Tribhuvan University

Institute of Engineering

Pulchowk Campus

COMPUTER NETWORKS

Lab 5

Subnetting and Supernetting

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SUBMITTED TO:

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Title
Subnetting amd Supernetting

Objectives

- To be familiar with subnetting with FLSM and VLSM
- To be familiar with supernetting and CIDR

Tools required

- A Computer
- Cisco Packet Tracer

Activities

A The following network topology was created, and the following activities were performed:

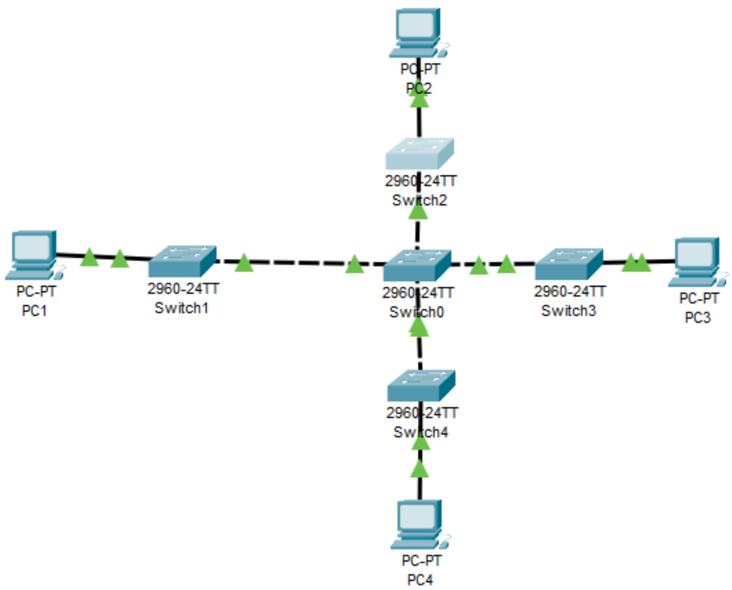


Figure 1: Setup of activity A

1 **IP address of PC1, PC2, PC3 and PC4 were set as:**

- PC1: 202.22.22.11 255.255.255.0
- PC2: 202.22.22.21 255.255.255.0

- PC3: 202.22.22.41 255.255.255.0
- PC4: 202.22.22.81 255.255.255.0

2 **The connectivity from each of the computers to all other computers were using ping.**
All PCs could be pinged from other PCs.
This is because all PCs fall under same subnet and are connected.

3 **The subnet mask was changed to 255.255.255.192 and Step 2 was repeated.**
PC4 was separated from the rest. All other PCs could ping each other.
This is because the change in subnet meant that PC4 was excluded. PC4 is in another subnet.

4 **The subnet mask was changed to 255.255.255.224 and Step 2 was repeated.**
PC3 and PC4 were separated from the rest. PC1 and PC2 could ping each other.
This is because the change in subnet meant that PC3 and PC4 were excluded. PC3 and PC4 are in another subnet. Since this new subnet is not setup, PC3 and PC4 couldn't ping each other either.

5 **The subnet mask was changed to 255.255.255.240 and Step 2 was repeated.**
No devices could ping each other.
This is because the new subnet only has PC1. Thus pings to and from PC1 couldn't connect. However, other subnets aren't set up. Thus, other devices couldn't ping each other either.

6 **The central switch was replaced by a router and the interfaces were set as:**

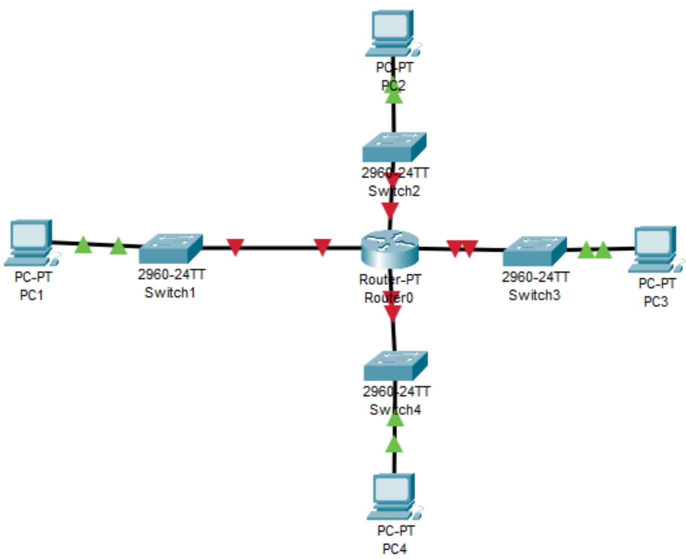


Figure 2: Setup for Activity A after replacing switch with router

- Fa 0/0: 202.22.22.12 255.255.255.240
- Fa 1/0: 202.22.22.22 255.255.255.240
- Fa 2/0: 202.22.22.42 255.255.255.240
- Fa 3/0: 202.22.22.82 255.255.255.240

```
Bishal(config)#interface FastEthernet0/0
Bishal(config-if)#ip address 202.22.22.12 255.255.255.240
Bishal(config-if)#no shutdown
Bishal(config-if)#exit

Bishal(config)#interface FastEthernet1/0
Bishal(config-if)#ip address 202.22.22.22 255.255.255.240
Bishal(config-if)#no shutdown
Bishal(config-if)#exit

Bishal(config)#interface FastEthernet2/0
Bishal(config-if)#ip address 202.22.22.42 255.255.255.240
Bishal(config-if)#no shutdown
Bishal(config-if)#exit

Bishal(config)#interface FastEthernet3/0
Bishal(config-if)#ip address 202.22.22.82 255.255.255.240
Bishal(config-if)#no shutdown
Bishal(config-if)#exit
```

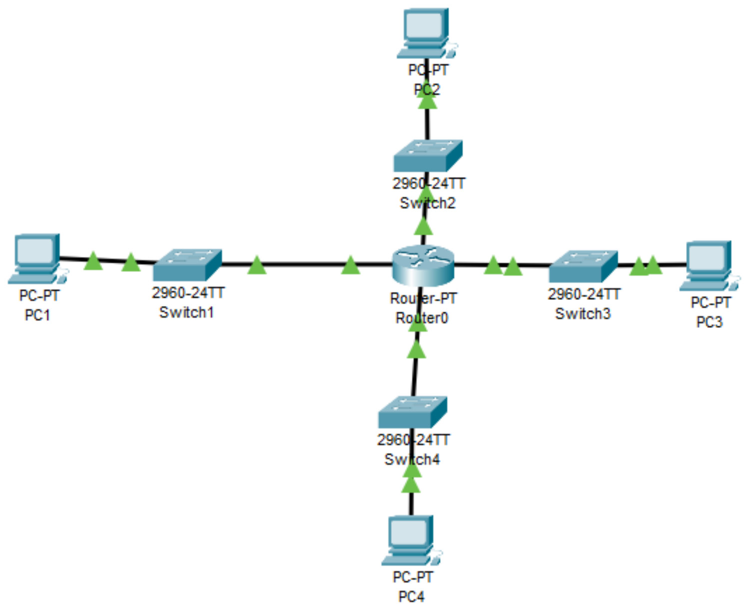


Figure 3: Setup for Activity A after configuring interfaces

7 **Each computer was configured with a default gateway equivalent to the corresponding interface of the router. The connectivity from each of the computers to all other computers was tested using ping.**

- PC1: 202.22.22.12
- PC2: 202.22.22.22
- PC3: 202.22.22.42
- PC4: 202.22.22.82

All PCs could connect to each other.
This is because each PC forwards the packets to its default gateway in absence of a direct connection. In this case, the default gateway is the router interface. Once the packet reaches router, a router can forward packets to a completely different subnet as long as it is connected.

B The following network topology was created similar to Activity A, and the following activities were performed:

IP address of PC1, PC2, PC3 and PC4 were set as:

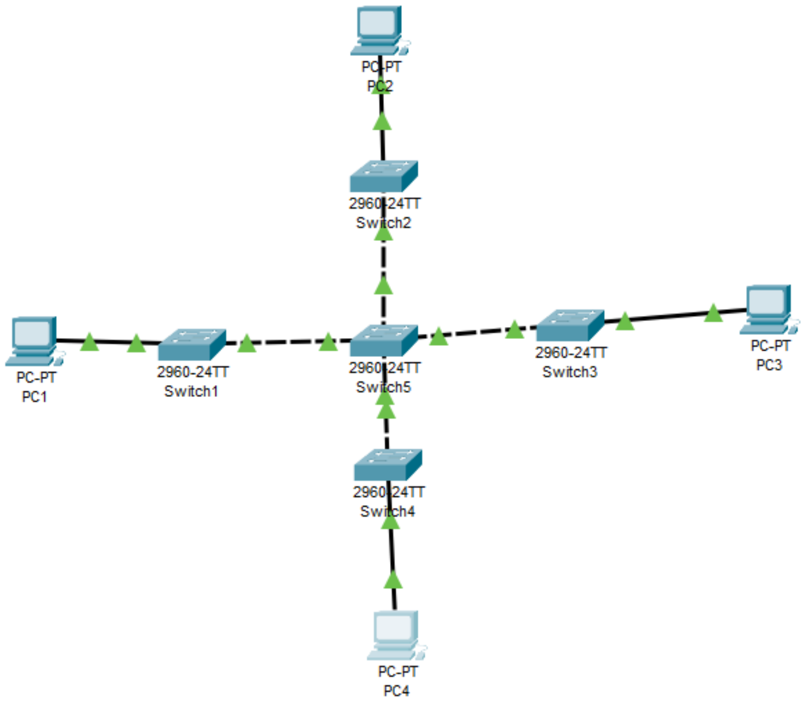


Figure 4: Setup of activity B

- PC1: 202.44.8.2
- PC2: 202.44.9.2
- PC3: 202.44.10.2
- PC4: 202.44.12.2

1 **The connectivity from each of the computers to all other computers were using ping.**
No PCs could connect to each other.
This is because they aren't in the same subnet.

2 **The subnet mask was changed to 255.255.254.0 and Step 1 was repeated.**
PC1 and PC2 to connect to each other. Pings to and from PC3 and PC4 didn't work.
This is because only PC1 and PC2 falls in given subnet.

3 **The subnet mask was changed to 255.255.252.0 and Step 1 was repeated.**
Now PC1, PC2 and PC3 are on the same network and they can ping each other. PC4 is on a separate network and cannot be pinged.

4 **The subnet mask was changed to 255.255.248.0 and Step 1 was repeated.**
Each PC could ping every other PC.
This is because they all lie under same subnet.

C The given IP addresses of 202.70.91.0/24 from ISP was divided range equally for five different departments A, B, C, D and two networks E & F for inter-connection between routers.

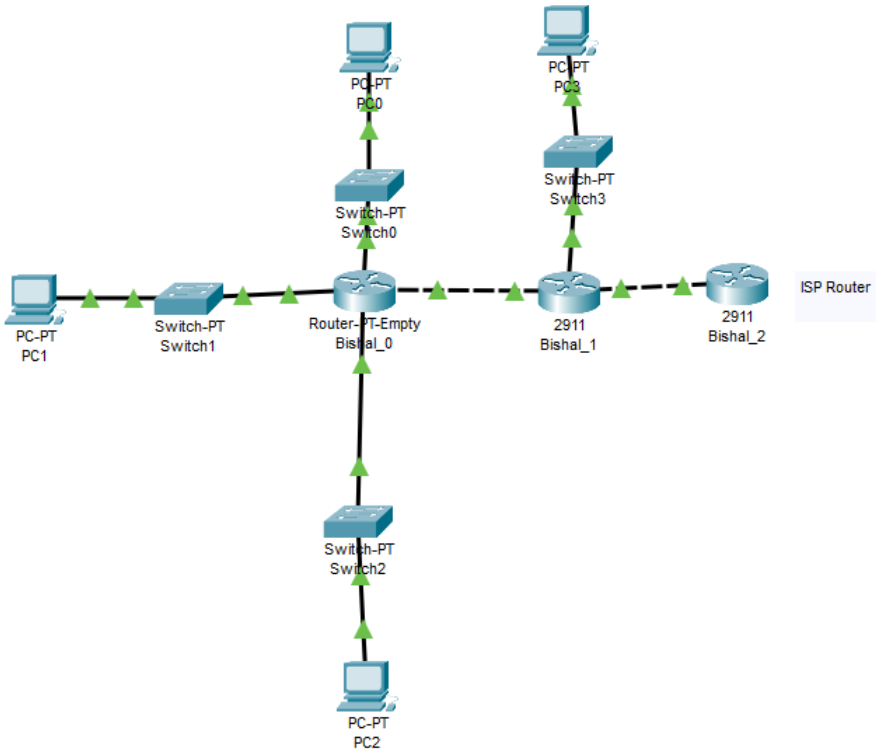


Figure 5: Setup for Activity C

The IP address range allocated for each of the departments with their network address, broadcast address and subnet mask are:
Here we are given 202.70.91.24/24 from ISP that is 256 IP addresses i.e. 0 to 255. For six networks we need to divide this to nearest power of 2 i.e. 8 ranges with 256/8 = 32 IPs in each range.

Network	**First 3 octets**	**IP range**	**Network address**	**Broadcast ID**	**Subnet Mask**
A	202.70.91	0 - 31	0	31	/27
B	202.70.91	32 - 63	32	63	/27
C	202.70.91	64 - 95	64	95	/27
D	202.70.91	96 - 127	96	127	/27
E	202.70.91	128 - 159	128	159	/27
F	202.70.91	160 - 191	160	191	/27
Remaining	202.70.91	192 - 255	NA	NA	NA

Static routing in between each of the department's networks as well as to the Internet via ISP Router were setup.

1 **The connectivity from each of the networks to all other networks were tested using ping.**

All networks could ping each other.
This is because they aren't in the same subnet.

2 **The traceroute command was used from a computer of each of the networks to the rest of the given networks.**
Since all pings were successful, all traceroutes will be successful too. The result however depends on the path taken and routers encountered. Some of the results are:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>tracert 202.70.91.65

Tracing route to 202.70.91.65 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.70.91.130
  2   *         0 ms      0 ms      202.70.91.97
  3   0 ms      0 ms      0 ms      202.70.91.65

Trace complete.

C:\>tracert 202.70.91.33

Tracing route to 202.70.91.33 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.70.91.130
  2   0 ms      0 ms      0 ms      202.70.91.97
  3   0 ms      3 ms      0 ms      202.70.91.33

Trace complete.

C:\>tracert 202.70.91.1

Tracing route to 202.70.91.1 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.70.91.130
  2   0 ms      0 ms      0 ms      202.70.91.97
  3   *         0 ms      0 ms      202.70.91.1

Trace complete.
```

Figure 6: tracert from network D to A, B and C

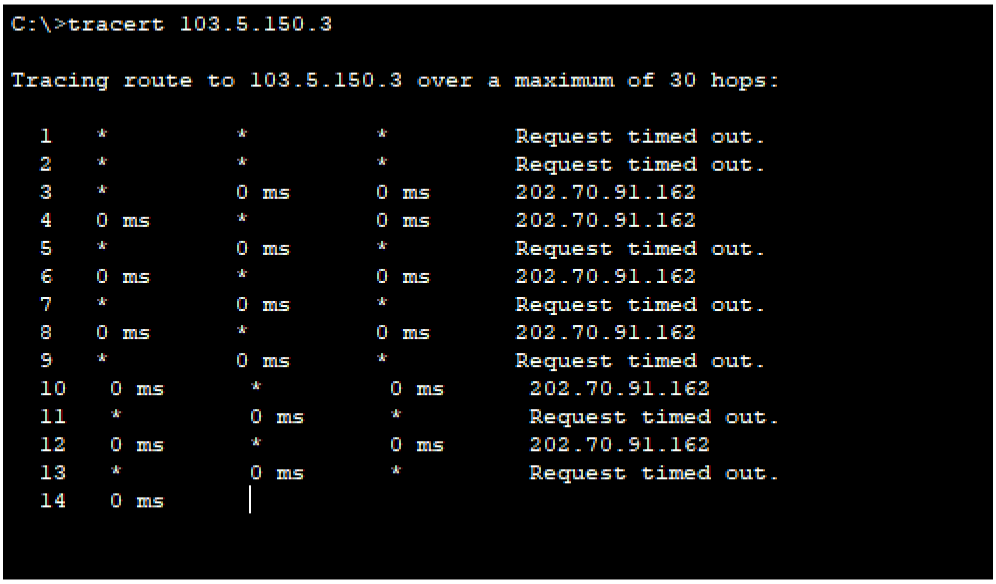
```
C:\>tracert 202.70.91.1

Tracing route to 202.70.91.1 over a maximum of 30 hops:

  1   0 ms     0 ms     0 ms     202.70.91.1

Trace complete.

C:\>tracert 202.70.91.33

Tracing route to 202.70.91.33 over a maximum of 30 hops:

  1   0 ms     0 ms     0 ms     202.70.91.2
  2   0 ms     0 ms     0 ms     202.70.91.33

Trace complete.

C:\>tracert 202.70.91.65

Tracing route to 202.70.91.65 over a maximum of 30 hops:

  1   0 ms     0 ms     0 ms     202.70.91.2
  2   0 ms     0 ms     0 ms     202.70.91.65

Trace complete.

C:\>tracert 202.70.91.129

Tracing route to 202.70.91.129 over a maximum of 30 hops:

  1   0 ms     0 ms     0 ms     202.70.91.2
  2   0 ms     0 ms     0 ms     202.70.91.98
  3   0 ms     0 ms     0 ms     202.70.91.129

Trace complete.
```

Figure 7: tracert from network A to A, B, C and D

Similar results can be observed from others.

3 **The traceroute command was used to the destination address of 103.5.150.3.**

The packet reaches to the default router i.e.the ISP router.



```
C:\>tracert 103.5.150.3

Tracing route to 103.5.150.3 over a maximum of 30 hops:

  1   *         *         *         Request timed out.
  2   *         *         *         Request timed out.
  3   *         0 ms      0 ms      202.70.91.162
  4   0 ms      *         0 ms      202.70.91.162
  5   *         0 ms      *         Request timed out.
  6   0 ms      *         0 ms      202.70.91.162
  7   *         0 ms      *         Request timed out.
  8   0 ms      *         0 ms      202.70.91.162
  9   *         0 ms      *         Request timed out.
  10   0 ms      *         0 ms      202.70.91.162
  11   *         0 ms      *         Request timed out.
  12   0 ms      *         0 ms      202.70.91.162
  13   *         0 ms      *         Request timed out.
  14   0 ms      |
```

Figure 8: tracert to 103.5.150.3

D The IP address of 202.51.78.0/23 was divided to address range for different departments A, B, C, D, E and F interconnected as below with 100, 40, 50, 60, 12 and 20 numbers of hosts respectively along three networks G, H and I having only two hosts in each.

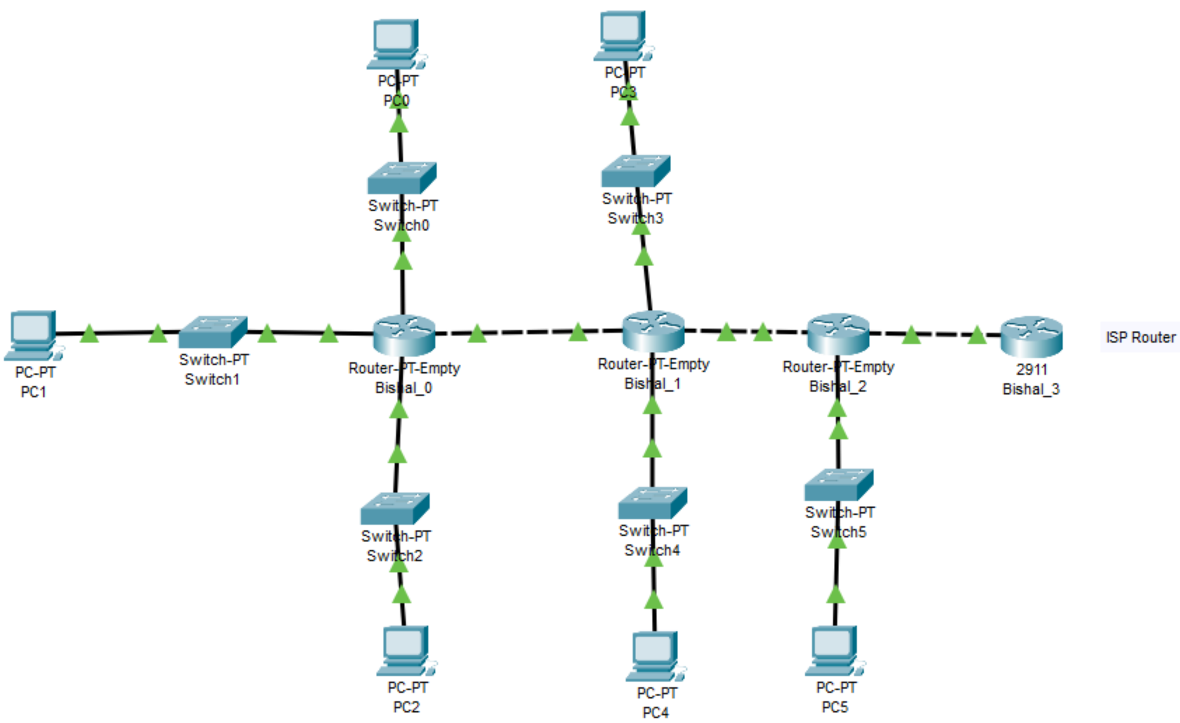


Figure 9: Setup for Activity D

The IP address range for each of the sub-networks with their network address,

broadcast address and subnet mask are:
Here we were given 202.51.78.0/23 from ISP that is 512 IP addresses i.e. 202.51.78.0 to 202.51.79.255. For given networks we had to sort the networks in descending order and round them to nearest larger power of 2.

Network (No.of hosts)	**Rounded to**	**First 3 octets**	**IP range**	**Network address**	**Broadcast ID**
A(100)	128	202.51.78	0 - 127	0	127
D(60)	64	202.51.78	128 - 191	128	191
C(50)	64	202.51.78	192 - 255	192	255
B(40)	64	202.51.79	0 - 63	0	63
F(20)	32	202.51.79	64 - 95	64	95
E(12)	16	202.51.79	96 - 111	96	111
G(2)	4	202.51.79	112 - 115	112	115
H(2)	4	202.51.79	116 - 119	116	119
I(2)	4	202.51.79	120 - 123	120	123
Remaining	NA	202.51.79	124 - 255	NA	NA

Also the static routing in between each of the department's networks as well as to the Internet via ISP Router were setup.

1 **The connectivity from each of the networks to the rest of the given networks was tested using ping command.**
Pings to and from each PC and each router were successful.

2 **The traceroute command was used from a computer of each of the networks to the rest of the given networks.**
Since the pings were successful, all traceroutes will be successful too. Some of the routes are in snaps below.

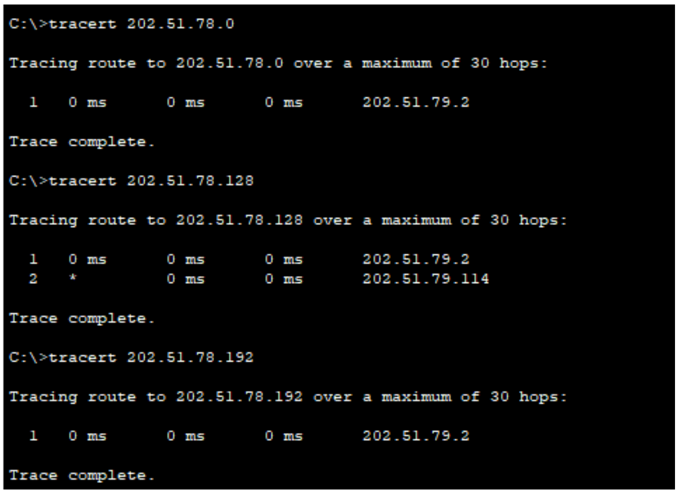
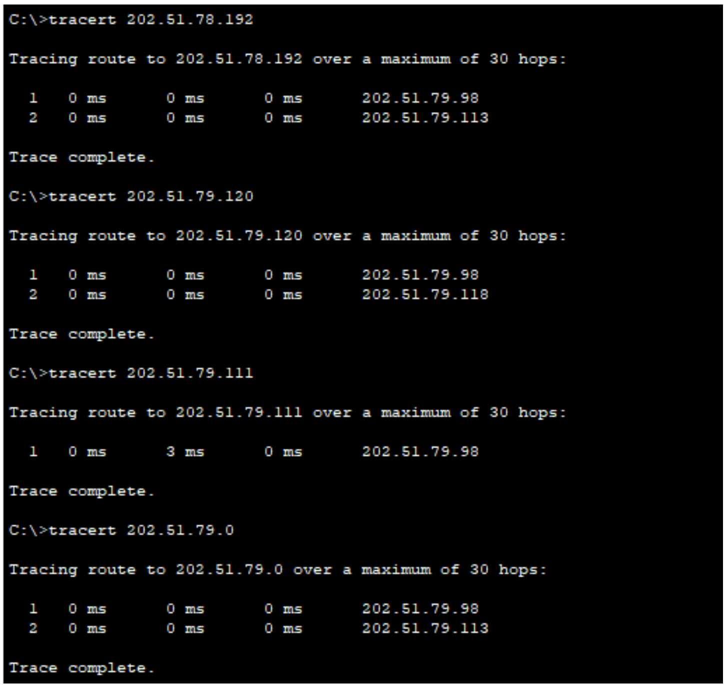
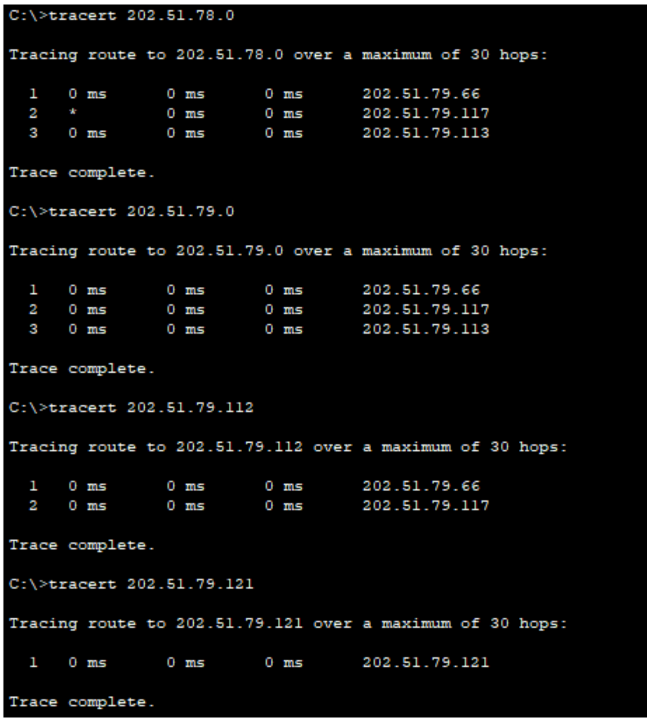


Figure 10: Snaps of Activity D(2) for PC1



```
C:\>tracert 202.51.78.192

Tracing route to 202.51.78.192 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.98
  2   0 ms      0 ms      0 ms      202.51.79.113

Trace complete.

C:\>tracert 202.51.79.120

Tracing route to 202.51.79.120 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.98
  2   0 ms      0 ms      0 ms      202.51.79.118

Trace complete.

C:\>tracert 202.51.79.111

Tracing route to 202.51.79.111 over a maximum of 30 hops:

  1   0 ms      3 ms      0 ms      202.51.79.98

Trace complete.

C:\>tracert 202.51.79.0

Tracing route to 202.51.79.0 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.98
  2   0 ms      0 ms      0 ms      202.51.79.113

Trace complete.
```

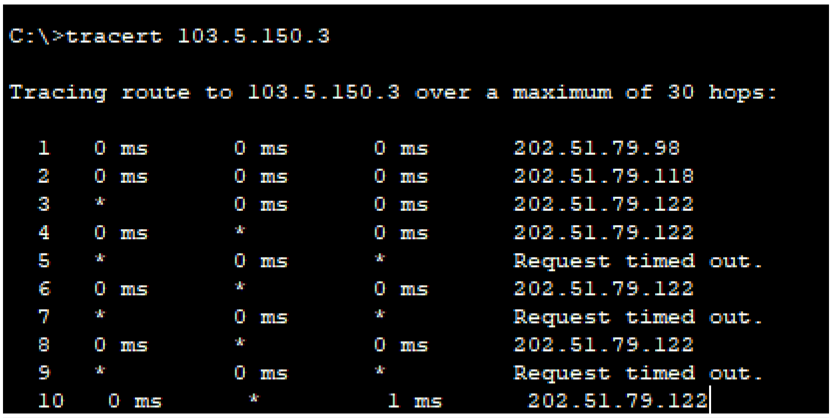
Figure 11: Snaps of Activity D(2) for PC2



```
C:\>tracert 202.51.78.0

Tracing route to 202.51.78.0 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.66
  2   *         0 ms      0 ms      202.51.79.117
  3   0 ms      0 ms      0 ms      202.51.79.113

Trace complete.

C:\>tracert 202.51.79.0

Tracing route to 202.51.79.0 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.66
  2   0 ms      0 ms      0 ms      202.51.79.117
  3   0 ms      0 ms      0 ms      202.51.79.113

Trace complete.

C:\>tracert 202.51.79.112

Tracing route to 202.51.79.112 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.66
  2   0 ms      0 ms      0 ms      202.51.79.117

Trace complete.

C:\>tracert 202.51.79.121

Tracing route to 202.51.79.121 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.121

Trace complete.
```

Figure 12: Snaps of Activity D(2) for PC5

3 **Traceroute command was used to the destination address of 103.5.150.3.**
The packet reaches ISP router and times out.



```
C:\>tracert 103.5.150.3

Tracing route to 103.5.150.3 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      202.51.79.98
  2   0 ms      0 ms      0 ms      202.51.79.118
  3   *         0 ms      0 ms      202.51.79.122
  4   0 ms      *         0 ms      202.51.79.122
  5   *         0 ms      *         Request timed out.
  6   0 ms      *         0 ms      202.51.79.122
  7   *         0 ms      *         Request timed out.
  8   0 ms      *         0 ms      202.51.79.122
  9   *         0 ms      *         Request timed out.
  10   0 ms      *         1 ms      202.51.79.122
```

Figure 13: Traceroute to 103.5.150.3 from PC4

Conclusion and Discussion

In this way “Lab 5: Subnetting and Supernetting” was completed through the use of Cisco Packet Tracer.

Exercise

I **What is a subnet mask? Why is it used? Explain with examples.**
A subnet mask is a 32-bit integer, divided into 4 octets, used to differentiate the network component of an IP by dividing the IP address into a network address and host address. The first part of subnet mask is the network component and it consists of only ones. The second part of the mask is the host address and this differentiates one subnet from another. It can also be written in the form of /XX where XX is the number of consecutive ones in network part.
Subnet masks are used because:

- To reduce IP wastage.
- To help divide IPs into smaller subnets.
- To standardize network and broadcast address.
- To identify network and host address of a device.
- To route packets across networks.

For example:
Consider a subnet mask of 255.255.255.0. Out of 32 bits, 24 bits are for network and 8 for host address. Thus it can also be written as /24. This indicates a network that can have up to 2ˆ8 = 256 hosts. Here the first three octets for each device's IP address are the same and represents network. The final octet's value ranging from 0 to 255 separates the host within this network.
Similarly,
Consider a subnet mask of 255.255.255.128. Out of 32 bits, 25 bits are for network and 7 for host address. Thus it can also be written as /25. This indicates a network that can have up to 2ˆ7 = 128 hosts. Here the first three octets and a bit for each device's IP address are the same and represents network. The final seven bit's value separates the host within this network.

II **Explain subnetting and VLSM with their importance in networking with suitable examples.**
Subnetting is the process of division of network into smaller subnets under local administration. In subnetting, out of the 32 bit subnet mask, some bits from the host field are borrowed to the subnet field. Subnet IP address thus has network field, subnet field and host field. Subnetting is important as it allows a single subnet to be divided into smaller subnets thus utilizing Ips that might otherwise go to waste. For example: 202.70.91.0/24 can be divided into subnets 202.70.91.0/25, 202.70.91.128/25.

VLSM stands for Variable Length Subnet Mask. VLSM is one of the subnetting techniques that allows network administrators to divide IP addresses into subnets of different size. VLSM is important as it allows flexibility in choice of subnet size and thus further reduces IP wastage. Also, in real life not all networks or sub-networks have equal number of hosts. For example: 202.70.91.0/24 can be divided into subnets 202.70.91.0/25, 202.70.91.128/26 and 202.70.91.192/26.

III **What is classless routing? Why is it used in the Internet system? Explain with suitable examples.**
Classless routing is a routing method where the router uses the default route to forward traffic if no other specific routes are found. It includes subnet mask information in the routing update and is supported by RIPv2, OSPF, and EIGRP protocols. Classless routing systems allow VLSM since they send the subnet mask along with their updates.
Classless routing is used in Internet system because it reduces the size of the routing table by means of address aggregation. It is beneficial because it reduces the number of assigned but unnecessary IP addresses.
For example: Consider four class-C network addresses from classful routing.

- 202.70.91.0
- 202.70.92.0
- 202.70.93.0
- 202.70.94.0

with a subnet mask of 255.255.255.0 In classless routing, we can aggregate them into a supernet by using the subnet mask 255.255.252.0

IV **Observe and note down the output of each of the above mentioned tasks and comment on the result by explaining the reason in detail.**
Refer to activity section in Lab Report.