Switching & VLANs

NETWORK ADMINISTRATION
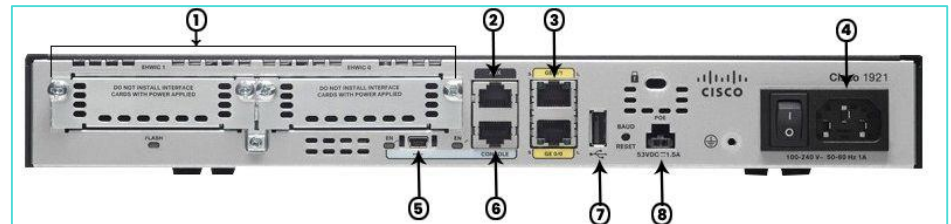
Songyut Phoemphon

Email: songyut@sut.ac.th

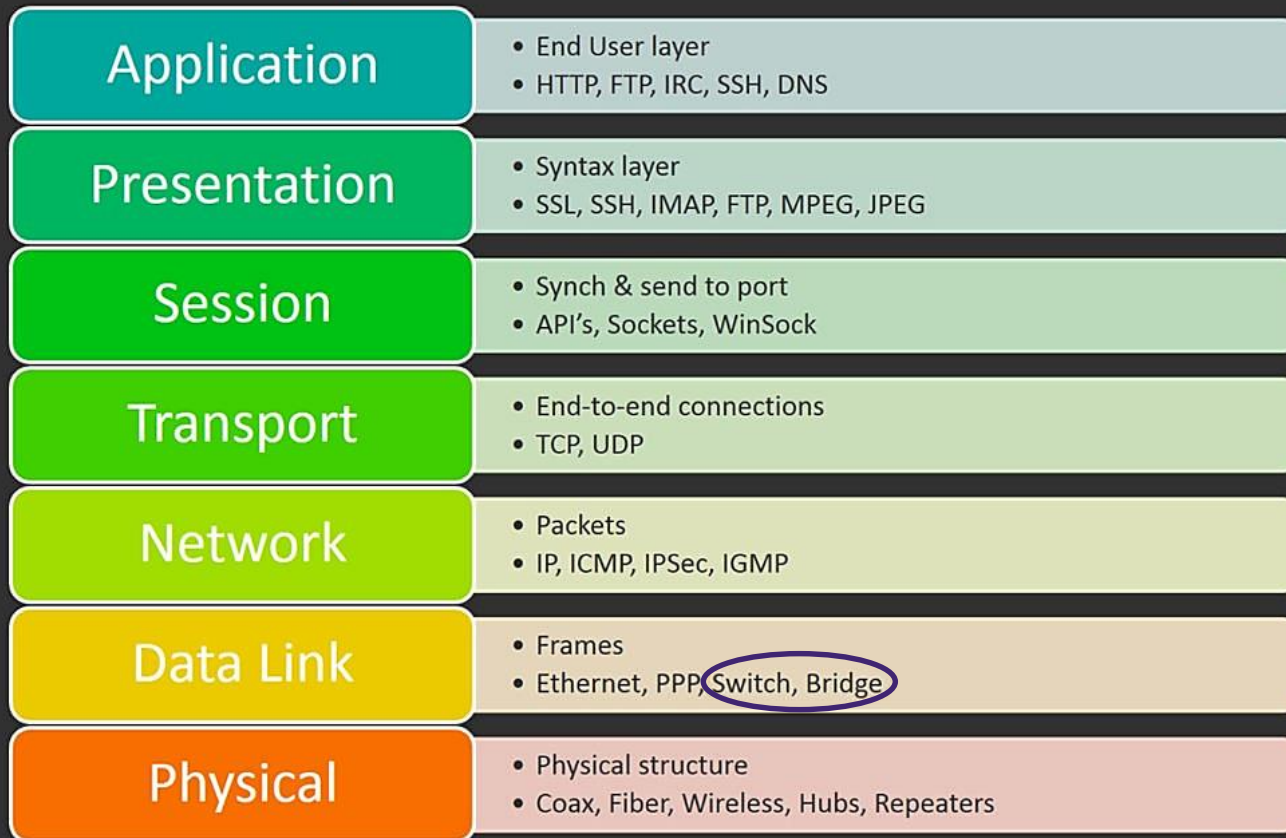# Objective

Student are able to

- understand how switching and VLAN are working

- configure switch (Layer-2)

OSI Layer

7 Layers of the OSI Model

| Layer	Description
Application	• End User layer • HTTP, FTP, IRC, SSH, DNS
Presentation	• Syntax layer • SSL, SSH, IMAP, FTP, MPEG, JPEG
Session	• Synch & send to port • API's, Sockets, WinSock
Transport	• End-to-end connections • TCP, UDP
Network	• Packets • IP, ICMP, IPSec, IGMP
Data Link	• Frames • Ethernet, PPP, Switch, Bridge
Physical	• Physical structure • Coax, Fiber, Wireless, Hubs, Repeaters

Layer-2 Switching

- Separate collision domain

- Better performance than hub

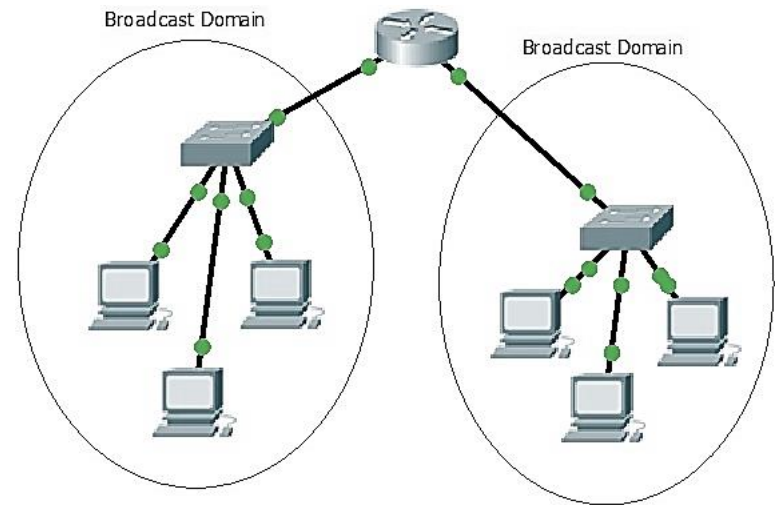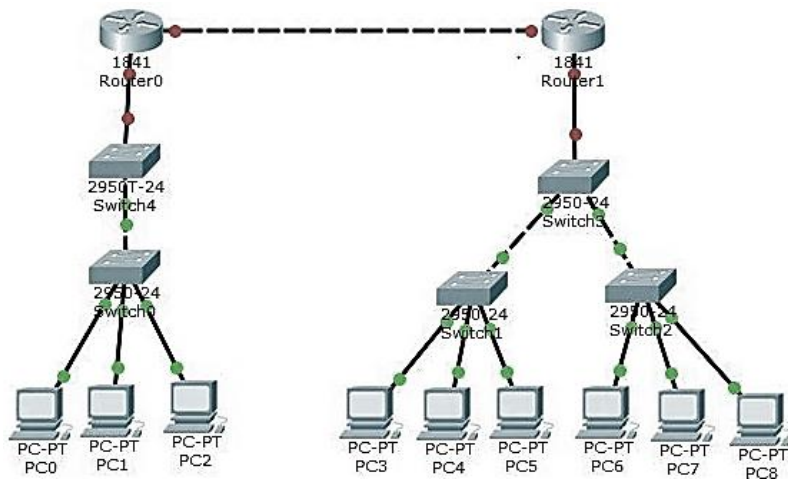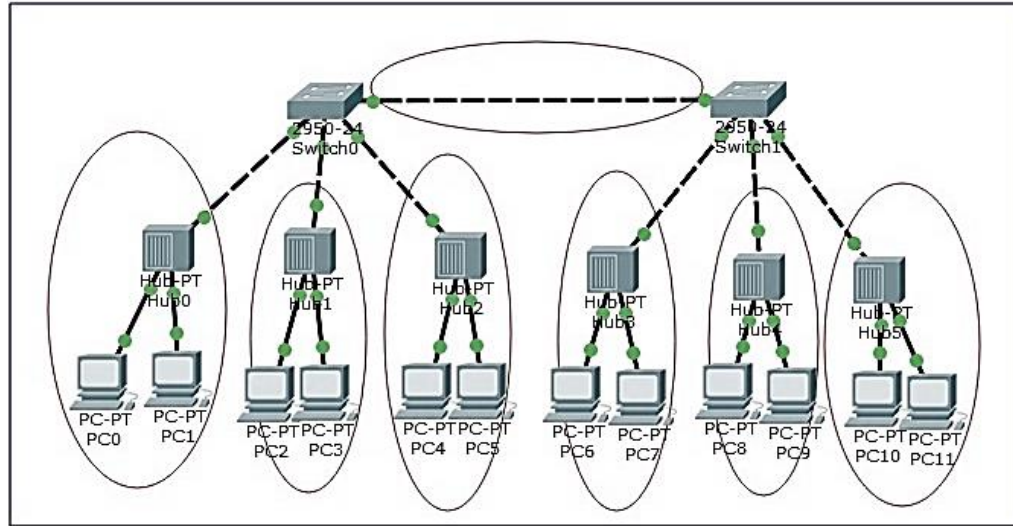- Use Spanning Tree Protocol (STP)
    - Loop prevention
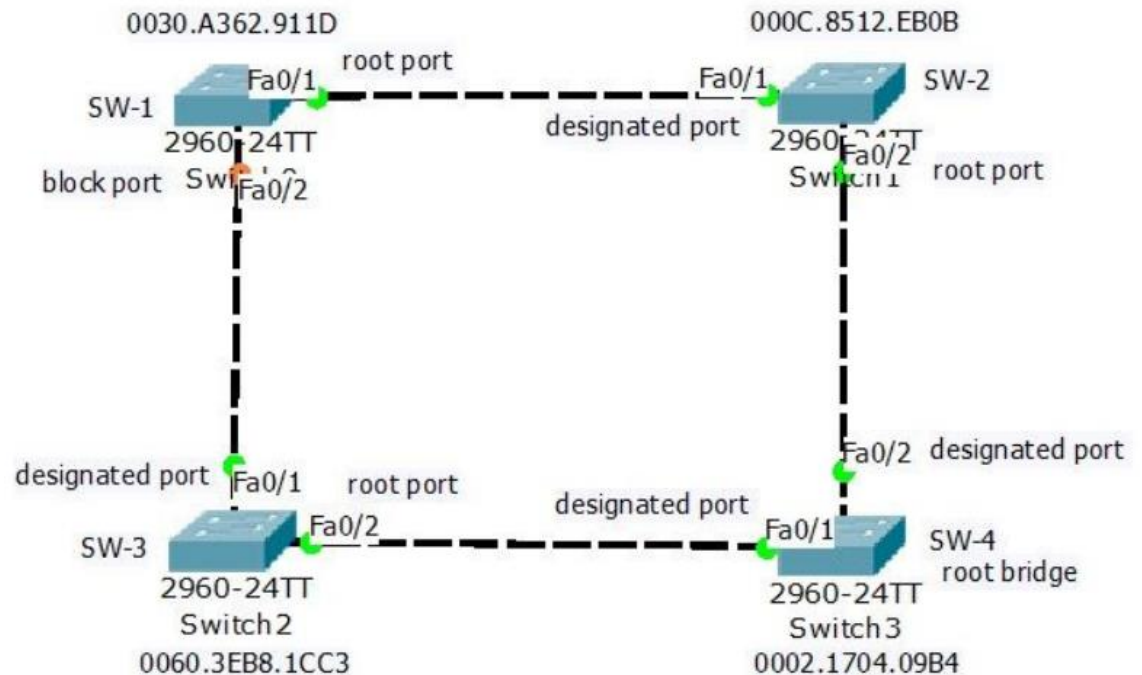
Switching

- Without switch (Layer-2)

- With switch (Layer-2)
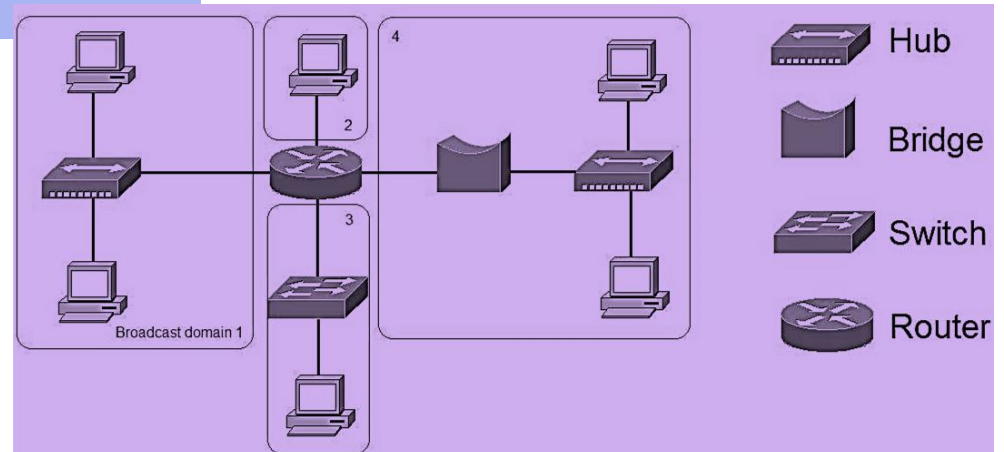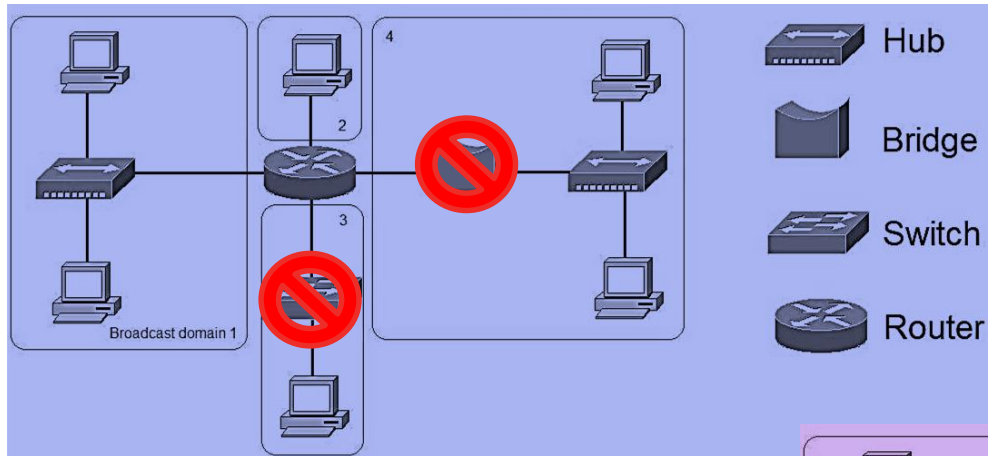
Design a switch

Switch mode

latency vs reliability

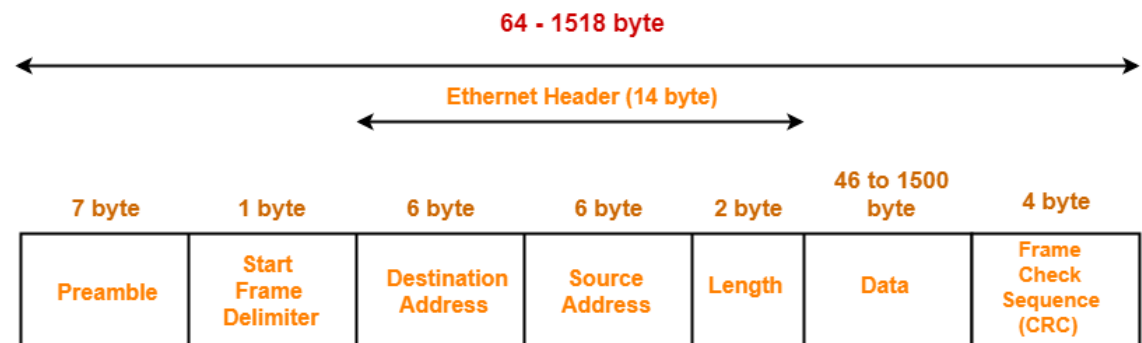Cut-Through Switching (Real Time, Fast Forward)

- Fast, no error checking (only look at destination)

Fragment-Free Switching (Modified Cut-Through)

- Prevent collision (look at the first 64 Bytes)

Store-and-Forward Switching

- Use CRC for error checking

64 - 1518 byte

Ethernet Header (14 byte)

7 byte	1 byte	6 byte	6 byte	2 byte	46 to 1500 byte	4 byte
Preamble	Start Frame Delimiter	Destination Address	Source Address	Length	Data	Frame Check Sequence (CRC)

IEEE 802.3 Ethernet Frame Format

Switching

Services

- Hardware based bridging (ASIC)

- Wire speed, Low latency, Low cost

Limitation

- need correct collision domain separation

- not separate broadcast domain

- 80% of traffic should be in local

Switching vs Bridging

Switching = Multi-port Bridge

- Bridge may have only one STP tree

- Switch may have multiple STP trees

- Both forward broadcast

- Both forward from MAC address learning

| A NETWORK BRIDGE	A NETWORK SWITCH
SW-based	HW-based
Method of switching of a Bridge is store and forward.	Method of switching of a Switch can be store and forward, cut-through, or fragment-free.
A Bridge has only 2 ports.	A switch can handle many ports.
A Bridge is a device that connects two LANs and controls data flow between them.	A Switch is a networking device that learns which machine is connected to its port by using the device's Address.
Bridges divide collision domain into two parts. Bridges can create collision domains but not broadcast domains.	Switches are used to connect the work stations or computer systems. If there are 20 workstations connected to a switch then there will be separate collision domain for each of the nodes.

How does Switch work?

Switches processing

- Listening

- Learning

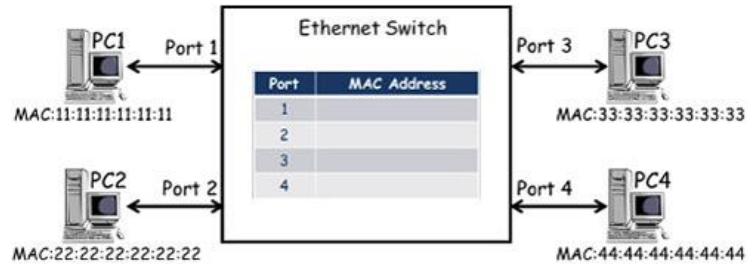- Forwarding

- Flooding
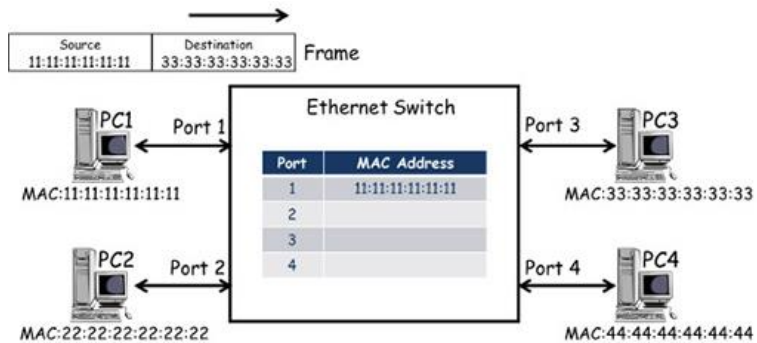
- Filtering

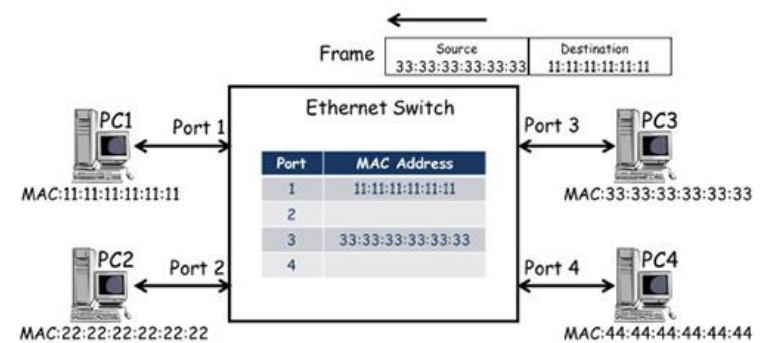Spanning tree protocol

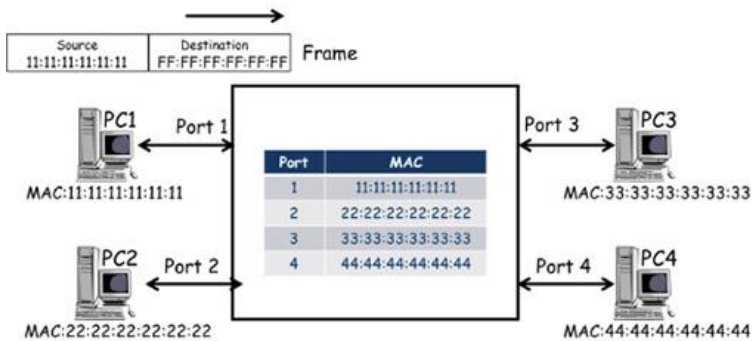- Prevent loop
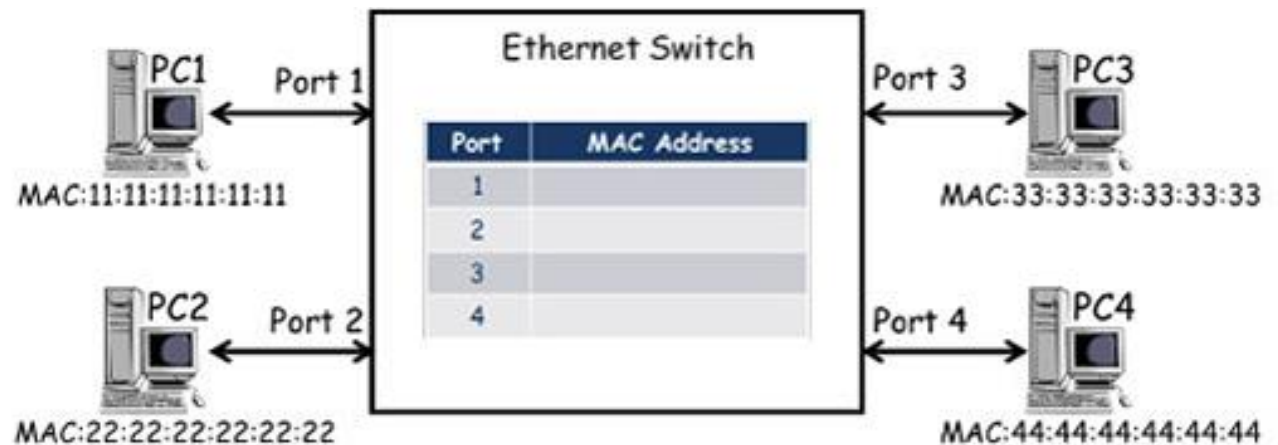
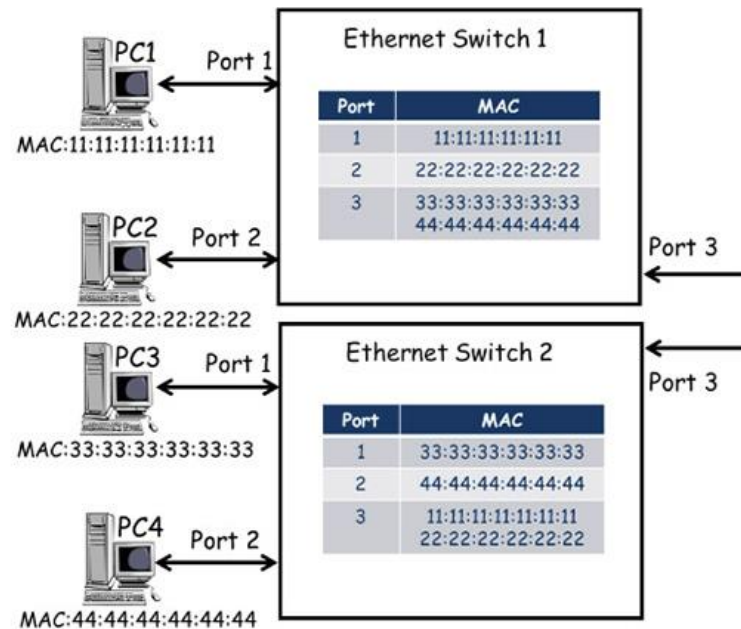# How does Switch work?

How does Switch work?

EtherChannel

Link Aggregation

- combination of physical interfaces as Logical interface
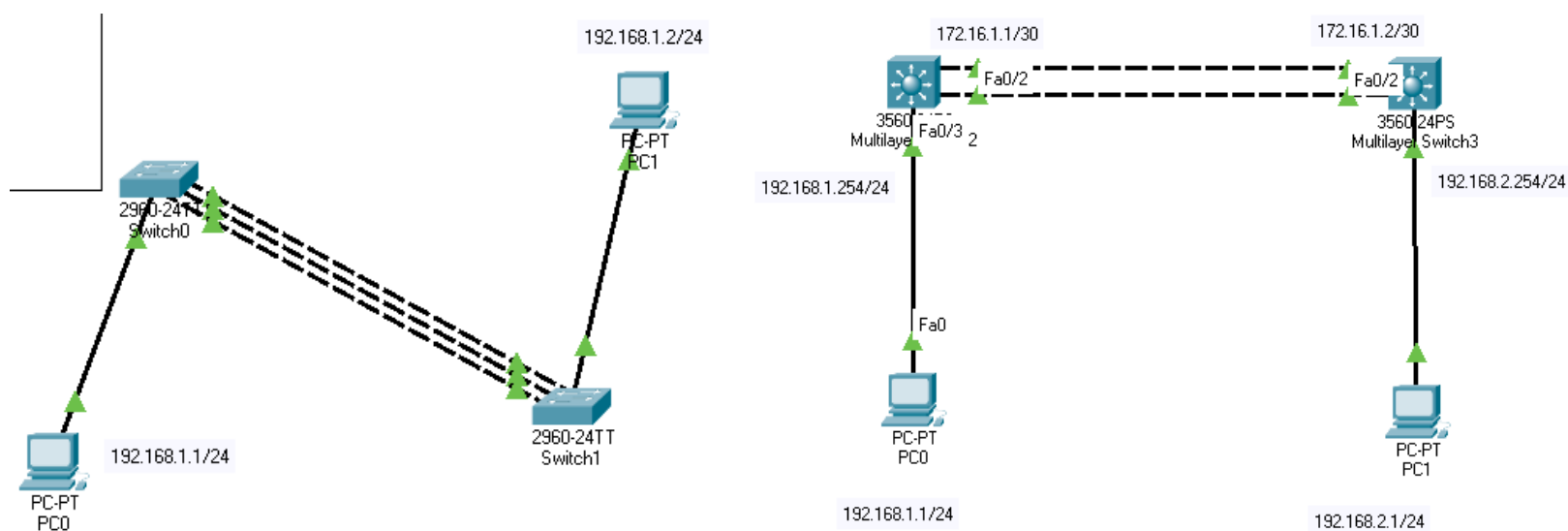
Advantages

- Congestion

- Redundant

Etherchannel

EtherChannel Protocol

- **PAgP** – Cisco Proprietary

- **LACP** – IEEE 802.3ad Standard of Link Aggregation

Mode

- **Active** (LACP) – other device (Active or Passive)

- **Passive** (LACP) – other device (only Active)

- **Desirable** (PAgP) – other device (Desirable or Auto)

- **Auto** (PAgP) – other device (Desirable)

- **on** – Not exchange PAgP and LACP Packet (other device (on))

- **off** – prevent EtherChannel

Network device
switch – switch
switch – server
server – switch
switch – router
router – switch

Switching Loop

- Broadcast Storm

- Multiple Frame Transmissions

- MAC Database Instability
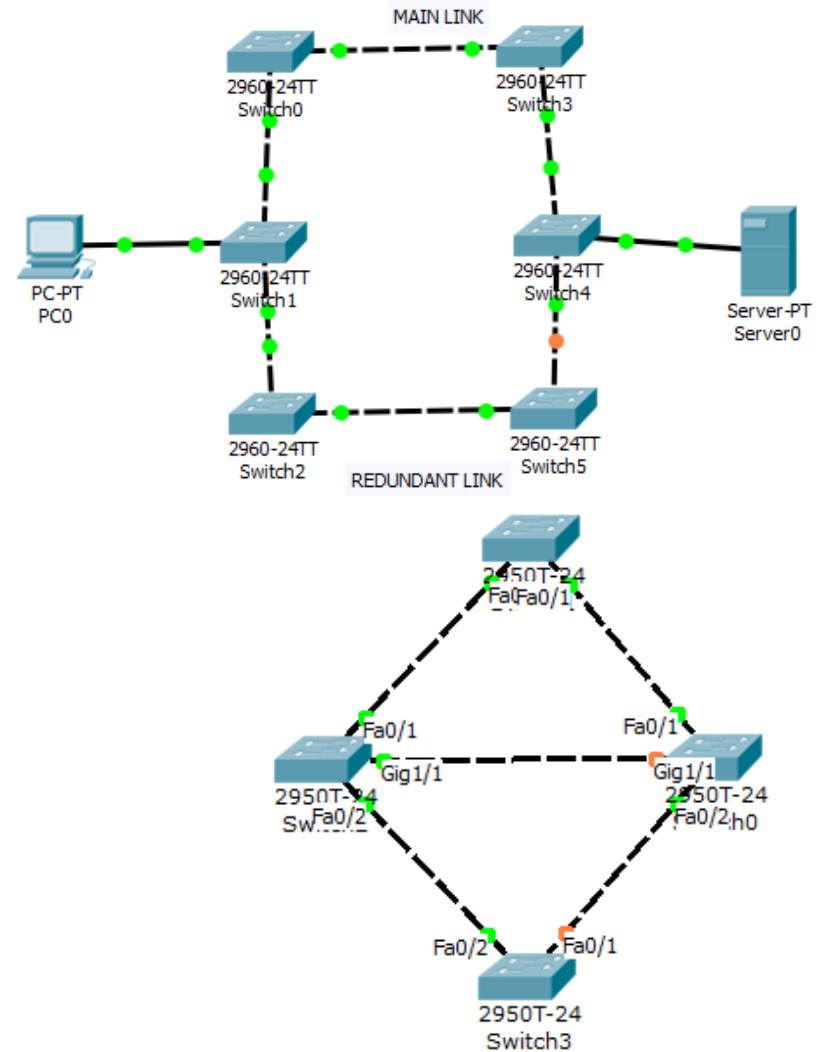
Spanning Tree Protocol (STP)

Root bridge (a bridge as root) vs Non-root bridge

Bridge ID (usually use MAC address)

- Root port (port that point to root)

- Designated port = Forwarding port

- Non-designated port = Block port

Spanning Tree Example
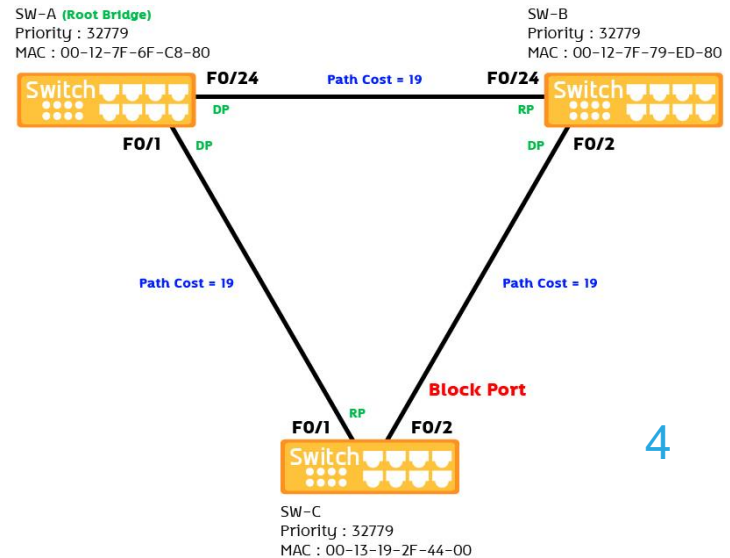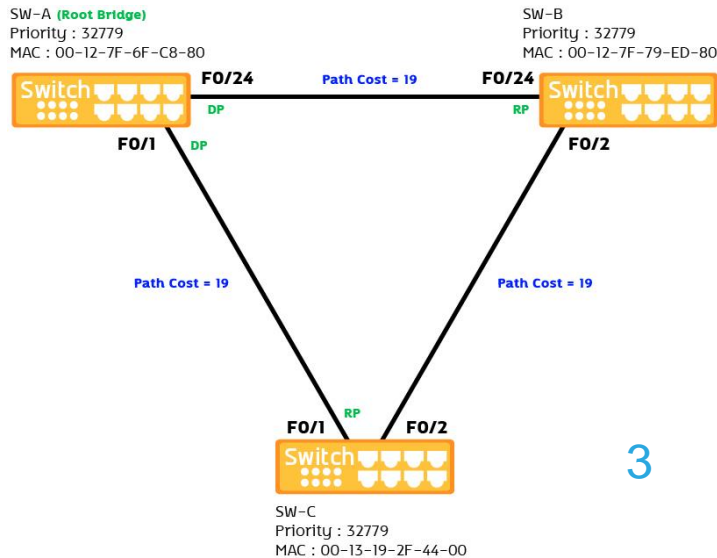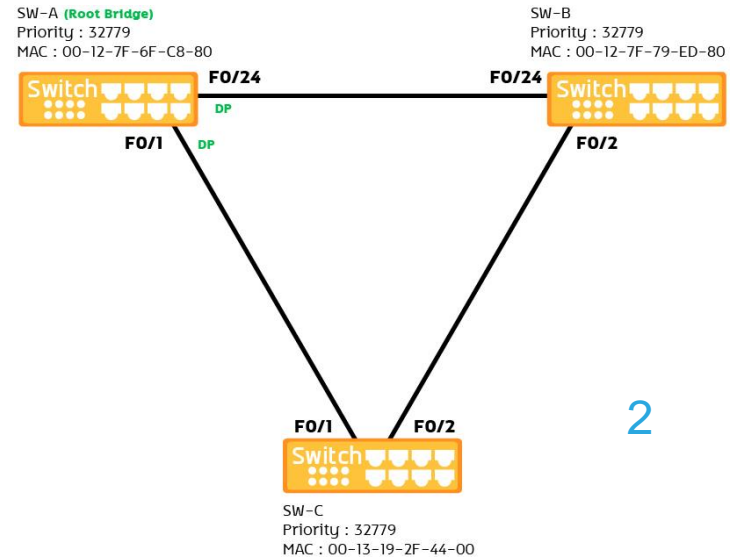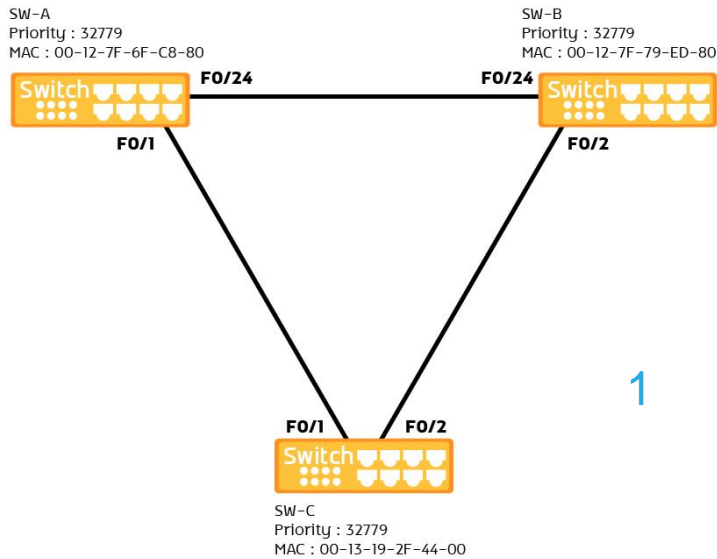
Spanning Tree Operation

- Select root bridge

- Select designated port

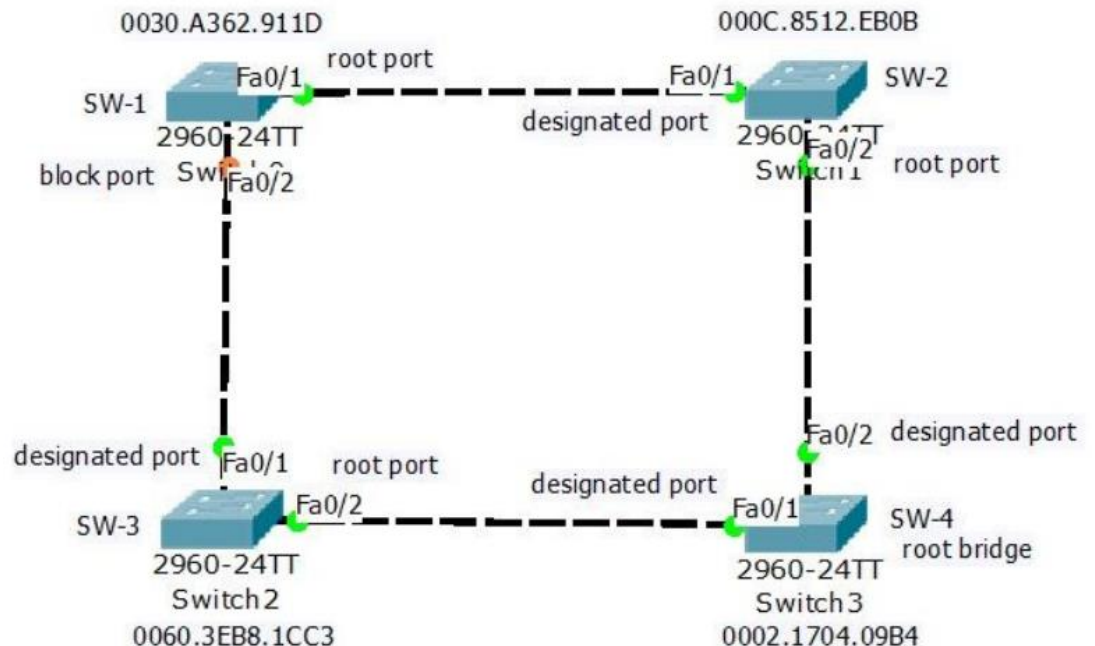| Protocol Identifier	Protocol Version Identifier	BPDU Type	Flags	Root Identifier	Root Path Cost	Bridge Identifier	Port Identifier	Message Age	Max Age	Hello Time	Forward Delay

Bandwidth /Speed	New IEEE Cost	Original IEEE Cost	RSTP/MS TP cost
1000 Gbps	N/A	N/A	20
100 Gbps	N/A	N/A	200
10000 Mbps / 10 Gbps	2	1	2000
1000 Mbps / 1 Gbps	4	1	20000
100 Mbps	19	19	200000
10 Mbps	100	100	2000000

Switching Loops

Spanning tree port states (IEEE802.1D)

- Blocking

- Listening

- Learning

- Forwarding

- Disabled

STP Modes	Receive BPDUs	Send BPDUs	Learn MAC Address	Forward Data Packets
Blocking	Yes	No	No	No
Listening	Yes	Yes	No	No
Learning	Yes	Yes	Yes	No
Forwarding	Yes	Yes	Yes	Yes
Disabled	No	No	No	No

Switching Loops

Spanning tree port states (IEEE802.1W)

- Discarding

- Learning

- Forwarding

STP Modes	Receive BPDUs	Send BPDUs	Learn MAC Address	Forward Data Packets
Discarding	Yes	No	No	No
Discarding	Yes	Yes	No	No
Learning	Yes	Yes	Yes	No
Forwarding	Yes	Yes	Yes	Yes
Discarding	No	No	No	No

Virtual LANs (VLAN)

Group of networks determined by port of a switch

- Group by location, department, application etc.

Reduce broadcast domain

- Reduce traffic

Easy for management

- Flexibility and Scalability

Security
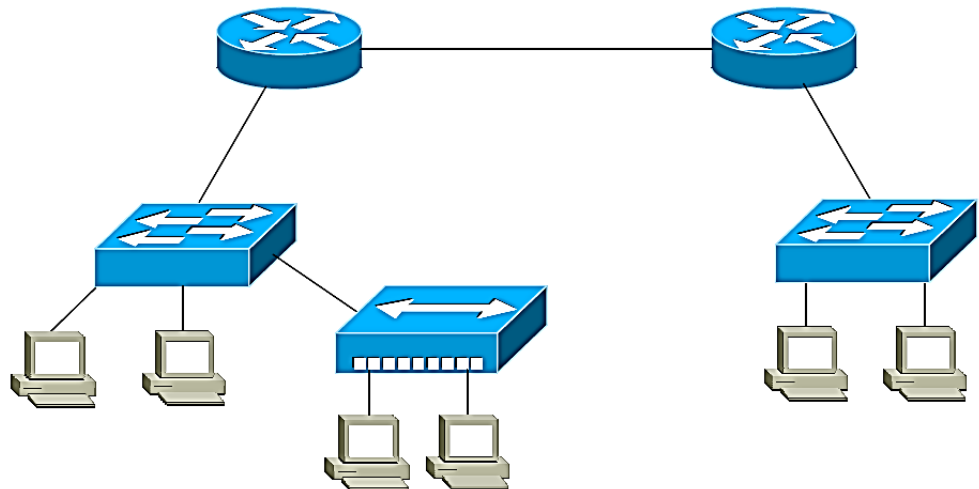
Virtual LANs (VLAN)

- Marketing

- Finance

- Sales

- Management

Provide inter-VLAN Communication
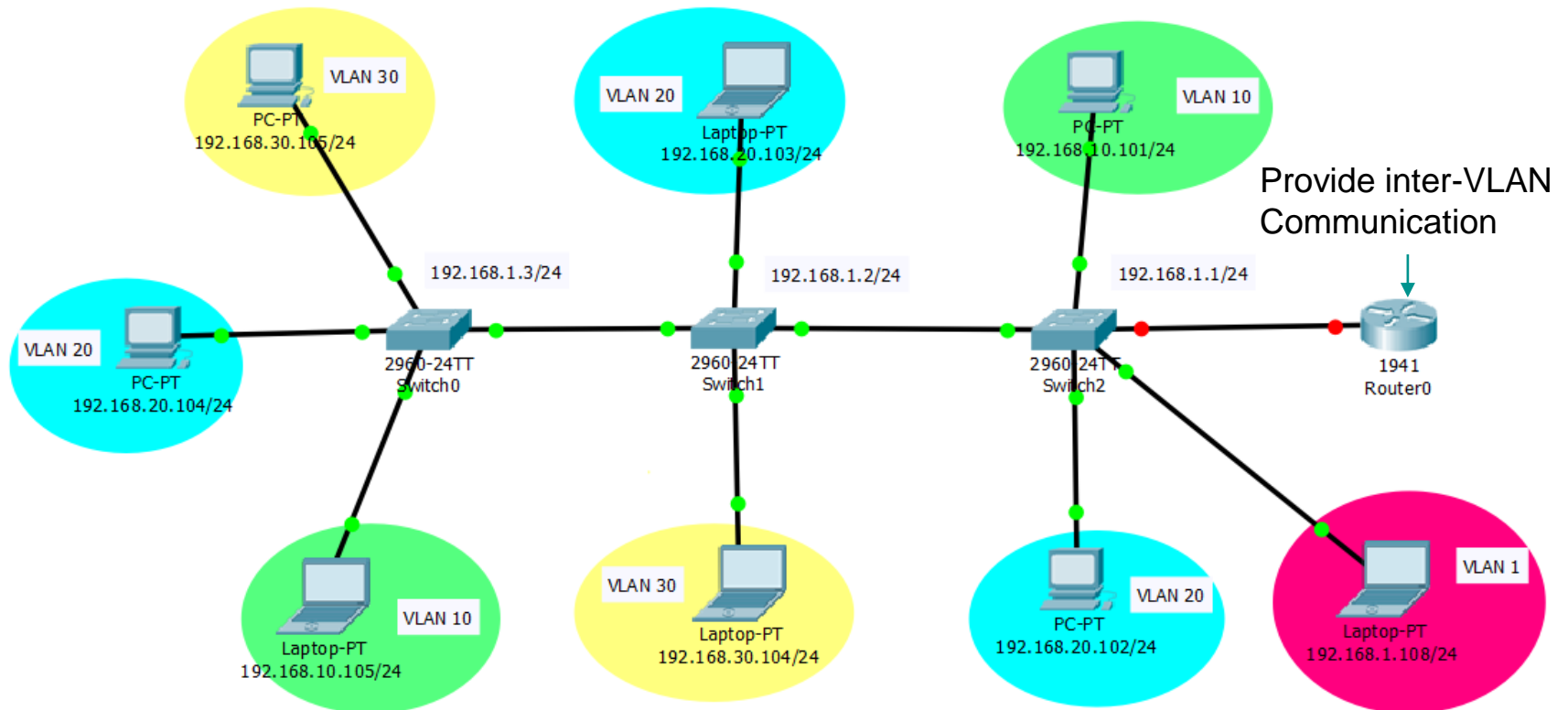
VLANs

Membership management

- Statics: the most secure & typically used method
- Dynamics
  - MAC address, protocol
  - VLAN Management Policy Server (VMPS)
    - MAC address database

Type of links

- Access – one VLAN
- Trunk – multiple VLAN
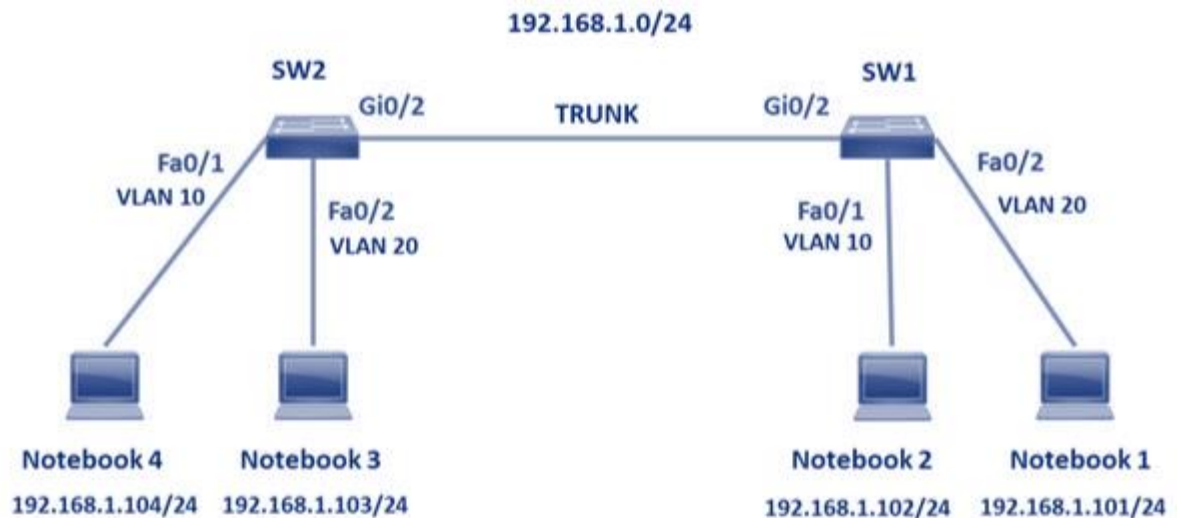
Frame tagging

Add an ID to a frame for VLAN operation

VLAN ID

- Inter-switch link (ISL)
  - Cisco proprietary: Fast / Gigabit Ethernet

- IEEE 802.1Q
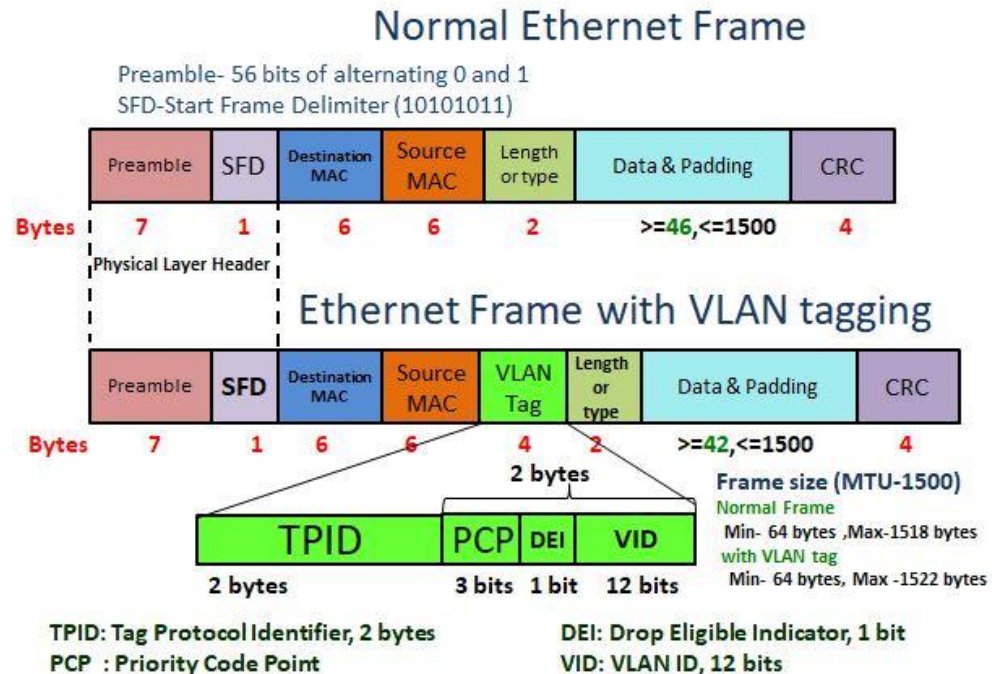
VLAN Trunk Protocol (VTP)

Protocol for sharing VLAN values to switches

- Server: default for catalyst
  - require at least one per domain

- Client: for sending-receiving data

- Transparent: forward VTP but not involving

Linking with Router
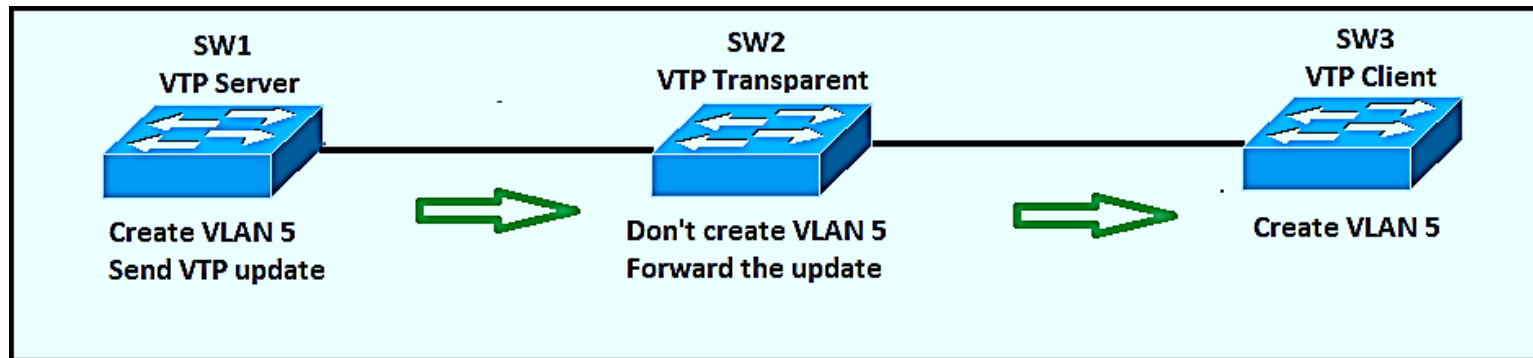
- 1 VLAN per 1 port

- Combine VLANs into 1 port

Traditional Inter-VLAN Routing

R1
Fa0/0   Fa0/1
Fa0/1   Fa0/2
S1
Fa0/6   Fa0/11

PC1   VLAN 10: 192.168.10.0/24   PC2
       VLAN 20: 192.168.20.0/24

192.168.10.10   192.168.20.10
VLAN 10   VLAN 20

"Router-on-a-Stick" Inter-VLAN Routing

R2
Fa0/0
Fa0/1
S2
Fa0/6   Fa0/11

PC3   VLAN 30: 192.168.30.0/24   PC4
       VLAN 40: 192.168.40.0/24

192.168.30.10   192.168.40.10
VLAN 30   VLAN 40
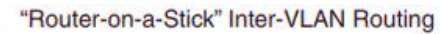
VLAN Configuration

VLAN Configuration

- sw(config)# vlan <ID> names <txt>

- sw(config)# vlan 2 names sales

- sw(config)# vlan 3 names marketing

VLAN Display

- sw# show vlan

- sw# show vlan brief

router# show vlan-switch

Assign port to VLAN

- sw(config)# int f0/2

- sw(config-if)#vlan-membership static 3 or

- sw(config-if)#switchport access vlan 3

VLAN Configuration

Setting in Trunk port

- sw(config)# int f0/2

- sw(config-if)# trunk on or

- sw(config-if)# switchport mode trunk

- sw(config-if)# switchport trunk encapsulation dot1q/isl <ID>

Setting in Router

- Router(config)# int f0/0.1

- Router(config-subif)#encapsulation dot1q <ID>

VLAN Setting

```
Switch(config)#vtp domain network
Changing VTP domain name from NULL to network
Switch(config)#vtp mod
Switch(config)#vtp mode client
Setting device to VTP CLIENT mode.
Switch(config)#vtp pas
Switch(config)#vtp password admin
Setting device VLAN database password to admin
Switch(config)#vtp
Switch(config)#vtp ver
Switch(config)#vtp version 2
Cannot modify version in VTP client mode
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console
```
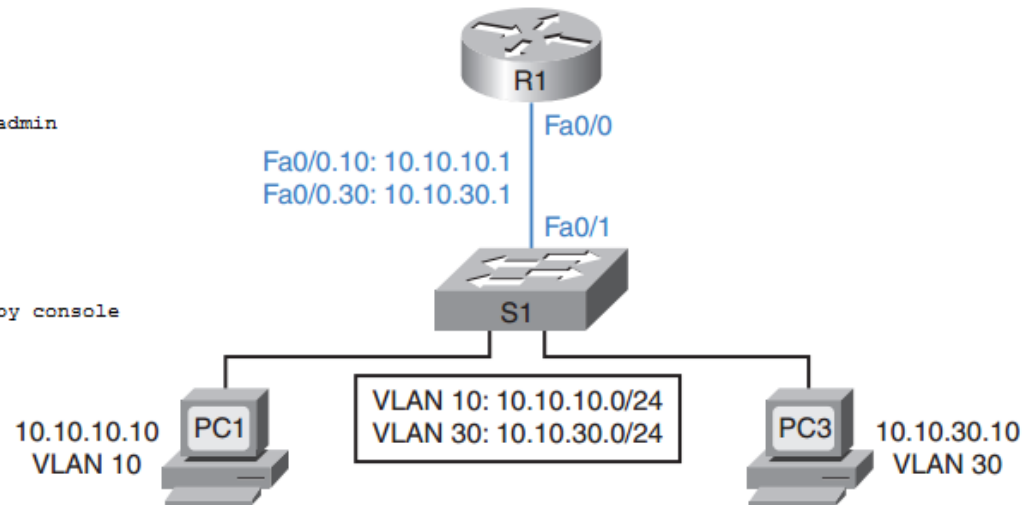
R1

Fa0/0

Fa0/0.10: 10.10.10.1
Fa0/0.30: 10.10.30.1

Fa0/1

S1

10.10.10.10
VLAN 10

PC1

VLAN 10: 10.10.10.0/24
VLAN 30: 10.10.30.0/24

PC3

10.10.30.10
VLAN 30

In the following lines, record the commands to configure R1 with router-on-a-stick inter-VLAN routing:

```
R1(config)#interface fastethernet 0/0

R1(config-if)#no shutdown

R1(config-if)#interface fastethernet 0/0.10

R1(config-subif)#encapsulation dot1q 10

R1(config-subif)#ip address 10.10.10.1 255.255.255.0

R1(config-subif)#interface fastethernet 0/0.30

R1(config-subif)#encapsulation dot1q 30

R1(config-subif)#ip address 10.10.30.1 255.255.255.0
```

Example

- SW#config t

- SW(config)#int f0/1

- SW(config)#switchport mode trunk

- SW(config)#int f0/2

- SW(config)#switchport access vlan 1

- SW(config)#int f0/3

- SW(config)#switchport access vlan 2

VLAN 1
85 Hosts
HostA

172.16.10.126

F0/2

F0/1

F0/3

VLAN 2
115 Hosts
HostB
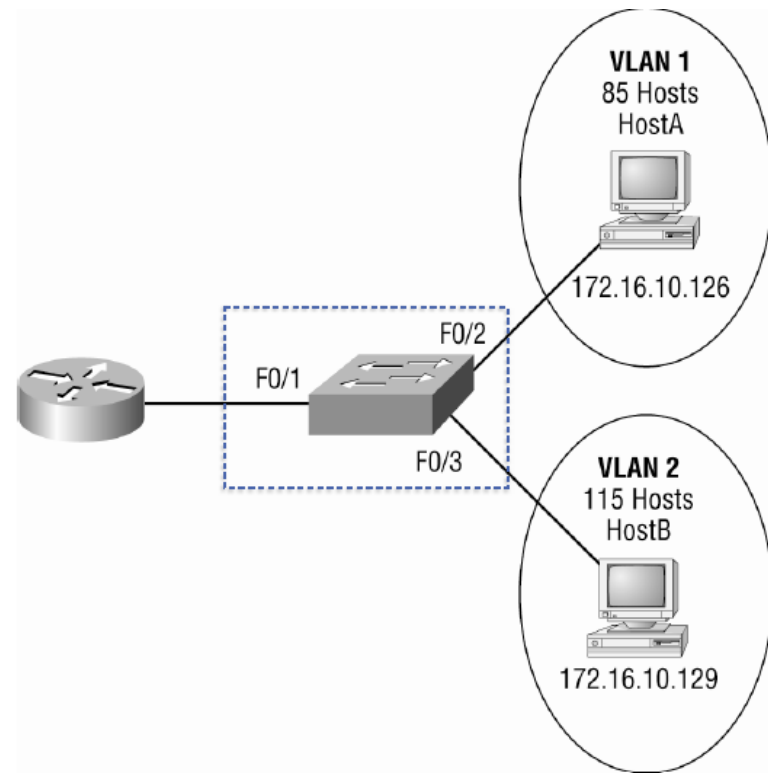
172.16.10.129

Example

- Router#config t

- Router(config)#int f0/0

- Router(config-if)#no ip address

- Router(config-if)#no shutdown • Router(config-if)#int f0/0.1

- Router(config-subif)#encapsulation dot1q 1

- Router(config-subif)#ip address 172.16.10.1 255.255.255.128

- Router(config-subif)#int f0/0.2

- Router(config-subif)#encapsulation dot1q 2

- Router(config-subif)#ip address 172.16.10.254 255.255.255.128

VLAN 1
85 Hosts
HostA
172.16.10.126

F0/2

F0/1

F0/3
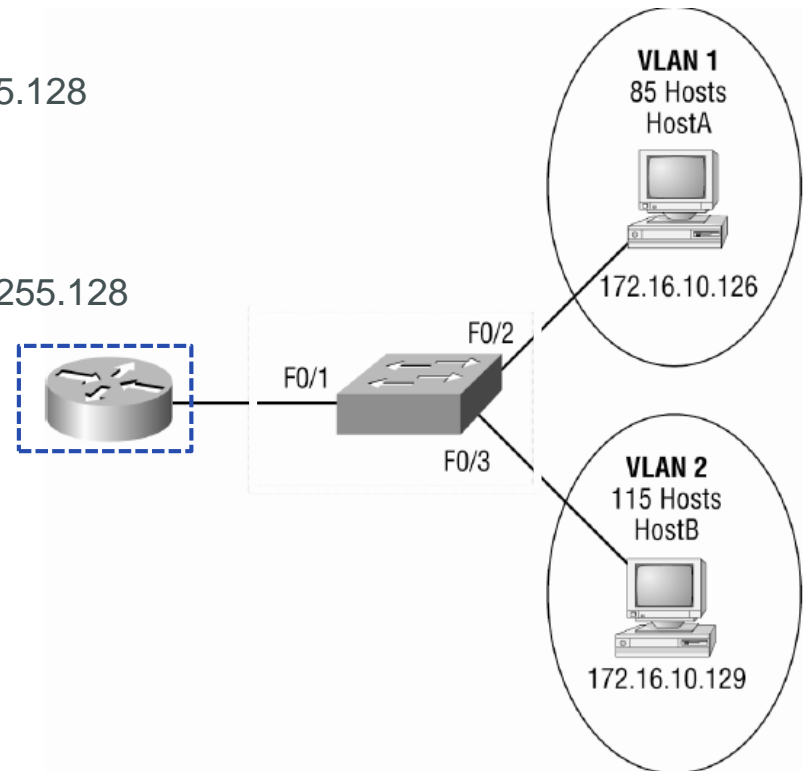
VLAN 2
115 Hosts
HostB
172.16.10.129

Example

- sw# config t

- sw(config)#int f0/1

- sw(config-if)#switchport mode trunk

- sw(config-if)#int f0/2

- sw(config-if)#switchport access vlan 1

- sw(config-if)#int f0/3

- sw(config-if)#switchport access vlan 1

- sw(config-if)#int f0/4

- sw(config-if)#switchport access vlan 3

- sw(config-if)#int f0/5

- sw(config-if)#switchport access vlan 3

- sw(config-if)#int f0/6 • sw(config-if)#switchport access vlan 2

Example

- R# config t

- R(config)# int f0/0

- R(config-if)# no ip address

- R(config-if)# no shutdown

- R(config-if)# int f0/0.1 • Router(config-subif)# encapsulation dot1q 1

- R(config-subif)# ip address 192.168.10.17 255.255.255.240

- R(config-subif)# int f0/0.2

- R(config-subif)# encapsulation dot1q 2

- R(config-subif)# ip address 192.168.10.33 255.255.255.240

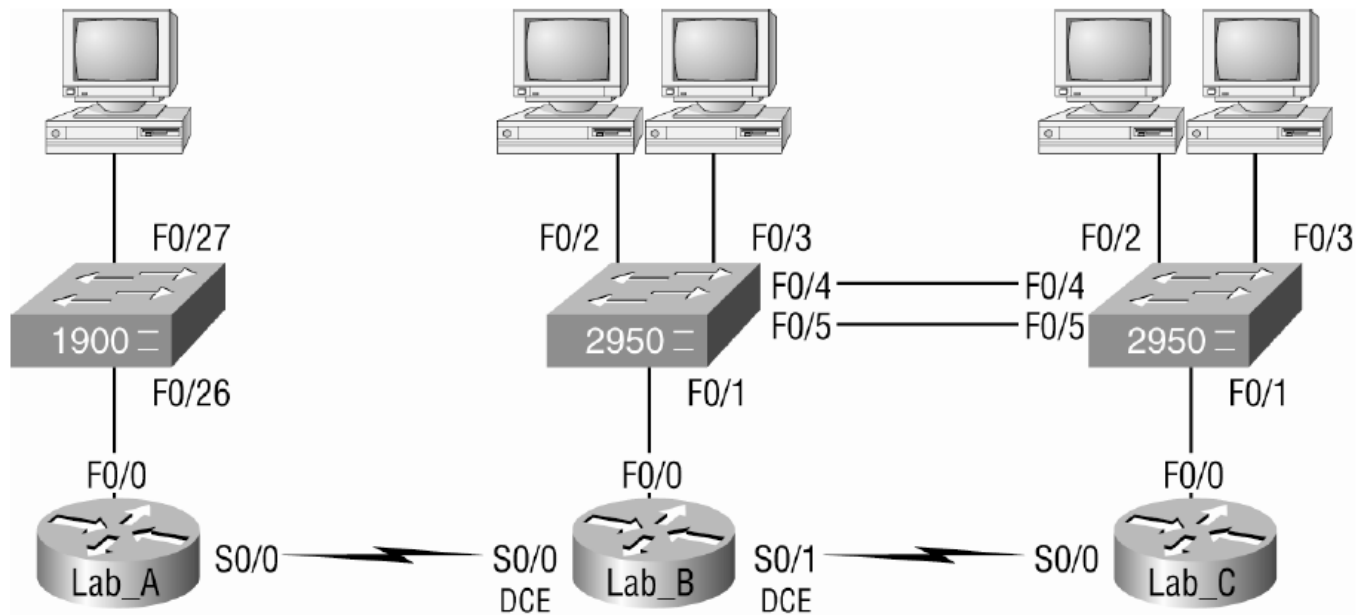- R(config-subif)# int f0/0.3

- R(config-subif)# encapsulation dot1q 3

- R(config-subif)# ip address 192.168.10.49 255.255.255.240
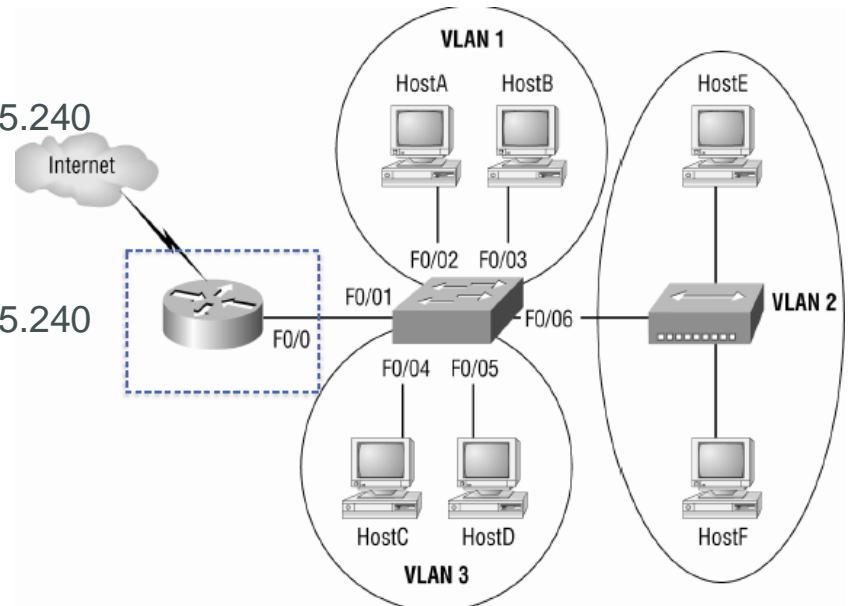
Example

2950C

```
2950C(config)#int f0/1
2950C(config-if)#description Connection to router
2950C(config-if)#interface f0/4
2950C(config-if)#description Connection to 2950B
2950C(config-if)#int f0/5
2950C(config-if)#description 2nd connection to 2950B
2950C(config-if)#int vlan1
2950C(config-if)#ip address 172.16.10.2 255.255.255.0
2950C(config-if)#no shut
2950C(config-if)#exit
2950C(config)#ip default-gateway 172.16.10.1
2950C(config)#^Z
2950C#copy run start
Destination filename [startup-config]? [Press Enter]
Building configuration...
[OK]
2950C#
```

```
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#hostname 2950C
2950C(config)#enable secret todd
2950C(config)#line con 0
2950C(config-line)#login
2950C(config-line)#password console
2950C(config-line)#line vty 0 15
2950C(config-line)#login
2950C(config-line)#password telnet
2950C(config-line)#banner motd #
Enter TEXT message.  End with the character '#'.
This is my 2950C switch
#
```
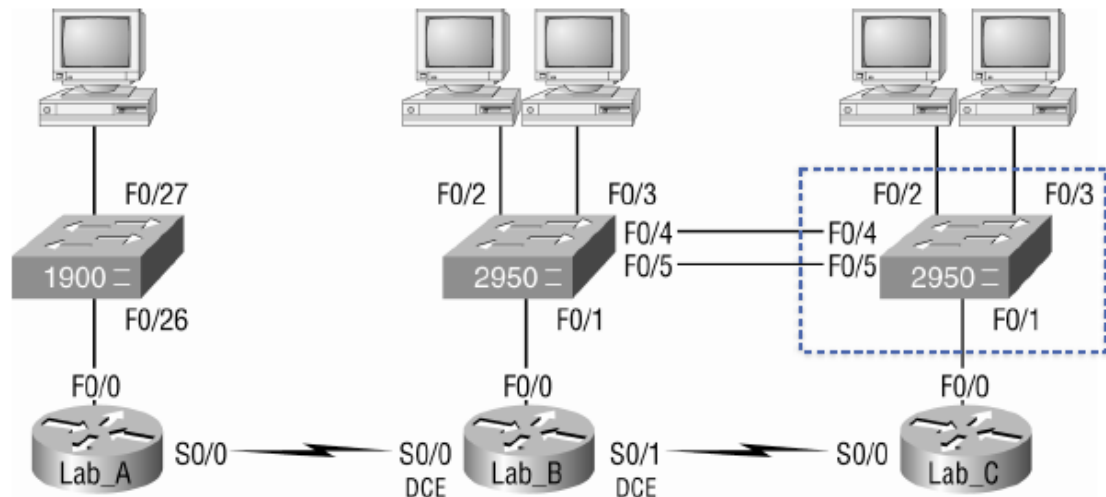
2950B
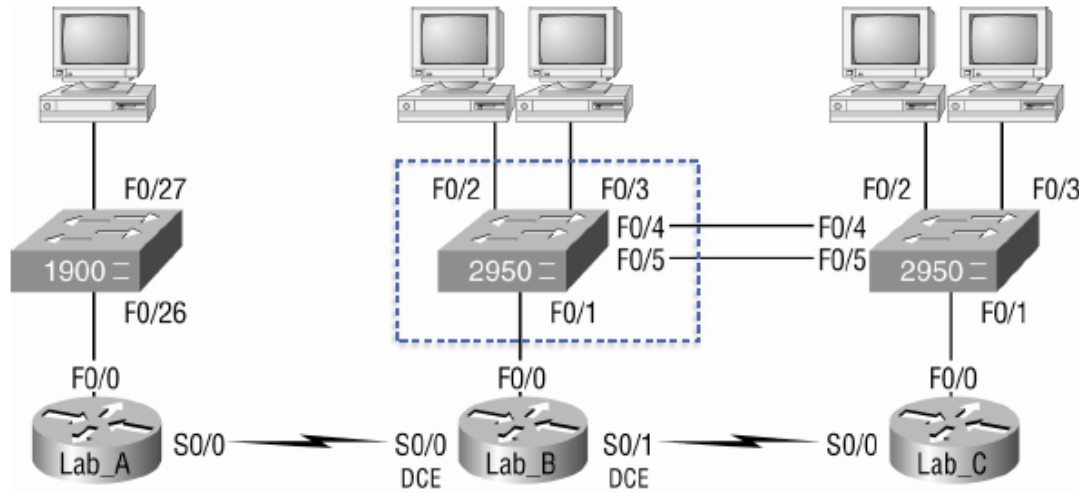

```
Switch(config)#hostname 2950B
2950B(config)#enable secret todd
2950B(config)#line con 0
2950B(config-line)#login
2950B(config-line)#password console
2950B(config-line)#line vty 0 15
2950B(config-line)#login
2950B(config-line)#password telnet
2950B(config-line)#banner motd #
Enter TEXT message.  End with the character '#'.
This is my 2950B switch
#
2950B(config)#
2950B(config)#int f0/4
2950B(config-if)#desc connection to 2950C
2950B(config-if)#int f0/5
```

```
2950B(config-if)#desc 2nd connection to 2950C
2950B(config-if)#int vlan 1
2950B(config-if)#ip address 172.16.10.3 255.255.255.0
2950B(config-if)#no shut
2950B(config-if)#exit
2950B(config)#ip default-gateway 172.16.10.1
2950B(config)#exit
2950B#copy run start
Destination filename [startup-config]? [Press Enter]
Building configuration...
[OK]
2950B#
```
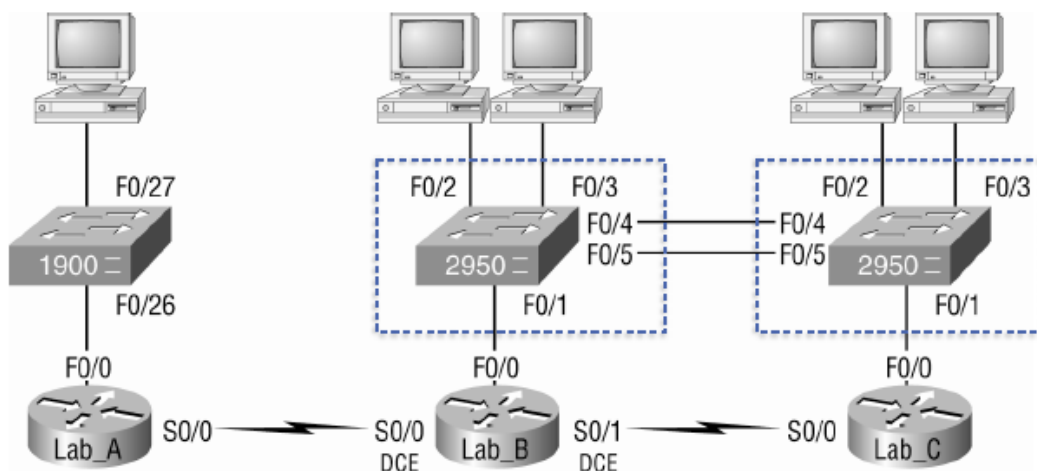
Setup a Trunk


```
2950B#config t
2950B(config)#int f0/1
2950B(config-if)#switchport mode trunk
2950B(config-if)#int f0/4
2950B(config-if)#switchport mode trunk
2950B(config-if)#int fa0/5
2950B(config-if)#switchport mode trunk
2950B(config-if)#
```
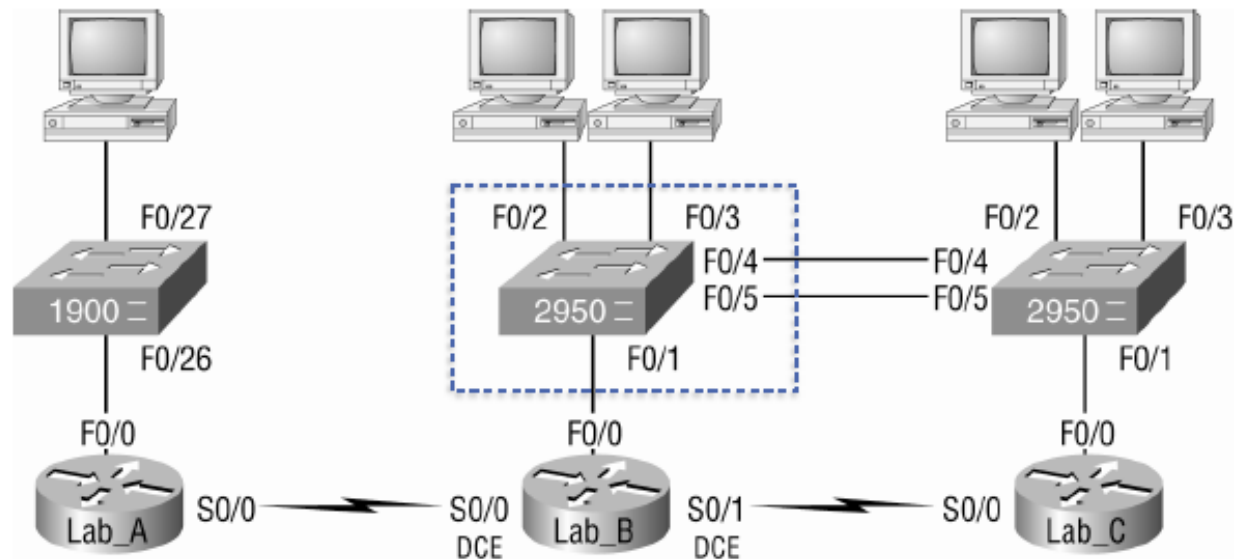
```
2950C#config t
Enter configuration commands, one per line.  End with CNTL/Z.
2950C(config)#int fa0/4
2950C(config-if)#switchport mode trunk
2950C(config-if)#int fa0/5
2950C(config-if)#switchport mode trunk
2950C(config-if)#
```

Checking a Trunk


```
2950B#sh int trunk

Port      Mode        Encapsulation   Status       Native vlan
Fa0/1     on          802.1q          trunking     1
Fa0/4     on          802.1q          trunking     1
Fa0/5     on          802.1q          trunking     1
```

Setting VTP, Name a VLAN

```
2950C#config t
Enter configuration commands, one per line.  End with CNTL/Z.
2950C(config)#vtp mode server
Device mode already VTP SERVER.
2950C(config)#vtp domain RouterSim
2950C(config)#^z
2950C#vlan database
2950C(vlan)#vlan 2 name Sales
VLAN 2 added:
    Name: Sales
2950C(vlan)#vlan 3 name Marketing
VLAN 3 added:
    Name: Marketing
2950C(vlan)#apply
APPLY completed.
2950C(vlan)#
```
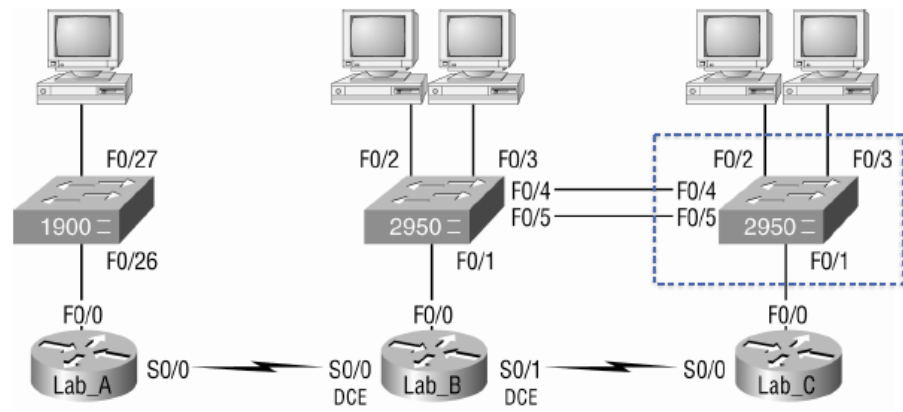


```
2950C#sh vlan brief

VLAN Name             Status    Ports
---- ---------------- --------- ------------------------------
1    default          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                Fa0/7, Fa0/8, Fa0/11, Fa0/12
2    Sales            active
3    Marketing        active
```

Setting up a port for VLAN
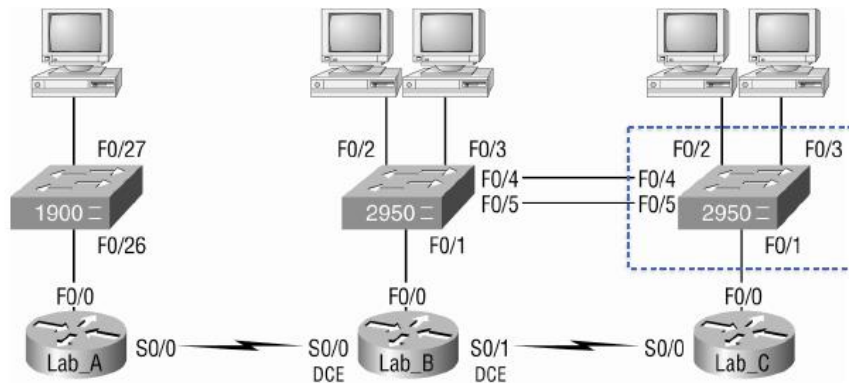

```
2950C#config t
2950C(config)#int fa0/2
2950C(config-if)#switchport access vlan 2
2950C(config-if)#int fa0/3
2950C(config-if)#switchport access vlan 3
```

```
2950C#sh vlan brief
```

VLAN	Name	Status	Ports
1	default	active	Fa0/1, Fa0/4, Fa0/5, Fa0/6
			Fa0/7, Fa0/8, Fa0/9, Fa0/10
2	Sales	active	Fa0/2
3	Marketing	active	Fa0/3

Specify values for 2950B


```
2950B#config t
Enter configuration commands, one per line.  End with CNTL/Z.
2950B(config)#vtp domain RouterSim
Device mode set to VTP CLIENT.
2950B(config)#vtp mode client
2950B(config)#^z
2950B#


2950B#config
2950B(config)#int fa0/2
2950B(config-if)#switchport access vlan 2
2950B(config-if)#int fa0/3
2950B(config-if)#switchport access vlan 3
```
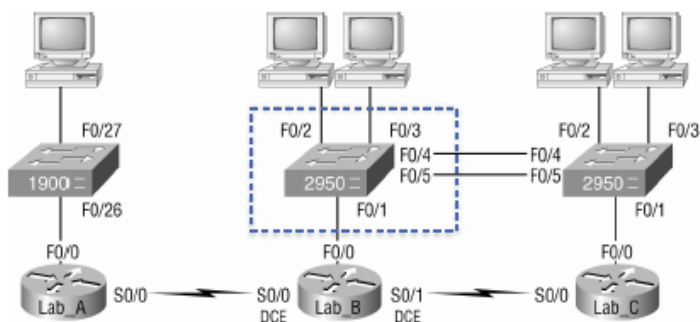
```
2950B#sh vlan brief

VLAN Name                 Status    Ports
---- -------------------- --------- ----------------------------
1    default              active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                    Fa0/7, Fa0/8, Fa0/11, Fa0/12
2    Sales                active
3    Marketing            active


2950B#sh vlan brief

VLAN Name                 Status    Ports
---- -------------------- --------- ----------------------------
1    default              active    Fa0/1, Fa0/4, Fa0/5, Fa0/6
                                    Fa0/7, Fa0/8, Fa0/9, Fa0/10
2    Sales                active    Fa0/2
3    Marketing            active    Fa0/3
```

Link between VLANs

```
Router>enable
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname Trunkrouter
Trunkrouter(config)#int f0/0
Trunkrouter(config-if)#no ip address
Trunkrouter(config-if)#no shutdown
Trunkrouter(config-if)#int f0/0.1
Trunkrouter(config-subif)#ip address 172.16.10.1 255.255.255.0
Configuring IP routing on a LAN subinterface is only allowed if that
subinterface is already configured as part of an IEEE 802.10, IEEE 802.1Q, or
ISL VLAN.
Trunkrouter(config-subif)#encapsulation dot1q 1
Trunkrouter(config-subif)#ip address 172.16.10.1 255.255.255.0
Trunkrouter(config-subif)#int f0/0.2
Trunkrouter(config-subif)#encap dot1q 2
Trunkrouter(config-subif)#ip address 172.16.20.1 255.255.255.0
Trunkrouter(config-subif)#int f0/0.3
Trunkrouter(config-subif)#encap dot1q 3
Trunkrouter(config-subif)#ip address 172.16.30.1 255.255.255.0
Trunkrouter(config-subif)#exit
```
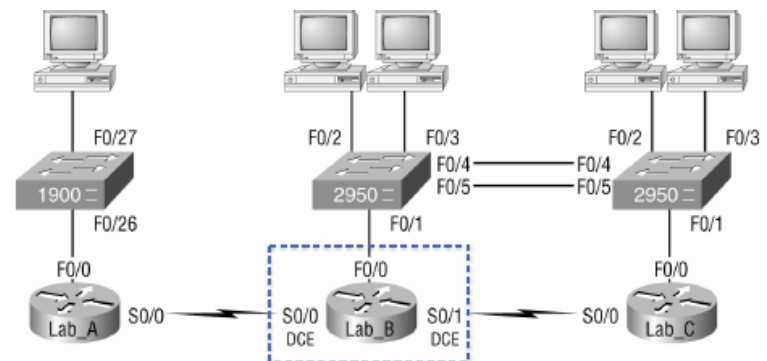
Summary

- Switch and Bridge

- VTP

- RSTP

- VLAN

- VTP

Thank you.

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