OSI REFERENCE MODEL

2.1 OBJECTIVES

The objective of this chapter is to familiarize with : -

i) Concept of data encapsulation

ii) Characteristics of the OSI Layers

iii) OSI Model and Communication Between Systems

iv) OSI layers

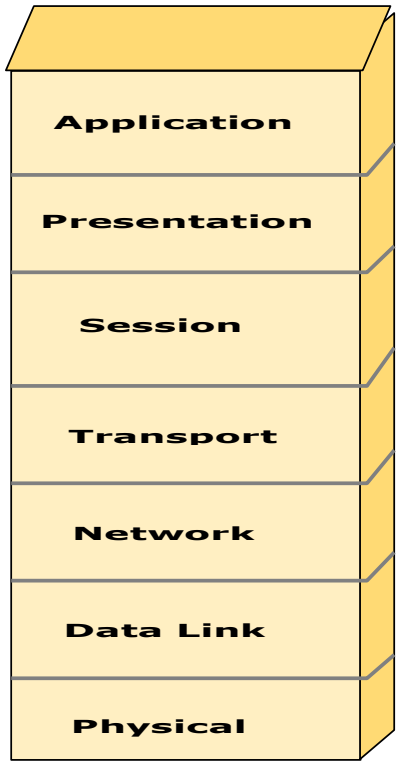
2.2 INTRODUCTION

The International Organization introduced the OSI layer for Standardization (ISO) in 1984 in order to provide a reference model to make sure products of different vendors would interoperate in networks. OSI is short for Open System Interconnection.

The OSI layer shows WHAT needs to be done to send data from an application on one computer, trough a network, to an application on another computer, not HOW it should be done. A layer in the OSI model communicates with three other layers: the layer above it, the layer below it, and the same layer at its communication partner. Data transmitted between software programs passes all 7 OSI layers. The Application, Presentation and Session layers are also known as the Upper Layers.

The Data Link and Physical layers are often implemented together to define LAN and WAN specifications.

- **Data Encapsulation**
- **Application Layer**
- **Presentation Layer**
- **Session Layer**
- **Transport Layer**
- **Network Layer**
- **Data Link Layer**
- **Physical Layer**



2.2 DATA ENCAPSULATION

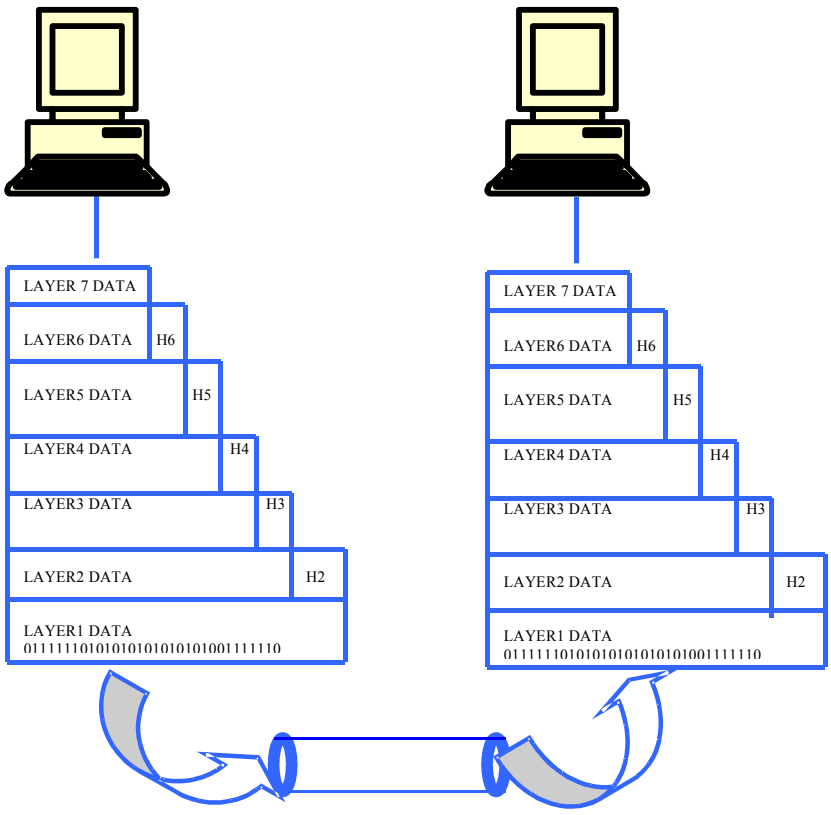
Data Encapsulation is the process of adding a header to wrap the data that flows down the OSI model. Each OSI layer may add it's own header to the data received from above. (from the layer above or from the software program 'above' the Application layer.)

There are five steps of Data Encapsulation : -

1. The Application, Presentation and Session layers create DATA from users' input.
2. The Transport layer converts the DATA to SEGMENTS
3. The Network layer converts the SEGMENTS to PACKETS (or datagrams)
4. The Data Link layer converts the PACKETS to FRAMES
5. The Physical layer converts the FRAMES to BITS.

At the sending computer the information goes from top to bottom while each layers divides the information received from upper layers in to smaller pieces and adds a header. At the receiving computer the information flows up the model discarding the corresponding header at each layer and putting the pieces back together.

The Figure shows layered model of two directly interconnected end systems. The transmission media is not included in the seven layers and, therefore, it can be regarded as layer number zero. Functions and services of various layers are described



2.3 CHARACTERISTICS OF THE OSI LAYERS

The seven layers of the OSI reference model can be divided into two categories: upper layers and lower layers.

The upper layers of the OSI model deal with application issues and generally are implemented only in software. The highest layer, the application layer, is closest to the end user. Both users and application layer processes interact with software applications that contain a communications component. The term upper layer is sometimes used to refer to any layer above another layer in the OSI model.

The lower layer*s* of the OSI model handle data transport issues. The physical layer and the data link layer are implemented in hardware and software. The lowest layer, the physical layer, is closest to the physical network medium (the network cabling, for example) and is responsible for actually placing information on the medium.

PROTOCOLS

The OSI model provides a conceptual framework for communication between computers, but the model itself is not a method of communication. Actual communication is made possible by using communication protocols. In the context of data networking, a *protocol* is a formal set of rules and conventions that governs how computers exchange information over a network medium. A protocol implements the functions of one or more of the OSI layers. A wide variety of communication protocols exist. Some of these include:

LAN protocols operate at the physical and data link layers of the OSI model and define communication over the various LAN media.

WAN protocols operate at the lowest three layers of the OSI model and define communication over the various wide-area media.

Routing protocols are network layer protocols that are responsible for exchanging information between routers so that the routers can select the proper path for network traffic.

Network protocols are the various upper-layer protocols that exist in a given protocol suite. Many protocols rely on others for operation.

For example, many routing protocols use network protocols to exchange information between routers. This concept of building upon the layers already in existence is the foundation of the OSI model.

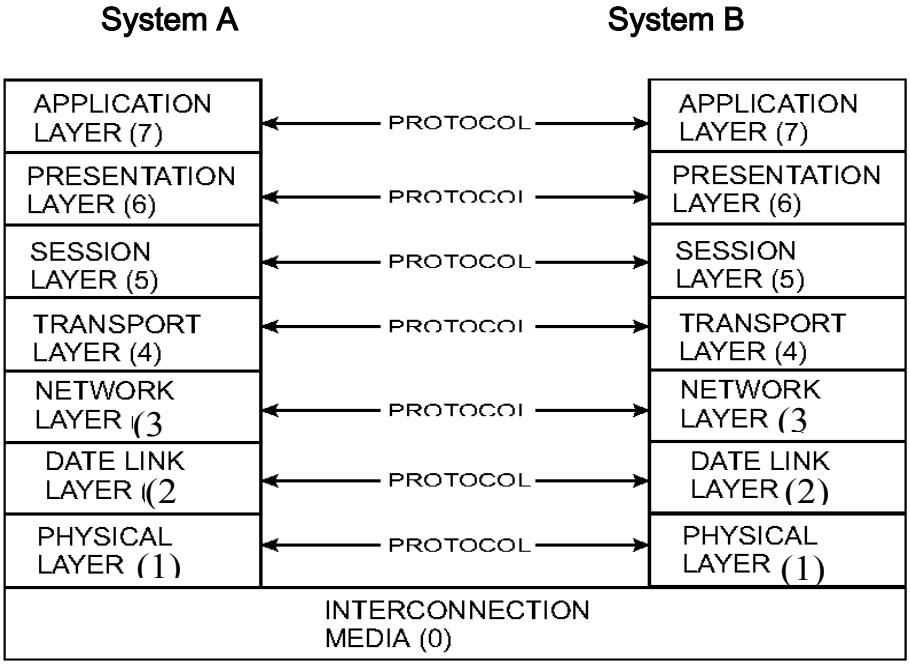
2.4 OSI MODEL & COMMUNICATION BETWEEN SYSTEMS

Information being transferred from a software application in one computer system to a software application in another must pass through the OSI layers. For example, if a software application in System A has information to transmit to a software application in System B. The application program in System A will pass its information to the application layer (Layer 7) of System A.

The application layer then passes the information to the presentation layer (Layer 6), which relays the data to the session layer (Layer 5), and so on down to the physical layer (Layer 1). At the physical layer, the information is placed on the physical network medium and is sent across the medium to System B. The physical layer of System B removes the information from the physical medium, and then its physical layer passes the information up to the data link layer (Layer 2), which passes it to the network layer (Layer 3), and so on, until it reaches the application layer (Layer 7) of System B. Finally, the application layer of System B passes the information to the recipient application program to complete the communication process.

2.5 INTERACTION BETWEEN OSI MODEL LAYERS

A given layer in the OSI model generally communicates with three other OSI layers: the layer directly above it, the layer directly below it, and its peer layer in other networked computer systems. The data link layer in System A, for example, communicates with the network layer of System A, the physical layer of System A, and the data link layer in System B. Figure below illustrates this example.



OSI LAYER SERVICES

One OSI layer communicates with another layer to make use of the services provided by the second layer. The services provided by adjacent layers help a given OSI layer communicate with its peer layer in other computer systems. Three basic elements are involved in layer services: the service user, the service provider, and the service access point (SAP).

In this context, the *service user* is the OSI layer that requests services from an adjacent OSI layer. The *service provider* is the OSI layer that provides services to service users. OSI layers can provide services to multiple service users. The SAP is a conceptual location at which one OSI layer can request the services of another OSI layer.

Application Layer (Layer 7)

Application Layer provides network services directly to applications. Type of software programs vary a lot: from groupware and web browser to Tactical Ops (video game). Software programs itself are not part of the OSI model. It determines the identity and availability of communication partners, and determines if sufficient resources are available to start program-to-program communication. This layer is closest to the user. Gateways operate at this layer. Following are the examples of Application layer protocols:

i) Telnet
ii) SMTP
iii) FTP
iv) SNMP
v) NCP
vi) SMB

Presentation Layer (Layer 6)

Presentation Layer defines coding and conversion functions. It ensures that information sent from the application layer of one system is readable by the application layer of another system. It includes common data representation formats, conversion of character representation formats, common data compression schemes, and common data encryption schemes, common examples of these formats and schemes are:

i) MPEG, QuickTime
ii) ASCII, EBCDIC
iii) GIF, TIFF, JPEG

Gateways operate at this layer. It transmits data to lower layers.

Session Layer (Layer 5)

The session layer establishes, manages, maintains and terminates communication channels between software programs on network nodes. It provides error reporting for the Application and Presentation layer. Examples of Session layer protocols are:

i) NFS
ii) SQL
iii) RPC
iv) Zone Information Protocol (ZIP)

Gateways operate at this layer. It transmits data to lower layers.

Transport Layer (Layer 4)

The main purpose of this layers is making sure that the data is delivered error-free and in the correct sequence. It establishes, maintains and terminates virtual circuits. It provides error detection and recovery. It is concerned with reliable and unreliable

transport. When using a connection-oriented, reliable transport protocol, such as TCP, acknowledgments is send back to the sender to confirm that the data has been received. It provides Flow Control and Windowing. It provides multiplexing; the support of different flows of data to different applications on the same host. Examples of Transport layer protocols are:

i) TCP (connection-oriented, reliable, provides guaranteed delivery.)

ii) UDP (connectionless, unreliable, less overhead, reliability can be provided by the Application layer)

iii) SPX

Gateways operate at this layer. It transmits data to lower layers.

Network Layer (Layer 3)

This layer defines logical addressing for nodes and networks/segments. It enables internetworking, passing data from one network to another. It defines the logical network layout so routers can determine how to forward packets trough an internet-work. Routing occurs at this layer, hence Routed and Routing protocols reside on this layer. Routed protocols are used to encapsulate data into packets. The header added by the Network layer contains a network address so it can be routed trough an internet-work. Examples of Network layer Routed protocols are:

i) IP

ii) IPX

iii) AppleTalk

Routing protocols are used to create routing tables; routing tables are used to determine the best path / route. Routing protocols provide periodic communication between routers in an Internet work to maintain information on network links in a routing table. It transmits Packets. Routers operate at this layer. Examples of Network layer Routing protocols are:

i) OSPF

ii) IGRP/EIGRP

iii) RIP

iv) BGP

v) NLSP

Data Link Layer (Layer 2)

It defines psychical addressing, network topology, and is also concerned with error notification, sequencing of frames and flow control. Examples of network topologies are:

i) Star

ii) Bus

iii) Ring

Physical addresses are also known as hardware and BIA's (Burned In Addressess) but most commonly as MAC addresses. Examples of Data Link LAN specifications are:

i) Ethernet

ii) Fast Ethernet

iii) Token Ring

iv) FDDI

Examples of Data Link WAN specifications are:

i) Frame Relay (operates also on the Physical layer)

ii) PPP (operates also on the Physical layer)

iii) X.25 (operates also on the Physical and Network layer)

Data Link layer Transmits Frames. Bridges and Switches operate at this layer.The Data Link layer consists of two sub-layers:

- LCC (Logical Link Control) Layer

  Manages communication between devices over a single link of a network. Enables multiple higher-layer protocols to share a single physical data link.

- MAC Layer

  Manages protocol access to the physical network medium and determines hardware addresses.

Physical Layer (Layer 1)

The physical layer defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the physical link between communicating network systems. It transmits and receives bits (bit stream) to transmission media. Physical layer specifications define characteristics such as:

- Voltage levels
- Timing of voltage changes
- Physical data rates
- Maximum transmission distances
- Physical connectors

Physical layer implementations can be categorized as either LAN or WAN specifications. The examples of LAN and WAN specifications are given below: -

LAN specifications

i) Ethernet

ii) Fast Ethernet

iii) Token Ring

iv) FDDI

WAN specifications are:

i) HSSI

ii) V.24

iii) V.35

iv) BRI

v) SLIP

vi) RS-232

The core of this standard is the OSI Reference Model, a set of seven layers that define the different stages that data must go through to travel from one device to another over a network.

2.6 SUMMARY

The core of this standard is the OSI Reference Model, a set of seven layers that define the different stages that data must go through to travel from one device to another over a network. Think of the layers as the assembly line in the computer. At each layer, certain things happen to the data that prepare it for the next layer. The seven layers, which separate into two sets, are:

- Application Set:
- Layer 7: Application - This is the layer that actually interacts with the **operating system** or application whenever the user chooses to transfer files, read messages or perform other network-related activities.
- Layer 6: Presentation - Takes the data provided by the Application layer and converts it into a standard format that the other layers can understand.
- Layer 5: Session - Establishes, maintains and ends communication with the receiving device.
- Transport Set:
- Layer 4: Transport - This layer maintains flow control of data and provides for error checking and recovery of data between the devices. Flow control means that the Transport layer looks to see if data is coming from more than one application and integrates each application's data into a single stream for the physical network.
- Layer 3: Network - The way that the data will be sent to the recipient device is determined in this layer. Logical **protocols**, **routing** and **addressing** are handled here.
- Layer 2: Data - In this layer, the appropriate physical protocol is assigned to the data. Also, the type of network and the **packet sequencing** is defined.
- Layer 1: Physical - This is the level of the actual hardware. It defines the physical characteristics of the network such as connections, voltage levels and timing