CCNA 200-301

CISCO™

Lesson 15

Layer 3 (Network layer) connectivity

Operating Cisco Routers

- Installing Enterprise Routers
- Cisco ISR
- Accessing to Router CLI
- Router Interfaces

IPv4 on router interfaces

IP Routing

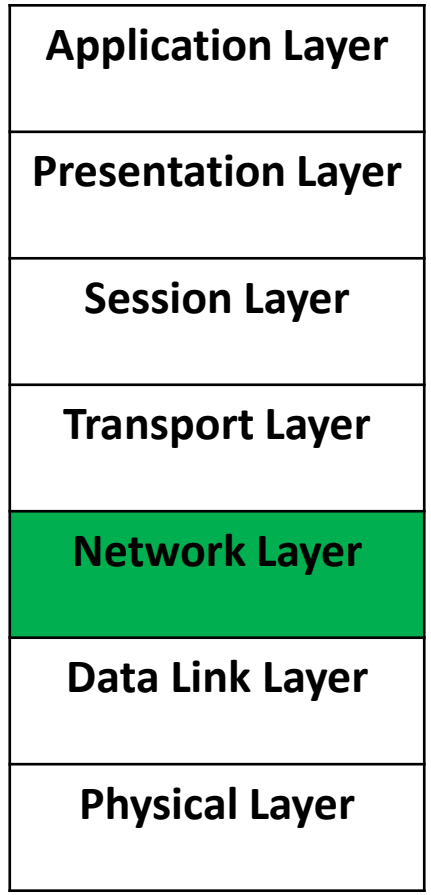
- Connected routes
- #show ip route analyze

Layer 3 connectivity

According to the conceptual OSI model IP routing is done on Layer 3 (Network Layer). In Layer 2 we spoke about frame and another Layer 2 protocols. Layer 3 is responsible to send IP Packet from source to destination. This is called routing.

Routing is made with static routing or dynamic routing protocols like RIP, OSPF, EIGRP.

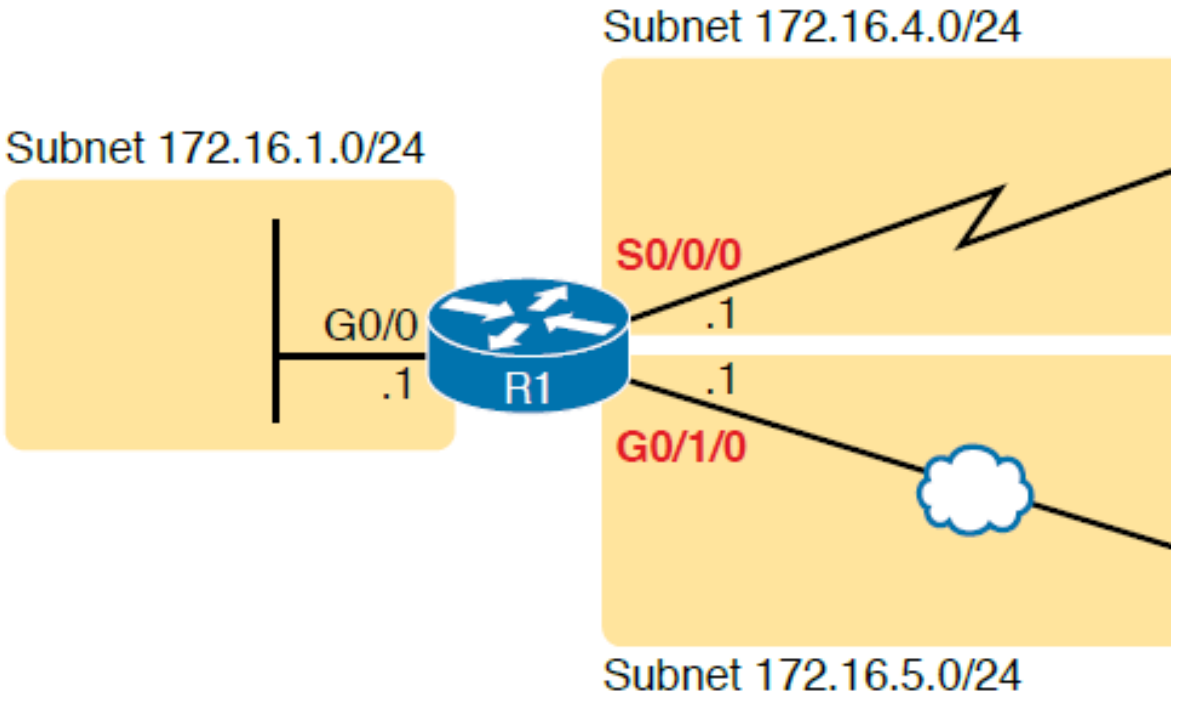
As network component on Layer 3 is Router is the main, additional Multilayer Switches are also used on Layer 3.



Installing Enterprise Routers

Enterprise Router Interfaces

- Ethernet LAN: for LAN devices.
- Ethernet WAN: to SP network
- Serial WAN: Point-to-Point Serial Link



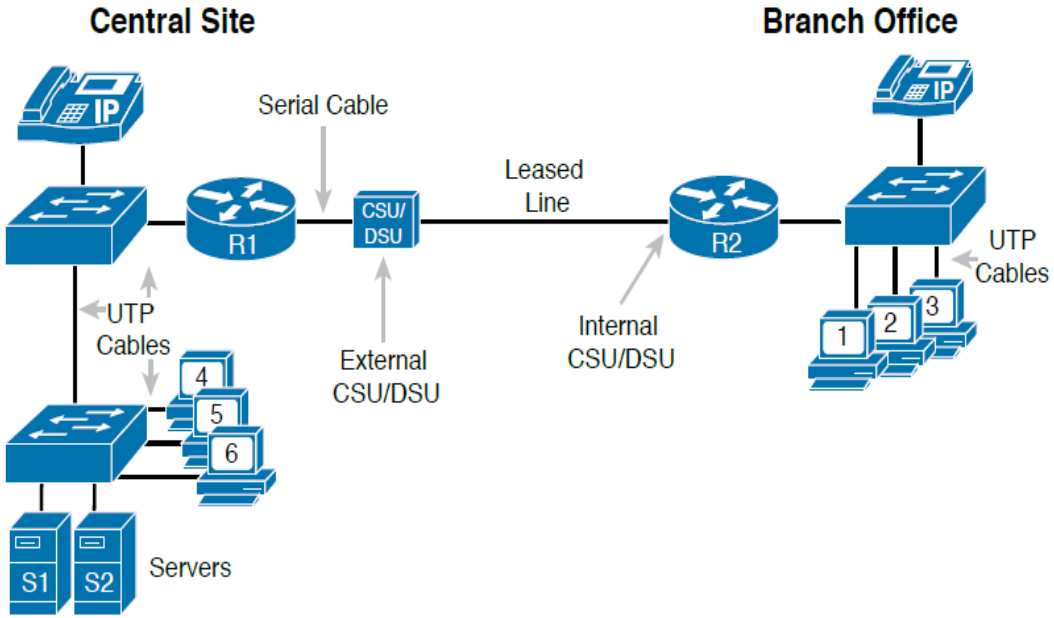
Installing Enterprise Routers cont.

In the topology we see two routers connected with leased line. Each router is connected to LAN network respectively.

Between the routers we see CSU/DSU (Channel / Data Service Units).

For R1 CSU/DSU is connected as a external device, however for R2 CSU/DSU is internal device.

To connect CSU/DSU RJ48 standard is used.



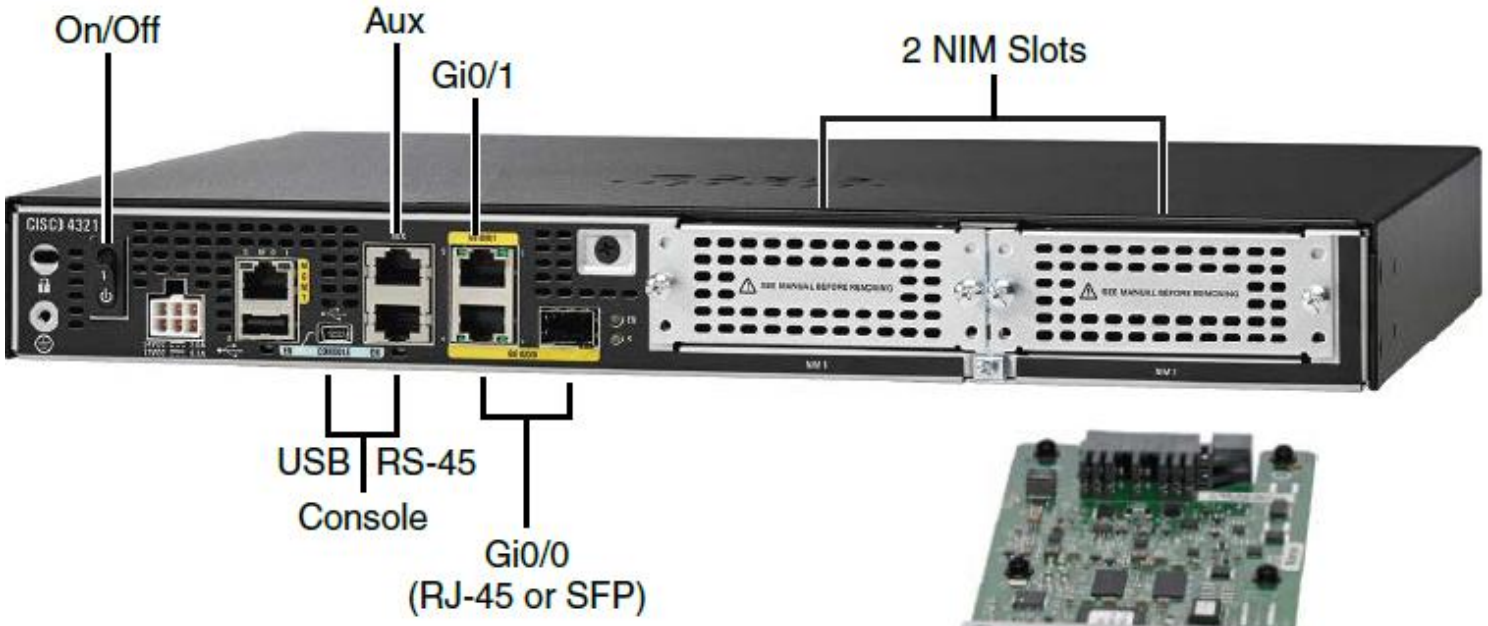
1.RJ45 and RJ48 use the same connector

2.RJ45 differs from RJ48 in the way they are wired

3.RJ45 is predominantly used in LAN while RJ48 is more commonly seen on T1 lines

4.RJ45 is connected with UTP cable while RJ48 uses STP

Cisco Integrated Service Router



2-Port Serial NIM

Product vendors, including Cisco, typically provide several different types of router hardware. Today, routers often do much more work than simply routing packets; in fact, they serve as a device or platform from which to provide many network services. Cisco even brands its enterprise routers not just as routers, but as “integrated services routers,” emphasizing the multipurpose nature of the products.

Image shows a photo of the Cisco 4321 ISR.

The bottom of the photo shows one example NIM (a NIM that provides two serial interfaces). The router has other items as well, including both an RJ-45 and USB console port.

Accessing Router CLI

Cisco switches and routers share many of the same CLI navigation features and many of the same configuration commands for management features.

- User and Enable (privileged) mode
- Entering and exiting configuration mode, using the **configure terminal**, **end**, and **exit** commands and the Ctrl+Z key sequence
- Configuration of console, Telnet (vty), and enable secret passwords
- Configuration of Secure Shell (SSH) encryption keys and username/password login credentials
- Configuration of the hostname and interface description
- Configuration of Ethernet interfaces that can negotiate speed using the **speed** and **duplex**commands
- Configuration of an interface to be administratively disabled (**shutdown**) and administratively enabled (**no shutdown**)
- Navigation through different configuration mode contexts using commands like **line console 0** and **interface** *type number*
- CLI help, command editing, and command recall features
- The meaning and use of the startup-config (in NVRAM), running-config (in RAM), and external servers (like TFTP), along with how to use the **copy** command to copy the configuration files and IOS images

Difference between Switch and Router CLI

The configuration of IP addresses differs in some ways, with switches using a VLAN interface and routers using an IP address configured on each working interface.

- Many Cisco router models have an auxiliary (Aux) port, intended to be connected to an external modem and phone line to allow remote users to dial in to the router, and access the CLI, by making a phone call. Cisco switches do not have auxiliary ports.

- Router IOS defaults to disallow both Telnet and SSH into the router because of the typical router default setting of **transport input none** in vty configuration mode. (Cisco Catalyst LAN switches typically default to allow both Telnet and SSH.) “Configuring Basic Switch Management,” already discussed the various options on this command to enable Telnet (**transport input telnet**), SSH (**transport input ssh**), or both (**transport input all** or **transport input telnet ssh**).

Router Interfaces

Some Router Interface types:

```
interface ethernet 0
interface fastethernet 0/1
interface gigabitethernet 0/0
interface gigabitethernet 0/1/0
interface serial 1/0/1
```

Two of the most common commands to display the interfaces, and their status, are the **show ip interface brief** and **show interfaces** commands.

```
R1# show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Embedded-Service-Engine0/0 unassigned      YES NVRAM  administratively down down
GigabitEthernet0/0         172.16.1.1      YES NVRAM  up                    up
GigabitEthernet0/1         unassigned      YES NVRAM  administratively down down
Serial0/0/0                172.16.4.1      YES manual up                    up
Serial0/0/1                unassigned      YES unset  administratively down down
GigabitEthernet0/1/0       172.16.5.1      YES NVRAM  up                    up

R1# show interfaces gigabitEthernet 0/1/0
GigabitEthernet0/1/0 is up, line protocol is up
  Hardware is EHWIC-1GE-SFP-CU, address is 0201.a010.0001 (bia 30f7.0d29.8570)
  Description: Link in lab to R3's G0/0/0
  Internet address is 172.16.5.1/24
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 1Gbps, media type is RJ45
```

Router Interfaces cont.

Typical Combinations of Interface Status Codes

Line Status	Protocol Status	Typical Reasons
Administratively down	Down	The interface has a shutdown command configured on it.
Down	Down	The interface is not shutdown, but the physical layer has a problem. For example, no cable has been attached to the interface, or with Ethernet, the switch interface on the other end of the cable is shut down, or the switch is powered off, or the devices on the ends of the cable use a different transmission speed.
Up	Down	Almost always refers to data-link layer problems, most often configuration problems. For example, serial links have this combination when one router was configured to use PPP and the other defaults to use HDLC.
Up	Up	Layer 1 and Layer 2 of this interface are functioning.

IPv4 on router interfaces

We compare Cisco router and Switch IOS. According to out comparison we give IP address to Interface VLAN on Cisco Catalyst switches. On Cisco routers it is possible to assign IP address to physical interfaces.

IPv4 configuration on Cisco Router we need to go interface configuration mode with the command from global configuration mode with the next command.

R(config)# interface Gi0/0/0

R(conf-if)# ip address x.x.x.x y.y.y.y

x.x.x.x – IP address

y.y.y.y – Subnet mask

Packet traces example….

Command	Lines of Output per Interface	IP Configuration Listed	Interface Status Listed?
show ip interface brief	1	Address	Yes
show protocols [*type number*]	1 or 2	Address/mask	Yes
show interfaces [*type number*]	Many	Address/mask	Yes

IP routing

IP routing—the process of forwarding IP packets—delivers packets across entire TCP/IP networks, from the device that originally builds the IP packet to the device that is supposed to receive the packet. In other words, IP routing delivers IP packets from the sending host to the destination host.

The complete end-to-end routing process relies on network layer logic on hosts and on routers. The sending host uses Layer 3 concepts to create an IP packet, forwarding the IP packet to the host's default gateway (default router). The process requires Layer 3 logic on the routers as well, by which the routers compare the destination address in the packet to their routing tables, to decide where to forward the IP packet next.

IPv4 Routing Process Reference

Step 1. If the destination is local, send directly:

A. Find the destination host's MAC address. Use the already-known Address Resolution Protocol (ARP) table entry, or use ARP messages to learn the information.

B. Encapsulate the IP packet in a data-link frame, with the destination data-link address of the destination host.

Step 2. If the destination is not local, send to the default gateway:

A. Find the default gateway's MAC address. Use the already-known Address Resolution Protocol (ARP) table entry, or use ARP messages to learn the information.

B. Encapsulate the IP packet in a data-link frame, with the destination data-link address of the default gateway.

IP routing cont.

With the following five-step summary of a router's routing logic, the router takes the first two steps just to receive the frame and extract the IP packet, before thinking about the packet's destination address.

1. For each received data-link frame, choose whether or not to process the frame.

Process it if

A. The frame has no errors (per the data-link trailer Frame Check Sequence [FCS] field).

B. The frame's destination data-link address is the router's address (or an appropriate multicast or broadcast address).

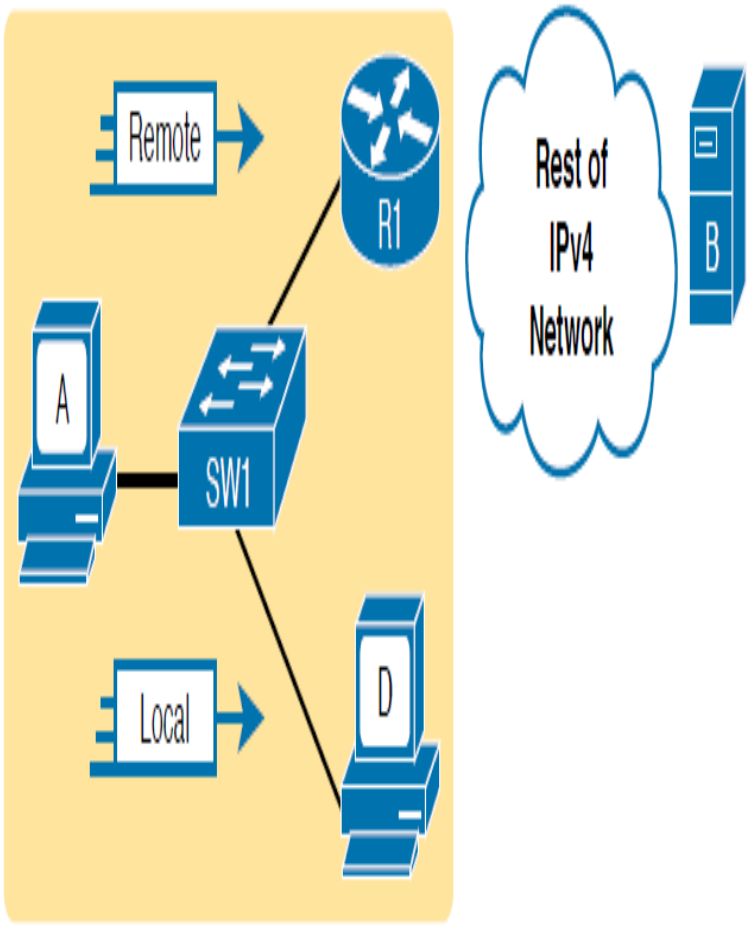
2. If choosing to process the frame at Step 1, de-encapsulate the packet from inside the data-link frame.

3. Make a routing decision. To do so, compare the packet's destination IP address to the routing table and find the route that matches the destination address. This route identifies the outgoing interface of the router and possibly the next-hop router.

4. Encapsulate the packet into a data-link frame appropriate for the outgoing interface.

When forwarding out LAN interfaces, use ARP as needed to find the next device's MAC address.

5. Transmit the frame out the outgoing interface, as listed in the matched IP route.



Connected Routes

A Cisco router automatically adds a route to its routing table for the subnet connected to each interface, assuming that the following two facts are true:

- The interface is in a working state. In other words, the interface status in the **show interfaces** command lists a line status of up and a protocol status of up.
- The interface has an IP address assigned through the **ip address** interface subcommand.

The concept of connected routes is relatively basic. The router, of course, needs to know the subnet number connected to each of its interfaces, so the router can route packets to that subnet. The router does the math, taking the interface IP address and mask and calculating the subnet ID. However, the router only needs that route when the interface is up and working, so the router includes a connected route in the routing table only when the interface is working.

The output from the **show ip route** command, which lists these routes with a ***c*** as the route code, meaning *connected*.

#show IP route analyze

- C – connected route
- L – Local route.

Note that the router also automatically produces a different kind of route, called a *local route*. The local routes define a route for the one specific IP address configured on the router interface. Each local route has a /32 prefix length, defining a *host route*, which defines a route just for that one IP address.

Routing Protocol Code: The legend at the top of the **show ip route** output (about nine lines) lists all the routing protocol codes (exam topic 3.1.a). This book references the codes for connected routes (C), local (L), static (S), and OSPF (O).

Packet Tracer example…

```
R1# 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
       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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet0/0
L        172.16.1.1/32 is directly connected, GigabitEthernet0/0
C        172.16.4.0/24 is directly connected, Serial0/0/0
L        172.16.4.1/32 is directly connected, Serial0/0/0
C        172.16.5.0/24 is directly connected, GigabitEthernet0/1/0
L        172.16.5.1/32 is directly connected, GigabitEthernet0/1/0
```

That is all for Lesson 15

The key is :

Learn

Repeat

Practice

You will be able to reach your goals.

GOOD LUCK !!!!!...