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Computer Network

Lab 5: Subnetting & Supernetting

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LAB No: 5
Subnetting & Supernetting

Objectives:
- To be familiar with subnetting with FLSM and VLSM
- To be familiar with supernetting and classless addressing

Environmental Setup:
- Network simulation tool: Packet Tracer

Theory:

Routing involves directing data packets from a source to a destination through a network. Routers use routing tables and algorithms to determine the best path for data transmission. There are two main types of routing:

1. Static Routing:

   This type of routing are manually configured by network administrators and provides fixed routes to network destinations. Simplicity and security are some advantages of the static routing while its scalability for larger networks and requiring manual updates are its disadvantages.

2. Dynamic Routing:

Task Performed and Observations:

Activity A:

[1, 2] - The network topology was created and the IP addresses of the PCs were assigned as directed and the subnet mask of all these PCs were set to 255.255.255.0. Then the connectivity of all the computers were tested using the ping command, which showed proper connectivity between the computers.

[3, 5] - Now the subnetting mask of all computers was changed to 255.255.255.192. The ping command showed a proper connectivity between the PC1, PC2 and PC3 but the PC4 seemed to be disconnected. Again, the subnet mask of all the computers was changed to 255.255.255.224. The ping command showed connection between PC1 and PC2 but PC3 and PC4 seemed to have been disconnected from the network. Finally the subnet mask of all the computers was changed to 255.255.255.240. The ping command clearly demonstrated that only a single PC1 was connected to the network and all other computers were disconnected.

The reason these PCs were disconnected is because of the limited ip addresses that could be used as per the subnet mask. For example, when the subnet mask was changed to 255.255.255.240 (11111111.11111111.11111111.11110000), the last 4 bits of this address gave the range of host that could be used with in the network i.e. the number of hosts per subnet is given as

2^(32-28) - 2 = 2^4 - 2 = 16 - 2 = 14 hosts

These 14 hosts can have usable IP addresses from x.x.x.1 to x.x.x.14 And only PC1 has an IP address (202.22.22.11) that lies within the range of usable IP addresses, PC1 is connected to the network (belongs to the subnet) and other PCs with out of the range IP Addresses are disconnected from the network (belongs to a different subnet) even though they have a visible physical connection through switches.

[6, 7] - The **central switch was then replaced by a router i.e. Router0,** The hostname of the router was configured as Mavis021 and its interfaces were configured with directed IP addresses and subnet mask. Then each computer was configured with a default gateway i.e IP address of the corresponding interface of the router. The connectivity of each computer to all other computers were tested using the ping command. All the pings across PCs were successful even though they all belonged to different subnets.

Activity B:

[1] - The network topology was created and the IP addresses of the PCs were assigned as directed and the subnet mask of all these PCs were set to 255.255.255.0. Then the connectivity of all the computers were tested using the ping command, but all the pings replied **Request Time Out** indicating these PCs were not within the connectivity even though they were connected physically.

[2, 4] - The subnet mask of all the computers was now changed to 255.255.254.0. The ping command replied ‘ request time out ‘ for other PCs but showed proper connectivity for **PC1 and PC2**. Now when changing the subnet mask to 255.255.252.0, the ping command displayed the connectivity between **PC1, PC2 and PC3** but replied ‘ request time out ‘ for the PC4. Finally, the subnet mask of all the computers were replaced with 255.255.248.0, this time all the PCs were connected to a single subnet and were able to communicate with each other.

Activity C:

[**Initial Evaluation and Allocations**] Based on the CIDR (slash notation) for the subnet mask, the given IP Address 200.70.90.0 /24 belongs to class C. It indicated that there can be a total of 254 usable hosts. But we are assigned a task to divide this address range equally for different departments A, B, C, D and two networks E & F for interconnection between routers. In other words, these departments are divided into different subnets from the provided class C IP address.

Given 6 different departments, borrowing 3 bits (11111111.11111111.11111111.11100000) from the host portion will provide us with 8 networks and 30 hosts i.e. (8 - 2=6) usable ip addresses. Allocating the IP address range for each of the departments:

Departments	Binary	Network Address	Broadcast Address	Subnet Mask
A	.00100000	202.70.90.32	202.70.90.63	255.255.255.224
B	.01000000	202.70.90.64	202.70.90.95	255.255.255.224
C	.01100000	202.70.90.96	202.70.90.126	255.255.255.224
D	.10000000	202.70.90.128	202.70.90.159	255.255.255.224
E	.10100000	202.70.90.160	202.70.90.191	255.255.255.224
F	.11000000	202.70.90.192	202.70.90.223	255.255.255.224

Assuming the number of hosts to be the same in all the subnets, the division has been made with a Fixed Length Subnet Mask technique. The router interfaces have following addresses:

FastEthernet	Routers		
	Mamata_01	Mamata_02	Mamata_03
0/0	202.70.90.33	202.70.90.194	202.70.90.161
1/0	202.70.90.65	202.70.90.162	102.70.90.161
2/0	202.70.90.97	202.70.90.129	------
3/0	202.70.90.193	------	------

Let each department (subnets) be represented by a single pc, the ip addresses of each pc or router connected to the route interfaces are assigned as below:

FastEthernet	PC/next hop Addresses at the router interface		
	Mamata_01	Mamata_02	Mamata_03
0/0	202.70.90.34	202.70.90.193	202.70.90.162
1/0	202.70.90.66	202.70.90.161	102.70.90.162
2/0	202.70.90.98	202.70.90.130	------
3/0	202.70.90.194	------	------

Now configuring static routing in between each of the department's networks as well as to the Internet via ISP Router, For router Mamata_01

```
102.70.90.160 [1/0] via 202.70.90.194
202.70.90.128 [1/0] via 202.70.90.194
```

For router Mamata_02

```
102.0.0.0/27 is subnetted, 1 subnets
   102.70.90.160 [1/0] via 202.70.90.161
202.70.90.0/27 is subnetted, 6 subnets
   202.70.90.32 [1/0] via 202.70.90.193
   202.70.90.64 [1/0] via 202.70.90.193
                [1/0] via 202.70.90.33
   202.70.90.96 [1/0] via 202.70.90.193
                [1/0] via 202.70.90.33
```

For router Mamata_03

```
202.70.90.0/27 is subnetted, 5 subnets
   202.70.90.32 [1/0] via 202.70.90.162
   202.70.90.64 [1/0] via 202.70.90.162
   202.70.90.96 [1/0] via 202.70.90.162
   202.70.90.128 [1/0] via 202.70.90.162
```

[1] The internetwork is all set and done, the connectivity of networks with each other was tested using ping command which showed a 'Request Time Out' for the first packet on the first ping and then displayed a proper connectivity afterwards. The first packet went time out because the ARP message was taking a long time to identify the mac address of the destination device but once the mac address was known it had a smooth packed flow from the next time.

[2] The output of the traceroute from computers connected to the network presented the number of hops it took to reach to the destination. For instance, the tracert command from the PCA (network A) took a **single hop** to get to the department that belonged to the same network such as PCB and PCC and took **3 hops** to get to PCD and **4 hops** to move out of the ISP Router.

[3] When tracerouting to the destination address of 103.5.150.3, it reached the destination from PCA in 4 hops following Mamata_01 -> Mamata_02 -> Mamata_03 -> 103.5.150.3

Activity D:

[**Initial Evaluation and Allocations**] The IP address of 200.50.40.0 /23 was provided by APNIC (Asia Pacific Network Information Center) And needs to be divided for different departments A, B, C, D, E and F, each having 100, 40, 50, 60, 12 and 20 number of hosts respectively and G, H, and I having only two hosts in each.

In order to divide the provided IP address space into a hierarchy of subnets of different sizes, VLSM (Variable Length Subnet Mask) can be used which makes it possible to create subnets with very different host counts.

Available addresses (2^9 = 512) > Required addresses (100 + 60 + 50 + 40 +20 + 12 + 3 *2 = 288)

For the network topology as directed in labsheet, following would be the division of IP addresses:

Departments	Hosts	Network Address	Broadcast Address	Subnet Mask
A	100	200.50.40.0	200.50.40.127	255.255.255.128
D	60	200.50.40.128	200.50.40.191	255.255.255.192
C	50	200.50.40.192	200.50.40.255	255.255.255.192
B	40	200.50.41.0	200.50.41.63	255.255.255.192
F	20	200.50.41.64	200.50.41.95	255.255.255.224
E	12	200.50.41.96	200.50.41.111	255.255.255.240
G	2	200.50.41.112	200.50.41.115	255.255.255.252
H	2	200.50.41.116	200.50.41.119	255.255.255.252
I	2	200.50.41.120	200.50.41.123	255.255.255.252

Now configuring the network interfaces as follows:

FastEthernet	Routers			
	Mamata_01	Mamata_02	Mamata_03	Mamata_03
0/0	200.50.40.1	200.50.41.114	200.50.41.118	200.50.41.125
1/0	200.50.41.1	200.50.41.97	200.50.41.65	103.5.150.4
2/0	200.50.40.193	200.50.41.117	200.50.41.124	---
3/0	200.50.41.113	200.50.40.129	---	---

Similarly the computers representing each network has the following IP addresses:

Networks	IP Address	Default Gateway
PCA	200.50.40.2	200.50.40.1
PCB	200.50.41.2	200.50.41.1
PCC	200.50.40.194	200.50.40.193
PCD	200.50.41.130	200.50.41.129
PCE	200.50.41.98	200.50.41.97
PCF	200.50.41.66	200.50.41.65
PCOuter	103.5.150.3	103.5.150.4

Finally configuring the IP route for all the routers.

When configuring the IP route it was realized that the network D and network B both have 62 usable range but have subnet masks of /26 each. Network B had its network address as 202.50.41.0 which separated it from other networks that used the same router. In order to be able to use a **route aggregation technique** the Ip Addresses assigned to B and D were **switched.**

Now the three networks connected to Mamata_01 are:

[A] - 200.50.40.0/25 (128 addresses)

[B] - 200.50.40.128/26 (64 addresses)

[C] - 200.50.40.192/26 (64 addresses)

The range from 200.50.40.0 to 200.50.40.255 can be represented as a single /24 network. With this configuration, any packet from the networks 200.50.40.0/25, 200.50.40.128/26, and 200.50.40.192/26 destined for a network outside of these subnets will use the summarized route and be forwarded to the next hop IP address 200.50.41.114.

Hence, IP route configuration

For router Mamata_01 can be performed as:

```
Mamata_01(config)#no ip route 200.50.40.0 255.255.255.0 200.50.41.114
Mamata_01(config)#ip route 200.50.41.0 255.255.255.0 200.50.41.114
Mamata_01(config)#ip route 103.5.150.0 255.255.255.0 200.50.41.114
Mamata_01(config)#
```

For router Mamata_02:

```
Mamata_02(config)#ip route 200.50.40.0 255.255.255.0 200.50.41.113
Mamata_02(config)#ip route 200.50.41.64 255.255.255.224 202.50.41.118
Mamata_02(config)#ip route 103.5.150.0 255.255.255.0 202.50.41.118
Mamata_02(config)#
```

For router Mamata_03:

```
Mamata_03(config)#ip route 200.50.40.0 255.255.255.0 200.50.41.117
Mamata_03(config)#ip route 200.50.41.0 255.255.255.192 200.50.41.117
Mamata_03(config)#ip route 200.50.41.96 255.255.255.240 200.50.41.117
Mamata_03(config)#ip route 103.5.150.0 255.255.255.0 200.50.41.122
Mamata_03(config)#
```

For router Mamata_04:

```
Mamata_04(config)#ip route 200.50.40.0 255.255.255.0 200.50.41.121
Mamata_04(config)#ip route 200.50.41.0 255.255.255.0 200.50.41.121
Mamata_04(config)#
```

[1] The internetwork is all set and done, the connectivity of networks with each other was tested using ping command which showed a ‘Request Time Out’ for the first packet on the first ping and then displayed a proper connectivity afterwards. The first packet went time out because the ARP message was taking a long time to identify the mac address of the destination device but once the mac address was known it had a smooth packed flow from the next time.

[2] The output of the traceroute from computers connected to the network presented the number of hops it took to reach to the destination. For instance, the tracert command from the PCA (network A) took a **single hop** to get to the department that belonged to the same network such as PCB and PCC and took **3 hops** to get to PCD and PCE, took 4 hops to get to PCF and **5 hops** to move out of the ISP Router.

[3] When tracerouting to the destination address of 103.5.150.3, it reached the destination from PCA in 5 hops following Mamata_01 -> Mamata_02 -> Mamata_03 -> Mamata_04 -> 103.5.150.3

Exercise:

1. What is a Subnet Mask? Why is it Used? Explain with Examples.

   A subnet mask is a 32-bit number used in IP networking to divide an IP address into a network and host portion. It helps determine which part of an IP address refers to the network and which part refers to the host.

   Example:

   - IP Address: `192.168.1.10`

   - Subnet Mask: `255.255.255.0`

   In binary:

   - IP Address: `11000000.10101000.00000001.00001010`

   - Subnet Mask: `11111111.11111111.11111111.00000000`

   The first 24 bits (the network portion) are masked (indicated by the subnet mask's 1s), and the last 8 bits (the host portion) are left for host addresses.

2. What is Subnetting with FLSM and Subnetting with VLSM? Mention Their Importance in Networking with Suitable Examples.

   Subnetting is the process of dividing a larger network into smaller, more manageable sub-networks (subnets). In Fixed Length Subnet Masking (FLSM), all subnets created are of equal size. This method is simple to implement and manage but can lead to inefficient use of IP addresses.

   - Example: Dividing a `192.168.1.0/24` network into four subnets with a `255.255.255.192` subnet mask, each subnet has 64 addresses.

   In contrast, Variable Length Subnet Masking (VLSM) allows for subnets of different sizes, which makes more efficient use of IP addresses by assigning address spaces according to the specific needs of each subnet.

- Example: Dividing a `192.168.1.0/24` network into subnets with different masks, such as `192.168.1.0/26` (64 addresses), `192.168.1.64/26` (64 addresses), `192.168.1.128/27` (32 addresses), and so on.

Importance:

- FLSM: Easier to manage but can lead to wasted IP addresses.

- VLSM: Maximizes IP address usage, suitable for networks of varying sizes.

3. What is Classless Routing? Why is it Important in the Internet System? Explain with Suitable Examples.

   Classless routing, which uses CIDR (Classless Inter-Domain Routing), allocates IP addresses and routing without adhering to the traditional classful network boundaries (A, B, C classes). This flexibility prevents the wastage of IP addresses and supports the growth of the Internet. For example, a classful network might allocate a 192.168.0.0/24 network for an office that only needs 10 addresses, wasting the remaining addresses. With classless routing, a 192.168.0.0/28 network can be allocated, providing precisely 16 addresses, thus avoiding wastage. Classless routing's ability to allocate addresses efficiently and flexibly is crucial for managing the growing number of devices and networks on the Internet.

Conclusion:

This Lab Exercise was really helpful for understanding how Subnet masks help in defining network boundaries, while subnetting (both FLSM and VLSM) enables efficient use of IP addresses. And how Classless routing further enhances flexibility and efficiency.