**Research and Development Report on IP Addressing and Subnetting in IPv4 & IPv6**

**Introduction:** IP addressing and subnetting are fundamental concepts in computer networking, essential for efficient utilization of IP address space and network management. This research report aims to provide a comprehensive understanding of IP addressing and subnetting in both IPv4 and IPv6, including the creation of subnets, subnet masks, CIDR range calculation, and counting usable and total hosts within an IP address range.

**1. IP Addressing:**

* **IPv4:** IPv4 addresses are 32-bit numerical values represented in dotted-decimal notation (e.g., 192.168.1.1). The address consists of two parts: the network portion and the host portion.
* **IPv6:** IPv6 addresses are 128-bit hexadecimal values represented in colon-separated notation (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334). IPv6 significantly expands the address space compared to IPv4.

**2. Subnetting:**

* Subnetting involves dividing a large network into smaller, more manageable sub-networks or subnets.
* Subnetting allows for efficient utilization of IP address space, improved network performance, and enhanced security.

**3. Subnet Mask:**

* A subnet mask is a 32-bit (IPv4) or 128-bit (IPv6) value used to divide an IP address into network and host portions.
* In IPv4, the subnet mask consists of consecutive 1s representing the network portion and consecutive 0s representing the host portion.
* In IPv6, the subnet mask is represented similarly but with 128 bits.

**4. CIDR (Classless Inter-Domain Routing) Notation:**

* CIDR notation is a compact representation of an IP address and its associated network prefix.
* It is expressed as "IP address/prefix length" (e.g., 192.168.1.0/24).
* The prefix length indicates the number of bits used for the network portion of the address.

**5. Counting Usable and Total Hosts:**

* **Usable Hosts:** These are the IP addresses that can be assigned to devices within a subnet, excluding the network and broadcast addresses.
* **Total Hosts:** This includes all possible IP addresses within a subnet, including the network and broadcast addresses.

**6. Example Scenario:**

* Let's consider the IPv4 address range 192.168.1.0/24:
  + Subnet Mask: 255.255.255.0
  + Network Address: 192.168.1.0
  + Broadcast Address: 192.168.1.255
  + Usable Host Range: 192.168.1.1 to 192.168.1.254
  + Total Hosts: 254 (2^8 - 2)

**Conclusion:** IP addressing and subnetting are foundational concepts in computer networking. Understanding how to create subnets, determine subnet masks, calculate CIDR ranges, and count usable and total hosts within an IP address range is essential for network administrators and engineers. This research report provides an overview of these concepts in both IPv4 and IPv6 environments, facilitating efficient network design and management.