



Configuring Layer 3 Interfaces

This chapter describes the Layer 3 interfaces on a Catalyst 4500 series switch. It also provides guidelines, procedures, and configuration examples.

This chapter includes the following major sections:

- [Overview of Layer 3 Interfaces, page 23-1](#)
- [Configuration Guidelines, page 23-3](#)
- [Configuring Logical Layer 3 VLAN Interfaces, page 23-3](#)
- [Configuring Physical Layer 3 Interfaces, page 23-4](#)
- [Configuring EIGRP Stub Routing, page 23-6](#)



Note

For complete syntax and usage information for the switch commands used in this chapter, refer to the *Catalyst 4500 Series Switch Cisco IOS Command Reference* and related publications at <http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123cgr/index.htm>.

Overview of Layer 3 Interfaces

This section contains the following subsections:

- [Logical Layer 3 VLAN Interfaces, page 23-2](#)
- [Physical Layer 3 Interfaces, page 23-2](#)

The Catalyst 4500 series switch supports Layer 3 interfaces with the Cisco IOS IP and IP routing protocols. Layer 3, the *network* layer, is primarily responsible for the routing of data in packets across logical internetwork paths.

Layer 2, the *data link* layer, contains the protocols that control the *physical* layer (Layer 1) and how data is framed before being transmitted on the medium. The Layer 2 function of filtering and forwarding data in frames between two segments on a LAN is known as *bridging*.

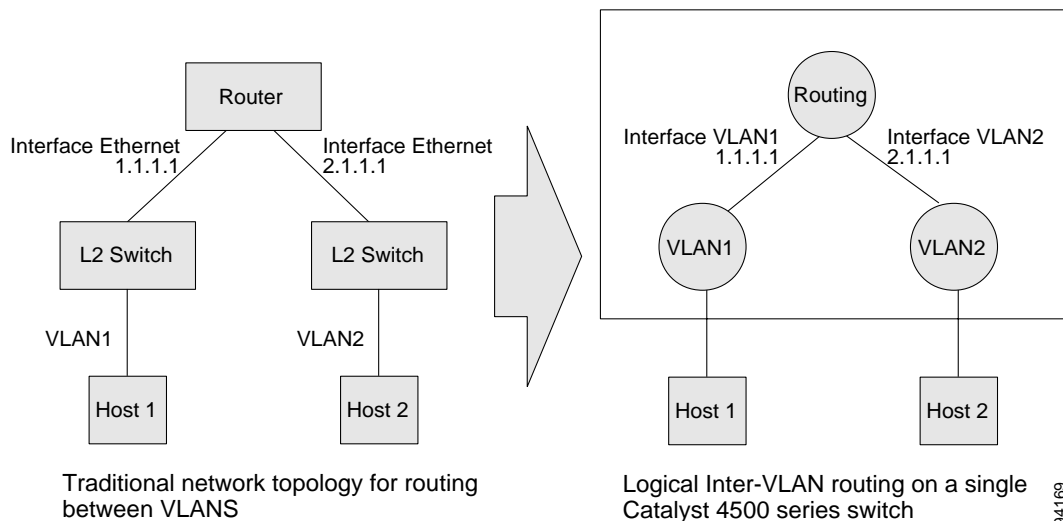
The Catalyst 4500 series switch supports two types of Layer 3 interfaces. The logical Layer 3 VLAN interfaces integrate the functions of routing and bridging. The physical Layer 3 interfaces allow the Catalyst 4500 series switch to be configured like a traditional router.

Logical Layer 3 VLAN Interfaces

The logical Layer 3 VLAN interfaces provide logical routing interfaces to VLANs on Layer 2 switches. A traditional network requires a physical interface from a router to a switch to perform inter-VLAN routing. The Catalyst 4500 series switch supports inter-VLAN routing by integrating the routing and bridging functions on a single Catalyst 4500 series switch.

Figure 23-1 shows how the routing and bridging functions in the three physical devices of the traditional network are performed logically on one Catalyst 4500 series switch.

Figure 23-1 Logical Layer 3 VLAN Interfaces for the Catalyst 4500 Series Switch

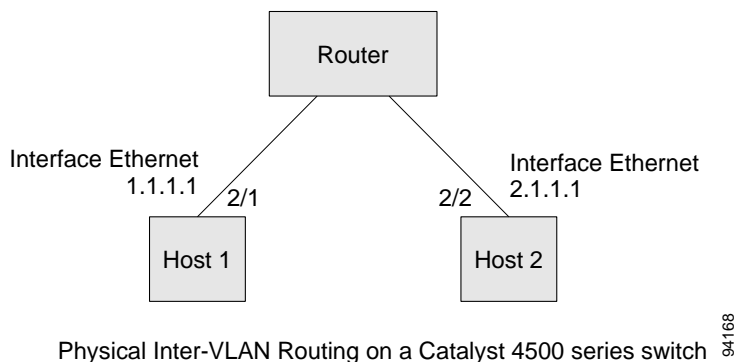


Physical Layer 3 Interfaces

The physical Layer 3 interfaces support capabilities equivalent to a traditional router. These Layer 3 interfaces provide hosts with physical routing interfaces to a Catalyst 4500 series switch.

Figure 23-2 shows how the Catalyst 4500 series switch functions as a traditional router.

Figure 23-2 Physical Layer 3 Interfaces for the Catalyst 4500 Series Switch



Configuration Guidelines

A Catalyst 4500 series switch supports AppleTalk routing and IPX routing. For AppleTalk routing and IPX routing information, refer to “Configuring AppleTalk” and “Configuring Novell IPX” in the Cisco IOS AppleTalk and Novell IPX Configuration Guide at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/atipx_c/index.htm

A Catalyst 4500 series switch does not support subinterfaces or the **encapsulation** keyword on Layer 3 Fast Ethernet or Gigabit Ethernet interfaces.



Note

As with any Layer 3 interface running Cisco IOS software, the IP address and network assigned to an SVI cannot overlap those assigned to any other Layer 3 interface on the switch.

Configuring Logical Layer 3 VLAN Interfaces



Note

Before you can configure logical Layer 3 VLAN interfaces, you must create and configure the VLANs on the switch, assign VLAN membership to the Layer 2 interfaces, enable IP routing if IP routing is disabled, and specify an IP routing protocol.

To configure logical Layer 3 VLAN interfaces, perform this task:

	Command	Purpose
Step 1	Switch(config)# vlan <i>vlan_ID</i>	Creates the VLAN.
Step 2	Switch(config)# interface vlan <i>vlan_ID</i>	Selects an interface to configure.
Step 3	Switch(config-if)# ip address <i>ip_address</i> <i>subnet_mask</i>	Configures the IP address and IP subnet.
Step 4	Switch(config-if)# no shutdown	Enables the interface.
Step 5	Switch(config-if)# end	Exits configuration mode.
Step 6	Switch# copy running-config startup-config	Saves your configuration changes to NVRAM.
Step 7	Switch# show interfaces [<i>type slot/interface</i>] Switch# show ip interfaces [<i>type slot/interface</i>] Switch# show running-config interfaces [<i>type slot/interface</i>] Switch# show running-config interfaces vlan <i>vlan_ID</i>	Verifies the configuration.

This example shows how to configure the logical Layer 3 VLAN interface `vlan 2` and assign an IP address:

```
Switch> enable
Switch# config term
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# vlan 2
Switch(config)# interface vlan 2
Switch(config-if)# ip address 10.1.1.1 255.255.255.248
Switch(config-if)# no shutdown
Switch(config-if)# end
```

This example uses the **show interfaces** command to display the interface IP address configuration and status of Layer 3 VLAN interface vlan 2:

```
Switch# show interfaces vlan 2
Vlan2 is up, line protocol is down
  Hardware is Ethernet SVI, address is 00D.588F.B604 (bia 00D.588F.B604)
  Internet address is 172.20.52.106/29
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    0 packets input, 0 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 packets output, 0 bytes, 0 underruns
    0 output errors, 0 interface resets
    0 output buffer failures, 0 output buffers swapped out
Switch#
```

This example uses the **show running-config** command to display the interface IP address configuration of Layer 3 VLAN interface vlan 2:

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

Current configuration : !
interface Vlan2
  ip address 10.1.1.1 255.255.255.248
  !
  ip classless
  no ip http server
  !
  !
  line con 0
  line aux 0
  line vty 0 4
  !
end
```

Configuring Physical Layer 3 Interfaces



Note

Before you can configure physical Layer 3 interfaces, you must enable IP routing if IP routing is disabled, and specify an IP routing protocol.

To configure physical Layer 3 interfaces, perform this task:

	Command	Purpose
Step 1	Switch(config)# ip routing	Enables IP routing (Required only if disabled.)
Step 2	Switch(config)# interface {fastethernet gigabitethernet tengigabitethernet} slot/port {port-channel port_channel_number}	Selects an interface to configure.
Step 3	Switch(config-if)# no switchport	Converts this port from physical Layer 2 port to physical Layer 3 port.
Step 4	Switch(config-if)# ip address ip_address subnet_mask	Configures the IP address and IP subnet.
Step 5	Switch(config-if)# no shutdown	Enables the interface.
Step 6	Switch(config-if)# end	Exits configuration mode.
Step 7	Switch# copy running-config startup-config	Saves your configuration changes to NVRAM.
Step 8	Switch# show interfaces [type slot/interface] Switch# show ip interfaces [type slot/interface] Switch# show running-config interfaces [type slot/interface]	Verifies the configuration.

This example shows how to configure an IP address on Fast Ethernet interface 2/1:

```
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# ip routing
Switch(config)# interface fastethernet 2/1
Switch(config-if)# no switchport
Switch(config-if)# ip address 10.1.1.1 255.255.255.248
Switch(config-if)# no shutdown
Switch(config-if)# end
Switch#
```

This example uses the **show running-config** command to display the interface IP address configuration of Fast Ethernet interface 2/1:

```
Switch# show running-config
Building configuration...
!
interface FastEthernet2/1
 no switchport
 ip address 10.1.1.1 255.255.255.248
!
...
ip classless
no ip http server
!
!
line con 0
line aux 0
line vty 0 4
!
end
```

Configuring EIGRP Stub Routing

Overview

The EIGRP stub routing feature, available in all images, reduces resource utilization by moving routed traffic closer to the end user.

The IP base image contains only EIGRP stub routing. The IP services image contains complete EIGRP routing.

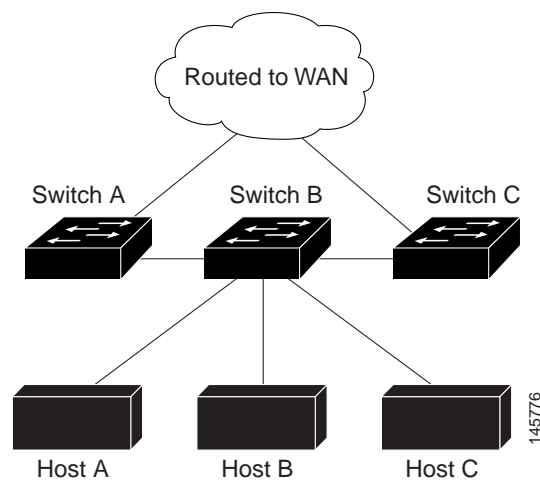
In a network using EIGRP stub routing, the only route for IP traffic to follow to the user is through a switch that is configured with EIGRP stub routing. The switch sends the routed traffic to interfaces that are configured as user interfaces or are connected to other devices.

When using EIGRP stub routing, you need to configure the distribution and remote routers to use EIGRP, and to configure only the switch as a stub. Only specified routes are propagated from the switch. The switch responds to all queries for summaries, connected routes, and routing updates.

Any neighbor that receives a packet informing it of the stub status does not query the stub router for any routes, and a router that has a stub peer does not query that peer. The stub router depends on the distribution router to send the proper updates to all peers.

In [Figure 23-3](#), switch B is configured as an EIGRP stub router. Switches A and C are connected to the rest of the WAN. Switch B advertises connected, static, redistribution, and summary routes from switch A and C to Hosts A, B, and C. Switch B does not advertise any routes learned from switch A (and the reverse).

Figure 23-3 EIGRP Stub Router Configuration



For more information about EIGRP stub routing, see “Configuring EIGRP Stub Routing” part of the *Cisco IOS IP Configuration Guide, Volume 2 of 3: Routing Protocols*, Release 12.2.

How to Configure EIGRP Stub Routing

The EIGRP Stub Routing feature improves network stability, reduces resource utilization, and simplifies stub router configuration.

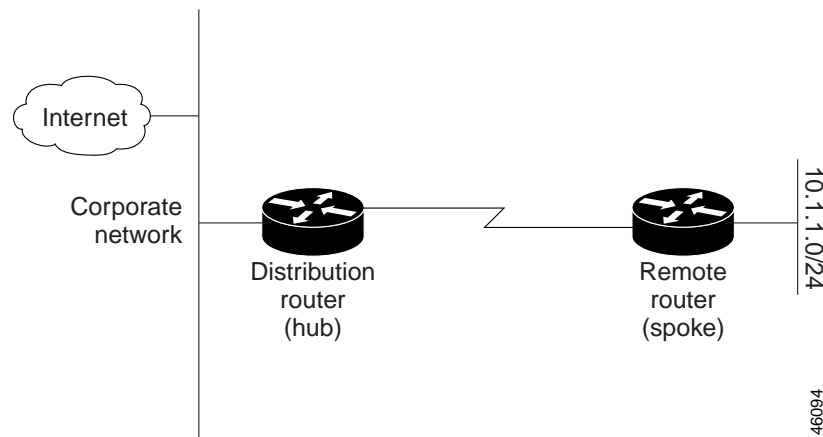
Stub routing is commonly used in a hub-and-spoke network topology. In a hub-and-spoke network, one or more end (stub) networks are connected to a remote router (the spoke) that is connected to one or more distribution routers (the hub). The remote router is adjacent only to one or more distribution routers. The only route for IP traffic to follow into the remote router is through a distribution router. This type of configuration is commonly used in WAN topologies where the distribution router is directly connected to a WAN. The distribution router can be connected to many more remote routers. Often, the distribution router will be connected to 100 or more remote routers. In a hub-and-spoke topology, the remote router must forward all nonlocal traffic to a distribution router, so it becomes unnecessary for the remote router to hold a complete routing table. Generally, the distribution router need not send anything more than a default route to the remote router.

When using the EIGRP Stub Routing feature, you need to configure the distribution and remote routers to use EIGRP, and to configure only the remote router as a stub. Only specified routes are propagated from the remote (stub) router. The stub router responds to all queries for summaries, connected routes, redistributed static routes, external routes, and internal routes with the message “inaccessible.” A router that is configured as a stub will send a special peer information packet to all neighboring routers to report its status as a stub router.

Any neighbor that receives a packet informing it of the stub status will not query the stub router for any routes, and a router that has a stub peer will not query that peer. The stub router will depend on the distribution router to send the proper updates to all peers.

Figure 4 shows a simple hub-and-spoke configuration.

Figure 4 Simple Hub-and-Spoke Network



The stub routing feature by itself does not prevent routes from being advertised to the remote router. In the example in Figure 4, the remote router can access the corporate network and the Internet through the distribution router only. Having a full route table on the remote router, in this example, would serve no functional purpose because the path to the corporate network and the Internet would always be through the distribution router. The larger route table would only reduce the amount of memory required by the remote router. Bandwidth and memory can be conserved by summarizing and filtering routes in the distribution router. The remote router need not receive routes that have been learned from other networks because the remote router must send all nonlocal traffic, regardless of destination, to the distribution router. If a true stub network is desired, the distribution router should be configured to send only a default route to the remote router. The EIGRP Stub Routing feature does not automatically enable summarization on the distribution router. In most cases, the network administrator will need to configure summarization on the distribution routers.



Note When configuring the distribution router to send only a default route to the remote router, you must use the **ip classless** command on the remote router. By default, the **ip classless** command is enabled in all Cisco IOS images that support the EIGRP Stub Routing feature.

Without the stub feature, even after the routes that are sent from the distribution router to the remote router have been filtered or summarized, a problem might occur. If a route is lost somewhere in the corporate network, EIGRP could send a query to the distribution router, which in turn will send a query to the remote router even if routes are being summarized. If there is a problem communicating over the WAN link between the distribution router and the remote router, an EIGRP stuck in active (SIA) condition could occur and cause instability elsewhere in the network. The EIGRP Stub Routing feature allows a network administrator to prevent queries from being sent to the remote router.

Dual-Homed Remote Topology

In addition to a simple hub-and-spoke network where a remote router is connected to a single distribution router, the remote router can be dual-homed to two or more distribution routers. This configuration adds redundancy and introduces unique issues, and the stub feature helps to address some of these issues.

A dual-homed remote router will have two or more distribution (hub) routers. However, the principles of stub routing are the same as they are with a hub-and-spoke topology. Figure 5 shows a common dual-homed remote topology with one remote router, but 100 or more routers could be connected on the same interfaces on distribution router 1 and distribution router 2. The remote router will use the best route to reach its destination. If distribution router 1 experiences a failure, the remote router can still use distribution router 2 to reach the corporate network.

Figure 5 Simple Dual-Homed Remote Topology

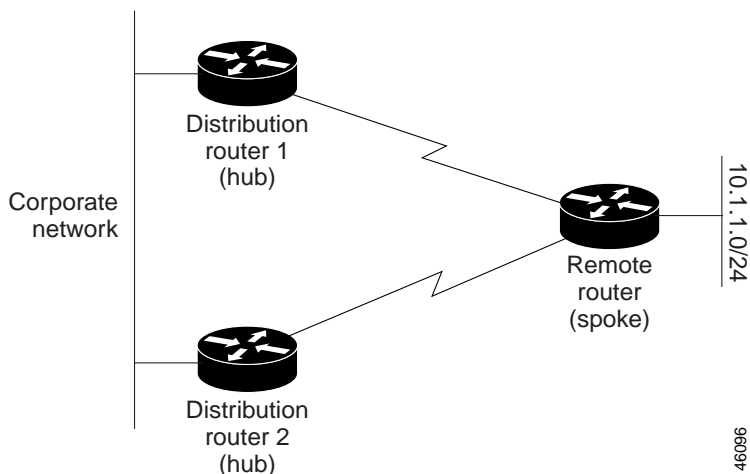


Figure 5 shows a simple dual-homed remote with one remote router and two distribution routers. Both distribution routers maintain routes to the corporate network and stub network 10.1.1.0/24.

Dual-homed routing can introduce instability into an EIGRP network. In Figure 6, distribution router 1 is directly connected to network 10.3.1.0/24. If summarization or filtering is applied on distribution router 1, the router will advertise network 10.3.1.0/24 to all of its directly connected EIGRP neighbors (distribution router 2 and the remote router).

Figure 6 *Dual-Homed Remote Topology With Distribution Router 1 Connected to Two Networks*

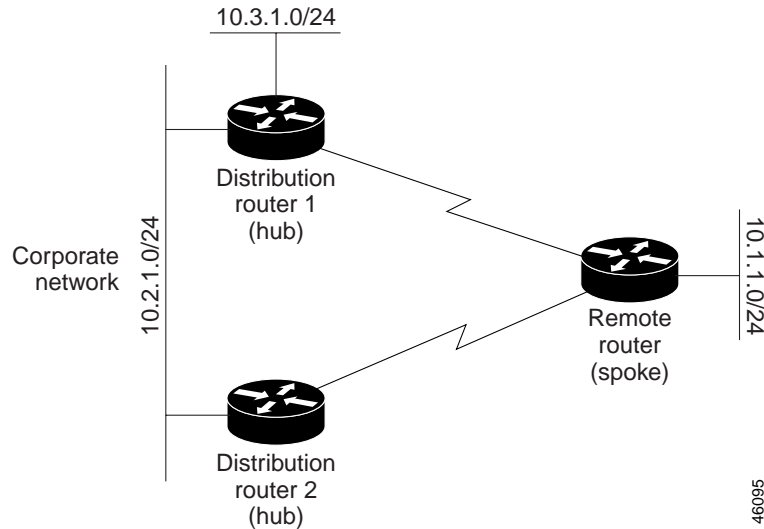
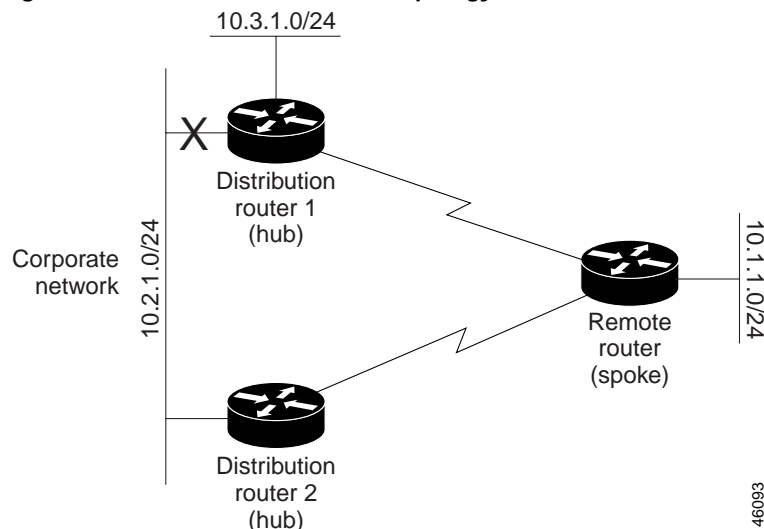


Figure 6 shows a simple dual-homed remote router where distribution router 1 is connected to both network 10.3.1.0/24 and network 10.2.1.0/24.

If the 10.2.1.0/24 link between distribution router 1 and distribution router 2 has failed, the lowest cost path to network 10.3.1.0/24 from distribution router 2 is through the remote router (see Figure 7). This route is not desirable because the traffic that was previously traveling across the corporate network 10.2.1.0/24 would now be sent across a much lower bandwidth connection. The over utilization of the lower bandwidth WAN connection can cause a number of problems that might affect the entire corporate network. The use of the lower bandwidth route that passes through the remote router might cause WAN EIGRP distribution routers to be dropped. Serial lines on distribution and remote routers could also be dropped, and EIGRP SIA errors on the distribution and core routers could occur.

Figure 7 *Dual-Homed Remote Topology with a Failed Route to a Distribution Router*



It is not desirable for traffic from distribution router 2 to travel through any remote router in order to reach network 10.3.1.0/24. If the links are sized to handle the load, it would be acceptable to use one of the backup routes. However, most networks of this type have remote routers located at remote offices with relatively slow links. This problem can be prevented if proper summarization is configured on the distribution router and remote router.

It is typically undesirable for traffic from a distribution router to use a remote router as a transit path. A typical connection from a distribution router to a remote router would have much less bandwidth than a connection at the network core. Attempting to use a remote router with a limited bandwidth connection as a transit path would generally produce excessive congestion to the remote router. The EIGRP Stub Routing feature can prevent this problem by preventing the remote router from advertising core routes back to distribution routers. Routes learned by the remote router from distribution router 1 will not be advertised to distribution router 2. Since the remote router will not advertise core routes to distribution router 2, the distribution router will not use the remote router as a transit for traffic destined for the network core.

The EIGRP Stub Routing feature can help to provide greater network stability. In the event of network instability, this feature prevents EIGRP queries from being sent over limited bandwidth links to nontransit routers. Instead, distribution routers to which the stub router is connected answer the query on behalf of the stub router. This feature greatly reduces the chance of further network instability due to congested or problematic WAN links. The EIGRP Stub Routing feature also simplifies the configuration and maintenance of hub-and-spoke networks. When stub routing is enabled in dual-homed remote configurations, it is no longer necessary to configure filtering on remote routers to prevent those remote routers from appearing as transit paths to the hub routers.

**Caution**

EIGRP Stub Routing should only be used on stub routers. A stub router is defined as a router connected to the network core or distribution layer through which core transit traffic should not flow. A stub router should not have any EIGRP neighbors other than distribution routers. Ignoring this restriction will cause undesirable behavior.

**Note**

Multi-access interfaces, such as ATM, Ethernet, Frame Relay, ISDN PRI, and X.25, are supported by the EIGRP Stub Routing feature only when all routers on that interface, except the hub, are configured as stub routers.

EIGRP Stub Routing Configuration Task List

To configure EIGRP Stub Routing, perform the tasks described in the following sections. The tasks in the first section are required; the task in the last section is optional.

- [Configuring EIGRP Stub Routing](#) (required)
- [Verifying EIGRP Stub Routing](#) (optional)

Configuring EIGRP Stub Routing

To configure a remote or spoke router for EIGRP stub routing, use the following commands beginning in router configuration mode:

	Command	Purpose
Step 1	<code>router(config)# router eigrp 1</code>	Configures a remote or distribution router to run an EIGRP process.
Step 2	<code>router(config-router)# network network-number</code>	Specifies the network address of the EIGRP distribution router.
Step 3	<code>router(config-router)# eigrp stub [receive-only connected static summary]</code>	Configures a remote router as an EIGRP stub router.

Verifying EIGRP Stub Routing

To verify that a remote router has been configured as a stub router with EIGRP, use the **show ip eigrp neighbor detail** command from the distribution router in privileged EXEC mode. The last line of the output will show the stub status of the remote or spoke router. The following example shows output is from the **show ip eigrp neighbor detail** command:

```
router# show ip eigrp neighbor detail
IP-EIGRP neighbors for process 1
H   Address                Interface    Hold Uptime   SRTT   RTO  Q  Seq Type
                               (sec)          (ms)        Cnt Num
0   10.1.1.2                Se3/1       11 00:00:59   1    4500  0  7
Version 12.1/1.2, Retrans: 2, Retries: 0
Stub Peer Advertising ( CONNECTED SUMMARY ) Routes
```

Monitoring and Maintaining EIGRP

To delete neighbors from the neighbor table, use the following command in EXEC mode:

Command	Purpose
<code>Router# clear ip eigrp neighbors [ip-address interface]</code>	Delete neighbors from the neighbor table.

To display various routing statistics, use the following commands in EXEC mode:

Command	Purpose
<code>Router# show ip eigrp interfaces [interface] [as-number]</code>	Display information about interfaces configured for EIGRP.
<code>Router# show ip eigrp neighbors [type number static]</code>	Display the EIGRP discovered neighbors.
<code>Router# show ip eigrp topology [autonomous-system-number [[ip-address] mask]]</code>	Display the EIGRP topology table for a given process.
<code>Router# show ip eigrp traffic [autonomous-system-number]</code>	Display the number of packets sent and received for all or a specified EIGRP process.

EIGRP Configuration Examples

This section contains the following examples:

- [Route Summarization Example](#)
- [Route Authentication Example](#)
- [Stub Routing Example](#)

Route Summarization Example

The following example configures route summarization on the interface and also configures the autosummary feature. This configuration causes EIGRP to summarize network 10.0.0.0 out Ethernet interface 0 only. In addition, this example disables autosummarization.

```
interface Ethernet 0
 ip summary-address eigrp 1 10.0.0.0 255.0.0.0
!
router eigrp 1
 network 172.16.0.0
 no auto-summary
```



Note

You should not use the **ip summary-address eigrp** summarization command to generate the default route (0.0.0.0) from an interface. This causes the creation of an EIGRP summary default route to the null 0 interface with an administrative distance of 5. The low administrative distance of this default route can cause this route to displace default routes learned from other neighbors from the routing table. If the default route learned from the neighbors is displaced by the summary default route, or if the summary route is the only default route present, all traffic destined for the default route will not leave the router, instead, this traffic will be sent to the null 0 interface where it is dropped.

The recommended way to send only the default route out a given interface is to use a **distribute-list** command. You can configure this command to filter all outbound route advertisements sent out the interface with the exception of the default (0.0.0.0).

Route Authentication Example

The following example enables MD5 authentication on EIGRP packets in autonomous system 1.

Router A

```
interface ethernet 1
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 holly
key chain holly
key 1
 key-string 0987654321
 accept-lifetime 04:00:00 Dec 4 1996 infinite
 send-lifetime 04:00:00 Dec 4 1996 04:48:00 Dec 4 1996
exit
key 2
 key-string 1234567890
 accept-lifetime 04:00:00 Dec 4 1996 infinite
 send-lifetime 04:45:00 Dec 4 1996 infinite
```

Router B

```
interface ethernet 1
  ip authentication mode eigrp 1 md5
  ip authentication key-chain eigrp 1 mikel
key chain mikel
  key 1
    key-string 0987654321
    accept-lifetime 04:00:00 Dec 4 1996 infinite
    send-lifetime 04:00:00 Dec 4 1996 infinite
  exit
  key 2
    key-string 1234567890
    accept-lifetime 04:00:00 Dec 4 1996 infinite
    send-lifetime 04:45:00 Dec 4 1996 infinite
```

Router A will accept and attempt to verify the MD5 digest of any EIGRP packet with a key equal to 1. It will also accept a packet with a key equal to 2. All other MD5 packets will be dropped. Router A will send all EIGRP packets with key 2.

Router B will accept key 1 or key 2, and will send key 1. In this scenario, MD5 will authenticate.

Stub Routing Example

A router that is configured as a stub with the **eigrp stub** command shares connected and summary routing information with all neighbor routers by default. Four optional keywords can be used with the **eigrp stub** command to modify this behavior:

- **receive-only**
- **connected**
- **static**
- **summary**

This section provides configuration examples for all forms of the **eigrp stub** command. The **eigrp stub** command can be modified with several options, and these options can be used in any combination except for the **receive-only** keyword. The **receive-only** keyword will restrict the router from sharing any of its routes with any other router in that EIGRP autonomous system, and the **receive-only** keyword will not permit any other option to be specified because it prevents any type of route from being sent. The three other optional keywords (**connected**, **static**, and **summary**) can be used in any combination but cannot be used with the **receive-only** keyword. If any of these three keywords is used individually with the **eigrp stub** command, connected and summary routes will not be sent automatically.

The **connected** keyword will permit the EIGRP Stub Routing feature to send connected routes. If the connected routes are not covered by a network statement, it may be necessary to redistribute connected routes with the **redistribute connected** command under the EIGRP process. This option is enabled by default.

The **static** keyword will permit the EIGRP Stub Routing feature to send static routes. Without this option, EIGRP will not send any static routes, including internal static routes that normally would be automatically redistributed. It will still be necessary to redistribute static routes with the **redistribute static** command.

The **summary** keyword will permit the EIGRP Stub Routing feature to send summary routes. Summary routes can be created manually with the **summary address** command or automatically at a major network border router with the **auto-summary** command enabled. This option is enabled by default.

In the following example, the **eigrp stub** command is used to configure the router as a stub that advertises connected and summary routes:

```
router eigrp 1
network 10.0.0.0
eigrp stub
```

In the following example, the **eigrp stub connected static** command is used to configure the router as a stub that advertises connected and static routes (sending summary routes will not be permitted):

```
router eigrp 1
network 10.0.0.0
eigrp stub connected static
```

In the following example, the **eigrp stub receive-only** command is used to configure the router as a stub, and connected, summary, or static routes will not be sent:

```
router eigrp 1
network 10.0.0.0 eigrp
stub receive-only
```