

Day 11 - Static Routing (pt 2)

Saturday, August 22, 2026 2:50 PM

11. STATIC ROUTING : PART 2

REVIEW:

SWITCHES forward traffic WITHIN LAN's ROUTERS forward traffic BETWEEN LAN's

WAN (Wide Area Network)

- Network spread over a large area



R2 Connected & Local Routes

```
R2# conf t
R2(config)# interface g0/0
R2(config-if)# ip address 192.168.12.2 255.255.255.0
R2(config-if)# no shutdown
R2(config)# interface g0/1
R2(config-if)# ip address 192.168.24.2 255.255.255.0
R2(config-if)# no shutdown

R2# show ip route
!codes output omitted

192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.12.0/24 is directly connected, GigabitEthernet0/0
L    192.168.12.2/32 is directly connected, GigabitEthernet0/0
C    192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.24.0/24 is directly connected, GigabitEthernet0/1
L    192.168.24.2/32 is directly connected, GigabitEthernet0/1
```

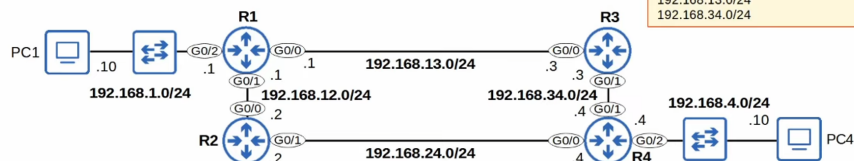
The following routes are automatically added to the routing table for each interface with an IP address configured:

- **C - Connected**
→ A route to the network the interface is connected to. (with the actual netmask configured on the interface)
- **L - Local**
→ A route to the actual IP address configured on the interface. (with a /32 netmask)

R2 knows how to reach its own IP addresses and destinations in its connected networks, but it doesn't know how to reach destinations in remote networks.

Knows:
192.168.12.0/24 (incl. 192.168.12.2/32)
192.168.24.0/24 (incl. 192.168.24.2/32)

Doesn't know:
192.168.1.0/24
192.168.4.0/24
192.168.13.0/24
192.168.34.0/24





R3 Connected & Local Routes

```
R3# conf t
R3(config)# interface g0/0
R3(config-if)# ip address 192.168.13.3 255.255.255.0
R3(config-if)# no shutdown
R3(config)# interface g0/1
R3(config-if)# ip address 192.168.34.3 255.255.255.0
R3(config-if)# no shutdown

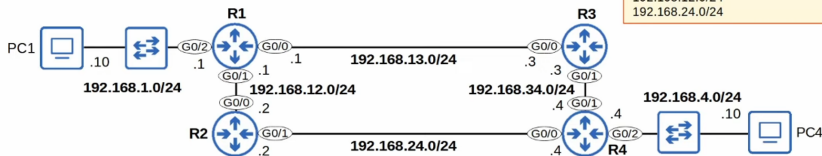
R3# show ip route
!codes output omitted

192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.13.0/24 is directly connected, GigabitEthernet0/0
L    192.168.13.3/32 is directly connected, GigabitEthernet0/0
C    192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.34.0/24 is directly connected, GigabitEthernet0/1
L    192.168.34.3/32 is directly connected, GigabitEthernet0/1
```

R3 knows how to reach its own IP addresses and destinations in its connected networks, but it doesn't know how to reach destinations in remote networks.

Knows:
192.168.13.0/24 (incl. 192.168.13.3/32)
192.168.34.0/24 (incl. 192.168.34.3/32)

Doesn't know:
192.168.1.0/24
192.168.4.0/24
192.168.12.0/24
192.168.24.0/24





R4 Connected & Local Routes

```
R4# conf t
R4(config)# interface g0/0
R4(config-if)# ip address 192.168.24.4 255.255.255.0
R4(config-if)# no shutdown
R4(config)# interface g0/1
R4(config-if)# ip address 192.168.34.4 255.255.255.0
R4(config-if)# no shutdown
R4(config)# interface g0/2
R4(config-if)# ip address 192.168.4.4 255.255.255.0
R4(config-if)# no shutdown

R4# show ip route
!codes output omitted

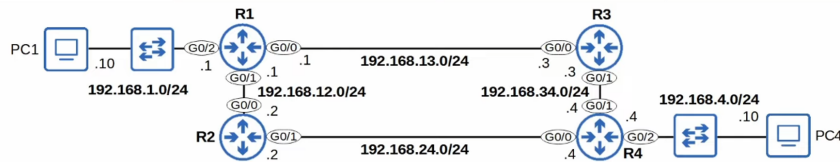
192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.4.0/24 is directly connected, GigabitEthernet0/2
L    192.168.4.4/32 is directly connected, GigabitEthernet0/2
C    192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.24.0/24 is directly connected, GigabitEthernet0/0
L    192.168.24.4/32 is directly connected, GigabitEthernet0/0
C    192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.34.0/24 is directly connected, GigabitEthernet0/1
L    192.168.34.4/32 is directly connected, GigabitEthernet0/1
```

R4 knows how to reach its own IP addresses and destinations in its connected networks, but it doesn't know how to reach destinations in remote networks.

Knows:
192.168.4.0/24 (incl. 192.168.4.4/32)
192.168.24.0/24 (incl. 192.168.24.4/32)
192.168.34.0/24 (incl. 192.168.34.4/32)

Doesn't know:
192.168.1.0/24
192.168.12.0/24
192.168.13.0/24

```
C 192.168.34.0/24 is directly connected, GigabitEthernet0/1
L 192.168.34.4/32 is directly connected, GigabitEthernet0/1
```



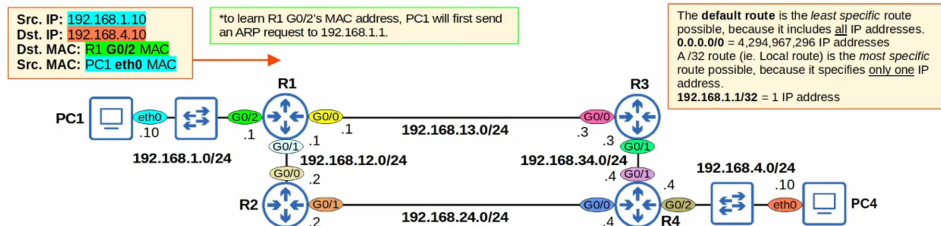
Routing Packets: Default Gateway

- End hosts like PC1 and PC4 can send packets directly to destinations in their connected network.
→ PC1 is connected to 192.168.1.0/24, PC4 is connected to 192.168.4.0/24.
- To send packets to destinations outside of their local network, they must send the packets to their **default gateway**.
PC1 (Linux) Config:

```
iface eth0 inet static
address 192.168.1.10/24
gateway 192.168.1.1
```


PC4 (Linux) Config:

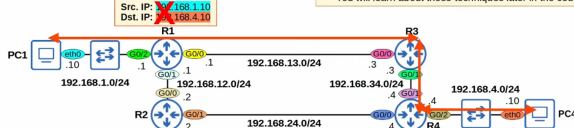
```
iface eth0 inet static
address 192.168.4.10/24
gateway 192.168.4.4
```
- The **default gateway** configuration is also called a **default route**.
→ It is a route to 0.0.0.0/0 = all netmask bits set to 0. Includes all addresses from 0.0.0.0 to 255.255.255.255.
- End hosts usually have no need for any more specific routes.
→ They just need to know: to send packets outside of my local network, I should send them to my default gateway.



STATIC ROUTES:

Routing Packets: Static Routes

- When R1 receives the frame from PC1, it will de-encapsulate it (remove L2 header/trailer) and look at the inside packet.
- It will check the routing table for the most-specific matching route:
- R1 has no matching routes in its routing table.
→ It will drop the packet.
- To properly forward the packet, R1 needs a route to the destination network (192.168.4.0/24).
→ Routes are instructions: To send a packet to destinations in network 192.168.4.0/24, forward the packet to next hop Y.
- There are two possible path packets from PC1 to PC4 can take:
1) PC1 → R1 → R3 → R4 → PC4
2) PC1 → R1 → R2 → R4 → PC4
- In this video, we will use the path via R3, not the path via R2.

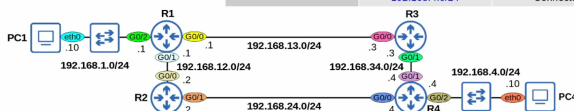


STATIC ROUTE CONFIGURATION:

Static Route Configuration

- Each router in the path needs **two** routes: a route to 192.168.1.0/24 and a route to 192.168.4.0/24.
→ This ensures **two-way reachability** (PC1 can send packets to PC4, PC4 can send packets to PC1).
- R1 already has a **Connected route** to 192.168.1.0/24. R4 already has a **Connected route** to 192.168.4.0/24.
→ The other routes must be manually configured (using **Static routes**).
- To allow PC1 and PC4 to communicate with each other over the network, let's configure these **Static routes** on R1, R3, and R4.

Router	Destination	Next-Hop
R1	192.168.1.0/24	Connected
R1	192.168.4.0/24	192.168.13.3
R3	192.168.1.0/24	192.168.13.1
R3	192.168.4.0/24	192.168.34.4
R4	192.168.1.0/24	192.168.34.3
R4	192.168.4.0/24	Connected



Static Route Configuration (R1)

```
R1(config)# ip route 192.168.4.0 255.255.255.0 192.168.13.3
```

```
R1(config)# ip route ip-address netmask next-hop
```

```
R1(config)# do 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
!some code output omitted
```

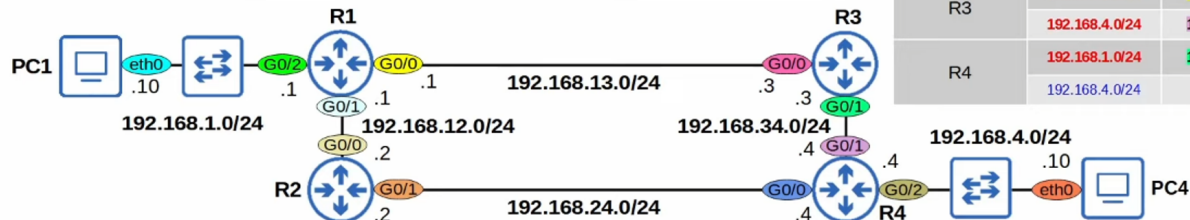
Gateway of last resort is not set

```

S 192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.1.0/24 is directly connected, GigabitEthernet0/2
L   192.168.1.1/32 is directly connected, GigabitEthernet0/2
S 192.168.4.0/24 [1/0] via 192.168.13.3
S 192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.12.0/24 is directly connected, GigabitEthernet0/1
L   192.168.12.1/32 is directly connected, GigabitEthernet0/1
S 192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.13.0/24 is directly connected, GigabitEthernet0/0
L   192.168.13.1/32 is directly connected, GigabitEthernet0/0
```

The [1/0] displayed in static routes means:
[Administrative Distance/Metric]
We will cover these concepts later in the course.

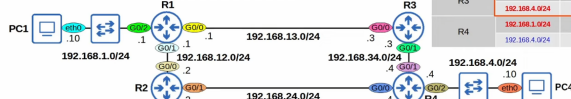
Router	Destination	Next-Hop
R1	192.168.1.0/24	Connected
	192.168.4.0/24	192.168.13.3
R3	192.168.1.0/24	192.168.13.1
	192.168.4.0/24	192.168.34.4
R4	192.168.1.0/24	192.168.34.3
	192.168.4.0/24	Connected



Static Route Configuration (R3)

```
R3(config)# ip route 192.168.1.0 255.255.255.0 192.168.13.1
R3(config)# ip route 192.168.4.0 255.255.255.0 192.168.34.4
R3(config)# do 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
!some code output omitted
Gateway of last resort is not set
S 192.168.1.0/24 [1/0] via 192.168.13.1
S 192.168.4.0/24 [1/0] via 192.168.34.4
C 192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
L 192.168.13.0/24 is directly connected, GigabitEthernet0/0
C 192.168.13.3/32 is directly connected, GigabitEthernet0/0
L 192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.34.0/24 is directly connected, GigabitEthernet0/1
L 192.168.34.3/32 is directly connected, GigabitEthernet0/1
```

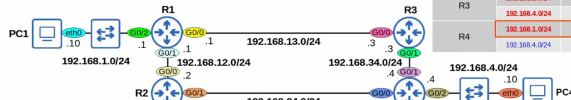
Router	Destination	Next-Hop
R1	192.168.1.0/24	Connected
	192.168.4.0/24	192.168.13.3
R3	192.168.1.0/24	192.168.13.1
	192.168.4.0/24	192.168.34.4
R4	192.168.1.0/24	192.168.34.3
	192.168.4.0/24	Connected



Static Route Configuration (R4)

```
R4(config)# ip route 192.168.1.0 255.255.255.0 192.168.34.3
R4(config)# ip route 192.168.4.0 255.255.255.0 192.168.34.3
R4(config)# do 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
!some code output omitted
Gateway of last resort is not set
S 192.168.1.0/24 [1/0] via 192.168.34.3
S 192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.4.0/24 is directly connected, GigabitEthernet0/2
L   192.168.4.4/32 is directly connected, GigabitEthernet0/2
S 192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.24.0/24 is directly connected, GigabitEthernet0/0
L   192.168.24.4/32 is directly connected, GigabitEthernet0/0
S 192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.34.0/24 is directly connected, GigabitEthernet0/1
L   192.168.34.3/32 is directly connected, GigabitEthernet0/1
```

Router	Destination	Next-Hop
R1	192.168.1.0/24	Connected
	192.168.4.0/24	192.168.13.3
R3	192.168.1.0/24	192.168.13.1
	192.168.4.0/24	192.168.34.4
R4	192.168.1.0/24	192.168.34.3
	192.168.4.0/24	Connected



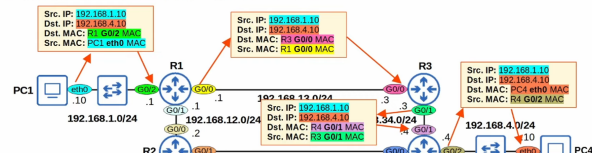
PC1 ↔ PC4

```
PC1>> ping 192.168.4.10
PING 192.168.4.10 (192.168.4.10): 56 data bytes
64 bytes from 192.168.4.10: seq=1 ttl=42 time=8.745 ms
64 bytes from 192.168.4.10: seq=1 ttl=42 time=4.423 ms
64 bytes from 192.168.4.10: seq=2 ttl=42 time=3.428 ms
64 bytes from 192.168.4.10: seq=3 ttl=42 time=3.544 ms
64 bytes from 192.168.4.10: seq=4 ttl=42 time=3.520 ms
^C
-- 192.168.4.10 ping statistics --
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max = 3.428/4.732/8.745 ms
```

If the ping is successful, that means there is two-way reachability.
PC1 can reach PC4, and PC4 can reach PC1.

Packet traveling from PC1 to PC4:

*we will examine this step-by-step in the "Life of a Packet" video



STATIC ROUTE CONFIGURATION with *exit-interface*



Static Route Configuration with exit-interface

```

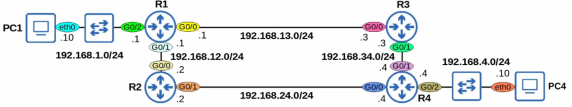
R2(config)# ip route 192.168.1.0 255.255.255.0 g0/0
R2(config)# ip route 192.168.4.0 255.255.255.0 g0/1 192.168.24.4
R2(config)# do show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       /some code output omitted
Gateway of last resort is not set

S    192.168.1.0/24 is directly connected, GigabitEthernet0/0
S    192.168.4.0/24 [1/0] via 192.168.24.4, GigabitEthernet0/1
S    192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.12.0/24 is directly connected, GigabitEthernet0/0
C    192.168.12.2/32 is directly connected, GigabitEthernet0/0
L    192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.24.0/24 is directly connected, GigabitEthernet0/1
L    192.168.24.2/32 is directly connected, GigabitEthernet0/1
    
```

R2(config)# ip route ip-address network exit-interface

R2(config)# ip route ip-address network exit-interface next-hop

- Static routes in which you specify only the exit-interface rely on a feature called **Proxy ARP** to function.
- This is usually not a problem, but generally you can stick to *next-hop* or *exit-interface next-hop*.
- Neither is "better" than the other: use which you prefer.



DEFAULT ROUTE



Default Route

```

R1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.2
R1(config)# do show ip route
/most codes omitted
ia - is-is inter area, * - candidate default, U - per-user static route
/most codes omitted
Gateway of last resort is 203.0.113.2 to network 0.0.0.0

S*   0.0.0.0/0 [1/0] via 203.0.113.2
S    10.0.0.0/8 [1/0] via 192.168.12.2
S    172.16.0.0/16 [1/0] via 192.168.13.3
C    192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
L    192.168.12.0/24 is directly connected, GigabitEthernet0/1
L    192.168.12.1/32 is directly connected, GigabitEthernet0/1
C    192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.13.0/24 is directly connected, GigabitEthernet0/0
L    192.168.13.1/32 is directly connected, GigabitEthernet0/0
C    203.0.113.0/24 is variably subnetted, 2 subnets, 2 masks
L    203.0.113.0/24 is directly connected, GigabitEthernet0/2
L    203.0.113.1/32 is directly connected, GigabitEthernet0/2
    
```

