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**Welcome
To
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Subnetting**



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Subnetting:

- IP Subnetting is a process of dividing a large IP network into smaller IP networks.
- In Subnetting we create multiple small manageable networks from a single large IP network.
- 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.
- In computer networking, Subnetting is used to divide a large IP network in smaller IP networks known as subnets.
- A default class A, B and C network provides 16777214, 65534, 254 hosts respectively. Having so many hosts in a single network always creates several issues such as broadcast, collision, congestion, etc.
- As we know default subnet mask for all class. Class A subnet mask default is 255.0.0.0 or /8, Class B default is 255.255.0.0 or /16 and Class C is 255.255.255.0 or /24.
- It is the process of Dividing a single Network into Multiple Networks converting host bits into Network bits that is Converting 0's into 1's.

Subnetting can be perform in two ways:

1. FLSM (Fixed Length subnet Mask).
2. VLSM (Variable Length subnet Mask).

Subnetting can be done based on requirement.

Benefits of Subnetting:

- Reduce Broadcast.
- Reduce Network Complexity.
- Shortage of IP address solve.
- Improve Security.
- Improve Network Performance.
- Improve Network Management.

Pre requisites for Subnetting:

- Binary Numbers System.
- Decimal Numbers System.
- Binary to Decimal Conversion.
- Decimal to Binary Conversion.
- IPV4 Address (Class A, B, and C)

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- Basic Mathematics

Subnetting Terminology:

Subnet Mask: A mask used to determine what subnet an IP address belongs to.

Subnetting: The Process of dividing a network into small network sections is called subnetting.

CIDR: Classless Inter-Domain Routing simply represents the number of bits used for the subnet mask. For example, /8, /14, /16 etc.

FLSM: Fixed-Length Subnet Masks all subnets will have same number of available hosts addresses.

VLSM: Variable Length Subnet Making is a way of further subnetting a subnet. All subnets have different number of hosts address.

Supernetting: Supernetting combines several networks into one large one. Supernetting reduces the number of entries in a routing table.

Network ID: In classfull addressing, the portion of the IP address that identifies the network is called the Network-ID.

Host ID: In Classfull addressing, the portion of the IP address that identifies the host is called the Host-ID.

Classful IP: Classful is based on the default Class A, B or C networks.

Classless IP: Classless IP addressing means you can use any subnetmask you want.

Default Subnet Mask: A subnet Mask Before Subnetting such as 255.0.0.0 class A, 255.255.0.0 Class B, and 255.255.255.0 class C.

Customize Subnet Mask: A subnet Mask after Subnetting Such as 255.128.0.0, 255.255.192.0 and 255.255.255.224 etc.

Networks and Host-Per-Subnet:

- The number of newly created subnet Formula = $2^{\text{power } n}$
- The number of hosts per subnet Formula = $2^{\text{power } n} - 2$.
- Where n is borrow bits.

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Customize Subnet Mask:

Binary	Decimal
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252
11111110	254
11111111	255

2 Power table for Subnetting:

$2^1=2$	$2^9=512$
$2^2=4$	$2^{10}=1,024$
$2^3=8$	$2^{11}=2,048$
$2^4=16$	$2^{12}=4,096$
$2^5=32$	$2^{13}=8,192$
$2^6=64$	$2^{14}=16,384$
$2^7=128$	$2^{15}=32,768$
$2^8=256$	

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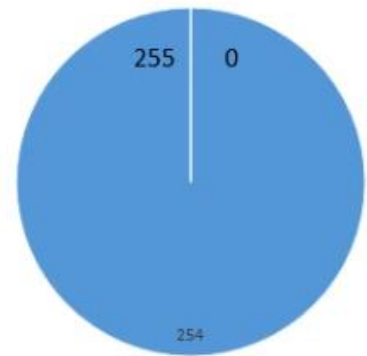
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Class C Subnetting

- IP Address 192.168.100.1
- Subnet Mask 255.255.255.0
- 11000000.10101000.11000100.00000001
- 11111111.11111111.11111111.00000000
- CIDR: /24
- Hosts: $2^8 - 2 = 254$
- NID 1: 192.168.100.0/24
- BID 2: 192.168.100.255/24



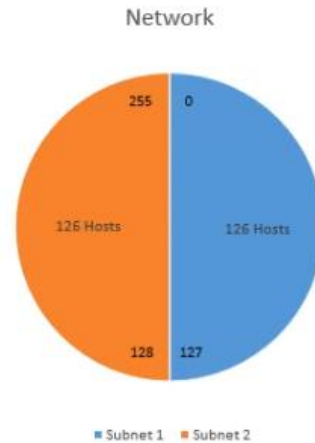
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Subnetting Class C

128	64	32	16	8	4	2	1
1	0	0	0	0	0	0	0

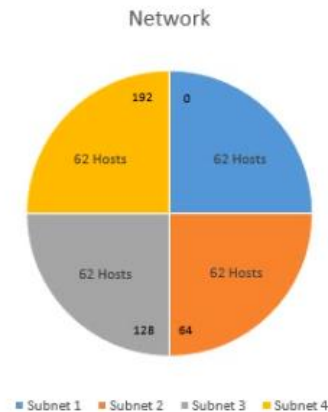
- IP Address 192.168.100.1
- Subnet Mask 255.255.255.0
- New Subnet 255.255.255.128
- SM 11111111.11111111.11111111.00000000
- SM 11111111.11111111.11111111.10000000
- CIDR Notation: /24 + 1 = /25
- Hosts: $2^7 - 2 = 126$
- NID 1: 192.168.100.0/25
- **BID 1: 192.168.100.127/25**
- NID 2: 192.168.100.128/25
- **BID 2: 192.168.100.255/25**



Subnetting Class C

128	64	32	16	8	4	2	1
1	1	0	0	0	0	0	0

- IP Address 192.168.100.1
- Subnet Mask 255.255.255.0
- New Subnet 255.255.255.192
- SM 11111111.11111111.11111111.00000000
- SM 11111111.11111111.11111111.11000000
- CIDR Notation: /24 + 2 = /26
- Hosts: $2^6 - 2 = 62$
- NID 1: 192.168.100.0/26
- **BID 1: 192.168.100.63/26**
- NID 2: 192.168.100.64/26
- **BID 2: 192.168.100.127/26**
- NID 3: 192.168.100.128/26
- **BID 3: 192.168.100.191/26**



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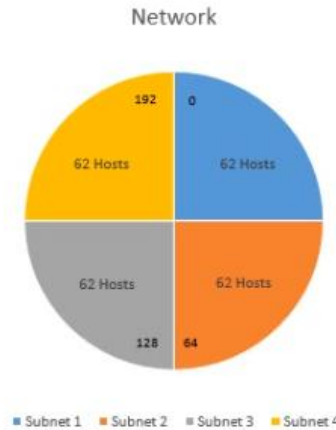
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Subnetting Class C

128	64	32	16	8	4	2	1
1	1	0	0	0	0	0	0

- IP Address 192.168.100.1
- Subnet Mask 255.255.255.0
- New Subnet 255.255.255.192
- SM 11111111.11111111.11111111.00000000
- SM 11111111.11111111.11111111.11000000
- CIDR Notation: /24 + 2 = /26
- Hosts: $2^6 - 2 = 62$
- NID 1: 192.168.100.0/26
- BID 1: 192.168.100.63/26
- NID 2: 192.168.100.64/26
- BID 2: 192.168.100.127/26
- NID 3: 192.168.100.128/26
- BID 3: 192.168.100.191/26



Some Practices Question:

- "255.224.0.0" in slash notation form? - Answer /11
- "/18" in binary form? - Answer is 255.255.192
- "252.0.0.0" in slash notation form? - Answer is /6

IP (Internet Protocol):

IP Addresses are divided into 5 Classes, these are divided by IANA: - Internet Assigned Number authority.

We are using two type of version

- IPV4
- IPV6

So let start first discussing IP V4.

- IP uses packets called IP packets to carry information. Every IP packet should have address.
- The IP address (IPV4) is 32 bit and consists of 2 parts, the network part and the host part.

Example:

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192	168	1	1
8 Bit	8 Bit	8 Bit	8 Bit
N	N	N	H

The IP address is 32 bit but we write it into 4 block of **8 bit** as given above.

IP Addresses are divided into 5 Classes, There are divided by IANA:- Internet Assigned Number Authority.

Class A 1-126

Class B 128-191

Class C 192-223

Class D 224-239 - Multicast

Class E 240-255 - Reserved

So we are only using Class A,B & C IP address

Subnet Mask: It's an address used to identify the network and host portion of the IP address

Class A	N.H.H.H	255.0.0.0	/8
Class B	N.N.H.H	255.255.0.0	/16
Class C	N.N.N.H	255.255.255.0	/24

Remember 255 represent Network bit and 0 represent Host bit.

Class A = /8 = 2^{24} (16,600,000) Addresses for hosts

Class B = /16 = 2^{16} (65,000) Addresses for hosts

Class C = /24 = 2^8 (256) Addresses for hosts

Class A's default mask is 255.0.0.0, or /8

Class B's default mask is 255.255.0.0, or /16

Class C's default mask is 255.255.255.0, or /24

255.0.0.0 in binary is 11111111 00000000 00000000 00000000.

255.255.0.0 in binary is 11111111 11111111 00000000 00000000.

255.255.255.0 in binary is 11111111 11111111 11111111 00000000.

Procedure for Subnetting:

1. Check how many host required. Calculate host bits required (h) => $2^{\text{power } h-2} \geq \text{req.}$
2. Calculated Converted network bits (n) that is Total Host Bits – Required host Bits.

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- 3. **Total. Network Bits = total network bits + converted bits**
- 4. **Block size = 2 power h**
- 5. **Subnets = 2 power n**
- 6. **Range:**

Network ID ----- Broadcast ID

This is the procedure let do one question.

Required 40 hosts using IP add 192.168.1.0/24

- 1. $2^{\text{power } h} - 2 \geq \text{req}$
 $2^{\text{power } 6} - 2 \geq 40$
 $64 - 2 \geq 40$
 $62 \geq 40$
 Host bits required (h) = 6
- 2. **Converted network Bits (n) = Total Host Bits – Required Host Bits**
 $= 8 - 6 = 2(n)$
- 3. **Total Network Bits = total network bits + converted bits**
 $= 24 + 2 = 26$ that is /26
- 4. **Block size = 2 power h = 2 power 6 = 64**
- 5. **Subnets = 2 power n = 4 subnets**
- 6. **Range:**

Network ID ----- Broadcast ID

192.168.1.0/26	192.168.1.63/26
192.168.1.64/26	192.168.1.127/26
192.168.1.128/26	192.168.1.191/26
192.168.1.192/26	192.168.1.255/26

Example 2:

Req = 500 hosts using B-class address network 172.16.0.0/16
 1. Req = 500 hosts using B-class address network 172.16.0.0/16
 $2^{\text{power } h} - 2 \geq \text{req}$

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$2^9 - 2 \geq 500$

$512 - 2 \geq 500$

$510 \geq 500$

2. Host bits required (h) = 9

3. Converted network Bits (n) = Total. H. Bits -- req. H. Bits
 $= 16 - 9 = 7$ (n)

4. Total . Network Bits = total network bits + converted bits = $16 + 7 = /23$

subnet mask = (/23) = 255.255.254.0

5. Blocksize = $2^h = 2^9 = 512$

6. Subnets = $2^n = 2^7 = 128$ Subnets

Range

Network ID --- Broadcast ID

172.16.0.0/23 ---- 172.16.1.255/23

172.16.2.0/23 ---- 172.16.3.255/23

172.16.4.0/23 ---- 172.16.5.255/23

172.16.6.0/23 ---- 172.16.7.255/23

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