Configuring VLANs

This chapter describes how to configure your access point/bridge to operate with the VLANs set up on your wired LAN. These sections describe how to configure your access point/bridge to support VLANs:

Understanding VLANs

A VLAN is a switched network that is logically segmented, by functions, project teams, or applications rather than on a physical or geographical basis. For example, all workstations and servers used by a particular workgroup team can be connected to the same VLAN, regardless of their physical connections to the network or the fact that they might be intermingled with other teams. You use VLANs to reconfigure the network through software rather than physically unplugging and moving devices or wires.

A VLAN can be thought of as a broadcast domain that exists within a defined set of switches. A VLAN consists of a number of end systems, either hosts or network equipment (such as access point/bridges and routers), connected by a single bridging domain. The bridging domain is supported on various pieces of network equipment such as LAN switches that operate bridging protocols between them with a separate group for each VLAN.

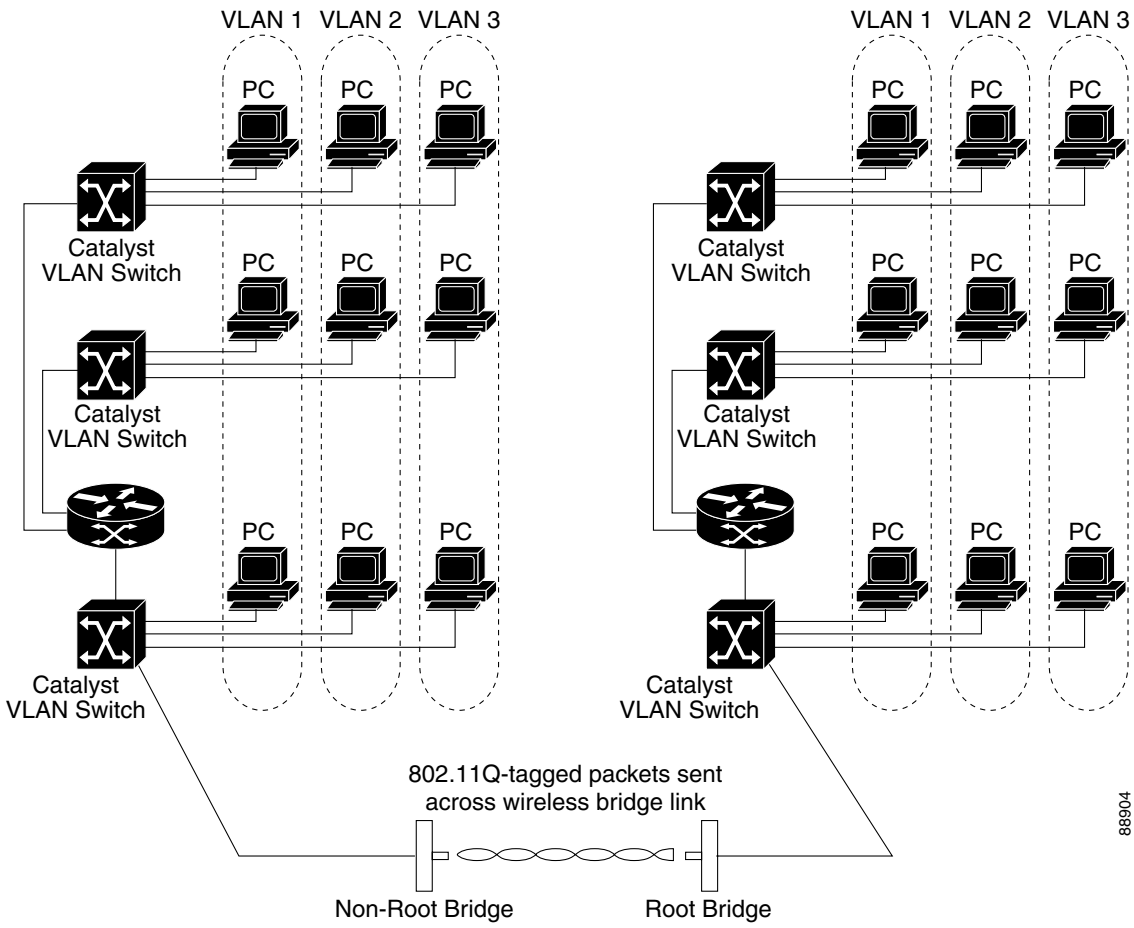
VLANs provide the segmentation services traditionally provided by routers in LAN configurations. VLANs address scalability, security, and network management. You should consider several key issues when designing and building switched LAN networks:

- LAN segmentation
- Security
- Broadcast control
- Performance
- Network management
- Communication between VLANs

You extend VLANs into a wireless LAN by adding IEEE 802.11Q tag awareness to the access point/bridge. Frames destined for different VLANs are transmitted by the access point/bridge wirelessly on different SSIDs with different WEP keys. Only the clients associated with that VLAN receive those packets. Conversely, packets coming from a client associated with a certain VLAN are 802.11Q tagged before they are forwarded onto the wired network.

Figure 13-1 shows two access point/bridges sending 802.11Q-tagged packets between two LAN segments that use logical VLAN segmentation.

Figure 13-1 AN and VLAN Segmentation with Wireless Devices



Related Documents

These documents provide more detailed information pertaining to VLAN design and configuration:

- *Cisco IOS Switching Services Configuration Guide.* Click this link to browse to this document: http://www.cisco.com/en/US/docs/ios/12_2/switch/configuration/guide/fswtch_c.html
- *Cisco Internetwork Design Guide.* Click this link to browse to this document: http://www.cisco.com/en/US/docs/internetworking/design/guide/idg4.html
- *Cisco Internetworking Technology Handbook.* Click this link to browse to this document: http://www.cisco.com/en/US/docs/internetworking/technology/handbook/ito_doc.html
- *Cisco Internetworking Troubleshooting Guide.* Click this link to browse to this document: http://www.cisco.com/en/US/docs/internetworking/troubleshooting/guide/tr1901.html

Incorporating Wireless Access Point/Bridges into VLANs

The basic wireless components of a VLAN consist of an access point and a client associated to it using wireless technology. The access point is physically connected through a trunk port to the network VLAN switch on which the VLAN is configured. The physical connection to the VLAN switch is through the access point's Ethernet port.

In fundamental terms, the key to configuring an access point/bridge to connect to a specific VLAN is to configure its SSID to recognize that VLAN. Because VLANs are identified by a VLAN ID or name, it follows that if the SSID on an access point/bridge is configured to recognize a specific VLAN ID or name, a connection to the VLAN is established. When this connection is made, associated wireless client devices having the same SSID can access the VLAN through the access point/bridge. The VLAN processes data to and from the clients the same way that it processes data to and from wired connections. You can configure up to 16 SSIDs on your access point/bridge, so you can support up to 16 VLANs. You can assign only one SSID to a VLAN.

You can use the VLAN feature to deploy wireless devices with greater efficiency and flexibility. For example, one access point/bridge can now handle the specific requirements of multiple users having widely varied network access and permissions. Without VLAN capability, multiple access point/bridges would have to be employed to serve classes of users based on the access and permissions they were assigned.

These are two common strategies for deploying wireless VLANs:

- Segmentation by user groups: You can segment your wireless LAN user community and enforce a different security policy for each user group. For example, you can create three wired and wireless VLANs in an enterprise environment for full-time and part-time employees and also provide guest access.
- Segmentation by device types: You can segment your wireless LAN to allow different devices with different security capabilities to join the network. For example, some wireless users might have handheld devices that support only static WEP, and some wireless users might have more sophisticated devices using dynamic WEP. You can group and isolate these devices into separate VLANs.

Note You cannot configure multiple VLANs on an access point/bridge configured as a repeater access point. Repeater access points support only the native VLAN.

Configuring VLANs

These sections describe how to configure VLANs on your access point/bridge:

- Configuring a VLAN, page 13-4
- Viewing VLANs Configured on the Access Point/Bridge, page 13-7

Configuring a VLAN

Configuring your access point/bridge to support VLANs is a five-step process:

1. Create subinterfaces on the radio and Ethernet interfaces.
2. Enable 802.1q encapsulation on the subinterfaces and assign one subinterface as the native VLAN.

3. Assign a access point/bridge group to each VLAN.
4. (Optional) Enable WEP on the native VLAN.
5. Assign the access point/bridge's SSID to the native VLAN.

This section describes how to assign an SSID to a VLAN and how to enable a VLAN on the access point/bridge radio and Ethernet ports. For detailed instructions on assigning authentication types to SSIDs, see Chapter 10, "Configuring Authentication Types."

Beginning in privileged EXEC mode, follow these steps to assign an SSID to a VLAN and enable the VLAN on the access point/bridge radio and Ethernet ports:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface dot11radio0.x**	Create a radio subinterface and enter interface configuration mode for the subinterface.
Step 3	**encapsulation dot1q** *vlan-id* [**native**]	Enable a VLAN on the subinterface. (Optional) Designate the VLAN as the native VLAN. On many networks, the native VLAN is VLAN 1.
Step 4	**bridge-group** *number*	Assign the subinterface to a bridge group. You can number your bridge groups from 1 to 255. **Note** When you enter the **bridge-group** command, the bridge enables the subinterface to be ready to participate in STP when you enter the **bridge** *n* **protocol ieee** command. See Chapter 8, "Configuring Spanning Tree Protocol," for complete instructions on enabling STP on the bridge.
Step 5	**exit**	Return to global configuration mode.
Step 6	**interface fastEthernet0.x**	Create an Ethernet subinterface and enter interface configuration mode for the subinterface.
Step 7	**encapsulation dot1q** *vlan-id* [**native**]	Enable a VLAN on the subinterface. (Optional) Designate the VLAN as the native VLAN. On many networks, the native VLAN is VLAN 1.
Step 8	**bridge-group** *number*	Assign the subinterface to a bridge group. You can number your bridge groups from 1 to 255.
Step 9	**exit**	Return to global configuration mode.
Step 10	**interface dot11radio 0**	Enter interface configuration mode for the radio interface.
Step 11	**ssid** *ssid-string*	Create an SSID and enter SSID configuration mode for the new SSID. The SSID can consist of up to 32 alphanumeric characters. SSIDs are case sensitive. You can create only one SSID on the access point/bridge. **Note** You use the **ssid** command's authentication options to configure an authentication type for each SSID. See Chapter 10, "Configuring Authentication Types," for instructions on configuring authentication types.
Step 12	**vlan** *vlan-id*	Assign the SSID to the native VLAN.

	Command	Purpose
Step 13	**infrastructure-ssid**	Designate the SSID as the infrastructure SSID. It is used to instruct a non-root access point/bridge or workgroup bridge radio to associate with this SSID.
Step 14	**encryption** [**vlan** *vlan-id*] **mode wep** {**optional** [**key-hash**] | **mandatory** [**mic**] [**key-hash**]}	(Optional) Enable WEP and WEP features on the native VLAN. • (Optional) Select the VLAN for which you want to enable WEP and WEP features. • Set the WEP level and enable TKIP and MIC. If you enter **optional**, another access point/bridge can associate to the access point/bridge with or without WEP enabled. You can enable TKIP with WEP set to optional but you cannot enable MIC. If you enter **mandatory**, other access point/bridges must have WEP enabled to associate to the access point/bridge. You can enable both TKIP and MIC with WEP set to mandatory. **Note** You can enable encryption for each VLAN, but the access point/bridge uses only the encryption on the native VLAN. For example, if the native VLAN encryption is set to 128-bit static WEP, that is the only encryption method used for traffic between the root and non-root access point/bridge.
Step 15	**exit**	Return to interface configuration mode for the radio interface.
Step 16	**end**	Return to privileged EXEC mode.
Step 17	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

This example shows how to:

- Enable the VLAN on the radio and Ethernet ports as the native VLAN
- Name an SSID
- Assign the SSID to a VLAN

```
ap# configure terminal
ap(config)# interface dot11radio0.1
ap(config-subif)# encapsulation dot1q 1 native
ap(config-subif)# bridge group 1
ap(config-subif)# exit
ap(config)# interface fastEthernet0.1
ap(config-subif)# encapsulation dot1q 1 native
ap(config-subif)# bridge group 1
ap(config-subif)# exit
ap(config)# interface dot11radio0
ap(config-if)# ssid batman
ap(config-ssid)# vlan 1
ap(config-ssid)# infrastructure-ssid
ap(config-ssid)# end
```

Viewing VLANs Configured on the Access Point/Bridge

In privileged EXEC mode, use the **show vlan** command to view the VLANs that the access point/bridge supports. This is sample output from a **show vlan** command:

```
Virtual LAN ID:  1 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interfaces:  Dot11Radio0
FastEthernet0
Virtual-Dot11Radio0

 This is configured as native Vlan for the following interface(s) :
Dot11Radio0
FastEthernet0
Virtual-Dot11Radio0

   Protocols Configured:   Address:              Received:        Transmitted:
        Bridging        Bridge Group 1             201688                  0
        Bridging        Bridge Group 1             201688                  0
        Bridging        Bridge Group 1             201688                  0

Virtual LAN ID:  2 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interfaces:  Dot11Radio0.2
FastEthernet0.2
Virtual-Dot11Radio0.2

   Protocols Configured:   Address:              Received:        Transmitted:
```

Assigning Names to VLANs

You can assign a name to a VLAN in addition to its numerical ID. VLAN names can contain up to 32 ASCII characters. The access point/bridge stores each VLAN name and ID pair in a table.

Guidelines for Using VLAN Names

Keep these guidelines in mind when using VLAN names:

- The mapping of a VLAN name to a VLAN ID is local to each access point/bridge, so across your network, you can assign the same VLAN name to a different VLAN ID.

Note If clients on your wireless LAN require seamless roaming, Cisco recommends that you assign the same VLAN name to the same VLAN ID across all access point/bridges, or that you use only VLAN IDs without names.

- Every VLAN configured on your access point/bridge must have an ID, but VLAN names are optional.
- VLAN names can contain up to 32 ASCII characters. However, a VLAN name cannot be a number between 1 and 4095. For example, *vlan4095* is a valid VLAN name, but *4095* is not. The access point/bridge reserves the numbers 1 through 4095 for VLAN IDs.

Creating a VLAN Name

Beginning in privileged EXEC mode, follow these steps to assign a name to a VLAN:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**dot11 vlan-name** *name* **vlan** *vlan-id*	Assign a VLAN name to a VLAN ID. The name can contain up to 32 ASCII characters.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Use the **no** form of the command to remove the name from the VLAN. Use the **show dot11 vlan-name** privileged EXEC command to list all the VLAN name and ID pairs configured on the access point/bridge.

Using a RADIUS Server to Assign Users to VLANs

You can configure your RADIUS authentication server to assign users or groups of users to a specific VLAN when they authenticate to the network.

Note Unicast and multicast cipher suites advertised in WPA information element (and negotiated during 802.11 association) may potentially mismatch with the cipher suite supported in an explicitly assigned VLAN. If the RADIUS server assigns a new vlan ID which uses a different cipher suite from the previously negotiated cipher suite, there is no way for the access point/bridge and client to switch back to the new cipher suite. Currently, the WPA and CCKM protocols do not allow the cipher suite to be changed after the initial 802.11 cipher negotiation phase. In this scenario, the client device is disassociated from the wireless LAN.

The VLAN-mapping process consists of these steps:

1. A client device associates to the access point/bridge using any SSID configured on the access point/bridge.
2. The client begins RADIUS authentication.
3. When the client authenticates successfully, the RADIUS server maps the client to a specific VLAN, regardless of the VLAN mapping defined for the SSID the client is using on the access point/bridge. If the server does not return any VLAN attribute for the client, the client is assigned to the VLAN specified by the SSID mapped locally on the access point/bridge.

These are the RADIUS user attributes used for vlan-id assignment. Each attribute must have a common tag value between 1 and 31 to identify the grouped relationship.

- IETF 64 (Tunnel Type): Set this attribute to **VLAN**
- IETF 65 (Tunnel Medium Type): Set this attribute to **802**
- IETF 81 (Tunnel Private Group ID): Set this attribute to *vlan-id*

Viewing VLANs Configured on the Access Point/Bridge

In privileged EXEC mode, use the **show vlan** command to view the VLANs that the access point/bridge supports. This is sample output from a **show vlan** command:

```
Virtual LAN ID:  1 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interfaces:  Dot11Radio0
FastEthernet0
Virtual-Dot11Radio0

 This is configured as native Vlan for the following interface(s) :
Dot11Radio0
FastEthernet0
Virtual-Dot11Radio0

   Protocols Configured:   Address:              Received:        Transmitted:
        Bridging        Bridge Group 1             201688                  0
        Bridging        Bridge Group 1             201688                  0
        Bridging        Bridge Group 1             201688                  0

Virtual LAN ID:  2 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interfaces:  Dot11Radio0.2
FastEthernet0.2
Virtual-Dot11Radio0.2

   Protocols Configured:   Address:              Received:        Transmitted:
```

VLAN Configuration Example

This example shows how to use VLANs to manage wireless devices on a college campus. In this example, three levels of access are available through VLANs configured on the wired network:

- Management access—Highest level of access; users can access all internal drives and files, departmental databases, top-level financial information, and other sensitive information. Management users are required to authenticate using Cisco LEAP.
- Faculty access—Medium level of access; users can access school's Intranet and Internet, access internal files, access student databases, and view internal information such as human resources, payroll, and other faculty-related material. Faculty users are required to authenticate using Cisco LEAP.
- Student access—Lowest level of access; users can access school's Intranet and the Internet, obtain class schedules, view grades, make appointments, and perform other student-related activities. Students are allowed to join the network using static WEP.

In this scenario, a minimum of three VLAN connections are required, one for each level of access. Because the access point/bridge can handle up to 16 SSIDs, you can use the basic design shown in Table 13-1.

Table 13-1 Access Level SSID and VLAN Assignment

Level of Access	SSID	VLAN ID
Management	boss	01
Faculty	teach	02
Student	learn	03

Managers configure their wireless client adapters to use SSID boss, faculty members configure their clients to use SSID teach, and students configure their wireless client adapters to use SSID learn. When these clients associate to the access point/bridge, they automatically belong to the correct VLAN.

You would complete these steps to support the VLANs in this example:

1. Configure or confirm the configuration of these VLANs on one of the switches on your LAN.
2. On the access point/bridge, assign an SSID to each VLAN.
3. Assign authentication types to each SSID.
4. Configure VLAN 1, the Management VLAN, on both the fastethernet and dot11radio interfaces on the access point/bridge. You should make this VLAN the native VLAN.
5. Configure VLANs 2 and 3 on both the fastethernet and dot11radio interfaces on the access point/bridge.
6. Configure the client devices.

Table 13-2 shows the commands needed to configure the three VLANs in this example.

Table 13-2 Configuration Commands for VLAN Example

Configuring VLAN 1	Configuring VLAN 2	Configuring VLAN 3
br1300# **configure terminal** br1300(config)# **interface dot11radio 0** br1300(config-if)# **ssid boss** br1300(config-ssid)# **vlan 01** br1300(config-ssid)# **end**	br1300Router# **configure terminal** br1300Router(config)# **interface dot11radio 0** br1300Router(config-if)# **ssid teach** br1300Router(config-ssid)# **vlan 02** br1300Router(config-ssid)# **end**	br1300Router# **configure terminal** br1300Routerbr1300Router(config)# **interface dot11radio 0** br1300Router(config-if)# **ssid learn** br1300Router(config-ssid)# **vlan 03** br1300Router(config-ssid)# **end**

Table 13-2 Configuration Commands for VLAN Example (continued)

Configuring VLAN 1	Configuring VLAN 2	Configuring VLAN 3
br1300Router **configure terminal** br1300Router(config) **interface FastEthernet0.1** br1300Router(config-subif) **encapsulation dot1Q 1 native** br1300Router(config-subif) **exit**	br1300Router(config) **interface FastEthernet0.2** br1300Router(config-subif) **encapsulation dot1Q 2** br1300Router(config-subif) **bridge-group 2** br1300Router(config-subif) **exit**	br1300Router(config) **interface FastEthernet0.3** br1300Router(config-subif) **encapsulation dot1Q 3** br1300Router(config-subif) **bridge-group 3** br1300Router(config-subif) **exit**
br1300Router(config)# **interface Dot11Radio 0.1** br1300Router(config-subif)# **encapsulation dot1Q 1 native** br1300Router(config-subif)# **exit** **Note** You do not need to configure a bridge group on the subinterface that you set up as the native VLAN. This bridge group is moved to the native subinterface automatically to maintain the link to BVI 1, which represents both the radio and Ethernet interfaces.	br1300Router(config) **interface Dot11Radio 0.2** br1300Router(config-subif) **encapsulation dot1Q 2** br1300Router(config-subif) **bridge-group 2** br1300Router(config-subif) **exit**	br1300Router(config) **interface Dot11Radio 0.3** br1300Router(config-subif) **encapsulation dot1Q 3** br1300Router(config-subif) **bridge-group 3** br1300Router(config-subif) **exit**

Table 13-3 shows the results of the configuration commands in Table 13-2. Use the **show running** command to display the running configuration on the access point/bridge.

Table 13-3 Results of Example Configuration Commands

VLAN 1 Interfaces	VLAN 2 Interfaces	VLAN 3 Interfaces
interface Dot11Radio**0**.1 encapsulation dot1Q 1 native no ip route-cache no cdp enable bridge-group 1 bridge-group 1 subscriber-loop-control bridge-group 1 block-unknown-source no bridge-group 1 source-learning no bridge-group 1 unicast-flooding bridge-group 1 spanning-disabled	interface Dot11Radio**0**.2 encapsulation dot1Q 2 no ip route-cache no cdp enable bridge-group 2 bridge-group 2 subscriber-loop-control bridge-group 2 block-unknown-source no bridge-group 2 source-learning no bridge-group 2 unicast-flooding bridge-group 2 spanning-disabled	interface Dot11Radio**0**.3 encapsulation dot1Q 3 no ip route-cache bridge-group 3 bridge-group 3 subscriber-loop-control bridge-group 3 block-unknown-source no bridge-group 3 source-learning no bridge-group 3 unicast-flooding bridge-group 3 spanning-disabled
interface FastEthernet0.1 encapsulation dot1Q 1 native no ip route-cache bridge-group 1 no bridge-group 1 source-learning bridge-group 1 spanning-disabled	interface FastEthernet0.2 encapsulation dot1Q 2 no ip route-cache bridge-group 2 no bridge-group 2 source-learning bridge-group 2 spanning-disabled	interface FastEthernet0.3 encapsulation dot1Q 3 no ip route-cache bridge-group 3 no bridge-group 3 source-learning bridge-group 3 spanning-disabled

Notice that when you configure a bridge group on the radio interface, these commands are set automatically:

```
bridge-group 2 subscriber-loop-control
bridge-group 2 block-unknown-source
no bridge-group 2 source-learning
no bridge-group 2 unicast-flooding
bridge-group 2 spanning-disabled
```

When you configure a bridge group on the FastEthernet interface, these commands are set automatically:

```
no bridge-group 2 source-learning
bridge-group 2 spanning-disabled
```