MODULE-1: Introduction to Networking

VIT | Vidyalankar Institute of Technology

Accredited A+ by NAAC

Prepared by Prof. Amit K. Nerurkar

Module 1 Introduction to OSI Model

DESIGN ISSUES FOR THE LAYERS

i) Addressing

- For every layer, it is necessary to have a mechanism to identify senders and receivers.
- Since there are multiple possible destinations, some form of addressing is needed in order to specify a specific destination.

ii) Direction of Transmission

- Based on whether the system communicates only in one direction or otherwise i.e. complex, Half-duplex systems, Full-duplex systems.

iii) Error control

- Because physical communication circuits are not perfect.
- Error detection and correction both are essential.

iv) Avoid less of sequencing

- All the communication channels cannot preserve the order in which messages are sent on it.
- So there is a possibility of loss of sequencing.
- To avoid this, all the pieces should be numbered so that they can be put back together at the receiver in the appropriate sequence.

v) Ability of receiving long messages

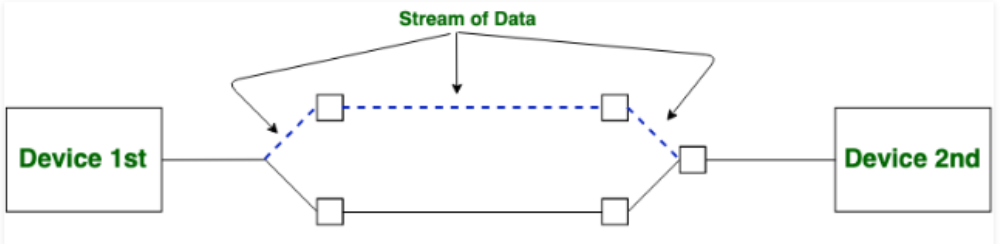
- At several levels, another problem should be solved which is inability of all processes to accept arbitrarily long messages.
- So a mechanism needs to the developed to dissemble transmit and then reassemble messages.

vi) To use multiplexing and demultiplexing

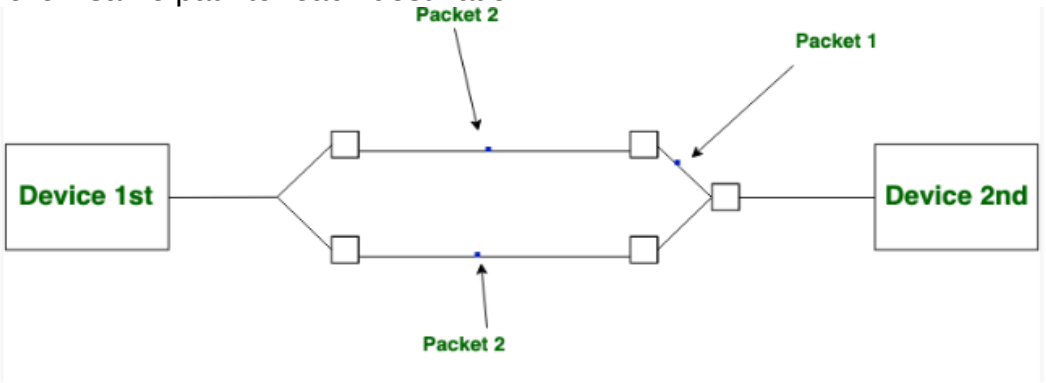
- Multiplexing and demultiplexing is to be used to share the same channel by many sources simultaneously.
- It can be used for any layer, multiplexing is needed in the physical layer.

CONNECTION ORIENTED AND CONNECTIONLESS SERVICES.

Connection-oriented service is related to the telephone system. It includes the connection establishment and connection termination. In connection-oriented service, Handshake method is used to establish the connection between sender and receiver.



Connection-less service is related to the postal system. It does not include any connection establishment and connection termination. Connection-less Service does not give the guarantee of reliability. In this, Packets do not follow same path to reach destination.



Parameter	Connection-oriented Service	Connectionless Service
1. Initial setup prior to transfer of information	Required	Not required or not possible
2. Destination Address	Only required during initial setup of connection	Required on every packet because they are routed independently.
3. Connection Release	After the end of a call	After every packet
4. Transfer capability	Can transfer both a stream of information in which the individual bits or bytes are not grouped into blocks.	Involves the transfer of clearly defined blocks of information.
5. Probability of errors, loss or incorrect delivery	Less	More
6. Applications in which preferred	Audio and Video	Text data

REFERENCE MODELS:

Layer details of OSI,

An ISO (International Standard Organization) that covers all aspects of network
Communications is the open systems interconnection model.
ISO is the organization. OSI is the model.

- The OSI model is a layered framework for the design of network systems that allows communications between all types of computer systems. It consist of seven separate but related layers, each of which defines a part of the process of moving information across a network.

Application
Presentation
Session
Transport
Network
Data Link
Physical

Seven layers of the OSI model

- The seven layers can be thought of as belonging to three sub-groups.

Layers 1, 2, 3 – physical, data link and network → Network Support layers

Network support layer deals with physical aspects of moving data from one device to another (such as electrical specifications, physical connections, physical addressing transport timing and reliability).

Layers 5, 6, 7 – Session, presentation and applications – User support layers, they allow inter-operability among unrelated software systems.

Layer 4, the transport layer, links the two subgroups.

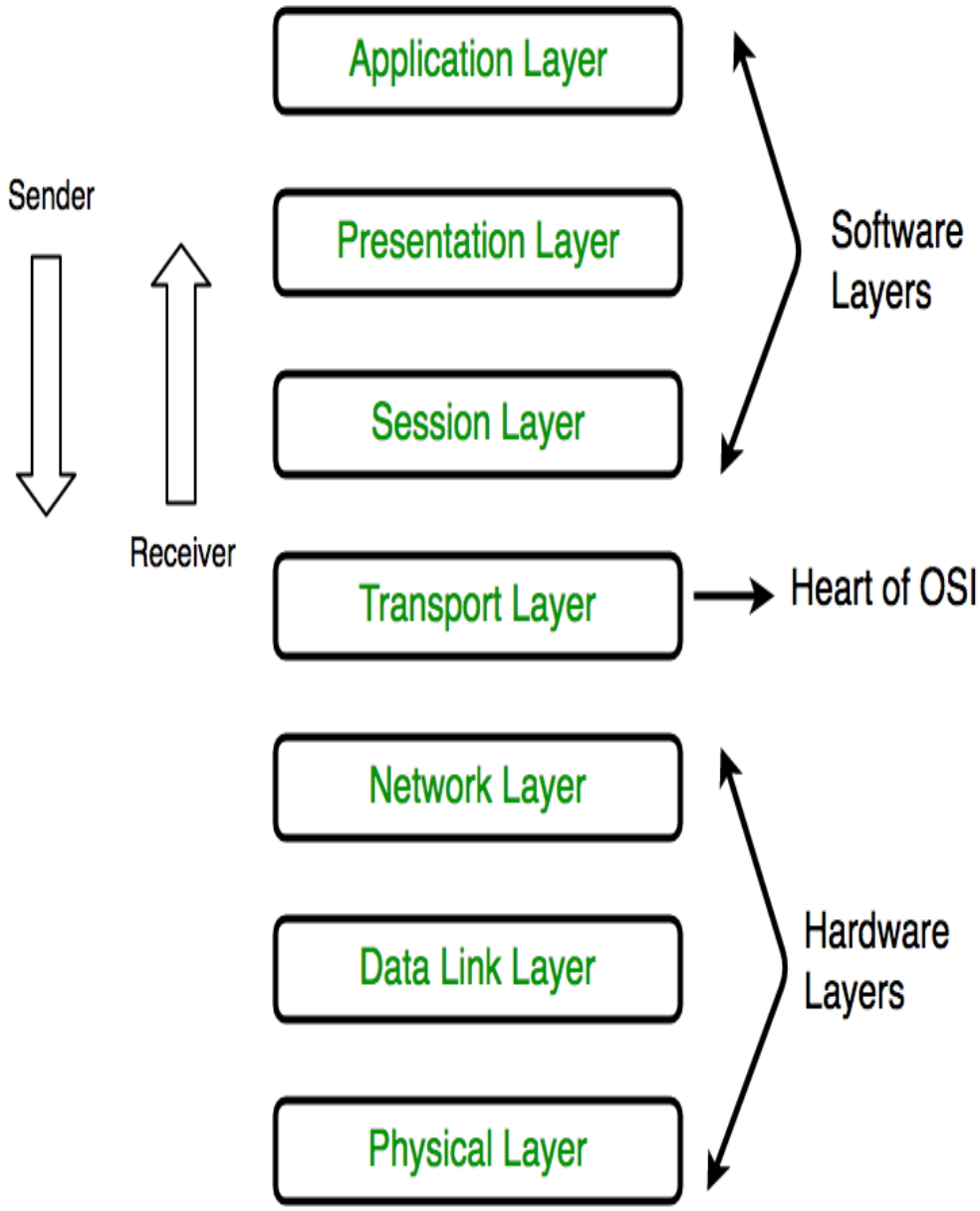


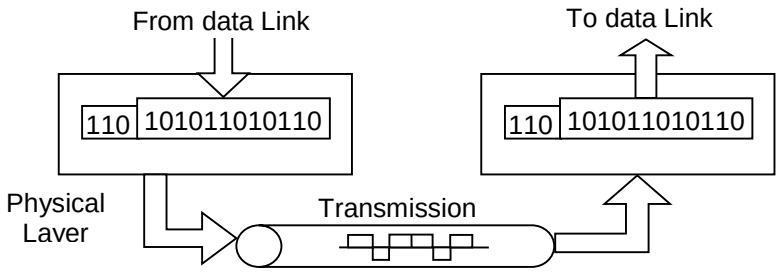
Image Source: https://media.geeksforgeeks.org/wp-content/uploads/computer-network-osi-model-layers.png

1. Physical Layer

- It is responsible for movements of individual bits from one hop (node) to the next.

Functions

i) To activate, maintain and deactivate the physical connection.
ii) To define voltages and data rates needed for transmission.
iii) To convert digital bits into electrical signal.
iv) To decide whether the transmission is simplex, half-duplex or full-duplex.
v) A physical layer is concerned with the connection of devices to the media (Line configuration).
vi) It also defines the physical topology.
vii) It also helps in synchronization of bits.



[Passive hubs, Simple active hubs, Terminators, Couplers, Cable, Connectors, Repeaters, multiplexers, transmitters and receivers are associated with physical layer.]

2. Data Link Layer

- The data link layer transforms the physical layer, a raw transmission facility to a reliable link.
- It is responsible for moving frames from one hop (node) to the next i.e. Hop-to-Hop delivery.

Functions

i) Framing : The layer divides the stream of bits received from the network layer into manageable data units called frames.
ii) Physical Addressing : It adds a header to the frame to define the physical address of the sender and / or receiver of the frame.
iii) Flow control : It provides a flow control mechanism to avoid a fast transmitter from over-running a slow receiver by buffering the extra bits.

iv) **Error control :** It is achieved by adding a trailer at the end of the frame. It also uses a mechanism to prevent duplication of frames.

v) **Access control :** The layer determines which device has control over the link at any given time, when two or more devices are connected to the same link.

3. Network Layer

- The network layer is responsible for the delivery of individual packets from the source host to the destination host i.e. End-to-End delivery or source to destination delivery.
- If two systems are connected on the same link, there is no need for a network layer.

Function

i) It translates logical network address into physical machine address i.e. the numbers used as destination IDs in the physical network cards.

ii) It determines the quality of service by deciding the priority of message and then route a message will take if there are several ways a message can get to its destination.

iii) It breaks the larger packets into smaller packets if the packet is larger than the largest data frame the data link will accept.

iv) Routers and gateways operate in the network layer.

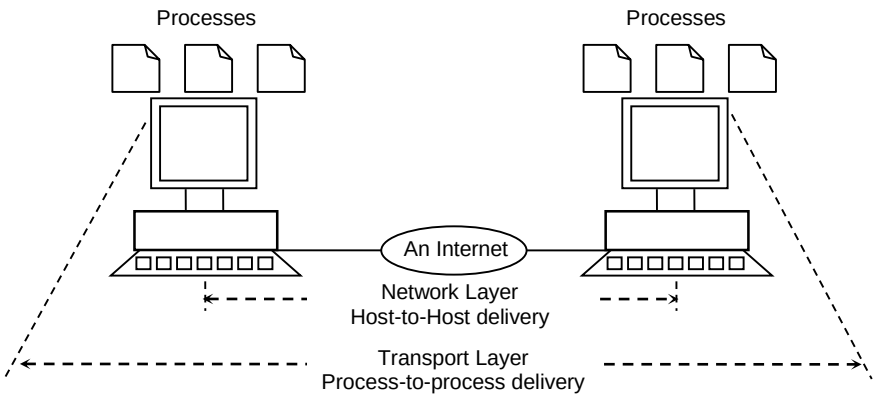
4. Transport Layer

- It is responsible for process-to-process delivery of the entire message i.e. source to destination delivery of the entire message.
- It ensures that the whole message arrives intact and in order, ensuring both error control and flow control at source destination level.

Functions :

i) **Segmentation and re-assembly :** It divides each message into packets at the source and reassembles than at the destination.

ii) **Service point addressing :** The transport layer header H4 includes service point address to deliver a specific process from source to a specific process at the destination.



iii) **Connector control :** The layer can be either connectionless or connection oriented.

iv) **Flow control :** It provides end-to-end flow control rather than across a single link.

v) **Error control :** It ensures that the entire message arrives at the receiving transport layer without error.

5. Session layer

- It is responsible for dialog control and synchronization i.e. it is network dialog controller.
- It establishes maintains and synchronizes the interaction among communicating systems.

Functions

i) **Dialog control :** The session layer allows two systems to enter into a dialog. It allows the communication between two processes to take place in either half-duplex or full-duplex mode.

ii) **Synchronization :** It allows a process to add checkpoints or synchronization points, to a stream of data. In case of crash, during the transmission of the data can be retransmitted from the checkpoint inspite of retransmitting it from the start.

– It is not inherently concerned with security and network logon process.

6. Presentation layer

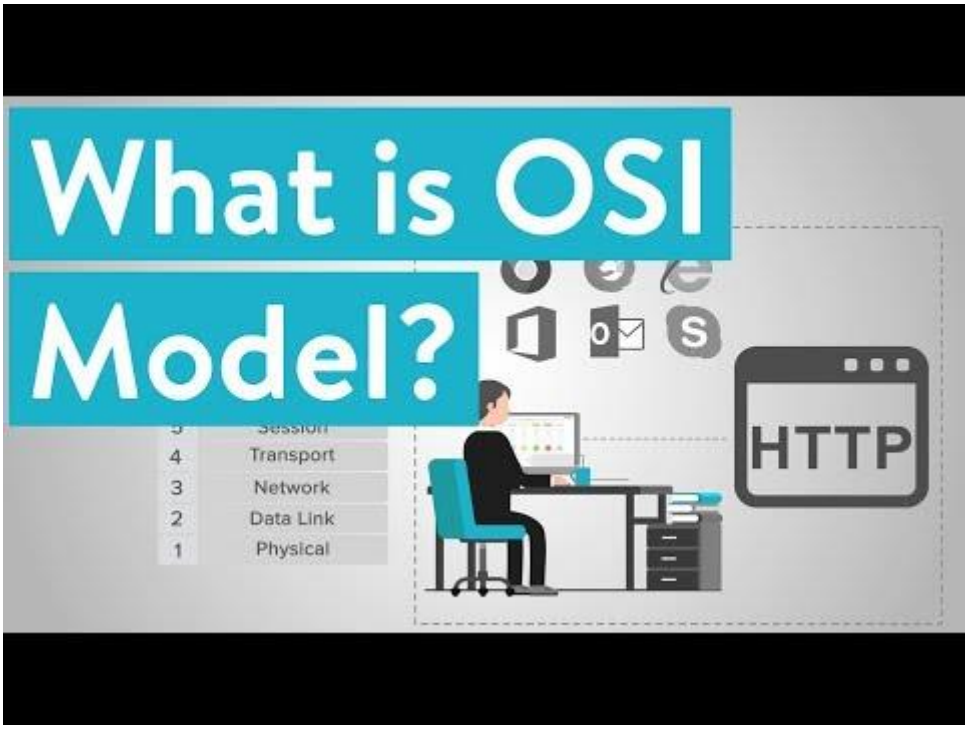
- It is responsible for translation, compression and encryption.
- It is concerned with the syntax and semantics of the information exchanged between two systems.

7. Application layer

- It is responsible for providing services to the user.
- It provides services that directly support user application such as database access, e-mail, and file transfer.

VIDEO

What is OSI Model?

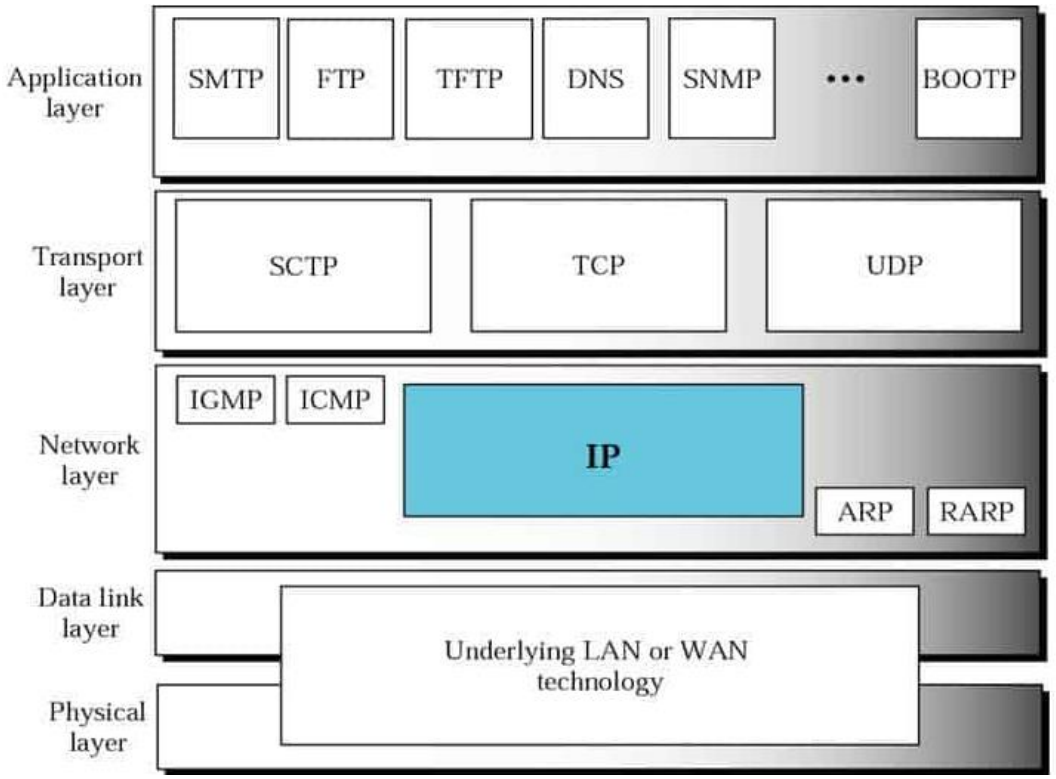


TCP/IP REFERENCE MODEL.

Transmission Control Protocol and the Internet Protocol (TCP/IP) was developed by the Department of Defense's Project Research Agency (ARPA, later DARPA) under its project on network interconnection.

- It is a set of protocols that allow communication across multiple diverse network and it is protocol of the Internet.
- This protocols describe the movement of data between the host computers on Internet.
- The protocol however is suite of many other protocols which provide for reliable communications across the internet and the web.

The figure below shows TCP/IP reference model along with the OSI model used for comparison.



The TCP/IP model has only four layers.

i) Host to network layer

- This is the lowest layer in TCP/IP reference model.
- The host has to connect to the network using some protocol. So that it can send the IP packets over it.
- This protocol varies from host to host and network to network.

ii) Internet layer

- The layer is called internet layer and it holds the whole architecture together.
- It is responsible for the transfer of information across different networks through the use of routers or gateways.
- One important function of the internet layer is the definition of globally unique addresses for machines that are connected to the internet.
- Internet Protocol (IP) packets are called datagram because they are routed independently when they are exchanged between routers. The connectionless approach for IP packets makes the system robust because if failures occur in a particular path, the packet may be routed through another path.
- The internet layer defines a packet format and a protocol called internet protocol (IP).
- TCP/IP internet layer is very similar to the network layer in OSI model as shown in the figure.

iii) Transport layer

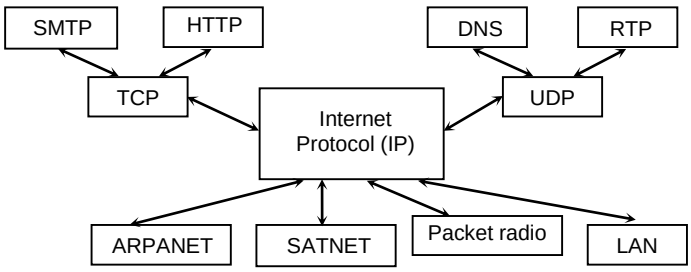
- This is the layer above the internet layer. Its functions are same as those of a transport layer in OSI layer.
- This layer allows peer entities of the source and destination machine to converse with each other.
- The transport layer offers two basic types of services. The first service offered consists of connectionless transfer of individual messages which is provided by the User Datagram Protocol (UDP). The second service offered consists of reliable connection-oriented transfer of data which is provided by the Transmission Control Protocol (TCP).
- The UDP does not provide error recovery and flow control. It is used for applications that require quick delivery of messages.

- The Hyper Text Transfer Protocol [HTTP] and SMTP operate over TCP, whereas Domain Name System (DNS), Real Time Protocol operate over UDP.
- The gateways that interconnect the intermediate networks may discard packets when congestion occurs and the responsibility for recovery from these lost packets is to be carried out by the transport layer.

iv) Application layer

- The layer on top of transport layer is called as application layer.
- The protocols related to this layer are all high-level protocols such as virtual terminal (TELNET), File Transfer (FTP) and Electronic Mail (SMTP).
  - SMTP (Simple Mail Transfer Protocol) provides a basic e-mail facility i.e. mechanism for transferring messages among separate hosts.
  - FTP is used to send files from one system to another system under user common.
  - TELNET provides a remote logon capability, which enables a user at terminal or PC to log on to a remote computer and function as if directly connected to that computer.
  - In TCP/IP model the application layer has the option of bypassing intermediate transport layer and directly run over the internet layer.

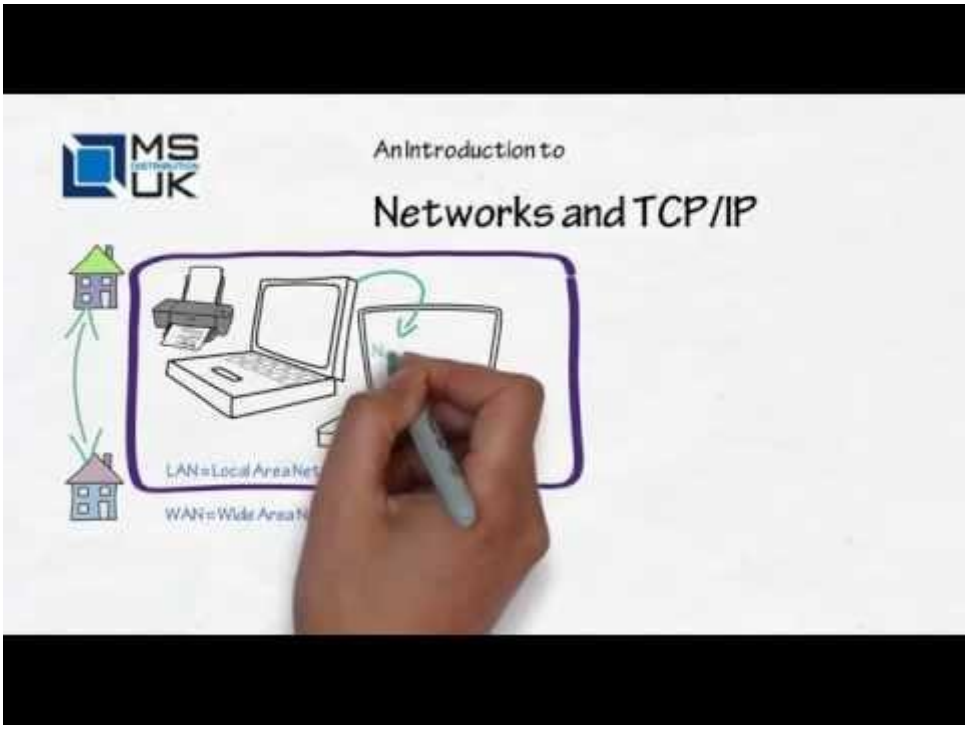
Application layer	TELNET, FTP, SMTP, DNS, HTTP, NNTP
Transport	TCP, UDP
Internet (Network)	IP
Host-to-network	ARPANET, SATNET, LAN, packet radio



Protocols and Networks in the TCP/IP model

VIDEO

AN INTRODUCTION TO TCP/IP



COMPARISON OF OSI AND TCP/IP REFERENCE MODEL.

Similarities

i) Both models are based on the concept of a stack of independent protocols. They roughly have the same functionality.

ii) The layers above transport are application oriented users of the transport service.

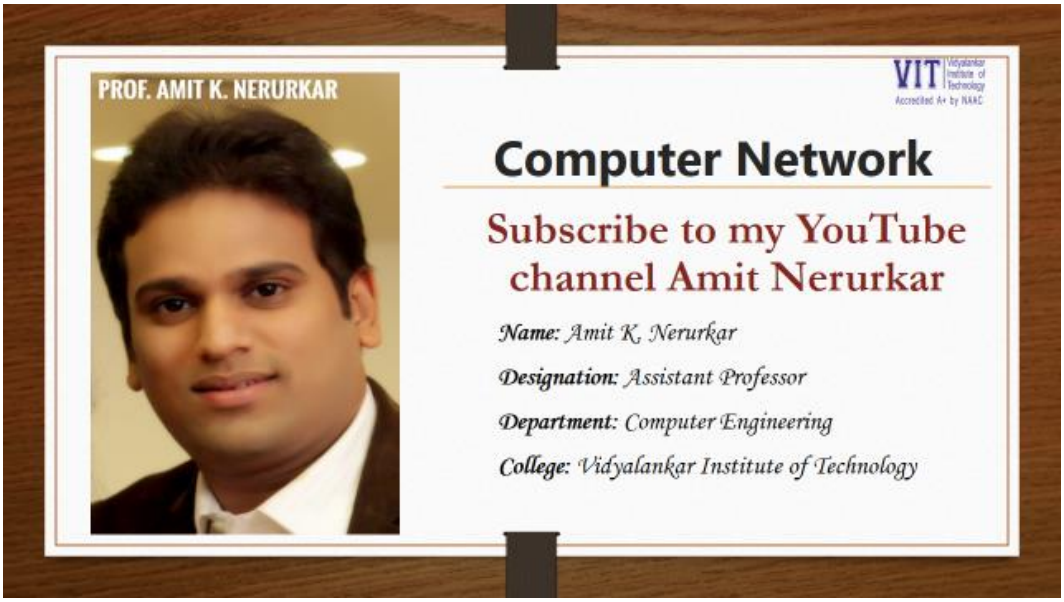
They both use the concept of layered architecture.

Differences

	OSI	TCP/IP
1.	It has 7 layers.	It has 4 layers.
2.	It defines the services, interfaces and protocols very clearly and makes a clear distinction between them.	It does not clearly distinguish between service, interfaces and protocols.
3.	The protocols are hidden and can be easily replaced as the technology changes.	It is not easy to replace protocols.
4.	The OSI reference model was devised before the corresponding protocols were invented.	Where as TCP/IP the reverse has true; the protocols came first and the model was description of the existing protocols.
5.	It has problem of protocol fitting into a model.	The model does not fit any other protocol stack.
6.	The OSI model supports both connection-oriented and connectionless communication in the network layers, but only connection oriented communication in the transport layer.	The TCP/IP model has only one mode in the network layer (connectionless) but supports both modes in the transport layer.

References

1. TCP/IP Protocol Suite by Fourozan
2. Computer Networks by Tanenbaum
3. https://www.geeksforgeeks.org/difference-between-connection-oriented-and-connection-less-services/



Subjects Taught by Amit K. Nerurkar

1. C programming
2. Data Structure
3. Computer Network
4. Network Security
5. Artificial Intelligence
6. Soft Computing
7. Distributed Systems
8. Internet of Things
9. Linux Administration
10. Database Management System