IP address and Subnet Mask

Maxamed Cali Maxamed

0633477899

studentslearning235@gmail.coma

What is an IP Address?

An IP address (**I**nternet **P**rotocol address) is a unique number assigned to a device on a network that uses IP.

It has two main purposes: -

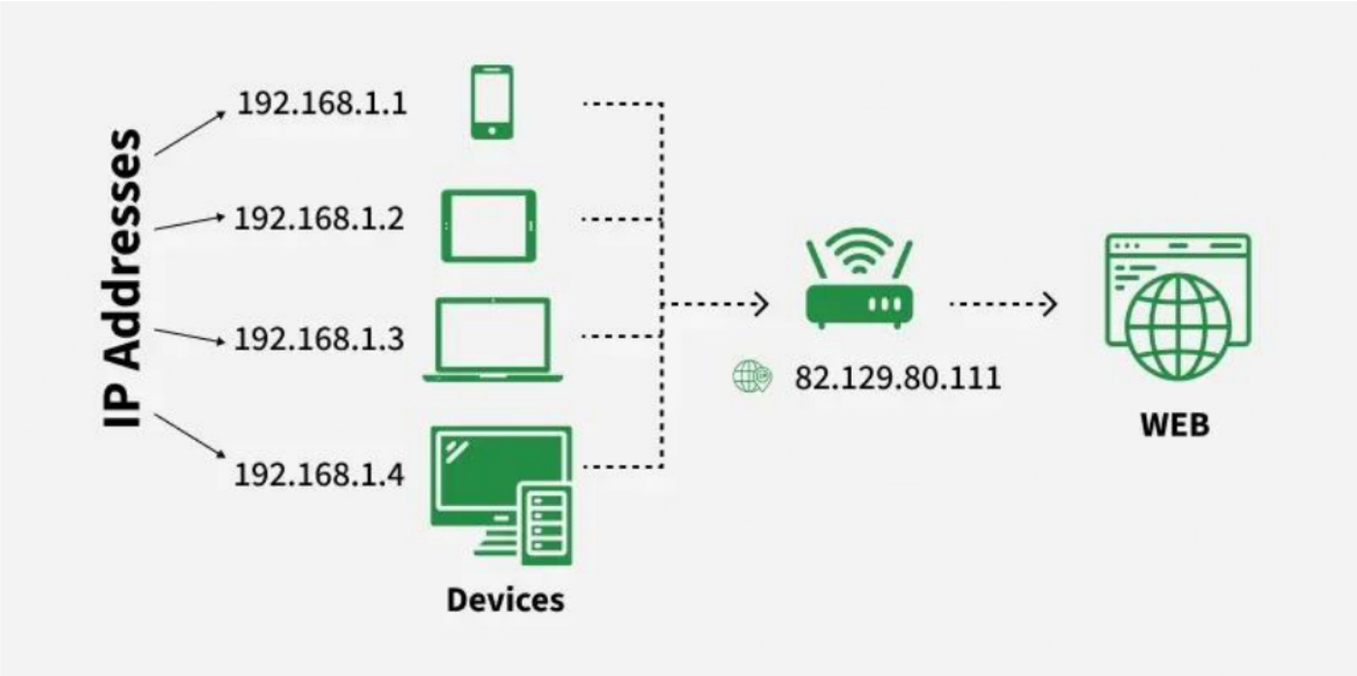
- Identify the device on the network.
- Locate the device so it can communicate with others over the Internet.

Internet Protocol (IP) is a set of rules that controls how data is sent and received over a network like the Internet.

It is responsible for:

- **Addressing** – assigning IP addresses to devices.
- **Packaging** – breaking data into packets.
- **Routing** – sending packets to the correct destination.

In simple terms, IP makes sure data travels from one device to another correctly across networks.



Components of an IP Address

1. **Network Portion:** Identifies the network to which the device belongs or owns.
2. **Host Portion:** Identifies the individual device on the network.
3. **Subnet Mask (for IPv4):** Defines which part of the IP is network and which part is host.

Example: -

IP: 192.168.1.10 with subnet mask **255.255.255.0**
Network ID: *192.168.1.0*
Host ID: *10*

Allocation of IP Addresses

IANA **I**nternet **A**ssigned **N**umbers **A**uthority (**IANA**).

IANA manages and provides IP Address Blocks provided by **R**egional **I**nternet **R**egistries (**RIRs**).

RIRs are responsible for assigning IP addresses to **I**nternet **S**ervice **P**roviders (**ISPs**).

There are 5 RIRs in the world.

1. **AfriNIC (**African Network Information Centre**):**

• Africa region

2. **APNIC (Asia Pacific Network Information Centre):**

• Asia/Pacific region

3. **ARIN (American Registry for Internet Numbers):**

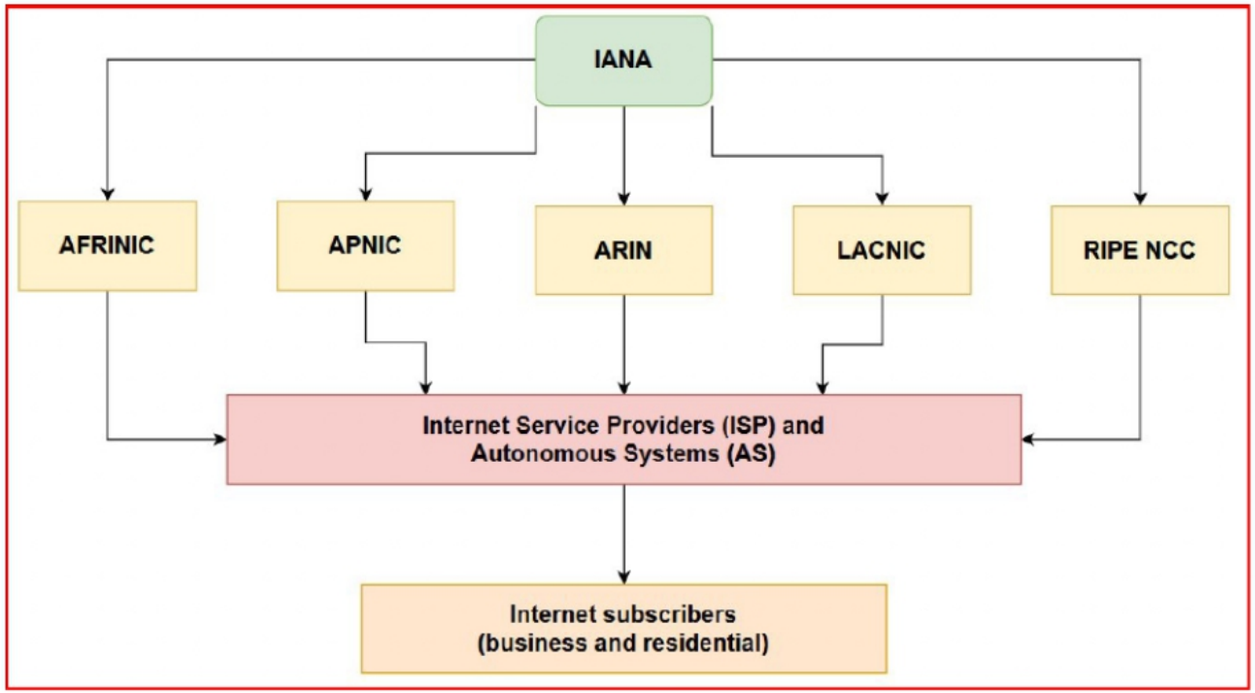
• North America region

4. **LACNIC (Latin American and Caribbean Network Information Centre):**

• Latin America and some Caribbean islands

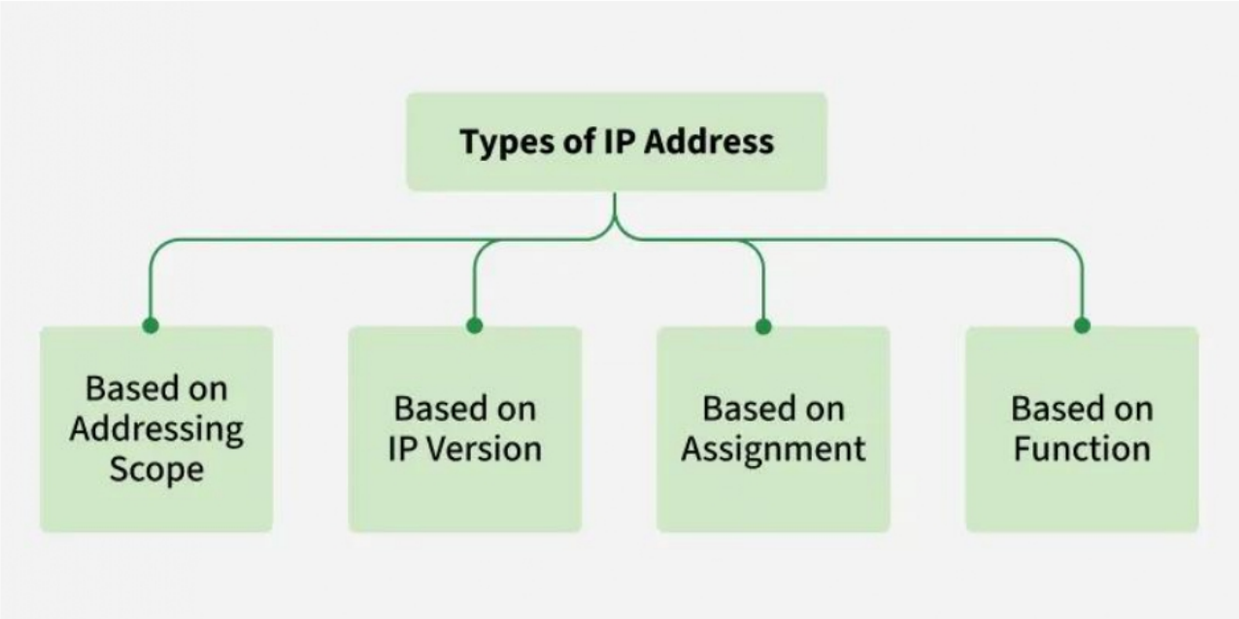
5. **RIPE NCC (Reseaux IP Europeans Network Coordination Centre):**

• Europe, the Middle East, and Central Asia


IANA
AFRINIC
APNIC
ARIN
LACNIC
RIPE NCC
Internet Service Providers (ISP) and
Autonomous Systems (AS)
Internet subscribers
(business and residential)

Types of IP Address

IP addresses can be classified in several ways based on their structure, purpose, and the type of network they are used in.



1. Based on Addressing Scope (IPv4 vs. IPv6)

1.1 Private IP Addresses.

Private is given to network hosts who do not connect to the Internet directly.

Private IP addresses are used within internal networks and are not routable on the global internet.

Class A	*Class B*	*Class C*
10.0.0.0 to 10.255.255.255	172.16.0.0 to 172.31.255.255	192.168.0.0 to 192.168.255.255

Public IP addresses are used to uniquely identify devices on the global internet.

Class A	***Class B***	***Class C***
1.0.0.0 to 126.255.255.255	128.0.0.0 to 191.255.255.255	192.0.0.0 to 223.255.255.255

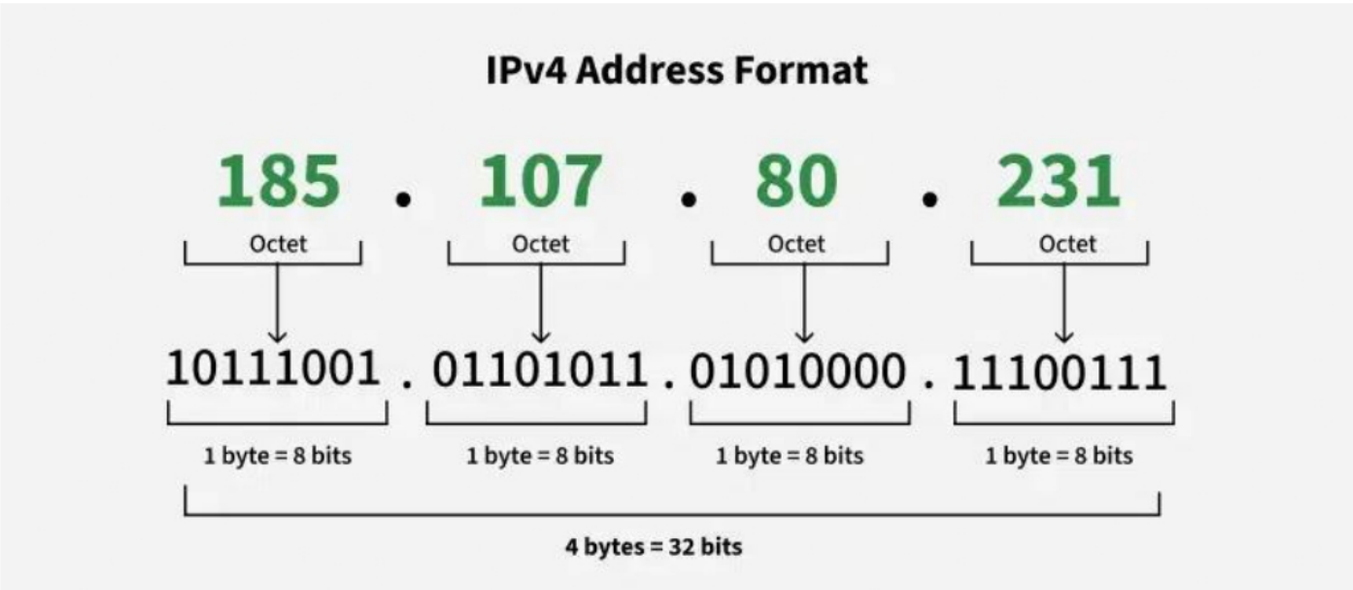
2. Based on IP Version

2.1 IPv4

This is the most common form of IP Address. It consists of **four** sets of numbers (**octets**) separated by **dots (.).**

This format can support over **4 billion** unique addresses. Each **octet** represents **eight bits**, or a **byte**, and can take a value from **0** to **255**.

This range is derived from the possible combinations of **eight bits (2^8 = 256 combinations**).



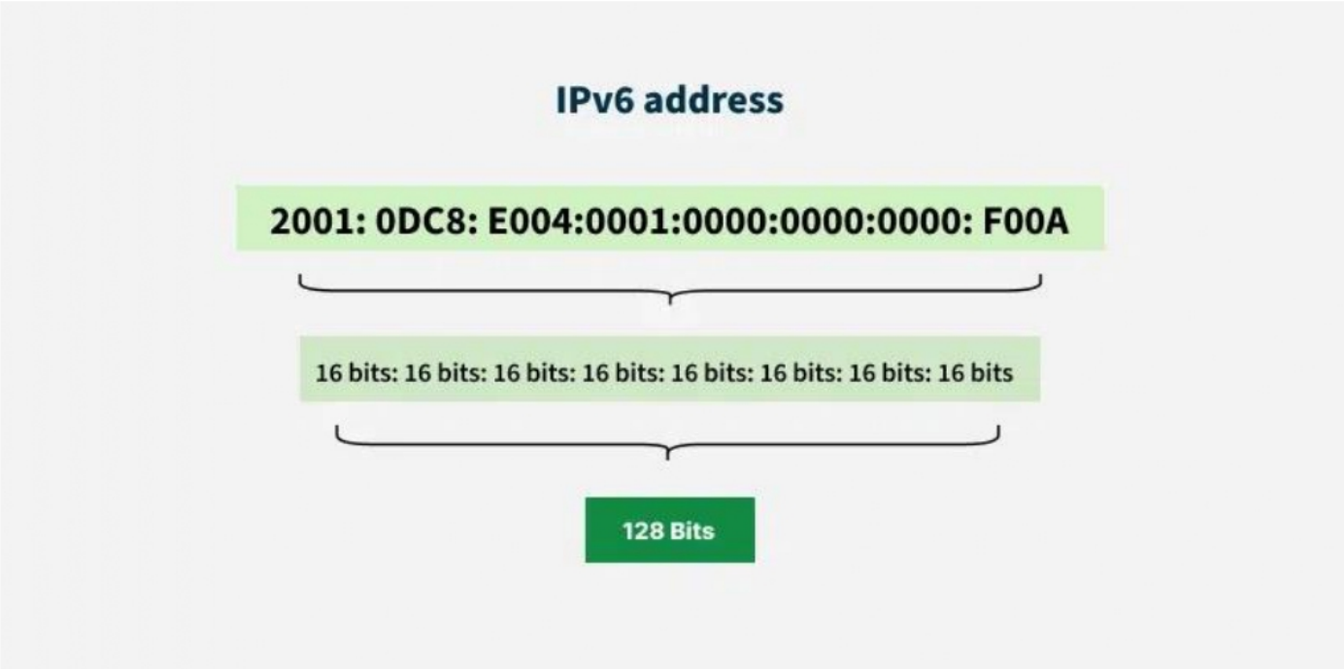
IPv4 Address Format

2.2 IPv6.

IPv6 gives us a very large number of IP addresses and is written using **numbers** and **letters** separated by **colons** (**:**).

They use **128** bits instead or rather than of **32**, so they can create many more IP addresses.

These addresses are expressed as **eight groups** of **four hexadecimal digits**, each group representing **16 bits**. The groups are separated by **colons** (**:**).



Example of IPv6 **Address**: **2001:0db8:85a3:0000:0000:8a2e:0370**

Each group (like **2001**, **0db8**, **85a3**, etc.) represents a **16-bit block** of the address.

3. Based on Assignment.

3.1 Static IP Addresses

A Static IP address is a fixed address that does not change.

It is usually given to **servers** or **important devices** that need the same address all the time.

It is reliable for services like **websites** and **remote access**.

3.2 Dynamic IP Addresses.

A **Dynamic IP address** is an IP address that changes automatically.

It is given to a device by a router or server when it connects to the network.

Most **home** and **office devices** use dynamic IP addresses because they are easier to manage.

4. Based on Function

4.1. Unicast Address

In unicast, data is sent from one sender to one specific receiver identified by a unique IP address. It is the most common type of communication used in networks.

Its Purpose is **One-to-one** communication.

- **Example:** Sending an email or loading a webpage - your computer directly communicates with a specific server.
- **Use Case:** Regular web browsing services, file transfers (**FTP**), email (**SMTP**), etc.

4. 2. Broadcast Address

In broadcast, a message is sent from one device to all devices in the same network segment. Every device in the network receives and processes the broadcast message.

Its Purpose is **One-to-all communication** within a network.

- **Example:** An **ARP** (**A**ddress **R**esolution **P**rotocol) request uses broadcasting to find a device's MAC address on the local network.

- **Use Case:** Network discovery, DHCP requests, ARP queries.

4. 3. Multicast Address

In **multicast**, data is sent from one source to multiple selected receivers that are part of a multicast group.

Only devices that have joined the group will receive the data, making it more efficient or more powerful than broadcasting.

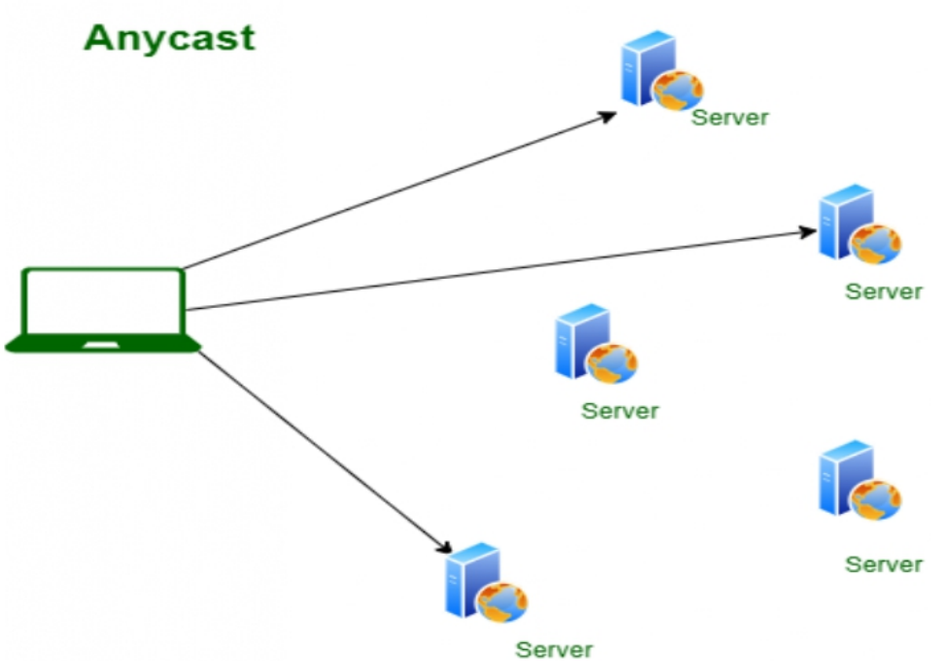
Its Purpose is **One-to-many** (selected group) communication.

- **Example:** Streaming live video or online conferencing to a group of users.
- **Use Case:** IP-TV, video conferencing, live streaming
- **IPv4 Range:**224.0.0.0224.0.0.0 to 239.255.255.255239.255.255.255

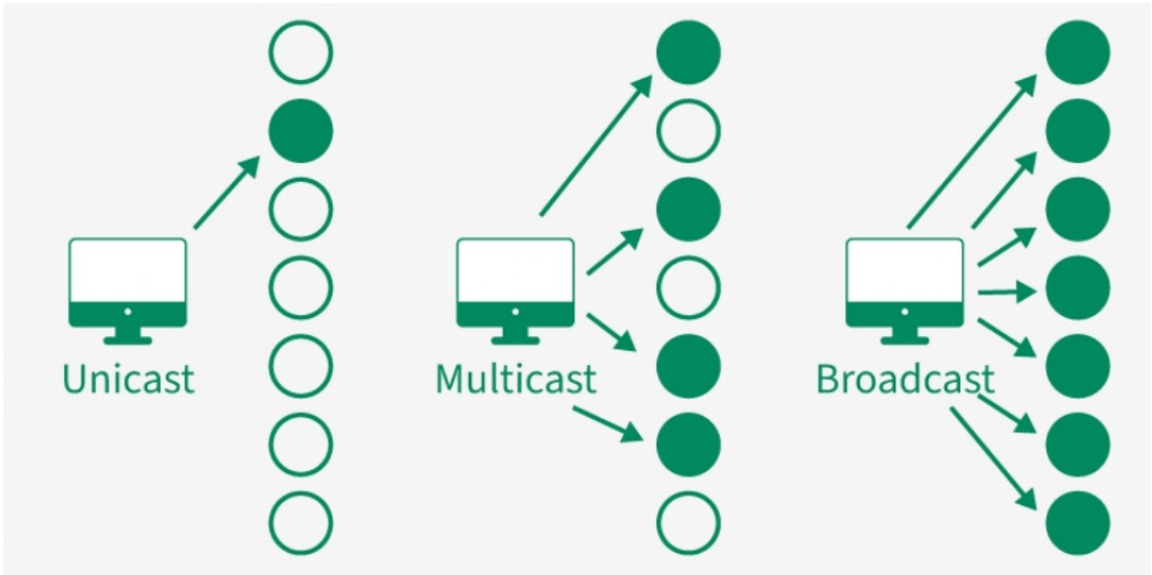
4.4. Anycast Address

In anycast, data is sent from one sender to the nearest receiver (**in terms of network distance)** among a group of devices sharing the same IP address. Routers determine the closest destination dynamically.

Its Purpose is ***One-to-nearest*** communication (based on routing distance).



- **Example:** Content Delivery Networks (**CDNs**) use anycast to route user requests to the nearest data center.
- **Use Case:** DNS servers, CDN routing, load balancing



Classes of IPv4 Address

There are about **4.3 billion IPv4 addresses**.

Managing all of them without grouping would be very difficult.

So, IP addresses are arranged in number order and divided into **five classes** to make them easier to manage and assign.

IP Class	Address Range	Maximum number of networks
Class **A**	1-126	126 (2^7-2)
Class **B**	128-191	16384
Class **C**	192-223	2097152
Class **D**	224-239	Reserve for multitasking
Class **E**	240-254	Reserved for Research and development

- **Class A** (1.0.0.0 **to** 127.**255.255.255**): Used for very large networks (***like multinational companies***). Supports up to **16 million** hosts per network.
- **Class B** (128.0.0.0 **to** 191.**255.255.255**): Used for medium-sized networks, such as **large organizations**. Supports up to **65,000** hosts per network.
- **Class C** (192.0.0.0 **to** 223.**255.255.255**): Used for smaller networks, like **small businesses or home networks**. Supports **up to 254** hosts per network.
- **Class D** (224.0.0.0 **to** 239.255.255.255): Reserved for multicast groups (**used to send data to multiple devices at once**). Not used for traditional devices or networks.
- **Class E** (240.0.0.0 **to** 255.255.255.255): Reserved for experimental purposes and future use.

Special IP Addresses.

There are also some special-purpose IP addresses that don't follow the usual structure:

- **Loopback Address**: The loopback addresses **127.0.0.1** is used to test network connectivity within the same device (i.e., sending data to yourself). Often called "localhost."
- **Broadcast Address:** The broadcast address allows data to be sent to all devices in a network. For a typical network with the IP range **192.168.1.0/24**, the broadcast address would be **192.168.1.255**.
- **Multicast Address**: Used to send data to a group of devices (**multicast**).

  For example, **233.0.0.1** is a multicast address.

How to Protect and Hide Your IP Address.

Use a VPN (Virtual Private Network): A by routing your internet traffic through a secure VPN server.

This masks your identity, encrypts your data, and prevents websites or attackers from tracking your location or online activities.

Use a Proxy Server: Is a computer or server that acts as a **middle man** between your device and the Internet.

When you request a website:

1. Your request goes to the **proxy server** first.
2. The proxy server sends the request to the website.
3. The website responds to the proxy, and the proxy sends the data back to you.

Why use a proxy server?

- 🔒 Improves privacy (hides your IP address).
- 🚫 Can block unwanted websites.

Can speed up access by caching data.
Adds extra security.

Use the Tor Browser: **Tor Browser** is a special web browser that helps you browse the Internet without anyone knowing who you are.

How it works:

- Your internet traffic is sent through **multiple servers (nodes)** around the world.
- This hides your real IP address.
- It makes it hard for others to track you.

Why use Tor?

- 🔒 Strong privacy protection.
- 🗼 hides your location.
- 🚫 Bypass some website restrictions or open websites that are restricted

  Meaning visit websites even if they are blocked.

Enable a Firewall: A firewall monitors and filters **incoming** and **outgoing** network traffic.

It blocks suspicious or unauthorized connections, reducing the risk of hackers targeting your device via your IP address.

Subnet Mask

Subnet mask is used to classify the **Network Portion** and **Host Portion**.

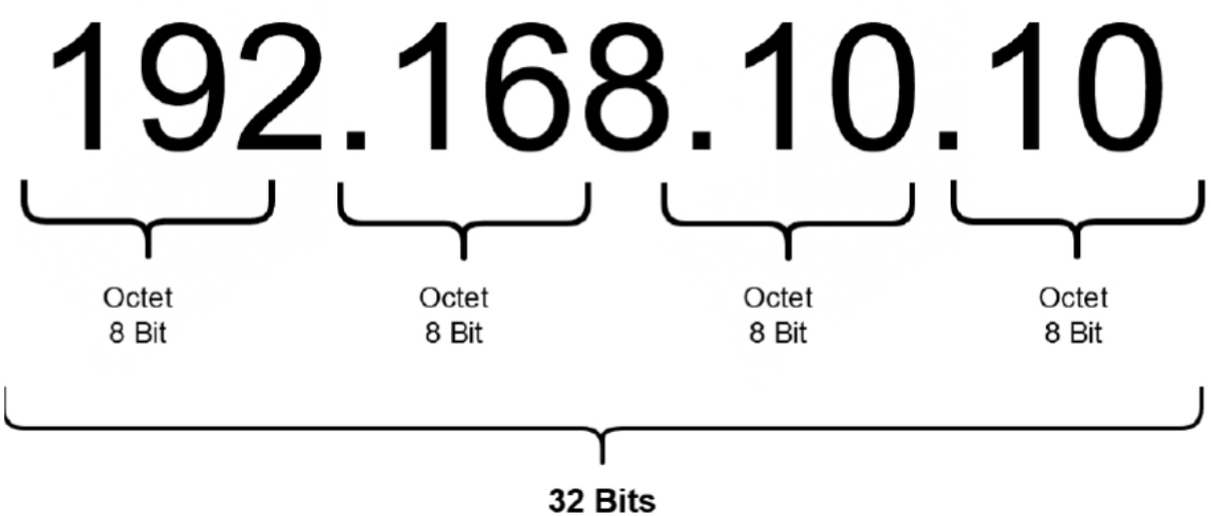
When given a device IP Address.

The subnet mask it is known by the device which network it belongs to.

An Internet Protocol (**IP**) address is the unique identifying number assigned to every device connected to the internet.

IPv4 contains **32 bits**, which can be either **1** or **0**.

Therefore, ***IPv4*** or **IP version 4** gives you **4,294,967,296** IP Addresses, which can be shortened to **4.3 billion** IP Addresses.



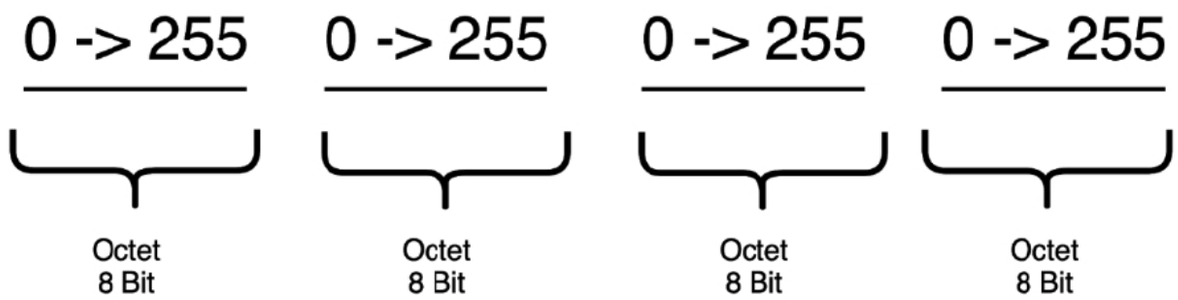
I mentioned earlier that **IPv4** is **32-bit**.

32-bit is divided into four, **32/4**.

There are four places for you **eight** or **8**.

Those four places are known as one **Octet**, instead an octet is **8 bits**.

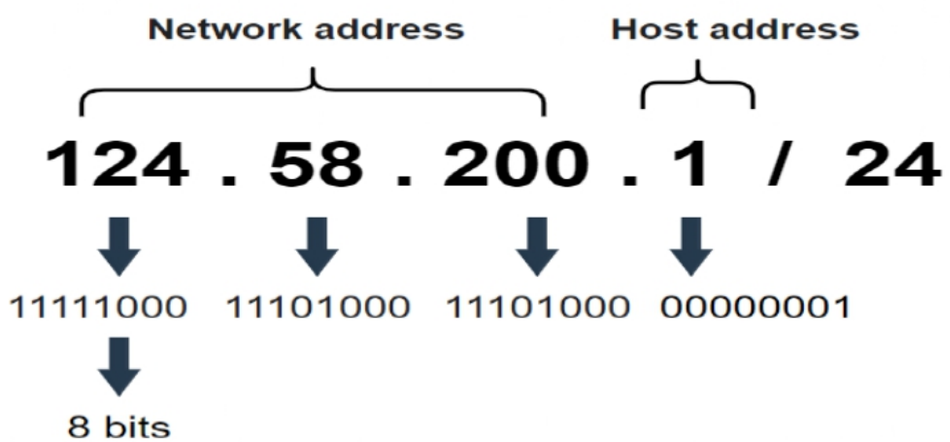
Four places of **eight bits** if you add them, it shows **32 bits**, and that's where it comes from.



IPv4 number cannot be more than **255**, and can be between his number is from **0** to **255**.

If you see an IP address **175.185.123.4** is a Correct IP Address. **1 Octet = 8 Bit.**

Another one **178.256.270.10** is not IP address because has been removed the limit of IPv4 numbers.



The format of an IP address

Class A
Subnet Mask

Netwok	Host	Host	Host
255	0	0	0

Class B
Subnet Mask

Netwok	Network	Host	Host
255	255	0	0

Class C
Subnet Mask

Netwok	Network	Network	Host
255	255	255	0

Default Gateway.

The default gateway is the IP address assigned to your system using when he wants to connect to another network outside the network your system is connected to.

Bit – A bit is a single number that can be either **1** or **0.**

- ✓ **The ones (1)** tell us the *network* bits of an IP address.
- ✓ **The zeros (0)** tell us the *host* bits of an IP address.

Bytes – **8** bits make **1 Byte**.

Octet – **8** bits make up **1 Octet.**

- A **Byte** usually means **8 bits** in modern computers.

- An **Octet** always means exactly **8** **bits** (used especially in networking, like IP addresses).

Network address

Network Address is a given number any device connected to the network.

That network address it is used to communicate with connected devices the network, or they can communicate with a device in a remote location.

Host address

A **host address** is the IP address given to a specific device on a network (like a computer, printer, or phone).

It identifies the **exact device** inside a network

IPv4 Address Classes

- **Class A**: 1.0.0.0 to 126.0.0.0 (**Large networks**)
- **Class B**: 128.0.0.0 to 191.255.0.0 (**Medium-sized networks**)
- **Class C**: 192.0.0.0 to 223.255.255.0 (**Small networks**)
- **Class D**: 224.0.0.0 to 239.255.255.255 (**Multicast**)
- **Class E**: 240.0.0.0 to 255.255.255.255 (**Experimental**)

What is CIDR?

CIDR (Classless Inter-Domain Routing) or notation is a common way to represent the number of network bits in a subnet mask. With **CIDR**, the number of network bits is added after a slash and you're done.

Class	IP Range	Default Subnet Mask	CIDR Notation
Class A	1.0.0.0 – 126.255.255.255	255.0.0.0	**/8**
Class B	128.0.0.0 – 191.255.255.255	255.255.0.0	**/16**
Class C	192.0.0.0 – 223.255.255.255	255.255.255.0	**/24**
Class D	224.0.0.0 – 239.255.255.255	Reserved (Multicast)	**N/A**
Class E	240.0.0.0 – 254.255.255.255	Experimental	**N/A**

Understanding Binary Numbering.

We have already talked about what IP Address contains **32-bit** further divided into four places of **8-bits,** called (**Octet**).

The **four octets** are written as decimal numbers so humans can understand them, but the computer reads them in **binary**.

Ip address.

92	***168***	***132***	***254***
11000000	***10101000***	***10000100***	***11111110***

Subnet Mask.

255	*255*	*255*	*0*
11111111	*11111111*	*11111111*	*00000000*

Where: -

1 is being used

0 is set to not be used.

If you need to Change **Decimal** number to **Binary** Number.

(**128, 64, 32, 16, 8, 4, 2, 1**). Use this Formula.

Bit	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1

Change Binary to Decimal.

Binary	Decimal
10110101	**181**
10000111	**135**
11000011	**195**
11111111	
10000001	
00111011	
00000111	

Scratch Area

128	64	32	16	8	4	2	1
1	0	1	1	0	1	0	1

128+32+16+4+1 = 181

Change Decimal to Binary.

Decimal	Binary
238	11101110
34	00100010
195	11000011
3	
237	
192	
62	

Scratch Area

238
-128
110
-64
46
-32
14
-8
6
-4
2
-2
0

34
-32
2
-2
0

Network Addresses.

Using the IP address and subnet mask shown write out the network address:

188.10.18.2 **188.10.0.0**

255.255.0.0

192.10.48.80 **10.10.48.0**
255.255.255.0

192.149.24.191 **192.149.24.0**
255.255.255.0

10.10.10.10
255.0.0.0

27.125.200.151
255.255.255.0

28.212.250.254
255.255.0.0

Host Addresses

Using the IP address and subnet mask shown write out the host address:

188.10.18.2 **0.0.18.2**
255.255.0.0

192.10.48.80 **0.0.0.80**
255.255.255.0

192.149.24.191 **0.0.0.191**
255.255.255.0

10.10.10.10
255.0.0.0

27.125.200.151
255.255.255.0

28.212.250.254
255.255.0.0

Default Subnet Masks

Write the correct default subnet mask for each of the following addresses:

177.100.18.4	**255.255.0.0**
119.18.45.0	**255.0.0.0**
191.249.234.191	**255.255.0.0**
223.23.223.109	
10.10.250.1	
126.123.23.1	
77.251.200.51	
189.210.50.1	

How to write Subnet

173.16.0.0 ***IP address***.
255.255.0.0 ***Subnet Mask***.

- Class **A** subnet mask: 255.0.0.0
- Class **B** subnet mask: 255.255.0.0
- Class **C** subnet mask: 255.255.255.0

2^s **-2** where the exponent **s** is equal to the number of bits left after subnet bits are borrowed.
2^h **-2** where the **h** is the number of hosts.

Example

Example 1

Number of needed subnets **14**
Number of needed usable hosts **14**
Network Address **192.10.10.0**

Solution

- **Class B** 192.10.10.0/16
  255.255.0.0
- **Change Binary**

128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0

- **Subnet**

$2^s - 2$

$2^4 - 2 = 16 - 2 = 14$

S = 14

128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1	0	0	0	0

255.255.240.0/20

- **Hosts**

$2^h - 2$

$2^4 - 2 = 16 - 2 = 14$

H = 14

Therefore: - IP: 192.10.10.0/20

Subnet: - 255.255.255.240

Block Size: - 16 **(256-240 = 16)**

Where come 240

128	64	32	16	8	4	2	1
1	1	1	1	0	0	0	0

Usable Networks

Subnet Network.

192.10.10.1
192.10.10.16
192.10.10.32
192.10.10.48
192.10.10.64
192.10.10.80
192.10.10.96
192.10.10.112
192.10.10.128
192.10.10.144
192.10.10.160
192.10.10.176
192.10.10.192
192.10.10.208
192.10.10.224
192.10.10.240

Ip Address

Start	To	End
192.10.10.1		192.10.10.15
192.10.10.16		192.10.10.31
192.10.10.32		192.10.10.47
192.10.10.48		192.10.10.63
192.10.10.64		192.10.10.79
192.10.10.80		192.10.10.95
192.10.10.96		192.10.10.111
192.10.10.112		192.10.10.127
192.10.10.128		192.10.10.143
192.10.10.144		192.10.10.159
192.10.10.160		192.10.10.175
192.10.10.176		192.10.10.191
192.10.10.192		192.10.10.207
192.10.10.208		192.10.10.223
192.10.10.224		192.10.10.239
192.10.10.240		192.10.10.255