



# L2VPN Pseudowire Redundancy

---

**First Published: April 20, 2005**  
**Last Updated: July 25, 2011**

The L2VPN Pseudowire Redundancy feature lets you configure your network to detect a failure in the network and reroute the Layer 2 (L2) service to another endpoint that can continue to provide service. This feature provides the ability to recover from a failure either of the remote provider edge (PE) router or of the link between the PE and customer edge (CE) routers.

## Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the [“Feature Information for L2VPN Pseudowire Redundancy”](#) section on page 15.

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

## Contents

- [Prerequisites for L2VPN Pseudowire Redundancy, page 2](#)
- [Restrictions for L2VPN Pseudowire Redundancy, page 2](#)
- [Information About L2VPN Pseudowire Redundancy, page 3](#)
- [How to Configure L2VPN Pseudowire Redundancy, page 5](#)
- [Configuration Examples for L2VPN Pseudowire Redundancy, page 11](#)
- [Additional References, page 13](#)
- [Feature Information for L2VPN Pseudowire Redundancy, page 15](#)



---

**Americas Headquarters:**  
**Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA**

## Prerequisites for L2VPN Pseudowire Redundancy

- This feature module requires that you understand how to configure basic L2 virtual private networks (VPNs). You can find that information in the following documents:
  - *Any Transport over MPLS*
  - *L2 VPN Interworking*
- The L2VPN Pseudowire Redundancy feature requires that the following mechanisms be in place to enable you to detect a failure in the network:
  - Label-switched paths (LSP) Ping/Traceroute and Any Transport over MPLS Virtual Circuit Connection Verification (AToM VCCV)
  - Local Management Interface (LMI)
  - Operation, Administration, and Maintenance (OAM)

## Restrictions for L2VPN Pseudowire Redundancy

### General Restrictions

- The primary and backup pseudowires must run the same type of transport service. The primary and backup pseudowires must be configured with AToM.
- Only static, on-box provisioning is supported.
- If you use L2VPN Pseudowire Redundancy with L2VPN Interworking, the interworking method must be the same for the primary and backup pseudowires.
- Setting the experimental (EXP) bit on the Multiprotocol Label Switching (MPLS) pseudowire is supported.
- Different pseudowire encapsulation types on the MPLS pseudowire are not supported.
- The **mpls l2transport route** command is not supported. Use the **xconnect** command instead.
- The ability to have the backup pseudowire fully operational at the same time that the primary pseudowire is operational is not supported. The backup pseudowire becomes active only after the primary pseudowire fails.
- The AToM VCCV feature is supported only on the active pseudowire.
- More than one backup pseudowire is not supported.

### Restrictions for Layer 2 Tunnel Protocol Version 3 (L2TPv3) Xconnect Configurations

- Interworking is not supported.
- Local switching backup by pseudowire redundancy is not supported.
- PPP, HDLC, and Frame-Relay attachment circuit (AC) types of L2TPv3 pseudowire redundancy are not supported.
- For the edge interface, only the Cisco 7600 series SPA Interface Processor-400 (SIP-400) linecard with the following shared port adapters (SPAs) is supported:
  - Cisco 2-Port Gigabit Ethernet Shared Port Adapter (SPA-2X1GE)
  - Cisco 2-Port Gigabit Ethernet Shared Port Adapter, Version 2 (SPA-2X1GE-V2)
  - Cisco 5-Port Gigabit Ethernet Shared Port Adapter, Version 2 (SPA-5X1GE-V2)

- Cisco 10-Port Gigabit Ethernet Shared Port Adapter, Version 2 (SPA-10X1GE-V2)
- Cisco 2-Port OC3c/STM1c ATM Shared Port Adapter (SPA-2XOC3-ATM)
- Cisco 4-Port OC3c/STM1c ATM Shared Port Adapter (SPA-4XOC3-ATM)
- Cisco 1-Port OC12c/STM4c ATM Shared Port Adapter (SPA-1XOC12-ATM)
- Cisco 1-Port OC-48c/STM-16 ATM Shared Port Adapter (SPA-1XOC48-ATM)

## Information About L2VPN Pseudowire Redundancy

L2VPNs can provide pseudowire resiliency through their routing protocols. When connectivity between end-to-end PE routers fails, an alternative path to the directed LDP session and the user data can take over. However, there are some parts of the network where this rerouting mechanism does not protect against interruptions in service. [Figure 1](#) shows those parts of the network that are vulnerable to an interruption in service.

**Figure 1**      *Points of Potential Failure in an L2VPN Network*



The L2VPN Pseudowire Redundancy feature provides the ability to ensure that the CE2 router in [Figure 1](#) can always maintain network connectivity, even if one or all the failures in the figure occur.

The L2VPN Pseudowire Redundancy feature enables you to set up backup pseudowires. You can configure the network with redundant pseudowires (PWs) and redundant network elements, which are shown in [Figure 2](#), [Figure 3](#), and [Figure 4](#).

Figure 2 shows a network with redundant pseudowires and redundant attachment circuits.

**Figure 2** *L2VPN Network with Redundant PWs and Attachment Circuits*



Figure 3 shows a network with redundant pseudowires, attachment circuits, and CE routers.

**Figure 3** *L2VPN Network with Redundant PWs, Attachment Circuits, and CE Routers*



Figure 4 shows a network with redundant pseudowires, attachment circuits, CE routers, and PE routers.

**Figure 4** *L2VPN Network with Redundant PWs, Attachment Circuits, CE Routers, and PE Routers*



# How to Configure L2VPN Pseudowire Redundancy

The L2VPN Pseudowire Redundancy feature enables you to configure a backup pseudowire in case the primary pseudowire fails. When the primary pseudowire fails, the PE router can switch to the backup pseudowire. You can have the primary pseudowire resume operation after it comes back up.

The default Label Distribution Protocol (LDP) session hold-down timer will enable the software to detect failures in about 180 seconds. That time can be configured so that the software can detect failures more quickly. See the **mpls ldp holdtime** command for more information.

The following sections explain how to configure the L2VPN Pseudowire Redundancy feature:

- [Configuring the Pseudowire, page 5](#) (required)
- [Configuring L2VPN Pseudowire Redundancy, page 6](#) (required)
- [Xconnect as a Client of BFD, page 8](#) (optional)
- [Forcing a Manual Switchover to the Backup Pseudowire VC, page 9](#) (optional)
- [Verifying the L2VPN Pseudowire Redundancy Configuration, page 9](#) (optional)

## Configuring the Pseudowire

The successful transmission of the Layer 2 frames between PE routers is due to the configuration of the PE routers. You set up the connection, called a pseudowire, between the routers.

The pseudowire-class configuration group specifies the characteristics of the tunneling mechanism, which are:

- Encapsulation type
- Control protocol
- Payload-specific options

You must specify the **encapsulation mpls** command as part of the pseudowire class for the AToM VCs to work properly. If you omit the **encapsulation mpls** command as part of the **xconnect** command, you receive the following error:

```
% Incomplete command.
```

Perform this task to configure a pseudowire class.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *name*
4. **encapsulation mpls**
5. **interworking** {**ethernet** | **ip**}

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"><li>Enter your password if prompted.</li></ul>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# configure terminal	Enters global configuration mode.
Step 3	<b>pseudowire-class name</b>  <b>Example:</b> Router(config)# pseudowire-class atom	Establishes a pseudowire class with a name that you specify. <ul style="list-style-type: none"><li>Enters pseudowire class configuration mode.</li></ul>
Step 4	<b>encapsulation mpls</b>  <b>Example:</b> Router(config-pw-class)# encapsulation mpls	Specifies the tunneling encapsulation. <ul style="list-style-type: none"><li>For AToM, the encapsulation type is <b>mpls</b>.</li></ul>
Step 5	<b>interworking {ethernet   ip}</b>  <b>Example:</b> Router(config-pw-class)# interworking ip	(Optional) Enables the translation between the different Layer 2 encapsulations.

## Configuring L2VPN Pseudowire Redundancy

Use the following steps to configure the L2VPN Pseudowire Redundancy feature.

## Prerequisites

For each transport type, the **xconnect** command is configured slightly differently. The following configuration steps use Ethernet VLAN over MPLS, which is configured in subinterface configuration mode. See *Any Transport over MPLS* to determine how to configure the **xconnect** command for other transport types.

## SUMMARY STEPS

- enable**
- configure terminal**
- interface gigabitethernet slot/subslot/interface.subinterface**
- encapsulation dot1q vlan-id**
- xconnect peer-router-id vcid {encapsulation mpls | pw-class pw-class-name}**
- backup peer peer-router-ip-addr vcid [pw-class pw-class-name]**
- backup delay enable-delay {disable-delay | never}**

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><b>enable</b></p> <p><b>Example:</b> Router&gt; enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> <li>Enter your password if prompted.</li> </ul>
Step 2	<p><b>configure terminal</b></p> <p><b>Example:</b> Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p><b>interface</b> <b>gigabitethernet</b> <i>slot/subslot/interface.subinterface</i></p> <p><b>Example:</b> Router(config)# interface gigabitethernet0/0/0.1</p>	<p>Specifies the Gigabit Ethernet subinterface and enters subinterface configuration mode.</p> <ul style="list-style-type: none"> <li>Make sure that the subinterface on the adjoining CE router is on the same VLAN as this PE router.</li> </ul>
Step 4	<p><b>encapsulation dot1q</b> <i>vlan-id</i></p> <p><b>Example:</b> Router(config-subif)# encapsulation dot1q 100</p>	<p>Enables the subinterface to accept 802.1Q VLAN packets.</p> <ul style="list-style-type: none"> <li>The subinterfaces between the CE and PE routers that are running Ethernet over MPLS must be in the same subnet. All other subinterfaces and backbone routers do not.</li> </ul>
Step 5	<p><b>xconnect</b> <i>peer-router-id vcid</i> {<b>encapsulation mpls</b>   <b>pw-class</b> <i>pw-class-name</i>}</p> <p><b>Example:</b> Router(config-subif)# xconnect 10.0.0.1 123 pw-class atom</p>	<p>Binds the attachment circuit to a pseudowire VC.</p> <ul style="list-style-type: none"> <li>The syntax for this command is the same as for all other Layer 2 transports.</li> <li>Enters xconnect configuration mode.</li> </ul>
Step 6	<p><b>backup peer</b> <i>peer-router-ip-addr vcid</i> [<b>pw-class</b> <i>pw-class-name</i>]</p> <p><b>Example:</b> Router(config-if-xconn)# backup peer 10.0.0.3 125 pw-class atom</p>	<p>Specifies a redundant peer for the pseudowire VC.</p> <ul style="list-style-type: none"> <li>The pseudowire class name must match the name you specified when you created the pseudowire class, but you can use a different pw-class in the <b>backup peer</b> command than the name that you used in the primary <b>xconnect</b> command.</li> </ul>
Step 7	<p><b>backup delay</b> <i>enable-delay</i> {<i>disable-delay</i>   <b>never</b>}</p> <p><b>Example:</b> Router(config-if-xconn)# backup delay 5 never</p>	<p>Specifies how long (in seconds) the backup pseudowire VC should wait to take over after the primary pseudowire VC goes down.</p> <ul style="list-style-type: none"> <li>The range is 0 to 180.</li> <li>Specifies how long the primary pseudowire should wait after it becomes active to take over for the backup pseudowire VC. The range is 0 to 180 seconds. If you specify the <b>never</b> keyword, the primary pseudowire VC never takes over for the backup.</li> </ul>

## Xconnect as a Client of BFD

Redundant pseudowires are deployed to provide fault tolerance and resiliency to L2VPN-backhauled connections. The speed at which a system recovers from failures, especially when scaled to large numbers of pseudowires, is critical to many service providers and service level agreements (SLAs). The configuration of a trigger for redundant pseudowire switchover reduces the time that it takes a large number of pseudowires to failover. The configuration of this feature refers to a bidirectional forwarding detection (BFD) configuration, such as the following (the second URL in the **bfd map** command is the loopback URL in the **monitor peer bfd** command):

```
bfd-template multi-hop mh
  interval min-tx 200 min-rx 200 multiplier 3 !
bfd map ipv4 10.1.1.0/24 10.1.1.1/32 mh
```

For more information about BFD configuration, see [Bidirectional Forwarding Detection](#). A fundamental component of this capability is enabled by fast-failure detection (FFD).

Perform this task to configure a trigger for redundant pseudowire switchover.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class mpls-ffd**
4. **encapsulation mpls**
5. **monitor peer bfd [local interface *loopback-url*]**

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# configure terminal	Enters global configuration mode.
Step 3	<b>pseudowire-class mpls-ffd</b>  <b>Example:</b> Router(config)# pseudowire-class mpls-ffd	Establishes a pseudowire class for MPLS fast-failure detection. <ul style="list-style-type: none"> <li>• Enters pseudowire class configuration mode.</li> </ul>



	Command or Action	Purpose
Step 4	<code>encapsulation mpls</code>  <b>Example:</b> Router(config-pw-class)# encapsulation mpls	Specifies the tunneling encapsulation to be MPLS.
Step 5	<code>monitor peer bfd [local interface loopback-url]</code>  <b>Example:</b> Router(config-pw-class)# monitor peer bfd local interface 10.1.1.1/32	Enables the pseudowire fast-failure detection capability. <ul style="list-style-type: none"> <li><b>local interface</b> <i>loopback-url</i> (optional)—Specifies a local interface for the source address to use when locating a BFD configuration.</li> </ul>

## Forcing a Manual Switchover to the Backup Pseudowire VC

To force the router switch over to the backup or primary pseudowire, you can enter the **xconnect backup force switchover** command in privileged EXEC mode. You can specify either the interface of the primary attachment circuit (AC) to switch to or the IP-address and VC ID of the peer router.

A manual switchover can be made only if the interface or peer specified in the command is actually available and the xconnect will move to the fully active state when the command is entered.

### SUMMARY STEPS

1. `enable`
2. `xconnect backup force-switchover interface {interface-info | peer ip-address vcid}`

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<code>enable</code>  <b>Example:</b> Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>Enter your password if prompted.</li> </ul>
Step 2	<code>xconnect backup force-switchover {interface interface-info   peer ip-address vcid}</code>  <b>Example:</b> Router# xconnect backup force-switchover peer 10.10.10.1 123	Specifies that the router should switch to the backup or to the primary pseudowire.

## Verifying the L2VPN Pseudowire Redundancy Configuration

Use the following commands to verify that the L2VPN Pseudowire Redundancy feature is correctly configured.



```
UP pri ac Et0/0(Ethernet)          UP mpls 10.55.55.2:1000          UP
IA sec ac Et0/0(Ethernet)          UP mpls 10.55.55.3:1001          DN
```

In this example, the topology is Attachment Circuit 1 to Attachment Circuit 2 with a Pseudowire backup for Attachment Circuit 2:

```
Router# show xconnect all
```

```
Legend: XC ST=Xconnect State, S1=Segment1 State, S2=Segment2 State
UP=Up, DN=Down, AD=Admin Down, IA=Inactive, NH=No Hardware
XC ST Segment 1                      S1 Segment 2                      S2
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
UP pri ac Se6/0:150(FR DLCI)          UP ac Se8/0:150(FR DLCI)          UP
IA sec ac Se6/0:150(FR DLCI)          UP mpls 10.55.55.3:7151          DN
```

#### Step 4 xconnect logging redundancy

In addition to the **show mpls l2transport vc** command and the **show xconnect** command, you can use the **xconnect logging redundancy** command to track the status of the xconnect redundancy group:

```
Router(config)# xconnect logging redundancy
```

When this command is configured, the following messages will be generated during switchover events:

Activating the primary member:

```
00:01:07: %XCONNECT-5-REDUNDANCY: Activating primary member 10.55.55.2:1000
```

Activating the backup member:

```
00:01:05: %XCONNECT-5-REDUNDANCY: Activating secondary member 10.55.55.3:1001
```

## Configuration Examples for L2VPN Pseudowire Redundancy

The following sections show the L2VPN Pseudowire Redundancy feature examples. These configuration examples show how the L2VPN Pseudowire Redundancy feature can be configured with the AToM (like-to-like), L2VPN Interworking, and Layer 2 Local Switching features.

- [Examples: L2VPN Pseudowire Redundancy and AToM \(Like to Like\), page 12](#)
- [Examples: L2VPN Pseudowire Redundancy and L2VPN Interworking, page 12](#)
- [Examples: L2VPN Pseudowire Redundancy with Layer 2 Local Switching, page 12](#)

Each of the configuration examples refers to one of the following pseudowire classes:

- AToM (like-to-like) pseudowire class:

```
pseudowire-class mpls
encapsulation mpls
```

- L2VPN IP interworking:

```
pseudowire-class mpls-ip
encapsulation mpls
interworking ip
```

## Examples: L2VPN Pseudowire Redundancy and AToM (Like to Like)

The following example shows a High-Level Data Link Control (HDLC) attachment circuit xconnect with a backup pseudowire:

```
interface Serial4/0
  xconnect 10.55.55.2 4000 pw-class mpls
  backup peer 10.55.55.3 4001 pw-class mpls
```

The following example shows a Frame Relay attachment circuit xconnect with a backup pseudowire:

```
connect fr-fr-pw Serial6/0 225 l2transport
  xconnect 10.55.55.2 5225 pw-class mpls
  backup peer 10.55.55.3 5226 pw-class mpls
```

## Examples: L2VPN Pseudowire Redundancy and L2VPN Interworking

The following example shows an Ethernet attachment circuit xconnect with L2VPN IP interworking and a backup pseudowire:

```
interface Ethernet0/0
  xconnect 10.55.55.2 1000 pw-class mpls-ip
  backup peer 10.55.55.3 1001 pw-class mpls-ip
```

The following example shows an Ethernet VLAN attachment circuit xconnect with L2VPN IP interworking and a backup pseudowire:

```
interface Ethernet1/0.1
  encapsulation dot1Q 200
  no ip directed-broadcast
  xconnect 10.55.55.2 5200 pw-class mpls-ip
  backup peer 10.55.55.3 5201 pw-class mpls-ip
```

The following example shows a Frame Relay attachment circuit xconnect with L2VPN IP interworking and a backup pseudowire:

```
connect fr-ppp-pw Serial6/0 250 l2transport
  xconnect 10.55.55.2 8250 pw-class mpls-ip
  backup peer 10.55.55.3 8251 pw-class mpls-ip
```

The following example shows a PPP attachment circuit xconnect with L2VPN IP interworking and a backup pseudowire:

```
interface Serial7/0
  encapsulation ppp
  xconnect 10.55.55.2 2175 pw-class mpls-ip
  backup peer 10.55.55.3 2176 pw-class mpls-ip
```

## Examples: L2VPN Pseudowire Redundancy with Layer 2 Local Switching

The following example shows an Ethernet VLAN-VLAN local switching xconnect with a pseudowire backup for Ethernet segment E2/0.2. If the subinterface associated with E2/0.2 goes down, the backup pseudowire is activated.

```
connect vlan-vlan Ethernet1/0.2 Ethernet2/0.2
  backup peer 10.55.55.3 1101 pw-class mpls
```

The following example shows a Frame Relay-to-Frame Relay local switching connect with a pseudowire backup for Frame Relay segment S8/0 150. If data-link connection identifier (DLCI) 150 on S8/0 goes down, the backup pseudowire is activated.

```
connect fr-fr-ls Serial6/0 150 Serial8/0 150
backup peer 10.55.55.3 7151 pw-class mpls
```

## Additional References

### Related Documents

Related Topic	Document Title
Cisco IOS commands	<i>Cisco IOS Master Commands List, All Releases</i>
MPLS commands	<i>Cisco IOS MPLS Command Reference</i>
Any transport over MPLS	<i>Any Transport over MPLS</i>
High availability for AToM	<i>AToM Graceful Restart</i>
L2VPN interworking	<i>L2VPN Interworking</i>
Layer 2 local switching	<i>Layer 2 Local Switching</i>
PWE3 MIB	<i>Pseudowire Emulation Edge-to-Edge MIBs for Ethernet and Frame Relay Services</i>
Packet sequencing	<i>Any Transport over MPLS (AToM) Sequencing Support</i>
Information about BFD	<i>Bidirectional Forwarding Detection</i>

### Standard

Standard	Title
None	—

### MIB

MIBs	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: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

### RFC

RFCs	Title
None	—

## Technical Assistance

Description	Link
<p>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.</p>	<p><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></p>

# Feature Information for L2VPN Pseudowire Redundancy

Table 1 lists the features in this module and provides links to specific configuration information.

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



## Note

Table 1 lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

**Table 1** Feature Information for L2VPN Pseudowire Redundancy

Feature Name	Releases	Feature Information
L2VPN Pseudowire Redundancy	12.0(31)S 12.2(28)SB 12.2(33)SRB 12.2(33)SXI 12.4(11)T 15.0(1)S	<p>This feature lets you set up your network to detect a failure in the network and reroute the Layer 2 service to another endpoint that can continue to provide service.</p> <p>In Cisco IOS Release 12.0(31)S, the L2VPN Pseudowire Redundancy feature was introduced for Any Transport over MPLS (AToM) on the Cisco 12000 series routers.</p> <p>This feature was integrated into Cisco IOS Release 12.2(28)SB, 12.2(33)SRB, 12.2(33)SXI, 12.4(11)T, and 15.0(1)S.</p> <p>The following commands were introduced or modified: <b>backup delay</b> (L2VPN local switching), <b>backup peer</b>, <b>show xconnect</b>, <b>xconnect backup force-switchover</b>, <b>xconnect logging redundancy</b>.</p>
L2VPN Pseudowire Redundancy for L2TPv3	12.2(33)SRE 15.0(1)S	<p>This feature provides L2VPN pseudowire redundancy for L2TPv3 xconnect configurations.</p> <p>In Cisco IOS Release 12.2(33)SRE, this feature was implemented on the Cisco 7600 series routers.</p>
Xconnect as a Client of BFD	15.1(3)S	<p>This feature provides fast-failure detection for L2VPN pseudowire redundancy.</p> <p>The following command was modified: <b>monitor peer bfd</b>.</p>

Cisco and the Cisco Logo are trademarks of Cisco Systems, Inc. and/or its affiliates in the U.S. and other countries. A listing of Cisco's trademarks can be found at [www.cisco.com/go/trademarks](http://www.cisco.com/go/trademarks). Third party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1005R)

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

© 2005–2011 Cisco Systems, Inc. All rights reserved.

