



IP Addressing in the IoT

- Imagine every device on the internet as a house. For you to send a letter to a friend living in one of these houses, you need their home address.
- In the digital world, this home address is what we call an **IP (Internet Protocol) Address**. It's a unique string of numbers separated by periods (IPv4) or colons (IPv6) that identifies each device connected to the internet or a local network.

Definition:

An IP address, or Internet Protocol address, is a unique string of numbers assigned to each device connected to a computer network that uses the Internet Protocol for communication.

It serves as an identifier that allows devices to send and receive data over the network, ensuring that this data reaches the correct destination.



IP Addressing in the IoT

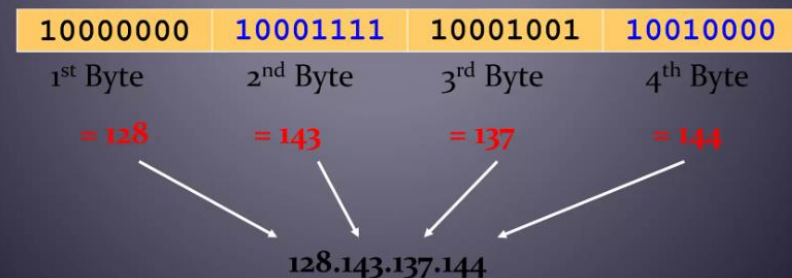
What is an IP address?

- An unique identifier for a computer or device (host) on a TCP/IP network.
- 32 bit binary sequence.
- Valid addresses can range from 0.0.0.0 to 255.255.255.255
- Total No.Of address= 2^{32} =4.3 Billion.

Dotted Decimal Notation

- IP addresses are written in a so-called *dotted decimal notation*
- Each byte is identified by a decimal number in the range [0..255]:

Example:





IP Addressing in the IoT



- IP addresses are numbers.
- In Internet Protocol version 4 (IPv4), almost 4.3 billion IP addresses are possible—4,294,967,296 to be precise, or 2^{32} .
- IP addresses are usually written as four 8-bit numbers separated by dots (from 0.0.0.0 to 255.255.255.255)—for example, 192.168.0.1 (which is often the address of your home router) or 8.8.8.8 (which is the address of one of Google’s DNS servers).
- This “dotted quad” is still exactly equivalent to the 32-bit number. □
8.8.8.x — One of several IP ranges assigned to Google.
- 192.168.x.x — A range assigned for private networks. □ Your home or office network router may well assign IP addresses in this range. 10.x.x.x — Another private range.



IP Addresses contd.



- Every machine on the Internet has at least one IP address. That means every computer, every network-connected printer, every smartphone, and every Internet of Things device has one.
- The private ranges such as 192.168.x.x offer one mitigation to this problem. Your home or office network might have only one publicly visible IP address.
- However, you could have all the IP addresses in the range 192.168.0.0 to 192.168.255.255 ($2^{16} = 65,536$ addresses) assigned to distinct devices.
- A better solution to this problem is the next generation of Internet Protocol, IPv6.



IP Addressing in the IoT



History:

- IP was the connectionless datagram service in the original.
- Transmission Control Program introduced by Vint Cerf and Bob Kahn in 1974; the other being the connection-oriented Transmission Control Protocol (TCP). The Internet protocol suite is therefore often referred to as TCP/IP.

General structure:

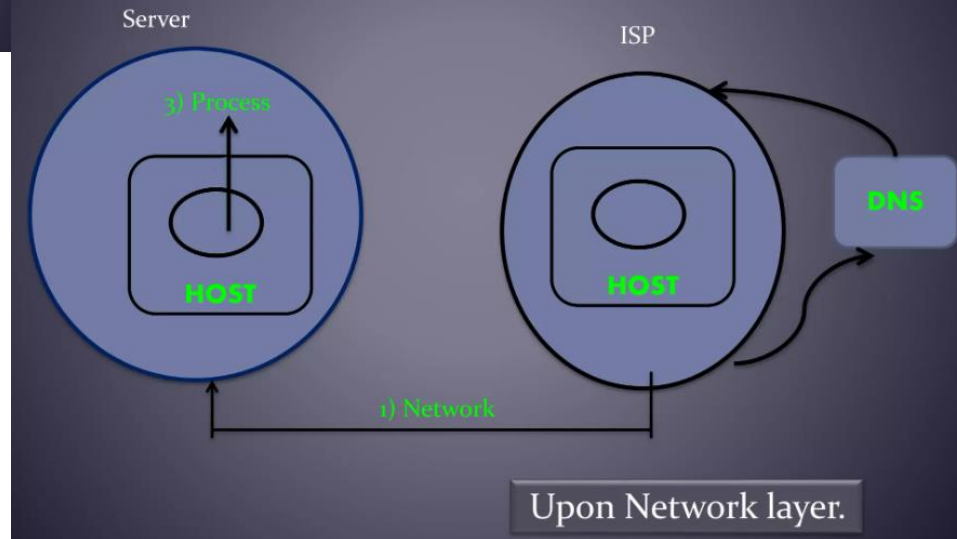
NETWORK ID

HIGH order bits

HOST ID

LOW order bits

How IP Works?





IP Addressing Types

- **Based on Addressing Scheme**

- ☐ IPv4
- ☐ IPv6

- **Based on Usage**

- ☐ Public
- ☐ Private

- **Based on Assignment Method**

- ☐ Static
- ☐ Dynamic



IP Addressing Types

Public IP Addresses

1. Public IP addresses are global and standardized.
2. Can be accessed over the Internet.
3. Internet Assigned Numbers Authority (IANA) formerly known as (InterNIC) is responsible for registering IP address to organizations and ISPs.
4. For multiple computers ;
Private IP addresses to address each computer and router gets the public IP address, and each of the computers, connected to your router (via wired or wifi) gets a private IP address from your router via DHCP (Client-server) protocol on network layer.

Private IP address

- Local or internal IP connect devices in a private network and can't access internet.
- They are Non-Routable.

CLASS	RANGE		# of HOST
A	10.0.0.0/8	10.255.255.255	16,777,216
B	172.16.0.0/12	172.31.255.255	1,048,576
C	192.168.0.0/16	192.168.255.255	65,536

- To allow direct access to a local device which is assigned a private IP address, a Network Address Translator (NAT) should be used.



IP Addressing Types

IPv4 and IPv6

- IPv6 is used by less than 1% of the networks, while IPv4 is still in use by the remaining 99%.

PARAMETERS	IPv4 address	IPv6 address
Length	• 32 bit	• 128 bit
Representation	• decimals (.)	• Hexadecimal (:))
Security	Application dependent	Inbuilt IPsec support.
Packet Fragmentation	Senders and Router.	Only Senders
Packet Flow	NOT AVAILABLE	FLOW label field in IPv6 header.
Address Configuration	Manual and DHCP support.	Auto-configuration.
Address Types	Unicast and Broadcast.	Multicast and Anycast.
Address Resolution Protocol (ARP)	ARP is available to map <u>IPv4 addresses</u> to MAC address.	MAC address embedded HID part.NDP Available.



IP Usage



IP Usage:

- An Internet Protocol provides for a set of rules that govern Internet activity and facilitate completion of transfer of files and E-mail on the World Wide Web.
- Used to connect to another computer via host or network interface identification and location addressing.
- IP is the core of the TCP/IP protocol suite. IP provides the fundamental mechanism using which data is delivered between devices which may or may not be in the same network.

- **DATA ENCAPSULATION** which provides security.
- **FRAGMENTATION** which promotes reliability.
- **REASSEMBLING** on the receiving device and passes it on to the higher layers for interpretation.
- **FORMATTING/PACKAGING** where format and package is only decipherable by the recipient.



MAC ADDRESSES



- As well as an IP address, every network-connected device also has a MAC address, which is like the final address on a physical envelope in our analogy.
- It is used to differentiate different machines on the same physical network so that they can exchange packets. This relates to the lowest-level “link layer” of the TCP/IP stack.
- Though MAC addresses are globally unique, they don’t typically get used outside of one Ethernet network (for example, beyond your home router). So, when an IP message is routed, it hops from node to node, and when it finally reaches a node which knows where the physical machine is, that node passes the message to the device associated with that MAC address.
- MAC stands for Media Access Control. It is a 48-bit number, usually written as six groups of hexadecimal digits, separated by colons—for example: 01:23:45:67:89:ab
- Most devices, such as your laptop, come with the MAC address burned into their Ethernet chips.
- Some chips, such as the Arduino Ethernet’s WizNet, don’t have a hard-coded MAC address, though.



MAC ADDRESSES contd.



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- This is for production reasons: if the chips are mass produced, they are, of course, identical. So they can't, physically, contain a distinctive address.
- The address could be stored in the chip's firmware, but this would then require every chip to be built with custom code compiled in the firmware.
- Alternatively, one could provide a simple data chip which stores just the MAC address and have the WizNet chip read that.
- Obviously, most consumer devices use some similar process to ensure that the machine always starts up with the same unique MAC address.
- The Arduino board, as a low-cost prototyping platform for developers, doesn't bother with that nicety, to save time and cost.
- Yet it does come with a sticker with a MAC address printed on it. Although this might seem a bit odd, there is a good reason for it: that MAC address is reserved and therefore is guaranteed unique if you want to use it.
- For development purposes, you can simply choose a MAC address that is known not to exist in your network.
- WizNet is a Korean manufacturer which specializes in networking chips for embedded devices. Many popular microcontrollers which we look at use these chips.



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Thank
You