Binary Overview

- **Binary** - A base-2 number system that uses only 0s and 1s. Computers and networking devices process data in binary.
- **Relation to IP Addresses** - IP addresses are written in decimal for human readability but are actually stored and processed in binary.

Example:

- Decimal: `192.168.1.10`
- Binary: `11000000.10101000.00000001.00001010`

Breakdown of first octet (192):

- 128 + 64 = 192 → Binary: `11000000`

So each octet of an IP address is an 8-bit binary number, which equals 1 byte. An IPv4 address is 32 bits (4 bytes).

IP Addressing and Subnetting Overview

IPv4 is a 32-bit value represented in dotted decimal notation (four 8-bit octets), used to uniquely identify devices on a network.

- Devices require:
  - **IPv4 Address**
  - **Subnet Mask**
  - **Default Gateway**

Subnetting

- **Subnetting** - The process of dividing a larger IP network into smaller, more manageable subnetworks. This improves efficiency, reduces broadcast traffic, and provides better network organization and security.
- Each subnet is defined by its **subnet mask**, which determines the division between the **network portion** and the **host portion** of an IP address.

IPv4 Address Classes and Ranges

Class A

- Public Range: 1.0.0.0 to 126.255.255.255
- Private Range: 10.0.0.0 to 10.255.255.255 → Binary: `00001010.00000000.00000000.00000000` to `00001010.11111111.11111111.11111111`
- Default Mask: 255.0.0.0 (/8)
- Leading Bits: 0xxxxxxx

Class B

- Public Range: 128.0.0.0 to 191.255.255.255
- Private Range: 172.16.0.0 to 172.31.255.255 → Binary: `10101100.00010000.00000000.00000000` to `10101100.00011111.11111111.11111111`
- Default Mask: 255.255.0.0 (/16)
- Leading Bits: 10xxxxxx

Class C

- Public Range: 192.0.0.0 to 223.255.255.255
- Private Range: 192.168.0.0 to 192.168.255.255 → Binary: `11000000.10101000.00000000.00000000` to `11000000.10101000.11111111.11111111`
- Default Mask: 255.255.255.0 (/24)
- Leading Bits: 110xxxxx

Creating Subnets and Determining Number of Hosts

- **Subnet Formula** = 2^S, where **S** equals the number of bits borrowed from the host portion.
- **Host Formula** = 2^H − 2, where **H** equals the number of host bits remaining.
    - The subtraction of 2 accounts for the **network address** and the **broadcast address**, which cannot be assigned to hosts.

Broadcast vs Directed Broadcast

- **Broadcast** - A packet sent to all hosts on a local network segment. Destination IP: `255.255.255.255` (limited broadcast).
- **Directed Broadcast** - A packet sent to all hosts within a specific network or subnet. For example, in `192.168.1.0/24`, the directed broadcast address is `192.168.1.255`.

RFC 3021

- **RFC 3021** defines the use of **/31 subnet masks** (255.255.255.254) for point-to-point links.
- Normally, the host formula (2^H − 2) would leave no usable addresses in a /31.
- RFC 3021 makes an exception: both addresses in the subnet can be assigned to devices, because point-to-point links only require two IPs and do not need a network or broadcast address.
- Example: `10.1.1.0/31` → usable IPs: `10.1.1.0` and `10.1.1.1`. Perfect for WAN links between two routers.

Determining NFLB (Network, First, Last, Broadcast)

- **Network Address**
- **First Usable Address**
- **Last Usable Address**
- **Directed Broadcast Address**

Block Size Method

- **Version 1 (Bits)** – Determine progression based on the subnet mask.
  - Example: /24 → binary mask = `11111111.11111111.11111111.00000000`
  - Find the last 1 in the subnet mask (circle it).
  - Identify which octet contains this bit → 3rd octet.
  - Determine the decimal value of that bit → 1.
  - This value is the block size in that octet.
- **Version 2 (Decimal)** – Determine progression based on the subnet mask.
  - Example: `255.255.255.0`
  - Find the last octet with a number greater than 0 (circle it).
  - Identify which octet it is → 3rd octet.
  - Subtract this number from 256 → 256 − 255 = 1.
  - This value is the block size in that octet.