

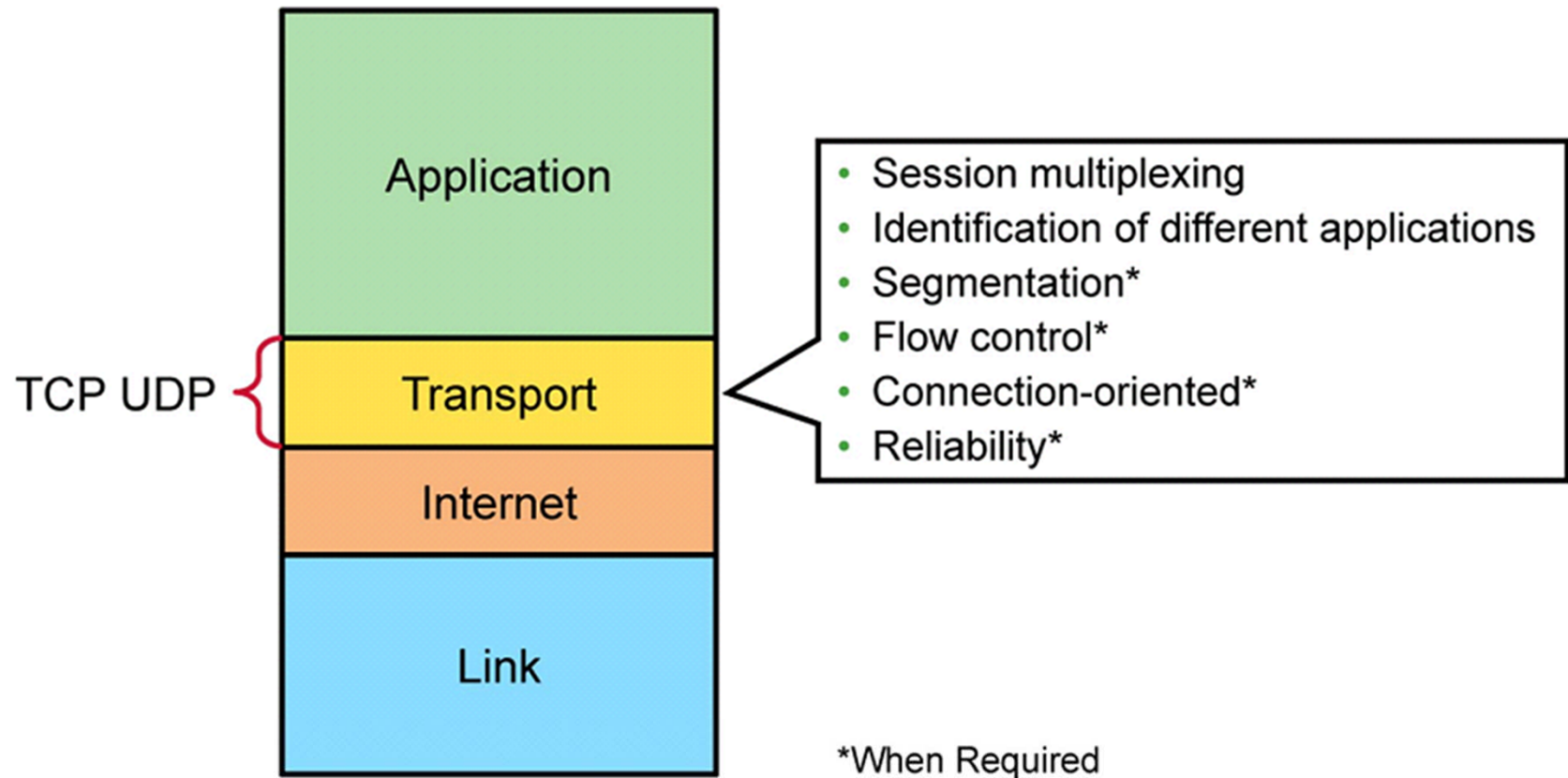




Understanding the TCP/IP Transport Layer

Establishing Internet Connectivity

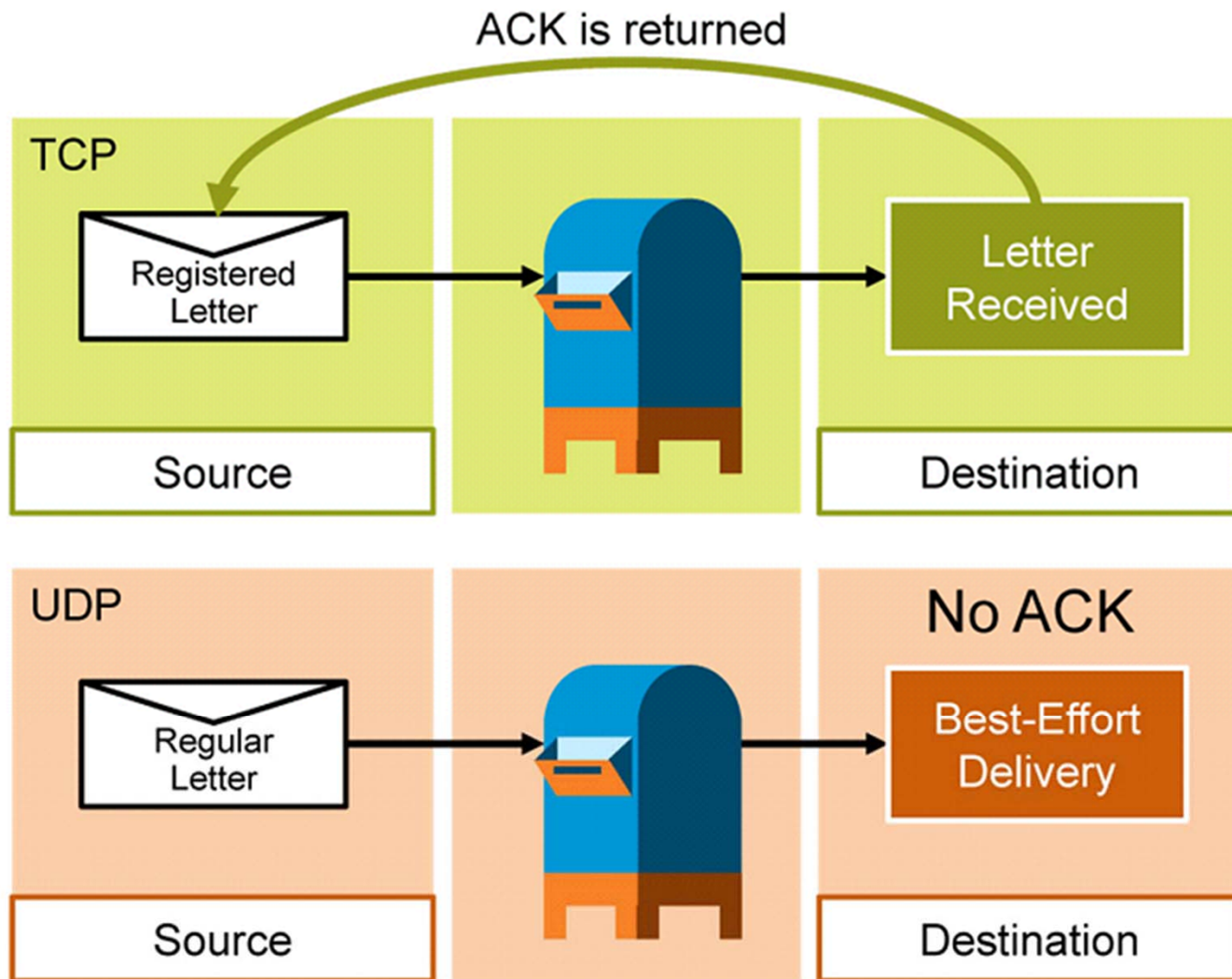
TCP/IP Transport Layer Functions



Reliable vs. Best-Effort Transport

	Reliable	Best Effort
Protocol	TCP	UDP
Connection Type	Connection-oriented	Connectionless
Sequencing	Yes	No
Uses	<ul style="list-style-type: none">• Email• File sharing• Downloading	<ul style="list-style-type: none">• Voice streaming• Video streaming

TCP vs. UDP Analogy



UDP Characteristics

- Operates at the transport layer of the TCP/IP stack
- Provides applications with access to the network layer without the overhead of reliability mechanisms
- Operates as a connectionless protocol
- Provides limited error checking
- Provides best-effort delivery
- Provides no data recovery features

UDP Characteristics (Cont.)

The UDP header:

16-Bit Source Port	16-Bit Destination Port
16-Bit UDP Length	16-Bit UDP Checksum
Data	

TCP Characteristics

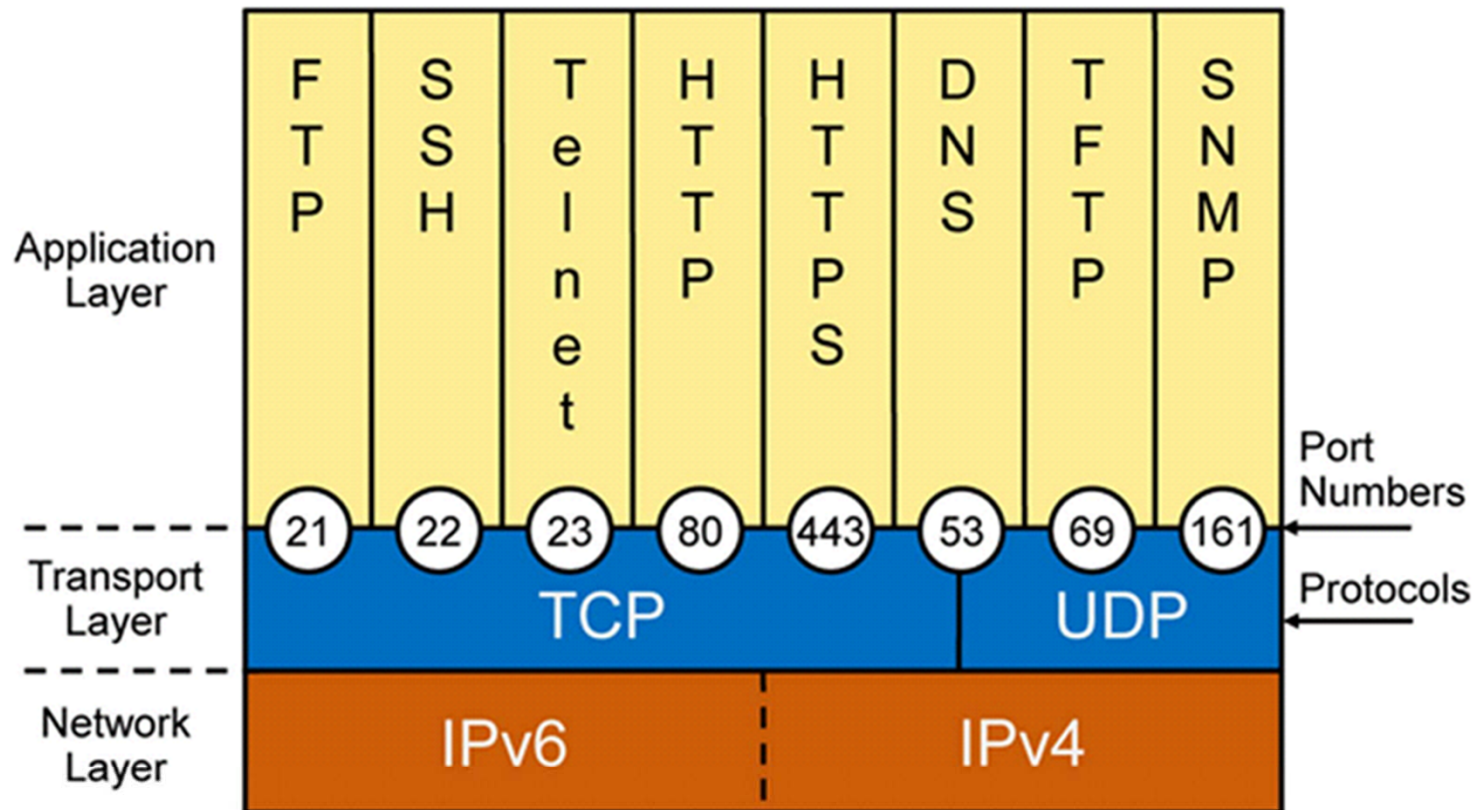
- Transport layer of the TCP/IP stack
- Access to the network layer for applications
- Connection-oriented protocol
- Full-duplex mode operation
- Error checking
- Sequencing of data packets
- Reliable delivery—acknowledgment of receipt
- Data recovery features
- Flow control

TCP Characteristics (Cont.)

The TCP header:

Source Port		Destination Port	
Sequence Number			
Acknowledgment Number			
Header Length	Reserved	Flags	Window Size
TCP Checksum		Urgent Pointer	
Options			
Data			

TCP/IP Applications



Summary

- The purpose of the transport layer is to hide the network requirements from the application layer and to ensure end-to-end transfer of application data.
- Connection-oriented transport provides reliable transport. Connectionless transport provides best-effort transport.
- UDP is a protocol that operates at the transport layer and provides applications with access to the network layer without the overhead of the reliability mechanisms of TCP. UDP is a connectionless, best-effort delivery protocol.
- TCP is a protocol that operates at the transport layer and provides applications with access to the network layer. TCP is connection-oriented and provides reliable transport.
- Port numbers identify applications.



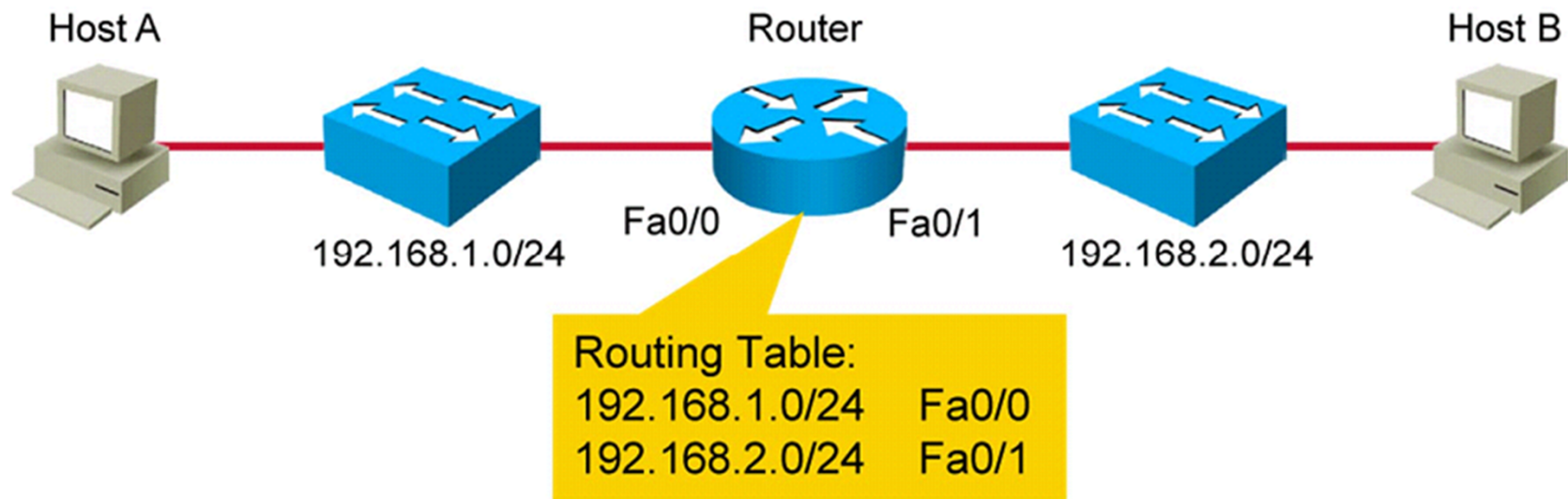


Exploring the Functions of Routing

Establishing Internet Connectivity

Role of a Router

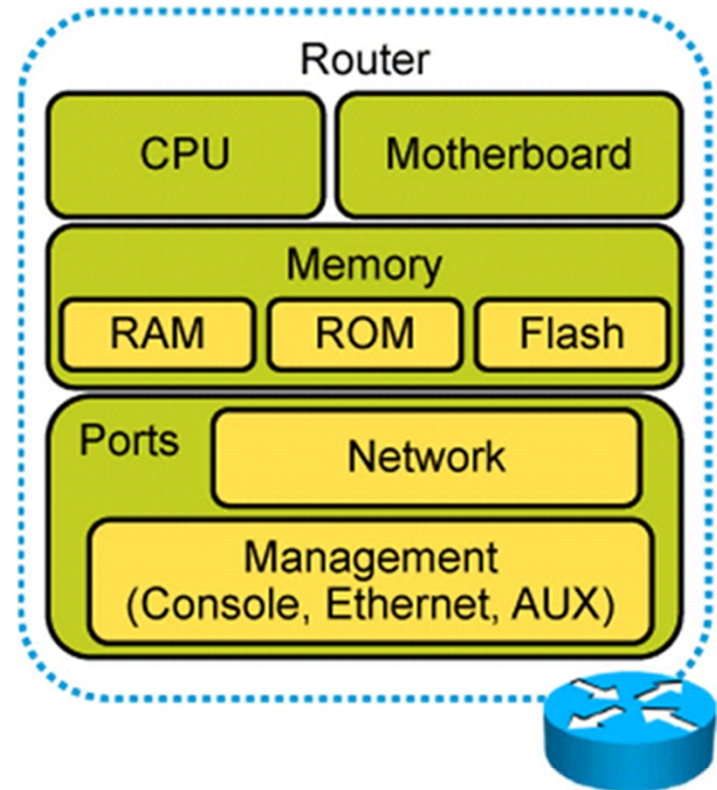
- Routers are required to reach hosts that are not in the local network.
- Routers use a routing table to route between networks.



Router Characteristics

Router components:

- CPU
- Motherboard
- Memory
 - Management: For the connection of a terminal used for management
 - Network: Various LAN or WAN media ports
- Ports



Router Functions

- Path determination
- Packet forwarding

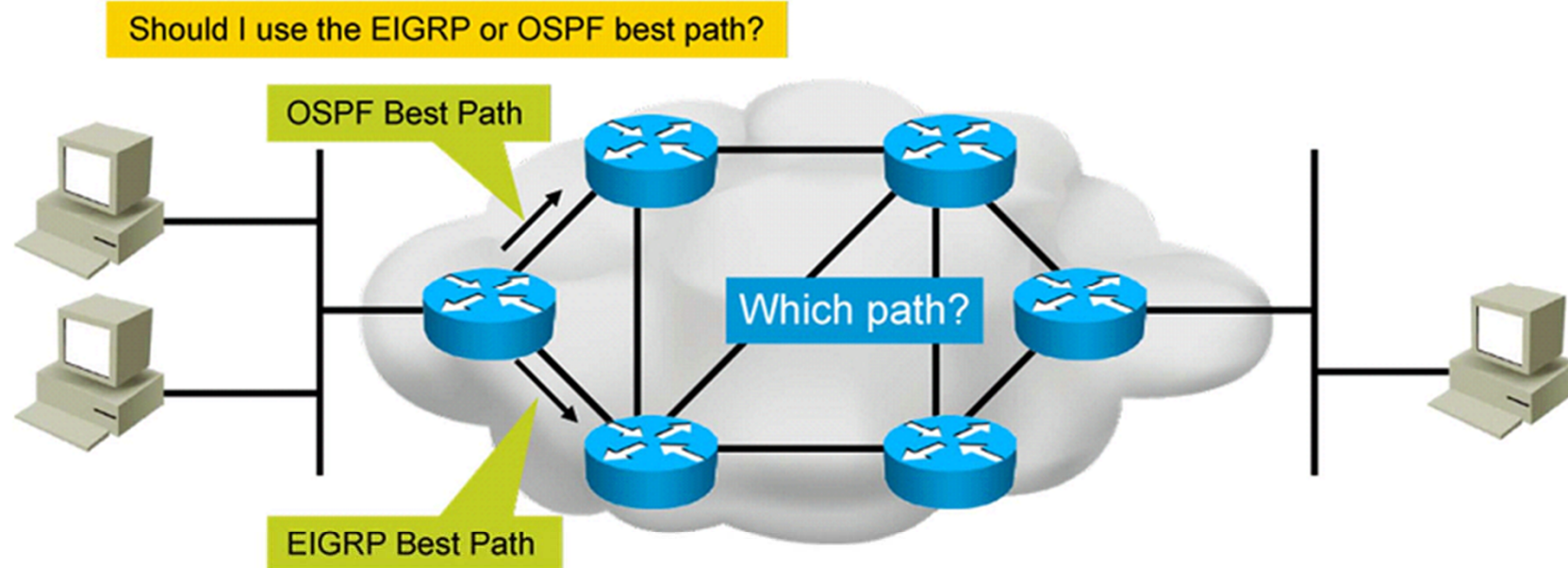
```
RouterA#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       <output omitted>
Gateway of last resort is not set

172.17.0.0/16 is variably subnetted, 8 subnets
O       172.17.14.0/24 [110/51] via 172.17.100.22, 1d05h
B       172.17.25.0/24 [200/0] via 172.17.100.22, 6d05h
D       172.17.43.0/24 [90/30720] via 172.17.50.4, 3d20h, GigabitEthernet0/0
C       172.17.50.0/24 is directly connected, GigabitEthernet0/0
L       172.17.50.2/32 is directly connected, GigabitEthernet0/0
S       172.17.92.0/24 [1/0] via 172.17.50.4
C       172.17.100.0/24 is directly connected, GigabitEthernet0/1
L       172.17.100.12/32 is directly connected, GigabitEthernet0/1
```

- Routing table on RouterA

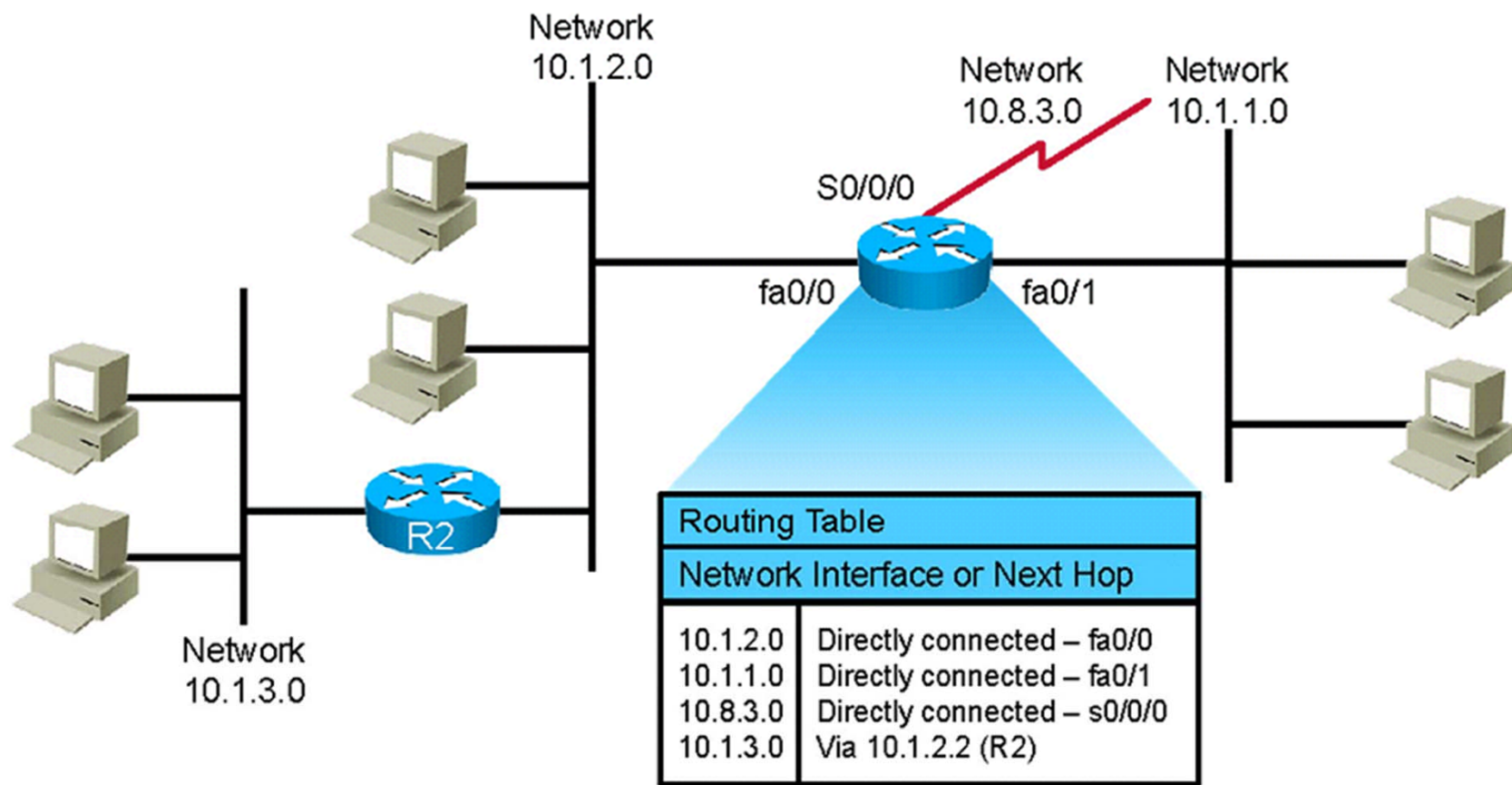
Path Determination

- Routers select the best path to the destination among various sources.
- Administrative distance defines the reliability of the route source.



Routing Table

A routing table lists all known destinations and information about how to reach them.



Types of Routes

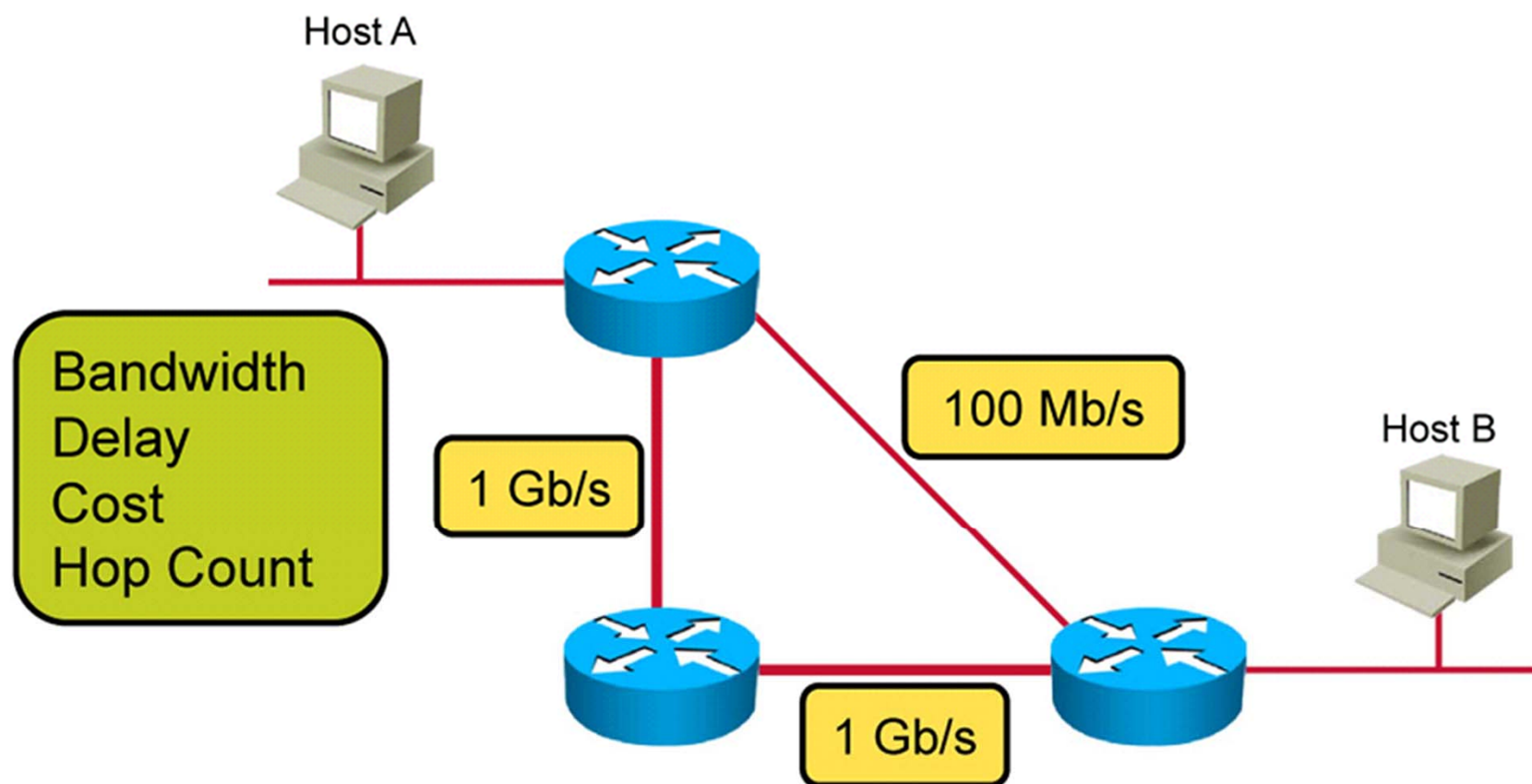
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       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, + - replicated route

Gateway of last resort is 10.1.1.1 to network 0.0.0.0

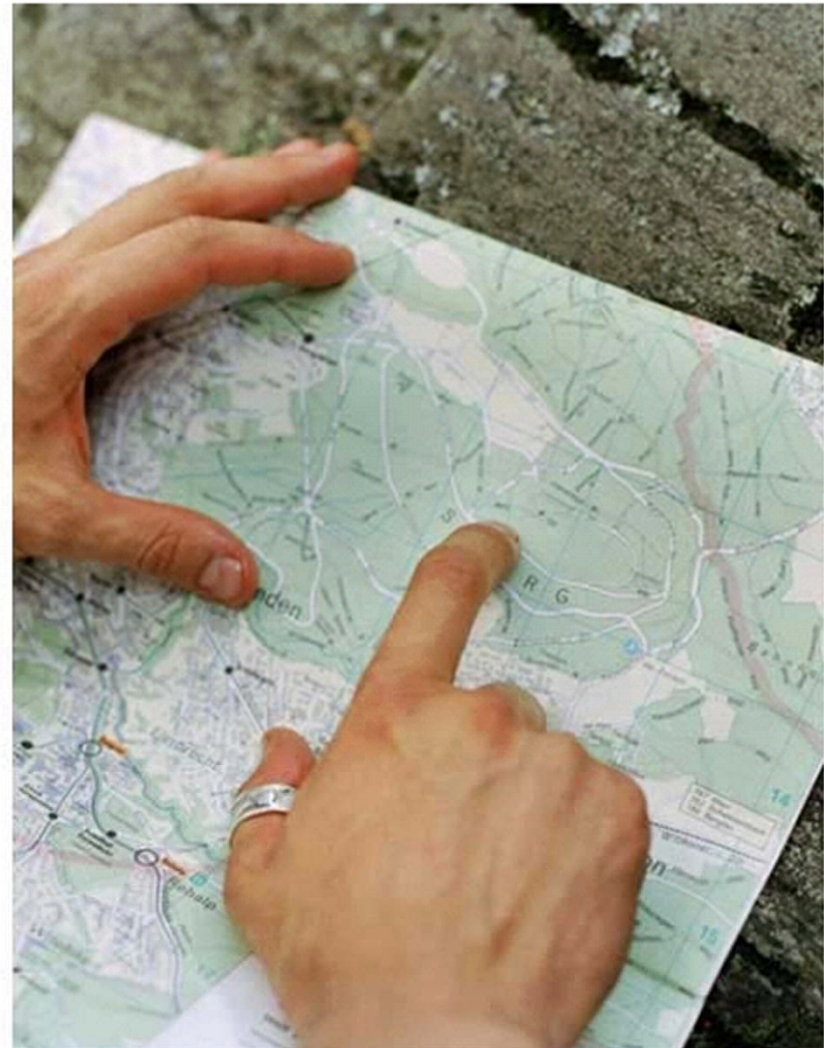
C 10.1.1.0/24 is directly connected, GigabitEthernet0/0
L 10.1.1.2/32 is directly connected, GigabitEthernet0/0
O 172.16.1.0/24 [110/2] via 192.168.10.2, 00:01:08, GigabitEthernet0/1
D 192.168.20.0/24 [90/156160] via 10.1.1.1, 00:01:23, GigabitEthernet0/0
S 192.168.30.0/24 [1/0] via 192.168.10.2
C 192.168.10.0/24 is directly connected, GigabitEthernet0/1
L 192.168.10.1/32 is directly connected, GigabitEthernet0/1
S* 0.0.0.0/0 [1/0] via 10.1.1.1
```

Dynamic Routing Protocols

Routing protocols choose different metrics to calculate best paths.



Distance Vector vs. Link State



Summary

- Routers enable internetwork communication.
- Routers include various ports and hardware similar to PCs.
- The primary functions of a router are path determination and packet forwarding.
- Routers select the best path from among different sources, based on administrative distance.
- Routing tables provide an ordered list of best paths to known networks.
- Routers use various types of routes: directly connected networks and static, dynamic, and default routes.
- Dynamic routing protocols use different metrics to calculate the best path.





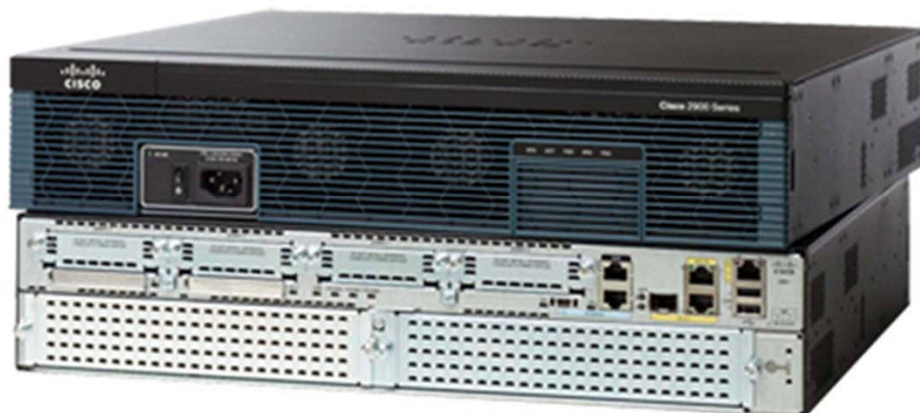
Configuring a Cisco Router

Establishing Internet Connectivity

Initial Router Startup

Initial startup:

- Before you start the router, verify the power and cooling requirements, cabling, and console connection.
- Push the power switch to On.
- System startup routines initiate the router software.
- Cisco IOS Software output text appears on the console.



Initial Router Setup



```
RouterX con0 is now available  
Press RETURN to get started.  
RouterX>
```

- A configured router with an existing configuration displays a user EXEC mode prompt.

```
--- System Configuration Dialog ---  
Would you like to enter the initial configuration dialog? [yes/no]:
```

- A router without an existing configuration enters the system configuration dialog.

Configuring Router Interfaces

```
RouterX(config)#interface GigabitEthernet 0/0  
RouterX(config-if)#
```

- Enters GigabitEthernet 0/0 interface configuration mode

```
RouterX(config)#interface Serial 0/0/0  
RouterX(config-if)#description Link to ISP
```

- Enters Serial 0/0/0 interface configuration mode and adds descriptive text

Configuring Router Interfaces (Cont.)

```
RouterX#configure terminal
RouterX(config)#interface GigabitEthernet 0/0
RouterX(config-if)#no shutdown
%LINK-3-UPDOWN: Interface GigabitEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0,
changed state to up
```

- Enables an interface that is administratively shut down

```
RouterX#configure terminal
RouterX(config)#interface Serial 0/0/0
RouterX(config-if)#shutdown
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed
state to down
```

- Administratively disables an interface

Configuring the Cisco Router IP Address

Each router interface needs a unique IP address.



```
RouterX#configure terminal
RouterX(config)#interface Serial 0/0/0
RouterX(config-if)#ip address 172.18.0.1 255.255.0.0
```

- Configures an IP address on the Serial 0/0/0 interface on router RouterX

Router show ip interface brief Command

```
RouterX#show ip interface brief
Interface                IP-Address      OK? Method Status
Protocol
Embedded-Service-Engine0/0 unassigned      YES NVRAM  administratively down
down
GigabitEthernet0/0      10.1.1.1        YES manual  up
up
GigabitEthernet0/1      209.165.200.226 YES manual  up
up
GigabitEthernet0/2      unassigned      YES NVRAM  administratively down
down
Serial0/0/0             172.18.0.1      YES manual  up
up
Serial0/0/1             unassigned      YES manual  administratively down
down
```

- Verifies the status of all interfaces

Router `show ip interface brief` Command (Cont.)

```
Branch#show ip route
<output omitted>
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.0/24 is directly connected, GigabitEthernet0/0
L       10.1.1.1/32 is directly connected, GigabitEthernet0/0
    172.18.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.18.0.0/16 is directly connected, Serial0/0/0
L       172.18.0.1/32 is directly connected, Serial0/0/0
    209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C       209.165.200.226/31 is directly connected, GigabitEthernet0/1
L       209.165.200.226/32 is directly connected, GigabitEthernet0/1
```

- Enabled interfaces populate the routing table

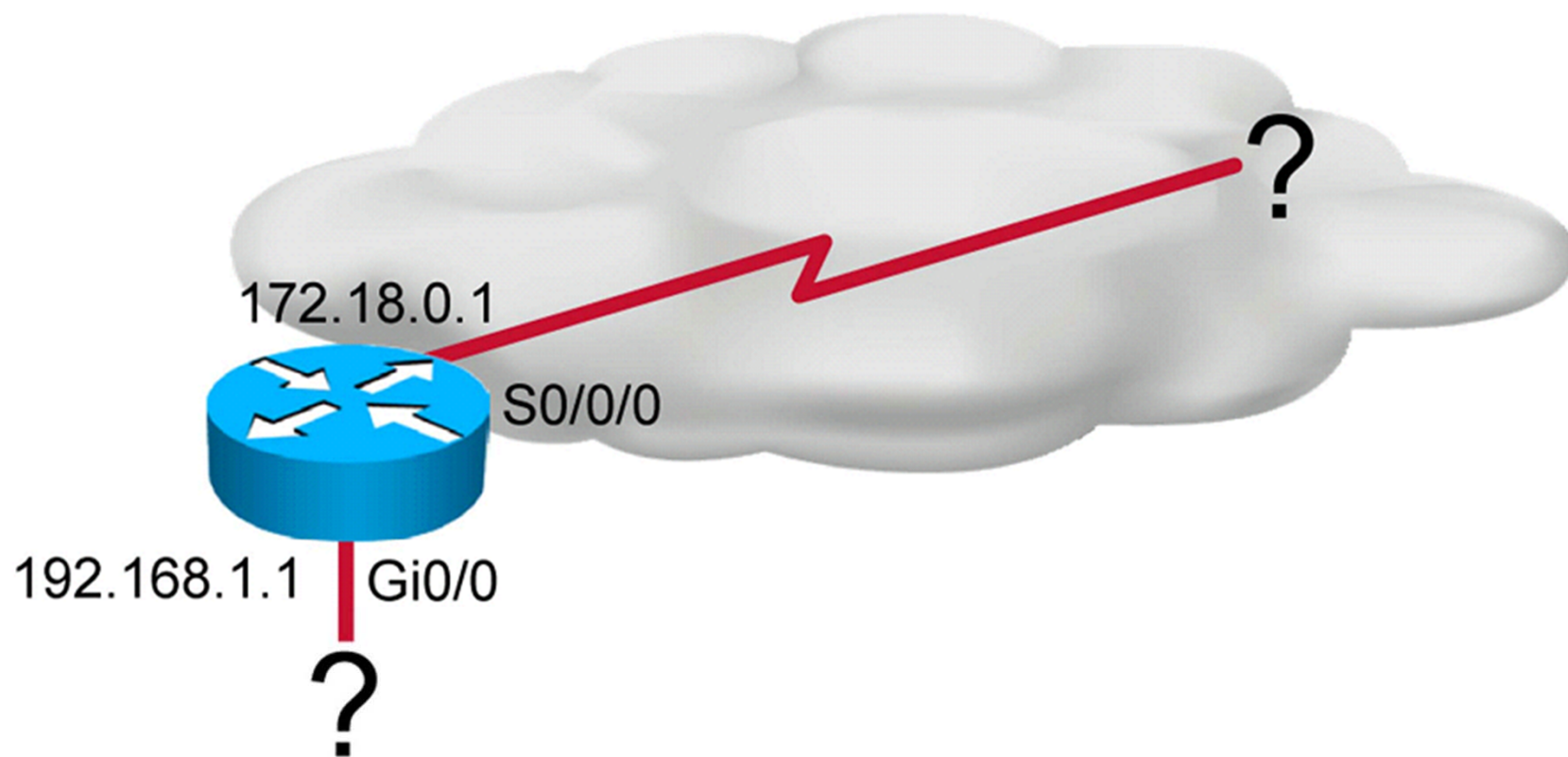
Router show interfaces Command

```
RouterX#show interfaces
GigabitEthernet0/0 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is f866.f231.7250 (bia
f866.f231.7250)
  Description: Link to LAN
  Internet address is 10.1.1.1/24
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 100Mbps, media type is RJ45
  output flow-control is unsupported, input flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:53, output 00:00:09, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
<output omitted>
```

- Verifies the statistics for all interfaces that are configured on the router

Exploring Connected Devices

What are the neighboring devices of the router?

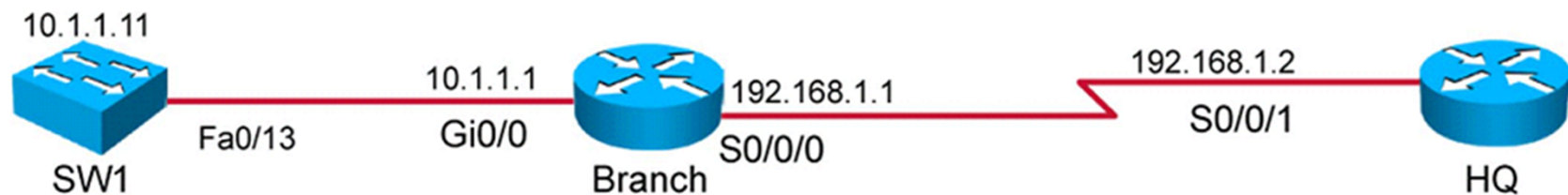


Cisco Discovery Protocol

- A proprietary utility that gathers information about directly connected Cisco switches, routers, and other Cisco devices
- Discovers neighboring devices, regardless of which protocol suite they are running
- LLDP—an alternative standards-based discovery protocol

Upper-layer entry addresses	IPv4, IPv6, and others
Cisco Discovery Protocol	Discovers and displays information about directly connected Cisco devices
Media	LAN, Frame Relay, ATM, others

Discovering Neighbors Using Cisco Discovery Protocol

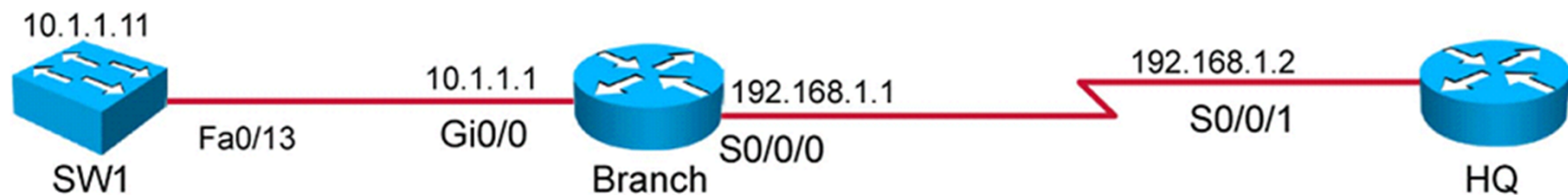


```
Branch#show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater, P - Phone,
                  D - Remote, C - CVTA, M - Two-port Mac Relay

Device ID    Local Intrfce    Holdtme    Capability    Platform    Port ID
HQ           Ser 0/0/0        123        R S I         CISCO2901   Ser 0/0/1
SW1          Gig 0/0          124        S I           WS-C2960-   Fas 0/13
```

- Displays information about neighboring devices discovered with Cisco Discovery Protocol

Using the `show cdp neighbors detail` Command



```
Branch#show cdp neighbors detail
-----
Device ID: HQ
Entry address(es):
  IP address: 192.168.1.2
Platform: Cisco CISCO2901/K9, Capabilities: Router Switch IGMP
Interface: Serial0/0/0, Port ID (outgoing port): Serial0/0/1
Holdtime: 132 sec
Version: Cisco IOS Software, C2900 Software (C2900-UNIVERSALK9-M),
Version 15.2(4)M1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Tue 20-Mar-12 18:57 by prod_rel_team
<output omitted>
```

- Displays detailed information about neighboring devices

Summary

- The router startup sequence begins with POST, then the Cisco IOS image is found and loaded. Finally, the configuration file is loaded, if it exists.
- If a router starts without a configuration, the Cisco IOS Software executes a question-driven configuration dialog, which can be skipped.
- The main function of a router is to relay packets from one network device to another.
- Interface characteristics, such as the IP address and description, are configured using interface configuration mode.
- When you have completed router interface configuration, you can verify it by using the **show ip interface brief** and **show interfaces** commands

Summary (Cont.)

- Cisco Discovery Protocol is an information-gathering tool used by network administrators to obtain information about directly connected devices.
- Cisco Discovery Protocol exchanges hardware and software device information with its directly connected Cisco Discovery Protocol neighbors.
- The **show cdp neighbors** command displays information about the Cisco Discovery Protocol neighbors of a router.
- The **show cdp neighbors detail** command displays detailed Cisco Discovery Protocol information on a Cisco device.





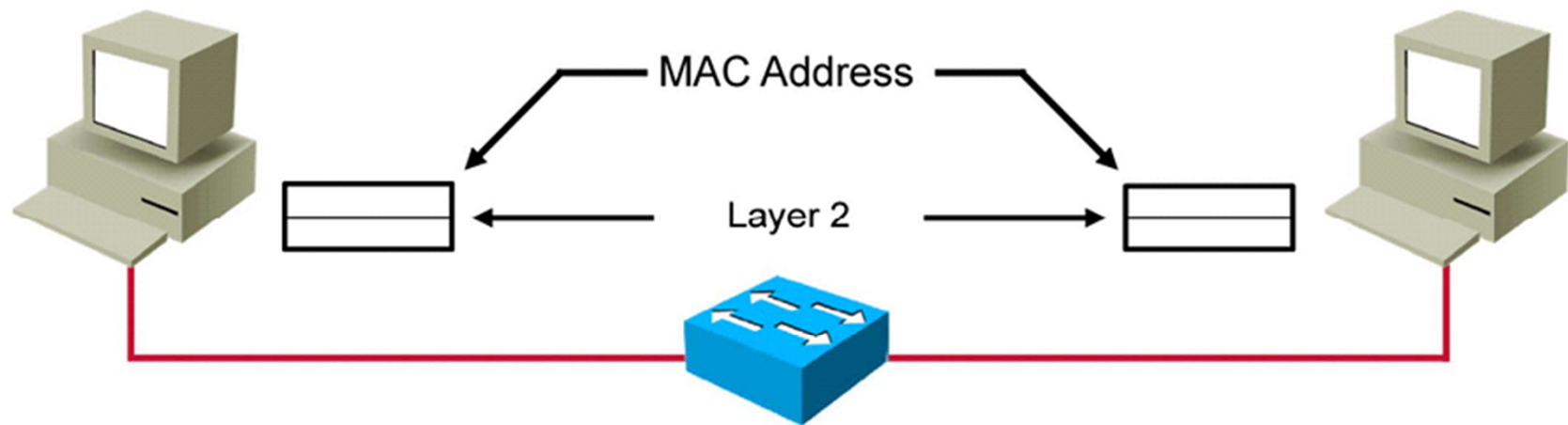
Exploring the Packet Delivery Process

Establishing Internet Connectivity

Layer 2 Addressing

Layer 2 characteristics:

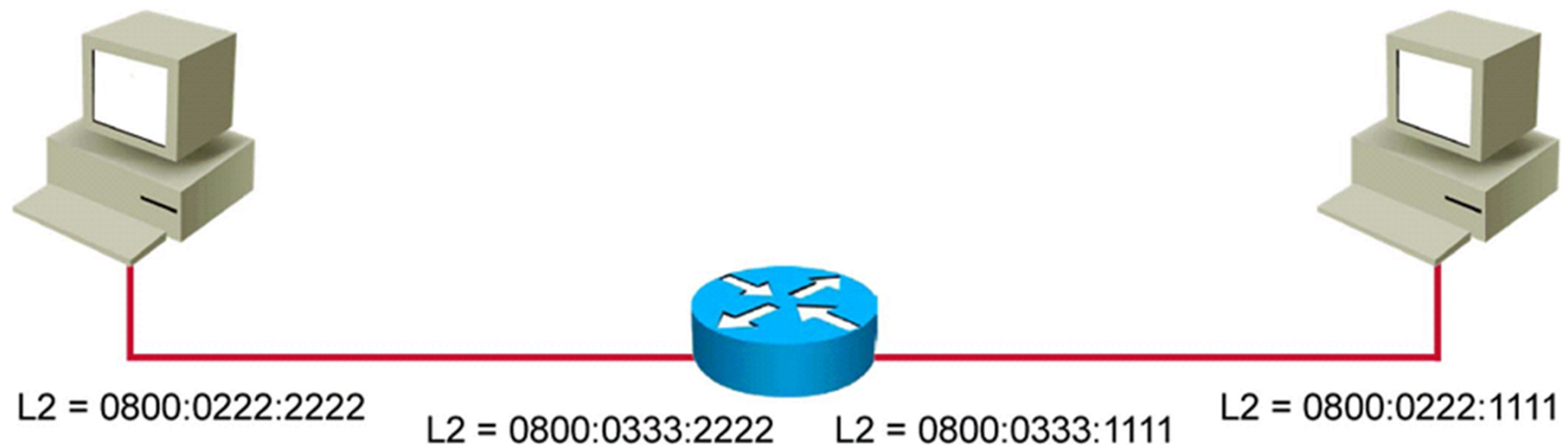
- Ethernet uses MAC addresses.
- Identifies end devices in the LAN.
- Enables the packet to be carried by the local media across each segment.



Layer 2 Addressing (Cont.)

Layer 2 addressing:

- The router has two interfaces directly connected to two PCs.
- Each PC and each router interface has its own unique MAC address.

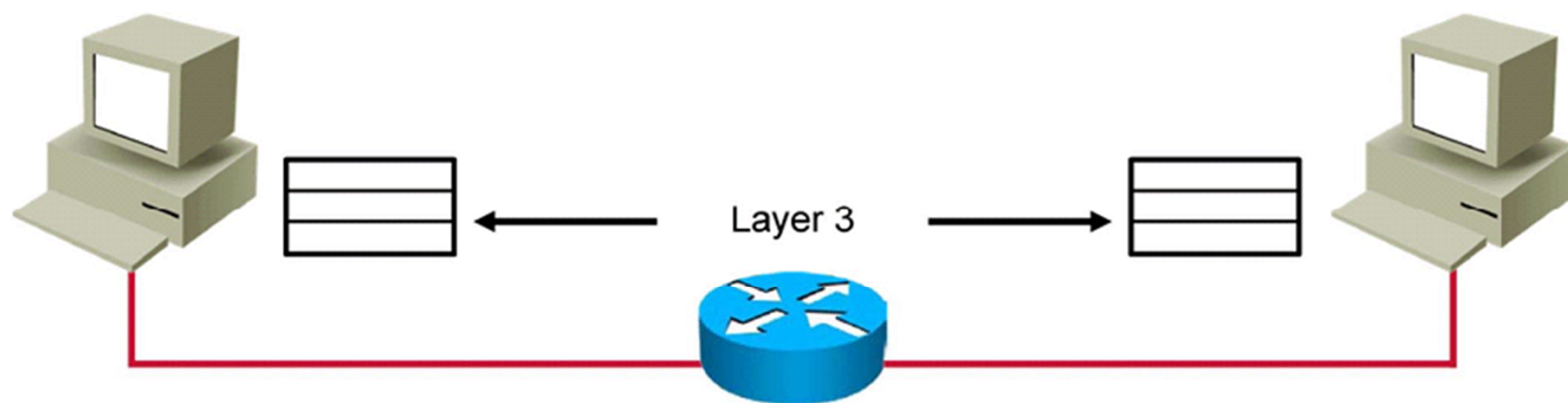


L2 = Layer 2

Layer 3 Addressing

Layer 3 devices and functions:

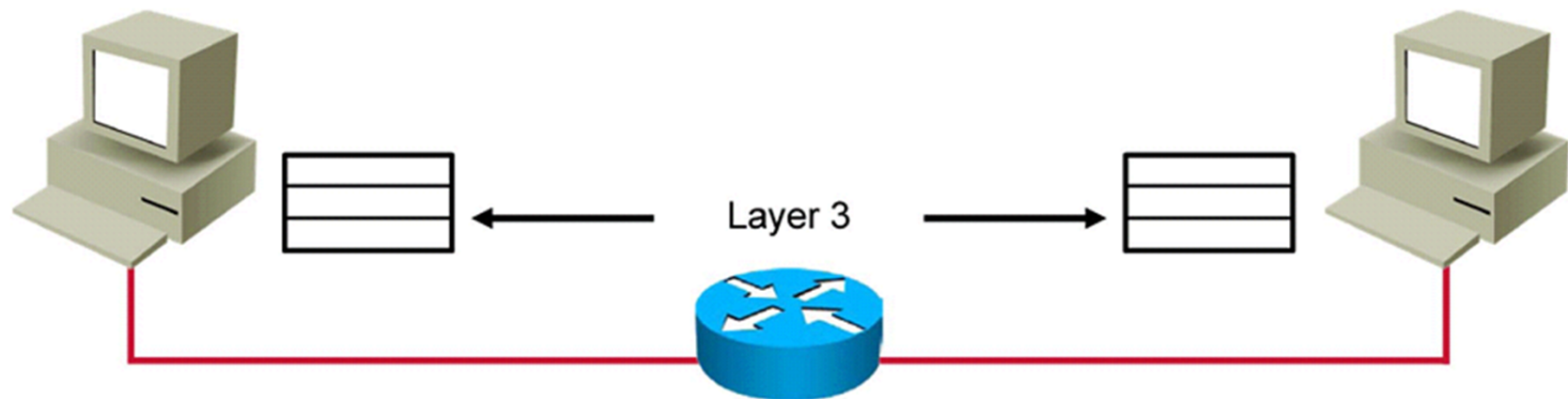
- The network layer provides connectivity and path selection between two host systems.
- In the host, this is the path between the data link layer and the upper layers.
- In the router, it is the actual path across the network.



Layer 3 Addressing (Cont.)

Layer 3 addressing:

- Layer 3 addresses must include identifiers that enable intermediary network devices to locate hosts on different networks.
- TCP/IP protocol stack uses IP.

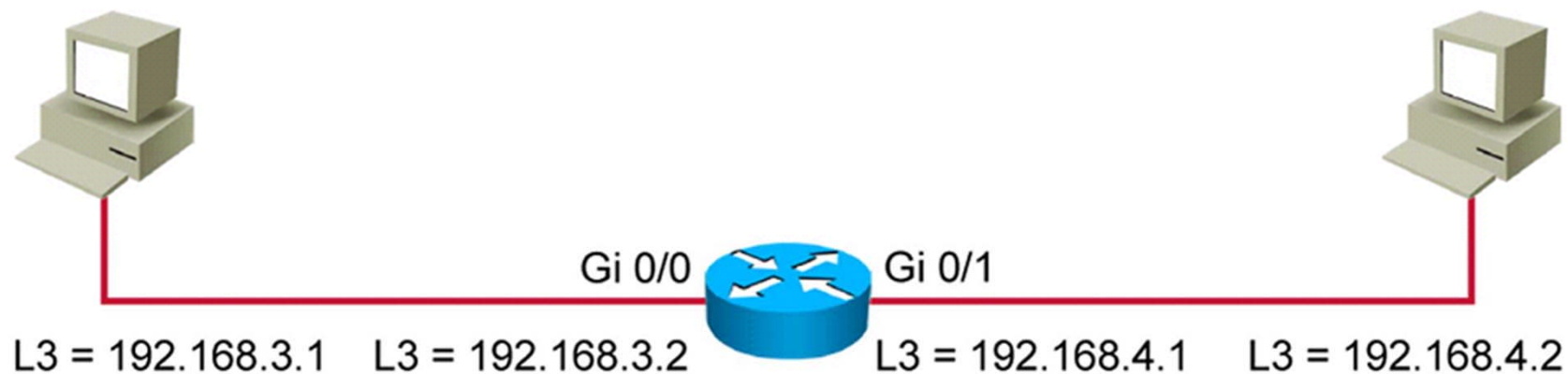


Layer 3 Addressing (Cont.)

- Layer 3 addresses are assigned to hosts and network devices that provide Layer 3 functions.
- Network devices maintain a routing table.

Routing Table

192.168.3.0/24	Interface Gi0/0
192.168.4.0/24	Interface Gi0/1



L3 = Layer 3