**Module 4. Easy Subnetting**

**Beginner Question**

**1. Explain Subnetting.**

**Subnetting** is the practice of dividing a network into two or more smaller networks. It increases routing efficiency, enhances the security of the network and reduces the size of the broadcast domain. IP Subnetting is a process of dividing a large IP network in smaller IP networks. In Subnetting we create multiple small manageable networks from a single large IP network.

Let’s take an example.

To best utilize available addresses if we put more than 16000000 hosts in a single network, due to broadcast and collision, that network will never work. If we put less hosts then remaining addresses will be wasted.

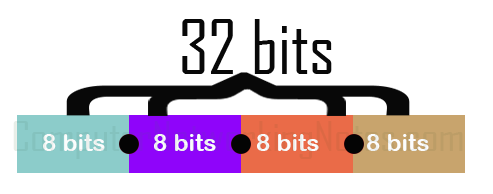
Subnetting provides a better way to deal with this situation. Subnetting allows us to create smaller networks from a single large network which not only fulfill our hosts’ requirement but also offer several other networking benefits.

I have already explained the advantages of Subnetting along with why Subnetting is necessary in previous parts of this tutorial. In this part, I will mainly focus on Subnetting components and terminology.

Identifying network portion and host portion in an IP address is the first step of Subnetting. Subnetting can only be done in host portion. Subnet mask is used to distinguish the network portion from host portion in an IP address.

An IP address and a subnet mask both collectively provide a numeric identity to an interface. Both addresses are always used together. Without subnet mask, an IP address is an ambiguous address and without IP address a subnet mask is just a number.

Both addresses are 32 bits in length. These bits are divided in four parts. Each part is known as octet and contains 8 bits. Octets are separated by periods and written in a sequence.



Subnet mask assigns an individual bit for each bit of IP address. If IP bit belongs to network portion, assigned subnet mask bit will be turned on. If IP bit belongs to host portion, assigned subnet mask bit will be turned off.

There are two popular notations to write the IP address and Subnet mask; Decimal notation and Binary notation.

In decimal notation, a value range 1 to 255 represents a turned on bit while a value 0 (zero) represents a turned off bit.

IP Address: 10.10.10.10

Subnet mask: 255.0.0.0

IP Address: 172.168.10.1

Subnet Mask: 255.255.0.0

IP Address: 192.168.1.1

Subnet Mask: 255.255.255.0

In binary notation, 1 (one) represents a turned on bit while 0 (zero) represents a turned off bit.

**2. What is subnet mask?**

Subnet mask is a [mask](https://www.webopedia.com/TERM/M/mask.html) used to determine what [subnet](https://www.webopedia.com/TERM/S/subnet.html) an [IP address](https://www.webopedia.com/TERM/I/IP_address.html) belongs to. An IP address has two components, the network address and the [host](https://www.webopedia.com/TERM/H/host.html) address. For example, consider the IP address **150.215.017.009**. Assuming this is part of a Class B network, the first two numbers (**150.215**) represent the Class B network address, and the second two numbers (**017.009**) identify a particular host on this network.

The subnet mask is the network address plus the bits reserved for identifying the subnetwork -- by convention, the bits for the network address are all set to 1, though it would also work if the bits were set exactly as in the network address. In this case, therefore, the subnet mask would be 11111111.11111111.11110000.00000000. It's called a [*mask*](https://www.webopedia.com/TERM/M/mask.html) because it can be used to identify the subnet to which an IP address belongs by performing a [bitwise](https://www.webopedia.com/TERM/B/bitwise_operator.html) [AND operation](https://www.webopedia.com/TERM/A/AND_operator.html) on the mask and the IP address. The result is the subnetwork address:

|  |  |  |
| --- | --- | --- |
| Subnet Mask | 255.255.240.000 | 11111111.11111111.11110000.00000000 |
| IP Address | 150.215.017.009 | 10010110.11010111.00010001.00001001 |
| Subnet Address | 150.215.016.000 | 10010110.11010111.00010000.00000000 |

The subnet address, therefore, is 150.215.016.000.

**3. Explain binary decimal hexadecimal with example**

**Binary** is the simplest kind of number system that uses only two digits of 0 and 1 (i.e. value of base 2). Since digital electronics have only these two states (either 0 or 1), so binary number is most preferred in modern computer engineer, networking and communication specialists, and other professionals.

Whereas **Hexadecimal** number is one of the number systems which has value is 16 and it has only 16 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and A, B, C, D, E, F. Where A, B, C, D, E and F are single bit representations of decimal value 10, 11, 12, 13, 14 and 15 respectively.

Hexadecimal number system provides convenient way of converting large binary numbers into more compact and smaller groups. There are various ways to convert a binary number into hexadecimal number. You can convert using direct methods or indirect methods. First, you need to convert a binary into other base system (e.g., into decimal, or into octal). Then you need to convert it hexadecimal number.

Example − Convert binary number 1101010 into hexadecimal number.

First convert this into decimal number:

= (1101010)2

= 1x26+1x25+0x24+1x23+0x22+1x21+0x20

= 64+32+0+8+0+2+0

= (106)10

Then, convert it into hexadecimal number

= (106)10

= 6x161+10x160

= (6A)16 which is answer.

**Intermediate Question**

**1. Classified Default subnet mask for Class A,B,C,D**

| **Class** | **Ist octet Decimal Range** | **Network/Host ID** | **Default subnet mask** |
| --- | --- | --- | --- |
| A | 1 to 126 | N.H.H.H | 255.0.0.0 |
| B | 128 to 191 | N.N.H.H | 255.255.0.0 |
| C | 192 to 223 | N.N.N.H | 255.255.255.0 |
| D | 224 to 239 | Reserved for Multicasting |  |
| E | 240 to 254 | Experimental |  |

**2. Explain Classless Inter-Domain Routing**

CIDR stands for Classless Inter-Domain Routing and is used for IP addressing and routing. It allocates IP addresses in a more flexible manner as compared to the original system of Internet Protocol (IP) address classes. In this way, it increases the number of available IP addresses with extensive use of [NAT (Network Address Translation)](https://www.whizlabs.com/blog/nat-gateway/).

By providing a new, more efficient way to allocate network addresses, CIDR has reduced the issue of wasted address space in the routers. With CIDR, one entry in the routing table entry represents a combination of networks existing in the forward path. This network aggregation in a single address is known as Supernet.

**CIDR Notation**

CIDR IP addresses can be described as consisting of two groups of bits. The most significant group of bits denotes the prefix i.e., a network address that is used for the identification of a network or sub-network. The least significant group of bits is known as host identifier that determines the total number of bits in the address. It is used to signify the device on the work that will receive incoming information packets.

For example, consider the following CIDR Notation

182.0.1.2/28

Here, the prefix is – 182.0.1.2, and

The total number of bits in this address is 28.

**3. How to define subnetting address of class A,B,C,D**

**Class A**:

In Class A, only the first octet is used as Network identifier and rest of three octets are used to be assigned to Hosts (i.e. 16777214 Hosts per Network). To make more subnet in Class A, bits from Host part are borrowed and the subnet mask is changed accordingly.

For example, if one MSB (Most Significant Bit) is borrowed from host bits of second octet and added to Network address, it creates two Subnets (21=2) with (223-2) 8388606 Hosts per Subnet. The Subnet mask is changed accordingly to reflect subnetting.

In case of subnetting too, the very first and last IP address of every subnet is used for Subnet Number and Subnet Broadcast IP address respectively. Because these two IP addresses cannot be assigned to hosts, sub-netting cannot be implemented by using more than 30 bits as Network Bits, which provides less than two hosts per subnet.

**Class B:**

By default, using Classful Networking, 14 bits are used as Network bits providing (214) 16384 Networks and (216-2) 65534 Hosts. Class B IP Addresses can be subnetted the same way as Class A addresses, by borrowing bits from Host bits.

## Class C:

Class C IP addresses are normally assigned to a very small size network because it can only have 254 hosts in a network.

Internet Service Providers may face a situation where they need to allocate IP subnets of different sizes as per the requirement of customer. One customer may ask Class C subnet of 3 IP addresses and another may ask for 10 IPs. For an ISP, it is not feasible to divide the IP addresses into fixed size subnets, rather he may want to subnet the subnets in such a way which results in minimum wastage of IP addresses.

**Class D:**

Class D is reserved for Multicasting.