

Abstract geometric lines in the top left corner, consisting of several thin, light brown lines that intersect to form various polygons and shapes, creating a complex, web-like pattern.

Networking Fundamental Concepts

LOCHANA KORALAGE

WHAT ? COMPUTER NETWORK

Computer networking refers to interconnected computing devices that can exchange data and share resources with each other. These networked devices use a system of rules, called communications protocols, to transmit information over physical or wireless technologies



BENEFIT OF NETWORK

- **It enhances communication and availability of information.**
- **It allows for more convenient resource sharing**
- **file sharing**
- **It is highly flexible**
- **It is an inexpensive system**
- **It increases cost efficiency**
- **It boosts storage capacity**

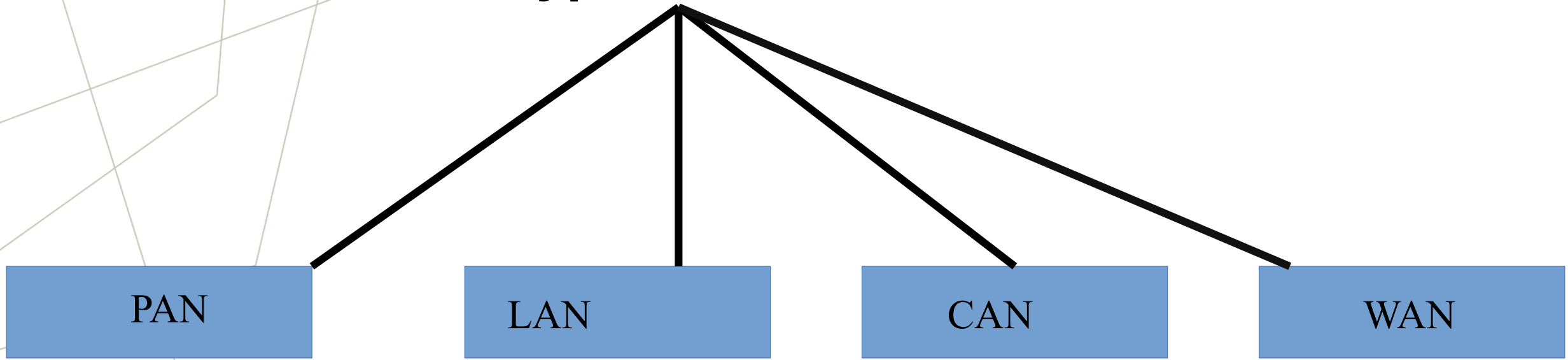




Disadvantages of Computer Networking

- **It lacks independence**
- **It poses security difficulties**
- **It lacks robustness**
- **It allows for more presence of computer viruses and malware**
- **Its light policing usage promotes negative acts**

Type of Network



- PAN (Personal area Network)
- LAN (Local area Network)
- CAN (campus area Network)
- MAN (Metropolitan area Network)
- WAN (wide area Network)

A **local area network**, or **LAN**, consists of a computer network at a single site, typically an individual office building. A LAN is very useful for sharing resources, such as data storage and printers. LAN can be built with relatively inexpensive hardware, such as hubs, network adapters and Ethernet cables

What is the LAN ?

A **personal area network**, or **PAN**, is a computer network organized around an individual person within a single building. This could be inside a small office or residence. A typical PAN would include one or more computers, telephones, peripheral devices, video game consoles and other personal entertainment devices



Wide area network

WAN, occupies a very large area, such as an entire country or the entire world. A WAN can contain multiple smaller networks, such as LANs or MANs. The Internet is the best-known example of a public WAN

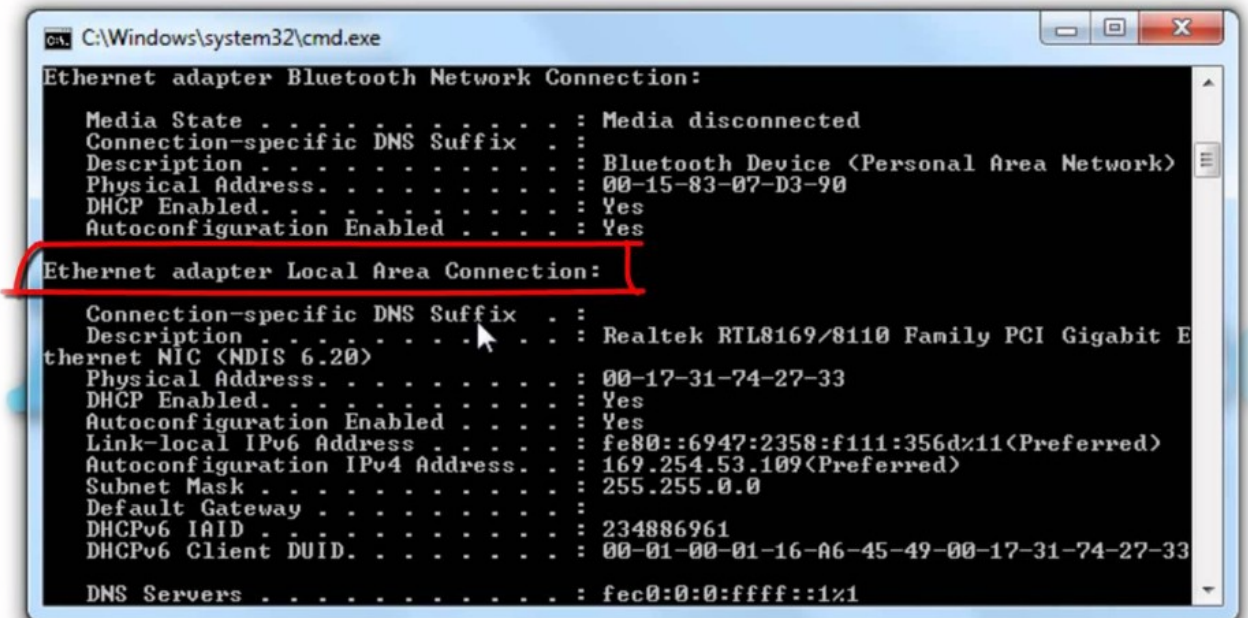
Metropolitan Area Network

MAN, consists of a computer network across an entire city, college campus or small region. A MAN is larger than a LAN, which is typically limited to a single building or site. Depending on the configuration, this type of network can cover an area from several miles to tens of miles. A MAN is often used to connect several LANs together to form a bigger network. When this type of network is specifically designed for a college campus, it is sometimes referred to as a campus area network, or CAN

What is the mac address ?

A media access control address (MAC address) is a unique identifier assigned to a network interface controller (NIC) for use as a network address in communications within a network segment.

MAC spoofing is a technique for changing a factory-assigned Media Access Control (MAC) address of a network interface on a networked device. The MAC address that is hard-coded on a network interface controller (NIC) cannot be changed. However, many drivers allow the MAC address to be changed.



```
C:\Windows\system32\cmd.exe

Ethernet adapter Bluetooth Network Connection:

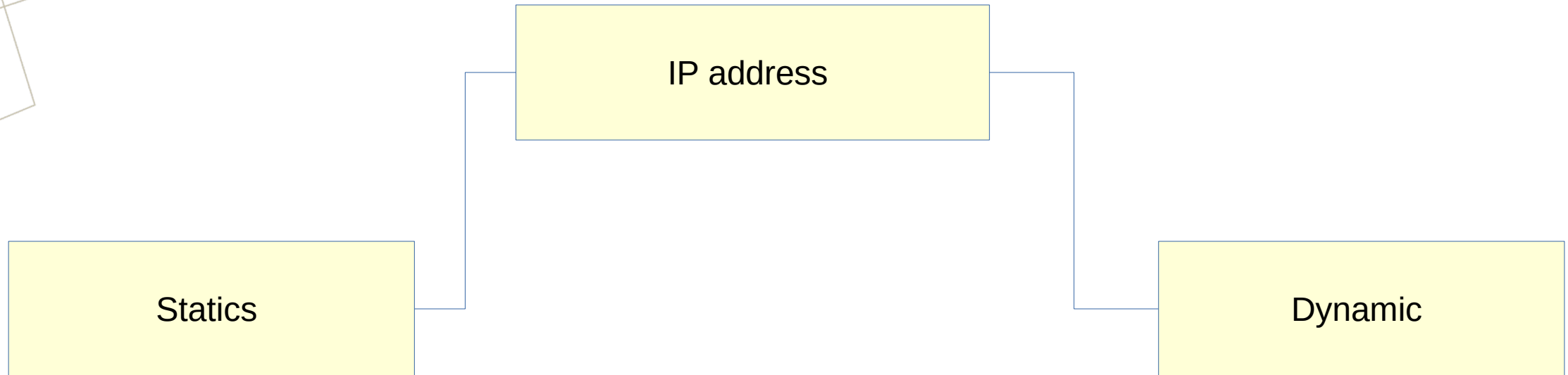
Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . : 
Description . . . . . : Bluetooth Device (Personal Area Network)
Physical Address. . . . . : 00-15-83-07-D3-90
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes

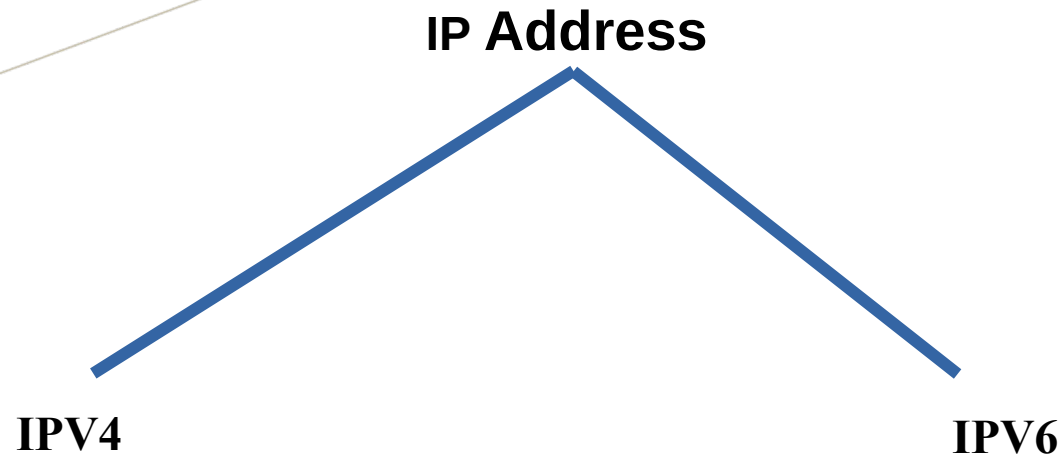
Ethernet adapter Local Area Connection:

Connection-specific DNS Suffix . : 
Description . . . . . : Realtek RTL8169/8110 Family PCI Gigabit Ethernet NIC (NDIS 6.20)
Physical Address. . . . . : 00-17-31-74-27-33
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . . : fe80::6947:2358:f111:356d%11(Preferred)
Autoconfiguration IPv4 Address. . : 169.254.53.109(Preferred)
Subnet Mask . . . . . : 255.255.0.0
Default Gateway . . . . . : 
DHCPv6 Iaid . . . . . : 234886961
DHCPv6 Client DUID. . . . . : 00-01-00-01-16-A6-45-49-00-17-31-74-27-33
DNS Servers . . . . . : fec0:0:0:ffff::1%1
```


IP address (Internet Protocol)

An IP address is a unique address that identifies a device on the internet or a local network. IP stands for "Internet Protocol," which is the set of rules governing the format of data sent via the internet or local network





**Logical address
assigned to devices**

IPV4 : IPv4 stands for Internet Protocol Version 4, which is a standard who enables a total range of 4.2 billion addresses. It consists of four segments which are divided by dots

IPV6 : IPv6 stands for Internet Protocol version 6, and it is the newer version of the Internet Protocol (IP). Yet, can you imagine it was around for more than 20 years? It was introduced back in December 1995! The main goal for its creation is to take over and eventually replace the previous protocol – IPv4. The reason is simple. The number of devices that want to connect to the Internet is growing tremendously, and IPv4 is not able to satisfy such needs.



Address Classes Explained with Examples

TCP/IP defines five classes of IP addresses: class A, B, C, D, and E. Each class has a range of valid IP addresses. The value of the first octet determines the class. IP addresses from the first three classes (A, B and C) can be used for host addresses. The other two classes are used for other purposes – class D for multicast and class E for experimental purposes

| Class | First octet value | Subnet mask |
|-------|-------------------|-------------|
| A | 0-127 | 8 |
| B | 128-191 | 16 |
| C | 192-223 | 24 |
| D | 224-239 | - |
| E | 240-255 | - |

This My Physical address :
Home Address
No 35
52 Lane Kandy



Network address : Like Street
address

Host address : Like Home
address

What is your physical address ?





→ Ex: IP address 32 bit ipv4 address Example : 172.16.10.5

→ 8 bit octets

→ Logical address

→ Easy to use

→ Flexible

IPv4 address - bit address 32 bit

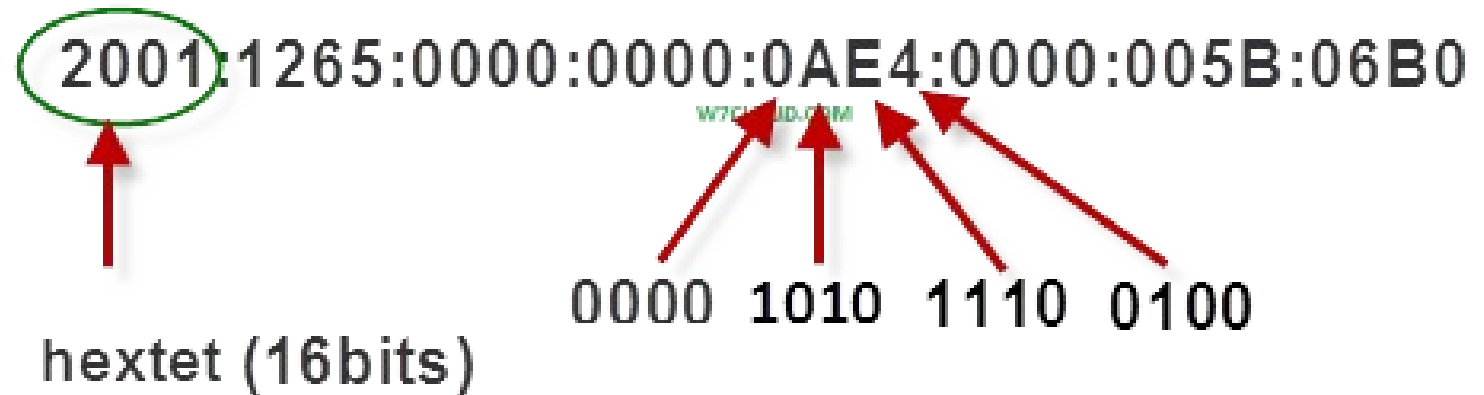
Total address - 2^{32}

IPv6 address - bit address 128 bit

Total address - 2^{128}

Introduction of IPv6

IPv6 was developed by Internet Engineering Task Force (IETF) to deal with the problem of IP v4 exhaustion. IP v6 is a 128-bits address having an address space of 2^{128} , which is way bigger than IPv4. In IPv6 we use Colon-Hexa representation. There are 8 groups and each group represents 2 Bytes



IPv6 Address Example

Questions 01

- You performed a packet capture of traffic on the network. The packet highlighted in the graphic came from a network interface card (NIC) manufactured by Samsung, and it has a MAC address of d0:03:df:89:52:fc. What portion of the MAC address identified the NIC manufacturer as Samsung?
- Although a MAC address is typically written using hexadecimal notation, how many binary bits are contained in a MAC address?
- An IPv6 address is 32 bits in length.?
- In an IPv4 address, what is used to identify the network and host portions of the address

- You're examining the output of the `ipconfig` command issued on an Apple Mac running MacOS, which shows IP address information for the computer. You notice that this computer has an IPv6 address of `2600:1700:35f0:7640:1034:3f5b:9812:ddb3` and a prefix length of 64 bits. The output is shown in the graphic.

Based on this information, how many bits are used to identify a host on this network?

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=567<RXCSUM,TXCSUM,VLAN_MTU,TSO4,TSO6,AV,CHANNEL_IO>
    ether d0:81:7a:d5:49:e3
    inet6 fe80::c1:3f7d:fe98:4279%en0 prefixlen 64 secured scopeid 0x4
    inet 172.16.109.74 netmask 0xffff0000 broadcast 172.16.255.255
    inet6 2600:1700:35f0:7640:1034:3f5b:9812:ddb3 prefixlen 64 autoconf secured
    inet6 2600:1700:35f0:7640:dc1a:d8e7:5eaa:a324 prefixlen 64 autoconf temporary
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect (1000baseT <full-duplex>)
    status: active
```


Pieces of Network



A network card (also called a network adapter, network interface card, or NIC for short) acts as the interface between a computer and a network cable. The purpose of the network card is to prepare, send, and control data on the network.



A network switch connects devices within a network (often a local area network, or LAN) and forwards data packets to and from those devices. Unlike a router, a switch only sends data to the single device it is intended for (which may be another switch, a router, or a user's computer), not to networks of multiple devices.

Router

A router is a device that communicates between the internet and the devices in your home that connect to the internet. As its name implies, it “routes” traffic between the devices and the internet



Wireless access points (APs or WAPs) are networking devices that allow Wi-Fi devices to connect to a wired network. They form wireless local-area networks (WLANs).

OSI Model

The Open Systems Interconnection (OSI) model describes seven layers that computer systems use to communicate over a network. The modern Internet is not based on OSI, but on the simpler TCP/IP model. However, the OSI 7-layer model is still widely used, as it helps visualize and communicate how networks operate, and helps isolate and troubleshoot networking problems

| | | |
|---|--------------------|--|
| 7 | Application Layer | Human-computer interaction layer, where applications can access the network services |
| 6 | Presentation Layer | Ensures that data is in a usable format and is where data encryption occurs |
| 5 | Session Layer | Maintains connections and is responsible for controlling ports and sessions |
| 4 | Transport Layer | Transmits data using transmission protocols including TCP and UDP |
| 3 | Network Layer | Decides which physical path the data will take |
| 2 | Data Link Layer | Defines the format of data on the network |
| 1 | Physical Layer | Transmits raw bit stream over the physical medium |

- **Application Layer:** The application layer is used by end-user software such as web browsers and email clients. It provides protocols that allow software to send and receive information and present meaningful data to users.
- **Presentation Layer :** The presentation layer prepares data for the application layer. It defines how two devices should encode, encrypt, and compress data so it is received correctly on the other end
- **Session Layer :** The session layer creates communication channels, called sessions, between devices
- **Transport Layer :** The transport layer takes data transferred in the session layer and breaks it into “segments” on the transmitting end.
- **Network Layer :** The network layer has two main functions. One is breaking up segments into network packets, and reassembling the packets on the receiving end
- **Data Link Layer :**

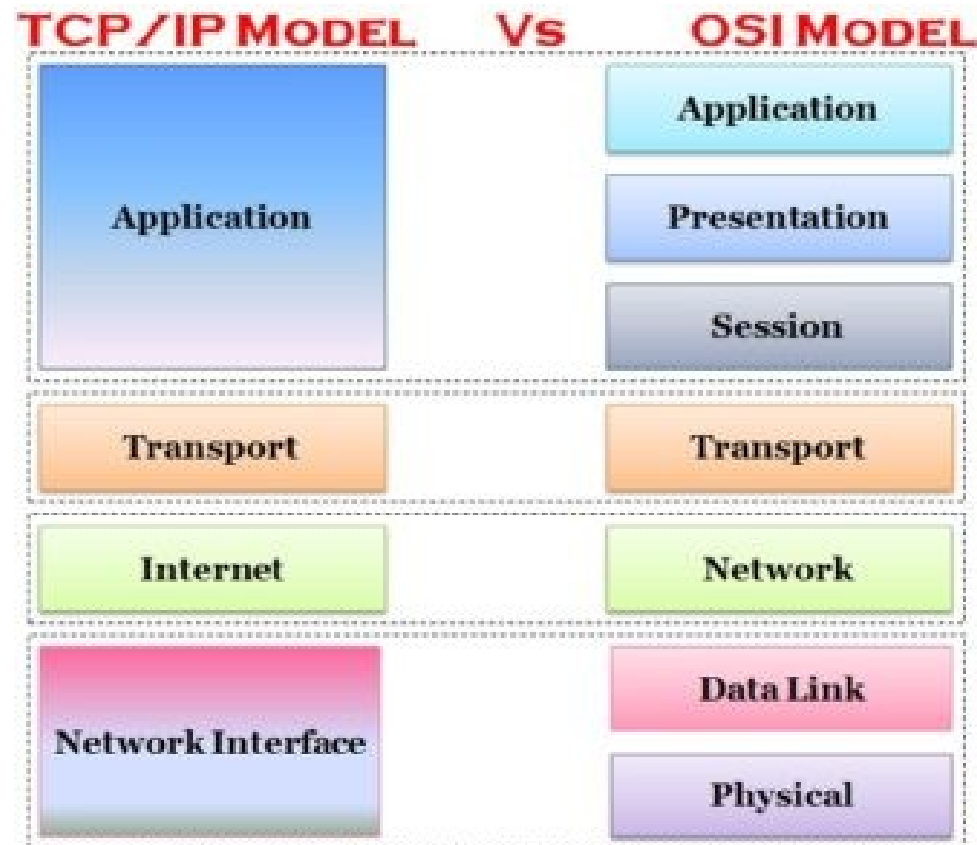
- **Data Link Layer** :The data link layer establishes and terminates a connection between two physically-connected nodes on a network. It breaks up packets into frames and sends them from source to destination. This layer is composed of two parts—Logical Link Control (LLC), which identifies network protocols, performs error checking and synchronizes frames, and Media Access Control (MAC) which uses MAC addresses to connect.
- **Physical Layer** : The physical layer is responsible for the physical cable or wireless connection between network nodes

Advantages of OSI Model

- The OSI model helps users and operators of computer networks:
 - Determine the required hardware and software to build their network.
 - Understand and communicate the process followed by components communicating across a network.
- Perform troubleshooting, by identifying which network layer is causing an issue and focusing efforts on that layer.

TCP/IP Model: Layers & Protocol

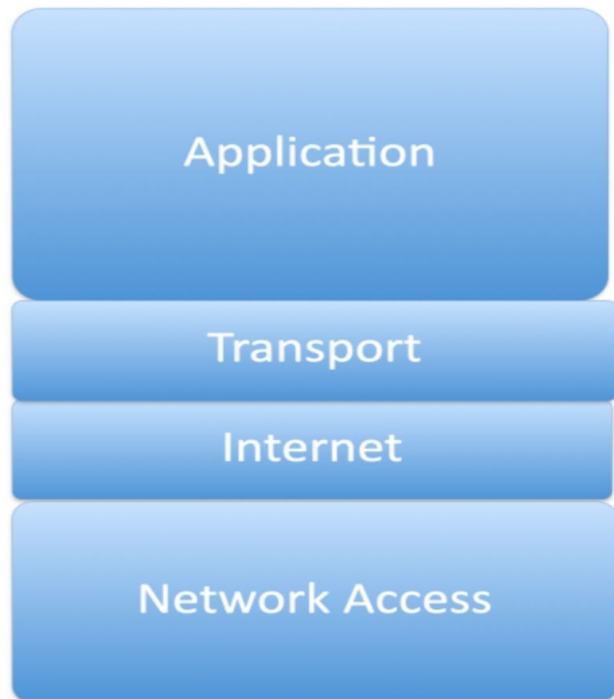
The TCP/IP model is a part of the Internet Protocol Suite. This model acts as a communication protocol for computer networks and connects hosts on the Internet. It is a concise version of the OSI Model and comprises four layers in its structure



Question 01

There are several variants of the TCP/IP Model, one of which is shown in the image. Which layers of the OSI Model are included in the TCP/IP Model's Network Access layer?

(TCP/IP Model)



Question 02

- The TCP/IP Model Application Layer combines which 3 OSI Model layers?

Question 03

- TCP and UDP reside at what layer of the OSI Model?

Question 04

- In the OSI model Which layer is concerned with physical addressing?

Network services

DHCP (Dynamic Host Configuration Protocol) is a protocol that provides quick, automatic, and central management for the distribution of IP addresses within a network. It's also used to configure the subnet mask, default gateway, and DNS server information on the device.

DNS (The Domain Name System (DNS) is the phonebook of the Internet. Humans access information online through domain names, like iit.ac.lk. Web browsers interact through Internet Protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources)

Network Address Translation (NAT) is an Internet standard that enables a local-area network (LAN) to use one set of IP addresses for internal traffic and a second set of addresses for external traffic. Developed by Cisco, the NAT process relies on a device (usually a router) to make all necessary IP address translations where the LAN meets the Internet.

- NAT serves three practical purposes:
- To provide a type of firewall by hiding internal IP addresses
- To enable a company to use more internal IP addresses
- To allow a company to merge multiple ISDN connections to form a single Internet connection

Ex 01

Network Address Translation (NAT)

