CSCI 5010 – Fundamentals of Data Communications

Lab
Static and Dynamic Routing

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Department of Computer Science
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Summary

This lab is intended to be an overview of Cisco IOS configuration, and routing technologies, such as static routes, default routes, link failover, and dynamic routing protocols.

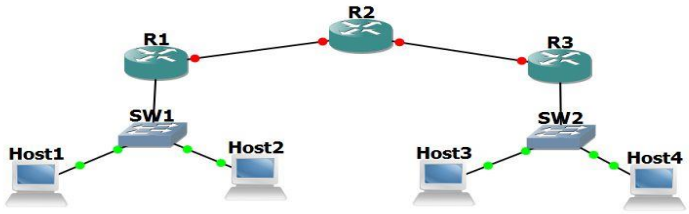
The questions in the lab are intentionally vague. The purpose of this is for you not only to research, investigate, and learn the technologies, but also become proficient at interpreting both non-technical and technical questions. Being able to research and discover answers on your own will be critical as you progress in your career.

- Learn how to perform basic router configuration & troubleshooting including:
  - Configure static routes and populate the routing tables
  - Apply administrative distance for automatic route failover
  - Designing and configuring a routing protocol to create dynamically learned routes
  - Routing protocol convergence and failover

Part 1

Objective 1: Network Design and Setup [16 points]

Create the following network topology, enable all the appropriate ports, and configure the basic setup for the devices in the topology.



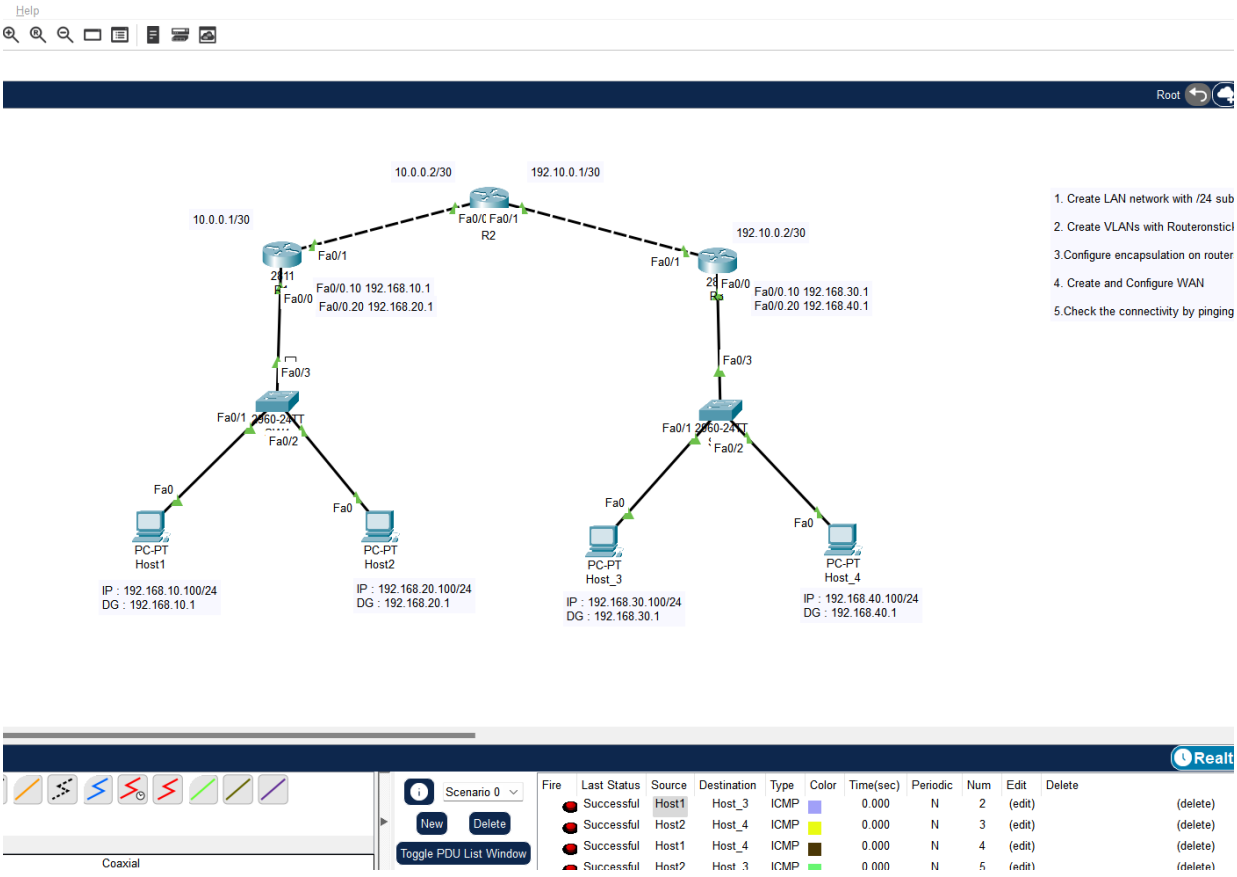
1. Use /24 subnets for all LANs (Each host is in a different subnet) (private IPv4 addresses). Other than IP and subnet, nothing else is configured on the hosts.

   IP address on host with /24 subnet: 192.168.10.100, 192.168.20.100 192.168.30.100, 192.168.40.100

2. Use /30 subnets for network connecting routers (private IPv4 addresses)

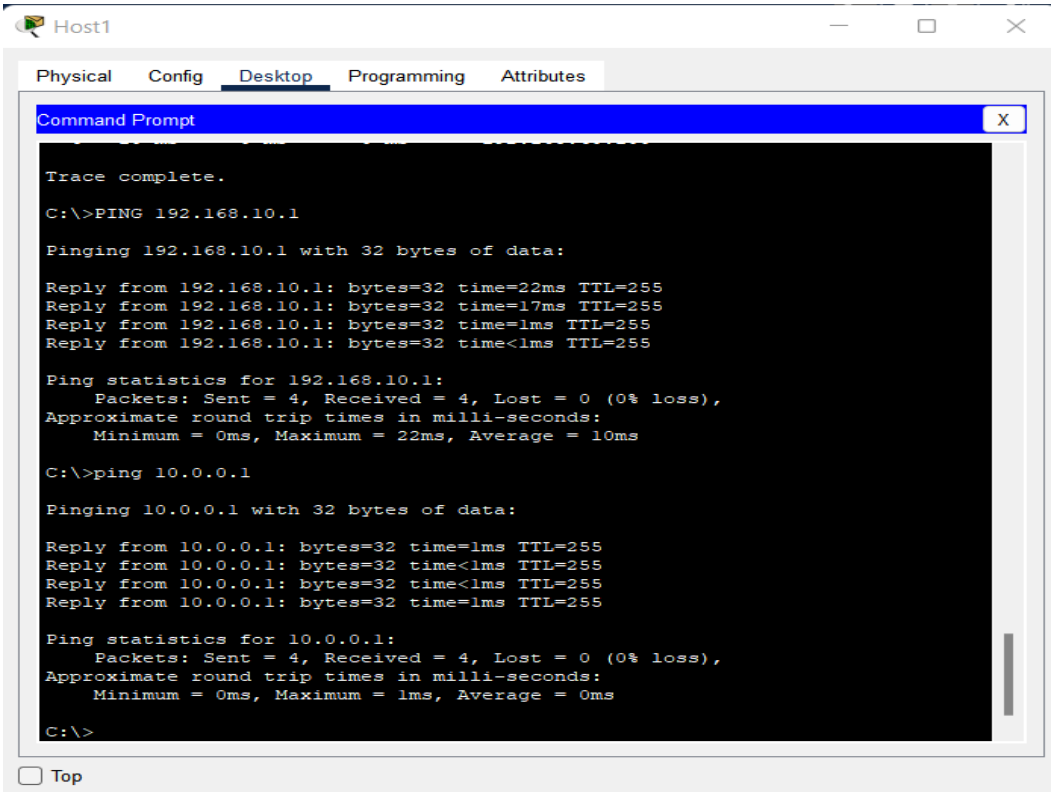
   IP address on routers with /30 subnet: 10.0.0.1 10.0.0.2 192.10.0.1 192.10.0.2

   Add your addressing scheme to the network diagram (drawing) indicating the subnets for each network, as well as the interface/PC addresses used in your design [**10 points**]

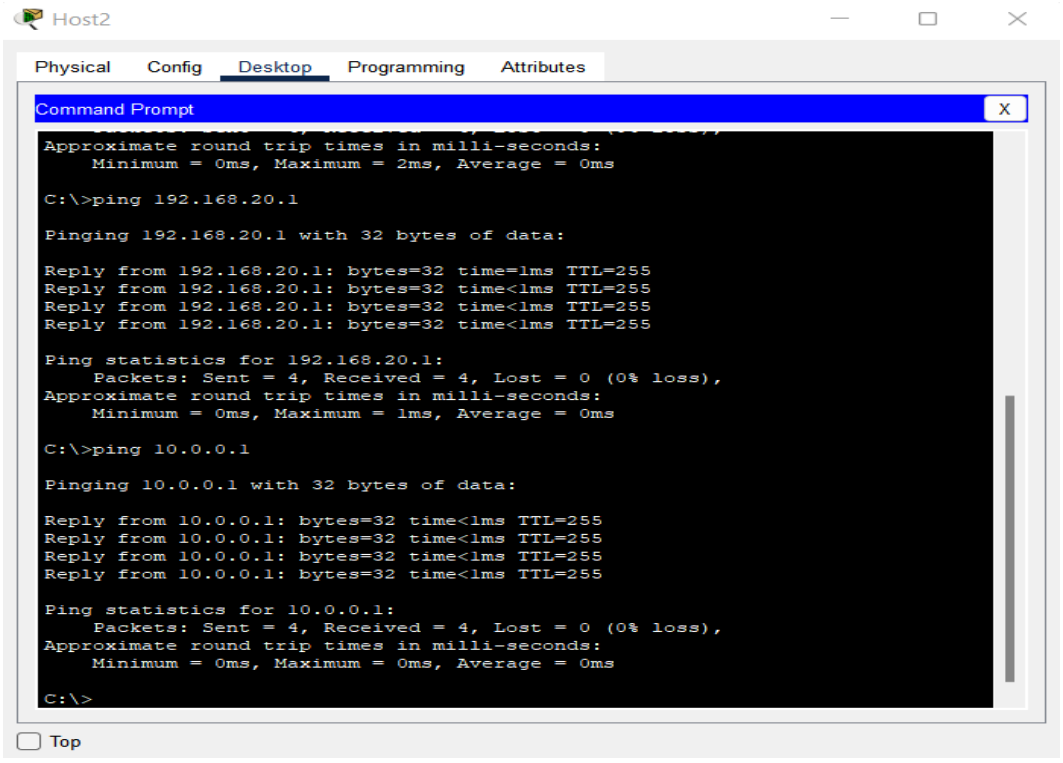


3. Make sure there is IP connectivity from each PC to the local router (ping the LAN & WAN interfaces).

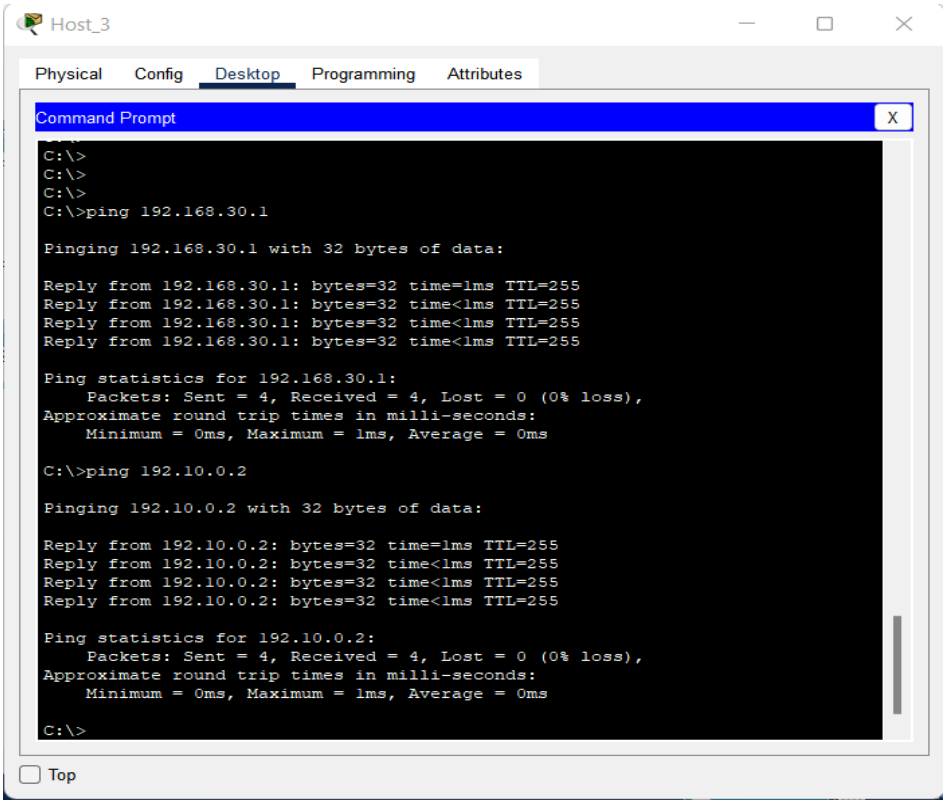
   Host_1 to Local Router R1 Fa0/0 and WAN Interface Fa0/1 :



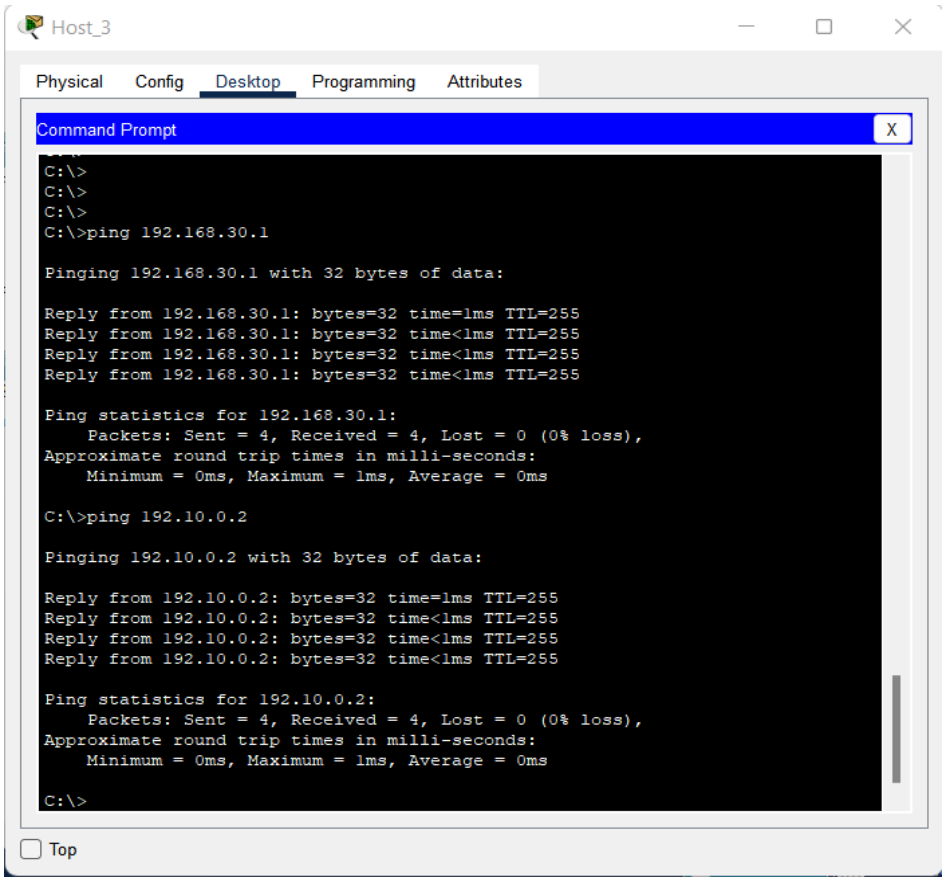
Host_2 to Local Router R1 Fa0/0 and WAN Interface Fa0/1 :



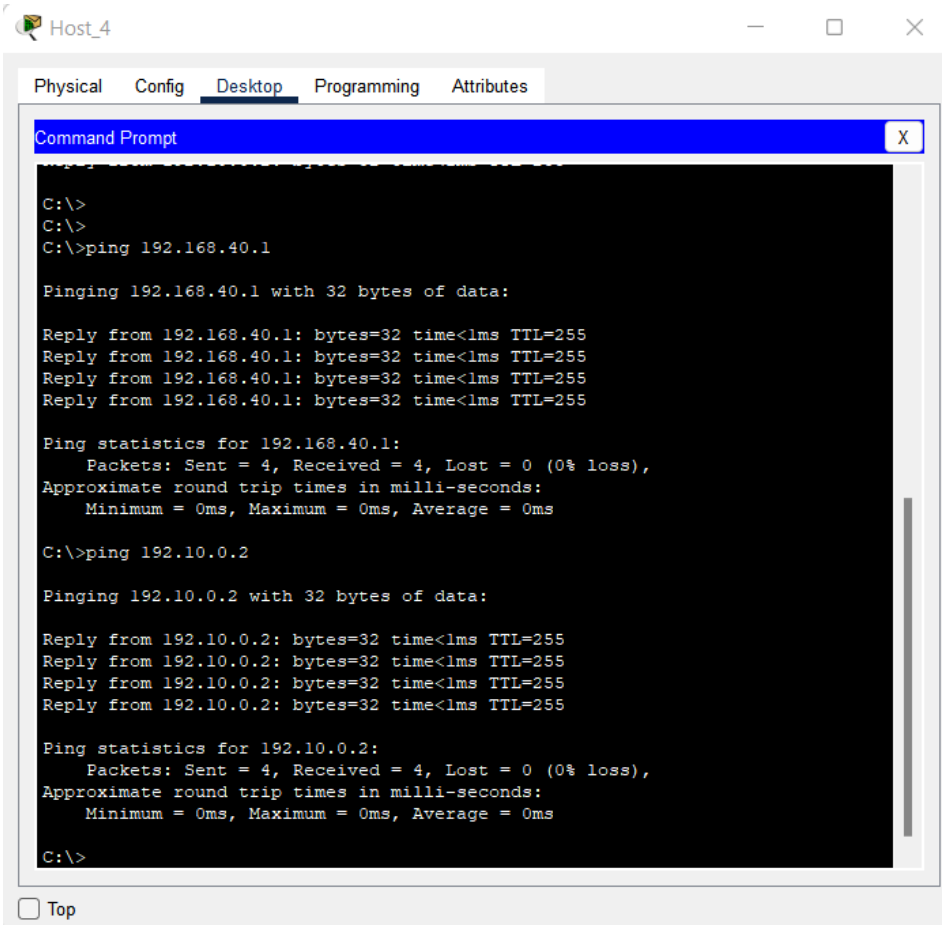
Host_3 to Local Router R1 Fa0/0 and WAN Interface Fa0/1 :



Host_3 to Local Router R1 Fa0/0 and WAN Interface Fa0/1 :

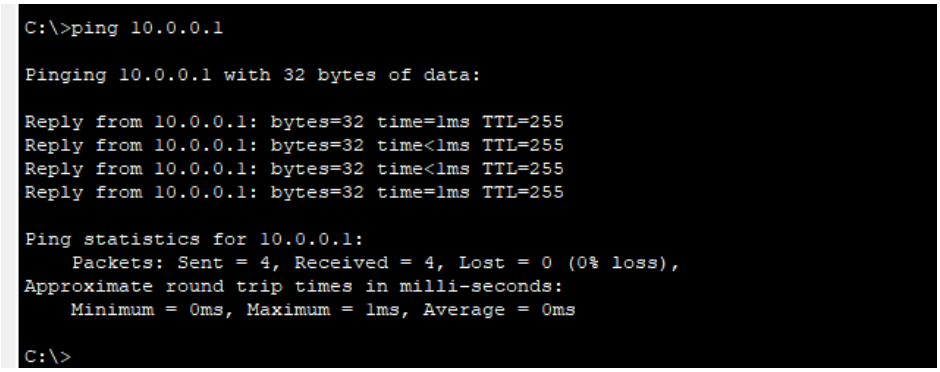


Host_4 to Local Router R1 Fa0/0 and WAN Interface Fa0/1 :



4. Can PC1 ping the WAN interface IP address of R1? Why or why not? [**2 points**]

   Yes. PC1 can ping WAN int IP address of R1



5. Is PC1 able to ping R3? Why or why not? [**2 points**]

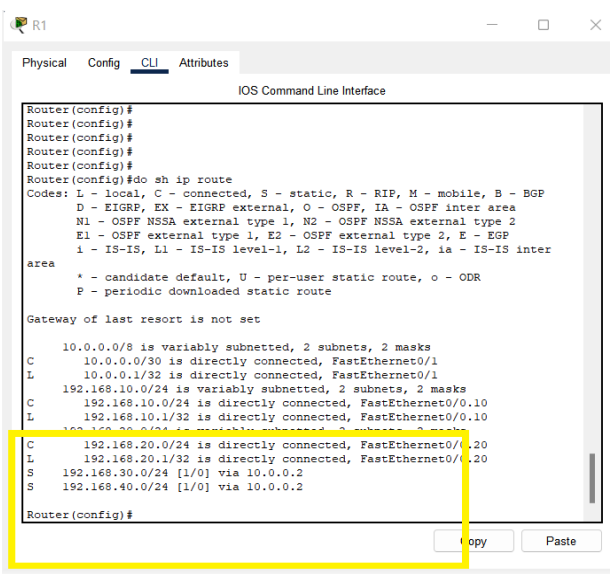
   No. The PC1 ping to R3 is failing because, the routing protocol is not enabled

6. Explain one reason why PC1 could ping the LAN IP address of R1, but could not ping the WAN IP address of R1. [**2 points**]

Objective 2: Static Routing [14 points]

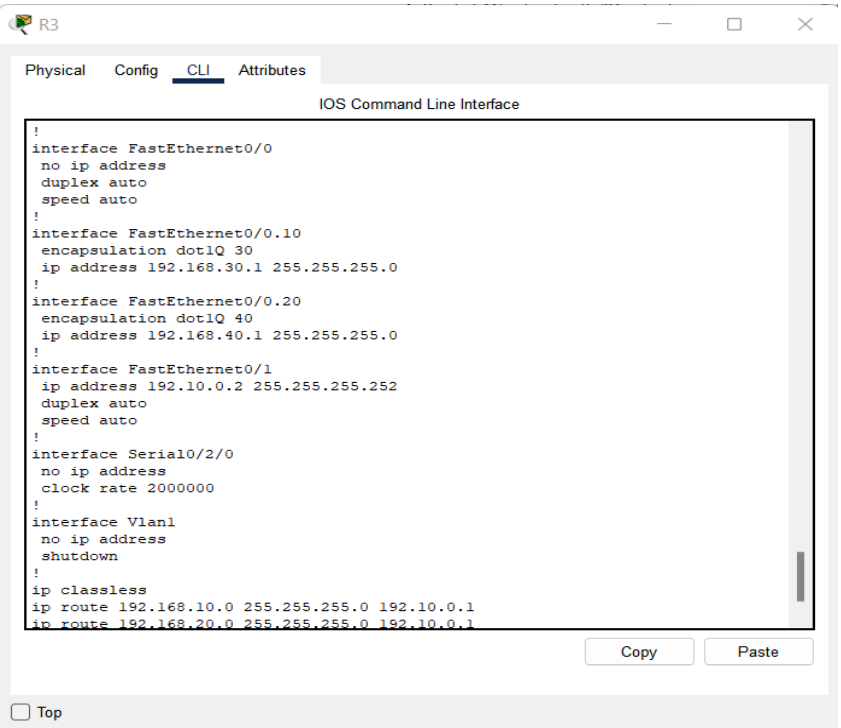
1. Configure static routes in each router to ensure connectivity between all routers and PCs in the network.
    a. Show the static routes configured
        i. Show the routes in the route table of R1 and R2 [**2 points**]

Ans :: do sh ip route

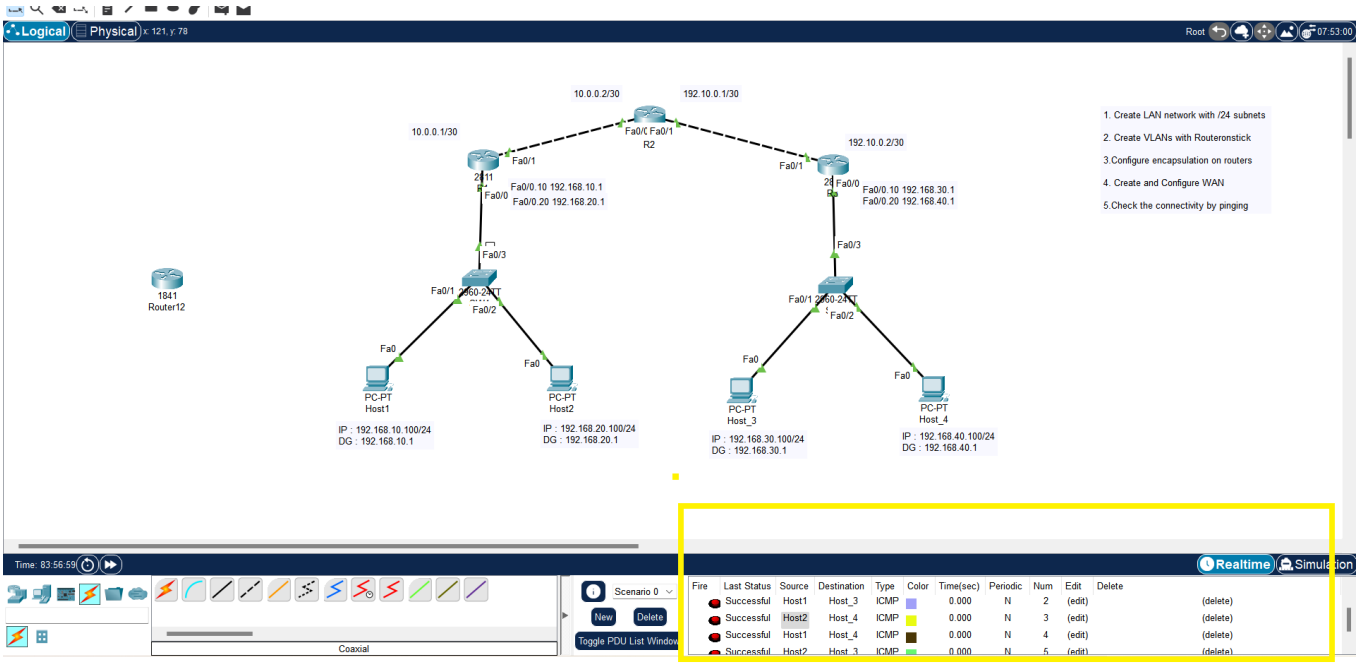


        ii. Show the routes in the running configuration of R3 [**2 points**]

Ans :: show running-conf



2. Configure Inter-VLAN routing, ensure and maintain 100% connectivity between all devices in the network.

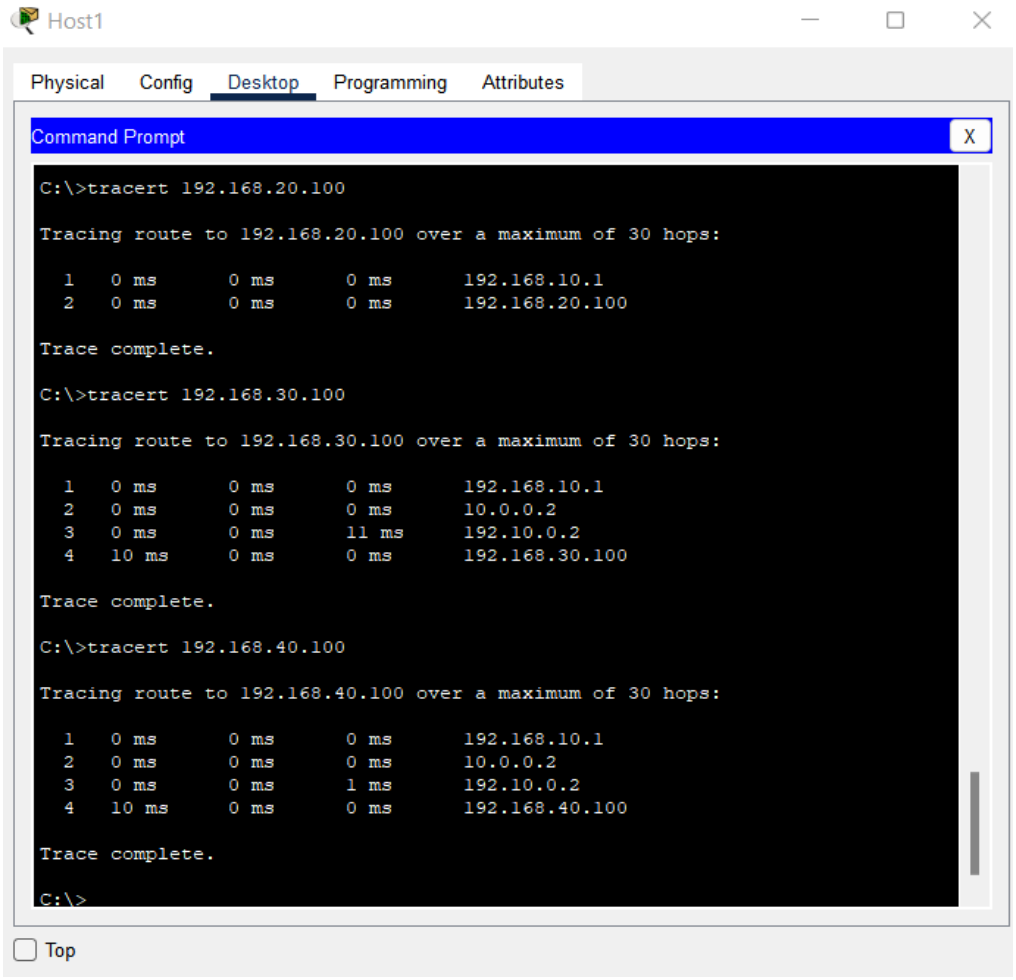


a. Provide the output from traceroutes from PC1 to PC2, 3, & 4 [**10 points**]

Ans :: Tracert from PC1 to PC2 : tracert 192.168.20.100

PC1 to PC3: tracert 192.168.30.100

PC1 to PC4: tracert 192.168.40.100



Objective 3: Understanding Routing Protocols [25 points]

3.1 For the network given below in Figure. 1, give global distance-vector tables **WHEN:**

(a) Each node knows only the distance of its immediate neighbors. **[4pt]**
(b) Each node has reported the information it had in the preceding step to its immediate neighbors. **[4pt]**
(c) Repeat step (b) one more time. **[4pt]**

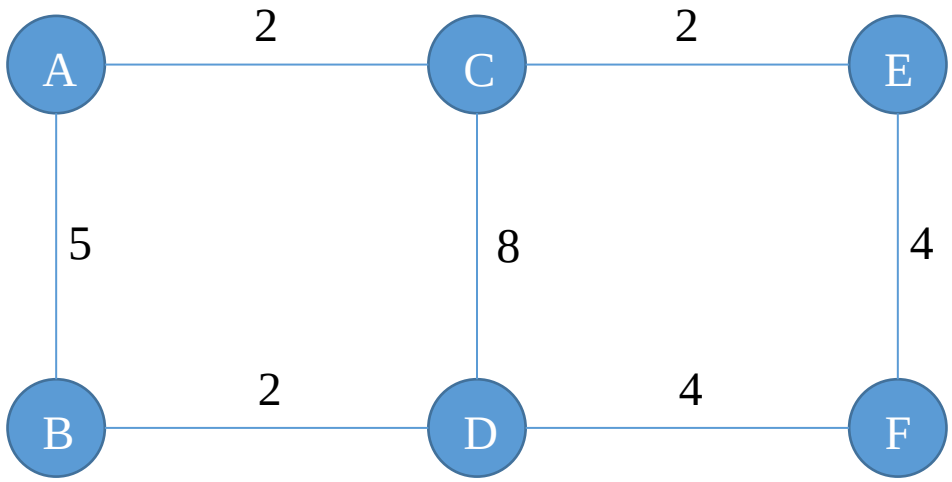


Figure. 1

Refer the slides below for an example of how to do this question:

lec10-routing_DV.pdf

https://www.youtube.com/watch?v=dmS1t2twFrI

3.2 (7 points)

Again for the network graph in Figure. 1. Show how the link-state algorithm builds the routing table for node D.
(a) Show the detailed link-state algorithm. **[5pt]**
(b) Show the final routing table of node D. **[2pt]**

Refer the slides below for an example of how to do this question:

lec10-routing_LV.pdf

3.3 (6 points)

Consider this directional graph below in Figure 4. Use Dijkstra's algorithm to find the shortest path from node v3 to v5. Write down the **steps**. Do you have any comments on the result (what if the link cost of v3-v1 was 1 instead of 5?)? [**6 pts]**

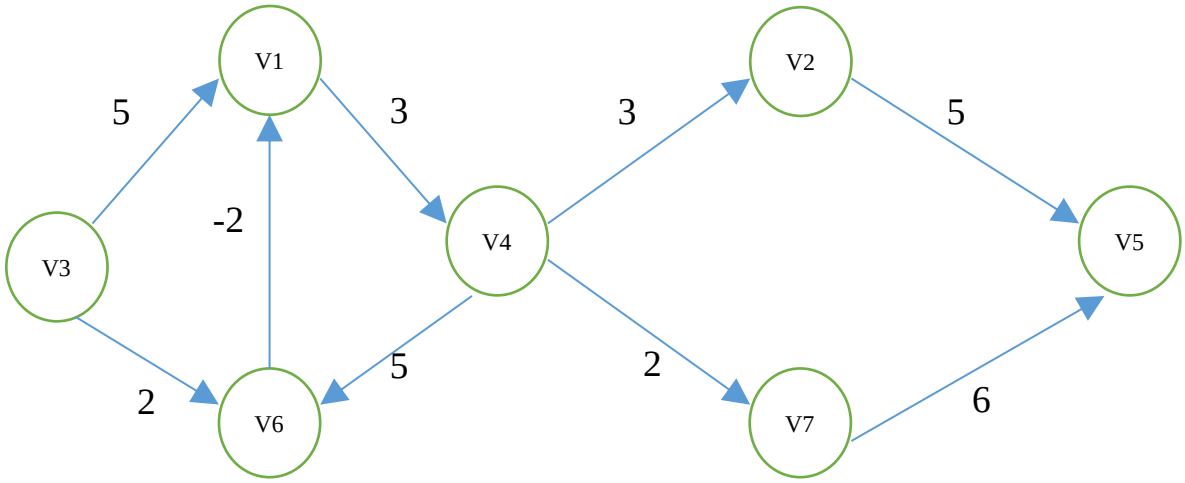
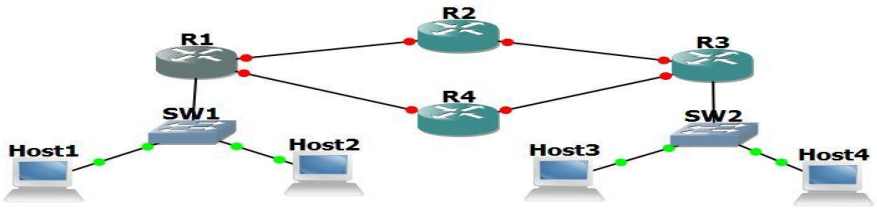


Figure. 4

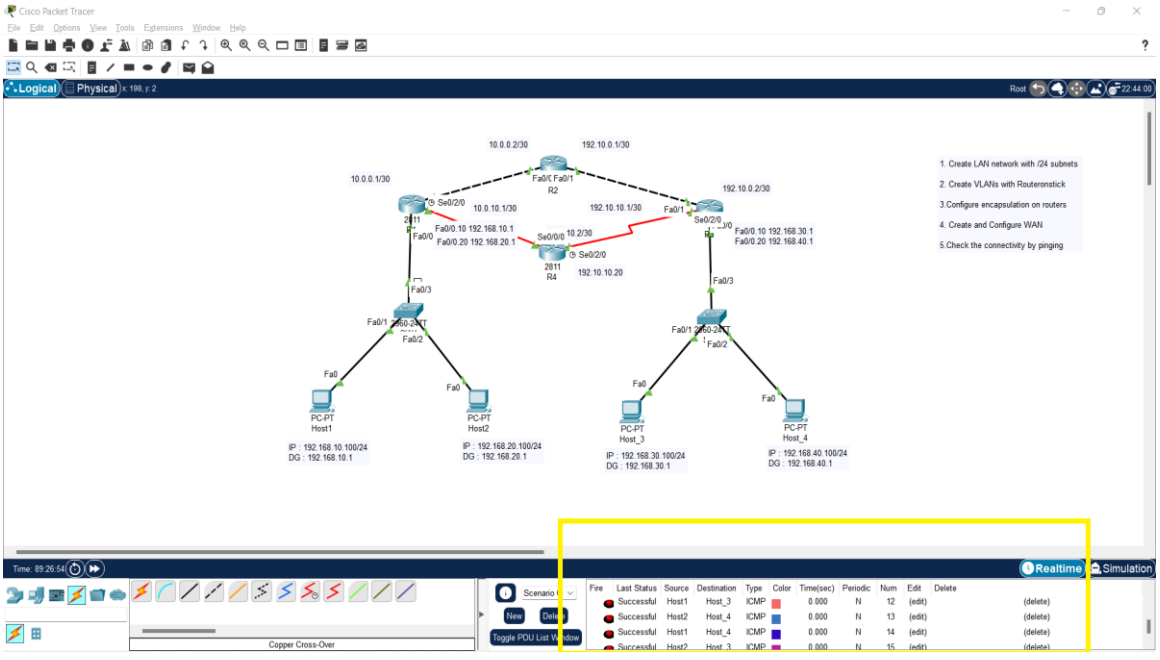
Objective 4: Dynamic Routing (RIP or OSPF) [30 points]

Create the following network topology, enable all the appropriate ports, and configure the basic setup for the devices in the topology.



1. Remove the static routes from all router configurations.

   Configure RIPv2 or OSPF on all router interfaces and networks. :: RIPV2 is configured



a. Provide commands used to implement, screenshot of the route table (from R2 & R4) indicating the network has converged [**20 points**]

The commands used to implement the RIP V2 Routing are

ROUTER RIP

VERSION 2

NETWORK <IP ADDRRESS>

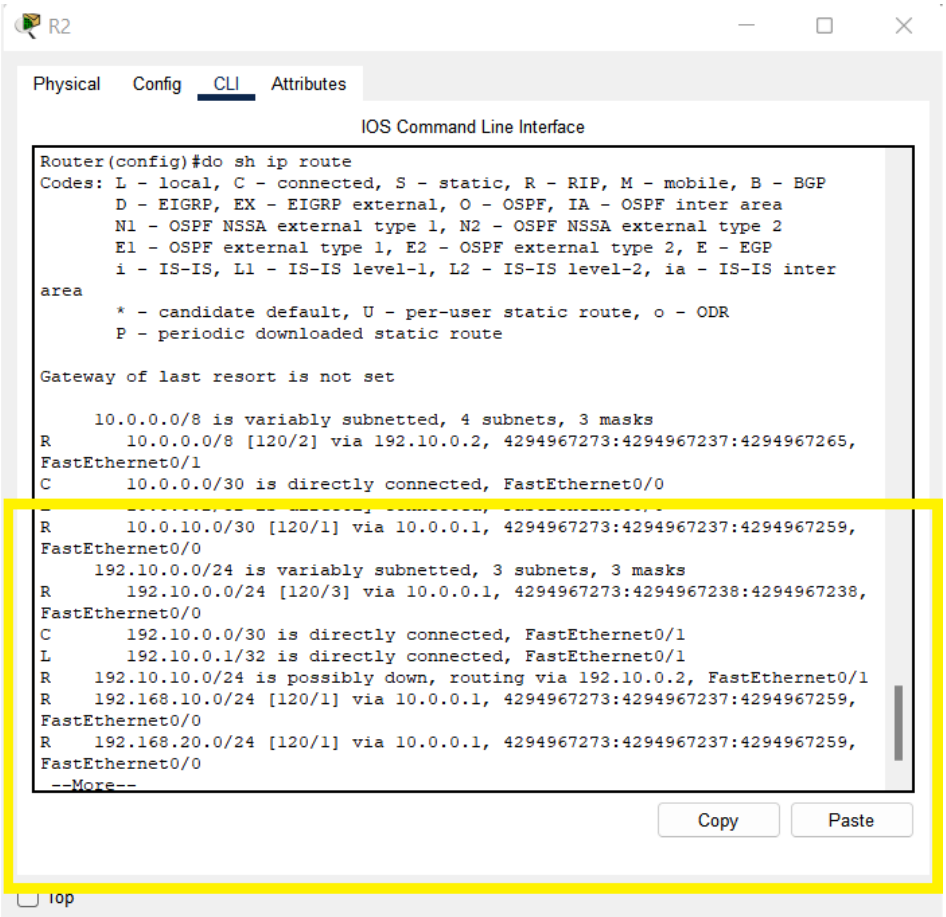
```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#network 10.0.0.1
Router(config-router)#network 192.10.0.1
Router(config-router)#network 10.0.0.0
Router(config-router)#network 192.10.0.0
Router(config-router)#network 192.168.10.0
Router(config-router)#network 192.168.20.0
Router(config-router)#network 192.168.30.0
Router(config-router)#network 192.168.40.0
Router(config-router)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#wr me
Building configuration...
[OK]
Router#
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#so sh ip route
               ^
```

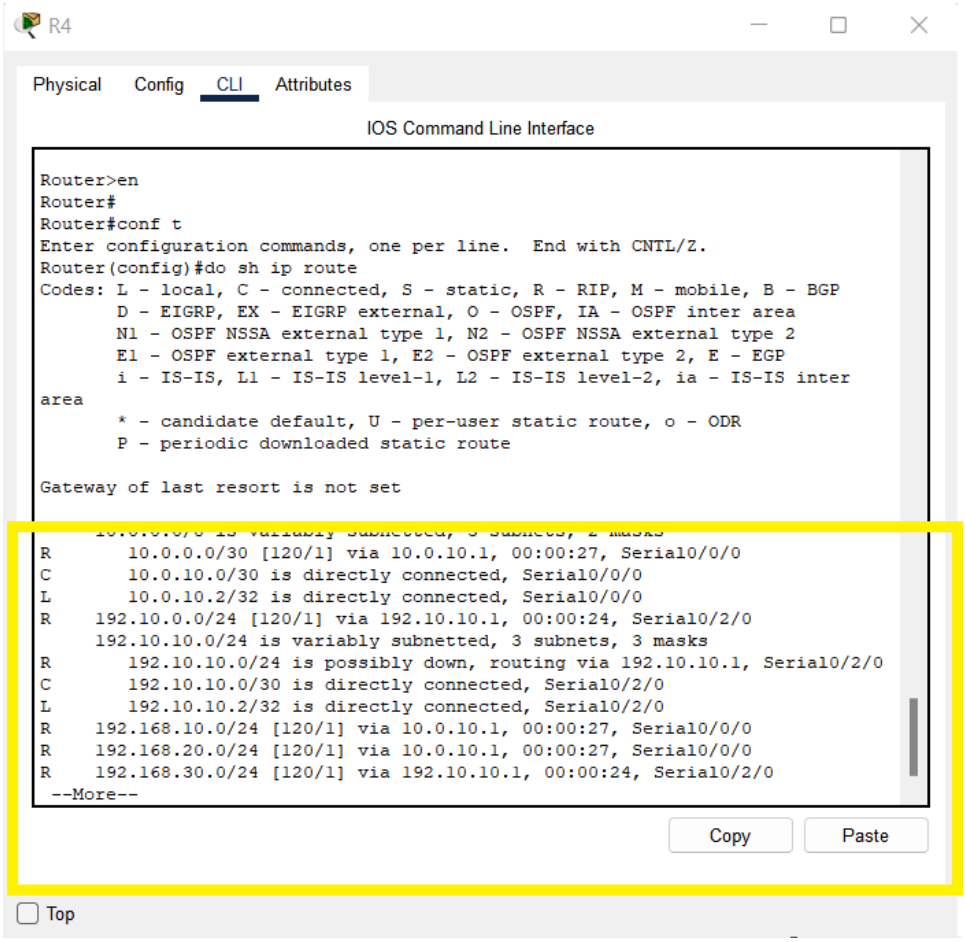
Copy Paste

Top

RIP Configured Routing table from R2:



RIPV2 configured Routing table from R4:



i. What does convergence mean, and why is it important? [**10 points**]

Convergence or routing convergence is the state in which a group of routers in a network share the same topological information. Routers in a network gather topology information from each other through routing protocols. A state of convergence is reached when all routers broadcast routing information to all routers in the network. In a converged network, all routers are aware of the network topology and the best route to send packets. Changes on the network, such as device failures, affect convergence until information about the change is propagated to all routers and convergence is achieved again. The time it takes for routers in the network to converge after a topology change is called convergence time. Detection, Local Repair, Global repair are the few actions on which convergence speed depends upon.

Why is it important:

1.A converged network makes it easier to manage network performance. In the past, managing network performance was difficult because multiple networks and services could only be managed individually. A converged network provides an efficient and scalable design that allows properties to add new services and features in a more cost-effective manner.

2.A converged network can make it easier to identify and solve problems, and prevent them from escalating. A unified network simplifies cabling and hardware infrastructure. Converged networks connect different services, simplifying cabling and hardware infrastructure.

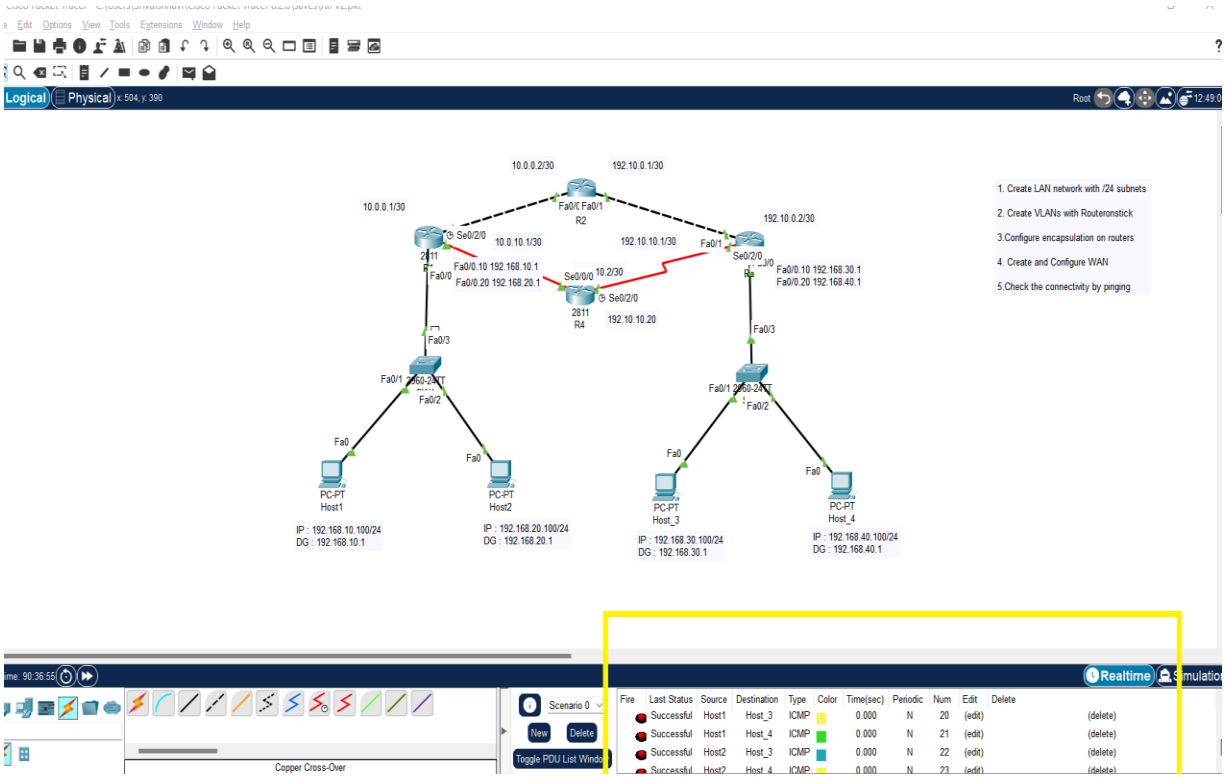
3.Converged networks allow the same equipment and space to be used for multiple systems. This type of network helps eliminate redundancy while optimizing the delivery of all services. Additionally, once your converged network is ready, the infrastructure makes it easy to add new services to your setup. This method is much cheaper than other options.

4. Converged networks can be used to implement better energy resource management. Minimize the need for technical and physical resources by managing, operating and maintaining all your business systems from a single connection. It saves resources, manpower and space. A converged network can help reduce power consumption and maintenance costs, reducing overall environmental impact.

5. A unified network provides a better experience for users. Company members can use the Internet on any device on company premises. This configuration can improve productivity and increase output opportunities. This simplifies the user's experience and administrator's responsibilities. This type of network setup provides everything users need to successfully complete their tasks.

Extra Credit: Implement RIPv2 as well as OSPF separately on the network and answer question for Objective 4. **[+5 points]**

OSPF is configured separately on the network on which RIP v2 was configured:

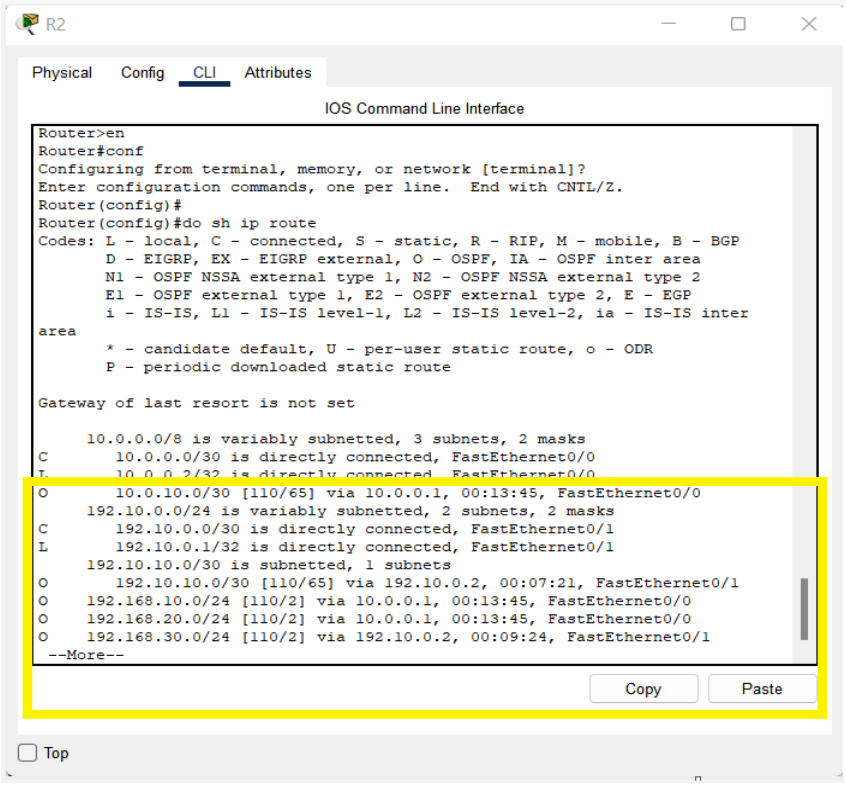


The commands used to implement the OSPF Routing are

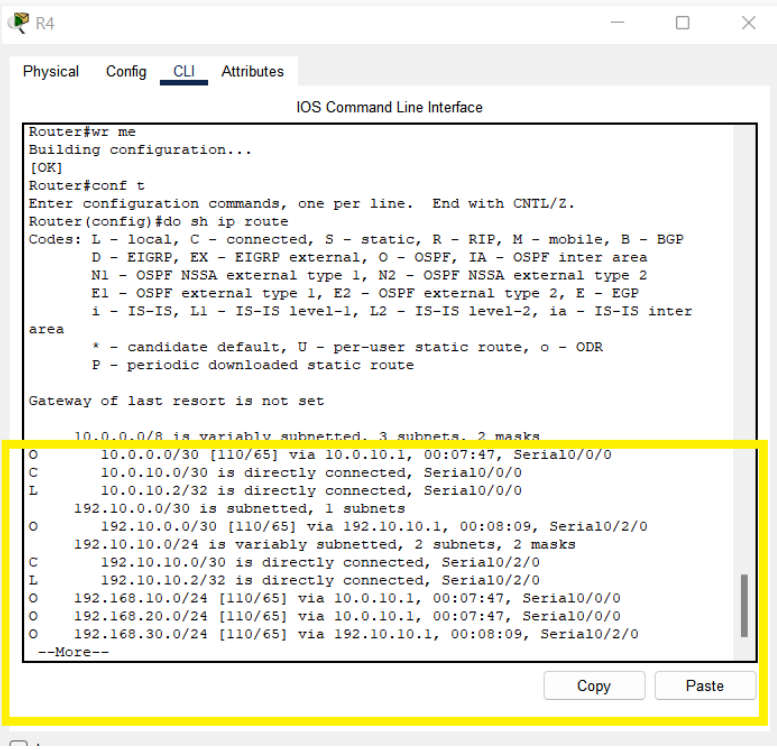
ROUTER OSPF 1

NETWORK <IP ADDRRESS> <WILD CARD MASK> <AREA>

OSPF configured Routing table from R2:



OSPF configured Routing table from R4:

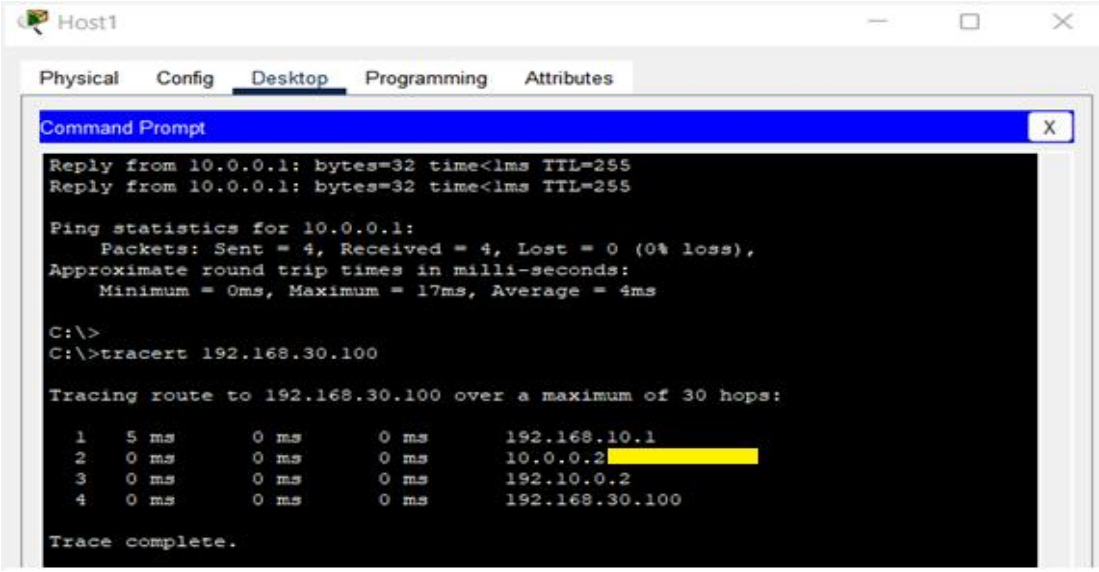


Objective 5: Routing Protocol Failover [17 points]

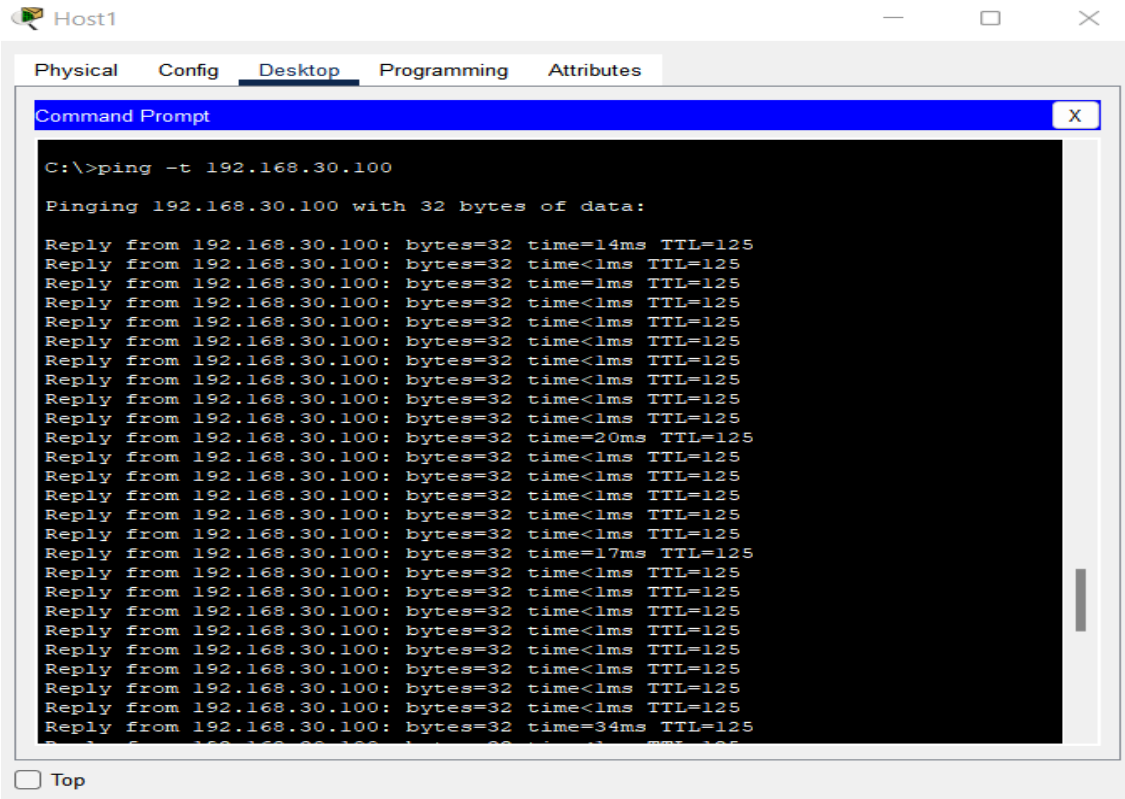
1. Demonstrate Failover

   a. Issue a traceroute from PC1 to PC3. Which path is it taking? [**2 points**]

Its taking PC1 – R1 – R2 – R3 – PC3 path. Below is tracert from PC1 to PC3



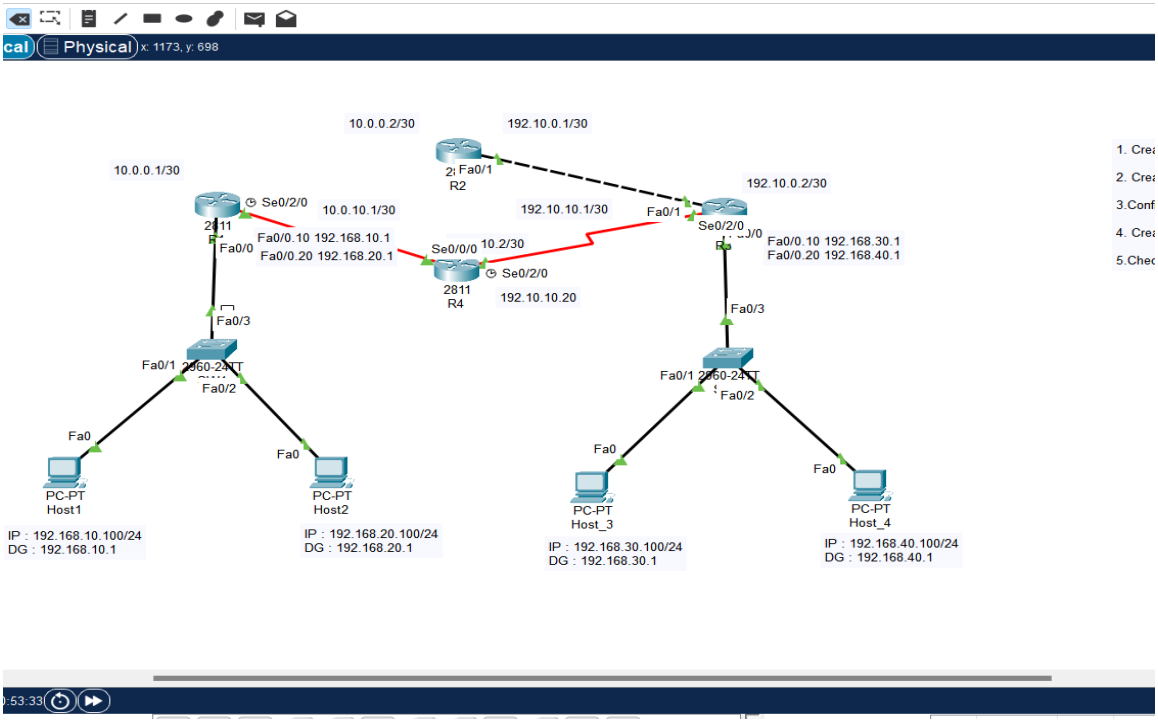
   b. Issue a continuous ping from PC1 to PC3



c. Remove the router link/connection between the active path routers (discovered in above [1.a]). *For example, if the path was R1, R2, R3, then remove the connection to R2*.

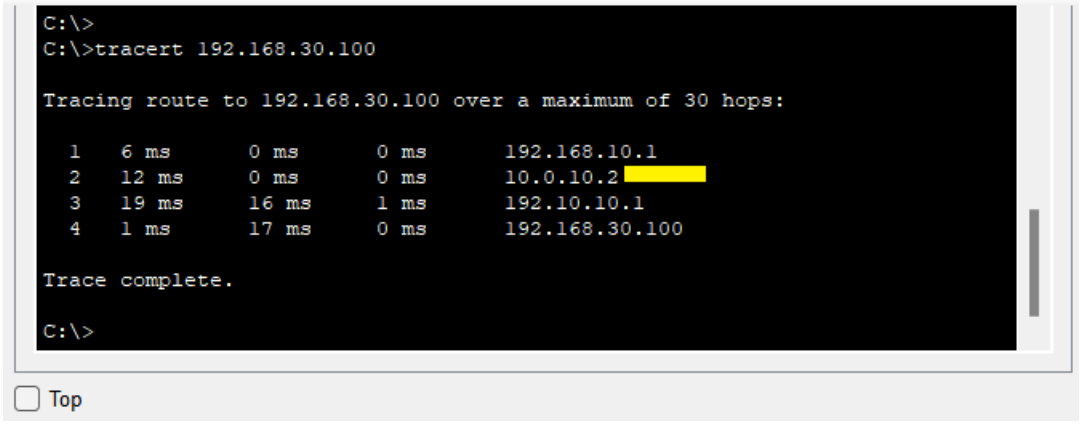
i. Were any packets lost? If packets were lost, how long was the network down? Explain this, and indicate how the traffic failed over and the new traffic flow [**5 points**]

Removed the path link from R1 - R2

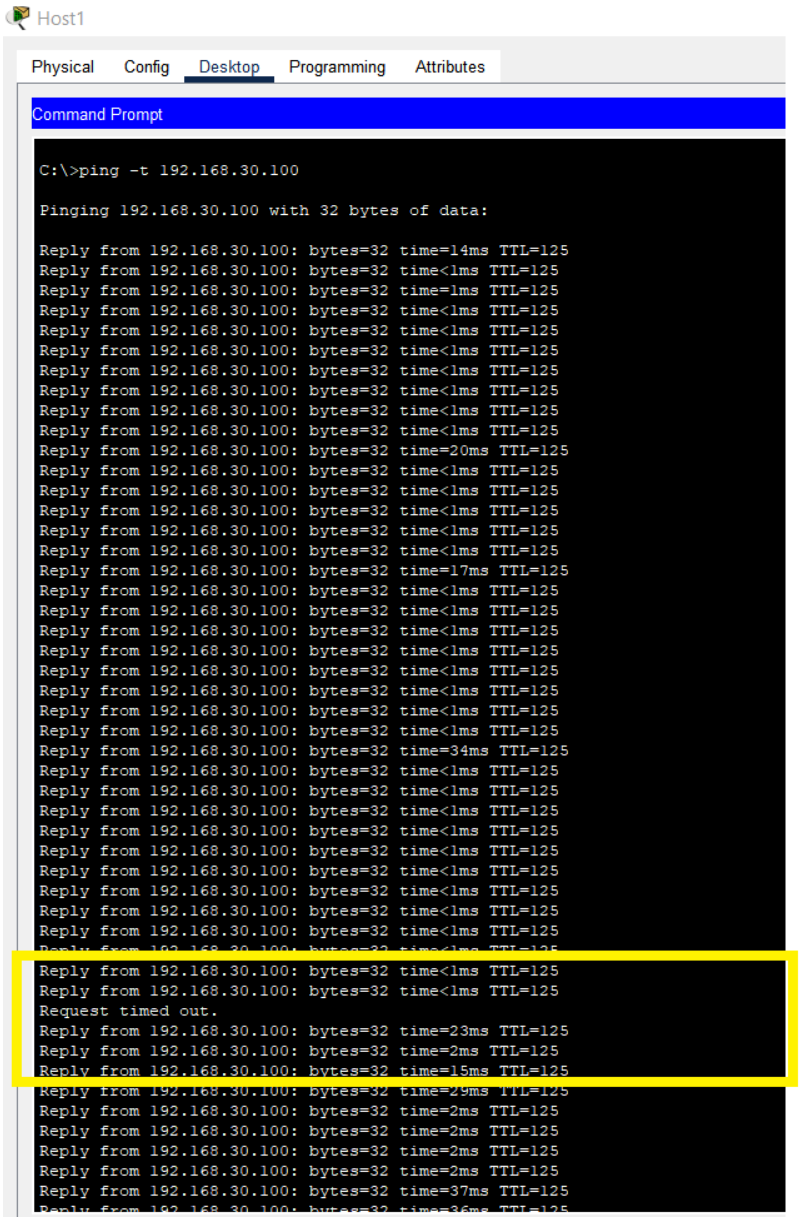


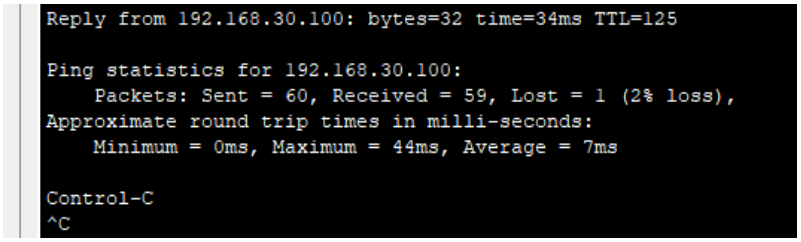
And the ping failed with “Request timed out” for a milli second and then the packet transfer reinitiated with time < ms and 2% packetloss. The new flow is from R1-R4-R3

Difference :: The IP in the above tracert screenshot showed 10.0.0.2 (R2) is changed to 10.0.10.2 (R4), the OSPF protocol dynamically initiated packet flow



Link Failure Request Time-out:





d. Do some critical thinking and research. Could failover be achieved with this network design using only static routes? Explain [**10 points**]

YES. One way to do is by load balancing the traffic between the links with static routes having same admin distance. And the other is, in this network 10.0.0.1 has two possible next hops, and we could use "qualified next hop" statement on both devices to enable the failover

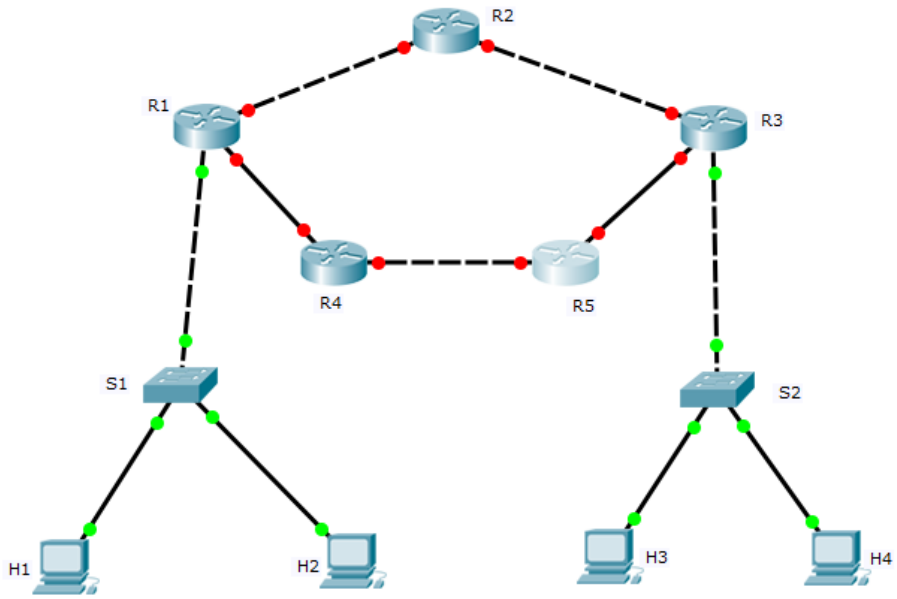
On R1, configure a static route to the customer network.

[edit routing-options static route 192.168.47.0/24] ***set next-hop <ip address of R2>***

On R1, configure a backup route to the customer network.

[edit routing options static route 192.168.47.0/24] ***set qualified-next-hop <IP address of R4 > preference***

Extra Credit [10 points]:



Consider the above network. RIP and OSPF both are simultaneously working on this network.
For H1 to reach H3, R1 gives a RIP path R1-R2-R3 and OSPF gives R1-R4-R5-R3. Which path would packets from H1 going to H3 via R1 take?
Explain why you think a particular path would be chosen.

Thinking from two aspects, one, RIP hop count is less R1-R2-R3 that's three hops compared to

distance from R1-R4-R5-R3, because it is a small network with three routers, as a networking rule, one could use Distance Vector Protocol : RIP. But in this scenario, the best route to the network may not be the route with least hops. Because going by the the concept of Administrative distance – the feature using which the router will chose the preferred path, OSPF Administartive Distance is 110 and RIP Administrative distance is 120, so i think OSPF will be used based on the concept of Administrative distance.

Report Questions: [18 points]

- What are the advantages of using routing protocols?

  Failure of one line doesn't affect the whole network

  Incase of failure of a particular link, because of network convergence, routing protocol enables auto re-route via other path links without any manual intervention

  Routing protocols generally work independent of network size

  Suitable for larger and complex networks

  Fewer router resource overhead requirements

- What is the difference between Distance Vector and Link State Routing protocols?

Distance Vector	Link-State
uses Bellman-Ford Algorithm for making routing tables.	use of Dijkstra's Algorithm for making routing tables
Topology information from neighbour point of view	Complete information on network topology
Based on least no. of HOPS	Based on COST
Periodic updates	Triggered updates
moderate convergence time	Fast covergence time
Updates using broadcast	Updates using multicast
RIP,IGRP, EGRP	OSPF, IS-IS

- What are the advantages of using static routing or when would static routing be preferred over dynamic routing?

  Static Routes are not advertised over the network, hence enables better security

  Static Routes use less bandwidth as routers don't exchange routes

  Static Routes don't use cpu cycle to calculate and communicate the routes

  Static Routing is preffered over dynamic routing for smaller networks with only one path to an outside network. They also provide security in a larger network for certain types of traffic or links to

other networks that need more control

- Classify the below routing protocols as Distance Vector and Link State Routing protocols:

  I. OSPF, BGP, RIP, IS-IS

  OSPF, IS-IS – Link-state Routing protocols

  RIP – Distance Vector protocol

  BGP – Path Vector protocol

- Give:
  - Scenario when distance vector routing protocol would be used in the network.

    Distance vector are great for smaller networks, usually less than 100 routers, It uses hop count, so for example, For example, if there are 3 offices located in the same city, each office has its own network and if the PC1 from office 1 is trying to telnet to PC4 in the office 3, and the packet must cross three routers to get to PC4, then the hop count is three – in such cases distance vector is used.
  - Scenario when link state routing protocol would be used in the network.

  Link-state are used for larger networks with fast convergence for example, consider there is 14 offices, located in different states of america, and each office has it's own ISP provider (AT&T, Charter, etc.); just whatever is available at that location. Each office is it's own network. Those 14 sites are connected to a Data Center network, and if you want to achieve interconnection between , all the office and also some selective offices only

  14 offices - <data center>
  Office 1 – Office 4
  Office 6 – Office 12
  Office 14 – Office 2
  In this case we use link state protocol for two reasons shortest routing path selection and also the faster convergence helps in early fault detection when link-state is used in large enterprise networks.

- What is an Administrative Distance (AD) for a routing protocol? Give AD for OSPF and RIP.

  Administrative Distance Administrative distance is property that routers use in order to select the best route path when there are two or more different routes to the same destination. The DEFAULT AD value is 120 for RIP routes and 110 for OSPF Routes.

- What is a metric in a routing protocol?

Metric is a numerical value associate with specific routes that are used by routing protocols to prioritize the most preffered route to the least preferred route. Different routing algorithms use different variables to compute the route metric. The metrics are calculated based on the one or more following attributes :

1. Bandwidth
2. Cost
3. Path Length
4. Reliability

Total Score = _____/135