VLANs & Inter VLAN

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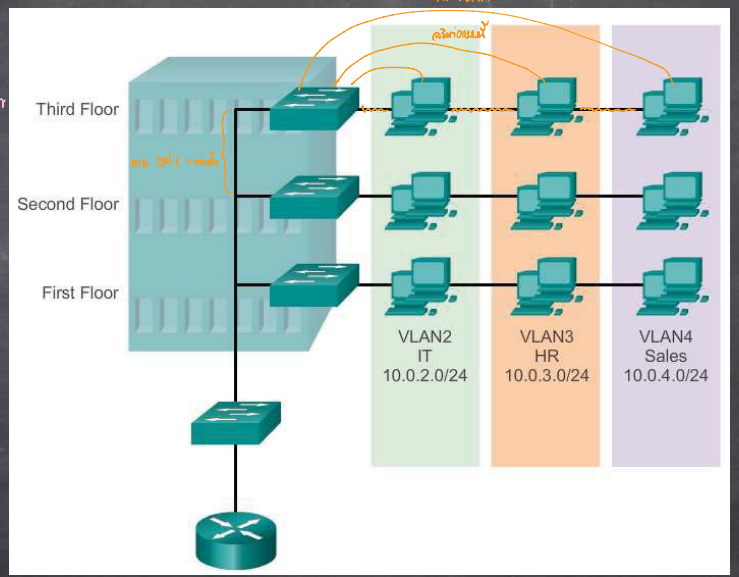
- VLANs
  - Overview of VLANs
    - VLAN Definitions / Benefits of VLANs / Type of VLANs
  - VLANs in a Multi-Switched Environment
    - VLAN Trunk
    - Controlling Broadcast Domains with VLANs
    - Tagging Ethernet Frames for VLAN
  - VLAN Implementation

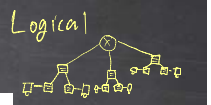
VLAN Definitions

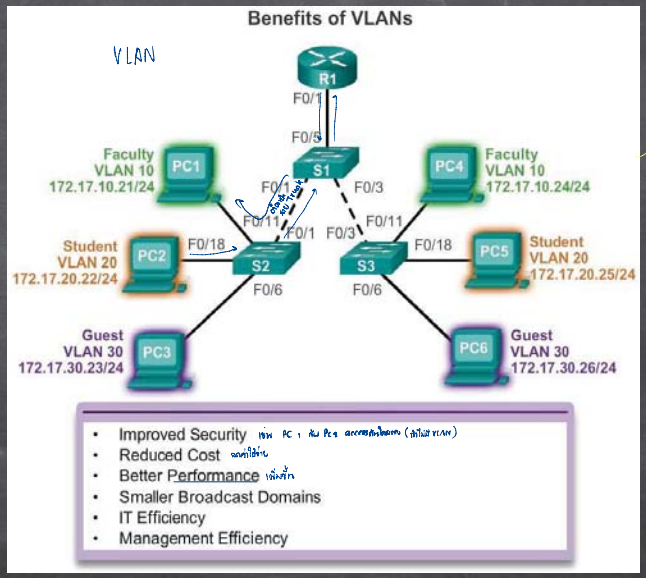
- VLAN (virtual LAN) is a logical partition of a layer 2 network
- Multiple partition can be created, allowing for multiple VLANs to co-exist
- Each VLAN is a broadcast domain, usually with its own IP network
- VLANS are mutually isolated and packets can only pass between them through a router
- The partitioning of the layer 2 network takes inside a layer 2 device, usually a switch.
- The hosts grouped within a VLAN are unaware of the VLAN's existence

VLAN Definitions



Benefits of VLANs





Types of VLANs

VLAN 1

```
Switch# show vlan brief

VLAN Name                Status    Ports
---- ------------------- --------- -------------------------------
1    default             active    Fa0/1,  Fa0/2,  Fa0/3,  Fa0/4
                                   Fa0/5,  Fa0/6,  Fa0/7,  Fa0/8
                                   Fa0/9,  Fa0/10, Fa0/11, Fa0/12
                                   Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                   Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                   Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                   Gi0/1,  Gi0/2
1002 fddi-default        act/unsup
1003 token-ring-default  act/unsup
1004 fddinet-default     act/unsup
1005 trnet-default       act/unsup
```

- All ports assigned to VLAN 1 to forward data by default.
- Native VLAN is VLAN 1 by default.
- Management VLAN is VLAN 1 by default.
- VLAN 1 cannot be renamed or deleted.

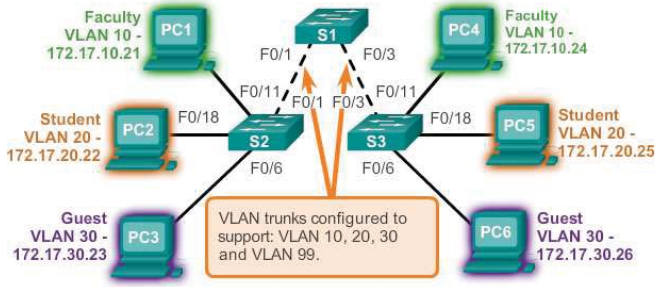
VLANs in a Multi-Switched Environment

- VLAN Trunks
  - A VLAN trunk carries more than one VLAN
  - Usually established between switches so same-VLAN devices can communicate even if physically connected to different switches
  - A VLAN trunk is not associated to any VLANs. Neither is the trunk ports used to establish the trunk link
  - Cisco IOS supports IEEE802.1q, a popular VLAN trunk protocol

VLAN Trunks

VLAN 10 Faculty/Staff - 172.17.10.0/24
VLAN 20 Students - 172.17.20.0/24
VLAN 30 Guest - 172.17.30.0/24
VLAN 99 Management and Native - 172.17.99.0/24

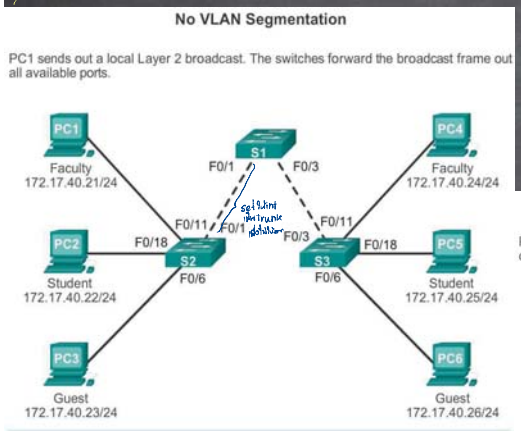
F0/1-5 are 802.1Q trunk interfaces with native VLAN 99.
F0/11-17 are in VLAN 10.
F0/18-24 are in VLAN 20.
F0/6-10 are in VLAN 30.

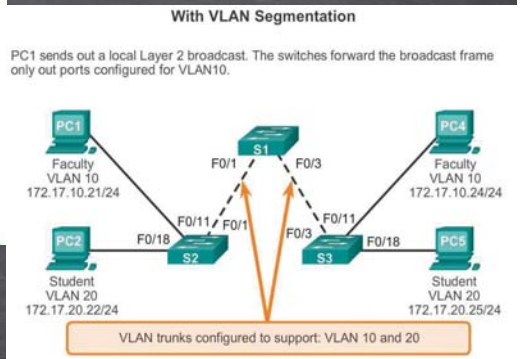


Controlling Broadcast Domains with VLANs

- VLANs can be used to limit the reach of broadcast frames
- A VLAN is a broadcast domain of its own
- Therefore, a broadcast frame sent by a device in a specific VLAN is forwarded within that VLAN only.
- This help controlling the reach of broadcast frames and their impact in the network
- Unicast and multicast frames are forwarded within the originating VLAN as well

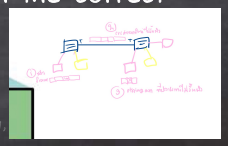
Controlling Broadcast Domains with VLANs



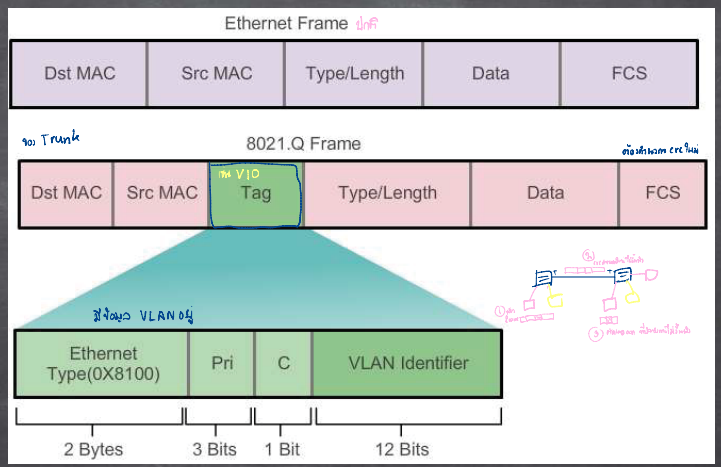


Tagging Ethernet Frames for VLAN Identification

- Frame tagging is used to properly transmit multiple VLAN frames through a trunk link
- Switches will tag frames to identify the VLAN they belong. Different tagging protocols exist, with IEEE 802.1q being a very popular one
- The protocol defines the structure of the tagging header added to the frame
- Switches will add VLAN tags to the frames before placing them into trunk links and remove the tags before forwarding frames through non-trunk ports
- Once properly tagged, the frames can transverse any number of switches via trunk links and still be forward within the correct VLAN at the destination



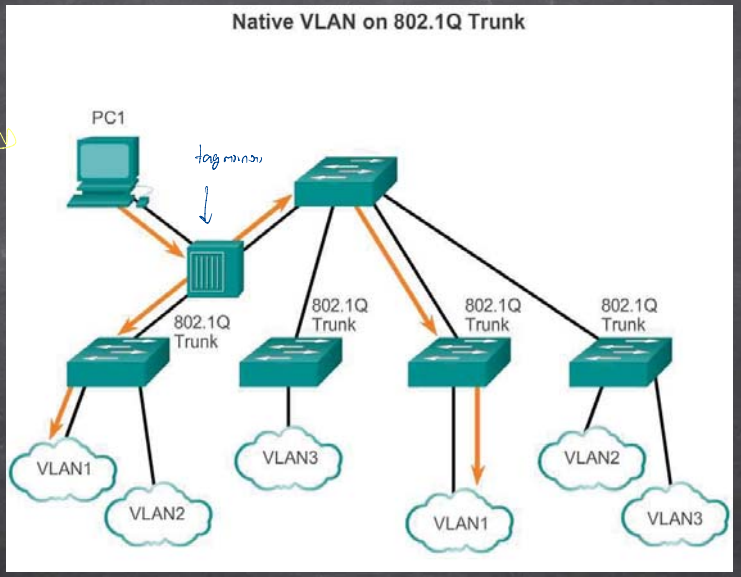
Tagging Ethernet Frames for VLAN Identification



Native VLAN & 802.1Q Tagging

- A frame that belongs to the native VLAN will not be tagged
- A frame that is received untagged will remain untagged and placed in the native VLAN when forwarded
- If there are not ports associated to the native VLAN and no other trunk links, an untagged frame will be dropped
- In Cisco switches, the native VLAN is VLAN 1 by default

Native VLAN & 802.1Q Tagging



VLAN Assignment

- VLAN Ranges On Catalyst Switches
  - The Catalyst 2960 and 3560 Series switches support over 4,000 VLANs
  - These VLANs are split into 2 categories:
  - Normal Range VLANs
  - VLAN numbers from 1 through 1005
  - Configurations stored in the vlan.dat (in the flash)
  - VTP can only learn and store normal range VLANs
  - Extended Range VLANs
  - VLAN numbers from 1006 through 4096
  - Configurations stored in the running-config (in the NVRAM)
  - VTP does not learn extended range VLANs

VLAN Assignment

- Creating a VLAN

Cisco Switch IOS Commands	
Enter global configuration mode.	S1# **configure terminal**
Create a VLAN with a valid id number.	S1(config)# **vlan** vlan_id
Specify a unique name to identify the VLAN.	S1(config-vlan)# **name** vlan_name
Return to the privileged EXEC mode.	S1(config-vlan)# **end**

VLAN Assignment

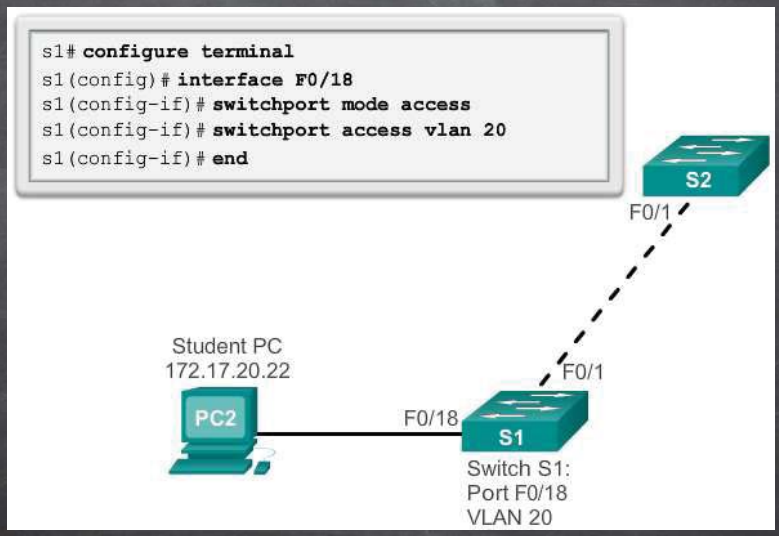
- Assigning Ports To VLANs

Cisco Switch IOS Commands	
Enter global configuration mode.	S1 # **configure terminal**
Enter interface configuration mode for the SVI.	S1(config) # **interface** *interface_id*
Set the port to access mode.	S1(config-if) # **switchport mode access**
Assign the port to a VLAN.	S1(config-if) # **switchport access vlan** *vlan_id*
Return to the privileged EXEC mode.	S1(config-if) # **end**

VLAN Assignment

- Assigning Ports To VLANs

```
s1# configure terminal
s1(config)# interface F0/18
s1(config-if)# switchport mode access
s1(config-if)# switchport access vlan 20
s1(config-if)# end
```



VLAN Assignment

- Changing VLAN Port Membership

```
S1(config)# int fa0/18
S1(config-if)# no switchport access vlan
S1(config-if)# end
S1# show vlan brief

VLAN Name              Status    Ports
---- ----------------- --------- -------------------------------
1    default           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                 Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                 Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                 Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                 Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                 Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                 Gi0/1, Gi0/2
20   student           active
1002 fddi-default      act/unsup
1003 token-ring-default act/unsup
1004 fddinet-default   act/unsup
1005 trnet-default     act/unsup
S1#
```


VLAN Assignment

- Changing VLAN Port Membership

```
S1# config t
S1(config)# int fa0/11
S1(config-if)# switchport mode access
S1(config-if)# switchport access vlan 20
S1(config-if)# end
S1#
S1# show vlan brief

VLAN Name                 Status    Ports
---- -------------------- --------- -------------------------------
1    default              active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                    Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                    Fa0/9, Fa0/10, Fa0/12, Fa0/1
                                    Fa0/14, Fa0/15, Fa0/16, Fa0/
                                    Fa0/18, Fa0/19, Fa0/20, Fa0/
                                    Fa0/22, Fa0/23, Fa0/24, Gi0/
                                    Gi0/2
20   student              active    Fa0/11
1002 fddi-default         act/unsup
1003 token-ring-default   act/unsup
1004 fddinet-default      act/unsup
1005 trnet-default        act/unsup
S1#
```

VLAN Assignment

- Deleting VLANs

```
S1# conf t
S1(config)# no vlan 20
S1(config)# end
S1#
S1# sh vlan brief

VLAN Name                Status    Ports
---- ----------------    --------- -------------------------------
1    default             active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                   Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                   Fa0/9, Fa0/10, Fa0/12, Fa0/13
                                   Fa0/14, Fa0/15, Fa0/16, Fa0/17
                                   Fa0/18, Fa0/19, Fa0/20, Fa0/21
                                   Fa0/22, Fa0/23, Fa0/24, Gi0/1
                                   Gi0/2
1002 fddi-default        act/unsup
1003 token-ring-default  act/unsup
1004 fddinet-default     act/unsup
1005 trnet-default       act/unsup
S1#
```


VLAN Assignment

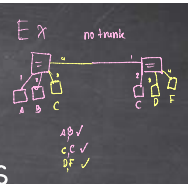
- Verifying VLAN Information

```
S1# show vlan name student

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
20   student                           active    Fa0/11, Fa0/18

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
20   enet  100020     1500  -      -      -        -    -        0      0

Remote SPAN VLAN
----------------
Disabled

Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------

S1# show vlan summary
Number of existing VLANs            : 7
Number of existing VTP VLANs        : 7
Number of existing extended VLANS   : 0

S1#
```

```
S1#show interfaces vlan 20
Vlan20 is up, line protocol is down
  Hardware is EtherSVI, address is 001c.57ec.0641 (bia
001c.57ec.0641)
  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 IP multicast)
     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
```


VLAN Assignment

- Configuring IEEE 802.1q Trunk Links



Cisco Switch IOS Commands	
Enter global configuration mode.	S1# **configure terminal**
Enter interface configuration mode for the SVI.	S1(config)# **interface** *interface_id*
Force the link to be a trunk link.	S1(config)# **switchport mode trunk**
Specify a native VLAN for untagged 802.1Q trunks.	S1(config-if)# **switchport trunk native vlan** *vlan_id*
Specify the list of VLANs to be allowed on the trunk link.	S1(config-if)# **switchport trunk allowed vlan** *vlan-list*
Return to the privileged EXEC mode.	S1(config-if)# **end**

```
S1(config)# interface FastEthernet0/1
S1(config-if)# switchport mode trunk
S1(config-if)# switchport trunk native vlan 99
S1(config-if)# switchport trunk allowed vlan 10,20,30
S1(config-if)# end
```


VLAN Assignment

- Resetting the Trunk To Default State

Resetting Trunk Link Example

```
S1(config)# interface f0/1
S1(config-if)# no switchport trunk allowed vlan
S1(config-if)# no switchport trunk native vlan
S1(config-if)# end
S1# show interfaces f0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
<output omitted>
Administrative private-vlan trunk mappings: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
<output omitted>
```

Return Port to Access Mode

```
S1(config)# interface f0/1
S1(config-if)# switchport mode access
S1(config-if)# end
S1# show interfaces f0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: static access
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
Negotiation of Trunking: Off
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
<output omitted>
```

VLAN Assignment

- Verifying Trunk Configuration

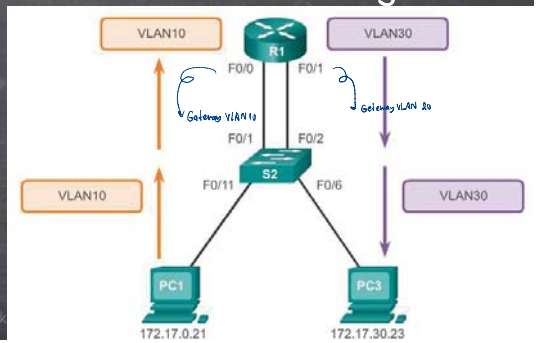
Verifying Trunk Configuration

```
S1(config)# interface f0/1
S1(config-if)# switchport mode trunk
S1(config-if)# switchport trunk native vlan 99
S1(config-if)# end
S1# show interfaces f0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 99 (VLAN0099)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk associations: none
Administrative private-vlan trunk mappings: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
<output omitted>
```


- Inter-VLAN Routing
  - Inter-VLAN Routing Operation
  - Inter-VLAN Routing Configuration
  - Troubleshooting Inter-VLAN Routing

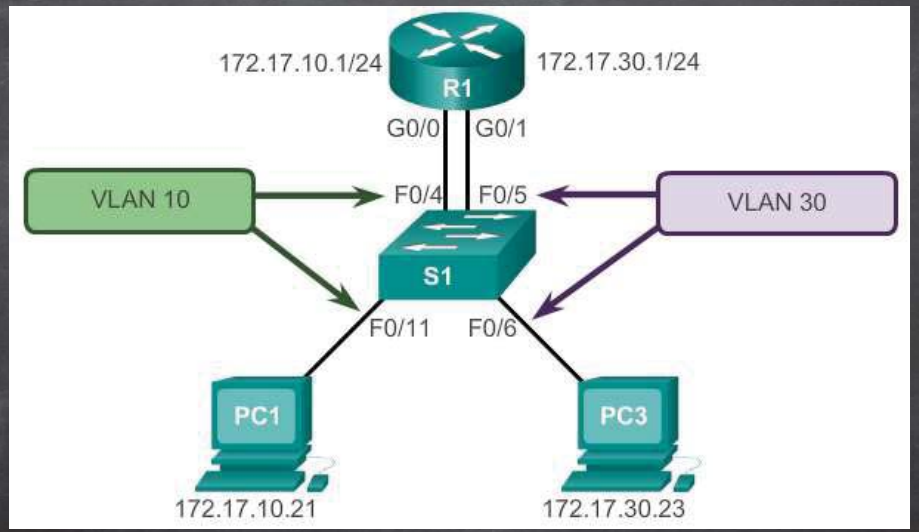
Inter-VLAN Routing Operation

- What is Inter-VLAN Routing?
  - Layer 2 switches can't forward traffic between VLANs without the assistance of a router
  - Inter-VLAN routing is a process for forwarding network traffic from one VLAN to another using a router



Inter-VLAN Routing Configuration

- Preparation



Inter-VLAN Routing Configuration

- Switch Configuration

```
S1(config)# vlan 10
S1(config-vlan)# vlan 30
S1(config-vlan)# interface f0/11
S1(config-if)# switchport access vlan 10
S1(config-if)# interface f0/4
S1(config-if)# switchport access vlan 10
S1(config-if)# interface f0/6
S1(config-if)# switchport access vlan 30
S1(config-if)# interface f0/5
S1(config-if)# switchport access vlan 30
S1(config-if)# end
*Mar 20 01:22:56.751: %SYS-5-CONFIG_I: Configured from console by
console
S1# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

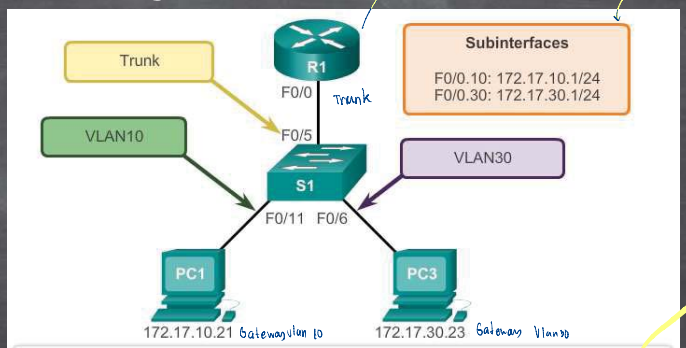

Inter-VLAN Routing Configuration

- Router Interface Configuration

```
R1(config)# interface g0/0
R1(config-if)# ip address 172.17.10.1 255.255.255.0
R1(config-if)# no shutdown
*Mar 20 01:42:12.951: %LINK-3-UPDOWN: Interface GigabitEthernet0/0,
changed state to up
*Mar 20 01:42:13.951: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet0/0, changed state to up
R1(config-if)# interface g0/1
R1(config-if)# ip address 172.17.30.1 255.255.255.0
R1(config-if)# no shutdown
*Mar 20 01:42:54.951: %LINK-3-UPDOWN: Interface GigabitEthernet0/1,
changed state to up
*Mar 20 01:42:55.951: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet0/1, changed state to up
R1(config-if)# end
R1# copy running-config startup-config
```


Inter-VLAN Routing Configuration

- Switch Configuration




```
S1(config)# vlan 10
S1(config-vlan)# vlan 30
S1(config-vlan)# interface f0/5
S1(config-if)# switchport mode trunk
S1(config-if)# end
S1#
```


Inter-VLAN Routing Configuration

- Router Interface Configuration

```
R1(config)# interface g0/0.10
R1(config-subif)# encapsulation dot1q 10
R1(config-subif)# ip address 172.17.10.1 255.255.255.0
R1(config-subif)# interface g0/0.30
R1(config-subif)# encapsulation dot1q 30
R1(config-subif)# ip address 172.17.30.1 255.255.255.0
R1(config)# interface g0/0
R1(config-if)# no shutdown
*Mar 20 00:20:59.299: %LINK-3-UPDOWN: Interface GigabitEthernet0/0,
 changed state to down
*Mar 20 00:21:02.919: %LINK-3-UPDOWN: Interface GigabitEthernet0/0,
 changed state to up
*Mar 20 00:21:03.919: %LINEPROTO-5-UPDOWN: Line protocol on
 changed state to down
*Mar 20 00:21:02.919: %LINK-3-UPDOWN: Interface GigabitEthernet0/0,
 changed state to up
*Mar 20 00:21:03.919: %LINEPROTO-5-UPDOWN: Line protocol on
 Interface GigabitEthernet0/0, changed state to up
```

Verifying Subinterfaces

```
R1# show vlans
<output omitted>
Virtual LAN ID:  10 (IEEE 802.1Q Encapsulation)

  vLAN Trunk Interface:   GigabitEthernet0/0.10

   Protocols Configured:  Address:     Received:   Transmitted:
          IP              172.17.10.1          11              18
<output omitted>
Virtual LAN ID:  30 (IEEE 802.1Q Encapsulation)

  vLAN Trunk Interface:   GigabitEthernet0/0.30

   Protocols Configured:  Address:     Received:   Transmitted:
          IP              172.17.30.1          11               8
<output omitted>


R1# show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP,
       l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

   172.17.0.0/16 is variably subnetted, 4 subnets, 2 masks
C     172.17.10.0/24 is directly connected, GigabitEthernet0/0.10
L     172.17.10.1/32 is directly connected, GigabitEthernet0/0.10
C     172.17.30.0/24 is directly connected, GigabitEthernet0/0.30
L     172.17.30.1/32 is directly connected, GigabitEthernet0/0.30
```

```
R1# show vlans
<output omitted>
Virtual LAN ID:  10 (IEEE 802.1Q Encapsulation)

  vLAN Trunk Interface:   GigabitEthernet0/0.10

   Protocols Configured:  Address:     Received:   Transmitted:
          IP              172.17.10.1          11              18
<output omitted>
Virtual LAN ID:  30 (IEEE 802.1Q Encapsulation)

  vLAN Trunk Interface:   GigabitEthernet0/0.30

   Protocols Configured:  Address:     Received:   Transmitted:
          IP              172.17.30.1          11               8
<output omitted>
```

```
R1# show ip route
Gateway of last resort is not set

   172.17.0.0/16 is variably subnetted, 4 subnets, 2 masks
C     172.17.10.0/24 is directly connected, GigabitEthernet0/0.10
L     172.17.10.1/32 is directly connected, GigabitEthernet0/0.10
C     172.17.30.0/24 is directly connected, GigabitEthernet0/0.30
L     172.17.30.1/32 is directly connected, GigabitEthernet0/0.30
```


Questions and Answers