Computer Networks

IP ADDRESSING

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IP ADDRESSING

IP Addressing

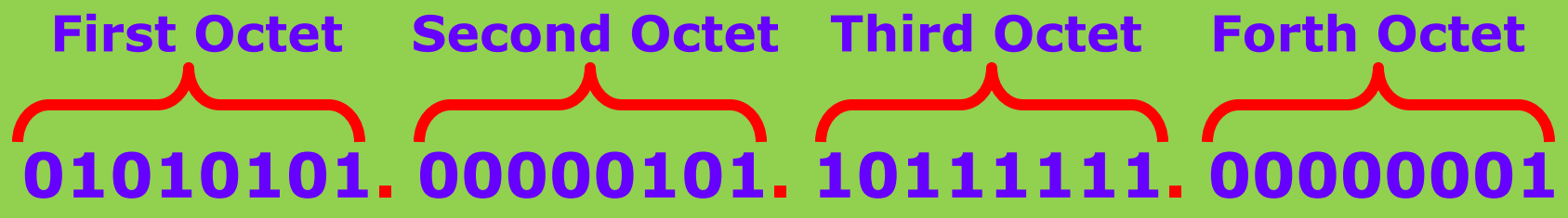
- IP Addressing is Logical Addressing
- It works on Network Layer (Layer 3)
- Two Versions of Addressing Scheme
  - IP version 4 – 32 bit addressing
  - IP version 6 – 128 bit addressing

IP version 4

Bit is a value that will represent 0's or 1's (i.e. Binary)

01010101000001011011111100000001

- **32 bits are divided into 4 Octets known as Dotted Decimal Notation**



IP version 6

- **128-bit address is divided along 16-bit boundaries, and each 16-bit block is converted to a 4-digit hexadecimal number and separated by colons (Colon-Hex Notation)**

  FEDC:BA98:7654:3210:FEDC:BA98:7654:3210

Binary to Decimal Conversion

Taking Example for First Octet :

Total 8 bits, Value will be 0's and 1's

i.e. $2^8 = 256$ combination

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
0	0	0	0	0	0	0	0	=	0
0	0	0	0	0	0	0	1	=	1
0	0	0	0	0	0	1	0	=	2
0	0	0	0	0	0	1	1	=	3
0	0	0	0	0	1	0	0	=	4
1	1	1	1	1	1	1	1	=	255

Total IP Address Range

0 . 0 . 0 . 0

to

255.255.255.255

IP Address Classes

- **Total IP Addressing Scheme is divided into 5 Classes**

- **CLASS A**
- **CLASS B** } **LAN & WAN**
- **CLASS C**
- **CLASS D** } **Multicasting**
- **CLASS E** } **Research & Development**

Priority Bit Concept

- To identify the range of each class a bit called priority bit is used.
- Priority Bit is the left most bits in the First Octet
- CLASS A priority bit is 0
- CLASS B priority bit is 10
- CLASS C priority bit is 110
- CLASS D priority bit is 1110
- CLASS E priority bit is 1111

CLASS A Range

For Class A range : First bit of the first octet should be reserved for the priority bit.

0xxxxxxx. xxxxxxxx. xxxxxxxx. xxxxxxxx

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
0	0	0	0	0	0	0	0	=	0
0	0	0	0	0	0	0	1	=	1
0	0	0	0	0	0	1	0	=	2
0	0	0	0	0	0	1	1	=	3
0	0	0	0	0	1	0	0	=	4
0	1	1	1	1	1	1	1	=	127

Class A Range

0 . 0 . 0 . 0 to 127.255.255.255

Exception

0.X.X.X and 127.X.X.X network are reserved

CLASS B Range

For Class B range : First two bits of the first octet should be reserved for the priority bit.

10xxxxxx. xxxxxxxx. xxxxxxxx. xxxxxxxx

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
1	0	0	0	0	0	0	0	=	128
1	0	0	0	0	0	0	1	=	129
1	0	0	0	0	0	1	0	=	130
1	0	0	0	0	0	1	1	=	131
1	0	0	0	0	1	0	0	=	132
1	0	1	1	1	1	1	1	=	191

Class B Range

128. 0 . 0 . 0

to

191.255.255.255

CLASS C Range

For Class C range : First Three bits of the first octet should be reserved for the priority bit.

110xxxxx. xxxxxxxx. xxxxxxxx. xxxxxxxx

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
1	1	0	0	0	0	0	0	=	192
1	1	0	0	0	0	0	1	=	193
1	1	0	0	0	0	1	0	=	194
1	1	0	0	0	0	1	1	=	195
1	1	0	0	0	1	0	0	=	196
1	1	0	1	1	1	1	1	=	223

Class C Range

192. 0 . 0 . 0

to

223.255.255.255

CLASS D Range

For Class D range : First four bits of the first octet should be reserved for the priority bit.

1110xxxx. xxxxxxxx. xxxxxxxx. xxxxxxxx

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
1	1	1	0	0	0	0	0	=	224
1	1	1	0	0	0	0	1	=	225
1	1	1	0	0	0	1	0	=	226
1	1	1	0	0	0	1	1	=	227
1	1	1	0	0	1	0	0	=	228
1	1	1	0	1	1	1	1	=	239

Class D Range

224. 0 . 0 . 0

to

239.255.255.255

CLASS E Range

For Class E range : First four bits of the first octet should be reserved for the priority bit.

1111xxxx. xxxxxxxx. xxxxxxxx. xxxxxxxx

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0		
1	1	1	1	0	0	0	0	=	240
1	1	1	1	0	0	0	1	=	241
1	1	1	1	0	0	1	0	=	242
1	1	1	1	0	0	1	1	=	243
1	1	1	1	0	1	0	0	=	244
1	1	1	1	1	1	1	1	=	255

Class E Range

240. 0 . 0 . 0

to

255.255.255.255

Octet Format

- **IP address is divided into Network & Host Portion**
- **CLASS A is written as N.H.H.H**
- **CLASS B is written as N.N.H.H**
- **CLASS C is written as N.N.N.H**

CLASS A – No. Networks & Host

- **Class A Octet Format is N.H.H.H**
- **Network bits : 8 Host bits : 24**

- **No. of Networks**
  - **= 2^{8-1} (-1 is Priority Bit for Class A)**
  - **= 2^{7}**
  - **= 128 – 2 (-2 is for 0 & 127 I**
  - **= 126 Networks**

- **No. of Host**
  - **= 2^{24} – 2 (-2 is for Network I**
  - **= 16777216 - 2**
  - **= 16777214 Hosts/Network**

CLASS A

126 Networks

&

16777214 Hosts/Nw

CLASS B – No. Networks & Host

- **Class B Octet Format is N.N.H.H**
- **Network bits : 16 Host bits : 16**

- **No. of Networks**
  = 2^{16-2} (-2 is Priority Bit for Class B)
  = 2^{14}
  = 16384 Networks

- **No. of Host**
  = 2^{16} – 2 (-2 is for Network 1
  = 65536 - 2
  = 65534 Hosts/Network

CLASS B

16384 Networks

&

65534 Hosts/Nw

CLASS C – No. Networks & Host

- **Class C Octet Format is N.N.N.H**
- **Network bits : 24 Host bits : 8**

- **No. of Networks**
  = 2^{24-3} (-3 is Priority Bit for Class C)
  = 2^{21}
  = 2097152 Networks

- **No. of Host**
  = 2^{8} – 2 (-2 is for Network I
  = 256 - 2
  = 254 Hosts/Network

CLASS C
2097152 Networks
&
254 Hosts/Nw

Network & Broadcast Address

- **The network address is represented with all bits as ZERO in the host portion of the address**
- **The broadcast address is represented with all bits as ONES in the host portion of the address**
- **Valid IP Addresses lie between the Network Address and the Broadcast Address.**
- **Only Valid IP Addresses are assigned to hosts/clients**

Example - Class A

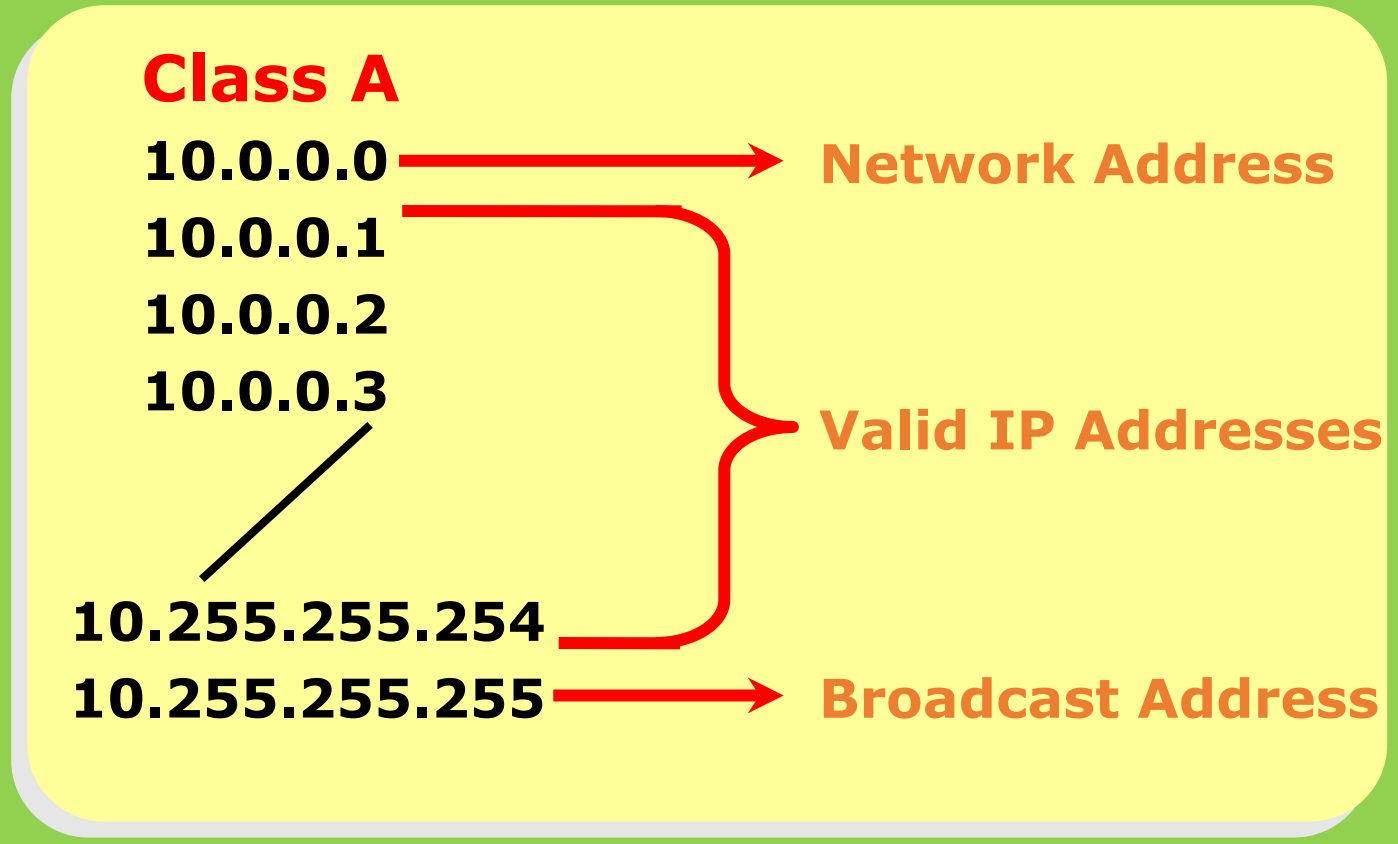
Class A : N.H.H.H

Network Address :

0xxxxxxx.00000000.00000000.00000000

Broadcast Address :

0xxxxxxx.11111111.11111111.11111111



Example - Class B

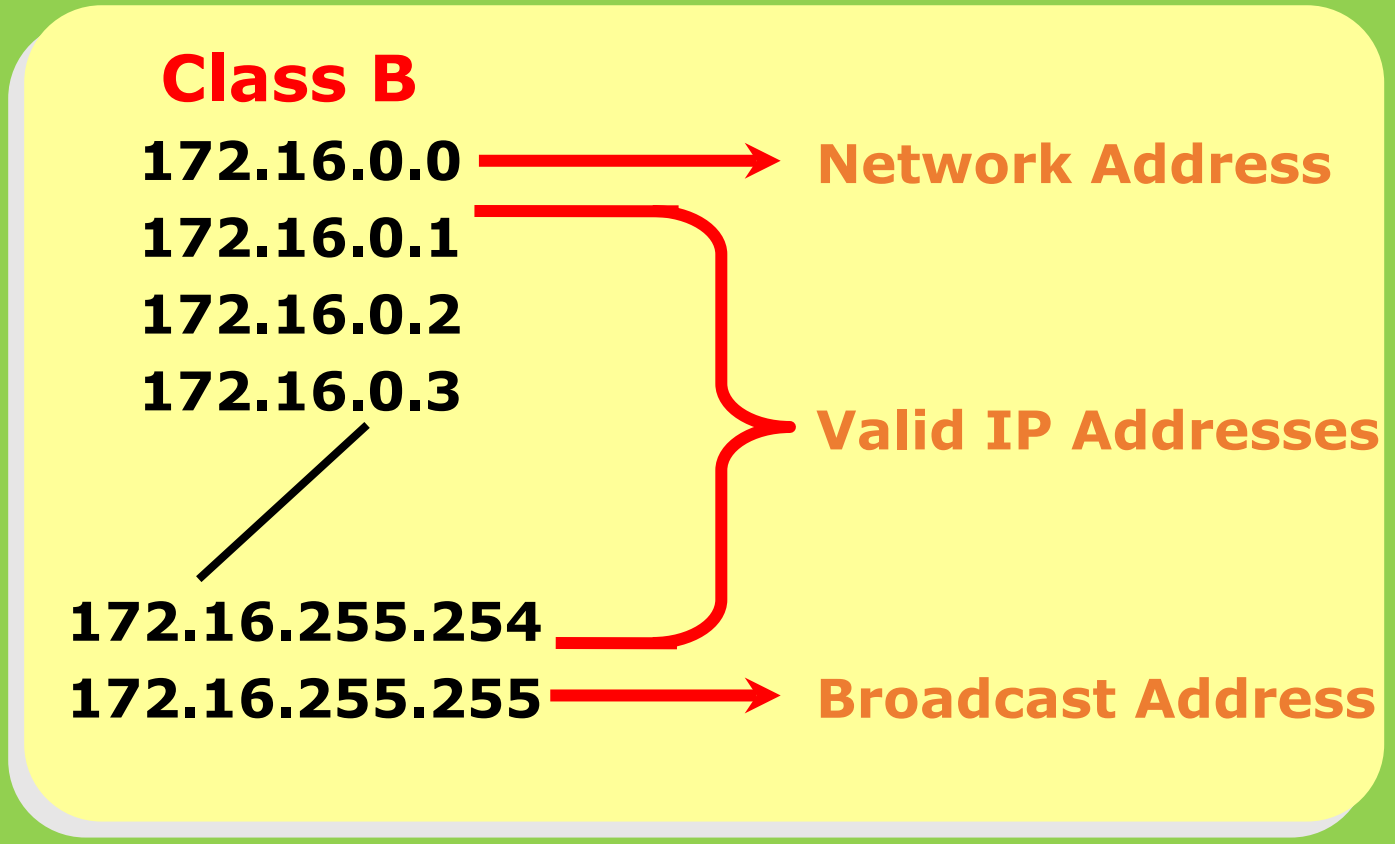
Class B : N.N.H.H

Network Address :

10xxxxxx.xxxxxxxx.00000000.00000000

Broadcast Address :

10xxxxxx.xxxxxxxx.11111111.11111111



Example - Class C

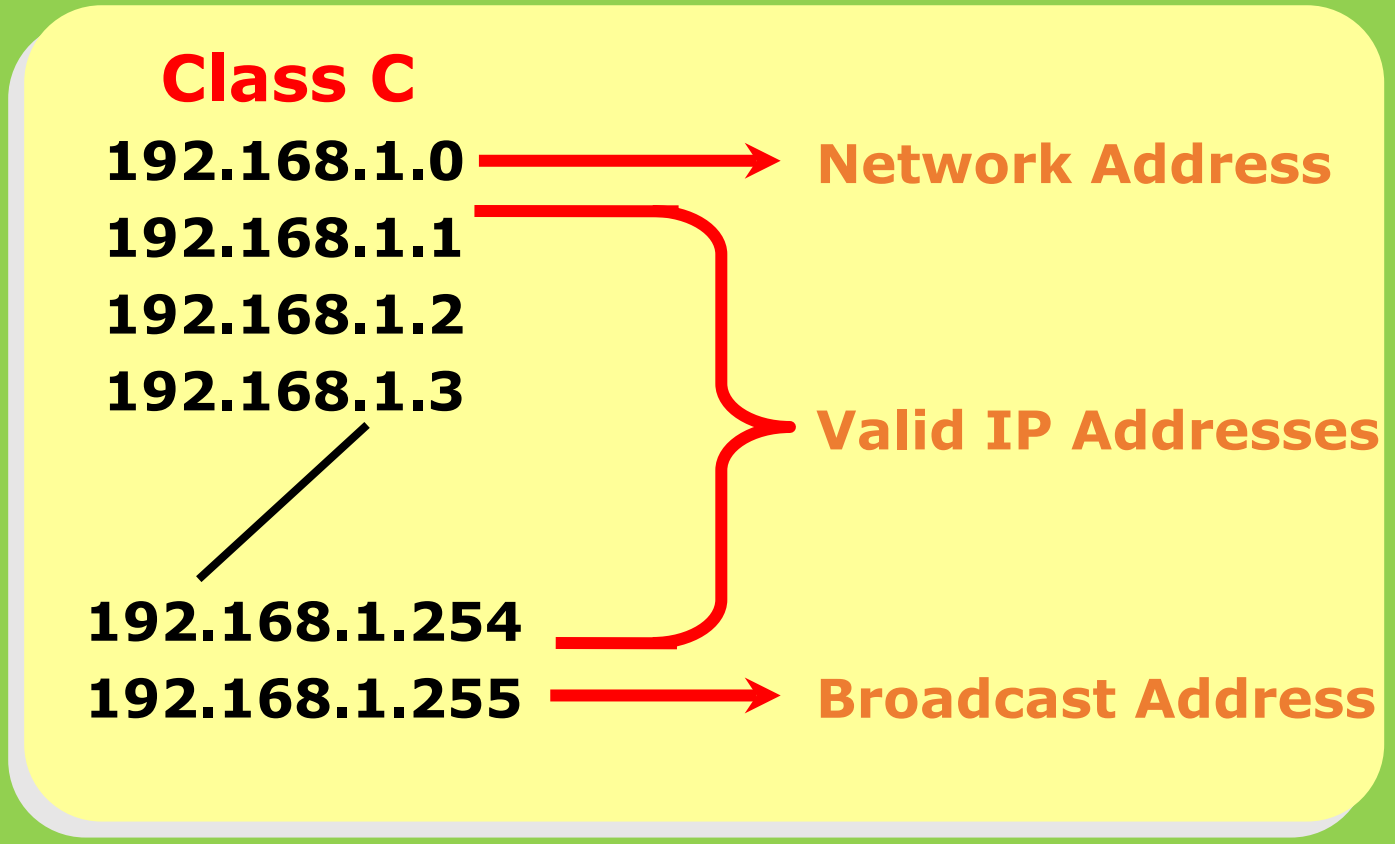
Class C : N.N.N.H

Network Address :

110xxxxx.xxxxxxxx.xxxxxxxx.00000000

Broadcast Address :

110xxxxx.xxxxxxxx.xxxxxxxx.11111111



Private IP Address

- **There are certain addresses in each class of IP address that are reserved for LAN. These addresses are called private addresses.**

- **They can be used for: home & office networks, networks not connected to Internet.**

Class A

10.0.0.0 to 10.255.255.255

Class B

172.16.0.0 to 172.31.255.255

Class C

192.168.0.0 to 192.168.255.255

Subnet Mask

- **Subnet Mask differentiates Network portion and Host Portion**
- **Subnet Mask is been given for host Identification of Network ID**
- **Represented with all 1’s in the network portion and with all 0’s in the host portion.**

Subnet Mask - Examples

Class A : N.H.H.H

11111111.00000000.00000000.00000000

Default Subnet Mask for Class A is 255.0.0.0

Class B : N.N.H.H

11111111.11111111.00000000.00000000

Default Subnet Mask for Class B is 255.255.0.0

Class C : N.N.N.H

11111111.11111111.11111111.00000000

Default Subnet Mask for Class C is 255.255.255.0

How Subnet Mask Works ?

IP Address : 192.168.1.1

Subnet Mask : 255.255.255.0

ANDING PROCESS :

192.168.1.1 = 11000000.10101

255.255.255.0 = 11111111.11111

==========

192.168.1.0 = 11000000.10101

==========

The output of an AND table is 1 if

For all other possible inputs the ou

AND TABLE

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Subnetting

- **Dividing a Single Network into Multiple Networks.**
- **Converting Host bits to Network Bits**

  i.e. Converting 0’s into 1’s
- **Subnetting is also called as FLSM (Fixed Length Subnet Mask)**
- **Subnetting can be done in three ways.**
  - **Requirement of Networks**
  - **Requirement of Hosts**
  - **Cisco / Notation**

Scenario

ZOOM Technologies is having 100 PC

- **Which Class is preffered for the network ?**
  Answer : Class C.

- **In ZOOM Technologies we have Five Departments with 20 Pcs each**

  ZOOM Technologies – 192.168.1.0/24

  - **MCSE** → **192.168.1.1 to 192.168.1.20**
  - **CISCO** → **192.168.1.21 to 192.168.1.40**
  - **FIREWALL** → **192.168.1.41 to 192.168.1.60**
  - **SOLARIS** → **192.168.1.61 to 192.168.1.80**
  - **TRAINING** → **192.168.1.81 to 192.168.1.100**

Scenario (...continued)

- **Administrator's Requirement :**
  Inter-department communication should not be possible ?

  Solution.
  Allocate a different Network to each Department
  i.e.
  - **MCSE** → **192.168.1.1 to 192.168.1.20**
  - **CISCO** → **192.168.2.1 to 192.168.2.20**
  - **FIREWALL** → **192.168.3.1 to 192.168.3.20**
  - **SOLARIS** → **192.168.4.1 to 192.168.4.20**
  - **TRAINING** → **192.168.5.1 to 192.168.5.20**

- **In the above Scenario inter-department communication is not possible.**

Main Aim of Subnetting

Problem with the previous Scenario is :-

- **Loss of bandwidth as the broadcasting is done for 254 machines rather than for 20 machines.**
- **Wastage of IP addresses (Approximately 1000)**
- **No Security**

Power table

POWER TABLE

$2^1 = 2$	$2^9 = 512$	$2^{17} = 131072$	$2^{25} = 33554432$
$2^2 = 4$	$2^{10} = 1024$	$2^{18} = 262144$	$2^{26} = 67108864$
$2^3 = 8$	$2^{11} = 2048$	$2^{19} = 524288$	$2^{27} = 134217728$
$2^4 = 16$	$2^{12} = 4096$	$2^{20} = 1048576$	$2^{28} = 268435456$
$2^5 = 32$	$2^{13} = 8192$	$2^{21} = 2097152$	$2^{29} = 536870912$
$2^6 = 64$	$2^{14} = 16384$	$2^{22} = 4194304$	$2^{30} = 1073741824$
$2^7 = 128$	$2^{15} = 32768$	$2^{23} = 8388608$	$2^{31} = 2147483648$
$2^8 = 256$	$2^{16} = 65536$	$2^{24} = 16777216$	$2^{32} = 4294967296$

Some Important Values

VALUES IN SUBNET MASK

Bit	Value	Mask
1	128	10000000
2	192	11000000
3	224	11100000
4	240	11110000
5	248	11111000
6	252	11111100
7	254	11111110
8	255	11111111

Requirement of Networks is 5 ?
Example – 1

Class C : N.N.N.H

110xxxxx.xxxxxxxx.xxxxxxxx.xxxxxxxx

Class C : 192.168.1.0

- **No. of Subnet**
  - **= $2^n - 2 \geq$ Req. of Subnet**
  - **= $2^3 - 2 \geq 5$ (-2 is for First & Last Subnet Range)**
  - **= 8 – 2**
  - **= 6 Subnet**
- **No. of Host**
  - **= $2^h - 2$ (-2 is for Network ID & Broadcast ID)**
  - **= $2^5 - 2$**
  - **= 32 – 2**
  - **= 30 Hosts/Subnet**

HELP

Example – 1 (Continued…)

If you convert 3 Host Bits to Network Bits
6 Subnet & 30 Hosts/Subnet

Customize Subnet Mask
255.255.255.224

Subnet Range

192.168.1.32 to 192.168.1.63 → MCSE
192.168.1.64 to 192.168.1.95 → CISCO
192.168.1.96 to 192.168.1.127 → FIREWALL
192.168.1.128 to 192.168.1.159 → SOLARIS
192.168.1.160 to 192.168.1.191 → TRAINING
192.168.1.192 to 192.168.1.223 → Future Use

Requirement of Networks is 14 ?
Example – 2

Class C : N.N.N.H

110xxxxx.xxxxxxxx.xxxxxxxx.xxxxxxxx

Class C : 192.168.1.0

- **No. of Subnet**
  - **= $2^n - 2 \geq$ Req. of Subnet**
  - **= $2^4 - 2 \geq 14$ (-2 is for First & Last Subnet Range)**
  - **= 16 – 2**
  - **= 14 Subnet**
- **No. of Host**
  - **= $2^h - 2$ (-2 is for Network ID & Broadcast ID)**
  - **= $2^4 - 2$**
  - **= 16 - 2**
  - **= 14 Hosts/Subnet**

HELP

Example – 2 (Continued…)

If you convert 4 Host Bits to Network Bits

14 Subnet & 14 Hosts/Subnet

Customize Subnet Mask

255.255.255.240

Subnet Range

192.168.1.16 to 192.168.1.31

192.168.1.32 to 192.168.1.47

192.168.1.48 to 192.168.1.63

192.168.1.64 to 192.168.1.80

192.168.1.224 to 192.168.1.239

THE END