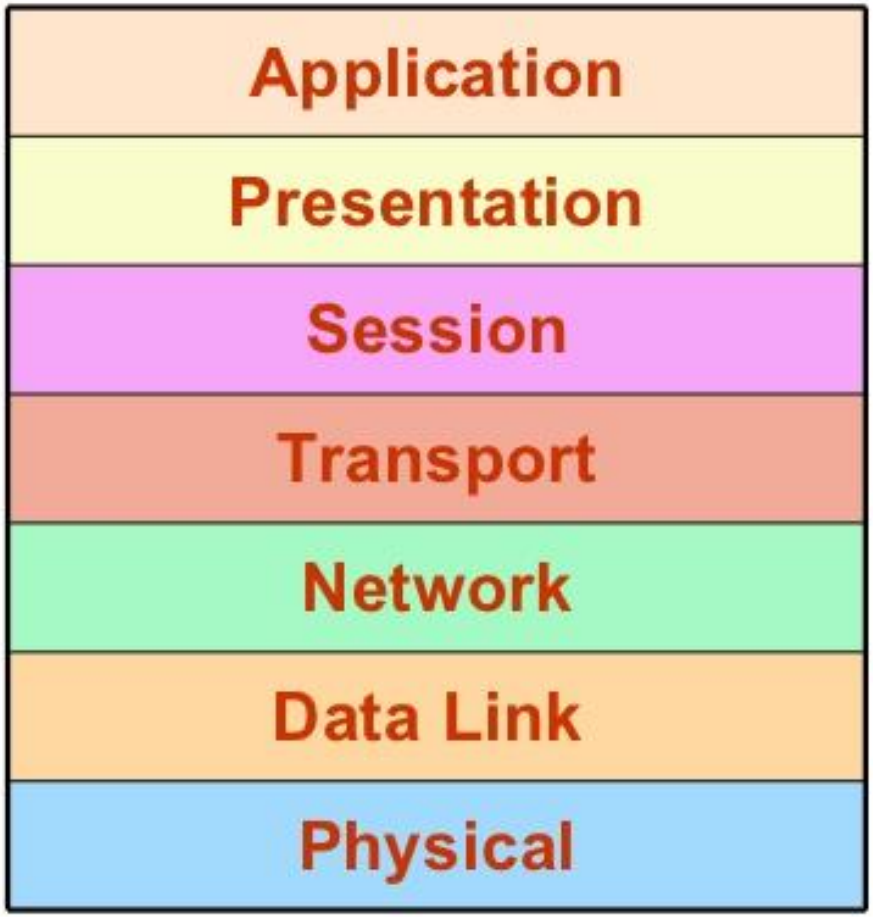
ISO/OSI Model in Communication Networks

There are n numbers of users who use computer network and are located over the world. So to ensure, national and worldwide data communication, systems must be developed which are compatible to communicate with each other. ISO has developed this. ISO stands for International organization of Standardization. This is called a model for Open System Interconnection (OSI) and is commonly known as OSI model.

The Layers of the OSI Model



The Layers of the OSI Model
Some Mnemonics

All **People** **Seem** **To** **Need** **Data** **Processing**

Please **Do** **Not** **Tell** **Secret** **Passwords** **Anytime**

Physical layer

- Specifications for the physical components of the network.
- Functions of Physical Layer:
  - Bit representation – encode bits into electrical or optical signals
  - Transmission rate – The number of bits sent each second
  - Physical characteristics of transmission media
  - Synchronizing the sender and receiver clocks
  - Transmission mode – simplex, half-duplex, full duplex
  - Physical Topology – how devices are connected – ring, star, mesh, bus topology

Data Link Layer

Responsible for delivery of data between two systems on the same network

Main functions of this layer are:

- Framing – divides the stream of bits received from network layer into manageable data units called frames.
- Physical Addressing – Add a header to the frame to define the physical address of the source and the destination machines.
- Flow control – Impose a flow control – control rate at which data is transmitted so as not to flood the receiver (Feedback-based flow control)
- Error Control – Adds mechanisms to detect and retransmit damaged or lost frames. This is achieved by adding a trailer to the end of a frame

Network Layer

Main functions of this layer are:

- Responsible for delivery of packets across multiple networks
- Routing – Provide mechanisms to transmit data over independent networks that are linked together.
- Network layer is responsible only for delivery of individual packets and it does not recognize any relationship between those packets

Transport Layer

Main functions of this layer are:

- Responsible for source-to-destination delivery of the entire message
- Segmentation and reassembly – divide message into smaller segments, number them and transmit. Reassemble these messages at the receiving end.
- Error control – make sure that the entire message arrives without errors – else retransmit.

Session Layer

Main functions of this layer are:

- Dialog control – allows two systems to enter into a dialog, keep a track of whose turn it is to transmit
- Synchronization – adds check points (synchronization points) into stream of data.

Presentation Layer

Responsibilities of this layer are:

- Translation
  - Different computers use different encoding systems (bit order translation)
  - Convert data into a common format before transmitting.
  - Syntax represents info such as character codes - how many bits to represent data – 8 or 7 bits
- Compression – reduce number of bits to be transmitted

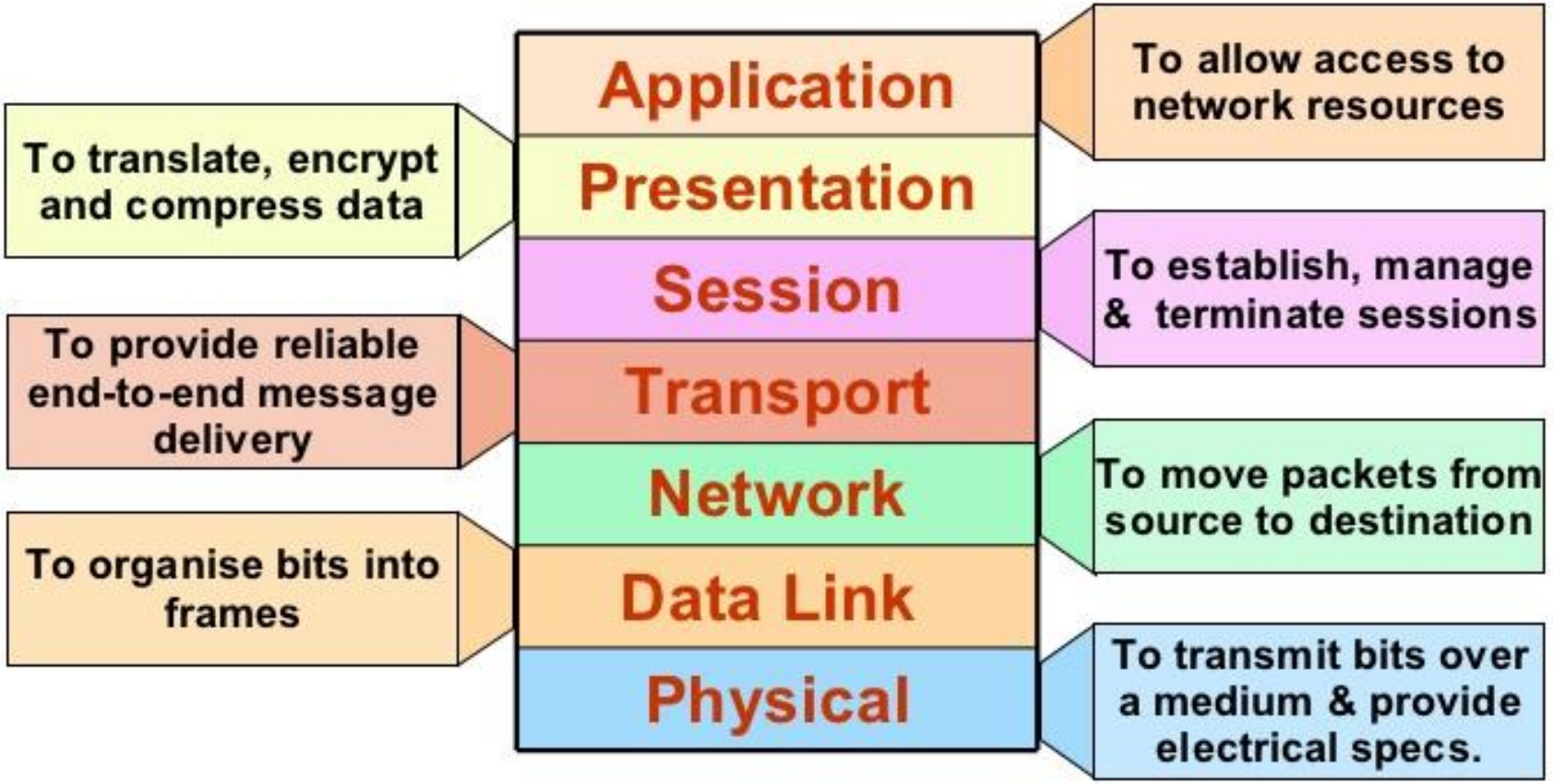
Presentation Layer

- Encryption – transform data into an unintelligible format at the sending end for data security
- Decryption – at the receiving end

Application Layer

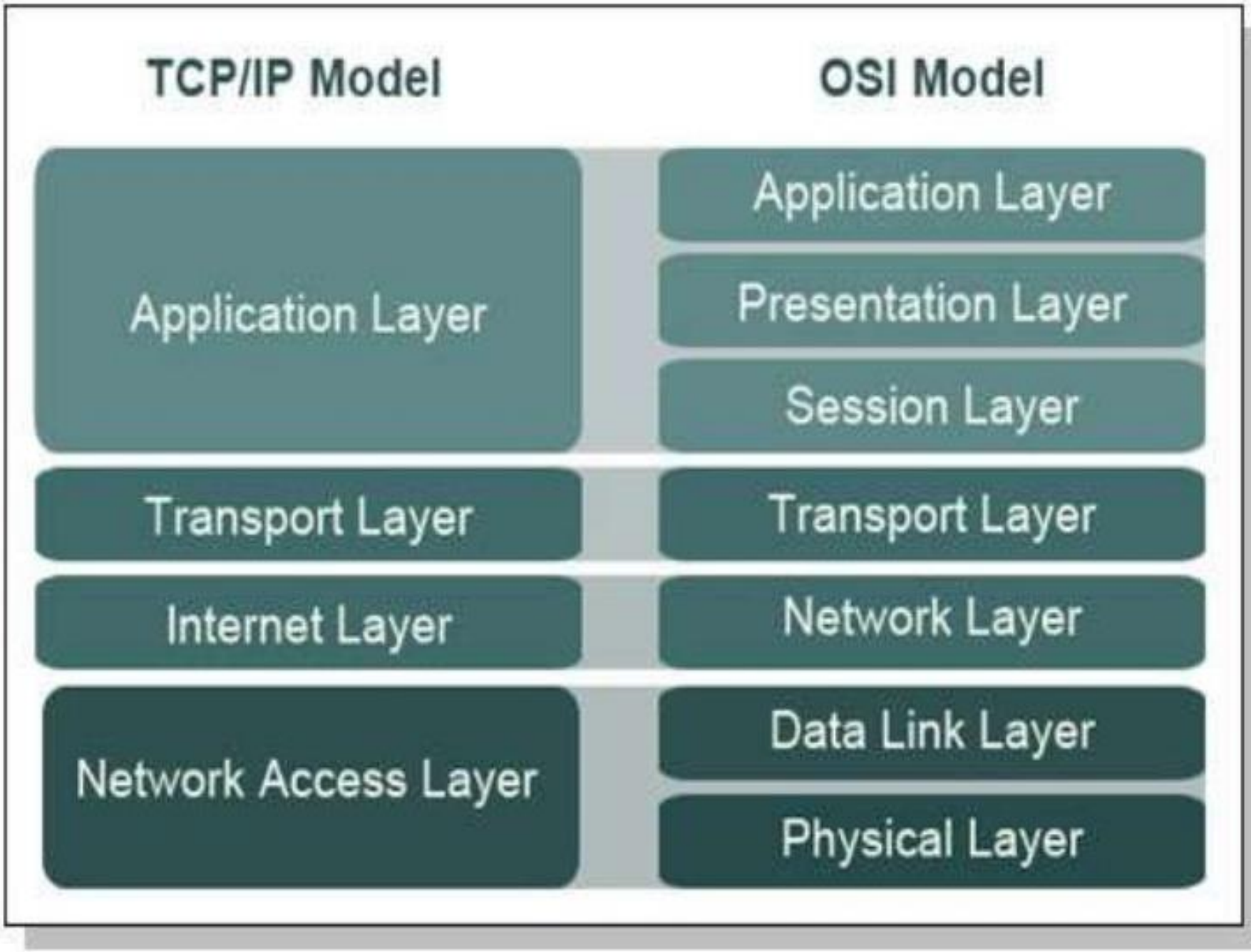
- Contains protocols that allow the users to access the network (FTP, HTTP, SMTP, etc)
- Does not include application programs such as email, browsers, word processing applications, etc.
- Protocols contain utilities and network-based services that support email via SMTP, Internet access via HTTP, file transfer via FTP, etc

Summary of Functions of Layers

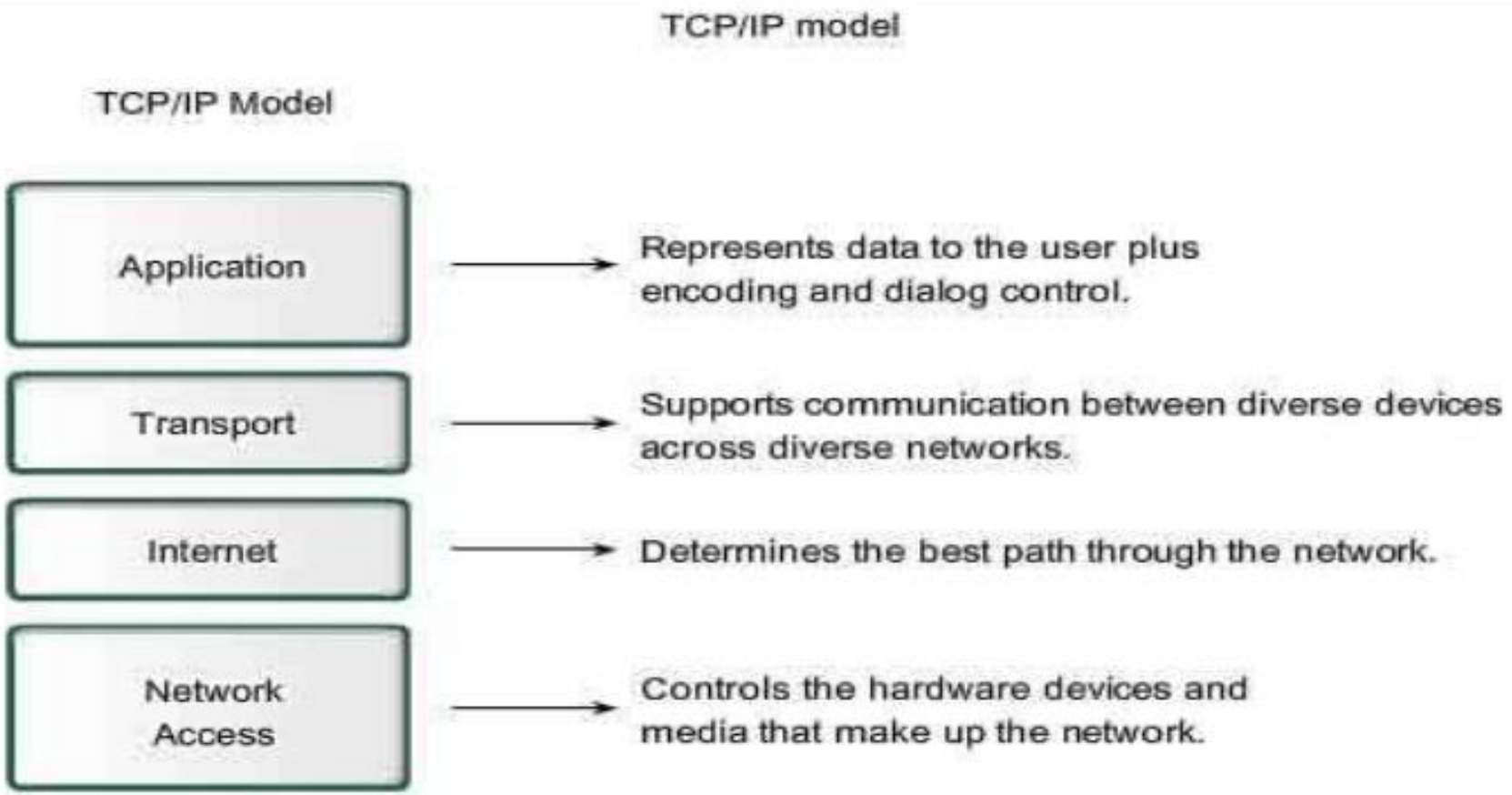


TCP/IP Model

- TCP/IP are two protocols of this model. TCP stands for Transmission Control Protocol and IP stands for Internet Protocol.
- There are 4 Layers in TCP/IP Model.


TCP/IP Model
OSI Model
Application Layer
Application Layer
Presentation Layer
Session Layer
Transport Layer
Transport Layer
Internet Layer
Network Layer
Network Access Layer
Data Link Layer
Physical Layer

TCP/IP model


TCP/IP Model
Application
Represents data to the user plus encoding and dialog control.
Transport
Supports communication between diverse devices across diverse networks.
Internet
Determines the best path through the network.
Network Access
Controls the hardware devices and media that make up the network.

Application Layer

- The Application Layer in TCP/IP groups the functions of OSI Application, Presentation Layer and Session Layer.
- Functions:
  - Refers to standard network services
  - Also defines compatible representation of all data

Transport Layer

- In TCP/IP architecture, there are two Transport Layer protocols. The Transmission Control Protocol (TCP) guarantees information transmission
- **Functions:**
  - Manages the transfer of data
  - Manages the connections between networked applications

Internet Layer

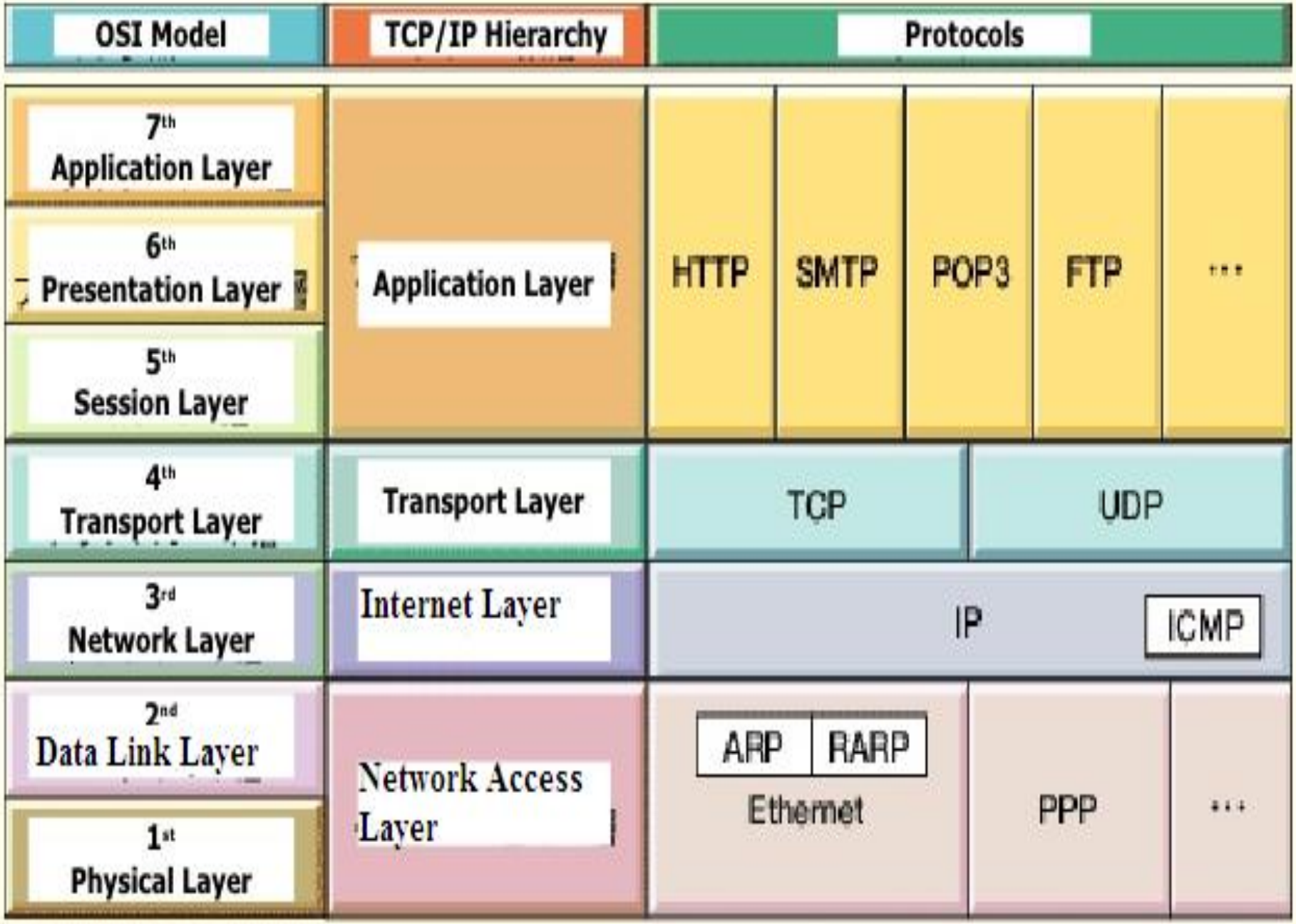
- The Internet Protocol (IP) is the primary protocol in the TCP/IP Network Layer.
- **Functions:**
  - Manages addressing of packets and delivery of packets between networks
  - Fragments packets so that they can be dealt with by lower level layer

Network Layer

- In the TCP/IP architecture, the Data Link Layer and Physical Layer are normally grouped together to become the Network Access layer
- **Functions:**
  - Delivers data via physical link
  - Provides error detection and packet framing

OSI Model vs.TCP/IP Model

- The OSI model consists of 7 architectural layers whereas the TCP/IP only has 4 layers.
- OSI is a reference model and TCP/IP is an implementation of OSI model.
- The OSI model however is a "generic, protocol-independent standard.


OSI Model
TCP/IP Hierarchy
Protocols
7th Application Layer
6th Presentation Layer
5th Session Layer
Application Layer
HTTP
SMTP
POP3
FTP
...
4th Transport Layer
Transport Layer
TCP
UDP
3rd Network Layer
Internet Layer
IP
ICMP
2nd Data Link Layer
1st Physical Layer
Network Access Layer
ARP
RARP
Ethernet
PPP
...

Internet Protocol (IP)

- The Internet Protocol (IP) is the method or protocol by which data is sent from one computer to another on the Internet. Each computer (known as a host) on the Internet has at least one IP address that uniquely identifies it from all other computers on the Internet.
- IP specifies the format of packets, also called datagrams, and the addressing scheme. Most networks combine IP with a higher-level protocol called Transmission Control Protocol (TCP), which establishes a virtual connection between a destination and a source.

Transmission Control Protocol

- TCP is a connection-oriented protocol. It is one of the most used protocols in digital network communications and is part of the Internet protocol suite, commonly known as the TCP/IP suite.
- Primarily, TCP ensures end-to-end delivery of data between distinct nodes. TCP works in collaboration with Internet Protocol, which defines the logical location of the remote node, whereas TCP transports and ensures that the data is delivered to the correct destination.
- Before transmitting data, TCP creates a connection between the source and destination node and keeps it live until the communication is active. TCP breaks large data into smaller packets and also ensures that the data integrity is intact once it is reassembled at the destination node.

USER DATAGRAM PROTOCOL (UDP)

- The User Datagram Protocol (UDP) is called a connectionless, unreliable transport protocol. UDP is widely used in video conferencing and real-time computer games. The protocol permits individual packets to be dropped and UDP packets to be received in a different order than that in which they were sent, allowing for better performance.
- UDP network traffic is organized in the form of datagrams, which comprise one message units. The first eight bytes of a datagram contain header information, while the remaining bytes contain message data. A UDP datagram header contains four fields of two bytes each:
  - Source port number
  - Destination port number
  - Datagram size
  - Checksum

ICMP

The IP protocol has no error-reporting or error-correcting mechanism. The IP protocol also lacks a mechanism for host and management queries. The **Internet Control Message Protocol (ICMP)** has been designed to compensate for the above two deficiencies. It is a companion to the IP protocol.

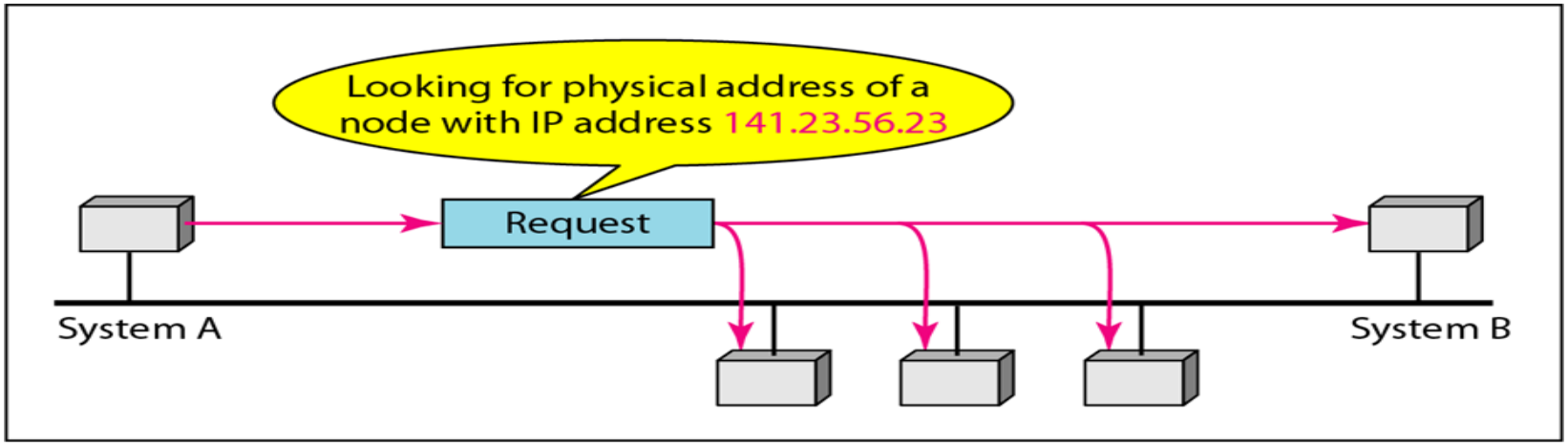
ADDRESS MAPPING

The delivery of a packet to a host or a router requires two levels of addressing: logical and physical. We need to be able to map a logical address to its corresponding physical address and vice versa. This can be done by using either static or dynamic mapping.

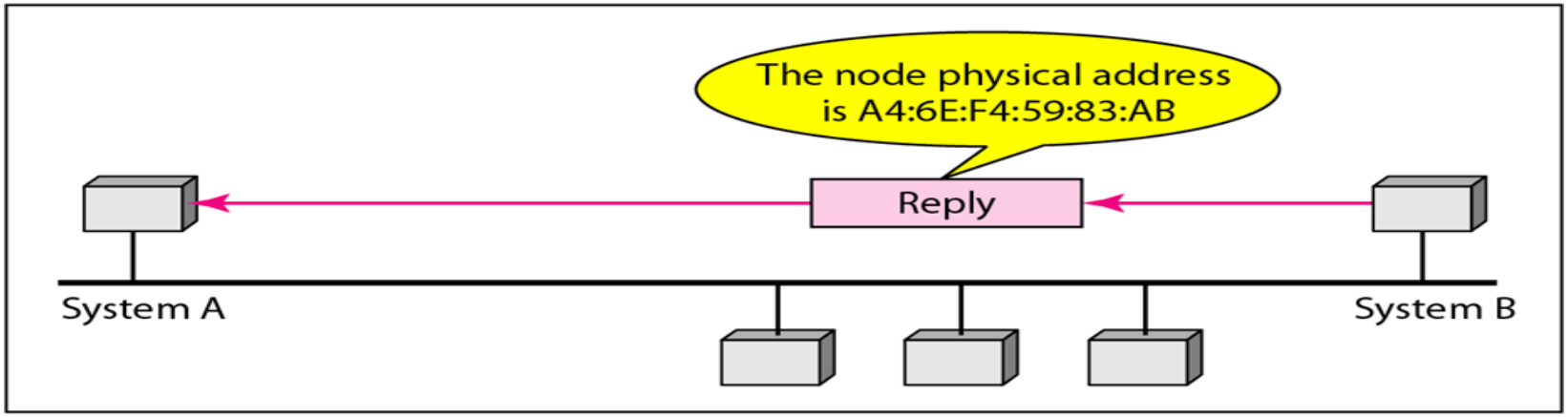
Address Resolution Protocol (ARP)

- ARP is a protocol used for mapping an IP address to a computer connected to a local network LAN.
- Since each computer has a unique physical address called a MAC address, the ARP converts the IP address to the MAC address. This ensures each computer has a unique network identification.
- The Address Resolution Protocol is used when information sent to a network arrives at the gateway, which serves as the entrance point to the network.
- The gateway uses the ARP to locate the MAC address of the computer based on the IP address the data is being sent to.

ARP operation



a. ARP request is broadcast



b. ARP reply is unicast

Reverse Address Resolution Protocol (RARP)

- RARP (Reverse Address Resolution Protocol) is a protocol by which a physical machine in a local area network can request to learn its IP address from a gateway server's Address Resolution Protocol (ARP) table or cache.
- A network administrator creates a table in a local area network's gateway router that maps the physical machine (or Media Access Control - MAC address) addresses to corresponding Internet Protocol addresses.

Ethernet Address or MAC Address

- Every NIC has a hardware address that's known as a MAC, for Media Access Control OR Ethernet address. Where IP addresses are associated with TCP/IP (networking software), MAC addresses are linked to the hardware of network adapters.

- A MAC address or Ethernet address is given to a network adapter when it is manufactured. It is hardwired or hard-coded onto your computer's network interface card (NIC) and is unique to it. Something called the ARP (Address Resolution Protocol) translates an IP address into a MAC address.