Lab 6. Static Route and RIP

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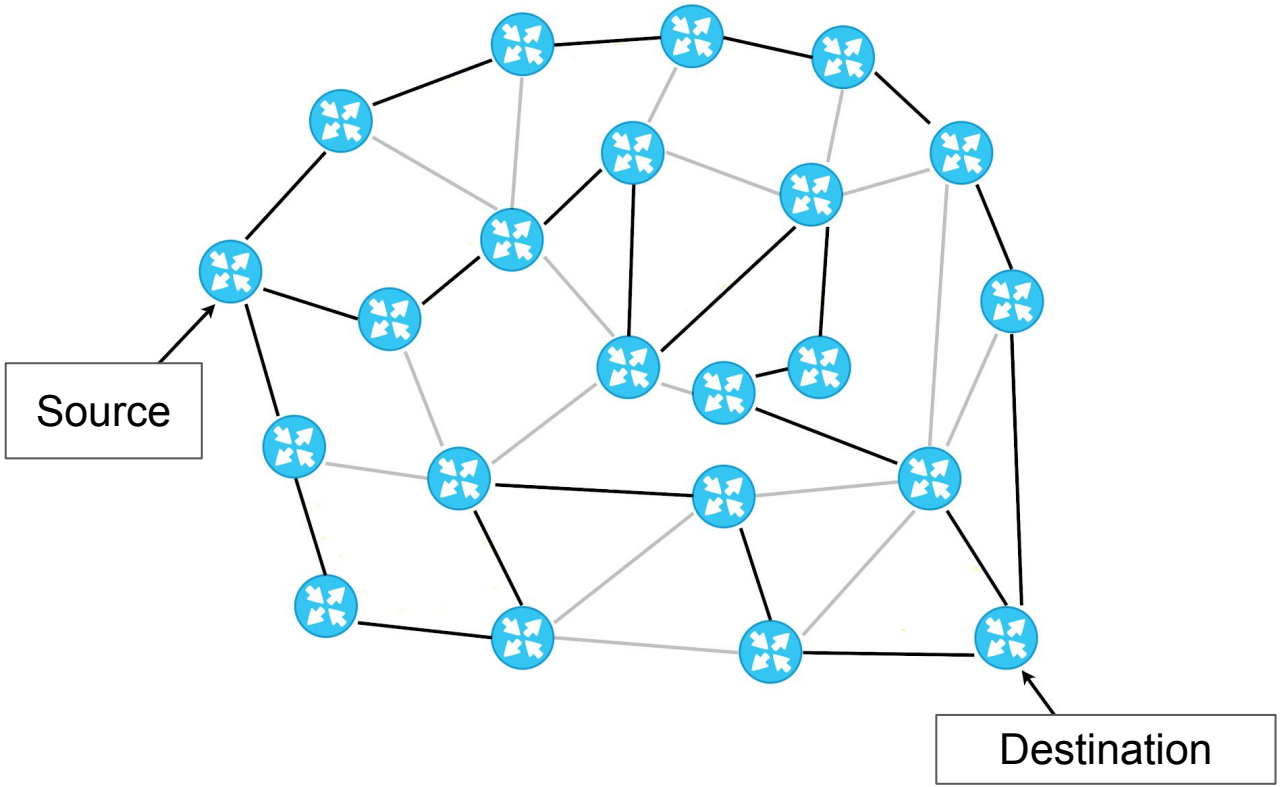
Outline

- Background Knowledge
- Purpose of this Lab
- Static Route
- Dynamic Route: RIP
- Disadvantage of RIP
- Link-state Routing Protocol

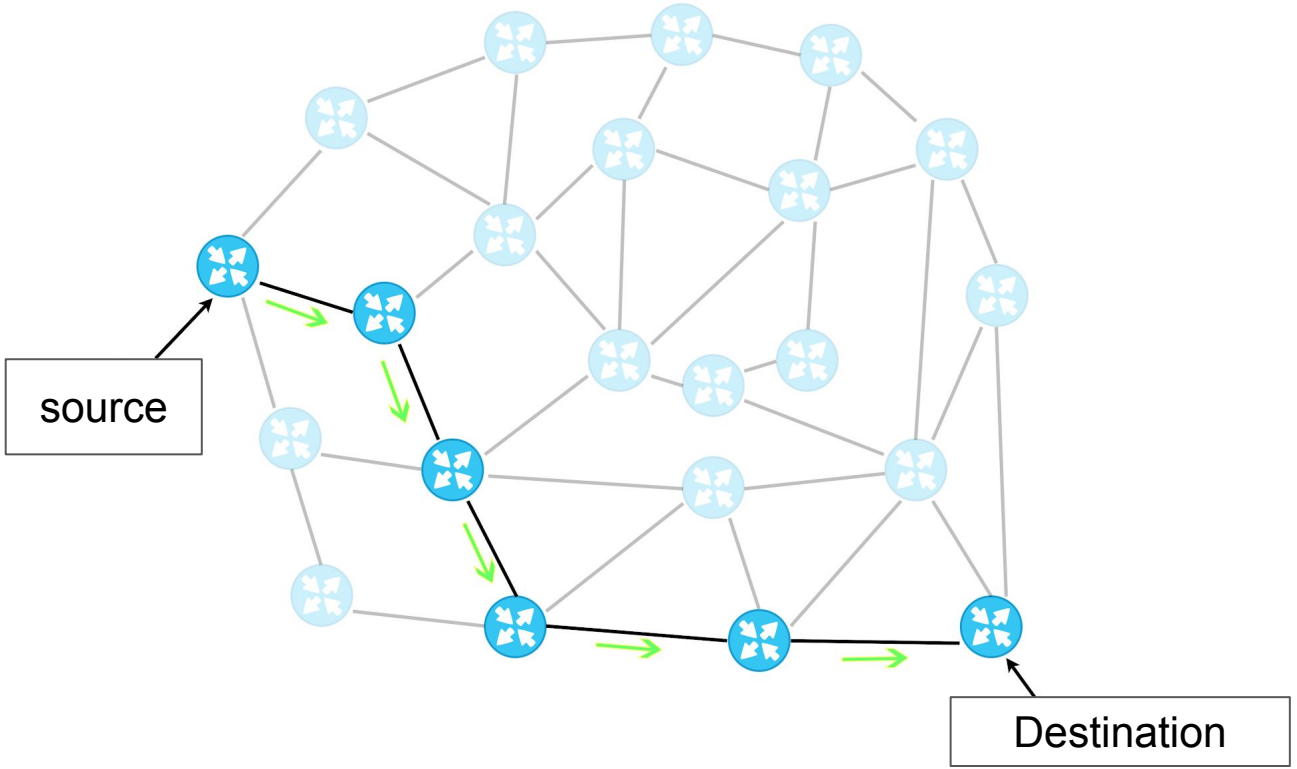
How Packet reaches its destination?



Destination Based Routing (1/2)

- A basic routing mode for IPv4 packets
- Each router determine a proper **next-hop** for a packet
- Based only on the **destination address** found in the packet.

Destination Based Routing (2/2)



Routing: Reach Remote Networks

- Routers learn next hops from
  - **Static** routing
    - **Manually** configured into the routing table
    - Must be reconfigured whenever the network topology changes
  - **Dynamic** routing
    - **Automatically** learned through dynamic routing protocols and configured into the routing table

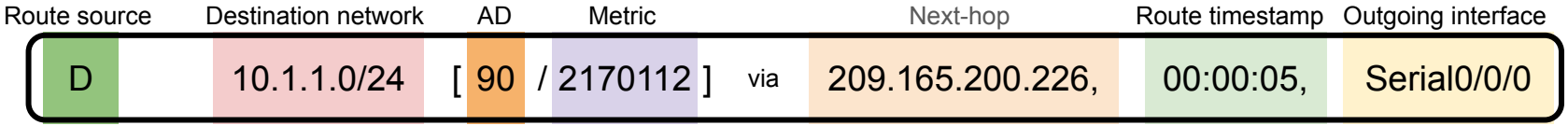
Purpose of this Lab

Purpose of this Lab

- Configuration of Static Routing
- Configuration of Dynamic Routing
- Configuration of Routing Information Protocol (RIP)

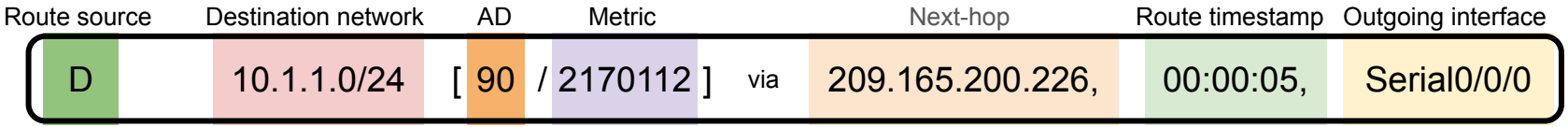
What is in the routing table?

Entries in the Routing Table



- **Route Source**: how the route was learned
- **Destination Network**: the destination of the packets
- **Administrative Distance (AD)**
  - The trustworthiness of the route source
  - The lower value, the more preferred route source
- **Metric**
  - The value assigned to reach the remote network.
  - The lower value, the more preferred route
- **Next-hop**: where the router should send to
- **Route Timestamp**: after the route was learned
- **Outgoing Interface**: the exit interface to forward packets

AD v.s. Metric



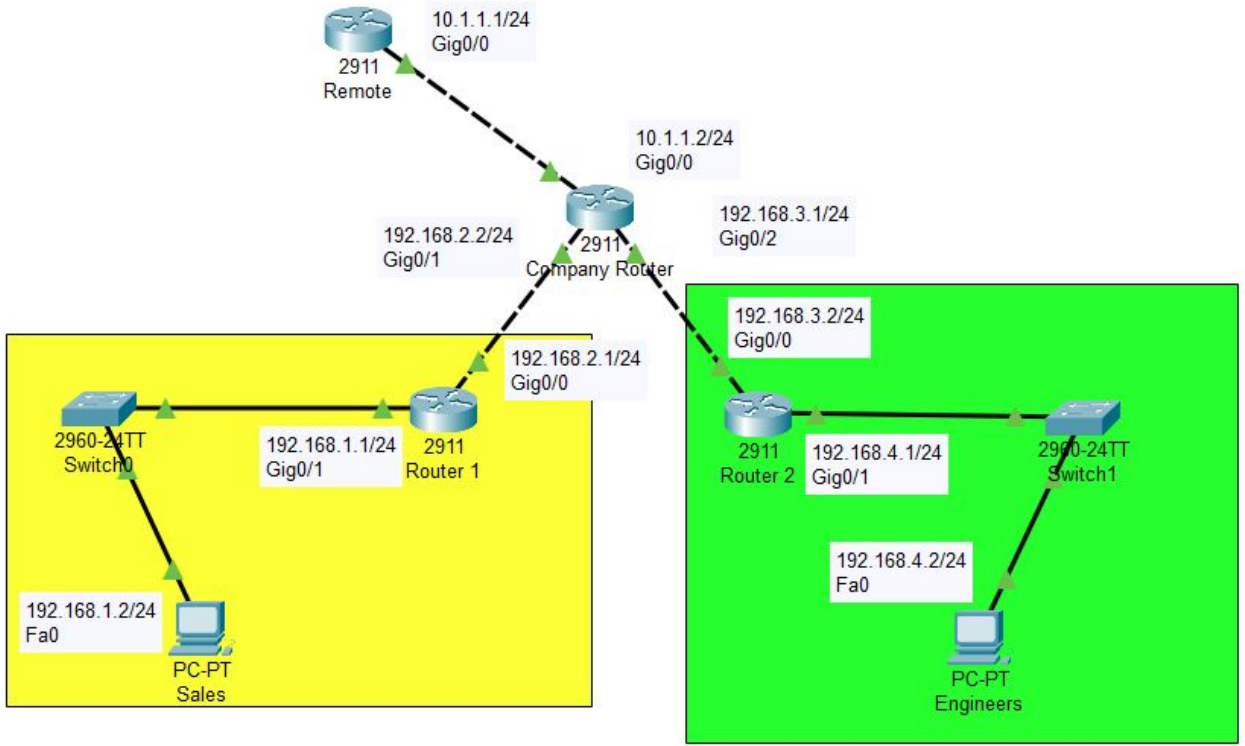
- **Administrative Distance (AD)**
  - the trustworthiness of the route source
  - the lower value, the more preferred route source
- **Metric**
  - the value assigned to reach the remote network.
  - the lower value, the more preferred route

Administrative Distance

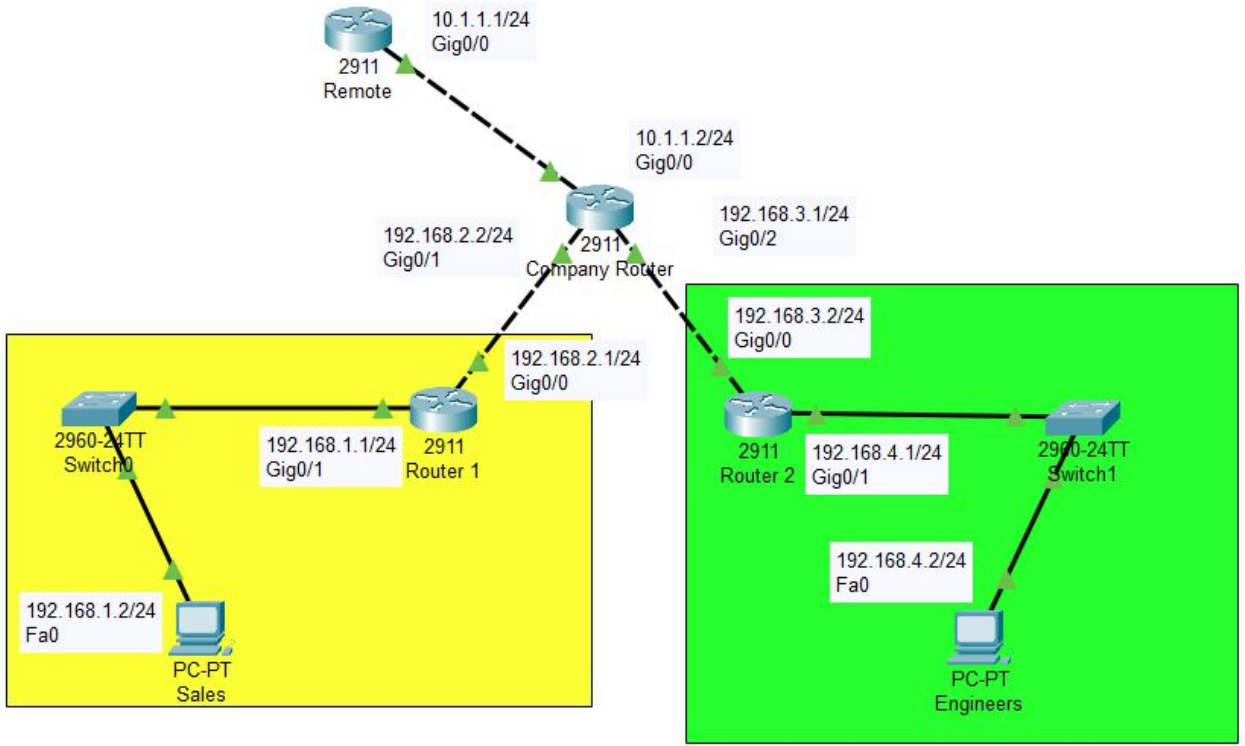
Route Source	**Administrative Distance**
Connected	0
Static	1
EIGRP summary route	5
External BGP	20
Internal EIGRP	90
IGRP	100
OSPF	110
RIP	120
External EIGRP	170
Internal BGP	200

Static Routing

Scenario: In a company, 2 PCs & 3 routers



Question 1: How Sales and Engineers communicate



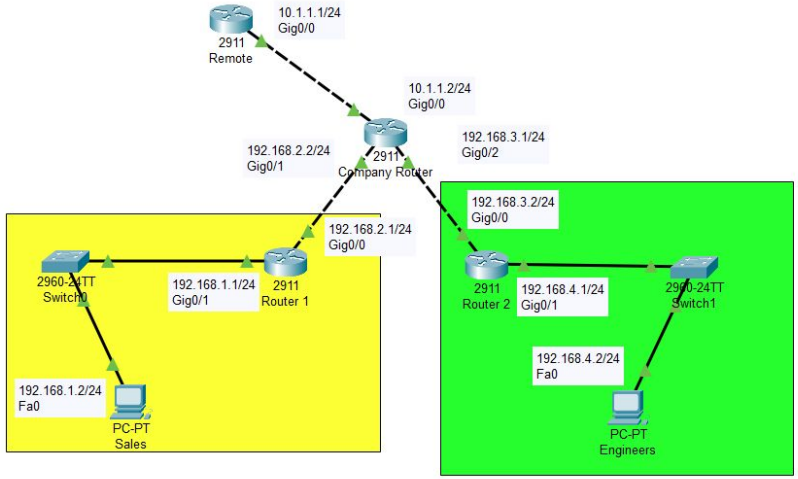
Static Route: IP Route Command

- Configure static route

```
Router(config) # ip route network-address subnet-mask { ip-address | exit-intf}
```

Parameter	Description
network-address	● Destination network address of the remote network to be added to the routing table
subnet-mask	● Subnet mask of the remote network to be added to the routing table ● The subnet mask can be modified to summarize a group of networks
ip-address	● Referred to as the next-hop router's IP address ● Creates a recursive lookup
exit-intf	● Use the outgoing interface to forward packets ● Also referred to as a directly attached static route

Static Route Configuration



For **Router1** & **Router2**

Method #1 (Router1): exit-interface

Try it !

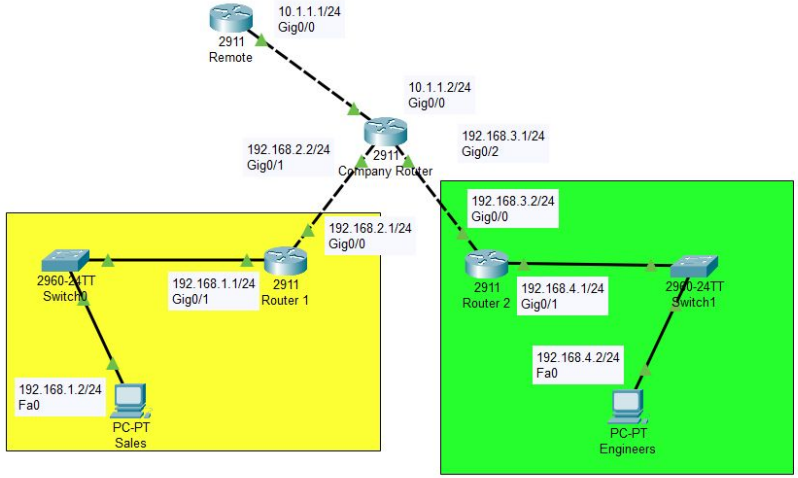
```
R1(config)# ip route 192.168.4.0 255.255.255.0 GigabitEthernet 0/0
```

Method #2 (Router2): IP-address

Try it !

```
R2(config)# ip route 192.168.1.0 255.255.255.0 192.168.3.1
```

Static Route Configuration



For **CompanyRouter**

Method #1 (Engineers): exit-interface

Try it !

```
CompanyR(config)# ip route 192.168.4.0 255.255.255.0 GigabitEthernet
0/2
```

Method #2 (Sales): IP-address

Try it !

```
CompanyR(config)# ip route 192.168.1.0 255.255.255.0 192.168.2.1
```

It works? Great!
Let’s see what is happening.

Show IP Route on Router

```
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
```

Routing Table for **exit-intf** (Router1)

- **Method #1 exit-intf:** routing table only needs to search once

```
R1# show ip 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, GigabitEthernet0/1
L 192.168.1.1/32 is directly connected, GigabitEthernet0/1
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
S 192.168.4.0/24 is directly connected, GigabitEthernet0/0
```

Routing Table for **IP-Address** (Router2)

- **Method #2 IP-address:** routing table needs to search twice

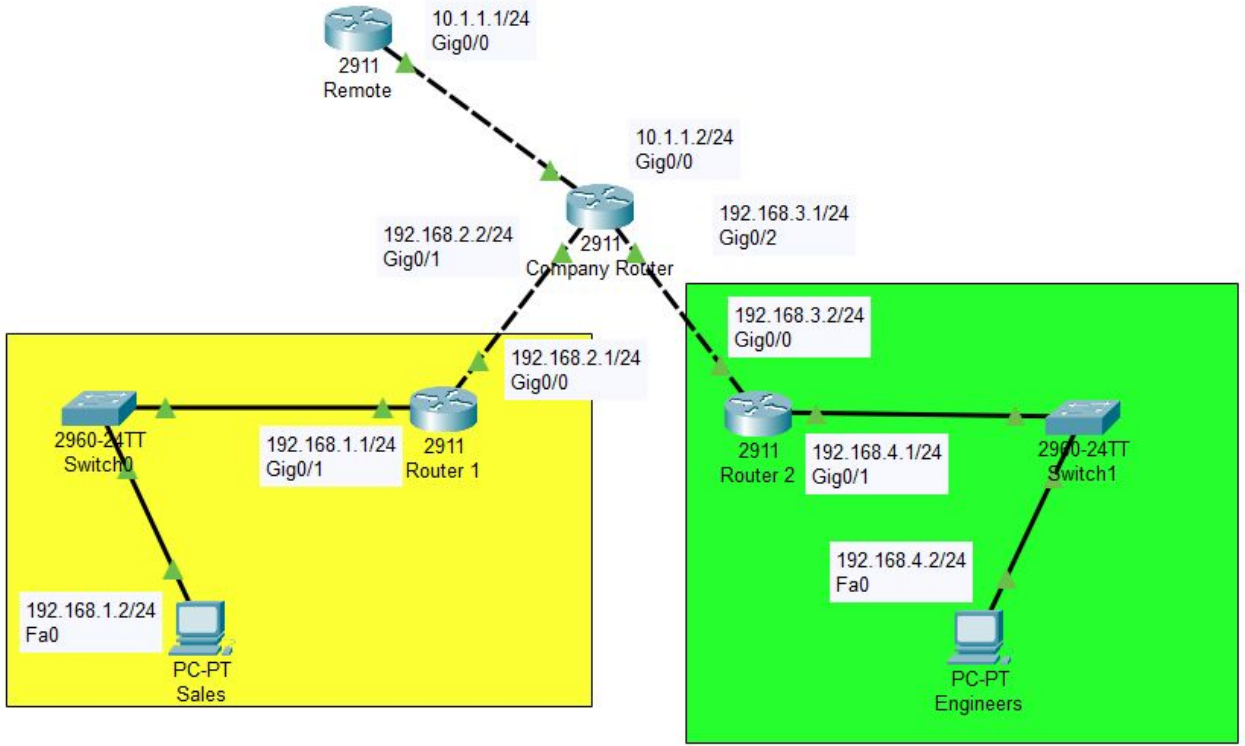
```
R2# show ip route
```

Try it !

```
……

Gateway of last resort is not set
S 192.168.1.0/24 [1/0] via 192.168.3.1
     192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.2/32 is directly connected, GigabitEthernet0/0
     192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.4.0/24 is directly connected, GigabitEthernet0/1
L 192.168.4.1/32 is directly connected, GigabitEthernet0/1
```

Question 2: How Sales & Engineers surf the Internet



Default Static Route

- Configure default static route

```
Router(config) # ip route 0.0.0.0 0.0.0.0 {ip-address | exit-intf}
```

Parameter	Description
`0.0.0.0 0.0.0.0`	● Matches any network address
`ip-address`	● next-hop router's IP address ● commonly creates a recursive lookup
`exit-intf`	● use the outgoing interface to forward packets ● also referred to as a directly attached static route

Default Route on Company Router

- Configure default route on Company Router

```
CompanyR(config)# ip route 0.0.0.0 0.0.0.0 gigabitEthernet 0/0
```

- Show ip route of Company Router

```
...
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/2
L 192.168.3.1/32 is directly connected, GigabitEthernet0/2
S 192.168.4.0/24 [1/0] via 192.168.3.2
S* 0.0.0.0/0 is directly connected, GigabitEthernet0/0
```

Default Route on Router 1 and Router 2

- Configure default route on Route 1

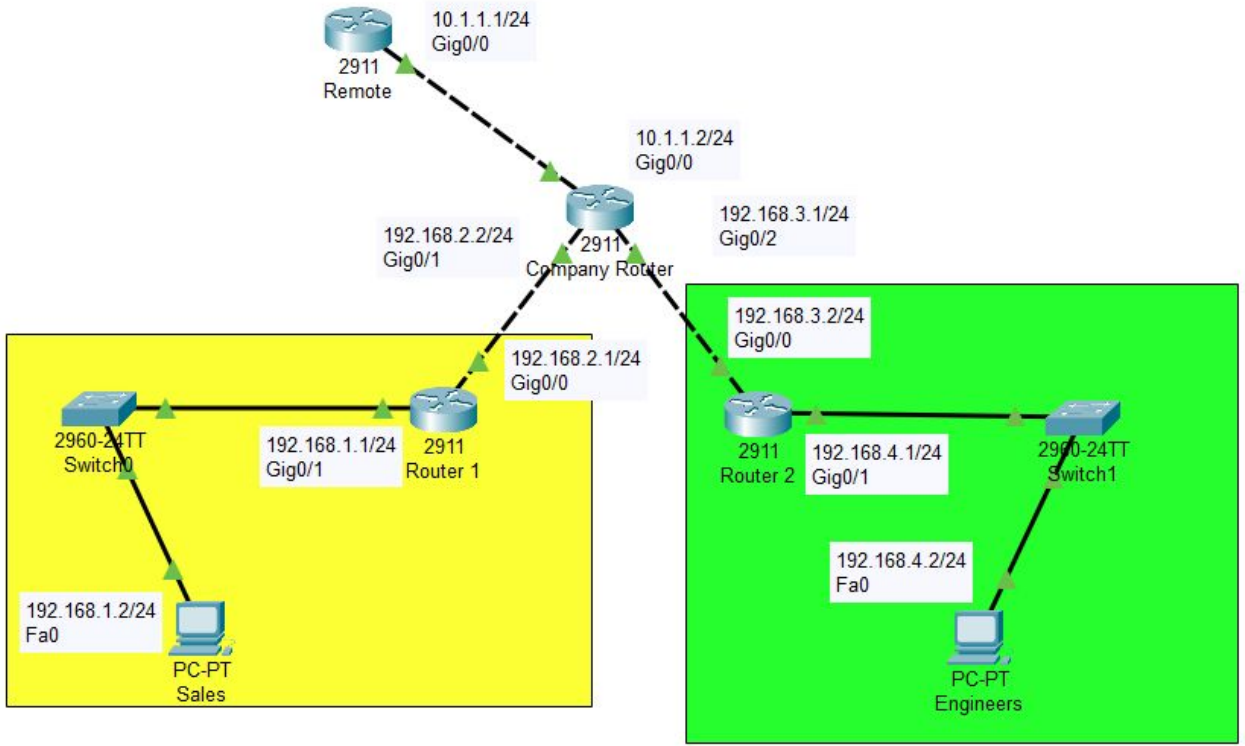
```
R1(config)# ip route 0.0.0.0 0.0.0.0 gigabitEthernet 0/0
```

- Show ip route of Route 1

```
...
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0
S 192.168.4.0/24 is directly connected, GigabitEthernet0/0
S* 0.0.0.0/0 is directly connected, GigabitEthernet0/0
```

Dynamic Routing:
RIP (Routing Information Protocol)

Question: How to communicate and surf the Internet with RIP



Dynamic Routing: Router RIP Configuration Mode

- Enable RIP

```
Router(config) # router rip

Router(config-router) #
```

Advertise Networks

- Start RIP routing

```
Router(config-router) # network {subnet}
```

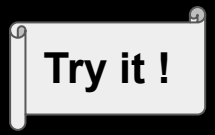
- RIPv1 is a classful routing protocol for IPv4.
- Classful routing protocol: In contrary to classless, a protocol that does not support ip except A, B, C classes
- Therefore, if a subnet address is entered, the IOS automatically converts it to the classful network address.
    - For example, entering the network 192.168.1.32 command would automatically be converted to network 192.168.1.0 on the running configuration file.
    - No error message, but IOS corrects the input and enters the classful network address.

Network Class

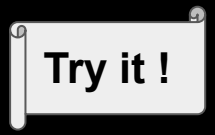
- A: 0.0.0.0 ~ 127.0.0.0 (subnet /8)
- B: 128.0.0.0 ~ 191.255.0.0 (subnet /16)
- C: 192.0.0.0 ~ 223.255.255.0 (subnet /24)
- D: 224.0.0.0 ~ 239.255.255.255 (multicast)
- E: 240.0.0.0 ~ 255.255.255.255 (reserved)

Dynamic Routing: RIP

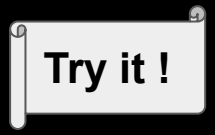
```
R1(config)# router rip
R1(config-router)# network 192.168.1.0
R1(config-router)# network 192.168.2.0
```



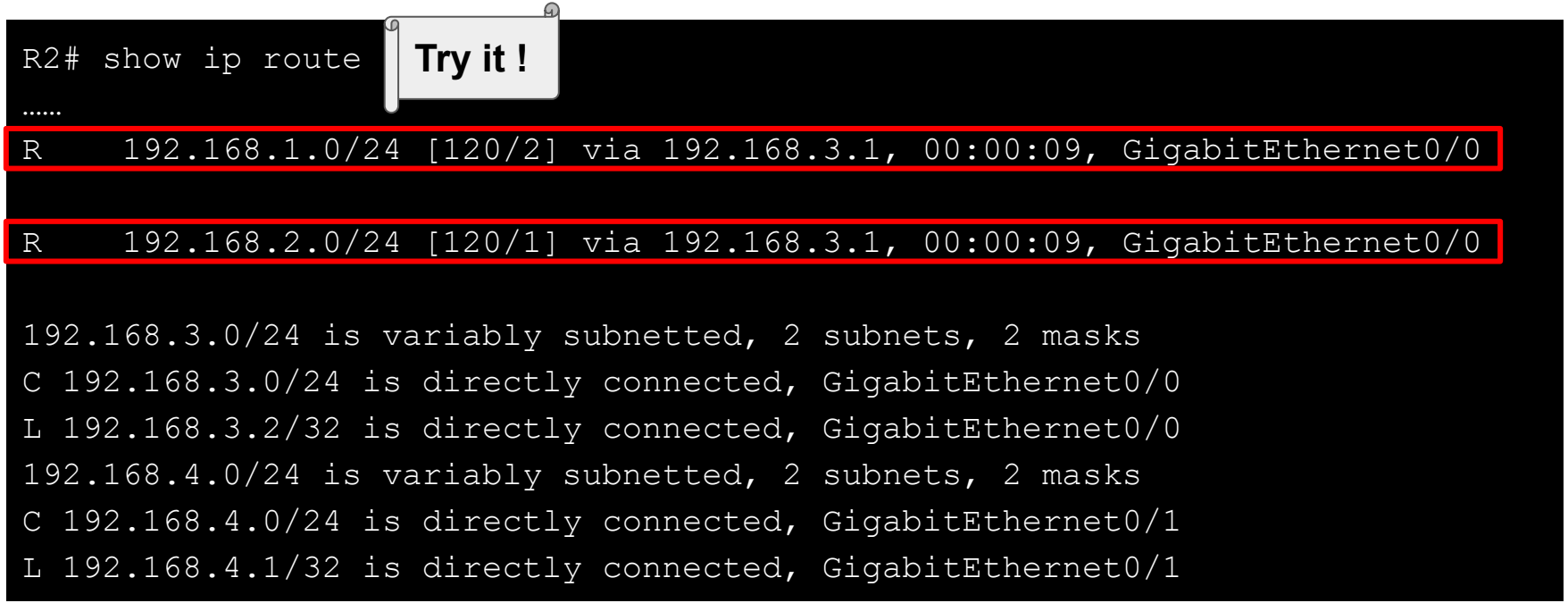

```
R2(config)# router rip
R2(config-router)# network 192.168.3.0
R2(config-router)# network 192.168.4.0
```




```
CompanyR(config)# router rip
CompanyR(config-router)# network 192.168.2.0
CompanyR(config-router)# network 192.168.3.0
```



Dynamic Routing: RIP



Propagate a Default Route

- Default static route be advertised to all other routers in the RIP routing domain
- Tell others in the same RIP routing domain where to connect Internet

```
Router(config)# ip route 0.0.0.0 0.0.0.0 {ip-address | exit-intf}
Router(config)# router rip
Router(config-router)# default-information originate
```

Propagate a Default Route

- Configure default route on Company Router


```
CompanyR(config)# ip route 0.0.0.0 0.0.0.0 gigabitEthernet 0/0
CompanyR(config)# router rip
CompanyR(config-router)# default-information originate
```

Propagate a Default Route

- Show ip route

```
CompanyR# show ip route
...

     192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/1
L 192.168.3.1/32 is directly connected, GigabitEthernet0/1
S* 0.0.0.0/0 is directly connected, GigabitEthernet0/2
```

Propagate a Default Route

- Show ip route

```
R1# show ip route
...
R 192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:23, GigabitEthernet0/0
R 192.168.4.0/24 [120/2] via 192.168.2.2, 00:00:23, GigabitEthernet0/0
R* 0.0.0.0/0 [120/1] via 192.168.2.2, 00:00:05, GigabitEthernet0/0
```

Enable and RIPv2

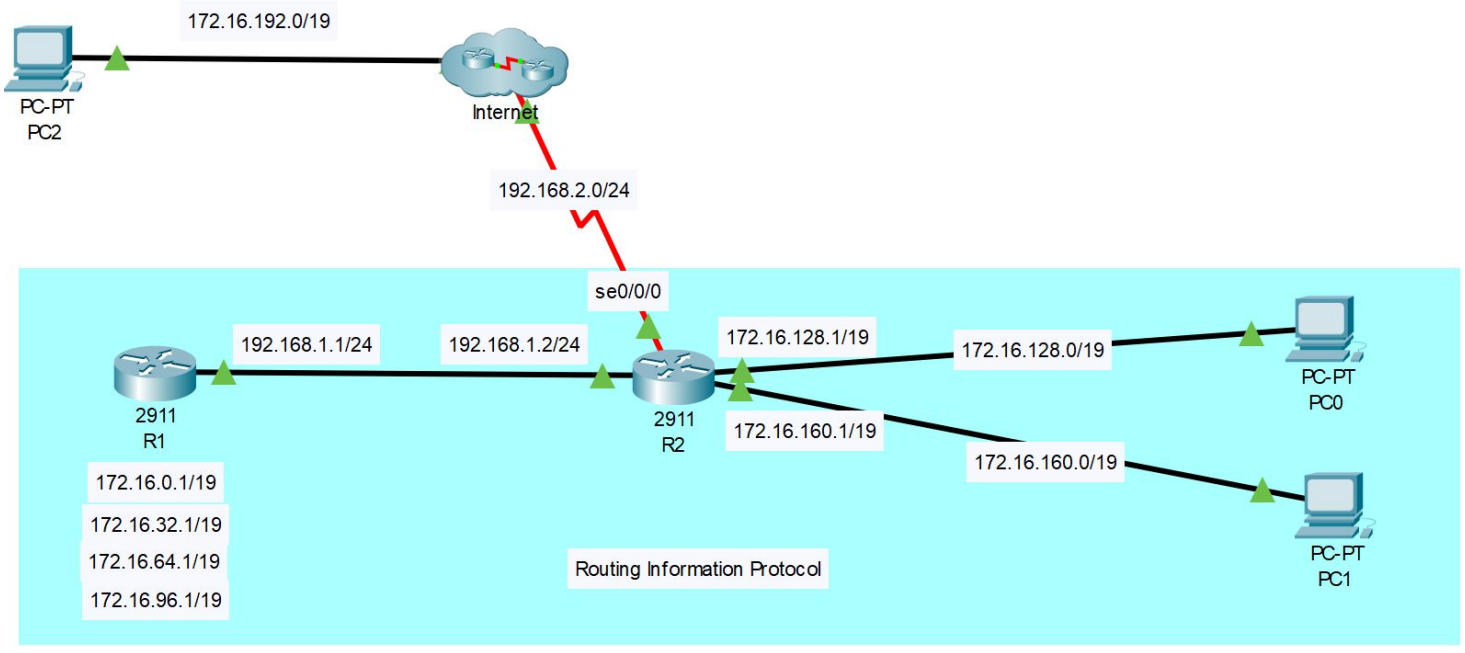
- Enable RIPv2
  - Make RIP a **classless** routing protocol

```
Router(config) # router rip

Router(config-router) # version 2
```

Auto Summarization

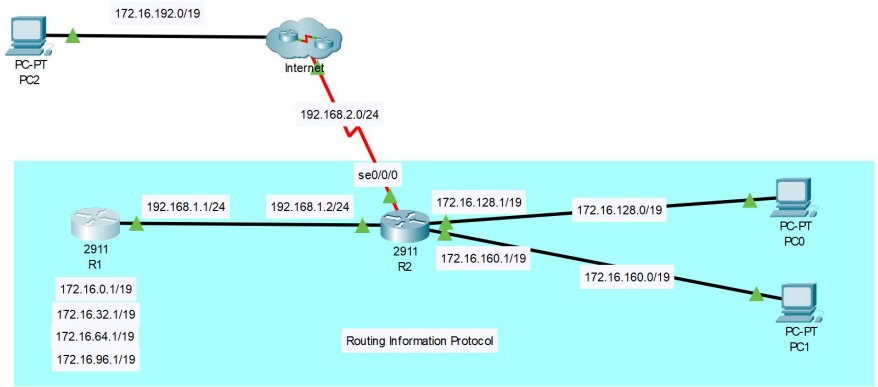
- Auto summarization is a feature which allows RIP to summarize its routes to their classful networks automatically.



Auto Summarization

- Default enable

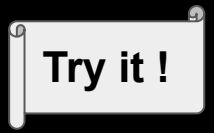
```
R1# show ip route
...
172.16.0.0/16 is variably subnetted, 9 subnets, 3 masks
R 172.16.0.0/16 [120/1] via 192.168.1.2, 00:00:21, GigabitEthernet0/0
C 172.16.0.0/19 is directly connected, Loopback0
L 172.16.0.1/32 is directly connected, Loopback0
```



Disable Auto Summarization

- Disable auto summarization on R2

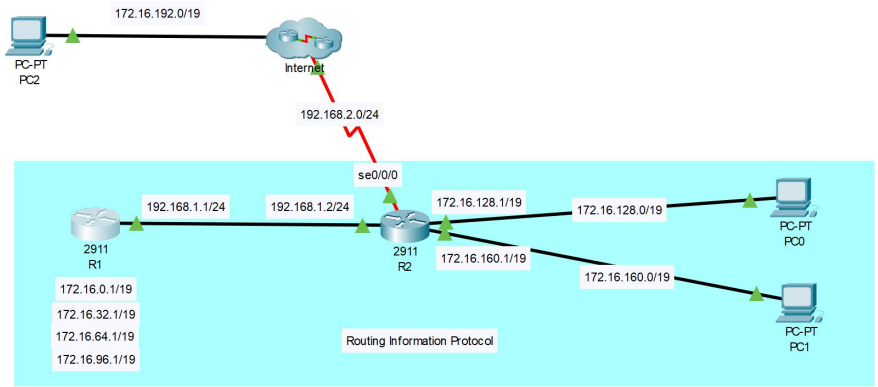
```
R2(config)# router rip
R2(config-router)# no auto-summary
```



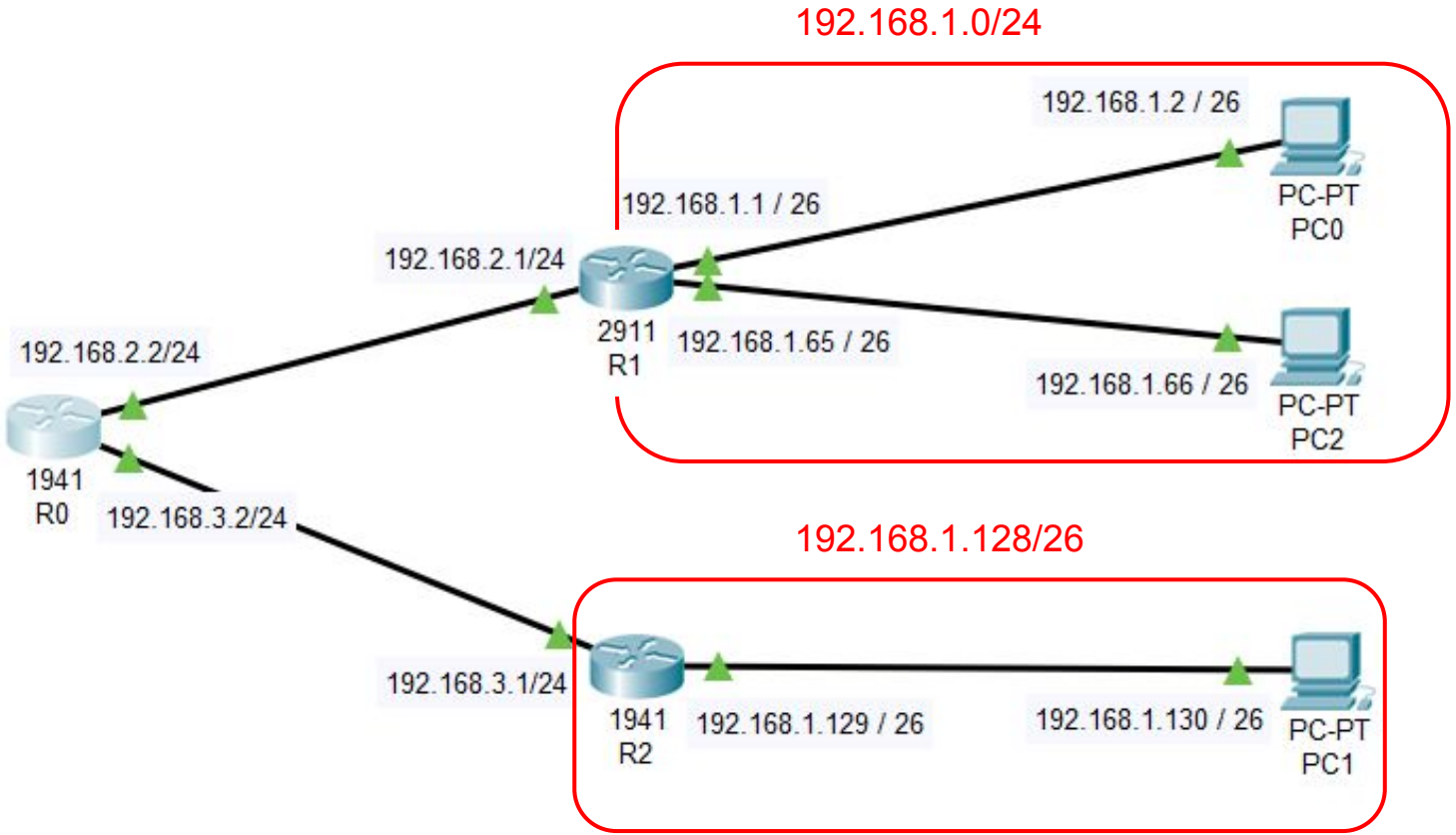
- This command has no effect when using RIPv1
- When automatic summarization has been disabled, RIPv2 no longer summarizes networks to their classful address at boundary routers

Disable Auto Summarization

```
R1# show ip route
...
C 172.16.96.0/19 is directly connected, Loopback3
L 172.16.96.1/32 is directly connected, Loopback3
R 172.16.128.0/19 [120/1] via 192.168.1.2, 00:00:13, GigabitEthernet0/0
R 172.16.160.0/19 [120/1] via 192.168.1.2, 00:00:13, GigabitEthernet0/0
```



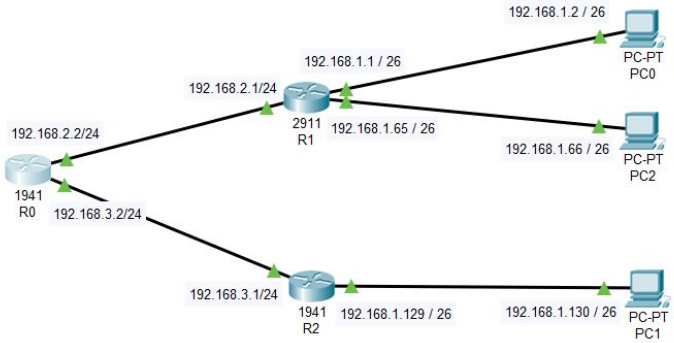
Longest Prefix Matching



Longest Prefix Matching

```
R0# show ip route
……
Gateway of last resort is not set

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
S       192.168.1.0/24 [1/0] via 192.168.2.1
S       192.168.1.128/26 [1/0] via 192.168.3.1
……
```



Supplement: Timer

- Update Timer
  - How long to send route update packet
- Invalid Timer
  - How long to mark a route invalid since last update
- Hold-Down Timer
  - How long hold-down time be
  - A route enters hold-down state when it’s **unreachable**
    - No update
    - Will be advertised as unreachable
- Flush Timer
  - How long to remove a route since last update
  - Starting at the same time as invalid timer

Disadvantage of RIP

Problems of RIP

- By default, RIP updates are forwarded out all RIP-enabled interfaces
- **Sending out unneeded updates** in a LAN impacts the network in three ways:
  - Wasted Bandwidth: RIP updates are either broadcasted or multicasted, switches also forward the updates out all ports
  - Wasted Resources**:** All devices on the LAN must process the update up to the transport layers, at which the devices will discard the update
  - Security Risk**:** RIP updates can be intercepted (listened) with packet sniffing software. Routing updates can be modified and sent back to the router.

Solution: Passive Interfaces

- Passive interface is a feature used by routing protocol to stop sending updates on the particular interface.
- Routing updates are only understood by the routers.

Solution: Passive Interfaces

- Configure passive interface

Method #1: Passive all and *no* specific

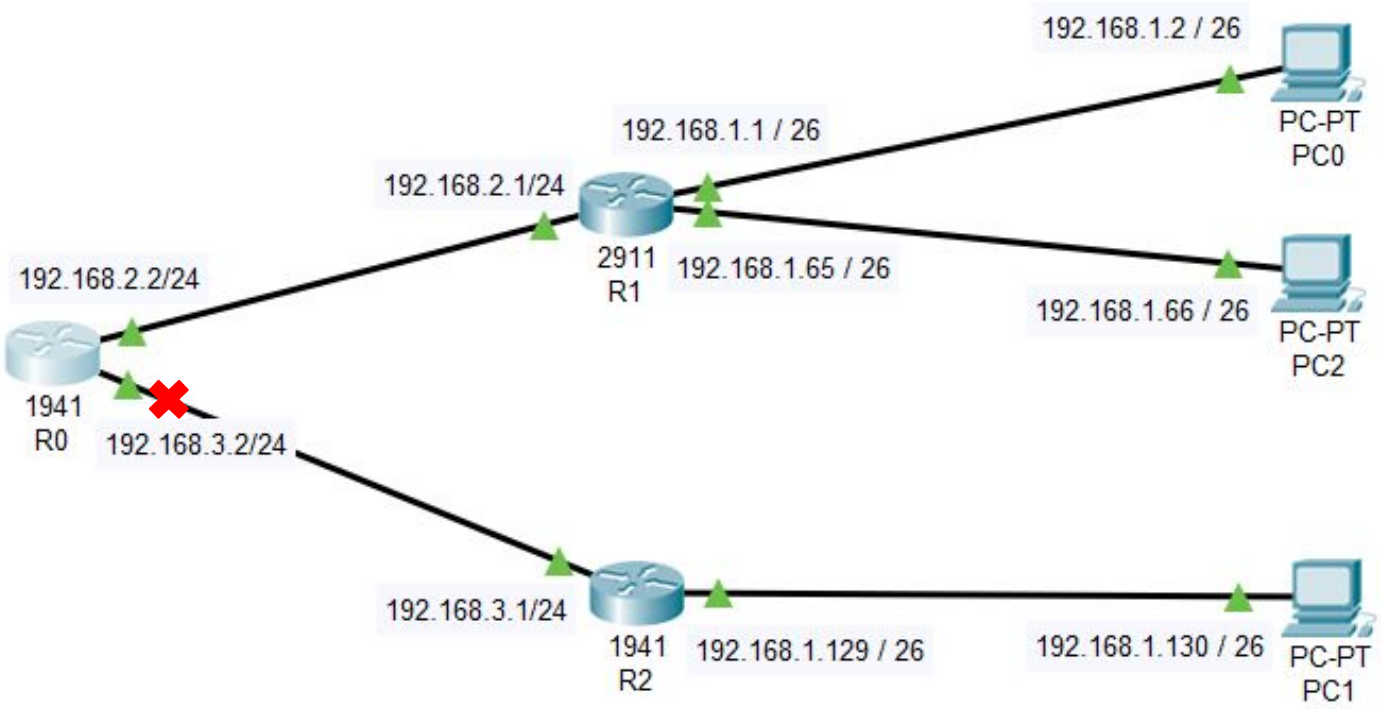
```
Router(config)# router rip
Router(config-router)# passive-interface default
Router(config-router)# no passive-interface Gigabit 0/1
```

Method #2: Passive specific

```
Router(config-router)# passive-interface GigabitEthernet 0/0
```

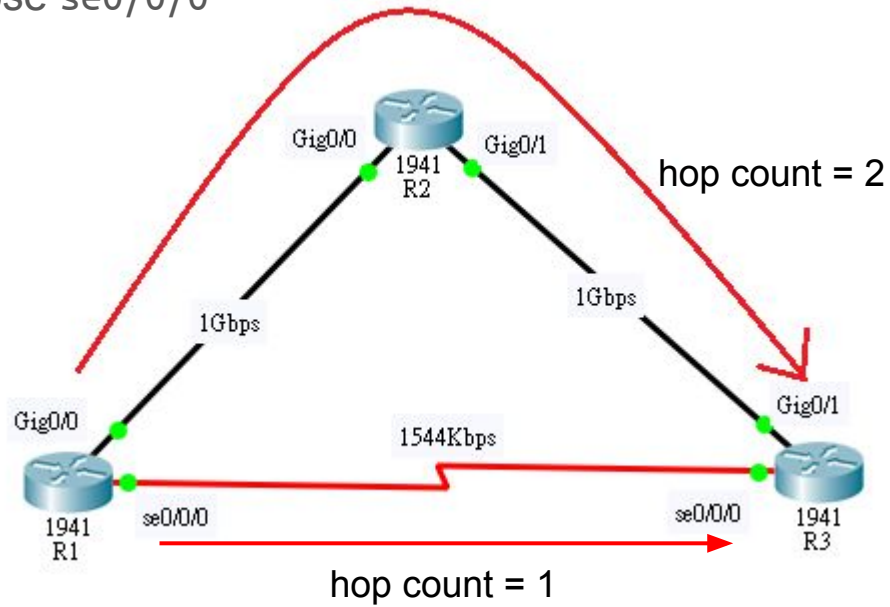
- The command stops routing updates out the specified interface

Solution: Passive Interfaces



Disadvantage of RIP

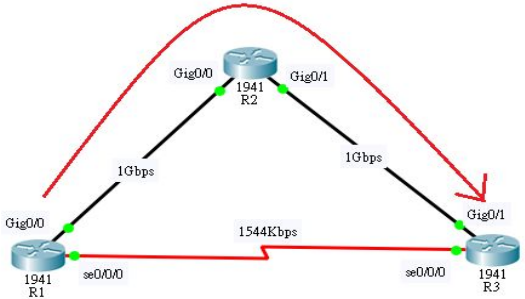
- Closest may not be fastest
  - Choose the closest path by **hop count** does not mean it's the fastest route
  - In RIP, choose `se0/0/0`



Disadvantage of RIP

- Example: transmit a file of 1544GB from R1 to R3

port	bandwidth	time
Gig0/0	1Gbps	12352 s
se 0/0/0	1544Kbps	$8 * 10^6$ s



Distance-Vector v.s. Link-State Routing Protocol

	Distance-Vector (E.g., RIP)	Link-State (E.g., OSPF)
Send What?	Routing Table	Link-State Advertisement (LSA)
Sending Range?	Only Neighbors	Whole Topology
Metric?	Hop Count	Cost

Link-State Routing Protocol

- Performed by every routing node in the network.
    a. Every node constructs a map of the connectivity to the network, showing which nodes are connected to which other nodes.
    b. Each node then calculates the next best **logical path** from it to every possible destination in the network.
    c. Each collection of best paths will then form each node's routing table.
- OSPF (Using Dijkstra algorithm)

Lab After Midterm:
OSPF

Thank you for listening!