ECCS-3631
Networks and Data Communications

Module 2-4
Routing Information Protocol (RIP)

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Routing in the Internet

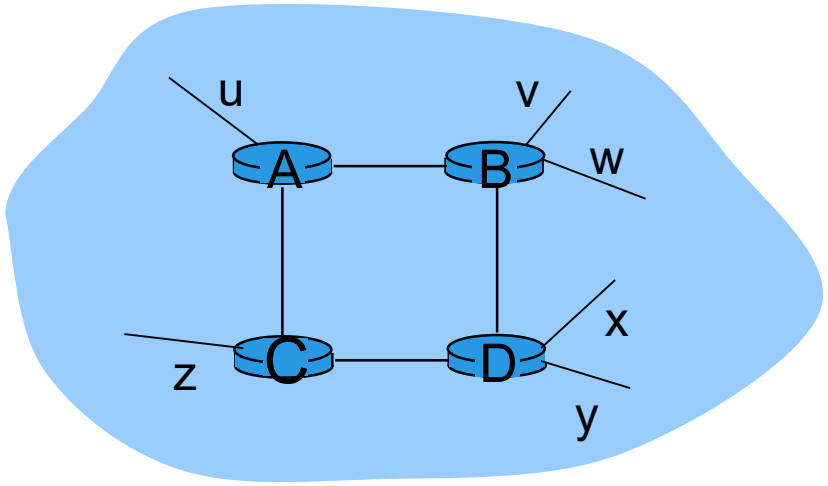
- Now, in this lecture we will focus on the Internet's routing protocols. The main goal of internet routing protocol is to determine the path taken by a packet between source and destination.
- Internet's routing protocols incorporates routing algorithms; link-state and distance-vector routing algorithms to find the shortest path.
- Each network system contains multiple subnets that requires routing protocol to select the best path to the destination.
- One of the most commonly used routing protocol is Routing Information Protocol (RIP)

RIP Protocol

- RIP is a distance-vector protocol that operates in a manner very close to the idealized distance-vector routing algorithm.
- RIP uses hop count as a cost metric, that is, each link has a cost of 1.
- RIP uses the term hop; hop is defined as the number of subnets traversed along the shortest path from source router to destination subnet including the destination subnet.
- In RIP, costs are from source router to the destination router.
- The maximum cost of a path is limited to 15, thus the use of RIP to a system that are fewer than 15 hops in diameter.
- In RIP, routing updates are exchanged between neighbors approximately every 30 seconds using a RIP response message. Response messages are also known as RIP advertisements.

RIP Protocol – Hop Count

- Each router maintains a RIP table, also known as a routing table.
- In RIP, Routing table includes both the router's distance vector and the router's forwarding table.
- Consider the following network diagram, u, v, w, x, y and z represent subnets, while A, B, C and D are routers.

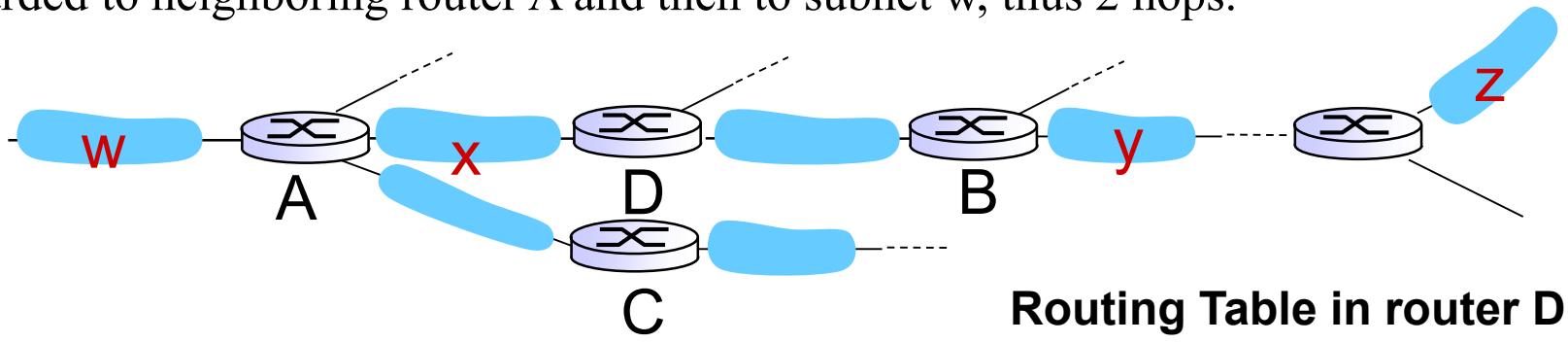


Number of hops from router A to destination subnets:

subnet	hops
u	1
v	2
w	2
x	3
y	3
z	2

RIP Example

- Let's consider the following example of how RIP advertisements work. In this figure, lines connecting the routers denote subnets. Dotted lines indicate that the system continues on; thus this system has many more routers and links than are shown.
- Routing table has three columns. First for destination subnet, second to identify next router, and third for number of hops
- In this example to send a packet from router D to destination subnet w, packet is first forwarded to neighboring router A and then to subnet w, thus 2 hops.



Routing Table in router D

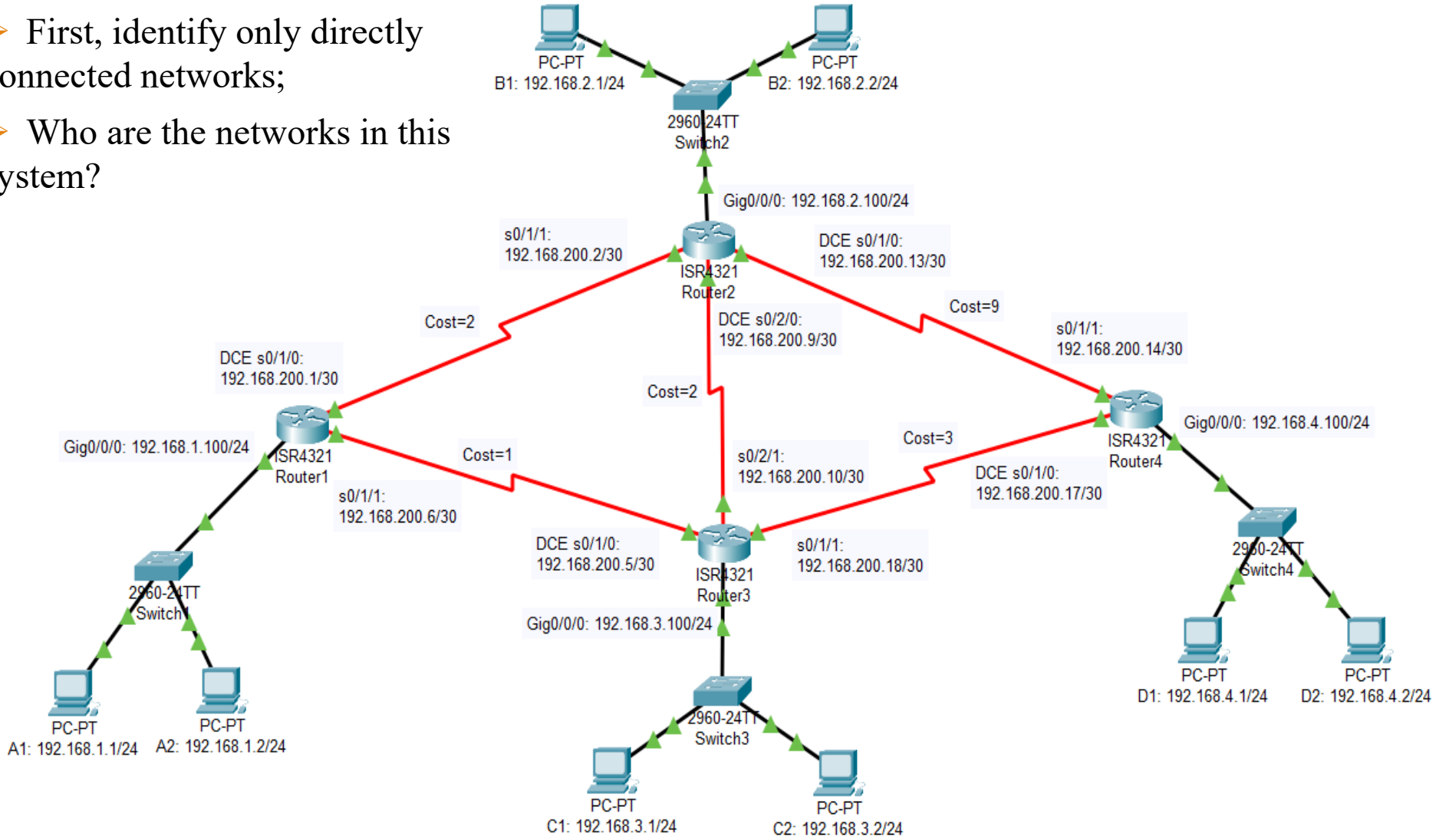
Destination Subnet	Next Router	No of Hops to Destination
w	A	2
y	B	2
z	B	7
x	--	1
….	….	….

RIP Link Failure, Recovery

- Recall that RIP routers exchange advertisements approximately every 30 seconds. If a router does not hear from its neighbor at least once very 180 seconds, that neighbor is considered to be no longer reachable. Either neighbor has died or connecting link has gone down.
- Then, RIP modifies the local routing table and propagates by sending advertisements to its neighboring routers.
- Routers send RIP request and response messages to each other.

Configuring RIP on R1

- Let's configure RIP on Router1.
- First, identify only directly connected networks;
- Who are the networks in this system?



Identify Directly Connected Networks

List Directly connected networks on Router1:

Network Address
192.168.1.0
192.168.200.0
192.168.200.4

Configuring RIP Routing on R1

Configuring RIP on Router1:

```
Router1(config)#router rip
Router1(config-router)#version 2
Router1(config-router)#network 192.168.1.0
Router1(config-router)#network 192.168.200.0
Router1(config-router)#network 192.168.200.4
Router1(config-router)#no auto-summary
Router1(config-router)#exit
```

Passive-Interfaces Connected to the Router

List all Passive Interfaces connected on Router1:

Name of Passive-Interface
192.168.1.0

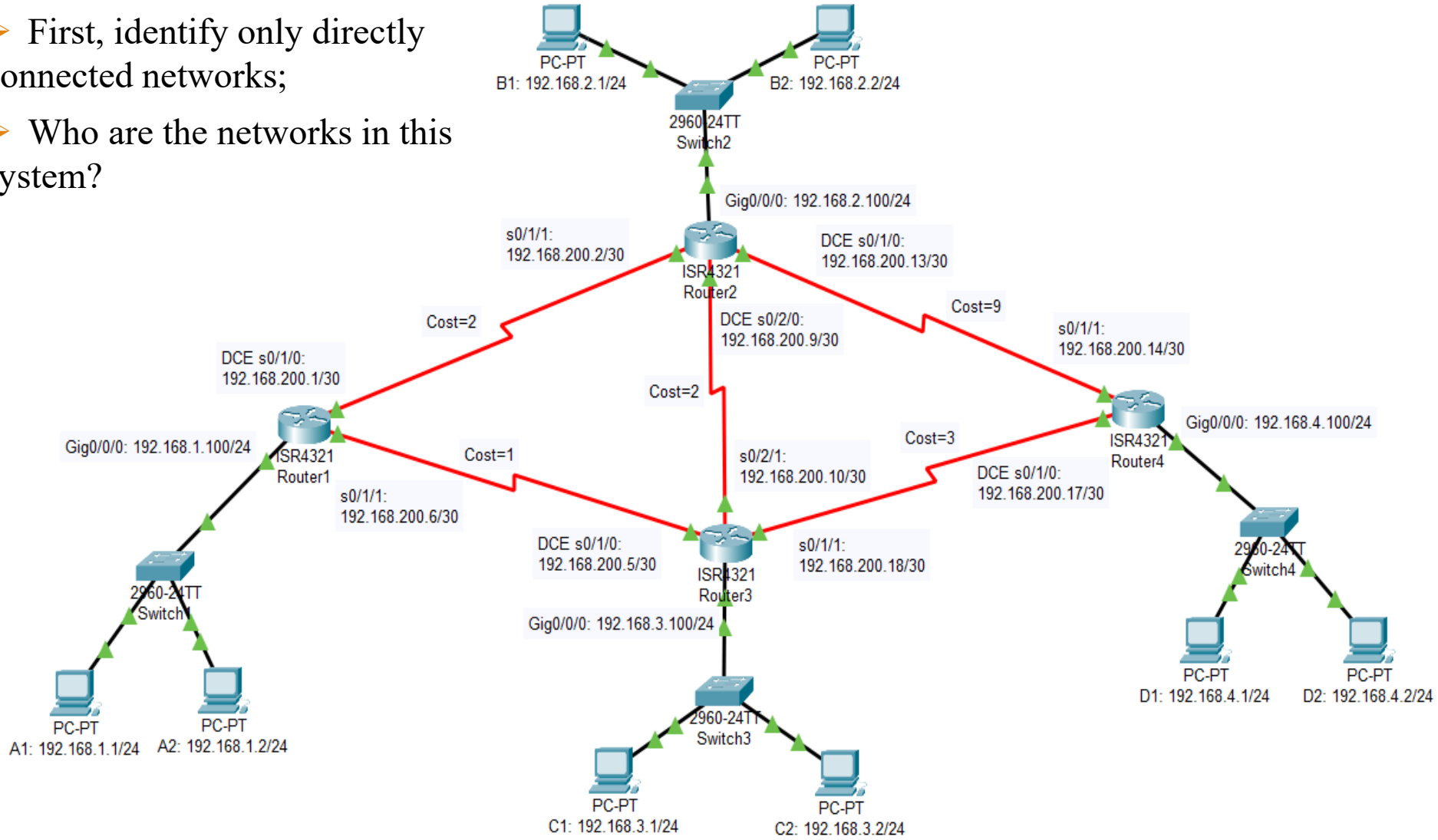
Configuring Passive Interface on R1

Configuring RIP on Router1:

```
Router1(config)#router rip
Router1(config-router)#version 2
Router1(config-router)#network 192.168.1.0
Router1(config-router)#network 192.168.200.0
Router1(config-router)#network 192.168.200.4
Router1(config-router)#no auto-summary
Router1(config-router)#passive-interface gig 0/0/0
Router1(config-router)#exit
```

Practice Configuring RIP on R2

- Let's configure RIP on Router1.
- First, identify only directly connected networks;
- Who are the networks in this system?



Identify Directly Connected Networks

List Directly connected networks on Router2:

Network Address

Passive-Interfaces Connected to the Router

List all Passive Interfaces connected on Router2:

Name of Passive-Interface

Configuring RIP Routing on R2

Configuring RIP on Router2:

```
Router2(config)#_____________________________________
Router2(config-router)#_____________________________________
Router2(config-router)#_____________________________________
Router2(config-router)#_____________________________________
Router2(config-router)#_____________________________________
Router2(config-router)#_____________________________________
Router2(config-router)#_____________________________________
```

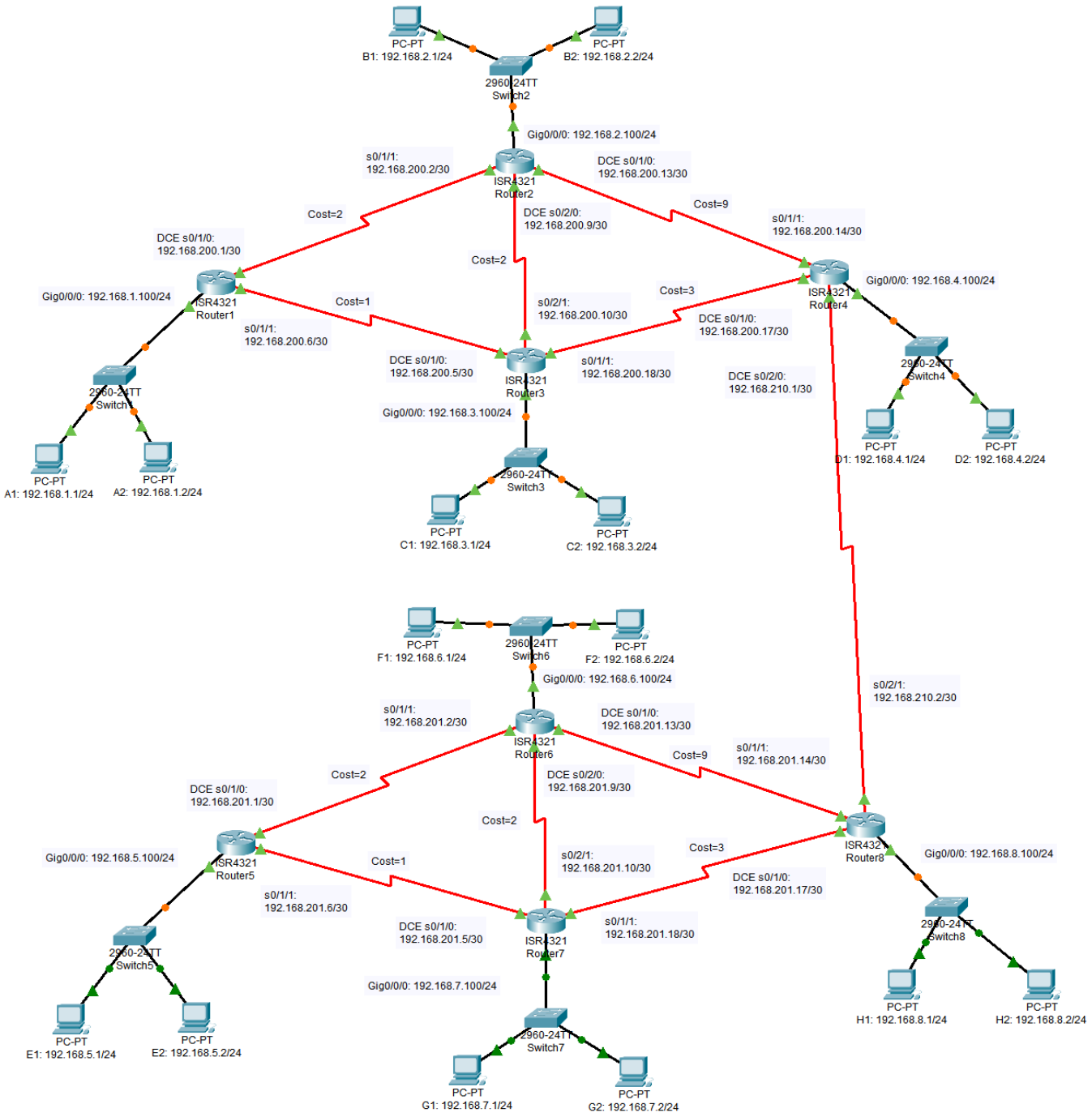
Removing RIP

The RIP routing protocol can be completely removed from the router by using:

Router(config)# **no router rip**

If you want to remove only one entry of a network, it can be done as:

Router(config-router)#**no network 192.168.2.0**


PC-PT
B1: 192.168.2.1/24
PC-PT
B2: 192.168.2.2/24
2960-24TT
Switch2
Gig0/0/0: 192.168.2.100/24
s0/1/1:
192.168.200.2/30
ISR4321
Router2
DCE s0/1/0:
192.168.200.13/30
Cost=2
DCE s0/2/0:
192.168.200.9/30
Cost=9
s0/1/1:
192.168.200.14/30
DCE s0/1/0:
192.168.200.1/30
Cost=2
Gig0/0/0: 192.168.1.100/24
ISR4321
Router1
Cost=1
s0/1/1:
192.168.200.6/30
s0/2/1:
192.168.200.10/30
Cost=3
DCE s0/1/0:
192.168.200.17/30
ISR4321
Router4
Gig0/0/0: 192.168.4.100/24
DCE s0/1/0:
192.168.200.5/30
ISR4321
Router3
s0/1/1:
192.168.200.18/30
DCE s0/2/0:
192.168.210.1/30
2960-24TT
Switch4
2960-24TT
Switch1
Gig0/0/0: 192.168.3.100/24
PC-PT
D1: 192.168.4.1/24
PC-PT
D2: 192.168.4.2/24
PC-PT
A1: 192.168.1.1/24
PC-PT
A2: 192.168.1.2/24
2960-24TT
Switch3
PC-PT
C1: 192.168.3.1/24
PC-PT
C2: 192.168.3.2/24
PC-PT
F1: 192.168.6.1/24
2960-24TT
Switch6
PC-PT
F2: 192.168.6.2/24
Gig0/0/0: 192.168.6.100/24
s0/2/1:
192.168.210.2/30
s0/1/1:
192.168.201.2/30
ISR4321
Router6
DCE s0/1/0:
192.168.201.13/30
Cost=9
s0/1/1:
192.168.201.14/30
Cost=2
DCE s0/2/0:
192.168.201.9/30
DCE s0/1/0:
192.168.201.1/30
Cost=2
Gig0/0/0: 192.168.5.100/24
ISR4321
Router5
Cost=1
s0/2/1:
192.168.201.10/30
Cost=3
ISR4321
Router8
Gig0/0/0: 192.168.8.100/24
DCE s0/1/0:
192.168.201.17/30
s0/1/1:
192.168.201.6/30
DCE s0/1/0:
192.168.201.5/30
ISR4321
Router7
s0/1/1:
192.168.201.18/30
2960-24TT
Switch8
2960-24TT
Switch5
Gig0/0/0: 192.168.7.100/24
PC-PT
H1: 192.168.8.1/24
PC-PT
H2: 192.168.8.2/24
PC-PT
E1: 192.168.5.1/24
PC-PT
E2: 192.168.5.2/24
2960-24TT
Switch7
PC-PT
G1: 192.168.7.1/24
PC-PT
G2: 192.168.7.2/24

CONFIGURING DEFAULT ROUTE USING RIP

We use default routing to send packets with a remote destination network not in the routing table to the next-hop router. By using a default route, you can just create one static route entry instead. However, we advertise this default route entry through RIP instead of configuring a default route on every router in the network. Here is the example to create a default route on Router4:

Router4(config)#**ip route 0.0.0.0 0.0.0.0 serial 0/1/0**

This above default route is also known as Gateway of Last Resort.

Then, the following set of statements are used to advertise this default route to other routers in the networks (such as Router1 in this example) through RIP

Router4(config)#**router rip**

Router4(config-router)#**default-information originate**

Default Routing

For Router4 and Router8: Apply default routing in your Router4 and Router8. **For Router4 and Router8:** View your Router4 and Router8 running configurations and make sure you see the correct default route statement in your router.

For Router4 and Router8: The following set of statements are applied to Router4 and Router8 to advertise this default route to other routers in the networks through RIP

Router4(config)#**router rip**

Router4(config-router)#**default-information originate**

Router8(config)#**router rip**

Router8(config-router)#**default-information originate**

Default Route on R4 and R8 – show ip route

For Router4 and Router8: Let's look at the routing table of Router4 and Router8. You will notice a route S*, which is the default route. View the output of the show ip route

```
Router4#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

R    192.168.1.0/24 [120/2] via 192.168.200.13, 00:00:22, Serial0/1/1
                    [120/2] via 192.168.200.18, 00:00:16, Serial0/1/0
R    192.168.2.0/24 [120/1] via 192.168.200.13, 00:00:22, Serial0/1/1
R    192.168.3.0/24 [120/1] via 192.168.200.18, 00:00:16, Serial0/1/0
     192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.4.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.4.100/32 is directly connected, GigabitEthernet0/0/0
     192.168.200.0/24 is variably subnetted, 7 subnets, 2 masks
R       192.168.200.0/30 [120/1] via 192.168.200.13, 00:00:22, Serial0/1/1
R       192.168.200.4/30 [120/1] via 192.168.200.18, 00:00:16, Serial0/1/0
R       192.168.200.8/30 [120/1] via 192.168.200.18, 00:00:16, Serial0/1/0
                         [120/1] via 192.168.200.13, 00:00:22, Serial0/1/1
C       192.168.200.12/30 is directly connected, Serial0/1/1
L       192.168.200.14/32 is directly connected, Serial0/1/1
C       192.168.200.16/30 is directly connected, Serial0/1/0
L       192.168.200.17/32 is directly connected, Serial0/1/0
     192.168.210.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.210.0/30 is directly connected, Serial0/2/0
L       192.168.210.1/32 is directly connected, Serial0/2/0
S*   0.0.0.0/0 is directly connected, Serial0/2/0
```

Default Route on R4 and R8 – show ip route

For Router4 and Router8: Let's look at the routing table of Router4 and Router8. You will notice a route S*, which is the default route. View the output of the show ip route

```
Router8#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

R    192.168.5.0/24 [120/2] via 192.168.201.18, 00:00:11, Serial0/1/0
                    [120/2] via 192.168.201.13, 00:00:14, Serial0/1/1
R    192.168.6.0/24 [120/1] via 192.168.201.13, 00:00:14, Serial0/1/1
R    192.168.7.0/24 [120/1] via 192.168.201.18, 00:00:11, Serial0/1/0
     192.168.8.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.8.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.8.100/32 is directly connected, GigabitEthernet0/0/0
     192.168.201.0/24 is variably subnetted, 7 subnets, 2 masks
R       192.168.201.0/30 [120/1] via 192.168.201.13, 00:00:14, Serial0/1/1
R       192.168.201.4/30 [120/1] via 192.168.201.18, 00:00:11, Serial0/1/0
R       192.168.201.8/30 [120/1] via 192.168.201.13, 00:00:14, Serial0/1/1
                         [120/1] via 192.168.201.18, 00:00:11, Serial0/1/0
C       192.168.201.12/30 is directly connected, Serial0/1/1
L       192.168.201.14/32 is directly connected, Serial0/1/1
C       192.168.201.16/30 is directly connected, Serial0/1/0
L       192.168.201.17/32 is directly connected, Serial0/1/0
     192.168.210.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.210.0/30 is directly connected, Serial0/2/1
L       192.168.210.2/32 is directly connected, Serial0/2/1
S*   0.0.0.0/0 is directly connected, Serial0/2/1
```

Default Route on R1 and others

All other routers, except Router4 and Router8, View the output of the showip route. You will notice a route R*, which is the default route injected through RIP.

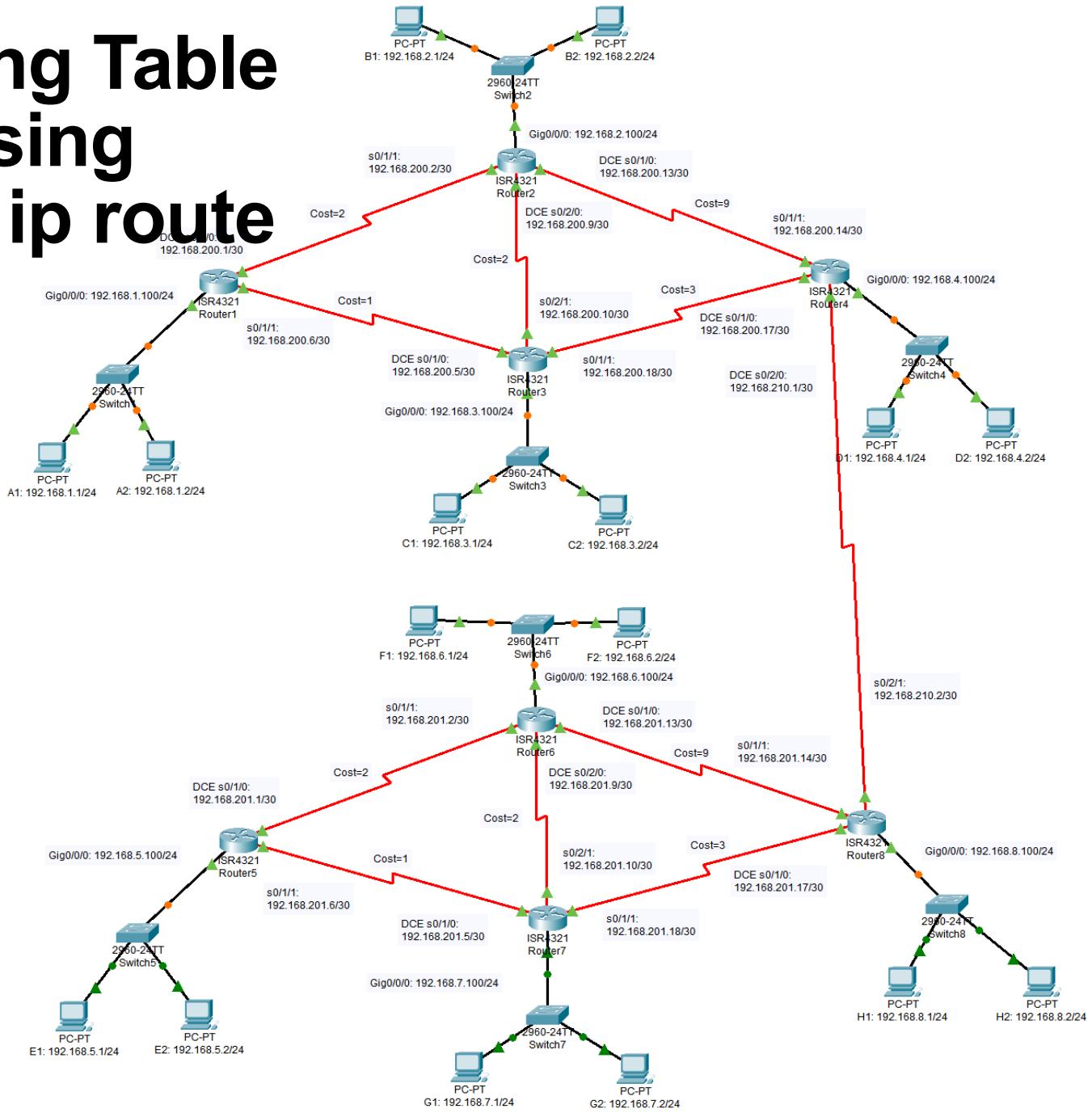
```
Router1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, 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

Gateway of last resort is 192.168.200.5 to network 0.0.0.0

     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.1.100/32 is directly connected, GigabitEthernet0/0/0
R    192.168.2.0/24 [120/1] via 192.168.200.2, 00:00:00, Serial0/1/0
R    192.168.3.0/24 [120/1] via 192.168.200.5, 00:00:07, Serial0/1/1
R    192.168.4.0/24 [120/2] via 192.168.200.2, 00:00:00, Serial0/1/0
                    [120/2] via 192.168.200.5, 00:00:07, Serial0/1/1
     192.168.200.0/24 is variably subnetted, 7 subnets, 2 masks
C       192.168.200.0/30 is directly connected, Serial0/1/0
L       192.168.200.1/32 is directly connected, Serial0/1/0
C       192.168.200.4/30 is directly connected, Serial0/1/1
L       192.168.200.6/32 is directly connected, Serial0/1/1
R       192.168.200.8/30 [120/1] via 192.168.200.2, 00:00:00, Serial0/1/0
                         [120/1] via 192.168.200.5, 00:00:07, Serial0/1/1
R       192.168.200.12/30 [120/1] via 192.168.200.2, 00:00:00, Serial0/1/0
R       192.168.200.16/30 [120/1] via 192.168.200.5, 00:00:07, Serial0/1/1
R*   0.0.0.0/0 [120/2] via 192.168.200.5, 00:00:07, Serial0/1/1
               [120/2] via 192.168.200.2, 00:00:00, Serial0/1/0
```

Default Route on R7 with RIP

All other routers, except Router4 and Router8, View the output of the showip route. You will notice a route R*, which is the default route injected through RIP.

```
Router7#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is 192.168.201.17 to network 0.0.0.0

R    192.168.5.0/24 [120/1] via 192.168.201.6, 00:00:07, Serial0/1/0
R    192.168.6.0/24 [120/1] via 192.168.201.9, 00:00:09, Serial0/2/1
     192.168.7.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.7.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.7.100/32 is directly connected, GigabitEthernet0/0/0
R    192.168.8.0/24 [120/1] via 192.168.201.17, 00:00:06, Serial0/1/1
     192.168.201.0/24 is variably subnetted, 8 subnets, 2 masks
R       192.168.201.0/30 [120/1] via 192.168.201.6, 00:00:07, Serial0/1/0
                         [120/1] via 192.168.201.9, 00:00:09, Serial0/2/1
C       192.168.201.4/30 is directly connected, Serial0/1/0
L       192.168.201.5/32 is directly connected, Serial0/1/0
C       192.168.201.8/30 is directly connected, Serial0/2/1
L       192.168.201.10/32 is directly connected, Serial0/2/1
R       192.168.201.12/30 [120/1] via 192.168.201.9, 00:00:09, Serial0/2/1
                          [120/1] via 192.168.201.17, 00:00:06, Serial0/1/1
C       192.168.201.16/30 is directly connected, Serial0/1/1
L       192.168.201.18/32 is directly connected, Serial0/1/1
R*   0.0.0.0/0 [120/1] via 192.168.201.17, 00:00:06, Serial0/1/1
```

Routing Table using show ip route



R1: Routing Table using show ip route

```
Router1#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is 192.168.200.5 to network 0.0.0.0

     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.1.100/32 is directly connected, GigabitEthernet0/0/0
R    192.168.2.0/24 [120/1] via 192.168.200.2, 00:00:20, Serial0/1/0
R    192.168.3.0/24 [120/1] via 192.168.200.5, 00:00:17, Serial0/1/1
R    192.168.4.0/24 [120/2] via 192.168.200.5, 00:00:17, Serial0/1/1
                    [120/2] via 192.168.200.2, 00:00:20, Serial0/1/0
     192.168.200.0/24 is variably subnetted, 7 subnets, 2 masks
C       192.168.200.0/30 is directly connected, Serial0/1/0
L       192.168.200.1/32 is directly connected, Serial0/1/0
C       192.168.200.4/30 is directly connected, Serial0/1/1
L       192.168.200.6/32 is directly connected, Serial0/1/1
R       192.168.200.8/30 [120/1] via 192.168.200.2, 00:00:20, Serial0/1/0
                         [120/1] via 192.168.200.5, 00:00:17, Serial0/1/1
R       192.168.200.12/30 [120/1] via 192.168.200.2, 00:00:20, Serial0/1/0
R       192.168.200.16/30 [120/1] via 192.168.200.5, 00:00:17, Serial0/1/1
R*   0.0.0.0/0 [120/2] via 192.168.200.5, 00:00:17, Serial0/1/1
               [120/2] via 192.168.200.2, 00:00:20, Serial0/1/0
```

Prepare the Routing Table using show ip route

Write the routing table of Router1

Network Address	Subnet Mask	Next-hop or Exit-interface

Prepare the Routing Table using show ip route

Write the routing table of Router1

Network Address	Subnet Mask	Next-hop or Exit-interface
192.168.1.0	255.255.255.0	Gig 0/0/0
192.168.2.0	255.255.255.0	192.168.200.2
192.168.3.0	255.255.255.0	192.168.200.5
192.168.4.0	255.255.255.0	192.168.200.5 or .2
192.168.200.0	255.255.255.252	s 0/1/0
192.168.200.4	255.255.255.252	s 0/1/1
192.168.200.8	255.255.255.252	192.168.200.2 or .5
192.168.200.12	255.255.255.252	192.168.200.2
192.168.200.16	255.255.255.252	192.168.200.5
0.0.0.0	0.0.0.0	192.168.200.5

R7: Routing Table using show ip route

```
Router7#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, E - EGP
       i - IS-IS, 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

Gateway of last resort is 192.168.201.17 to network 0.0.0.0

R    192.168.5.0/24 [120/1] via 192.168.201.6, 00:00:15, Serial0/1/0
R    192.168.6.0/24 [120/1] via 192.168.201.9, 00:00:22, Serial0/2/1
     192.168.7.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.7.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.7.100/32 is directly connected, GigabitEthernet0/0/0
R    192.168.8.0/24 [120/1] via 192.168.201.17, 00:00:17, Serial0/1/1
     192.168.201.0/24 is variably subnetted, 8 subnets, 2 masks
R       192.168.201.0/30 [120/1] via 192.168.201.6, 00:00:15, Serial0/1/0
                         [120/1] via 192.168.201.9, 00:00:22, Serial0/2/1
C       192.168.201.4/30 is directly connected, Serial0/1/0
L       192.168.201.5/32 is directly connected, Serial0/1/0
C       192.168.201.8/30 is directly connected, Serial0/2/1
L       192.168.201.10/32 is directly connected, Serial0/2/1
R       192.168.201.12/30 [120/1] via 192.168.201.9, 00:00:22, Serial0/2/1
                          [120/1] via 192.168.201.17, 00:00:17, Serial0/1/1
C       192.168.201.16/30 is directly connected, Serial0/1/1
L       192.168.201.18/32 is directly connected, Serial0/1/1
R*   0.0.0.0/0 [120/1] via 192.168.201.17, 00:00:17, Serial0/1/1
```

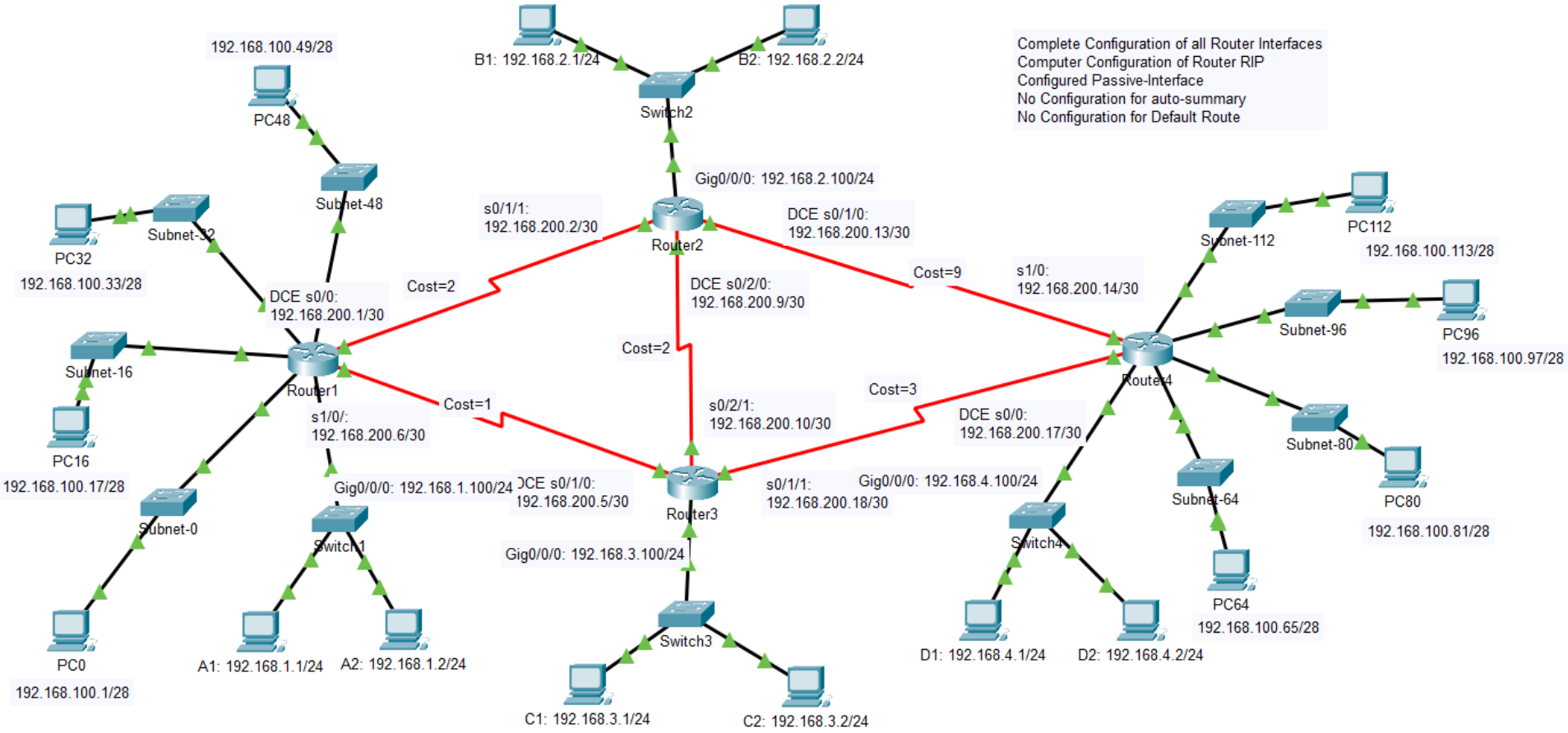
Practice: Prepare the Routing Table of R7

Network Address	Subnet Mask	Next-hop or Exit-interface

RIP Auto-Summary

- RIP automatically summarizes along classful network boundaries.
- So if your router sees that several subnets of the same network all use the same path, and there are no subnets of this network using a different path, it will automatically summarize this information. The routes to the individual subnets are suppressed.

RIP Auto-Summary



R1: show ip route without no auto-summary

```
Router1# show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, GigabitEthernet9/0
R    192.168.2.0/24 [120/1] via 192.168.200.2, 00:00:15, Serial0/0
R    192.168.3.0/24 [120/1] via 192.168.200.5, 00:00:20, Serial1/0
R    192.168.4.0/24 [120/2] via 192.168.200.5, 00:00:20, Serial1/0
                    [120/2] via 192.168.200.2, 00:00:15, Serial0/0
     192.168.100.0/28 is subnetted, 4 subnets
C       192.168.100.0 is directly connected, GigabitEthernet2/0
C       192.168.100.16 is directly connected, GigabitEthernet3/0
C       192.168.100.32 is directly connected, GigabitEthernet4/0
C       192.168.100.48 is directly connected, GigabitEthernet5/0
     192.168.200.0/30 is subnetted, 5 subnets
C       192.168.200.0 is directly connected, Serial0/0
C       192.168.200.4 is directly connected, Serial1/0
R       192.168.200.8 [120/1] via 192.168.200.2, 00:00:15, Serial0/0
                      [120/1] via 192.168.200.5, 00:00:20, Serial1/0
R       192.168.200.12 [120/1] via 192.168.200.2, 00:00:15, Serial0/0
R       192.168.200.16 [120/1] via 192.168.200.5, 00:00:20, Serial1/0
```

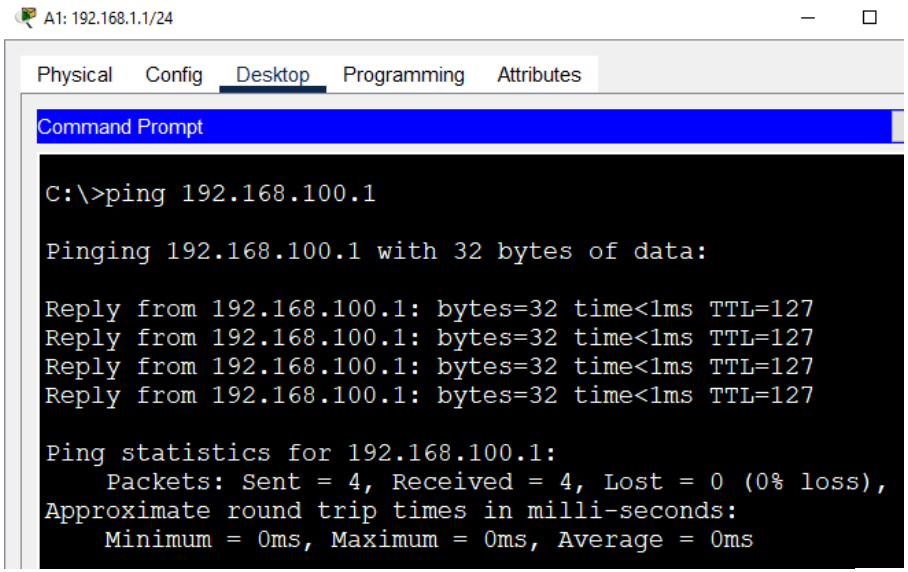
R4: show ip route without no auto-summary

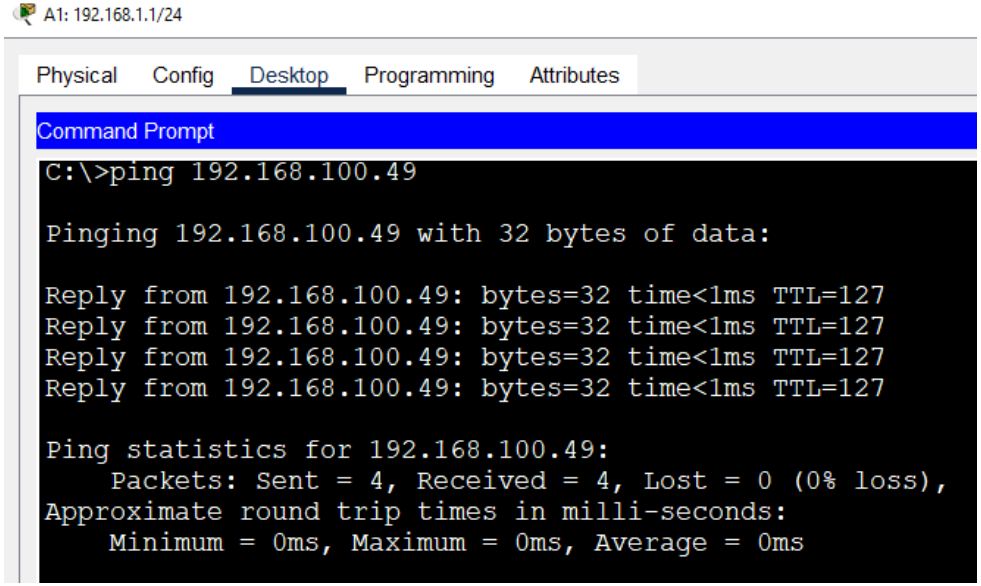
```
Router4#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

R    192.168.1.0/24 [120/2] via 192.168.200.13, 00:00:06, Serial1/0
                    [120/2] via 192.168.200.18, 00:00:06, Serial0/0
R    192.168.2.0/24 [120/1] via 192.168.200.13, 00:00:06, Serial1/0
R    192.168.3.0/24 [120/1] via 192.168.200.18, 00:00:06, Serial0/0
C    192.168.4.0/24 is directly connected, GigabitEthernet9/0
     192.168.100.0/28 is subnetted, 4 subnets
C       192.168.100.64 is directly connected, GigabitEthernet2/0
C       192.168.100.80 is directly connected, GigabitEthernet3/0
C       192.168.100.96 is directly connected, GigabitEthernet4/0
C       192.168.100.112 is directly connected, GigabitEthernet5/0
     192.168.200.0/30 is subnetted, 5 subnets
R       192.168.200.0 [120/1] via 192.168.200.13, 00:00:06, Serial1/0
R       192.168.200.4 [120/1] via 192.168.200.18, 00:00:06, Serial0/0
R       192.168.200.8 [120/1] via 192.168.200.13, 00:00:06, Serial1/0
                      [120/1] via 192.168.200.18, 00:00:06, Serial0/0
C       192.168.200.12 is directly connected, Serial1/0
C       192.168.200.16 is directly connected, Serial0/0
```

R2: show ip route without no auto-summary

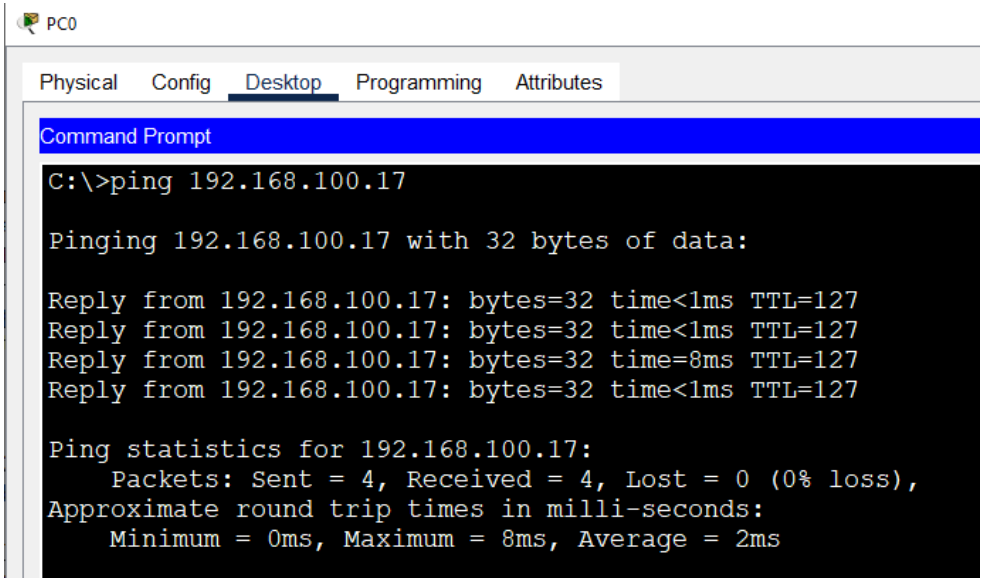
```
Router2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

R    192.168.1.0/24 [120/1] via 192.168.200.1, 00:00:10, Serial0/1/1
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.2.100/32 is directly connected, GigabitEthernet0/0/0
R    192.168.3.0/24 [120/1] via 192.168.200.10, 00:00:28, Serial0/2/0
R    192.168.4.0/24 [120/1] via 192.168.200.14, 00:00:00, Serial0/1/0
R    192.168.100.0/24 [120/1] via 192.168.200.1, 00:00:10, Serial0/1/1
                      [120/1] via 192.168.200.14, 00:00:00, Serial0/1/0
     192.168.200.0/24 is variably subnetted, 8 subnets, 2 masks
C       192.168.200.0/30 is directly connected, Serial0/1/1
L       192.168.200.2/32 is directly connected, Serial0/1/1
R       192.168.200.4/30 [120/1] via 192.168.200.10, 00:00:28, Serial0/2/0
                         [120/1] via 192.168.200.1, 00:00:10, Serial0/1/1
C       192.168.200.8/30 is directly connected, Serial0/2/0
L       192.168.200.9/32 is directly connected, Serial0/2/0
C       192.168.200.12/30 is directly connected, Serial0/1/0
L       192.168.200.13/32 is directly connected, Serial0/1/0
R       192.168.200.16/30 [120/1] via 192.168.200.10, 00:00:28, Serial0/2/0
                          [120/1] via 192.168.200.14, 00:00:00, Serial0/1/0
```

Connectivity Test from 192.168.1.1 PC

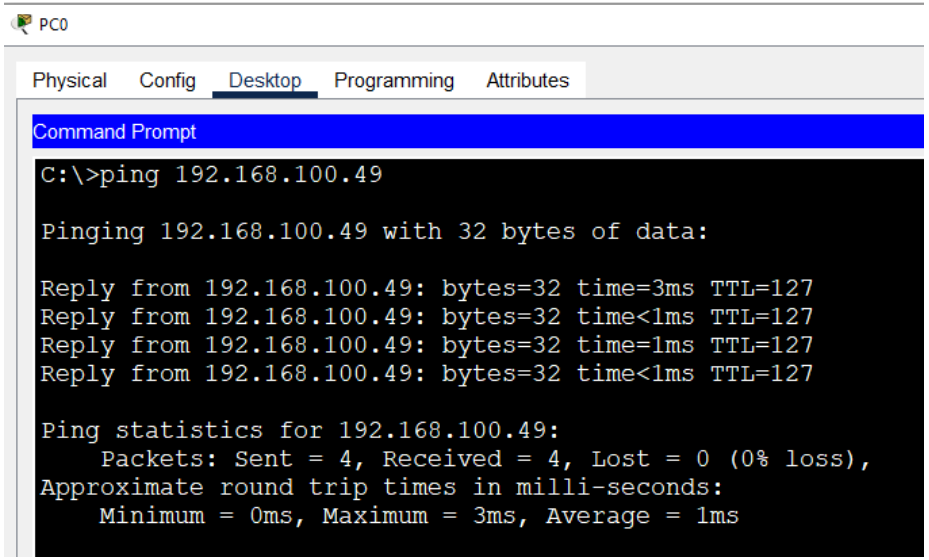




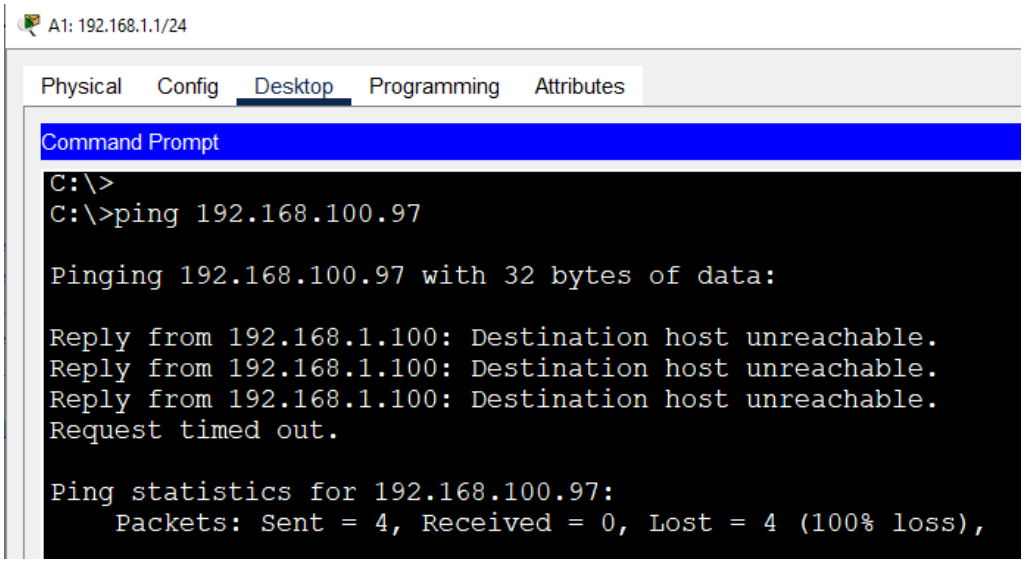
Connectivity Test from 100.1 PC



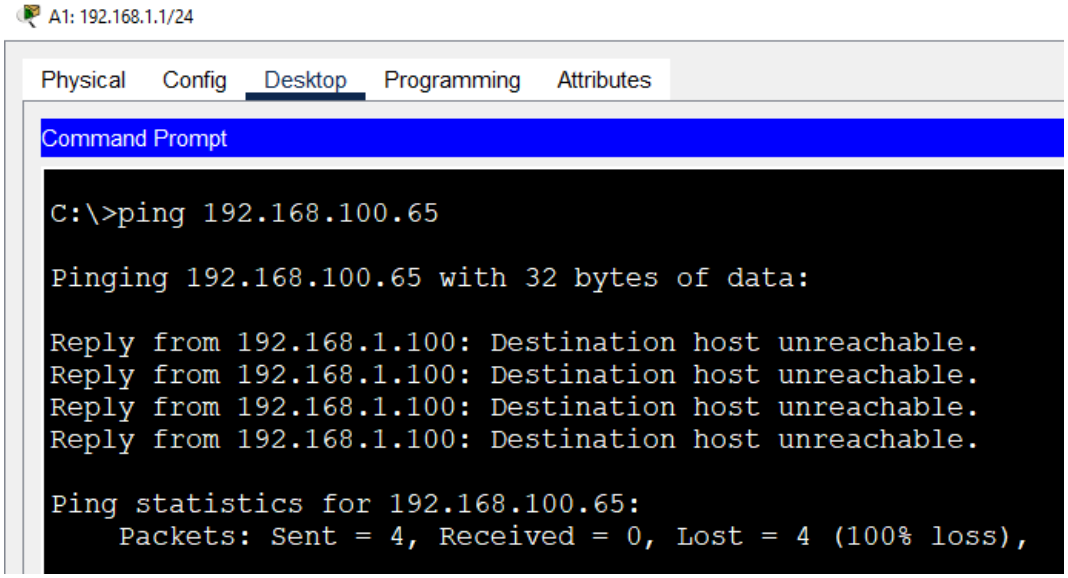
Successful from 192.168.1.1 to Router1 Subnets of 192.168.100.0/28



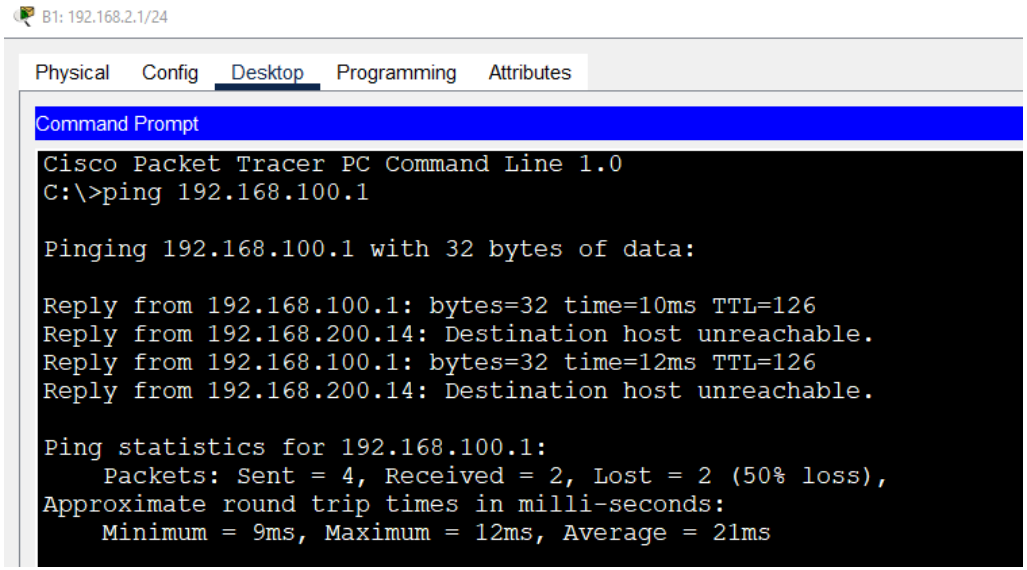
Connectivity Test from 192.168.1.1 PC



Failed from 192.168.1.1 to Router4 Subnets of 192.168.100.0/28

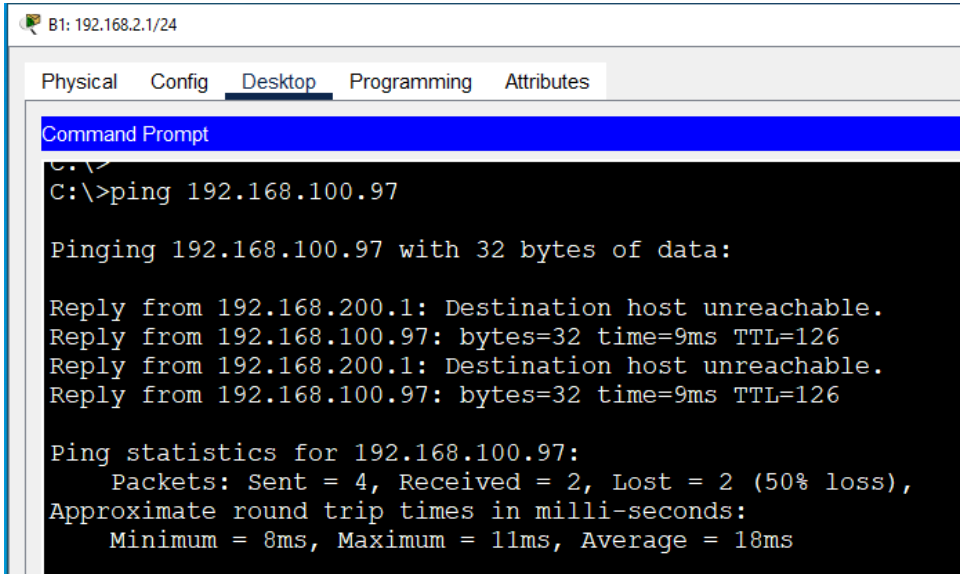


Connectivity Test from 192.168.2.1 PC



Interesting Results from 192.168.2.1 to Router1 Subnets of 192.168.100.0/28 and Router4 Subnets.

Connected and Unreachable, because of two different routes, one to Router1 and other to Router4



R1: show ip route with no auto-summary

```
C    192.168.1.0/24 is directly connected, GigabitEthernet9/0
R    192.168.2.0/24 [120/1] via 192.168.200.2, 00:00:21, Serial0/0
R    192.168.3.0/24 [120/1] via 192.168.200.5, 00:00:08, Serial1/0
R    192.168.4.0/24 [120/2] via 192.168.200.2, 00:00:21, Serial0/0
                    [120/2] via 192.168.200.5, 00:00:08, Serial1/0
     192.168.100.0/24 is variably subnetted, 9 subnets, 2 masks
R       192.168.100.0/24 is possibly down, routing via 192.168.200.2, Serial0/0
C       192.168.100.0/28 is directly connected, GigabitEthernet2/0
C       192.168.100.16/28 is directly connected, GigabitEthernet3/0
C       192.168.100.32/28 is directly connected, GigabitEthernet4/0
C       192.168.100.48/28 is directly connected, GigabitEthernet5/0
R       192.168.100.64/28 [120/2] via 192.168.200.5, 00:00:08, Serial1/0
                          [120/2] via 192.168.200.2, 00:00:21, Serial0/0
R       192.168.100.80/28 [120/2] via 192.168.200.5, 00:00:08, Serial1/0
                          [120/2] via 192.168.200.2, 00:00:21, Serial0/0
R       192.168.100.96/28 [120/2] via 192.168.200.5, 00:00:08, Serial1/0
                          [120/2] via 192.168.200.2, 00:00:21, Serial0/0
R       192.168.100.112/28 [120/2] via 192.168.200.5, 00:00:08, Serial1/0
                           [120/2] via 192.168.200.2, 00:00:21, Serial0/0
     192.168.200.0/30 is subnetted, 5 subnets
C       192.168.200.0 is directly connected, Serial0/0
C       192.168.200.4 is directly connected, Serial1/0
R       192.168.200.8 [120/1] via 192.168.200.2, 00:00:21, Serial0/0
                      [120/1] via 192.168.200.5, 00:00:08, Serial1/0
R       192.168.200.12 [120/1] via 192.168.200.2, 00:00:21, Serial0/0
R       192.168.200.16 [120/1] via 192.168.200.5, 00:00:08, Serial1/0
```

R4: show ip route with no auto-summary

```
R    192.168.1.0/24 [120/2] via 192.168.200.13, 00:00:03, Serial1/0
                    [120/2] via 192.168.200.18, 00:00:15, Serial0/0
R    192.168.2.0/24 [120/1] via 192.168.200.13, 00:00:03, Serial1/0
R    192.168.3.0/24 [120/1] via 192.168.200.18, 00:00:15, Serial0/0
C    192.168.4.0/24 is directly connected, GigabitEthernet9/0
     192.168.100.0/24 is variably subnetted, 9 subnets, 2 masks
R       192.168.100.0/24 is possibly down, routing via 192.168.200.13, Serial1/0
R       192.168.100.0/28 [120/2] via 192.168.200.13, 00:00:03, Serial1/0
                         [120/2] via 192.168.200.18, 00:00:15, Serial0/0
R       192.168.100.16/28 [120/2] via 192.168.200.13, 00:00:03, Serial1/0
                          [120/2] via 192.168.200.18, 00:00:15, Serial0/0
R       192.168.100.32/28 [120/2] via 192.168.200.13, 00:00:03, Serial1/0
                          [120/2] via 192.168.200.18, 00:00:15, Serial0/0
R       192.168.100.48/28 [120/2] via 192.168.200.13, 00:00:03, Serial1/0
                          [120/2] via 192.168.200.18, 00:00:15, Serial0/0
C       192.168.100.64/28 is directly connected, GigabitEthernet2/0
C       192.168.100.80/28 is directly connected, GigabitEthernet3/0
C       192.168.100.96/28 is directly connected, GigabitEthernet4/0
C       192.168.100.112/28 is directly connected, GigabitEthernet5/0
     192.168.200.0/30 is subnetted, 5 subnets
R       192.168.200.0 [120/1] via 192.168.200.13, 00:00:03, Serial1/0
R       192.168.200.4 [120/1] via 192.168.200.18, 00:00:15, Serial0/0
R       192.168.200.8 [120/1] via 192.168.200.13, 00:00:03, Serial1/0
                      [120/1] via 192.168.200.18, 00:00:15, Serial0/0
C       192.168.200.12 is directly connected, Serial1/0
C       192.168.200.16 is directly connected, Serial0/0
```

R2: show ip route with no auto-summary

```
R    192.168.1.0/24 [120/1] via 192.168.200.1, 00:00:11, Serial0/1/1
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.2.100/32 is directly connected, GigabitEthernet0/0/0
R    192.168.3.0/24 [120/1] via 192.168.200.10, 00:00:23, Serial0/2/0
R    192.168.4.0/24 [120/1] via 192.168.200.14, 00:00:21, Serial0/1/0
     192.168.100.0/24 is variably subnetted, 9 subnets, 2 masks
R       192.168.100.0/24 is possibly down, routing via 192.168.200.10, Serial0/2/0
R       192.168.100.0/28 [120/1] via 192.168.200.1, 00:00:11, Serial0/1/1
R       192.168.100.16/28 [120/1] via 192.168.200.1, 00:00:11, Serial0/1/1
R       192.168.100.32/28 [120/1] via 192.168.200.1, 00:00:11, Serial0/1/1
R       192.168.100.48/28 [120/1] via 192.168.200.1, 00:00:11, Serial0/1/1
R       192.168.100.64/28 [120/1] via 192.168.200.14, 00:00:21, Serial0/1/0
R       192.168.100.80/28 [120/1] via 192.168.200.14, 00:00:21, Serial0/1/0
R       192.168.100.96/28 [120/1] via 192.168.200.14, 00:00:21, Serial0/1/0
R       192.168.100.112/28 [120/1] via 192.168.200.14, 00:00:21, Serial0/1/0
     192.168.200.0/24 is variably subnetted, 8 subnets, 2 masks
C       192.168.200.0/30 is directly connected, Serial0/1/1
L       192.168.200.2/32 is directly connected, Serial0/1/1
R       192.168.200.4/30 [120/1] via 192.168.200.1, 00:00:11, Serial0/1/1
                         [120/1] via 192.168.200.10, 00:00:23, Serial0/2/0
C       192.168.200.8/30 is directly connected, Serial0/2/0
L       192.168.200.9/32 is directly connected, Serial0/2/0
C       192.168.200.12/30 is directly connected, Serial0/1/0
L       192.168.200.13/32 is directly connected, Serial0/1/0
R       192.168.200.16/30 [120/1] via 192.168.200.14, 00:00:21, Serial0/1/0
                          [120/1] via 192.168.200.10, 00:00:23, Serial0/2/0
```