

# Research and Development Document on IP Addressing and Subnetting

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# 1 Introduction to IP Addressing

IP (Internet Protocol) addressing is fundamental to communication in modern networks. It allows devices to identify and communicate with each other across networks, including the internet. Each device is assigned a unique IP address that acts like a digital home address.

## 2 Types of IP Addresses

### 2.1 IPv4

IPv4 (Internet Protocol version 4) is the fourth version and the most commonly used format. It uses a 32-bit address, usually represented in dot-decimal notation (e.g., 192.168.1.1).

**Structure:**

- 32 bits = 4 octets
- Each octet ranges from 0 to 255
- Example: 192.168.0.1

**Classes:**

- Class A: 0.0.0.0 to 127.255.255.255
- Class B: 128.0.0.0 to 191.255.255.255
- Class C: 192.0.0.0 to 223.255.255.255

### 2.2 IPv6

IPv6 is the successor to IPv4, developed to address IP address exhaustion. It uses 128-bit addresses, providing a vastly larger address space.

**Structure:**

- 128 bits = 8 groups of 16-bit hexadecimal numbers
- Example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334
- Can be shortened using double colons (::)

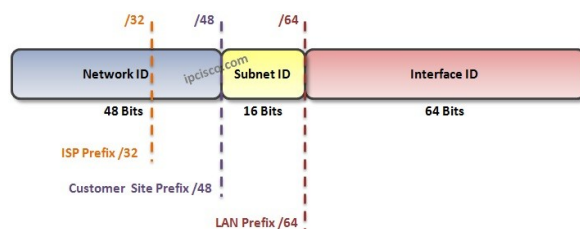


Figure 2: Enter Caption

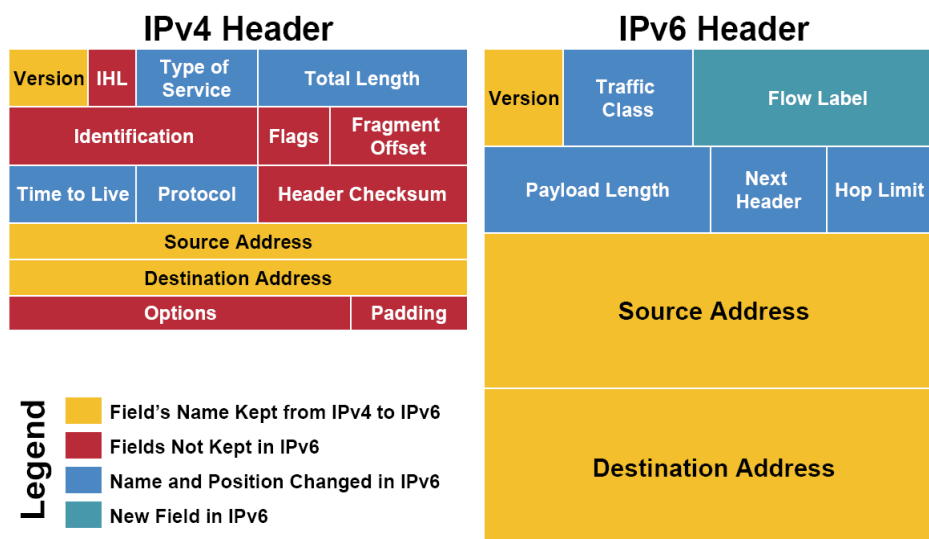


Figure 1: Comparison of IPv4 and IPv6 Addressing

### 3 Subnetting

Subnetting is the process of dividing a network into smaller logical subnetworks. It improves network efficiency, security, and management.

#### 3.1 Subnet Masks

A subnet mask separates the IP address into the network and host portions. For example:

- IP: 192.168.1.10
- Subnet Mask: 255.255.255.0
- Network: 192.168.1.0

#### 3.2 CIDR (Classless Inter-Domain Routing)

CIDR uses the format IP/prefix, where the prefix denotes the number of network bits.

- Example: 192.168.1.0/24
- /24 means 255.255.255.0

**Subnetting from CIDR Notation**

192.168.60.55 /20 (255.255.240.0)

Network ID:	192	168	48	0
Broadcast ID:	192	168	255	255

Usable IPs:

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

XXXXXXXX.XXXXXXXX .00111100.XXXXXXXX  
 11111111.11111111.11100000.00000000  
 .00110000.

Figure 3: CIDR Representation and Subnet Masking

## 4 Calculating Hosts in a Subnet

### 4.1 Formula

**Example:** 192.168.1.0/24

- $32 - 24 = 8$
- Hosts =  $2^8 - 2 = 254$  usable hosts

### 4.2 Examples of Subnetting

- /30: 4 addresses, 2 usable
- /29: 8 addresses, 6 usable
- /28: 16 addresses, 14 usable
- /24: 256 addresses, 254 usable

## 5 IPv6 Subnetting

IPv6 uses a similar concept but due to the enormous address space, it's simpler. Subnets are generally assigned with a /64 prefix.

**Example:**

- Network: 2001:db8::/64
- Host IDs:  $2^{64}$  possible addresses

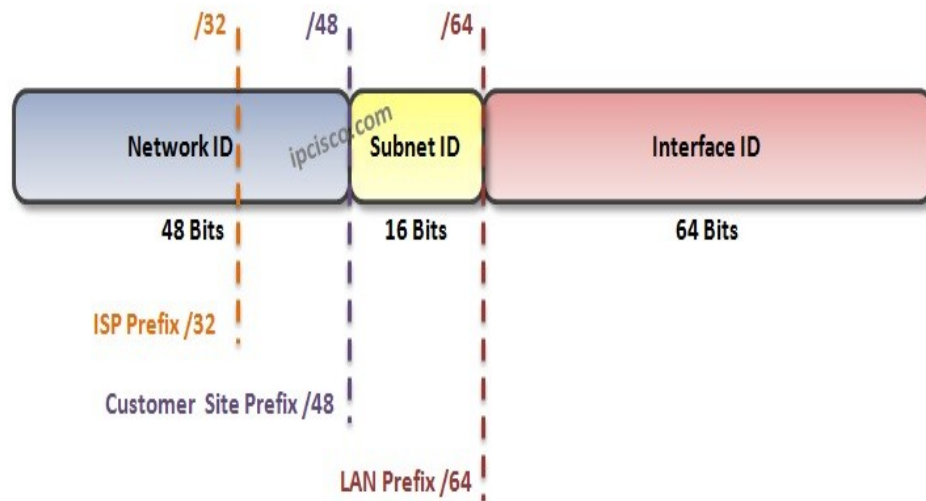


Figure 4: IPv6 Subnetting Structure

## 6 Conclusion

Understanding IP addressing and subnetting is critical for designing scalable and efficient networks. Mastery of subnetting allows network engineers to optimize the allocation of IP addresses and improve network performance and security.

## References

- Forouzan, B. A. (2007). *Data Communications and Networking*.
- <https://www.geeksforgeeks.org/introduction-of-ip-addressing-and-subnetting/>
- <https://www.cloudflare.com/learning/network-layer/what-is-an-ip-address/>