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Data Communication and Computer Networks(SEng2092)

Chapter 5:
OSI Reference Model

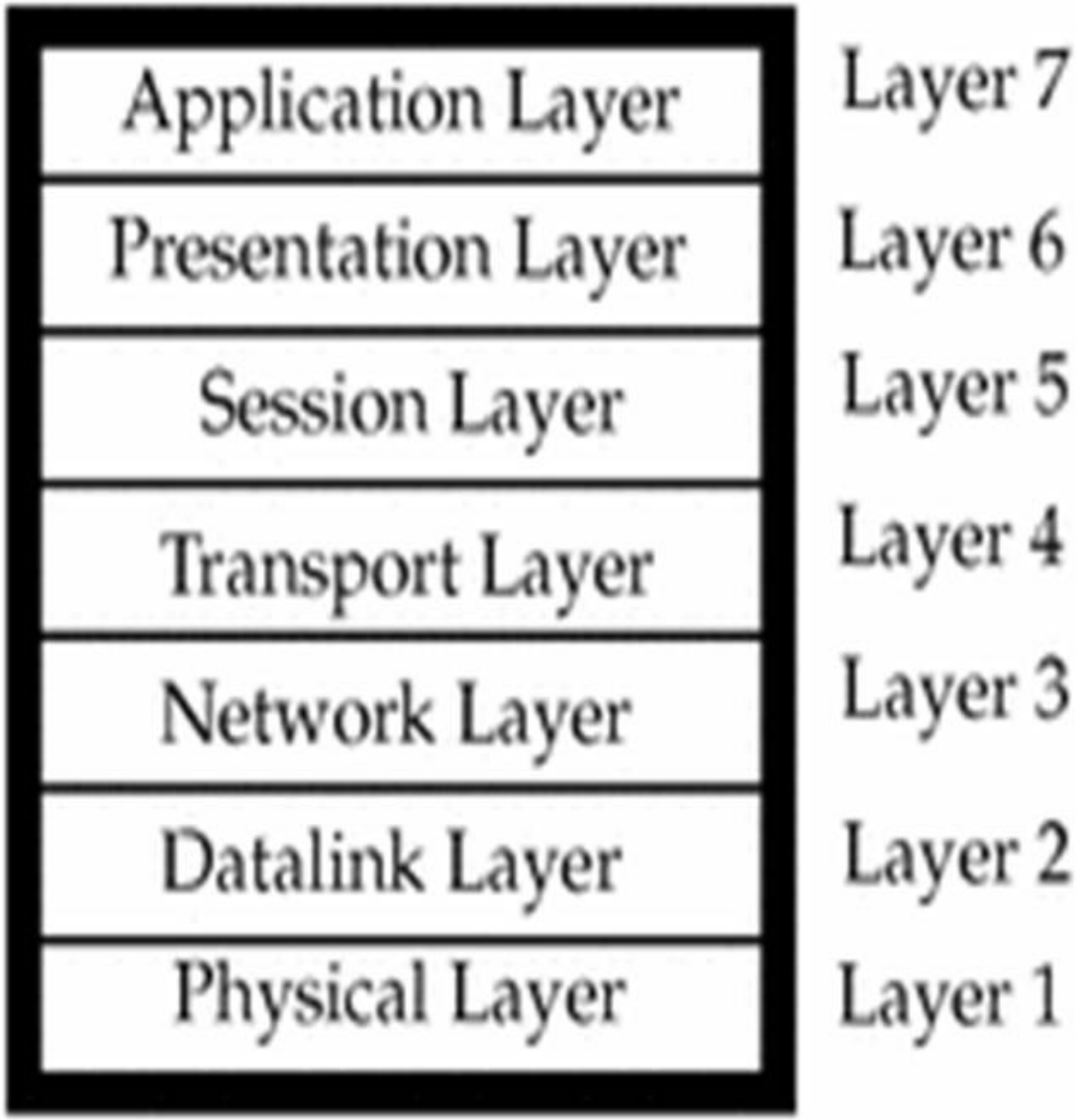
2.1 What is OSI Reference model?

- The Open System Interconnection (**OSI**) model defines a networking **framework** to implement protocols in seven **layers**.
- OSI (Open Systems Interconnection) is a reference model for how applications communicate over a network.

OSI Reference Model

- A reference model is a conceptual framework for understanding relationships. The purpose of the OSI reference model is to guide vendors and developers so the digital communication products and software programs they create Communication and to facilitate a clear framework that describes the functions of a networking.

Layered Framework of OSI



SEVEN LAYERS OF OSI REFERENCE MODEL

1. Physical Layer:
   - physical layer is the bottom layer of the OSI reference model. The physical layer has four important characteristics.

   1, Mechanical. Relates to the physical properties of the interface to a transmission medium. Typically, the specification is of a pluggable connector that joins one or more signal conductors, called circuits.

Physical layer

2, Electrical:-Relates to the representation of bits (e.g., in terms of voltage levels) and the data transmission rate of bits.

3, Functional:- Specifies the functions performed by individual circuits of the physical interface between a system and the transmission medium.

4, Procedural:- Specifies the sequence of events by which bit streams are exchanged across the physical medium.

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The physical layer has the following major functions

- It defines the electrical and physical specifications of the data connection. It defines the relationship between a device and a physical transmission medium (e.g., a copper or fiber optical cable).
- It defines the protocol to establish and terminate a connection between two directly connected nodes over a communications medium.
- it may define the protocol for flow control.
- it defines a protocol for the provision of a (not necessarily reliable) connection between two directly connected nodes,

2. Data Link Layer:

- The data link layer provides reliable transmission of data (frames) between adjacent nodes, built on top of a raw and unreliable bit transmission service provided by the physical layer.
  standards of the Institute of Electrical and Electronics Engineers (IEEE) 802 separate the data-link layer into two sub layers:

Data Link Layer:

1,Logical Link Control(LLC)

2,Media Accesses Control(MAC)

1,Logical Link Control (LLC) layer:- the upper of the two layers, which is responsible for flow control, error correction, and address notification for connection-oriented communication.

2,Media Accesses Control(MAC)

✓(MAC) layer the lower of the two layers which Determines which computer has access to the network media at any given time

✓Determines where one frame ends and the next one starts, called frame synchronization

Function of Data Link Layer

- Framing. The data link layer divides the stream of bits received from the network layer into manageable data units called frames.
- Physical addressing. If frames are to be distributed to different systems on the network, the data link layer adds a header to the frame to define the sender and/or receiver of the frame. If the frame is intended for a system outside the sender's

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network, the receiver address is the address of the device that connects the network to the next one.

- Flow control. If the rate at which the data are absorbed by the receiver is less than the rate at which data are produced in the sender, the data link layer imposes a flow control mechanism to avoid over whelming the receiver.

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- Error control. The data link layer adds reliability to the physical layer by adding mechanisms to detect and damaged or lost frames. It also uses a mechanism to recognize duplicate frames.
- Access control. When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time

3. Network Layer:

- The network layer provides the functional and procedural means of transferring variable length data sequences (datagrams) from one node to another connected to the same *network.*
- Layer 3 of the Open Systems Interconnection (OSI) reference model have the following function.
  Establishing and releasing connections and paths between two nodes on a network
- Transferring data generating and confirming receipts, and resetting connections

4. Transport Layer:

- Layer 4 of the Open Systems Interconnection (OSI) reference model The transport layer is responsible for providing reliable transport services to the upper-layer protocols. These services include the following:
- Flow control to ensure that the transmitting device does not send more data than the receiving device can handle.

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- Packet sequencing for segmentation of data packets and remote reassembly.
- Error handling and acknowledgments to ensure that data is retransmitted when required.
- Multiplexing for combining data from several sources for transmission over one data path.
- Virtual circuits for establishing relation to sessions communicating stations.

5. Session Layer:

- Layer 5 of the Open Systems Interconnection (OSI) reference model, which enables sessions between computers
  on a network to be established and terminated.
- The session layer does not concern itself with issues such as the reliability and efficiency of data transfer between stations because these functions are provided by the first four layers of the OSI reference model.
- The session layer handles session setup, data or message exchanges, and tears down when the session ends.

Functions:

Therefore session layer functionality includes

- Dialog control: The session layer has the option of providing one-or-two-way communication called dialogue control.
  It allows the communication between two processes to take place in either half- duplex (one way at a time) or full-duplex (two ways at a time)mode.

Functions:

- Creation of dialog units
- Connection parameter negotiations
- Partitioning of services into functional groups.
- Retransmission of data if it is not received by a device
- Acknowledgments of data received during a session

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6. Presentation Layer:

- The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems

  Specific responsibilities of the presentation layer include the following characteristic:-

- Character code translation: for example, ASCII to EBCDIC.

  Data compression: reduces the number of bits that need to be transmitted on the network.

- Data encryption: encrypt data for security purposes. For example, password encryption.

- Data conversion: bit order, integer-floating point, and so on.

Characterstics

- Encryption To carry sensitive information, a system must be able to ensure privacy. Encryption means that the sender transforms the original information to another form and sends the resulting message out over the network.

charactertics:

Decryption reverses the original process to transform the message back to its original form.

- Compression Data compression reduces the number of bits contained in the information. Data compression becomes particularly important in the transmission of multimedia such as text, audio, and video.

7. Application layer:

- Layer 7 of the Open Systems Interconnection (OSI) reference model, in which network-aware, user-controlled software is implemented.
- This layer supports application and end-user processes.
- Communication partners are identified, quality of service is identified, user authentication and privacy are considered, and any constraints on data syntax are identified.

for example, e-mail, file transfer utilities, and terminal access.

- The application layer represents the window between the user and the network.

Examples of protocols that run at the application layer include File Transfer Protocol (FTP), Hypertext Transfer Protocol (HTTP), telnet, and similar protocols that can be implemented as utilities the user can interface with.

7. Application layer:

- File transfer, access, and management. This application allows a user to access files in a remote host (to make changes or read data), to retrieve files from a remote computer for use in the local computer, and to manage or

  control files in a remote computer locally.

Generally OSI model many benefits which include:

A, Compatibility: The OSI model can fit to any compatible software/hardware from different users in other parts of the world. As software/hardware differs among various users so OSI is a model that is compatible to all.

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B, Easy Troubleshooting: Since each layer in an OSI is independent of each other so it makes it easier to detect and solve all errors prevailing in it**.**

C, Easy Understanding Nature: OSI model is very interactive and even guides us to know what a Model is, how it operates, and common methodologies, how new technologies are developed in existing networks.

D, Security: OSI model have functionality for Encryption and Decryption which has a major contribution for security purpose. This makes it Reliable.

E. Add Multiple Network Models: The OSI model is designed in such a way that user can further extend**.**

Summery about OSI reference model

Summary:

- Physical Layer: How to transmit bits
- Data Link Layer: How to transmits frames
- Network: How to route packets to the node.
- transport: How to send packets to the applications.
- Session: Manage connections ,session setup, message.
- Presentation: Encode/Decode messages, security.
- Application: Everything else.

Bits, Datagram, packet & Frames

bits

- Bit is the basic unit of information in computing in digital communication.
- Bit can transmit one bit at a time in serial transmission and multiple number of bit can transmit in parallel transmission
- Physical layer responsible for the transmission of bits from one nod to the next node.

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Bits, Datagram, packet & Frames

Frames

- Packets in the Data Link Layer are called *frames*.
- A frame has markers to show the beginning and end of the packet as well as addresses for sending and receiving.

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Bits, Datagram, packet & Frames
Packets

- Frames in Internet Protocol (IP) are called *packets*.
- Packets are used primarily on the Network layer so their role is to deliver a packet from one logical address (in the case of IP, an IP address) to another.
- The IP packet header is the header used by routers to send packets through the network from source to destination so understanding the IP packet also gives a brief introduction to the basic concept of routing.

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Bits, Datagram, packet & Frames

Datagrams

- A *datagram* is the general word for a packet that is over a connectionless transport protocol. That is, the transmission, timing, and order are not guaranteed.
  For example, a packet sent over User Datagram Protocol(UDP) is a datagram.
- A datagram contains a header and a payload (with the data to be communicated). In UDP, the header contains source *port number* and
  a destination port number.

Bits, Datagram, packet & Frames

A port number is simply a number that identifies some process using network resources.

When a packet is sent, it is sent out “through” this abstract port and when a packet is received, it is accepted through a port.

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Bits, Datagram, packet & Frames

. Physical signalling and encoding

The three fundamental functions of the Physical layer are:

- The physical components
- Data encoding
- Signaling
- The physical elements are the electronic hardware devices, media and connectors that transmit and carry the signals to represent the bits.

Encoding

- Encoding is a method of converting a stream of data bits into a predefined code.
- Codes are groupings of bits used to provide a predictable pattern that can be recognized by both the sender and the received. Using predictable patterns helps to distinguish data bits from control bits and provide better media error detection.

Bits, Datagram, packet & Frames

Signalling

- The Physical layer must generate the electrical, optical, or wireless signals that represent the "1" and "0" on the media.
- The method of representing the bits is called the signalling method.
- The Physical layer standards must define what type of signal represents a "1" and a "0". This can be as simple as a change in the level of an electrical signal or optical pulse or a more complex signalling method..

Bits, Datagram, packet & Frames

Bits are represented on the medium by changing one or more of the following characteristics of a signal:

- Amplitude
- Frequency
- Phase