R&D Document on IP Addressing and Subnetting (IPv4 & IPv6)

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1. What is IP Addressing?

An IP address (Internet Protocol Address) is a unique identifier assigned to each device connected to a network. It allows devices to communicate over the internet or LAN.

2. Types of IP Addresses: IPv4 vs IPv6

IPv4:

- Format: 32-bit, written as four octets (e.g., 192.168.1.1)

- Total IPs: ~4.3 billion (2^32)

- Example: 192.168.0.1

IPv6:

- Format: 128-bit, written as 8 blocks of 4 hex digits (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334)

- Total IPs: 2^128 (virtually unlimited)

- Example (shortened): 2001:db8:85a3::8a2e:370:7334

3. Subnetting: Overview

Subnetting divides a larger network into smaller, manageable sub-networks (subnets). It improves routing efficiency and enhances security.

- Network portion: Identifies the network.

- Host portion: Identifies devices within that network.

4. Subnet Masks & CIDR

Subnet Mask: Used to determine which part of the IP address is the network and which part is the host.

CIDR (Classless Inter-Domain Routing): Compact format to express subnet mask. Example: 192.168.1.0/24

Common CIDR and Subnet Mask Table

CIDR	Subnet Mask	Usable Hosts
/24	255.255.255.0	254
/25	255.255.255.128	126
/26	255.255.255.192	62
/27	255.255.255.224	30
/28	255.255.255.240	14
/29	255.255.255.248	6
/30	255.255.255.252	2

5. Creating Subnets – Step-by-Step

Example: Subnet 192.168.1.0/24 into 4 subnets

- Total Hosts in /24: 2^8 = 256 addresses (254 usable)

- Need 2 extra bits → 2^2 = 4 subnets

- New subnet mask = /26

Subnets:

1. 192.168.1.0/26 → 192.168.1.1 – 192.168.1.62

2. 192.168.1.64/26 → 192.168.1.65 – 192.168.1.126

3. 192.168.1.128/26 → 192.168.1.129 – 192.168.1.190

4. 192.168.1.192/26 → 192.168.1.193 – 192.168.1.254

6. Calculating Hosts

Formula:

Total Hosts = 2^(32 - subnet_bits)

Usable Hosts = Total Hosts - 2

Example for /26:

Total = 2^6 = 64

Usable = 62

7. IPv6 Subnetting (Basic)

IPv6 Format: xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx

- No broadcast address

- Subnetting typically on /64

- Example: 2001:db8::/64 → massive number of hosts

8. Summary Table

Refer to the CIDR and Subnet Mask Table above.

9. Practice Examples

Example 1: IP 10.0.0.0/8 → create 16 subnets

- 2^4 = 16 → New CIDR = /12

- Hosts per subnet: 2^20 = 1,048,576

Example 2: IP 172.16.0.0/16 → create 100 subnets

- 2^7 = 128 → New CIDR = /23

- Hosts per subnet: 2^9 = 512 (510 usable)

Conclusion

Understanding IP addressing and subnetting is crucial for network design and management. Mastering CIDR, subnet masks, and address calculations enables efficient IP resource allocation and routing.