# VIT-AP UNIVERSITY, ANDHRA PRADESH

## Lab Sheet 2 : Study of IP, Subnetting & Supernetting

**Academic year:** 2020-2021
Semester: Winter
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**Branch/ Class:** B.Tech
Date: 13/02/2021
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1. Study of network IP

- Classification of IP address
- Sub netting
- Super netting

| Class | Address range | Purposes |
|---|---|---|
| A | 0.0.0.0-127.255.255.255 | IP addresses are used for huge networks, like those deployed by Internet Service Providers (ISPs). Class A IP addresses support up to 16 million hosts (hosts are devices that connect to a network (computers, servers, switches, routers, printers...etc.) |
| B | 128.0.0.0–192.168.0.101 | IP addresses are used for medium and large-sized networks in enterprises and organizations. They support up to 65,000 hosts on 16,000 individual networks. |
| C | 192.0.0.0–255.255.255.0 | addresses are most common and used in small business and home networks. These support up to 256 hosts on each of 2 million networks. |
| D | 224.0.0.0–239.255.255.255 | Class D is reserved for a not widely used, and reserved for special cases largely for services and applications to stream audio and video to many subscribers at once |

| | | |
|---|---|---|
| E | 240.0.0.0 – 255.255.255.255 | Reserved IP<br>Class E addresses are reserved for research purposes by those responsible for Internet networking and IP address research, management, and development |

2. **Sub netting**

Why we Develop sub netting and How to calculate subnet mask and how to identify subnet address?

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Subnetting is the process of stealing bits from the HOST part of an IP address in order to divide the larger network into smaller sub-networks called subnets. After subnetting, we end up with NETWORK SUBNET HOST fields. We always reserve an IP address to identify the subnet and another one to identify the broadcast subnet address.

Conservation of IP addresses: Imagine having a network of 20 hosts. Using a Class C network will waste a lot of IP addresses (254-20=234). Breaking up large networks into smaller parts would be more efficient and would conserve a great amount of addresses.

Calculate Subnet Mask

You can calculate IPv4 subnet masks by hand if you so desire, but it is much easier to just use a subnet calculator. For the die hard, however, let's walk you through IP subnetting step by step.

By default, the subnet mask for a Class C IP address class is set to 255.255.255.0, meaning that the first 3 octets (24 bits) in an IP address are used to identify the network ID, and the last octet (8 bits) are dedicated to the host ID.

But subnetting your network by hand can be tricky. Using an online subnet calculator like the Spiceworks Subnet Calculator can quickly help you divide your IP network into smaller subnet ranges.

That means that on this particular subnet, there are 256 possible IP addresses. How did we figure this out? Remember that 255 is the highest number that can be represented in binary with 8 bits. To get to 255, all of the 8 bits must be set to 1, each one representing a number in decimal (1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 = 255). When you include the number zero that makes 256 possible values.

| Subnet Mask 255.255.255.0 | | | | |
|---|---|---|---|---|
| | 24 bits for Network ID | | | 8 bits for Host ID |
| Decimal | 255 | 255 | 255 | 0 |
| Binary | 11111111 | 11111111 | 11111111 | 00000000 |

But if we had a subnet mask of 255.255.255.192, that would mean there are only 6 bits available to us (we get 192 because the bits representing 128 and 64 are masked out). Because 63 is the highest decimal value that can be represented with 6 binary bits (1 + 2 + 4 + 8 + 16 + 32), when you add the zero, that makes 64 possible values.

| Subnet Mask 255.255.255.192 | | | | |
|---|---|---|---|---|
| | 26 bits for Network ID | | | 6 bits for Host ID |
| Decimal | 255 | 255 | 255 | 192 |
| Binary | 11111111 | 11111111 | 11111111 | 11000000 |

A quicker way to figure out how many hosts will exist on a particular subnet is to use the formula $2^n$-2, where n is the number of bits available to the host ID, where $2^n$ represents 2 raised to the nth power. You must then subtract two from the result because 2 addresses are reserved for the network ID and broadcast address or ID.

So in our examples above:

2^8 – 2 = 254

2^6 – 2 = 62

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But you don't have to do that work manually. If you're going to calculate a subnet mask, ere's a quick cheat sheet to help you figure out how many host addresses are available depending upon the CIDR notation.

| **CIDR notation** | **Available IP Addresses** | **Hosts** | **Netmask** |
|---|---|---|---|
| /30 | 4 | 2 | 255.255.255.252 |
| /29 | 8 | 6 | 255.255.255.248 |
| /28 | 16 | 14 | 255.255.255.240 |
| /27 | 32 | 30 | 255.255.255.224 |
| /26 | 64 | 62 | 255.255.255.192 |
| /25 | 128 | 126 | 255.255.255.128 |
| /24 | 256 | 254 | 255.255.255.0 |
| /23 | 512 | 510 | 255.255.254.0 |
| /22 | 1,024 | 1,022 | 255.255.252.0 |
| /21 | 2,048 | 2,046 | 255.255.248.0 |
| /20 | 4,096 | 4,094 | 255.255.240.0 |
| /19 | 8,192 | 8,190 | 255.255.224.0 |
| /18 | 16,384 | 16,382 | 255.255.192.0 |
| /17 | 32,768 | 32,766 | 255.255.128.0 |
| /16 | 65,536 | 65,534 | 255.255.0.0 |
| /15 | 131,072 | 131,070 | 255.254.0.0 |

| | | | |
|---|---|---|---|
| /14 | 262,144 | 262,142 | 255.252.0.0 |
| /13 | 524,288 | 524,286 | 255.248.0.0 |
| /12 | 1,048,576 | 1,048,574 | 255.240.0.0 |
| /11 | 2,097,152 | 2,097,150 | 255.224.0.0 |
| /10 | 4,194,304 | 4,194,302 | 255.192.0.0 |
| /9 | 8,388,608 | 8,388,606 | 255.128.0.0 |
| /8 | 16,777,216 | 16,777,214 | 255.0.0.0 |
| /7 | 33,554,432 | 33,554,430 | 254.0.0.0 |
| /6 | 67,108,864 | 67,108,862 | 252.0.0.0 |
| /5 | 134,217,728 | 134,217,726 | 248.0.0.0 |
| /4 | 268,435,456 | 268,435,454 | 240.0.0.0 |
| /3 | 536,870,912 | 536,870,910 | 224.0.0.0 |
| /2 | 1,073,741,824 | 1,073,741,822 | 192.0.0.0 |
| /1 | 2,147,483,648 | 2,147,483,646 | 128.0.0.0 |
| /0 | 4,294,967,296 | 4,294,967,294 | 0.0.0.0 |

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3. **Super netting**
   Why we develop super netting and How to calculate super net mask and how to identify super net Address?

The main purpose of super netting is reducing the size of the routing table on routers. For example, instead of a router having 8 individual routes (pointing to the same next hop), it can have an aggregated route of these 8 individual routes. This is important for several reasons:

1. It saves memory and processing resources on routing devices. Basically, they need less space to store their routing table and less processing power to search through the routing table.
2. It provides stability on the network because fluctuations in one part of the network are not propagated to all parts of the network i.e. fluctuations can be isolated.

ust like subnetting, supernetting is about counting in orders of 2 i.e. 2, 4, 8, 16, etc. When you create a supernet, you need to ensure that it covers only the networks you want to aggregate and not more. In fact, less is better so as to avoid routing issues which we will discuss in a later section.

The rules to create supernets are as follows:

- Make sure the networks are contiguous (defined as “next or together in sequence”).
- Determine the number of networks to be aggregated and ensure that this number is an order of 2.
- Compare the value of the first *non-common octet* in the *first (lowest) IP address block* in the list of networks to be aggregated to the number of networks to be aggregated (which is also an order of 2). The value of the first *non-common octet* must be:
  - Zero (0), or
  - A multiple of the number of networks to be aggregated. For example, 16 is a multiple of 8 but 8 is not a multiple of 16.

Let’s take examples to explain these rules in detail. Consider the following lists of networks to be aggregated:

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| List 1 | List 2 | List 3 | List 4 | List 5 |
|---|---|---|---|---|
| 192.168.0.0/24 | 192.168.1.0/24 | 192.168.0.0/24 | 192.168.0.0/24 | 10.4.0.0/16 |
| 192.168.1.0/24 | 192.168.2.0/24 | 192.168.1.0/24 | 192.168.1.0/24 | 10.5.0.0/16 |
| | | 192.168.2.0/24 | 192.168.2.0/24 | 10.6.0.0/16 |
| | | | 192.168.4.0/24 | 10.7.0.0/16 |

We will apply the rules to each list and if any one of the rules is broken, then we cannot create one supernet for all those networks without causing some issues.

**Rule #1: Contiguous networks**

- The networks in List 1 are contiguous because the next subnet after 192.168.0.0/24 is 192.168.1.0/24. ***Qualifies for next round***.
- The networks in List 2 are contiguous because the next subnet after 192.168.1.0/24 is 192.168.2.0/24. ***Qualifies for next round***.
- The networks in List 3 are contiguous because the next subnet after 192.168.0.0/24 is 192.168.1.0/24 and after that is 192.168.2.0/24. ***Qualifies for next round***.
- The networks in List 4 are not contiguous because the next subnet after 192.168.2.0/24 is 192.168.3.0/24, not 192.168.4.0/24. ***Does not qualify for next round***.
- The networks in List 5 are contiguous. ***Qualifies for next round***.

**Rule #2: Number of networks order of 2**

- There are two networks to be aggregated in List 1 which is an order of 2. ***Qualifies for next round***.
- There are two networks to be aggregated in List 2 which is an order of 2. ***Qualifies for next round***.
- There are three networks to be aggregated in List 3 which is not an order of 2. ***Does not qualify for next round***.
- There are four networks to be aggregated in List 5 which is an order of 2. ***Qualifies for next round***.

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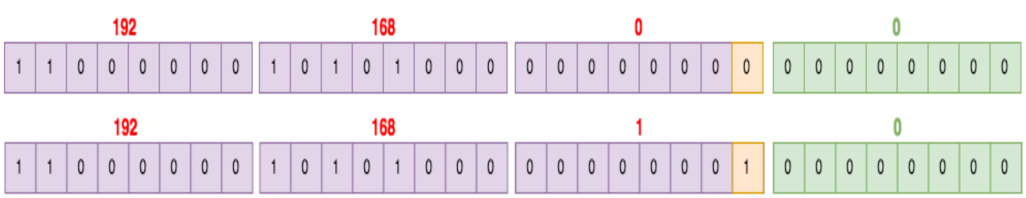
**Rule #3: Value of non-common octet in first IP block is zero or a multiple of the number of networks to be aggregated**

**Note**: This rule is dependent on the previous rule being met. For example, even though 3 is a multiple of 6, 6 is not an order of 2.

- The first non-common octet in List 1 is the 3rd octet i.e. 0 vs. 1. The first (lowest) IP address block is 192.168.0.0/24. The decimal value of the 3rd octet in this address block is 0. ***Qualifies to be aggregated***.
- The first non-common octet in List 2 is the 3rd octet i.e. 1 vs. 2. The first (lowest) IP address block is 192.168.1.0/24. The decimal value of the 3rd octet in this address block is 1. This value is not zero or a multiple of the number of networks to aggregated (2). ***Does not qualify to be aggregated***.
- The first non-common octet in List 5 is the 2nd octet i.e. 4 vs. 5 vs. 6 vs. 7. The first (lowest) IP address block is 10.4.0.0/16. The decimal value of the 2nd octet in this address block is 4. This value is a multiple of the number of networks to aggregated (4). ***Qualifies to be aggregated***.

- Once you have gone through the rules of supernetting above, you can now aggregate the networks by determining which of their bits are common and making all other bits from that point 0.

- For example, let's consider our List 1 above made up of 192.168.0.0/24 and 192.168.1.0/24:




These two networks are the same all the way to the 23rd block (counting from the left side starting at 1). The 24th block is where the difference is (highlighted in orange). Therefore, the subnet mask of the new supernet will be 1 all the way to the 23rd block and then 0 from there:

| 192 | 168 | 0 | 0 |
|---|---|---|---|
| 1 1 0 0 0 0 0 0 | 1 0 1 0 1 0 0 0 | 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 |

| 192 | 168 | 1 | 0 |
|---|---|---|---|
| 1 1 0 0 0 0 0 0 | 1 0 1 0 1 0 0 0 | 0 0 0 0 0 0 0 1 | 0 0 0 0 0 0 0 0 |

| 255 | 255 | 254 | 0 |
|---|---|---|---|
| 1 1 1 1 1 1 1 1 | 1 1 1 1 1 1 1 1 | 1 1 1 1 1 1 1 0 | 0 0 0 0 0 0 0 0 |

Finally, the supernet will be the first IP block in the list (192.168.0.0) with the new subnet mask i.e. 192.168.0.0 255.255.254.0 or 192.168.0.0/23.

**Note**: We usually count binary from right to left, starting at 0. However, we humans are used to counting from left to right, starting at 1 and that's why I have used that analogy here.

Let's try another one. The networks in List 5 above are: 10.4.0.0/16, 10.5.0.0/16, 10.6.0.0/16, 10.7.0.0/16. These networks are the same up to the 14th bit. Therefore, the supernet is 10.4.0.0 255.252.0.0 or 10.4.0.0/14:

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| 10 | 4 | 0 | 0 |
|---|---|---|---|
| 0 0 0 0 1 0 1 0 | 0 0 0 0 0 1 0 0 | 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 |

| 10 | 5 | 0 | 0 |
|---|---|---|---|
| 0 0 0 0 1 0 1 0 | 0 0 0 0 0 1 0 1 | 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 |

| 10 | 6 | 0 | 0 |
|---|---|---|---|
| 0 0 0 0 1 0 1 0 | 0 0 0 0 0 1 1 0 | 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 |

| 10 | 7 | 0 | 0 |
|---|---|---|---|
| 0 0 0 0 1 0 1 0 | 0 0 0 0 0 1 1 1 | 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 |

| 255 | 252 | 0 | 0 |
|---|---|---|---|
| 1 1 1 1 1 1 1 1 | 1 1 1 1 1 1 0 0 | 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 |