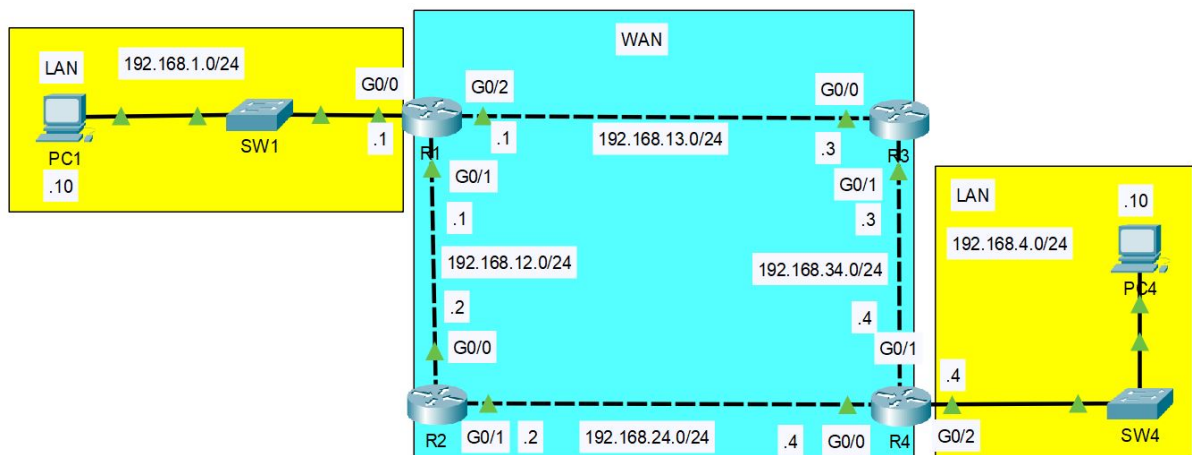


DAY 12 - Static Routing

Purinat33

Static Routing

Review: **Local** & **Connected** Routes:



```
R2>en
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int g0/0
R2(config-if)#ip address 192.168.12.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#int g0/1
R2(config-if)#ip address 192.168.24.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#do show ip int brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	192.168.12.2	YES	manual	up	up
GigabitEthernet0/1	192.168.24.2	YES	manual	up	up
GigabitEthernet0/2	unassigned	YES	NVRAM	administratively down	down
Vlan1	unassigned	YES	unset	administratively down	down

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, 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

```

      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
      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
```

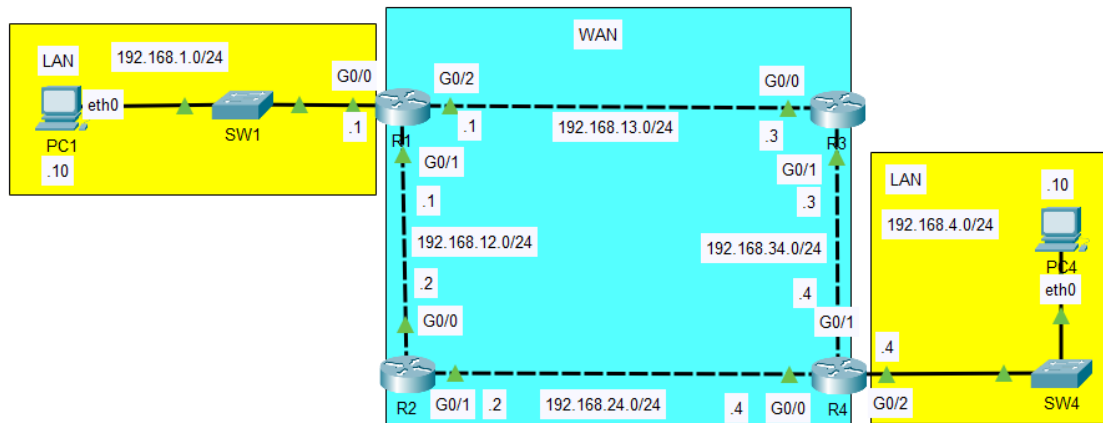
The following routes are automatically added to the routing table for each interface with an IP address configured:

1. **C - Connected:**
 - (a) A route to the network the interface is connected to. (With the actual netmask configured on the interface).
2. **L - Local:**
 1. 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 (including 192.168.12.2/32)
 - 192.168.24.0/24 (including 192.168.24.2/32)
 - **Doesn't know:**
 - 192.168.1.0/24
 - 192.168.13.0/24
 - 192.168.34.0/24
 - 192.168.4.0/24

Default Gateway



- End hosts like **PC1** and **PC4** can send packets directly to destinations *within* 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* their local network, they must send the packets to their **Default Gateway**.
 - Configuring interfaces on a Linux PC:

* **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
 - * The **Default Route** is the **LEAST** specific route possible, because it includes **All** the IP addresses.
 - 0.0.0.0/0 = 4,294,967,296 IP addresses.
 - * The **Local Route** is the **MOST** specific route possible, because it includes **One** IP address.
 - 192.168.1.1/32 = 1 IP address.
- End hosts usually have no need for any more specific routes.
 - They just need to know that "To send packets outside my local network,

*I should send them to my **default gateway**.*

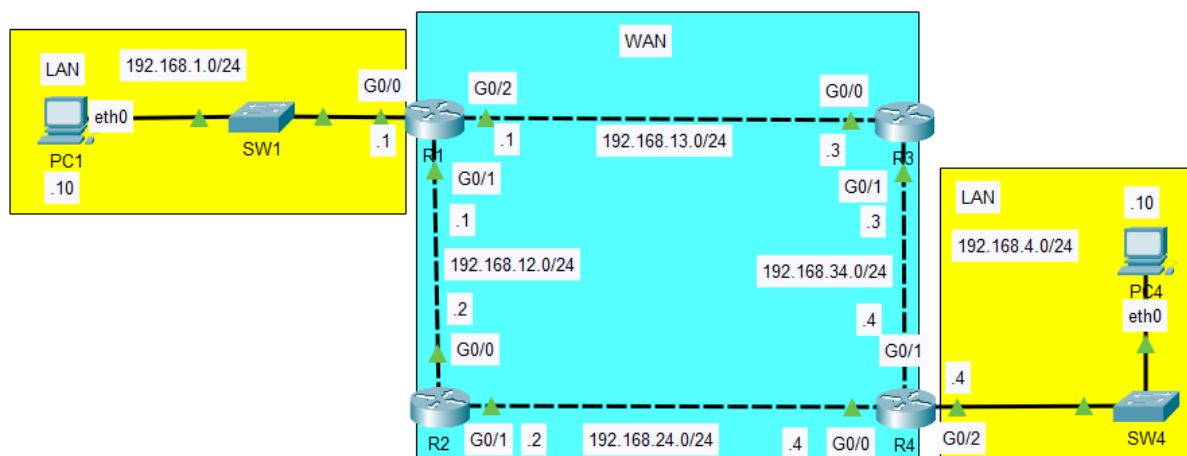
* **Source IP:** 192.168.1.10

* **DST IP:** 192.168.4.10

* **DST MAC:** R1's G0/0 MAC

· To learn R1's G0/0 MAC address, PC1 will first send an **ARP Request** to 192.168.1.1

* **SRC MAC:** PC1's eth0 MAC



- 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 its routing table for the most specific matching route:

```
R1#show ip route
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, 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

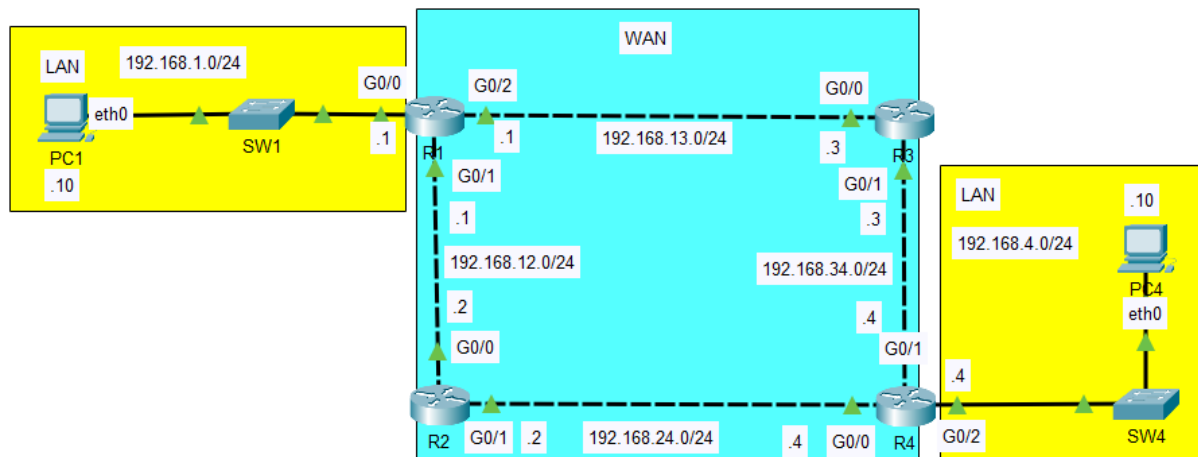
```

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.1.0/24 is directly connected, GigabitEthernet0/0
L    192.168.1.1/32 is directly connected, GigabitEthernet0/0
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
192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.13.0/24 is directly connected, GigabitEthernet0/2
L    192.168.13.1/32 is directly connected, GigabitEthernet0/2
```

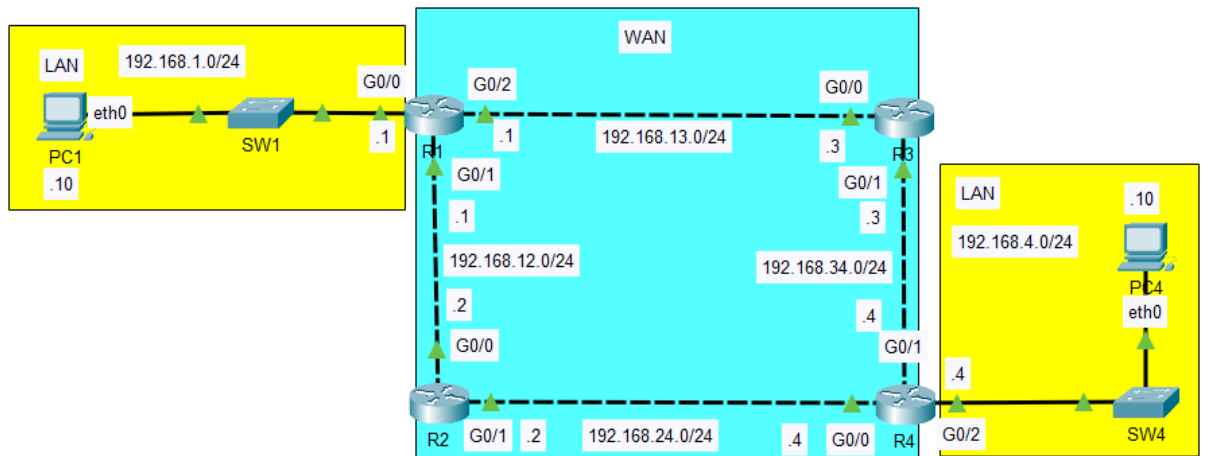
- R1 has no matching routes in its routing table.
 - It will drop the packet.
- To properly forward the packet, R1 needs a route to the destination network of 192.168.4.0/24 .
 - Routes are instructions: *"To send a packet to destinations in network 192.168.4.0/24 , forward the packet to Next Hop Y "*
- There are two possible path packets from PC1 to PC4 can take:

1. PC1 → R1 → **R3** → R4 → PC4
 2. PC1 → R1 → **R2** → R4 → PC4
- For now, we will use the path via **R3** and not **R2**
 - * Though it is possible to configure the routers to:
 - **Load-Balance** between path **1** and path **2** .
 - Use path **1** as the main path and path **2** as a backup path.
-

Static Route Configuration



- Each router in the path needs **TWO** routes:
 - a route to **192.168.1.0/24** (**PC1** network) and
 - a route to **192.168.4.0/24** (**PC4** network)
- This ensures **Two-Way Reachability**
 - **PC1** can send packets to **PC4** & Vice-Versa.
- Routers don't need routes to all networks in the path to the destination.
 - **R1** doesn't need a route to **192.168.34.0/24** , it only needs to know a route to **R3**. **R3** will handle the route to **192.168.34.0/24** by itself.
 - **R4** also doesn't need a route to **192.168.13.0/24** , **R3** will handle it.
- **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 (**Non-Connected Routes**) still needed to be manually configured using **Static Route**.



Router	Destination	Next-Hop	Note
R1	192.168.1.0/24	Connected	-
	192.168.4.0/24	192.168.13.3	R3's G0/0
R3	192.168.1.0/24	192.168.13.1	R1's G0/2
	192.168.4.0/24	192.168.34.4	R4's G0/1
R4	192.168.1.0/24	192.168.34.3	R3's G0/1
	192.168.4.0/24	Connected	-

- To allow **PC1** and **PC4** to communicate with each other over the network, we will configure the **Static Routes** on **R1**, **R3**, **R4** based on the pre-planning table above.
- Use `ip route ip-address netmask next-hop`
 - Where:
 - * `ip-address` : The **Destination**'s IP address.
 - * `netmask` : The netmask of Destination's network.
 - * `next-hop` : Next-Hop IP Address

Demo:

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

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

- Added R1's **Static Route** via:

```
ip route 192.168.4.0 255.255.255.0 192.168.13.3
```

– Where:

- * 192.168.4.0 = Destination Network
- * 255.255.255.0 = Destination Netmask
- * 192.168.13.3 = Next Hop

- A Code **S** **Static Route** is added.

– The [1/0] display for **Static Routes** means:

- * [Administrative Distance / Metric]
- * The concept will be covered later.

```
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, 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

```
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
      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
      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 needed 2 routes.

```

R4(config)#ip route 192.168.1.0 255.255.255.0 192.168.34.3
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, 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

S    192.168.1.0/24 [1/0] via 192.168.34.3
    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
    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
    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 needed 1 route.