



4.9.4.3 IP Addresses & Subnets

IP Address Structure

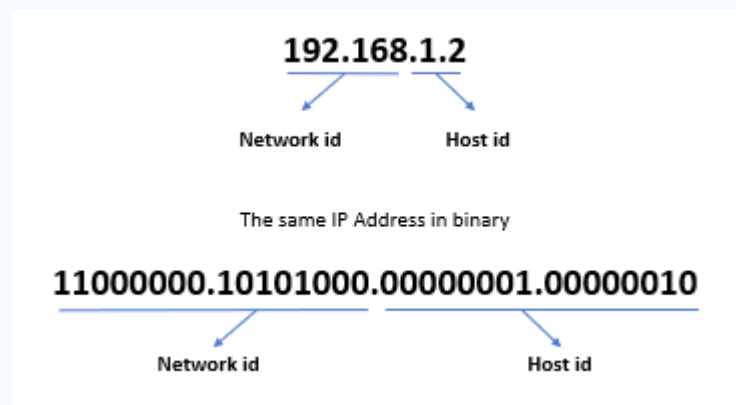
An IP address is a **32-bit logical address** for a device on a network.

It is made up of two parts:

- A network identifier
- A host identifier

For example, an IPv4 address can use 16 bits for the network identifier and 16 bits for the host identifier.

An IP Address with 16 bits for the network id and 16 bits for the host id



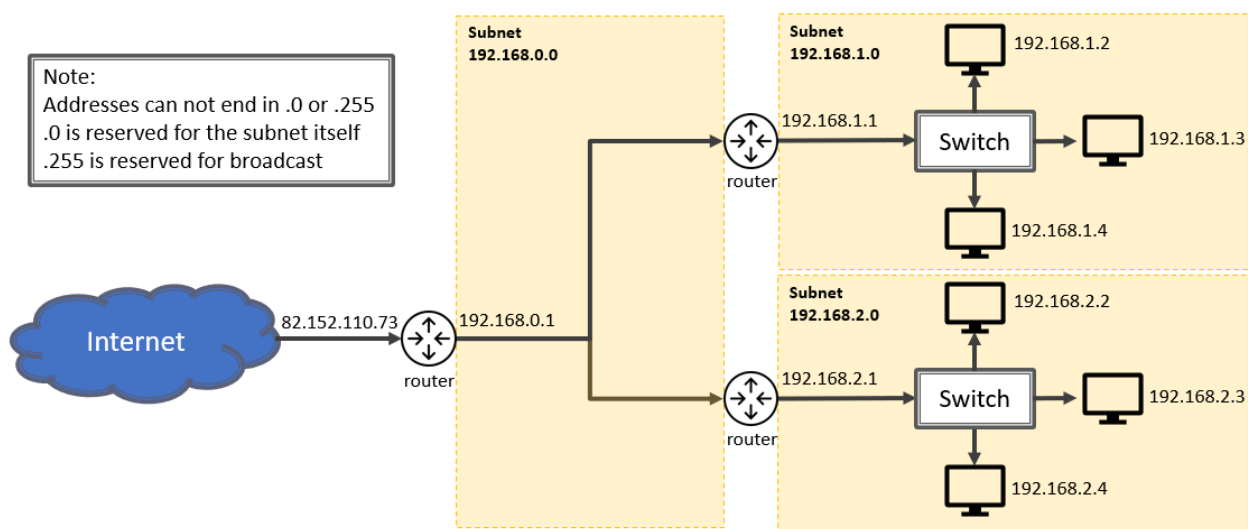


Subnets

Networks can be divided into subnets to:

- Reduce network traffic by limiting the size of broadcast domains.
- Improve security by separating parts of a network.

The network identifier identifies the network or subnet that a device belongs to, while the host identifier identifies the device within that network or subnet.





Subnet Mask

A **subnet mask** is a binary mask that can be used to isolate the network identifier of an IP address using a **bitwise AND operation**.

A device can use the subnet mask to determine whether another IP address is on the same subnet or whether the packet needs to be sent to a router.

Let the network id of an IP address be the first 16 bits and the host id be the last 16 bits

192.168.1.2

To find the network id we could use the binary form of the IP address

11000000.10101000.00000001.00000010

Then use the subnet mask below

11111111.11111111.00000000.00000000

Performing a bitwise AND operation on them gives the network id

11000000. 10101000.00000001.00000010

11111111.11111111.00000000.00000000 AND

11000000. 10101000.00000000.00000000

This gives the network ID 192.168.0.0





IP Standards

There are currently two standards of IP address:

IPv4

e.g. 192.168.1.2

IPv4 addresses are made up of 4 groups of 8 bits separated by a dot.

This can uniquely identify $2^{32} = 4,294,967,296$ possible IPv4 addresses.

As the number of devices and networks connected to the Internet grew, the number of available IPv4 addresses became insufficient

IPv6

e.g. 6a35:83fa:3112:0000:0012:d07a:3aa8:643b

IPv6 addresses are made up of 8 groups of 4 hexadecimal digits separated by a colon.

This provides $2^{128} = 3.4 \times 10^{38}$ possible IPv6 addresses.

This fixes the problem of IPv4 running out of unique addresses.





Private and Public IP Addresses

An IP address can be either:

- A **private (non-routable)** IP address.
- Or a **public (routable)** IP address.

Private IP addresses

Private IP addresses are reserved for use in within private networks and not routable over the internet.

This allows devices to communicate on a LAN using these IP addresses without using public IP addresses.

Private IP addresses are not routed across the public Internet, so the same private addresses can be reused on many different private networks.

NAT is normally used to allow devices using private IP addresses to communicate with the Internet using a public IP address (topic 4.9.4.8).

Public IP addresses

A public IP address is a globally routable IP address used to identify a device or network interface on the Internet.

IANA coordinates the global allocation of IP address space. ISPs assign public IP addresses to their customers.

