

IP Addresses

IP addresses

IP address can be stored as dot decimal notation, and this is the notation that is most familiar to us. There are four numbers stored as a value between 0 and 255 that are separated by a point.

192. 168. 33. 22
11000000 10101000 00100001 00010110

IP address structure

IP addresses are split into a network identifier and a host identifier part. The IP address is made up of the network ID plus Host ID. Which part of the IP address corresponds to the network and host ID depends on the mask.

Subnet masking - Network

Subnet masks allow us to identify the network identifier part of the IP address. This is achieved by applying a bitwise logical AND to the IP address with the subnet mask.

Example

address	11000000 10101000 00100001 00010110	192.168.33.22
mask	11111111 11111111 11100000 00000000	255.255.224.0
network	11000000 10101000 00100000 00000000	192.168.32.0

Subnet masking - Host

Subnet masks allows us to identify the host part of the IP address. This is achieved by applying a logical NAND to the IP address with the subnet mask.

Example

address	11000000 10101000 00100001 00010110	192.168.33.22
mask	11111111 11111111 11100000 00000000	255.255.224.0
NOT mask	00000000 00000000 00011111 11111111	0.0.31.255
Host	00000000 00000000 00000001 00010110	0.0.1.22

Reserved IP addresses

- A host cannot have the following IP addresses if we have 8 bits for the host:
 - xxx.xxx.xxx.0 Network identifier
 - xxx.xxx.xxx.255 Broadcast across the whole network not to a single machine.
- Therefore there are $2^n - 2$ possible host where n is the number of bits for the host identifier.

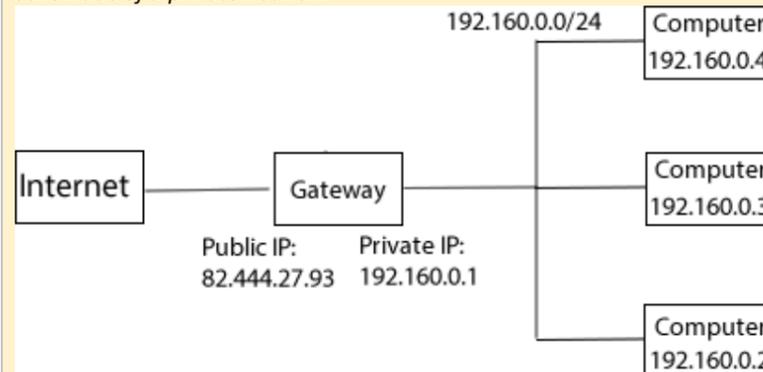
Classless inter-domain routing (CIDR)

Instead of an IP address with a mask you might also see an IP address presented as: 192.168.33.22/19. This means that the first 19 bits represent the network identifier and the remaining 13 bits represent the host part. This is therefore the same as the mask: 11111111 11111111 11100000 00000000 (255.255.224.0)

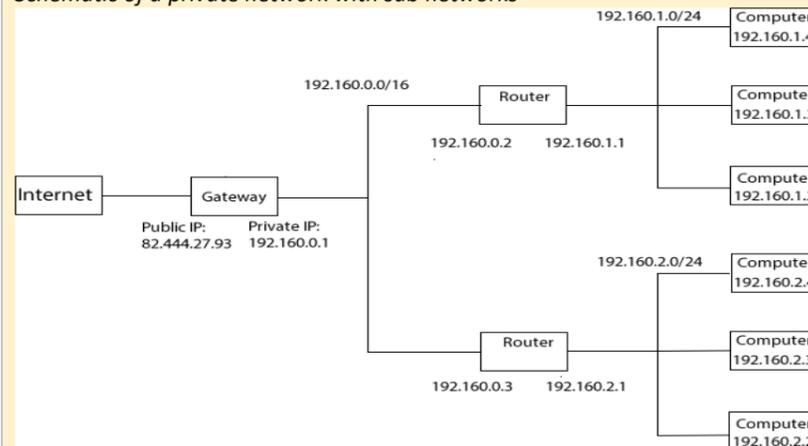
CIDR and subnet

Subnet Mask	Last two octets	CIDR	Number host bits	Number of hosts on each subnet
255.255.255.252	11111111.11111100	/30	2	2
255.255.255.248	11111111.11111000	/29	3	6
255.255.255.240	11111111.11110000	/28	4	14
255.255.255.224	11111111.11100000	/27	5	30
255.255.255.192	11111111.11000000	/26	6	62
255.255.255.128	11111111.10000000	/25	7	126
255.255.255.0	11111111.00000000	/24	8	254
255.255.252.0	11111110.00000000	/23	9	510
255.255.128.0	11100000.00000000	/19	13	1022

Schematic of a private network



Schematic of a private network with sub networks



Dynamic Host configuration Protocol (DHCP)

- Static IP addresses never change.
- Dynamic addresses are allocated each time a device connects to a network.
- Each time a host is connected an IP address will be allocated from a list of available addresses and will then be removed from the list.
- When a device is no longer connected the IP address is then added to the list of available addresses ready to be allocated once again.
- A DHCP server is used to perform this task.
- This is a way of preserving IPv4 addresses.

Public and private IP addresses

- Public IP addresses are routable and must be unique. This means that they can be addressed by any other device on the internet.
- Private IP addresses are non-routable and only need to be unique within the local area network in which they reside.
- Private IP addresses have helped conserve IPv4 addresses because they are not unique globally.
- This means that it is not possible to have direct external access private IP addresses.

IP standards

Every device on the internet needs to have a unique IP (internet protocol) address. Packets contain the sender's and receiver's IP address so that routers know where to direct the packets. Just like every house in the country has a unique postal address.

IPv4 has 32 bits and 4.3 billion addresses. All these have been exhausted now but IPv6 was introduced to overcome this challenge and designed to run alongside IPv4. Each IP address is split into 4 blocks and contains a denary value between 0 and 255. Example of IPv4 address: 172.92.255.01

IPv6 has 128 bits so the number of addresses is 3.4×10^{38} . This is unlikely to be exhausted anytime soon! IP address is split into 8 blocks of up to 4 hexadecimal numbers. Example of IPv6 address: 2001:0db8:0a0b:12f0:f00e:1200:cc00:d001

Network address translation

- Network address translation (NAT) allows external connection to IP addresses within a private LAN
- Translates IP addresses between public and private IP addresses so that private IP addresses can be addressed
- Assigns a public address inside a private network. Limits the number of IP addresses and allows us to preserve IP addresses
- To access the internet outside the private network

Port forwarding

- Computers on a private network cannot be seen by computers outside local network
- Port forwarding is an application of NAT that allows remote computers on the internet to communicate with a specific computer within a private local-area network (LAN).
- A specific port on the gateway/router will be used to forward communications on to a specified computer on the private network
- Eg to access a web server on a private network a port number of 80 is normally used.