

A man in a white shirt and red tie is holding a large red pipe over a colorful landscape. The landscape is divided into sections of blue, green, and yellow, with a blue sky above. The man is standing on a green slope, and the pipe is arched over the landscape.

Catalyst Switch Operations

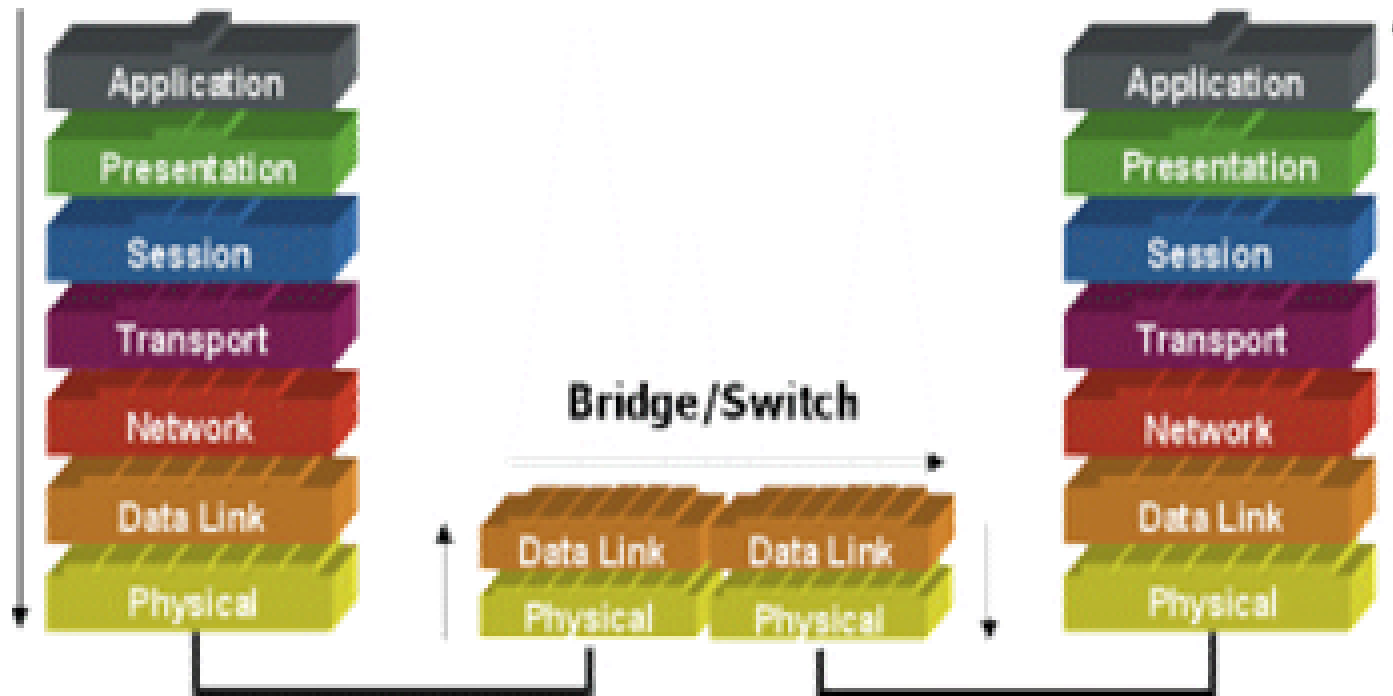


Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

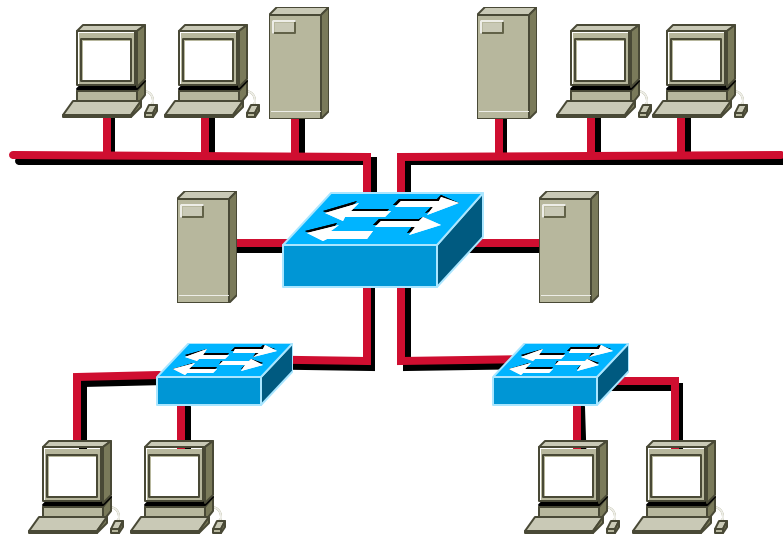
- **Describe Layer 2 switching (bridging) operations**
- **Describe the Catalyst 1900 switch operations**
- **Describe the Catalyst 1900 switch default configuration**
- **Configure Catalyst 1900 switch**
- **Use show commands to verify Catalyst 1900 switch configuration and operations**

Switching /bridging at OSI



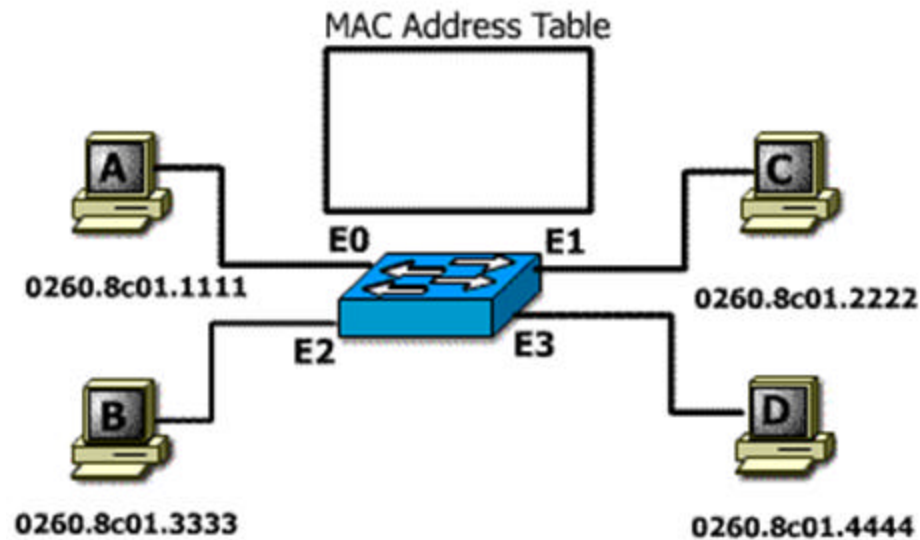
The layer of the OSI reference model at which bridging and switching technologies operate

Three Switch Functions



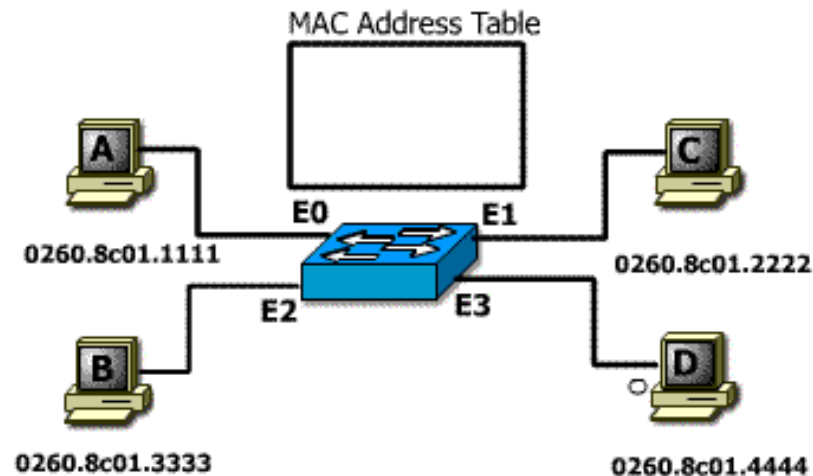
- **Address learning**
- **Forward/filter decision**
- **Loop avoidance**

How Switches Learn Host Locations



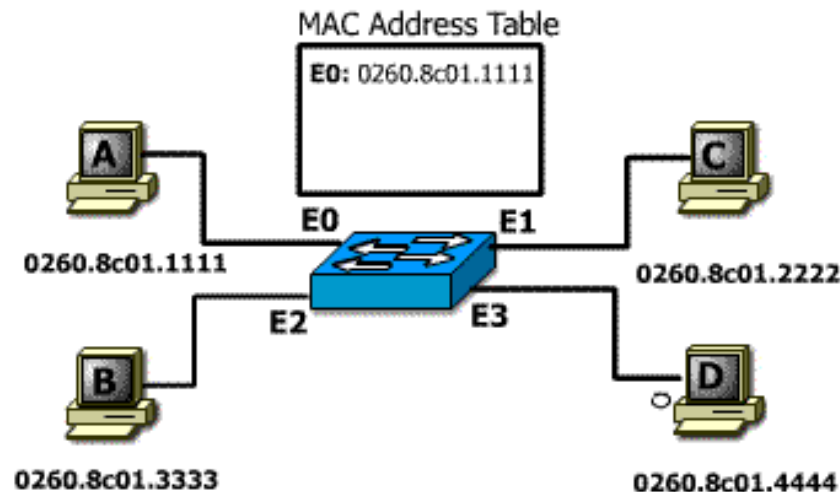
- Initial MAC address table is empty

How Switches Learn Hosts Locations



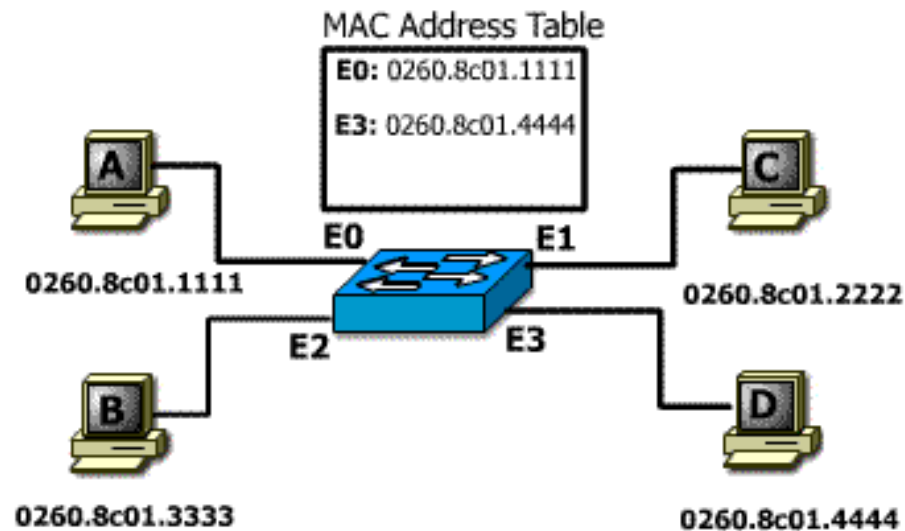
- Station A sends a frame to Station C
- Switch caches station A MAC address to port E0 by learning the source address of data frames
- The frame from station A to station C is flooded out to all ports except port E0 (unknown unicasts are flooded)

How Switches Learn Host Locations



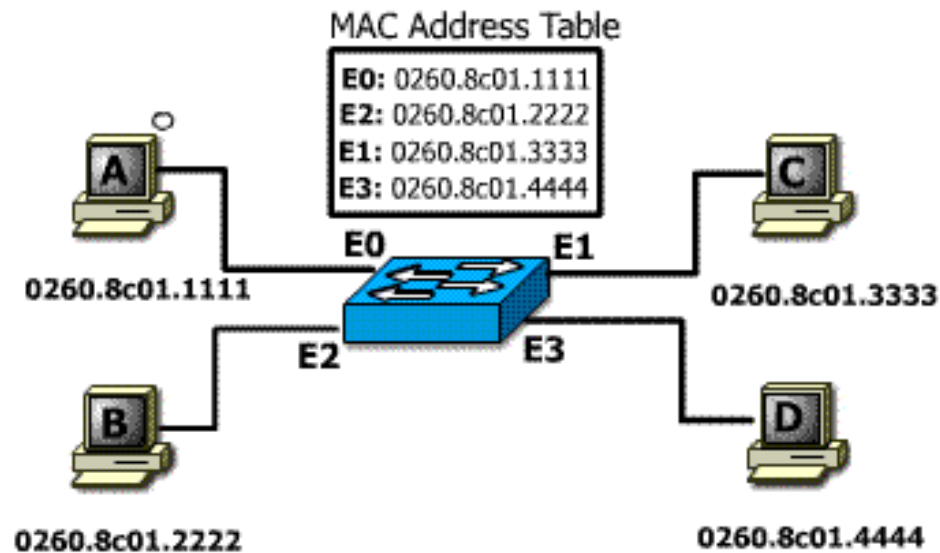
- Station D sends a frame to station C
- Switch caches station D MAC address to port E3 by learning the source Address of data frames
- The frame from station D to station C is flooded out to all ports except port E3 (unknown unicasts are flooded)

How Switches Filter Frames



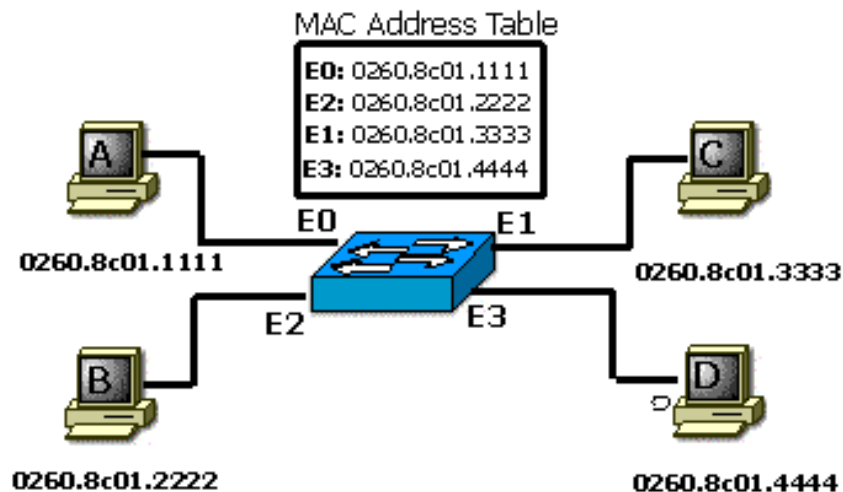
- Station C sends a frame to station A
- Destination is known, frame is not flooded

Forward/Filter Process



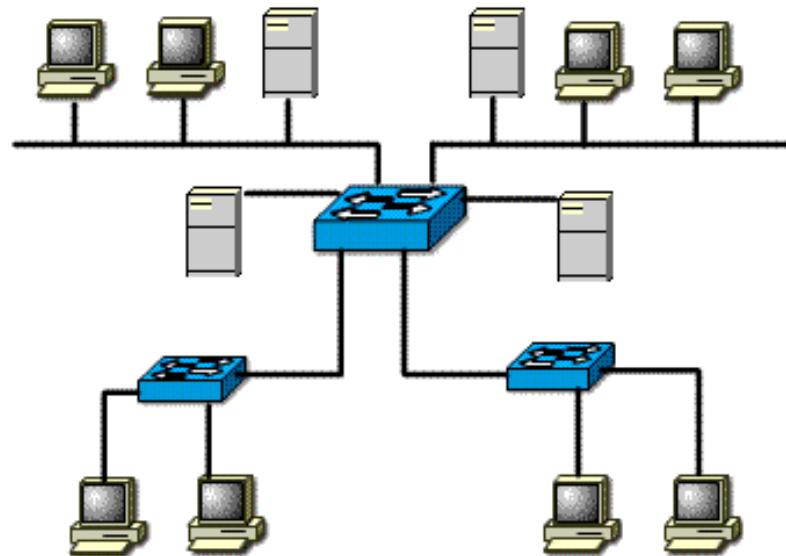
Destination is known, frame is not flooded

Broadcast and Multicast Frames



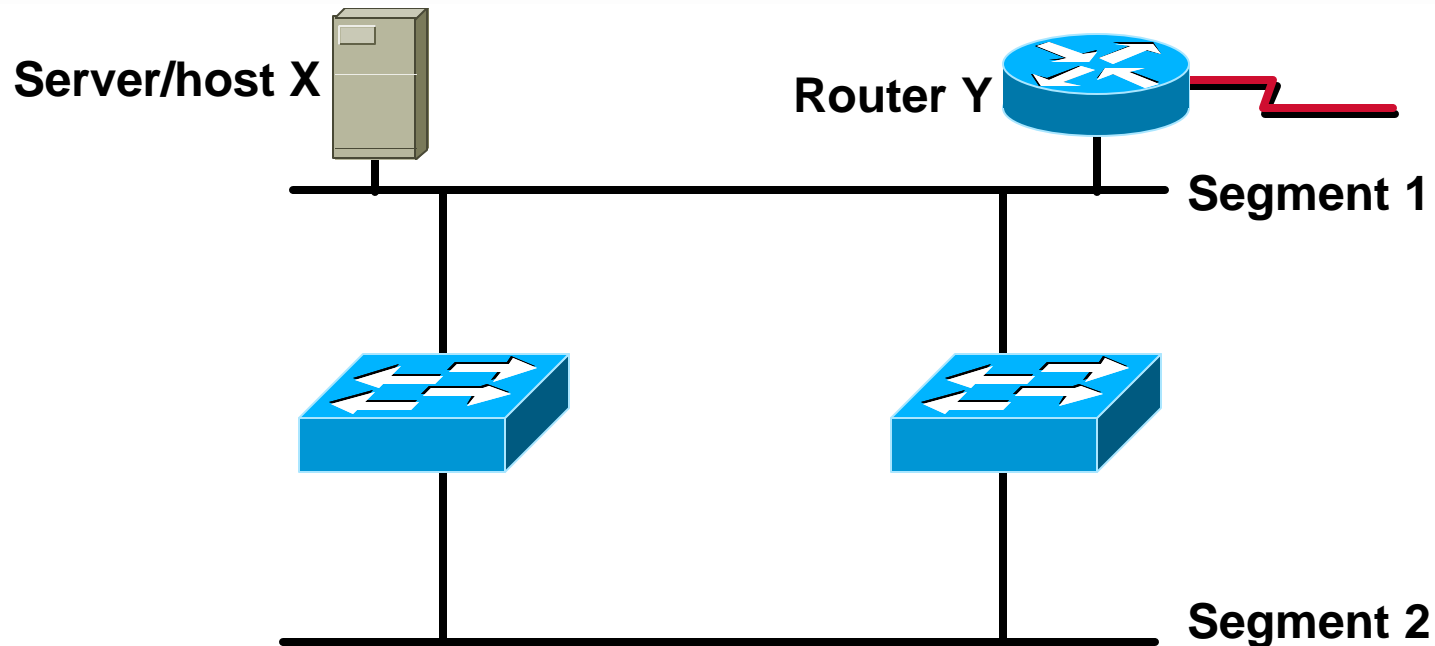
- **Station D sends a broadcast or multicast frame**
- **Broadcast and multicast frames are flooded to all ports other than the originating port**

Forward/Filter Process



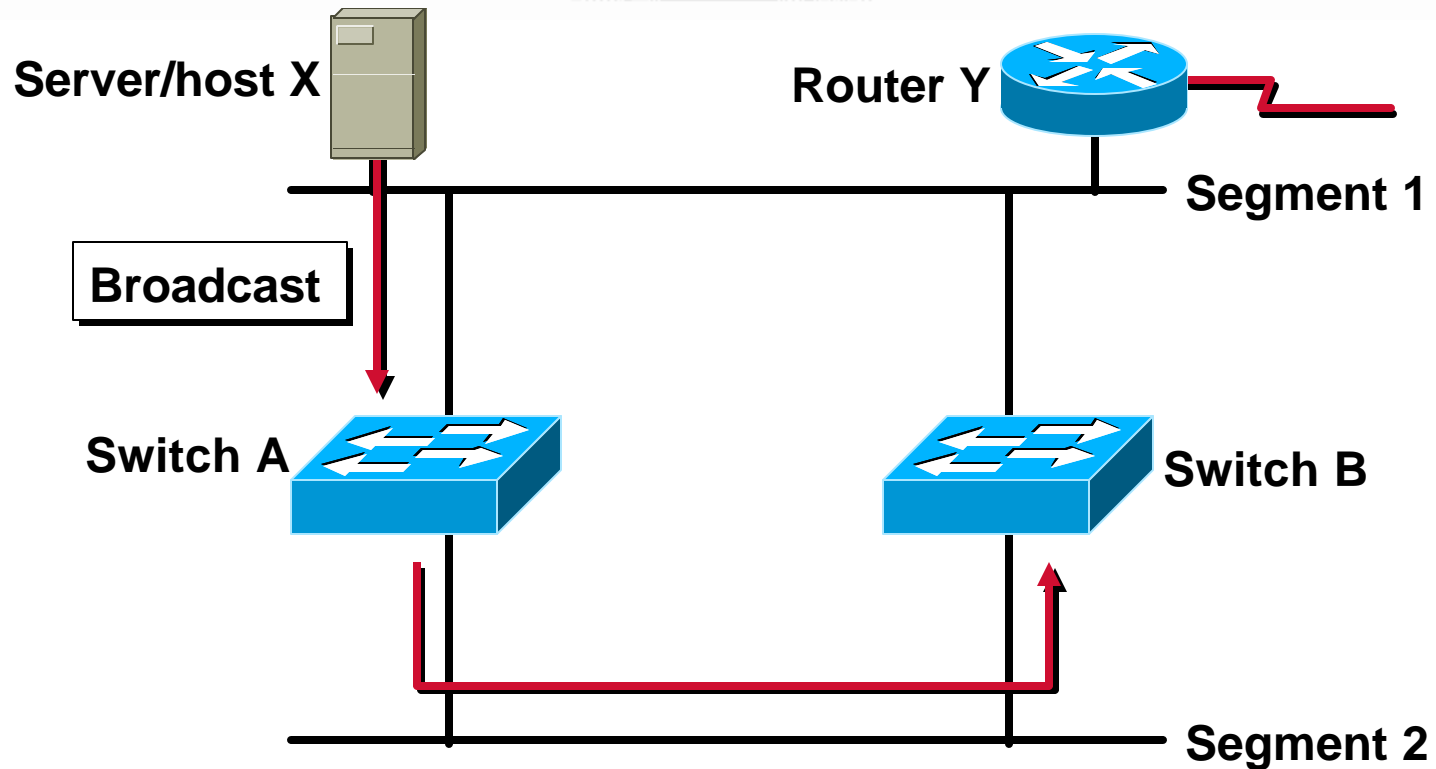
Example of Forward/Filter Process

Redundant Topology



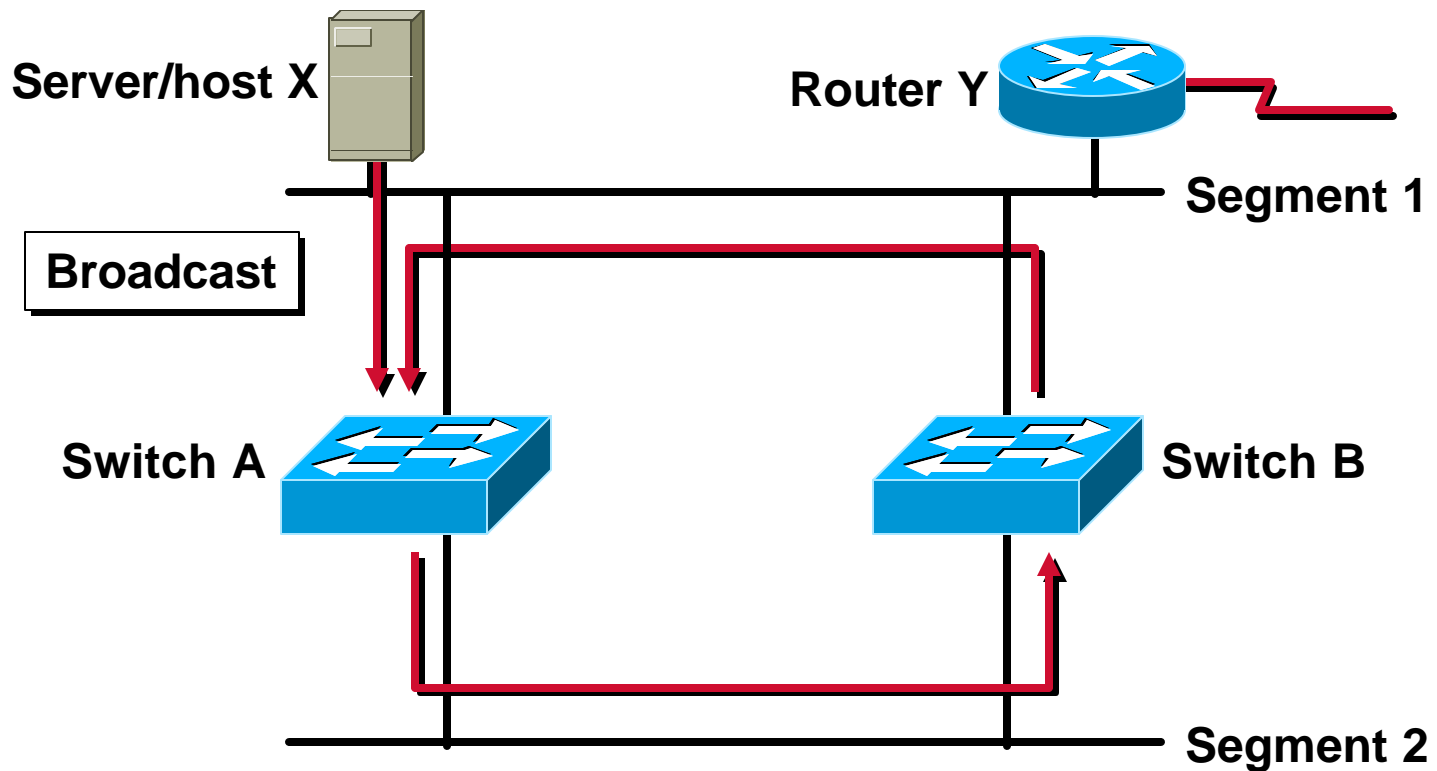
- Redundant topology eliminates single points of failure
- Redundant topology causes broadcast storms, multiple frame copies, and MAC address table instability problems

Broadcast Storms



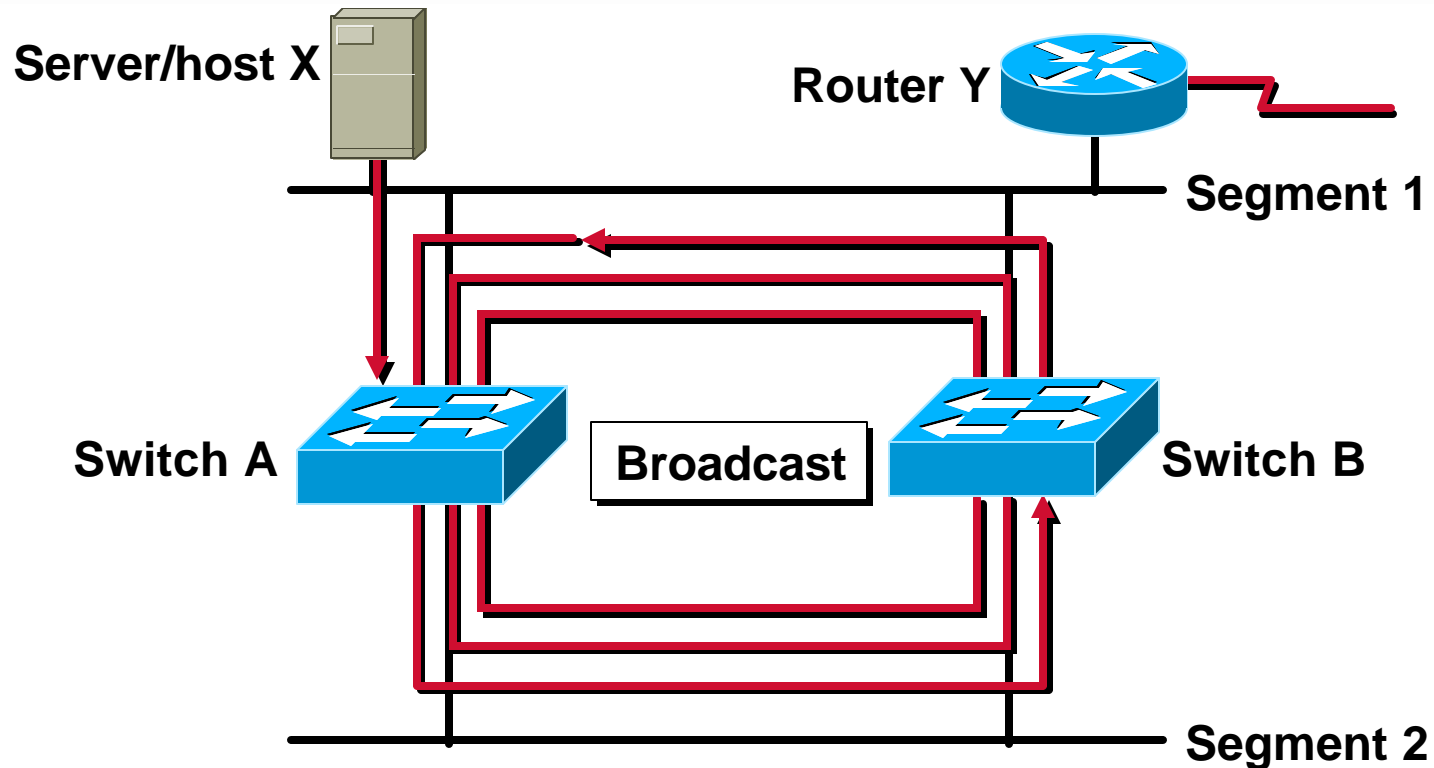
Host X sends a Broadcast

Broadcast Storms



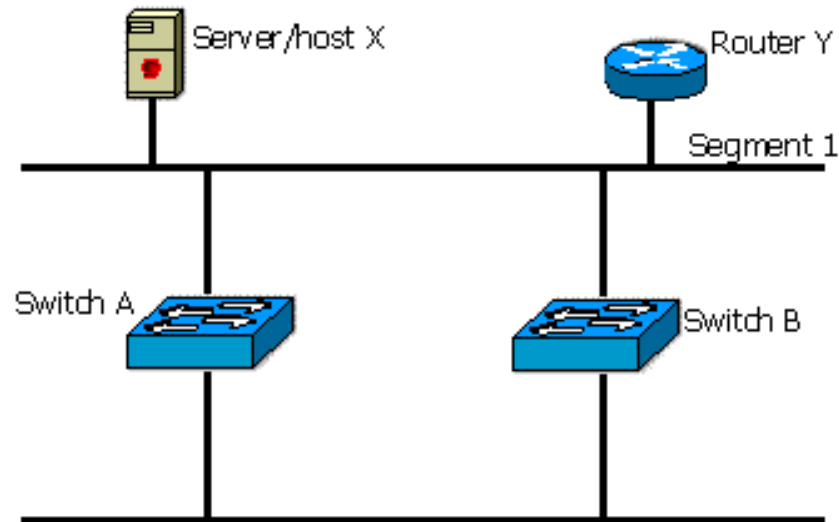
Host X sends a Broadcast

Broadcast Storms



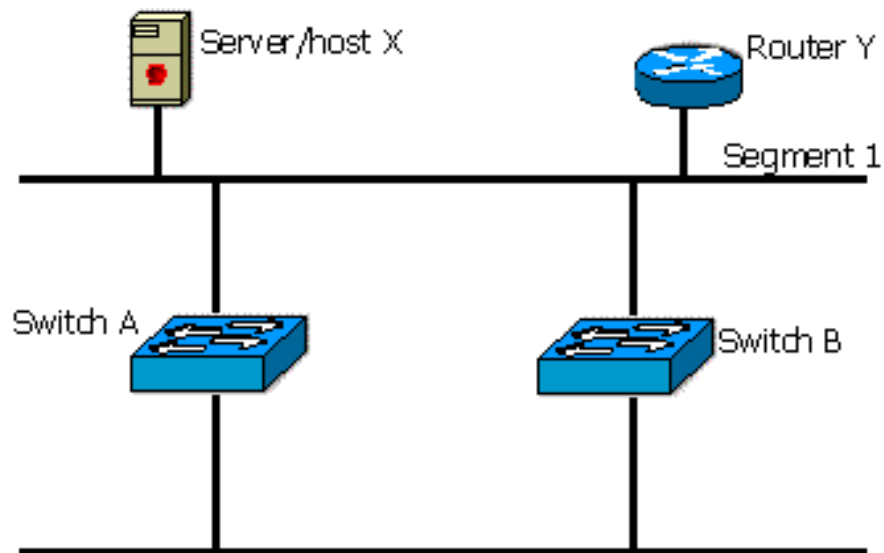
Switches continue to propagate broadcast traffic over and over

Multiple Frame Copies



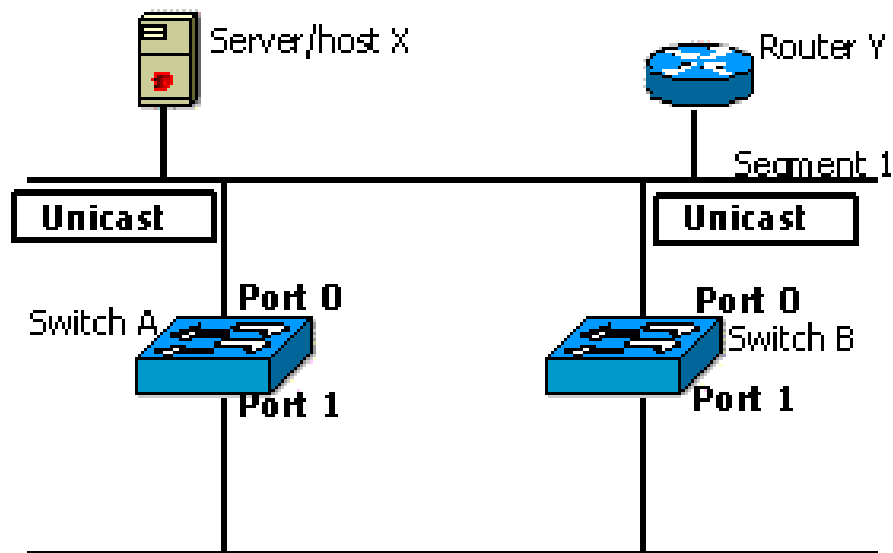
- Host X sends an unicast frame to router Y
- Router Y MAC address has not been learned by either switch yet

Multiple Frame Copies



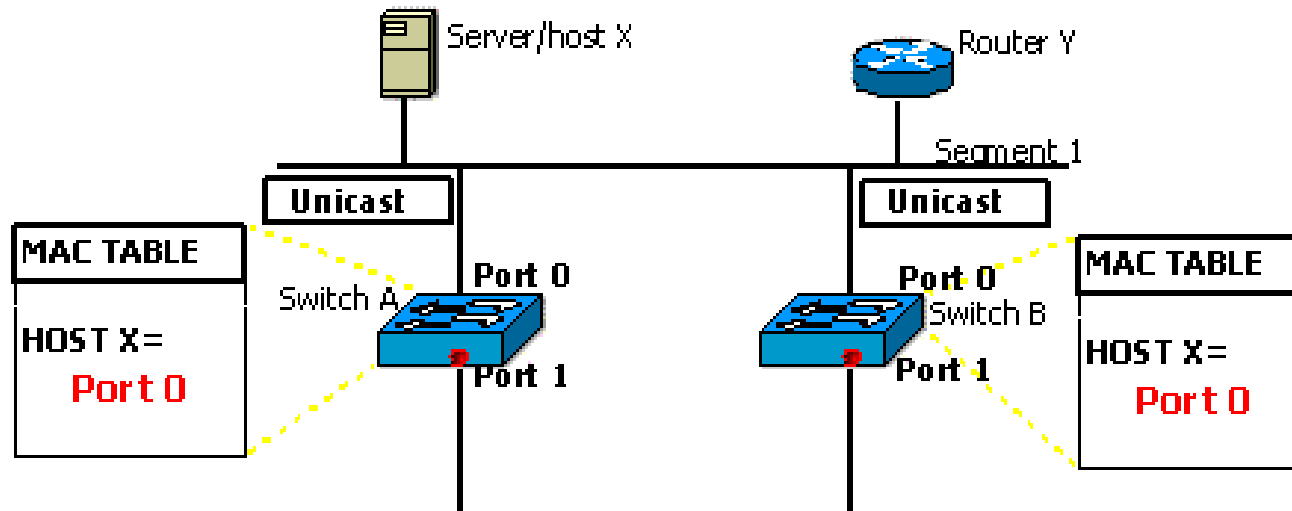
- Host X sends an unicast frame to Router Y
- Router Y MAC Address has not been learned by either Switch yet
- Router Y will receive two copies of the same frame

MAC Database Instability



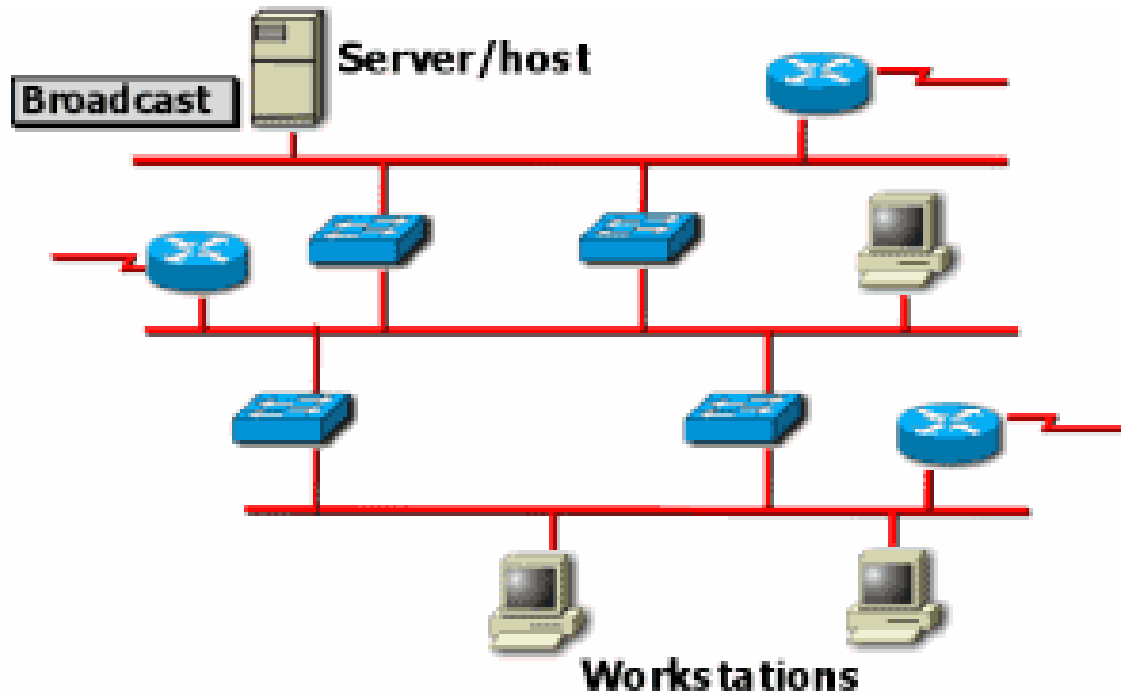
- Host X sends an unicast frame to Router Y
- Router Y MAC Address has not been learned by either Switch yet
- Switch A and B learn Host X MAC address on port 0

MAC Database Instability



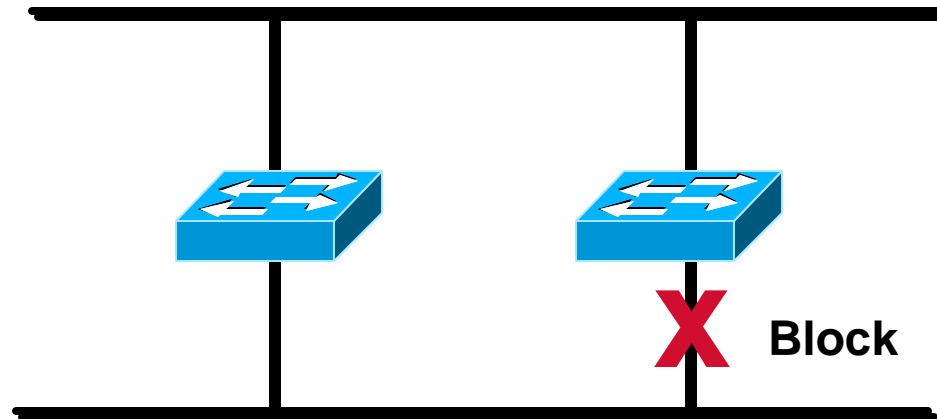
- Host X sends an unicast frame to Router Y
- Router Y MAC Address has not been learned by either Switch yet
- Switch A and B learn Host X MAC address on port 0
- Frame to Router Y is flooded
- Switch A and B incorrectly learn Host X MAC address on port 1

Multiple Loop Problems



- Complex topology can cause multiple loops to occur
- Layer 2 has no mechanism to stop the loop

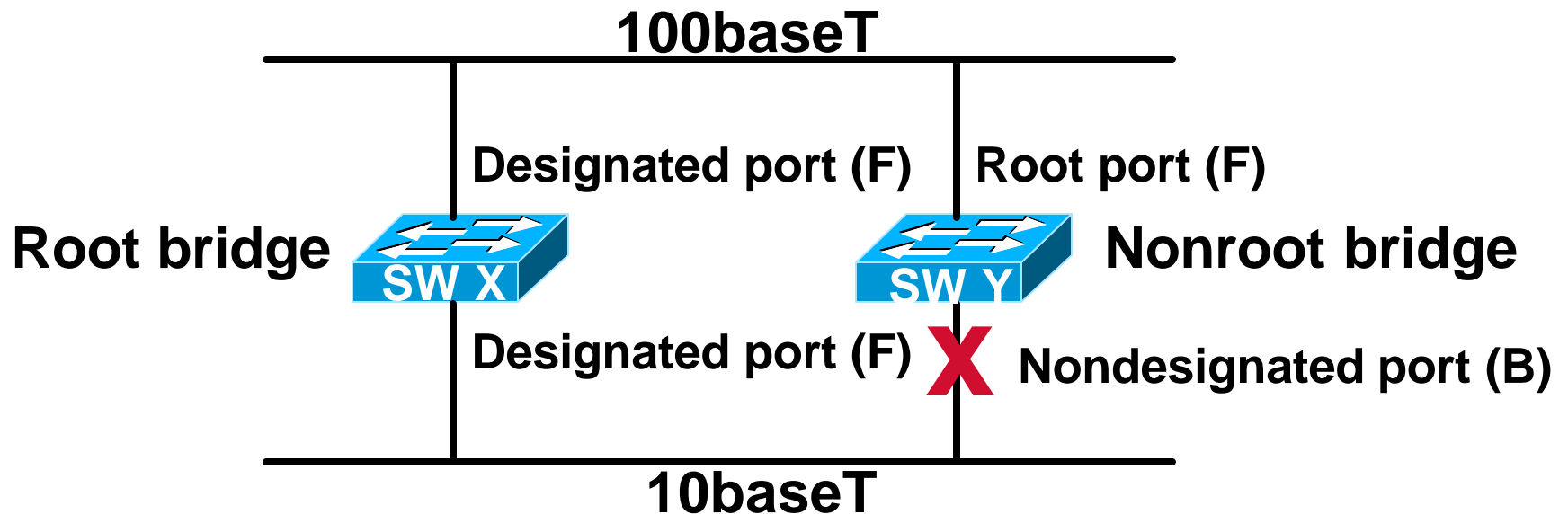
Solution: Spanning-Tree Protocol



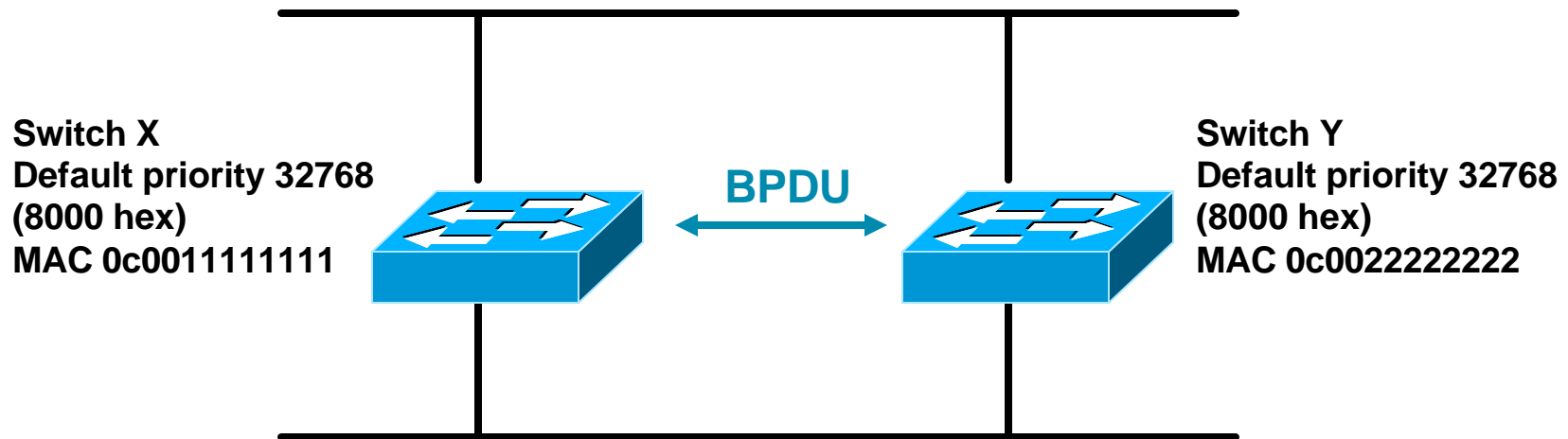
Provides a loop free redundant network topology by placing certain ports in the blocking state

Spanning-Tree Operations

- One root bridge per network
- One root port per nonroot bridge
- One designated port per segment



Spanning-Tree Protocol Root Bridge Selection



BPDU = Bridge protocol data unit

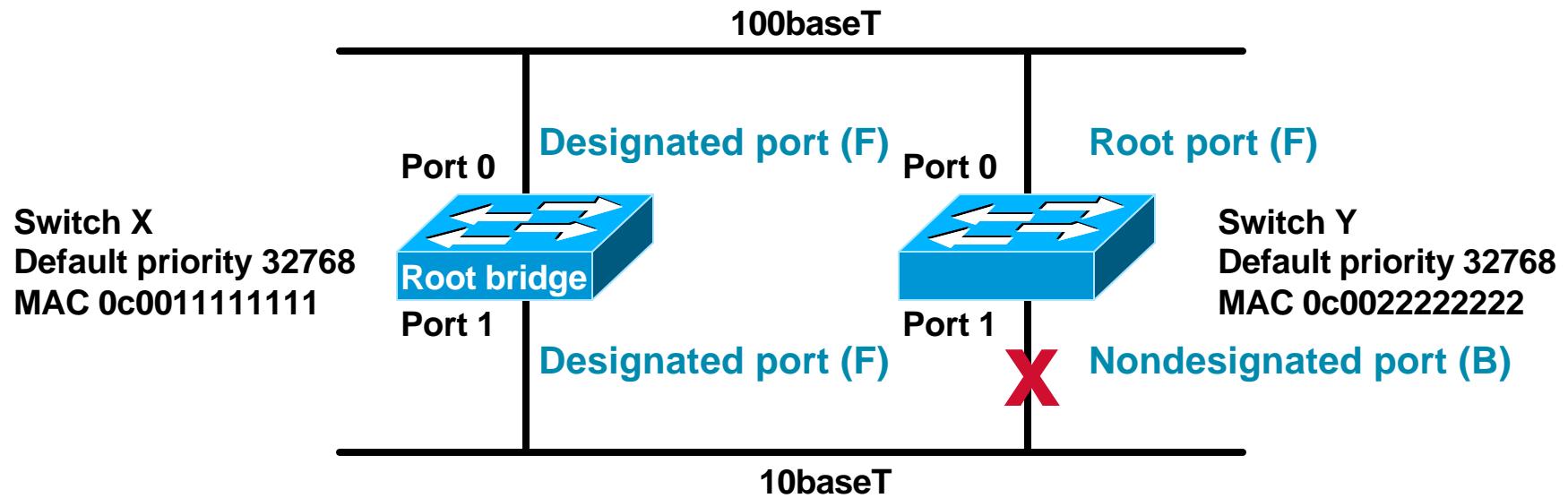
(default = sent every 2 seconds)

Root bridge = Bridge with the lowest bridge ID

Bridge ID = Bridge priority + bridge MAC address

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

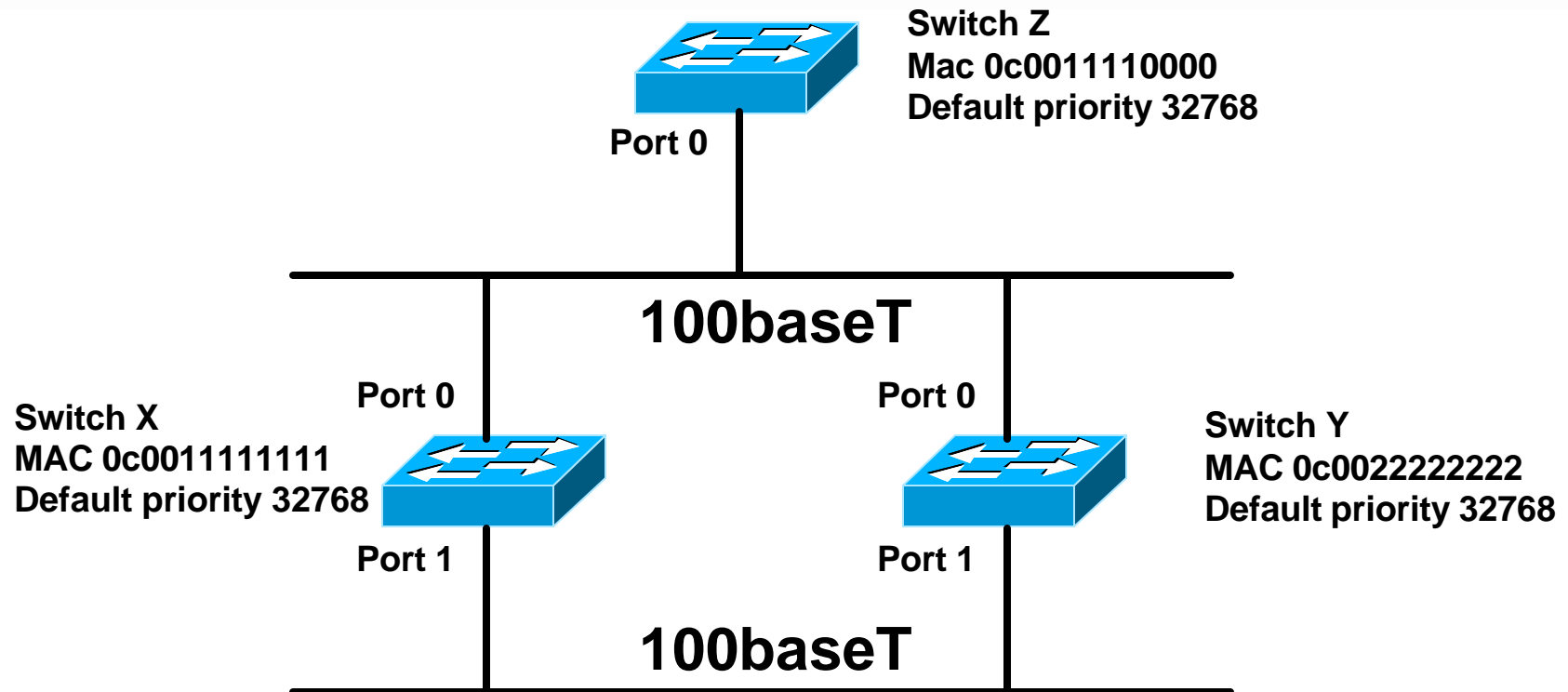
Spanning-Tree Protocol Port States



Spanning-Tree Protocol Path Cost

Link Speed	Cost (reratify IEEE spec)	Cost (previous IEEE spec)
10 Gbps	2	1
1 Gbps	4	1
100 Mbps	19	10
10 Mbps	100	100

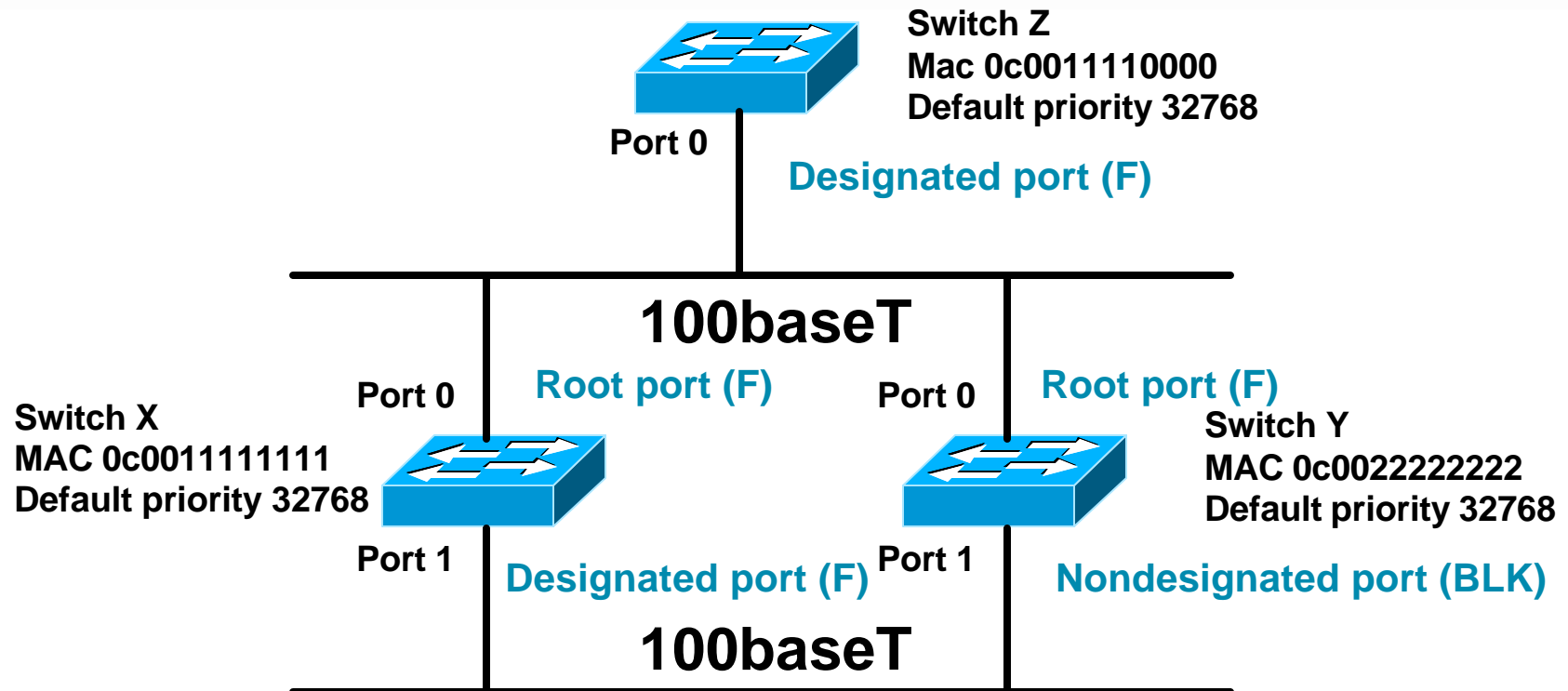
Spanning-Tree:



Can you figure out:

- What is the root bridge?
- What are the designated, nondesignated, and root ports?
- Which are the forwarding and blocking ports?

Spanning-Tree:

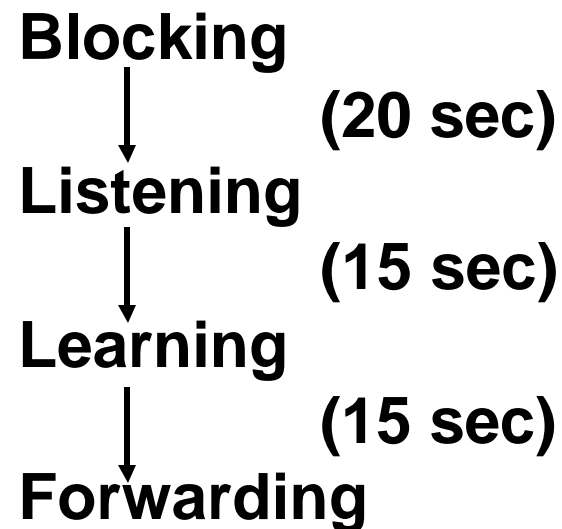


Can you figure out:

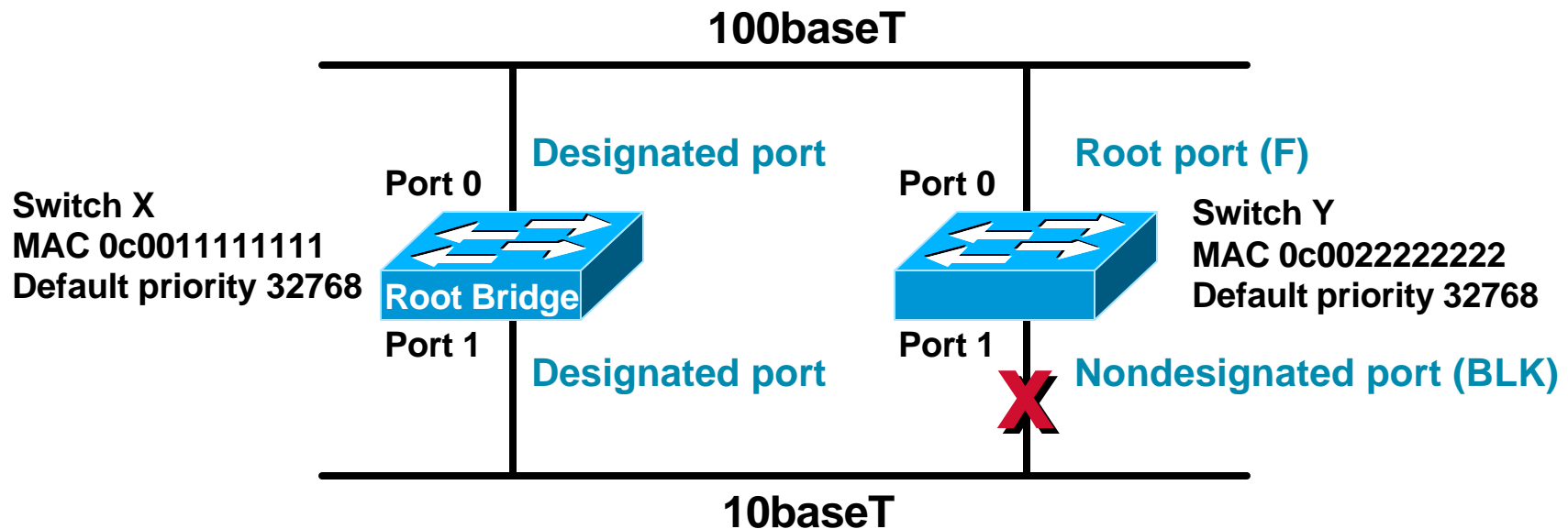
- What is the root bridge?
- What are the designated, nondesignated, and root parts?
- Which are the forwarding and blocking ports?

Spanning-Tree Port States

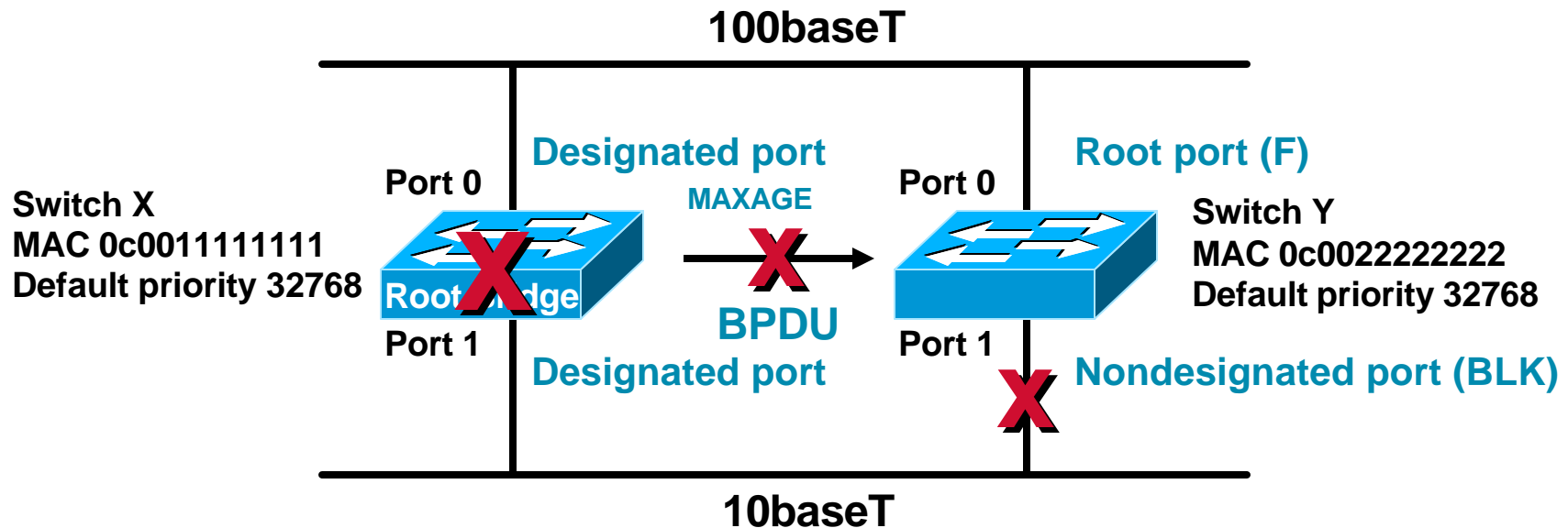
Spanning-tree transitions each port through several different state:



Spanning-Tree Recalculation



Spanning-Tree Recalculation



Key Issue: Time to Convergence

- **Convergence occurs when all the switch and bridge ports have transitioned to either the forwarding or blocking state**
- **When network topology changes, switches and bridges must recompute the Spanning-Tree Protocol, which disrupts user traffic**

Bridging Compared to LAN Switching

Bridging

Primarily software based

One spanning-tree instance per bridge

Usually up to 16 ports per bridge

LAN Switching

Primarily hardware based (ASIC)

Many spanning-tree instances per switch

More ports on a switch

Transmitting Frames Through a Switch

Cut-through

- **Switch checks destination address and immediately begins forwarding frame**



Transmitting Frames through a Switch

Cut-through

- Switch checks destination address and immediately begins forwarding frame



Store and forward

- Complete frame is received and checked before forwarding



Transmitting Frames through a Switch

Cut-through

Store and forward



Fragment free
(modified cut-through)—Cat1900 Default

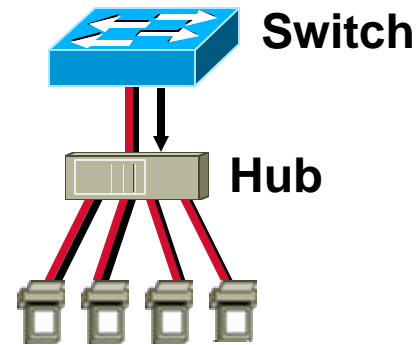
- Switch checks the first 64 bytes then immediately begins forwarding frame



Duplex Overview

Half duplex (CSMA/CD)

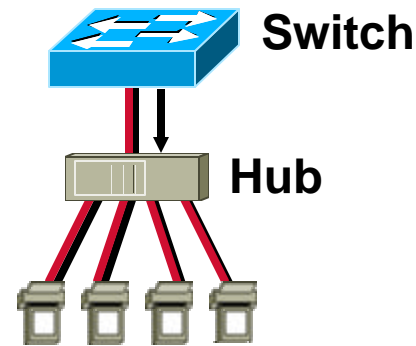
- Unidirectional data flow
- Higher potential for collision
- Hubs connectivity



Duplex Overview

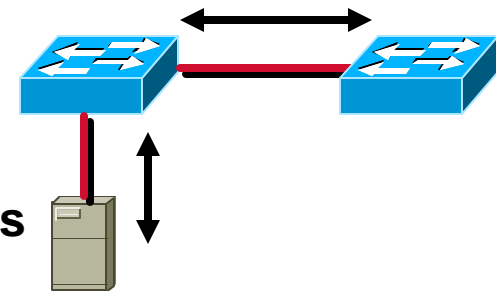
Half duplex (CSMA/CD)

- Unidirectional data flow
- Higher potential for collision
- Hubs connectivity



Full duplex

- Point-to-point only
- Attached to dedicated switched port
- Requires full-duplex support on both ends
- Collision free
- Collision detect circuit disabled



Configuring the Switch



- **Catalyst 1900**
 - Menu driven interface
 - Web-based VSM
(Visual Switch Manager)
 - IOS CLI
(command-line interface)

Catalyst 1900 Default Configurations

- **IP address: 0.0.0.0**
- **CDP: Enabled**
- **Switching mode: fragment free**
- **100baseT port: Auto-negotiate duplex mode**
- **10baseT port: Half duplex**
- **Spanning Tree: Enabled**
- **Console password: none**

Ports on the Catalyst 1900

	Cat1912	Cat1924
10baseT ports	e0/1 to e0/12	e0/1 to e0/24
AUI port	e0/25	e0/25
100baseT uplink ports	fa0/26 (port A) fa0/27 (port B)	fa0/26 (port A) fa0/27 (port B)

Ports on the Catalyst 1900

```
wg_sw_d#sh run
```

```
Building configuration...
```

```
Current configuration:
```

```
!  
!  
interface Ethernet 0/1  
!  
interface Ethernet 0/2
```

```
wg_sw_d#sh span
```

```
Port Ethernet 0/1 of VLAN1 is Forwarding
```

```
Port path cost 100, Port priority 128
```

```
Designated root has priority 32768, address 0090.8673.3340
```

```
Designated bridge has priority 32768, address 0090.8673.3340
```

```
Designated port is Ethernet 0/1, path cost 0
```

```
Timers: message age 20, forward delay 15, hold 1
```

```
wg_sw_a#show vlan-membership
```

Port	VLAN	Membership	Type	Port	VLAN	Membership	Type
1	5	Static	13	1	Static		
2	1	Static		14	1	Static	
3	1	Static		15	1	Static	

Configuring the Switch

- **Configuration Modes**



Global configuration mode

```
wg_sw_a# conf term
```

```
wg_sw_a(config)#
```

Interface configuration mode

```
wg_sw_a(config)# interface e0/1
```

```
wg_sw_a(config-if)#
```

Configuring the Switch IP Address

```
wg_sw_a(config)#
```

```
ip address {ip address} {mask}
```

Configuring the Switch IP Address

```
wg_sw_a(config)#
```

```
ip address {ip address} {mask}
```

```
wg_sw_a(config)#ip address 10.5.5.11 255.255.255.0
```

Configuring the Switch Default Gateway

```
wg_sw_a(config)#
```

```
ip default-gateway {ip address}
```

Configuring the Switch Default Gateway

```
wg_sw_a(config)#
```

```
ip default-gateway {ip address}
```

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

Showing the Switch IP Address

```
wg_sw_a#show ip
IP address: 10.5.5.11
Subnet mask: 255.255.255.0
Default gateway: 10.5.5.3
Management VLAN: 1
Domain name:
Name server 1: 0.0.0.0
Name server 2: 0.0.0.0
HTTP server: Enabled
HTTP port: 80
RIP: Enabled
wg_sw_a#
```

Speed and Duplex Options

```
wg_sw_a(config)#interface e0/1  
wg_sw_a(config-if)#
```

```
duplex {auto | full | full-flow-control | half}
```


Setting Duplex Options

```
wg_sw_a(config)#interface e0/1  
wg_sw_a(config-if)#
```

```
duplex {auto | full | full-flow-control | half}
```

```
wg_sw_a(config-if)#duplex half
```

Showing Duplex Options

```
wg_sw_a#sh interfaces
```

```
Ethernet 0/1 is Enabled  
Hardware is Built-in 10Base-T  
Address is 0090.8673.3341  
MIU 1500 bytes, BW10000 Kbits  
802.1d STP State: Forwarding      Forward Transitions: 1  
Port monitoring: Disabled  
Unknown unicast flooding: Enabled  
Unregistered multicast flooding: Enabled  
Description:  
Duplex setting: Half duplex  
Back pressure: Disabled
```

Receive Statistics		Transmit Statistics	
-----		-----	
Total good frames	44841	Total frames	404502
Total octets	4944550	Total octets	29591574
Broadcast/multicast frames	31011	Broadcast/multicast frames	390913
Broadcast/multicast octets	3865029	Broadcast/multicast octets	28478154
Good frames forwarded	44832	Deferrals	0
Frames filtered	9	Single collisions	0
Runt frames	0	Multiple collisions	0
No buffer discards	0	Excessive collisions	0
Errors:		Queue full discards	0
FCS errors	0	Errors:	
Alignment errors	0	Late collisions	0
Giant frames	0	Excessive deferrals	0
Address violations	0	Jabber errors	0
		Other transmit errors	0

Duplex Mismatches

- **The manually set duplex parameter differs between connected ports**
- **The switch port is in autonegotiate and the attached port is set to full duplex with no auto-negotiation capability causing the switch port to be in half-duplex mode**

FCS and Late Collision Errors

```
wg_sw_a#show interfaces
```

```
Ethernet 0/1 is Enabled  
Hardware is Built-in 10Base-T  
Address is 0090.8673.3341  
MIU 1500 bytes, BW10000 Kbits  
802.1d STP State: Forwarding      Forward Transitions: 1  
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Description:  
Duplex setting: Half duplex  
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```

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		Queue full discards	0
Errors:		Errors:	
FCS errors	0	Late collisions	0
Alignment errors	0	Excessive deferrals	0
Giant frames	0	Jabber errors	0
Address violations	0	Other transmit errors	0

Managing Mac Address Table

```
wg_sw_a#show mac-address-table
```

Managing Mac Address Table

```
wg_sw_a#show mac-address-table
```

```
wg_sw_a#sh mac-address-table
```

```
Number of permanent addresses : 0
```

```
Number of restricted static addresses : 0
```

```
Number of dynamic addresses : 6
```

Address	Dest Interface	Type	Source Interface List
00E0.1E5D.AE2F	Ethernet 0/2	Dynamic	All
00D0.588F.B604	FastEthernet 0/26	Dynamic	All
00E0.1E5D.AE2B	FastEthernet 0/26	Dynamic	All
0090.273B.87A4	FastEthernet 0/26	Dynamic	All
00D0.588F.B600	FastEthernet 0/26	Dynamic	All
00D0.5892.38C4	FastEthernet 0/27	Dynamic	All

Setting Permanent MAC Address

wg_sw_a(config)#

```
mac-address-table permanent {mac-address type module/port}
```

Setting Permanent MAC Address

wg_sw_a(config)#

```
mac-address-table permanent {mac-address type module/port}
```

wg_sw_a(config)#mac-address-table permanent 2222.2222.2222 ethernet 0/3

Setting Permanent MAC Address

wg_sw_a(config)#

```
mac-address-table permanent {mac-address type module/port}
```

wg_sw_a(config)#mac-address-table permanent 2222.2222.2222 ethernet 0/3

wg_sw_a#sh mac-address-table

Number of permanent addresses : 1

Number of restricted static addresses : 0

Number of dynamic addresses : 4

Address	Dest Interface	Type	Source Interface List
00E0.1E5D.AE2F	Ethernet 0/2	Dynamic	All
2222.2222.2222	Ethernet 0/3	Permanent	All
00D0.588F.B604	FastEthernet 0/26	Dynamic	All
00E0.1E5D.AE2B	FastEthernet 0/26	Dynamic	All
00D0.5892.38C4	FastEthernet 0/27	Dynamic	All

Setting Restricted Static MAC Address

wg_sw_a(config)#

```
mac-address-table restricted static {mac-address type module/port src-if-list}
```

Setting Restricted Static MAC Address

```
wg_sw_a(config)#
```

```
mac-address-table restricted static {mac-address type module/port src-if-list}
```

```
wg_sw_a(config)#mac-address-table restricted static 1111.1111.1111 e0/4 e0/1
```

Setting Restricted Static MAC Address

```
wg_sw_a(config)#
```

```
mac-address-table restricted static {mac-address type module/port src-if-list}
```

```
wg_sw_a(config)#mac-address-table restricted static 1111.1111.1111 e0/4 e0/1
```

```
wg_sw_a#sh mac-address-table
```

```
Number of permanent addresses : 1
```

```
Number of restricted static addresses : 1
```

```
Number of dynamic addresses : 4
```

Address	Dest Interface	Type	Source Interface List
1111.1111.1111	Ethernet 0/4	Static	Et0/1
00E0.1E5D.AE2F	Ethernet 0/2	Dynamic	All
2222.2222.2222	Ethernet 0/3	Permanent	All
00D0.588F.B604	FastEthernet 0/26	Dynamic	All
00E0.1E5D.AE2B	FastEthernet 0/26	Dynamic	All
00D0.5892.38C4	FastEthernet 0/27	Dynamic	All

Configuring Port Security

wg_sw_a(config-if)#

port secure [max-mac-count *count*]

- **Configures an interface to be a secured port**
- **Define a maximum number of mac addresses allowed in the address table for this port**
- **Count can be from 1 to 132**
- **Default is 132**

Configuring Port Security

wg_sw_a(config-if)#

port secure [max-mac-count *count*]

- **Configures an interface to be a secured port**
- **Define a maximum number of mac addresses allowed in the address table for this port**
- **Count can be from 1 to 132**
- **Default is 132**

wg_sw_a(config)#interface e0/4

wg_sw_a(config-if)#port secure

wg_sw_a(config-if)#port secure max-mac-count 1

Configuring Port Security

```
wg_sw_a#show mac-address-table security
```

```
wg_sw_a#show mac-address-table security  
Action upon address violation : Suspend
```

Interface	Addressing Security	Address Table Size
Ethernet 0/1	Disabled	N/A
Ethernet 0/2	Disabled	N/A
Ethernet 0/3	Disabled	N/A
Ethernet 0/4	Enabled	1
Ethernet 0/5	Disabled	N/A
Ethernet 0/6	Disabled	N/A
Ethernet 0/7	Disabled	N/A
Ethernet 0/8	Disabled	N/A
Ethernet 0/9	Disabled	N/A
Ethernet 0/10	Disabled	N/A
Ethernet 0/11	Disabled	N/A
Ethernet 0/12	Disabled	N/A

Configuring Port Security

```
wg_sw_a#show mac-address-table security
```

```
wg_sw_a#show mac-address-table security  
Action upon address violation : Suspend
```

Interface	Addressing Security	Address Table Size
Ethernet 0/1	Disabled	N/A
Ethernet 0/2	Disabled	N/A
Ethernet 0/3	Disabled	N/A
Ethernet 0/4	Enabled	1
Ethernet 0/5	Disabled	N/A
Ethernet 0/6	Disabled	N/A
Ethernet 0/7	Disabled	N/A
Ethernet 0/8	Disabled	N/A
Ethernet 0/9	Disabled	N/A
Ethernet 0/10	Disabled	N/A
Ethernet 0/11	Disabled	N/A
Ethernet 0/12	Disabled	N/A

```
wg_sw_a(config)#address-violation {suspend | disable | ignore}
```


Show Version

```
wg_sw_a#show version
```

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

```
Version V8.01.01
```

```
Copyright (c) Cisco Systems, Inc. 1993-1998
```

```
ROM System Bootstrap, Version 3.03
```

```
wg_sw_d uptime is 8day(s) 17hour(s) 53minute(s) 25second(s)
```

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

```
Hardware board revision is 1
```

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

```
Config File Status: File wgsd.cfg downloaded from 10.1.1.1
```

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

```
Base Ethernet Address: 00-90-86-73-33-40
```

```
wg_sw_a#
```

Managing Configuration File

To send the configuration to a TFTP server:

wg_sw_a#

```
copy nvram tftp://host/dst_file
```

Managing Configuration File

To send the configuration to a TFTP server:

wg_sw_a#

```
copy nvram tftp://host/dst_file
```

To download the configuration from a TFTP server:

wg_sw_a#

```
copy tftp://host/src_file nvram
```

Managing Configuration File

To send the configuration to a TFTP server:

wg_sw_a#

```
copy nvram tftp://host/dst_file
```

To download the configuration from a TFTP server:

wg_sw_a#

```
copy tftp://host/src_file nvram
```

```
wg_sw_a#copy nvram tftp://10.1.1.1/wgswd.cfg  
Configuration upload is successfully completed
```

```
wg_sw_a#copy tftp://10.1.1.1/wgswd.cfg nvram  
TFTP successfully downloaded configuration file
```

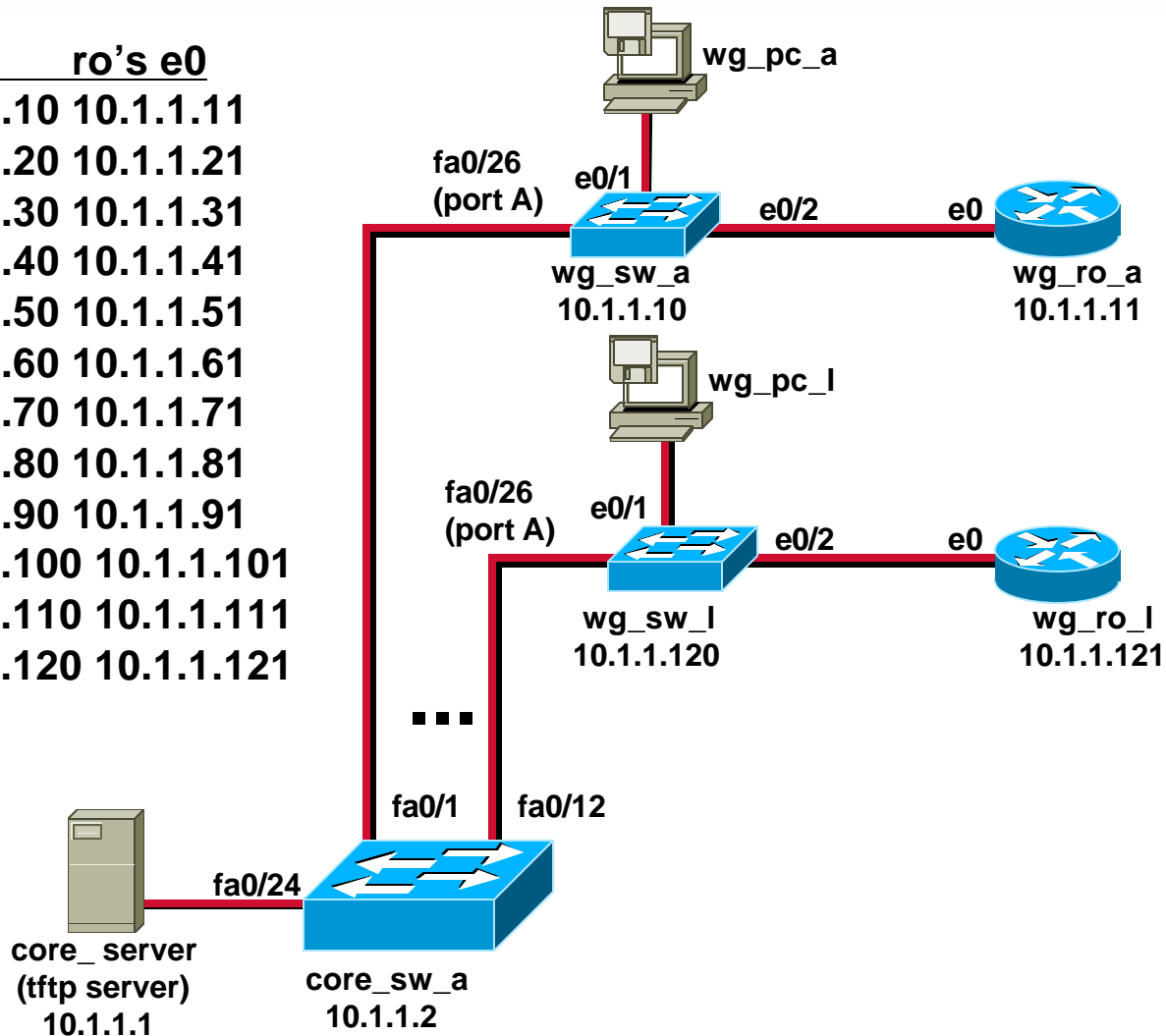
Clear NVRAM

```
wg_sw_d#delete nvram
```

- Resets the system configuration to factory defaults.

Visual Objective

pod	sw	ro's e0
A	10.1.1.10	10.1.1.11
B	10.1.1.20	10.1.1.21
C	10.1.1.30	10.1.1.31
D	10.1.1.40	10.1.1.41
E	10.1.1.50	10.1.1.51
F	10.1.1.60	10.1.1.61
G	10.1.1.70	10.1.1.71
H	10.1.1.80	10.1.1.81
I	10.1.1.90	10.1.1.91
J	10.1.1.100	10.1.1.101
K	10.1.1.110	10.1.1.111
L	10.1.1.120	10.1.1.121



Summary

After completing this chapter, you should be able to perform the following tasks:

- **Describe Layer 2 switching (bridging) operations**
- **Describe the Catalyst 1900 switch operations**
- **Describe the Catalyst 1900 switch's default configuration**
- **Configure Catalyst 1900 switch**
- **Use show commands to verify Catalyst 1900 switch configuration and operations**