CyberPatriot Basic Routing

Topic 4 – Basic Routing

- IP addressing a simple network
- Static routing/RIP routing
- L3 Tools (Ping, traceroute)

Cisco Basic Routing Agenda

- Review IP Addressing: 10 min
- Review Basic Routing: 20 min
- Static Routing: 15 min
- Static Routing Lab: 30 min
- RIP Routing: 20 min
- RIP Routing Lab: 20 min

Topics

- Identify a router as a computer with an OS and hardware designed for the routing process.
- Demonstrate the ability to configure devices and apply addresses.
- Describe the structure of a routing table.
- Describe how a router determines a path and switches packets
- Discuss Static and RIP Routing

Router as a Computer

- Describe the basic purpose of a router

  -Computers that specialize in sending packets over the data network. They are responsible for interconnecting networks by selecting the best path for a packet to travel and forwarding packets to their destination

- Routers are the network center

  -Routers generally have multiple network connections:

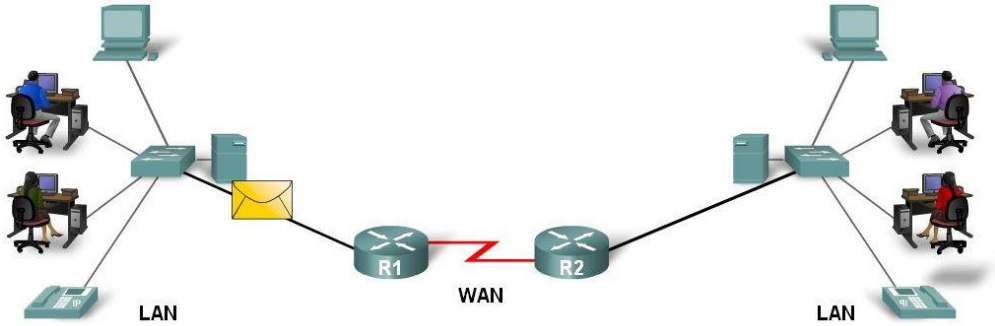
  -WAN connection to ISP

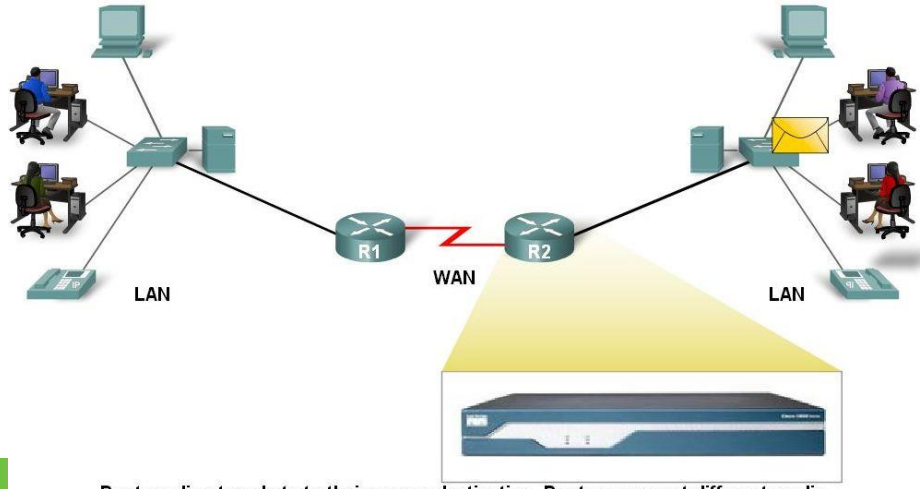
  -WAN connection to other remote sites

  -Multiple LAN connections

Router as a Computer

- Data is sent in form of packets between 2 end devices
- Routers are used to direct packet to its destination

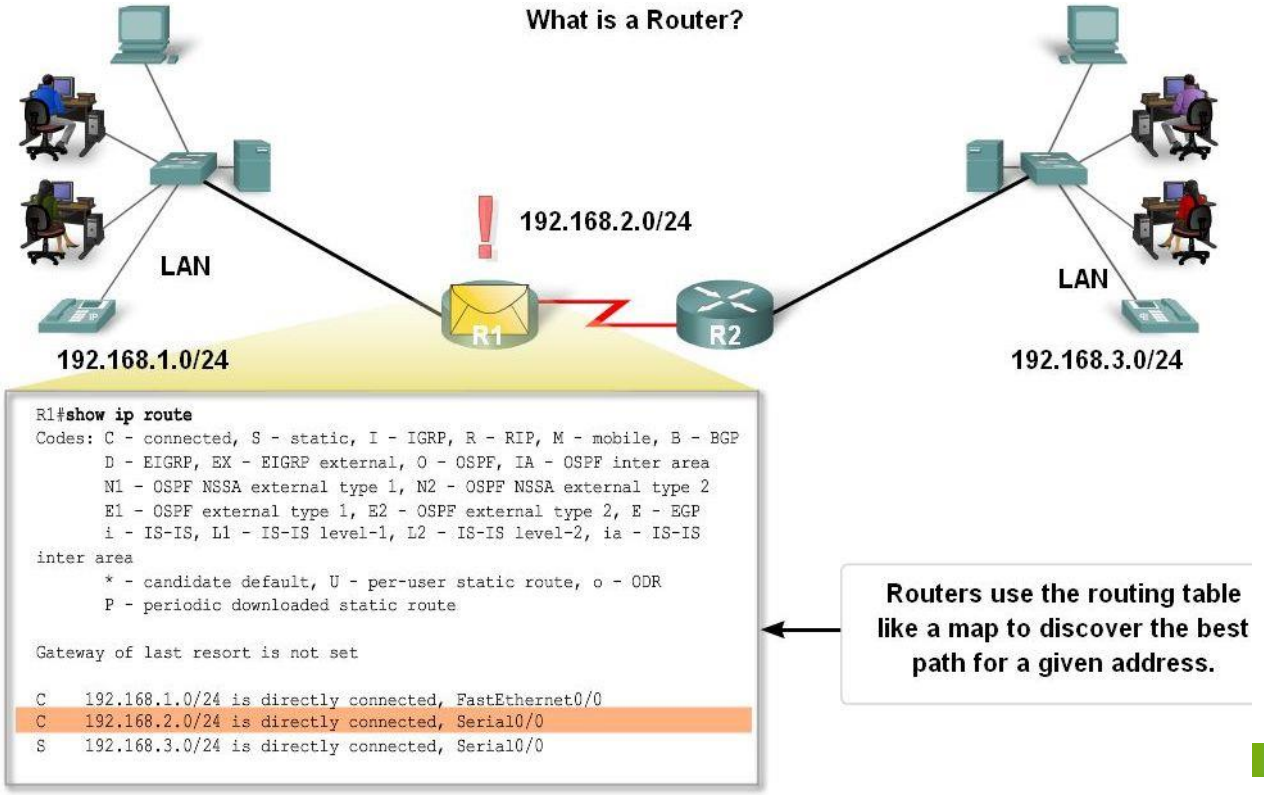




Routers direct packets to their proper destination. Routers connect different media.

Router as a Computer

- Routers examine a packet's destination IP address and determine the best path by enlisting the aid of a routing table

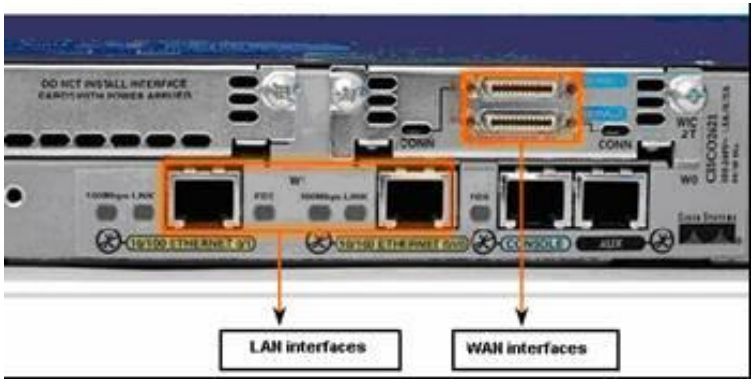


Router as a Computer

- Two major groups of Router Interfaces

  LAN Interfaces:

  - Are used to connect router to LAN network
  - Has a layer 2 MAC address
  - Can be assigned a Layer 3 IP address
  - Usually consist of an RJ-45 jack



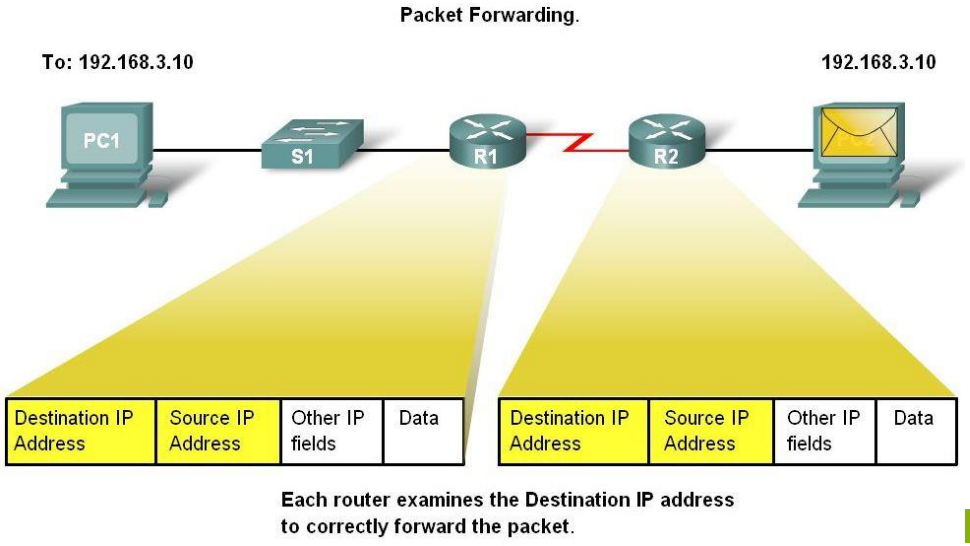
- WAN Interfaces
  - Are used to connect routers to external networks that interconnect LANs.
  - Depending on the WAN technology, a layer 2 address may be used.
  - Uses a layer 3 IP address

Router as a Computer

- Routers and the Network Layer

  Routers use destination IP address to forward packets

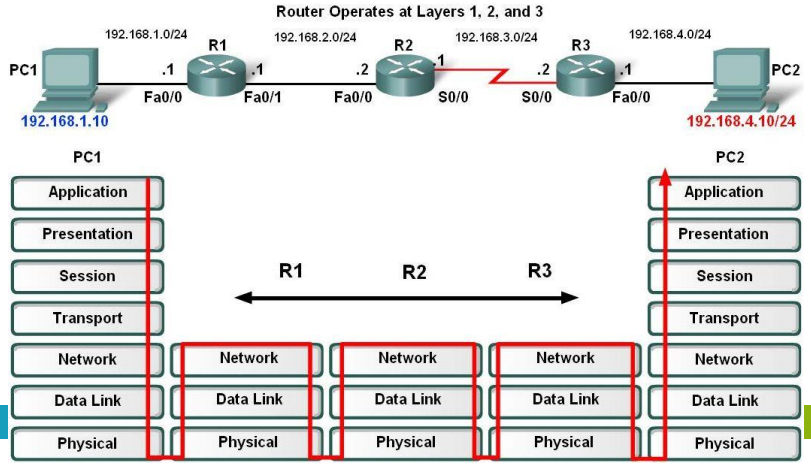
  - The path a packet takes is determined after a router consults information in the routing table.
  - After router determines the best path
  - Packet is encapsulated into a frame
  - Frame is then placed on network medium in form of Bits



Router as a Computer

- Routers Operate at Layers 1, 2 & 3
  - Router receives a stream of encoded bits
  - Bits are decoded and passed to layer 2
  - Router de-encapsulates the frame
  - Remaining packet passed up to layer 3

    -Routing decision made at this layer by examining destination IP address
  - Packet is then re-encapsulated & sent out outbound interface



Configure Devices and Apply Addresses

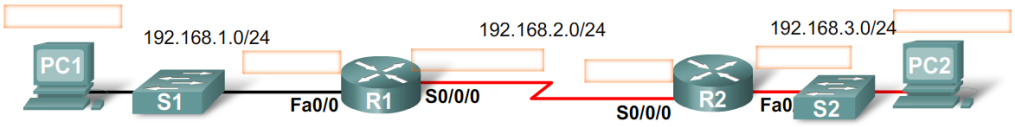
- Implementing Basic Addressing Schemes
- When designing a new network or mapping an existing network you must provide the following information in the form of a document:

  -Topology drawing that Illustrates physical connectivity

  –Address table that provides the following information:

  - Device name
  - Interfaces used
  - IP addresses
  - Default gateway

Documenting an Addressing Scheme



Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	192.168.2.1	255.255.255.0	N/A
R2	Fa0/0		255.255.255.0	N/A
	S0/0/0		255.255.255.0	N/A
PC1	N/A	192.168.1.10	255.255.255.0	192.168.1.1
PC2	N/A		255.255.255.0	

Configure Devices and Apply Addresses

- Verify Basic Router Configuration

  -Issue the *show running-config* command

  -Save the basic router configuration by Issuing the *copy running-config startup-config* command

  -Additional commands that will enable you to further verify router configuration are:

  - Show running-config - Displays configuration currently in RAM
  - Show startup-config - Displays configuration file NVRAM
  - Show IP route - Displays routing table
  - Show interfaces - Displays all interface configurations
  - Show IP int brief - Displays abbreviated interface configuration information

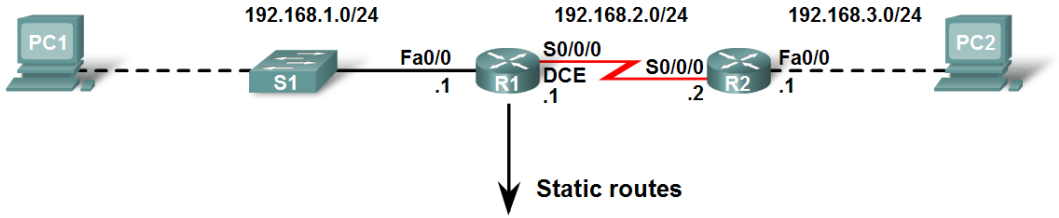
Routing Table Structure

- Routing Table is stored in ram and contains information about:
  - Directly connected networks - this occurs when a device is connected to another router interface
  - Remotely connected networks - this is a network that is not directly connected to a particular router
  - Detailed information about the networks include source of information, network address & subnet mask, and Ip address of next-hop router
- Show ip route command is used to view a routing table

Routing Table Structure

- Adding a connected network to the routing table
  - -Router interfaces
    - Each router interface is a member of a different network
    - Activated using the *no shutdown* command
    - In order for static and dynamic routes to exist in routing table you must have directly connected networks

Connected and Static Routes




```
R1#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
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       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, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
S    192.168.3.0/24 [1/0] via 192.168.2.2
```

Routing Table Structure

- Static routes in the routing table

  -Includes: network address and subnet mask and IP address of next hop router or exit interface

  -Denoted with the code **S** in the routing table

  -Routing tables must contain directly connected networks used to connect remote networks before static or dynamic routing can be used

- When to use static routes

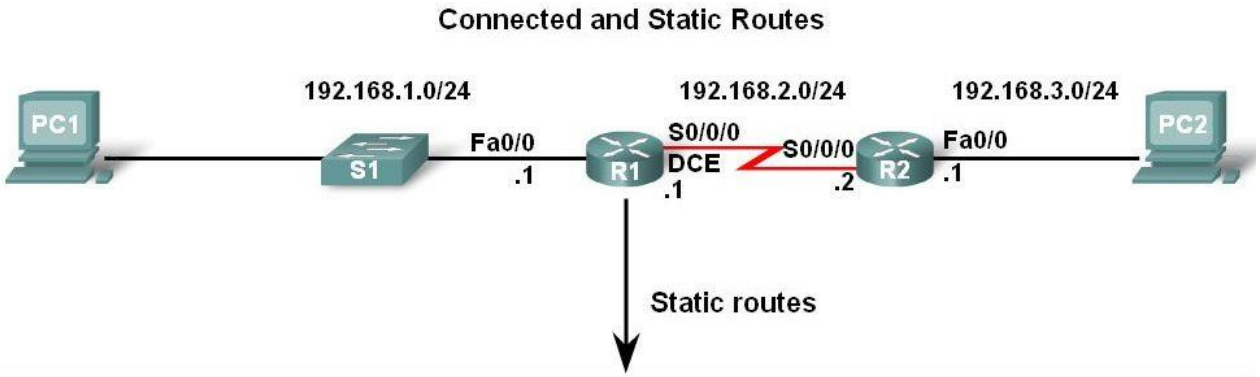
  -When network only consists of a few routers

  -Network is connected to internet only through one ISP

  -Hub & spoke topology is used on a large network

Routing Table Structure

- Connected and Static routes

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Routing Table Structure

- Dynamic routing protocols

  -Used to add remote networks to a routing table

  -Are used to discover networks

  -Are used to update and maintain routing tables

- Automatic network discovery

  -Routers are able discover new networks by sharing routing table information

Routing Table Structure

- Maintaining routing tables

  -Dynamic routing protocols are used to share routing information with other router & to maintain and up date their own routing table.

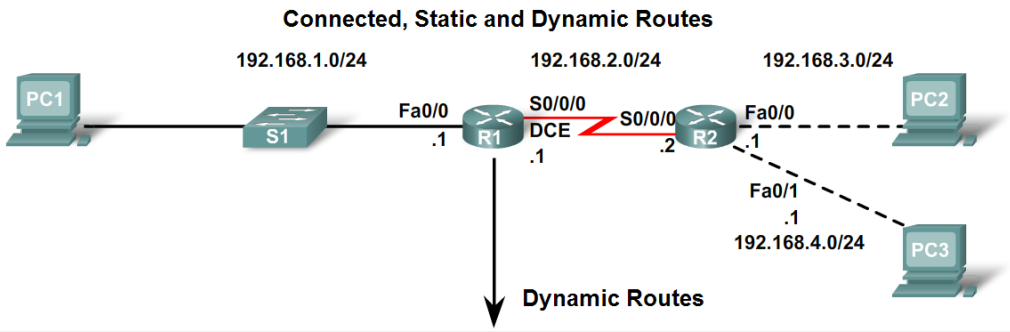
- IP routing protocols. Example of routing protocols include:

  -RIP

  -IGRP

  -EIGRP

  -OSPF

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C    192.168.2.0/24 is directly connected, Serial0/0/0
S    192.168.3.0/24 [1/0] via 192.168.2.2
R    192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:20, Serial0/0/0
```

Routing Table Structure

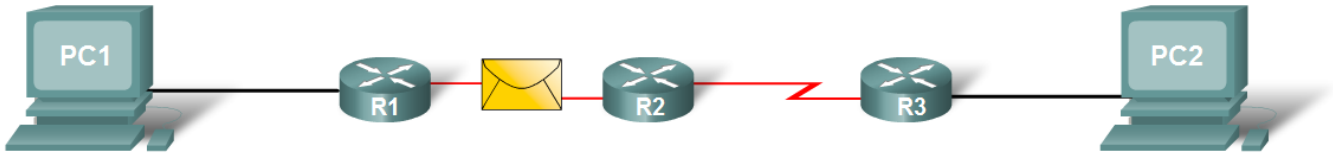
- Routing Table Principles

-3 principles regarding routing tables:

- Every router makes its decisions alone, based on the information it has in its routing table.
- Different routing table may contain different information
- A routing table can tell how to get to a destination but not how to get back

Routing Principle 3 in Action

R1 has a route to PC2's network.

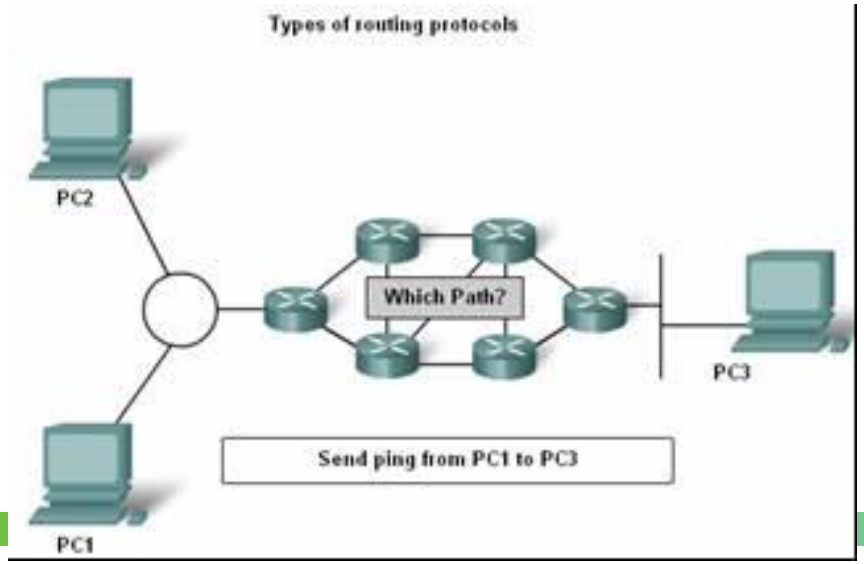


Routing Table Structure

- Effects of the 3 Routing Table Principles

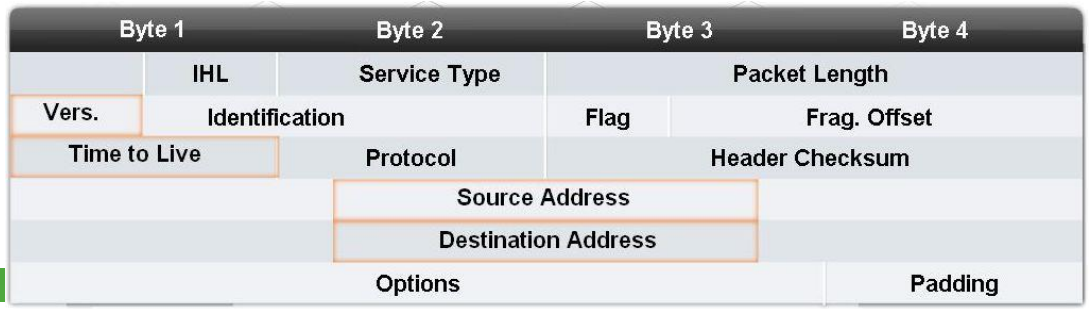
  -Packets are forwarded through the network from one router to another, on a hop by hop basis.

  -Packets can take path “X” to a destination but return via path “Y” (Asymmetric routing).



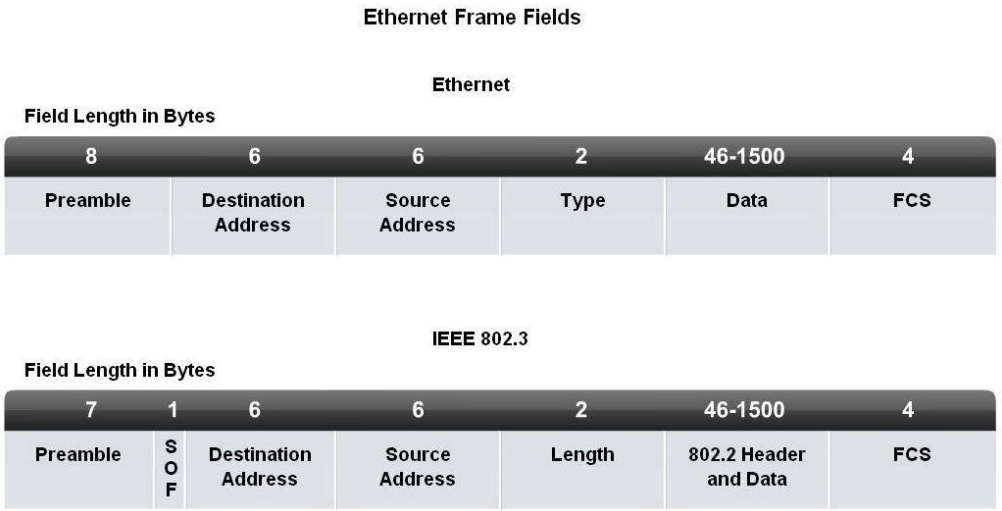
Router Paths and Packet Switching

- Internet Protocol (IP) packet format contains fields that provide information about the packet and the sending and receiving hosts
- Fields that are importance for students:
  - -Destination IP address
  - -Source IP address
  - -Version & TTL
  - -IP header length
  - -Precedence & type of service
  - -Packet length



Router Paths and Packet Switching

- MAC Layer Frame Format
- MAC Frames are also divided into fields. They include:
  - -Preamble
  - -Start of frame delimiter
  - -Destination MAC address
  - -Source MAC address
  - -Type/length
  - -Data and pad
  - -Frame check sequence

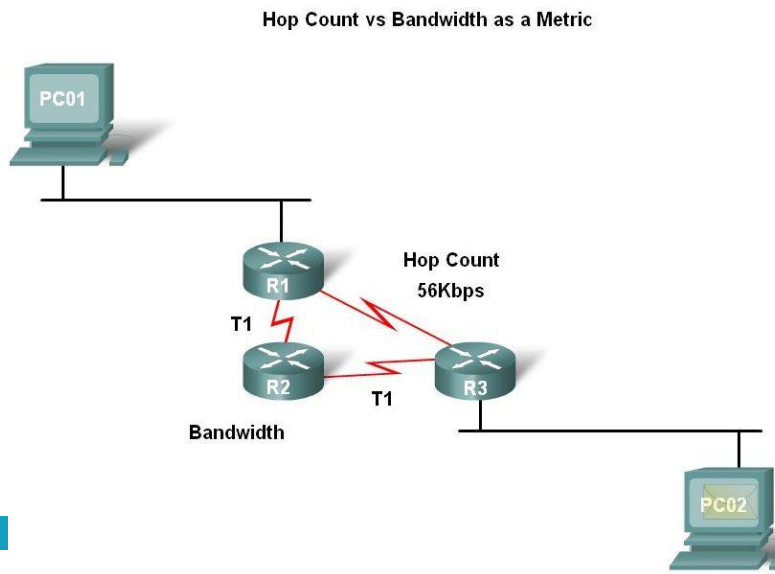


Router Paths and Packet Switching

- A **Metric** is a numerical value used by routing protocols help determine the best path to a destination
  - –The smaller the metric value the better the path
- 2 types of metrics used by routing protocols are:

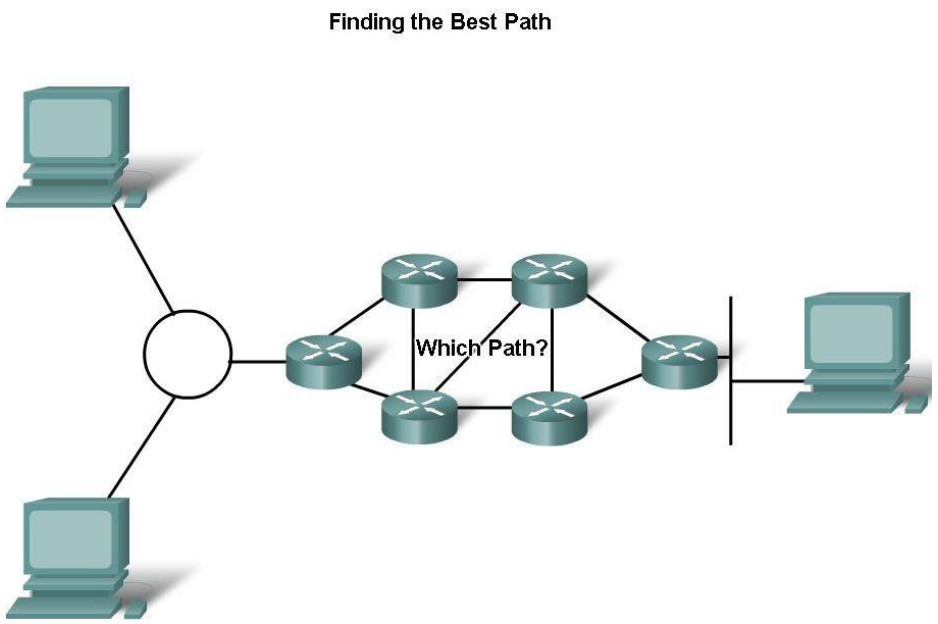
  -Hop count - this is the number of routers a packet must travel through to get to its destination

  -Bandwidth - this is the "speed" of a link also known as the data capacity of a link



Router Paths and Packet Switching

- **Path determination** is a process used by a router to pick the best path to a destination
- One of 3 path determinations results from searching for the best path
  - Directly connected network
  - Remote network
  - No route determined



Routers determine the best path to the destination

Router Paths and Packet Switching

- **Switching Function** of Router is the process used by a router to switch a packet from an incoming interface to an outgoing interface on the same router.

  -A packet received by a router will do the following:

  - Strips off layer 2 headers.
  - Examines destination IP address located in Layer 3 header to find best route to destination.
  - Re-encapsulates layer 3 packet into layer 2 frame.
  - Forwards frame out exit interface.

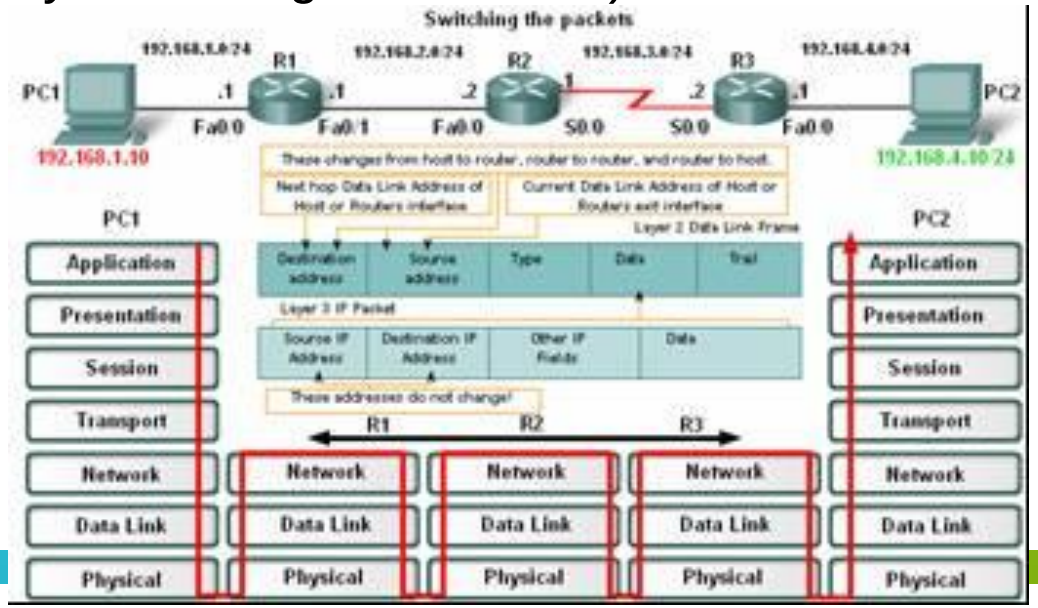
Router Paths and Packet Switching

- As a packet travels from one networking device to another

  -The Source and Destination IP addresses **NEVER** change

  -The Source & Destination MAC addresses **CHANGE** as packet is forwarded from one router to the next.

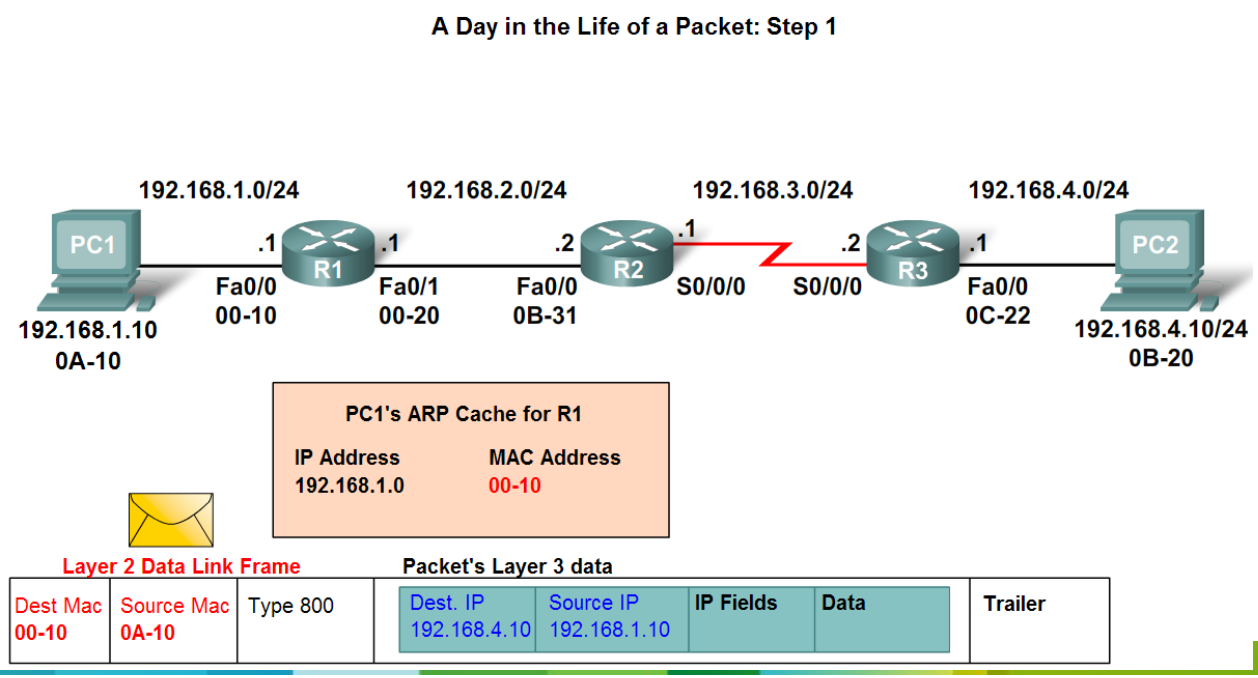
  -TTL field decrement by one until a value of zero is reached at which point router discards packet (prevents packets from endlessly traversing the network)



Router Paths and Packet Switching

- Path determination and switching function details. PC1 Wants to send something to PC 2 here is part of what happens

  Step 1 - PC1 encapsulates packet into a frame. Frame contains R1's destination MAC address



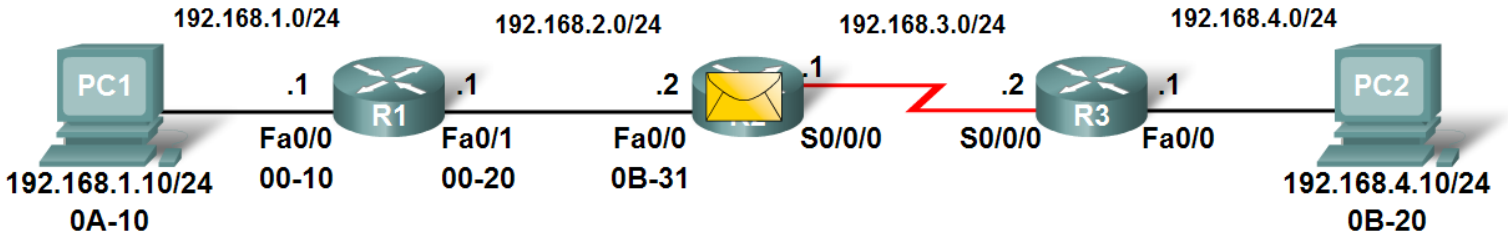
Router Paths and Packet Switching

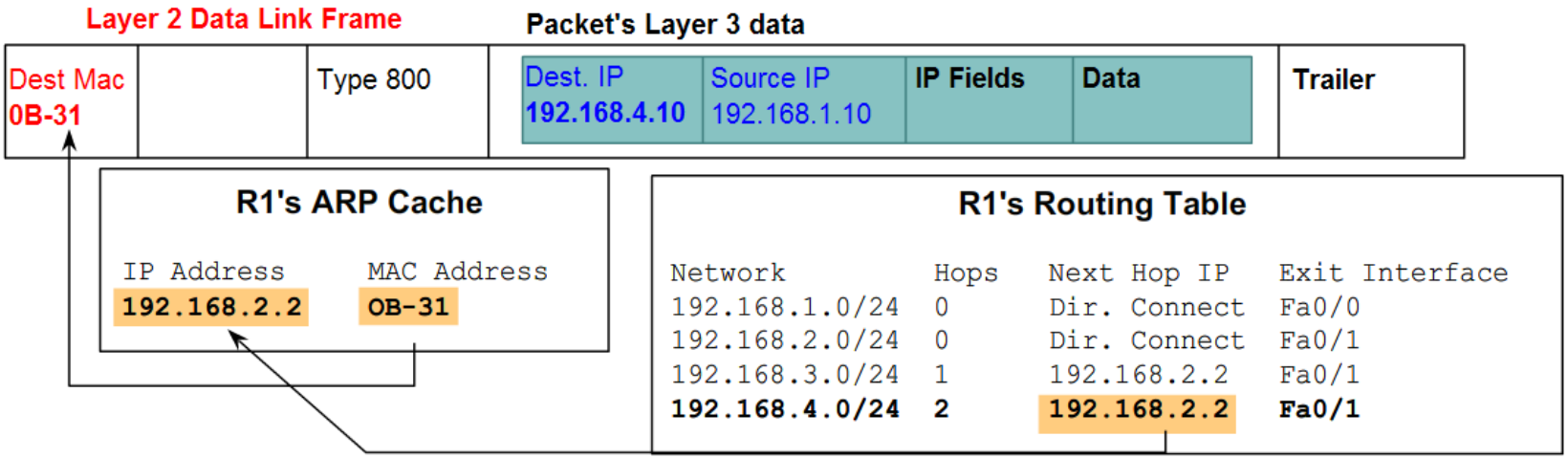
Step 2 - R1 receives Ethernet frame.

- R1 sees that destination MAC address matches its own MAC.
- R1 then strips off Ethernet frame.
- R1 Examines destination IP.
- R1 consults routing table looking for destination IP.
- After finding destination IP in routing table, R1 now looks up next hop IP address.
- R1 re-encapsulates IP packet with a new Ethernet frame.
- R1 forwards Ethernet packet out Fa0/1 interface.

Router Paths and Packet Switching

A day in a life of a packet: Step 2



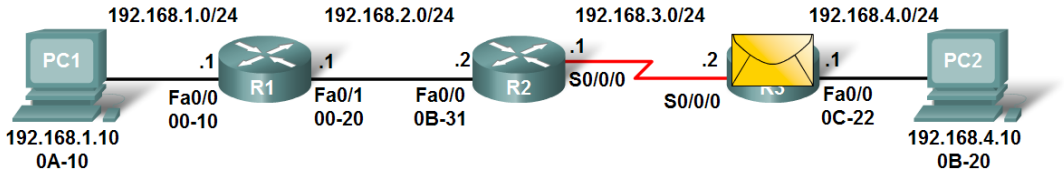


Router Paths and Packet Switching

- Path determination and switching function details. PC1 Wants to send something to PC 2 here is part of what happens

Step 3 - Packet arrives at R2

- R2 receives Ethernet frame
- R2 sees that destination MAC address matches its own MAC
- R2 then strips off Ethernet frame
- R2 Examines destination IP
- R2 consults routing table looking for destination IP
- After finding destination IP in routing table, R2 now looks up next hop IP address
- R2 re-encapsulates IP packet with a new data link frame
- R2 forwards Ethernet packet out S0/0 interface



Layer 2 Data Link Frame | Packet's Layer 3 data

		Type 800	Dest. IP 192.168.4.10	Source IP 192.168.1.10	IP fields	Data	Trailer

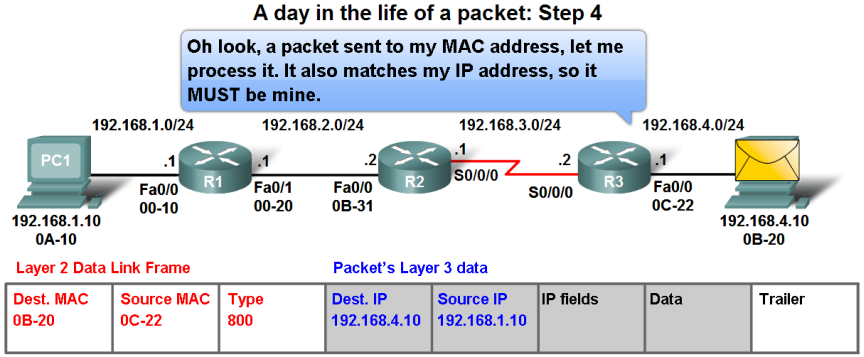
Router Paths and Packet Switching

- Path determination and switching function details. PC1 Wants to send something to PC 2 here is part of what happens

Step 4 - Packet arrives at R3

- R3 receives PPP frame
- R3 then strips off PPP frame
- R3 Examines destination IP
- R3 consults routing table looking for destination IP
- After finding destination IP in routing table, R3 is directly connected to destination via its fast Ethernet interface
- R3 re-encapsulates IP packet with a new Ethernet frame
- R3 forwards Ethernet packet out Fa0/0 interface

Step 5 - IP packet arrives at PC2. Frame is decapsulated & processed by upper layer protocols.



Summary

- Routers determine a packets path to its destination by doing the following
  - Receiving an encapsulated frame & examining destination MAC address.
  - If the MAC address matches then Frame is de-encapsulated so that router can examine the destination IP address.
  - If destination IP address is in routing table or there is a static route then Router determines next hop IP address. Router will re-encapsulate packet with appropriate layer 2 frame and send it out to next destination.
  - Process continues until packet reaches destination.
  - Note - only the MAC addresses will change the source and destination IP addresses do not change.

Interfaces

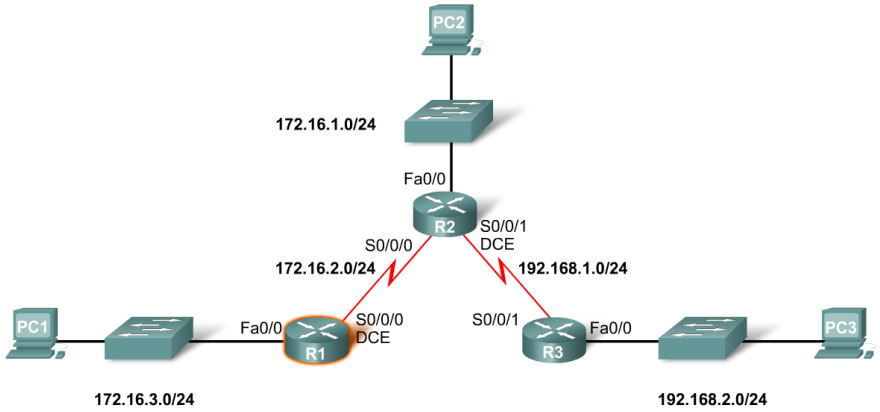
- **Examining Router Interfaces**

-Show IP route command – used to view routing table

-Show Interfaces command – used to show status of an interface

-Show IP Interface brief command – used to show a portion of the interface information

-Show running-config command – used to show configuration file in RAM

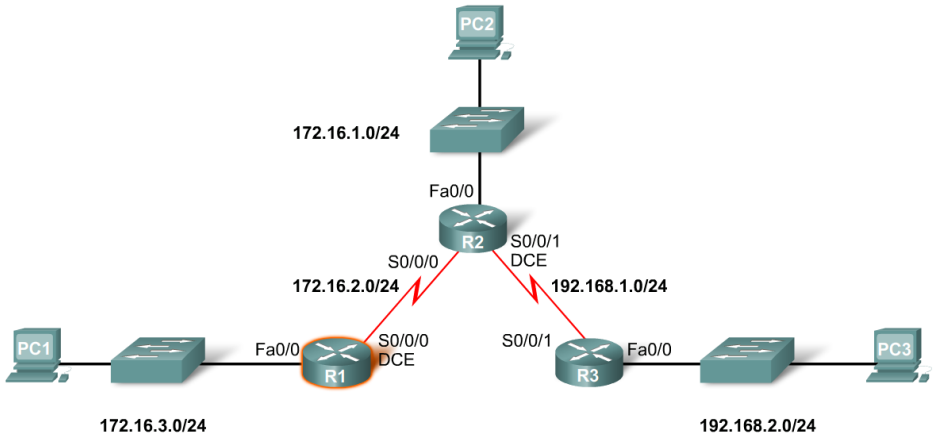


Interfaces

- **Configuring an Ethernet interface**

  -By default all serial and Ethernet interfaces are down

  -To enable an interface use the No Shutdown command

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       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

R1#
```

Routing Tables

- **Purpose of the debug ip routing command**
  - Allows you to view changes that the router performs when adding or removing routes
  - Example:

    -R2#debug ip routing

    -IP routing debugging is on

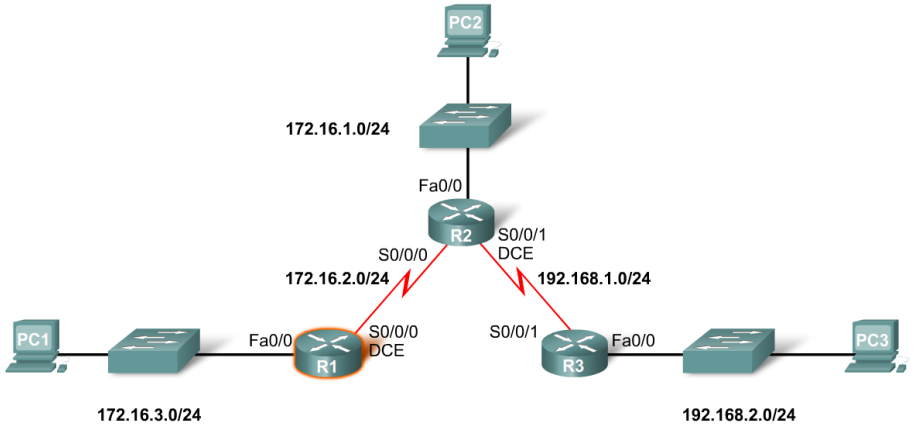
Routing Tables

- To **configure an Ethernet interface**
  - Example:

    -R2(config)#interface fastethernet 0/0

    -R2(config-if)#ip address 172.16.1.1 255.255.255.0

    -R2(config-if)#no shutdown

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Gateway of last resort is not set

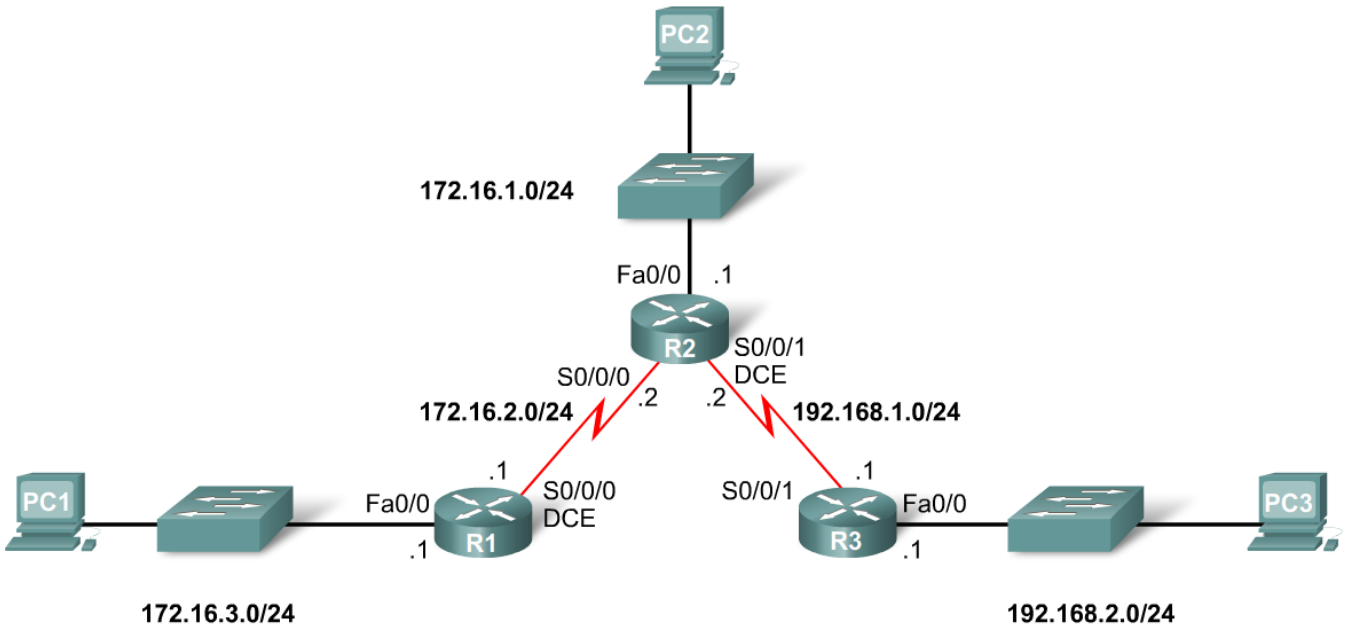
R1#
```

Routing Tables

- When a router only has its interfaces configured & no other routing protocols are configured then:

  -The routing table contains only the directly connected networks

  -Only devices on the directly connected networks are reachable



Routing Tables

Summary of interface status with `show ip interface brief`

```
R1#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES manual administratively down down
Serial0/0/0                unassigned      YES unset  administratively down down
FastEthernet0/1            unassigned      YES unset  administratively down down
Serial0/0/1                unassigned      YES unset  administratively down down
```

Routing table has no routes

```
R1#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
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       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, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

R1#
```

```
R1#show running-config
!
version 12.3
!
hostname R1
!
!
enable secret 5 $1$.3RO$VLUOdBF2OqNBn0EjQBvR./
!
!
interface FastEthernet0/0
 mac-address 000c.3010.9260
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface FastEthernet0/1
```

```
R2(config)#interface serial 0/0/1
R2(config-if)#ip address 192.168.1.2 255.255.255.0
R2(config-if)#clock rate 64000
R2(config-if)#no shutdown
```

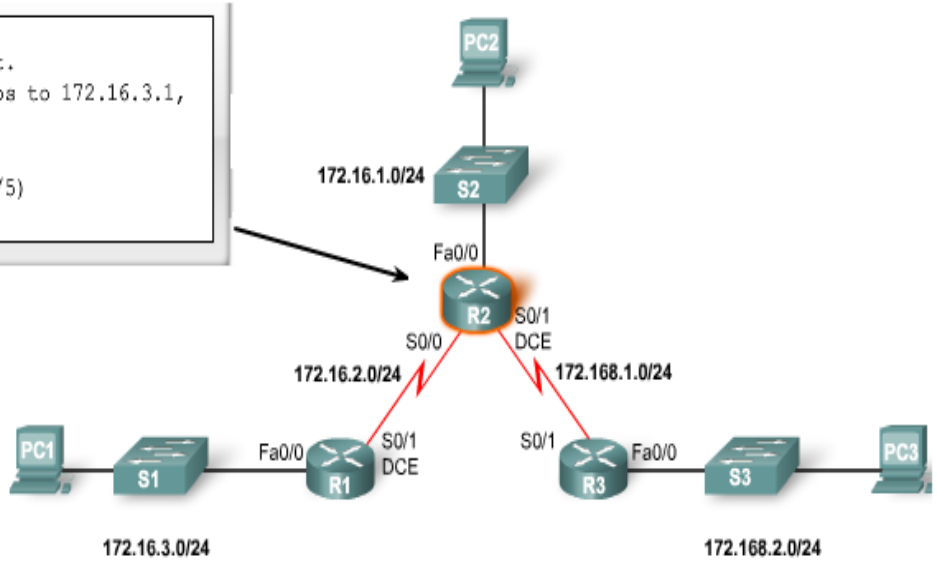
```
R3(config)#interface fastethernet 0/0
R3(config-if)#ip address 192.168.2.1 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#interface serial 0/0/1
R3(config-if)#ip address 192.168.1.1 255.255.255.0
R3(config-if)#no shutdown
```

Routing Tables

- Checking each route in turn

  The ping command is used to check end to end connectivity

```
R2#ping 172.16.3.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.3.1,
  timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R2#
```



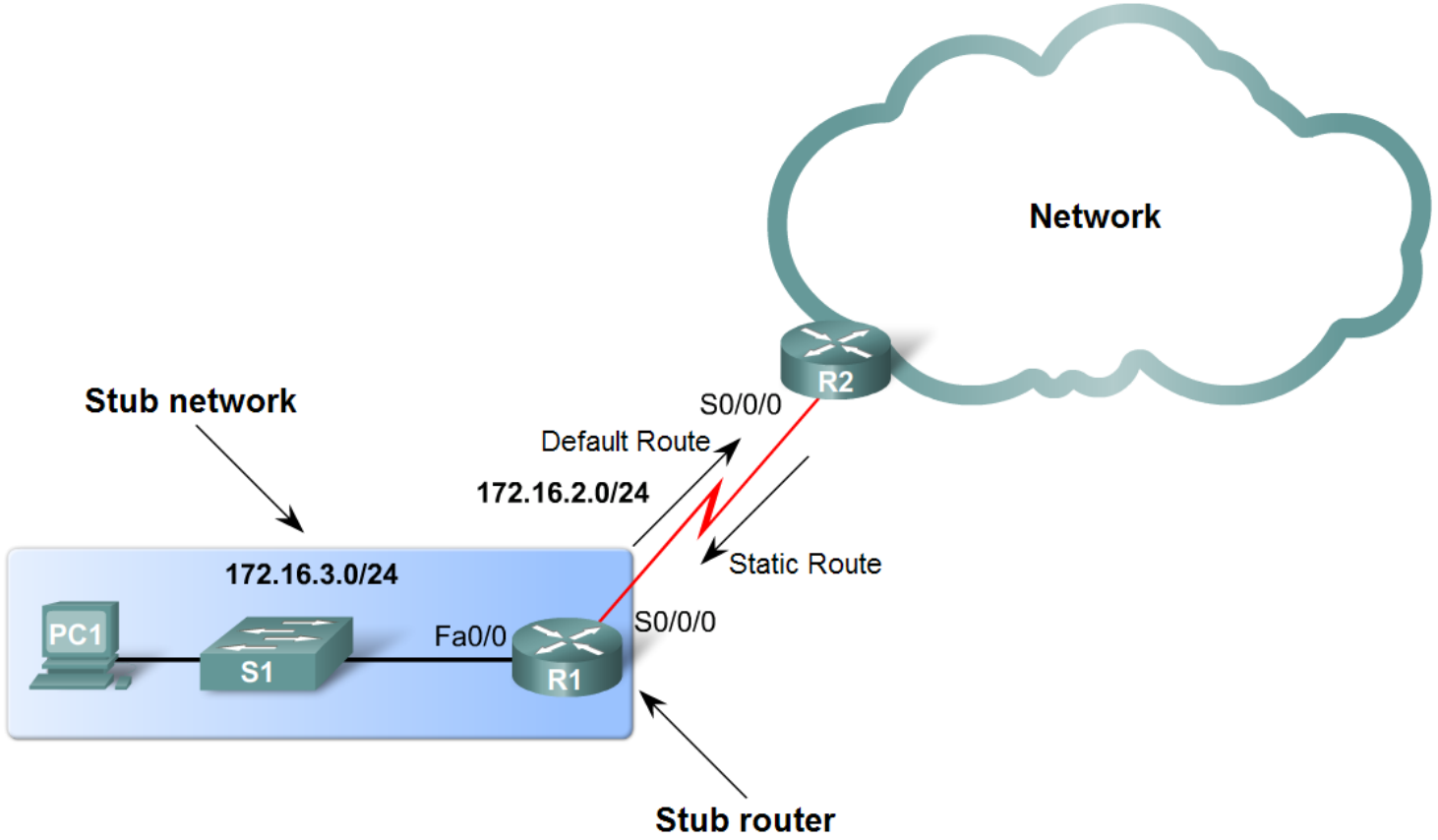

```
R2#show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 2 subnets
C    172.16.1.0 is directly connected, FastEthernet0/0
C    172.16.2.0 is directly connected, Serial0/0
C    192.168.1.0/24 is directly connected, Serial0/1
R2#
```

Destination IP Address	172.16.3.1	0101100.00010000.00000011.00000001	
First route in routing table	172.16.1.0	10101100.00010000.00000001.00000000	No Match
Destination IP Address	172.16.3.1	10101100.00010000.00000011.00000001	
Second route in routing table	172.16.1.0	10101100.00010000.00000001.00000000	No Match
Destination IP Address	172.16.3.1	10101100.00010000.00000011.00000001	
Third route in routing table	172.16.1.0	10101100.00010000.00000001.00000000	No Match

Static Routes

- **Purpose of a static route**

  A manually configured route used when routing from a network to a stub network



Static Routes

- **IP route command**
  - To configure a static route use the following command: ip route
  - Example:

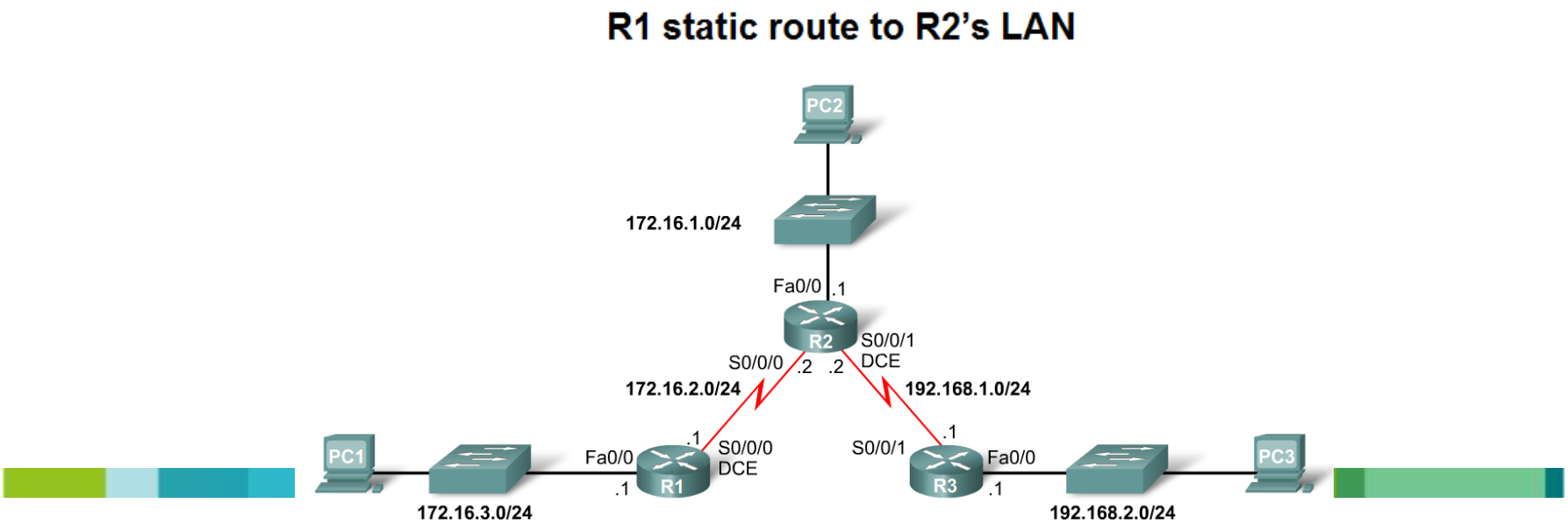
    -Router(config)# ip route network-address subnet-mask {ip-address | exit-interface }

```
Router(config)# ip route network-address subnet-mask
{ip-address | exit-interface }
```

Parameter	Description
network-address	Destination network address of the remote network to be added to the routing table.
subnet-mask	Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
ip-address	Commonly referred to as the next-hop router's IP address.
exit-interface	Outgoing interface that is used to forward packets to the destination network.

Static Routes

- **Dissecting static route syntax**
  - ip route - Static route command
  - 172.16.1.0 – Destination network address
  - 255.255.255.0 - Subnet mask of destination network
  - 172.16.2.2 - Serial 0/0/0 interface IP address on R2, which is the "next-hop" to this network



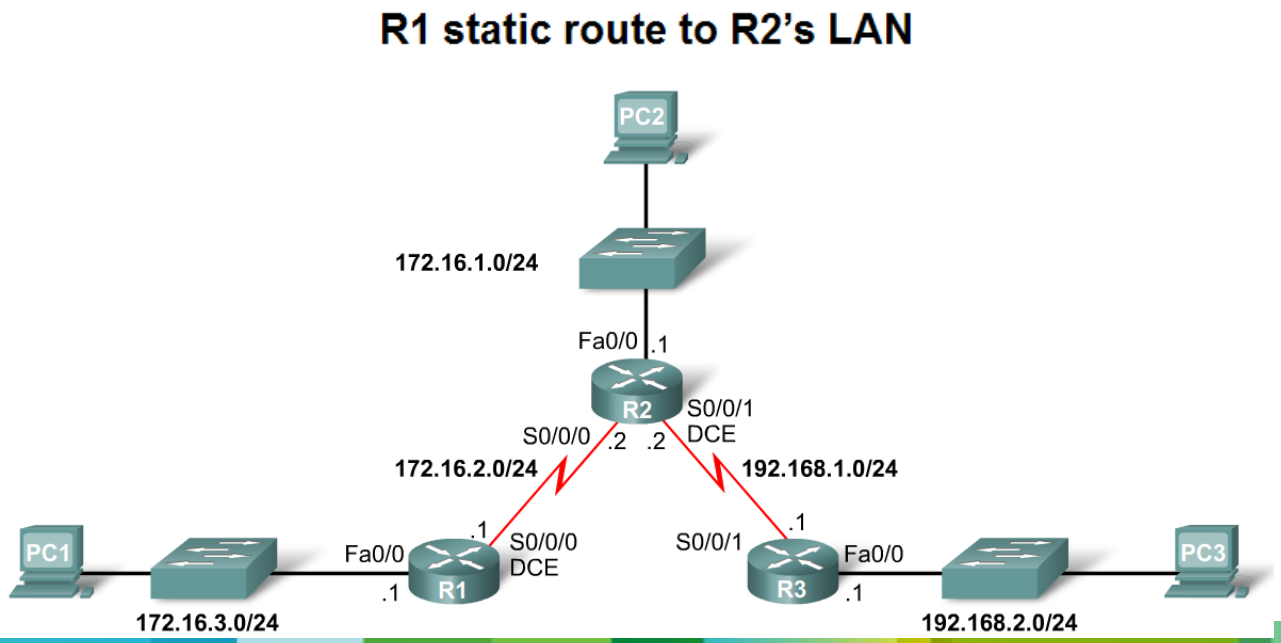
Static Routes

- **Configuring routes to 2 or more remote networks**

  Use the following commands for R1

  -R1(config)#ip route 192.168.1.0 255.255.255.0 172.16.2.2

  -R1(config)#ip route 192.168.2.0 255.255.255.0 172.16.2.2



Static Routes

- **Zinin's 3 routing principles**
  - **Principle 1**: "Every router makes its decision alone, based on the information it has in its own routing table.“
  - **Principle 2**: "The fact that one router has certain information in its routing table does not mean that other routers have the same information.“
  - **Principle 3**: "Routing information about a path from one network to another does not provide routing information about the reverse, or return path."

Static Routes

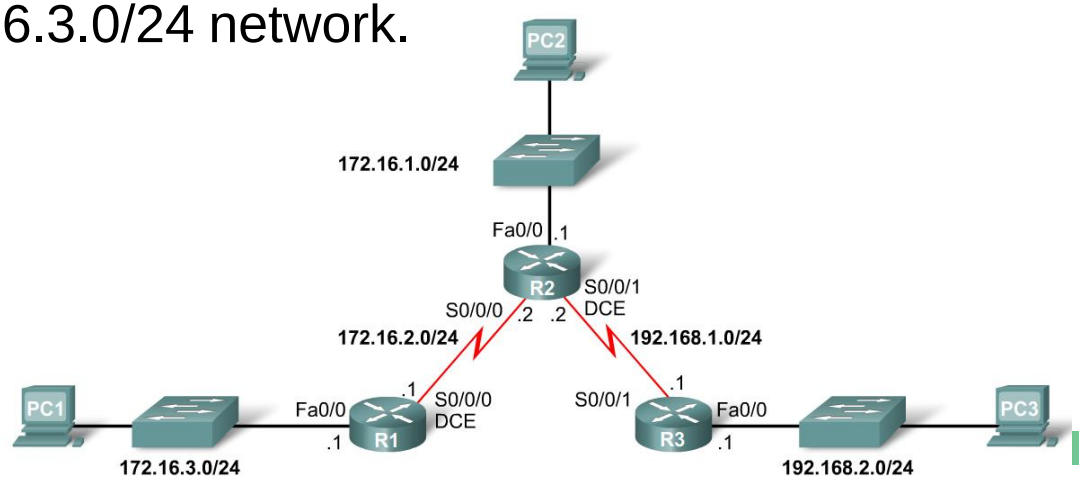
- Using Zinin's 3 routing principles, how would you answer the following?

  -Would packets from PC1 reach their destination?

  Yes, packets destined for 172.16.1.0/24 and 192.168.1.0/24 networks would reach their destination.

  -Does this mean that any packets from these networks destined for 172.16.3.0/24 network will reach their destination?

  No, because neither R2 nor R3 router has a route to the 172.16.3.0/24 network.

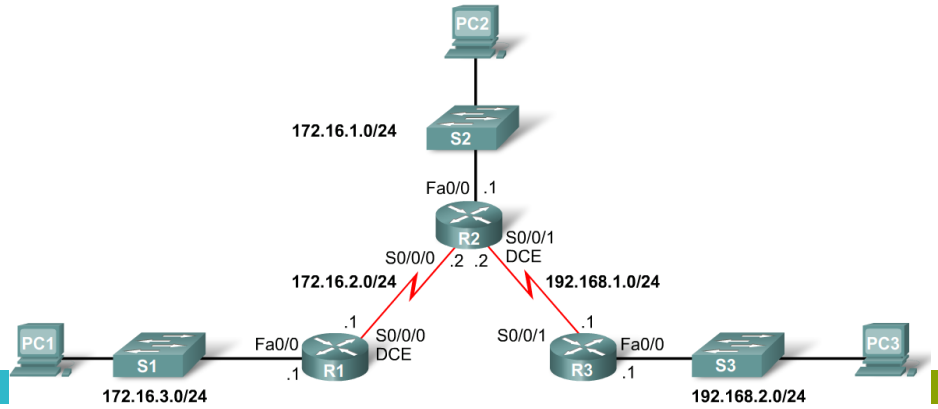


Static Routes

- **Verifying the Static Route Configuration**

  -Use the following commands

  - Step 1 show running-config
  - Step 2 verify static route has been entered correctly
  - Step 3 show ip route
  - Step 4 verify route was configured in routing table
  - Step 5 issue ping command to verify packets can reach destination and that Return path is working



Summary and Default Route

- **Default Static Route**
  - This is a route that will match all packets. Stub routers that have a number of static routes all exiting the same interface are good candidates for a default route.
    - -Like route summarization this will help reduce the size of the routing table
- **Configuring a default static route**
  - Similar to configuring a static route. Except that destination IP address and subnet mask are all zeros
  - Example:
    - -Router(config)#ip route 0.0.0.0 0.0.0.0 [exit-interface | ip-address]

Summary and Default Route

- **Static routes and subnet masks**

  The routing table lookup process will use the most specific match when comparing destination IP address and subnet mask

- **Default static routes and subnet masks**

  Since the subnet mask used on a default static route is 0.0.0.0 all packets will match.

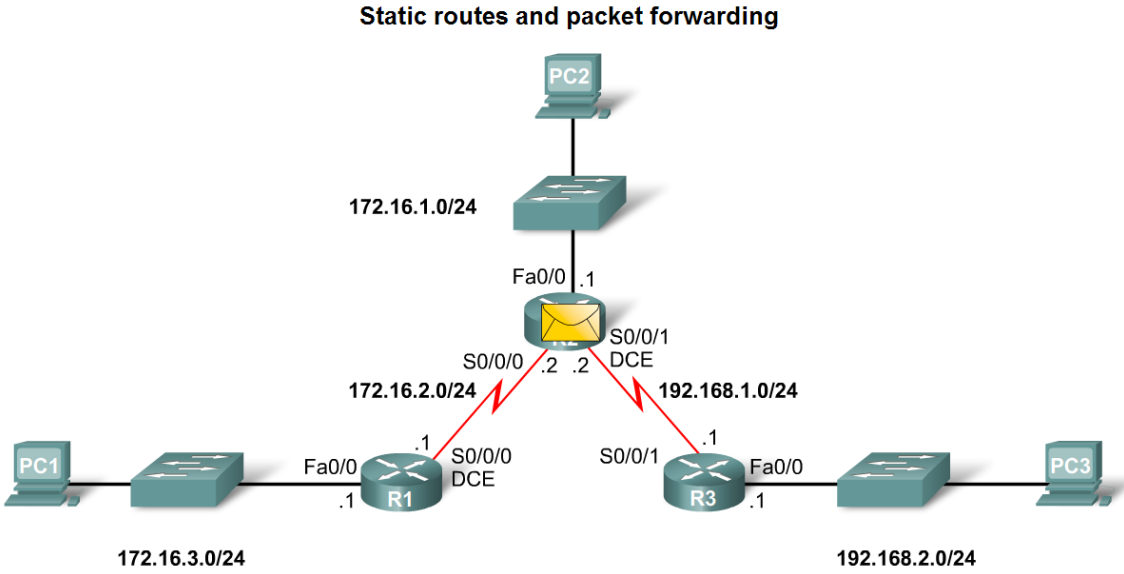
Static Routes and Packet Forwarding

- Packet forwarding with static routes. (recall Zinin's 3 routing principles)
- Router 1

  Packet arrives on R1's Fastethernet 0/0 interface

  R1 does not have a route to the destination network, 192.168.2.0/24

  R1 uses the default static route.



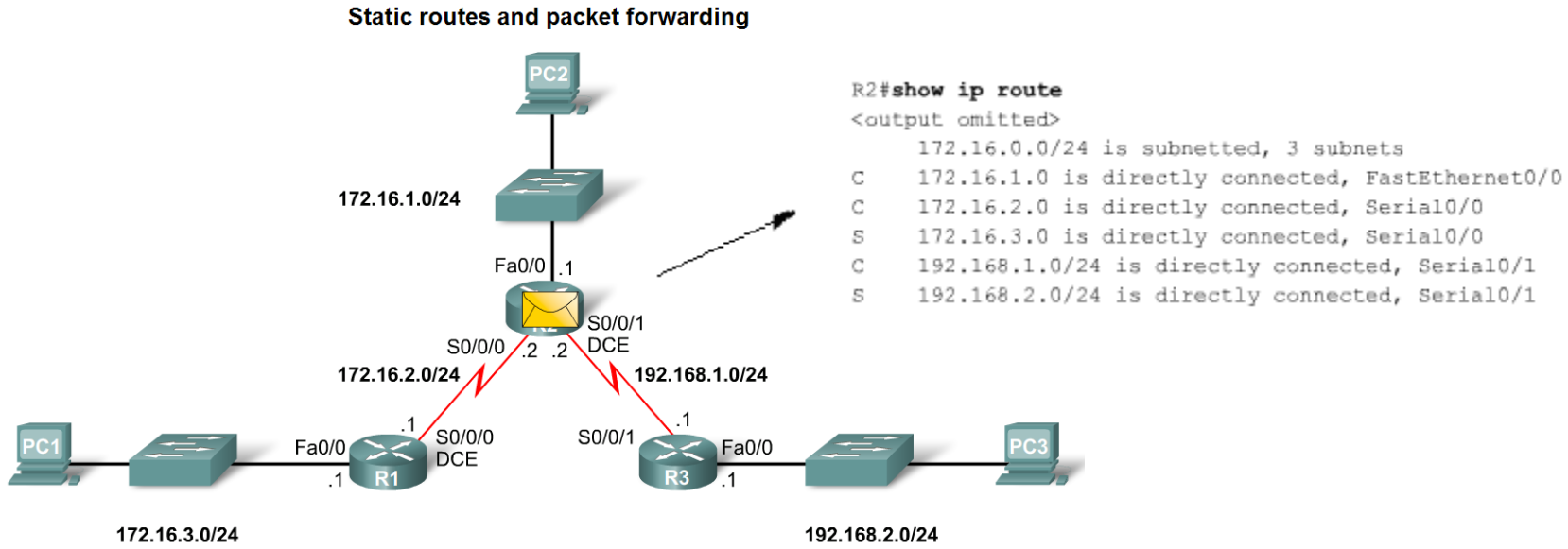

```
R1#show ip route
<output omitted>
     172.16.0.0/24 is subnetted, 2 subnets
C    172.16.2.0 is directly connected, Serial0/0
C    172.16.3.0 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 is directly connected, Serial0/0
```

Static Routes and Packet Forwarding

- Packet forwarding with static routes. (recall Zinin's 3 routing principles)
- Router 2

  The packet arrives on the Serial 0/0/0 interface on R2.

  R2 has a static route to 192.168.2.0/24 out Serial0/0/1.

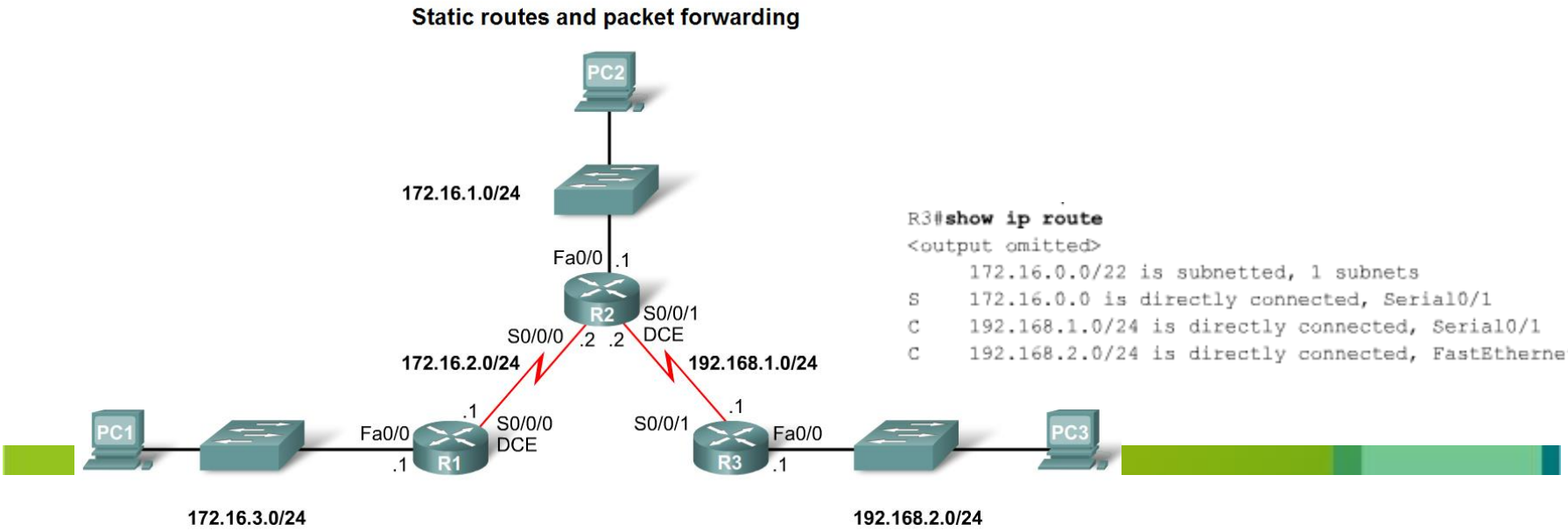


Static Routes and Packet Forwarding

- Packet forwarding with static routes. (recall Zinin's 3 routing principles)
- Router 3

  The packet arrives on the Serial0/0/1 interface on R3.

  R3 has a connected route to 192.168.2.0/24 out Fastethernet 0/1.



Static Routes and Packet Forwarding

- Troubleshooting a Missing Route
- Tools that can be used to isolate routing problems include:

  -Ping– tests end to end connectivity

  -Traceroute– used to discover all of the hops (routers) along the path between 2 points

  -Show IP route– used to display routing table & ascertain forwarding process

  -Show ip interface brief- used to show status of router interfaces

  -Show cdp neighbors detail– used to gather configuration information about directly connected neighbors

Static Routes and Packet Forwarding

- Solving a Missing Route
- Finding a missing or mis-configured route requires methodically using the correct tools

  -Start with PING. If ping fails then use traceroute to determine where packets are failing to arrive

- Issue: show ip route to examine routing table.

  -If there is a problem with a mis-configured static route remove the static route then reconfigure the new static route

Dynamic Routing Protocols

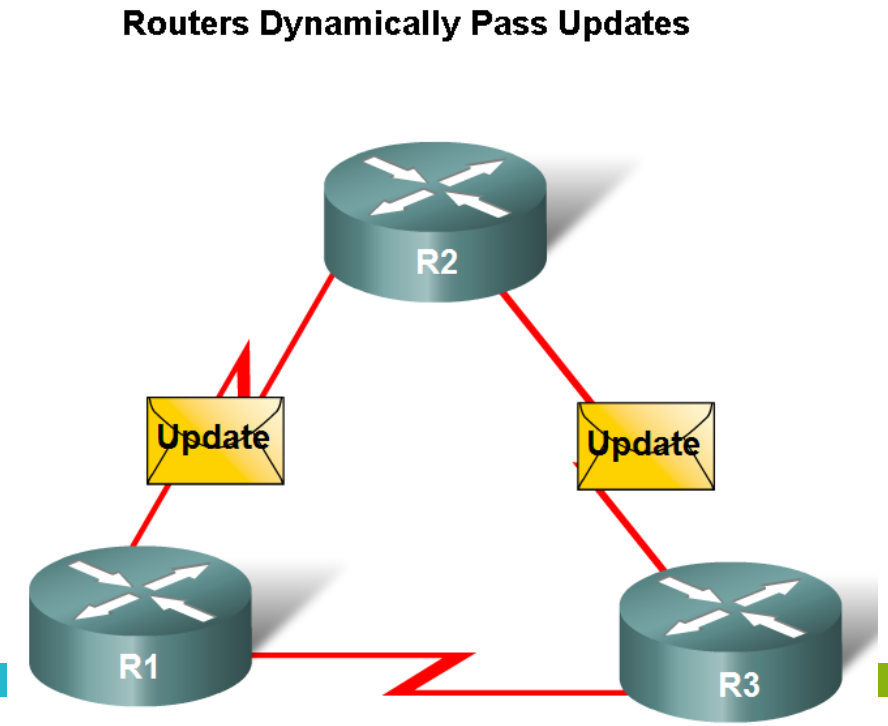
Dynamic Routing Protocols

- Function(s) of Dynamic Routing Protocols:

  -Dynamically share information between routers.

  -Automatically update routing table when topology changes.

  -Determine best path to a destination.



Dynamic Routing Protocols

- The **purpose of a dynamic routing protocol** is to:

  -Discover remote networks

  -Maintaining up-to-date routing information

  -Choosing the best path to destination networks

  -Ability to find a new best path if the current path is no longer available

Routing Protocol Operation

Routing protocols are used to exchange routing information between the routers.

RIPv1

- RIP Characteristics

  -A classful, Distance Vector (DV) routing protocol

  -Metric = hop count

  -Routes with a hop count > 15 are unreachable

  -Updates are broadcast every 30 seconds

RIPv1

- RIP Operation
  - RIP uses 2 message types:
    - Request message

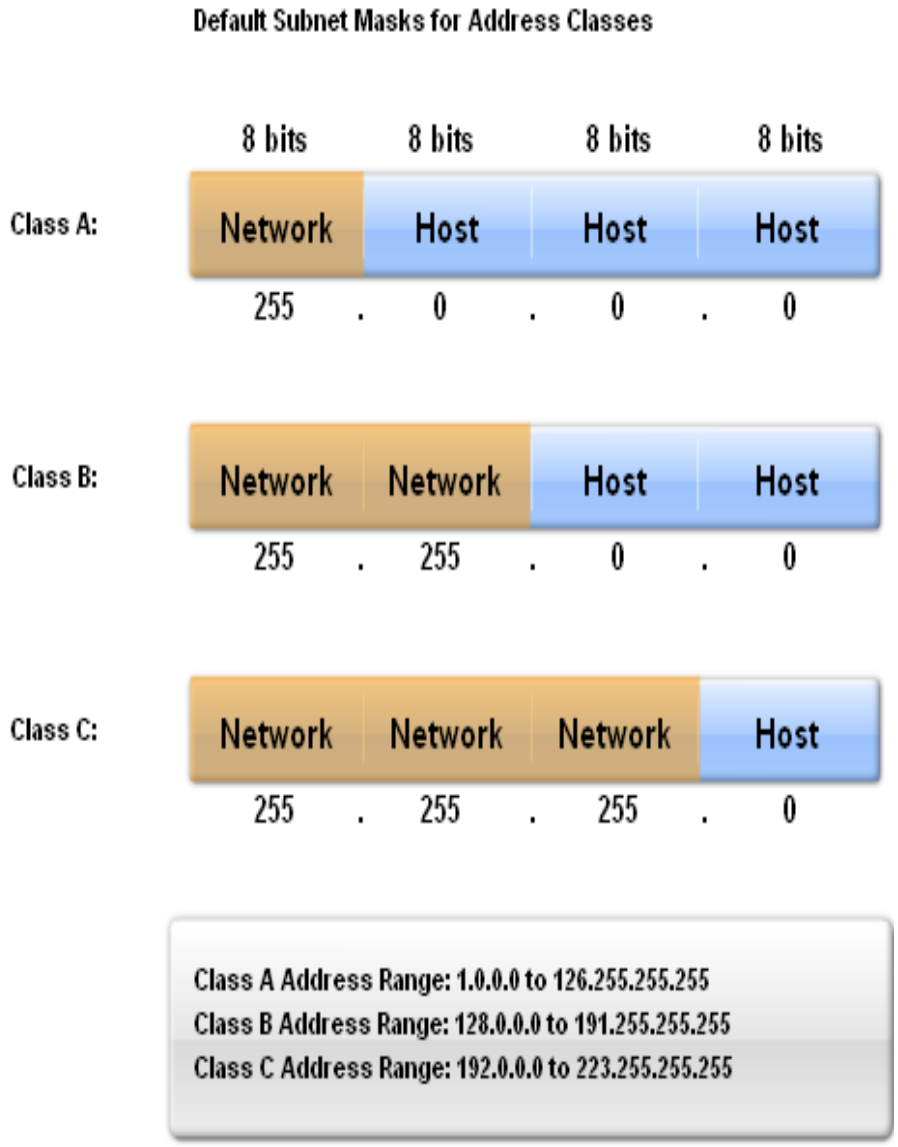
      -This is sent out on startup by each RIP enabled interface

      -Requests all RIP enabled neighbors to send routing table
    - Response message

      -Message sent to requesting router containing routing table

RIPv1

- IP addresses initially divided into classes
  - -Class A
  - -Class B
  - -Class C
- RIP is a classful routing protocol
  - -Does not send subnet masks in routing updates



Basic RIPv1 Configuration

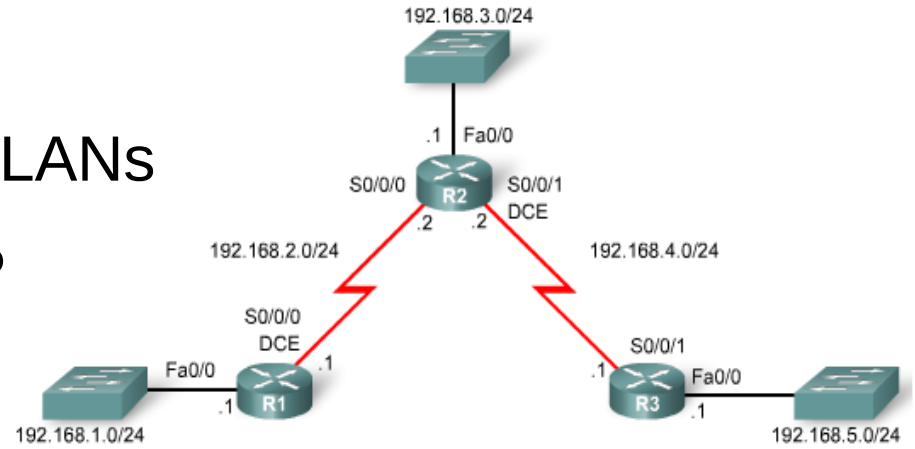
- **A typical topology suitable for use by RIPv1 includes:**

  -Three router set up

  -No PCs attached to LANs

  -Use of 5 different IP subnets

RIP Topology: Scenario A



Addressing Table: Scenario A

Device	Inferface	IP Address	Subnet Mask
R1	Fa0/0	192.168.1.1	255.255.255.0
	S0/0/0	192.168.2.1	255.255.255.0
R2	Fa0/0	192.168.3.1	255.255.255.0
	S0/0/0	192.168.2.2	255.255.255.0
	S0/0/1	192.168.4.2	255.255.255.0
R3	Fa0/0	192.168.5.1	255.255.255.0
	S0/0/1	192.168.4.1	255.255.255.0

Basic RIPv1 Configuration

- Router RIP Command
  - –To enable RIP enter:
    - -*Router rip* at the global configuration prompt
    - -Prompt will look like ***R1(config-router)#***

```
R1#conf t
Enter configuration commands, one per line. End with CTRL/Z.
R1(config)#router ?
  bgp         Border Gateway Protocol (BGP)
  egp         Exterior Gateway Protocol (EGP)
  eigrp       Enhanced Interior Gateway Protocol (EIRGP)
  igrp        Interior Gateway Routing Protocol (IGRP)
  isis        ISO IS-IS
  iso-igrp    IGRP for OSI networks
  mobile      Mobile routes
  odr         On Demand stub Routes
  ospf        Open Shortest Path First (OSPF)
  rip         Routing Information Protocol (RIP)

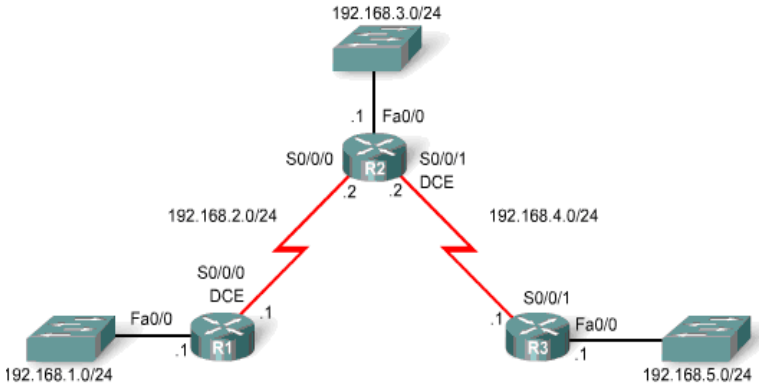
R1(config)#router rip
R1(config-router)#
```

Basic RIPv1 Configuration

- Specifying Networks
  - –Use the ***network*** command to:

-Enable RIP on all interfaces that belong to this network

-Advertise this network in RIP updates sent to other routers every 30 seconds




```
R1(config)#router rip
R1(config-router)#network 192.168.1.0
R1(config-router)#network 192.168.2.0
```

```
R2(config)#router rip
R2(config-router)#network 192.168.2.0
R2(config-router)#network 192.168.3.0
R2(config-router)#network 192.168.4.0
```

```
R3(config)#router rip
R3(config-router)#network 192.168.4.0
R3(config-router)#network 192.168.5.0
```

Verification and Troubleshooting

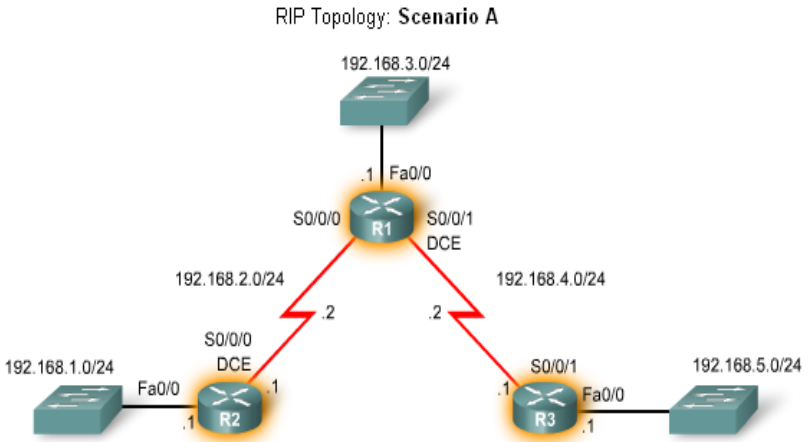
- Show ip Route
- To verify and troubleshoot routing

  -Use the following commands:

  -show ip route

  -show ip protocols

  -debug ip rip




```
R 192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:23, Serial 0/0/0
```

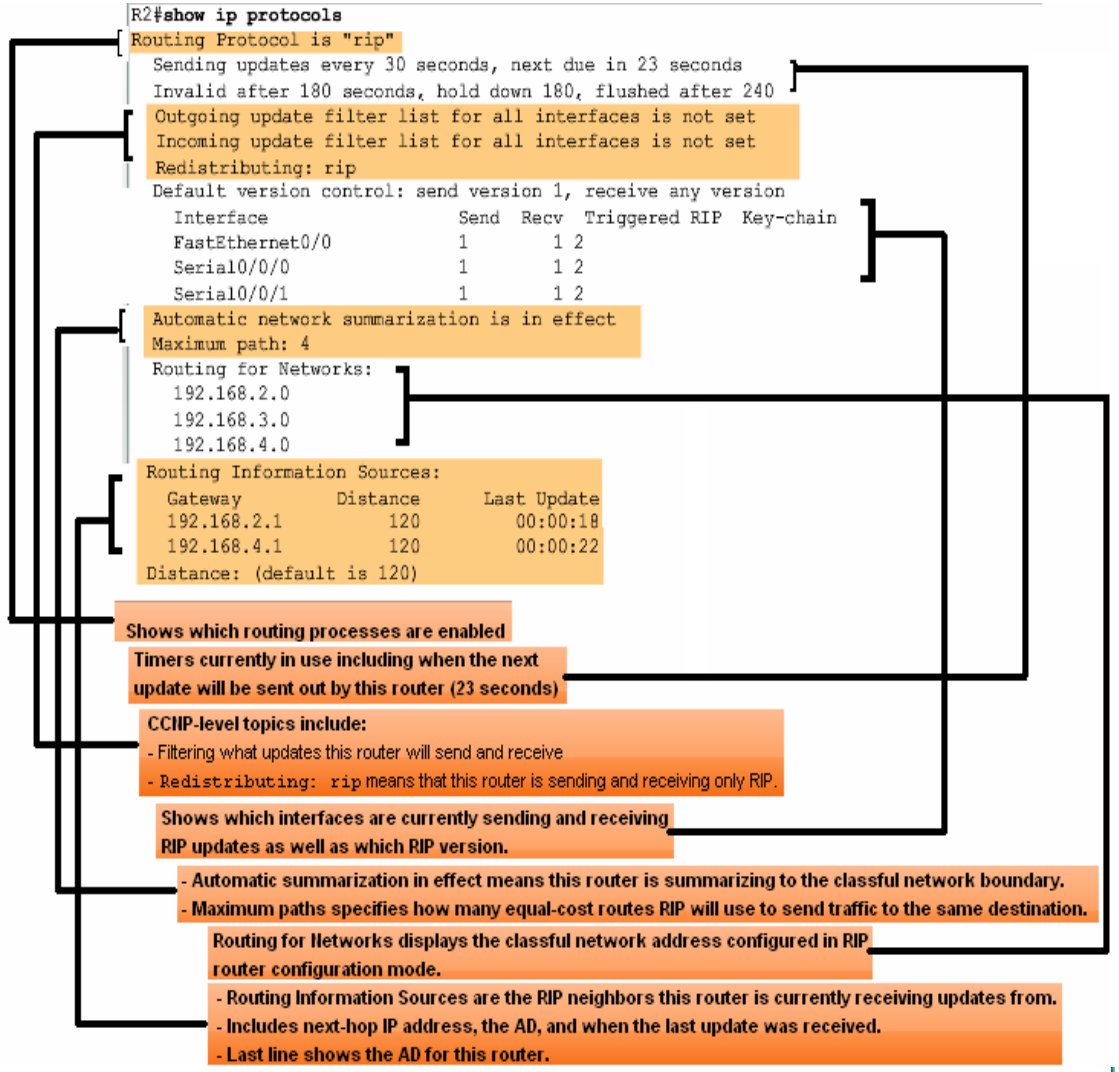
Interpreting a RIP Route in the Routing Table

`R`	Identifies the source of the route as RIP.
`192.168.5.0`	Indicates the address of the remote network.
`/24`	The subnet mask used for this network
`[120/2]`	The administrative distance (120) and the metric (2 hops)
`via 192.168.2.2`	Specifies the address of the next-hop router (R2) to send traffic to for the remote network.
`00:00:23`	Specifies the amount of time since the route was updated (here, 23 seconds). Another update is due in 7 seconds.
`Serial0/0/0`	192.168.4.2

Verification and Troubleshooting

- *show ip protocols* command

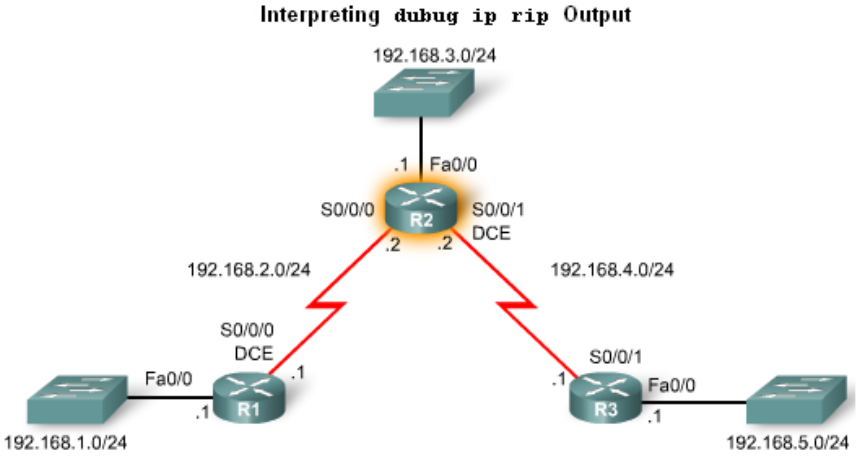
  -Displays routing protocol configured on router



Verification and Troubleshooting

- **Debug ip rip** command

-Used to display RIP routing updates as they are happening




```
R2#debug ip rip
RIP protocol debugging is on
RIP: received v1 update from 192.168.2.1 on Serial0/0/0
      192.168.1.0 in 1 hops
RIP: received v1 update from 192.168.4.1 on Serial0/0/1
      192.168.5.0 in 1 hops
RIP: sending  v1 update to 255.255.255.255 via FastEthernet0/0 (192.168.3.1)
RIP: build update entries
      network 192.168.1.0 metric 2
      network 192.168.2.0 metric 1
      network 192.168.4.0 metric 1
      network 192.168.5.0 metric 2
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/1 (192.168.4.2)
RIP: build update entries
      network 192.168.1.0 metric 2
      network 192.168.2.0 metric 1
      network 192.168.3.0 metric 1
RIP: sending  v1 update to 255.255.255.255 via Serial0/0/0 (192.168.2.2)
RIP: build update entries
```

- R2 receives an update from R1 advertising the R1's directly connected LAN.
- R2 receives an update from R3 advertising the R3's directly connected LAN.
- R2 sends an update out Fa0/0 to all networks in the routing table except the network attached to Fa0/0.
- R2 sends an update out S0/0/1 to R3. Included in the update are R1's LAN, the WAN between R1 and R2, and R2's LAN.
- Note that split horizon is in effect. R2 does not advertise the R3 LAN back to R3.

Verification and Troubleshooting

- **Passive interface** command

  -Used to prevent a router from sending updates through an interface

  -Example:

  Router(config-router)#passive-interface interface-type interface-number

Verification and Troubleshooting

- **Passive interfaces**

```
R2(config)#router rip
R2(config-router)#passive-interface FastEthernet 0/0
R2(config-router)#end
R2#show ip protocols
Routing Protocol is "rip"
    Sending updates every 30 seconds, next due in 14 seconds
    Invalid after 180 seconds, hold down 180, flushed after 240
    Outgoing update filter list for all interfaces is
    Incoming update filter list for all interfaces is
    Redistributing: rip
    Default version control: send version 1, receive any version
        Interface              Send  Recv  Triggered RIP  Key-chain
        Serial0/0/0            1     1 2
        Serial0/0/1            1     1 2
    Automatic network summarization is in effect
    Routing for Networks:
        192.168.2.0
        192.168.3.0
        192.168.3.0
        192.168.4.0
    Passive Interface(s):
       FastEthernet0/0
    Routing Information Sources:
    Gateway         Distance      Last Update
       192.168.2.1          120      00:00:27
       192.168.4.1          120      00:00:23
Distance: (default is 120)
```

Notice FastEthernet 0/0 is no longer listed under "Default version contol:"
However, R2 is still routing for 192.168.3.0 and now lists FastEthernet under "Passive Interfaces:"

Default Route and RIPv1

- Modified Topology: Scenario C
- Default routes

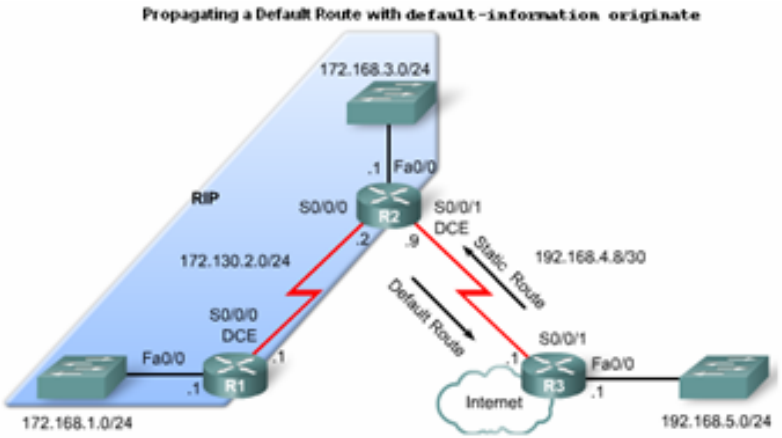
  Packets that are not defined specifically in a routing table will go to the specified interface for the default route

  Example: Customer routers use default routes to connect to an ISP router.

  Command used to configure a default route is

  ip route 0.0.0.0 0.0.0.0 s0/0/1

Default Route and RIPv1



Propagating a Default Route with `default-information originate`

- Disable RIP routing on R2 for the 192.168.4.0 network only.
- Configure R2 with a default route pointing to R3.

```
R2(config)#router rip
R2(config-router)#no network 192.168.4.0
R2(config-router)#exit
R2(config)#ip route 0.0.0.0 0.0.0.0 serial 0/0/1
```

- Completely disable RIP routing on R3.
- Configure R3 with a static route pointing R2.

```
R3(config)#no router rip
R3(config)#ip route 172.30.0.0 255.255.252.0 serial 0/0/1
```

```
R1#show ip route
Gateway of last resort is not set

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.1.0 is directly connected, FastEthernet0/0
C       172.30.2.0 is directly connected, Serial0/0/0
R       172.30.3.0 [120/1] via 172.30.2.2, 00:00:05, Serial0/0/0
```

```
R2#show ip route
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     172.30.0.0/24 is subnetted, 3 subnets
R       172.30.1.0 [120/1] via 172.30.2.1, 00:00:03, Serial0/0/0
C       172.30.2.0 is directly connected, Serial0/0/0
C       172.30.3.0 is directly connected, FastEthernet0/0
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
S*   0.0.0.0/0 is directly connected, Serial0/0/1
```

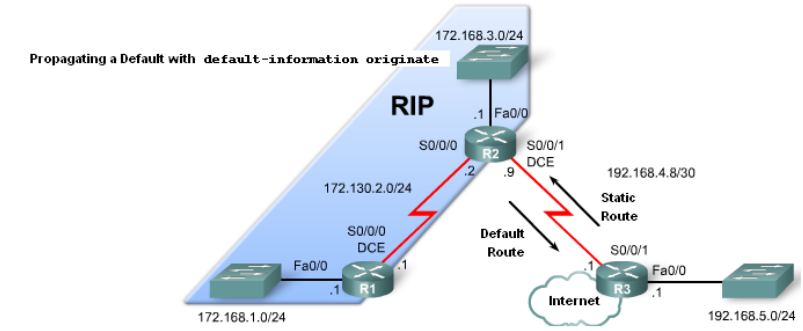
```
R3#show ip route
Gateway of last resort is not set

     172.30.0.0/22 is subnetted, 1 subnets
S       172.30.0.0 is directly connected, Serial0/0/1
     192.168.4.0/30 is subnetted, 1 subnets
C       192.168.4.8 is directly connected, Serial0/0/1
C    192.168.5.0/24 is directly connected, FastEthernet0/0
```

Default Route and RIPv1

- Propagating the Default Route in RIPv1
- *Default-information originate* command

  -This command is used to specify that the router is to originate default information, by propagating the static default route in RIP update.




```
R2(config)#router rip
R2(config-router)#default-information originate
R2(config-router)#end
R2#debug ip rip
RIP protocol debugging is on
RIP: sending v1 update to 255.255.255.255 via Serial0/0/0 (172.30.2.2)
RIP: build update entries
           subnet 0.0.0.0 metric 1
           subnet 172.30.3.0 metric 2
R2#undebug all
All possible debugging has been turned off
```

R2 is now sending a "quad-zero" route to R1.

```
R1#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
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       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, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 172.30.2.2 to network 0.0.0.0

   172.30.0.0/24 is subnetted, 3 subnets
C  172.30.2.0 is directly connected, Serial0/0/0
R  172.30.3.0 [120/1] via 172.30.2.2 00:00:16, Serial0/0/0
C  172.30.1.0 is directly connected, Fast Ethernet0/0
R* 0.0.0.0/0 [120/1] via 172.30.2.2, 00:00:16, Serial0/0/0
```

R1 has a "gateway of last resort", a candidate default route.

Summary

- RIP characteristics include:

  Classful, distance vector routing protocol

  Metric is Hop Count

  Does not support VLSM or discontiguous subnets

  Updates every 30 seconds

- Rip messages are encapsulated in a UDP segment with source and destination ports of 520