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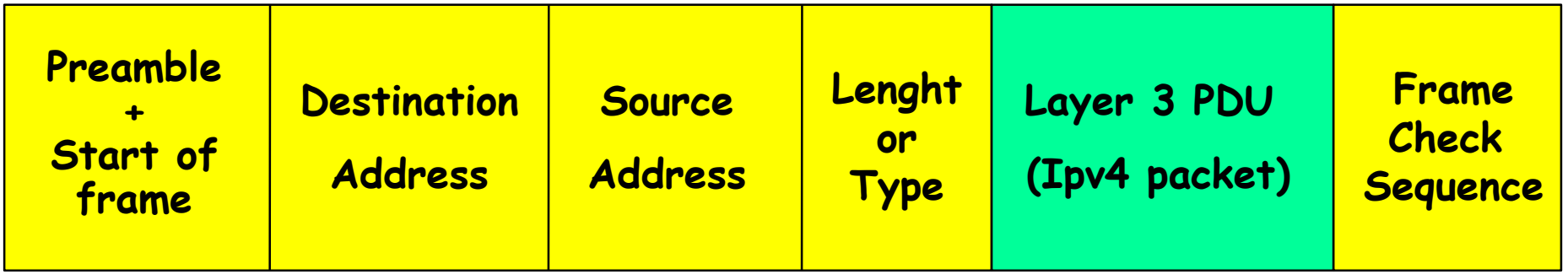
Virtual LAN (VLAN)

Ethernet

- Ethernet standard (IEEE 802.3) for Local Area Network (LAN).
- CSMA/CD (Carrier Sense Multiple Access/Collision Detection)
- **Carrier Sense**: all devices have to "sense" the medium before sending frames.
- **Multiple Access**: collisions
- **Collision Detection**: Back-off algorithm

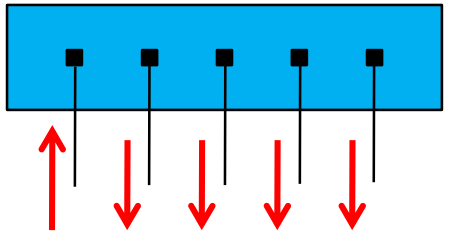
Ethernet frame



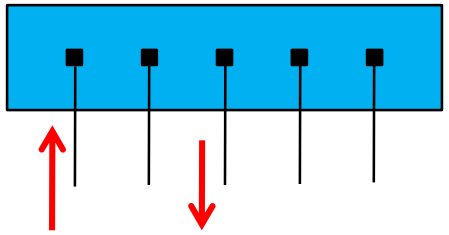
- MAC address: 6 bytes. Hexadecimal format: 00-24-9A-3C-74-02, 00:24:9A:3C:74:02, 0024.9A3C.7402

Ethernet devices

- **Hub**: forwards frames on all interfaces

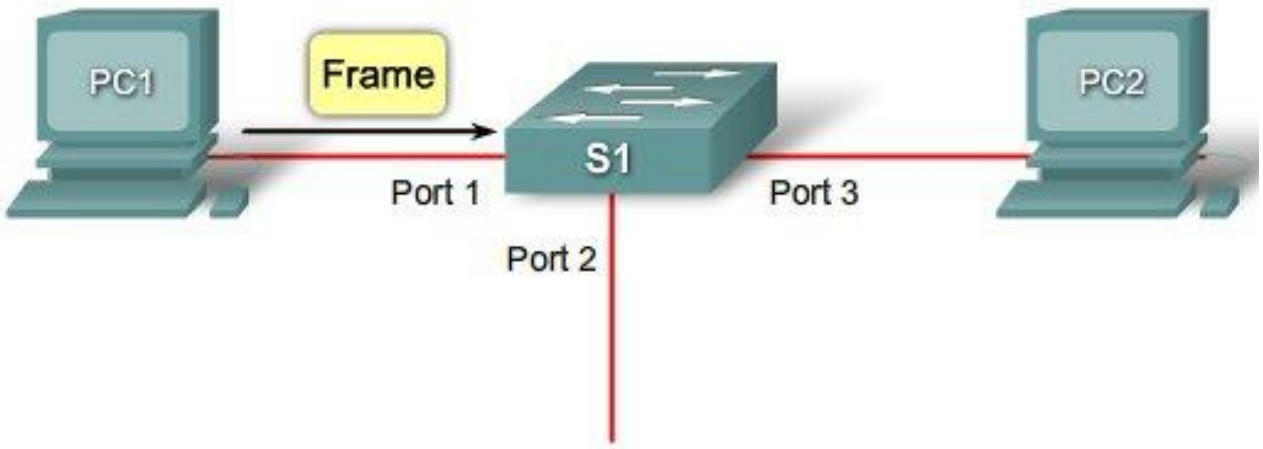


- **Switch**: forwards frames only on the proper outgoing interface (the one to reach the destination). It has a MAC forwarding table.



MAC forwarding table

- For each (known) MAC address, the proper outgoing interface.
- The MAC forwarding table is populated by means of a Mac learning procedure.



Basic switch configuration

- The switch IOS is similar to the router one
- The basic configuration parameters are:
  - IP address and subnet mask (?)
  - Default gateway (?)

- Only for switch management: **Telnet connection**
  - Passwords must be configured to provide access and configuration

- The default gateway needs to provide access to an external web/tftp server (mainly to download a new IOS version)

Management interface

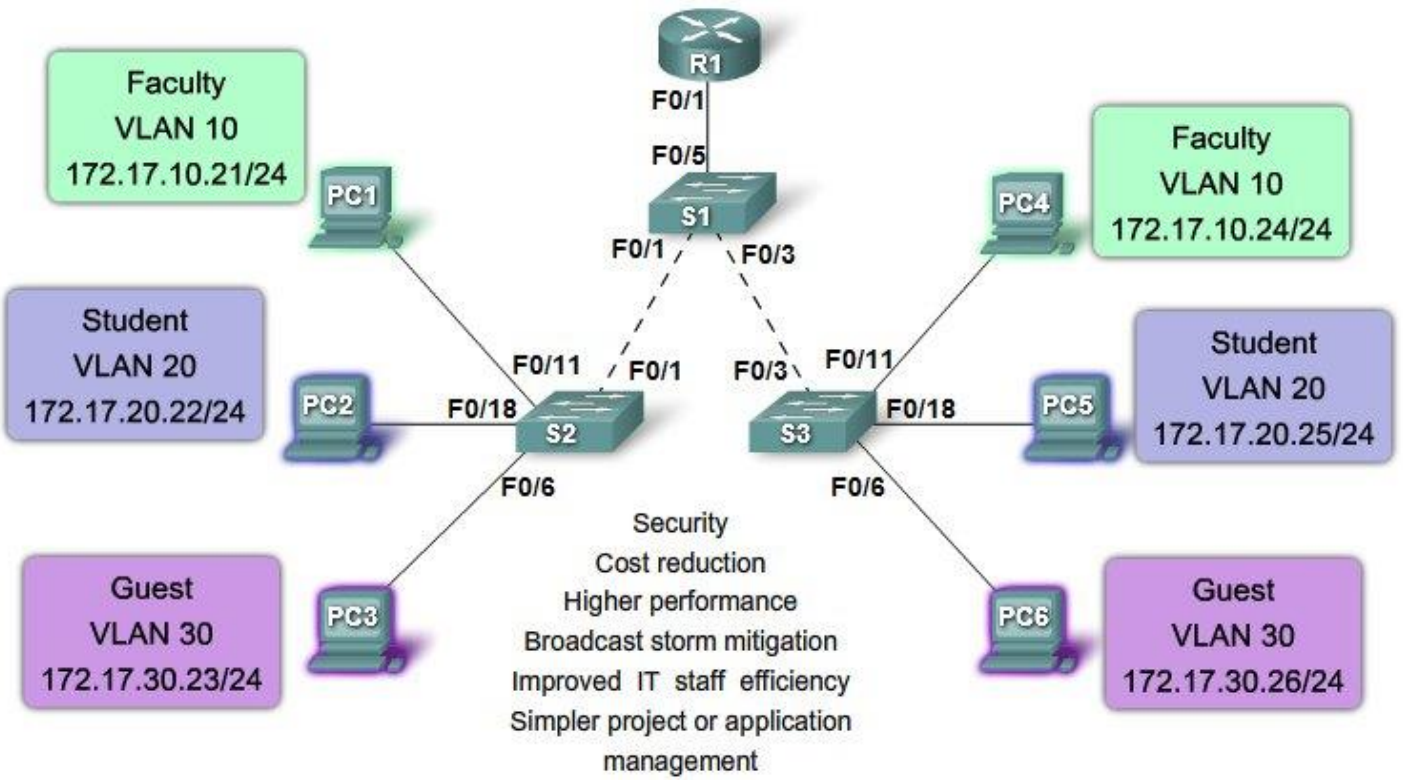
Cisco IOS CLI Command Syntax	
Switch from privileged EXEC mode to global configuration mode.	`S1#configure terminal`
Enter the interface configuration mode for the VLAN 99 interface.	`S1(config)#interface vlan 99`
Configure the interface IP address.	`S1(config-if)#ip address 172.17.99.11 255.255.255.0`
Enable the interface.	`S1(config-if)#no shutdown`
Return to privileged EXEC mode.	`S1(config-if)#end`
Enter global configuration mode.	`S1#configure terminal`
Enter the interface to assign the VLAN.	`S1(config)#interface fastethernet 0/18`
Define the VLAN membership mode for the port.	`S1(config-if)#switchport mode access`
Assign the port to a VLAN.	`S1(config-if)#switchport acces vlan 99`
Return to privileged EXEC mode.	`S1(config-if)#end`
Save the running configuration to the switch start-up configuration.	`S1#copy running-config startup-config`

VLAN: motivations

- LAN Ethernet: all hosts connected to the same physical infrastructure (switches, hubs, cavi) belong to the same IP network.
- If several IP networks are needed in the same physical location (i.e. a building), several physical infrastructures are required.
- The introduction of Virtual LAN (VLAN) feature allows for the sharing of the same physical infrastructure among different IP networks.
- VLAN: IP network sharing a physical network with different VLANs.

VLAN advantages

- Security
- Cost saving
- Reduction of broadcast traffic

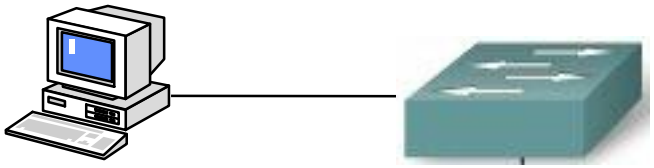


VLAN: configuration

- Switches must be properly configured.
- Each VLAN is identified by a number (VLAN ID: 1 - 1005) and has its own address block
- The VLANs of a network must be defined in all the switches:

Switch (config)# vlan *x*

Switch (config-vlan)# name *name* (optional)



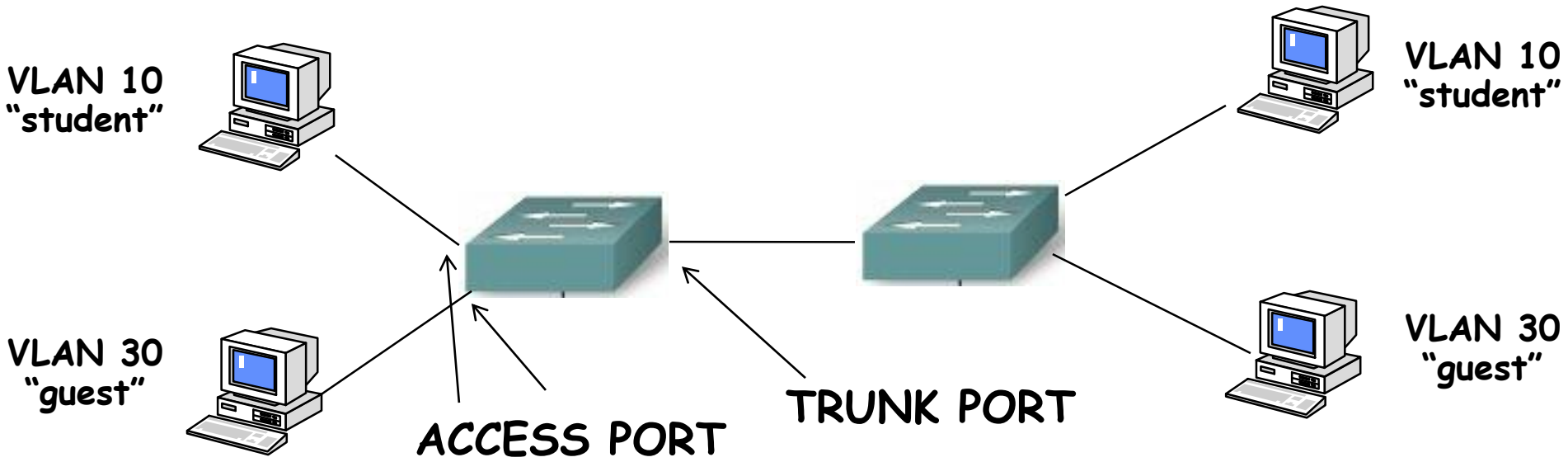
VLAN 10
"student"

Switch (config)# vlan 10

Switch (config-vlan)# name student

Switch ports

- **Access port**: connected to hosts belonging to a single VLAN
- **Trunk port**: receiving and forwarding frames belonging to different VLANs → a mechanism to differentiate frames of different VLANs is needed

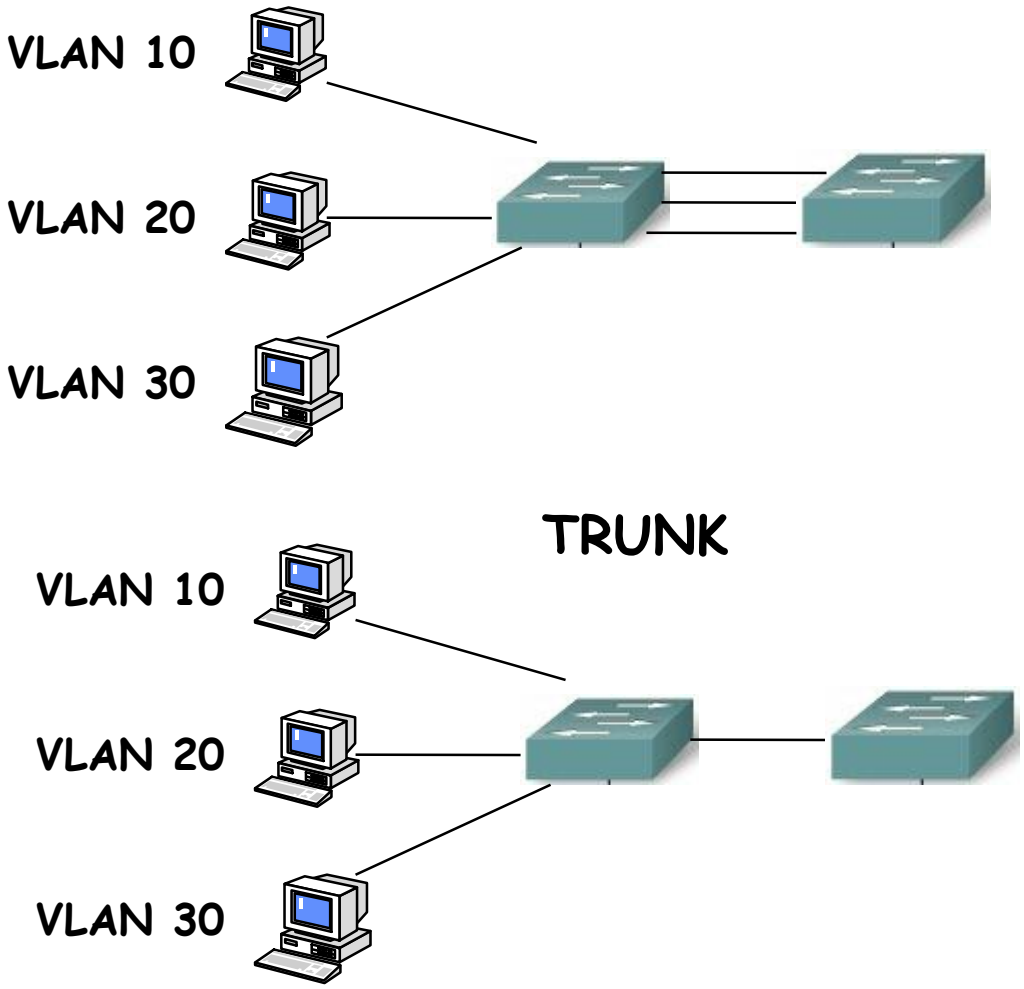


Access Port

- Port-based VLAN → access port are statically associated to a specific VLAN.
- Configuration:

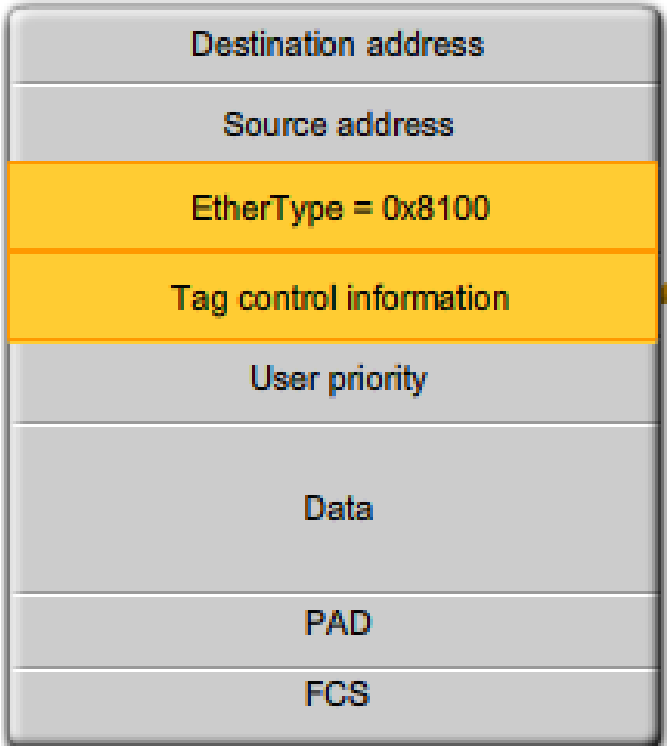
```
Switch (config)# interface FastEthernet 1/0
Switch (config-if)# switchport mode access
Switch (config-if)# switchport access vlan X
```

Access ports limitation



Trunk Port (1/3)

- How to associate a VLAN to a received frame on a trunk port?
- Ethernet standard must be extended.
- 802.3Q: a tag is inserted in the ethernet header to insert the VLAN ID → "tagged" frames



Trunk Port (2/3)

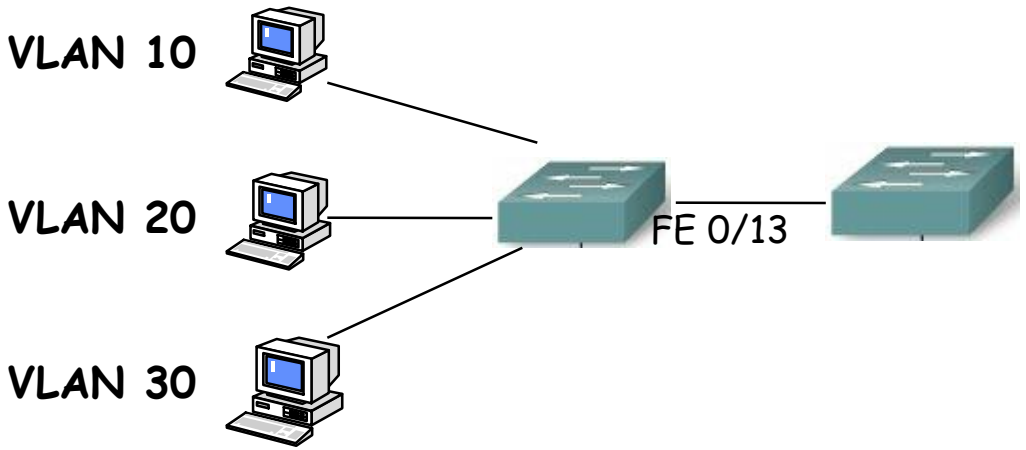
- With the ***trunk*** word, we refer to the point-to-point link among directly connected trunk ports
- The frames crossing a trunk are all "tagged". The only exception regards frames belonging to a single VLAN: the Native VLAN.

```
Switch (config)# interface FastEthernet o/x
Switch (config-if)# switchport mode trunk
Switch (config-if)# switchport trunk native vlan 99
```

Trunk Port (3/3)

- By default the trunk port forward and receive all VLANs frames.
- It is also possible to configure the trunk port so that only a subset of VLANs is allowed:

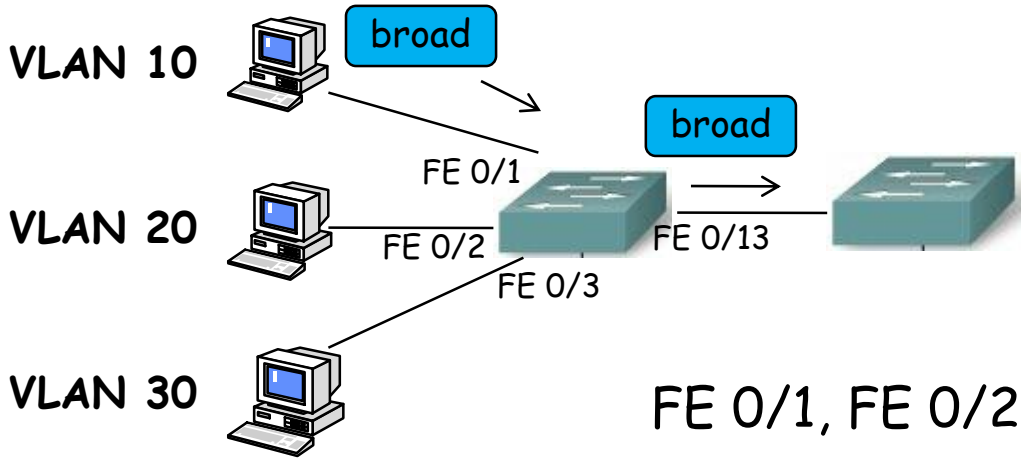
Switch (config-if)# switchport trunk allowed vlan y




```
R(config)# interface FastEthernet 0/13
R(config-if)# switchport mode trunk
R(config-if)# switchport trunk native vlan 99
R(config-if)# switchport trunk allowed 10-20
```

Switch functioning

- Switch forwarding operations depends on the VLANs configuration.
- The broadcast traffic received on an access interface will be forwarded only on the interfaces "connected" to the same VLAN of the access port.



FE 0/1, FE 0/2 e FE 0/3: access port

FE 0/13: trunk port (allowed 10,20,30)

VLAN management (1/2)

- The ***show vlan brief*** command lists all the VLANs configured and the associated access interfaces

```
S1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, 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
```

No VLANs configured

```
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, Fa0/19, Fa0/20, Fa0/21
                                                Fa0/22, Fa0/23, Fa0/24, Gi0/1
                                                Gi0/2
20   student                          active    Fa0/18
```

VLAN 20 configured and associated to FastEthernet 0/18

VLAN management (2/2)

- The ***show interface FastEthernet x/y switchport*** command is used to check the mode of an interface

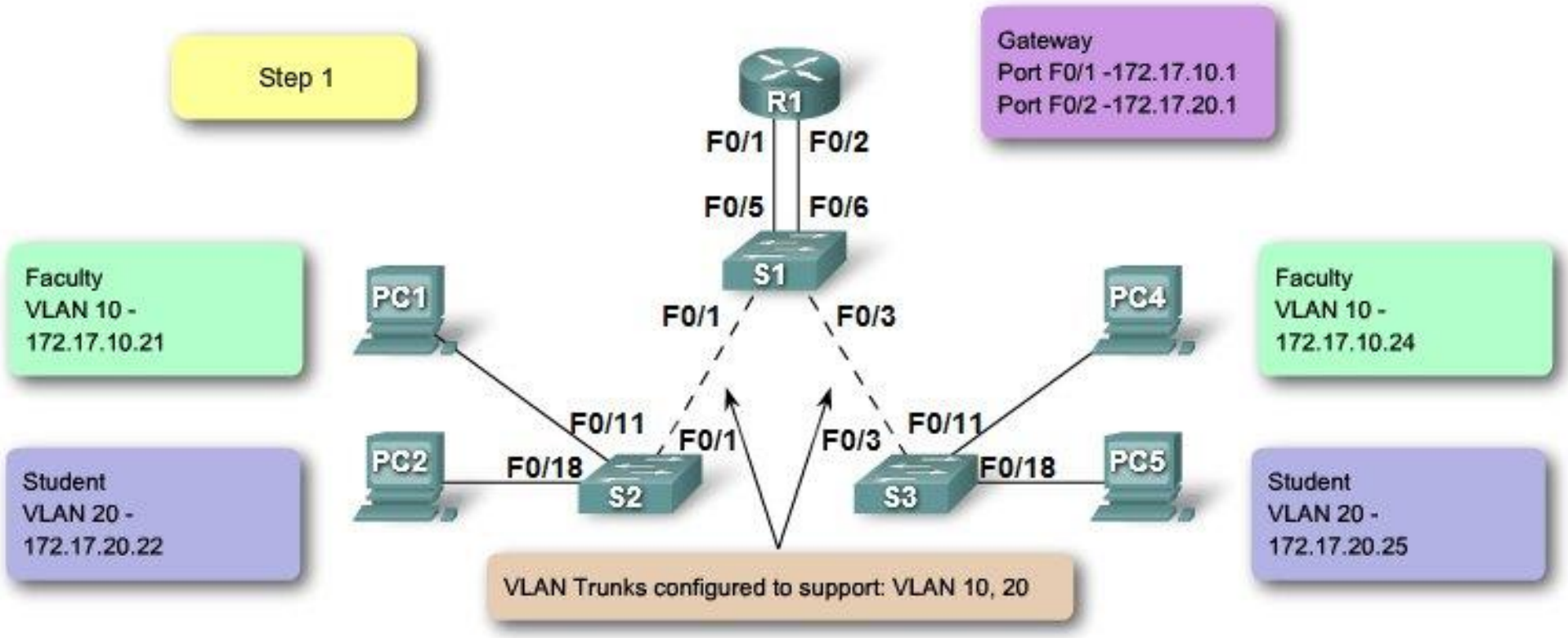
Access port

```
S1#show interfaces fa0/18 switchport
Name: Fa0/18
Switchport: Enabled
Administrative Mode: static access
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: Off
Access Mode VLAN: 20 (student)
Trunking Native Mode VLAN: 1 (default)
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 private VLANs: none
Operational private-vlan: none
```

Trunk port

```
S1#show interfaces f0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 99 (management)
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 private VLANs: none
Operational private-vlan: none
Trunking VLANs Enabled: 10,20,30
```

Inter-VLAN routing



VLAN Troubleshooting

Misconfiguration of VLANs:

- Native VLAN mismatch
- Trunk mode mismatch
- Wrong IP addresses for VLAN hosts
- VLAN not allowed on trunk ports