IPv4/IPv6 Address and Subnet Calculation

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IPv4

Source Information

Here is the source information to be used for the following subnetting process:

- IP Address: `120.48.7.105` — `01111000.00110000.00000111.01101001`

- Subnet Mask: `255.255.255.248` — `11111111.11111111.11111111.11111000`

Network Address Calculation

Calculating the network address involves performing an AND operation with the IP address and the subnet mask in binary:

$$\begin{array}{c} \texttt{01111000.00110000.00000111.01101001} \\ \text{AND} \\ \underline{\texttt{11111111.11111111.11111111.11111000}} \\ \texttt{01111000.00110000.00000111.01101000} \end{array}$$

The resulting network address in decimal is:
`120.48.7.104`

Broadcast Address Calculation

Calculating the broadcast address involves inverting the subnet mask and performing an OR operation with the network address.

Inverted subnet mask:

$$\begin{array}{c} \underline{\texttt{11111111.11111111.11111111.11111000}} \\ \texttt{00000000.00000000.00000000.00000111} \end{array}$$

Performing the OR operation with the network address and the inverted subnet mask:

$$\begin{array}{c} \texttt{01111000.00110000.00000111.01101000} \\ \text{OR} \\ \underline{\texttt{00000000.00000000.00000000.00000111}} \\ \texttt{01111000.00110000.00000111.01101111} \end{array}$$

The result converted from binary to decimal is:
`120.48.7.111`

First and Last Usable IP Addresses

The first usable IP address is the network address plus one:

$$\texttt{120.48.7.104} + 1 = \texttt{120.48.7.105}$$

The last usable IP address is the broadcast address minus one:

$$\texttt{120.48.7.111} - 1 = \texttt{120.48.7.110}$$

IPv6

Source Information

Here is the source information to be used for the following subnetting process:

- IP Address: `2001:0db8:85a3:0000:0000:8a2e:0370:7334`

- Prefix Length: `/64`

Network Address Calculation

Calculating the network address involves keeping the bits up to the prefix length and setting the remaining bits to zero:

$$2001:0db8:85a3:0000:0000:8a2e:0370:7334$$
$$\text{AND}$$
$$\underline{ffff:ffff:ffff:ffff:0000:0000:0000:0000}$$
$$2001:0db8:85a3:0000:0000:0000:0000:0000$$

The resulting network address is:
`2001:db8:85a3::/64`

First and Last Usable IP Addresses

The first usable IP address is the network address plus one. Since IPv6 addresses are hexadecimal, this operation is similar to adding one in binary:

$$2001:db8:85a3::1$$

The last usable IP address is the address before the next network address, calculated by setting all bits after the prefix to one and subtracting one:

$$2001:0db8:85a3:0000:0000:0000:0000:0000$$
$$\text{OR}$$
$$\underline{0000:0000:0000:ffff:ffff:ffff:ffff:ffff}$$
$$2001:0db8:85a3:ffff:ffff:ffff:ffff:ffff$$

Subtracting one gives us:
`2001:db8:85a3:ffff:ffff:ffff:ffff:fffe`

Example Subnet Calculation

Suppose we need to create four subnets within the `2001:db8:85a3::/64` network. This requires borrowing two bits from the host portion:

- New Prefix Length: `/66`

The subnet addresses are then:

- `2001:db8:85a3:0::/66`

- `2001:db8:85a3:0:0:0:0:4000::/66`

- `2001:db8:85a3:0:0:0:0:8000::/66`

- `2001:db8:85a3:0:0:0:0:c000::/66`