

TANet 區網中心網路基礎教育訓練

麟瑞科技 溫德鈞

Cisco Icons and Symbols



ATM
Switch



Bridge



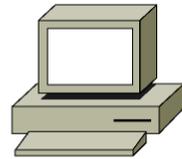
File
Server



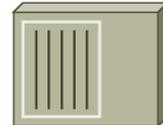
Network
Cloud



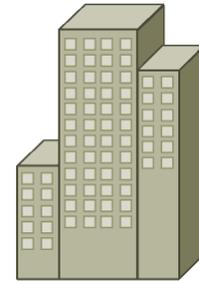
Router



PC



Hub



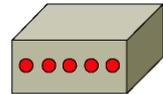
Building



Switch



Laptop



Modem
(CSU/DSU)



Comm
Server



Phones



Phone
Customer

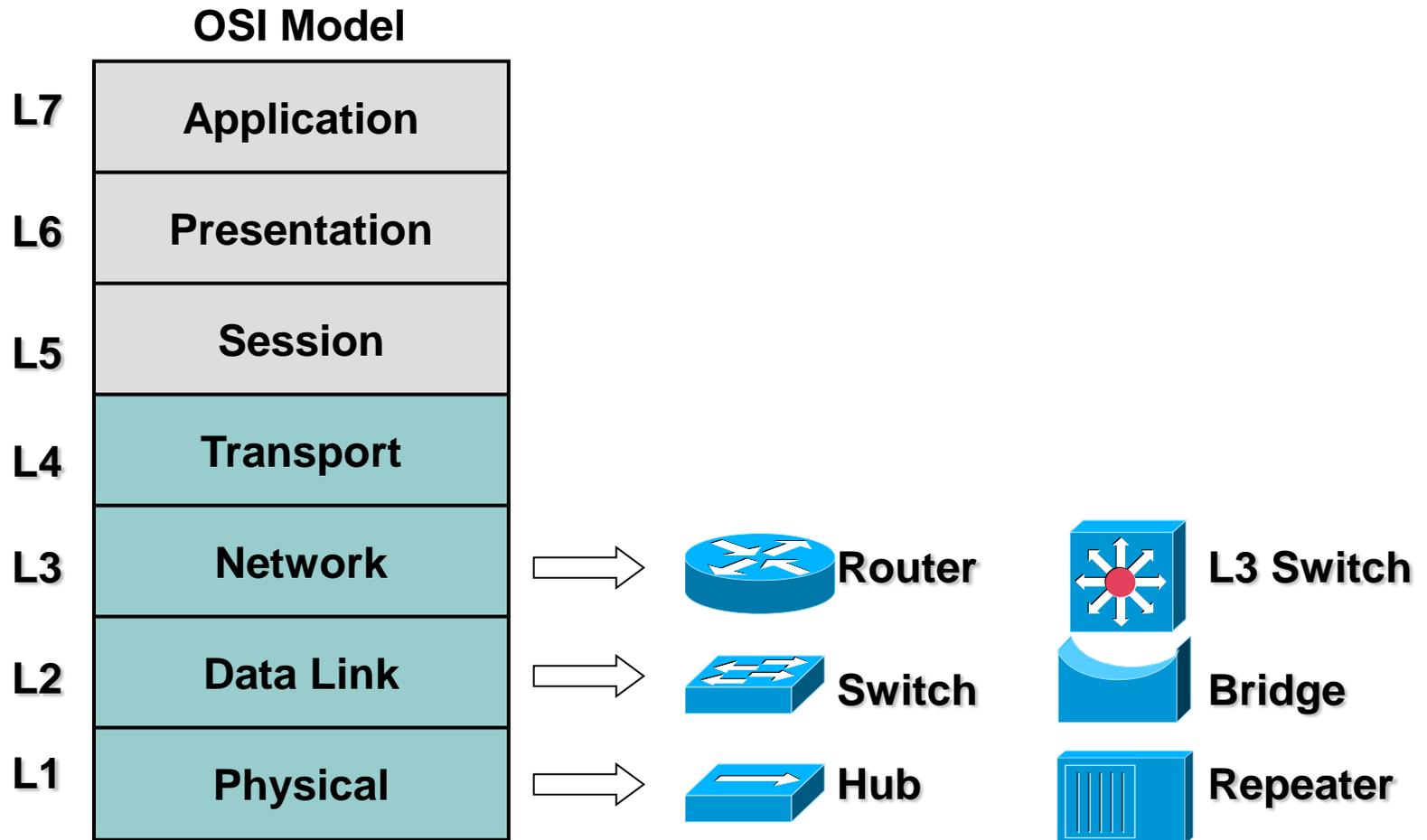


Home
Office



ISDN
Switch

OSI Reference Model



The Catalyst Access portfolio was completely refreshed in 2013

FEATURES

NEW Jul 2013

**TRADITIONAL
WORKSPACE**



Data



Voice

Cisco Catalyst
2960-X

- Secure, reliable access
- Low TCO & energy-efficient



**Competitive Feature Set
at Compelling Prices**

NEW Jan 2013

**UNIFIED
WORKSPACE**



BYOD



Video



Mobility

Converged Wired/Wireless Access

Lead Stackable Switch

Cisco Catalyst 3850/3650



- Upto 480G Stacking
- Upto 4x10G Uplinks
- Stackpower with 3850
- Supports up to 50AP's

Lead Modular Switch

Cisco Catalyst 4500-E



- Scale and Performance
- 928G Backplane
- 8 Modular 1/10G Uplinks
- Supports 50AP's*

SCALE

Catalyst 4500E Portfolio

Four Chassis Options

7 and 10 Slot with Sup Redundancy



Supervisors

Traditional and Wireless Convergence

928G Wired, 20G Wireless



WS-X45-SUP8-E



WS-X45-SUP7-E



WS-X45-SUP7L-E

Port Scale: Access and Collapse Agg

384 10/100/1000 POE/PoE+/UPOE

96 SFP+ , 192 SFP



POE: WS-X4748-UPOE+E



10GE: WS-X4712-SFP+E



Data: WS-X4748-RJ45-E



1GE: 12/24/48 port
WS-X47xx-SFP-E

Power Supply

Maximize UPOE/POE+/POE delivery

Fully Loaded 10-Slot with POE



PWR-C45-9000ACV



PWR-C45-6000ACV



PWR-C45-4200ACV

Nexus 7000 Series

Expanding the family with the Nexus 7700

Cisco Nexus® 7000 Series

Cisco Nexus 7000 Series
Switches

Cisco Nexus 7700
Platform Switches

Common Cisco® NX-OS

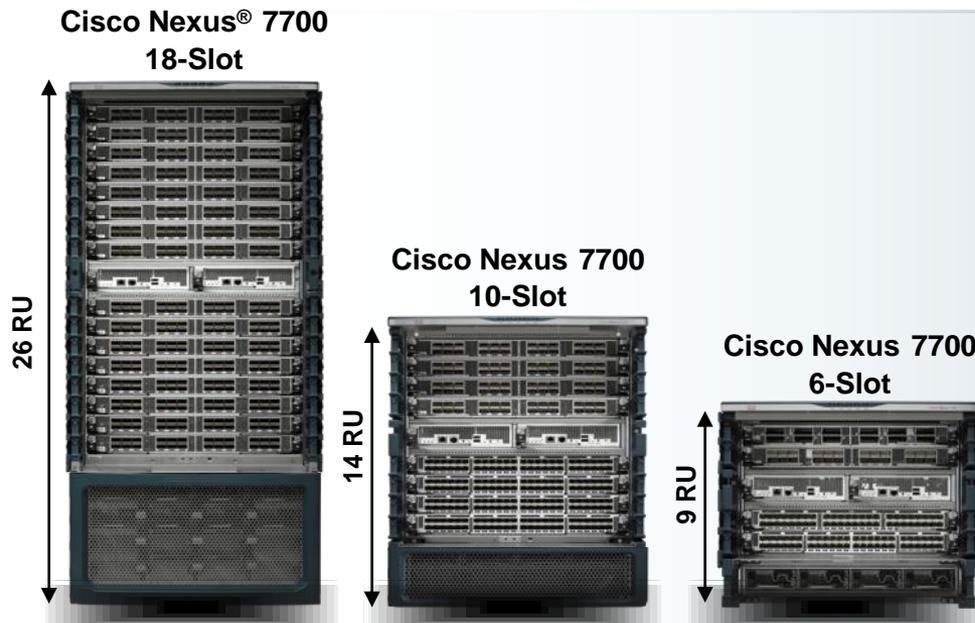
Common Fabric Architecture

Common Cisco's Custom Silicon

Both Platforms Suitable for Campus Core

Nexus 7700 Platform Switches

Value Proposition



Fabric **BANDWIDTH**
1.32
Tbps

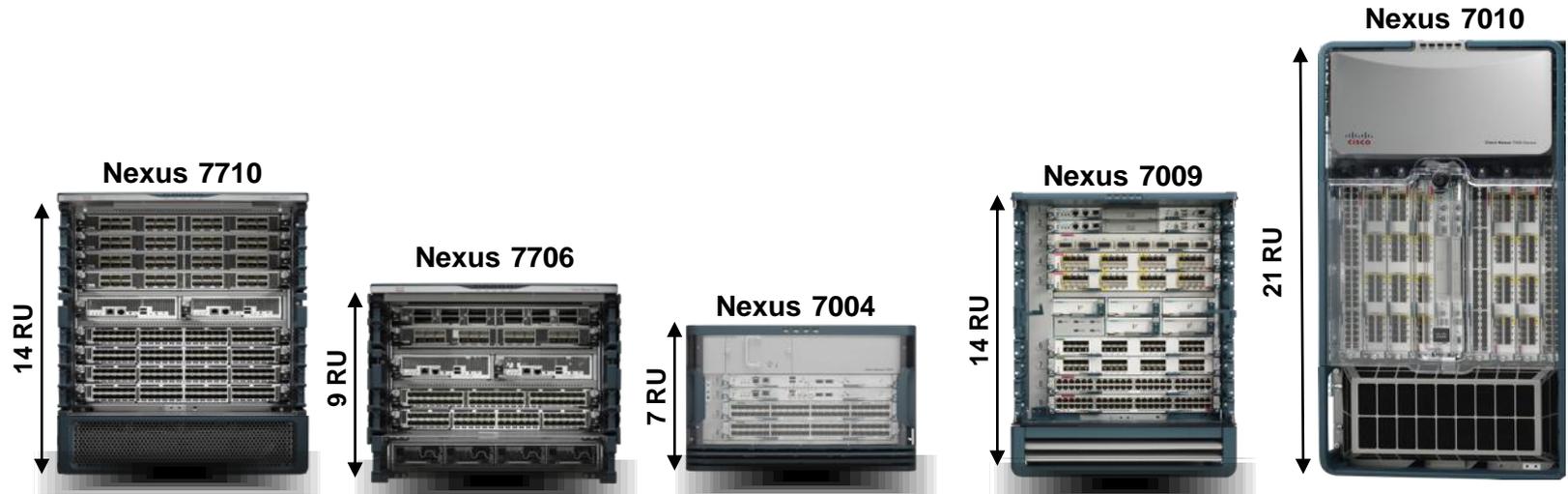
Smaller **FOOTPRINT**
33% more
compact

Environmental **EFFICIENCY**
True front-to-back
airflow

	Nexus 7718	Nexus 7710	Nexus 7706
100G Density	192	96	48
40G density	384	192	96
1G / 10G density	768	384	192

Nexus 7000 Chassis Summary

Form factors more suitable for Campus Core



	Nexus 7710	Nexus 7706	Nexus 7004	Nexus 7009	Nexus 7010
1G / 10G density	384	192	96	336	384
40G density	192	96	24	84	96
100G Density	96	48	12	42	48
I/O Modules	8	6	2	7	8
Supervisors	2	2	2	2	2
Air Flow	Front to Back	Front to Back	Side to Rear	Side to Side	Front to Back

Smaller Nexus 7000 for the Campus Core

Delivering from 48 up to 192 wire rate 10GbE ports

Nexus 7004



Nexus 7706





Operating and Configuring Cisco IOS Devices

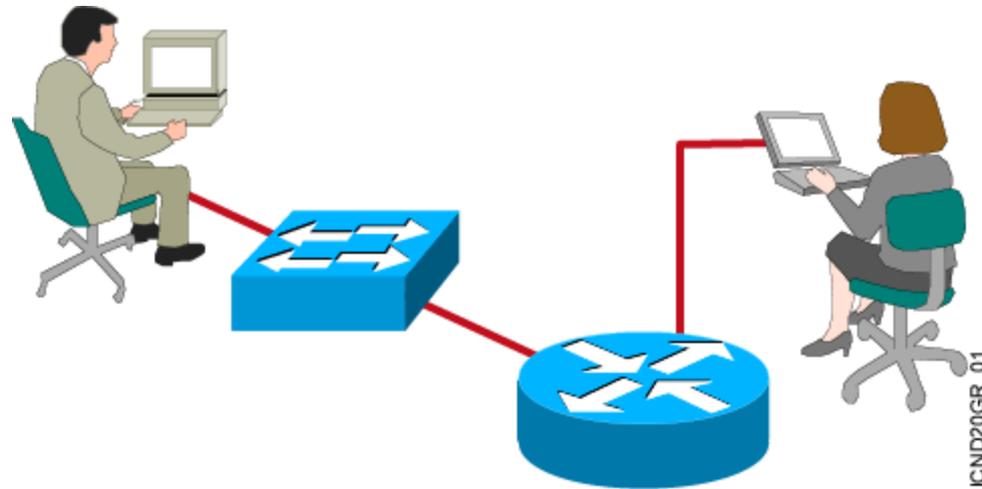
Objectives

Upon completing this module, you will be able to:

- Use the available configuration tools to establish connectivity to the appropriate network device in order to complete the initial device configuration
- Verify the default configuration of each device, given a functioning access layer switch and router

Operating Cisco IOS Software

Cisco IOS Software Features



- **Cisco IOS software delivers network services and enables networked applications.**

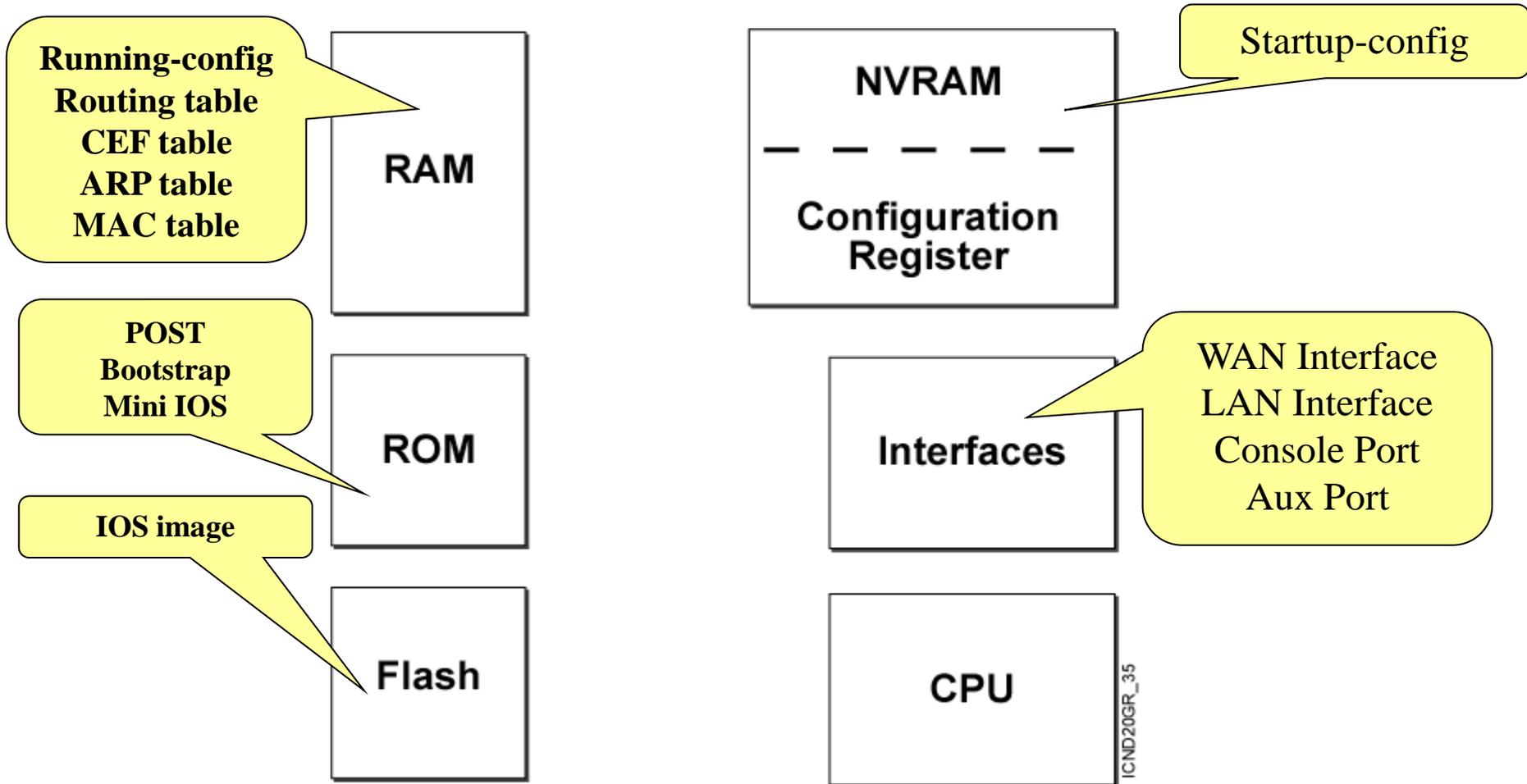
An Overview of Cisco Device Startup

- 1. Find and check device hardware.**
- 2. Find and load Cisco IOS software image.**
- 3. Find and apply device configurations.**

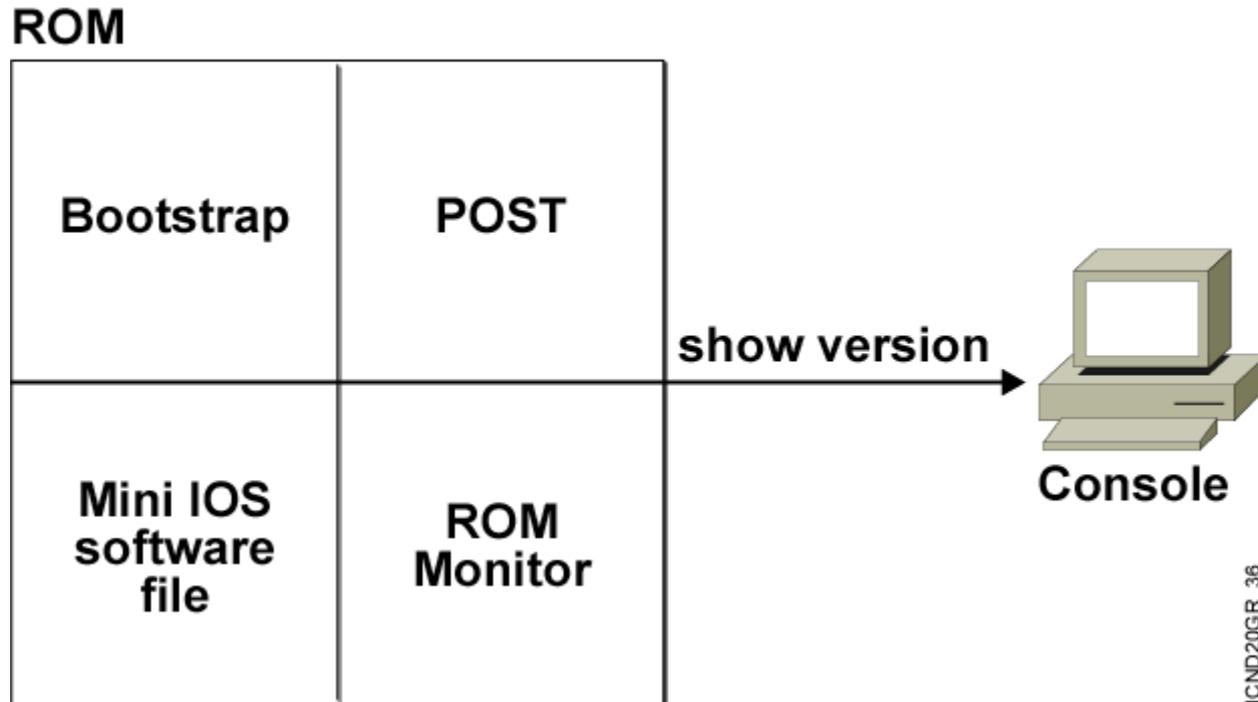


ICND20GR_02

Router/Switch Internal Components

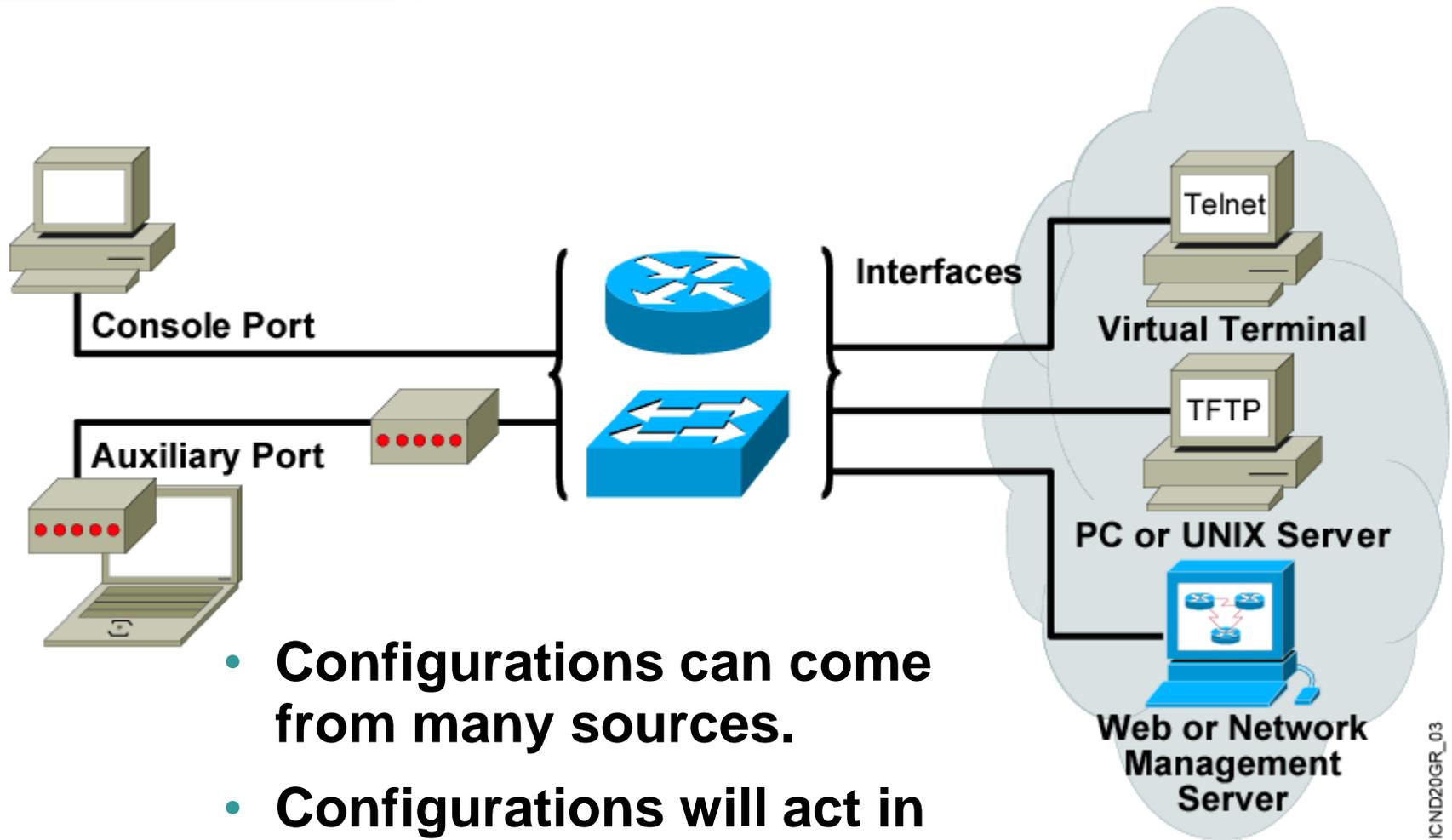


ROM Functions



- **Contains microcode for basic functions**

External Configuration Sources



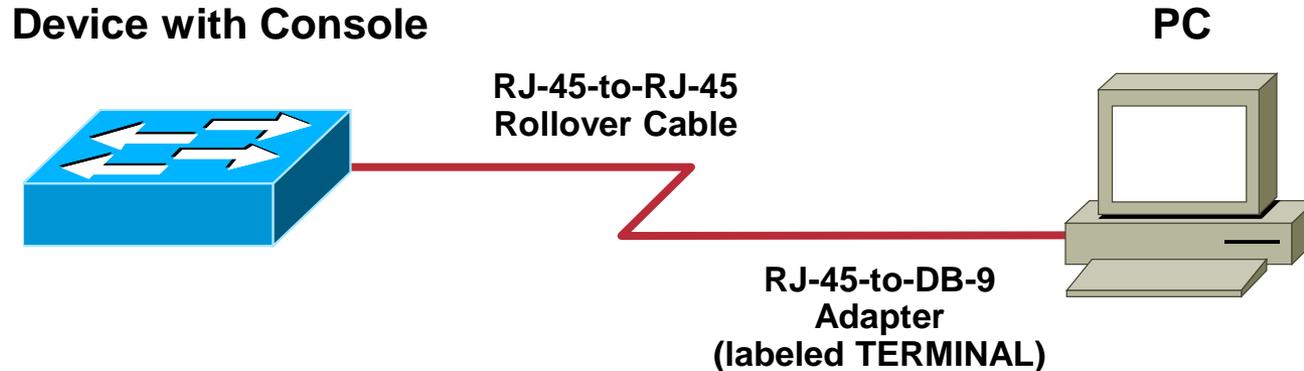
- **Configurations can come from many sources.**
- **Configurations will act in device memory.**

Cisco IOS User Interface Functions

- A CLI is used to enter commands.
- Operations vary on different internetworking devices.
- Users type or paste entries in the console command modes.
- Enter key instructs device to parse and execute the command.
- Two primary EXEC modes are user mode and privileged mode.
- Command modes have distinctive prompts.



Setting Up a Console Connection

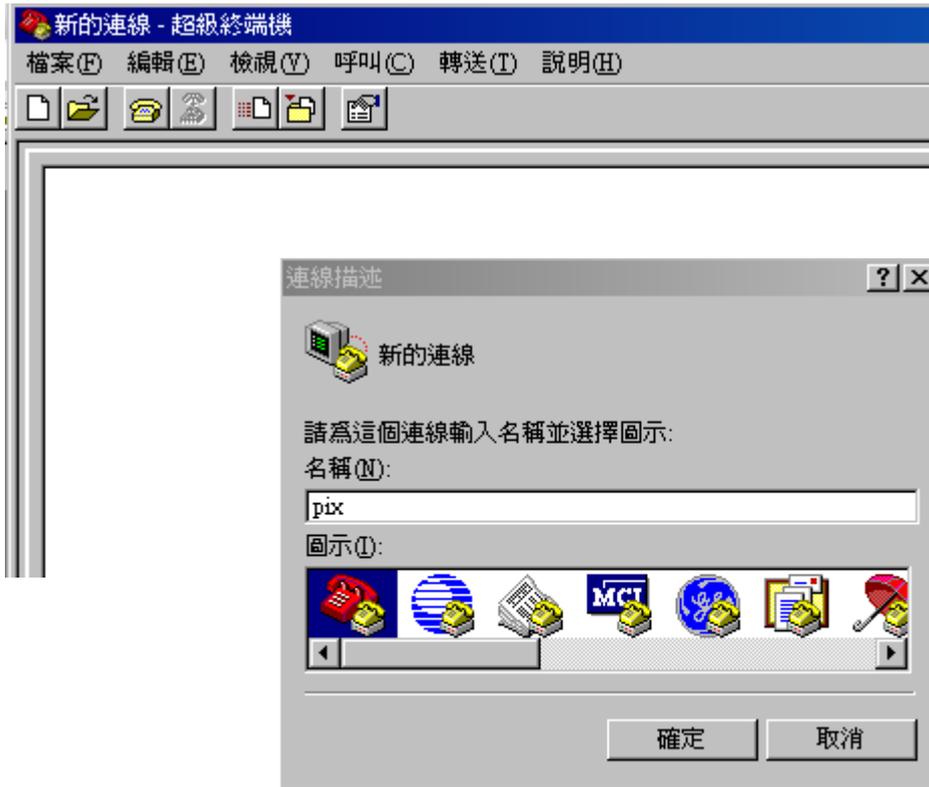


- PCs require an RJ-45-to-DB-9 or RJ-45-to-DB-25 adapter.
- COM port settings are 9600 bps, 8 data bits, no parity, 1 stop bit, no flow control.
- This provides out-of-band console access.
- AUX port (switch or router if provided) may be used for a modem-connected console.

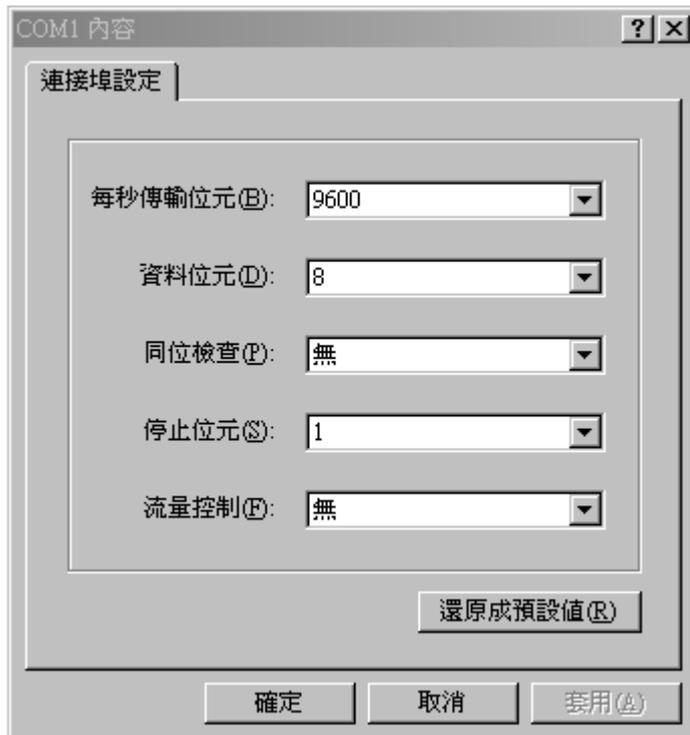
Get console terminal

Start :

Programs>Accessories>HyperTerminal

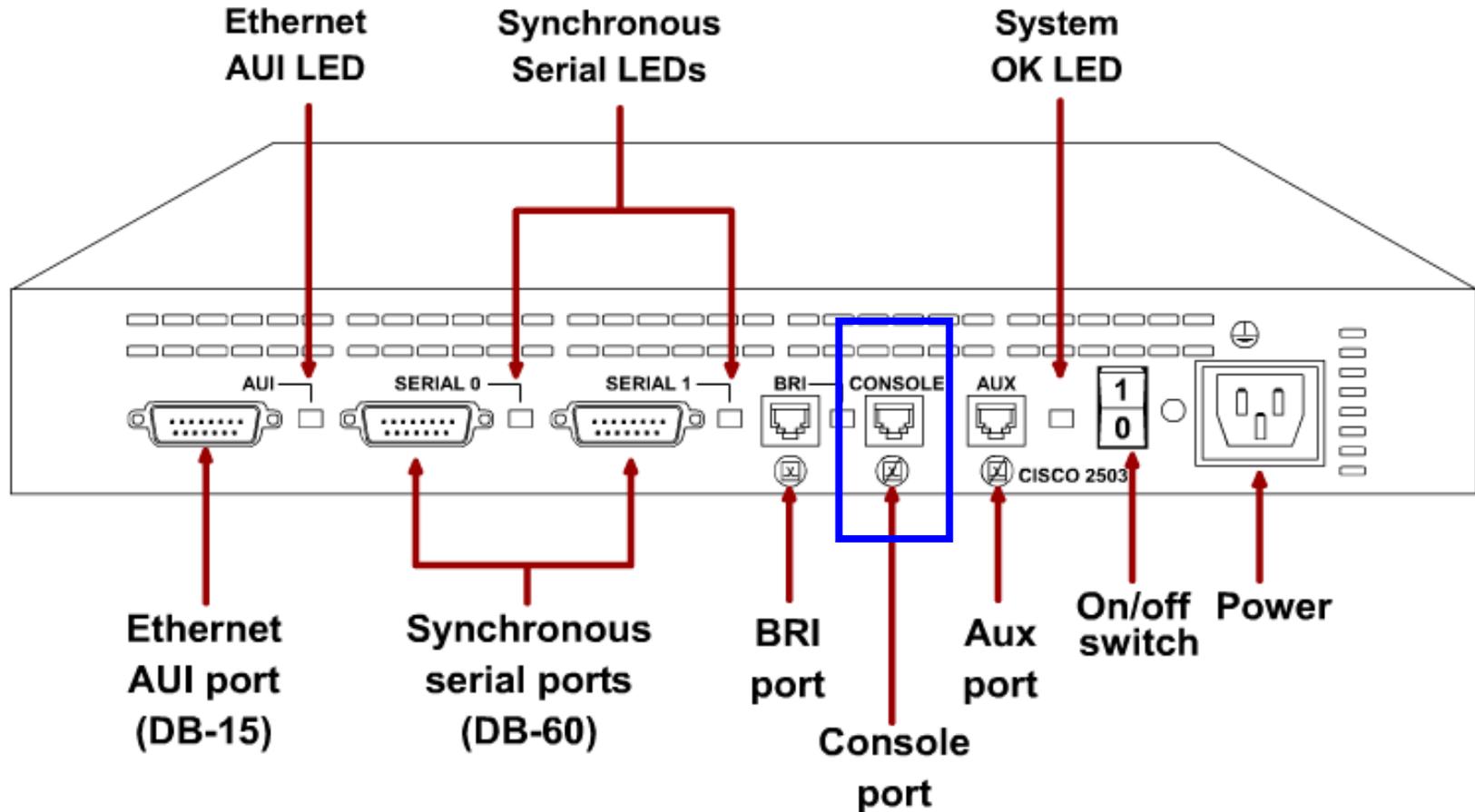


Get console terminal



- Bits per second to 9600.
- Data bits to 8.
- Parity to None.
- Stop bits to 1.
- No Flow control

Cisco 2500 Router



Connecting Router Console Interface 1/3

Step 1 Identify connectors and components

- a. Examine the router and locate the RJ-45 connector labeled Console.

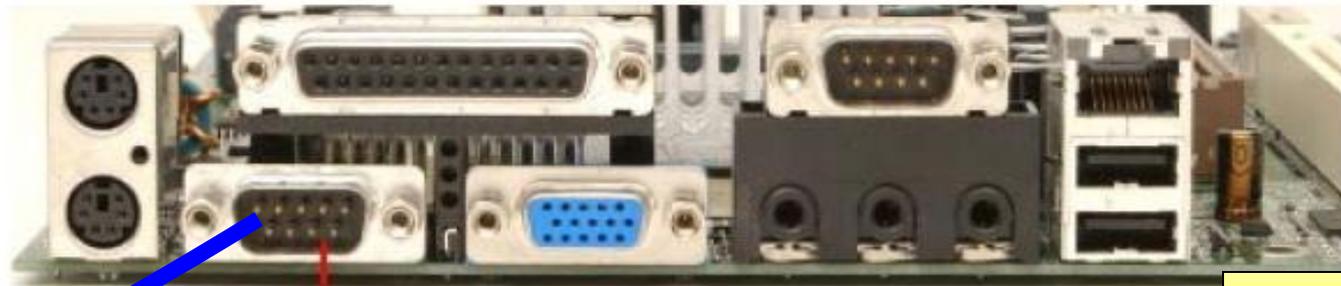


Cisco 2600 Router

Console Port

Step 2 Identify the computer serial interface (COM 1 or 2)

- a. Examine the computer and locate a 9-pin or 25-pin male connector labeled serial. It may or may not be identified.



PC

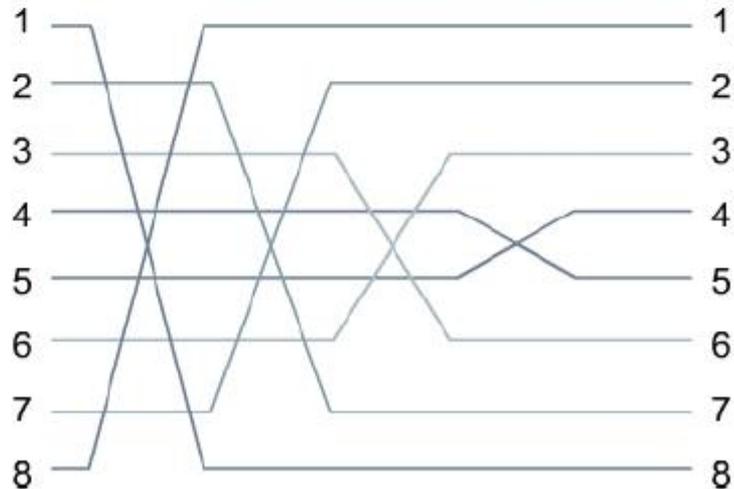
9 pin male

Connecting Router Console Interface 2/3

Step 4 Locate or build a rollover cable

- Use a console or rollover cable of adequate length to connect the router to one of the workstations. Make a rollover cable if necessary.

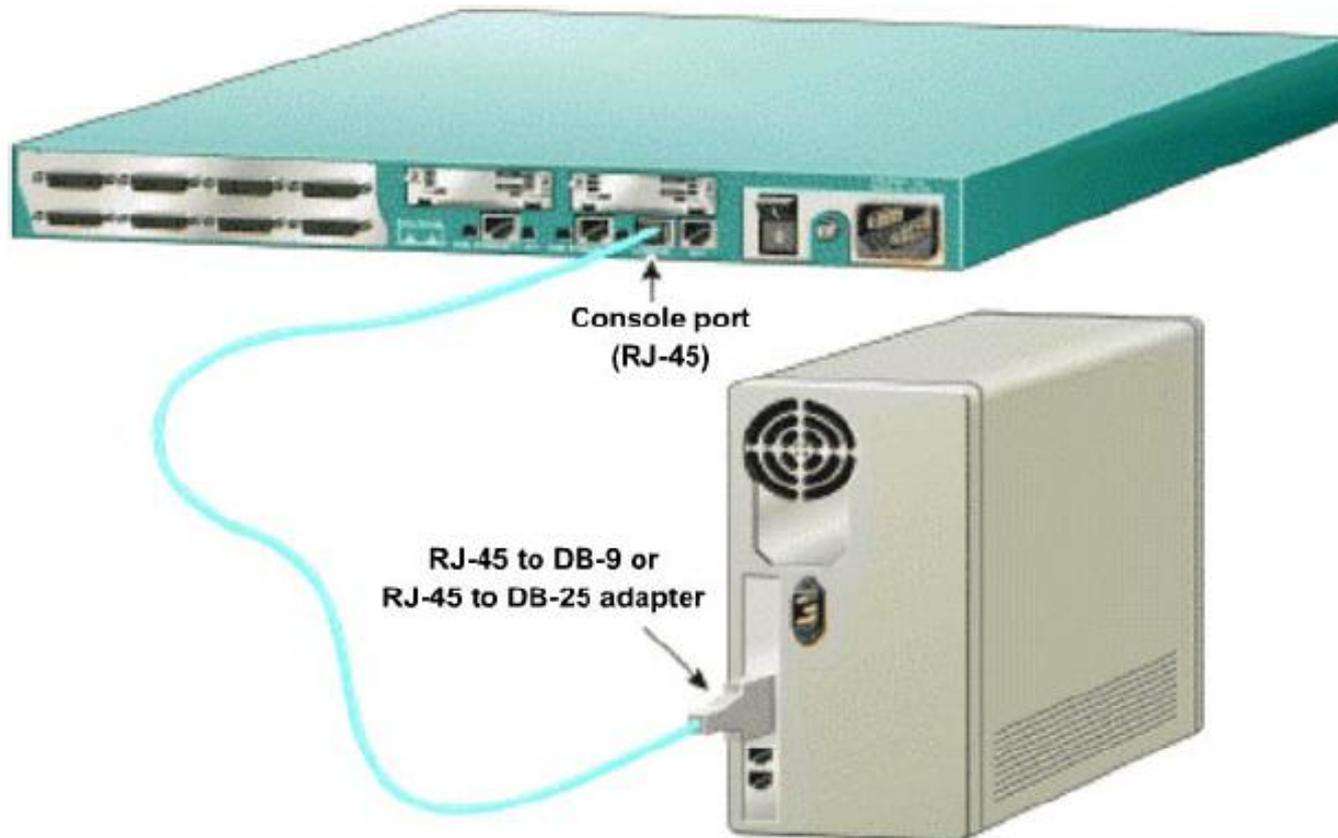
Step 3 Locate the RJ-45 to DB-9 adapter



Connecting Router Console Interface 3/3

Step 5 Connect cabling components

- a. Connect the console or rollover cable to the router console port, an RJ-45 connector. Next, connect the other end of the console or rollover cable to the RJ-45 to DB-9 or RJ-45 to DB-25 adapter depending on the available PC serial port. Finally attach the adapter to a PC serial port, either DB-9 or DB-25, depending on the computer.



Cisco IOS Software EXEC Mode

- There are two main EXEC modes for entering commands.



First Mode:

User Mode

- Limited examination of switch or router
- Command prompt: `hostname>`

Cisco IOS Software EXEC Mode (Cont.)

Second Mode (and Most Commonly Used):

Privileged (or Enabled) Mode

- Detailed examination of switch or router
- Enables configuration and debugging
- Prerequisite for other configuration modes
- Command prompt: `hostname#`



Configuring Switch

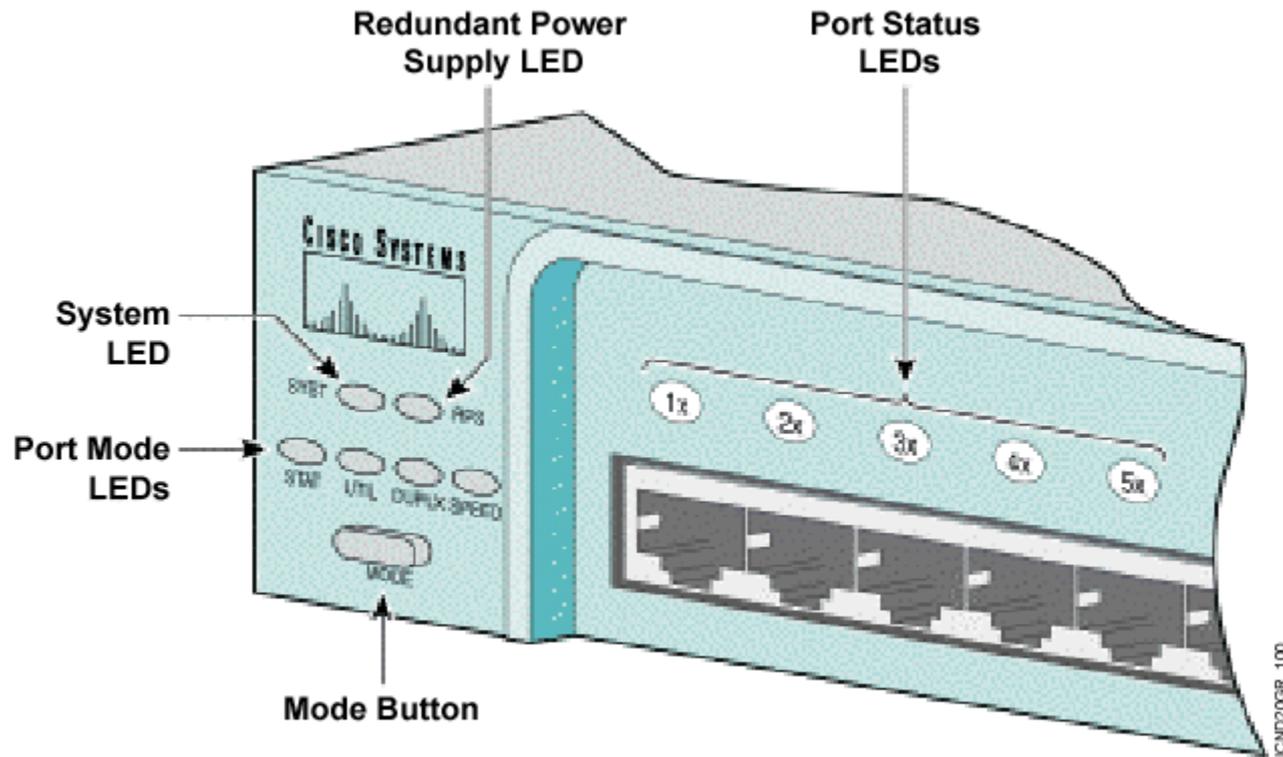
Initial Startup of the Catalyst Switch

- **System startup routines initiate switch software.**
- **Initial startup uses default configuration parameters.**

1. Before you start the switch, verify the cabling and console connection.
2. Attach the power cable plug to the switch power supply socket.
3. Observe the boot sequence:
 - LEDs on the switch chassis
 - Cisco IOS software output text



Catalyst 2950 Switch LED Indicators



Port LEDs During Switch POST

- 1. At the start, all port LEDs are green.**
- 2. Each LED turns off after its test completes.**
- 3. If a test fails, its LED turns amber.**
- 4. System LED turns amber if any test fails.**
- 5. If no test fails, POST completes.**
- 6. On POST completion, LEDs blink, then turn off.**

Catalyst Switch 2950/2960 Series Default Configuration

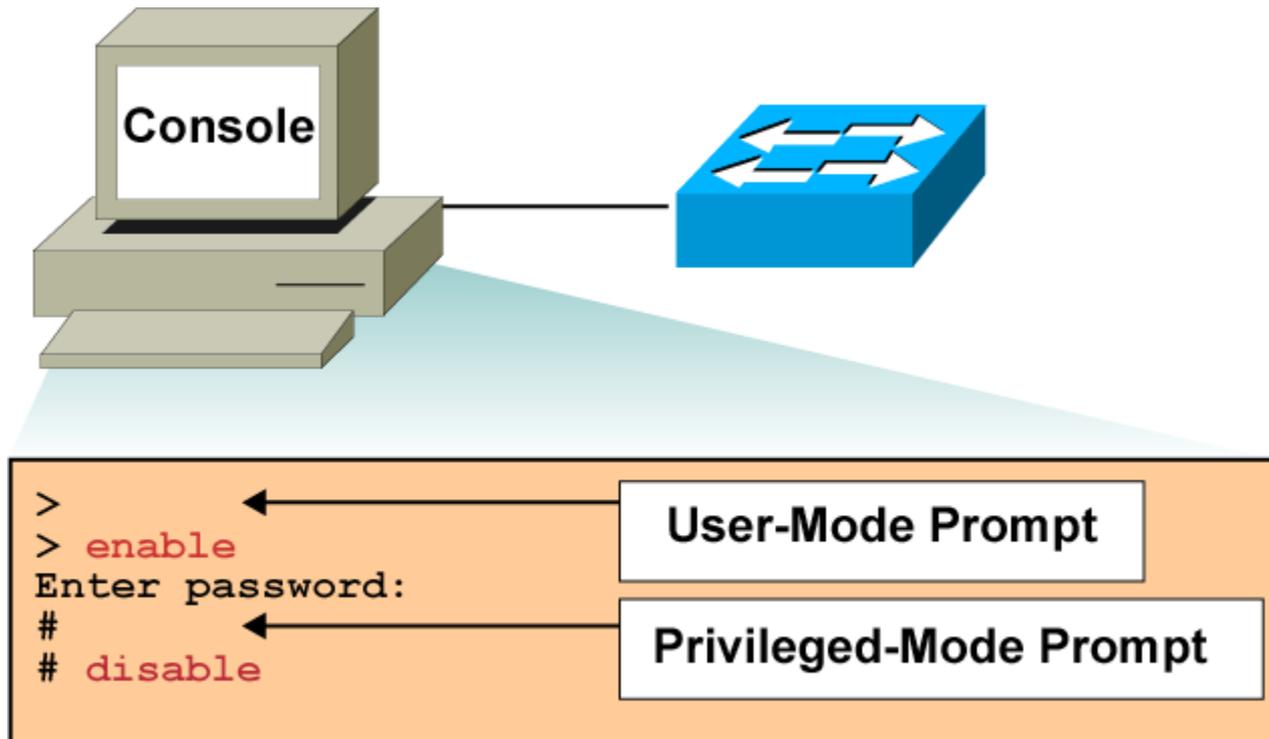
- **IP address: 0.0.0.0**
- **CDP: enabled**
- **100baseT port: autonegotiate duplex mode**
- **Spanning tree: enabled**
- **All ports belong to : VLAN 1**
- **Console password: none**

Initial Bootup Output from the Catalyst 2950 Switch

--- System Configuration Dialog ---

```
At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[' ].
Continue with configuration dialog? [yes/no]: yes
Enter IP address: ip_address
Enter IP netmask: ip_netmask
Would you like to enter a default gateway address? [yes]: yes
IP address of the default gateway: ip_address
Enter a host name: host_name
Enter enable secret: secret_password
Would you like to configure a Telnet password? [yes] yes
Enter Telnet password: telnet_password
Would you like to enable as a cluster command switch? no
Enter cluster name: cls_name
```

Logging In to the Switch and Entering the Enable Password



Configuring the Switch



Configuration Modes:

- **Global configuration mode**
 - `wg_sw_a#configure terminal`
 - `wg_sw_a(config)#`
- **Interface configuration mode**
 - `wg_sw_a(config)#interface e0/1`
 - `wg_sw_a(config-if)#`

Configuring Switch Identification

Switch Name

```
(config) #hostname wg_sw_c  
wg_sw_c (config) #
```



ICND20GR_12

- Sets the local identity for the switch

Port Names on Catalyst 2950 Series Switches

```
wg_sw_2950#show run
```

```
Building configuration...  
Current configuration:
```

```
!  
!  
interface FastEthernet0/1  
!  
interface FastEthernet0/2
```

```
wg_sw_2950#show spantree
```

```
Interface Fa0/1 (port 7) in Spanning tree 1 is FORWARDING  
Port path cost 19, Port priority 128  
Designated root has priority 32768, address 0008.a445.c980  
Designated bridge has priority 32768, address 0008.a445.c980  
Designated port is 7, path cost 0  
Timers: message age 0, forward delay 0, hold 0  
BPDU: sent 8316, received 4
```

```
wg_sw_2950#show vlan
```

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

Configuring the Switch IP Address

Catalyst 2950 Series

```
wg_sw_2950 (config-if)#ip address {ip_address} {mask}
```

- Configures an IP address and subnet mask for the switch VLAN1 interface

```
wg_sw_2950 (config)#interface vlan 1  
wg_sw_2950 (config-if)#ip address 10.5.5.11 255.255.255.0
```

Configuring the Switch Default Gateway

```
wg_sw_a(config)# ip default-gateway {ip address}
```

- Configures the switch default gateway for the Catalyst 2950 series switches

```
wg_sw_a(config)# ip default-gateway 10.5.5.3
```

Showing the Switch IP Address

Catalyst 2950 Series

```
wg_sw_2950#show interface vlan 1
Vlan1 is up, line protocol is up
  Hardware is Cat5k Virtual Ethernet, address is 0010.f6a9.9800 (bia 0010.f6a9.9800)
  Internet address is 172.16.80.79/24
  Broadcast address is 255.255.255.255
  . . .
wg_sw_2950#
```

Setting Duplex Options

Catalyst 2950 Series

```
wg_sw_2950(config)#interface fe0/1  
wg_sw_2950(config-if)#duplex {auto | full | half}
```

Showing Duplex Options

```
Switch#show interfaces fastethernet0/3
```

```
FastEthernet0/3 is up, line protocol is down
```

```
Hardware is Fast Ethernet, address is 0000.0000.0003 (bia 0000.0000.0003)
```

```
MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,  
reliability 255/255, txload 1/255, rxload 1/255
```

```
Encapsulation ARPA, loopback not set
```

```
Keepalive set (10 sec)
```

```
Half-duplex, 10Mb/s
```

```
input flow-control is off, output flow-control is off
```

```
ARP type: ARPA, ARP Timeout 04:00:00
```

```
Last input never, output never, output hang never
```

```
Last clearing of "show interface" counters never
```

```
Queueing strategy: fifo
```

```
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
```

```
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 runts, 0 giants, 0 throttles
```

```
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
```

```
0 input packets with dribble condition detected
```

```
0 packets output, 0 bytes, 0 underruns
```

```
0 output errors, 0 collisions, 2 interface resets
```

```
0 babbles, 0 late collision, 0 deferred
```

```
0 lost carrier, 0 no carrier
```

```
0 output buffer failures, 0 output buffers swapped out
```

Managing the MAC Address Table

Catalyst 2950 Series

```
wg_sw_2950#show mac-address-table
Dynamic Address Count:                1
Secure Address Count:                 0
Static Address (User-defined) Count:  0
System Self Address Count:            25
Total MAC addresses:                  26
Maximum MAC addresses:                 8192
Non-static Address Table:
Destination Address  Address Type  VLAN  Destination Port
-----
0050.0f02.3372     Dynamic      1     FastEthernet0/2
```

Setting a Permanent MAC Address

Catalyst 2950 Series Only

```
wg_sw_2950(config)#mac-address-table static  
mac_addr {vlan vlan_id} [interface int1 [int2 ... int15]]
```

Configuring Port Security

Catalyst 2950 Series

```
wg_sw_2950(config-if)#port security max-mac-count count
```

```
wg_sw_2950(config)#interface fa0/1  
wg_sw_2950(config-if)#port security  
wg_sw_2950(config-if)#port security max-mac-count 10
```

Configuring the Switch IP Address

```
wg_ro_c#configure terminal
wg_ro_c(config)#interface vlan 1
wg_ro_c(config-if)#ip address 192.168.1.254 255.255.255.0
wg_ro_c(config-if)#no shutdown
wg_ro_c(config-if)#exit
```

Configuring an Interface

```
Router(config) #interface type number  
Router(config-if) #
```

- *type* includes serial, ethernet, token ring, fddi, hssi, loopback, dialer, null, async, atm, bri, tunnel, and so on
- *number* is used to identify individual interfaces

```
Router(config) #interface type slot/port  
Router(config-if) #
```

- For modular routers, selects an interface

```
Router(config-if) #exit
```

- Quits from current interface configuration mode

Interface Description

```
CoreSw(config)#interface gigabitEthernet 2/1  
CoreSW(config-if)#description xxxx
```

```
interface GigabitEthernet2/1  
description "to-Server-Farm-2960"  
no ip address  
switchport  
switchport access vlan 390  
switchport mode access  
!  
interface GigabitEthernet2/2  
description "to-2F-2950"  
no ip address  
switchport  
switchport access vlan 3  
switchport mode access
```

Switch:Show interface

CoreSw(config)#interface GigabitEthernet 2/31

GigabitEthernet2/31 is **up**, line protocol is **up** (connected)
Hardware is C6k 1000Mb 802.3, address is 0012.4414.5c00 (bia 0012.4414.5c00)
Internet address is 192.168.30.254/24
MTU 1500 bytes, BW 100000 Kbit, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 100Mb/s
input flow-control is off, output flow-control is off
Clock mode is auto
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:00, output 00:00:26, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 1
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec

Switch Configuring Example

```
Switch>  
Switch>enable  
Password:  
Switch#configure terminal  
Switch(config)#interface gigabitEthernet 2/1  
Switch(config-if)#exit  
Switch(config)#interface vlan 390  
Switch(config-if)#exit  
Switch(config)#line console 0  
Switch(config-line)#exit  
Switch(config)#line vty 0 4  
Switch(config-line)#
```

Switch:show version

```
wg_sw_a#show version
```

```
Cisco Catalyst 1900/2820 Enterprise Edition Software
```

```
Version V8.01.01      written from 171.068.229.225
```

```
Copyright (c) Cisco Systems, Inc. 1993-2001
```

```
wg_sw_c uptime is 15day(s) 21hour(s) 53minute(s) 11second(s)
```

```
cisco Catalyst 1900 (486sx1) processor with 2048K/1024K bytes of memory
```

```
Hardware board revision is 5
```

```
Upgrade Status: No upgrade currently in progress.
```

```
Config File Status: No configuration upload/download is in progress
```

```
27 Fixed Ethernet/IEEE 802.3 interface(s)
```

```
Base Ethernet Address: 00-50-BD-73-E2-C0
```

Showing Switch Initial Startup Status

```
wg_sw_a#show version
```

- Displays the configuration of the system hardware, software version, names and sources of configuration files, and boot images

```
wg_sw_a#show running-configuration
```

- Displays the switch's current active configuration file

```
wg_sw_a#show interfaces
```

- Displays statistics for all interfaces configured on the switch

```
wg_sw_a#show ip
```

- Displays the IP address, subnet mask, and default gateway

Summary

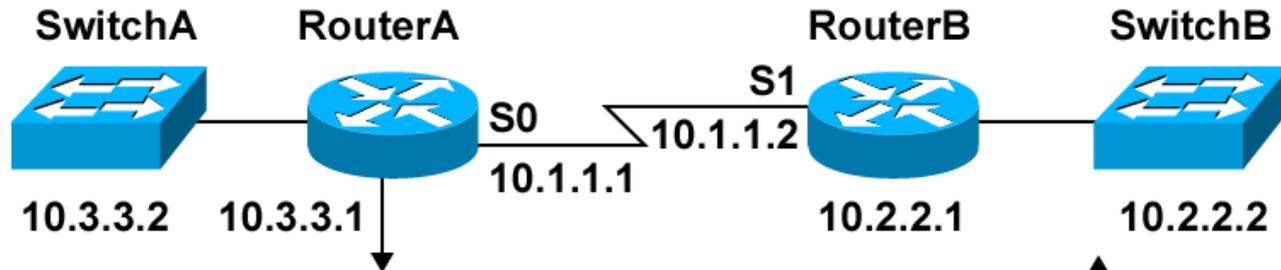
- **A Catalyst switch comes with factory default settings that can be displayed with the show command.**
- **To configure an IP address and subnet mask on a switch, use the ip address command. To configure a default gateway, use the ip default-gateway command.**
- **Half-duplex transmission uses collision detection. The faster full-duplex mode is used for directly connected devices where collision detection is not needed.**
- **Use the duplex command to configure switch duplex options.**
- **MAC address tables include dynamic, permanent, and static addresses. Use the mac-address-table command to set permanent and static addresses.**

Summary (Cont.)

- **Use the mac-address-table restricted static command to associate a restricted static address with a particular port.**
- **Secured ports restrict the use of a port to a user-defined group of stations, set with the port secure command.**
- **As your network endpoint topology changes by adding new devices or interfaces, or moving or changing existing ones, you may need to modify the switch configuration.**
- **The copy command can be used to copy a configuration from or to a file server, while the delete nvram command resets the switch configuration to the factory default settings.**

Getting Information About Remote Devices

Using Telnet to Connect to Remote Devices

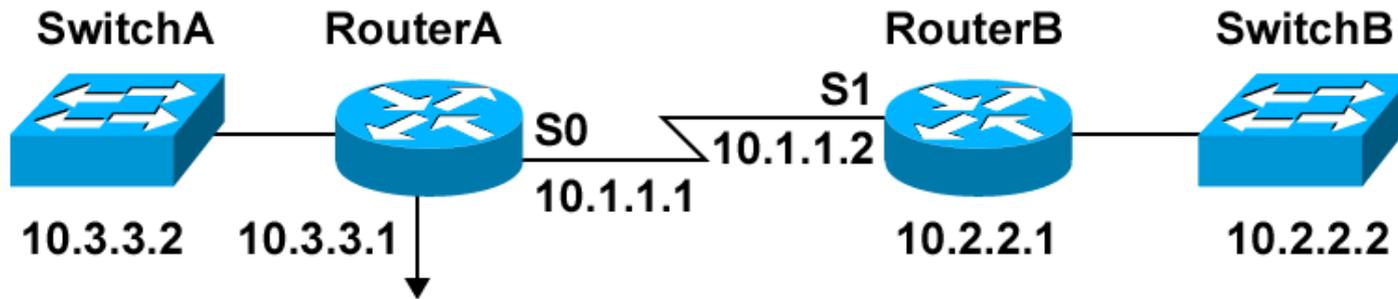


```
RouterA#telnet 10.2.2.2
Trying 10.2.2.2 ... Open
-----
Catalyst 1900 Management Console
Copyright (c) Cisco Systems, Inc. 1993-1998
All rights reserved.
Enterprise Edition Software
Ethernet Address:      00-90-86-73-33-40
PCA Number:           73-2239-06
PCA Serial Number:    FAA02359H8K
Model Number:         WS-C1924-EN
System Serial Number: FAA0237X0FQ
.
```

SwitchB>

Remote device

Closing a Telnet Session



```
RouterA#disconnect ←————— Closes the current  
Closing connection to 10.3.3.2 [confirm] session opened by you
```

```
RouterA#clear line 11 ←————— Closes a session opened  
[confirm] by a remote device  
[OK]
```

Using the ping and trace Commands

```
Router###ping 10.1.1.10
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 10.1.1.10, timeout is 2 seconds:  
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

```
Router#trace 192.168.101.101
```

```
Type escape sequence to abort.
```

```
Tracing the route to 192.168.101.101
```

```
  1 plr1 (192.168.1.49)  20 msec  16 msec  16 msec
```

```
  2 plr2 (192.168.1.18) 48 msec *  44 msec
```

```
Router#
```

- Tests the connectivity and path to a remote device

Managing Cisco IOS Devices

Cisco IOS File System and Devices



system:



nvram:



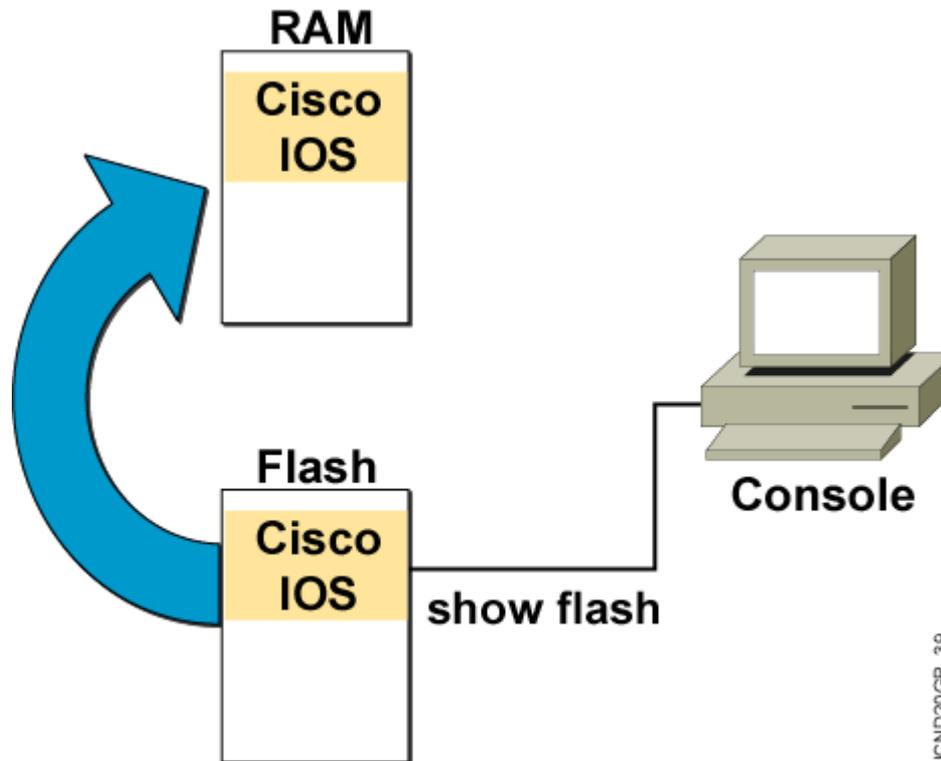
flash:



**TFTP
Server**

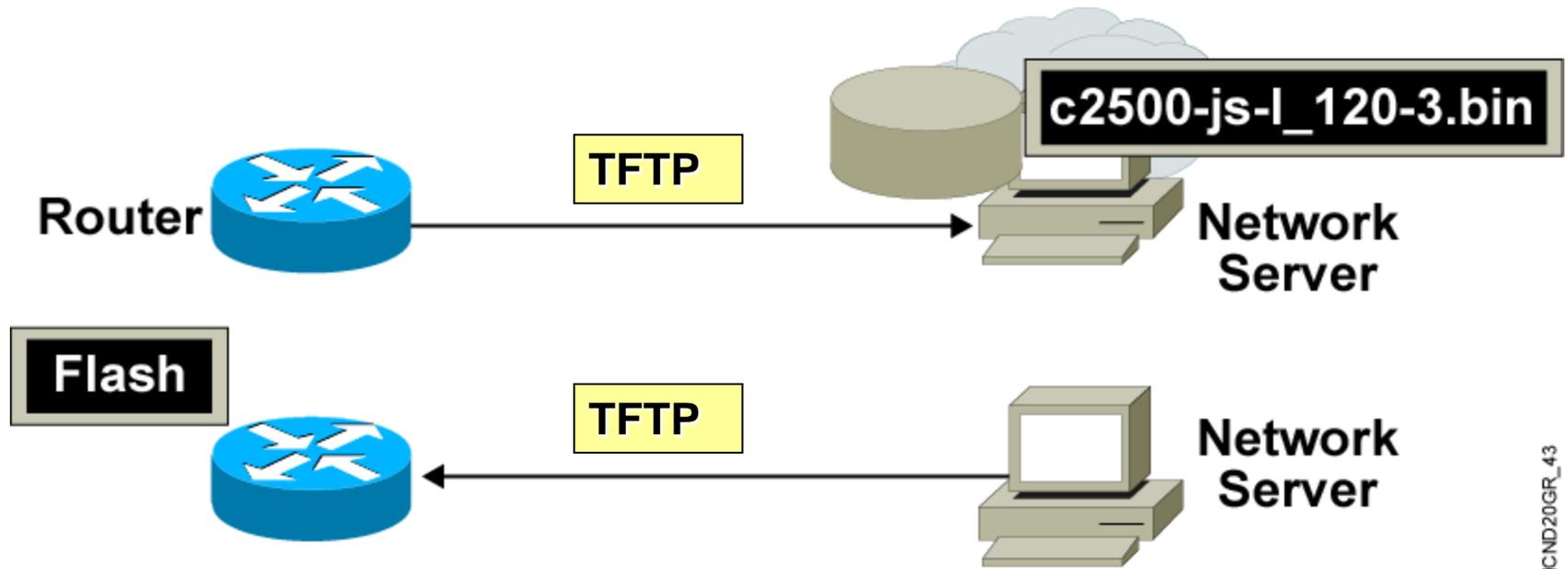
tftp:

Loading the Cisco IOS Software from Flash Memory



- The flash memory file is decompressed into RAM.

Managing Cisco IOS Images



Verifying Memory and Deciphering Image Filenames

```
wg_ro_a#show flash
```

```
System flash directory:
```

File	Length	Name/status
1	10084696	c2500-js-1_120-3.bin

```
[10084760 bytes used, 6692456 available, 16777216 total]  
16384K bytes of processor board System flash (Read ONLY)
```

- **Verify that flash memory has room for the Cisco IOS image.**

Creating a Software Image Backup



```
wg_ro_a#copy flash tftp
Source filename []? c2500-js-1_120-3.bin
Address or name of remote host []? 10.1.1.1
Destination filename [c2500-js-1_120-3.bin]?
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
<output omitted>
10084696 bytes copied in 709.228 secs (14223 bytes/sec)
wg_ro_a#
```

ICND20GR_44

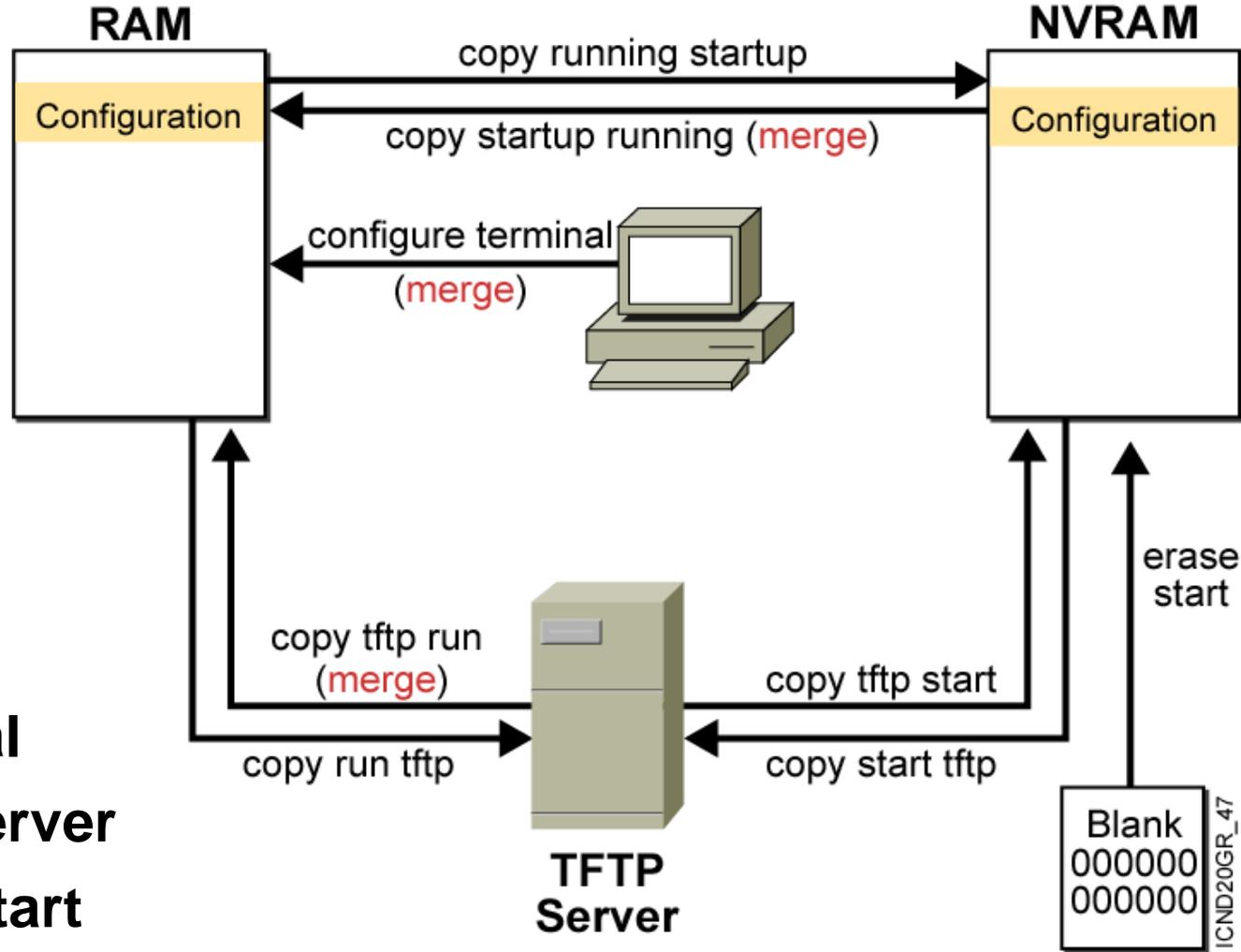
- Back up current files prior to updating flash memory.

Upgrading the Image from the Network



```
wg_ro_a#copy tftp flash
Address or name of remote host [10.1.1.1]?
Source filename []? c2500-js-l_120-3.bin
Destination filename [c2500-js-l_120-3.bin]?
Accessing tftp://10.1.1.1/c2500-js-l_120-3.bin...
Erase flash: before copying? [confirm]
Erasing the flash filesystem will remove all files! Continue? [confirm]
Erasing device... eeeee (output omitted) ...erased
Erase of flash: complete
Loading c2500-js-l_120-3.bin from 10.1.1.1 (via Ethernet0): !!!!!!!!!!!!!!!!!!!!!!!
(output omitted)
[OK - 10084696/20168704 bytes]
Verifying checksum... OK (0x9AA0)
10084696 bytes copied in 309.108 secs (32636 bytes/sec)
wg_ro_a#
```

Cisco IOS copy Command



- NVRAM
- Terminal
- TFTP server
- Erase start

Cisco IOS copy Command Example

running-config

```
interface s0
  ip address 10.1.1.1 255.255.255.0

interface e0
  ip address 10.2.2.2 255.255.255.0

interface e1
  no ip address
```

TFTP Server saved.cfg

```
interface e0
  ip address 172.16.1.1 255.255.255.0

interface e1
  ip address 192.168.1.1 255.255.255.0
```

copy tftp run (merged)

Resulting running-config

```
interface s0
  ip address 10.1.1.1 255.255.255.0

interface e0
  ip address 172.16.1.1 255.255.255.0

interface e1
  ip address 192.168.1.1 255.255.255.0
```

copy run tftp and copy tftp run Commands

```
wg_ro_a#copy running-config tftp
Address or name of remote host []? 10.1.1.1
Destination filename [running-config]? wgroa.cfg
.!!
1684 bytes copied in 13.300 secs (129 bytes/sec)

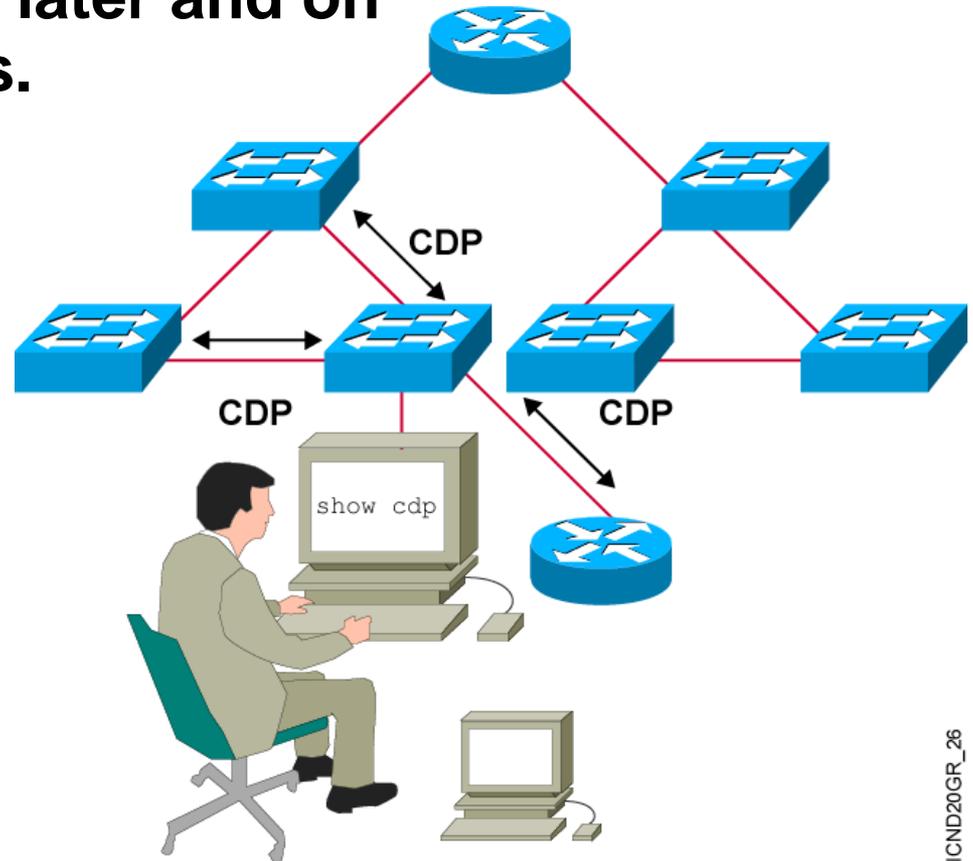
wg_ro_a#copy tftp running-config
Address or name of remote host []? 10.1.1.1
Source filename []? wgroa.cfg
Destination filename [running-config]?
Accessing tftp://10.1.1.1/wgroa.cfg...
Loading wgroa.cfg from 10.1.1.1 (via Ethernet0): !
[OK - 1684/3072 bytes]

1684 bytes copied in 17.692 secs (99 bytes/sec)
```

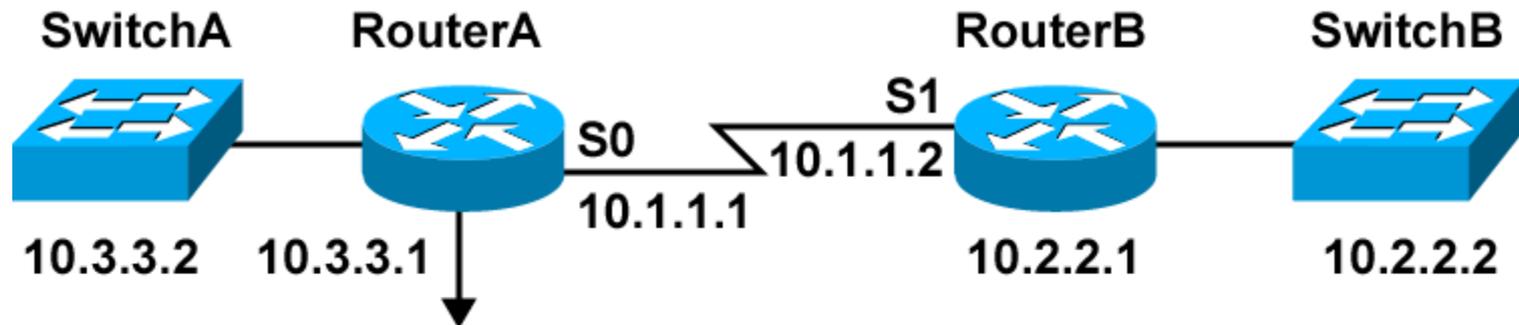
Cisco CDP Protocol

Discovering Neighbors with CDP

- CDP runs on routers with Cisco IOS® software Release 10.3 or later and on Cisco switches and hubs.
- Summary information includes:
 - Device identifiers
 - Address list
 - Port identifier
 - Capabilities list
 - Platform

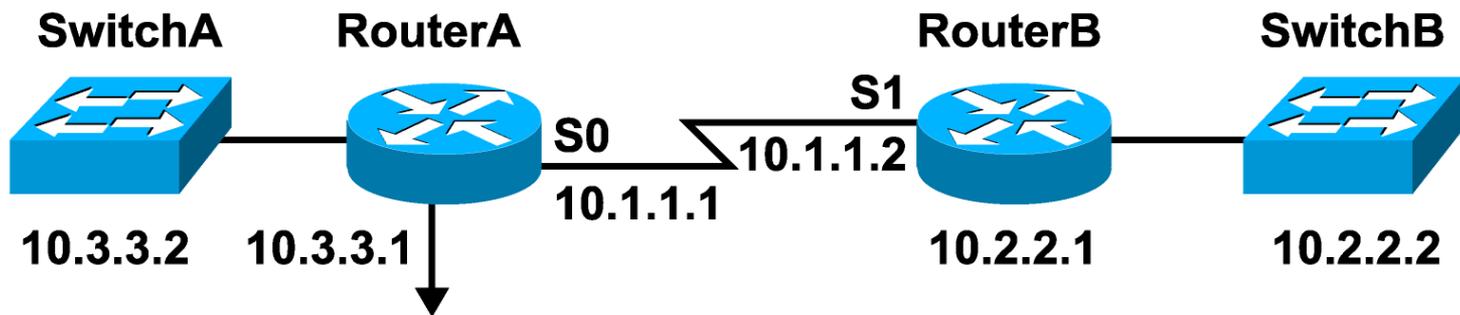


Using CDP



```
RouterA#show cdp ?
  entry      Information for specific neighbor entry
  interface  CDP interface status and configuration
  neighbors  CDP neighbors entries
  traffic    CDP statistics
  <cr>
RouterA(config-if)#exit
RouterA(config)#no cdp run
RouterA(config)#interface serial0
RouterA(config-if)#no cdp enable
```

Using the show cdp neighbors Command

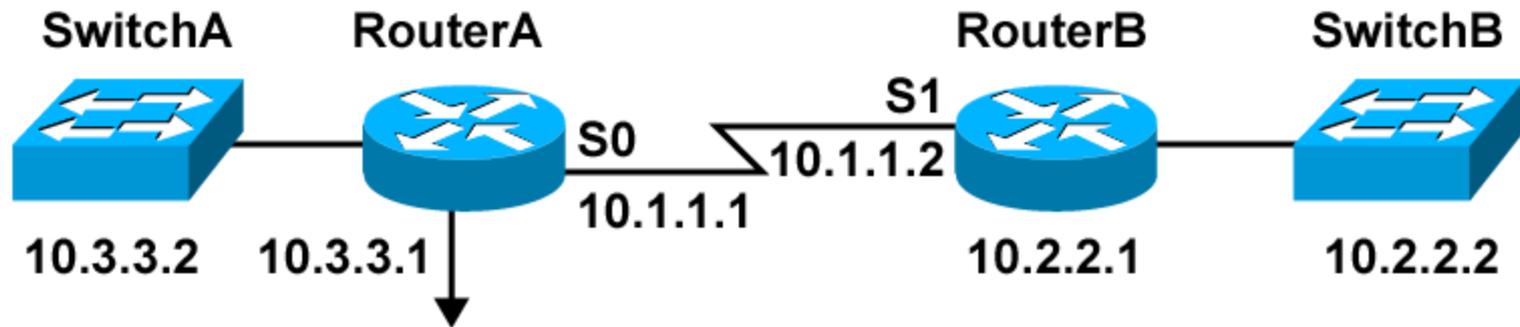


```
RouterA#show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID           Local Intrfce   Holdtme    Capability   Platform   Port ID
RouterB              Ser 0          148        R            2522       Ser 1
SwitchA0050BD855780 Eth 0          167        T S          1900       2
```

↑ SwitchA also provides its MAC address (Catalyst 1900 only).

Using the show cdp entry Command



```
RouterA#show cdp entry *
-----
Device ID: RouterB
Entry address(es):
  IP address: 10.1.1.2
Platform: cisco 2522, Capabilities: Router
Interface: Serial0, Port ID (outgoing port): Serial1
Holdtime : 168 sec

Version :
Cisco Internetwork Operating System Software
IOS (tm) 2500 Software (C2500-JS-L), Version 12.0(3), RELEASE SOFTWARE (fci)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Mon 08-Feb-99 18:18 by phanguye
```



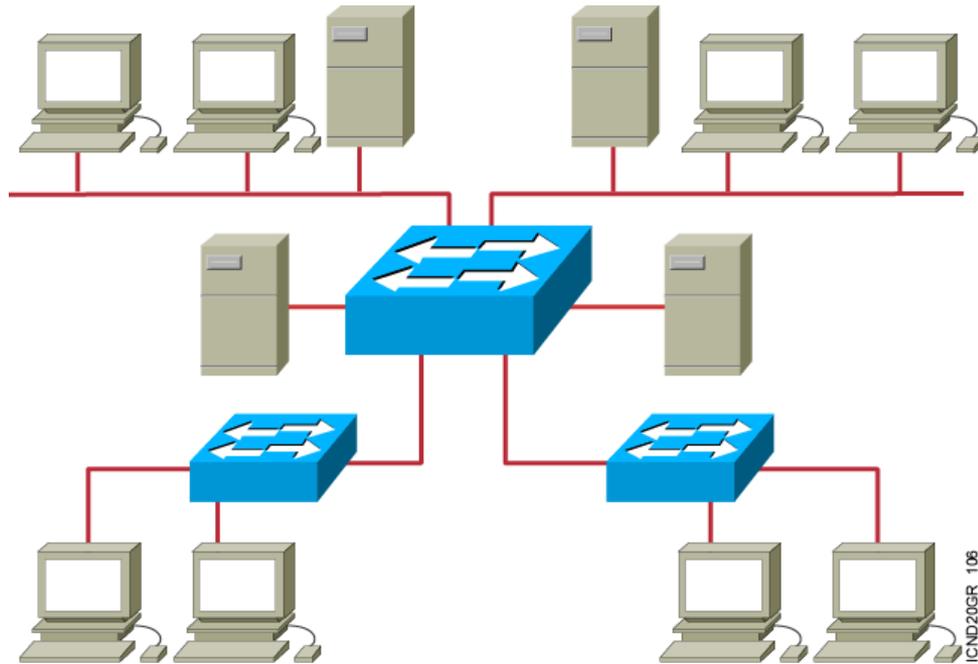
Basic Layer 2 Switching and Bridging Functions

Objectives

Upon completing this module, you will be able to:

- **Explain how bridging and switching operates**
- **Explain the purpose and operations of the Spanning-Tree Protocol**
- **Verify the default configuration of the device, given a functioning access layer switch**
- **Build a functional access switch configuration to support the specified network operational parameters, given a network design**
- **Execute an add, move, or change on an access layer switch, given a new network requirement**

Ethernet Switches and Bridges

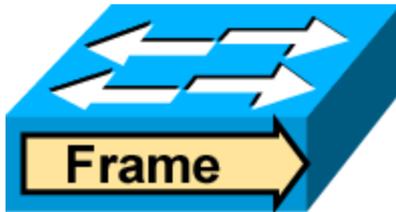


- **MAC Address learning**
- **Forward/filter decision**
- **Loop avoidance**

Transmitting Frames

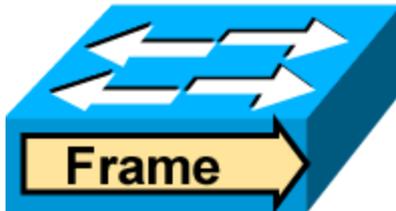
Cut-Through

- Switch checks destination address and immediately begins forwarding frame.



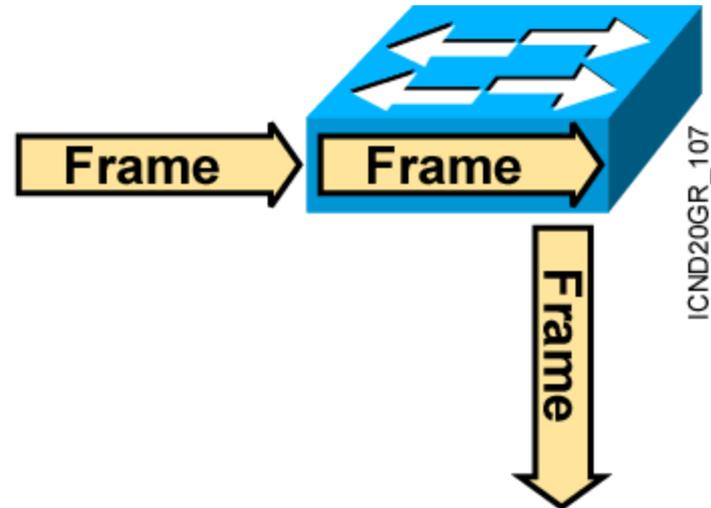
Fragment-Free

- Switch checks the first 64 bytes, then immediately begins forwarding frame.

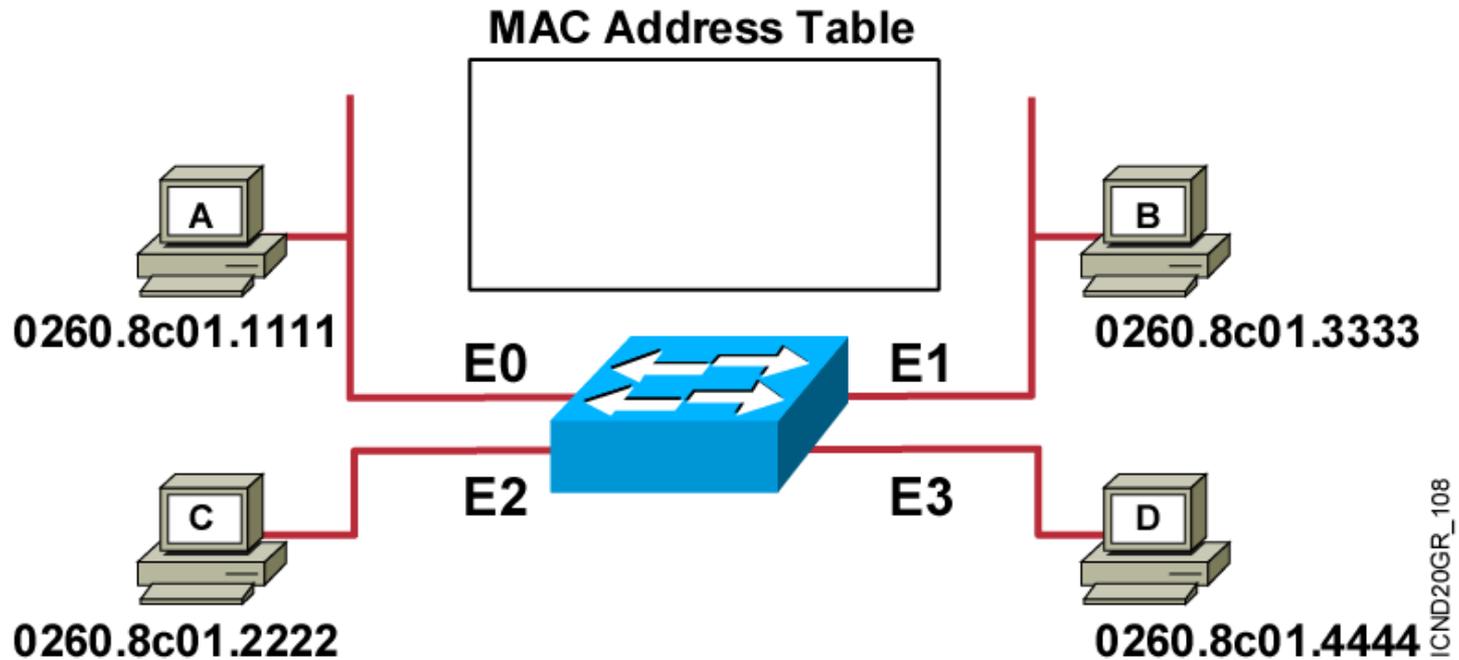


Store and Forward

- Complete frame is received and checked before forwarding.

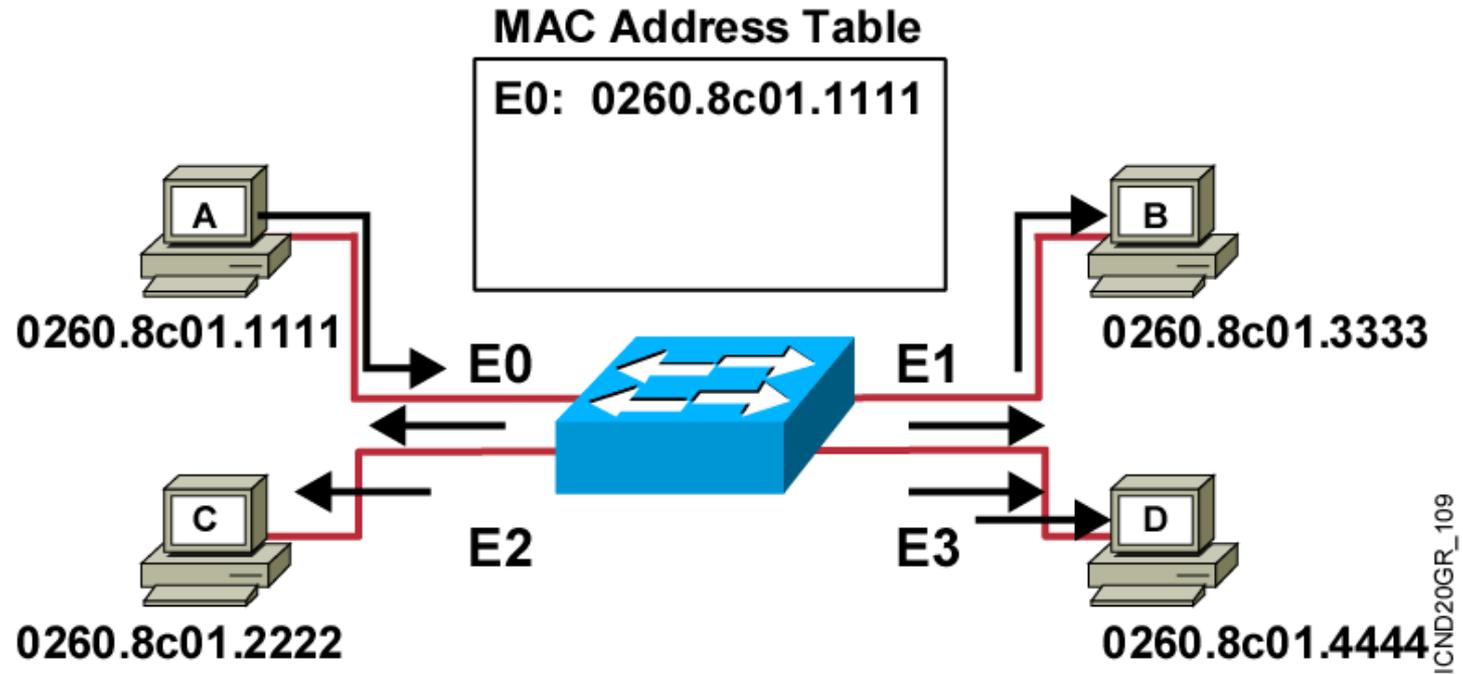


MAC Address Table



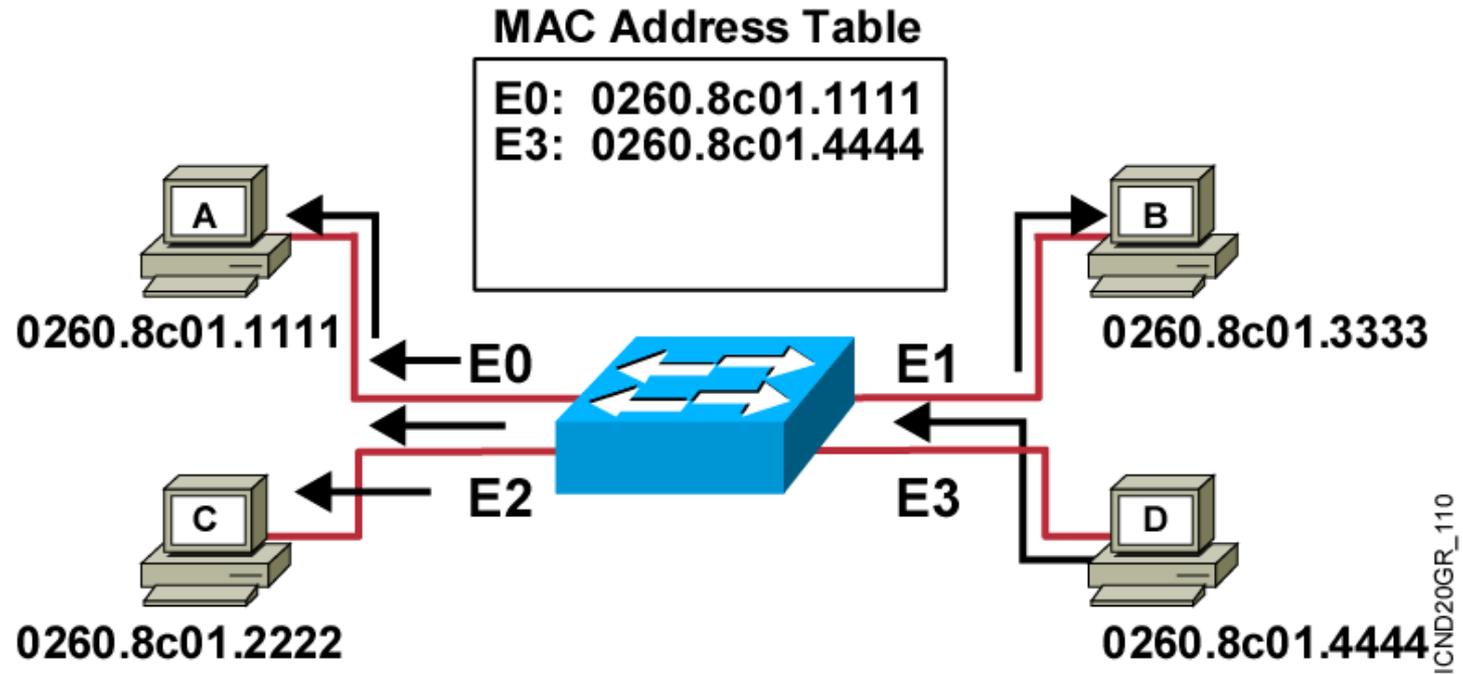
- Initial MAC address table is empty.

Learning Addresses



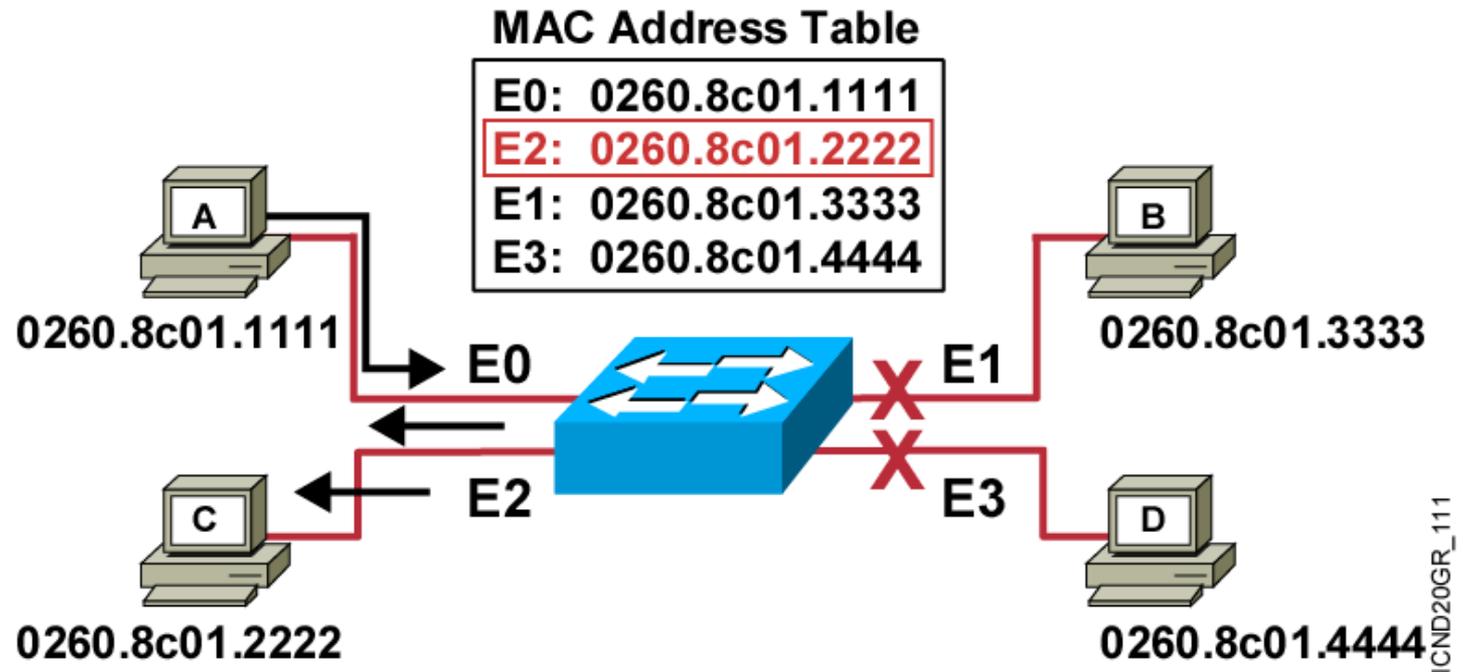
- Station A sends a frame to station C.
- Switch caches the MAC address of station A to port E0 by learning the source address of data frames.
- The frame from station A to station C is flooded out to all ports except port E0 (unknown unicasts are flooded).

Learning Addresses (Cont.)



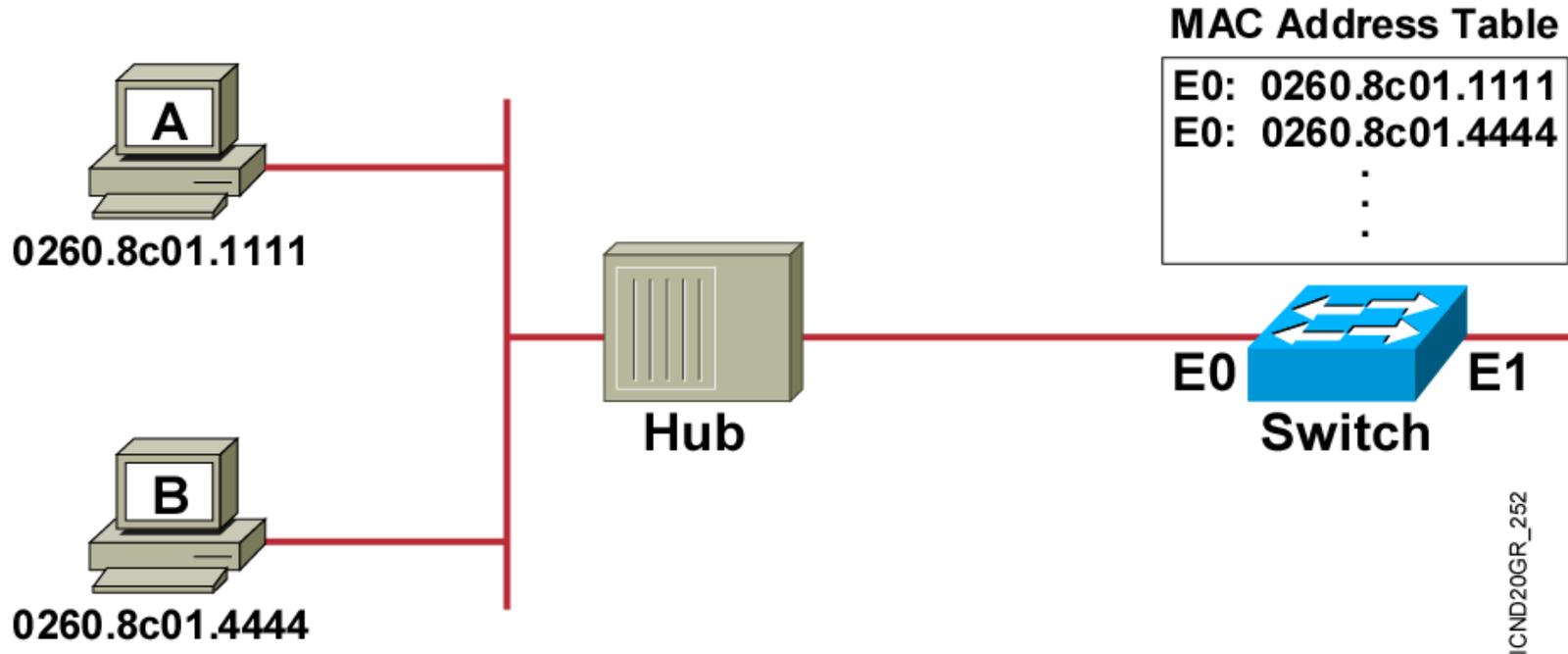
- Station D sends a frame to station C.
- Switch caches the MAC address of station D to port E3 by learning the source address of data frames.
- The frame from station D to station C is flooded out to all ports except port E3 (unknown unicasts are flooded).

Filtering Frames



- Station A sends a frame to station C.
- Destination is known; frame is not flooded.

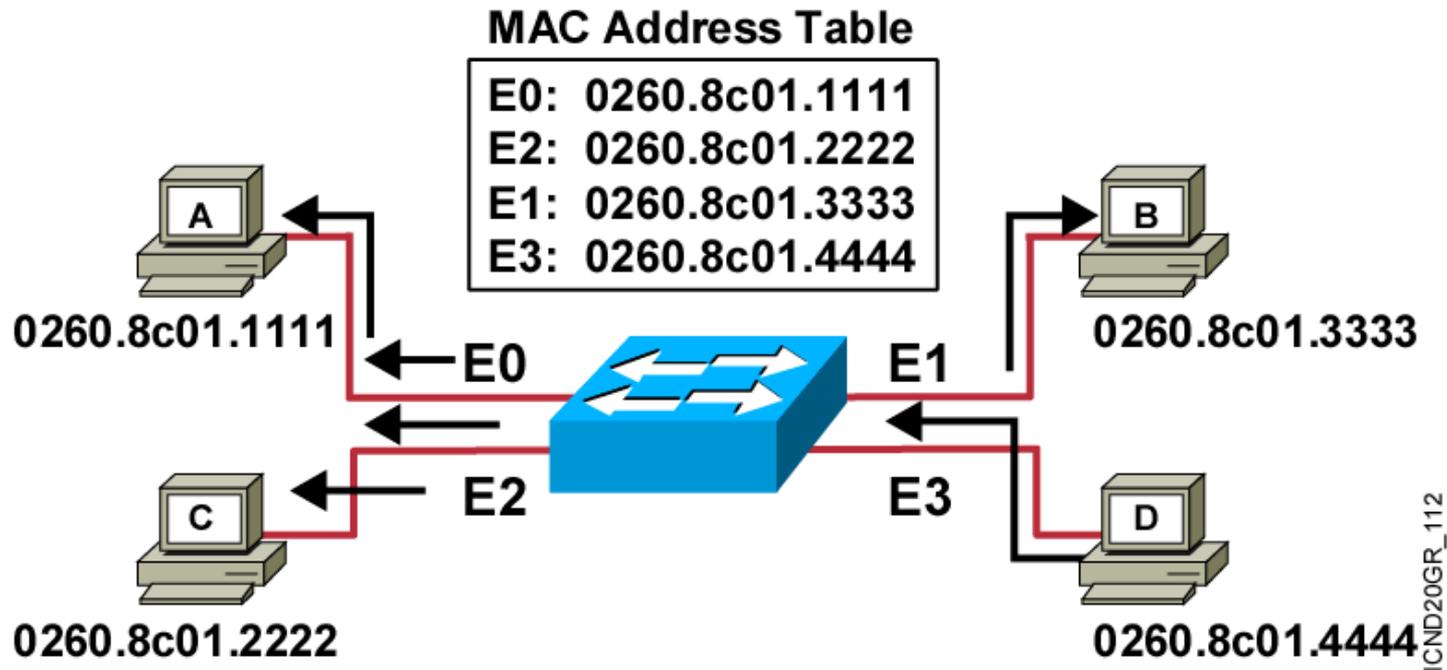
Filtering Frames (Cont.)



ICND20GR_252

- Station A sends a frame to station B.
- The switch has the address for station B in the MAC address table.

Broadcast and Multicast Frames



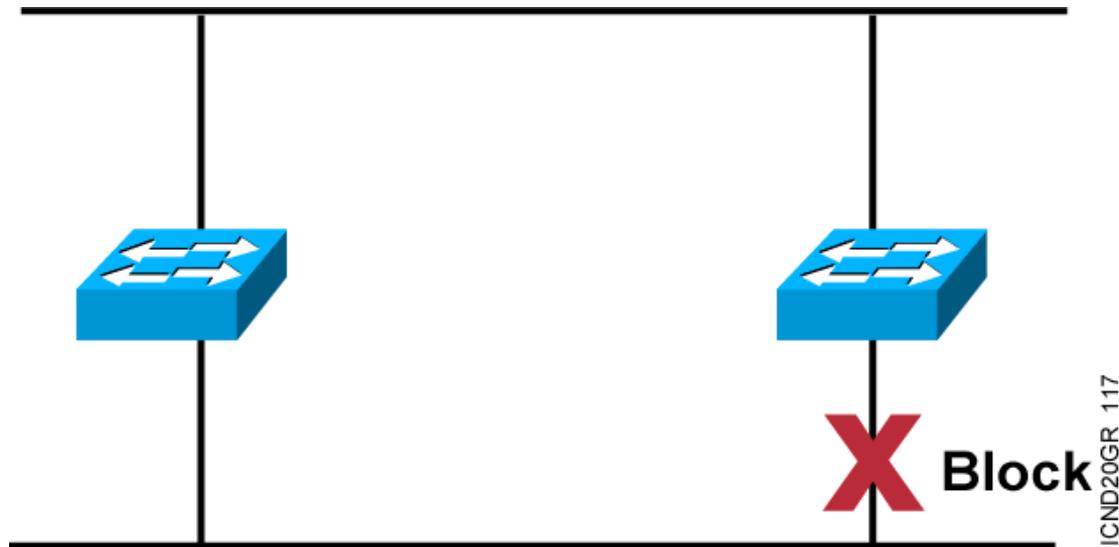
- Station D sends a broadcast or multicast frame.
- Broadcast and multicast frames are flooded to all ports other than the originating port.

Summary

- **Ethernet switches and bridges increase the available bandwidth of a network by creating dedicated network segments and interconnecting the segments.**
- **Switches and bridges use one of three operating modes to transmit frames: store and forward, cut-through, and fragment-free.**
- **Switches and bridges maintain a MAC address table to store address-to-port mappings so it can determine the locations of connected devices.**
- **When a frame arrives with a known destination address, it is forwarded only on the specific port connected to the destination station.**

Spanning Tree Protocol Overview

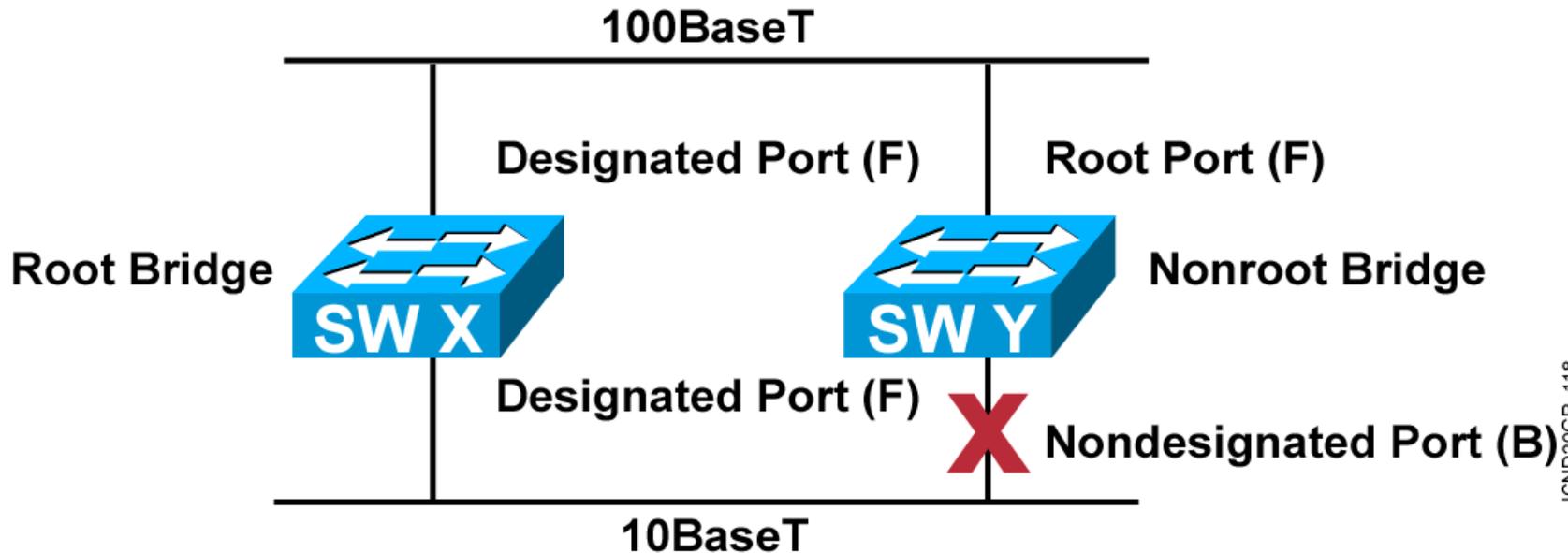
Spanning Tree Protocol



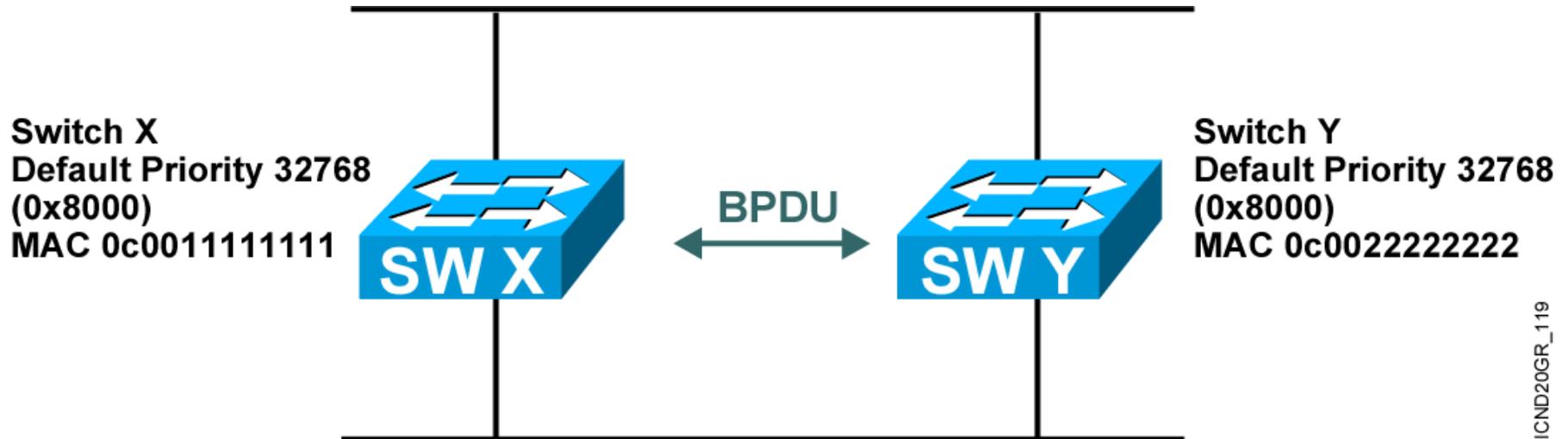
- Provides a loop-free redundant network topology by placing certain ports in the blocking state.

Spanning-Tree Operation

- One root bridge per network
- One root port per nonroot bridge
- One designated port per segment
- Nondesignated ports are unused



Spanning Tree Protocol Root Bridge Selection



- Bpdu = Bridge Protocol Data Unit
(default = sent every two seconds)
- Root bridge = Bridge with the lowest bridge ID

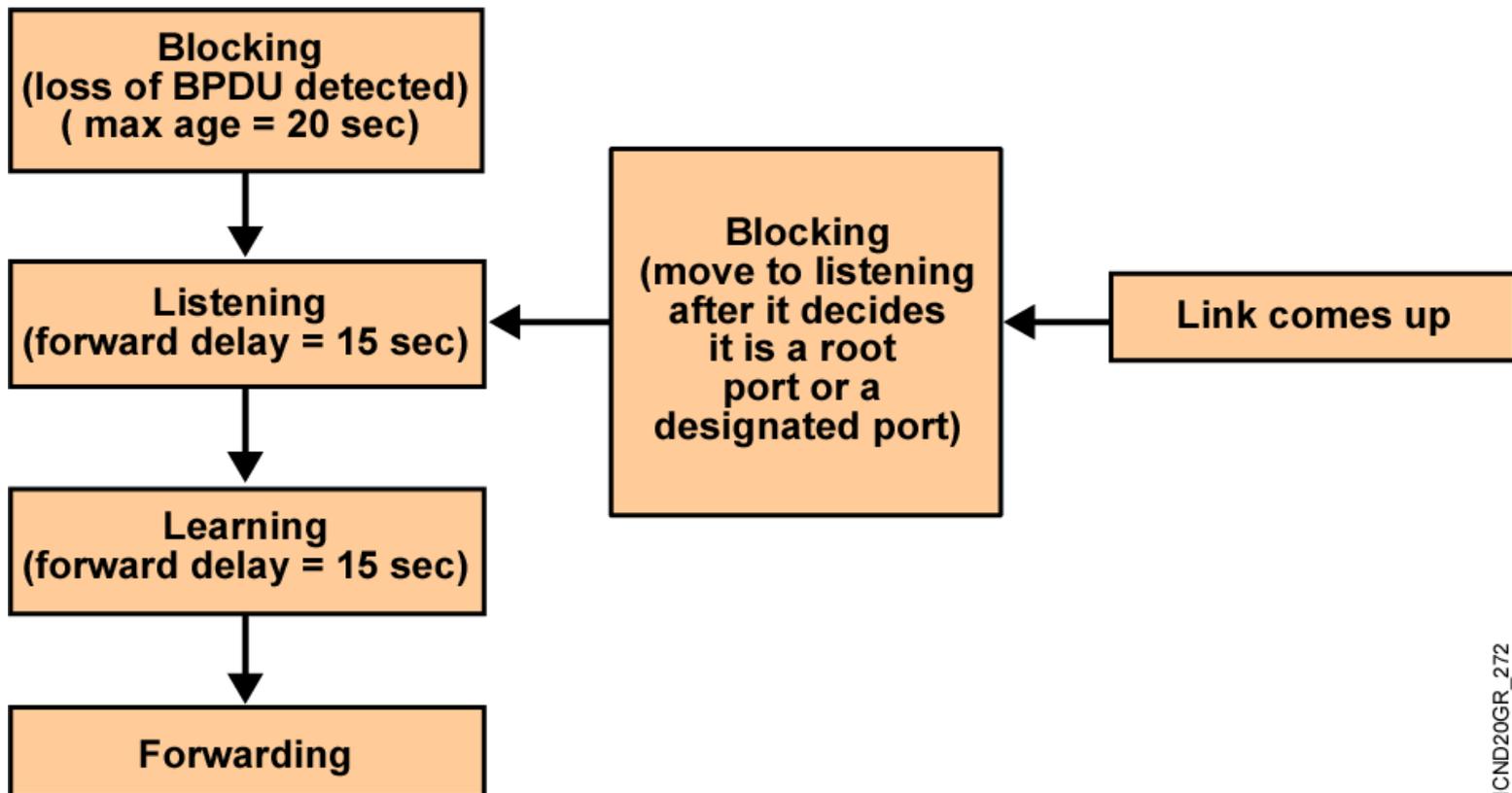
- Bridge ID =

Bridge Priority	MAC Address
--------------------	----------------

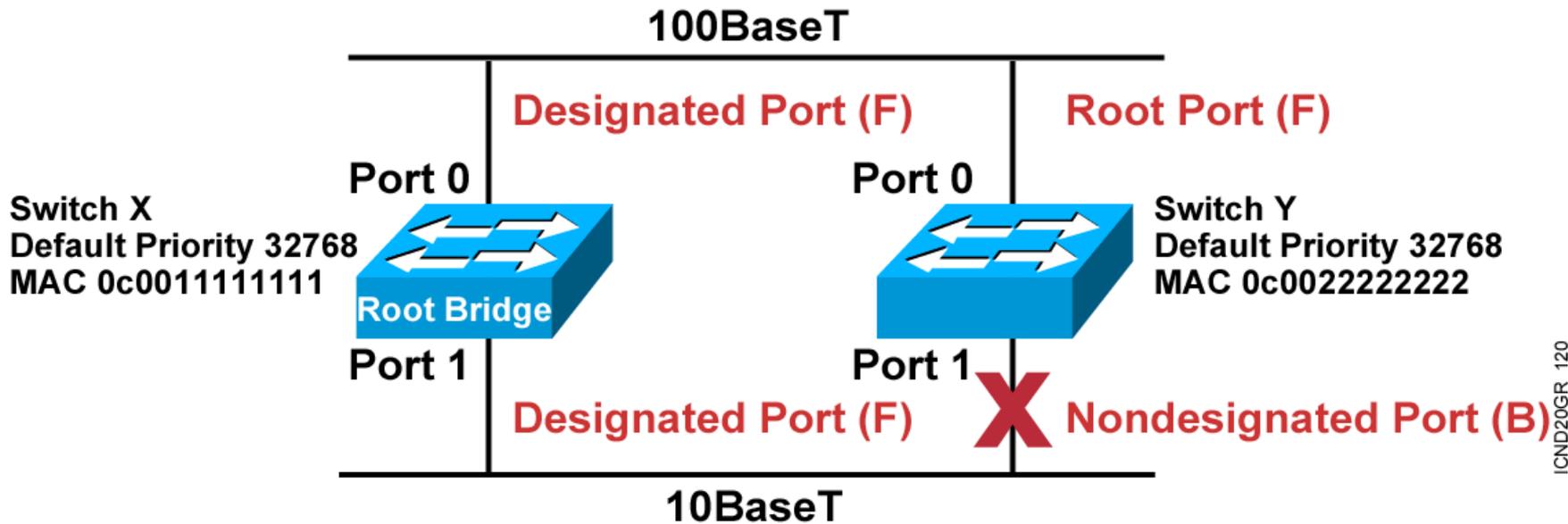
- In this example, which switch has the lowest bridge ID?

Spanning-Tree Port States

- Spanning tree transits each port through several different states:



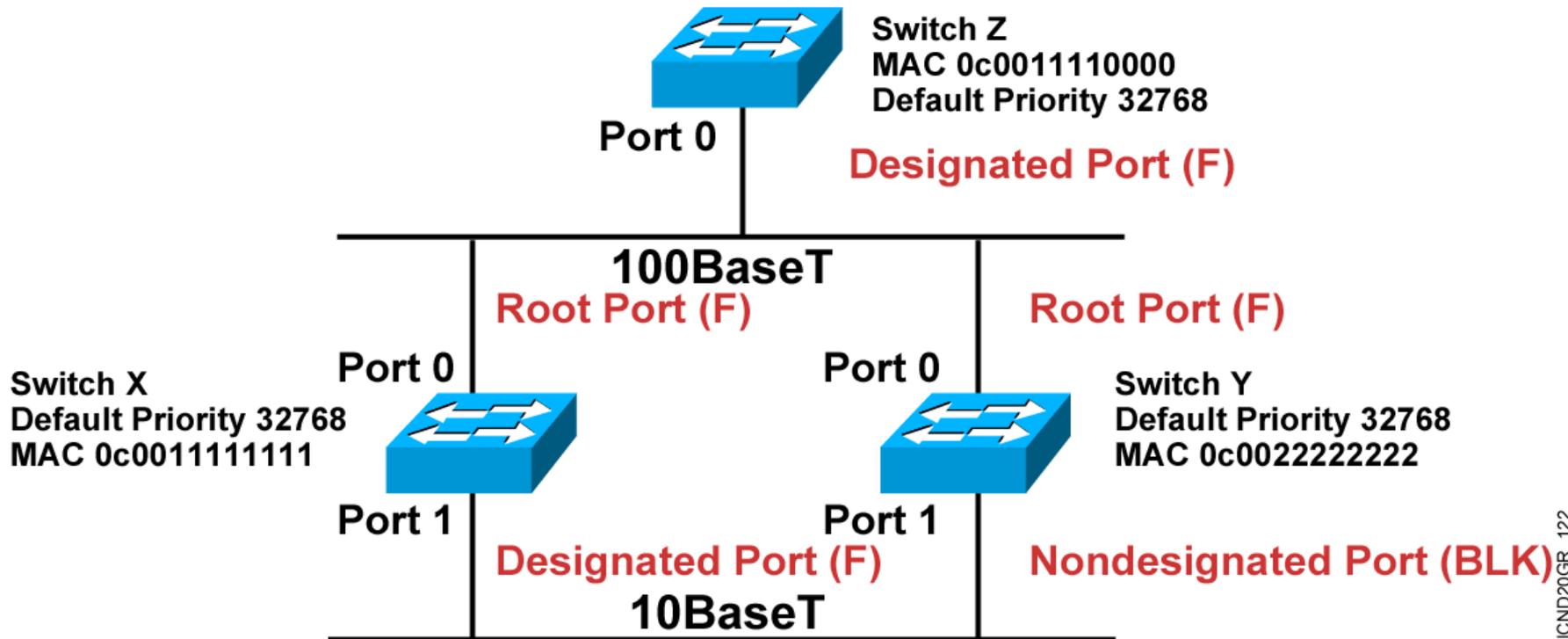
Spanning-Tree Port States (Cont.)



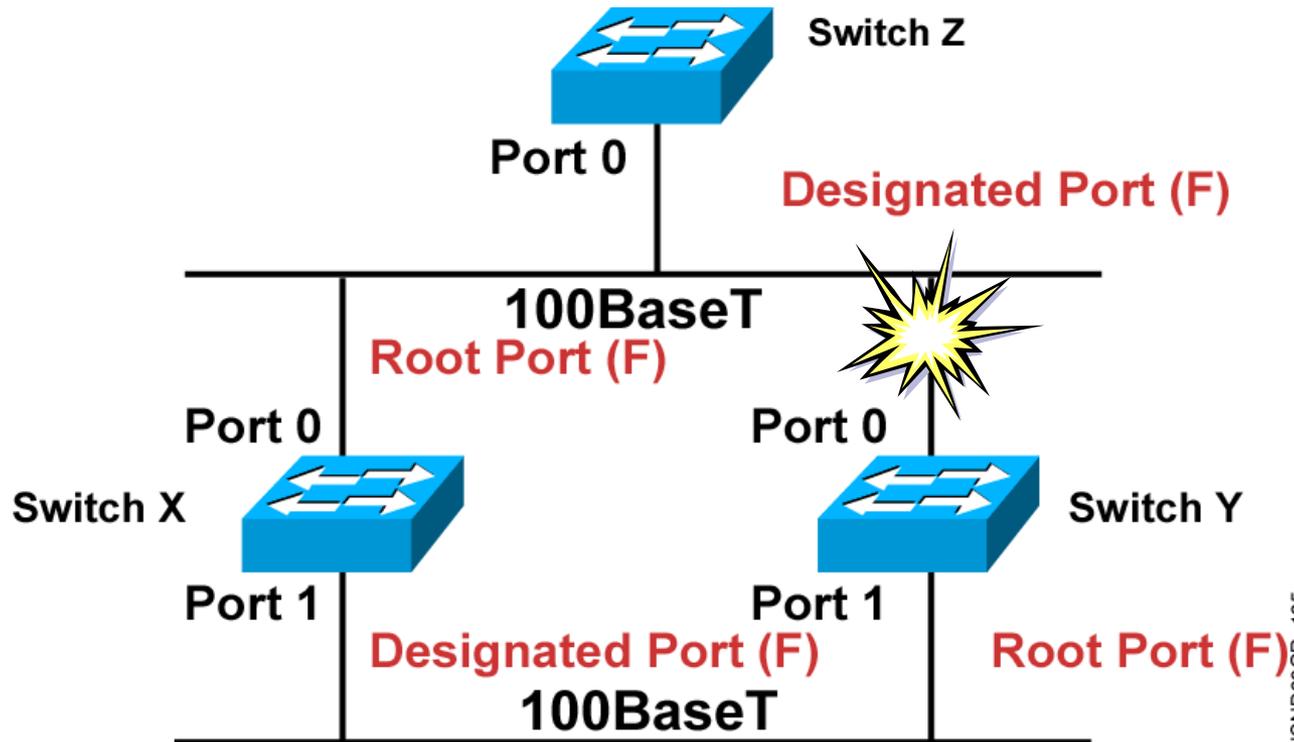
Spanning-Tree Path Cost

Link Speed	Cost (Revised IEEE Spec)	Cost (Previous IEEE Spec)
10 Gbps	2	1
1 Gbps	4	1
100 Mbps	19	10
10 Mbps	100	100

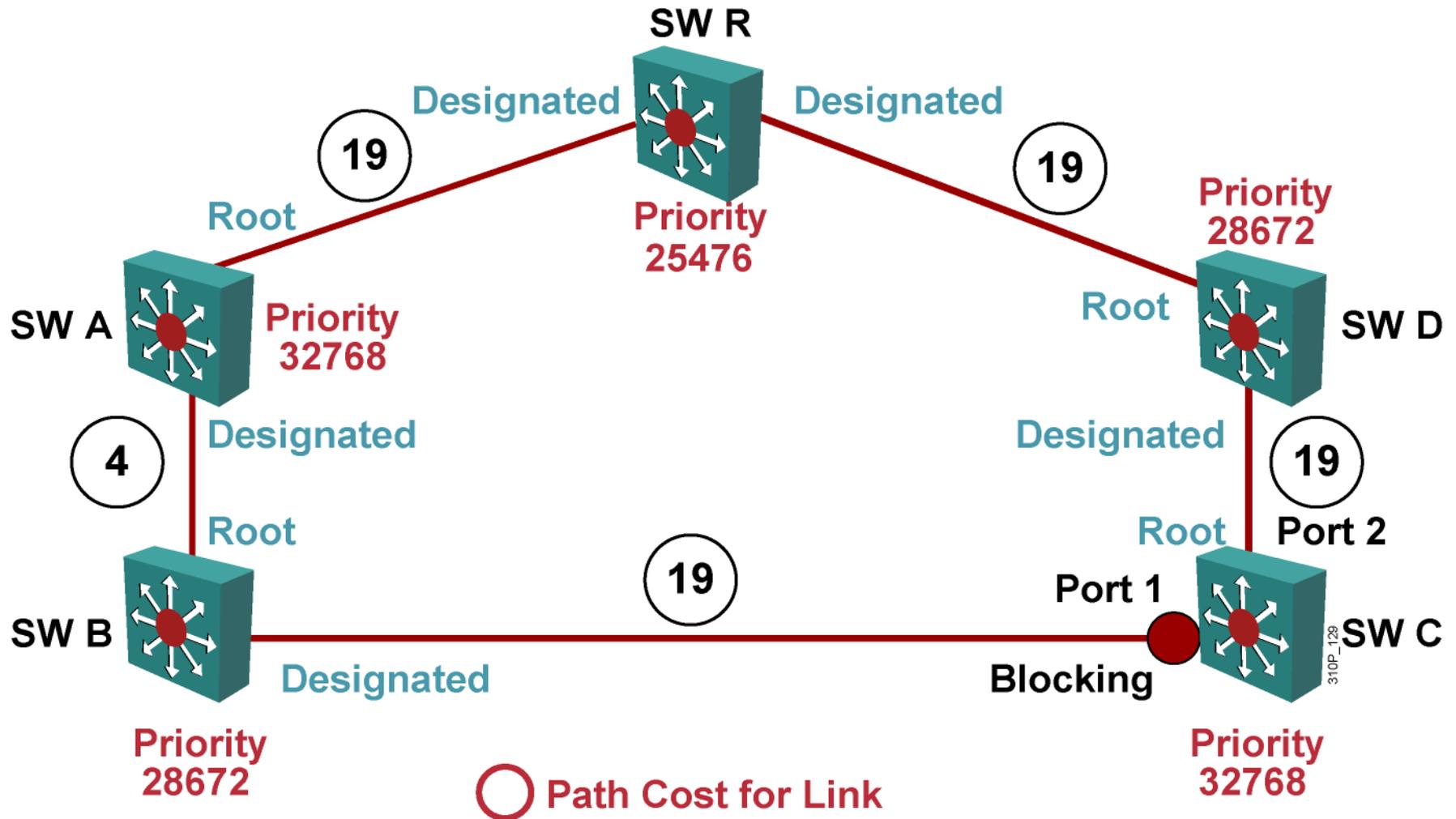
Spanning-Tree Example



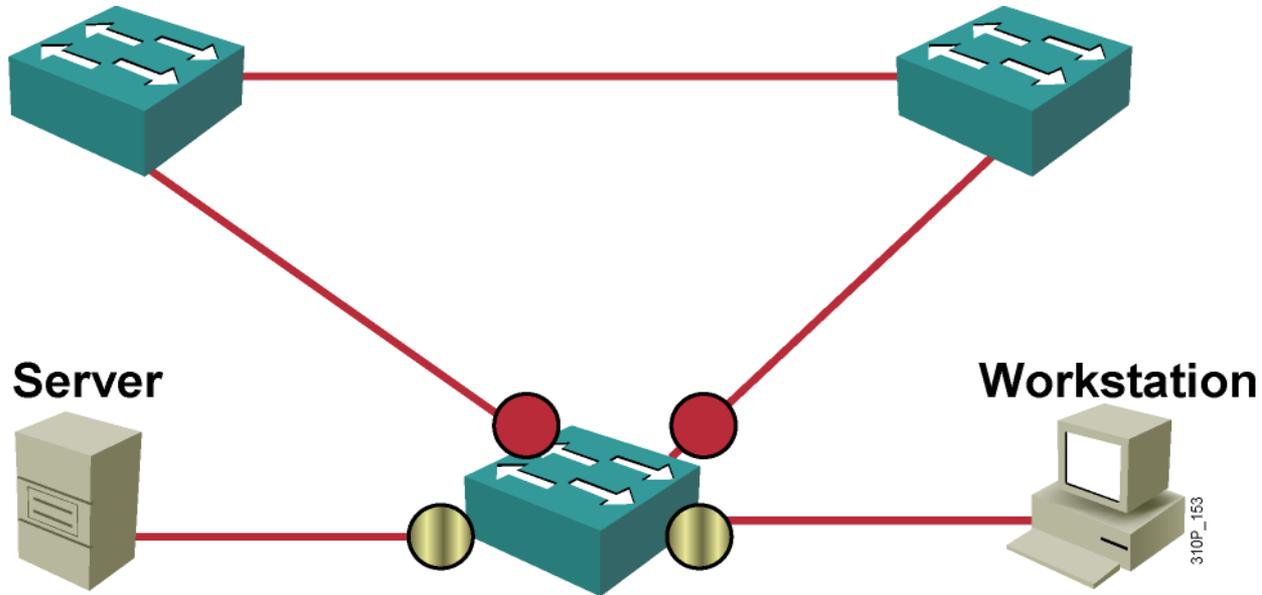
Spanning-Tree Recalculation



Example: Layer 2 Topology Negotiation



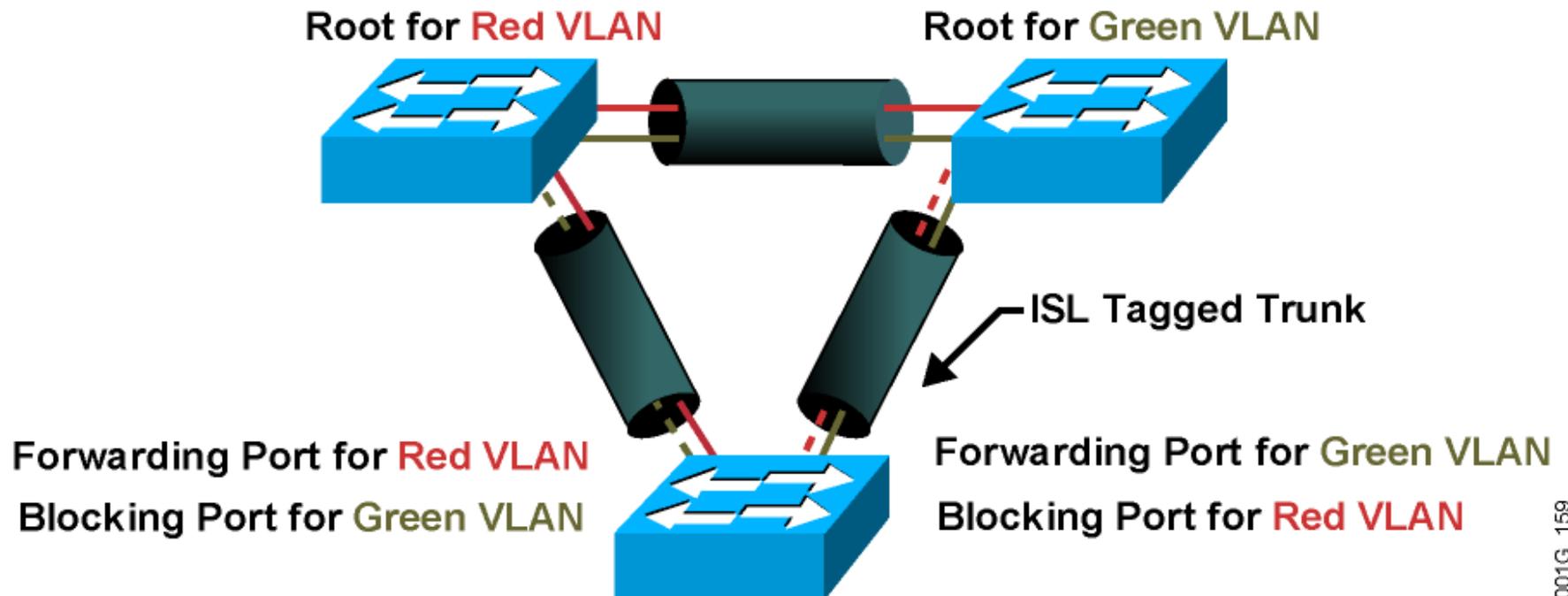
Describing PortFast



On these access switch ports:

-  Configure PortFast.
-  Do not configure PortFast.

Per VLAN Spanning Tree



Verifying spanning-tree of 2960

C2960-F121#sh spanning-tree

VLAN0001

Spanning tree enabled protocol ieee

Root ID Priority 4097

Address 0016.4684.cf80

Cost 3004

Port 1 (GigabitEthernet0/1)

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 49153 (priority 49152 sys-id-ext 1)

Address 0017.0e90.2380

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Aging Time 300

Uplinkfast enabled

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----------	------	-----	------	----------	------

Gi0/1	Root	FWD	3004	128.1	P2p
-------	------	-----	------	-------	-----

Gi0/2	Altn	BLK	3004	128.2	P2p
-------	------	-----	------	-------	-----

Configuring the Root Bridge

```
Switch(config)#spanning-tree vlan 1 root primary
```

- This command forces this switch to be the root.

```
Switch(config)#spanning-tree vlan 1 root secondary
```

- This command configures this switch to be the secondary root.

Or

```
Switch(config)#spanning-tree vlan 1 priority priority
```

- This command statically configures the priority (in increments of 4096).

Configuring PortFast

Configuring

- spanning-tree portfast (**interface command**)
- or
- spanning-tree portfast default (**global command**)
 - **enables PortFast on all nontrunking ports**

Verifying

- show running-config interface fastethernet 1/1

Summary

- **STP is a bridge-to-bridge protocol used to maintain a loop-free network.**
- **STP establishes a root bridge, a root port, and designated ports.**
- **With STP, the root bridge has the lowest BID, which is made up of the bridge priority and MAC address.**
- **With STP, ports transition through four states: blocking, listening, learning, and forwarding.**
- **If a change occurs to the network topology, STP maintains connectivity by transitioning some blocked ports to the forwarding state.**
- **RSTP significantly speeds the recalculation of the spanning tree (within 5s) when the network topology changes.**



Extending Switched Networks with VLANs

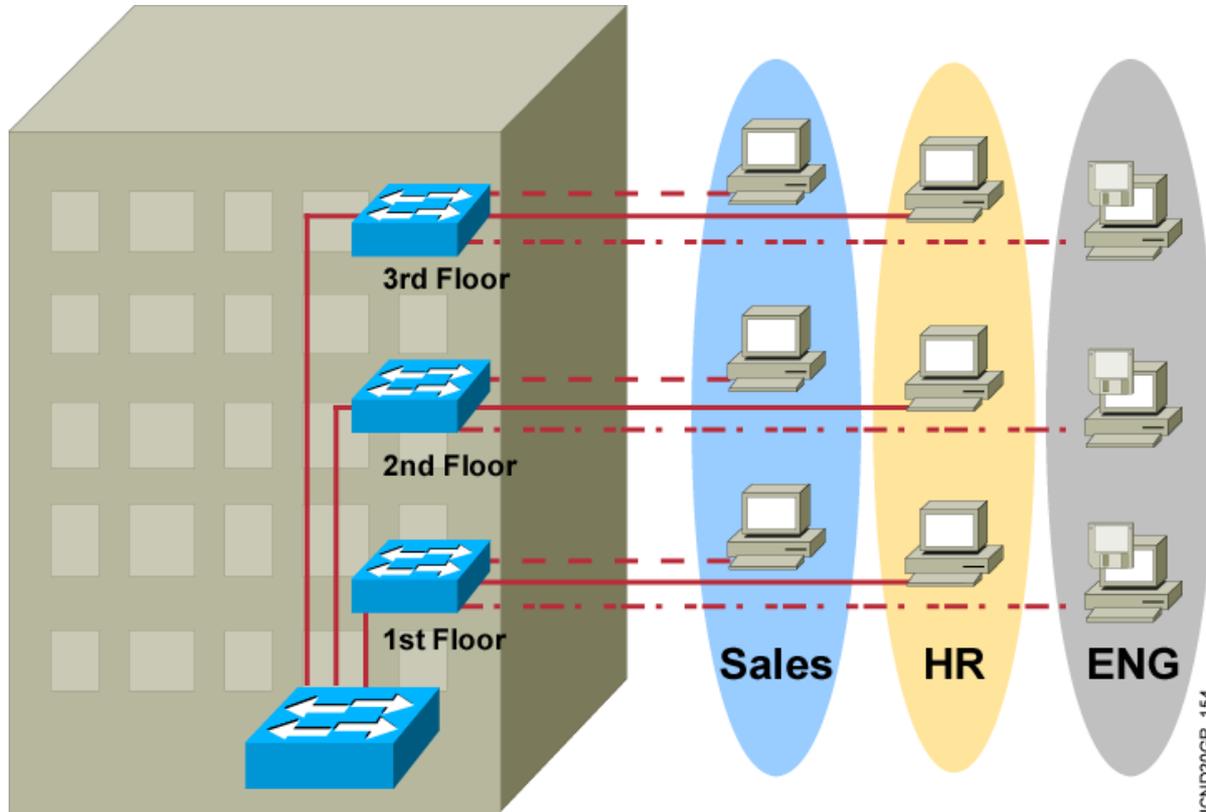
Objectives

Upon completing this module, you will be able to:

- **Use Cisco IOS commands to configure VLANs, VTP, IEEE 802.1Q trunking, and ISL trunking, given a functioning access layer switch**
- **Execute an add, move, or change on an access layer switch, given a new network requirement**
- **Use show commands to identify anomalies in VLAN, VTP, ISL trunking, and spanning-tree operations, given an operational access layer switch**
- **Use debug commands to identify events and anomalies in VLAN, VTP, ISL trunking, and spanning-tree operations, given an operational access layer switch**

VLAN Operation Overview

VLAN Overview

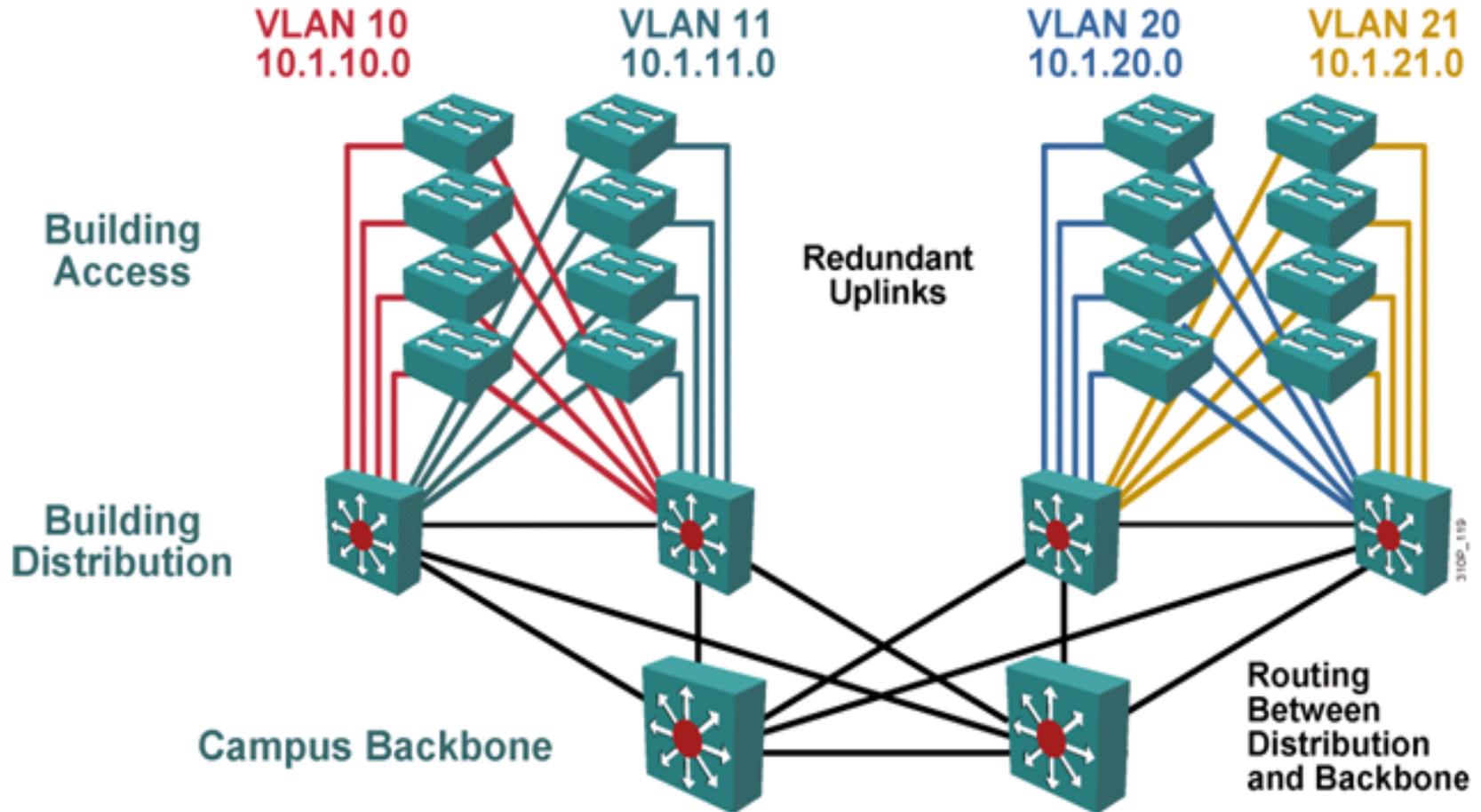


- **Segmentation**
- **Flexibility**
- **Security**

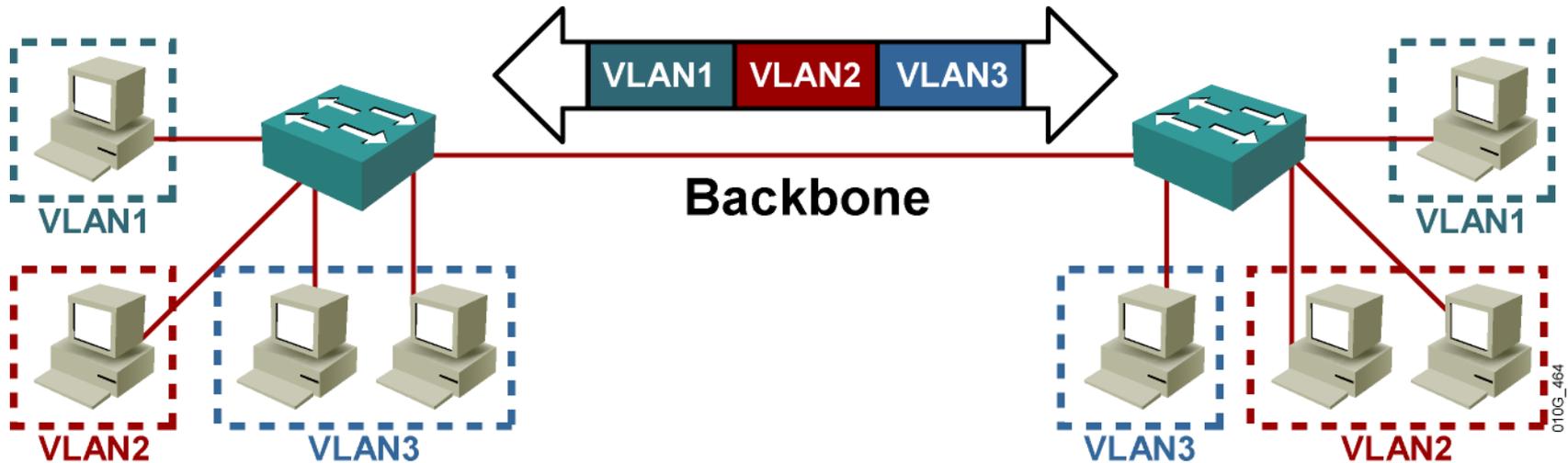
ICND20GR_154

A VLAN = A Broadcast Domain = Logical Network (Subnet)

VLAN and the Logical Network

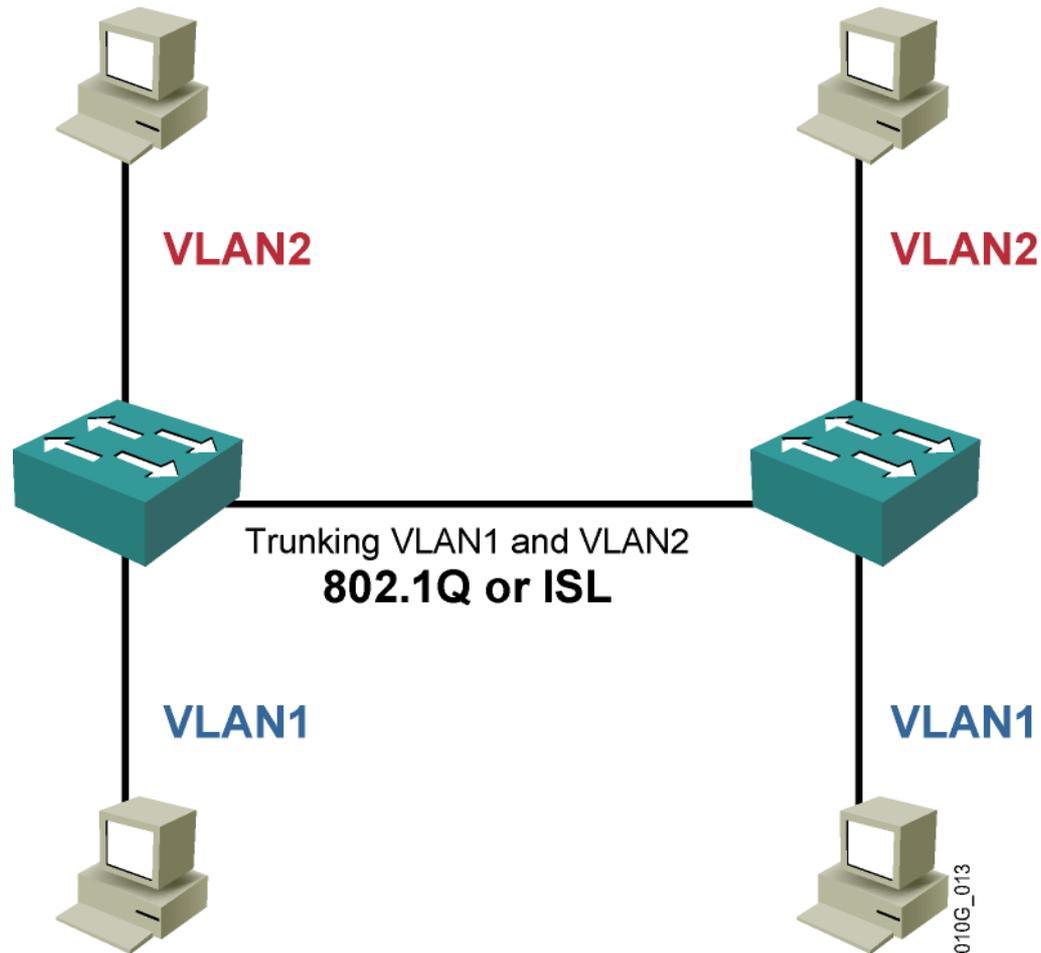


Maintaining Specific VLAN Identification

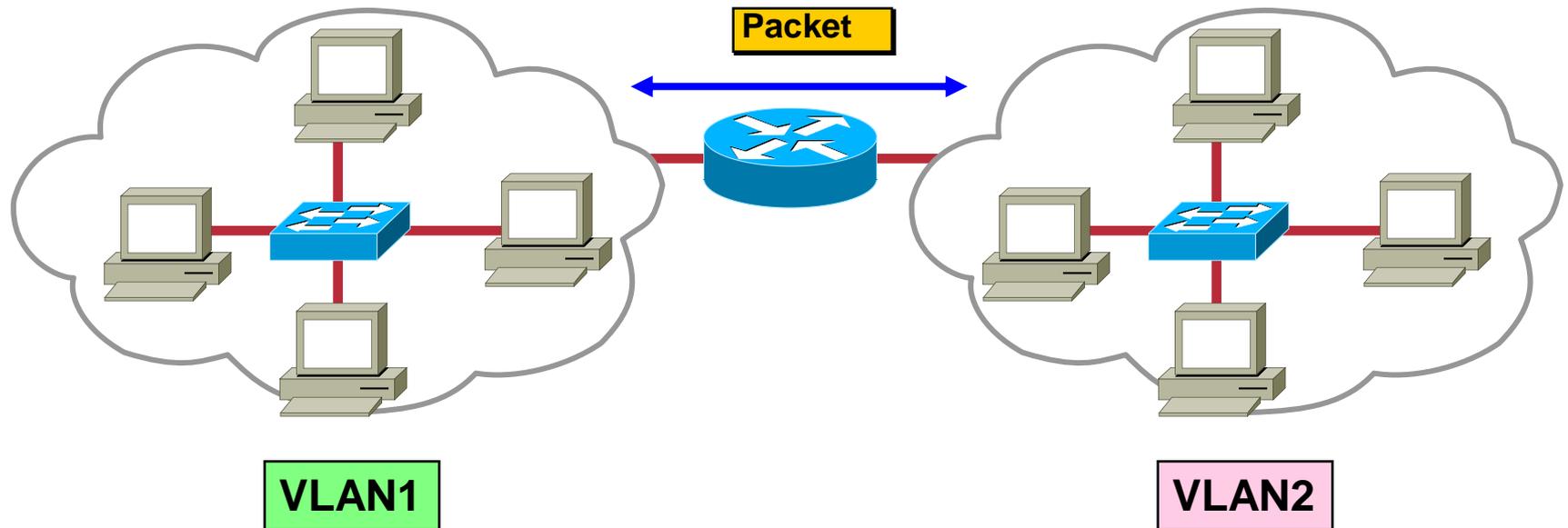


- Specifically developed for multi-VLAN interswitch communications
- Places a unique identifier in each frame
- Functions at Layer 2

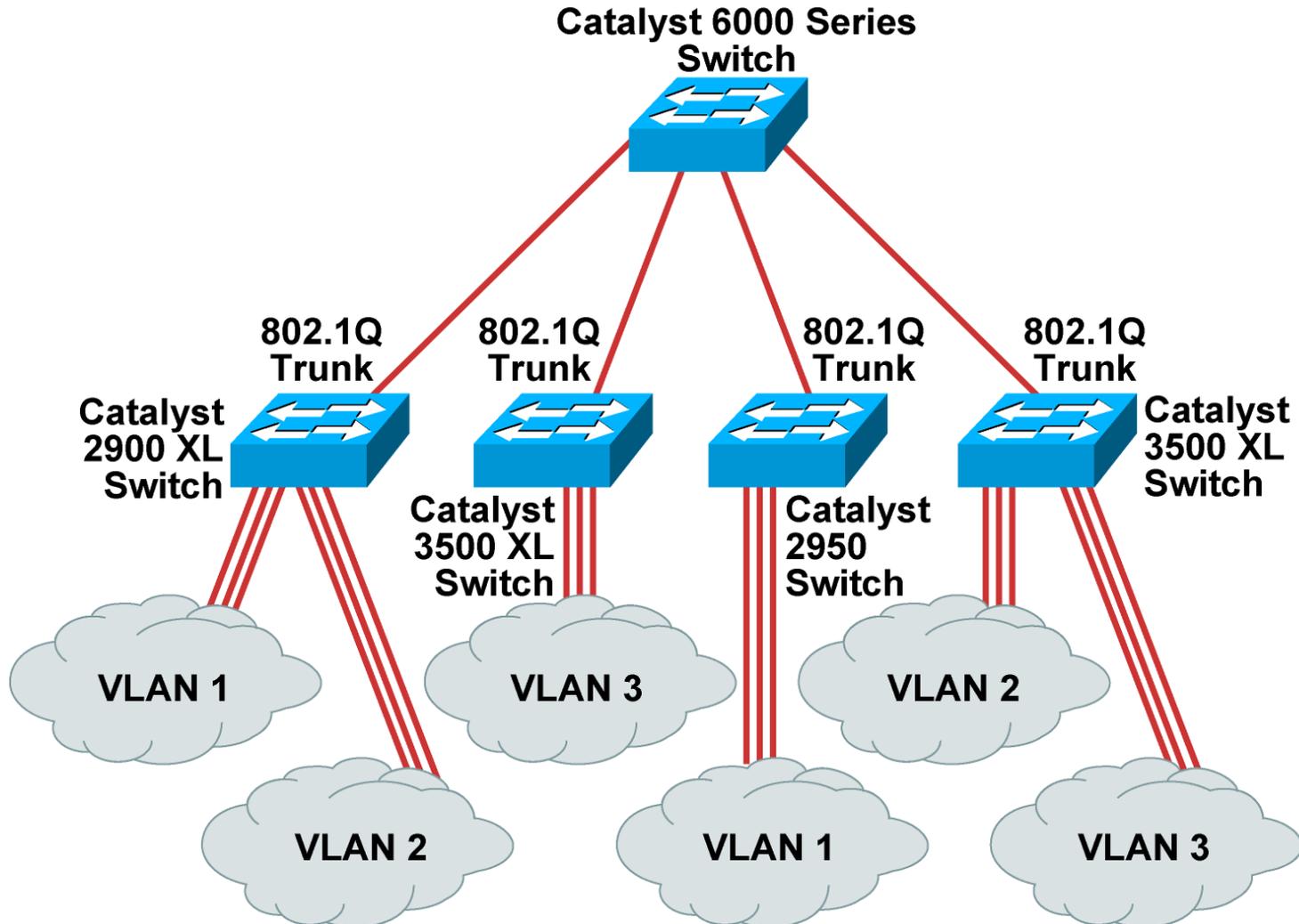
VLAN Trunking



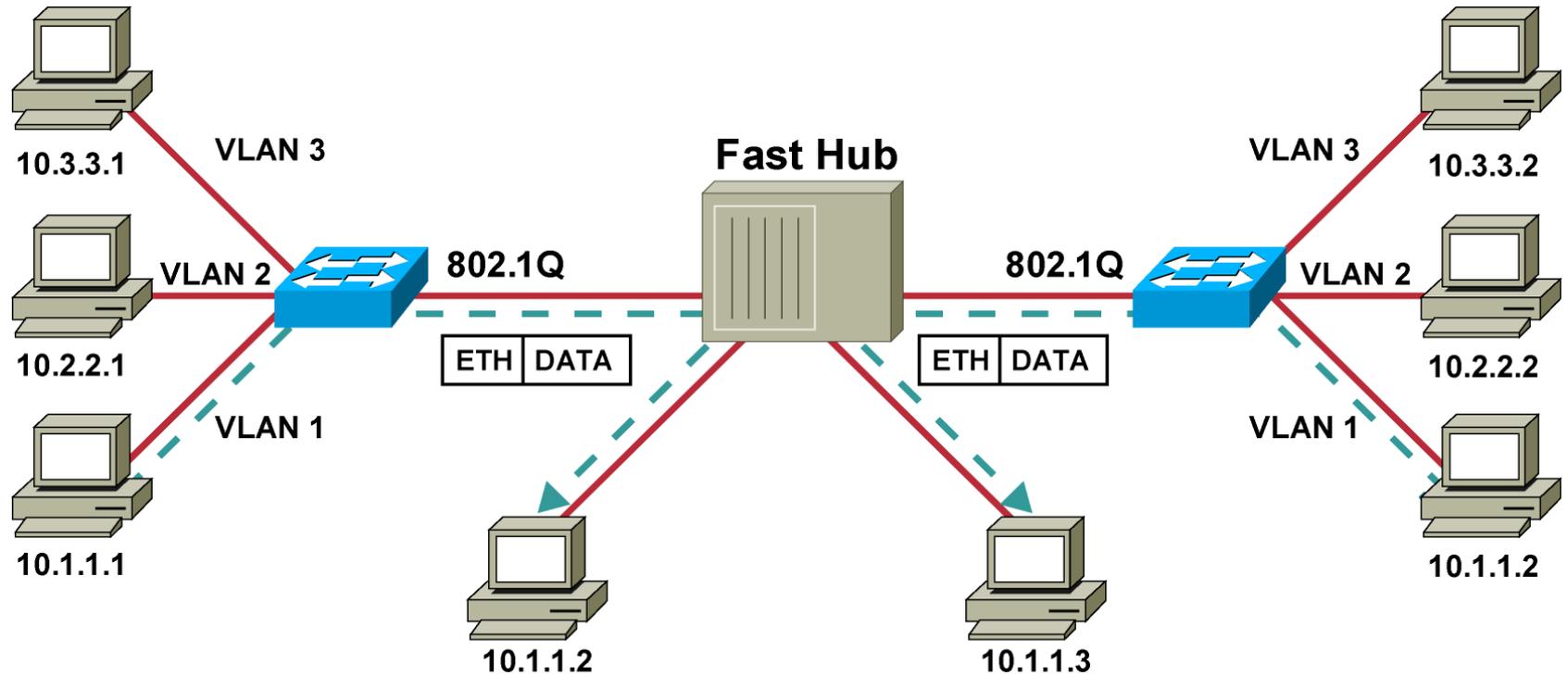
Communicating Between VLANs



802.1Q Trunk Implementing

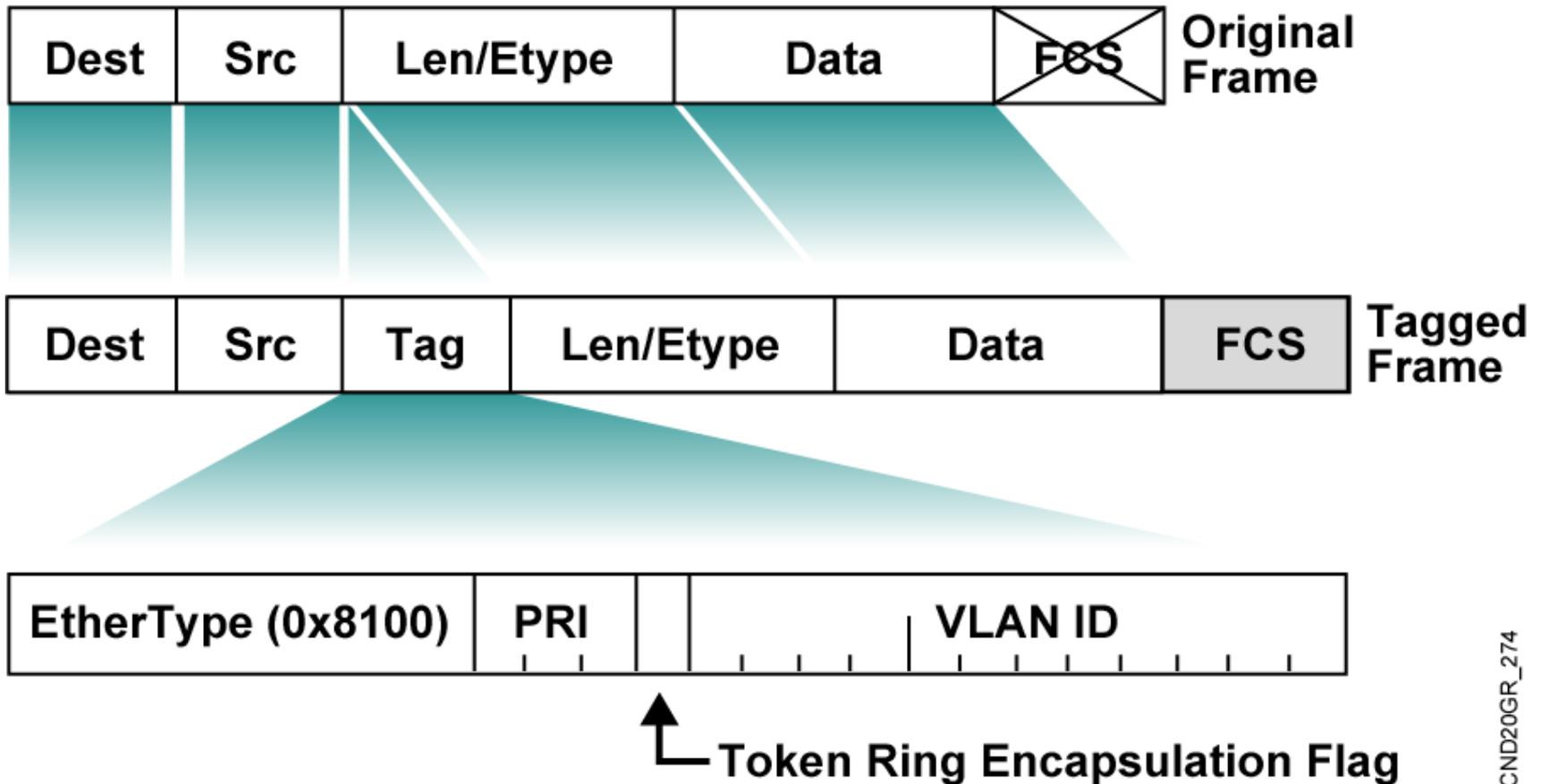


Importance of Native VLANs



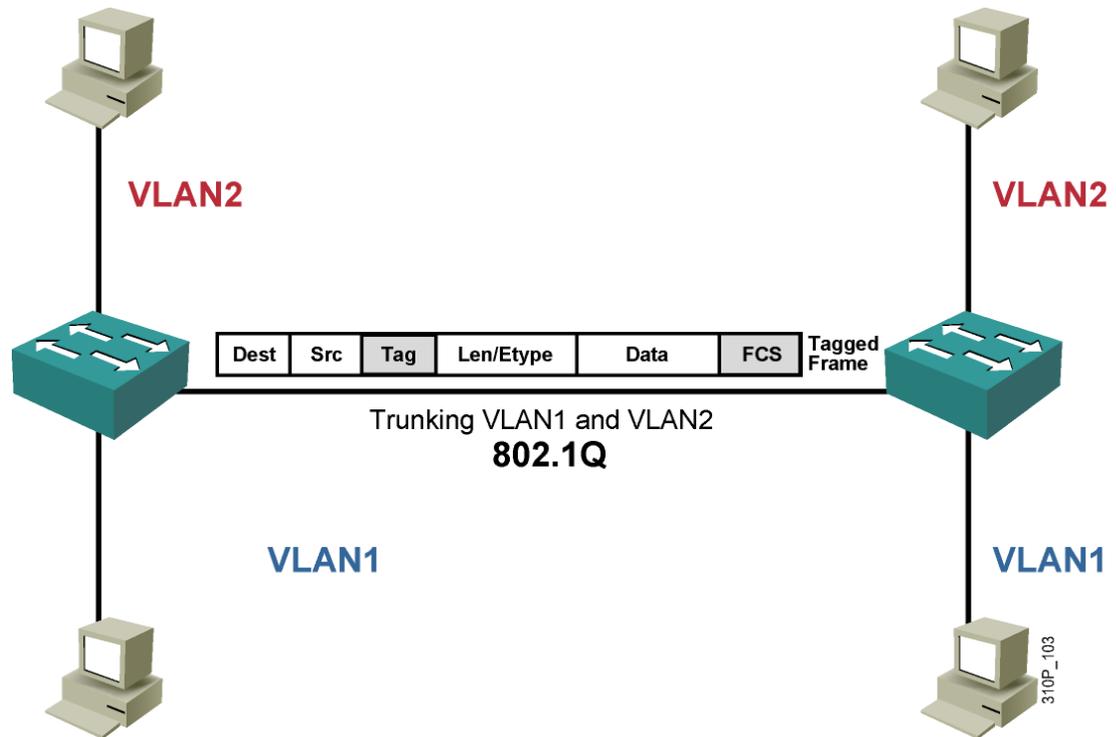
---> VLAN 1 untagged traffic (native VLAN)

802.1Q Frame

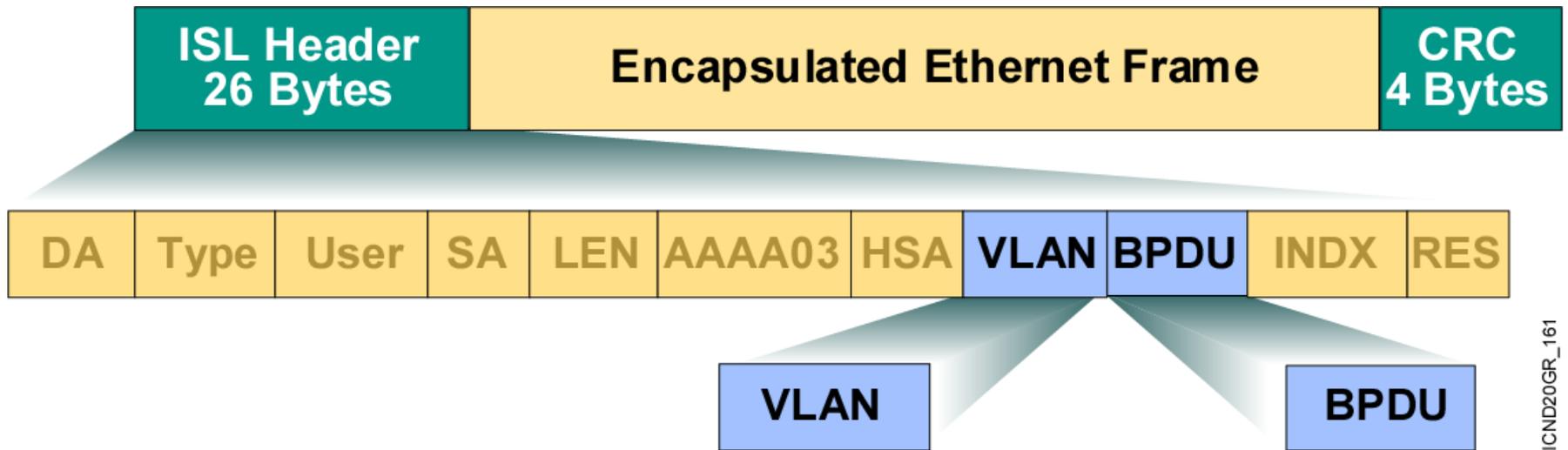


Trunking with 802.1Q

- An IEEE standard
- Adds a 4-byte tag to the original frame
- Additional tag includes a priority field
- Does not tag frames that belong to the native VLAN
- Supports Cisco IP telephony

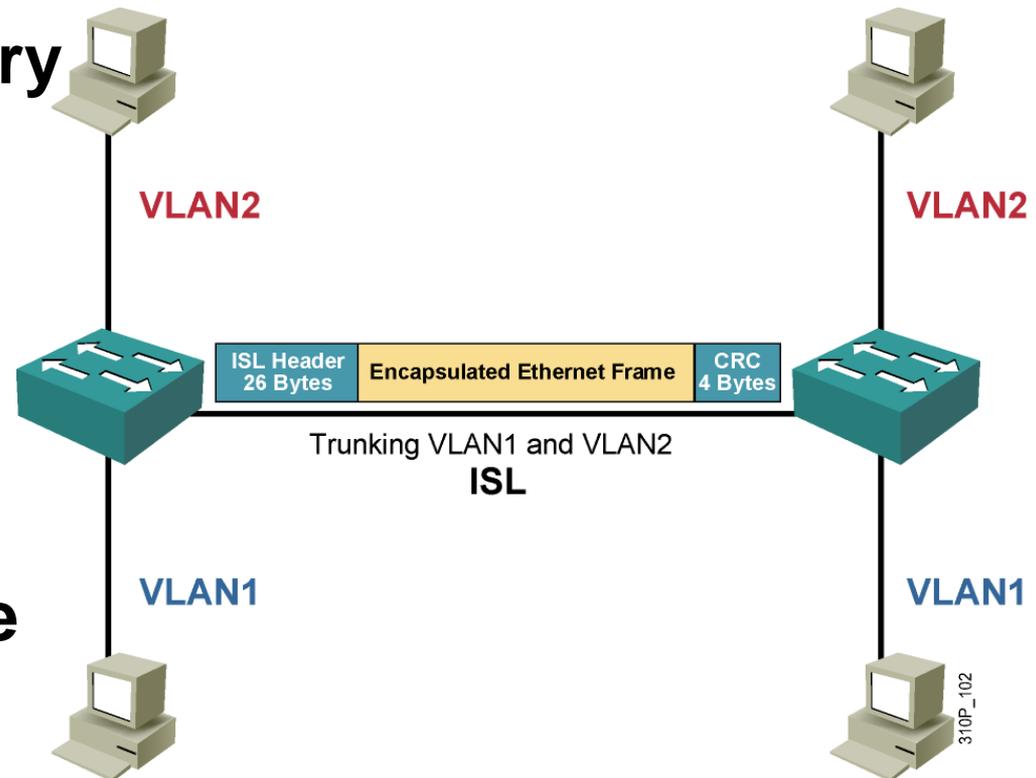


ISL Encapsulation



Trunking with ISL

- Is a Cisco proprietary protocol
- Supports PVST
- Uses an encapsulation process
- Does not modify the original frame



Comparing ISL and 802.1Q

ISL	802.1Q
Proprietary	Nonproprietary
Encapsulated	Tagged
Protocol independent	Protocol dependent
Encapsulates the old frame in a new frame	Adds a field to the frame header

VLAN Ranges

VLAN Range	Use
0, 4095	Reserved for system use only
1	Cisco default
2–1001	For Ethernet VLANs
1002– 1005	Cisco defaults for FDDI and Token Ring
1006– 4094	Ethernet VLANs only, unusable on specific legacy platforms

How to Configure Trunking

- 1. Enter interface configuration mode.**
- 2. Shut down interface.**
- 3. Select the encapsulation (802.1Q or ISL).**
- 4. Configure the interface as a Layer 2 trunk.**
- 5. Specify the trunking native VLAN (for 802.1Q).**
- 6. Configure the allowable VLANs for this trunk.**
- 7. Use the no shutdown command on the interface to activate the trunking process.**
- 8. Verify the trunk configuration.**

802.1Q Trunk Configuration

```
Switch(config)#interface fastethernet 5/8
Switch(config-if)#shutdown
Switch(config-if)#switchport trunk encapsulation dot1q
Switch(config-if)#switchport trunk allowed vlan 1,5,11,1002-1005
Switch(config-if)#switchport mode trunk
Switch(config-if)#switchport trunk native vlan 99
Switch(config-if)#switchport nonegotiate
Switch(config-if)#no shutdown
```

Verifying the 802.1Q Configuration

```
Switch#show running-config interface {fastethernet |  
gigabitethernet} slot/port
```

```
Switch#show interfaces [fastethernet | gigabitethernet] slot/port  
[ switchport | trunk ]
```

```
Switch#show interfaces fastEthernet 5/8 switchport  
Name: fa5/8  
Switchport: Enabled  
Administrative Mode: trunk  
Operational Mode: trunk  
Administrative Trunking Encapsulation: dot1q  
Operational Trunking Encapsulation: dot1q  
Negotiation of Trunking: Off  
Access Mode VLAN: 1 (default)  
Trunking Native Mode VLAN: 99 (trunk_only)  
Trunking VLANs Enabled: 1,5,11,1002-1005  
Pruning VLANs Enabled: 2-1001
```

```
. . .
```

Verifying a 802.1Q Dynamic Trunk Link

```
Switch#show running-config interface fastethernet 5/8
```

```
Building configuration...
```

```
Current configuration:
```

```
!
```

```
interface FastEthernet5/8
  switchport mode dynamic desirable
  switchport trunk encapsulation dot1q
```

```
Switch#show interfaces fastethernet 5/8 trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Fa5/8	desirable	802.1q	trunking	99

Port	Vlans allowed on trunk
Fa5/8	1,5,11,1002-1005

Port	Vlans allowed and active in management domain
Fa5/8	1,5,1002-1005

Port	Vlans in spanning tree forwarding state and not pruned
Fa5/8	1,5,1002-1005

ISL Trunk Configuration

```
Switch(config)#interface fastethernet 2/1
Switch(config-if)#shutdown
Switch(config-if)#switchport trunk encapsulation isl
Switch(config-if)#switchport trunk allowed vlan 1-5,1002-1005
Switch(config-if)#switchport mode trunk
Switch(config-if)#switchport nonegotiate
Switch(config-if)#no shutdown
```

Verifying ISL Trunking

```
Switch#show running-config interface {fastethernet |  
gigabitethernet} slot/port
```

```
Switch#show interfaces [fastethernet | gigabitethernet] slot/port  
[ switchport | trunk ]
```

```
Switch#show interfaces fastethernet 2/1 trunk
```

Port	Mode	Encapsulation	Status	Native VLAN
Fa2/1	trunk	isl	trunking	99

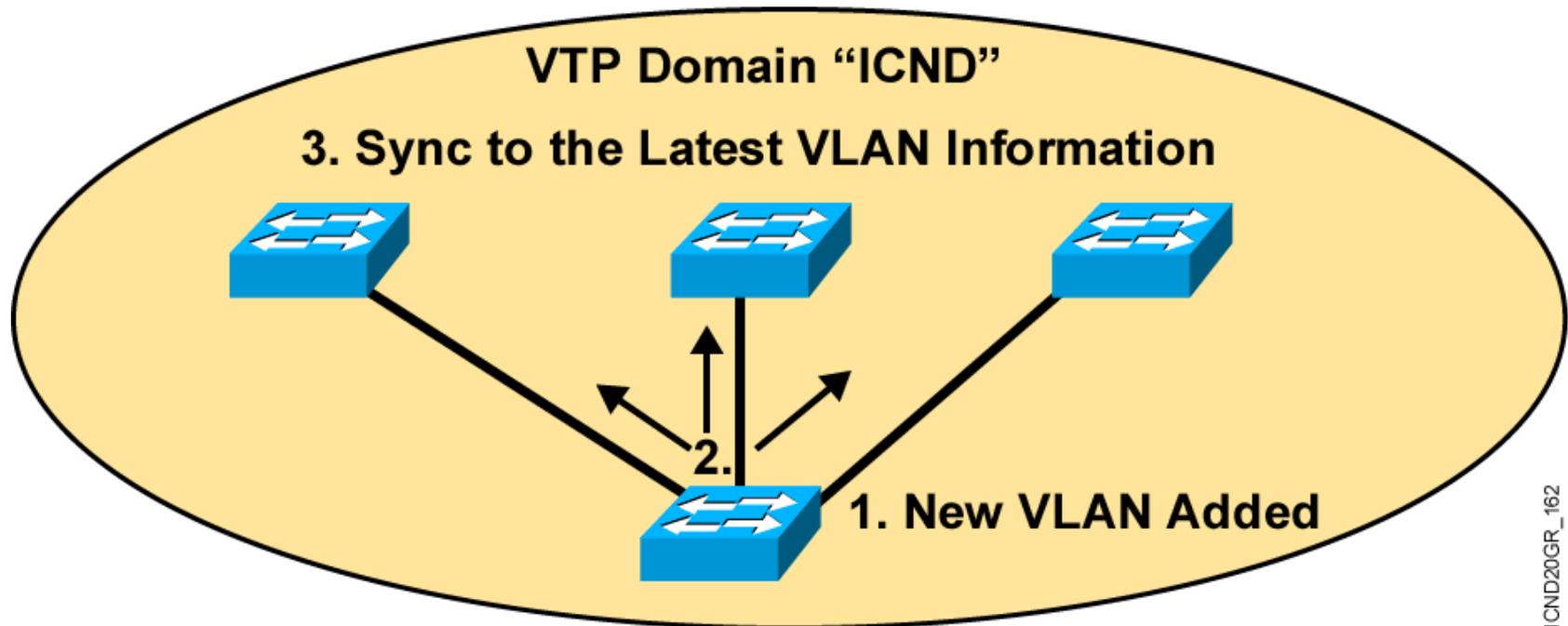
Port	VLANs allowed on trunk
Fa2/1	1-5,1002-1005

Port	VLANs allowed and active in management domain
Fa2/1	1-2,1002-1005

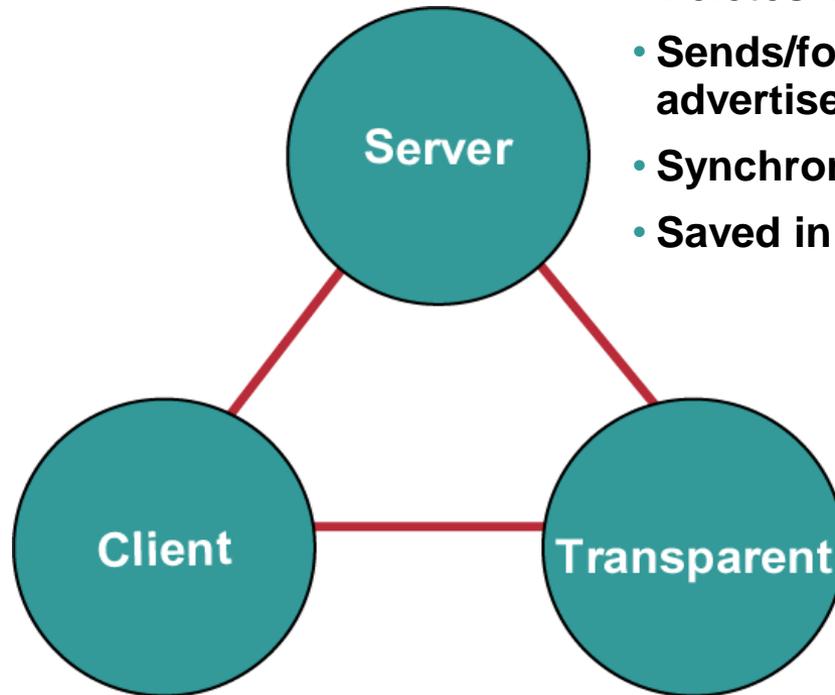
Port	VLANs in spanning tree forwarding state and not pruned
Fa2/1	1-2,1002-1005

VTP Protocol Features

- A messaging system that advertises VLAN configuration information
- Maintains VLAN configuration consistency throughout a common administrative domain
- Sends advertisements on trunk ports only



VTP Modes



- Forwards advertisements
- Synchronizes
- Not saved in NVRAM

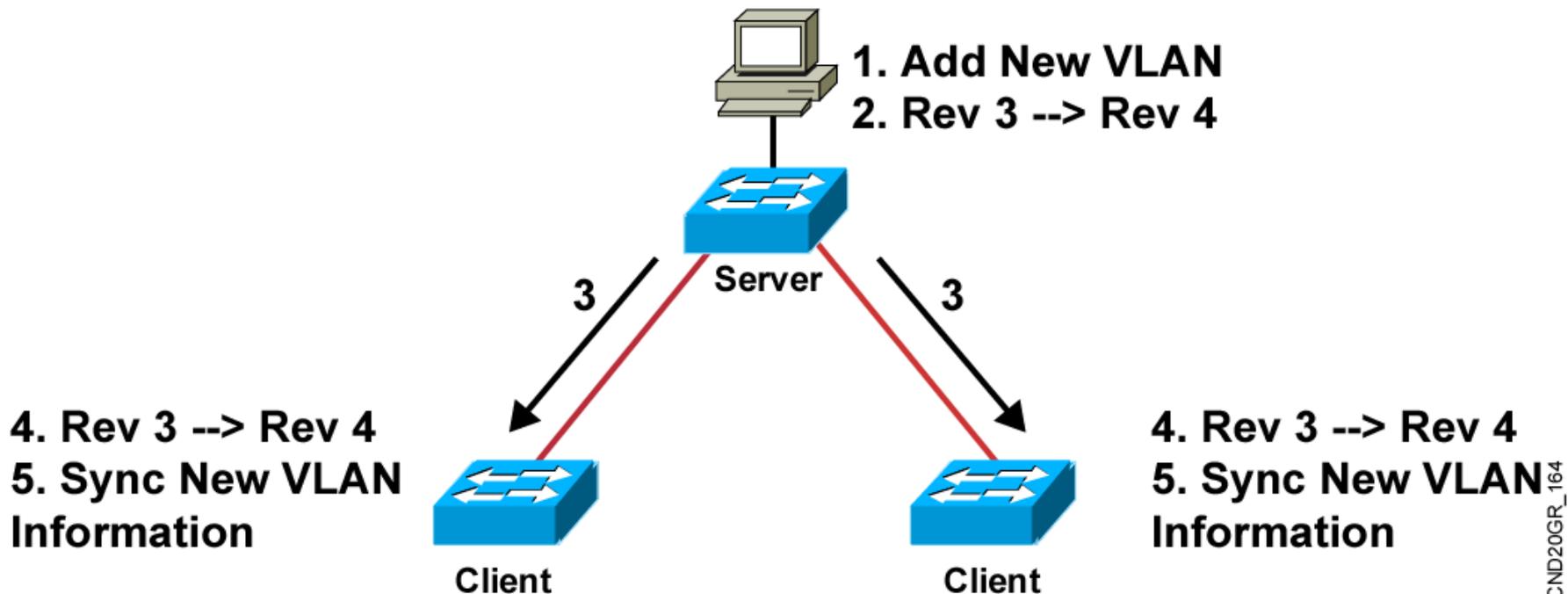
- Creates VLANs
- Modifies VLANs
- Deletes VLANs
- Sends/forwards advertisements
- Synchronizes
- Saved in NVRAM

- Creates VLANs
- Modifies VLANs
- Deletes VLANs
- Forwards advertisements
- Does not synchronize
- Saved in NVRAM

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VTP Operation

- VTP advertisements are sent as multicast frames.
- VTP servers and clients are synchronized to the latest revision number.
- VTP advertisements are sent every 5 minutes or when there is a change.



Summary

- **A VLAN permits a group of users to share a common broadcast domain regardless of their physical location in the internetwork. VLANs improve performance and security in switched networks.**
- **A Catalyst switch operates in a network like a traditional bridge. Each VLAN configured on the switch implements address learning, forwarding/filtering decisions, and loop avoidance mechanisms.**
- **Ports belonging to a VLAN are configured with a membership mode that determines to which VLAN they belong. Catalyst switches support two VLAN membership modes: static and dynamic.**
- **The IEEE 802.1Q protocol is used to transport frames for multiple VLANs between switches and routers, and for defining VLAN topologies.**

Summary (Cont.)

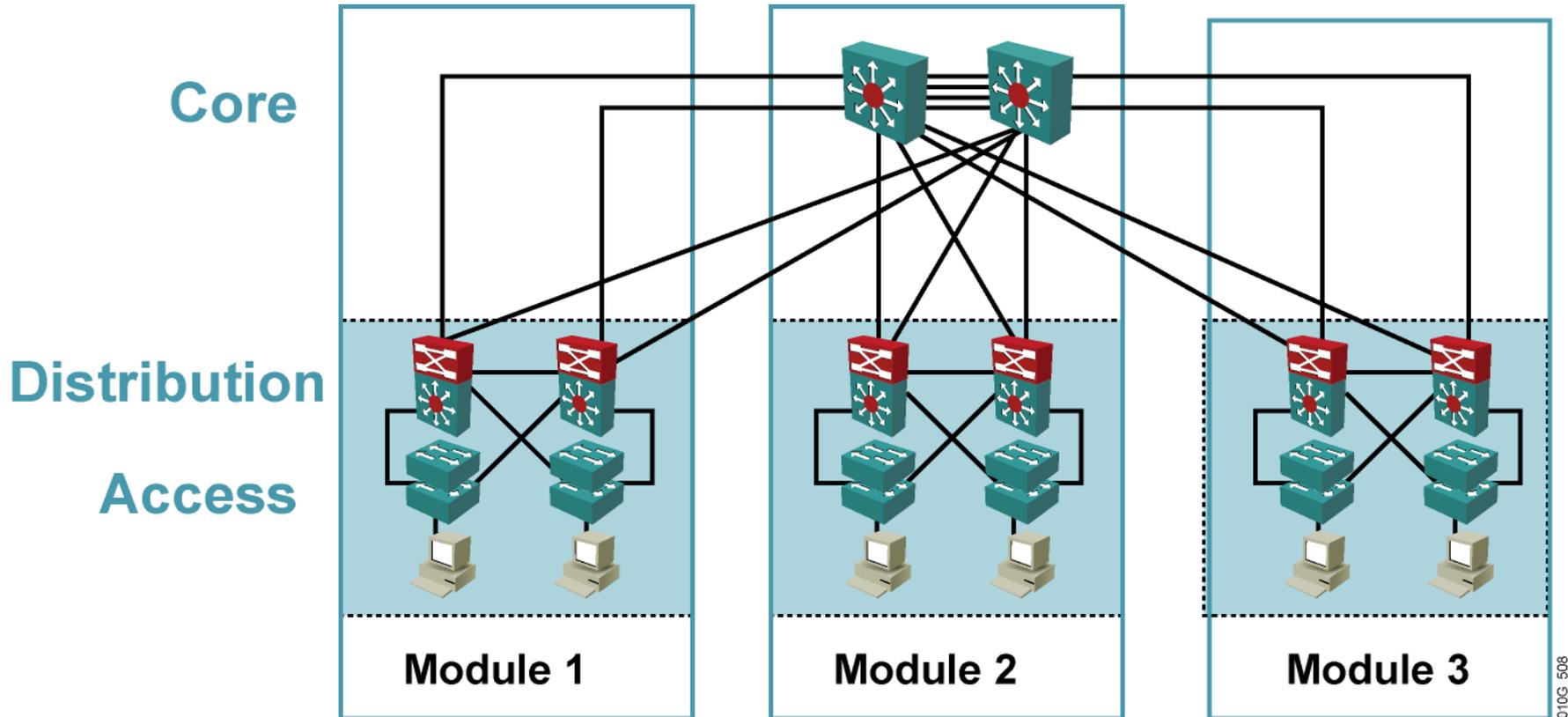
- **ISL is a Cisco proprietary protocol to transport multiple VLANs between switches and routers. ISL provides VLAN tagging capabilities while maintaining full wire-speed performance.**
- **VTP is a protocol used to distribute and synchronize identifying information about VLANs configured throughout a switched network. VTP allows switched network solutions to scale to large sizes by reducing the manual configuration required on each switch in the network.**
- **VTP operates in one of three modes: server, client, or transparent. The default VTP mode is server mode, but VLANs are not propagated over the network until a management domain name is specified or learned.**

Configuring VLANs

VLAN configuration Step

1. Configure VTP (option by Cisco)
2. Configure Trunking(Tagging)
(on interconnection interface of Switch)
3. Creat new vlan (on vtp server)
4. Assign port to vlan (on every switch)

Campus Infrastructure Module



VTP Configuration Guidelines

- VTP domain name
- VTP mode (server/client/transparent) VTP server mode is the default
- VTP password
- VTP trap

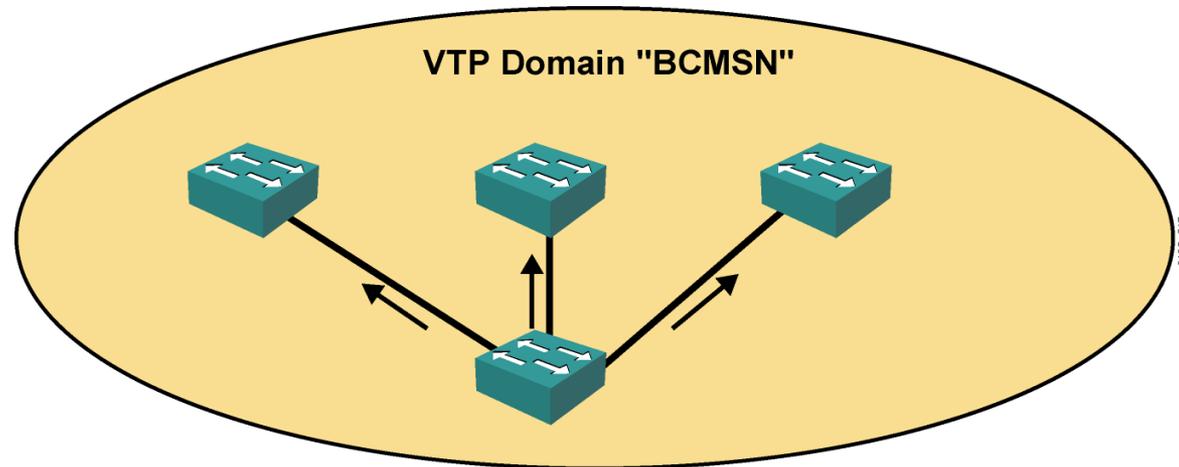
Use caution when adding a new switch to an existing domain. Add a new switch in client mode to prevent the new switch from propagating incorrect VLAN information.

Use the delete vtp command to reset the VTP revision number.

VTP Configuration Commands

Configuring VTP

- vtp domain
- vtp mode
- vtp password



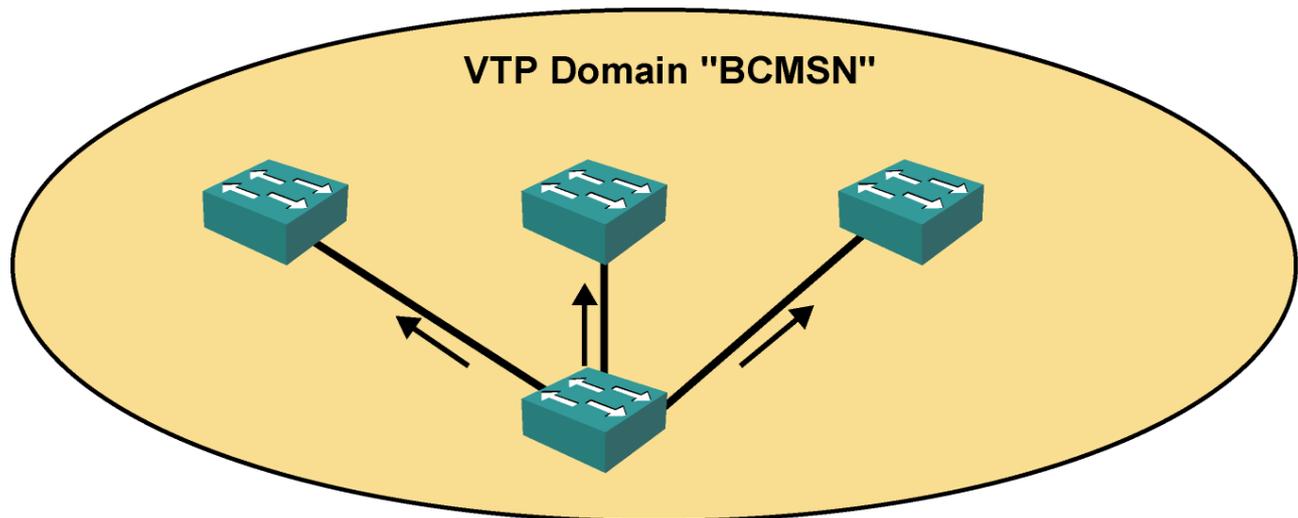
Verifying VTP

- show vtp status
- show vtp counters

Configuring a VTP Management Domain

Configure each switch in the following order to avoid dynamic learning of the domain name:

- VTP password
- VTP domain name (case sensitive)
- VTP mode (server mode is the default)



Configuring and Verifying VTP

```
Switch#show vlan brief
```

- Displays a list of current VLANs

```
Switch(config)#vtp password password_string
```

- Sets the VTP password

```
Switch(config)#vtp domain domain_name
```

- Sets the VTP domain name

```
Switch(config)#vtp mode
```

- Sets the VTP mode to server, client, or transparent

```
Switch# show vtp status
```

- Displays the current settings for VTP

Verifying the VTP Configuration

```
Switch#show vtp status
```

```
Switch#show vtp status
```

```
VTP Version : 2
Configuration Revision : 28
Maximum VLANs supported locally : 1005
Number of existing VLANs : 17
VTP Operating Mode : Client
VTP Domain Name : BCMSN
VTP Pruning Mode : Enabled
VTP V2 Mode : Disabled
VTP Traps Generation : Disabled
MD5 digest : 0x45 0x52 0xB6 0xFD 0x63 0xC8 0x49 0x80
Configuration last modified by 10.1.1.1 at 8-12-05 15:04:49
Switch#
```

Creating a VTP Domain on 2950

Catalyst 2950 Series (New:Global Configure Mode)

```
wg_sw_2950(config)#vtp mode [ server | client | transparent ]  
wg_sw_2950(config)#vtp domain domain-name  
wg_sw_2950(config)#vtp password password  
wg_sw_2950(config)#snmp-server enable traps vtp  
wg_sw_2950(vlan)#exit
```

Catalyst 2950 Series (Old:Database Configure Mode)

```
wg_sw_2950#vlan database  
wg_sw_2950(vlan)#vtp [ server | client | transparent ]  
wg_sw_2950(vlan)#vtp domain domain-name  
wg_sw_2950(vlan)#vtp password password  
wg_sw_2950(vlan)#snmp-server enable traps vtp  
wg_sw_2950(vlan)#exit
```

VLAN Configuration Guidelines

- **Maximum number of VLANs is switch-dependent.**
- **Catalyst desktop switches support 64 VLANs with a separate spanning tree per VLAN.**
- **VLAN 1 is the factory default Ethernet VLAN.**
- **CDP and VTP advertisements are sent on VLAN 1.**
- **The Catalyst switch IP address is in the management VLAN (VLAN 1 by default).**
- **To add or delete VLANs, the switch must be in VTP server or transparent mode.**

VLAN Configuration Modes

Global Mode

```
Switch# configure terminal
Switch(config)# vlan 3
Switch(config-vlan)# name Vlan3
Switch(config-vlan)# exit
Switch(config)# end
```

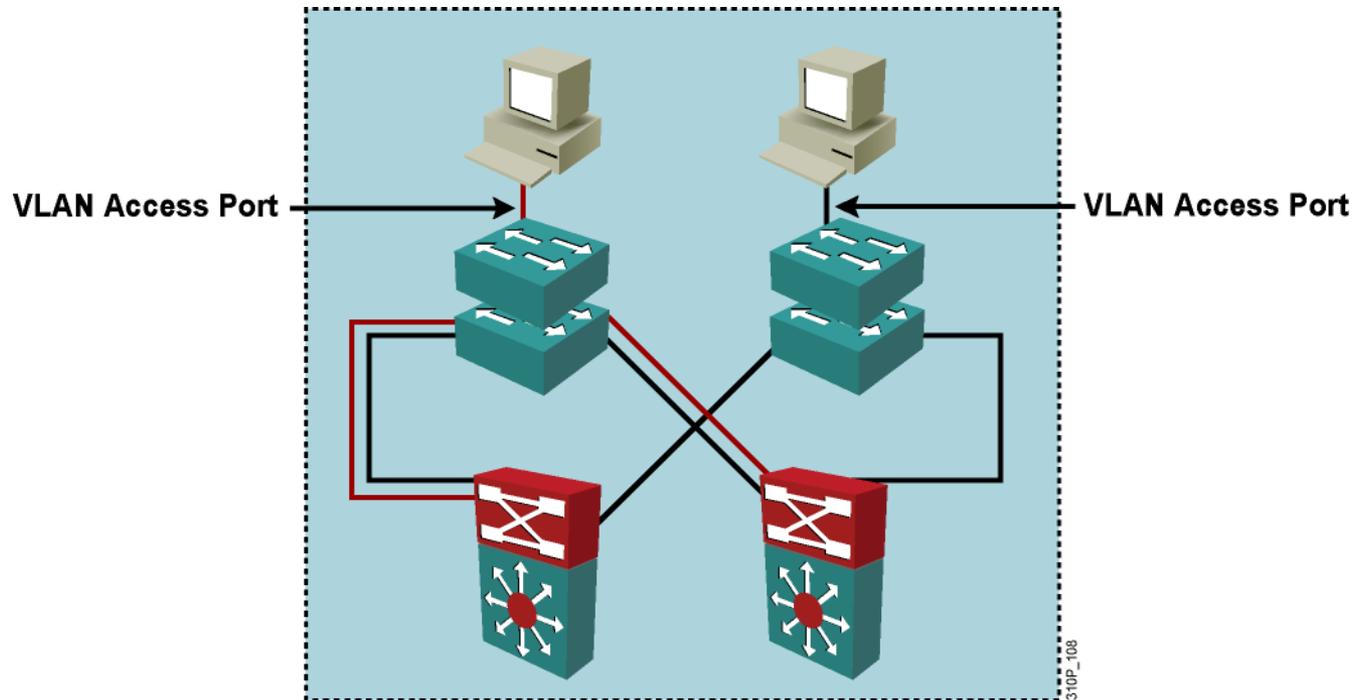
VLAN Configuration Modes

Database Mode

```
Switch# vlan database
Switch(vlan)# vlan 3

VLAN 3 added:
    Name: VLAN0003
Switch(vlan)# exit
APPLY completed.
Exiting....
```

VLAN Access Ports



The access switch port associated with a single data VLAN

VLAN Implementation Commands

Configuring VLANs

- `vlan 101`
- `switchport mode access`
- `switchport access vlan 101`

Verifying VLANs

- `show interfaces`
- `show vlan`

Configuring an Access VLAN

```
Switch(config)# vlan vlan_id
```

Create a VLAN.

```
Switch(config-vlan)# name vlan_name
```

Provide a VLAN name.

```
Switch(config-if)# switchport mode access
```

Place the switch port into access mode.

```
Switch(config-if)# switchport access vlan vlan_id
```

Associate the access switch port with a VLAN.

Verifying VLAN Membership on a Catalyst 2950 Series

```
wg_sw_2950#show vlan brief
```

```
wg_sw_2950#show vlan brief
VLAN      Name                Status              Ports
-----  -
1         default             active              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
5         VLAN5               active              Fa0/3
9         VLAN9               active              Fa0/22, Fa0/23
1002      fddi-default        active
1003      token-ring-default  active
1004      fddinet-default     active
1005      trnet-default       active
```

```
wg_sw_2950#show interfaces interface switchport
```

Summary

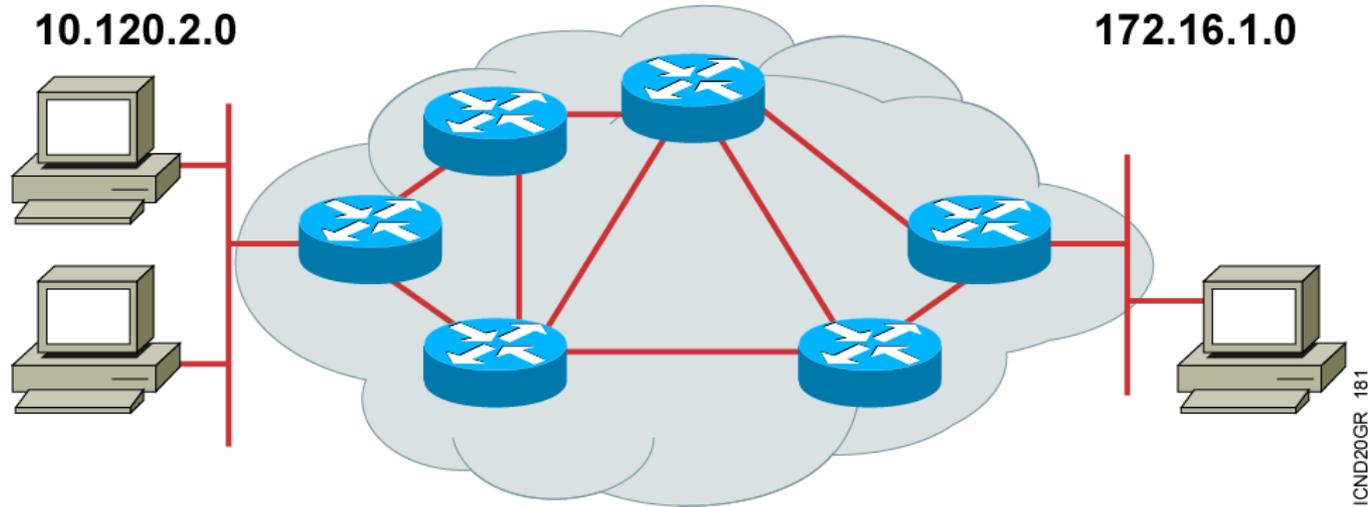
- **Before you create VLANs, you must decide whether to use VTP in your network. With VTP, you can make configuration changes centrally on one or more switches and have those changes automatically communicated to all the other switches in the network.**
- **You will configure IEEE 802.1Q to carry traffic for multiple VLANs over a single link on a multivendor network.**
- **ISL operates in a point-to-point environment to carry traffic for multiple VLANs over a single link.**
- **Most Catalyst desktop switches support a maximum of 64 active VLANs. The Catalyst 1900 series supports 1,024 VLANs with the Enterprise Edition software. Depending on the model, the 2950 series can support up to 250 VLANs.**

Summary (Cont.)

- **After creating a VLAN, you can statically assign a port or a number of ports to that VLAN. A port can belong to only one VLAN at a time.**
- **You can verify the VLAN configuration using the show commands.**
- **As network topologies, business requirements, and individual assignments change, VLAN requirements also change.**
- **Misconfiguration of a VLAN is one of the most common errors in switched networks.**

Routing Overview

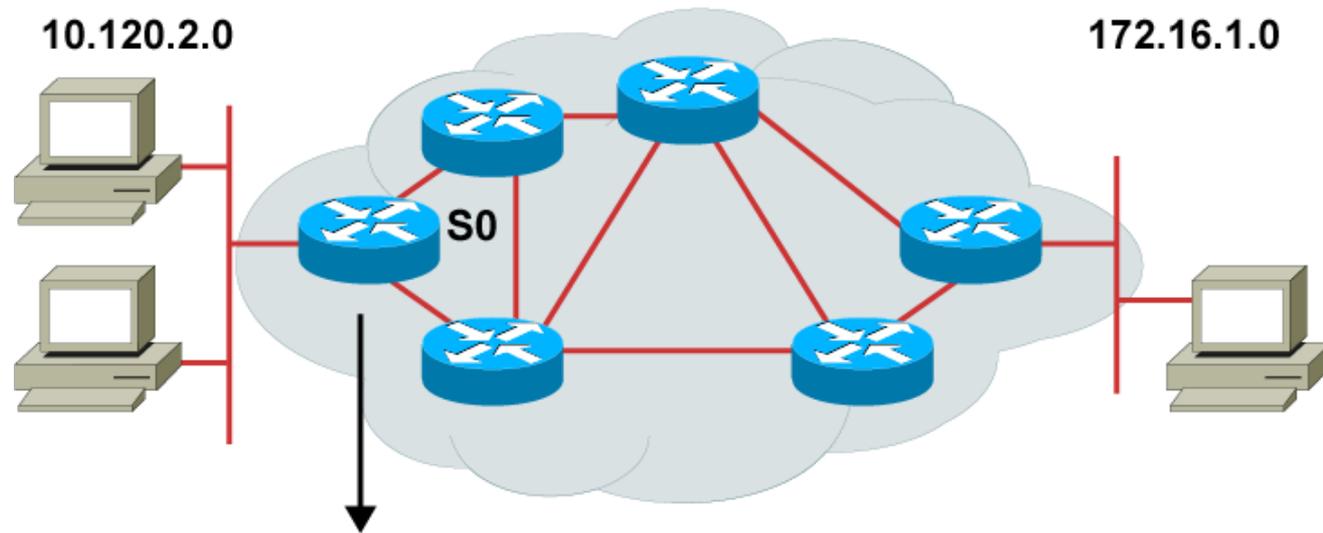
What Is Routing?



To route, a router needs to do the following:

- Know the destination address
- Identify the sources it can learn from
- Discover possible routes
- Select the best route
- Maintain and verify routing information

What Is Routing? (Cont.)



Network Protocol	Destination Network	Exit Interface
Connected	10.120.2.0	E0
Learned	172.16.1.0	S0

Routed Protocol: IP

ICND20GR_182

- **Routers must learn destinations that are not directly connected.**

Identifying Static and Dynamic Routes

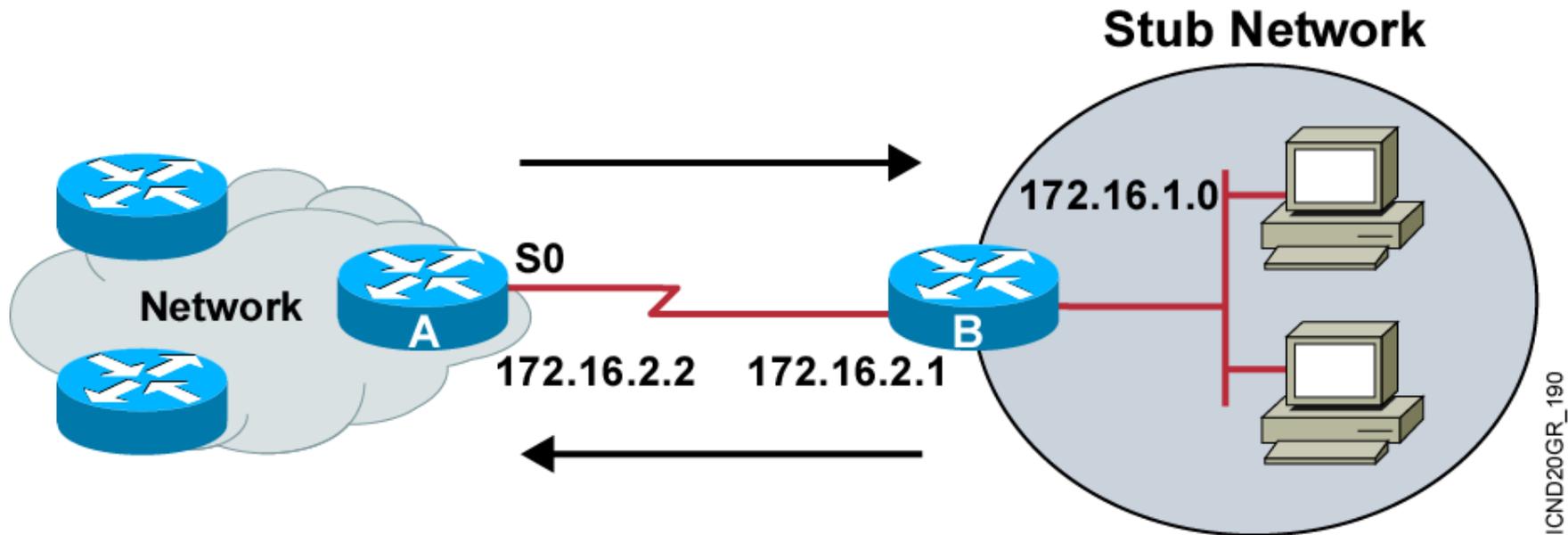
Static Route

- Uses a route that a network administrator enters into the router manually

Dynamic Route

- Uses a route that a network **routing protocol** adjusts automatically for topology or traffic changes

Static Routes



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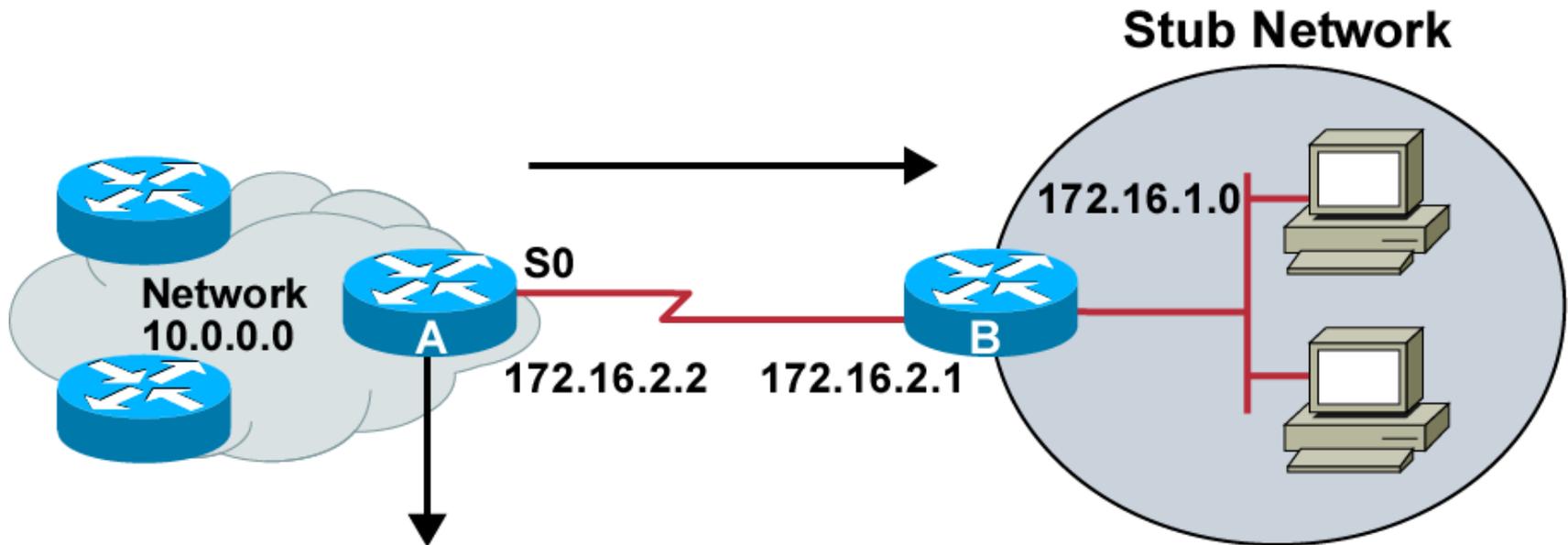
- **Configure unidirectional static routes to and from a stub network to allow communications to occur**

Static Route Configuration

```
Router(config)#ip route network [mask]  
{address | interface}[distance] [permanent]
```

- Defines a path to an IP destination network or subnet or host

Static Route Example

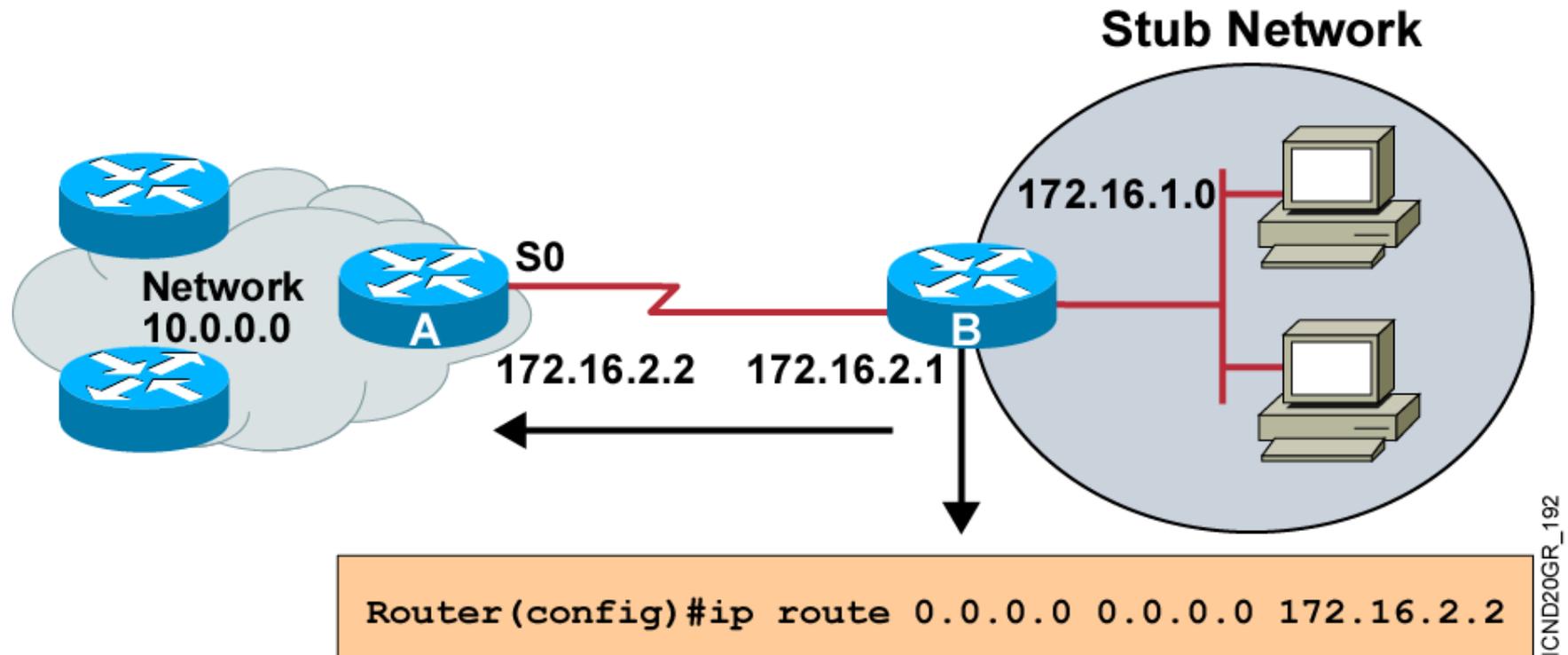


```
Router(config)#ip route 172.16.1.0 255.255.255.0 172.16.2.1
```

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- This is a unidirectional route. You must have a route configured in the opposite direction.

Default Routes



- This route allows the stub network to reach all known networks beyond router A.

Verifying the Static Route Configuration

```
router#show ip route
```

```
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP  
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP  
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default  
       U - per-user static route
```

```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0
```

```
10.0.0.0/8 is subnetted, 1 subnets
```

```
C      10.1.1.0 is directly connected, Serial0
```

```
S*    0.0.0.0/0 is directly connected, Serial0
```



Thanks !!