**Module 8.IP Routing**

Beginner Question

1. Explain Routing Basics with command

IP routing is a process of transferring data from one network to another as IP packets. By default, hosts of different networks cannot communicate with each other. If two hosts located in different IP networks want to communicate with each other, they use IP routing.

Routers provide IP routing. A router is a specialized device that connects different IP networks. Let’s take a simple example. Suppose two IP hosts; 10.10.10.10/8 and 20.20.20.20/8 want to communicate. Since they both belong to the different IP networks, they need a router to communicate.

## Routing protocols v/s Routed or Routable protocols:

A routed protocol is used to encapsulate the data that is exchanged between the source host and the destination host. In IP routing, the **IP protocol** is used as the routed protocol.

By using the IP protocol, a source host packs data pieces and adds the source address and the destination address on each data piece. A data piece with both addresses (source and destination) is known as the **IP packet**.

Any router that works on a path that connects the source host to the destination host uses both (source and destination) addresses to find out where the packet came from and where it will go.

##### **Routing protocols**

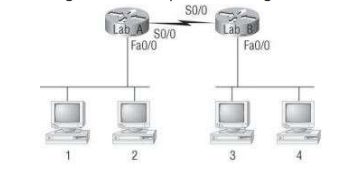
Routers use a routing protocol for the following purposes.

To figure out all available paths of the network. A router stores these paths in a table known as the **routing table**.

To select the best and fastest path to get a destination host. When a router receives an IP packet, the router checks its routing table and compares all available paths to get the destination network of the received IP packet and selects the fastest path from all available paths.

The process of IP routing begins when a host creates a data packet for a host that is located in another network and ends when that destination host receives the packet.

2. Configuration basic ip address in fig.



Labs A:

Router>en

Router#conf t

Enter configuration commands, one per line. End with CNTL/Z.

Router(config)#inter

Router(config)#interface fa

Router(config)#interface fastEthernet 0/0

Router(config-if)#ip add

Router(config-if)#ip address 10.0.0.1 255.0.0.0

Router(config-if)# no shut

Router(config-if)# interface serial 0/0

Router(config-if)#ip address 20.0.0.1 255.0.0.0

Router(config-if)# no shut

Router(config-if)# exit

Lab B:

Router>en

Router#conf t

Enter configuration commands, one per line. End with CNTL/Z.

Router(config)#inter

Router(config)#interface fa

Router(config)#interface fastEthernet 0/0

Router(config-if)#ip add

Router(config-if)#ip address 30.0.0.1 255.0.0.0

Router(config-if)# no shut

Router(config-if)# interface serial 0/0

Router(config-if)#ip address 20.0.0.2 255.0.0.0

Router(config-if)# no shut

Router(config-if)# exit

Intermediate Question

1. Explain Static Routing

**Static routing** is a form of [routing](https://en.wikipedia.org/wiki/Routing) that occurs when a router uses a manually-configured routing entry, rather than information from a dynamic routing traffic. In many cases, static routes are manually configured by a [network administrator](https://en.wikipedia.org/wiki/Network_administrator) by adding in entries into a [routing table](https://en.wikipedia.org/wiki/Routing_table), though this may not always be the case.[[2]](https://en.wikipedia.org/wiki/Static_routing#cite_note-SLA-2) Unlike [dynamic routing](https://en.wikipedia.org/wiki/Dynamic_routing), static routes are fixed and do not change if the network is changed or reconfigured. Static routing and [dynamic routing](https://en.wikipedia.org/wiki/Dynamic_routing) are not mutually exclusive. Both dynamic routing and static routing are usually used on a router to maximize routing efficiency and to provide backups in the event that dynamic routing information fails to be exchanged. Static routing can also be used in [stub networks](https://en.wikipedia.org/wiki/Stub_network), or to provide a [gateway of last resort](https://en.wikipedia.org/wiki/Default_route).

Static routing may have the following uses:

* Static routing can be used to define an exit point from a router when no other routes are available or necessary. This is called a [default route](https://en.wikipedia.org/wiki/Default_route).
* Static routing can be used for small networks that require only one or two routes. This is often more efficient since a link is not being wasted by exchanging dynamic routing information.
* Static routing is often used as a complement to dynamic routing to provide a failsafe backup in the event that a dynamic route is unavailable.
* Static routing is often used to help transfer routing information from one routing protocol to another (routing redistribution).

The commands to add a static route are as follows:

Router> enable

Router# configure terminal

Router(config)# interface s0/0/0

Router(config)# ip route 10.10.20.0 255.255.255.0 192.168.100.1

Network configurations are not restricted to a single static route per destination:

Router> enable

Router# configure terminal

Router(config)# ip route 197.164.73.0 255.255.255.0 197.164.72.2

Router(config)# ip route 197.164.74.0 255.255.255.0 197.164.72.2

2. Explain Default Routing

Default routing can be considered a special type of static routing. The difference between a normal static route and a default route is that a default route is used to send packets destined to any unknown destination to a single next hop address. To understand how this works, consider Router1 from our example (Figure 4-2), without any static routes in it. When it receives a packet destined to 192.168.5.0/24 it will drop it since it does not know where the destination network is. If a default route is added in Router1 with next hop address of Router2, all packets destined to any unknown destination, such as 192.168.5.0/24 will be sent to Router2.

Default routes are useful when dealing with a network with a single exit point. It is also useful when a bulk of destination networks have to be routed to a single next-hop device. When adding a default route, you should ensure that the next-hop device can route the packet further, or else the next hop device will drop the packet.

Another point to remember is that when a more specific route to a destination exists in the routing table, the router will use that route and not the default route. The only time the router will use the default route is when a specific route does not exist.

The command to add a default route is same as that of adding a static route, but with the network address and mask set to 0.0.0.0 as shown below:

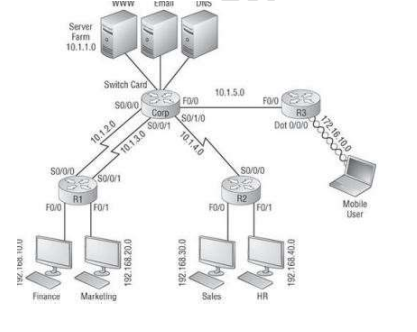
**ip route 0.0.0.0 0.0.0.0***next-hop*

In our example network, the only exit point for the 192.168.1.0/24 and 192.168.5.0/24 networks is towards Router2. Hence, we can remove the static routes from Router1 and Router3 and add default routes as shown below:

Router1(config)#no ip route 10.1.2.0 255.255.255.0 10.1.1.2  
Router1(config)#no ip route 192.168.5.0 255.255.255.0 10.1.1.2  
**Router1(config)#ip route 0.0.0.0 0.0.0.0 10.1.1.2**

Router3(config)#no ip route 10.1.1.0 255.255.255.0 10.1.2.1  
Router3(config)#no ip route 192.168.1.0 255.255.255.0 10.1.2.1  
**Router3(config)#ip route 0.0.0.0 0.0.0.0 10.1.2.1**

3. Configuring IP routing



4. Explain rip Command

Routing Information Protocol (RIP) is designed to function on small to large networks but can suffer when a network is not designed to accommodate its eccentricities. The information presented focuses primarily on RIPv2, rather than on RIPv1, because with RIPv1, all systems must use class-based network masks or be subnetted exactly the same way. RIPv2, on the other hand, supports Variable Length Subnet Masks (VLSM).

If you choose to deploy network IDs across your network you will likely want to deploy VSLM in order to conserve addresses on your network. So, if you plan to deploy RIP as a protocol, you will likely use version 2.

The biggest issue with RIPv1 is that all systems must use class-based network masks or be subnetted exactly the same way, whereas RIPv2 supports Variable Length Subnet Masks (VLSM).

## Enabling RIP

## As with most routing protocols, when you enable the RIP protocol, you will be placed in Router Configuration mode (config-router).

## Router2>enable

## Password:

## Router2#configure terminal

Enter configuration commands, one per line. End with CNTL/Z.

Router2(config)#ip routing

Router2(config)#router rip

Router2(config-router)#network 192.168.10.0

Router2(config-router)#network 192.168.1.0

Router2(config-router)#exit

Router2(config)#exit

Advance question

1. Explain Dynamic Routing

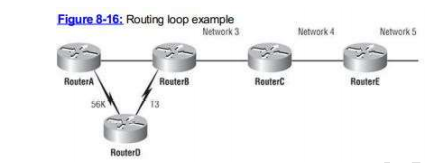
Dynamic routing is a networking technique that provides optimal data routing. Unlike static routing, dynamic routing enables routers to select paths according to real-time logical network layout changes. In dynamic routing, the routing protocol operating on the router is responsible for the creation, maintenance and updating of the dynamic routing table. In static routing, all these jobs are manually done by the system administrator.  
  
Dynamic routing uses multiple algorithms and protocols. The most popular are Routing Information Protocol (RIP) and Open Shortest Path First (OSPF).

The cost of routing is a critical factor for all organizations. The least-expensive routing technology is provided by dynamic routing, which automates table changes and provides the best paths for data transmission.  
  
Typically, dynamic routing protocol operations can be explained as follows:

1. The router delivers and receives the routing messages on the router interfaces.
2. The routing messages and information are shared with other routers, which use exactly the same routing protocol.
3. Routers swap the routing information to discover data about remote networks.
4. Whenever a router finds a change in topology, the routing protocol advertises this topology change to other routers.

Dynamic routing is easy to configure on large networks and is more intuitive at selecting the best route, detecting route changes and discovering remote networks. However, because routers share updates, they consume more bandwidth than in static routing; the routers' CPUs and RAM may also face additional loads as a result of routing protocols. Finally, dynamic routing is less secure than static routing.

2. Explain routing loop



When converged, all the routers in the network shown above will know about the 192.168.5.0/24 network. If RouterD looses connectivity to 192.168.5.0/24, it will remove the route to that network from its routing table. When RouterC receives the next periodic update from RouterD, it will know that the route to 192.168.5.0/24 is lost, and will remove it from its routing table. At this stage, RouterA and RouterB still think that 192.168.5.0/24 is reachable via RouterC.

While RouterC waits to send out the periodic update, if RouterB sends its own update, it will contain 192.168.5.0/24 as a destination network. Since RouterC does not have that network in its routing table, it will assume that it is a new destination and RouterB knows about and will install the route to that network, pointing towards RouterB. After this, the periodic update form RouterC will contain the 192.168.5.0/24 network and RouterB will assume that it knows of all the networks contained in that update!

Now when RouterB receives a packet destined to 192.168.5.0/24, it will forward it out to RouterC. When RouterC receives that packet, it will see that 192.168.5.0/24 is towards RouterB and will send it back. This loop will continue till the IP TTL value in the packet header reaches zero and one of the routers drops it.

3. Explain Routing Information Protocol (RIP)

**Routing Information Protocol** (RIP) is a dynamic routing protocol which uses hop count as a routing metric to find the best path between the source and the destination network. It is a distance vector routing protocol which has AD value 120 and works on the application layer of OSI model. RIP uses port number 520.

**RIP versions:**   
There are three versions of routing information protocol – **RIP Version1**, **RIP Version2** and **RIPng**.

**RIP v1**is known as Classful Routing Protocol because it doesn’t send information of subnet mask in its routing update.  
**RIP v2** is known as Classless Routing Protocol because it sends information of subnet mask in its routing update.

>> Use debugs command to get the details:

# debug ip rip

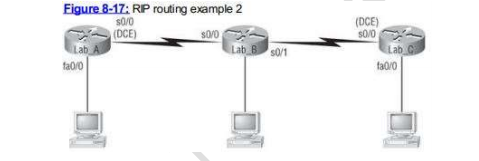
>> Use this command to show all routes configured in router, say for router R1:

R1# show ip route

>> Use this command to show all protocols configured in router, say for router R1:

R1# show ip protocols

4. Explain RIP with command



Routers also receive broadcasts (routing updates) on their active interfaces. Routers compare their routing tables with routing updates to learn about new IP subnets.

Router **R1** receives one broadcast from the router R2 and learns one new IP subnet 192.168.1.248/30.

Router **R2** receives two broadcasts: one from the router R1 and another from the router R2. From these broadcasts, the router R2 learns two new IP subnets: 10.0.0.0/8 and 20.0.0.0/8.

Router **R3** receives one broadcast from the router R2 and learns one new IP subnet 192.168.1.252/30.

Routers add newly learned IP subnets with their respective ports in routing tables.

After 30 seconds (default time interval between two routing updates) all routers broadcast their routing tables again with updated information.

* **R1** broadcast the IP subnets: 10.0.0.0/8, 192.168.1.248/30 and 192.168.1.252/30.
* **R2** broadcast the IP subnets: 10.0.0.0/8, 20.0.0.0/8, 192.168.1.248/30 and 192.168.1.252/30.
* **R3** broadcast the IP subnets: 20.0.0.0/8, 192.168.1.248/30 and 192.168.1.252/30.

Routers also learn from the received broadcasts.

* **R1** learns about the network 20.0.0.0/8 from R2’s broadcast.
* **R2** learns nothing new from R1’s and R2’s broadcasts.
* **R3** learns about the network 10.0.0.0/8 from R2’s broadcast.

After 30 seconds, routers broadcast new routing information again. But this time, all routers know all routes of the network, so they will update nothing. This stage is known as **convergence**. The convergence is a term that refers to the time taken by all routers in understanding the current topology of the network.

The RIP protocol broadcasts successive routing updates even after achieving the phase of convergence. This helps the router to detect and adapt to any new changes that occur after the convergence.

5. Different between RIPv1 vs. RIPv2

### Routing Information Protocol Version 1 (RIPv1):

• RIPv1 is a [Distance-Vector Routing protocol](https://www.omnisecu.com/cisco-certified-network-associate-ccna/introduction-to-distance-vector-routing-protocols.php).

• RIPv1 is a Classful routing protocol. Classful routing protocols support only the networks which are not subnetted. Classful routing protocols do not send subnet mask information with their routing updates. In other words, if you have a subnetted network in your RIPv1 routing domain, RIPv1 will announce that network to other as unsubnetted network.

• RIPv1 does not support [VLSM (Variable Length Subnet Masking)](https://www.omnisecu.com/tcpip/variable-length-subnet-masking-vlsm.php).

• RIPv1 support maximum[metric (hop count)](https://www.omnisecu.com/cisco-certified-network-associate-ccna/what-is-routing-metric-value.php) value of 15. Any router farther than 15 hops away is considered as unreachable.

• RIPv1 send routing updates periodically every 30 seconds as [broadcasts](https://www.omnisecu.com/cisco-certified-network-associate-ccna/unicast-multicast-broadcast.php) using destination IP address as [limited broadcast IP adddress 255.255.255.255](https://www.omnisecu.com/tcpip/internet-layer-ip-addresses.php). Since the updates are sent using the destination IP address of [limited broadcast IP adddress](https://www.omnisecu.com/tcpip/internet-layer-ip-addresses.php) 255.255.255.255, every router need to process the routing update messages (whether they are running RIPv1 or not).

• RIPv1 does not support authentication of update messages (plain-text or MD5).

### Routing Information Protocol Version 2 (RIPv2):

RIPv2 is a [Hybrid Routing Protocol](https://www.omnisecu.com/cisco-certified-network-associate-ccna/introduction-to-hybrid-routing-protocols.php). A [Hybrid Routing Protocol](https://www.omnisecu.com/cisco-certified-network-associate-ccna/introduction-to-hybrid-routing-protocols.php) is basically a [Distance-Vector protocol](https://www.omnisecu.com/cisco-certified-network-associate-ccna/introduction-to-distance-vector-routing-protocols.php) which some characteristics of [Link State routing protocols](https://www.omnisecu.com/cisco-certified-network-associate-ccna/introduction-to-link-state-routing-protocols.php).  
  
RIPv2 is classless routing, which allows us to use subnetted networks also. RIPv2 has the option for sending network mask in the update to allow classless routing.

• RIPv2 support [VLSM (Variable Length Subnet Masking)](https://www.omnisecu.com/tcpip/variable-length-subnet-masking-vlsm.php).

• RIPv2 support maximum [metric](https://www.omnisecu.com/cisco-certified-network-associate-ccna/what-is-routing-metric-value.php) (hop count) value of 15. Any router farther than 15 hops away is considered as unreachable.

• RIPv2 supports triggered updates.

• RIPv2 routing updates are sent as [Multicast traffic](https://www.omnisecu.com/cisco-certified-network-associate-ccna/unicast-multicast-broadcast.php) at destination multicast address of 224.0.0.9. Multicast updates reduce the network traffic. The Multicast routing updates also helps in reducing routing update message processing overhead in routers which are not running RIPv2. Only the routers running RIPv2 join to the multicast group 224.0.0.9. Other routers which are not running RIPv2 can simply filter the routing update packet at Layer 2.

• RIPv2 support [authentication of RIPv2 update messages](https://www.omnisecu.com/cisco-certified-network-associate-ccna/how-to-configure-rip-authentication-keychain.php) (plain-text or MD5). [Authentication](https://www.omnisecu.com/cisco-certified-network-associate-ccna/how-to-configure-rip-authentication-keychain.php) helps in confirming that the updates are coming from authorized sources.