Subnetting

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Overview

- A **Subnet** is a *logical* **subdivision** of a physical **IP network**
  - The practice of dividing a network into two or more networks is **subnetting**
- Devices that are in the same subnet share the same **most significant bits** within their IP addresses
  - IPv4 has 32 bit addresses
  - IPv6 has 128 bit addresses
- This subdivides an IP address of a device into two fields
  - **Routing Prefixes**: Identifies the network or subnet to which the device belongs
  - Host Identifier: Uniquely identifies the device within that subnet
- Subnetting can enhance routing efficiency or make network managment easier

Routing Prefixes - CIDR Notation

- CIDR specifies an IP address, a slash, and a decimal number
- The decimal number is the count of leading 1-bits in the **network mask**
  - Each 1 in this mask denotes a bit of the address range that must be **identical** across the whole subnet

Examples of CIDR Notation

- `198.51.100.14/24` represents the IPv4 address `198.51.100.14` and its associated network prefix `198.51.100.0`, or equivalently, its subnet mask `255.255.255.0`, which has 24 leading 1-bits.
- The IPv4 block `198.51.100.0/22` represents the 1024 IPv4 addresses from `198.51.100.0` to `198.51.103.255`.
- The IPv6 block `2001:db8::/48` represents the block of IPv6 addresses from `2001:db8:0:0:0:0:0:0` to `2001:db8:0:ffff:ffff:ffff:ffff:ffff`.

- The number of usable addresses in a subnet is calculated as:

$$2^{\text{address length} - \text{prefix length}}$$

- For example:
  - `2001:db8::/48` (IPv6) has 2^{128-48} possible addresses (an extremely large number).
  - `198.51.100.0/22` (IPv4) has $2^{32-22} = 1024$ possible addresses.
- **Reserved Addresses:**
  - In IPv4, the **first address** of the subnet (e.g., `198.51.100.0` in `198.51.100.0/22`) is reserved as the **network address**.
  - The **last address** (e.g., `198.51.103.255` in `198.51.100.0/22`) is reserved as the **broadcast address**.
  - These two addresses cannot be assigned to hosts.
  - The remaining addresses (e.g., `198.51.100.1` to `198.51.103.254`) are usable for devices.
  - Often, the **first usable address** is assigned to the default gateway (router) for the subnet.
- In IPv6, there is no broadcast address, but the **first address** is typically reserved as the subnet-router anycast address. Some addresses may also be reserved for special purposes (e.g., gateway, network infrastructure).

Subnets for Network Addressing and Routing

- Addressing using subnetting allows for selective routing of IP packets across multiple different networks
- All routing done between different networks (that will have different prefixes) requires the use of **routers**
- Routers define logical or physical **borders between subnets**
- Each subnet requires a **designated default router**
  - Could consist internally of multiple segments interconnected by switches
- Given an IPv4 Address, it's subnet mask, and destination address - a router can easily determine whether the destination is local or remote
- Each local subnet must be represented separatly on a **routing table**

Calculating Subnets

You're given:

- A `/23` network: `152.78.70.0/23`
- You need **3 subnets**:
  - Subnet A: 200 devices
  - Subnet B: 100 devices
  - Subnet C: 100 devices

How would you divide the given network to satisfy these requirements? Specify the subnet addresses and prefix lengths for each subnet.

- `/23` subnet allows for $2^{32-23} - 2$ networks $= 510$
- We can split this into three subnets, one that can accomodate for 256 addresses and two that can accomodate for 128
- Use one `/24` network and two `/25` networks

The new Networks:

- `152.78.70.0/24`
- `152.78.71.0/25`
- `152.78.71.128/25`