Configuring Inter−VLAN Routing with Catalyst 3750 Series Switches in a Stacked Configuration

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Contents

Introduction

This document provides a sample configuration for inter−VLAN routing using two Catalyst 3750s series switches stacked together running EMI software in a typical network scenario. The document uses a Catalyst 2950 series switch and a Catalyst 2948G switch as Layer 2 (L2) closet switches connecting to the stack of Catalyst 3750s. The stack of Catalyst 3750s is also configured for a default route for all traffic going to the Internet with the next hop pointing to a Cisco 7200VXR router, which can be substituted by a firewall or other routers. Configuring inter−VLAN routing on a single 3750 is the same as configuring this feature on a Catalyst 3550 series switch. For information on configuring inter−VLAN routing on a single Catalyst 3750 series switch, refer to Configuring Inter−VLAN Routing with Catalyst 3550 Series Switches.

Before You Begin

Conventions

For more information on document conventions, see the Cisco Technical Tips Conventions.

Prerequisites

Before attempting this configuration, please ensure that you meet the following prerequisites:

- knowledge of creating VLANs; for more information, refer to Creating Ethernet VLANs on Catalyst Switches
- knowledge of creating VLAN trunks; for more information, refer to the *Configuring VLAN Trunking* section of Configuring VLANs

Components Used

The information in this document is based on the software and hardware versions below.

- Two Catalyst 3750G–24T switches running 12.1(14)EA1 EMI Software Release stacked together
- Catalyst 2950G–48 running 12.1(12c)EA1 EI Software Release
- Catalyst 2948G running 6.3(10) Software Release

Note: The configuration from the Cisco 7200VXR is not relevant and, therefore, is not shown in this document.

The information presented in this document was created from devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If you are working in a live network, ensure that you understand the potential impact of any command before using it.

Background Theory

In a switched network, VLANs separate devices into different collision domains and Layer 3 (L3) subnets. Devices within a VLAN can communicate with one another without requiring routing. On the contrary, devices in separate VLANs require a routing device to communicate with one another.

L2 only switches require a L3 routing device (either external to the switch or in another module on the same chassis). A new breed of switches, however, (for example, 3550 and 3750) incorporate routing capability within the switch. The switch receives a packet, determines that it belongs to another VLAN, and sends the packet to the appropriate port on the other VLAN.

A typical network design segments the network based on the group or function the device belongs to. For example, the engineering department VLAN would only have devices associated with the engineering department, while the finance VLAN would only have finance related devices. If routing is enabled, the devices in each VLAN can talk to one another without all the devices being in the same broadcast domain. Such a VLAN design also has the added benefit of allowing the administrator to restrict communication between VLANs using access–lists. In our example, the engineering VLAN could be restricted (using access–lists) from accessing devices on the finance VLAN.

IP Routing on a Stack of 3750s

On a stack of Catalyst 3750 switches, the software running on the master determines the capabilities of the whole stack. If the master switch is running an EMI image, the whole stack will support the full set of supported routing protocols (such as Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), and such) even if the other stack members are just running an SMI image. However, it is advisable to have the same software running on the different stack members. If the stack master fails, you would lose the extended routing capabilities if the other members run an SMI image as opposed to the EMI image of the former master.

A stack of Catalyst 3750 switches appears to the network as a single router, independent to which of the stack switches the routing peer is connected. A router will create a single adjacency with a stack of 3750 routers.

The stack master performs the following tasks:

- Initialization and configuration of the routing protocols
- Generation of routing protocol messages
- Processing of received routing protocol messages
- Generating and distribution of the Distributed Cisco Express Forwarding (dCEF) database to the

different stack members
- The MAC address of the master is used as source MAC of routed packets
- Packets that need process switching are handled by CPU of the master

The stack members perform the following tasks:

- They act as routing standby switches which can take over when the stack master fails
- Programming of the routes in the dCEF database in hardware

When the master fails, the stack members will (apart from a momentarily interruption) continue to forward the packets in hardware while no protocols are active.

After a new master has been selected following a master failure, the newly elected master will start sending gratuitous ARPs with its own MAC address in order to update the devices in the network with the new MAC address that will be used to rewrite the routed packets.

For more information regarding 3750 switch stack behavior and configuration, refer to the Managing Switch Stacks documentation.

Related Products

This configuration can also be used with the following hardware and software versions.

- Any Catalyst 3750 switch running EMI software or SMI version 12.1(14)EA1 and later.
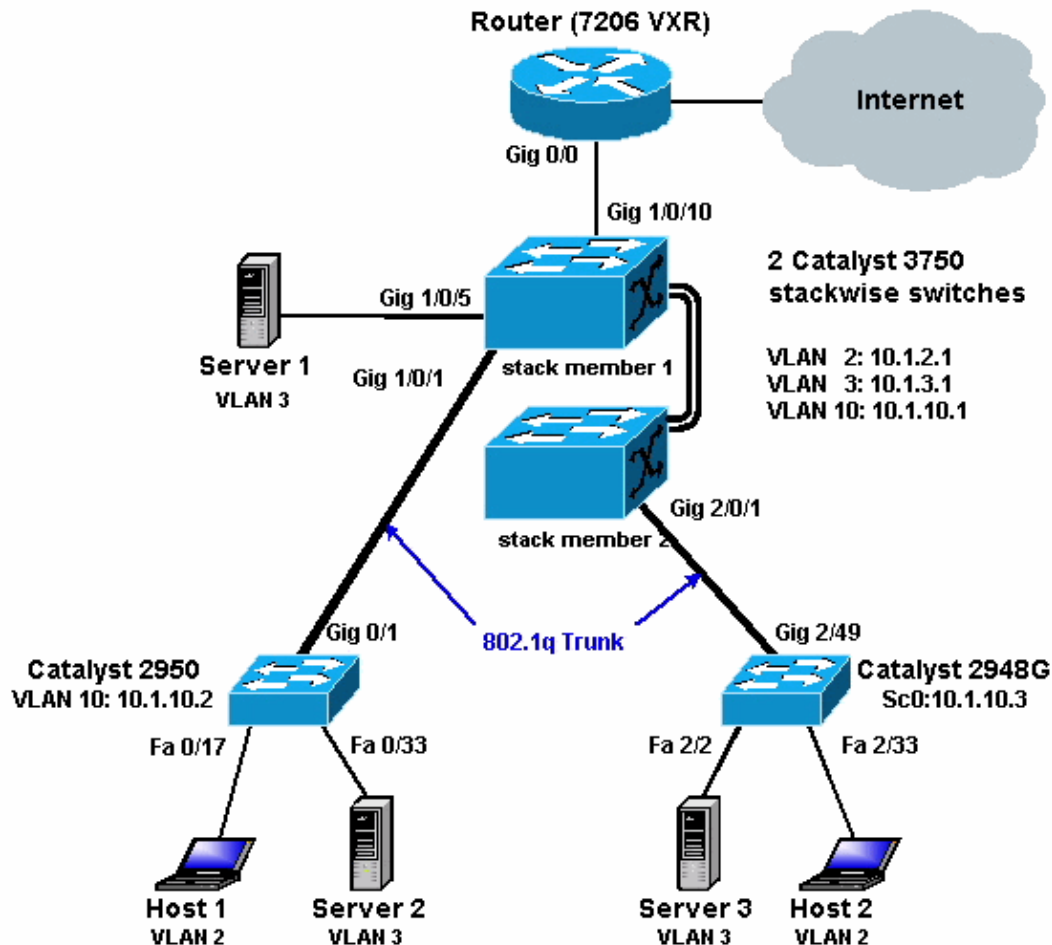- Any Catalyst 2900XL/3500XL/2950/3550 or Catalyst OS switches for access layer switch.

Configure

In this section, you are presented with the information to configure the features described in this document.

Note: To find additional information on the commands used in this document, use the Command Lookup Tool (registered customers only) .

Network Diagram

This document uses the network setup shown in the diagram below.

Router (7206 VXR)

Internet

Gig 0/0

Gig 1/0/10

Gig 1/0/5

2 Catalyst 3750
stackwise switches

Server 1
VLAN 3

Gig 1/0/1

stack member 1

VLAN 2: 10.1.2.1
VLAN 3: 10.1.3.1
VLAN 10: 10.1.10.1

Gig 2/0/1

stack member 2

Gig 0/1

802.1q Trunk

Gig 2/49

Catalyst 2950
VLAN 10: 10.1.10.2

Catalyst 2948G
Sc0:10.1.10.3

Fa 0/17

Fa 0/33

Fa 2/2

Fa 2/33

Host 1
VLAN 2

Server 2
VLAN 3

Server 3
VLAN 3

Host 2
VLAN 2

The above diagram shows a small sample network with the stack of Catalyst 3750s providing inter−VLAN routing between the various segments.

The following are the three user defined VLANs:

- VLAN 2 – user VLAN
- VLAN 3 – server VLAN
- VLAN 10 – management VLAN

The default gateway configured on each server and host device should be the corresponding VLAN interface IP address on the stack of 3750s. For example, for servers, the default gateway is 10.1.3.1. The Catalyst 2950 is trunked to the top Catalyst 3750 switch (stack master) and the Catalyst 2848G is trunked to the bottom Catalyst 3750 switch (stack member).

The default route for the stack is pointing to the Cisco 7200VXR router. The stack of 3750s uses this default route to route traffic destined for the Internet. Therefore, traffic for which the 3750s does not have a routing table entry is sent to the 7200VXR for proccessing.

Practical Tips

- In this diagram, the management VLAN is separate from the user or server VLAN. This VLAN is different from the user or server VLAN. This is done to prevent the management of switches from being affected by potential broadcast/packet storms in the user or server VLAN.
- VLAN 1 is not used for management. All ports in Catalyst switches default to VLAN 1, and any devices connected to non−configured ports will be in VLAN 1. This may cause potential issues for

the management of switches, as explained above.

- A Layer 3 (L3) (routed) port is used to connect to the default gateway port. In this diagram, a Cisco 7200VXR router could be easily replaced by a firewall that connects to the Internet gateway router.
- A routing protocol is not run between the stack of Catalyst 3750s and the Internet gateway router. Instead, a static default route is configured on the 3750. This setup is preferred if there is only one route to the Internet. Make sure to configure static routes (preferably summarized) on the gateway router (7200VXR) for subnets that can be reached by the Catalyst 3750s. This step is very important since routing protocols are not being used.
- If you need additional bandwidth for the uplink ports, you can configure EtherChannel. Configuring EtherChannel also provides link redundancy in case of a link failure.

Configurations

This document uses the configurations shown below.

- Catalyst 3750
- Catalyst 2950
- Catalyst 2948G

As you can see below, although there are two Catalyst 3750 switches stacked together, they are configured just as if they had only one switch. Both switches have twenty–four 10/100/1000 interfaces and in the configuration they show up as gigabit Ethernet 1/0/1 up to gigabit 1/0/24 for the first switch, and gigabit 2/0/1 up to gigabit 2/0/24 for the second one. So looking at the configuration, it appears as if there is just one switch with two modules that each have 24 ports.

Extending this exercise to 3, 4, 5, and so on, switches in a stack would appear similar, but for each switch that is added to the stack, it shows up in the configuration as if one module is added to the switch.

Cat3750 (Cisco Catalyst 3750G–24T)

```
C3750G-24T#show run
Building configuration...
Current configuration : 2744 bytes
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname C3750G-24T
!
!
ip subnet-zero
ip routing
!
no ip domain-lookup
!
spanning-tree mode pvst
no spanning-tree optimize bpdu transmission
spanning-tree extend system-id
!
!
!
interface GigabitEthernet1/0/1
 description To 2950
 switchport trunk encapsulation dot1q
!
```

```
!--- Dot1q trunking (with negotiation) is configured on the L2 switch.
!--- If DTP is not supported on the far switch, issue the
!--- switchport mode trunk command
!--- to force the switch port to trunk mode.


!--- Note: The default trunking mode is dynamic auto. If a trunk link
!--- is established using default trunking mode, it does not appear
!--- in the configuration even though a trunk has been established on
!--- the interface. Use the show interfaces trunk command to verify the
!--- trunk has been established.

!
interface GigabitEthernet1/0/2
!

!--- Output suppressed.

!
interface GigabitEthernet1/0/5
 description to SERVER_1

!--- Configure the server port to be in the server VLAN (VLAN 3).

 switchport access vlan 3

!--- Configure the port to be an access port to
!--- prevent trunk negotiation delays.

 switchport mode access

!--- Configure port-fast for initial STP delay.
!--- Refer to Using PortFast and Other Commands to Fix Workstation
!--- Startup Connectivity Delays for more information.

spanning-tree portfast
!
interface GigabitEthernet1/0/6
!

!--- Output suppressed.

!
interface GigabitEthernet1/0/10
 description To Internet_Router

!--- Port connected to router is converted into a routed (L3) port.

 no switchport

!--- IP address is configured on this port.

 ip address 200.1.1.1 255.255.255.252
!
interface GigabitEthernet1/0/21
!

!--- Output suppressed.

!
interface GigabitEthernet1/0/22
!
interface GigabitEthernet1/0/23
!
interface GigabitEthernet1/0/24
!
```

```
interface GigabitEthernet2/0/1
 description To 2948G
 switchport trunk encapsulation dot1q
!

!--- Output suppressed.


!
interface GigabitEthernet2/0/23
!
interface GigabitEthernet2/0/24
!
interface Vlan1
 no ip address
 shutdown
!
interface Vlan2
 description USER_VLAN

!--- This IP address would be the default gateway for users.

 ip address 10.1.2.1 255.255.255.0
!
interface Vlan3
 description SERVER_VLAN

!--- This IP address would be the default gateway for servers.

 ip address 10.1.3.1 255.255.255.0
!
interface Vlan10
 description MANAGEMENT_VLAN

!--- This IP address would be the default gateway for other L2 switches

 ip address 10.1.10.1 255.255.255.0
!
ip classless

!--- This route statement will allow the 3550 to send Internet traffic to
!--- its default router (in this case, 7200VXR Fe 0/0 interface).


ip route 0.0.0.0 0.0.0.0 200.1.1.2
ip http server
!
!
line con 0
 exec-timeout 0 0
line vty 0 4
 exec-timeout 0 0
 login
line vty 5 15
 login
!
end

C3750G-24T#
```

Note: Since the 3750 is configured as a VLAN Trunk Protocol (VTP) server, the VTP configuration is not displayed by the switch. This is standard behavior. The commands below are used on this switch to create a VTP server with the three user−defined VLANs from global configuration mode.

```
      C3750G-24T(config)#vtp domain cisco
      C3750G-24T(config)#vtp mode server
```

```
C3750G-24T(config)#vlan 2
C3750G-24T(config-vlan)#name USER_VLAN
C3750G-24T(config-vlan)#exit
C3750G-24T(config)#vlan 3
C3750G-24T(config-vlan)#name SERVER_VLAN
C3750G-24T(config-vlan)#exit
C3750G-24T(config)#vlan 10
C3750G-24T(config-vlan)#name MANAGEMENT
```

Cat2950 (Cisco Catalyst 2950G–48 Switch)

```
Cat2950#show running-config
Building configuration...

Current configuration : 2883 bytes
!
version 12.1
no service single-slot-reload-enable
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Cat2950
!
!
ip subnet-zero
!
spanning-tree extend system-id
!
!
interface FastEthernet0/1
 no ip address
!

!--- Output suppressed.

interface FastEthernet0/16
 no ip address
!
interface FastEthernet0/17
 description SERVER_2
 switchport access vlan 3
 switchport mode access
 no ip address
 spanning-tree portfast
!

!--- Output suppressed.

!
interface FastEthernet0/33
 description HOST_1

!--- Host_1 is configured to be the user VLAN (VLAN 2).

 switchport access vlan 2
 switchport mode access
 no ip address
 spanning-tree portfast
!

!--- Output suppressed.

interface GigabitEthernet0/1
 switchport trunk encapsulation dot1q
```

```
 no ip address
!
interface GigabitEthernet0/2
 no ip address
!
interface Vlan1
 no ip address
 no ip route-cache
 shutdown
!
interface Vlan10
 description MANAGEMENT
```

!--- IP address used to manage this switch.

```
ip address 10.1.10.2 255.255.255.0
 no ip route-cache
!
```

!--- Default gateway is configured so that the switch is reachable
!--- from other VLANs/sub-nets. Gateway points to VLAN 10 interface
!--- on the 3750.

```
ip default-gateway 10.1.10.1
ip http server
!
!
line con 0
line vty 5 15
!
end
```

Note: Since the Catalyst 2950 is configured as a VTP client, the VTP configuration is not displayed by the switch. This is standard behavior. The 2950 acquires the VLAN information from the VTP server (3750). The commands below are used on this switch to make it a VTP client in the VTP domain cisco from the global configuration mode.

```
Cat2950(config)#vtp domain cisco
Cat2950(config)#vtp mode client
```

Cat2948G (Cisco Catalyst 2948G Switch)

```
Cat2948G> (enable) show config
```

!--- This command shows non-default configurations only.
*!--- Use the **show config all** command to show both*
!--- default and non-default configurations.

```
...........

..................
..

begin
!
# ***** NON-DEFAULT CONFIGURATION *****
!
!
#time: Fri Jun 30 1995, 05:04:47
!
#version 6.3(10)
!
!
```

```
#system web interface version(s)
!
#test
!
#system
set system name  Cat2948G
!
#frame distribution method
set port channel all distribution mac both
!
#vtp

!--- VTP domain is configured to be that same as the 3550 (VTP server).

set vtp domain cisco

!--- VTP mode is chosen as client for this switch.

set vtp mode client
!
#ip

!--- The management IP address is configured in VLAN 10.

set interface sc0 10 10.1.10.3/255.255.255.0 10.1.10.255

set interface sl0 down
set interface me1 down

!--- The default route is defined so that the switch is reachable.

set ip route 0.0.0.0/0.0.0.0        10.1.10.1
!
#set boot command
set boot config-register 0x2
set boot system flash bootflash:cat4000.6-3-10.bin
!
#module 1 : 0-port Switching Supervisor
!
#module 2 : 50-port 10/100/1000 Ethernet

!--- Host_2 and SERVER_3 ports are configured in respective VLANs.

set vlan 2    2/2
set vlan 3    2/23
set port name      2/2  To HOST_2
set port name      2/23 to SERVER_3

!--- Trunk is configured to 3750 with dot1q encapsulation.

set trunk 2/49 desirable dot1q 1-1005
end
```

Verify

This section provides information you can use to confirm your configuration is working properly.

Certain **show** commands are supported by the Output Interpreter Tool (registered customers only) , which allows you to view an analysis of **show** command output.

Catalyst 3750

- **show switch** – The show switch command tells what the stack consists of and which of stack members is the master.

```
C3750G-24T#show switch
                                        Current
        Switch#  Role     Mac Address    Priority   State
        -----------------------------------------------------
        *1       Master   000c.30ae.6280    15       Ready
         2       Slave    000c.30ae.2a80    1        Ready
```

- **show vtp status**

```
C3750G-24T#show vtp status
VTP Version                     : 2
Configuration Revision          : 3
Maximum VLANs supported locally : 1005
Number of existing VLANs        : 8
VTP Operating Mode              : Server
VTP Domain Name                 : cisco
VTP Pruning Mode                : Disabled
VTP V2 Mode                     : Disabled
VTP Traps Generation            : Disabled
MD5 digest                      : 0xA2 0xF4 0x9D 0xE9 0xE9 0x1A 0xE3 0x77
Configuration last modified by 200.1.1.1 at 3-1-93 03:15:42
Local updater ID is 10.1.2.1 on interface Vl2 (lowest numbered VLAN interface found)
C3750G-24T#
```

- **show interfaces trunk**

```
C3750G-24T#show interfaces trunk

Port      Mode          Encapsulation  Status        Native vlan
Gi1/0/1   desirable     802.1q         trunking      1
Gi2/0/1   desirable     802.1q         trunking      1

Port      Vlans allowed on trunk
Gi1/0/1   1-4094
Gi2/0/1   1-4094

Port      Vlans allowed and active in management domain
Gi1/0/1   1-3,10
Gi2/0/1   1-3,10

Port      Vlans in spanning tree forwarding state and not pruned

Gi1/0/1   1-3,10
Gi2/0/1   1-3,10
```

- **show ip route**

```
C3750G-24T#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 200.1.1.2 to network 0.0.0.0

     200.1.1.0/30 is subnetted, 1 subnets
C       200.1.1.0 is directly connected, GigabitEthernet1/0/10
     10.0.0.0/24 is subnetted, 3 subnets
C       10.1.10.0 is directly connected, Vlan10
```

```
C       10.1.3.0 is directly connected, Vlan3
C       10.1.2.0 is directly connected, Vlan2
S*  0.0.0.0/0 [1/0] via 200.1.1.2
```

Catalyst 2950

- **show vtp status**

```
Cat2950#show vtp status
VTP Version                     : 2
Configuration Revision          : 3
Maximum VLANs supported locally : 250
Number of existing VLANs        : 8
VTP Operating Mode              : Client
VTP Domain Name                 : cisco
VTP Pruning Mode                : Disabled
VTP V2 Mode                     : Disabled
VTP Traps Generation            : Disabled
MD5 digest                      : 0x54 0xC0 0x4A 0xCE 0x47 0x25 0x0B 0x49
Configuration last modified by 200.1.1.1 at 3-1-93 01:06:24
```

- **show interfaces trunk**

```
Cat2950#show interfaces trunk

Port        Mode            Encapsulation  Status        Native vlan
Gi0/1       desirable       802.1q         trunking      1

Port        Vlans allowed on trunk
Gi0/1       1-4094

Port        Vlans allowed and active in management domain
Gi0/1       1-3,10

Port        Vlans in spanning tree forwarding state and not pruned
Gi0/1       1-3,10
```

Catalyst 2948G

- **show vtp domain**

```
Cat2948G> (enable) show vtp domain
Domain Name                      Domain Index VTP Version Local Mode  Password
-------------------------------- ------------ ----------- ----------- ----------
cisco                            1            2           client      -

Vlan-count Max-vlan-storage Config Revision Notifications
---------- ---------------- --------------- -------------
8          1023             3               disabled

Last Updater    V2 Mode  Pruning  PruneEligible on Vlans
--------------- -------- -------- ------------------------
200.1.1.1       disabled disabled 2-1000
```

- **show trunk**

```
Cat2948G> (enable) show trunk
* - indicates vtp domain mismatch
Port      Mode         Encapsulation  Status        Native vlan
--------  -----------  -------------  ------------  -----------
 2/49     desirable    dot1q          trunking      1

Port      Vlans allowed on trunk
--------  ----------------------------------------------------------------------
 2/49     1-1005
```

```
Port      Vlans allowed and active in management domain
--------  --------------------------------------------------------------------
 2/49     1-3,10

Port      Vlans in spanning tree forwarding state and not pruned
--------  --------------------------------------------------------------------
 2/49     1-3,10
```

Troubleshoot

This section provides information you can use to troubleshoot your configuration.

Troubleshooting Procedure

Follow the instructions below to troubleshoot your configuration.

1. If you are not able to ping devices within the same VLAN, you should check the VLAN assignment of the source and destination ports by issuing the **show port** *mod/port* command for CatOS and the **show interface status** command for Cisco IOS® Software, to make sure they are in the same VLAN. If they are not in the same switch, make sure that trunking is configured properly by issuing the **show trunk** command for CatOS and the **show interfaces trunk** command for Cisco IOS Software, and that the native VLAN is matching on either side. Make sure the subnet mask is matching between the source and destination devices.
2. If you are not able to ping devices in different VLANs, make sure you can ping the respective default gateway (refer to step 1 above). Also, make sure the device's default gateway is pointing to the correct VLAN interface IP address and that the subnet mask is matching.
3. If you are able to reach the Internet, make sure the default route on the 3750 points to the correct IP address, and that the subnet address matches the Internet gateway router by issuing the **show ip interface** *interface−id* and **show ip route** commands. Make sure that the Internet gateway router has routes to the Internet and the internal networks.

Related Information

- **Creating Ethernet VLANs on Catalyst Switches**
- **LAN Switching Technology Support**
- **Catalyst LAN and ATM Switches Product Support**
- **Technical Support − Cisco Systems**