IPv4 addressing, subnetting, VLSM and IPv6 addressing

Outline

This unit will give a detailed overview of IPv4 and IPv6 addresses. We will also learn about subnetting, VLSM and how to assign networks based on business requirements.

Learning outcomes

- Identify and analyze the structure of an IPv4 address
- Determine the network address, usable host addresses and broadcast address

- Apply subnetting and VLSM to design addressing scheme as per specific given requirements
- Identify the different types of IPv6 addresses
- Compress an IPv6 address to shortest form acceptable

Week 8 & 9: In-class presentation on IPv4 addressing, subnetting and VLSM

Binary to Decimal conversion

$Base^{Exponent}$	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Place Value	128	64	32	16	8	4	2	1
Example: Binary Number	1	0	1	1	1	0	0	1
Decimal Number Total: 185	128	0	32	16	8	0	0	1

1 0 1 1 1 0 0 1 = (128 * 1) + (64 * 0) + (32 * 1) + (16 * 1) + (8 * 1) + (4 * 0) + (2 * 0) + (1 * 1)
1 0 1 1 1 0 0 1 = 128 + 0 + 32 + 16 + 8 + 0 + 0 + 1
1 0 1 1 1 0 0 1 = 185

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Decimal to Binary conversion

Base^{Exponent}	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Place Value	128	64	32	16	8	4	2	1
Example: Convert decimal 35 to binary	0	0	1	0	0	0	1	1

$35 = 2^5 + 2^1 + 2^0$

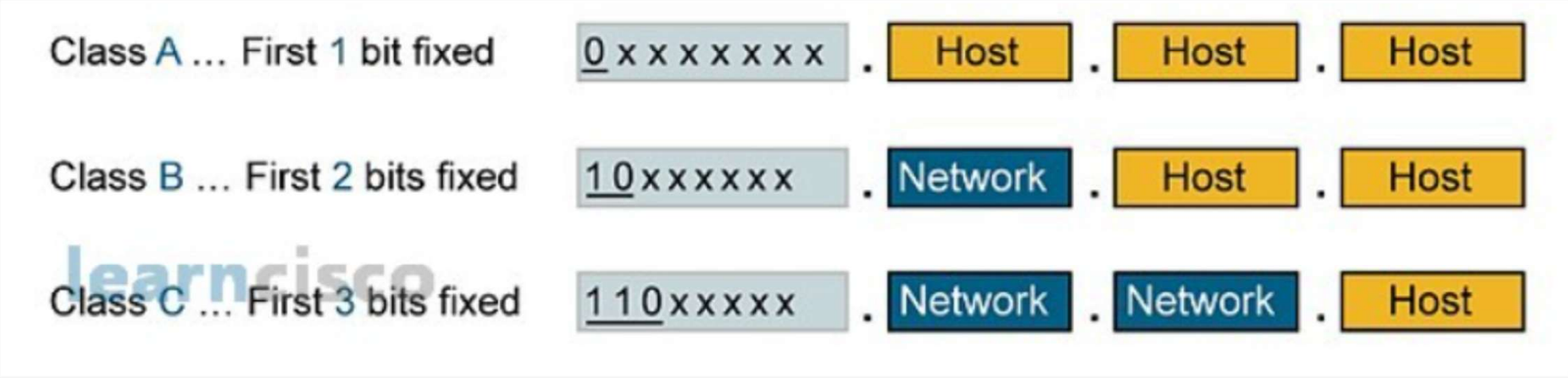
$35 = (32 * 1) + (2 * 1) + (1 * 1)$

$35 = 0 + 0 + 1 + 0 + 0 + 0 + 1 + 1$

$35 = 00100011$

Classful addressing scheme

In the early days of the Internet, the IANA, or Internet Assigned Numbers Authority, came up with the classful addressing scheme in which the class of the address defines the number of bits dedicated to the network ID, and the number of bits dedicated to the host ID, as well as the boundary between the two in or within the IP address.



IP address ranges

So, the first octet is between 1 to 126, then we are talking about Class A. Just by looking at the first octet and seeing it between 128 and 191, we are talking about Class B. And, if the range of that first octet is 192 through 223, then this a Class C.

IP Address Class	First Octet Binary Value	First Octet Decimal Value	Possible Number of Hosts
Class A	1 – 126	00000001 to 01111110	16 777 214
Class B	128 – 191	10000000 to 10111111	65 534
Class C	192 – 223	11000000 to 11011111	254

Private IP addresses

With the volume of devices out in the public network, it became apparent that the 32 bits on the IPv4 IP address would not be sufficient. IPv4 is a current version of IP commercially available and operational on the Internet. The newer IPv6 is starting to gain ground, and soon enough will become the standard on that network. Meanwhile, intermediate solutions were found to allow for more and more devices to obtain an IP address without it needing to be public. The private address ranges listed here for class A, B, and C can be used internally, and the organizational network allocated and assigned according to organizational rules, which are independent of the Internet and then translated to a public address when traffic or packets needed to access a public network.

Class	Private Address Range
A	10.0.0.0 to 10.255.255.255
B	172.16.0.0 to 172.31.255.255
C	192.168.0.0 to 192.168.255.255

Prefix length and Subnet mask

Subnet Mask	32-bit Address	Prefix Length
255.0.0.0	11111111.00000000.00000000.00000000	/8
255.255.0.0	11111111.11111111.00000000.00000000	/16
255.255.255.0	11111111.11111111.11111111.00000000	/24
255.255.255.128	11111111.11111111.11111111.10000000	/25
255.255.255.192	11111111.11111111.11111111.11000000	/26
255.255.255.224	11111111.11111111.11111111.11100000	/27
255.255.255.240	11111111.11111111.11111111.11110000	/28
255.255.255.248	11111111.11111111.11111111.11111000	/29
255.255.255.252	11111111.11111111.11111111.11111100	/30

Network and Hosts

The prefix length also indicates the number of bits used for the network portion.

The remaining number of bits = host bits

Example: a /24 prefix means 24 bits are used for the network and remaining 8 bits are for the hosts.

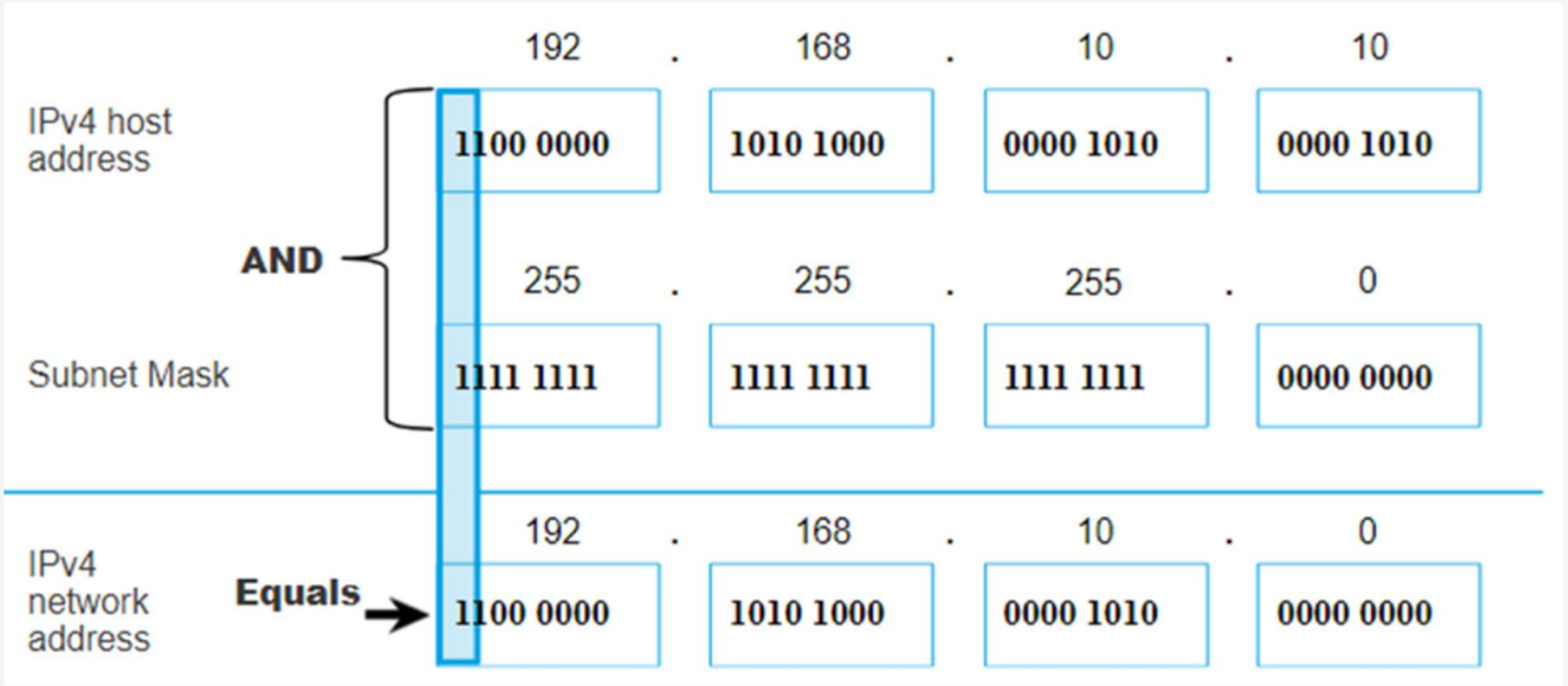
Host bits = 32 – prefix length

Number of hosts = 2^host bits – 2 (1 for network address and 1 for broadcast address)

Number of hosts is thus 2^8 – 2 = 254

Determing the network: logical ANDing

To identify the network address, the host IPv4 address is logically ANDed, bit by bit, with the subnet mask to identify the network address.



Network, hosts and broadcast addresses

	Network Portion	Host Portion	Host Bits
Subnet mask **255.255.255.**0 or **/24**	255 255 255 11111111 11111111 11111111	0 00000000	
Network address **192.168.10.**0 or **/24**	192 168 10 11000000 10100000 00001010	0 00000000	All 0s
First host address **192.168.10.**1 or **/24**	192 168 10 11000000 10100000 00001010	1 00000001	All 0s and a 1
Last host address **192.168.10.**254 or **/24**	192 168 10 11000000 10100000 00001010	254 11111110	All 1s and a 0
Broadcast address **192.168.10.**255 or **/24**	192 168 10 11000000 10100000 00001010	255 11111111	All 1s

Subnetting

Let us understand how subnetting works by watching video available at the below link:

https://youtu.be/nii-H-7WwnE

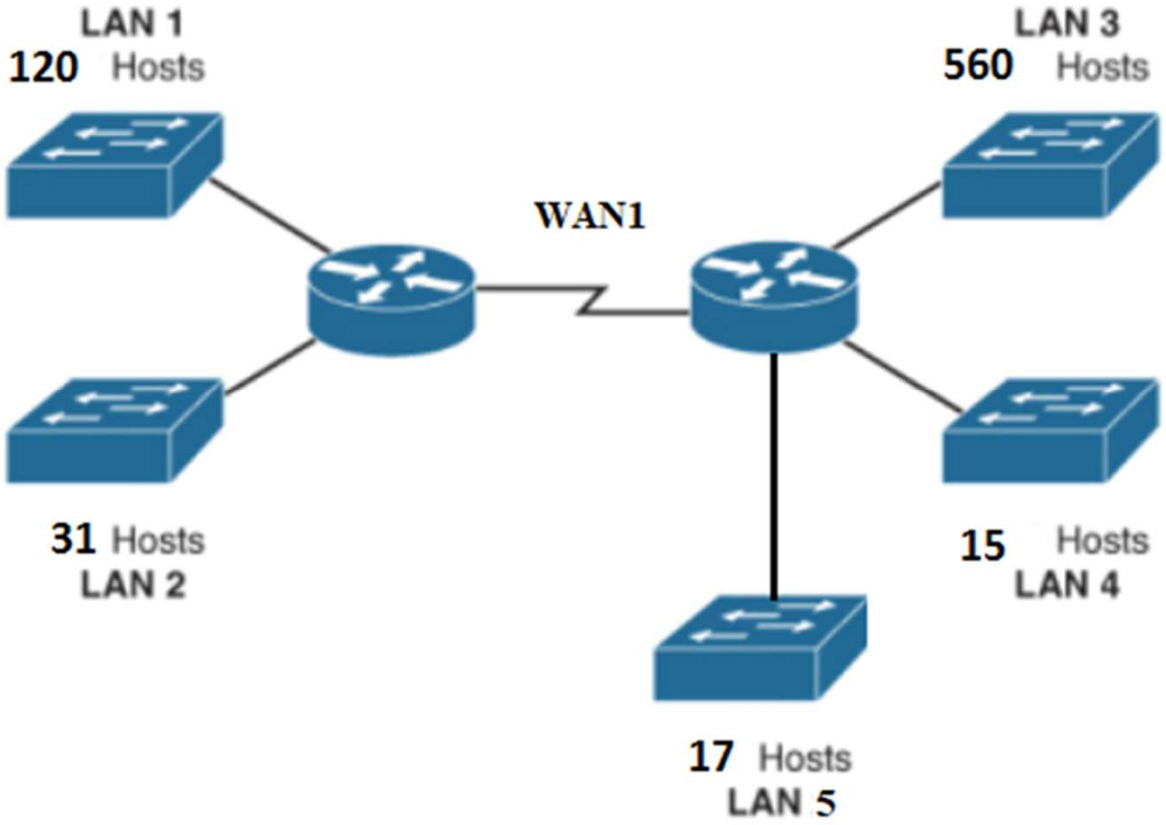
VLSM

Let us understand how VLSM works by watching video available at the below link:

https://youtu.be/WWuEdSk5L1Y

Week 9: In-class Activity on VLSM

Given the address space 172.57.64.0/18 and the network requirements shown in Figure below, apply an addressing scheme that conserves the most amount of addresses for future growth.



Week 9: In-class activity on IPv6 addressing

Let us learn about IPv6 by using the link below:

https://youtu.be/aUwWyKj2JIM