DATA COMMUNICATION & NETWORKING

EE 424

HANDBOOK FOR LAB PROJECT

DHANANI SCHOOL OF SCIENCE AND ENGINEERING

RAILWAY COMMUNICATION NETWORK (RCN)

VIRTUAL LOCAL AREA NETWORK (VLAN) DESIGN & IMPLEMENTATION USING CISCO PACKET TRACER

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EXECUTIVE SUMMARY:

This project serves as an exploration of the advantages, disadvantages and challenges that can be faced when using Virtual LAN in implementation of a network topology. To determine the configurations of all the components of the system, i.e. end devices, CISCO network devices. The main emphasizes is on how the security of LAN can be enhanced, so that it restricts/limits access of certain domains and avoids IP address intervention and hacking.

This project serves as an exploration of the advantages, disadvantages and challenges that can be faced when using Virtual LAN in implementation of a Railway Communication Networking. To determine the configurations of all the components of the system, i.e. end devices, CISCO network devices. The main emphasizes is on how the security of VLAN can be enhanced, so that it restricts/limits access of certain domains and avoids IP address intervention and hacking.

Furthermore, the inter network communication between routers has been implemented through Border Gateway Protocol (BGP), Open Shortest Path First (OSPF) and Routing Information Protocol. A Web Server and an Email Server set up as a medium to exchange information from isolated networks.

Inter network routing allows users from one end to communicate to the other end devices without being directly connected to the same router. Furthermore, NAT has been implemented to enhance network security so that no data is lost during communication.

LITERATURE REVIEW:

OSPF:

Open Shortest Path First (OSPF) is an Interior Gateway Protocol (IGP) standardized by the Internet Engineering Task Force (IETF) and commonly used in large Enterprise networks. OSPF is a link-state routing protocol providing fast convergence and excellent scalability. Like all link-state protocols, OSPF is very efficient in its use of network bandwidth. (Open Shortest Path First, n.d.)

On the other hand, OSPF have many short comes and some of them are:

- It requires more memory to hold the adjacency (list of OSPF neighbors), topology and routing tables.
- It requires extra CPU processing to run the SPF algorithm
- It is complex to configure and more difficult to troubleshoot.

(Routing Protocols, n.d.)

BORDER GATEWAY PROTOCOL (BGP):

Border Gateway Protocol (BGP) is an Internet Engineering Task Force (IETF) standard, and the most scalable of all routing protocols. BGP is the routing protocol of the global Internet, as well as for Service Provider private networks. BGP has expanded upon its original purpose of carrying Internet reachability information, and can now carry routes for Multicast, IPv6, VPNs, and a variety of other data. (Border Gateway Protocol, n.d.)

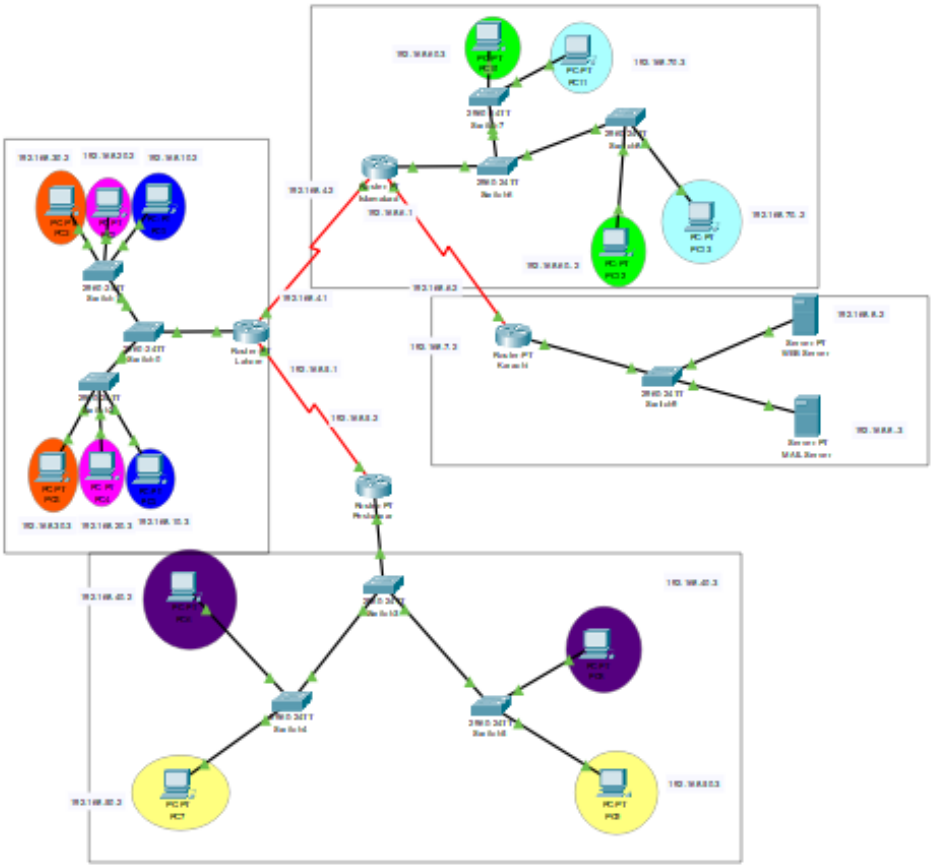
ROUTING INFORMATION PROTOCOL (RIP):

Routing Information Protocol (RIP) is a commonly used routing protocol in small to medium TCP/IP networks. It is a stable protocol that uses a distance-vector algorithm to calculate routes. (RIP, n.d.)

- Limited to a hop count of 15; after a packet travels through 15 routers and still has another router to travel to, it will be discarded.
- Doesn't support a variable-length subnet mask (VLSM), which means that it sends routing updates based only on a fixed-length subnet mask (FLSM) or routes that fall on classful boundaries. So RIP V1 will not work with a network that has been subnetted beyond the normal /8, /16, /24 (255.0.0.0, 255.255.0.0, 255.255.255.0) or Class A, B, and C network boundaries.
- Converges slowly, especially on large networks
- Doesn't have knowledge of the bandwidth of a link
- Doesn't support multiple paths for the same route
- Routing updates can require significant bandwidth, as the entire routing table is sent when a link's status changes
- Prone to routing loops

(Network Training, n.d.)

DISCUSSION:



This network consist of a Railway Network in which 4 cities are connected to each other through inter network routing protocol.

The first part of network is Lahore in which Inter VLAN has been used to connect users to router. The following commands have been used:

Configuration for Network 10:

```
Router> en
Router(config)# conf t
Router(config)# ip dhcp excluded-address 192.168.10.1
Router(dhcp-config)# ip dhcp pool NETWORK10
Router(dhcp-config)# network 192.168.10.0 255.255.255.0
Router(dhcp-config)# default-router 192.168.10.1
end
```

Configuration for Network 20:

```
Router> en
Router# conf t
Router(config)# ip dhcp excluded-address 192.168.20.1
Router(dhcp-config)# ip dhcp pool NETWORK20
Router(dhcp-config)# network 192.168.20.0 255.255.255.0
Router(dhcp-config)# default-router 192.168.20.1
Router(dhcp-config)# end
```

Configuration for Network 30:

```
Router> en
Router# conf t
Router(config)# ip dhcp excluded-address 192.168.30.1
Router(dhcp-config)# ip dhcp pool NETWORK30
Router(dhcp-config)# network 192.168.30.0 255.255.255.0
Router(dhcp-config)# default-router 192.168.30.1
Router(dhcp-config)# end
```

Switch-1 Configuration (Form the Vlan's):

```
Switch> en
Switch# conf t
Switch(config)# vlan 10
Switch(config-vlan)# name TEN
Switch(config-vlan)# vlan 20
Switch(config-vlan)# name TWENTY
Switch(config-vlan)# vlan 30
Switch(config-vlan)# name Thirty
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 10
Switch(config)# int range fa0/4-6
```

```
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 20
Switch(config)# int range fa0/7-9
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 30
Switch(config)# int range fa0/22-24
Switch(config-if)# switchport mode trunk
Switch(config-if)# end
```

Switch-2 Configuration:

Form the Vlan's:

```
Switch> en
Switch# conf t
Switch(config)# vlan 10
Switch(config-vlan)# name TEN
Switch(config-vlan)# vlan 20
Switch(config-vlan)# name TWENTY
Switch(config-vlan)# vlan 30
Switch(config-vlan)# name THIRTY
Switch(config-vlan)#end
```

***Assignment of vlan's to interfaces*:**

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 10
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 20
Switch(config)# int range fa0/7-9
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 30
Switch(config-vlan)#end
```

Switch-3 Configuration:

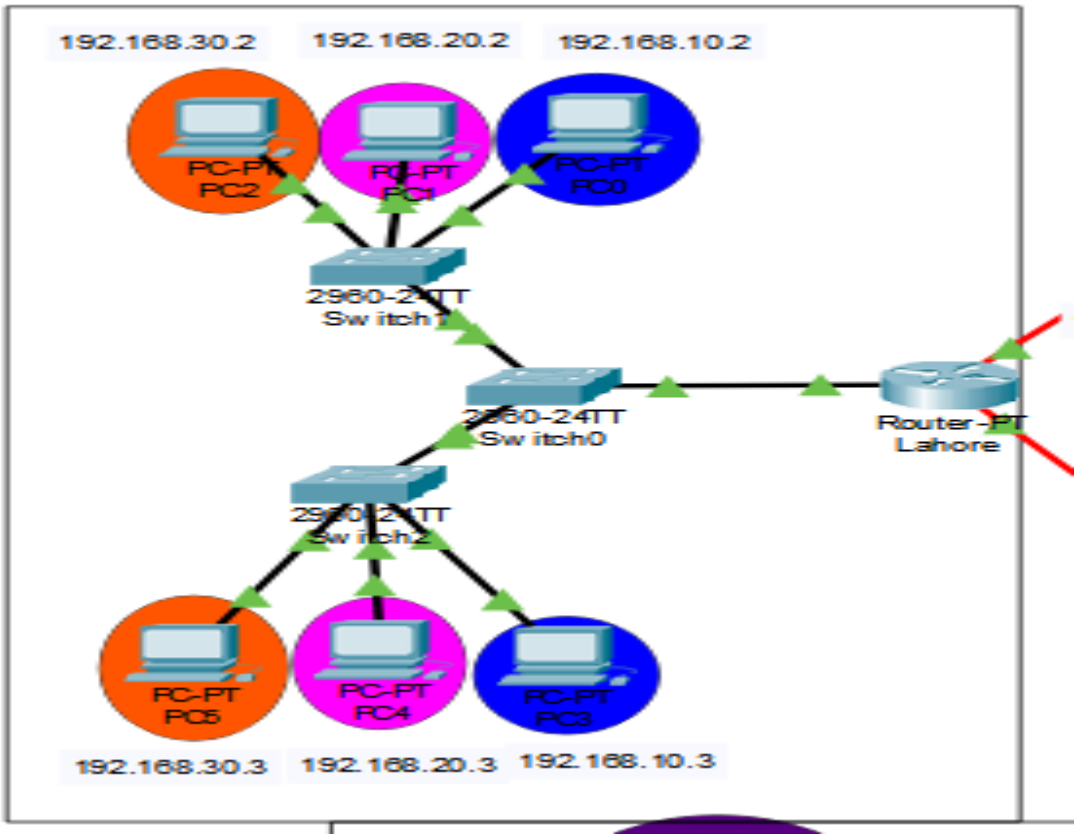
Form the Vlan's:

```
Switch> en
Switch# conf t
Switch(config)# vlan 10
Switch(config-vlan)# name TEN
Switch(config-vlan)# vlan 20
Switch(config-vlan)# name TWENTY
Switch(config-vlan)# vlan 30
Switch(config-vlan)# name THIRTY
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 10
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 20
Switch(config)# int range fa0/7-9
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 30
Switch(config-vlan)#end
```

```
Router> en
Router# conf t
Router(config)# int fa0/0.10
Router(config-subif)# encapsulation dot1q 10
Router(config-subif)# ip address 192.168.10.1 255.255.255.0
Router(config)# int fa0/0.20
Router(config-subif)# encapsulation dot1q 20
Router(config-subif)# ip address 192.168.20.1 255.255.255.0
Router(config)# int fa0/0.30
Router(config-subif)# encapsulation dot1q 30
Router(config-subif)# ip address 192.168.30.1 255.255.255.0
```

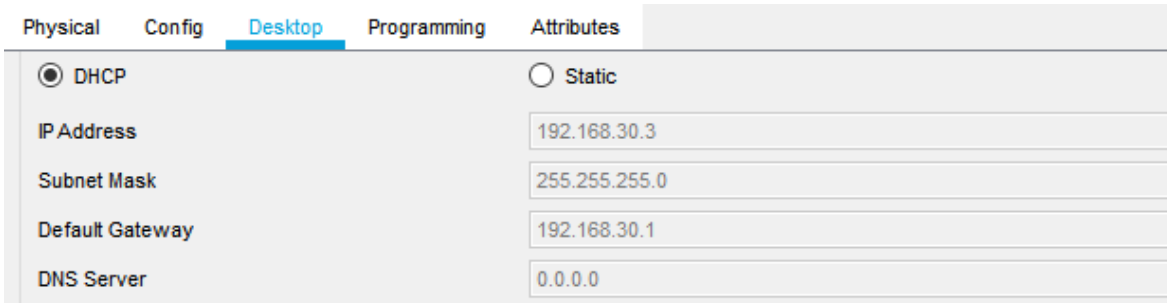


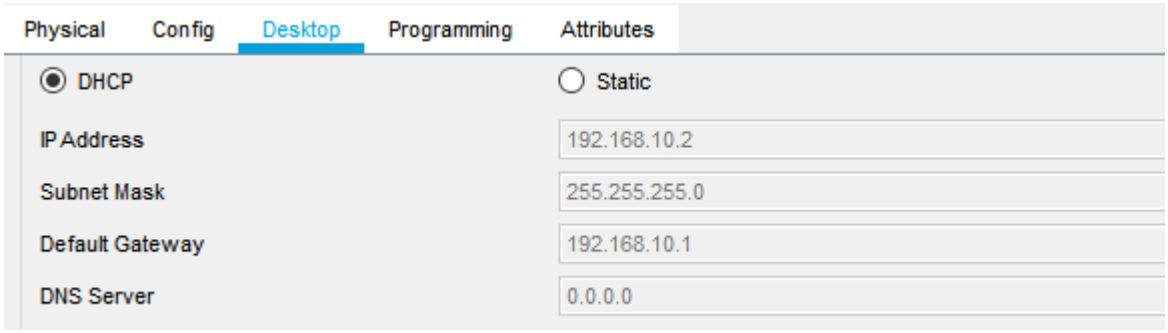
Physical Config Desktop Programming Attributes

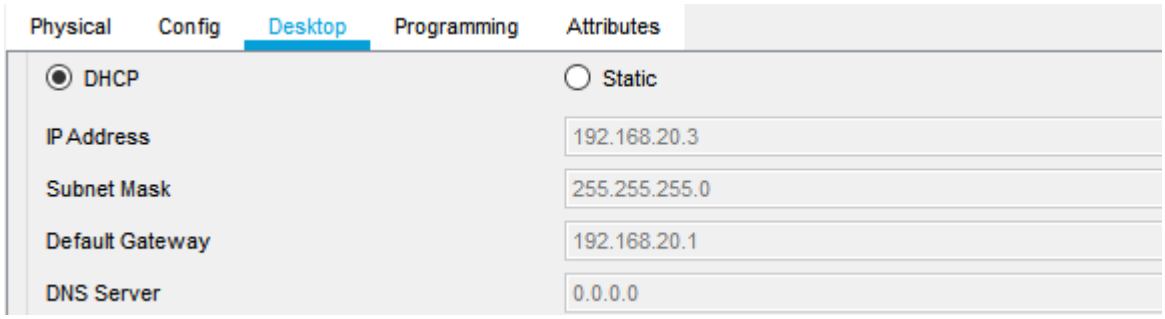
DHCP	Static
IP Address	192.168.10.3
Subnet Mask	255.255.255.0
Default Gateway	192.168.10.1
DNS Server	0.0.0.0

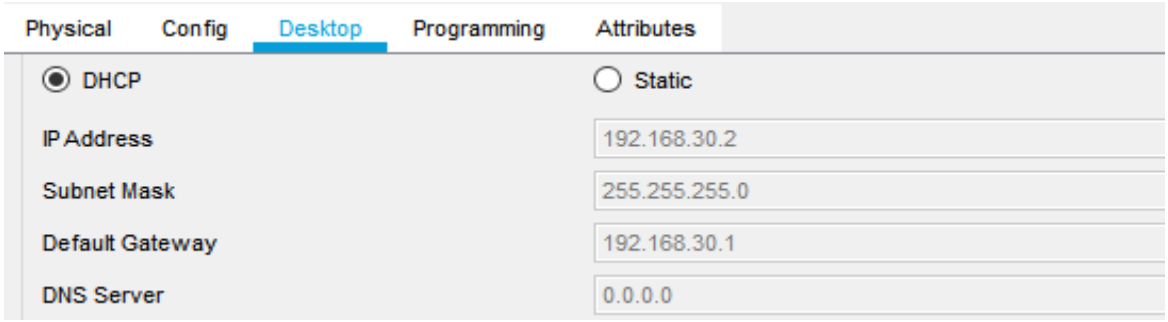
Physical Config Desktop Programming Attributes

DHCP	Static
IP Address	192.168.20.2
Subnet Mask	255.255.255.0
Default Gateway	192.168.20.1
DNS Server	0.0.0.0









The second part of network is Peshawar in which Inter VLAN has been used to connect users to router. The following commands have been used:

Configuration for Network 40:

```
Router> en
Router(config)# conf t
Router(config)# ip dhcp excluded-address 192.168.40.1
Router(dhcp-config)# ip dhcp pool NETWORK40
Router(dhcp-config)# network 192.168.40.0 255.255.255.0
```

```
Router(dhcp-config)# default-router 192.168.40.1
```

Configuration for Network 50:

```
Router> en
Router# conf t
Router(config)# ip dhcp excluded-address 192.168.50.1
Router(dhcp-config)# ip dhcp pool NETWORK50
Router(dhcp-config)# network 192.168.50.0 255.255.255.0
Router(dhcp-config)# default-router 192.168.50.1
Router(dhcp-config)# end
```

Switch-1 Configuration (From the Vlan's):

```
Switch> en
Switch# conf t
Switch(config)# vlan 40
Switch(config-vlan)# name FORTY
Switch(config-vlan)# vlan 50
Switch(config-vlan)# name FIFTY
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 40
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 50
Switch(config)# int range fa0/22-24
Switch(config-if)# switchport mode trunk
Switch(config-if)# end
```

Switch-2 Configuration:

Form the Vlan's:

```
Switch> en
Switch# conf t
Switch(config)# vlan 40
Switch(config-vlan)# name FORTY
Switch(config-vlan)# vlan 50
```

```
Switch(config-vlan)# name FIFTY
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 40
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 50
Switch(config-vlan)#end
```

Switch-3 Configuration:

Form the Vlan's:

```
Switch> en
Switch# conf t
Switch(config)# vlan 40
Switch(config-vlan)# name FORTY
Switch(config-vlan)# vlan 50
Switch(config-vlan)# name FIFTY
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

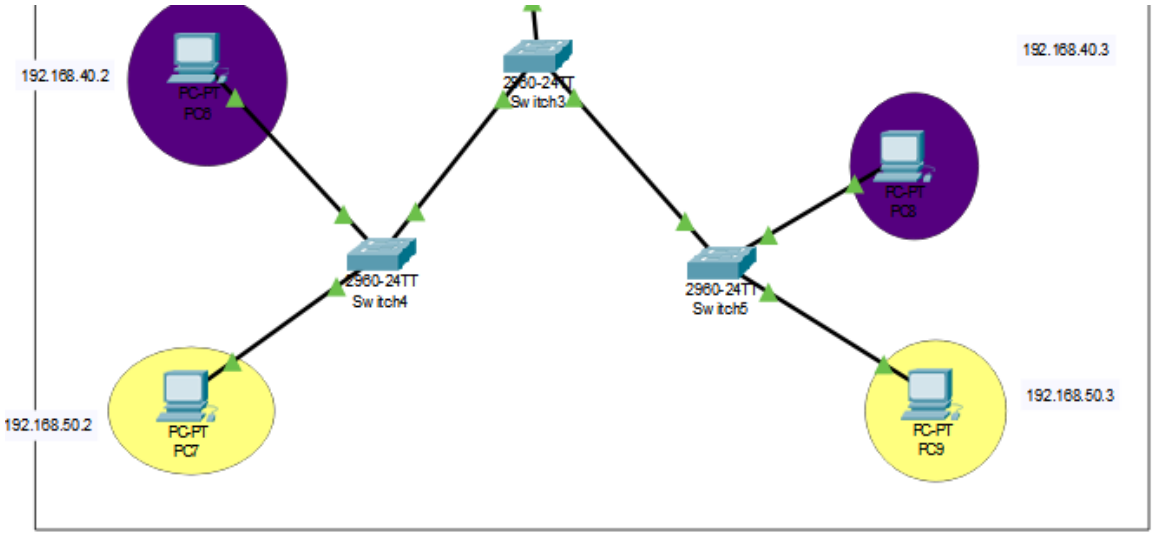
```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 40
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 50
Switch(config-vlan)#end
```

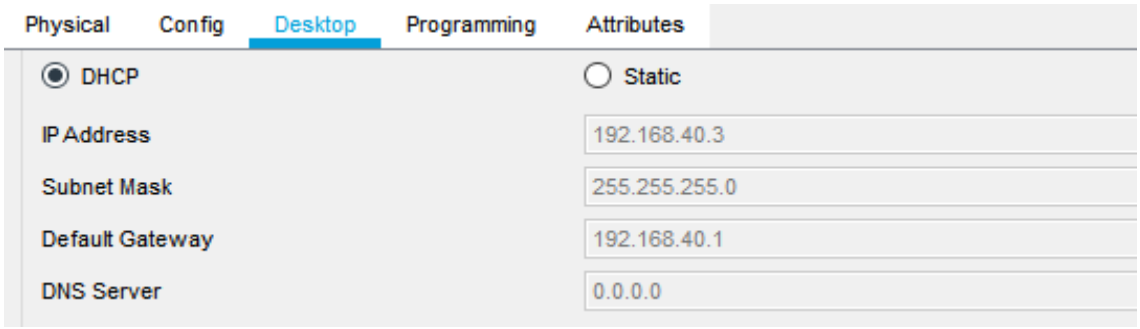
```
Router> en
Router# conf t
Router(config)# int fa0/0.10
Router(config-subif)# encapsulation dot1q 10
Router(config-subif)# ip address 192.168.40.1 255.255.255.0
```

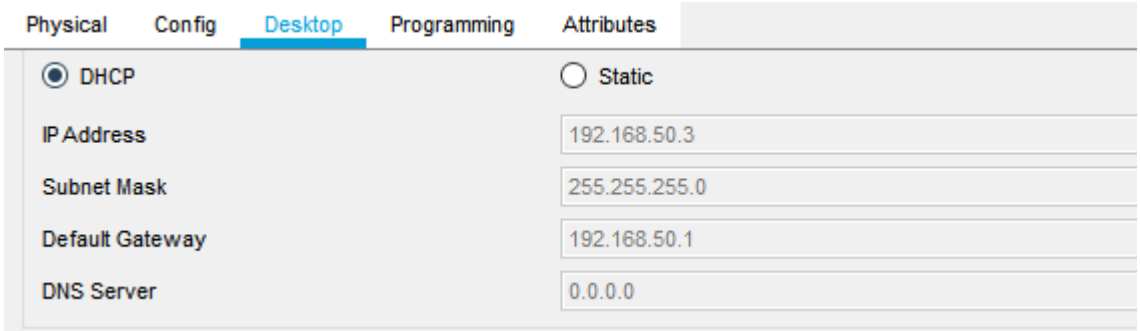
Router(config)# int fa0/0.20

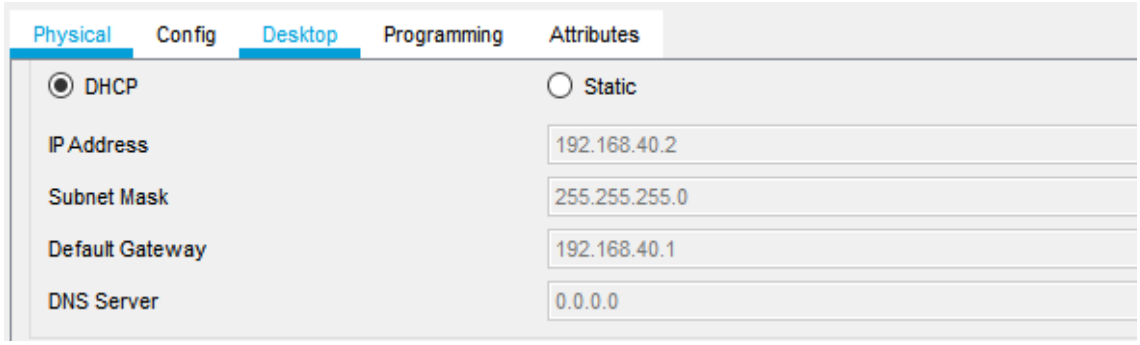
Router(config-subif)# encapsulation dot1q 20

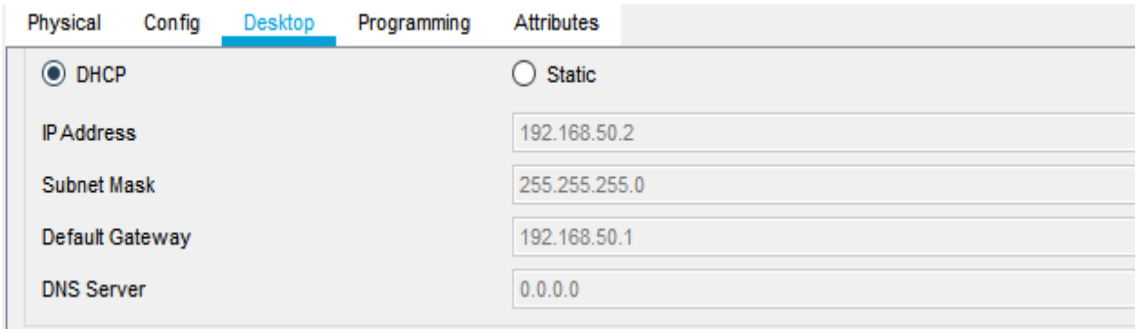
Router(config-subif)# ip address 192.168.50.1 255.255.255.0











The third part of network is Islamabad in which Inter VLAN has been used to connect users to router. The following commands have been used:

Configuration for Network 60:

```
Router> en
Router(config)# conf t
Router(config)# ip dhcp excluded-address 192.168.60.1
Router(dhcp-config)# ip dhcp pool NETWORK60
Router(dhcp-config)# network 192.168.60.0 255.255.255.0
Router(dhcp-config)# default-router 192.168.60.1
end
```

Configuration for Network 70:

```
Router> en
Router# conf t
Router(config)# ip dhcp excluded-address 192.168.70.1
Router(dhcp-config)# ip dhcp pool NETWORK70
Router(dhcp-config)# network 192.168.70.0 255.255.255.0
Router(dhcp-config)# default-router 192.168.70.1
Router(dhcp-config)# end
```

Switch-1 Configuration (Form the Vlan's):

```
Switch> en
Switch# conf t
Switch(config)# vlan 60
Switch(config-vlan)# name SIXTY
Switch(config-vlan)# vlan 70
Switch(config-vlan)# name SEVENTY
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 60
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 70
Switch(config)# int range fa0/22-24
Switch(config-if)# switchport mode trunk
Switch(config-if)# end
```

Switch-2 Configuration:

Form the Vlan's:

```
Switch> en
Switch# conf t
Switch(config)# vlan 60
Switch(config-vlan)# name SIXTY
Switch(config-vlan)# vlan 70
Switch(config-vlan)# name SEVENTY
Switch(config-vlan)#end
```

Assignment of vlan's to interfaces:

```
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 60
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 70
Switch(config-vlan)#end
```

Switch-3 Configuration:

Form the Vlan's:

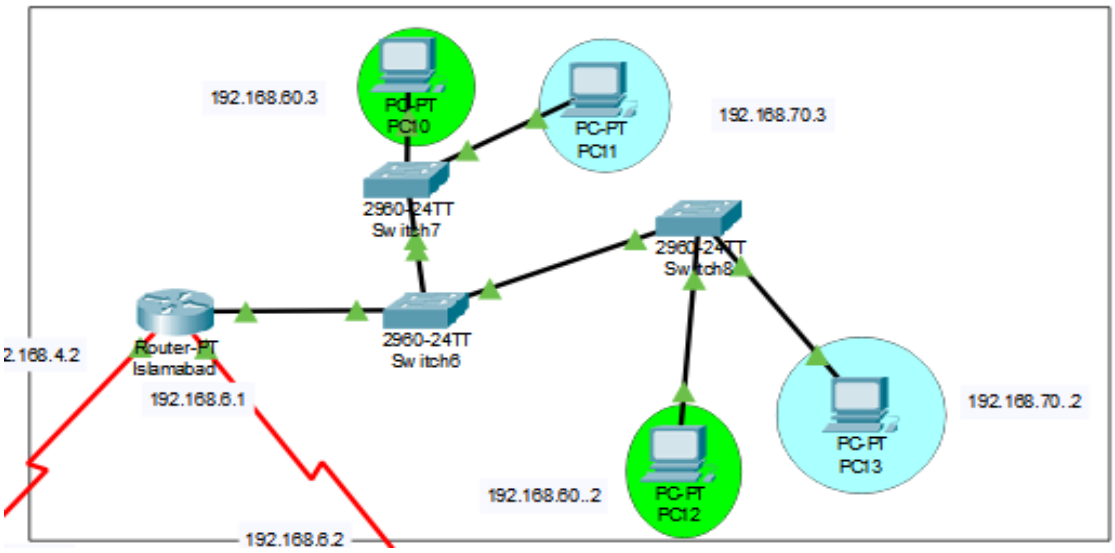
```
Switch> en
Switch# conf t
Switch(config)# vlan 60
```

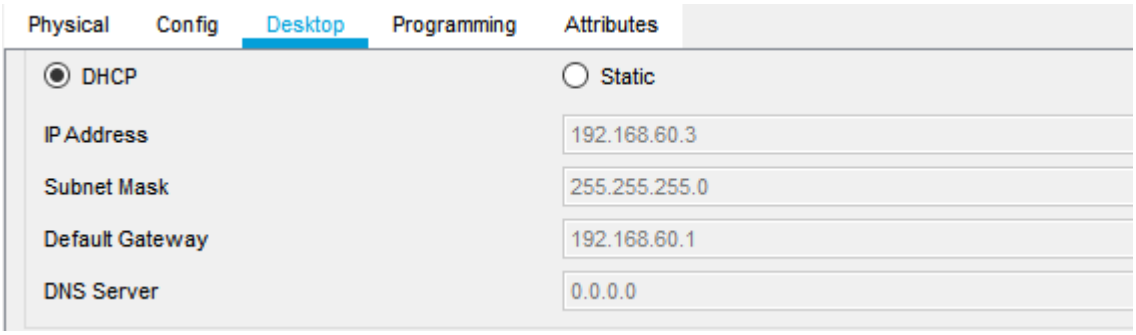
Switch(config-vlan)# name SIXTY
Switch(config-vlan)# vlan 70
Switch(config-vlan)# name SEVENTY
Switch(config-vlan)#end

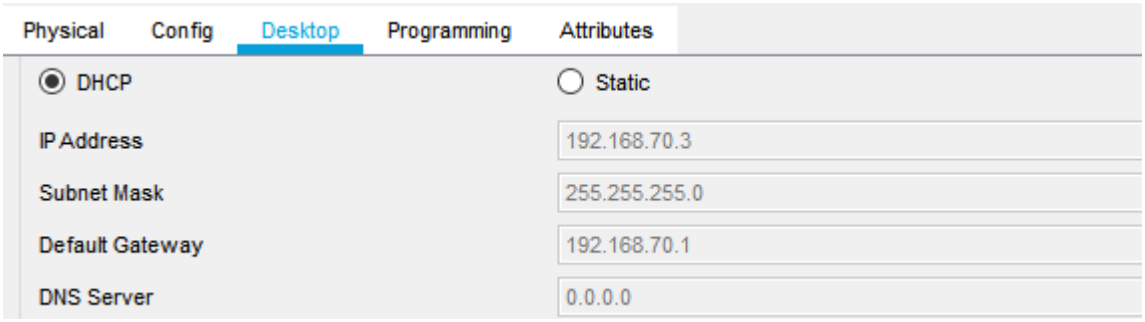
Assignment of vlan's to interfaces:

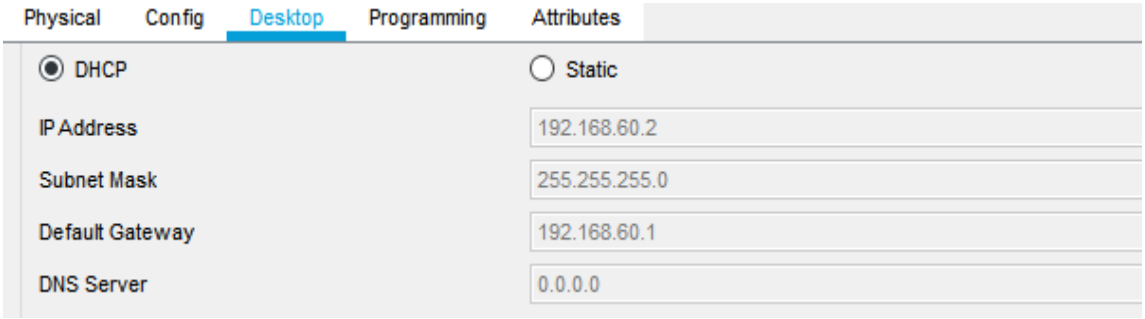
Switch# conf t
Switch(config)# int range fa0/1-3
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 60
Switch(config)# int range fa0/4-6
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 70
Switch(config-vlan)#end

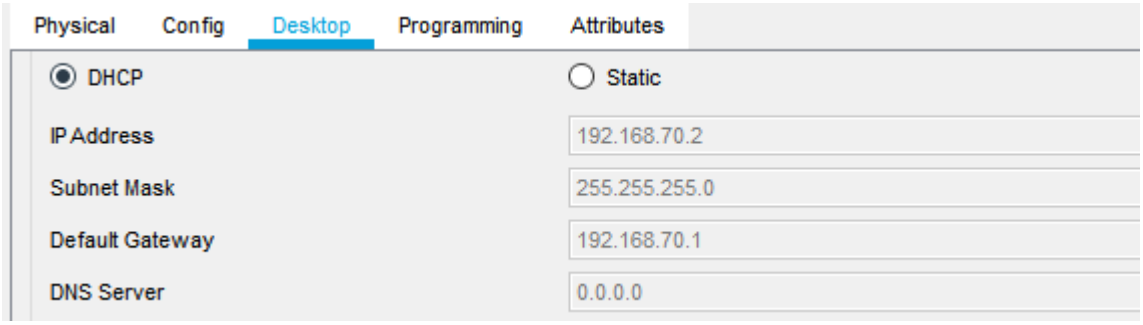
Router> en
Router# conf t
Router(config)# int fa0/0.10
Router(config-subif)# encapsulation dot1q 10
Router(config-subif)# ip address 192.168.60.1 255.255.255.0
Router(config)# int fa0/0.20
Router(config-subif)# encapsulation dot1q 20
Router(config-subif)# ip address 192.168.70.1 255.255.255.0





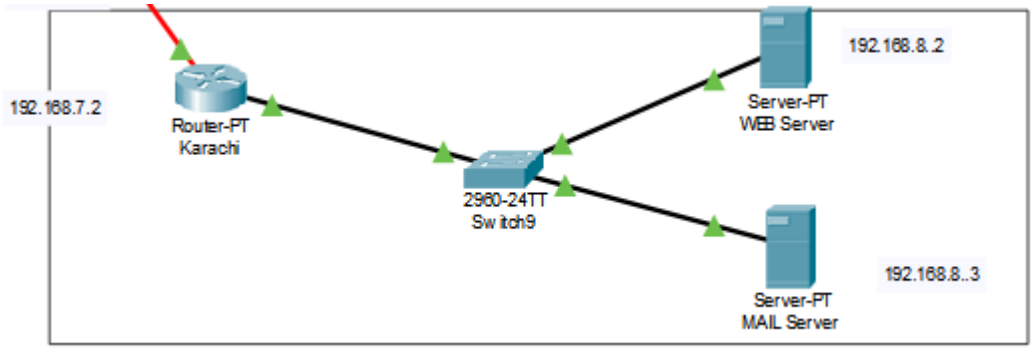




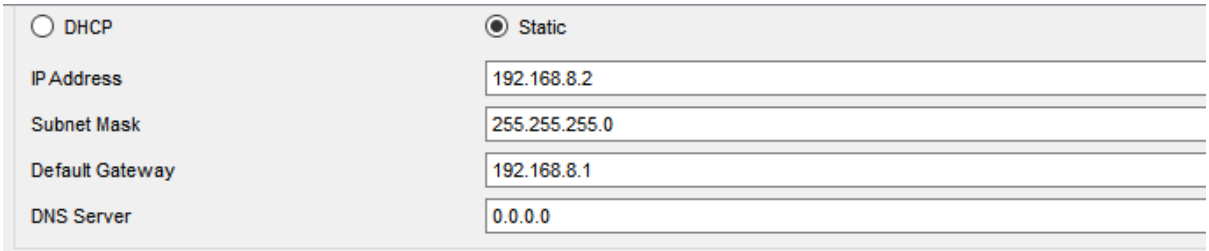


The fourth network which is Karachi, the central network for communication having the Web Server and Mail Server. Following commands have been implemented:

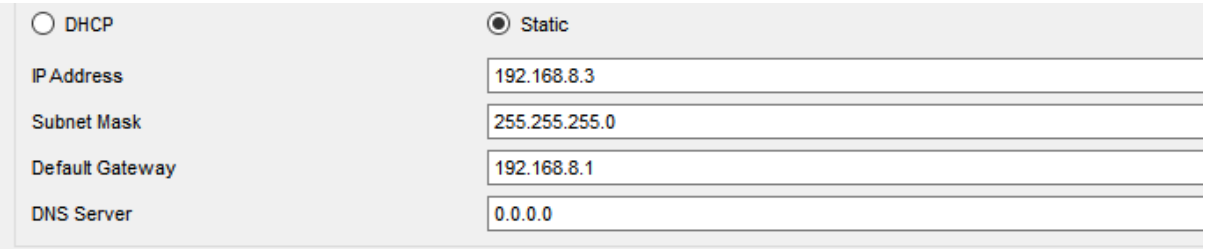
```
Router> en
Router# conf t
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 192.168.8.1 255.255.255.0
```

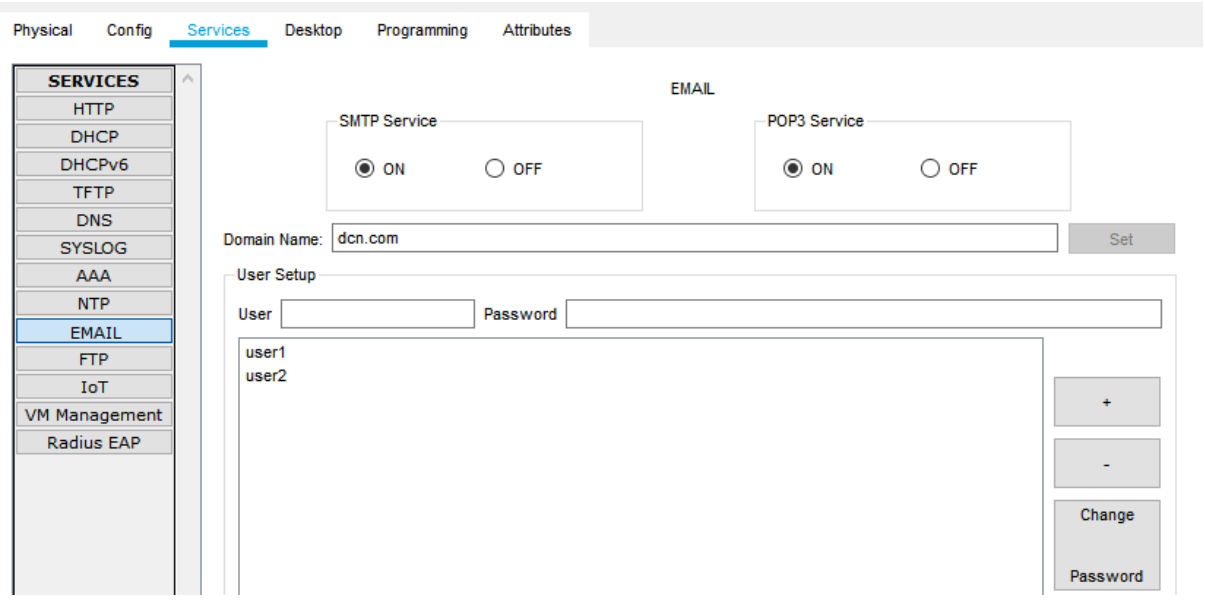


Web Server has been assigned with static ip of 192.168.8.2.



Mail Server has been assigned with static ip of 192.168.8.3.





Routing Protocol:

Between Network 1 (Lahore) and Network 2 (Peshawar).

At Router Lahore:

Router(config)# router rip
Router(config)#network 192.168.5.0
Router(config)#network 192.168.10.0
Router(config)#network 192.168.20.0
Router(config)#network 192.168.30.0

At Router Peshawar:

Router(config)# router rip
Router(config)#network 192.168.5.0
Router(config)#network 192.168.40.0
Router(config)#network 192.168.50.0

```
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.4.0/24 is directly connected, Serial2/0
C    192.168.5.0/24 is directly connected, Serial3/0
C    192.168.10.0/24 is directly connected, FastEthernet0/0.10
C    192.168.20.0/24 is directly connected, FastEthernet0/0.20
C    192.168.30.0/24 is directly connected, FastEthernet0/0.30
B    192.168.40.0/24 [20/0] via 192.168.5.2, 00:00:00
B    192.168.50.0/24 [20/0] via 192.168.5.2, 00:00:00
B    192.168.60.0/24 [20/0] via 192.168.4.2, 00:00:00
B    192.168.70.0/24 [20/0] via 192.168.4.2, 00:00:00
```

```
C    192.168.5.0/24 is directly connected, Serial2/0
B    192.168.10.0/24 [20/0] via 192.168.5.1, 00:00:00
B    192.168.20.0/24 [20/0] via 192.168.5.1, 00:00:00
B    192.168.30.0/24 [20/0] via 192.168.5.1, 00:00:00
C    192.168.40.0/24 is directly connected, FastEthernet0/0.10
C    192.168.50.0/24 is directly connected, FastEthernet0/0.20
B    192.168.60.0/24 [20/0] via 192.168.5.1, 00:00:00
B    192.168.70.0/24 [20/0] via 192.168.5.1, 00:00:00
```

Between Network 3 (Islamabad) and Network 4 (Karachi).

At Router Islamabad:

Router(config)# router ospf 1
Router(config)#network 192.168.6.0 0.0.0.255 area 0
Router(config)#network 192.168.60.0 0 0.0.0.255 area 0
Router(config)#network 192.168.70.0 0 0.0.0.255 area 0

At Router Karachi:

Router(config)# router ospf 1
Router(config)#network 192.168.6.0 0.0.0.255 area 0
Router(config)#network 192.168.8.0 0 0.0.0.255 area 0

```
C    192.168.6.0/24 is directly connected, Serial3/0
C    192.168.8.0/24 is directly connected, FastEthernet0/0
O    192.168.60.0/24 [110/65] via 192.168.6.1, 00:12:51, Serial3/0
O    192.168.70.0/24 [110/65] via 192.168.6.1, 00:12:51, Serial3/0
```

```
C    192.168.4.0/24 is directly connected, Serial2/0
C    192.168.6.0/24 is directly connected, Serial3/0
O    192.168.8.0/24 [110/65] via 192.168.6.2, 00:13:29, Serial3/0
B    192.168.10.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.20.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.30.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.40.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.50.0/24 [20/0] via 192.168.4.1, 00:00:00
C    192.168.60.0/24 is directly connected, FastEthernet0/0.10
C    192.168.70.0/24 is directly connected, FastEthernet0/0.20
```

Between Network 2 (Lahore) and Network 3 (Islamabad).

At Router Lahore:

Router(config)# router bgp 100
Router(config)#network 192.168.4.0
Router(config)#network 192.168.10.0
Router(config)#network 192.168.20.0
Router(config)#network 192.168.30.0
Router(config)#neighbor 192.168.60.2 remote-as 200
Router(config)#neighbor 192.168.60.3 remote-as 200
Router(config)#neighbor 192.168.70.2 remote-as 200
Router(config)#neighbor 192.168.70.3 remote-as 200
Router(config)#neighbor 192.168.4.2 remote-as 200

At Router Islamabad:

Router(config)# router bgp 200
Router(config)#network 192.168.4.0
Router(config)#network 192.168.60.0
Router(config)#network 192.168.70.0
Router(config)#neighbor 192.168.10.2 remote-as 200
Router(config)#neighbor 192.168.10.3 remote-as 200

Router(config)#neighbor 192.168.20.2 remote-as 200
Router(config)#neighbor 192.168.20.3 remote-as 200
Router(config)#neighbor 192.168.30.2 remote-as 200
Router(config)#neighbor 192.168.30.3 remote-as 200
Router(config)#neighbor 192.168.4.1 remote-as 200

```
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.4.0/24 is directly connected, Serial2/0
C    192.168.5.0/24 is directly connected, Serial3/0
C    192.168.10.0/24 is directly connected, FastEthernet0/0.10
C    192.168.20.0/24 is directly connected, FastEthernet0/0.20
C    192.168.30.0/24 is directly connected, FastEthernet0/0.30
B    192.168.40.0/24 [20/0] via 192.168.5.2, 00:00:00
B    192.168.50.0/24 [20/0] via 192.168.5.2, 00:00:00
B    192.168.60.0/24 [20/0] via 192.168.4.2, 00:00:00
B    192.168.70.0/24 [20/0] via 192.168.4.2, 00:00:00
```

```
C    192.168.4.0/24 is directly connected, Serial2/0
C    192.168.6.0/24 is directly connected, Serial3/0
O    192.168.8.0/24 [110/65] via 192.168.6.2, 00:13:29, Serial3/0
B    192.168.10.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.20.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.30.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.40.0/24 [20/0] via 192.168.4.1, 00:00:00
B    192.168.50.0/24 [20/0] via 192.168.4.1, 00:00:00
C    192.168.60.0/24 is directly connected, FastEthernet0/0.10
C    192.168.70.0/24 is directly connected, FastEthernet0/0.20
```

CONCLUSION:

This project is totally dedicated to the fresh Network Engineer for new and smart learning of the Network Structure. In this concept it is possible for the networker to check the incoming & the outgoing traffic and to maintain some security concepts as well. In this logic we use the multiple Routing Protocols & Security concepts in the Networking Environment. It shows the proper movement of the data packets from one department of the Railway office to the other Departments across cities. The project is associated such that it's taking the Network Support & Maintenance Contract through Network Bulls Technology.

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