National University of Computer and Emerging Sciences (NUCES) Islamabad

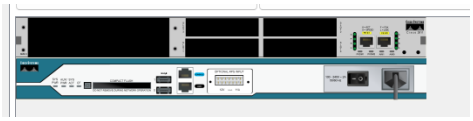
Computer Networks Lab
Spring 2024
Week 11

Dynamic Routing (RIP and OSPF)

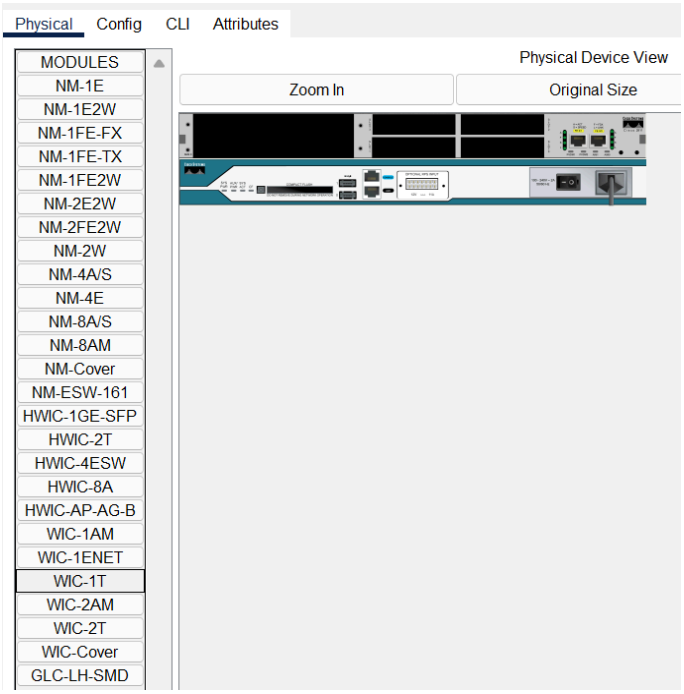
Router in use:

How to add and use Serial Cable:

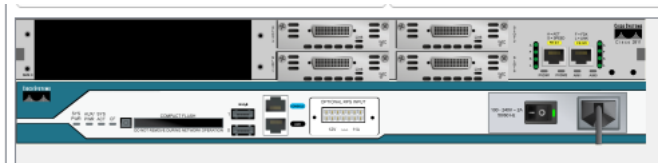
1. Go to the physical portion of the router.
2. Turn off the router.



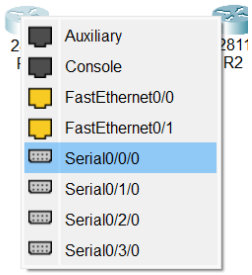
3. Choose WIC-1T



4. Add ports according to need, and turn on the router



5. To connect two routers using serial cable, use Serial DTE wire 
6. Connect one's serial port with the other router's



7. And you will have a connection like:

8. Add ip address, turn on the ports and you are good to go.

Dynamic routing protocol #1
RIP routing

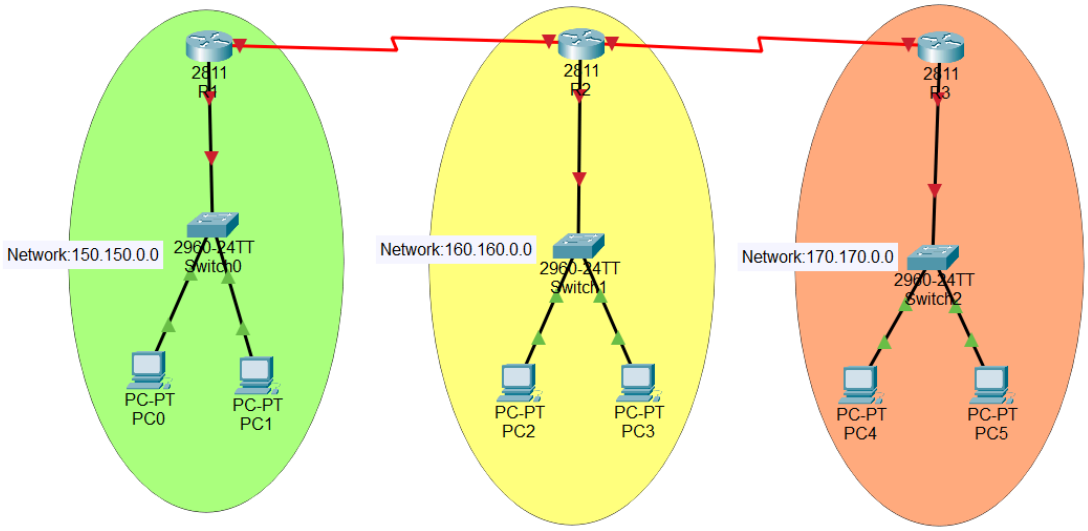
Routing Information Protocol (RIP) is a dynamic routing protocol that uses hop count as a routing metric to find the best path between the source and the destination network. It is a distance-vector routing protocol that has an AD value of 120 and works on the Network layer of the OSI model. RIP uses port number 520.
Hop count is the number of routers occurring in between the source and destination network. The path with the lowest hop count is considered as the best route to reach a network and therefore placed in the routing table. RIP prevents routing loops by limiting the number of hops allowed in a path from source and destination. The maximum hop count allowed for RIP is 15 and a hop count of 16 is considered as network unreachable.

Features of RIP:

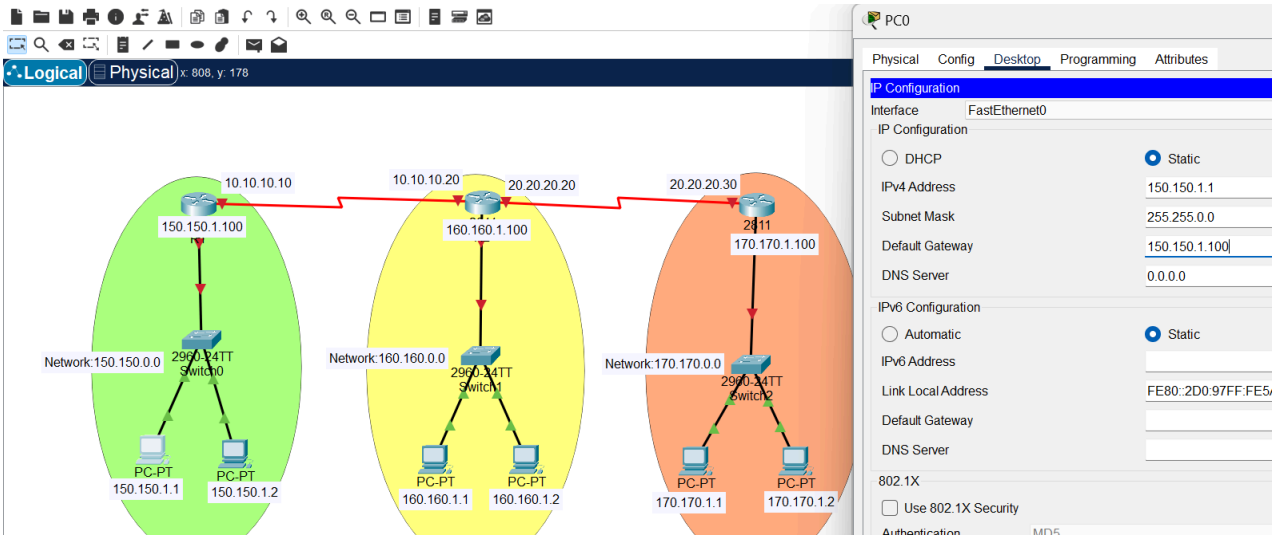
1. Updates of the network are exchanged periodically.
2. Updates (routing information) are always broadcast.
3. Full routing tables are sent in updates.
4. Routers always trust routing information received from neighbor routers. This is also known as Routing on rumors.

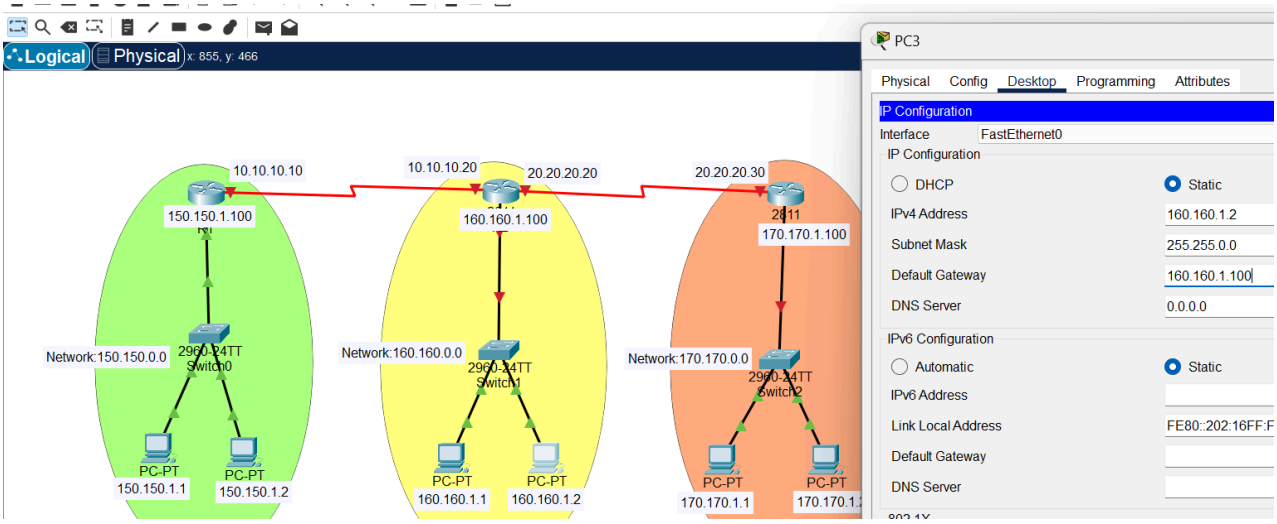
Walk Through Task:

Step 1: Create a topology as such:



Step 2: Assign ip addresses to the PC accordingly as mentioned in the image above with the accurate default gateway.





Step 3: Once all the systems are assigned with an ip address, set the default gateway.

For router in network: 150.150.0.0 (green area):

Step 3.1: go to the router's CLI

Step 3.2: type '**en**'

Step 3.3: type '**config t**' to access configuration terminal

Step 3.4: access the interface connected to the switch in the network (in this case its port 0/0)

Step 3.5: add ip address by using the command '**ip address 150.150.1.100 255.255.0.0**'. Here 150.150.1.100 is the ip address, while 255.255.0.0 is the subnet mask.

Step 3.6: '**no shutdown**' the interface.

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 150.150.1.100 255.255.0.0
Router(config-if)#ip address 150.150.1.100 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

For router in network: 160.160.0.0 (yellow area):

Step 3.1: go to the router's CLI

Step 3.2: type '**en**'

Step 3.3: type '**config t**' to access configuration terminal

Step 3.4: access the interface connected to the switch in the network (in this case its port 0/0)

Step 3.5: add ip address by using the command '**ip address 160.160.1.100 255.255.0.0**'. Here 160.160.1.100 is the ip address, while 255.255.0.0 is the subnet mask.

Step 3.6: '**no shutdown**' the interface.

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 160.160.1.100 255.255.0.0
Router(config-if)#ip address 160.160.1.100 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

For router in network: 170.170.0.0 (orange area):

Step 3.1: go to the router's CLI

Step 3.2: type '**en**'

Step 3.3: type '**config t**' to access configuration terminal

Step 3.4: access the interface connected to the switch in the network (in this case its port 3/0)

Step 3.5: add ip address by using the command '**ip address 170.170.1.100 255.255.0.0**'. Here 170.170.1.100 is the ip address, while 255.255.0.0 is the subnet mask.

Step 3.6: '**no shutdown**' the interface.

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 170.170.1.100 255.255.0.0
Router(config-if)#ip address 170.170.1.100 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

Step 4: Once all the networks with the PCs connected are all set, send PDUs to the respective router to check the correctness of the topology.

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	R1	ICMP		0.000	N	0	(edit)	(delete)
	Successful	PC2	R2	ICMP		0.000	N	1	(edit)	(delete)
	Successful	R3	PC4	ICMP		0.000	N	2	(edit)	(delete)

Step 5: Set up the routes between the routers of the area in pink and blue

For the router in the area in green:

Step 5.1: go to the router's CLI

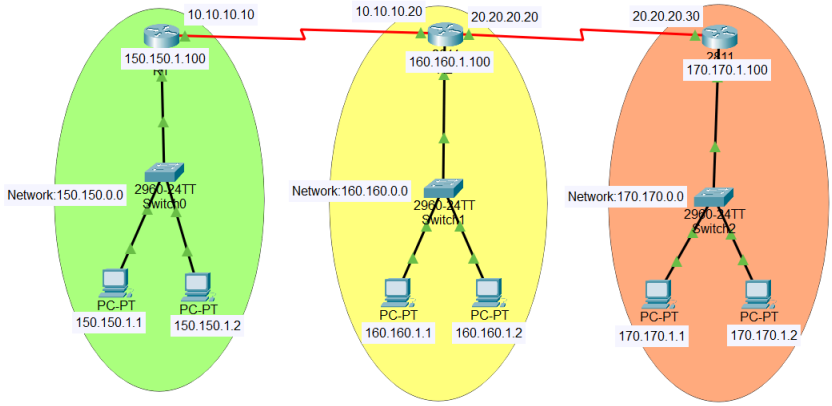
Step 5.2: type '**en**'
Step 5.3: type '**config t**' to access configuration terminal
Step 5.4: access the interface connected to the switch in the network (in this case its serial port 0/0/0)
Step 5.5: add ip address by using the command '**ip address 10.10.10.10 255.0.0.0**'. Here 10.10.10.10 is the ip address, while 255.0.0.0 is the subnet mask.
Step 5.6: '**no shutdown**' the interface.

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 10.10.10.10 255.0.0.0
Router(config-if)#ip address 10.10.10.10 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

For the router in the area in yellow:
Step 5.1: go to the router's CLI
Step 5.2: type '**en**'
Step 5.3: type '**config t**' to access configuration terminal
Step 5.4: access the interface connected to the switch in the network in this case its serial port 0/0/0)
Step 5.5: add ip address by using the command '**ip address 10.10.10.20 255.0.0.0**'. Here 10.10.10.20 is the ip address, while 255.0.0.0 is the subnet mask.
Step 5.6: '**no shutdown**' the interface.

```
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial0/0/0
Router(config-if)#ip address 10.10.10.20 255.0.0.0
Router(config-if)#ip address 10.10.10.20 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

Repeat step 5 for the other area as well



Step 6: Set up the rip routing

Connecting network 160.160.0.0 (area in green) with others networks

Step 6.1: use the command to add the network from that router to the next one

router(config)# Router rip

router(config-router)#

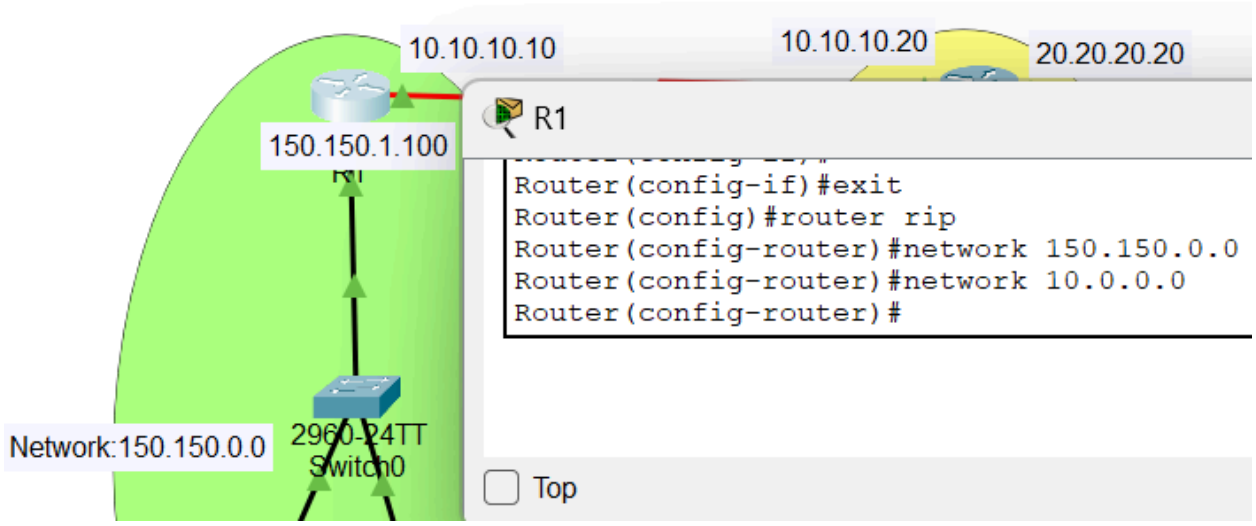
Once you are in routing configuration mode, enter the classful network address for each **directly connected network**, using the network command.

router(config-router)# network 150.150.0.0

router(config-router)# network 10.0.0.0

router(config-router)#

```
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 150.150.0.0
Router(config-router)#network 10.0.0.0
Router(config-router)#
```



Connecting network 160.160.0.0 (area in yellow) with others networks

Step 6.1: use the command to add the network from that router to the next one

router(config)# Router rip

router(config-router)#

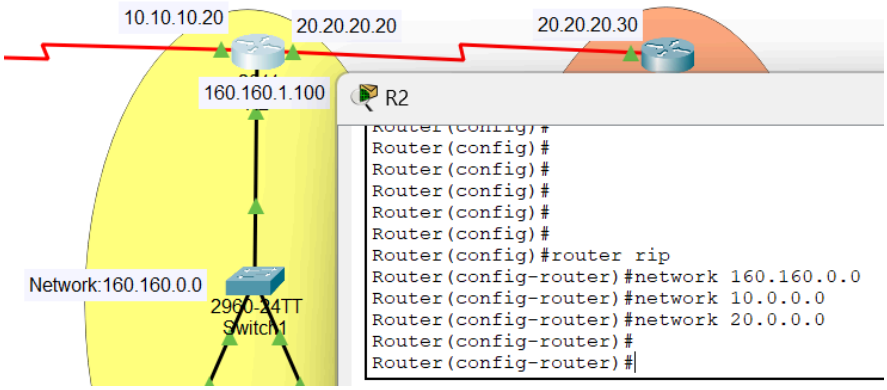
Once you are in routing configuration mode, enter the classful network address for each **directly connected network**, using the network command.

router(config-router)# network 160.160.0.0

router(config-router)# network 10.0.0.0

router(config-router)#network 20.0.0.0

```
Router(config)#router rip
Router(config-router)#network 160.160.0.0
Router(config-router)#network 10.0.0.0
Router(config-router)#network 20.0.0.0
Router(config-router)#
```



Connecting network 170.170.0.0 (area in orange) with others networks

Step 6.1: use the command to add the network from that router to the next one

router(config)# Router rip

router(config-router)#

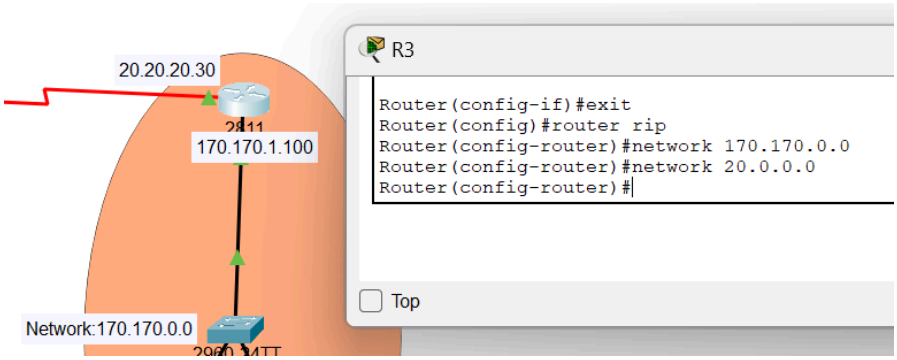
Once you are in routing configuration mode, enter the classful network address for each **directly connected network**, using the network command.

router(config-router)# network 170.170.0.0

router(config-router)# network 20.0.0.0

router(config-router)#

```
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 170.170.0.0
Router(config-router)#network 20.0.0.0
Router(config-router)#
```



Step 7: Once all set, send PDUs to the respective router to check the correctness of the topology.

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC0	PC4	ICMP		0.000	N	0	(edit)	(delete)
	Successful	PC0	PC5	ICMP		0.000	N	1	(edit)	(delete)
	Successful	PC1	PC3	ICMP		0.000	N	2	(edit)	(delete)
	Successful	PC2	PC5	ICMP		0.000	N	3	(edit)	(delete)

Dynamic routing protocol #2
OSPF routing

Open Shortest Path First (OSPF) is a link-state routing protocol that is used to find the best path between the source and the destination router using its own Shortest Path First). OSPF is developed by Internet Engineering Task Force (IETF) as one of the Interior Gateway Protocol (IGP), i.e, the protocol which aims at moving the packet within a large autonomous system or routing domain. It is a network layer protocol which works on protocol number 89 and uses AD value 110. OSPF uses multicast address 224.0.0.5 for normal communication and 224.0.0.6 for update to designated router(DR)/Backup Designated Router (BDR).

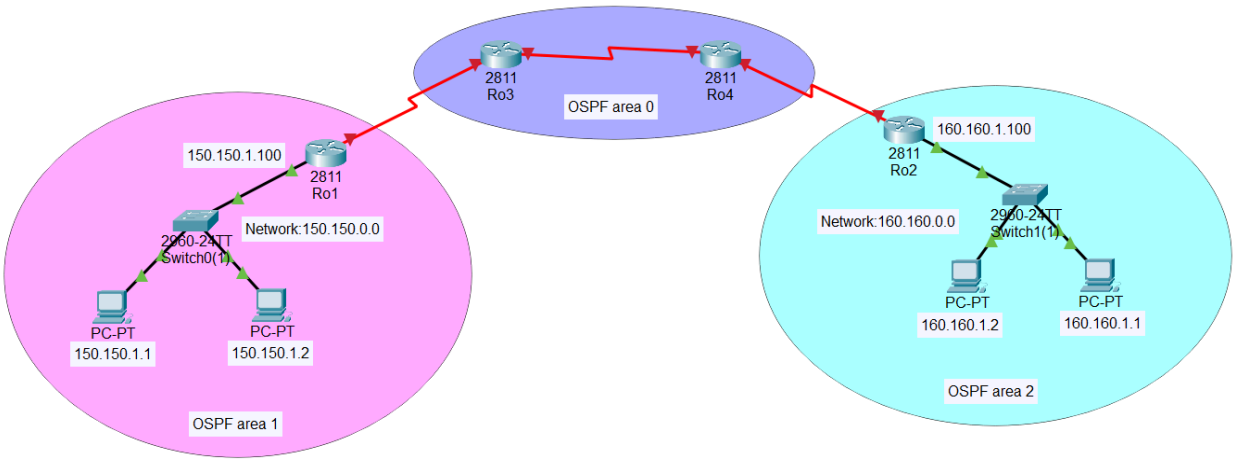
Features of OSPF:

1. Link-State Protocol: OSPF is a link-state routing protocol. It builds a detailed topology of the entire network by exchanging link-state advertisements (LSAs) between routers.
2. Hierarchical Design: OSPF supports hierarchical network design through the use of areas. This allows for scalability and reduced routing overhead.
3. Fast Convergence: OSPF converges quickly in response to network changes due to its efficient SPF (Shortest Path First) algorithm.
4. Variable-Length Subnet Masking (VLSM): OSPF supports VLSM, allowing for the creation of subnets with different subnet masks within the same network.
5. Authentication: OSPF supports authentication mechanisms to secure routing information exchange between OSPF routers.
6. Cost-Based Metric: OSPF calculates the cost of each route based on the bandwidth of the link. This metric helps in choosing the shortest path to a destination.
7. Multiple Routing Tables: OSPF supports multiple routing tables, including one for IP routes and another for MPLS (Multi-Protocol Label Switching) traffic.
8. Dynamic Routing Updates: OSPF routers exchange routing information only when there are changes in the network topology, reducing unnecessary bandwidth consumption compared to RIP.
9. Neighbor Adjacencies: OSPF routers establish neighbor adjacencies only with directly connected OSPF routers, enhancing security and stability.

10. Route Summarization: OSPF allows for route summarization, which can reduce the size of routing tables and simplify routing in larger networks.
11. Support for IPv6: OSPF supports IPv6, making it suitable for modern networks that utilize IPv6 addressing.
12. Load Balancing: OSPF can perform load balancing by distributing traffic across multiple equal-cost paths to a destination.

Walk Through Task:

Step 1: Create a topology as such:



Step 2: Assign ip addresses to the PC accordingly as mentioned in the image above with the accurate default gateway.

Step 3: Once all the systems are assigned with an ip address, set the default gateway.

For router in network: 150.150.0.0 (pink area):

Step 3.1: go to the router's CLI

Step 3.2: type '**en**'

Step 3.3: type '**config t**' to access configuration terminal

Step 3.4: access the interface connected to the switch in the network (in this case its port 0/0)

Step 3.5: add ip address by using the command '**ip address 150.150.1.100 255.255.0.0**'. Here 150.150.1.100 is the ip address, while 255.255.0.0 is the subnet mask.

Step 3.6: '**no shutdown**' the interface.

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 150.150.1.100 255.255.0.0
Router(config-if)#ip address 150.150.1.100 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

For router in network: 160.160.0.0 (blue area):

Step 3.1: go to the router's CLI

Step 3.2: type '**en**'

Step 3.3: type '**config t**' to access configuration terminal

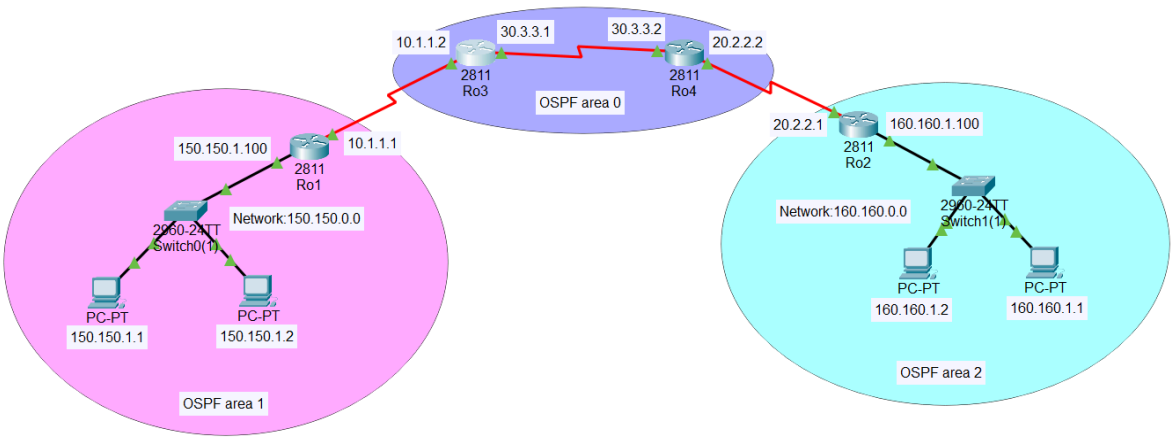
Step 3.4: access the interface connected to the switch in the network (in this case its port 0/0)

Step 3.5: add ip address by using the command '**ip address 160.160.1.100 255.255.0.0**'. Here 160.160.1.100 is the ip address, while 255.255.0.0 is the subnet mask.

Step 3.6: '**no shutdown**' the interface.

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 160.160.1.100 255.255.0.0
Router(config-if)#ip address 160.160.1.100 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#
```

Repeat step 3 for the other area as well



Step 4: Set up the OSPF routing

Router OSPF process_id

Network network_id subnetmask area area_number

Process id can be any number from 1 to 65525. Let us choose 10 for the process id

For the router in area 1

Step 4.1: For router in area 1

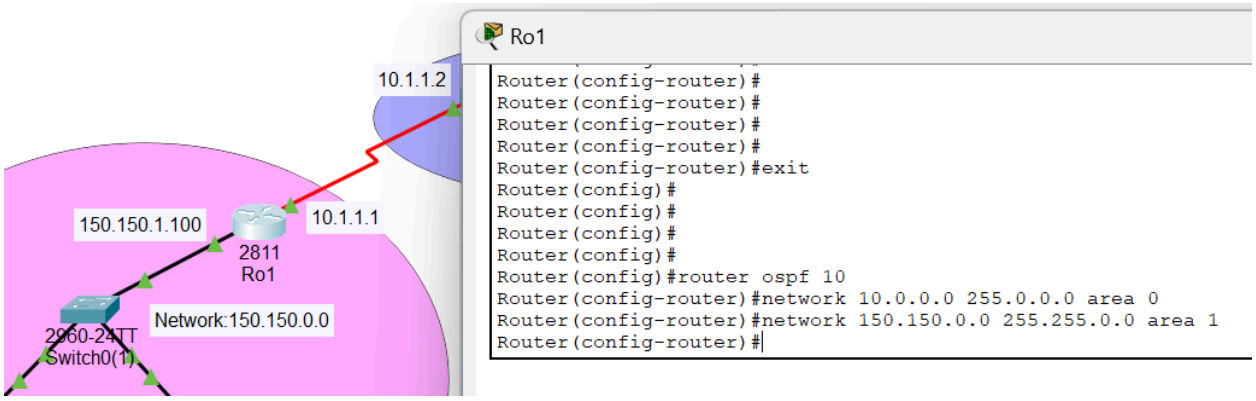
Run the following commands

router(config)# router ospf 10

router(router-config)# network 10.0.0.0 255.0.0.0 area 0

router(router-config)# network 150.150.0.0 255.255.0.0 area 1

(trick here to remember is the wire going out of the network like here the wire in network 10 will not be in the backbone area)



For the router in area 0 connecting to area 1

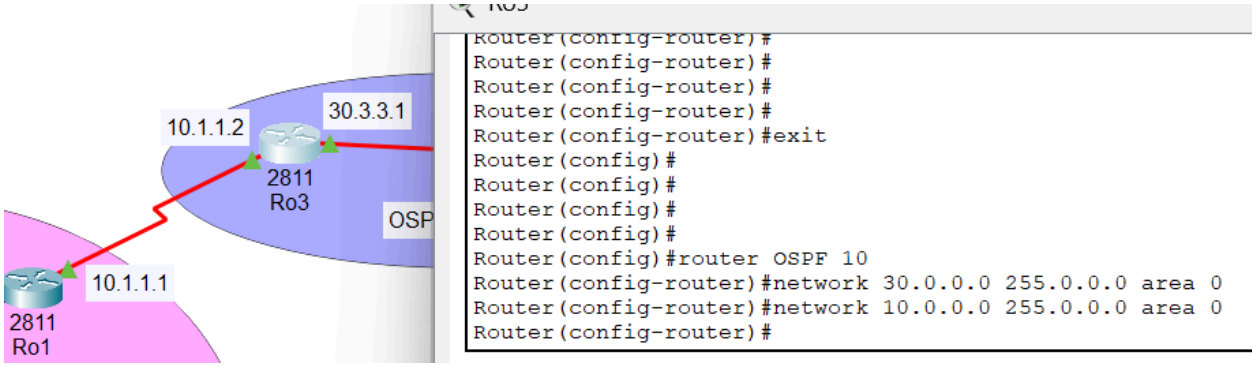
Step 4.1: For router in area 0

Run the following commands

router(config)# router ospf 10

router(router-config)# network 10.0.0.0 255.0.0.0 area 0

router(router-config)# network 30.0.0.0 255.0.0.0 area 0



For the router in area 0 connecting to area 2

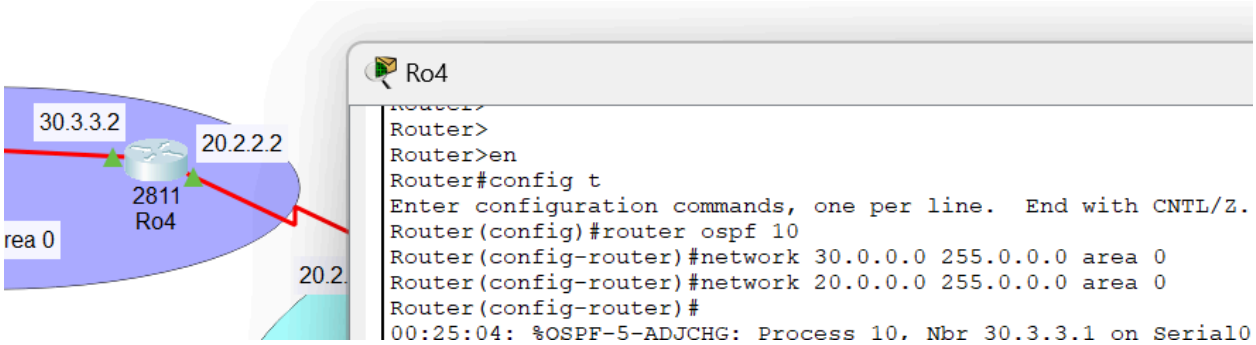
Step 4.1: For router in area 0

Run the following commands

router(config)# router ospf 10

router(router-config)# network 20.0.0.0 255.0.0.0 area 0

router(router-config)# network 30.0.0.0 255.0.0.0 area 0



For the router in area 2

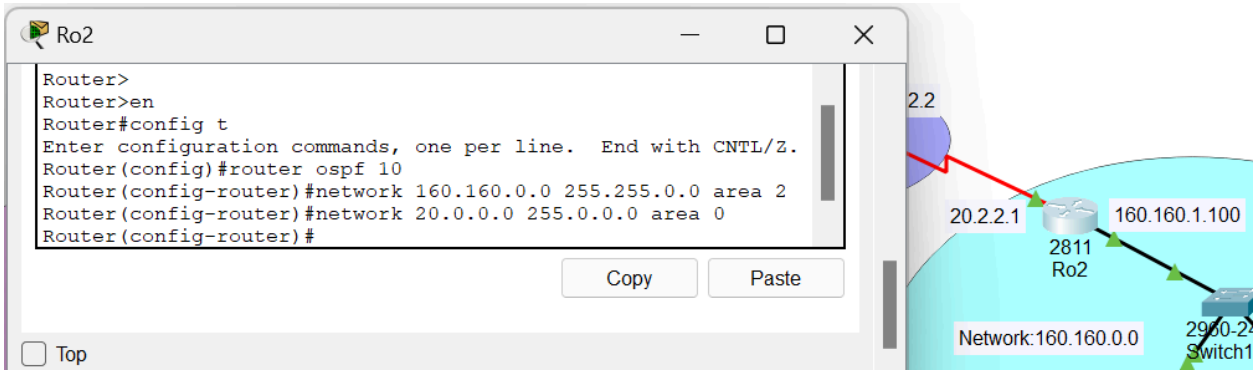
Step 4.1: For router in area 2

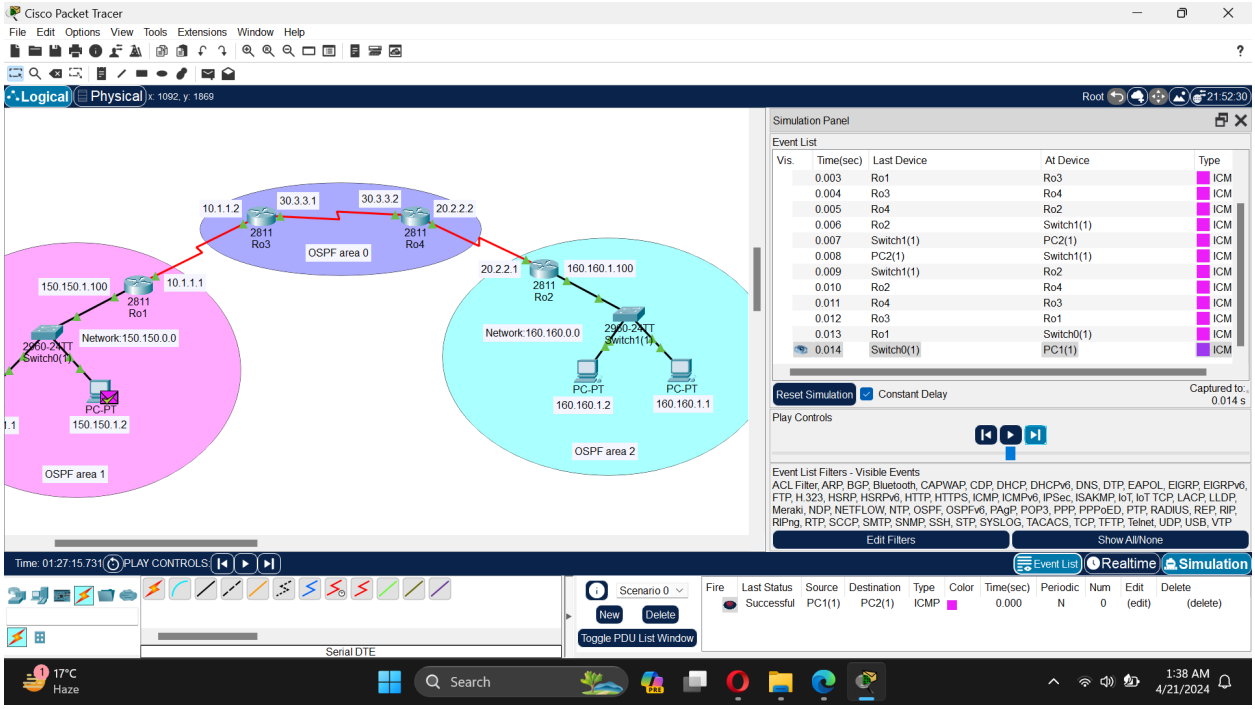
Run the following commands

router(config)# router ospf 10

router(router-config)# network 160.160.0.0 255.255.0.0 area 2

router(router-config)# network 20.0.0.0 255.0.0.0 area 0




Cisco Packet Tracer
File Edit Options View Tools Extensions Window Help
Logical Physical
Root
21:52:30
10.1.1.2
30.3.3.1
30.3.3.2
20.2.2.2
2811 Ro3
2811 Ro4
OSPF area 0
150.150.1.100
10.1.1.1
2811 Ro1
Network:150.150.0.0
2960-24TT Switch0(1)
PC-PT
150.150.1.2
OSPF area 1
20.2.2.1
160.160.1.100
2811 Ro2
Network:160.160.0.0
2960-24TT Switch1(1)
PC-PT
160.160.1.2
PC-PT
160.160.1.1
OSPF area 2
Simulation Panel
Event List
Vis. Time(sec) Last Device At Device Type
0.003 Ro1 Ro3 ICM
0.004 Ro3 Ro4 ICM
0.005 Ro4 Ro2 ICM
0.006 Ro2 Switch1(1) ICM
0.007 Switch1(1) PC2(1) ICM
0.008 PC2(1) Switch1(1) ICM
0.009 Switch1(1) Ro2 ICM
0.010 Ro2 Ro4 ICM
0.011 Ro4 Ro3 ICM
0.012 Ro3 Ro1 ICM
0.013 Ro1 Switch0(1) ICM
0.014 Switch0(1) PC1(1) ICM
Reset Simulation
Constant Delay
Captured to: 0.014 s
Play Controls
Event List Filters - Visible Events
ACL Filter, ARP, BGP, Bluetooth, CAPWAP, CDP, DHCP, DHCPv6, DNS, DTP, EAPOL, EIGRP, EIGRPv6, FTP, H.323, HSRP, HSRPv6, HTTP, HTTPS, ICMP, ICMPv6, IPSec, ISAKMP, IoT, IoT TCP, LACP, LLDP, Meraki, NDP, NETFLOW, NTP, OSPF, OSPFv6, PAgP, POP3, PPP, PPPoED, PTP, RADIUS, REP, RIP, RIPng, RTP, SCCP, SMTP, SNMP, SSH, STP, SYSLOG, TACACS, TCP, TFTP, Telnet, UDP, USB, VTP
Edit Filters
Show All/None
Time: 01:27:15.731
PLAY CONTROLS:
Event List
Realtime
Simulation
Scenario 0
New
Delete
Toggle PDU List Window
Fire Last Status Source Destination Type Color Time(sec) Periodic Num Edit Delete
Successful PC1(1) PC2(1) ICMP 0.000 N 0 (edit) (delete)
Serial DTE
17°C Haze
Search
1:38 AM 4/21/2024

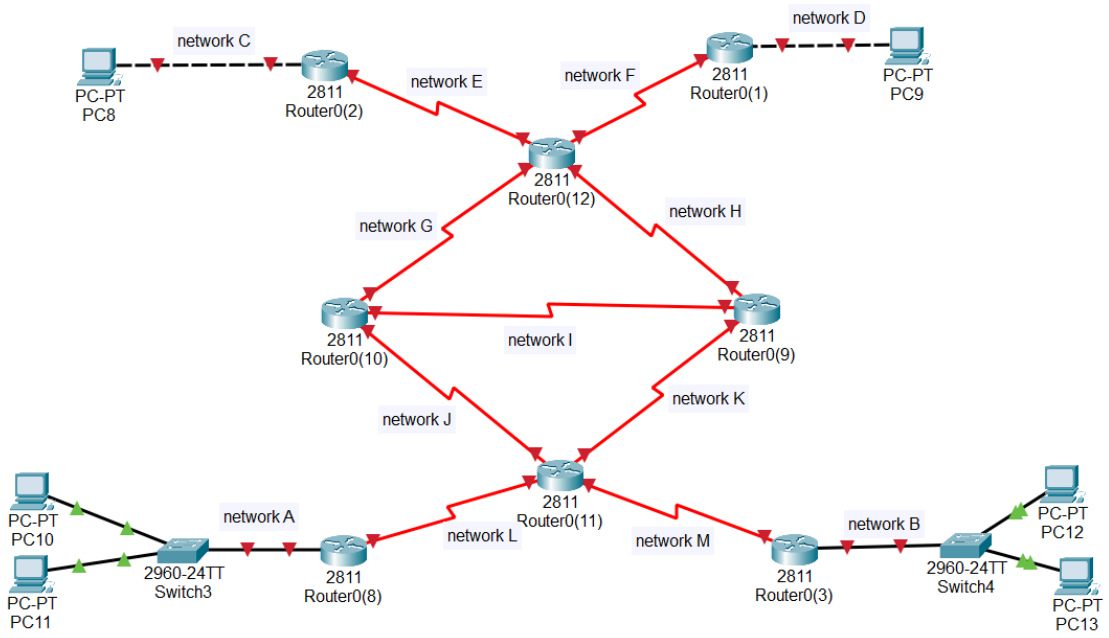
Practice tasks

Consider your roll number
Let xx be the last two digits of your roll number
Example: for roll number 22i0027
27 be xx and 28 will be xx+1

Task 1:

Construct the given network topology and implement RIP.
Ip addressing:

Network A: 192.xx.0.0
Network B: 192.xx+1.0.0
Network C: 192.xx+2.0.0
Network D: 192.xx+3.0.0
Network E: 192.xx+4.0.0
Network F: 192.xx+5.0.0
Network G: 192.xx+6.0.0
Network H: 192.xx+7.0.0
Network I: 192.xx+8.0.0
Network J: 192.xx+9.0.0
Network K: 192.xx+10.0.0
Network L: 192.xx+11.0.0
Network M: 192.xx+12.0.0

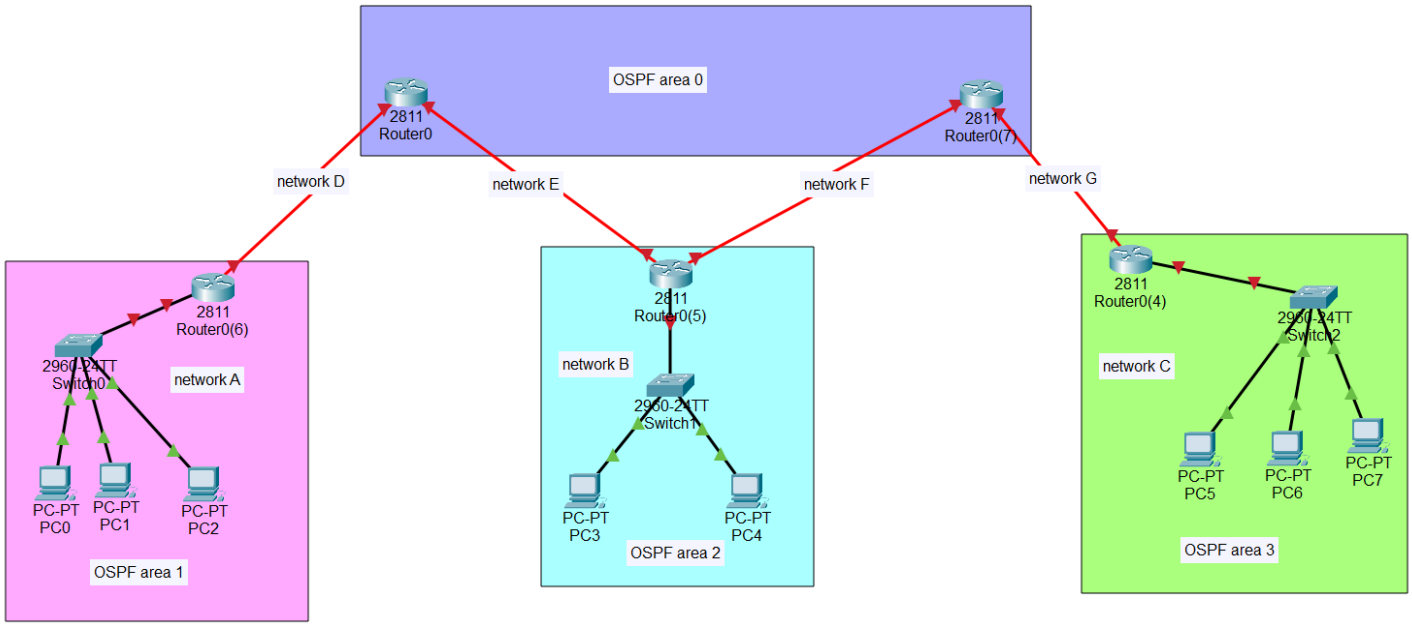


Task 2:

Construct a network topology and implement OSPF.

Ip addressing:

Network A: 162.xx.0.0
Network B: 162.xx+1.0.0
Network C: 162.xx+2.0.0
Network D: 162.xx+3.0.0
Network E: 162.xx+4.0.0
Network F: 162.xx+5.0.0
Network G: 162.xx+6.0.0



Submission Guidelines:

- Submit the .pkt file , renamed to your roll number with task number.
- Submit a screenshots of successful message transfer between different networks.