



## Simulation of Campus Area Network using routing protocols

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### ABSTRACT

*Campus Area Network is an interconnection of LANs in a limited geographical area serving a corporation, universities, or government agency. A routing protocol is to determine the choice of the best route from source to ultimate destination. IPv4 static and Default route, OSPF, RIP, and EIGRP are used from source to destination to transfer IP packets.*

**Keywords**— IPv4 static and Default route, OSPF, RIP, EIGRP

### 1. INTRODUCTION

A computer network is a group of computer systems and connected together for the purpose of sharing resources. The types of networks have many kinds. Different networks can use different routing protocols. A router is a network device and the layer three of the OSI reference model. A router works to route IP packets using static or dynamic routing techniques to the destination. Routing is sent IP packets from one network to another network.

Cisco Packet Tracer is a software allows users to simulate the complete network by adding and connecting difference network devices. The configuration of cisco routers and switches use command line interface.

### 2. ELEVEN TYPES OF NETWORKS

#### 2.1 Personal Area Network (PAN)

This network is the most basic type and smallest network. This is made up of a wireless modem. These are computers, phones, tablets, printers, etc. This type of network is found in one building and small offices.

#### 2.2 Local Area Network (LAN)

This network is the most widely used and simplest type of network in short distance. This type of network is found in one building and between two or three buildings.

#### 2.3 Wireless Local Area Network (WLAN)

This network is made up of wireless network technology (e.g. Wi-Fi). This network is not required relay devices to connect the network on physical cables.

#### 2.4 Campus Area Network (CAN)

This network is seen in universities or small businesses. This is larger than LANs but smaller than WANs or MANs. Users can share resources because they can spread several buildings.

#### 2.5 Metropolitan Area Network (MAN)

This network is seen in a town or city or a large company. This is larger than LANs but smaller than WANs. This network is incorporated elements of both types of networks.

#### 2.6 Wide Area Network (WAN)

This network is connecting all computers together around the world (e.g. Internet). This is across longer physical distances.

#### 2.7 Storage-Area Network (SAN)

This network is a dedicated high-speed network. This network can be accessed as a drive attached to a server in the same fashion.

#### 2.8 System-Area Network (SAN)

This network operates at very high speeds as a single system. In server to server applications, this network provides the high-speed connection.

#### 2.9 Passive Optical Local Area Network (POLAN)

This network uses optical splitters from one strand of single mode into multiple signals to split an optical signal.

#### 2.10 Enterprise Private Network (EPN)

This network is securely connected to share computer resources in its various locations.

#### 2.11 Virtual Private Network (VPN)

This network extends a private network across a public network. This network is allowed remote users to securely access encrypted connection.

### 3. ROUTING ALGORITHMS

Broadly, three ways in classify routing algorithms. The first way is a global routing algorithm or a decentralized routing algorithm. The second way is a static routing algorithm or a dynamic routing algorithm. The third way is a load-sensitive algorithm or a load-insensitive algorithm.

### 4. ROUTING PROTOCOLS

A routing protocol specifies router communicate and distributing information. Routing algorithms determine the choice of route. There are many kinds of routing protocols.

Four major classes are the widest use of IP networks:

- (i) **IPv4 Static and Default route.**
- (ii) Interior gateway dynamic routing protocols (type 1), link-state routing protocols, **OSPF.**
- (iii) Interior gateway dynamic routing protocols (type 2), distance-vector routing protocol, **RIPv2, EIGRP.**
- (iv) Exterior gateway dynamic routing protocols, (exchange routing information between Autonomous Systems) **BGP.**

Static routes are very common and do not require overhead and the same amount of processing as dynamic routing protocols.

Open Shortest Path First (OSPF) is a link-state routing protocol developed as a replacement for RIP, the distance vector routing protocol. RIP was an acceptable routing protocol of networking and the Internet Single-area OSPF is used in smaller networks, links are not complex, and paths to individual destinations are easy.

Multi-area OSPF is used to divide a large OSPF network. Many routers in one area create a large link-state database and increase the load on the CPU. Multi-area OSPF requires a hierarchical network design. The main area is called the backbone area (area 0) and all other areas must connect to the backbone area. OSPF version 2 (OSPFv2) is available for IPv4 while OSPF version 3 (OSPFv3) is available for IPv6.

Enhanced Interior Gateway Routing Protocol (EIGRP) is a distance vector routing protocol includes features found in link-state routing protocols. EIGRP is an advanced distance vector routing protocol developed by Cisco Systems. EIGRP is suited for many different topologies and media.

Table 1: Addressing Table

| Device | Interface    | IP Address   | Subnet Mask     | Default Gateway |
|--------|--------------|--------------|-----------------|-----------------|
| R1     | G0/0         | 192.168.1.1  | 255.255.255.0   | N/A             |
|        | S0/0/0 (DCE) | 192.168.12.1 | 255.255.255.252 | N/A             |
|        | S0/0/1       | 192.168.13.1 | 255.255.255.252 | N/A             |
| R2     | G0/0         | 192.168.2.1  | 255.255.255.0   | N/A             |
|        | S0/0/0       | 192.168.12.2 | 255.255.255.252 | N/A             |
|        | S0/0/1 (DCE) | 192.168.23.1 | 255.255.255.252 | N/A             |
| R3     | G0/0         | 192.168.3.1  | 255.255.255.0   | N/A             |
|        | S0/0/0       | 192.168.13.2 | 255.255.255.252 | N/A             |
|        | S0/0/1 (DCE) | 192.168.33.1 | 255.255.255.252 | N/A             |
| R4     | G0/0         | 192.168.4.1  | 255.255.255.0   | N/A             |
|        | S0/0/0       | 192.168.23.2 | 255.255.255.252 | N/A             |
|        | S0/0/1 (DCE) | 192.168.33.2 | 255.255.255.252 | N/A             |
| PC-1   | NIC          | 192.168.1.2  | 255.255.255.0   | 192.168.1.1     |
| PC-2   | NIC          | 192.168.1.3  | 255.255.255.0   | 192.168.1.1     |
| PC-3   | NIC          | 192.168.2.2  | 255.255.255.0   | 192.168.2.1     |
| PC-4   | NIC          | 192.168.2.3  | 255.255.255.0   | 192.168.2.1     |
| PC-5   | NIC          | 192.168.3.2  | 255.255.255.0   | 192.168.3.1     |
| PC-6   | NIC          | 192.168.3.3  | 255.255.255.0   | 192.168.3.1     |
| PC-7   | NIC          | 192.168.4.2  | 255.255.255.0   | 192.168.4.1     |
| PC-8   | NIC          | 192.168.4.3  | 255.255.255.0   | 192.168.4.1     |

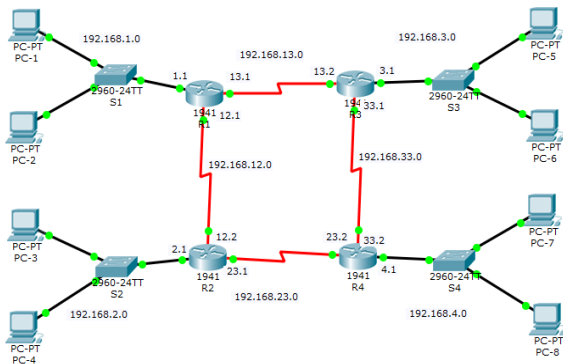


Fig. 1: Campus area network created using cisco packet tracer

Figure 1 shows that the design of the campus area network. This design includes five parts of configures. There are:

- Part 1: Build the network and Configure Basic Device Settings
- Part 2: Configure Static and Default Routes
- Part 3: Configure and Verify OSPF Routing
- Part 4: Configure and Verify RIPv2 Routing
- Part 5: Configure and Verify EIGRP Routing

4.1 Build the Network and Configure Basic Device Settings (Part 1)

Step 1: Cable the network.

Step 2: Initialize and reload the routers.

Step 3: Configure basic settings for each router.

- (i) Disable DNS lookup.
- (ii) Configure the device name as shown in the topology.
- (iii) Assign **class** as the privileged EXEC password.
- (iv) Assign **cisco** as the console and **cisco** as VTY passwords.
- (v) Configure a message of the day (MOTD) banner to warn users that unauthorized access is prohibited.
- (vi) Configure **logging synchronous** for the console line.
- (vii) Configure the IP address listed in the Addressing Table for all interfaces.
- (viii) Set the clock rate for all DCE serial interfaces at **128000**.
- (ix) Copy the running configuration to the startup configuration.

Router R1 Configuration:

- i. Router(config)# no ip domain lookup
- ii. Router(config)#hostname R1
- iii. R1(config)#enable password class
- iv. R1(config)#line console 0  
R1(config-line)#password cisco  
R1(config-line)#login  
R1(config)#exit
- v. R1(config)#line vty 0 4  
R1(config-line)#password cisco  
R1(config-line)#login  
R1(config)#exit
- vi. R1(config)#banner motd #' unauthorized access is prohibited'#
- vii. R1(config)#line console 0  
R1(config-line)#logging synchronous  
R1(config-line)#exit
- viii. R1(config)#interface g0/0  
R1(config-if)#ip address 192.168.1.1 255.255.255.0  
R1(config-if)#no shut  
R1(config)#exit
- ix. R1(config)#interface s0/0/0  
R1(config-if)#ip address 192.168.12.1 255.255.255.252  
R1(config-if)#clock rate 128000  
R1(config-if)#no shut  
R1(config-if)#exit
- x. R1(config)#interface s0/0/1  
R1(config-if)#ip address 192.168.13.1 255.255.255.252  
R1(config-if)#no shut  
R1(config-if)#exit  
R1(config)#exit
- xi. R1#copy running-config startup-config

Configure basic settings on R2, R3, and R4.

Step 4: Configure PC hosts.

Step 5: Test connectivity.

4.2 Configure Static and Default Routes (Part 2)

Step 1: Configure recursive static routes on R1.

```
R1(config)# ip route 192.168.2.0 255.255.255.0 192.168.12.2
R1(config)# ip route 192.168.2.0 255.255.255.0 192.168.23.1
R1(config)# ip route 192.168.3.0 255.255.255.0 192.168.13.2
R1(config)# ip route 192.168.3.0 255.255.255.0 192.168.33.1
R1(config)# ip route 192.168.4.0 255.255.255.0 192.168.23.2
R1(config)# ip route 192.168.4.0 255.255.255.0 192.168.33.2
R1(config)# ip route 192.168.23.0 255.255.255.252
192.168.12.2
R1(config)# ip route 192.168.23.0 255.255.255.252
192.168.33.2
R1(config)# ip route 192.168.33.0 255.255.255.252
192.168.13.2
R1(config)# ip route 192.168.33.0 255.255.255.252
192.168.23.2
```

**Step 2:** Configure directly attached static routes on R2.

```
R2(config)# ip route 192.168.1.0 255.255.255.0 192.168.12.1
R2(config)# ip route 192.168.1.0 255.255.255.0 192.168.13.1
R2(config)# ip route 192.168.3.0 255.255.255.0 192.168.13.2
R2(config)# ip route 192.168.3.0 255.255.255.0 192.168.33.1
R2(config)# ip route 192.168.4.0 255.255.255.0 192.168.23.2
R2(config)# ip route 192.168.4.0 255.255.255.0 192.168.33.2
R2(config)# ip route 192.168.13.0 255.255.255.252
192.168.12.1
R2(config)# ip route 192.168.13.0 255.255.255.252
192.168.33.1
R2(config)# ip route 192.168.33.0 255.255.255.252
192.168.13.2
R2(config)# ip route 192.168.33.0 255.255.255.252
192.168.23.2
```

**Step 3:** Configure directly attached static routes on R3.

```
R3(config)# ip route 192.168.1.0 255.255.255.0 192.168.12.1
R3(config)# ip route 192.168.1.0 255.255.255.0 192.168.13.1
R3(config)# ip route 192.168.2.0 255.255.255.0 192.168.12.2
R3(config)# ip route 192.168.2.0 255.255.255.0 192.168.23.1
R3(config)# ip route 192.168.4.0 255.255.255.0 192.168.23.2
R3(config)# ip route 192.168.4.0 255.255.255.0 192.168.33.2
R3(config)# ip route 192.168.12.0 255.255.255.252
192.168.13.1
R3(config)# ip route 192.168.12.0 255.255.255.252
192.168.23.1
R3(config)# ip route 192.168.23.0 255.255.255.252
192.168.12.2
R3(config)# ip route 192.168.23.0 255.255.255.252
192.168.33.2
```

**Step 4:** Configure a default route on R4.

```
R4(config)# ip route 0.0.0.0 0.0.0.0 192.168.23.1
R4(config)# ip route 0.0.0.0 0.0.0.0 192.168.33.1
```

**Step 5:** Verify static route configurations.

**Step 6:** Verify Connectivity.

### 4.3 Configure and Verify OSPF Routing (Part 3)

**Step1:** Configure OSPF on R1

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.1.0 0.0.0.255 area 0
R1(config-router)#network 192.168.12.0 0.0.0.3 area 0
R1(config-router)#network 192.168.13.0 0.0.0.3 area 0
R1(config-router)#exit
```

**Step 2:** Configure OSPF on R2

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.2.0 0.0.0.255 area 0
R2(config-router)#network 192.168.12.0 0.0.0.3 area 0
R2(config-router)#network 192.168.23.0 0.0.0.3 area 0
R2(config-router)#exit
```

**Step 3:** Configure OSPF on R3

```
R3(config)#router ospf 1
R3(config-router)#network 192.168.3.0 0.0.0.255 area 0
R3(config-router)#network 192.168.13.0 0.0.0.3 area 0
R3(config-router)#network 192.168.33.0 0.0.0.3 area 0
R3(config-router)#exit
```

**Step 4:** Configure OSPF on R4

```
R4(config)#router ospf 1
R4(config-router)#network 192.168.4.0 0.0.0.255 area 0
R4(config-router)#network 192.168.23.0 0.0.0.3 area 0
R4(config-router)#network 192.168.33.0 0.0.0.3 area 0
R4(config-router)#exit
```

**Step 5:** Verify OSPF neighbors and routing information.

**Step 6:** Verify OSPF protocol setting.

**Step 7:** Verify end-to-end connectivity.

### 4.4 Configure and Verify RIPv2 Routing (Part 4)

**Step 1:** Configure RIPv2 on R1

```
R1(config)#router rip
R1(config)#version 2
R1(config)#passive-interface g0/0
R1(config-router)#network 192.168.0.0
R1(config-router)#exit
```

**Step 2:** Configure RIPv2 on R2

```
R2(config)#router rip
R2(config)#version 2
R2(config)#passive-interface g0/0
R2(config-router)#network 192.168.0.0
R2(config-router)#exit
```

**Step 3:** Configure RIPv2 on R3

```
R3(config)#router rip
R3(config)#version 2
R3(config)#passive-interface g0/0
R3(config-router)#network 192.168.0.0
R3(config-router)#exit
```

**Step 4:** Configure RIPv2 on R4

```
R4(config)#router rip
R4(config)#version 2
R4(config)#passive-interface g0/0
R4(config-router)#network 192.168.0.0
R4(config-router)#exit
```

**Step 5:** Examine the current state of the network.

**Step 6:** Verify the RIP protocol setting.

**Step 7:** Verify end-to-end connectivity.

### 4.5 Configure and Verify EIGRP Routing (Part 5)

**Step1:** Configure EIGRP on R1

```
R1(config)#router eigrp 10
R1(config-router)#network 192.168.1.0 0.0.0.255
R1(config-router)#network 192.168.12.0 0.0.0.3
R1(config-router)#network 192.168.13.0 0.0.0.3
R1(config-router)#exit
```

**Step 2:** Configure EIGRP on R2

```
R2(config)#router eigrp 10
R2(config-router)#network 192.168.2.0 0.0.0.255
R2(config-router)#network 192.168.12.0 0.0.0.3
R2(config-router)#network 192.168.23.0 0.0.0.3
R2(config-router)#exit
```

**Step 3:** Configure EIGRP on R3

```
R3(config)#router eigrp 10
R3(config-router)#network 192.168.3.0 0.0.0.255
R3(config-router)#network 192.168.13.0 0.0.0.3
```

```
R3(config-router)#network 192.168.33.0 0.0.0.3
R3(config-router)#exit
```

**Step 4: Configure EIGRP on R4**

```
R4(config)#router eigrp 10
R4(config-router)#network 192.168.4.0 0.0.0.255
R4(config-router)#network 192.168.23.0 0.0.0.3
R4(config-router)#network 192.168.33.0 0.0.0.3
R4(config-router)#exit
```

**Step 5: Verify EIGRP neighbors and routing information.**

**Step 6: Verify EIGRP protocol setting.**

**Step 7: Verify end-to-end connectivity.**

Figure 4 shows that test connectivity to ping the IP addresses of PC-5 and PC-6 from PC-1.

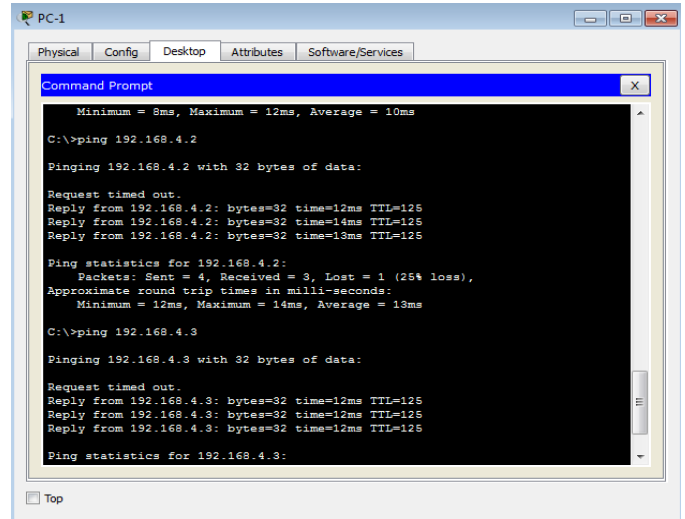


Fig. 5: Ping test from PC-1 to PC-7 and PC-8

Figure 5 shows that test connectivity to ping the IP addresses of PC-7 and PC-8 from PC-1.

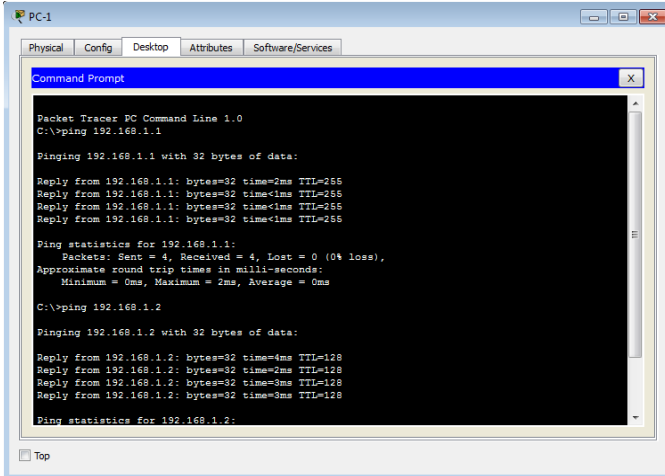


Fig. 2: Ping test from PC-1 to PC-2

Figure 2 shows that test connectivity to ping the IP address of PC-2 from PC-1.

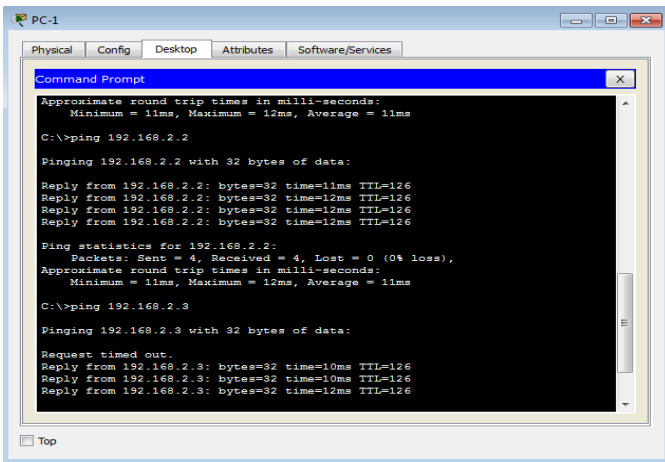


Fig. 3: Ping test from PC-1 to PC-3 and PC-4

Figure 3 shows that test connectivity to ping the IP addresses of PC-3 and PC-4 from PC-1.

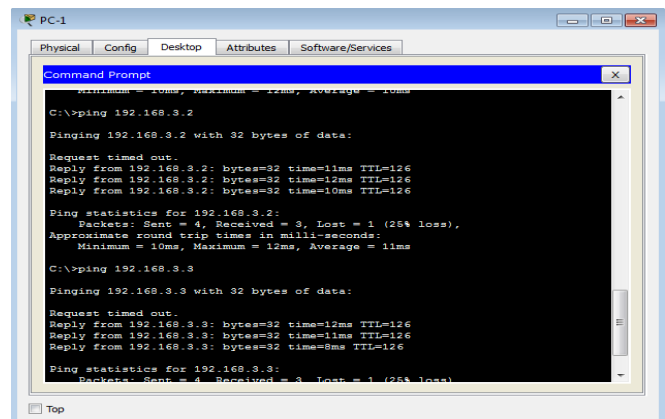


Fig. 4: Ping test from PC-1 to PC-5 and PC-6

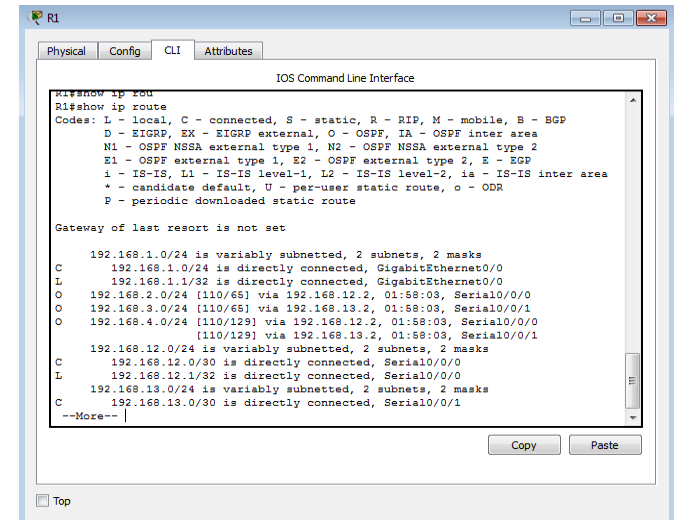


Fig.6: IP route for R1

Figure 6 shows that R1 displays its own subnet and directly connected.

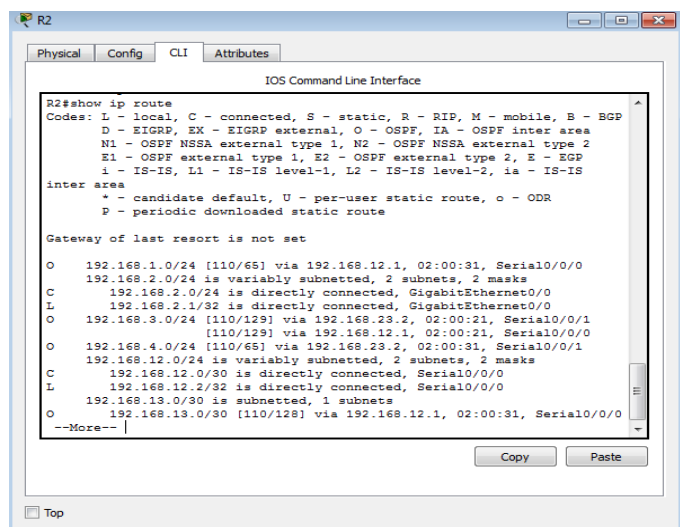


Fig. 7: IP route for R2

Figure 7 shows that R2 displays its own subnet and directly connected.



```

R3#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

O 192.168.1.0/24 [110/65] via 192.168.13.1, 02:05:20, Serial0/0/0
O 192.168.2.0/24 [110/129] via 192.168.13.1, 02:05:20, Serial0/0/0
   [110/129] via 192.168.33.2, 02:05:20, Serial0/0/1
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.0/24 is directly connected, GigabitEthernet0/0
L 192.168.3.1/32 is directly connected, GigabitEthernet0/0
O 192.168.4.0/24 [110/65] via 192.168.33.2, 02:05:20, Serial0/0/1
   [110/65] via 192.168.12.0/30, 02:05:20, Serial0/0/0
192.168.12.0/30 is subnetted, 1 subnets
O 192.168.12.0/30 [110/128] via 192.168.13.1, 02:05:20, Serial0/0/0
O 192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.13.0/30 is directly connected, Serial0/0/0
L 192.168.13.2/32 is directly connected, Serial0/0/0
--More--
    
```

Fig. 8: IP route for R3

Figure 8 shows that R3 displays its own subnet and directly connected.

```

R4#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

O 192.168.1.0/24 [110/129] via 192.168.23.1, 02:07:28, Serial0/0/0
   [110/129] via 192.168.33.1, 02:07:28, Serial0/0/1
O 192.168.2.0/24 [110/65] via 192.168.23.1, 02:07:28, Serial0/0/0
O 192.168.3.0/24 [110/65] via 192.168.33.1, 02:07:28, Serial0/0/1
192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.4.0/24 is directly connected, GigabitEthernet0/0
L 192.168.4.1/32 is directly connected, GigabitEthernet0/0
O 192.168.12.0/30 is subnetted, 1 subnets
O 192.168.12.0/30 [110/128] via 192.168.23.1, 02:07:28, Serial0/0/0
O 192.168.13.0/30 is subnetted, 1 subnets
O 192.168.13.0/30 [110/128] via 192.168.33.1, 02:07:28, Serial0/0/1
192.168.23.0/24 is variably subnetted, 2 subnets, 2 masks
--More--
    
```

Fig. 9: IP route for R4

Figure 9 shows that R4 displays its own subnet and directly connected.

## 5. CONCLUSION

Static and Default route and Interior gateway dynamic routing protocols (OSPF, RIP, and EIGRP) are provided between campus area networks for communication. OSPF is a classless routing protocol. OSPF, RIPv2, EIGRP can each be configured to authenticate their routing information.

## 6. ACKNOWLEDGEMENT

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