DCN – Addressing in TCP/IP

Physical layer transmits raw bits in the form of electrical signals.

The data link layer prepares data frames from the network layer and also is used to transfer block of bits across the links

It also indicates the frame Boundaries. It inserts control information in the data frame to enable the error correction or detection across the frame boundaries,

The logical address is used to communicate or identify the address of the next HOP that is the address of the router that connects the previous LAN to the next LAN.

There are 4 types of addressing mechanisms used in TCP/IP:

- **Logical**
- **Physical**
- **Port And**
- **Application Specific.**
-

The **logical address is a 32 bit IP address** used **to identify the address of the next HOP**.

2 LANs are connected by a Router that has an input port and output port.

Each port has a combination of physical and logical addresses.

The logical address is denoted by an alphabet and the physical address is denoted by a numeric value.

When a frame or packet tries to move across the networks it should first identify the next HOP of the current LAN and use the ARP to map the logical address to the physical address and add the source and destination physical addresses to the outgoing frame.

The router moves the data frame from one LAN to the next LAN by using Logical addresses of the LAN.

Now the devices in the current LAN compare their own physical addresses with the physical address of the data frame received.

If the physical addresses match, then the data only is taken and the rest of the component are discarded.

But if the physical address of the received data frame does not match with any of the physical addresses of the machines within the LAN then the packet or the frame is discarded by all the machines.

Then the next-hop is identified with the help of the logical address from the current LAN router and it is forwarded to the next LAN.

Now the data frame would be moved to the next LAN by using the address resolution protocol to convert the logical address of the interface connecting the LAN and the current packet is moved into the current LAN.

The machines within the LAN compare the physical address of the received packet with their own physical addresses and if a match is found then the packet with its data component is taken into the physical layer of the machine and propagated to the upper layers far further processing.

The logical address is a 32-bit address indicating the address or identity of the next LAN via router to move the data packet from the current network to the next hop LAN.

Now this packet has a 48-bit physical address that needs to be compared with the physical addresses of the devices that are existent in the current LAN.

If a match is found then the data component is extracted and sent to the upper layers for further processing.

This process continues till the packet or frame reaches they intended destiny.

In this entire process the logical address of the source and the physical address of the destination are not changed during the entire transmission till the packet is absorbed by the intended destination machine.

Each node has a ***Physical Address*** for the specific hardware device that connects it to a network.

Example: A physical address on an Ethernet network is a 6-byte numeric value, such as 08-00-14-57-69-69.

It is assigned by the manufacturer of the Ethernet interface hardware.

Physical addresses are also called **Media Access Control** (MAC) addresses.

Because IP uses a 32-bit address and Ethernet uses a 48-bit Ethernet address, there is a conflict.

To associate the IP address to a physical address on an Ethernet network, a mapping must occur between the two types.

The address resolution protocol (ARP) **provides a mapping between the two different forms of addresses.**

Address Resolution Protocol (ARP): Used ***to associate a logical address with a physical address.***

On a typical physical network, such as a LAN, **each device on a link is identified by a physical or station address, usually imprinted on the network interface card (NIC)**.

ARP is used to find the physical address of the node when its Internet address is known.

Reverse Address Resolution Protocol (RARP):

- Allows a host to discover its Internet address when it knows only its physical address.
- Used when a computer is connected to a network for the first time or when a diskless computer is booted.

Each physical medium has its own *physical* address for nodes on that medium.

The physical addresses are also called MAC addresses.

Ethernet and token ring networks use 6-byte MAC addresses.

Mapping Internet Addresses to Physical Addresses

When an IP address is mapped to a physical, or MAC, address, ARP is used on broadcast networks such as Ethernet, token ring, and ARCnet.

When a node uses IP to send a packet, it must determine which physical address on the network corresponds to the destination IP address.

To find the physical address, the node broadcasts an ARP packet containing the destination IP address.

The node with the specified destination IP address sends its physical address back to the requesting node.

Logical Addresses

Necessary for universal communications that are independent of underlying physical networks.

Physical addresses are not adequate in an internetwork environment where different networks can have different address formats.

A universal addressing system is needed in which each host can be identified uniquely, regardless of the underlying physical network.

The logical addresses are designed for this purpose.

A logical address in the Internet is currently a 32-bit address that can uniquely define a host connected to the Internet.

No two publicly addressed and visible hosts on the Internet can have the same IP address.

A **MAC address (Media Access Control Address)** is **a 12-digit hexadecimal number assigned to each device connected to the network**.

Primarily specified as a unique identifier during device manufacturing, the ***MAC address is often found on a device's network interface card (NIC)***.

A MAC address is required when trying to locate a device or when performing diagnostics on a network device.

The MAC address **belongs to the data link layer** of the Open Systems Interconnection (OSI) model.

The DLL encapsulates the MAC address of the source and destination in the header of each data frame to ensure node-to-node communication.

Each NIC in a device is assigned a unique MAC address, so it's possible for a device to have more than one MAC address.

For example, if a laptop has both an Ethernet cable port and built-in Wi-Fi, there will be two MAC addresses shown in the system configuration.

What is the difference between a MAC address vs. IP address?

Both MAC addresses and IP addresses serve the same purpose, which is to identify a device on a network. While the MAC address identifies the physical address of a device on the same local network, the IP address identifies the device globally or through its internet address.

MAC Address

- is a unique hardware identifier that recognizes devices on a local scale;
- is hardcoded into the device during manufacturing;
- is sometimes called a *physical address*;
- can be used by a device for sending data to all devices on the same network through the broadcast MAC address;
- resides at Layer 2 of the OSI or TCP/IP reference model; and
- is permanent and unchangeable.

IP Address

- helps identify a network connection;
- is assigned by the network administrator or internet service provider;
- describes how the devices on the internet communicate on a global scale;
- can be used for broadcasting or multicasting;
- resides at Layer 3, or the network layer, of the TCP/IP or OSI model;
- can be changed at any time;
- is sometimes referred to as the *logical address*; and
- is assigned to devices through software configurations.

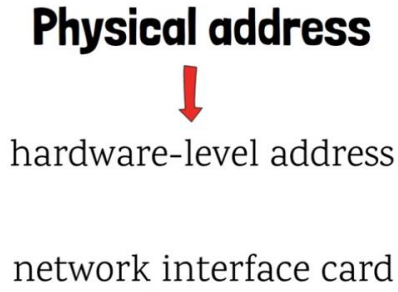
TCP/IP protocol suite includes:

1) **Physical Address**
2) **Logical Address**
3) **Port Address And**
4) **Specific Address**.

Physical Address: The physical address is the permanent hardware level address embedded in the network interface card of a device by its manufacturer

IEEE gives a block of addresses to the manufacturer.

The manufacturer of NIC takes an address from the address pool and embeds a unique physical address in each NIC it manufactures.



Logical address is written in the form of 12 hexadecimal numbers where each byte is separated by colons.

It is also called **Physical Address or LAN address or MAC address**.

Consider 4 computers connected to the bus topology local area network.

Let us write the physical addresses as a 2 digit number host a is the sender with physical address 10 and host P is the receiver with physical address 87.

Within a LAN only physical addresses are enough to transfer data so the data from host is encapsulated with destination physical address and source physical address to form a frame at the data link layer.

The trailer contains bits for added detection.

Note: In a frame the destination physical address comes before the source physical address.

Most Ethernets uses ***a 48 bit physical address written in the form of 12 hexadecimal numbers***.

Note that **in a frame** ***the destination physical address comes before the source physical address***.

The ***transmitted frame then propagates in both directions***.

The ***frame moved to the left dies at the cable termination*** while **the one moved to the right is received by all connected hosts**.

Host P drops the frame because the destination address does not match with their physical address.

However Host P finds the match so it drops the header and trailer from the frame and delivers data to the upper layers.

The both physical addresses helped to deliver data to the correct destination device within a network

Logical Address

Multiple networks **link** to each other to form an Internet work or the Internet.

On the Internet the devices are identified with an address called a logical address

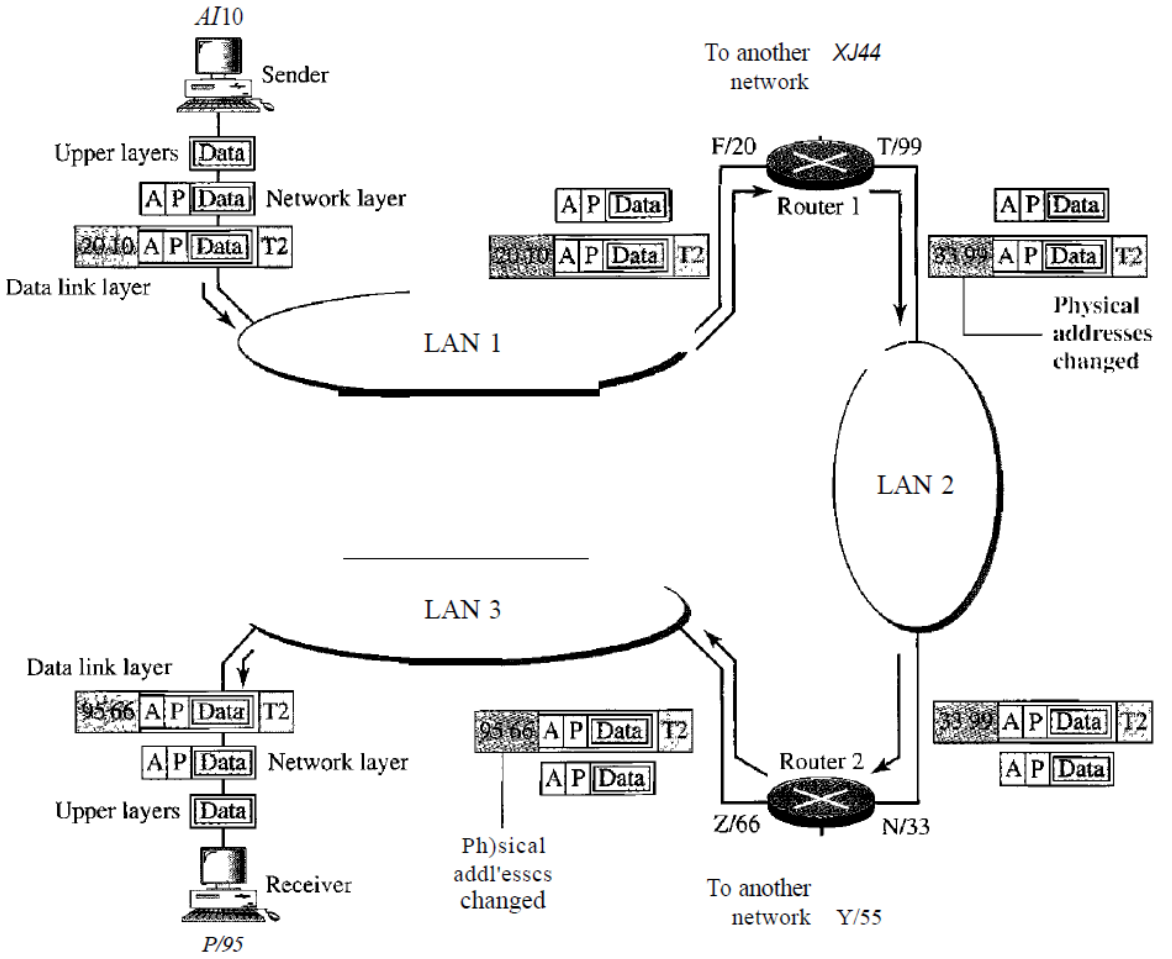
It is **a 32 bit address written in the form of decimal numbers** separated with dots it is called dotted decimal notation.

Decimal numbers range from 0 to 255.

Note: **2 devices on the Internet can have the same logical address**.

Example: Consider an Internetwork of 3 local area networks connected by 2 routers.

Host A is present in LAN-01 and Host B is present in LAN-03.



Each interface of the device has a pair of logical and physical addresses.

In this example logical address is written in the form of letters and physical address is written as numbers.

Now Host A needs to send data to Host P.

Here data will move from one network to another so senders and receivers logical addresses A and B are encapsulated with the data to form a packet in the network layer.

Note that the logical source address is written before the logical destination address since the destination host is present in different LAN so the data first must route to the Router-01.
The network layer finds the logical address of the Router-01 using the routing table.

The address resolution protocol gives its physical address 20.

The network layer passes this address to the data link layer which encapsulates the packet with destination physical address 20 and the source physical address 10 to form a frame.

All devices in LAN-01 receives the frame but only the Router-01 accepts it others drop it.

Router-01 decapsulates the frame and looks at the logical destination address P, which is different from its logical address; Now the Router knows the packet needs to be forwarded.

The router finds the logical address of the next hope that is Router-02.

With this routing table, the address resolution protocol provides the physical address of Router-02.

A frame with physical destination address 33 and physical source address 99 is created and transmitted LAN-02.

The Router accepts the frame, decapsulates it and checks the logical destination address P and then repeats the same scenario.

Finally the frame with physical destination address 95 and physical source address 66 is transmitted.

The Host P accepts the frame, decapsulates it and sends the data to upper layers.

Note that with every hop, the physical address in the frame changes on the other hand the logical addresses remain the same.

The logical address should remain the same otherwise the package will be lost in the network

Hence the Logical Address is used to deliver data across networks.

Port Address

A process running on one computer sends data to another process running in another computer.

The destination host can have multiple processes running simultaneously.

So once the destination host receives the data using physical and logical addresses it should be delivered to the right process.

For this each process is assigned a label called port address.

The port address in TCP/IP is 16 bit in length.

Consider Host A is running 3 processes with port addresses A, B & C.

Host P is running 2 processes with port address J & K.

Process A in Host A generates some data which should be delivered to process J in Host P.

To ensure the correct delivery of data to the right process the transport layer encapsulates data from the application layer with source and destination port addresses A and J.

The network layer adds the logical source address A and logical destination address P to the segment.

The physical address is then added to the packet to form a frame which is then transmitted in the network.

The frame is received by Host P which after decapsulation provides data to process J.

Since the physical address changes with each hop so the frame which host P receives has a different physical address.

Logical and Port addresses remain the same.

The logical addresses deliver data to the right network.

Physical addresses deliver data to the right host and

The port addresses deliver data to the right process.

Specific Address

User friendly addresses such as email addresses, URLs are referred to as specific addresses.

Example: abc@gmail.com and www.google.co.in.

These addresses get changed to the port address and logical address at the sender using DNS.

So these are the 4 addresses used on the Internet employing TCP/IP protocol.