**TRIBHUVAN UNIVERSITY**

**INSTITUTE OF ENGINEERING**

**PULCHOWK CAMPUS**

# LAB – 4: Static Routing and Default Route

**( Computer Network )**


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**Exercises:**

**Q.1. To know whether the destination computer is on the same network**
1. Get the host's IP address, subnet mask, and destination IP address.
2. Perform bitwise AND between the host's IP address and subnet mask to get host’s network address.
3. Perform a bitwise AND between the destination IP address and subnet mask to get the destination’s network address.
4. If the network addresses match, destination is on the same network; else, it's on a different network.

**Q. 2. How data is forwarded from the sending host,**
<u>a. When the destination computer is within the same network:</u>
1. The sending host checks its ARP cache for the destination IP's MAC address. If not found, it sends an ARP request.
2. The destination computer replies with its MAC address.
3. The sending host sends the data frame directly to the destination's MAC address over the local network.
4. The destination computer receives the frame and processes the data.

<u>b. When the destination computer is on a different network:</u>
1. The sending host forwards the packet to its default gateway (router).
2. The router examines the packet's destination IP, consults its routing table, and forwards the packet to the next hop toward the destination network.
3. This process may repeat through multiple routers.
4. The last router in the path sends the packet to the destination computer's MAC address on the local network.
5. The destination computer receives the frame and processes the data.

**Q. 3.** Routing is the process of selecting paths in a network along which to send network traffic. Networks consist of multiple devices, known as nodes, interconnected by various links or paths. Routers use routing tables to determine the best path for forwarding packets to their destination network.

**Static Routing**
Static Routing involves manually configuring the routes in the router's routing table. This means the network administrator specifies the exact path that packets should take to reach a particular destination. Static routing is simple and has low overhead, but it does not adapt to network changes automatically. When network changes occur, static routes must be manually reconfigured. Compared to dynamic routes, static routes use less bandwidth and do not require CPU cycles for calculating and analyzing routing updates.
**Configuration of Static Routing**
To configure a static route on a router, the ip route command is used in global configuration mode.
Syntax: *ip route <destination_network> <subnet_mask> <next_hop_address*

**Q. 4. Information from the Routing Table**
A routing table contains critical information used by the router to forward packets efficiently, which are:

Destination Network: The address of the network to which packets should be routed.
Subnet Mask: Used to determine the network portion of an IP address.
Next Hop: The IP address of the next router to which the packet should be forwarded.

Interface: The outgoing interface (e.g., Ethernet, Wi-Fi) that the router should use to forward the packet.
Metric: Value used to determine the most efficient route among multiple available paths to the same destination network.
Route Source: How the route was learned (e.g., static or dynamic protocols).
Administrative Distance: The trustworthiness of the route source.
Timestamp: When the route was last updated.

Observing the Routing Table
To observe the routing table of a router, access its CLI and use the command: *show ip route*
The output reveals destination networks, next hops, interfaces, metrics, and routing protocols, offering insights into how the router forwards traffic within the network.

**Q.5.** A default route defines the path for packets when no specific route matches the destination address in the routing table. In essence, it serves as a fallback option directing where packets should be forwarded if no other more specific route exists.

**Importance of Default Route:**
- Fallback Handling: It ensures that packets destined for unknown or external networks are not discarded but forwarded to a specified gateway.
- Internet Connectivity: In many network setups, the default route points to the gateway that connects to the broader Internet, enabling connectivity to external networks beyond the local subnet.

Default Route Configuration Syntax:
To configure a default route on a router, the following command syntax is used:
R1(config)# ip route 0.0.0.0 0.0.0.0 <next-hop, eg. 10.0.0.2>

**Q. 6. Observation and necessary commands of steps specified in activities A, B and C.**
**Activity A.**
**1.**
Router>enable
Router#configure terminal
Router(config)#hostname roshni_2
roshni_2(config)#line console 0
roshni_2(config-line)#password roshni
roshni_2(config-line)#login
roshni_2(config-line)#exit
roshni_2(config)#enable password cisco
roshni_2(config)#line vty 0 4
roshni_2(config-line)#password class
roshni_2(config-line)#login
This was repeated in the remaining 3 routers as well. It sets the enable password, console password and the virtual terminal passwords of the routers.

**2.** The IP address and subnet mask for each router were configured as given in figure.
**3.** The IP address, subnet mask and default gateway on each computer were configured as instructed.

**4.** In privileged mode of each router, *show ip route* command gave the route status of the network, with their IP address. C means Directly connected, indicating that the router has interfaces (GigabitEthernet0/0 and GigabitEthernet0/1) that are physically connected specific networks without any intermediate devices. L means Local referring to the specific addresses assigned to the router's interfaces within these directly connected networks, used by the router to manage and communicate within these networks.

<u>Router 0</u>

202.60.0.0/24 is variably subnetted, 2 subnets, 2 masks
C 202.60.0.0/24 is directly connected, GigabitEthernet0/0
L 202.60.0.1/32 is directly connected, GigabitEthernet0/0
202.60.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 202.60.1.0/24 is directly connected, GigabitEthernet0/1
L 202.60.1.1/32 is directly connected, GigabitEthernet0/1

Similar results were seen for the remaining routers; Router1, Router2 and Router3.

**5.** PC0 could only ping Server0 and Router0, the devices within the network 202.60.0.0 as it wasn’t configured to communicate outside the network.

**6.** PC1 could ping PC4 and Router1 in its local subnet but not PC0, PC2, PC3, Server0, Server1, Router0, Router2, or Router3.

**7.** PC2 could ping Router2, PC5 within its subnet but not PC0, PC1, PC3, Server0, Server1, Router0, Router1, or Router3.

**8.** PC3 could ping Router3, Server1, and devices within its subnet but not PC0, PC1, PC2, Server0, Router0, Router1, or Router2.

**In summary,**

- Pinging a router or PC in the same network was successful, confirming local network communication.
- Pinging a router on another network resulted in "Request timed out," suggesting possible firewall rules, routing issues, or network isolation.
- Pinging a server or PC on another network resulted in "Destination host unreachable," highlighting a lack of established cross-network communication, indicating a routing or network segmentation issue.

**9.** Router0 pinged PC0, Server0(within its subnet 202.60.0.0/24), and Router1 (directly connected) only.
**10.** Router1 could ping Router2 (directly connected) and PC4 within its subnet (202.60.2.0/24).
**11.** Router2 could ping Router1 (directly connected) and PC2, PC5 within its subnet (202.60.4.0/24).
**12.** Router3 could ping Server1, PC3(within its subnet 202.60.6.0/24), and Router2(directly connected).

Inter-router Communication is functioning correctly, as a router can successfully send packets to another router it is directly connected to.

A router can only ping and communicate with PCs within its own network, confirming that routers have proper connectivity with local devices but are not configured to reach devices in other networks.

**13.14.15.** Static routes were configured as given, by using telnet from PC0 to router0,router1, & so on.

**16.** After we set up static routes using Telnet for each destination network, we found that all the computers can now ping each other, even though they're on different networks. This means every device in our network can communicate with every other device without any issues.

<u>IP route after static ip configuration in router2</u>

*S 202.60.0.0/24 [1/0] via 202.60.1.1*
*202.60.1.0/24 is variably subnetted, 2 subnets, 2 masks*
*C 202.60.1.0/24 is directly connected, GigabitEthernet0/0*
*L 202.60.1.2/32 is directly connected, GigabitEthernet0/0*
*202.60.2.0/24 is variably subnetted, 2 subnets, 2 masks*

*C 202.60.2.0/24 is directly connected, GigabitEthernet0/2*
*L 202.60.2.1/32 is directly connected, GigabitEthernet0/2*
*202.60.3.0/24 is variably subnetted, 2 subnets, 2 masks*
*C 202.60.3.0/24 is directly connected, GigabitEthernet0/1*
*L 202.60.3.1/32 is directly connected, GigabitEthernet0/1*
*S 202.60.4.0/24 [1/0] via 202.60.3.2*
*S 202.60.5.0/24 [1/0] via 202.60.3.2*
*S 202.60.6.0/24 [1/0] via 202.60.3.2*

**17.** The tracert command output showed the path taken by packets (from PC0 to PC1 here, from the IP address 202.60.0.3 to 202.60.2.2), hopping through intermediate devices.
*tracert 202.60.2.2*
*Tracing route to 202.60.2.2 over a maximum of 30 hops:*
*1 0 ms 0 ms 0 ms 202.60.0.1*
*2 0 ms 0 ms 0 ms 202.60.1.2*
*3 0 ms 0 ms 0 ms 202.60.2.2*
*Trace complete.*

**18.** When I pinged 2.2.2.2, an external address outside the network, the tracert command output showed a routing loop for 30 hops. The packets repeatedly reached the default gateway (202.60.0.1) but didn't progress further. This indicates that the router at 202.60.0.1 lacks a route to 2.2.2.2, causing the packets to be sent back to itself continuously. So, the ping attempts resulted in either returns to the router or timeouts, indicating a failure to reach the external network.

**Activity B.**
**Q.1.** All the static routes were removed from the router and default routes were entered for each router.
Eg, for Router2, the routes were minimized as,
ip route 202.60.6.0 255.255.255.0 202.60.5.2
ip route 0.0.0.0 0.0.0.0 202.60.3.1

**Q.2.** PC0, PC1, PC2 and PC3 can ping all the PCs and all the routers.
**Q.3.** In each router, the default route was defined as the last resort in all the routers, as defined.

```
Gateway of last resort is 202.60.1.2 to network 0.0.0.0

     202.60.0.0/24 is variably subnetted, 2 subnets, 2 masks
C       202.60.0.0/24 is directly connected, GigabitEthernet0/0
L       202.60.0.1/32 is directly connected, GigabitEthernet0/0
     202.60.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       202.60.1.0/24 is directly connected, GigabitEthernet0/1
L       202.60.1.1/32 is directly connected, GigabitEthernet0/1
S*   0.0.0.0/0 [1/0] via 202.60.1.2
```

**Q.4.** The tracert command showed the path traveled to reach the destination(PC2 here) in hops.

```
C:\>tracert 202.60.4.3

Tracing route to 202.60.4.3 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.60.0.1
  2   0 ms      0 ms      0 ms      202.60.1.2
  3   0 ms      0 ms      0 ms      202.60.3.2
  4   0 ms      0 ms      0 ms      202.60.4.3

Trace complete.
```

**Q.5.** Similar details of hops through the route were shown in each of the tracert, from PC3 to PC0, PC1 and PC2. The default route was followed to router2, and then according to the destination, hops were made.

**Q.6.** When I used the tracert command from PC0 to 2.2.2.2, the terminal showed that the request timed out. But, in the network, as I have set the default route for Router0 towards Router1, and then from it to Router2, the packet passes till Router2 as the IP address doesn't match to any subnet there. Then, the default route from Router2 is towards Router1. So, the packet moves in a loop till the maximum hop count is reached.

**Activity C: The given network was created in Packet Tracer.**

**Q. 1.** The ip address and subnet mask of given computers were set as given.

**Q. 2.** The routers were configured as instructed.

Router>enable
Router#configure terminal
Router(config)#hostname poudel
poudel(config)#enable password cisco
poudel(config)#line console 0
poudel(config-line)#password roshni
poudel(config-line)#login
poudel(config-line)#exit
poudel(config)#line vty 0 4
poudel(config-line)#password poudel
poudel(config-line)#login

**Q.3.** Router Interfaces were set through the config terminal.

**Q. 4.**

```
Gateway of last resort is not set

     200.200.20.0/24 is variably subnetted, 6 subnets, 2 masks
C       200.200.20.0/27 is directly connected, GigabitEthernet0/0
L       200.200.20.1/32 is directly connected, GigabitEthernet0/0
C       200.200.20.32/27 is directly connected, GigabitEthernet0/1
L       200.200.20.33/32 is directly connected, GigabitEthernet0/1
C       200.200.20.64/27 is directly connected, GigabitEthernet0/2
L       200.200.20.65/32 is directly connected, GigabitEthernet0/2
```

```
Gateway of last resort is not set

     200.200.20.0/24 is variably subnetted, 4 subnets, 2 masks
C       200.200.20.64/27 is directly connected, GigabitEthernet0/0
L       200.200.20.66/32 is directly connected, GigabitEthernet0/0
C       200.200.20.96/27 is directly connected, GigabitEthernet0/1
L       200.200.20.99/32 is directly connected, GigabitEthernet0/1
```

**Q.5.** PC0 could only ping PC1 and PC2. Also, PC0 could ping only gig0/0 of router 0. In other devices, ping gives request timed out errors.

**Q.6.** PC3 could ping PC4, PC5, and the Gig0/1 interface of Router0 only. Ping to other devices resulted in a request time out error.

**Q.7.** PC6 can ping PC7, PC8, and the Gig0/1 interface of Router1. Ping to other devices results in a request timeout error.

Communication is limited to devices within the same subnet and the router interface connected to that subnet. PCs can communicate with other devices on the same subnet and with the router interface directly connected to their subnet. However, they cannot communicate with devices on other subnets due to the absence of routing configurations between these subnets.

**Q.8.** Router 0 successfully communicated with PCs connected to switches directly linked to it. However, it was unable to ping PC6, PC7, and PC8, and Gig0/1 of router1.

**Q.9.** Router 1 successfully communicated with PCs connected to switches directly linked to it and the Gig0/2 of Router0.

**Q.10.** The default gateway was assigned to each PC.
**Q.11.** PC0 could ping PC1,PC2,PC3,PC4,PC5 but it can't ping PC6,PC7,PC8 as it gives the result, *destination host unreachable*. Also now PC0 can ping all the interfaces of router 0 but not any interfaces of router 1. Similar observations for Q6 and 7.
The observation of the routers was the same as before in Q8-9.

**Q. 12.** The static route for destination network of Network 3 was configured, as:
*roshni(config)#ip route 200.200.20.96 255.255.255.224 200.200.20.66*

**Q.13.** The static route for destination network of Network 1 and 2 was configured, as:
*ip route 200.200.20.0 255.255.255.224 200.200.20.65*
*ip route 200.200.20.32 255.255.255.224 200.200.20.65*

**Q.14.** Now PC0 can ping all the PCs, and all the interfaces of router 1 as well.

**Q. 15.** The routes of router 1 were removed.
*poudel(config)# no ip route 200.200.20.0 255.255.255.224 200.200.20.65*
*poudel(config)#no ip route 200.200.20.32 255.255.255.224 200.200.20.65*

**Q.16.** Aggregated route for network 1 and 2:
*poudel(config)#ip route 200.200.20.0 255.255.255.192 200.200.20.65*

**Q.17.** The aggregation of routes on Router1 will not affect the reachability or the behavior of pings to the networks covered by those routes. Aggregating routes does not change the network topology or connectivity; it simply optimizes the routing table by representing multiple smaller routes with a single, larger route. As long as the aggregated route encompasses all the necessary sub-networks and has the correct next-hop information, the pings to those networks will continue to work as before.

**Q.18.** Removing the connection between Router0 and Router1 removes all the established connection between them, and the networks. There is no connection between N3 to N1 and N2, or vice versa, and the commands show that destination hosts are unavailable.

*show ip route* on Router0:

```
Gateway of last resort is not set

     200.200.20.0/24 is variably subnetted, 4 subnets, 2 masks
C       200.200.20.0/27 is directly connected, GigabitEthernet0/0
L       200.200.20.1/32 is directly connected, GigabitEthernet0/0
C       200.200.20.32/27 is directly connected, GigabitEthernet0/1
L       200.200.20.33/32 is directly connected, GigabitEthernet0/1

roshni#
```

*show ip route* on Router1:

```
Gateway of last resort is not set

     200.200.20.0/24 is variably subnetted, 2 subnets, 2 masks
C       200.200.20.96/27 is directly connected, GigabitEthernet0/1
L       200.200.20.99/32 is directly connected, GigabitEthernet0/1

poudel#
```

**Conclusion:**

In conclusion, this lab experiment provided us with a comprehensive understanding of static and default routing concepts essential for effective network management. By manually configuring static routes, we learned that we can ensure precise control over packet paths, which is ideal for small, stable networks. Default routing, on the other hand, offers a reliable fallback mechanism, directing traffic to a default gateway when no specific route is available, making it invaluable for networks with multiple exit points. Mastering these routing techniques has enhanced our learning on how to manage and optimize network traffic flow, ensuring efficient and robust communication across various network segments.