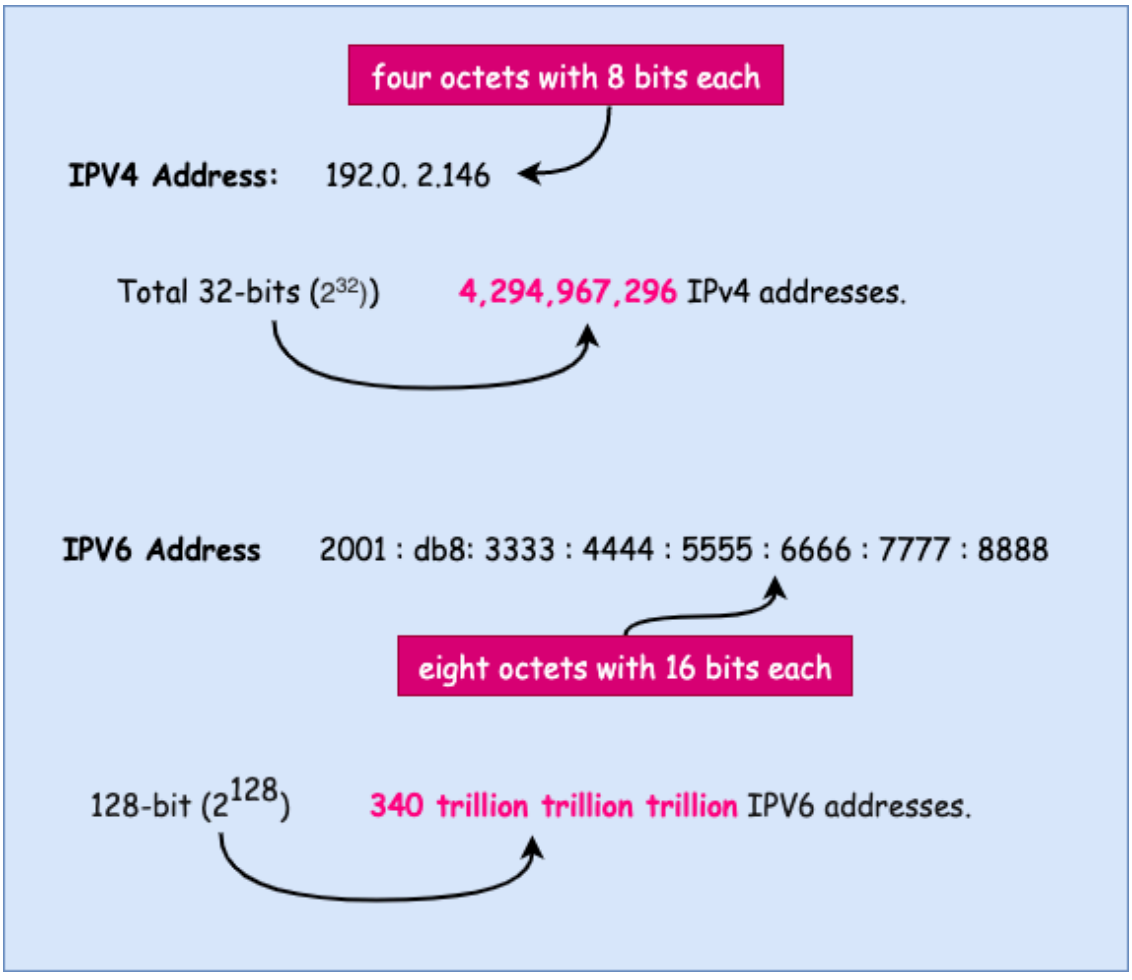
IP ADDRESSING AND SUBNETTING

Introduction to IP Addressing :

IP addressing is a method to assign unique identifiers to each device on a network. These identifiers help devices communicate with each other. It serves two main functions: identifying the host or network interface and providing the location of the host in the network. IP addresses are usually displayed such as 192.0.2.1, which consists of four decimal numbers separated by dots. Each part represents a group of 8 bits (an octet) of the address.



1. IPV4

(INTERNET PROTOCOL VERSION 4)

IPV4 addresses range from 0.0.0.0 to 255.255.255.255. It is a total of 4294967296 IP addresses (4.3 billion). It is divided into five classes.

Class	First Octet	Default Subnet Mask	
		Slash	Dotted Decimal
A	1 - 126	/8	255.0.0.0
B	128 - 191	/16	255.255.0.0
C	192 - 223	/24	255.255.255.0
D	224 - 239		
E	240 - 255		

IPV4 ADDRESSING

IPv4 is the older and most widely used version of IP addressing.

- Format: IPv4 addresses are 32 bits long and are written as four numbers separated by dots (called "dotted decimal format"). Example: 192.168.1.1
- Each number ranges from 0 to 255.
- Number of addresses: About 4.3 billion possible addresses — which is not enough for all devices today.

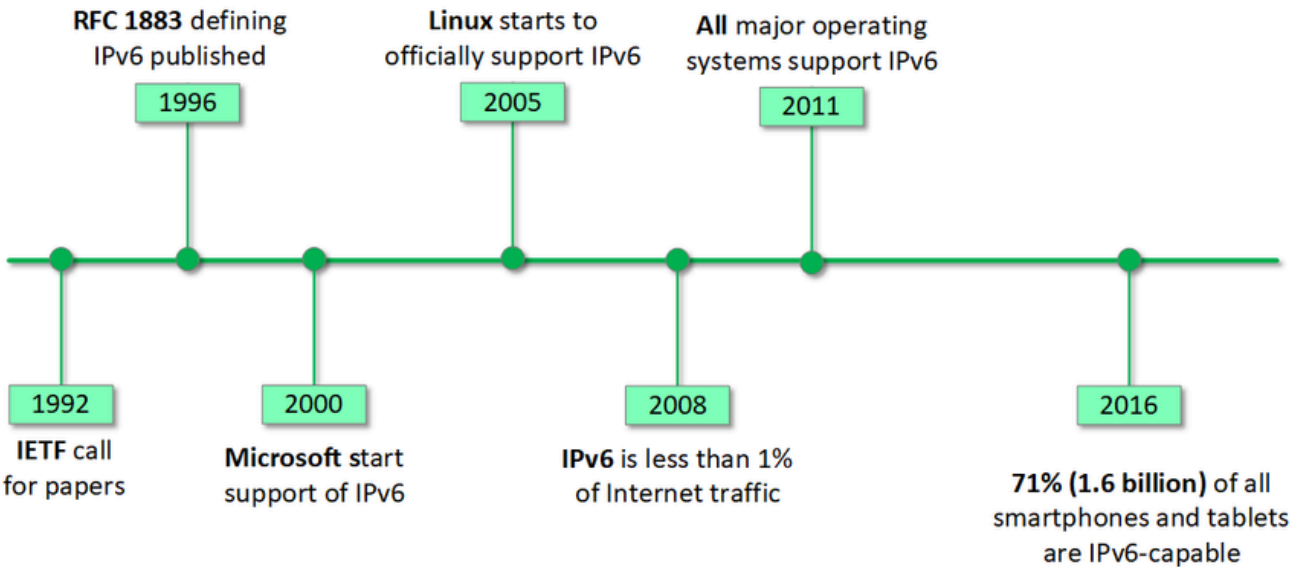
How it works:

- Devices are assigned an IPv4 address manually (static) or automatically using a service like DHCP.
- IPv4 uses subnets to organize and manage groups of IP addresses in a network.

1. IPV6

(INTERNET PROTOCOL VERSION 6)

IPV6 is the latest Internet Protocol. An IPV6 address looks like 1050:0000:0000:0000:0005:0600:300c:326. It contains eight octets with sixteen bits each. The total number of IPV6 addresses is 340 trillion trillion trillion addresses.



IPV6 ADDRESSING

IPv6 is the newer version of IP addressing, designed to fix the shortage of IPv4 addresses.

- Format: IPv6 addresses are 128 bits long and are written in eight groups of four hexadecimal digits, separated by colons.

Example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334

- Groups of zeros can be shortened using :: once in the address.

Shortened example: 2001:db8:85a3::8a2e:370:7334

How it works:

- IPv6 addresses can be assigned automatically using protocols like SLAAC (Stateless Address Autoconfiguration).

- It's more secure and efficient, with features like built-in encryption and no need for NAT (Network Address Translation).

SUBNETTING

What is Subnetting?

Subnetting is the process of dividing a large IP network into smaller, manageable pieces called subnets. It helps in:

- Efficient IP address usage
- Better network organization
- Improved security and performance

Subnet Mask

A subnet mask determines how many bits are used for the network and how many for hosts.

Example:

IP: 192.168.1.0

Subnet mask: 255.255.255.0

CIDR Notation

CIDR (Classless Inter-Domain Routing) uses a / to show how many bits are for the network portion.

Example: 192.168.1.0/24 → first 24 bits are for the network, the rest for hosts.

How to Calculate Subnets and Hosts

- Total hosts per subnet = 2^n

where n = number of host bits

- Usable hosts per subnet = $2^n - 2$

(because 1 address is reserved for network and 1 for broadcast)

CIDR NOTATION	NETMASK NOTATION	2^(32-N)	AVAILABLE HOSTS	NOTE
/0	0.0.0.0	4,294,967,296	4,294,967,294	The whole internet
/8	255.0.0.0	16,777,216	16,777,214	Class A
/16	255.255.0.0	65,535	65,533	Class B
/24	255.255.255.0	256	254	Class C
/25	255.255.255.128	128	126	
/26	255.255.255.192	64	62	
/27	255.255.255.224	32	30	
/28	255.255.255.240	16	14	
/29	255.255.255.248	8	6	
/30	255.255.255.252	4	2	
/31	255.255.255.254	2	2*	
/32	255.255.255.255	0	1*	

Subnetting Example

Let’s say you have the network: 192.168.1.0/24

You want to create 4 equal subnets.

- Borrow 2 bits ($2^2 = 4$ subnets) → CIDR becomes /26

- New subnet mask: 255.255.255.192

Each subnet will have:

- 64 total addresses

- 62 usable addresses (2 reserved: network & broadcast)

The subnets will be:

Subnet	Network Address	Usable Range	Broadcast Address
1:	192.168.1.0/26	192.168.1.1 – 192.168.1.62	192.168.1.63
2:	192.168.1.64/26	192.168.1.65 – 192.168.1.126	192.168.1.127
3:	192.168.1.128/26	192.168.1.129 – 192.168.1.190	192.168.1.191
4:	192.168.1.192/26	192.168.1.193 – 192.168.1.254	192.168.1.255

CONCLUSION

Understanding IP addressing and subnetting is a foundational skill for any network engineer, administrator, or IT professional. This document covered the core concepts of IPv4 and IPv6 addressing, including the structure and differences between the two. It also explored the principles of subnetting, including how to use natural subnet masks, CIDR notation, and calculate total and usable hosts in a given range.

By learning these topics, we can confidently:

- Design scalable and efficient networks
- Segment larger networks into manageable subnets
- Maximize IP address usage and improve network performance
- Transition between IPv4 and IPv6 environments effectively

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References:

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