Network Admin

Class 2 - Switching

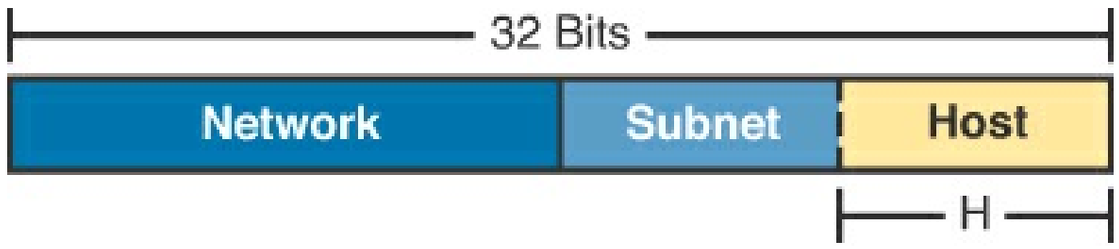
By Ian Robert Blair, M.Sc.

Agenda

- Hubs, Switching, and Bridges
- Forwarding and Internal Processing
- Intro to VLANs
- Telnet
- Show/Debug
- Memory

Number of Hosts per Subnet

- The subnet mask determines the size of the subnet
- The mask sets aside a number of host bits
- The number of hosts on a subnet is determined by 2^x-2
- So, a class B address with a subnet mask of 255.255.255.0
  - 16 bits for network
  - 8 bits for subnet
  - 8 for hosts = 2^8 - 2 = 254 possible host addresses



Number of Networks per Subnet

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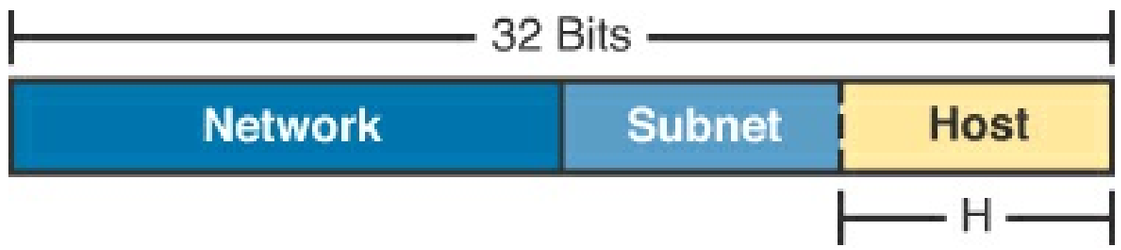


Broadcast and Range

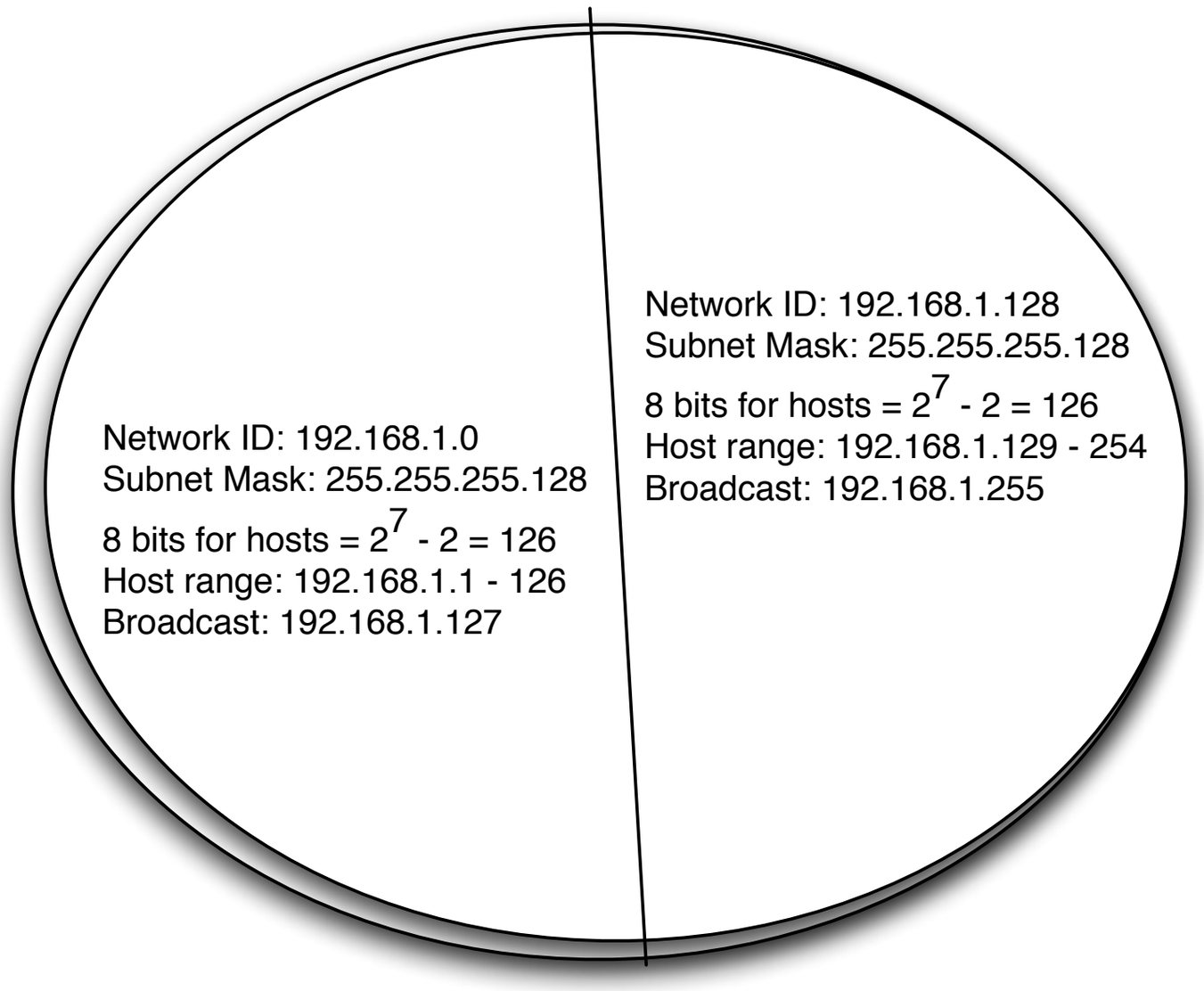
- The broadcast address is a reserved number in each subnet that, when used as the destination address of a packet, causes the routers to forward the packet to all hosts in that subnet
- The broadcast is the highest number in the subnet
- The range is the first usable IP address in a subnet to the last usable address
- So, for example:
  - If 192.168.1.0 is the network ID
  - Subnet mask is 255.255.255.0
  - The broadcast is 192.168.1.255
  - The range is 192.168.1.1 - 254

Practice 1

- What is the subnet ID, range, and broadcast for these IP Addresses?

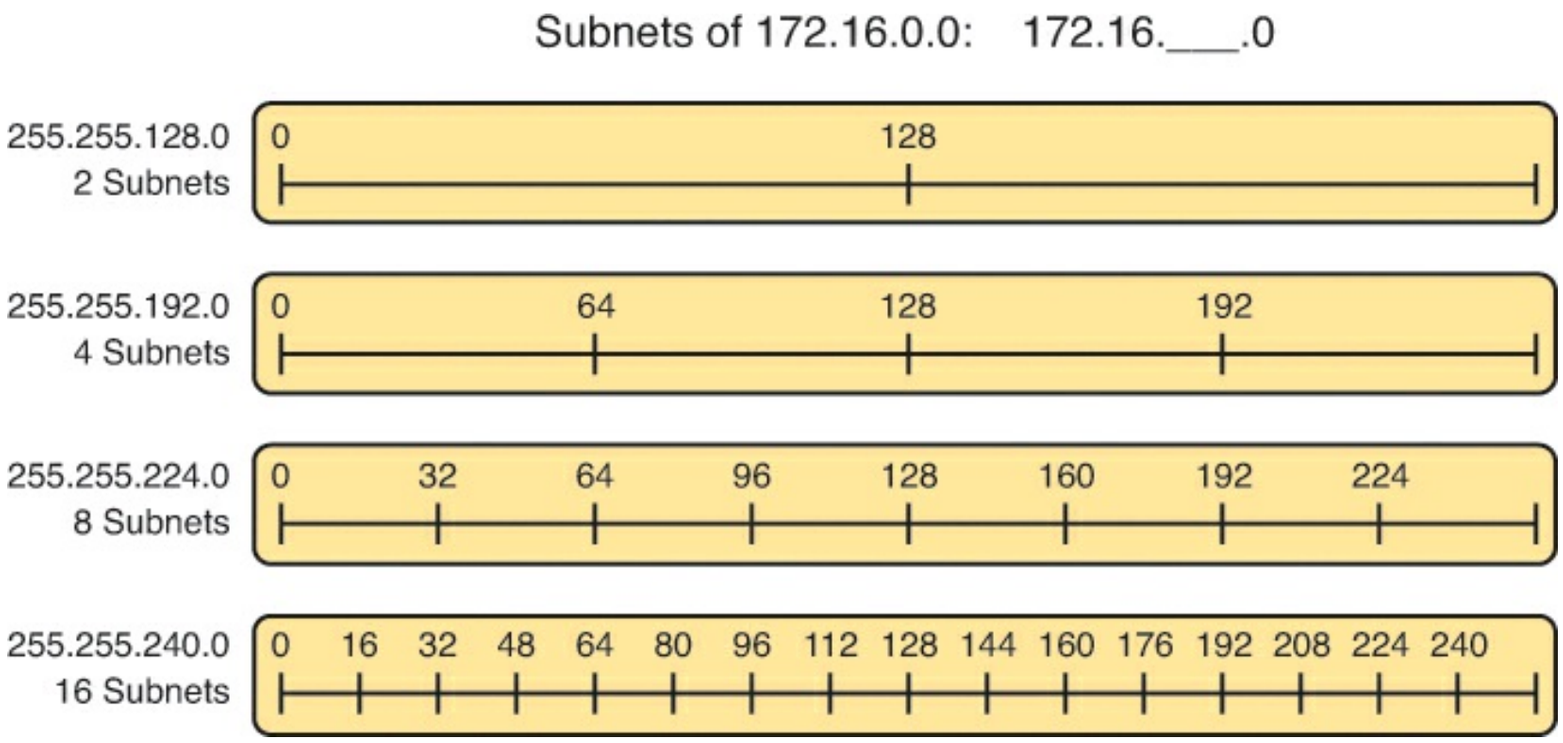
192.168.6.54	255.255.255.0
10.77.3.14	255.255.0.0
172.22.55.77	255.255.0.0
1.99.53.76	255.0.0.0

Subnets, pt. 1


Network ID: 192.168.1.0
Subnet Mask: 255.255.255.128
8 bits for hosts = 2^7 - 2 = 126
Host range: 192.168.1.1 - 126
Broadcast: 192.168.1.127
Network ID: 192.168.1.128
Subnet Mask: 255.255.255.128
8 bits for hosts = 2^7 - 2 = 126
Host range: 192.168.1.129 - 254
Broadcast: 192.168.1.255

Subnets, pt. 2

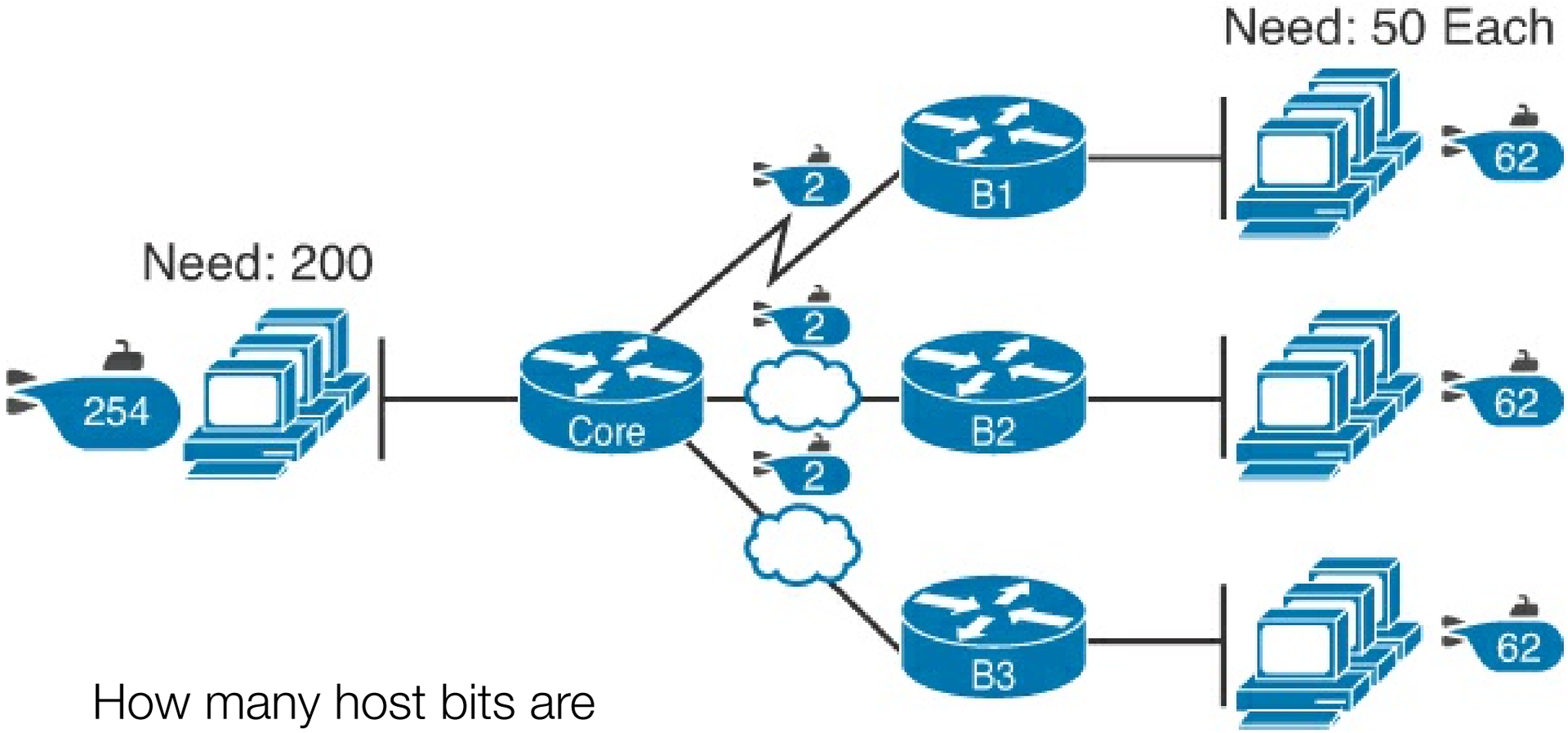
- To find a network ID for a more complex subnet, start with a IP address and mask
- Calculate the boundaries of the subnets (256 - mask)
- Locate the one that the address is within



Practice

Problem	IP Address	Mask	Subnet ID
1	10.77.55.3	255.248.0.0	
2	172.30.99.4	255.255.192.0	
3	192.168.6.54	255.255.255.252	
4	10.77.3.14	255.255.128.0	
5	172.22.55.77	255.255.254.0	
6	1.99.53.76	255.255.255.248	

Intro to VLSM



How many host bits are required for these subnets?

Possible Subnet Values

Binary Mask Octet	Decimal Equivalent	Number of Binary 1s
00000000	0	0
10000000	128	1
11000000	192	2
11100000	224	3
11110000	240	4
11111000	248	5
11111100	252	6
11111110	254	7
11111111	255	8

Sample Conversions

Binary Mask	Logic	Decimal Mask
11111111 11111111 11000000 00000000	11111111 maps to 255 11000000 maps to 192 00000000 maps to 0	255.255.192.0
11111111 11111111 11111111 11110000	11111111 maps to 255 11110000 maps to 240	255.255.255.240
11111111 11111000 00000000 00000000	11111111 maps to 255 11111000 maps to 248 00000000 maps to 0	255.248.0.0

Decimal Mask	Logic	Binary Mask
255.255.192.0	255 maps to 11111111 192 maps to 11000000 0 maps to 00000000	**11111111 11111111 11**000000 00000000
255.255.255.240	255 maps to 11111111 240 maps to 11110000	**11111111 11111111 11111111 1111**0000
255.248.0.0	255 maps to 11111111 248 maps to 11111000 0 maps to 00000000	**11111111 11111**000 00000000 00000000

Memory, pt. 1

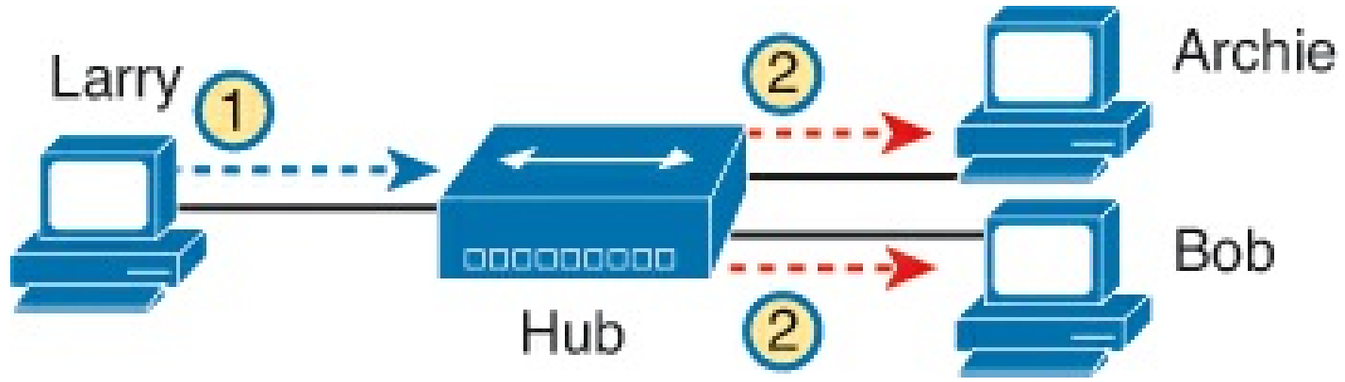
- RAM - Stores running configuration
- ROM - Stores the bootstrap which is responsible for loading the IOS into RAM
- Flash memory - Stores the Cisco IOS and can be used to store backup files
- NVRAM - Stores initial or startup configuration file when switch is loaded

Memory, pt. 2

- copy run start
- copy start run
- copy start tftp
- write erase
- show run
- show interfaces status

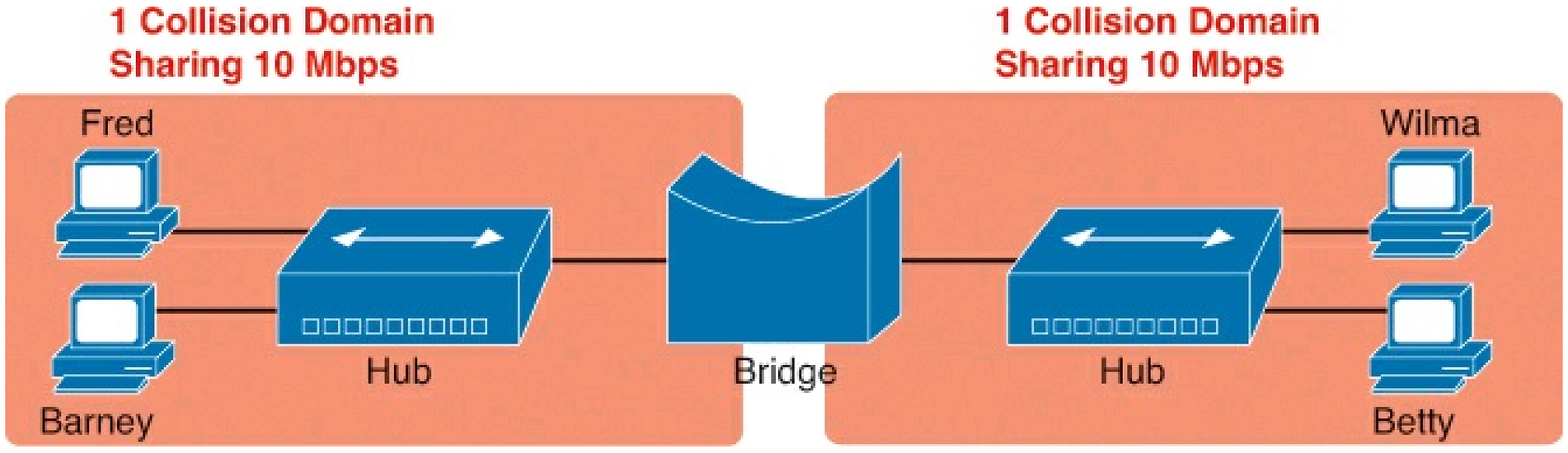
HUBs

- No longer used
- 10Mbps, Half duplex
- All data is repeated out all ports
- Devices have to wait until the wire is free to transmit, possibility of collisions
- CSMA/CD logic required



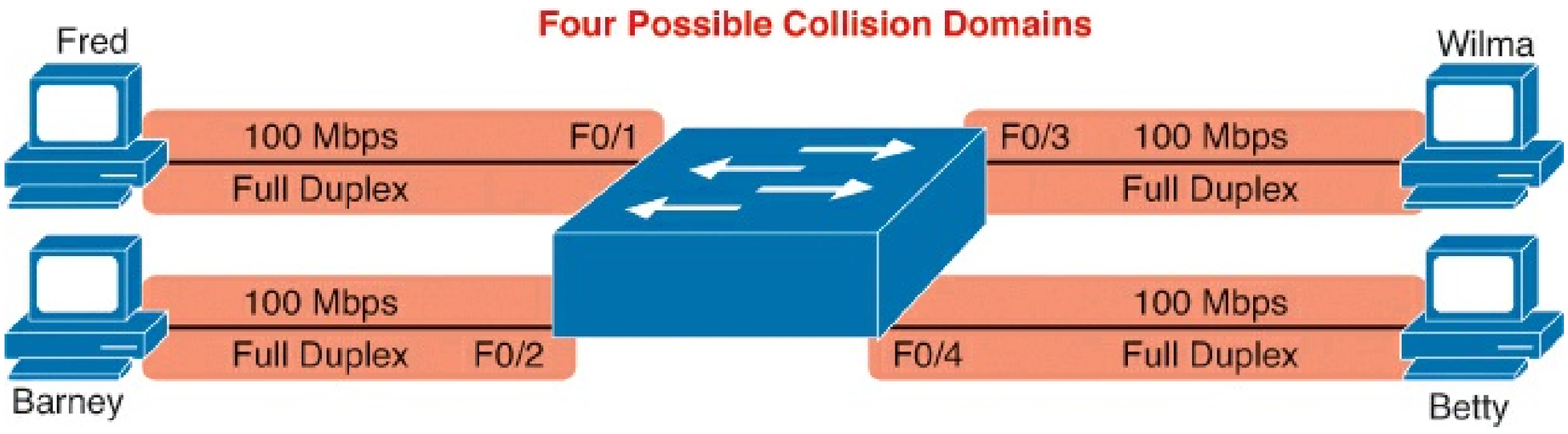
Bridges

- Create multiple collision domains
- Store and forward frames based on MAC address

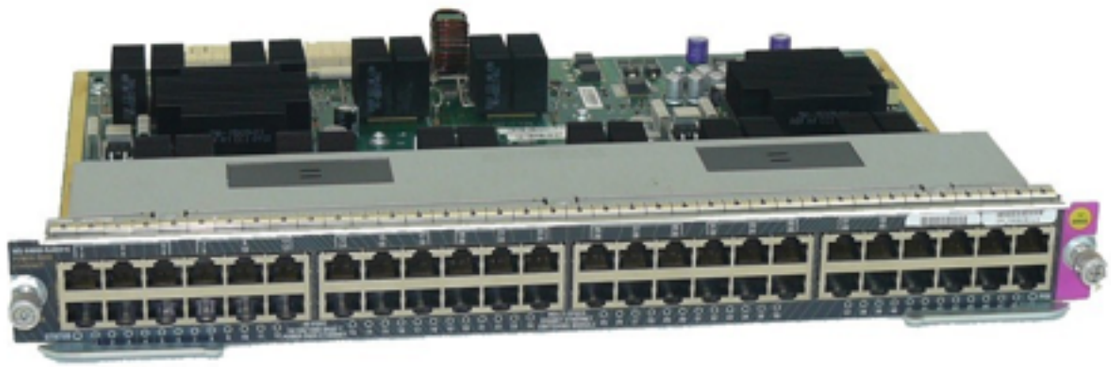


Network Switch

- Store MAC addresses in a table
- Each port on a switch is a separate collision domain
- Use Spanning Tree Protocol to prevent loops when connected other switches and bridges
- Switches can send data at different speeds/duplex on different ports (supports auto-negotiation)

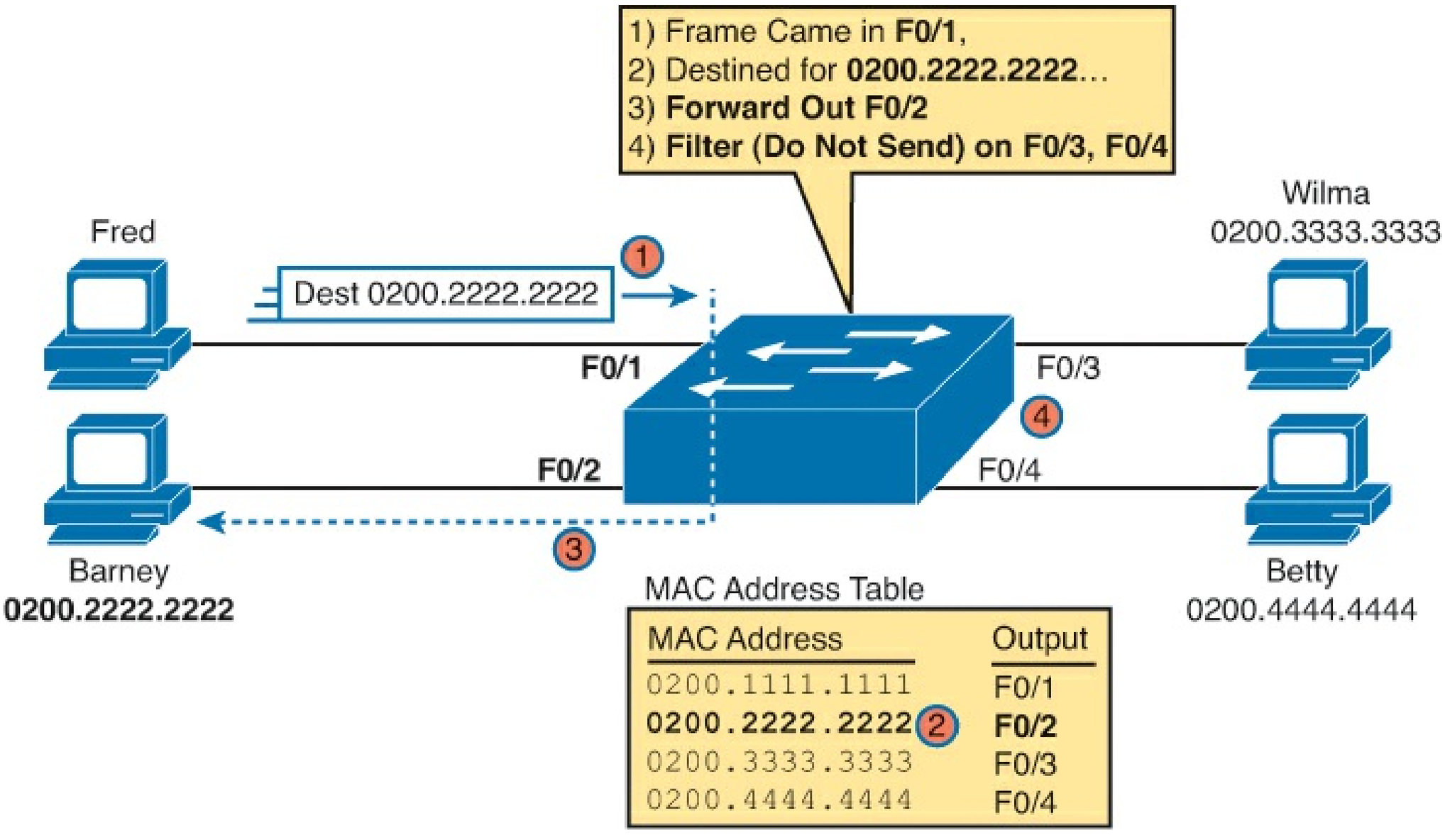


Network Switch

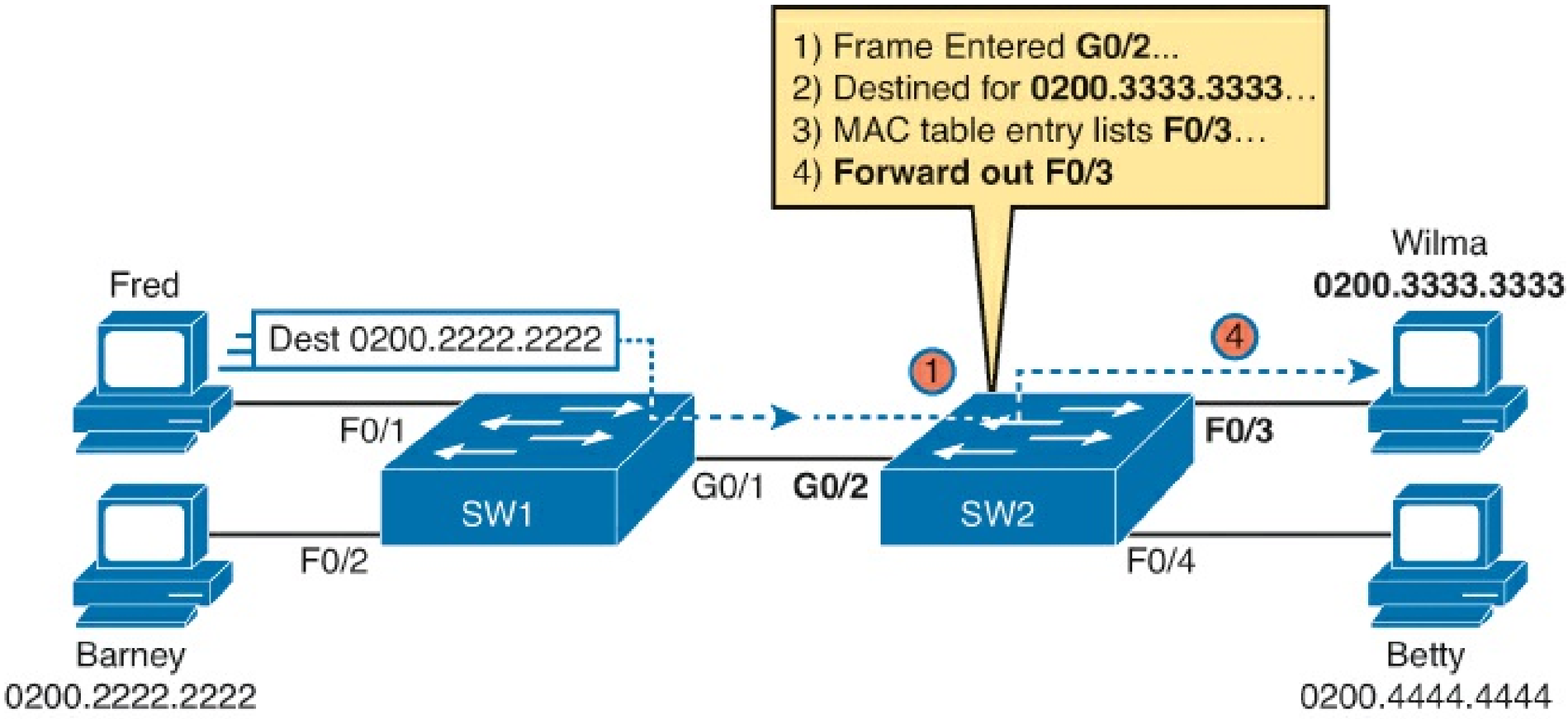


Cisco WS-4648

Forwarding Frames, pt. 1



Forwarding Frames, pt. 2



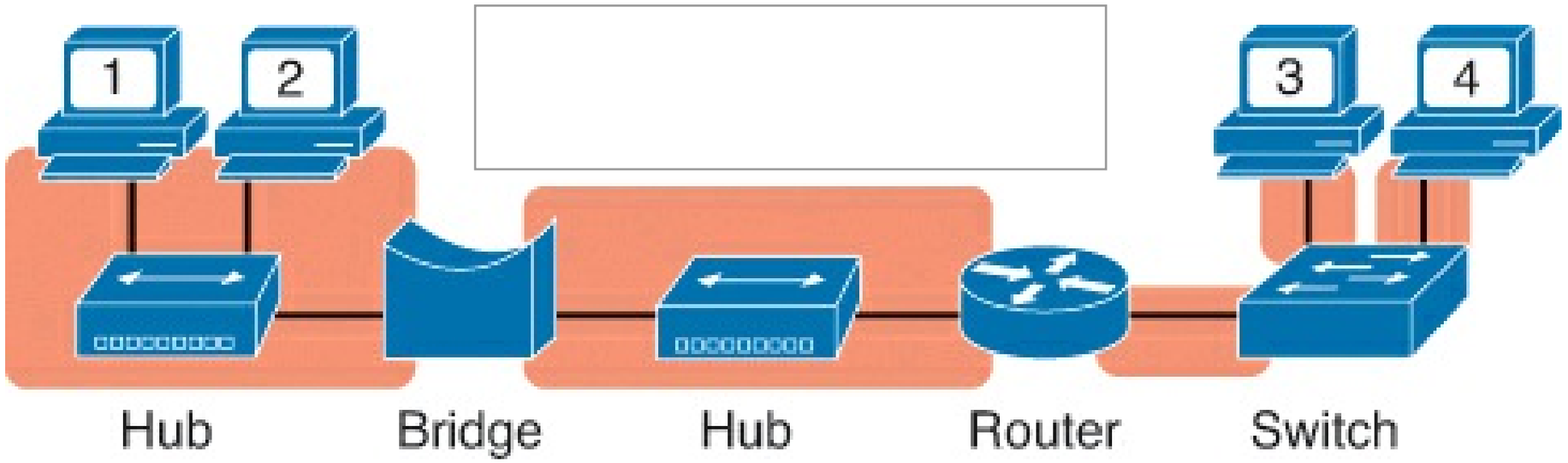
SW1 Address Table

MAC Address	Output
0200.1111.1111	F0/1
0200.2222.2222	F0/2
0200.3333.3333	**G0/1**
0200.4444.4444	G0/1

SW2 Address Table

MAC Address	Output
0200.1111.1111	G0/2
0200.2222.2222	G0/2
0200.3333.3333 (2)	**F0/3** (3)
0200.4444.4444	F0/4

Broadcast/Collision Domain



How many collision domains?

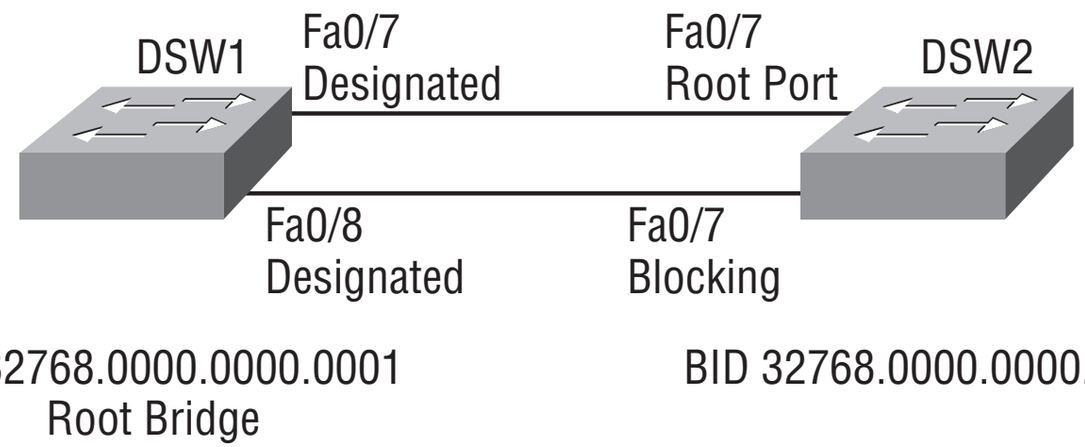
How many broadcast domains?

Spanning Tree

- STP's main task is to stop network loops from occurring on your layer 2 network (bridges or switches)
- STP uses the spanning-tree algorithm (STA) to first create a topology database
- With spanning tree you have the following:
  - **Root bridge** - the bridge with the best bridge ID
  - **BPDU** – is used for switches to exchange information in the selection of the root switch as well as in subsequent configuration of the network
  - **Bridge ID** – Identifies switches in the network
  - **Non-root bridges** – are not the root bridge
  - **Port cost** – helps determine the best path when there are multiple links

Spanning Tree, cont.

- In addition:
  - **Root port** - is always the link directly connected to the root bridge, or the shortest path to the root bridge
  - **Designated port** - is one that has been determined as having the best (lowest) cost
- **Non-designated port** - is one with a higher cost than the designated port
- **Forwarding port** - forwards frames
- **Blocked port** - in order to prevent loops, will not forward frames



Spanning Tree Portfast and BPDU Guard

- Use portfast on access ports (to connect servers, laptops, phones, printers, etc.)
- The port won't spend the usual 50 seconds to come up into forwarding mode while STP is converging

Switch(config-if)#spanning-tree portfast

or globally with:

spanning-tree portfast default

- BPDU guard will automatically disable an access port that receives a BPDU to prevent loops, it's enabled by default by:
  - spanning-tree bpduguard default
- or on a port by
  - spanning-tree bpduguard enable

Spanning Tree Show Commands

- show spanning-tree [brief | detail | summary]
- show spanning-tree interface fa 1/0

Configure Switch Ports

- Cisco ports are known as “interfaces”
- They are usually named Ethernet or Fast Ethernet 0/1 - n (some devices start at 1/0)
- To see all interfaces run:
  - Show interface status
  - show running config

Switch Port Configuration

#hostname SW1
#int range fastEthernet 1/14 - 15
(config-if-range)#int range fastEthernet 1/14 - 15
(config-if-range)#speed 100
(config-if-range)#duplex full
(config-if-range)#switchport mode trunk
(config-if-range)#switchport trunk encapsulation dot1q
spanning-tree vlan 1, 10-20 priority 4096
or
spanning-tree vlan 1, 10 -20 root primary
spanning-tree vlan 1, 10-20 root secondary

Backbonefast

- **BackboneFast** is a Cisco-proprietary feature that can save a switch up to 20 seconds (max_age timer) when it recovers from an indirect link failure

- It does this by having the switch figure out whether or not there is an alternate path to the root bridge

Uplinkfast

- You can set up **UplinkFast** to accelerate the choice of a new root port when a link or switch fails

- UplinkFast also speeds up things when the spanning tree instance reconfigures itself

- UplinkFast is only available when a switch is configured for PVST+

VTP

- **VLAN Trunk Protocol (VTP)** is a Cisco proprietary protocol that allows automation of updating and managing the VLAN database across multiple switches
- Switches that share the same VLAN database are grouped into what is called a VTP domain
- The VLAN database is propagated to all the switches in the same VTP domain
- VTP Modes:
  - Server
  - Client
  - Transparent
- **VTP Pruning** blocks traffic to a VLAN on a switch that doesn’t contain any ports in that VLAN

debug

- Logs cisco events and displays them on the terminal
- Processor intensive
- Used when troubleshooting
- “terminal monitor” command to view debugs when ever logged in to telnet or ssh

Banner

- motd - before login
- login - after login
- exec - after entering exec mode

Additional Commands

- Show history
- exec-timeout 120
- logging sync
- no logging

Show Commands

- View stored mac addresses
    - show mac-address-table

Interface Range Configuration

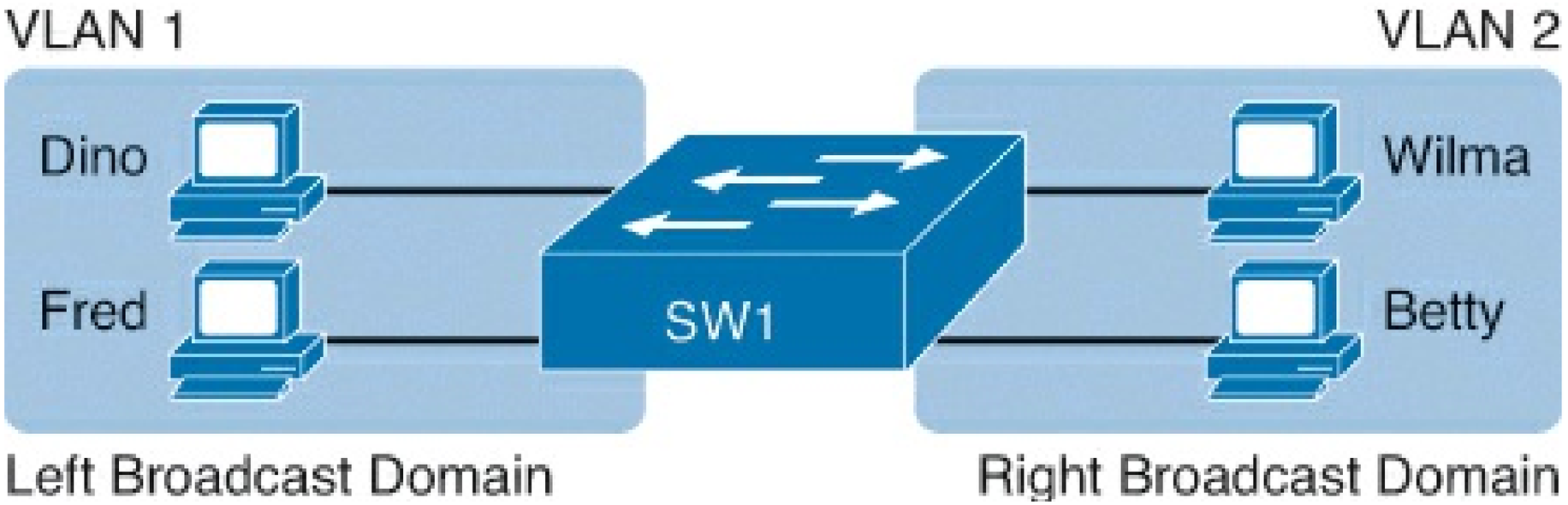
(config) interface range FastEthernet 0/11 - 20

(config-if-range) description end-users

(config-if-range) ^z

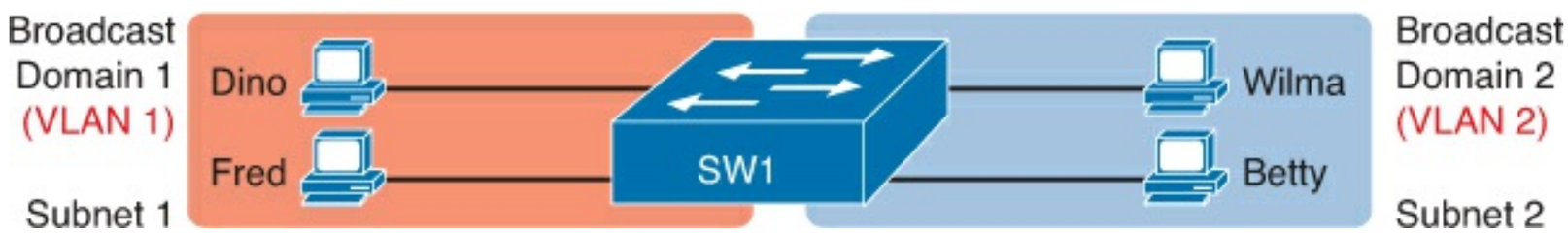
show int status

VLANs


VLAN 1
VLAN 2
Dino
Wilma
Fred
Betty
SW1
Left Broadcast Domain
Right Broadcast Domain

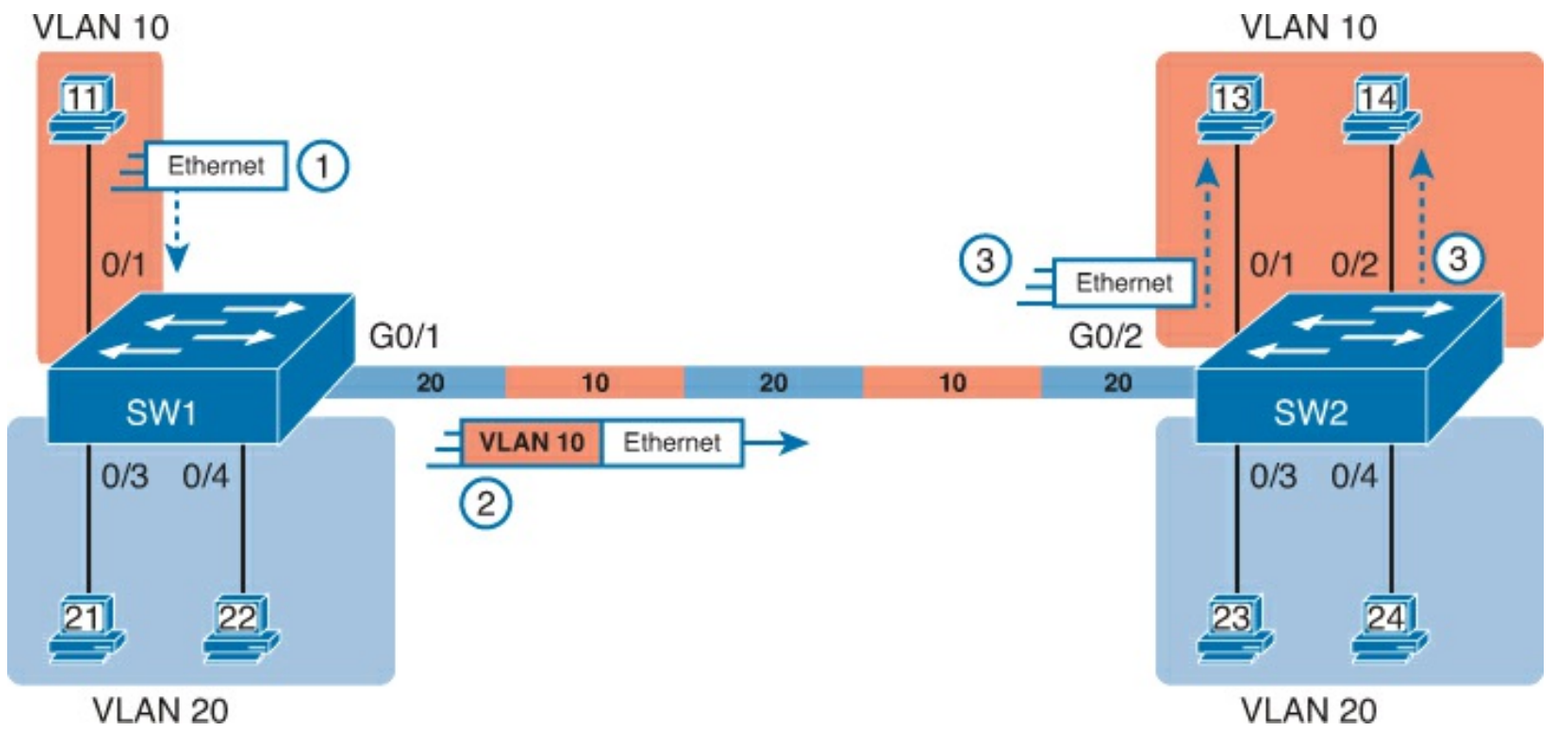
VLANs

- VLANs allow you to create virtual networks on one or more network switches
- VLANs:
  - Reduce security risks by creating boundaries
  - Reduce CPU overhead by limiting the number of devices the receive broadcasts
  - Create more flexible designs that group devices, instead of by physical location
  - Limit problems to a single VLAN or broadcast domain

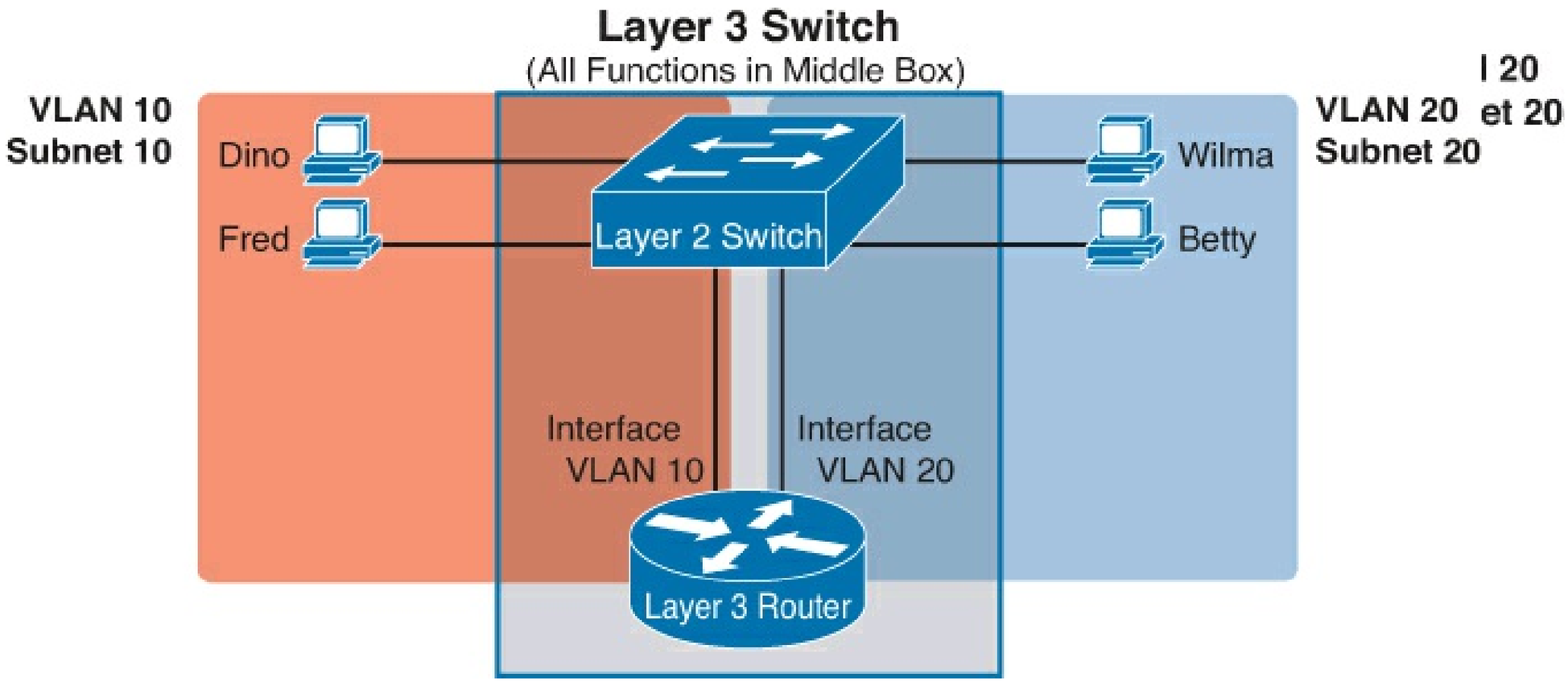


VLAN Trunking

- VLAN trunking (IEEE 802.1Q) creates links between switches
- Switches uses a process called VLAN tagging to add a identifier (VLAN ID) to a frame before sending it over the trunk
- 4094 VLANs supported
- Switches must agree on the native VLAN (untagged)



Inter-VLAN Routing



Assigning VLANs

(config) vlan 20
(config-vlan) name server1
(config-vlan) exit
(config) interface range fa 0/12 - 15
(config-if-range) switchport mode access
(config-if-range) switchport access vlan 20
(config-if-range) ^Z
show vlan brief
show vlan id 20
show interfaces trunk **(will show trunking interfaces)

Assigning VLANS GNS3

- # vlan database
- vlan 20 name MYSQL

Switchport Mode Options

Command Option	Description
access	Always act as an access (nontrunk) port
trunk	Always act as a trunk port
dynamic desirable	Initiates negotiation messages and responds to negotiation messages to dynamically choose whether to start using trunking
dynamic auto	Passively waits to receive trunk negotiation messages, at which point the switch will respond and negotiate whether to use trunking

CDP

- Cisco Discovery Protocol allows devices that share a subnet to share the following information:
  - Device ID (hostname)
  - Address list
  - Port Identifier
  - Capabilities list
  - Platform
- show cdp neighbors [detail]

Create Trunk

- On both sides
- enable
- # config t
- (config)#interface fastEthernet 1/0
- (config-if)#switchport mode trunk
- (config-if)#switchport trunk encapsulation dot1q
- #show int trunk

Router-on-a-Stick

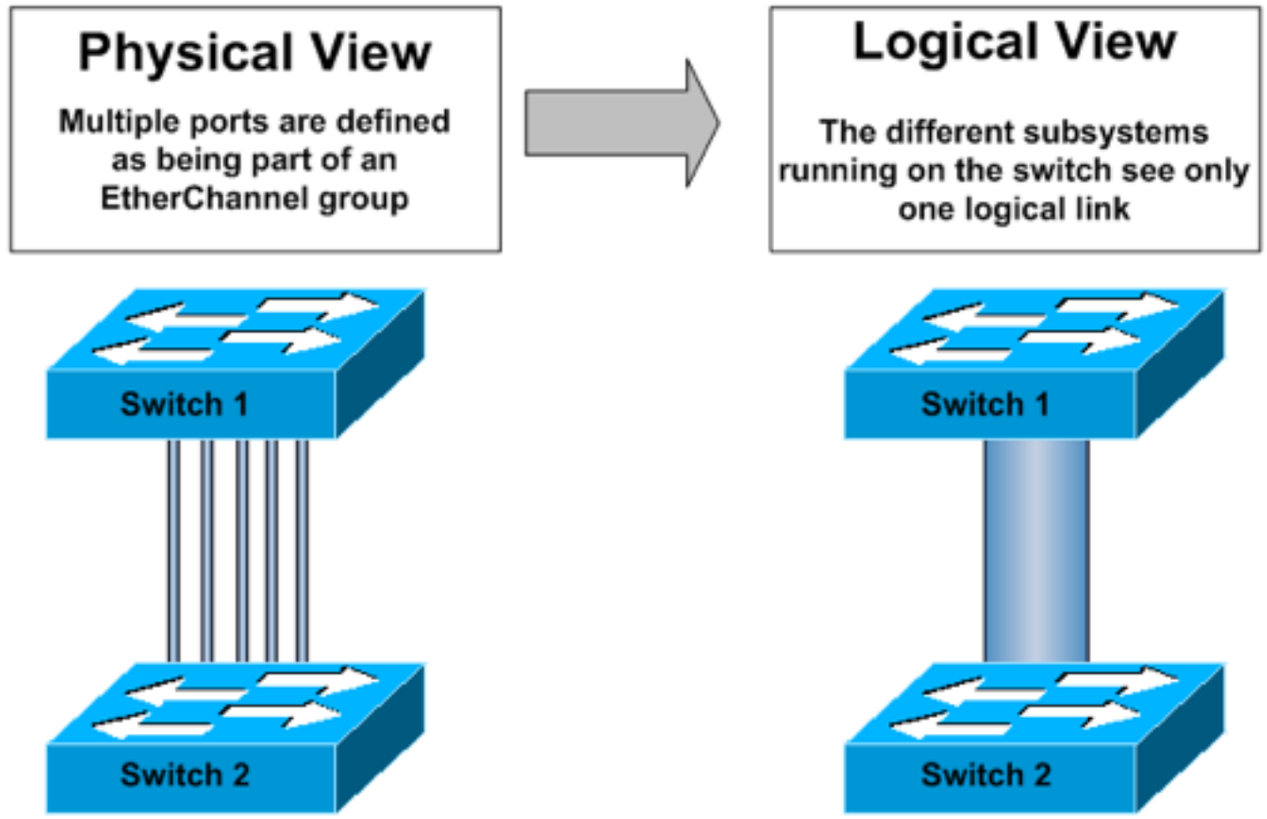
- (config)#int fa 0/0.10
- (config-subif)#description MYSQLGW
- (config-subif)#encapsulation dot1Q 10
- (config-subif)#ip address 192.168.10.1 255.255.255.0
- sh ip int br

Ether-Channel

- **Ether-Channel** is a switch-to-switch technique that inversely multiplexes multiple Fast or Gigabit Ethernet switch ports into one logical channel

- It can also be used to increase the bandwidth to a single server and for redundancy

- It can combine two, four, or eight ports



Ether-Channel Configuration

- On each switch

- (config)#interface port-channel 1
- (config)#interface range fastEthernet 1/14 -15
- (config-if-range)#speed 100
- (config-if-range)#duplex full
- (config-if-range)#switchport mode trunk
- (config-if-range)#switchport trunk encapsulation dot1q
- (config-if-range)#channel-group 1 mode on
- (config-if-range)#exit
- # show etherchannel brief (detail, summary)

Lab

- Using GNS add a switch interface card to a router
- Configure the interface on VLAN1
- Add 2 client computers to GNS and verify connectivity between both computers using a router with a switch card
- Add several VLANs to a switch
- Configure an etherchannel between two routers with switch cards
- Use CDP to gather information about an adjacent router
- Configure router on a stick to router packets between VLAN2 and VLAN3

Homework, pt. 1

- Read Chapter 2 and 3
- Preview Chapter 4 and 5
- Answer the following questions:
  - What is ether-channel? How does it work?
  - What is a VLAN? Why would we use them?
  - What is a root switch? How do I create a root switch?
  - What happens if the root switch fails?
  - How do we route packets between VLANs? (Name 3 ways)

Homework, pt. 2

- Complete the following two tables:

Prefix	Binary Mask	Decimal
	11111111 11111111 11000000 00000000	
		255.255.255.252
/25		
/16		
		255.0.0.0
	11111111 11111111 11111100 00000000	
		255.254.0.0
/27		

Problem	IP Address	Mask	Subnet ID
1	10.77.55.3	255.248.0.0	
2	172.30.99.4	255.255.192.0	
3	192.168.6.54	255.255.255.252	
4	10.77.3.14	255.255.128.0	
5	172.22.55.77	255.255.254.0	
6	1.99.53.76	255.255.255.248	