Department of Computer Science and Engineering

Islamic University of Technology (IUT)

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Laboratory Report

CSE 4512: Computer Networks Lab

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Title: Configuration of IPv4 and IPv6 static routing in a given network topology

Objective:

- Configure IPv4 Static and Floating Static Default Routes
- Configure IPv6 static and floating static default routes
- Configure IPv4 static and floating static routes to internal LANs
- Configure IPv6 static and floating static routes to the internal LANS
- Configure IPv4 host routes
- Configure IPv6 host routes

Devices/ Software Used:

Device: Windows PC
Software: Cisco Packet Tracer 7.3.0

Theory:

The job of a router is to deliver a packet from source to destination. To do so, the router has to forward to different hops and ensure that the packet reaches the proper destination. The path from sender to destination is not always a direct path. In most of the cases, there will be multiple hops through which the packet will go before it finally reaches its destination. It is not a straightforward task to find out the next hop to which the router will forward the packet in order to make the packet reach its destination. That is why a router takes the help from its **Routing Table** to forward its packets properly.

When an end device sends a packet, it gets forwarded to the default router. The router has to then decide how it will send this packet to the intended destination specified by its sender. To do so, the router looks up its routing table. The routing table consists of destination addresses along with the corresponding output interfaces. The router then finds the intended destination from the routing table and forwards the packet through the corresponding interface. But, the problem is, how are we supposed to form this routing table in the first place?

There are two ways to form a routing table - by manually configuring the routing entries or by using routing protocols to configure the routes dynamically. The approaches are called **Static Routing** and **Dynamic Routing** respectively. In static routing, the network administrator has to manually add all the routing entries. These entries will stay the same unless they are being updated. This is why it is called "Static" routing. On the contrary, dynamic routing doesn't need any manual configuration to set the routing table. It automatically updates the routing table over time. In case of a change of condition, for instance - a link went down, the static routing table table has to be manually updated with new information whereas the dynamic routing can automatically adapt to this change. Due to this reason, dynamic routing is generally prefered over static routing, whereas static routing is usually kept as a backup protocol to dynamic routing.

But static routing has some key advantages over dynamic routing. Static routing takes very less computational resources and bandwidth since no extra packets are required for the routing table to update its table. But the drawback is that the network administrator needs to have a clear understanding of the whole network topology and network addresses in order to effectively configure the routing table. That is why static routing is not used as the only routing mechanism in large scale networks as it is extremely difficult and time consuming to manually configure such networks.

When dealing with the routing table, we also have to take one scenario into consideration. We know that the routing table consists of destination addresses with their corresponding next hop addresses. But it may not be the case that every destination address will have a next hop address associated with it. What will the router do in such cases? In such cases, there will be a certain next hop address to which the packets with no next hop addresses found in the routing table will be forwarded to. Such an address should be an entry in the routing table and it is known as the default route. So, the default route will define the extting interface for packets which do not have any corresponding next-hop addresses in the routing table.
In CISCO devices, there are two types of static default routes -

- **Directly Connected Static Default Route**
- **Next-hop Static Default Route**

The commands use for such configurations is given below:

```
ip route destination_network_prefix destination_prefix_mask (next-
hop_address | interface) [distance_metric]

ipv6 route ipv6_destination_network_prefix(with CIDR) (ipv6 next-hop
address | interface) [distance_metric]
```

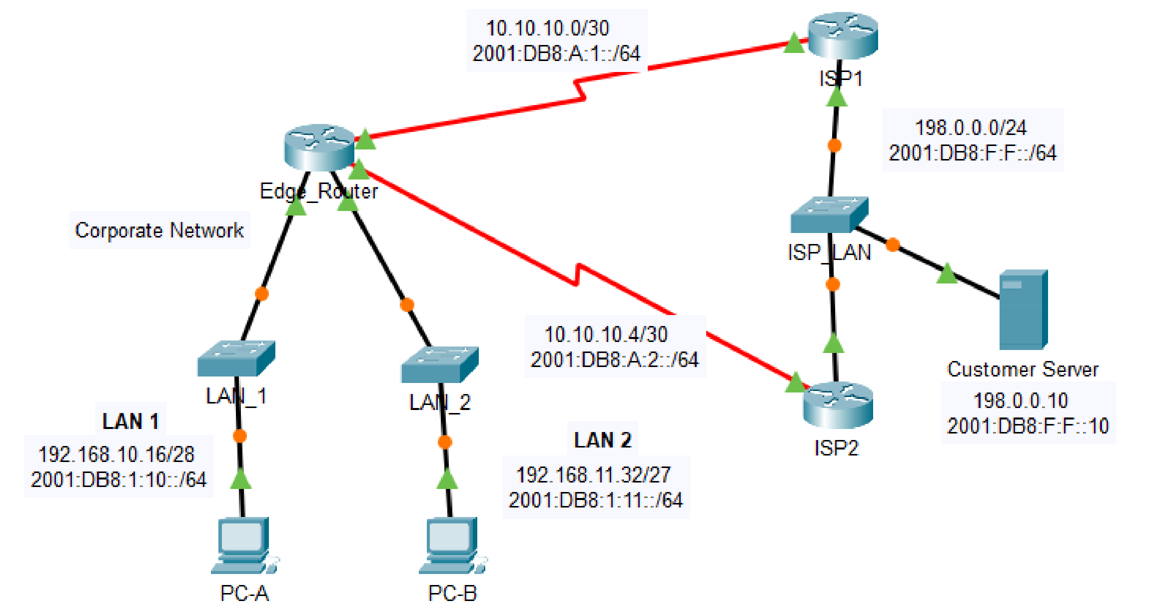
If the default route is specified to be Directly Connected, then we need to specify the interface instead of the next hop address. On the contrary, for Next-Hop static default routes, we need to specify the next hop address. There is a special use of the above command and it is to configure the primary static default route. In this case, both the destination network prefix and destination prefix mask will be set to 0.0.0.0. The IPv4 and IPv6 command formats for specifying the default route is:

```
ip route 0.0.0.0 0.0.0.0 (next-hop_address | interface) [distance
metric]

ipv6 route ::/0 (ipv6_next-hop_address | interface) [distance_metric]
```

While configuring static routing, we can also use **Floating Static Route**, which is simply the route to which the packets will be forwarded if the main route is unavailable. The floating routes are defined by creating multiple routing entries to the same destination but providing them a higher distance metric. It is also to be noted that if a distance metric is not provided while configuring a route then it will be set to 1 by default. For floating routes, the distance metric has to be manually set to a number greater than 1. Since routers always take the path with the **lower distance metric**, it will never prefer the floating static route over the main route. But when the main route is unreachable, only then the floating route will be taken and it will ensure that the packet will reach the destination, even though the main path is unavailable.

Diagram of the experiment:

Task #01:



Working Procedure:

TASK #01:

Part 1: Configure IPv4 Static and Floating Static Default Routes

The PT network requires static routes to provide internet access to the internal LAN users through the ISPs. In addition, the ISP routers require static routes to reach the internal LANs. In this part, we will configure an IPv4 static default route and a floating default route to add redundancy to the network.

Step 1: Configure an IPv4 static default route.

We click on the Edge_Router and go to the CLI. Then we configure a directly connected IPv4 default static route. The primary default route should be through router ISP1. The following command has been used:

```
Edge_Router>en
Edge_Router#configure terminal
Edge_Router(config)#ip route 0.0.0.0 0.0.0.0 s0/0/0
```

Explanation: As we have seen earlier, in order to set an IPv4 primary default route, we need to set both the destination network prefix and destination network prefix mask to 0.0.0.0. Since it is a direct connection, we need to specify the interface which is s0/0/0 in this case.

Step 2: Configure an IPv4 floating static default route

On Edge_Router, we configure a directly connected IPv4 floating static default route. This default route should be through router ISP2 and should have an administrative distance of 5. The following command has been used:

```
Edge_Router(config)#ip route 0.0.0.0 0.0.0.0 s0/0/1 5
```

Explanation: Just like step-1, we set both the destination network prefix and destination network prefix mask to 0.0.0.0. Since it is also a direct connection through ISP2, we set the interface as s0/0/1. One key difference is that it is a floating static default route and must have an administrative distance greater than 1. That is why, we put 5 at the end of the command to set the administrative distance to 5.

```
Edge_Router>en
Edge_Router#con
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/1,
changed state to u
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0,
changed state to up
Edge_Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Edge_Router(config)#ip route 0.0.0.0 0.0.0.0 s0/0/0
%Default route without gateway, if not a point-to-point
interface, may impact performance
Edge_Router(config)#ip route 0.0.0.0 0.0.0.0 s0/0/1 5
Edge_Router(config)#
```

Part 2: Configure IPv6 Static and Floating Static Default Routes

In this part of the activity,we will configure IPv6 static default and floating static default routes for IPv6.

Step 1: Configure an IPv6 static default route

On Edge_Router, we configure a next hop static default route. This primary default route should be through router ISP1. The following commands were used:

```
Edge_Router(config)#ipv6 route ::/0 2001:db8:a:1::1
```

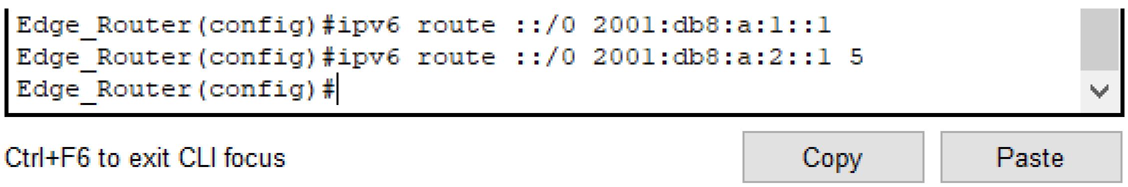
Explanation: Since we are configuring ipv6 addresses, we are using the ipv6 route command instead of the ip route command. We do not need to provide the subnet mask for the ipv6 addresses. Instead we provide the CIDR. Since it is a next hop static route we use the next hop address instead of the interface address. The next hop address is 2001:db8:a:1::1 in this case. For the primary default route we use ::/0 as the ipv6 destination network address prefix.

Step 2: Configure an IPv6 floating static default route

On Edge_Router, we configure a next hop IPv6 floating static default route. The route should be via router ISP2. Use an administrative distance of 5. The following commands were used:

```
Edge_Router(config)#ipv6 route ::/0 2001:db8:a:1::1 5
```

Explanation: Just like the previous step, we set the primary default route address to ::/0 but since it is a floating static default route, the administrative distance must be greater than 1. That is why we put 5 at the end of the command to set the administrative distance to 5.



Part 3: Configure IPv4 Static and Floating Static Routes to the Internal LANs

In this part, we will configure static and floating static routers from the ISP routers to the internal LANs

Step 1: Configure IPv4 static routes to the internal LANs

We open the configuration window on ISP1 and configure a next hop IPv4 static route to the LAN 1 network through Edge_Router. Then, we configure a next hop IPv4 static route to the LAN 2 network through Edge_Router. The following commands were used:

```
ISP1>en
ISP1#configure terminal
ISP1(config)#ip route 192.168.10.16 255.255.255.240 10.10.10.2
ISP1(config)#ip route 192.168.11.32 255.255.255.224 10.10.10.2
```

Explanation: We use ip route command to configure the ipv4 static routing. Looking up the provided table, we get the destination network address prefix and the subnet masks. Since, it is a next hop static route to LAN 2, we need to provide the IP address of LAN 2 as the next hop address. We can find this address by looking at the table and the address is 10.10.10.2.

Step 2: Configure IPv4 floating static routes to the internal LANs

On ISP1, we configure a directly connected floating static route to LAN 1 through the ISP2 router and use an administrative distance of 5. Then we configure a directly connected floating static route to LAN 2 through the ISP2 router and use an administrative distance of 5. The following commands were used:

```
ISP1(config)#ip route 192.168.10.16 255.255.255.240 g0/0 5
ISP1(config)#ip route 192.168.11.32 255.255.255.224 g0/0 5
```

Explanation: Similar to the first step, we set the IP route with the same destination network prefix and destination network prefix mask. But this is a direct connection, so the interface was specified and it is g0/0. Again, since it is a floating static route, the administrative distance was set to 5.

```
ISP1>en
ISP1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ISP1(config)#ip route 192.168.10.16 255.255.255.240 10.10.10.2
ISP1(config)#ip route 192.168.11.32 255.255.255.224 10.10.10.2
ISP1(config)#ip route 192.168.10.16 255.255.255.240 g0/0 5
ISP1(config)#ip route 192.168.11.32 255.255.255.224 g0/0 5
ISP1(config)#
```

Part 4: Configure IPv6 Static and Floating Static Routes to the Internal LANs

Step 1: Configure IPv6 static routes to the internal LANs

On ISP1, we configure a next hop IPv6 static route to the LAN 1 network through Edge_Router. Then, we configure a next hop IPv6 static route to the LAN 2 network through Edge_Router. The following commands were used:

```
ISP1(config)#ipv6 route 2001:db8:1:10::/64 2001:db8:a:1::2
ISP1(config)#ipv6 route 2001:db8:1:11::/64 2001:db8:a:1::2
```

Explanation: Similar to part 3, we configure the next hop static route. In this case, we use the ipv6 route command. We use the ipv6 addresses from the address table with the CIDR.Since it is the next hop static route, we provide the next hop address at the end which is the ipv6 address of the edge router. In this case, it is 2001:db8:a:1::2.

Step 2: Configure IPv6 floating static routes to the internal LANs

On ISP1, we configure a next hop IPv6 floating static route to LAN 1 through the ISP2 router and use an administrative distance of 5. Then, on ISP1, we configure a next hop IPv6 floating static route to LAN 2 through the ISP2 router and use an administrative distance of 5. The following commands were used:

```
ISP1(config)#ipv6 route 2001:db8:1:10::/64 2001:db8:f:f::2 5
ISP1(config)#ipv6 route 2001:db8:1:11::/64 2001:db8:f:f::2 5
```

Explanation: The floating addresses were configured similarly to part-1. The next hop IP addresses were given as the IP address of ISP2 router instead. Finally, a distance of 5 has been set since floating addresses must have a distance greater than the default distance 1.

```
ISP1(config)#ipv6 route 2001:db8:1:10::/64 2001:db8:a:1::2
ISP1(config)#ipv6 route 2001:db8:1:11::/64 2001:db8:a:1::2
ISP1(config)#ipv6 route 2001:db8:1:10::/64 2001:db8:f:f::2 5
ISP1(config)#ipv6 route 2001:db8:1:11::/64 2001:db8:f:f::2 5
ISP1(config)#
```

If the configuration has been completed correctly, we should be able to ping the Web Server from the hosts on LAN 1 and LAN 2. In addition, if the primary route link is down, connectivity between the LAN hosts and the Web Server should still exist.

From PC-A:

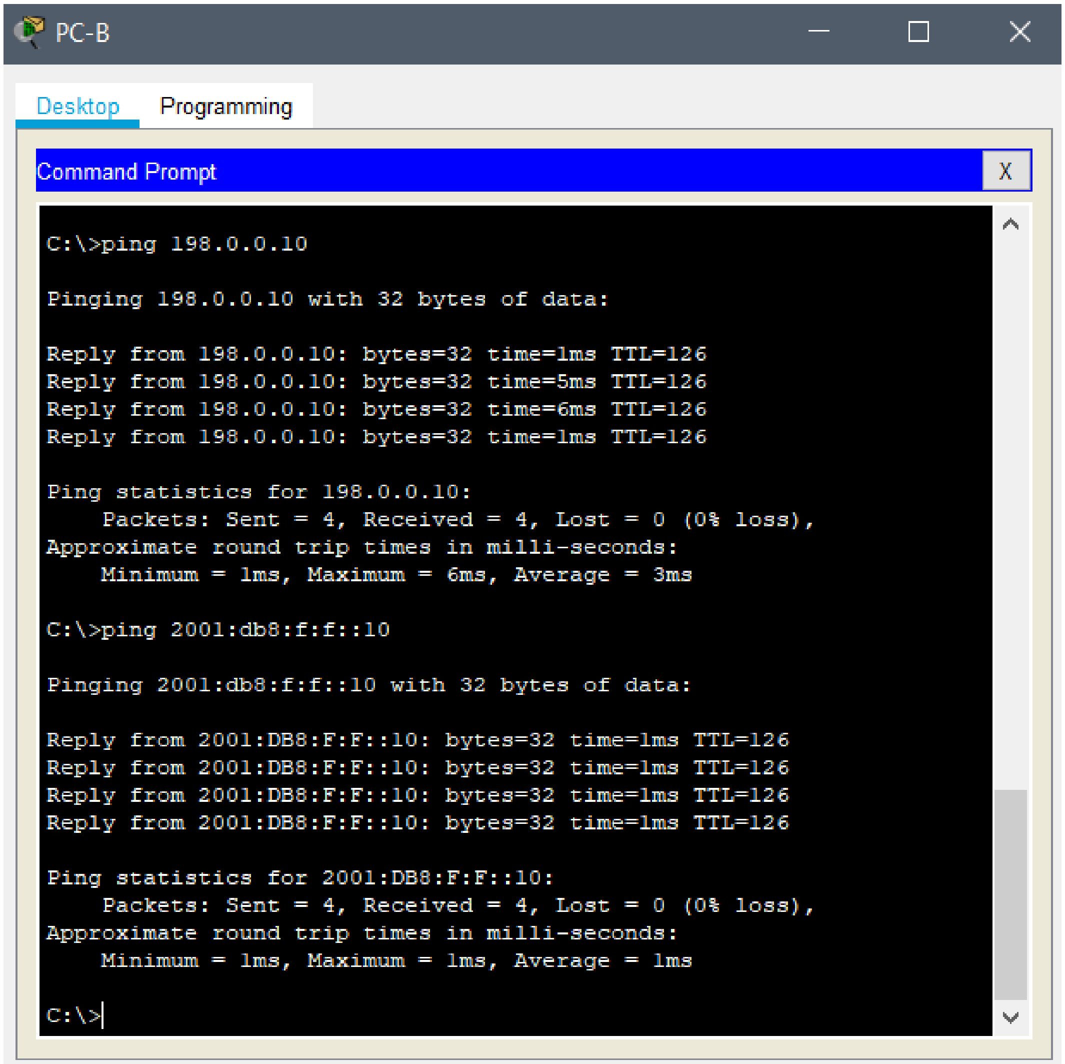
PC-A

Desktop Programming

Command Prompt

```
Packet Tracer PC Command Line 1.0
C:\>ping 198.0.0.10

Pinging 198.0.0.10 with 32 bytes of data:

Request timed out.
Reply from 198.0.0.10: bytes=32 time=1ms TTL=126
Reply from 198.0.0.10: bytes=32 time=1ms TTL=126
Reply from 198.0.0.10: bytes=32 time=1ms TTL=126

Ping statistics for 198.0.0.10:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\>ping 2001:db8:f:f::10

Pinging 2001:db8:f:f::10 with 32 bytes of data:

Reply from 2001:DB8:F:F::10: bytes=32 time=2ms TTL=126
Reply from 2001:DB8:F:F::10: bytes=32 time=3ms TTL=126
Reply from 2001:DB8:F:F::10: bytes=32 time=1ms TTL=126
Reply from 2001:DB8:F:F::10: bytes=32 time=1ms TTL=126

Ping statistics for 2001:DB8:F:F::10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 3ms, Average = 1ms
```

From PC-B:



Part 5: Configure Host Routes

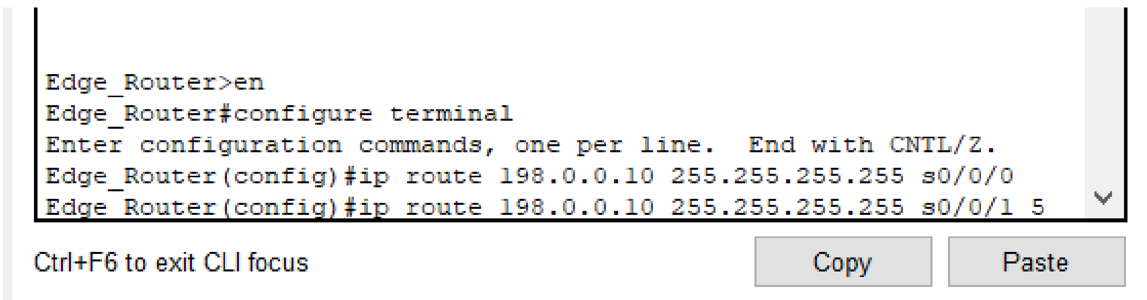
Users on the corporate network frequently access a server that is owned by an important customer. In this part, we will configure static host routes to the server. One route will be a floating static route to support the redundant ISP connections.

Step 1: Configure IPv4 host routes

We open the configuration window on Edge Router, configure an IPv4 directly connected host route to the customer server. Then, we configure an IPv4 directly connected floating host route to the customer server, and use an administrative distance of 5. The following commands were used:

```
Edge_Router(config)#ip route 198.0.0.10 255.255.255.255 s0/0/0
Edge_Router(config)#ip route 198.0.0.10 255.255.255.255 s0/0/1 5
```

Explanation: For IPv4 static routing, we use the IP route command. Then the destination network address prefix is provided as the IP address of the customer server. In this case it is 198.0.0.10. Then the subnet mask has to be provided. As we can see, the customer server is a single address. So, the subnet mask is 255.255.255.255. Finally, since we are directly connecting, we provide the interface number. While configuring the floating static route, we provide an administrative distance of 5 as the distance for the floating route must be greater than 1.

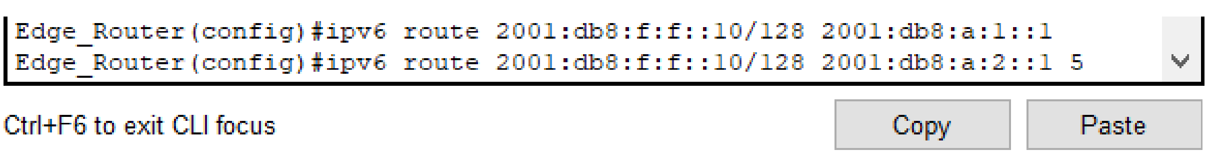


Step 2: Configure IPv6 host routes

On Edge Router, we configure an IPv6 next hop host route to the customer server through the ISP1 router. Then we configure an IPv6 directly connected floating host route to the customer server through the ISP2 router and use an administrative distance of 5. The following commands were used:

```
Edge_Router(config)#ipv6 route 2001:db8:f:f::10/128 2001:db8:a:1::1
Edge_Router(config)#ipv6 route 2001:db8:f:f::10/128 2001:db8:a:2::1 5
```

Explanation: Just like the previous step, we configure the static routing but use the ipv6 command and ipv6 addresses instead. But in this case, we use the next hop host route. So, the ipv6 address of the ISP1 router has been provided for the main next hop address, and the address is 2001:db8:a:1::1. The ipv6 address of ISP2 has been provided as the next hop address for floating host route and the address is 2001:db8:a:2::1. Since it is a floating route, the administrative distance has been set to 5. The destination network address has a CIDR 128 because the destination address refers to a single address only which is the ipv6 address of the customer server.



Observation:

Edge Router:

```
Edge_Router>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

     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.10.10.0/30 is directly connected, Serial0/0/0
L       10.10.10.2/32 is directly connected, Serial0/0/0
C       10.10.10.4/30 is directly connected, Serial0/0/1
L       10.10.10.6/32 is directly connected, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.10.16/28 is directly connected, GigabitEthernet0/0
L       192.168.10.17/32 is directly connected, GigabitEthernet0/0
     192.168.11.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.11.32/27 is directly connected, GigabitEthernet0/1
L       192.168.11.33/32 is directly connected, GigabitEthernet0/1
     198.0.0.0/32 is subnetted, 1 subnets
S       198.0.0.10/32 is directly connected, Serial0/0/0
S*   0.0.0.0/0 is directly connected, Serial0/0/0
```

The show ip route command lists all the ipv4 addresses and their connections to the router's interfaces. It also specifies whether the addresses are subnetted or not. The number of subnets and their addresses are also shown along with their connections. As we can see the subnets are directly connected to the interfaces. At the end, there is a special address 0.0.0.0/0 for the primary route which is directly connected to Serial 0/0/0. This means that if the packet's destination isn't within the routing table then the packet will be forwarded to the Serial 0/0/0 interface.

Edge Router:

```
ISP1>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

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.10.10.0/30 is directly connected, Serial0/0/0
L       10.10.10.1/32 is directly connected, Serial0/0/0
     192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
S       192.168.10.16/28 [1/0] via 10.10.10.2
S       192.168.10.32/27 [1/0] via 10.10.10.2
     192.168.11.0/27 is subnetted, 1 subnets
S       192.168.11.32/27 [1/0] via 10.10.10.2
     198.0.0.0/24 is variably subnetted, 2 subnets, 2 masks
C       198.0.0.0/24 is directly connected, GigabitEthernet0/0
L       198.0.0.1/32 is directly connected, GigabitEthernet0/0
```

Just like the edge_router, we see a list of all the ipv4 addresses connected to the interfaces of the ISP1 router. Then the subnets and their details are shown along with the connections of each subnet with the ISP1 interfaces. We can note that as no primary ip route was specified, the address 0.0.0.0/0 was not there at the end of the list.

As the ISP2 router is locked, we can not use the show IP route command in that router.

Challenges (if any):

- I was confused about the subnet mask address for the customer server as it has only a single IP address but I later figured it out. Apart from that the tasks were not too difficult.

- I also found the lab tasks to be much shorter than the first three labs, and was able to complete it in a single day. It would be appreciated if the future lab tasks are of similar length, or else it becomes tough for us to properly understand the lab tasks and complete them within the given deadline.