC-2 builds a VPDN tunnel to IP addresses 10.10.10.1 or 10.10.10.2, the LNS terminates the session on vpdn-group 3.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
Router(config-vpdn-acc-in)# source-ip 10.10.10.1
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# vpdn-group 2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
Router(config-vpdn-acc-in)# source-ip 10.10.10.2
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# vpdn-group 3
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# terminate-from hostname LAC-2
Router(config-vpdn-acc-in)# source-ip 10.10.10.1
Router(config-vpdn-acc-in)# exit
```

Example Configuring VPDN Group Selection Based on Hostname and VRF

The following example configuration shows a LAC-1 sending an SCCRQ on vrf service-A with any destination IP address, and the LNS terminating the VPDN tunnel on vpdn-group 1. If LAC-1 sends an SCCRQ on vrf service-B with any destination IP address, the LNS terminates the VPDN tunnel on vpdn-group 2. If LAC-2 sends an SCCRQ on vrf service-B with any destination IP address, the LNS terminates the VPDN tunnel on vpdn-group 3.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-A
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# vpdn-group 2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-B
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# vpdn-group 3
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-B
Router(config-vpdn-acc-in)# terminate-from hostname LAC-2
Router(config-vpdn-acc-in)# exit
```

Example Configuring VPDN Group Selection Based on an IP Address and VRF

The following example configuration shows a LAC-1/LAC-2 sending an SCCRQ on vrf service-A to destination IP address 10.10.10.1, and the LNS terminating the VPDN tunnel on vpdn-group 1. If LAC-1/LAC-2 sends an SCCRQ on vrf service-A to destination IP address 10.10.10.2, the LNS terminates the VPDN tunnel on vpdn-group 2.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-A
Router(config-vpdn-acc-in)# source-ip 10.10.10.1
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# exit
Router(config)# vpdn-group 2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-A
Router(config-vpdn-acc-in)# source-ip 10.10.10.2
Router(config-vpdn-acc-in)# exit
```

Example Configuring VPDN Group Selection Based on Hostname VRF and IP Address

The following example configuration shows a LAC-1 sending an SCCRQ on vrf service-A to destination IP address 10.10.10.1, and the LNS terminating the VPDN tunnel on vpdn-group 1. If LAC-1 sends an SCCRQ on vrf service-B to destination IP address 10.10.10.1, the LNS terminates the VPDN tunnel on vpdn-group 2.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-A
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
Router(config-vpdn-acc-in)# source-ip 10.10.10.1
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# exit
Router(config)# vpdn-group 2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# vpn vrf service-B
Router(config-vpdn-acc-in)# terminate-from hostname LAC-1
Router(config-vpdn-acc-in)# source-ip 10.10.10.1
Router(config-vpdn-acc-in)# exit
```

Examples Displaying VPDN Group Selection

The VPDN Group Selection feature allows you to display VPDN group information based in a source IP address, a hostname, or VFR.

For examples purposes, the following configuration will be used for the display examples.

```
Router> enable
Router# configure terminal
Router(config)# vpdn-group vgdefault
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 20
Router(config-vpdn-acc-in)# local name lns
Router(config-vpdn)# l2tp tunnel password 0 example
Router(config-vpdn)# exit
Router(config)# vpdn-group vg-ip2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 5
Router(config-vpdn-acc-in)# source-ip 10.1.1.2
Router(config-vpdn)# local name lns
Router(config-vpdn)# l2tp tunnel password 0 example
Router(config-vpdn)# exit
Router(config)# vpdn-group vg-ip3
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 5
Router(config-vpdn-acc-in)# source-ip 10.1.1.3
Router(config-vpdn)# local name lns
Router(config-vpdn)# l2tp tunnel password 0
 example

Router(config-vpdn)# exit
Router(config)# vpdn-group vg-lts
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in) # protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 5
Router(config-vpdn-acc-in)# terminate host lts
Router(config-vpdn)# local name lns
Router(config-vpdn)# l2tp tunnel password 0 example
Router(config-vpdn)# exit
Router(config)# vpdn-group vg-lts1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 5
Router(config-vpdn-acc-in)# terminate host lts1
Router(config-vpdn)# local name lns
Router(config-vpdn)# l2tp tunnel password 0 example
Router(config-vpdn)# exit
Router(config)# vpdn-group vg-lts1-ip2
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 5
Router(config-vpdn-acc-in)# terminate host lts1
Router(config-vpdn)# source-ip 10.1.1.2
Router(config-vpdn)# local name lns
Router(config-vpdn)# l2tp tunnel password 0 example
Router(config-vpdn)# exit
Router(config)# end
```

Examples Displaying VPDN Group-Select Summaries

The following example shows VPDN group-select information for the example configuration.

```
Router# show vpdn group-select summary
VPDN Group     Vrf    Remote Name     Source-IP     Protocol     Direction
vg-ip2            10.1.1.2     l2tp     accept-dialin
vg-ip3            10.1.1.3     l2tp     accept-dialin
vg-lts        lts     0.0.0.0     l2tp     accept-dialin
vg-lts1        lts1    0.0.0.0     l2tp     accept-dialin
vg-lts1-ip2     vfr101   lts1     10.1.1.2     l2tp     accept-dialin
vgdefault            0.0.0.0     l2tp     accept-dialin
```

The following is sample output from the **show vpdn group-select keys** command for a host with the name lac-1 and an IP address of 10.0.0.1:

```
Router# show vpdn group-select keys vrf vrf-blue hostname lac-1 source-ip 10.0.0.1
```

```
VPDN Group       Vrf        Hostname   Source Ip
vg1              vrf-blue   lac-1      10.0.0.1
```

The following shows an example output for the **show vpdn group-select default** command for the example configuration:

```
Router# show vpdn group-select default
Default VPDN Group       Protocol
vgdefault       l2tp
None       pptp
```

The following is sample output from the **show vpdn group-select keys**command for a host with the name lac-5 and an IP address of 10.1.1.0, and VRF name vrf-red:

```
Router# show vpdn group-select keys vrf vrf-red hostname lac-5 source-ip 10.1.1.0
VPDN Group    Vrf        Hostname    Source Ip
Vg2           vrf-red    lac-5         10.1.1.0
```

Where to Go Next

You can perform any of the relevant optional tasks in the VPDN Tunnel Management module.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
VPDN technology overview	VPDN Technology Overview
Information about PPP configurations	Configuring Asynchronous SLIP and PPP module
Dial Technologies commands	*Cisco IOS Dial Technologies Command Reference*
Information about IPSec transform sets, crypto maps, and ISAKMP policies	Configuring Internet Key Exchange for IPsec VPNs module
Security commands	*Cisco IOS Security Command Reference*
Information about QoS classification	Classification Overview module
QoS commands	*Cisco IOS Quality of Service Solutions Command Reference*
Information on MTU tuning for L2TP tunneling deployments	MTU Tuning for L2TP
Information on IP packet fragmentation and PMTUD	IP Fragmentation and PMTUD

Related Topic	Document Title
Information on throughput-reduction DoS attacks	Crafted ICMP Messages Can Cause Denial of Service

Standards

Standard	Title
None	--

MIBs

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

RFCs

RFC	Title
RFC 1191	*Path MTU Discovery*
RFC 2341	Cisco Layer Two Forwarding (Protocol) “L2F” **Note** Effective with Cisco Release 12.4(11)T, the L2F protocol was removed in Cisco IOS software
RFC 2637	Point-to-Point Tunneling Protocol (PPTP)
RFC 2661	*Layer Two Tunneling Protocol “L2TP”*
RFC 2923	TCP Problems with Path MTU Discovery
RFC 3193	Securing L2TP using IPsec

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 Additional VPDN Features

The following table provides release information about the feature or features described in this module. This table 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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 12: Feature Information for Configuring Additional VPDN Features

Feature Name	Software Releases	Feature Configuration Information
VPDN Group Selection	12.4(20)T	This feature configures customized, multiple VPDN tunnels with different VPDN group configurations between a LAC and an LNS. The following command were introduced by this feature: **show vpdn group-select**, **show vpdn group-select keys.**
L2TP Dial-Out Load Balancing and Redundancy	12.2(15)T 12.2(28)SB	This feature enables a tunnel server to dial out to multiple NASs. When the NAS with the highest priority goes down, it is possible for the tunnel server to fail over to another lower priority NAS. The tunnel server can also load balance sessions between multiple NASs that have the same priority settings. The following command was modified by this feature: **initiate-to**.

Feature Name	Software Releases	Feature Configuration Information
L2TP Security	12.2(4)T 12.2(28)SB	This feature allows the security features of IP Security (IPSec) to protect the L2TP tunnel and the PPP sessions within the tunnel. In addition, the L2TP Security feature provides built-in keepalives and standardized interfaces for user authentication and accounting to authentication, authorization, and accounting (AAA) servers. The following commands were introduced or modified by this feature: **crypto map** (global IPSec), **ip pmtu**, **l2tp security crypto-profile**.
VPDN Default Group Template	12.2(8)T 12.2(28)SB	This feature introduces the ability to configure global default values for VPDN group parameters in a VPDN template. These global default values are applied to all VPDN groups, unless specific values are configured for individual VPDN groups. The following commands were introduced by this feature: **source vpdn-template**, **vpdn-template**.
VRF-Aware VPDN Tunnels	12.2(15)T 12.2(28)SB	This feature enhances the support of VPDN tunnels by allowing VPDN tunnels to start outside an MPLS VPN and terminate within the MPLS VPN. The following command was introduced by this feature: **vpn**.

CHAPTER 7

VPDN Tunnel Management

This module contains information about managing virtual private dialup network (VPDN) tunnels and monitoring VPDN events. The tasks documented in this module should be performed only after configuring and deploying a VPDN.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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 table at the end of this module.

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

Prerequisites for VPDN Tunnel Management

Before you can perform the tasks in this module, you must configure a VPDN deployment. For an overview of VPDN deployments, see the VPDN Technology Overview module.

Information About VPDN Tunnel Management

Termination of VPDN Tunnels

VPDN tunnels can be terminated manually or through a soft shutdown. Manual termination of a VPDN tunnel results in the immediate shutdown of the specified VPDN tunnel and all sessions within that tunnel, resulting in a sudden disruption of VPDN services. Enabling soft shutdown on a router prevents the establishment of new VPDN sessions in all VPDN tunnels that terminate on that router, but does not affect existing sessions. Opting to terminate a VPDN tunnel by enabling soft shutdown prevents the disruption of established sessions that occurs when a VPDN tunnel is manually terminated.

VPDN Session Limits

The number of simultaneous VPDN sessions that can be established on a router can be manually configured, providing network administrators more control over the network. VPDN session limits can increase performance and reduce latency for routers that are otherwise forced to operate at high capacity.

The maximum number of VPDN sessions can be configured globally, at the level of a VPDN group, or for all VPDN groups associated with a particular VPDN template.

The hierarchy for the application of VPDN session limits is as follows:

- Globally configured session limits take precedence over session limits configured for a VPDN group or in a VPDN template. The total number of sessions on a router cannot exceed a configured global session limit.
- Session limits configured for a VPDN template are enforced for all VPDN groups associated with that VPDN template. The total number of sessions for all of the associated VPDN groups cannot exceed the configured VPDN template session limit.
- Session limits configured for a VPDN group are enforced for that VPDN group.

Control Packet Parameters for VPDN Tunnels

Certain control packet timers, retry counters, and the advertised control packet receive window size can be configured for Layer 2 Transport Protocol (L2TP) or Layer 2 Forwarding (L2F) VPDN tunnels. Adjustments to these parameters allow fine-tuning of router performance to suit the particular needs of the VPDN deployment.

L2TP Congestion Avoidance

L2TP congestion avoidance provides packet flow control and congestion avoidance by throttling L2TP control messages as described in RFC 2661. Throttling L2TP control message packets prevents input buffer overflows on the peer tunnel endpoint, which can result in dropped sessions.

Before the introduction of L2TP congestion avoidance, the window size used to send packets between the network access server (NAS) and the tunnel server was set to the value advertised by the peer endpoint and was never changed. Configuring L2TP congestion avoidance allows the L2TP packet window to be dynamically resized using a sliding window mechanism. The window size grows larger when packets are delivered successfully, and is reduced when dropped packets must be retransmitted.

L2TP congestion avoidance is useful in networks with a relatively high rate of calls being placed by either tunnel endpoint. L2TP congestion avoidance is also useful on highly scalable platforms that support many simultaneous sessions.

How L2TP Congestion Avoidance Works

TCP/IP and RFC 2661 define two algorithms--slow start and congestion avoidance--used to throttle control message traffic between a NAS and a tunnel server. Slow start and congestion avoidance are two independent algorithms that work together to control congestion. Slow start and congestion avoidance require that two variables, a slow start threshold (SSTHRESH) size and a congestion window (CWND) size, be maintained by the sending device for each connection.

The congestion window defines the number of packets that can be transmitted before the sender must wait for an acknowledgment from its peer. The size of the congestion window expands and contracts, but can never exceed the size of the peer device's advertised receive window.

The slow start threshold defines the point at which the sending device switches operation from slow start mode to congestion avoidance mode. When the congestion window size is smaller than the slow start threshold, the device operates in slow start mode. When the congestion window size equals the slow start threshold, the device switches to congestion avoidance mode.

When a new connection is established, the sending device initially operates in slow start mode. The congestion window size is initialized to one packet, and the slow start threshold is set to the receive window size advertised by the peer tunnel endpoint (the receiving side).

The sending device begins by transmitting one packet and waiting for it to be acknowledged. When the acknowledgment is received, the congestion window size is incremented from one to two, and two packets can be sent. When those two packets are each acknowledged, the congestion window is increased to four. The congestion window doubles for each complete round trip, resulting in an exponential increase in size.

When the congestion window size reaches the slow start threshold value, the sending device switches over to operate in congestion avoidance mode. Congestion avoidance mode slows down the rate at which the congestion window size grows. In congestion avoidance mode, for every acknowledgment received the congestion window increases at the rate of 1 divided by the congestion window size. This results in linear, rather than exponential, growth of the congestion window size.

At some point, the capacity of the peer device will be exceeded and packets will be dropped. This indicates to the sending device that the congestion window has grown too large. When a retransmission event is detected, the slow start threshold value is reset to half of the current congestion window size, the congestion window size is reset to one, and the device switches operation to slow start mode (if it was not already operating in that mode).

VPDN Extended Failover

Before Cisco IOS Release 12.2(13)T, L2TP failover described only one scenario: During tunnel establishment, if a router sent a Start-Control-Connection-Request (SCCRQ) message a number of times and received no response from the peer, the router could then "fail over" to the IP address of another peer (if so configured) and attempt tunnel establishment with that peer.

Cisco IOS Release 12.2(13)T extended L2TP failover to accommodate these scenarios:

- During tunnel establishment, a router receives a StopCCN message from its peer.
- During session establishment, a router receives a CDN message from its peer.

In either case, the router marks the peer IP address as busy for 60 seconds during which no attempt to establish a session or tunnel will be made to that peer. The router then selects an alternate peer to contact. If a tunnel is already established to this alternate peer, the router uses the existing tunnel to bring up the new session. Otherwise, the router will send an SCCRQ message to the alternate peer to initiate tunnel establishment.

Beginning with Cisco IOS Release 12.2(31)ZV, the VPDN Extended Failover feature extends the Result Code and Error Code values to include all L2TP CDN result codes, generating a failover if the L2TP session is not established.

These L2TP CDN result codes are exceptions for failover because they are considered session-specific errors:

- L2TP_RESULT_CDN_CARRIER_LOSS(1)
- L2TP_RESULT_CDN_NO_CARRIER(7)
- L2TP_RESULT_CDN__BUSY(8)
- L2TP_RESULT_CDN_NO_DIAL_TONE(9)
- L2TP_RESULT_CDN_TIMEOUT(10)
- L2TP_RESULT_CDN_BAD_FRAMING(11)

How VPDN Extended Failover Works

The VPDN Extended Failover feature extends L2TP failover to occur if during tunnel establishment an LNS receives a StopCCN message from its peer or during session establishment an LNS receives a CDN message from its peer. In either case, the LNS selects an alternate peer to contact.

A Result Code attribute-value pair (AVP) is included in both the StopCCN and CDN control messages that indicates the reason for tunnel or session termination, respectively. This AVP might also include an optional Error Code, which further describes the nature of the termination. The various Result Code and Error Code values were standardized in RFC 2661.

Failover Through an LTS

The VPDN Extended Failover feature provides support for failover when using an L2TP Tunnel Switch (LTS) by using this error code:

L2TP_VENDOR_ERROR_GROUP_BUSY(6)

This error indicates that all of the IP addresses specified in the VPDN group are busy.

In addition, the IP address of the LNS or LTS is placed on the busy list, even when an L2TP session is established, when these CDN messages are received:

L2TP_RESULT_CDN_ERROR L2TP_ERROR_VENDOR_SPECIFIC
L2TP_ERROR_VENDOR_GROUP_BUSY L2TP_ERROR_VENDOR_SLIMIT

VPDN Event Logging

There are two types of VPDN event logging available, VPDN failure event logging and generic VPDN event logging. The logging of VPDN failure events is enabled by default. Generic VPDN event logging is disabled by default, and must be explicitly enabled before generic event messages can be viewed.

How to Manage VPDN Tunnels

Manually Terminating VPDN Tunnels

Manual termination of a VPDN tunnel results in the immediate shutdown of the specified VPDN tunnel and all sessions within that tunnel, resulting in a sudden disruption of VPDN services. Before manually terminating a VPDN tunnel, consider performing the task in the Enabling Soft Shutdown of VPDN Tunnels, on page 282 instead.

A manually terminated VPDN tunnel can be restarted immediately when a user logs in. Manually terminating and restarting a VPDN tunnel while VPDN event logging is enabled can provide useful troubleshooting information about VPDN session establishment.

Perform this task to manually shut down a specific VPDN tunnel, resulting in the termination of the tunnel and all sessions in that tunnel. You can perform this task on these devices:

- The tunnel server
- The NAS when it is functioning as a tunnel endpoint

Note For Point-to-Point Tunneling Protocol (PPTP) tunnels and client-initiated L2TP tunnels, you can perform this task only on the tunnel server.

SUMMARY STEPS

1. **enable**
2. Do one of the following:
   - **clear vpdn tunnel** {**pptp** | **l2tp**} {**all** | **hostname** r*emote-name* [*local-name*] | **id** *local-id* | **ip** *local-ip-address* | **ip** *remote-ip-address*}
   - **clear vpdn tunnel l2f** {**all** | **hostname** *nas-name hgw-name* | **id** *local-id* | **ip** *local-ip-address* | **ip** *remote-ip-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	- Enter your password if prompted.

Step 2	Do one of the following:
	- **clear vpdn tunnel** {**pptp** | **l2tp**} {**all** | **hostname** *remote-name* [*local-name*] | **id** *local-id* | **ip** *local-ip-address* | **ip** *remote-ip-address*}
	- **clear vpdn tunnel l2f** {**all** | **hostname** *nas-name hgw-name* | **id** *local-id* | **ip** *local-ip-address* | **ip** *remote-ip-address*}
	Example:
	`Router# clear vpdn tunnel l2tp all`
	Example:
	`Router# clear vpdn tunnel l2f hostname nas12 hgw32`
		Shuts down a specified tunnel and all sessions within the tunnel.

Enabling Soft Shutdown of VPDN Tunnels

Enabling soft shutdown of VPDN tunnels on a router prevents the establishment of new VPDN sessions in all VPDN tunnels that terminate on that router, but does not affect existing sessions. Opting to terminate a VPDN tunnel by enabling soft shutdown prevents the disruption of established sessions that occurs when a VPDN tunnel is manually terminated. Enabling soft shutdown on a router or access server will affect all of the tunnels terminating on that device. There is no way to enable soft shutdown for a specific tunnel. If you want to shut down a specific tunnel on a device without affecting any other tunnels, perform the task in the Manually Terminating VPDN Tunnels, on page 281 instead.

When soft shutdown is performed on a NAS, the potential session will be authorized before it is refused. This authorization ensures that accurate accounting records can be kept.

When soft shutdown is performed on a tunnel server, the reason for the session refusal will be returned to the NAS. This information is recorded in the VPDN history failure table.

Note Enabling soft shutdown of VPDN tunnels does not affect the establishment of Multichassis Multilink PPP (MMP) tunnels.

Perform this task to prevent new sessions from being established in any VPDN tunnel terminating on the router without disturbing service for existing sessions. You can perform this task on these devices:

- The tunnel server
- The NAS when it is functioning as a tunnel endpoint

Note

- For PPTP tunnels and client-initiated L2TP tunnels, you can perform this task only on the tunnel server.
- Enabling soft shutdown of VPDN tunnels will not prevent new MMP sessions from being established.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn softshut**

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	**vpdn softshut** **Example:** `Router(config)# vpdn softshut`	Prevents new sessions from being established on a VPDN tunnel without disturbing existing sessions.

Verifying the Soft Shutdown of VPDN Tunnels

Perform this task to ensure that soft shutdown is working properly.

SUMMARY STEPS

1. Establish a VPDN session by dialing in to the NAS using an allowed username and password.
2. **enable**
3. **configure terminal**
4. **vpdn softshut**
5. **exit**
6. **show vpdn**
7. Attempt to establish a new VPDN session by dialing in to the NAS using a second allowed username and password.
8. **show vpdn history failure**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Establish a VPDN session by dialing in to the NAS using an allowed username and password.	
Step 2	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**vpdn softshut** **Example:** `Router(config)# vpdn softshut`	Prevents new sessions from being established on a VPDN tunnel without disturbing existing sessions. You can issue this command on either the NAS or the tunnel server.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits to privileged EXEC mode.
Step 6	**show vpdn** **Example:** `Router# show vpdn`	Displays information about active L2TP or L2F tunnels and message identifiers in a VPDN. Issue this command to verify that the original session is active:

	Command or Action	Purpose
Step 7	Attempt to establish a new VPDN session by dialing in to the NAS using a second allowed username and password.	If soft shutdown has been enabled, a system logging (syslog) message appears on the console of the soft shutdown router.
Step 8	**show vpdn history failure** **Example:** `Router# show vpdn history failure`	Displays the content of the history failure table.

Limiting the Number of Allowed Simultaneous VPDN Sessions

The number of simultaneous VPDN sessions that can be established on a router can be manually configured, providing network administrators more control over the network. VPDN session limits can increase performance and reduce latency for routers that are otherwise forced to operate at high capacity.

The maximum number of VPDN sessions can be configured globally, at the level of a VPDN group, or for all VPDN groups associated with a particular VPDN template.

The hierarchy for the application of VPDN session limits is as follows:

- Globally configured session limits take precedence over session limits configured for a VPDN group or in a VPDN template. The total number of sessions on a router cannot exceed a configured global session limit.
- Session limits configured for a VPDN template are enforced for all VPDN groups associated with that VPDN template. The total number of sessions for all of the associated VPDN groups cannot exceed the configured VPDN template session limit.
- Session limits configured for a VPDN group are enforced for that VPDN group.

For an example of the interactions of global, template-level, and group-level VPDN session limits, see the "Examples Configuring VPDN Session Limits" section.

Perform any or all of the following optional tasks to configure VPDN session limits:

You can perform these tasks on the NAS or the tunnel server.

Restrictions

For PPTP tunnels and client-initiated L2TP tunnels, you can perform these tasks only on the tunnel server.

Configuring Global VPDN Session Limits

Perform this task to limit the total number of VPDN sessions allowed on the router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn session-limit** *sessions*

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	**vpdn session-limit** *sessions* **Example:** `Router(config)# vpdn session-limit 6`	Limits the number of simultaneous VPDN sessions globally on the router.

Configuring VPDN Session Limits in a VPDN Template

Perform this task to configure a session limit in a VPDN template. The session limit is applied across all VPDN groups associated with the VPDN template.

Before You Begin

- A VPDN template must be configured. See the "Creating a VPDN Template" section in the "Configuring Additional VPDN Features" module.
- If you configure a named VPDN template, you must associate the desired VPDN groups with the VPDN template. See the "Associating a VPDN Group with a VPDN Template" section in the "Configuring Additional VPDN Features" module.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-template** [*name*]
4. **group session-limit** *sessions*

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	**vpdn-template** [*name*] **Example:** `Router(config)# vpdn-template l2tp`	Creates a VPDN template and enters VPDN template configuration mode.
Step 4	**group session-limit** *sessions* **Example:** `Router(config-vpdn-templ)# group session-limit 6`	Specifies the maximum number of concurrent sessions allowed across all VPDN groups associated with a particular VPDN template.

Configuring Session Limits for a VPDN Group

Perform this task to limit the number of VPDN sessions at the VPDN group level.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **session-limit** *number*

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	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group 1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**session-limit** *number* **Example:** `Router(config-vpdn)# session-limit 2`	Limits the number of sessions that are allowed through a specified VPDN group.

Verifying VPDN Session Limits

Perform this task to ensure that VPDN sessions are being limited properly.

Note If you use a Telnet session to connect to the NAS, enable the **terminal monitor** command, which ensures that your EXEC session is receiving the logging and debug output from the NAS.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn session-limit** *sessions*
4. Establish a VPDN session by dialing in to the NAS using an allowed username and password.
5. Attempt to establish a new VPDN session by dialing in to the NAS using a second allowed username and password.
6. **exit**
7. **show vpdn history failure**

DETAILED STEPS

Step 1 **enable**

Enter this command to enable privileged EXEC mode. Enter your password if prompted:

Example:

```
Router> enable
```

Step 2 **configure terminal**

Enters global configuration mode.

Example:

```
Router# configure terminal
```

Step 3 **vpdn session-limit** *sessions*

Limits the number of simultaneous VPDN sessions on the router to the number specified with the *sessions* argument.

Issue this command on either the NAS or the tunnel server.

Example:

```
Router(config)# vpdn session-limit 1
```

Step 4 Establish a VPDN session by dialing in to the NAS using an allowed username and password.

Step 5 Attempt to establish a new VPDN session by dialing in to the NAS using a second allowed username and password.

If VPDN session limits have been configured properly, this session will be refused and a syslog message similar to the following should appear on the console of the router:

Example:

```
00:11:17:%VPDN-6-MAX_SESS_EXCD:L2F HGW tunnelserver1 has exceeded configured local session-limit and
 rejected user user2@cisco.com
```

Step 6 **exit**

Exits to privileged EXEC mode.

Step 7 **show vpdn history failure**

Shows the content of the history failure table.

Example:

```
Router# show vpdn history failure
User:user2@scisco.com
 NAS:NAS1, IP address = 172.25.52.8, CLID = 2
 Gateway:tunnelserver1, IP address = 172.25.52.7, CLID = 13
 Log time:00:04:21, Error repeat count:1
 Failure type:Exceeded configured VPDN maximum session limit.
!This output shows that the configured session limit is being properly applied.
 Failure reason:
```

Configuring L2TP Control Packet Parameters for VPDN Tunnels

Control packet timers, retry counters, and the advertised control packet receive window size can be configured for L2TP VPDN tunnels. Adjustments to these parameters allow fine-tuning of router performance to suit the particular needs of the VPDN deployment.

Perform this task to configure control packet parameters if your VPDN configuration uses L2TP tunnels. The configuration of each parameter is optional. If a parameter is not manually configured, the default value will be used.

You can perform this task on these devices:

- The tunnel server
- The NAS when it is functioning as a tunnel endpoint

Before You Begin

Load balancing must be enabled for the configuration of the **l2tp tunnel retransmit initial timeout** command or the **l2tp tunnel retransmit initial retries** command to have any effect.

Note For client-initiated L2TP tunnels, you can perform this task only on the tunnel server.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **l2tp tunnel hello** *seconds*
5. **l2tp tunnel receive window** *packets*
6. **l2tp tunnel retransmit retries** *number*
7. **l2tp tunnel retransmit timeout** {**min** | **max**} *seconds*
8. **l2tp tunnel timeout no-session** {*seconds* | **never**}
9. **l2tp tunnel timeout setup** *seconds*
10. **l2tp tunnel zlb delay** *seconds*
11. **l2tp tunnel retransmit initial timeout** {**min** | **max**} *seconds*
12. **l2tp tunnel retransmit initial retries** *number*
13. **l2tp tunnel busy timeout** *seconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group group1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**l2tp tunnel hello** *seconds* **Example:** `Router(config-vpdn)# l2tp tunnel hello 90`	(Optional) Set the number of seconds between sending hello keepalive packets for an L2TP tunnel. • *seconds* --Time, in seconds, that the NAS and tunnel server will wait before sending the next L2TP tunnel keepalive packet. Valid values range from 0 to 1000. The default value is 60.
Step 5	**l2tp tunnel receive window** *packets* **Example:** `Router(config-vpdn)# l2tp tunnel receive window 500`	(Optional) Configures the number of packets allowed in the local receive window for an L2TP control channel. • *packets* --Number of packets allowed in the receive window. Valid values range from 1 to 5000. The default value varies by platform.
Step 6	**l2tp tunnel retransmit retries** *number* **Example:** `Router(config-vpdn)# l2tp tunnel retransmit retries 8`	(Optional) Configures the number of retransmission attempts made for an L2TP control packet. • *number* --Number of retransmission attempts. Valid values range from 5 to 1000. The default value is 10.
Step 7	**l2tp tunnel retransmit timeout** {**min** | **max**} *seconds* **Example:** `Router(config-vpdn)# l2tp tunnel retransmit timeout max 4`	(Optional) Configures the amount of time that the router will wait before resending an L2TP control packet. • **min** --Specifies the minimum time that the router will wait before resending a control packet. • **max** --Specifies the maximum time that the router will wait before resending a control packet. • *seconds* --Timeout length, in seconds, the router will wait before resending a control packet. Valid values range from 1 to 8. The default minimum value is 1. The default maximum value is 8.

	Command or Action	Purpose
Step 8	**l2tp tunnel timeout no-session** {*seconds* | **never**} **Example:** `Router(config-vpdn)# l2tp tunnel timeout no-session never`	(Optional) Configures the time a router waits after an L2TP tunnel becomes empty before tearing down the tunnel. • *seconds* --Time, in seconds, the router will wait before tearing down an empty L2TP tunnel. Valid values range from 0 to 86400. If the router is configured as a NAS, the default is 15 seconds. If the router is configured as a tunnel server, the default is 10. • **never** --Specifies that the router will never tear down an empty L2TP tunnel.
Step 9	**l2tp tunnel timeout setup** *seconds* **Example:** `Router(config-vpdn)# l2tp tunnel timeout setup 25`	(Optional) Configures the amount of time that the router will wait for a confirmation message after sending out the initial L2TP control packet before considering a peer busy. • *seconds* --Time, in seconds, the router will wait for a confirmation message. Valid values range from 60 to 6000. The default value is 10.
Step 10	**l2tp tunnel zlb delay** *seconds* **Example:** `Router(config-vpdn)# l2tp tunnel zlb delay 2`	(Optional) Configures the delay time before a zero length bit (ZLB) control message must be acknowledged. • *seconds* --Maximum number of seconds the router will delay before acknowledging ZLB control messages. Valid values range from 1 to 5. The default value is 3.
Step 11	**l2tp tunnel retransmit initial timeout** {**min** | **max**} *seconds* **Example:** `Router(config-vpdn)# l2tp tunnel retransmit initial timeout min 2`	(Optional) Sets the amount of time, in seconds, that the router will wait before resending an initial packet out to establish a tunnel. • **min** --Specifies the minimum time that the router will wait before resending an initial packet. • **max** --Specifies the maximum time that the router will wait before resending an initial packet. • *seconds* --Timeout length, in seconds, the router will wait before resending an initial packet. Valid values range from 1 to 8. The default minimum value is 1. The default maximum value is 8. **Note** Load balancing must be configured for the retry counter configured with the **l2tp tunnel retransmit initial timeout** command to take effect.
Step 12	**l2tp tunnel retransmit initial retries** *number* **Example:** `Router(config-vpdn)# l2tp tunnel retransmit initial retries 5`	(Optional--Cisco IOS Release 12.2(4)T, Cisco IOS Release 12.2(28)SB, or a later release) Sets the number of times that the router will attempt to send out the initial control packet for tunnel establishment before considering a router busy. • *number* --Number of retransmission attempts. Valid values range from 1 to 1000. The default value is 2.

	Command or Action	Purpose
		Note Load balancing must be configured for the retry counter configured with the **l2tp tunnel retransmit initial retries** command to take effect.
Step 13	**l2tp tunnel busy timeout** *seconds* **Example:** `Router(config-vpdn)# l2tp tunnel busy timeout 90`	(Optional) Configures the amount of time, in seconds, that the router will wait before attempting to recontact a router that was previously busy. • *seconds* --Time, in seconds, the router will wait before checking for router availability. Valid values range from 60 to 6000. The default value is 300.

Configuring L2F Control Packet Parameters for VPDN Tunnels

Certain control packet timers and retry counters can be configured for L2F VPDN tunnels. Adjustments to these parameters allow fine-tuning of router performance to suit the particular needs of the VPDN deployment.

Perform this task to configure control packet timers and retry counters if your VPDN configuration uses L2F tunnels. The configuration of each parameter is optional. If a parameter is not manually configured, the default values will be used.

You can perform this task on the NAS or the tunnel server.

Before You Begin

Note Load balancing must be enabled for the configuration of the **l2f tunnel retransmit initial retries** command to have any effect.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn-group** *name*
4. **l2f tunnel timeout setup** *seconds*
5. **l2f tunnel retransmit initial retries** *number*
6. **l2f tunnel busy timeout** *seconds*
7. **l2f tunnel retransmit retries** *number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**vpdn-group** *name* **Example:** `Router(config)# vpdn-group group1`	Creates a VPDN group and enters VPDN group configuration mode.
Step 4	**l2f tunnel timeout setup** *seconds* **Example:** `Router(config-vpdn)# l2f tunnel timeout setup 25`	(Optional) Sets the amount of time that the router will wait for a confirmation message after sending out the initial control packet before considering a router busy. • *seconds* --Time, in seconds, the router will wait for a return message. Valid values range from 60 to 6000. The default value is 10.
Step 5	**l2f tunnel retransmit initial retries** *number* **Example:** `Router(config-vpdn)# l2f tunnel retransmit initial retries 5`	(Optional) Sets the number of times that the router will attempt to send the initial control packet for tunnel establishment before considering a router busy. • *number* --Number of retries that will be attempted. Valid values range from 1 to 1000. The default value is 2. **Note** Load balancing must be configured for the retry counter configured with the **l2f tunnel retransmit initial retries** command to take effect.
Step 6	**l2f tunnel busy timeout** *seconds* **Example:** `Router(config-vpdn)# l2f tunnel busy timeout 90`	(Optional) Configures the amount of time that the router will wait before attempting to recontact a router that was previously busy. • *seconds* --Time, in seconds, to wait before checking for peer availability. Valid values range from 60 to 6000. The default value is 300.
Step 7	**l2f tunnel retransmit retries** *number* **Example:** `Router(config-vpdn)# l2f tunnel retransmit retries 10`	(Optional) Sets the number of times the router will attempt to resend tunnel control packets before tearing the tunnel down.

Configuring L2TP Congestion Avoidance

Perform this task to configure L2TP congestion avoidance on a tunnel endpoint, allowing dynamic throttling of the L2TP control packet window size.

You can perform this task on these devices:

- The tunnel server
- The NAS when it is functioning as a tunnel endpoint

This task need be performed only on the sending device.

Note

- This task is compatible only with VPDN deployments that use the L2TP tunneling protocol.
- For client-initiated L2TP tunnels, you can perform this task only on the tunnel server.
- The congestion window size cannot exceed the size of the advertised receive window set by the **l2tp tunnel receive-window** command on the peer device. To configure the advertised receive window on the remote peer device, see the Configuring L2TP Control Packet Parameters for VPDN Tunnels, on page 290.
- L2TP congestion avoidance is enabled (or disabled) only for those tunnels that are established after the configuration has been applied. Tunnels that already exist when the **l2tp congestion-control** command is issued are not affected by the command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2tp congestion-control**
4. **exit**
5. **show vpdn tunnel l2tp all**
6. **debug vpdn l2x-events**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2tp congestion-control** **Example:** `Router(config)# l2tp congestion-control`	Enables L2TP congestion avoidance.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits to privileged EXEC mode.
Step 5	**show vpdn tunnel l2tp all** **Example:** `Router# show vpdn tunnel l2tp all`	Displays information about all active L2TP VPDN tunnels.
Step 6	**debug vpdn l2x-events** **Example:** `Router(config)# debug vpdn l2x-events`	Displays troubleshooting information for protocol-specific VPDN tunneling events.

Configuring VPDN Failure Event Logging

Logging of a failure event to the history table is triggered by event logging by the syslog facility. The syslog facility creates a history failure table, which keeps records of failure events. The table defaults to a maximum of 20 entries, but the size of the table can be configured to retain up to 50 entries.

Failure entries are kept chronologically in the history table. Each entry records the relevant information of a failure event. Only the most recent failure event per user, unique to its name and tunnel client ID (CLID), is kept. When the total number of entries in the table reaches the configured maximum table size, the oldest record is deleted and a new entry is added.

The logging of VPDN failure events to the VPDN history failure table is enabled by default. You need enable VPDN failure event logging only if it has been previously disabled. Perform this task to enable VPDN failure event logging, to configure the maximum number of entries the history failure table can hold, and to display and clear the contents of the VPDN history failure table.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn history failure**
4. **vpdn history failure table-size** *entries*
5. **exit**
6. **show vpdn history failure**
7. **clear vpdn history failure**

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	**vpdn history failure** **Example:** `Router(config)# vpdn history failure`	(Optional) Enables logging of VPDN failure events to the history failure table. **Note** VPDN history failure logging is enabled by default. You need issue the **vpdn history failure** command only if you have previously disabled VPDN history failure logging using the **no vpdn history failure** command.
Step 4	**vpdn history failure table-size** *entries* **Example:** `Router(config)# vpdn history failure table-size 50`	(Optional) Sets the history failure table size. **Note** The VPDN history failure table size can be configured only when VPDN failure event logging is enabled using the **vpdn history failure** command.
Step 5	**exit** **Example:** `Router# exit`	Exits to privileged EXEC mode.
Step 6	**show vpdn history failure** **Example:** `Router# show vpdn history failure`	(Optional) Displays the contents of the history failure table.

	Command or Action	Purpose
Step 7	**clear vpdn history failure** **Example:** `Router# clear vpdn history failure`	(Optional) Clears the contents of the history failure table.

Enabling Generic VPDN Event Logging

Generic VPDN events are a mixture of error, warning, notification, and information reports logged by the syslog facility. When VPDN event logging is enabled locally or at a remote tunnel endpoint, VPDN event messages are printed to the console as the events occur. VPDN event messages can also be reported to a remote authentication, authorization, and accounting (AAA) server in a AAA vendor-specific attribute (VSA), allowing the correlation of VPDN call success rates with accounting records.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vpdn logging** [**accounting** | **local** | **remote** | **tunnel-drop** | **user**]

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	**vpdn logging** [**accounting** | **local** | **remote** | **tunnel-drop** | **user**] **Example:** `Router(config)# vpdn logging remote`	(Optional) Enables the logging of generic VPDN events. • You can configure as many types of generic VPDN event logging as you want by issuing multiple instances of the **vpdn logging** command. **Note** The reporting of VPDN event log messages to a AAA server can be enabled independently of all other generic VPDN event logging configurations.

	Command or Action	Purpose

Configuration Examples for VPDN Tunnel Management

Example Manually Terminating VPDN Tunnels

The following example manually terminates all L2TP tunnels that terminate on the router:

```
Router# clear vpdn tunnel l2tp all
```

The following example manually terminates the L2F tunnel with the tunnel ID 32:

```
Router# clear vpdn tunnel l2f id 32
```

Example Enabling Soft Shutdown of VPDN Tunnels

The following example enables soft shutdown of all VPDN tunnels that terminate on the device that the command is issue on:

```
Router# configure terminal
Router(config)# vpdn softshut
!The following syslog message will appear on the device whenever an attempt is made to
!establish a new VPDN session after soft shutdown is enabled.
!
00:11:17:%VPDN-6-SOFTSHUT:L2TP HGW tunnelserver1 has turned on softshut and rejected user
user2@cisco.com
```

Examples Configuring VPDN Session Limits

The following example configures a VPDN group named customer7 with a group-level session limit of 25. No more than 25 sessions can be associated with this VPDN group.

```
Router(config)# vpdn-group customer7
Router(config-vpdn)# session-limit 25
```

A VPDN template named customer4 is then created, and a session limit of 8 is configured at the VPDN template-level. Two VPDN groups are associated with the VPDN template, each with a VPDN group-level session limit of 5.

```
Router(config)# vpdn-template customer4
Router(config-vpdn-templ)# group session-limit 8
!
Router(config)# vpdn-group customer4_l2tp
Router(config-vpdn)# source vpdn-template customer4
Router(config-vpdn)# session-limit 5
!
Router(config)# vpdn-group customer4_l2f
Router(config-vpdn)# source vpdn-template customer4
Router(config-vpdn)# session-limit 5
```

With this configuration, if the VPDN group named customer4_l2tp has 5 active sessions, the VPDN group named customer4_l2f might establish only 3 sessions. The VPDN group named customer7 might still have up to 25 active sessions.

If a global limit of 16 VPDN sessions is also configured, the global limit takes precedence over the configured VPDN group and VPDN template session limits.

```
Router# configure terminal
Router(config)# vpdn session-limit 16
```

The three VPDN groups will be able to establish a total of 16 sessions between them. For example, if the VPDN group named customer4_l2tp has the maximum allowable number of active sessions (5 sessions), and the VPDN group named customer4_l2f has 2 active sessions, the VPDN group named customer7 might establish only up to 9 sessions.

Example Verifying Session Limits for a VPDN Group

Example of the show vpdn group command output (with resource manager enabled)

The following example creates the VPDN group named l2tp and restricts it to three sessions. When resource manager is enable, the configured session limit is displayed when the **show vpdn group** command is issued.

```
Router# configure terminal
Router(config)# vpdn-group l2tp
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 5
Router(config-vpdn-acc-in)# exit
Router(config-vpdn)# terminate-from hostname host1
Router(config-vpdn)# session-limit 3
Router(config-vpdn)# end
Router# show vpdn group l2tp
Tunnel (L2TP)
------
dnis:cg1
dnis:cg2
dnis:jan
cisco.com
Endpoint        Session Limit Priority Active Sessions Status Reserved Sessions
--------        ------------- -------- --------------- ------ -----------------
172.21.9.67     3             1        0               OK     -
--------------- -------------          ---------------        -----------------
Total           *                      0                      0
```

Example of the show vpdn group command output for session-limit information on an LNS (with or without resource manager enabled)

The new display for **show vpdn group** provides group session-limit information on the LNS:

```
Router# show vpdn group
VPDN group vg1
Group session limit 65535  Active sessions 1  Active tunnels 1
VPDN group vg2
Group session limit 65535  Active sessions 1  Active tunnels 1
```

Example Configuring L2F Control Packet Timers and Retry Counters for VPDN Tunnels

The following example configures all of the available L2F control packet timers and retry counters for the VPDN group named l2f:

```
Router# configure terminal

Router(config)# vpdn-group l2f

Router(config-vpdn)# l2f tunnel timeout setup 25
Router(config-vpdn)# l2f tunnel retransmit initial retries 5
Router(config-vpdn)# l2f tunnel busy timeout 90
Router(config-vpdn)# l2f tunnel retransmit retries 10
```

Example Configuring L2TP Control Packet Timers and Retry Counters for VPDN Tunnels

The following example configures custom values for all of the available L2TP control packet parameters for the VPDN group named l2tp:

```
Router# configure terminal

Router(config)# vpdn-group l2tp

Router(config-vpdn)# l2tp tunnel hello 90
Router(config-vpdn)# l2tp tunnel receive window 500
Router(config-vpdn)# l2tp tunnel retransmit retries 8
Router(config-vpdn)# l2tp tunnel retransmit timeout min 2
Router(config-vpdn)# l2tp tunnel timeout no-session 500
Router(config-vpdn)# l2tp tunnel timeout setup 25
Router(config-vpdn)# l2tp tunnel zlb delay 4
Router(config-vpdn)# l2tp tunnel retransmit initial timeout min 2
Router(config-vpdn)# l2tp tunnel retransmit initial retries 5
Router(config-vpdn)# l2tp tunnel busy timeout 90
```

Example Configuring Verifying and Debugging L2TP Congestion Avoidance

The following example configures a basic dial-in L2TP VPDN tunnel, sets the receive window size to 500 on the tunnel server (the receiving device), and enables L2TP congestion avoidance on the NAS (the sending device):

Tunnel Server Configuration

```
Router(config)# vpdn enable
!
Router(config)# vpdn-group 1
Router(config-vpdn)# accept-dialin
Router(config-vpdn-acc-in)# protocol l2tp
Router(config-vpdn-acc-in)# virtual-template 1
!
Router(config-vpdn)# terminate from hostname NAS1
Router(config-vpdn)# l2tp tunnel receive-window 500
```

NAS Configuration

```
Router(config)# vpdn enable
!
Router(config)# vpdn-group 1
Router(config-vpdn)# request-dialin
Router(config-vpdn-req-in)# protocol l2tp
Router(config-vpdn-req-in)# domain cisco.com
!
Router(config-vpdn)# initiate-to ip 172.22.66.25
Router(config-vpdn)# local name NAS1
!
Router(config)# l2tp congestion-control
```

The following example shows L2TP tunnel activity, including the information that L2TP congestion control is enabled. Note that the slow start threshold is set to the same size as the remote receive window size. The Remote RWS value advertised by the remote peer is shown in the Remote RWS field. When the actual RWS value differs from the advertised value, the actual RWS value will be displayed as *In Use Remote RWS <value>*.

```
Router# show vpdn tunnel l2tp all
L2TP Tunnel Information Total tunnels 1 sessions 1
Tunnel id 30597 is up, remote id is 45078, 1 active sessions
  Tunnel state is established, time since change 00:08:27
  Tunnel transport is UDP (17)
  Remote tunnel name is LAC1
    Internet Address 172.18.184.230, port 1701
  Local tunnel name is LNS1
    Internet Address 172.18.184.231, port 1701
  Tunnel domain unknown
  VPDN group for tunnel is 1
  L2TP class for tunnel is
  4 packets sent, 3 received
  194 bytes sent, 42 received
  Last clearing of "show vpdn" counters never
  Control Ns 2, Nr 4
  Local RWS 1024 (default), Remote RWS 256
  In Use Remote RWS 15
  Control channel Congestion Control is enabled
    Congestion Window size, Cwnd 3
    Slow Start threshold, Ssthresh 256
    Mode of operation is Slow Start
  Tunnel PMTU checking disabled
  Retransmission time 1, max 2 seconds
  Unsent queuesize 0, max 0
  Resend queuesize 0, max 1
  Total resends 0, ZLB ACKs sent 2
  Current nosession queue check 0 of 5
  Retransmit time distribution: 0 0 0 0 0 0 0 0 0
  Sessions disconnected due to lack of resources 0
  Control message authentication is disabled
```

The following partial output from the **debug vpdn l2x-events** command shows that congestion occurred. The congestion window size and the slow start threshold have been reset due to a packet retransmission event.

```
Router# debug vpdn l2x-events
!
*Jul 15 19:02:57.963:  Tnl 47100 L2TP: Congestion Control event received is retransmission
*Jul 15 19:02:57.963:  Tnl 47100 L2TP: Congestion Window size, Cwnd 1
*Jul 15 19:02:57.963:  Tnl 47100 L2TP: Slow Start threshold, Ssthresh 2
*Jul 15 19:02:57.963:  Tnl 47100 L2TP: Remote Window size, 500
*Jul 15 19:02:57.963:  Tnl 47100 L2TP: Control channel retransmit delay set to 4 seconds
*Jul 15 19:03:01.607:  Tnl 47100 L2TP: Update ns/nr, peer ns/nr 2/5, our ns/nr 5/2
!
```

The following partial output from the **debug vpdn l2x-events** command shows that traffic has been restarted with L2TP congestion avoidance operating in slow start mode.

```
Router# debug vpdn l2x-events
```

```
!
*Jul 15 14:45:16.123:  Tnl 30597 L2TP: Control channel retransmit delay set to 2 seconds
*Jul 15 14:45:16.123:  Tnl 30597 L2TP: Tunnel state change from idle to wait-ctl-reply
*Jul 15 14:45:16.131:  Tnl 30597 L2TP: Congestion Control event received is positive
acknowledgement
*Jul 15 14:45:16.131:  Tnl 30597 L2TP: Congestion Window size, Cwnd 2
*Jul 15 14:45:16.131:  Tnl 30597 L2TP: Slow Start threshold, Ssthresh 500
*Jul 15 14:45:16.131:  Tnl 30597 L2TP: Remote Window size, 500
*Jul 15 14:45:16.131:  Tnl 30597 L2TP: Congestion Ctrl Mode is Slow Start
!
```

Example Configuring VPDN Failure Event Logging

The following example first disables and then reenables VPDN failure event logging, and sets the maximum number of entries in the VPDN history failure table to 50. The contents of the history failure table are displayed and then cleared.

```
Router# configure terminal
Router(config)# no vpdn history failure
Router(config)# vpdn history failure
Router(config)# vpdn history failure table-size 50
Router(config)# end
Router# show vpdn history failure
!
Table size: 50
Number of entries in table: 1
User: user@cisco.com, MID = 1
NAS: isp, IP address = 172.21.9.25, CLID = 1
Gateway: hp-gw, IP address = 172.21.9.15, CLID = 1
Log time: 13:08:02, Error repeat count: 1
Failure type: The remote server closed this session
Failure reason: Administrative intervention
!
Router# clear vpdn history failure
```

Examples Configuring Generic VPDN Event Logging

The following example enables VPDN logging locally:

```
Router# configure terminal
Router(config)# vpdn logging local
```

The following example disables VPDN event logging locally, enables VPDN event logging at the remote tunnel endpoint, and enables the logging of both VPDN user and VPDN tunnel-drop events to the remote router:

```
Router# configure terminal
Router(config)# no vpdn logging local
Router(config)# vpdn logging remote
Router(config)# vpdn logging user
Router(config)# vpdn logging tunnel-drop
```

The following example disables the logging of VPDN events at the remote tunnel endpoint, and enables the logging of VPDN event log messages to the AAA server:

```
Router# configure terminal
Router(config)# no vpdn logging local
Router(config)# no vpdn logging remote
Router(config)# vpdn logging accounting
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VPDN commands	*Cisco IOS VPDN Command Reference*
VPDN technology overview	VPDN Technology Overview module
Technical support documentation for VPDNs	Virtual Private Dial-up Network (VPDN)
Dial Technologies commands	*Cisco IOS Dial Technologies Command Reference*

Standards

Standard	Title
TCP/IP; slow start and congestion avoidance algorithms	*TCP/IP Illustrated, Volume 1 , by W Richard Stevens*

MIBs

MIB	MIBs Link
• CISCO-VPDN-MGMT-MIB • CISCO-VPDN-MGMT-EXT-MIB	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 2341	Cisco Layer Two Forwarding (Protocol) L2F
RFC 2637	Point-to-Point Tunneling Protocol (PPTP)
RFC 2661	*Layer Two Tunneling Protocol L2TP*

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 VPDN Tunnel Management

The following table provides release information about the feature or features described in this module. This table 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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 13: Feature Information for VPDN Tunnel Management

Feature Name	Software Releases	Feature Configuration Information
VPDN Extended Failover	12.2(34)SB 12.2(31)ZV 12.2(33)SRE 12.2(33)XNE	This feature enables a failover with an LNS, if the LNS receives a valid L2TP CDN or stopCNN message before the LNS establishes a session.
L2TP Congestion Avoidance	12.2(28)SB	This feature provides packet flow control and congestion avoidance by throttling Layer 2 Transport Protocol (L2TP) control messages as described in RFC 2661. The following commands were introduced or modified by this feature: **debug vpdn**, **l2tp congestion-control**.

Feature Name	Software Releases	Feature Configuration Information
Session Limit per VRF	12.2(13)T	This feature allows you to apply session limits on all VPDN groups associated with a common VPDN template. You can limit the number of VPDN sessions that terminate in a single VPN Routing and Forwarding (VRF) instance. The following commands were introduced or modified by this feature: **group session-limit**, **source vpdn-template**, **vpdn-template**.
Timer and Retry Enhancements for L2TP and L2F	12.2(4)T 12.2(28)SB	This feature allows the user to configure certain adjustable timers and counters for L2TP and L2F. The following commands were introduced by this feature: **l2f tunnel busy timeout**, **l2f tunnel retransmit initial retries**, **l2f tunnel retransmit retries**, **l2f tunnel timeout setup**, **l2tp tunnel busy timeout**, **l2tp tunnel retransmit initial retries**, **l2tp tunnel retransmit initial timeout**.
VPDN Group Session Limiting	12.2(4)T 12.2(28)SB	This feature allows the user to configure a limit on the number of L2F or L2TP VPDN sessions allowed for each VPDN group. The following command was introduced by this feature: **session-limit** (VPDN).