Configuring Routing Between VLANs with IEEE 802.1Q Encapsulation

This chapter describes the required and optional tasks for configuring routing between VLANs with IEEE 802.1Q encapsulation.

For a complete description of the commands in this chapter, refer to the the *Cisco IOS Switching Services Command Reference*. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the section "Identifying Supported Platforms" in the chapter "Using Cisco IOS Software."

The IEEE 802.1Q protocol is used to interconnect multiple switches and routers, and for defining VLAN topologies. The IEEE 802.1Q standard is extremely restrictive to untagged frames. The standard provides only a per-port VLANs solution for untagged frames. For example, assigning untagged frames to VLANs takes into consideration only the port from which they have been received. Each port has a parameter called a *permanent virtual identification* (Native VLAN) that specifies the VLAN assigned to receive untagged frames.

The main characteristics of IEEE 802.1Q are as follows:

- Assigns frames to VLANs by filtering.
- The standard assumes the presence of a single spanning tree and of an explicit tagging scheme with one-level tagging.

IEEE 802.1Q Encapsulation VLANs Configuration Task List

You can configure routing between any number of VLANs in your network.

This section documents the configuration tasks for each protocol supported with IEEE 802.1Q encapsulation. The basic process is the same, regardless of the protocol being routed. It involves the following tasks:

- Enabling the protocol on the router
- Enabling the protocol on the interface

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

- Defining the encapsulation format as IEEE 802.1Q
- Customizing the protocol according to the requirements for your environment

To configure IEEE 802.1Q of your network, perform the tasks described in the following sections. The first three sections contain required tasks; the remaining tasks are optional:

- Configuring AppleTalk Routing over IEEE 802.1Q (Required)
- Configuring IP Routing over IEEE 802.1Q (Required)
- Configuring IPX Routing over IEEE 802.1Q (Required)

Perform the tasks in the following sections to connect a network of hosts over a simple bridging-access device to a remote access concentrator bridge between IEEE 802.1Q VLANs. The following sections contain configuration tasks for the Integrated Routing and Bridging, Transparent Bridging, and PVST+ Between VLANs with IEEE 802.1Q Encapsulation feature:

- Configuring a VLAN for a bridge-group with Default VLAN1(Optional)
- Configuring a VLAN for a bridge-group as a Native VLAN (Optional)
- Monitoring and Maintaining VLAN Subinterfaces (Optional)

Configuring AppleTalk Routing over IEEE 802.1Q

AppleTalk can be routed over virtual LAN (VLAN) subinterfaces using the IEEE 802.1Q VLAN encapsulation protocol. AppleTalk Routing provides full-feature Cisco IOS software AppleTalk support on a per-VLAN basis, allowing standard AppleTalk capabilities to be configured on VLANs.

To route AppleTalk over IEEE 802.1Q between VLANs, you need to customize the subinterface to create the environment in which it will be used. Perform these tasks in the order in which they appear:

- Enabling AppleTalk Routing
- Configuring AppleTalk on the Subinterface
- Defining the VLAN Encapsulation Format

Enabling AppleTalk Routing

To enable AppleTalk routing on IEEE 802.1Q interfaces, use the following command in global configuration mode:

Command	Purpose
`Router(config)# appletalk routing [eigrp router-number]`	Enables AppleTalk routing globally.

Note For more information on configuring AppleTalk, see the “Configuring AppleTalk” chapter in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*.

Configuring AppleTalk on the Subinterface

After you enable AppleTalk globally and define the encapsulation format, you need to enable it on the subinterface by specifying the cable range and naming the AppleTalk zone for each interface. To enable the AppleTalk protocol on the subinterface, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# appletalk cable-range cable-range [network.node]`	Assigns the AppleTalk cable range and zone for the subinterface.
Step 2	`Router(config-if)# appletalk zone zone-name`	Assigns the AppleTalk zone for the subinterface.

Defining the VLAN Encapsulation Format

To define the VLAN encapsulation format as IEEE 802.1Q, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# interface fastethernet slot/port.subinterface-number`	Specifies the subinterface the VLAN will use.
Step 2	`Router(config-if)# encapsulation dot1q vlan-identifier`	Defines the encapsulation format as IEEE 802.1Q (**dot1q**), and specifies the VLAN identifier.

Configuring IP Routing over IEEE 802.1Q

IP routing over IEEE 802.1Q extends IP routing capabilities to include support for routing IP frame types in VLAN configurations using the IEEE 802.1Q encapsulation.

To route IP over IEEE 802.1Q between VLANs, you need to customize the subinterface to create the environment in which it will be used. Perform the tasks described in the following sections in the order in which they appear:

- Enabling IP Routing
- Defining the VLAN Encapsulation Format
- Assigning an IP Address to Network Interface

Enabling IP Routing

IP routing is automatically enabled in the Cisco IOS software for routers. To reenable IP routing if it has been disabled, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ip routing`	Enables IP routing on the router.

Once you have IP routing enabled on the router, you can customize the characteristics to suit your environment. If necessary, refer to the IP configuration chapters in the *Cisco IOS IP Routing Configuration Guide* for guidelines on configuring IP.

Defining the VLAN Encapsulation Format

To define the encapsulation format as IEEE 802.1Q, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# interface fastethernet slot/port.subinterface-number`	Specifies the subinterface on which IEEE 802.1Q will be used.
Step 2	`Router(config-if)# encapsulation dot1q vlanid`	Defines the encapsulation format as IEEE 802.1Q (**dot1q**), and specifies the VLAN identifier

Assigning an IP Address to Network Interface

An interface can have one primary IP address. To assign a primary IP address and a network mask to a network interface, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# ip address ip-address mask`	Sets a primary IP address for an interface.

A mask identifies the bits that denote the network number in an IP address. When you use the mask to subnet a network, the mask is then referred to as a *subnet mask*.

Configuring IPX Routing over IEEE 802.1Q

IPX routing over IEEE 802.1Q VLANs extends Novell NetWare routing capabilities to include support for routing Novell Ethernet_802.3 encapsulation frame types in VLAN configurations. Users with Novell NetWare environments can configure Novell Ethernet_802.3 encapsulation frames to be routed using IEEE 802.1Q encapsulation across VLAN boundaries.

To configure Cisco IOS software on a router with connected VLANs to exchange IPX Novell Ethernet_802.3 encapsulated frames, perform the tasks described in the following sections in the order in which they are appear:

- Enabling NetWare Routing
- Defining the VLAN Encapsulation Format
- Configuring NetWare on the Subinterface

Enabling NetWare Routing

To enable IPX routing on IEEE 802.1Q interfaces, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ipx routing [node]`	Enables IPX routing globally.

Defining the VLAN Encapsulation Format

To define the encapsulation format as IEEE 802.1Q, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# interface fastethernet slot/port.subinterface-number`	Specifies the subinterface on which IEEE 802.1Q will be used.
Step 2	`Router(config-if)# encapsulation dot1q vlan-identifier`	Defines the encapsulation format as IEEE 802.1Q and specifies the VLAN identifier.

Configuring NetWare on the Subinterface

After you enable NetWare globally and define the VLAN encapsulation format, you may need to enable the subinterface by specifying the NetWare network number. Use this command in interface configuration mode:

Command	Purpose
`Router(config-if)# ipx network network`	Specifies the IPX network number.

Configuring a VLAN for a bridge-group with Default VLAN1

To configure a VLAN associated to a bridge group with a default native VLAN, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface fastethernet slot/port`	Selects a particular Fast Ethernet interface for configuration.
Step 2	`Router(config-subif)# encapsulation dot1q 1`	Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in VLANs, and defaults the associated VLAN as a native VLAN.
Step 3	`Router(config-subif)# bridge-group bridge-group`	Assigns each network interface to a bridge group.

Note If there is no explicitly defined native VLAN, the default VLAN 1 becomes the native VLAN 1.

Configuring a VLAN for a bridge-group as a Native VLAN

To configure a VLAN associated to a bridge group as a native VLAN, use the following beginning commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface fastethernet slot/port`	Selects a particular Fast Ethernet interface for configuration.
Step 2	`Router(config-subif)# encapsulation dot1q vlan-id native`	Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in VLANs, and defaults to 1.
Step 3	`Router(config-subif)# bridge-group bridge-group`	Assigns each network interface to a bridge group.

Note If there is an explicitly defined native VLAN, VLAN 1 will only be used to process CST.

Monitoring and Maintaining VLAN Subinterfaces

To indicate whether a VLAN is a native VLAN, use the following command in privileged EXEC mode:

Command	Purpose
`Router# show vlans`	Displays VLAN subinterfaces.

IEEE 802.1Q Encapsulation Configuration Examples

Configuration examples for each protocols are provided in the following sections:

- Configuring AppleTalk over IEEE 802.1Q Example
- Configuring IP Routing over IEEE 802.1Q Example
- Configuring IPX Routing over IEEE 802.1Q Example
- VLAN 100 for Bridge Group 1 with Default VLAN 1 Example
- VLAN 20 for Bridge Group 1 with Native VLAN Example
- VLAN ISL or IEEE 802.1Q Routing Example
- VLAN IEEE 802.1Q Bridging Example
- VLAN IEEE 802.1Q IRB Example

Configuring AppleTalk over IEEE 802.1Q Example

This configuration example shows AppleTalk being routed on VLAN 100:

```
!
appletalk routing
!
```

```
interface fastethernet 4/1.100
  encapsulation dot1q 100
  appletalk cable-range 100-100 100.1
  appletalk zone eng
!
```

Configuring IP Routing over IEEE 802.1Q Example

This configuration example shows IP being routed on VLAN 101:

```
!
ip routing
!
interface fastethernet 4/1.101
  encapsulation dot1q 101
  ip addr 10.0.0.11 255.0.0.0
!
```

Configuring IPX Routing over IEEE 802.1Q Example

This configuration example shows IPX being routed on VLAN 102:

```
!
ipx routing
!
interface fastethernet 4/1.102
  encapsulation dot1q 102
  ipx network 100
!
```

VLAN 100 for Bridge Group 1 with Default VLAN 1 Example

The following example configures VLAN 100 for bridge group 1 with a default VLAN 1:

```
interface FastEthernet 4/1.100
encapsulation dot1q 1
bridge-group 1
```

VLAN 20 for Bridge Group 1 with Native VLAN Example

The following example configures VLAN 20 for bridge group 1 as a native VLAN:

```
interface FastEthernet 4/1.100
encapsulation dot1q 20 native
bridge-group 1
```

VLAN ISL or IEEE 802.1Q Routing Example

The following example configures VLAN ISL or IEEE 802.10 routing:

```
ipx routing
appletalk routing
!
interface Ethernet 1
ip address 10.1.1.1 255.255.255.0
```

```
appletalk cable-range 1-1 1.1
appletalk zone 1
ipx network 10 encapsulation snap
!
router igrp 1
network 10.1.0.0
!
end
!
#Catalyst5000
!
set VLAN 110 2/1
set VLAN 120 2/2
!
set trunk 1/1 110,120
# if 802.1Q, set trunk 1/1 nonegotiate 110, 120
!
end
!

ipx routing
appletalk routing
!
interface FastEthernet 1/1.110
encapsulation isl 110
!if 802.1Q, encapsulation dot1Q 110
ip address 10.1.1.2 255.255.255.0
appletalk cable-range 1.1 1.2
appletalk zone 1
ipx network 110 encapsulation snap
!
interface FastEthernet 1/1.120
encapsulation isl 120
!if 802.1Q, encapsulation dot1Q 120
ip address 10.2.1.2 255.255.255.0
appletalk cable-range 2-2 2.2
appletalk zone 2
ipx network 120 encapsulation snap
!
router igrp 1
network 10.1.0.0
network 10.2.1.0.0
!
end
!

ipx routing
appletalk routing
!
interface Ethernet 1
ip address 10.2.1.3 255.255.255.0
appletalk cable-range 2-2 2.3
appletalk zone 2
ipx network 120 encapsulation snap
!
router igrp 1
network 10.2.0.0
!
end
```

VLAN IEEE 802.1Q Bridging Example

The following examples configures IEEE 802.1Q bridging:

```
interface FastEthernet4/0
 no ip address
 no ip route-cache
 half-duplex
!
interface FastEthernet4/0.100
 encapsulation dot1Q 100
 no ip route-cache
 bridge-group 1
!
interface FastEthernet4/0.200
 encapsulation dot1Q 200 native
 no ip route-cache
 bridge-group 2
!
interface FastEthernet4/0.300
 encapsulation dot1Q 1
 no ip route-cache
 bridge-group 3
!
interface FastEthernet10/0
 no ip address
 no ip route-cache
 half-duplex
!
interface FastEthernet10/0.100
 encapsulation dot1Q 100
 no ip route-cache
 bridge-group 1
!
interface Ethernet11/3
 no ip address
 no ip route-cache
 bridge-group 2
!
interface Ethernet11/4
 no ip address
 no ip route-cache
 bridge-group 3
!
bridge 1 protocol ieee
bridge 2 protocol ieee
bridge 3 protocol ieee
```

VLAN IEEE 802.1Q IRB Example

The following examples configures IEEE 802.1Q integrated routing and bridging:

```
ip cef
appletalk routing
ipx routing 0060.2f27.5980
!
bridge irb
!
interface TokenRing3/1
 no ip address
 ring-speed 16
```

```
 bridge-group 2
!
interface FastEthernet4/0
 no ip address
 half-duplex
!
interface FastEthernet4/0.100
 encapsulation dot1Q 100
 bridge-group 1
!
interface FastEthernet4/0.200
 encapsulation dot1Q 200
 bridge-group 2
!
interface FastEthernet10/0
ip address 10.3.1.10 255.255.255.0
 half-duplex
 appletalk cable-range 200-200 200.10
 appletalk zone irb
 ipx network 200
!
interface Ethernet11/3
 no ip address
 bridge-group 1
!
interface BVI 1
 ip address 10.1.1.11 255.255.255.0
 appletalk cable-range 100-100 100.11
 appletalk zone bridging
 ipx network 100
!
router rip
 network 10.0.0.0
 network 10.3.0.0
!
bridge 1 protocol ieee
 bridge 1 route appletalk
 bridge 1 route ip
 bridge 1 route ipx
bridge 2 protocol ieee
!
```