CSCI 5160

INTRODUCTION TO ENTERPRISE NETWORKS

Lab 3

Spring 2025

OBJECTIVES

1. **Learn how to configure static routes and populate a routing table using static routing.**
2. **Learn the operation and limitations of RIP and EIGRP.**
3. **Learn the application of default routes in a simple network environment.**

Background

GlobalTech Solutions is a rapidly growing software development company with three key areas: the **Headquarters** (HQ), **Research and Development (R&D) department**, and the **Sales** department. All departments are located on the same campus, but in different buildings. As the company expands, there is a growing need for these departments to communicate and share resources efficiently across buildings.

Each department has its own dedicated network, but with the growing demand for shared resources like file servers, internal applications, and databases, there is a need for seamless connectivity between buildings.

Network Design

The campus network is designed with three main subnets for each building. You can change the IP addresses as you wish. It is recommended to use ranges different from /24

- **HQ Network**: 40.20.30.0/16
- **R&D Network**: 192.168.10.0/24
- **Sales Network**: 192.168.20.0/24

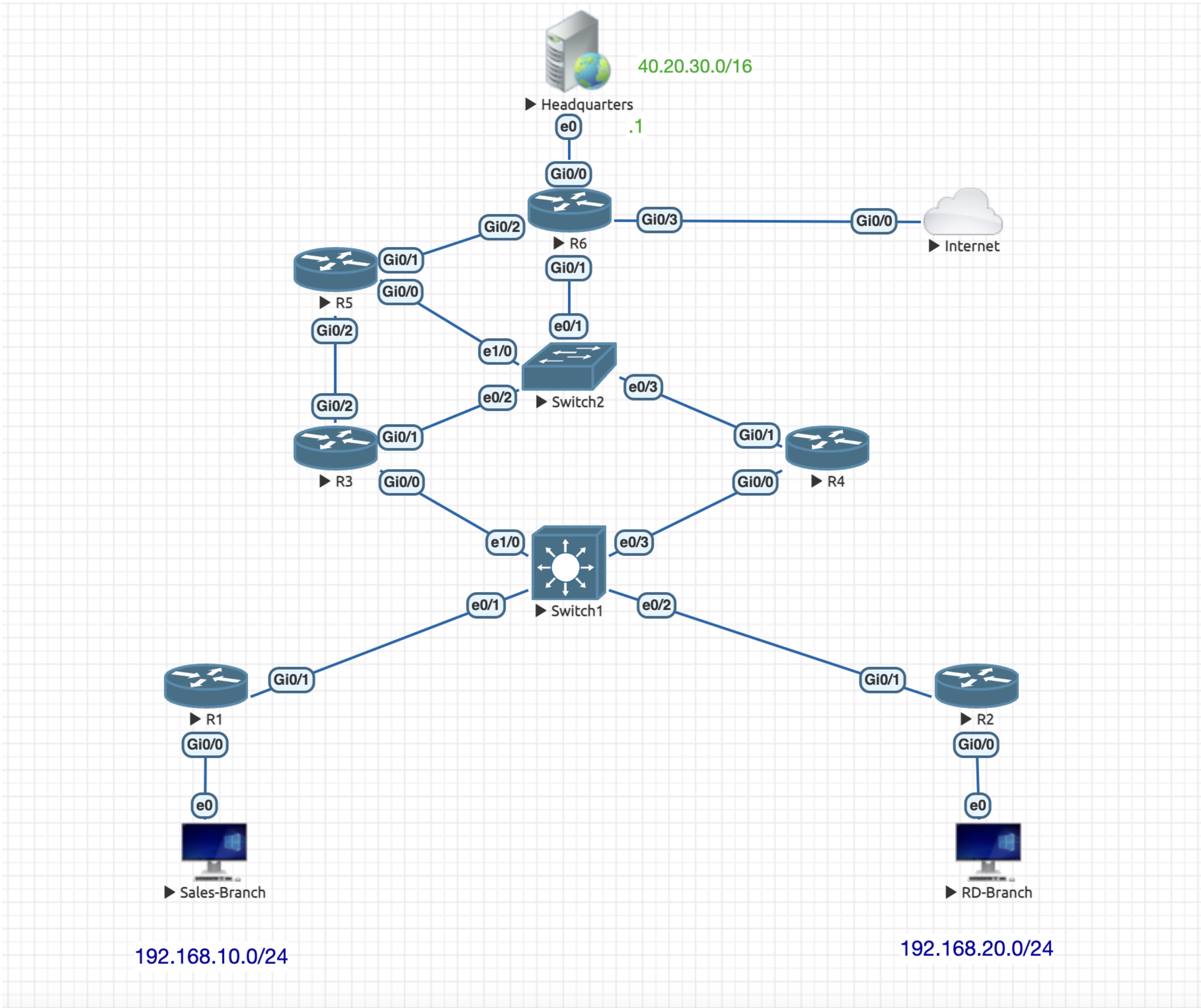
Challenge

The main challenge is to establish reliable communication between the three buildings, ensuring employees from each department can access resources across the campus. Additionally, the company needs to ensure that network traffic is efficiently routed between buildings without any disruptions.

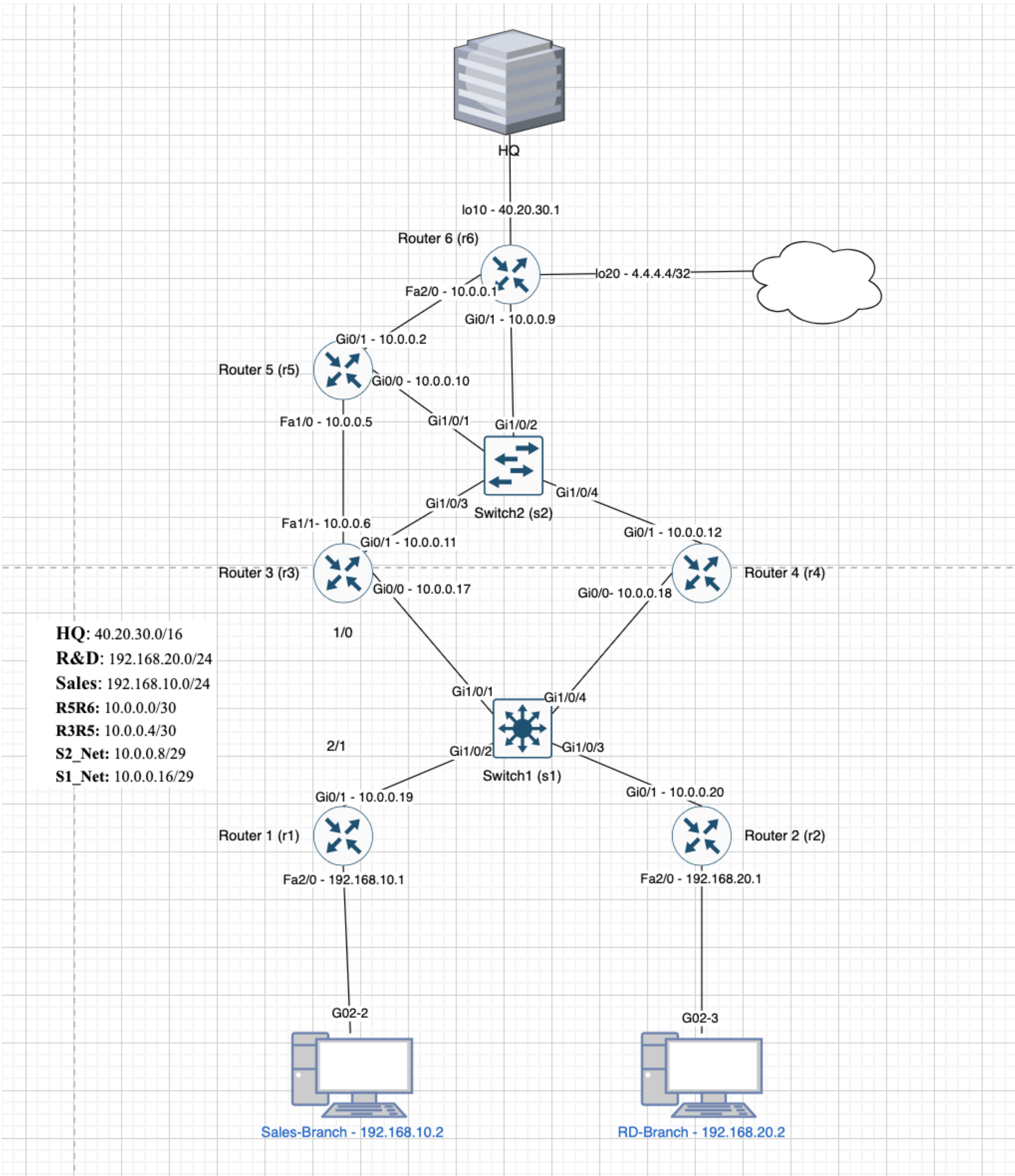
Solution Approach

The company decides to implement dynamic routing protocols (Static Routes, RIP, and EIGRP) to handle the inter-building communication. Since all buildings are located on the same campus, the network is relatively simple, but the goal is to ensure that the network can scale as the company grows.

- **Static Routing** will be used for direct, fixed connections between the routers for essential communication paths.
- **RIP** will be used for basic, distance-vector routing within the simpler, smaller building networks.
- **EIGRP** will be used for the headquarters network, which has a more complex infrastructure with many internal servers and network devices that require faster convergence and scalability.



Be aware that in the diagram **Switch1** is an MLS (MultiLayerSwitch)



1. Static Routing

a. Use IP range 10.0.0.0/8 to assign IP addressing to all links between routers, use optimally.

HQ: 40.20.30.0/16
R&D: 192.168.20.0/24
Sales: 192.168.10.0/24
R5R6: 10.0.0.0/30
R3R5: 10.0.0.4/30
S2_Net: 10.0.0.8/29
S1_Net: 10.0.0.16/29

b. Use static routes to achieve endpoint connectivity as follows:

When Sales pings the Headquarters, echo request follows path R1-R3-R5-R6; echo reply R6-R5-R4-R1. Remember ping makes roundtrip from source to destination, so you can configure different routes for outgoing and incoming ping packets.

```
  3 10.0.0.1 0 msec 0 msec *
R1#traceroute 40.20.30.1 source 192.168.10.1
Type escape sequence to abort.
Tracing the route to 40.20.30.1
VRF info: (vrf in name/id, vrf out name/id)
  1  *  *  *
  2 10.0.0.5 0 msec 0 msec 0 msec
  3 10.0.0.1 0 msec 0 msec *
R6#traceroute 192.168.10.1 source 40.20.30.1
Type escape sequence to abort.
Tracing the route to 192.168.10.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.0.2 0 msec 0 msec 0 msec
  2  *  *  *
  3 10.0.0.19 0 msec *  0 msec
R6#traceroute 192.168.10.1 source 40.20.30.1
```

c. Add a backup path via R3 for the echo reply, but ensure it is only used when the primary path through R5 fails. (Disconnect or Shut down R5 and see if you have reachability)

d. Verify that the clients can talk to each other using ping and traceroute at the host

```
^C
C:\Users\NetEngComputer7>tracert 40.20.30.1

Tracing route to 40.20.30.1 over a maximum of 30 hops

  1    <1 ms    <1 ms     1 ms  192.168.10.1
  2    <1 ms    <1 ms    <1 ms  10.0.0.17
  3     1 ms    <1 ms    <1 ms  10.0.0.5
  4     1 ms    <1 ms    <1 ms  40.20.30.1

Trace complete.
```

```
C:\Users\NetEngComputer7>
C:\Users\NetEngComputer7>ping 40.20.30.1 -S 192.168.10.2

Pinging 40.20.30.1 from 192.168.10.2 with 32 bytes of data:
Reply from 40.20.30.1: bytes=32 time=1ms TTL=252
Reply from 40.20.30.1: bytes=32 time=1ms TTL=252
Reply from 40.20.30.1: bytes=32 time=1ms TTL=252
Reply from 40.20.30.1: bytes=32 time=1ms TTL=252

Ping statistics for 40.20.30.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

e. Use **extended pings from** the routers to test the same condition and to check the path followed by the traffic

```
R1#
R1#show run | sec ip route
 ip route 40.20.0.0 255.255.0.0 10.0.0.17
 ip route 192.168.20.0 255.255.255.0 10.0.0.20
R1#ping
Protocol [ip]:
Target IP address: 40.20.30.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.10.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 40.20.30.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.10.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
R1#
```

f. Modify your configuration so RD-Branch system can talk to all other hosts

Report the commands + Screenshots of the traceroute or extended ping

R1: ip route 40.20.0.0 255.255.0.0 10.0.0.17
ip route 192.168.20.0 255.255.255.0 10.0.0.20

R2: ip route 192.168.10.0 255.255.255.0 10.0.0.19

R3: ip route 40.20.0.0 255.255.0.0 10.0.0.5
ip route 40.20.0.0 255.255.0.0 10.0.0.9 10
ip route 192.168.10.0 255.255.255.0 10.0.0.19

R4: ip route 192.168.10.0 255.255.255.0 10.0.0.19

R5: ip route 40.20.0.0 255.255.0.0 10.0.0.1
ip route 192.168.10.0 255.255.255.0 10.0.0.12
ip route 192.168.10.0 255.255.255.0 10.0.0.6 10

R6: ip route 192.168.10.0 255.255.255.0 10.0.0.2
ip route 192.168.10.0 255.255.255.0 10.0.0.11 10

*** Clear all static routes from all routers***

2. Before start this objective clear all static routes from all routers
RIP version 1 and 2

a. Create a loopback interface on each router according to the following pattern:

Router 1 (R1)

1. **Loopback 0:** 64.100.1.0/23

2. **Loopback 1:** 192.0.2.130/25

Router 2 (R2)

1. **Loopback 0:** 65.200.2.0/22
2. **Loopback 1:** 64.100.1.64/23

Router 3 (R3)

1. **Loopback 0:** 66.150.3.0/28
2. **Loopback 1:** 65.200.2.32/22

Router 4 (R4)

1. **Loopback 0:** 198.51.100.0/29
2. **Loopback 1:** 66.150.3.16/28

Router 5 (R5)

1. **Loopback 0:** 203.0.113.0/25
2. **Loopback 1:** 198.51.100.8/29

Router 6 (R6)

1. **Loopback 0:** 192.0.2.0/27
2. **Loopback 1:** 203.0.113.4/25

b. **IMPORTANT**. Apply the RIP protocol first with version 1and answer the following questions, then repeat with version 2 on all routers

** Be advised that report and screenshots showing the key differences between both versions are required.

c. Using **debug ip rip** messages and **show ip route,** document propagation of network advertisements.

Include In your report and screenshots the key differences between RIP version 1 and 2 based on the following table:

Feature	**RIP v1**	**RIP v2**
Classful/Classless	Classful	Classless
Supports VLSM	No	Yes
Authentication	No	Yes (plain text or MD5)
Update Transmission Method	Broadcast (255.255.255.255)	Multicast (224.0.0.9)
Route Tagging	No	Yes
Subnet Mask in Updates	Not included	Included

d. Use any of the computers provided to capture routing information exchanged by RIP. Enable appropriate debug command to monitor RIP events, report what all information you could see in the debug output.

Document your findings.

RIPV1:

```
.1)
*Feb  8 00:31:41.197: RIP: build flash update entries
*Feb  8 00:31:41.197:   network 40.0.0.0 metric 3
*Feb  8 00:31:41.197: RIP: sending v1 flash update to 255.255.255.255 via Loopback0 (64.100.0.1)
*Feb  8 00:31:41.197: RIP: build flash update entries
*Feb  8 00:31:41.197:   network 40.0.0.0 metric 3
*Feb  8 00:31:41.197: RIP: sending v1 flash update to 255.255.255.255 via Loopback1 (192.0.2.130)
*Feb  8 00:31:41.197: RIP: build flash update entries
*Feb  8 00:31:41.197:   network 40.0.0.0 metric 3
*Feb  8 00:31:41.197: RIP: sending v1 flash update to 255.255.255.255 via GigabitEthernet0/1 (10.0.0.
19)
*Feb  8 00:31:41.197: RIP: build flash update entries - suppressing null update
*Feb  8 00:31:44.177: RIP: sending v1 update to 255.255.255.255 via Loopback0 (64.100.0.1)
*Feb  8 00:31:44.177: RIP: build update entries
*Feb  8 00:31:44.177:   network 10.0.0.0 metric 1
*Feb  8 00:31:44.177:   network 40.0.0.0 metric 3
*Feb  8 00:31:44.177:   network 65.0.0.0 metric 2
*Feb  8 00:31:44.177:   network 66.0.0.0 metric 2
*Feb  8 00:31:44.177:   network 192.0.2.0 metric 1
*Feb  8 00:31:44.177:   network 192.168.10.0 metric 1
*Feb  8 00:31:44.177:   network 198.51.100.0 metric 2
*Feb  8 00:31:44.177:   network 203.0.113.0 metric 3
*Feb  8 00:31:45.321: RIP: sending v1 update to 255.255.255.255 via GigabitEthernet0/1 (10.0.0.19)
*Feb  8 00:31:45.321: RIP: build update entries
*Feb  8 00:31:45.321:   network 64.0.0.0 metric 1
*Feb  8 00:31:45.321:   network 192.0.2.0 metric 1
*Feb  8 00:31:45.321:   network 192.168.10.0 metric 1
*Feb  8 00:31:45.569: RIP: sending v1 update to 255.255.255.255 via Loopback1 (192.0.2.130)
*Feb  8 00:31:45.569: RIP: build update entries
*Feb  8 00:31:45.569:   network 10.0.0.0 metric 1
*Feb  8 00:31:45.569:   network 40.0.0.0 metric 3
*Feb  8 00:31:45.569:   network 64.0.0.0 metric 1
*Feb  8 00:31:45.569:   network 65.0.0.0 metric 2
*Feb  8 00:31:45.569:   network 66.0.0.0 metric 2
*Feb  8 00:31:45.569:   network 192.168.10.0 metric 1
*Feb  8 00:31:45.569:   network 198.51.100.0 metric 2
*Feb  8 00:31:45.569:   network 203.0.113.0 metric 3
*Feb  8 00:31:45.925: RIP: received v1 update from 10.0.0.20 on GigabitEthernet0/1
*Feb  8 00:31:45.925:      64.0.0.0 in 1 hops
```

I see in RIPv1 that the router sends broadcast advertisements out making known what routes they have and then broadcasting it out. The metric I see is also hop count.

RIPV2:

```
 no auto-summary
R1(config-router)#
*Feb 11 21:36:36.238: RIP: sending v2 update to 224.0.0.9 via Loopback1 (192.0.2.130)
*Feb 11 21:36:36.238: RIP: build update entries
*Feb 11 21:36:36.238:   10.0.0.16/29 via 0.0.0.0, metric 1, tag 0
*Feb 11 21:36:36.238:   192.168.10.0/24 via 0.0.0.0, metric 1, tag 0
*Feb 11 21:36:36.238: RIP: ignored v2 packet from 192.0.2.130 (sourced from one of our addresses
*Feb 11 21:36:39.958: RIP: sending v2 update to 224.0.0.9 via GigabitEthernet0/1 (10.0.0.19)
*Feb 11 21:36:39.958: RIP: build update entries
*Feb 11 21:36:39.958:   192.0.2.128/25 via 0.0.0.0, metric 1, tag 0
*Feb 11 21:36:39.958:   192.168.10.0/24 via 0.0.0.0, metric 1, tag 0
*Feb 11 21:36:47.762: RIP: sending v2 update to 224.0.0.9 via FastEthernet2/0 (192.168.10.1)
*Feb 11 21:36:47.762: RIP: build update entries
*Feb 11 21:36:47.762:   10.0.0.16/29 via 0.0.0.0, metric 1, tag 0
[*Feb 11 21:36:47.762:   192.0.2.128/25 via 0.0.0.0, metric 1, tag 0do show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
```

Here are the differences in these screenshots:

- In RIPv1, updates are sent via Bcast address while V2 is sent via multicast address
- In RIPv1, you can see the networks are segmented into classful networks with no subnet attached. In RIPv2 updates are shown with classless networks with subnets attached.

- In RIPv2 capture, we see VLSM is supported by listing the /30 networks and the network being readable when chopped up.

e. Document as well any information you find related to: Network Reachability (ping between loopbacks, or systems can reach each other?). Routing Table Completeness. (Document if anything is missing).

FOR EXAMPLE: R2 traceroute to 40.20.30.1 and route table. Proving connectivity here:

```
R2#tra
R2#traceroute 40.20.30.1
Type escape sequence to abort.
Tracing the route to 40.20.30.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.0.17 0 msec
    10.0.0.18 0 msec
    10.0.0.17 0 msec
  2 10.0.0.9 0 msec 0 msec *
R2#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
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 5 subnets, 3 masks
R        10.0.0.0/30 [120/2] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
                     [120/2] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
R        10.0.0.4/30 [120/1] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
R        10.0.0.8/29 [120/1] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
                     [120/1] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
C        10.0.0.16/29 is directly connected, GigabitEthernet0/1
L        10.0.0.20/32 is directly connected, GigabitEthernet0/1
      40.0.0.0/16 is subnetted, 1 subnets
R        40.20.0.0 [120/2] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
                   [120/2] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
      64.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        64.100.0.0/23 is directly connected, Loopback1
L        64.100.1.64/32 is directly connected, Loopback1
      65.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        65.200.0.0/22 is directly connected, Loopback0
L        65.200.0.1/32 is directly connected, Loopback0
      66.0.0.0/28 is subnetted, 1 subnets
R        66.150.3.16 [120/1] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
      192.0.2.0/24 is variably subnetted, 2 subnets, 2 masks
R        192.0.2.0/27 [120/2] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
                      [120/2] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
R        192.0.2.128/25 [120/1] via 10.0.0.19, 00:00:10, GigabitEthernet0/1
R     192.168.10.0/24 [120/1] via 10.0.0.19, 00:00:10, GigabitEthernet0/1
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, FastEthernet2/0
L        192.168.20.1/32 is directly connected, FastEthernet2/0
      198.51.100.0/29 is subnetted, 2 subnets
R        198.51.100.0 [120/1] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
R        198.51.100.8 [120/2] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
                      [120/2] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
      203.0.113.0/25 is subnetted, 1 subnets
R        203.0.113.0 [120/2] via 10.0.0.18, 00:00:09, GigabitEthernet0/1
                     [120/2] via 10.0.0.17, 00:00:16, GigabitEthernet0/1
R2#
```

f. Check the routing table. Are you missing any routes? Which ones? Try to fix the issue using no **auto-summary.**

I initially used no auto-sum, but to explain this, I would be missing routes if I did auto-sum because

it groups all classless routes into one classful route.

g. **IF you are still missing routes, use** Static Routes to complete the network map?

h. Add a loopback interface in the "Internet" node (Use an IOS router) with address 4.4.4.4/32

Assume this loopback works as an IP address on the internet and has a million more routes like it. There are two ways to advertise a route to this Internet network from the internal campus network. What are they?

Include screenshots showing successful ping from all routers to 4.4.4.4/32.

*** Don't use static routes to 4.4.4.4

*** DO NOT add network statements in RIP to 4.4.4.4/32

*** DO NOT use redistribution

1: We can set default routes to the routers for the next hop, and then for the final hop point it to Internet Router.

2: OR we can distribute the default route using default-information originate. This advertises the default route set by one router in a RIP network and sends it to its RIP neighbors. This is an easy way to keep the load on the routing table low and reduce complexity

```
R1#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
```

```
R2#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
```

```
R3#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
R4#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
R5#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
R5#
```

```
R6#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

i. As you can see, R1 has a one hop distance to R2. Adjust the RIP config on R1. **Config R1**, This time R1 introduces a hop count of 8 for its **loopback1**. While the hop count for loopback0 remains as default.

Show traceroutes results showing that a ping from R2 to loopback1 on R1 follows the path via other routers to reach R1 but the connection to loopback0 is just one hop away.

```
R2#tra
R2#traceroute 192.0.2.130
Type escape sequence to abort.
Tracing the route to 192.0.2.130
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.0.17 0 msec 0 msec 0 msec
  2 11.0.0.2 0 msec 0 msec *
R2#show
```

```
 permit 192.2.0.128 0.0.0.127
access-list 1 permit 192.0.2.128 0.0.0.127
R1#
```

```
R1#show run | sec router rip
router rip
 version 2
 offset-list 1 out 7 GigabitEthernet0/1
 network 10.0.0.0
```

***Hint: ACL required

j. Verify R1 and R2 learn two equal cost paths for the loopbacks on R6. Change the RIPv2 config in such a way that R2 always prefers the path via R3-R5 to reach R6.

This was done using offset lists for routers R3 and R4. I would offset the two links going to R6 which was two hops and added 5. This made it so the traffic would have to go through R3-R5 because the hop count is less.

R4:

```
router rip
 version 2
 offset-list 1 in 5 GigabitEthernet0/1
 network 10.0.0.0
 network 66.0.0.0
 network 198.51.100.0
 no auto-summary
!
```

```
access-list 1 permit 40.20.0.0 0.0.255.255
```

R3:

```
router rip
 version 2
 offset-list 1 in 5 GigabitEthernet0/1
 network 10.0.0.0
 network 11.0.0.0
 network 65.0.0.0
 no auto-summary
!
```

```
!
access-list 1 permit 40.20.0.0 0.0.255.255
```

EIGRP

Now we want to modernize our network by updating the routing protocol from RIP to EIGRP. Migration should happen gracefully and without downtime. Furthermore, if anything goes wrong, we can reverse it back to RIP. What solution/procedure can you think of that will permit this process to happen seamlessly?

***Hint: It's possible to run more than one protocol at the same time .

Report your solution

What is the metric used by EIGRP? Is it still hop count? Please explain.

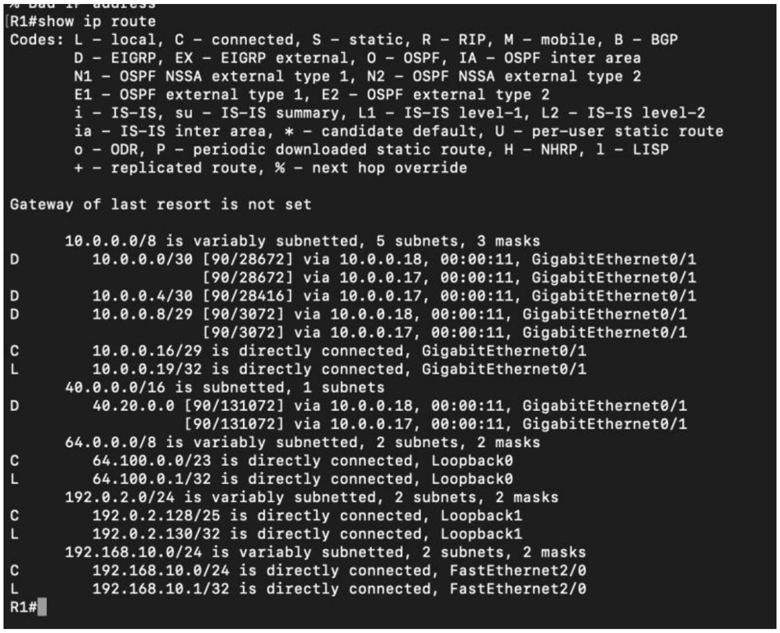
What I did was use more one protocol at the same time. I then just configured EIGRP and got connectivity:

```
router eigrp 100
 network 10.0.0.0
 network 40.0.0.0
R6#
```

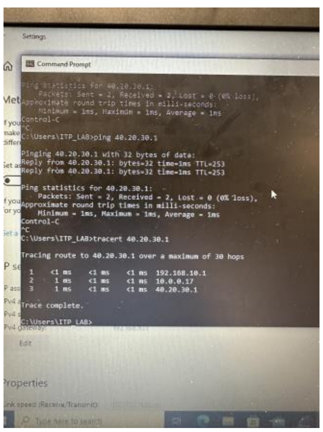
```
router eigrp 100
 network 10.0.0.0
R1#
```

Make sure you have complete reachability via EIGRP from Sales client to the Headquarters .

Evidence of reachability from Sales to headquarters:

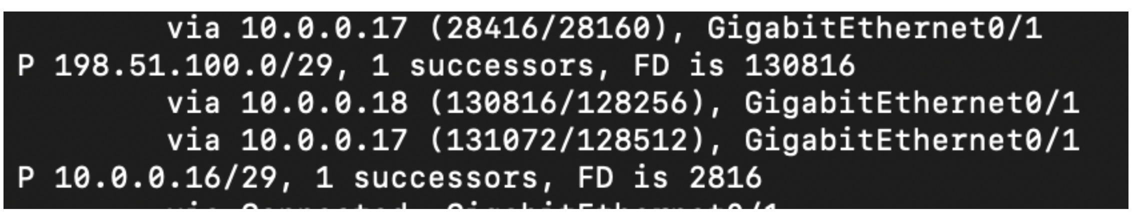


```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       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
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 5 subnets, 3 masks
D        10.0.0.0/30 [90/28672] via 10.0.0.18, 00:00:11, GigabitEthernet0/1
                     [90/28672] via 10.0.0.17, 00:00:11, GigabitEthernet0/1
D        10.0.0.4/30 [90/28416] via 10.0.0.17, 00:00:11, GigabitEthernet0/1
D        10.0.0.8/29 [90/3072] via 10.0.0.18, 00:00:11, GigabitEthernet0/1
                     [90/3072] via 10.0.0.17, 00:00:11, GigabitEthernet0/1
C        10.0.0.16/29 is directly connected, GigabitEthernet0/1
L        10.0.0.19/32 is directly connected, GigabitEthernet0/1
      40.0.0.0/16 is subnetted, 1 subnets
D        40.20.0.0 [90/131072] via 10.0.0.18, 00:00:11, GigabitEthernet0/1
                   [90/131072] via 10.0.0.17, 00:00:11, GigabitEthernet0/1
      64.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        64.100.0.0/23 is directly connected, Loopback0
L        64.100.0.1/32 is directly connected, Loopback0
      192.0.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.0.2.128/25 is directly connected, Loopback1
L        192.0.2.130/32 is directly connected, Loopback1
      192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.10.0/24 is directly connected, FastEthernet2/0
L        192.168.10.1/32 is directly connected, FastEthernet2/0
R1#
```



Report commands used + screenshots. Look at the routes available from R1 to R6 loopbacks:

- If you have multiple routes in the routing table: change the metric so route via R4 is a feasible successor.



```
         via 10.0.0.17 (28416/28160), GigabitEthernet0/1
P 198.51.100.0/29, 1 successors, FD is 130816
         via 10.0.0.18 (130816/128256), GigabitEthernet0/1
         via 10.0.0.17 (131072/128512), GigabitEthernet0/1
P 10.0.0.16/29, 1 successors, FD is 2816
```

  - For this objective, I set the bandwidth of R4 to 9000000 which calculated the feasible and advertised difference slightly above the R3 route. This made it the feasible successor if R3 link were to go down. Initially, they were equal cost paths.
- If there is only one route in your routing table, then configure EIGRP so this route becomes the feasible successor, and the backup becomes the successor.
  - The metrics were calculated similar enought to each other that both showed in the routing table, if I were to set the bandwidth to 0, then one of the routes would disapear in the topology due to the calculation being so bad.

- Now, modify the metrics of EIGRP so the path from R1-R3-R5-R6 becomes the **successor** and all others become **Feasible Successors**
  - The commands I used to achieve this was doing bandwidth 1 on both interfaces of R3 and R4 facing the next hop for HQ. Once this was done, both routes to that became feasible successors and the R3 route to R5 became the successor. Here is the traceroute and config for proof:

```
R4(config-if)#
R4(config-if)#do show run | sec 0/0
interface GigabitEthernet0/0
 bandwidth 1
 ip address 10.0.0.18 255.255.255.248
 delay 1000000
 duplex auto
 speed auto
 media-type rj45
R4(config-if)#
```

```
R2#traceroute 40.20.30.1
Type escape sequence to abort.
Tracing the route to 40.20.30.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.0.17 0 msec 0 msec 0 msec
  2 10.0.0.5 0 msec 0 msec 0 msec
  3 10.0.0.9 0 msec 0 msec *
R2#
```

Traceroute when this config isn’t in place:

```
R2#traceroute 40.20.30.1
Type escape sequence to abort.
Tracing the route to 40.20.30.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.0.18 0 msec 0 msec 0 msec
  2 10.0.0.9 0 msec 0 msec *
```

Report the commands you used + Screenshots showing the results

Study Questions (answer after each question):

1. What is meant by administrative distance and how is this important when one does a show ip route?

AD is a priority number that is given to different types of routing protocols that determine which route to take when there is two routes going to the same network with same subnet, it determines the lowest AD for it to go through.

2. Why do routing protocols use metrics?

Routing protocols use metrics to determine the most efficient path without loops and can change when the network changes.

3. What is convergence time?

Convergence time is the amount of time it takes for a routing protocol to achieve connectivity with a route when there was a change.

4. What is a distance vector routing protocol?

A DV routing protocol uses the Bellmon ford algorithm to determine the best path, it learns by rumor. It is most basically determined by distance and direction.

5. Name several problems associated with distance vector protocols?

They can be fast for smaller networks, but as hops increase, the number of broadcasts throughout the network will increase due to constant updates from every router. There can be the problem of routing loops, and when the rumor is started about a route, it can take time to travel across the network. Convergence is also very slow, being that each individual router has its own 30 second update timer (for RIP) that will take time to converge networks when something changes.

6. What does a routing protocol communicate?

A routing protocol can communicate a lot of things, based on the type of protocol it is. It can be a host of different metrics, but all protocols communicate a destination network

7. What does convergence mean?

When all the routers have a consistent and up to date understanding of the network topology

10.What is meant by default route?

The default route is a route that is taken if no other route is matched by a packet wanting to go to a certain destination network. It is the gateway of last resort.

11. What is meant by load sharing? load sharing is allowing for traffic to go to the same destination through multiple paths and not having one device handle all of the load/traffic.

12. What are the differences between RIPv1 and RIPv2 update packets?

- Broadcast updates vs multicast updates
- Classful network updates vs classless updates (VLSM)
- No next hop field vs having one

13. In a RIP routing table, how do you determine which networks are discovered by the routing protocol?

You can see the little R next to the route, this indicates it is a RIP route

14. List the different ways as to how RIP avoid loops?

Split horizon – will send a route back the interface it learned it on.

SH with Posion reverse – do the same thing as SH, but send back a hop count 16 route.

Route poison – When router detects failed route, it will send hop count 16 routes to other routers.

Hold-down timer – when a route fails, it will wait 180 seconds to receive updates about that route

Triggered updates – sends immediate updates when route fails.

15. List five major difference between RIPv1 and RIPv2

Routing Type: RIPv1 is classful and does not support subnet masks, while RIPv2 is classless and includes subnet masks in updates.

Routing Updates: RIPv1 broadcasts updates to all devices, while RIPv2 multicasts updates only to RIP routers.

Subnet Mask Support: RIPv1 does not include subnet mask information, whereas RIPv2 includes it for VLSM and CIDR.

Authentication: RIPv1 lacks authentication, while RIPv2 supports both plain-text and MD5 authentication.

Next-Hop Information: RIPv1 does not include next-hop information, while RIPv2 includes it for more efficient routing.