Namal Institute Mianwali

Computer Networks Laboratory Manual #11

Dynamic Routing

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Assignment No.	**11**

Course Title	Computer Networks	**Course Number**	CS – 331 L
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Dynamic Routing

Dynamic routing, also called adaptive **routing**, describes the capability of a system, through which routes are characterized by their destination, to alter the path that the route takes through the system in response to a change in conditions.

Static routing allows routing tables in specific routers to be set up by the network administrator. Dynamic routing use Routing Protocols that dynamically discover network destinations and how to get to them. Dynamic routing allows routing tables in routers to change if a router on the route goes down or if a new network is added.

In Dynamic Routing, Routing Protocols running in Routers continuously exchange network status updates between each other as broadcast or multicast. With the help of routing updates messages sent by the Routing Protocols, routers can continuously update the routing table when ever a network topology change happens.

Examples of Routing Protocols are Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP) and Open Shortest Path First (OSPF).

There are three basic types of routing protocols.

Distance-vector Routing Protocols: Distance-vector Routing Protocols use simple algorithms that calculate a cumulative distance value between routers based on hop count.

Example: Routing Information Protocol Version 1 (RIPv1) and Interior Gateway Routing Protocol (IGRP)

Link-state Routing Protocols: Link-state Routing Protocols use sophisticated algorithms that maintain a complex database of internetwork topology.

Example: Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS)

Hybrid Routing Protocols: Hybrid Routing Protocols use a combination of distance-vector and link-state methods that tries to incorporate the advantages of both and minimize their disadvantages.

Example: Enhanced Interior Gateway Routing Protocol (EIGRP), Routing Information Protocol Version 2 (RIPv2)

Important steps for dynamic routing

Step # 01 Design the below given network in packet tracer workspace

Step # 02 Assigning IP address on Fast Ethernet interface of router

Step # 03 Assigning IP address on serial interface of router

Step # 04 Assigning IP address on PCs using DHCP

Step #05 Apply dynamic Routing on Routers

Step # 06 Verify connectivity among different users (Use ping command)

Step # 01 Design the below given network in packet tracer workspace

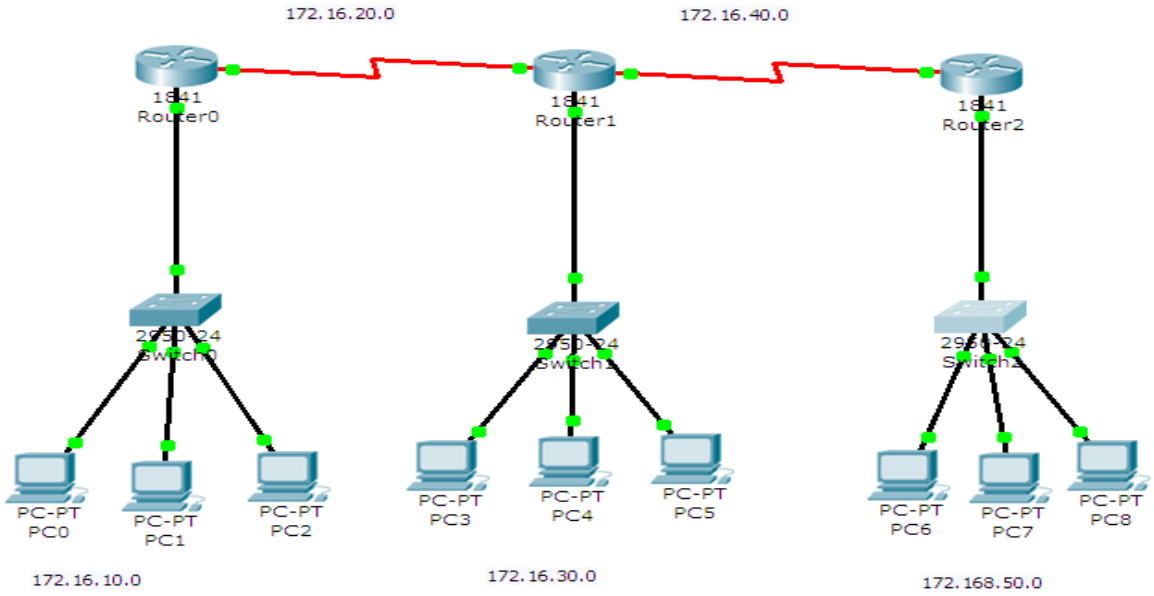


Figure 11.1 shows the network diagram

Table 11.1 shows the list of IP address used in above network

INTERFACE	DEVICE	IP ADDRESS
Fast Ethernet 0/0	R1	172.16.10.1
Serial 0/1/0	R1	172.16.20.1
Serial 0/1/0	R2	172.16.20.2
Serial 0/1/1	R2	172.16.40.1
Fast Ethernet 0/0	R2	172.16.30.1
Fast Ethernet 0/0	R3	172.16.50.1
Serial 0/1/0	R3	172.16.40.2
Fast Ethernet 0/2	PC1	172.16.10.2
Fast Ethernet 0/3	PC2	172.16.10.3
Fast Ethernet 0/4	PC3	172.16.10.4
Fast Ethernet 0/2	PC4	172.16.30.2
Fast Ethernet 0/3	PC5	172.16.30.3
Fast Ethernet 0/4	PC6	172.16.30.4
Fast Ethernet 0/2	PC7	172.16.50.2
Fast Ethernet 0/3	PC8	172.16.50.3
Fast Ethernet 0/4	PC9	172.16.50.4

Step # 02 Assigning IP address on Fast Ethernet interface of router

Router (config) #int fastEthernet 0/0

Router (config-if) #ip address 172.16.10.1 255.255.255.0

Router (config-if) #no shutdown

Note: Repeat above steps on all Fast Ethernet interfaces of all routers

Step # 03 Assigning IP address on serial interface of router

Router(config)#int serial 0/1/0

Router(config-if)#ip address 172.16.20.1 255.255.255.0

Router(config-if)#no shutdown

Router(config-if)#clock rate 56000

Router(config-if)#exit

Note: Repeat above steps on all serial interfaces of all routers

Note: Clock rate will only be set to DCE end of serial connection but not on DTE end.

Step # 04 Assigning IP address on PCs

Router(config)#

Router(config)#ip dhcp pool IP10

Router(dhcp-config)#network 172.16.10.0 255.255.255.0

Router(dhcp-config)#default-router 172.16.10.1

Router(dhcp-config)#exit

Note: Repeat above steps on all PCs

Step #05 Apply dynamic Routing on Routers

Router(config)#router rip

Router(config-router)#network 172.16.0.0

Router(config-router)#exit

Note: Repeat above steps on all routers

Step # 06 Verify connectivity among different users (Use ping command)

```
PC>ping 172.16.20.2

Pinging 172.16.20.2 with 32 bytes of data:

Reply from 172.16.20.2: bytes=32 time=60ms TTL=254
Reply from 172.16.20.2: bytes=32 time=60ms TTL=254
Reply from 172.16.20.2: bytes=32 time=60ms TTL=254
Reply from 172.16.20.2: bytes=32 time=60ms TTL=254

Ping statistics for 172.16.20.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 60ms, Maximum = 60ms, Average = 60ms
```

Note: Repeat above steps on all PCs

Configure OSPF routing on the routers.

1. Use the **router ospf** command in global configuration mode to enable OSPF on R1.
   ```
   R1(config)# router ospf 1
   ```
2. Configure the **network** statements for the networks on R1. Use an area ID of 0.
   ```
   R1(config-router)# network 192.168.1.0 0.0.0.255 area 0
   R1(config-router)# network 10.1.1.0 0.0.0.3 area 0
   ```
3. Configure OSPF on R2 and R3.

   ```
   R2(config)# router ospf 1
   R2(config-router)# network 10.1.1.0 0.0.0.3 area 0
   R2(config-router)# network 10.2.2.0 0.0.0.3 area 0
   R3(config)# router ospf 1
   R3(config-router)# network 10.2.2.0 0.0.0.3 area 0
   R3(config-router)# network 192.168.3.0 0.0.0.255 area 0
   ```

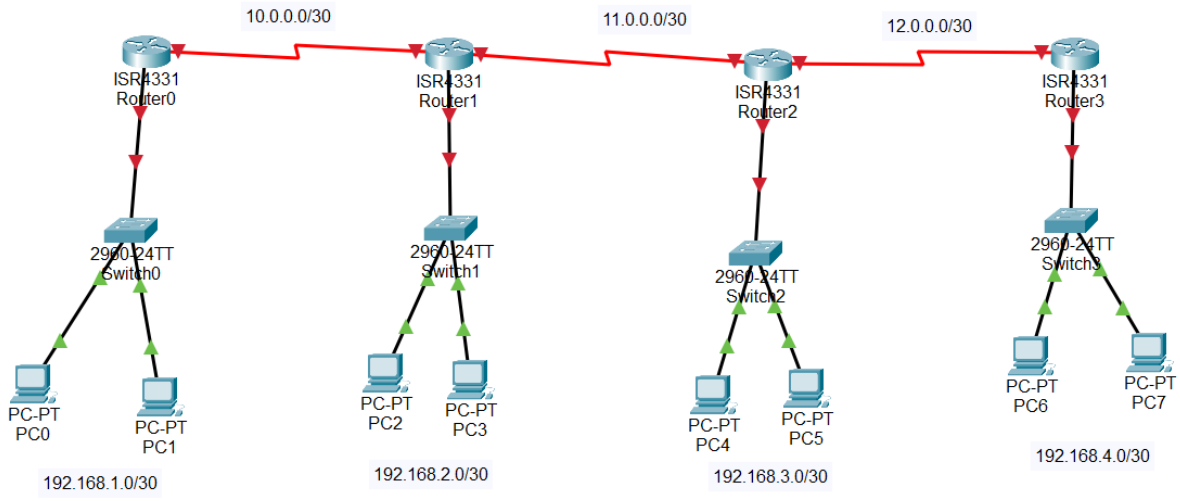
Verify OSPF neighbors and routing information.

1. Issue the **show ip ospf neighbor** command to verify that each router lists the other routers in the network as neighbors.
   ```
   R1# show ip ospf neighbor
   Neighbor IDPriStateDead TimeAddressInterface
   10.2.2.21FULL/BDR00:00:3710.1.1.2GigabitEthernet0/0/0
   ```
2. Issue the **show ip route** command to verify that all networks display in the routing table on all routers.
   ```
   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
   i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
   a - application route
   + - replicated route, % - next hop override, p - overrides from PfR
   Gateway of last resort is not set
   10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
   C10.1.1.0/30 is directly connected, GigabitEthernet0/0/0
   L10.1.1.1/32 is directly connected, GigabitEthernet0/0/0
   O10.2.2.0/30 [110/2] via 10.1.1.2, 00:01:11, GigabitEthernet0/0/0
   192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
   C192.168.1.0/24 is directly connected, GigabitEthernet0/0/1
   L192.168.1.1/32 is directly connected, GigabitEthernet0/0/1
   O192.168.3.0/24 [110/3] via 10.1.1.2, 00:01:07, GigabitEthernet0/0/
   ```

Lab Exercises:

Exercise 1

Implement RIP on a network consisting of Four routers.



Snapshot of CLI with routing commands on Router0

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown

Router(config)#
Router(config)#interface Serial0/2/0
Router(config-if)#ip address 10.0.0.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#clock rate 56000
Router(config-if)#exit
Router(config)#

Router(config)#router rip
Router(config-router)#network 192.168.1.0
Router(config-router)#network 10.0.0.0
Router(config-router)#
```

Snapshot of CLI with routing commands on Router1

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown

Router(config)#
Router(config)#interface Serial0/2/0
Router(config-if)#ip address 10.0.0.2 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/2/0, changed state to down
Router(config-if)#clock rate 56000
Router(config-if)#exit
Router(config)#


Router(config)#interface Serial0/2/1
Router(config-if)#ip address 11.0.0.1 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/2/1, changed state to down
Router(config-if)#clock rate 56000
Router(config-if)#exit
Router(config)#
```

```
Router>enable
Router#con ter
% Ambiguous command: "con ter"
Router#conf term
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router rip
Router(config-router)#network 192.168.2.0
Router(config-router)#network 11.0.0.0
Router(config-router)#network 10.0.0.0
Router(config-router)#
```

Snapshot of CLI with routing commands on Router2

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
```

```
Router>
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface Serial0/2/0
Router(config-if)#ip address 11.0.0.2 255.0.0.0
Router(config-if)#ip address 11.0.0.2 255.0.0.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/2/0, changed state to down
Router(config-if)#clock rate 56000
Router(config-if)#exit
Router(config)#

Router(config)#interface Serial0/2/1
Router(config-if)#ip address 12.0.0.1 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/2/1, changed state to down
Router(config-if)#clock rate 56000
Router(config-if)#exit
Router(config)#

Router>enable
Router#conf term
Router#conf terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router rip
Router(config-router)#network 192.168.3.0
Router(config-router)#network 11.0.0.0
Router(config-router)#network 12.0.0.0
Router(config-router)#exit
Router(config)#
```

Snapshot of CLI with routing commands on Router3

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.168.4.1 255.255.255.0
Router(config-if)#no shutdown


Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface Serial0/2/0
Router(config-if)#ip address 12.0.0.2 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/2/0, changed state to down
Router(config-if)#clock rate 56000
Router(config-if)#exit
Router(config)#
```

```
Router>enab
Router#conf term
Router#conf terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router rip
Router(config-router)#network 12.0.0.0
Router(config-router)#network 192.168.4.0
Router(config-router)#exit
Router(config)#
```

Ping Responses:

Paste the snapshot of Ping from PC 0 to PC2, PC4 and PC6

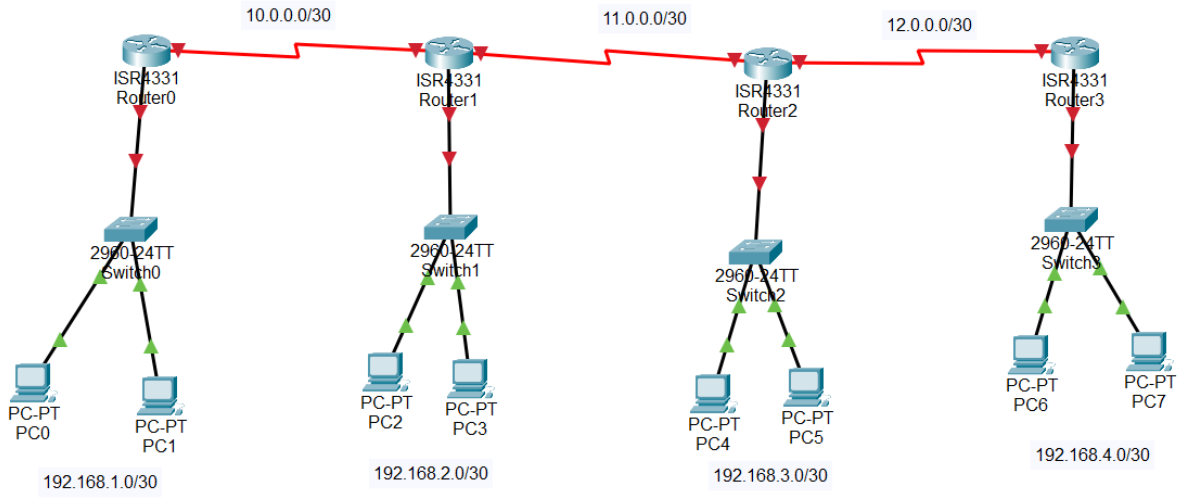
```
C:\>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:

Reply from 192.168.2.2: bytes=32 time=18ms TTL=126
Reply from 192.168.2.2: bytes=32 time=11ms TTL=126
Reply from 192.168.2.2: bytes=32 time=1ms TTL=126
Reply from 192.168.2.2: bytes=32 time=11ms TTL=126

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 18ms, Average = 10ms
```

```
C:\>ping 192.168.3.3

Pinging 192.168.3.3 with 32 bytes of data:

Reply from 192.168.3.3: bytes=32 time=22ms TTL=125
Reply from 192.168.3.3: bytes=32 time=18ms TTL=125
Reply from 192.168.3.3: bytes=32 time=12ms TTL=125
Reply from 192.168.3.3: bytes=32 time=17ms TTL=125

Ping statistics for 192.168.3.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 12ms, Maximum = 22ms, Average = 17ms
```

```
C:\>ping 192.168.4.3

Pinging 192.168.4.3 with 32 bytes of data:

Reply from 192.168.4.3: bytes=32 time=3ms TTL=124
Reply from 192.168.4.3: bytes=32 time=3ms TTL=124
Reply from 192.168.4.3: bytes=32 time=3ms TTL=124
Reply from 192.168.4.3: bytes=32 time=3ms TTL=124

Ping statistics for 192.168.4.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 3ms, Average = 3ms
```

Exercise 2

Implement OSPF on a network consisting of Four routers.



Snapshot of CLI with routing commands on Router0

```
Router#conf term
Router#conf terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 1
Router(config-router)#network 192.168.1.0 0.0.0.255 area 0
Router(config-router)#network 10.0.0.0 0.0.0.255 area 0
Router(config-router)#exit
Router(config)#
```

Snapshot of CLI with routing commands on Router1

```
Router>enable
Router#conf term
Router#conf terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 1
Router(config-router)#network 192.168.2.0 0.0.0.255 area 0
Router(config-router)#network 10.0.0.0 0.0.0.255 area 0
Router(config-router)#network 11.0.0.0 0.0.0.255 area 0
```

Snapshot of CLI with routing commands on Router2

```
Router>enable
Router#conf term
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 1
Router(config-router)#network 192.168.3.0 0.0.0.255 area 0
Router(config-router)#network 11.0.0.0 0.0.0.255 area 0
Router(config-router)#network 11.0.0.0 0.0.0.255 area 0
00:10:03: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.1 on Serial0/2/0 fr
Router(config-router)#network 12.0.0.0 0.0.0.255 area 0
```

Snapshot of CLI with routing commands on Router3

```
Router(config-router)#network 192.168.4.0 0.0.0.255 area 0
Router(config-router)#network 12.0.0.0 0.0.0.255 area 0
```

Ping Responses:

Paste the snapshot of Ping from PC 0 to PC2, PC4 and PC6

```
C:\>ping 192.168.2.3

Pinging 192.168.2.3 with 32 bytes of data:

Reply from 192.168.2.3: bytes=32 time=1ms TTL=126
Reply from 192.168.2.3: bytes=32 time=12ms TTL=126
Reply from 192.168.2.3: bytes=32 time=11ms TTL=126
Reply from 192.168.2.3: bytes=32 time=11ms TTL=126

Ping statistics for 192.168.2.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 12ms, Average = 8ms
```

```
C:\>ping 192.168.3.2

Pinging 192.168.3.2 with 32 bytes of data:

Reply from 192.168.3.2: bytes=32 time=21ms TTL=125
Reply from 192.168.3.2: bytes=32 time=12ms TTL=125
Reply from 192.168.3.2: bytes=32 time=12ms TTL=125
Reply from 192.168.3.2: bytes=32 time=26ms TTL=125

Ping statistics for 192.168.3.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 12ms, Maximum = 26ms, Average = 17ms
```

```
C:\>ping 192.168.4.2

Pinging 192.168.4.2 with 32 bytes of data:

Reply from 192.168.4.2: bytes=32 time=30ms TTL=124
Reply from 192.168.4.2: bytes=32 time=23ms TTL=124
Reply from 192.168.4.2: bytes=32 time=5ms TTL=124
Reply from 192.168.4.2: bytes=32 time=29ms TTL=124

Ping statistics for 192.168.4.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 5ms, Maximum = 30ms, Average = 21ms
```

Note: attach the **(.pkt)** file for each exercise and upload it to QoBE.

Rubrics Sheet

Task	**Marks**
RIP Configuration	4
OSPF Configuration	6