Computer Networks

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Recap

- Network Architecture
- Network Models

Unit 3

Network Layer

Contents

- Functions of Network Layer
- IP Protocol

Functions of Network Layer

- When data is to be sent, the network layer accepts data from the transport layer above, **divides and encapsulates it into packets and sends it to the data link layer.** The reverse procedure is done during receiving data.
- The network layer is **responsible for routing packets from the source host to the destination host**. The routes can be based upon static tables that are rarely changed; or they can be automatically updated depending upon network conditions.
- Many networks are partitioned into sub-networks or subnets. The network layer **controls the operations of the subnet**s. Network devices called routers operate in this layer to forward packets between the subnets or the different networks.
- The lower layers assign the physical address locally. When the data packets are routed to remote locations, a logical addressing scheme is required to differentiate the source system and the destination system. This is provided by the network layer.
- This layer also **provides mechanisms for congestion control**, in situations when too many packets overload the subnets.
- The network layer **tackles issues like transmission delays, transmission time, avoidance of jitters** etc.

IP Protocol

- Classes of IP (Network addressing)
- IPv4
- IPv6
- Network Address Translation
- Sub-netting
- CIDR

IP Addressing

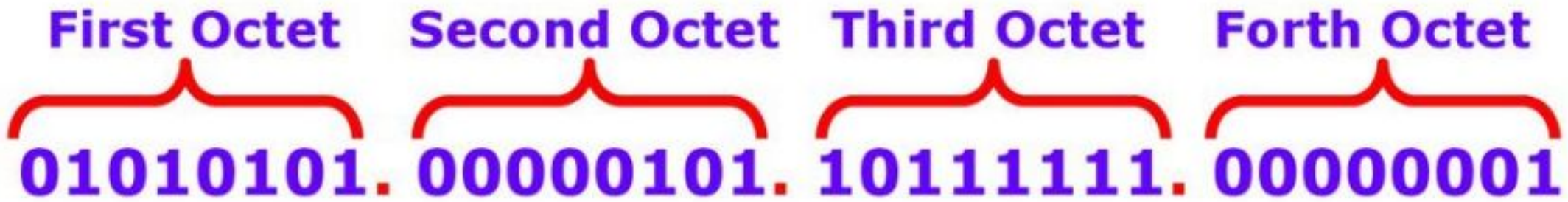
- IP Addressing is Logical Addressing
- It works on Network Layer (Layer 3)
- Two Versions of Addressing Scheme
  - IP version 4 – 32 bit addressing
  - IP version 6 – 128 bit addressing

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

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 (Classful Address)

- **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 – Number of networks & hosts

- 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
  = 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 – Number of networks & hosts

- 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 I
  = 65536 - 2
  = 65534 Hosts/Network

CLASS B
16384 Networks
&
65534 Hosts/Nw

Class C – Number of networks & hosts

- 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 II
  = 256 - 2
  = 254 Hosts/Network

CLASS C

2097152 Networks

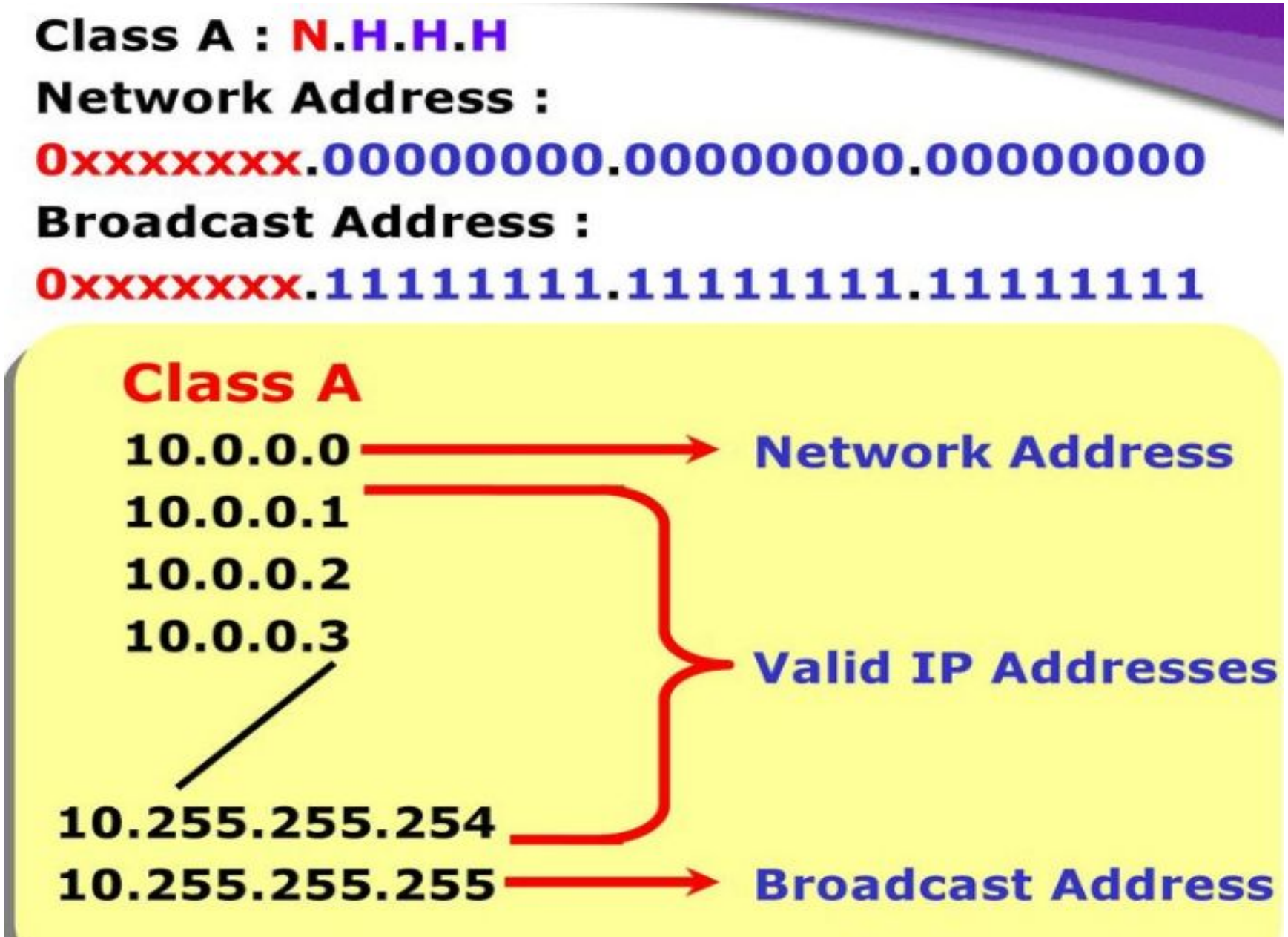
&

254 Hosts/Nw

Network Address & 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



Example – Class B

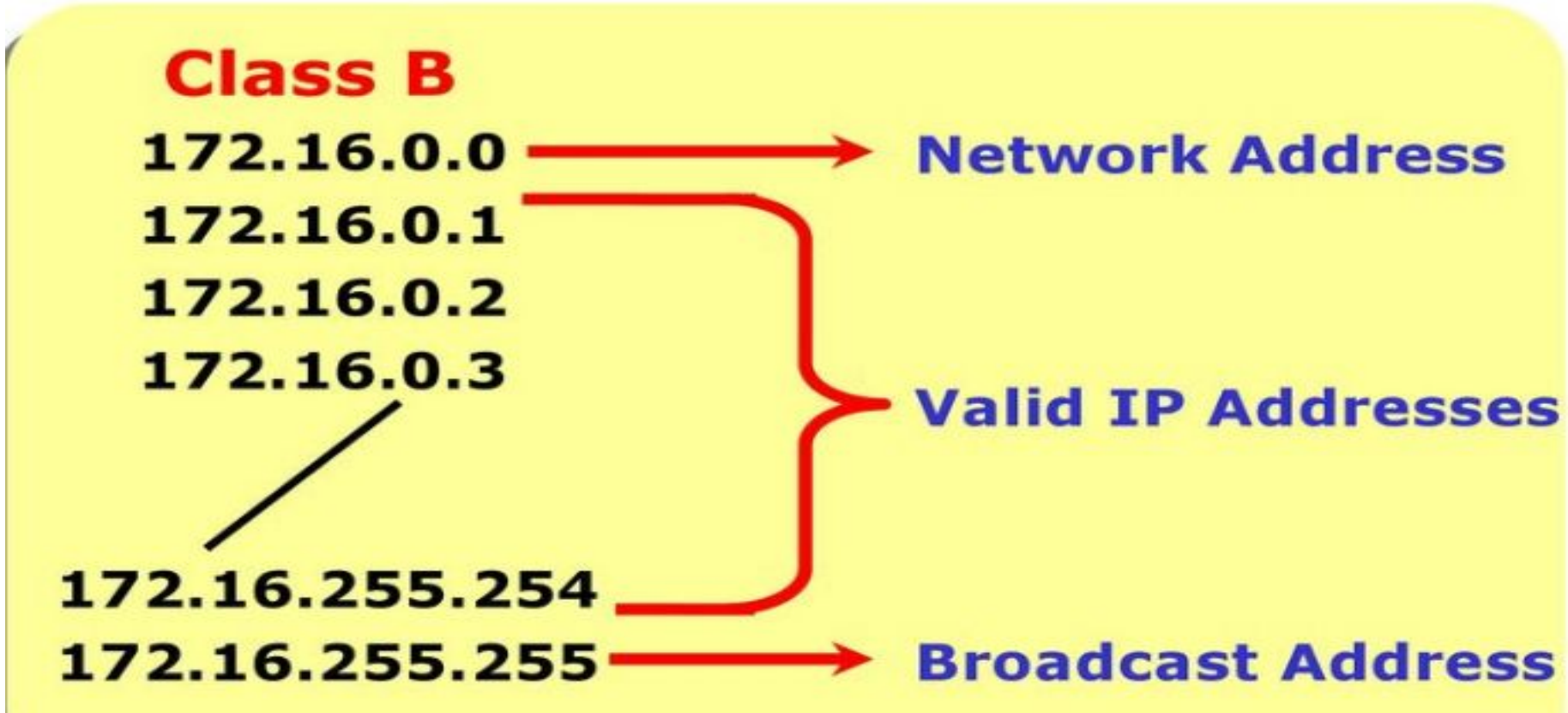
Class B : N.N.H.H

Network Address :

10xxxxxx.xxxxxxxx.00000000.00000000

Broadcast Address :

10xxxxxx.xxxxxxxx.11111111.11111111



Example – Class C

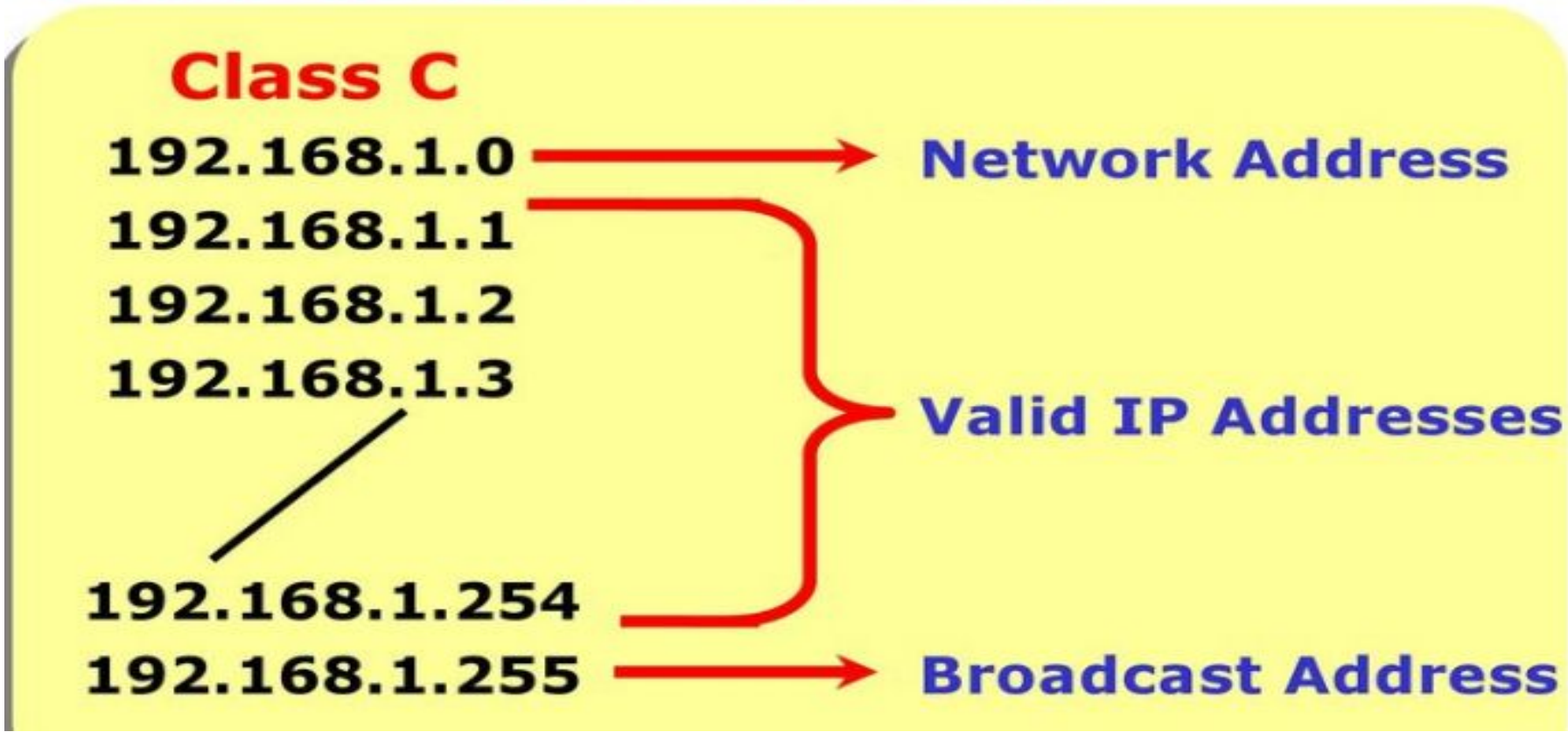
Class C : N.N.N.H

Network Address :

110xxxxx.xxxxxxxx.xxxxxxxx.00000000

Broadcast Address :

110xxxxx.xxxxxxxx.xxxxxxxx.11111111



Thank you