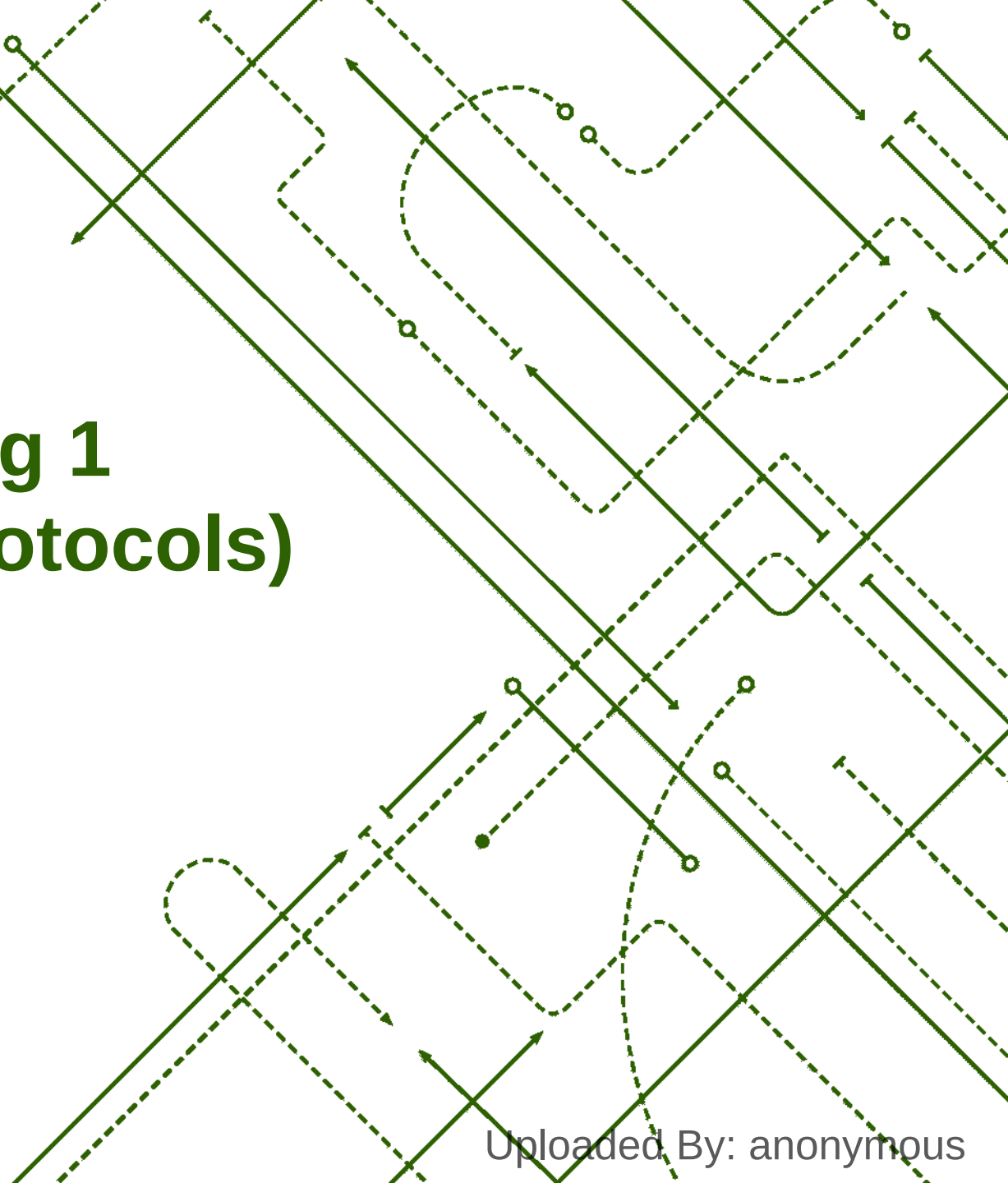
ENCS4130
Computer Networks Laboratory

EXP#3 Dynamic Routing 1 (Distance Vector Routing Protocols) RIP & EIGRP

Slides By: Tariq Odeh



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Objectives

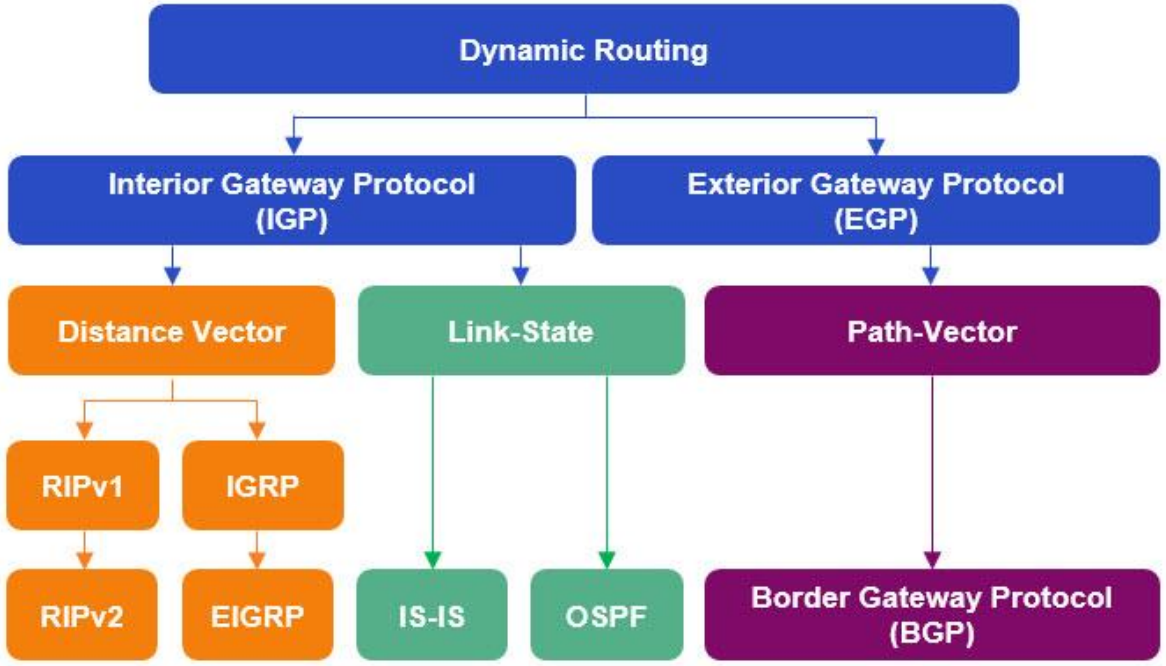
- Learn how to configure and verify IP routing with Cisco routers.
- Dynamic routing RIP and EIGRP.

Introduction

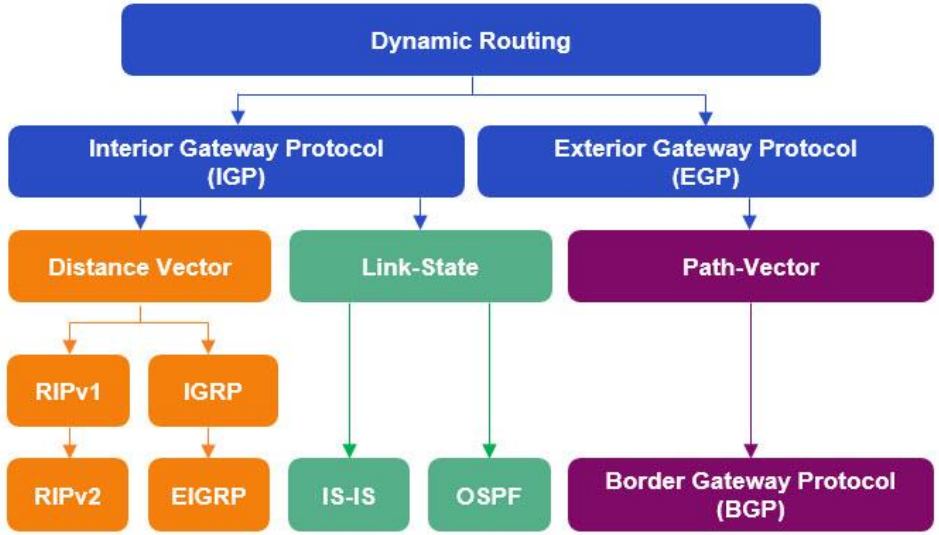
- **Static Routing**
  - Definition: Manually configured routes.
  - Advantages: Simple and predictable and low overhead.
  - Disadvantages: Requires manual updates and not scalable for large networks.
- **Dynamic Routing**
  - Definition: Automatically updates routes using protocols.
  - Advantages: Adapts to network changes and scalable and supports load balancing.
  - Disadvantages: More complex to manage and higher resource usage**.**

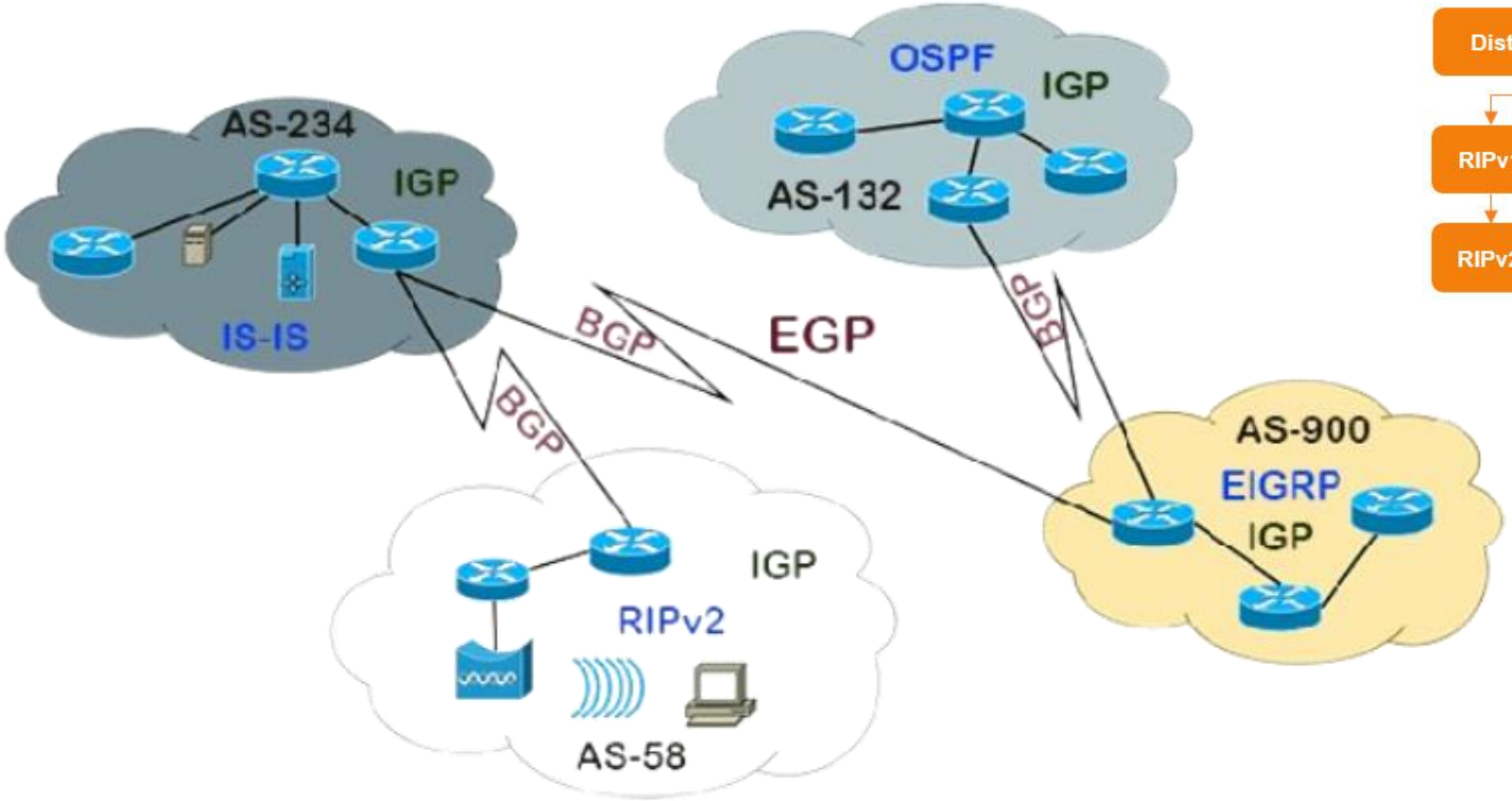
Dynamic Routing

- **Main Categories:**
  - **Interior Gateway Protocols (IGP):** Used for routing within an Autonomous System
  - **Exterior Gateway Protocols (EGP):** Used for routing between different Autonomous Systems.



Dynamic Routing (Cont.)





Administrative Distances (AD)

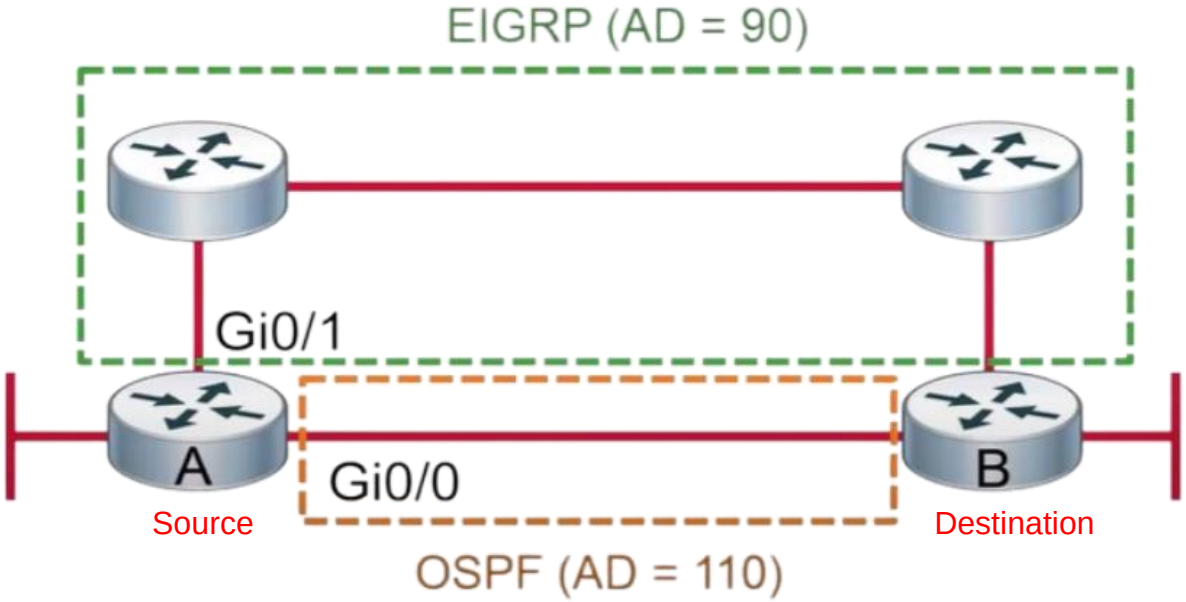
- **Definition:** Rates the trustworthiness of routing info from a neighbouring router.
- **Range:**
  - 0 = Most trusted (e.g., directly connected)
  - 255 = Untrusted (route won't be used)
- **Key Points:**
  - First criterion used by routers to select a routing protocol.
  - Purpose: Helps choose between multiple routing protocols for the same destination.
  - Local Significance: AD is only relevant on the router itself and is not shared in updates.

Administrative Distances (AD) Cont.

Route Source	Administrative Distance (AD)
Connected interface (directly)	0
Static Route	1
EIGRP	90
IGRP	100
RIP	120
Unreachable	255

- **Process:**
  1. Route with the lowest AD is placed in the routing table.
  2. If ADs are the same, metrics (e.g., hop count) are used.
  3. If both AD and metrics are identical, load-balancing occurs.

Administrative Distances (AD) Example



- **What happens if two routes have the same ad and metric?**
  - RIP: Number of hops.
  - EIGRP: Combination of bandwidth, delay, load, and reliability.

- **What if both advertised routes have the same ad and metric?**
  - Load Balancing occurs, meaning traffic is distributed across multiple routes.

Distance Vector Routing

- **Metric-based:** Routers advertise known networks with their own metric.
- **Periodic Updates:** Entire routing tables are shared regularly with neighbours.
- **Path Calculation:** Uses the Bellman-Ford algorithm.
- **Limited View:** Routers don't know the entire network topology.
- **Examples:** RIP, EIGRP.

Routing Table R_1

Dest. Net	Metric	Next-Router
Net_1	5	R_3
Net_2	2	R_7
⋮	⋮	⋮

Routing Information Protocol (RIP)

- **Overview:** Dynamic routing protocol using hop count to determine the best path.
- **Key Features:**
  - Hop Count: Maximum of 15 hops (16 is unreachable).
  - Load Balancing: Supports round robin for up to 6 equal-cost links (default is 4).
  - Classful Subnetting: Only supports Class A, B, and C networks, without sending subnet mask.
- **Configuration:**
  1. **Enable RIP:**
     - Router(config)# router rip
  2. **Advertise Networks:**
     - Router(config-router)# network <ID-OF-CONNECTED-NETWORKS>

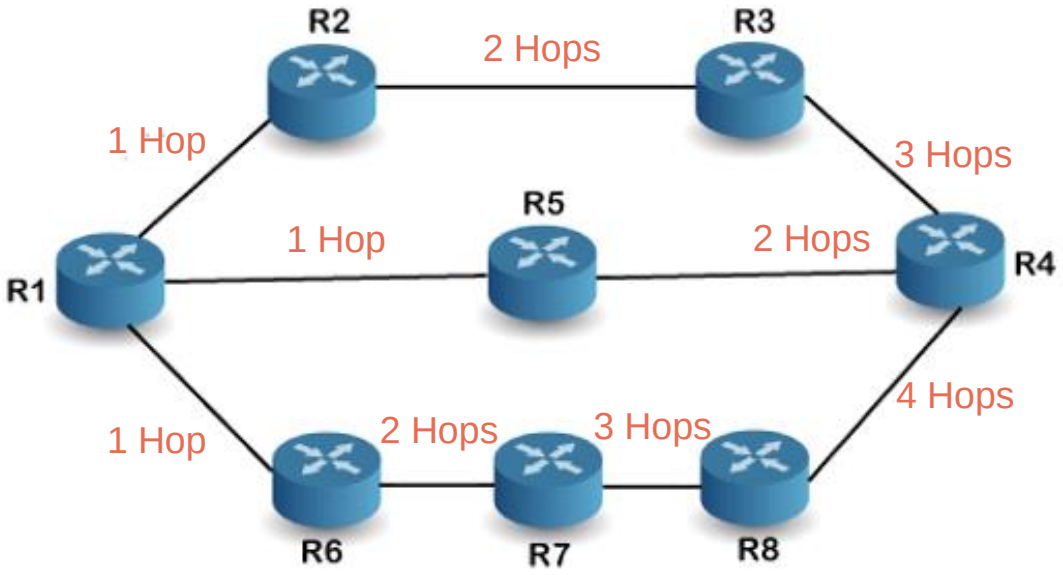
Classful Subnetting Example (RIP)

- **Can the networks 130.5.0.7 and 130.5.0.0 be configured in RIP?**
- **130.5.0.7:**
  - No, because it is classful and does not support subnet masks. RIP will interpret it as the entire Class B network 130.5.0.0/16.
- **130.5.0.0:**
  - Yes, since 130.5.0.0 is a Class B network (130.0.0.0 - 130.255.255.255), RIP will handle it as 130.5.0.0/16 without any issues.

Address Class	IP Range	Slash
Class A	1.0.0.1 – 126.255.255.254	/8
Class B	128.0.0.1 – 191.255.255.254	/16
Class C	192.0.0.1-223.255.255.254	/24

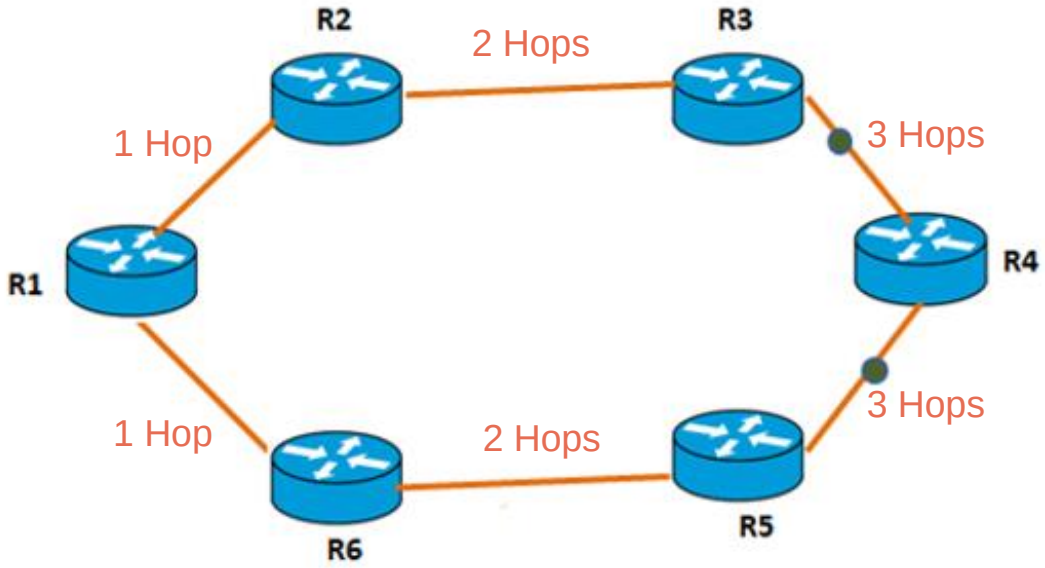
Routing Information Protocol (RIP) Example

Hop Count



Best Route from R1 to R4 = 2 Hops

Load Balancing

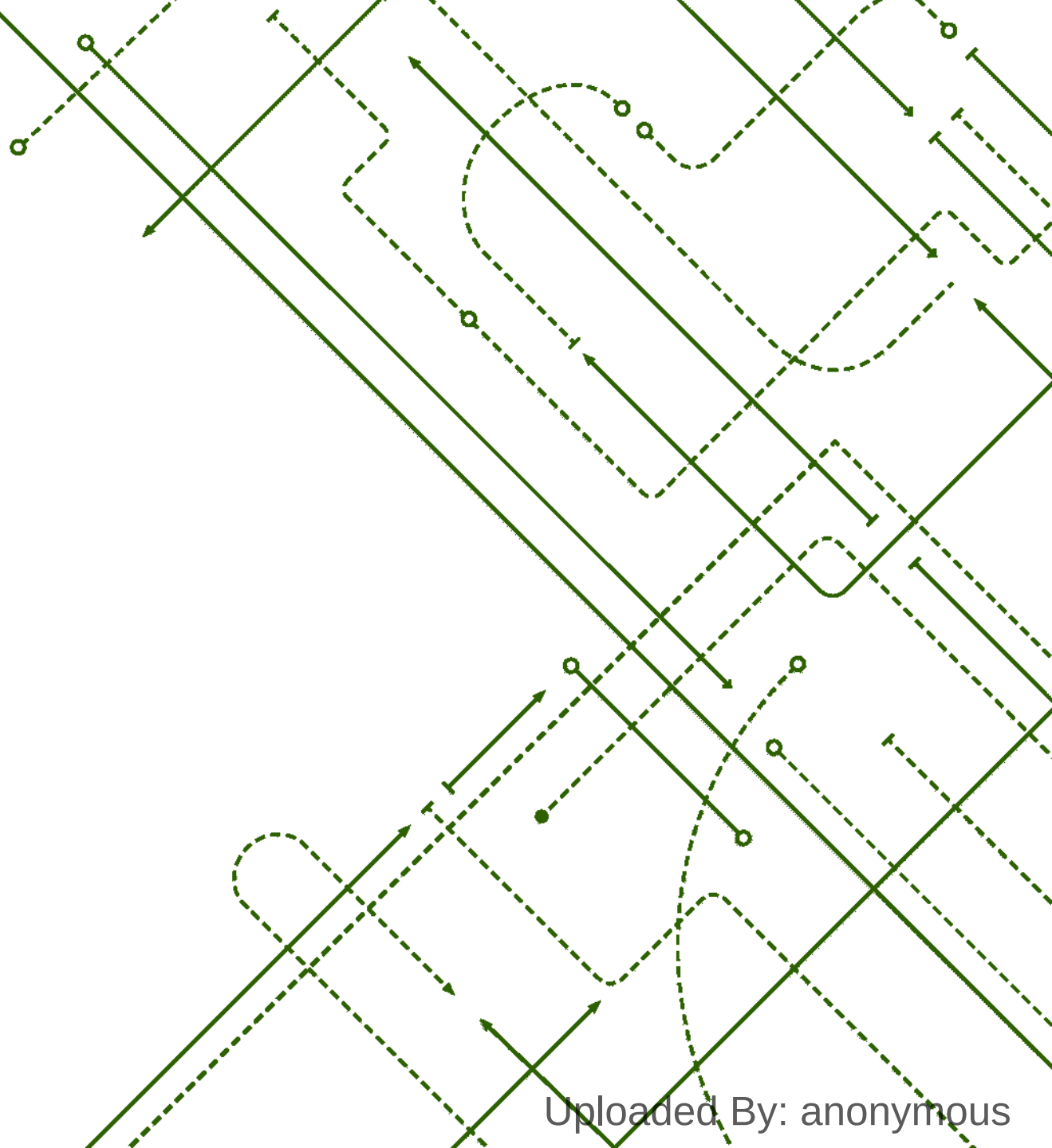


Best Route from R1 to R4 = 3 Hops

Enhanced Interior Gateway Routing Protocol (EIGRP)

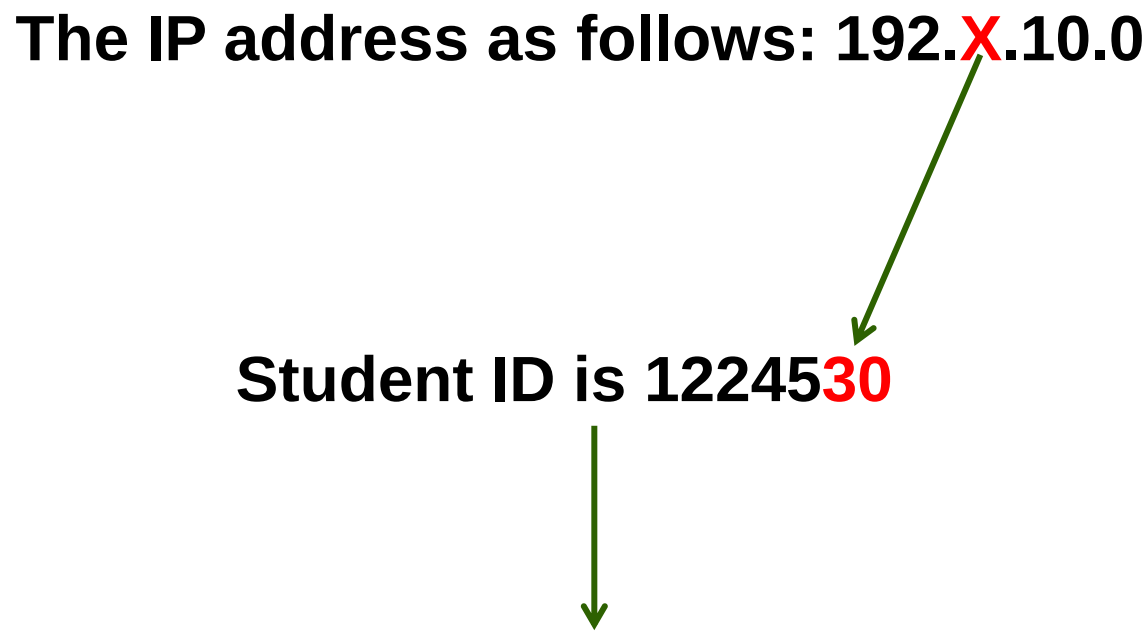
- **Overview:** Cisco-proprietary distance-vector routing protocol designed to overcome RIP limitations.
- **Key Features:**
  - Hop Count: Max of 255 (default 100).
  - Composite Metric: Uses bandwidth, load, delay and reliability to determine best routes.
- **Characteristics:**
  - Supports large internetworks.
  - Requires Autonomous System (AS) number for activation.
  - Full route table updates every 90 seconds.

Procedure



IP Address

- The IP address as follows: 192.X.10.0 → where X is : for example, student ID is 1224530, X = 30, and so the network will be 192.30.10.0/S.M



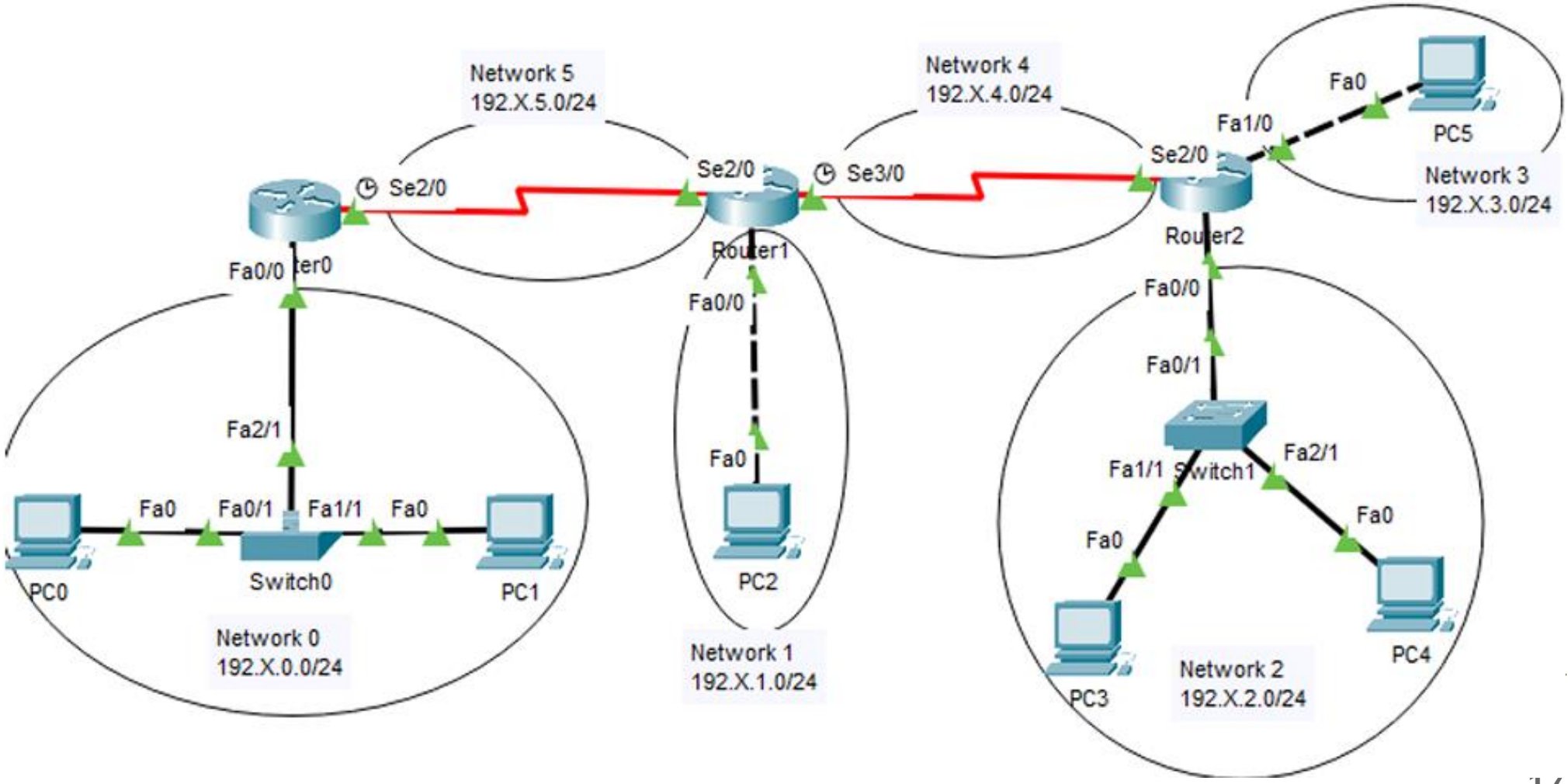
Topology

- **The topology contains:**

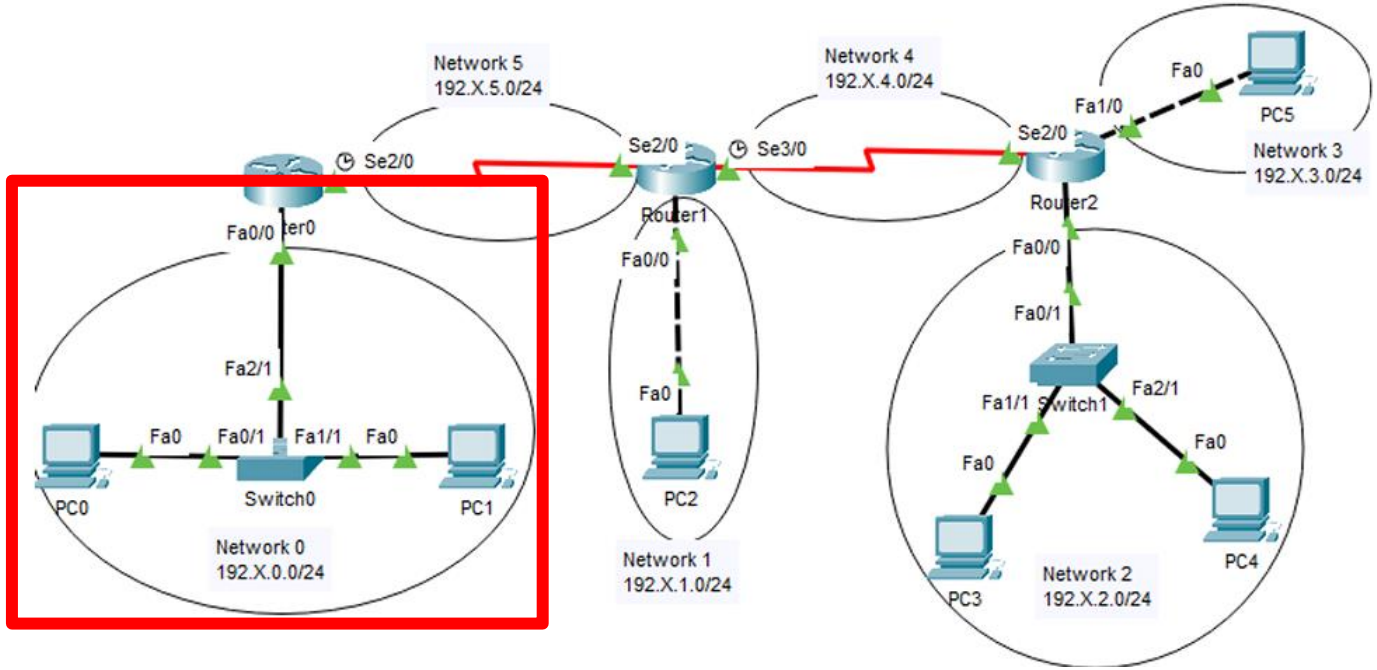
Name	Quantity	Symbol
Router-PT	3	 Router-PT
Switch-PT	2	 Switch-PT
PC-PT	6	 PC-PT

- Use Automatically use connection type: 

Topology (Cont.)

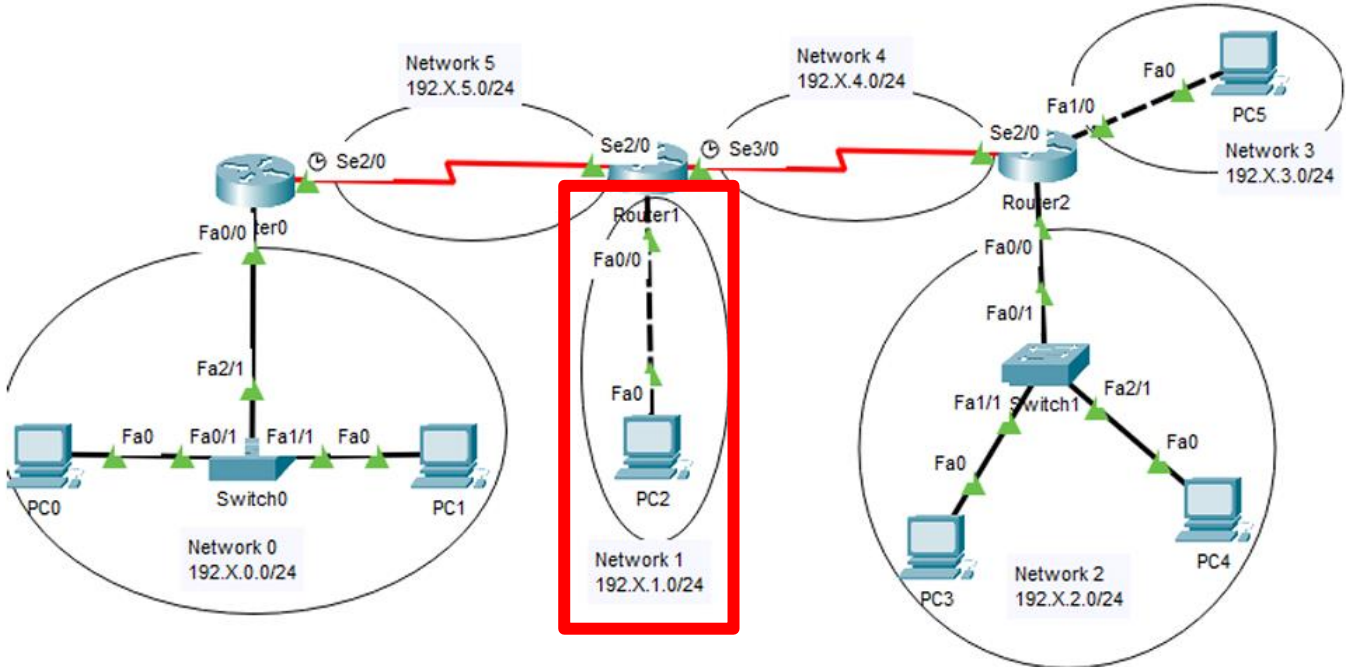


IP Address Distribution Network 0



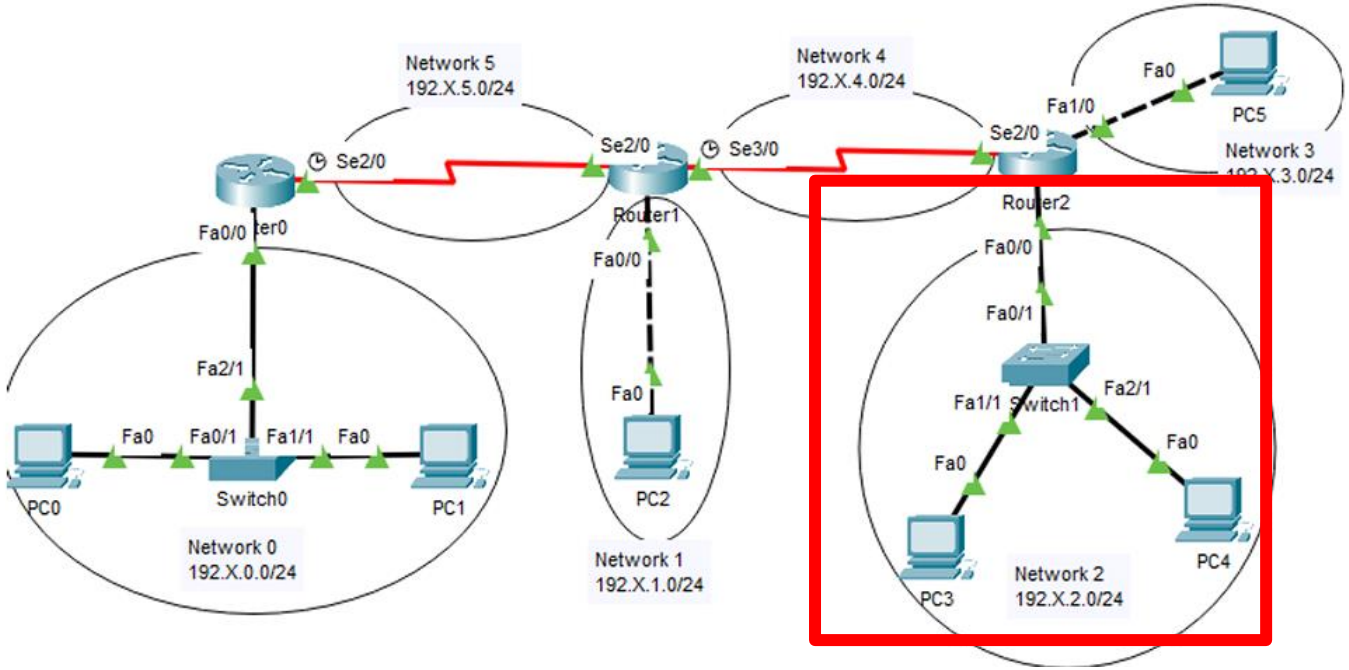
Network	Device/Interface	IP address	Subnet mask
Network 0 192.X.0.0/24	Router0 Fa0/0	192.X.0.1/24	255.255.255.0
	PC0	192.X.0.2/24	255.255.255.0
	PC1	192.X.0.3/24	255.255.255.0

IP Address Distribution Network 1



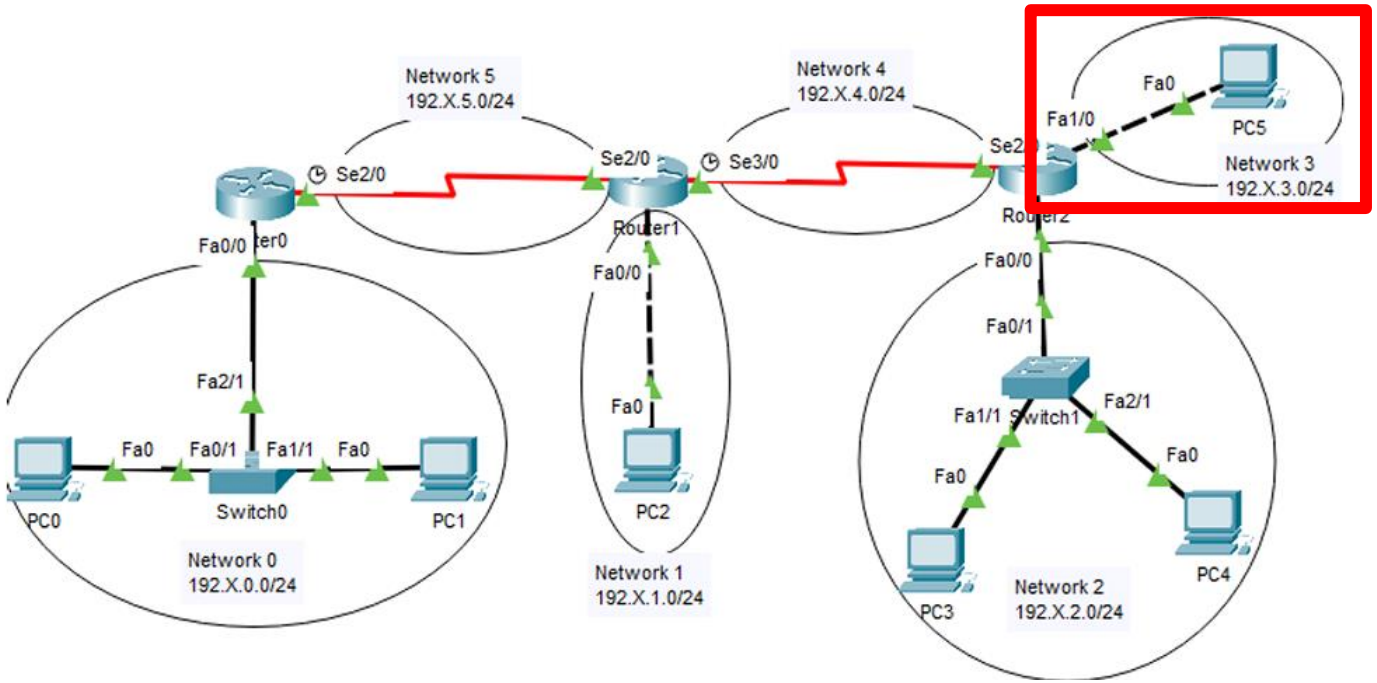
Network	Device/Interface	IP address	Subnet mask
Network 1 192.X.1.0/24	Router1 Fa0/0	192.X.1.1/24	255.255.255.0
	PC2	192.X.1.2/24	255.255.255.0

IP Address Distribution Network 2



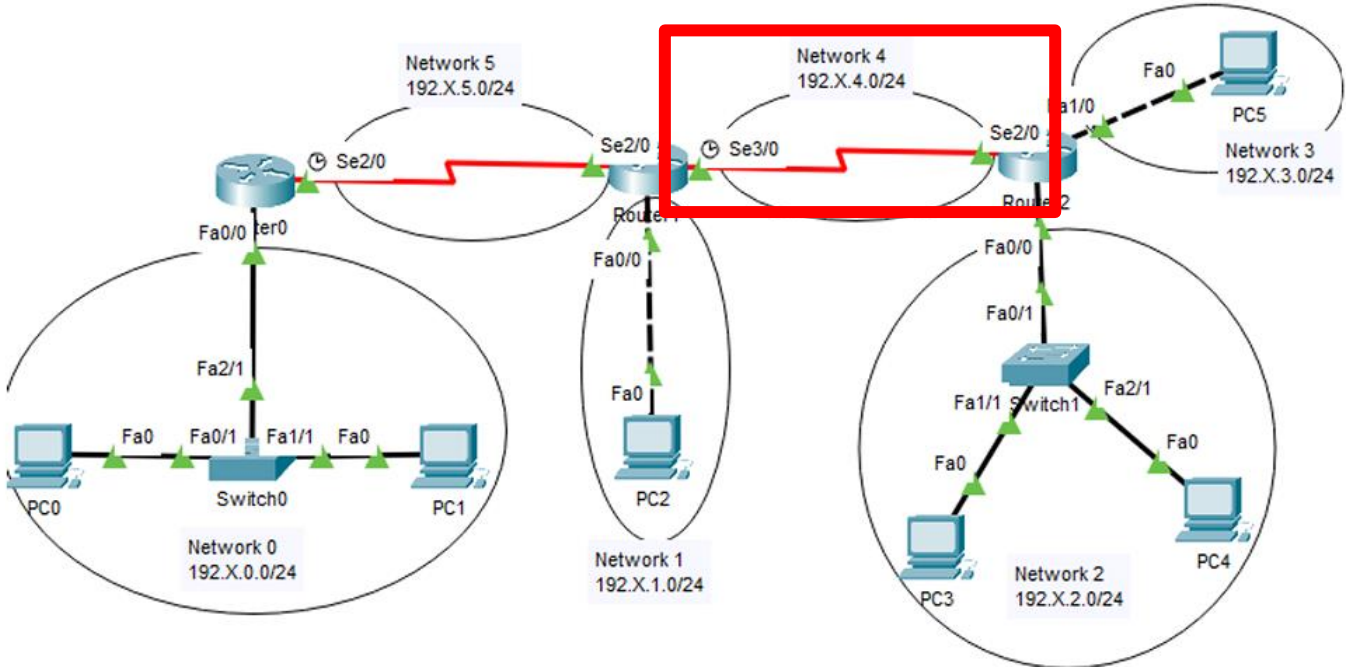
Network	Device/Interface	IP address	Subnet mask
Network 2 192.X.2.0/24	Router2 Fa0/0	192.X.2.1/24	255.255.255.0
	PC3	192.X.2.2/24	255.255.255.0
	PC4	192.X.2.3/24	255.255.255.0

IP Address Distribution Network 3



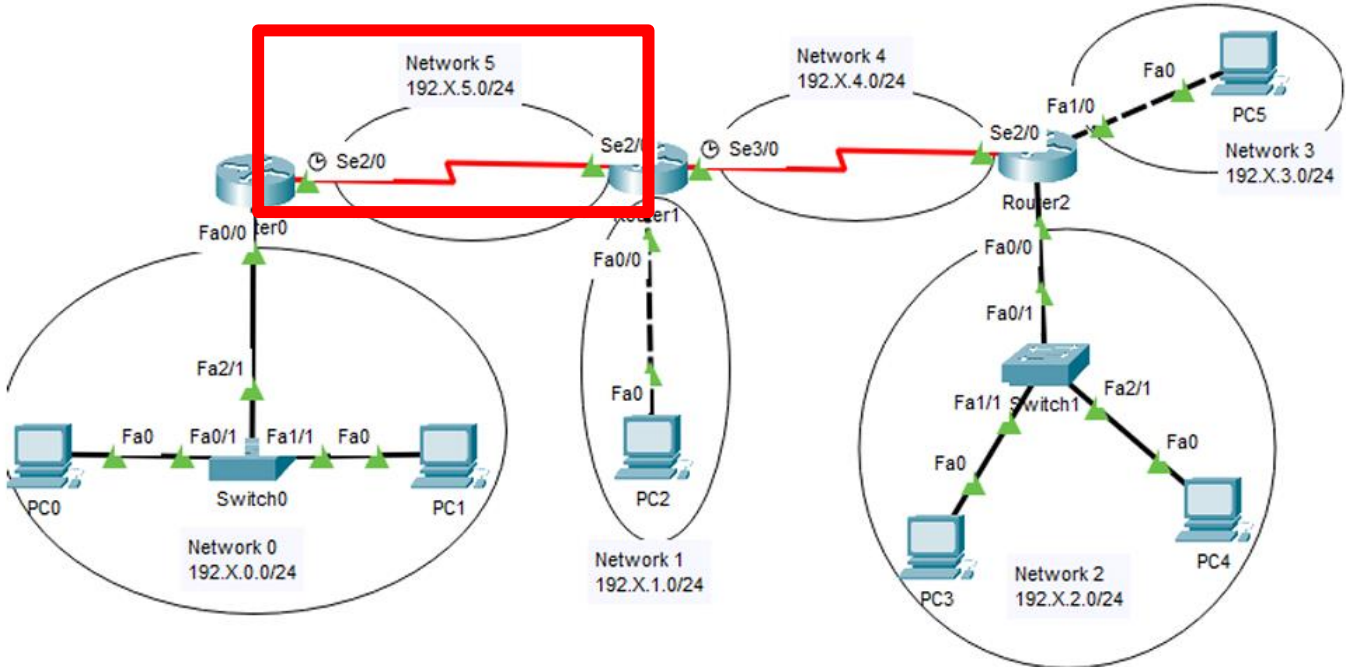
Network	Device/Interface	IP address	Subnet mask
Network 3 192.X.3.0/24	Router2 Fa1/0	192.X.3.1/24	255.255.255.0
	PC5	192.X.3.2/24	255.255.255.0

IP Address Distribution Network 4



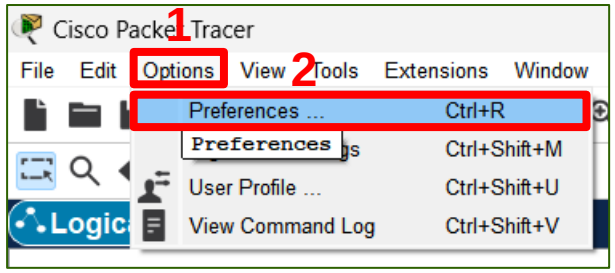
Network	Device/Interface	IP address	Subnet mask
Network 4 192.X.4.0/24	Router1 Se3/0	192.X.4.1/24	255.255.255.0
	Router2 Se2/0	192.X.4.2/24	255.255.255.0

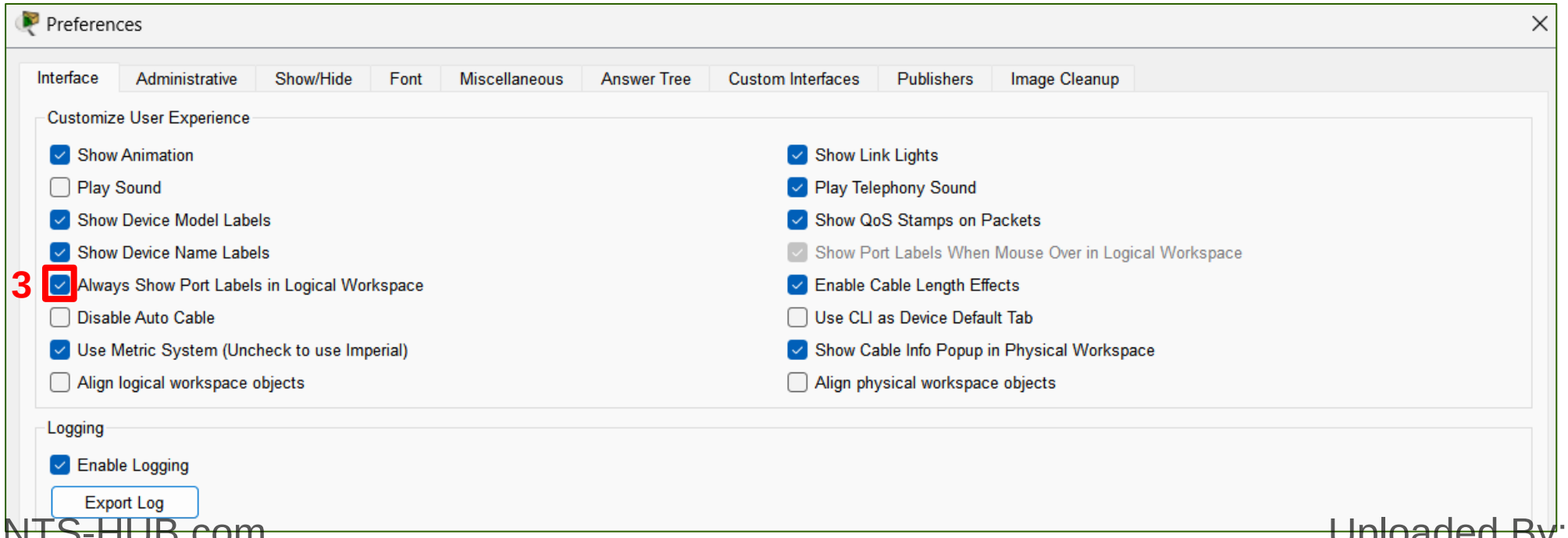
IP Address Distribution Network 5



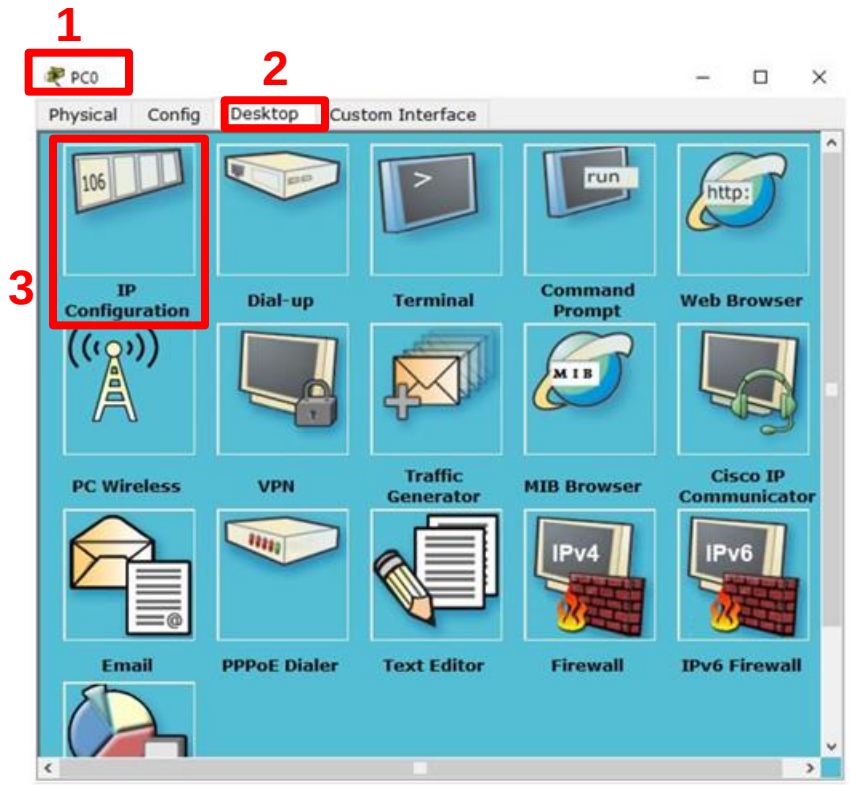
Network	Device/Interface	IP address	Subnet mask
Network 5 192.X.5.0/24	Router0 Se2/0	192.X.5.1/24	255.255.255.0
	Router1 Se2/0	192.X.5.2/24	255.255.255.0

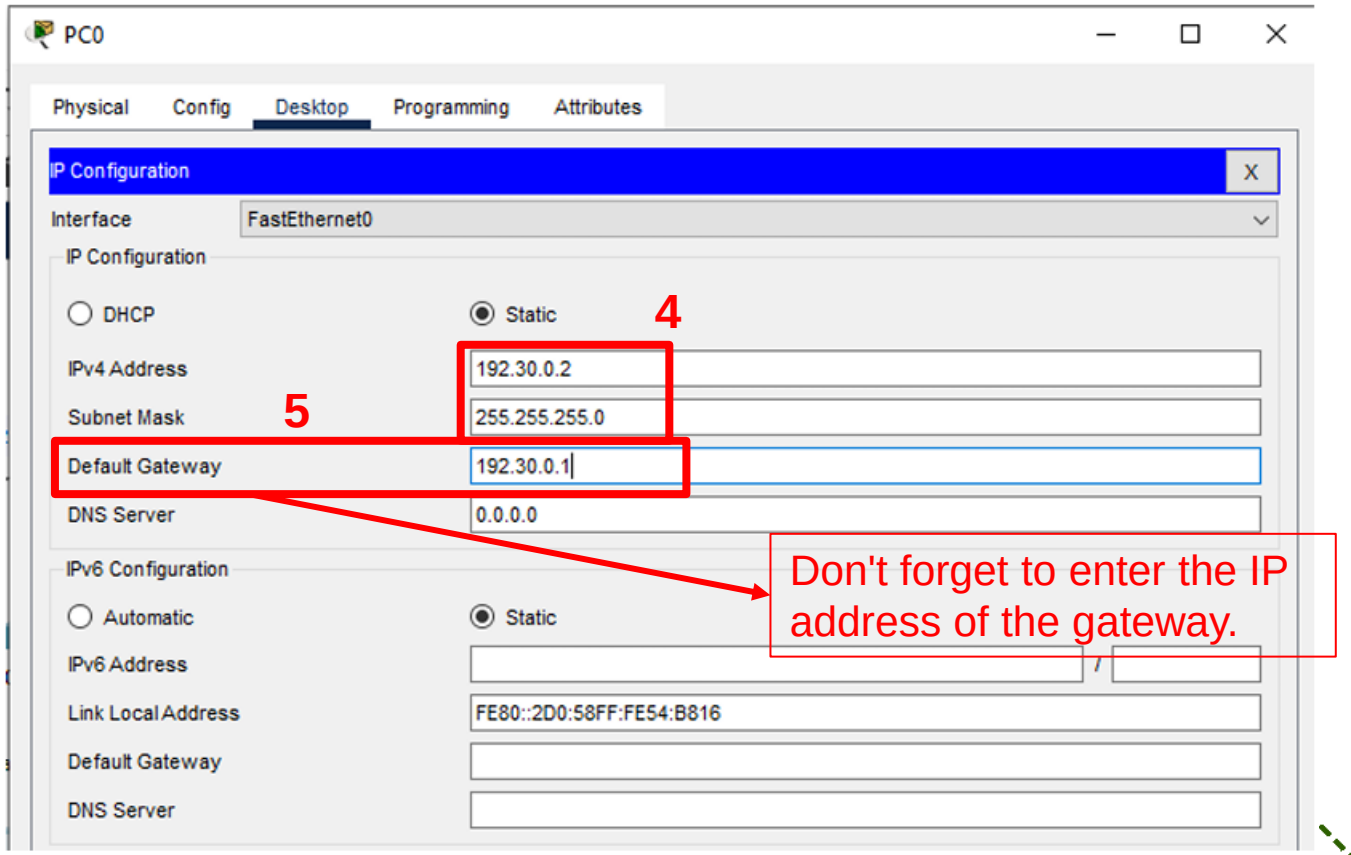
Show the port labels





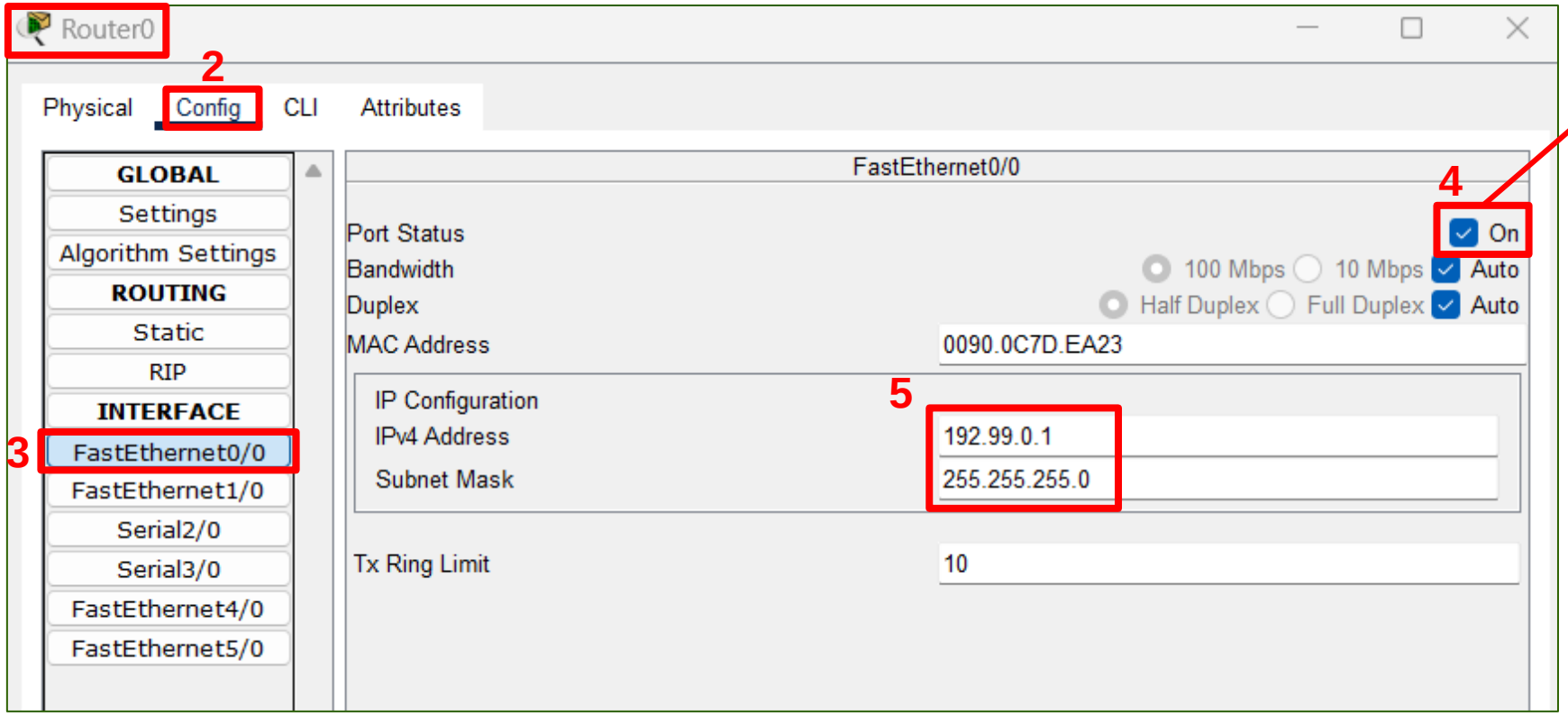
Configuring IPs for the PCs





→ **Assign the rest of the IP addresses to the rest of the PCs.**

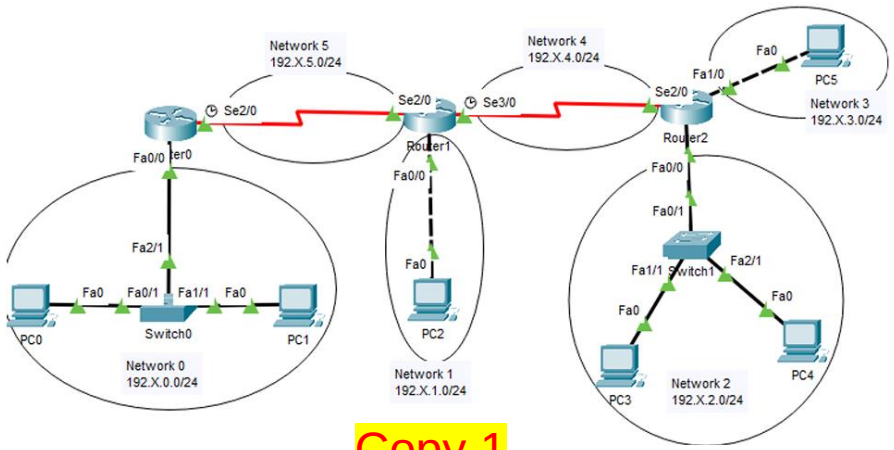
Configuring IPs for the Routers



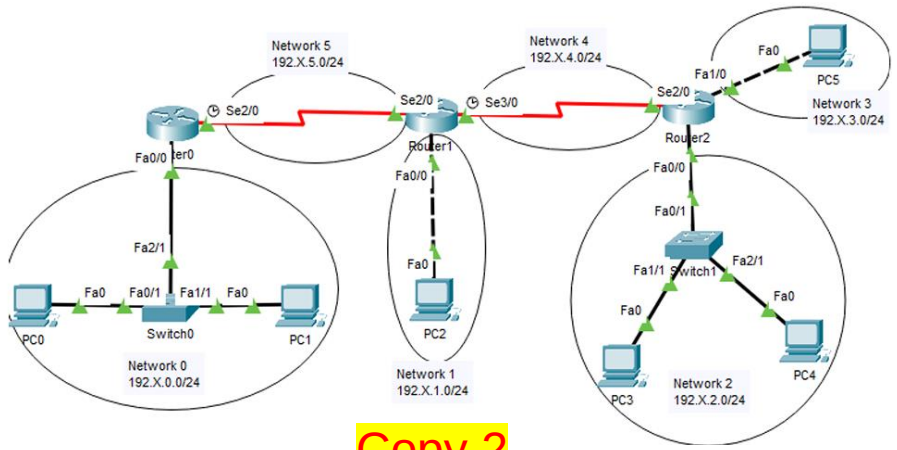
→ **Assign the rest of the IP addresses to the rest of the router interfaces.**

Setting Up Two Topologies

- **Step 1: Create the Base Topology**
  - Design the network with routers and devices (connections, IP addresses).
- **Step 2: Duplicate the Topology**
  - Copy 1: Configure routers with RIP Protocol.
  - Copy 2: Configure routers with EIGRP Protocol.

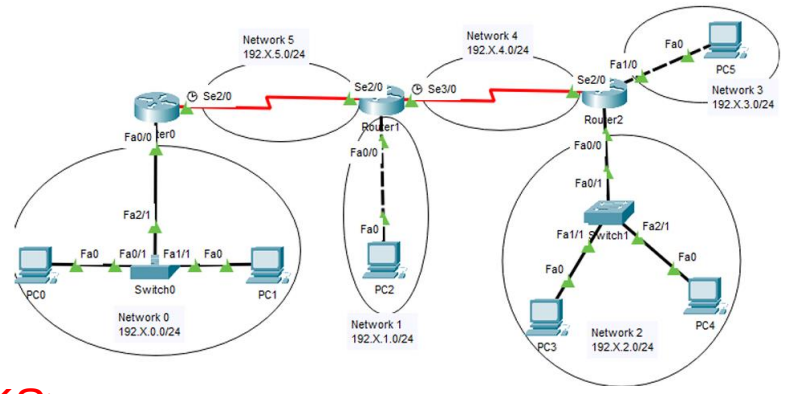


Copy 1



Copy 2

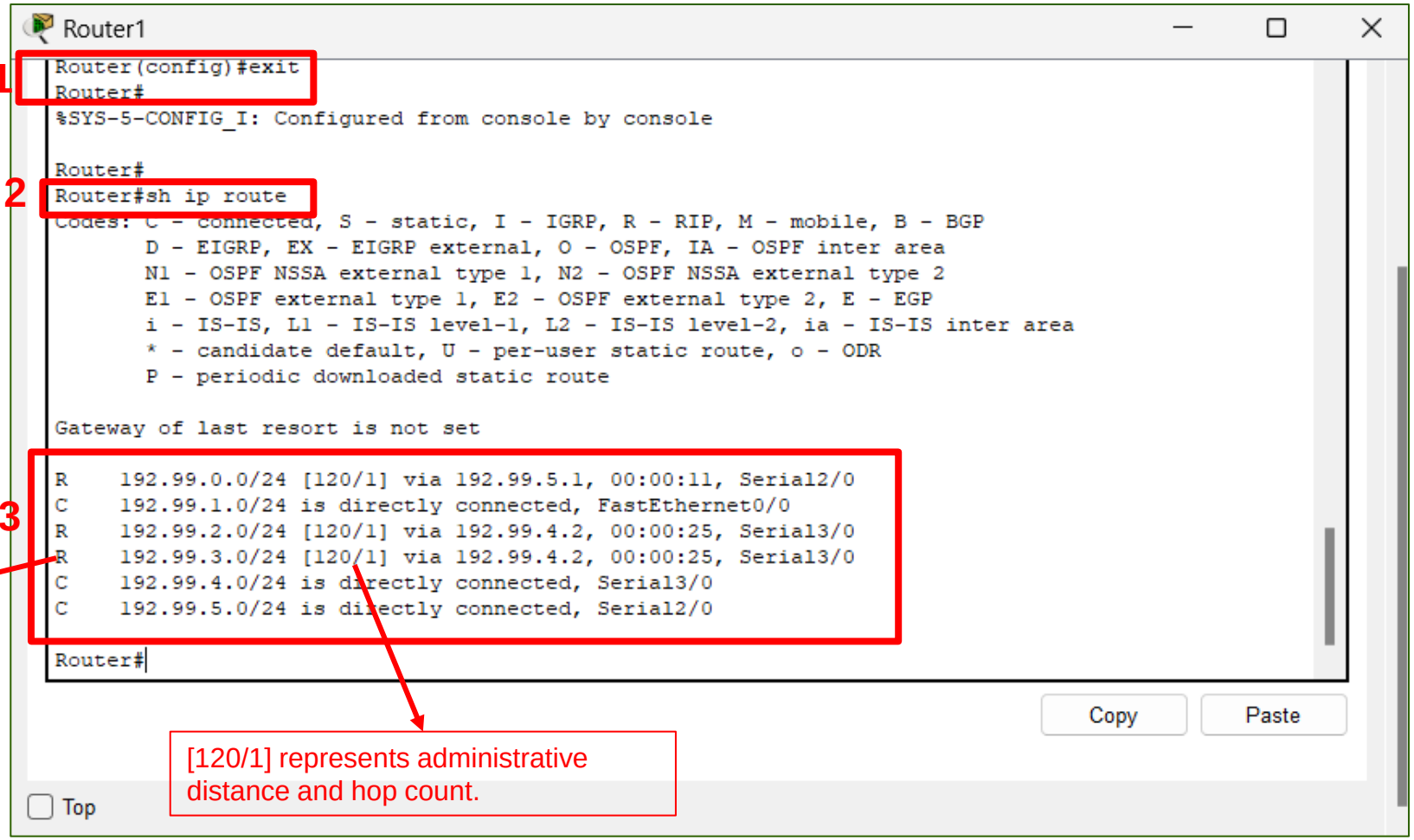
Configuring RIP Routing



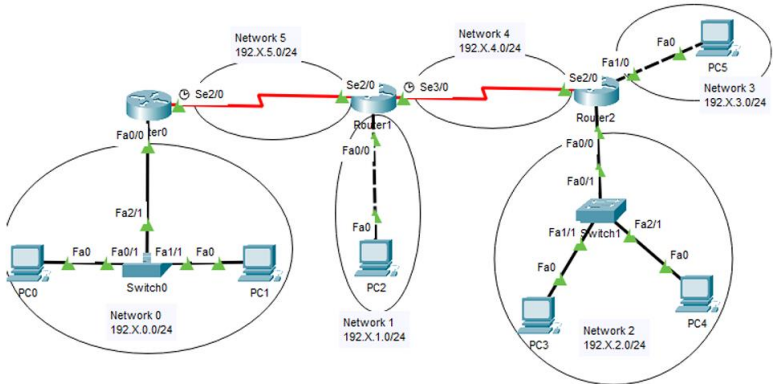
1. **Enable RIP:**
   - Router(config)# router rip
   - Router(config-router)# network <ID-OF-CONNECTED-NETWORKS>
2. **Router Configurations:**

Router 0	Router(config-router)# network 192.X.0.0
	Router(config-router)# network 192.X.5.0
Router 1	Router(config-router)# network 192.X.1.0
	Router(config-router)# network 192.X.4.0
	Router(config-router)# network 192.X.5.0
Router 2	Router(config-router)# network 192.X.2.0
	Router(config-router)# network 192.X.3.0
	Router(config-router)# network 192.X.4.0

Verifying the RIP Routing Tables

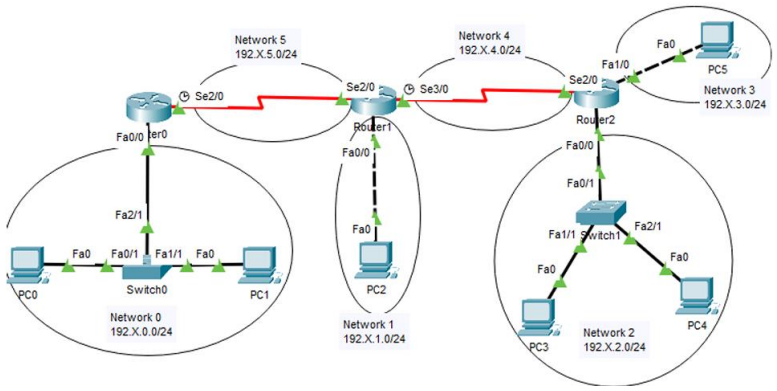


Configuring EIGRP Routing



1. **Enable EIGRP Protocol:**
   - Router(config)# router EIGRP <AS>
   - Router(config-router)# network <ID-OF-CONNECTED-NETWORKS>

Configuring EIGRP Routing Cont.



2. Router Configurations:

Router 1	Router(config)# router eigrp 10
	Router(config-router)# network 192.X.0.0
	Router(config-router)# network 192.X.5.0
Router 2	Router(config)# router eigrp 10
	Router(config-router)# network 192.X.1.0
	Router(config-router)# network 192.X.4.0
	Router(config-router)# network 192.X.5.0
Router 3	Router(config)# router eigrp 10
	Router(config-router)# network 192.X.2.0
	Router(config-router)# network 192.X.3.0
	Router(config-router)# network 192.X.4.0

Verifying the EIGRP Routing Tables

Router1

Physical Config CLI Attributes

IOS Command Line Interface

```
Router(config)#
Router(config)#
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#
Router#show ip route
Codes: C - connected, S - static, I - IGRP, 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

D    192.99.0.0/24 [90/20514560] via 192.99.5.1, 00:01:10, Serial2/0
C    192.99.1.0/24 is directly connected, FastEthernet0/0
D    192.99.2.0/24 [90/20514560] via 192.99.4.2, 00:00:34, Serial3/0
D    192.99.3.0/24 [90/20514560] via 192.99.4.2, 00:00:34, Serial3/0
C    192.99.4.0/24 is directly connected, Serial3/0
C    192.99.5.0/24 is directly connected, Serial2/0
```

1

2

3

D indicates routes injected by EIGRP.

[90/20514560] represents the administrative distance (90) and the metric value (20514560) for the EIGRP route.

Verifying Router Configurations

• Router# **show ip route**	**Displays the routing table.**
• Router# **show protocols**	**Shows the status of routing protocols.**
• Router# **show ip protocols**	**Details configured routing protocols.**
• Router# **debug ip rip**	**Enables real-time RIP packet debugging.**
• Router# **debug eigrp packets**	**Enables EIGRP packet debugging.**
• Router# **debug ip eigrp notifications**	**Shows EIGRP notification details.**
• Router# **debug ip eigrp neighbor**	**Displays EIGRP neighbour information.**

Saving Configurations

- **Don't forget to save the configurations on your router.**

  → **Router# write**
  → **Router# copy run start**

Video explaining the experiment

https://www.youtube.com/watch?v=IQR3uVKWdvQ&ab_channel=TariqOdeh

References

- **Manual for ENCS4130 Computer Networks Laboratory.**
- **Lecture Notes from Dr. Ahmed Shawahna**
- **Slides from Dr. Amr Slimi.**