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An Analysis of Open System Interconnection Reference Model

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ABSTRACT

The Open Systems Interconnection model (OSI) is a conceptual model that characterizes and standardizes the internal functions of a communication system by partitioning it into abstraction layers. The OSI model depicts how data communications should take place. It splits the functions or processes into seven groups that are defined in different types of layers.

Keywords: OSI, Model, Layers, Data, Process, IP, ANSI, IEEE

INTRODUCTION:

It OSI stands for Open System Interconnection. It is a reference model. The OSI model is a framework and reference model to explain how different networking technologies work together and interact.OSI is created by International Standards Organization (ISO) in 1984. The OSI model is a layer architecture and layer protocols and it has 7 layers. It beginning with the "Lowest" in the hierarchy (physical) and proceeding to the "Height" (Application) [1]. The lower 4 layer (Transport, Network, Data Link and Physical –Layer 4, 3, 2 and 1) are concerned with flow of data from end to end through the network. The upper 3 layer of the OSI model, Application, Presentation and Session-Layer 7, 6 and 5 are oriented more toward services to the application.

OSI Reference model includes seven layers

Physical Layer

The Physical Layer, the lowest layer of the OSI model. It described the electrical/ optical, mechanical and functional interfaces to the physical medium and the carries the signals for all of the higher layers. Example: FDDI, RJ45, V.35, V.24, Ethernet, etc.

Data Link Layer

The Data Link Layer provides error-free transfer of data frames from one node to another over the Physical Layer. It handles errors in the Physical layer. Example: PPP, FDDI, ATM, Frame Relay.

Network Layer

This Layer provides switching and routing technologies, creating logical paths known ad virtual circuits, for transmitting data from node to node. Example: Apple Talk DDP, IP, IPX.

Transport Layer

This layer provides transparent transfer of data between end systems or hosts. Example: TCP,

Session Layer

This Layer establishes, manages and terminates connection between applications. Example: NFS, SQL, RPC.

Presentation Layer

The Presentation Layer formats the data to be presented to the application layer. Example: ASCII, TIFF, GIF, JPEG, MPEG, MIDI.

Application Layer

This Layer supports application and end-user processes. Example: NFS, FTP, HTTP, TELNET.

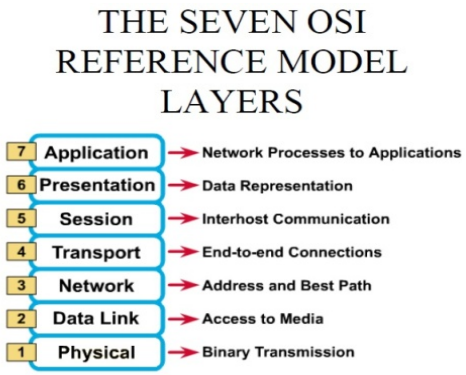

Figure 1: OSI Layer model

Characteristic of OSI Reference Model

The seven layers of the OSI reference model can be divided in two categories: Upper layers And Lower later as shown in Fig. The upper layers of the OSI model deal with application issues and generally are implements 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 [2]. The term upper layer is sometimes used to refer to any layer above another layer in the OSI model. The lower layer of the OSI model

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handles data transport issues. The physical layer and the data link layer are implemented in hardware and software. The lowest layer, the physical layer, is close to the physical network medium (the network cabling, for example) and is responsible for actually placing information on the medium [3].

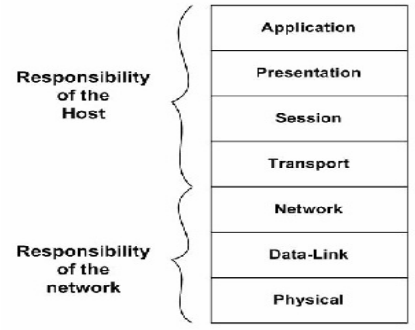

Figure 2: OSI reference system

Two set of layers make up the OSI layer

A. Why does the OSI model have 7 layers-no more no less?

The OSI Model was created based on recommendations from the International Organization for Standardization (ISO) in 1980, which started expanding on the DOD model in the late 1970s. The current standard was published in 1996. The official title for the model is the ISO OSI (Open Systems Interconnection) Reference Model since it describes or relates to connecting systems that are open for communication with other systems [4]. In the model, the functions of the communication system are standardized by categorizing them into abstract layers. The functions which are similar are grouped into the same layer and provide services to the layers above their existing layer [5].

B. What Does the OSI Model Do?

The OSI model depicts how data communications should take place. It splits the functions or processes into seven groups that are described as layers. When protocols or other standards are developed by other organizations such as the American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), and the International Telecommunications Union (ITU) formerly known as the CCITT (Consultative Committee for International Telephony and Telegraphy), they are placed into a layer of the model to help with communication protocol integration and conceptual understanding [6]. The majority of major network and computer vendors, large commercial entities, and governments support the use of the OSI model. Each of the layers of the OSI model is intended to function with those above and below it respectfully within the model definition [7].

Process of Moving data in the OSI Reference Model

The process of moving data between layers of the OSI model

A. Data Flow and Encapsulation:

Data flow occurs when two devices are connected in a network with some kind of shared transmission medium. An application running on the source device creates some kind of data. This happens at the **Application layer.**

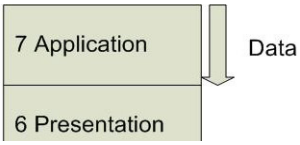

Figure 3: Application Layer

In our case the application needs to add encryption to that data. This will be done at the **Presentation layer.**

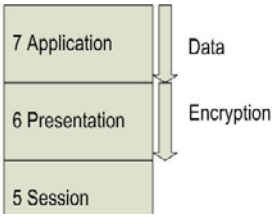

Figure 4: Presentation Layer

At the **Session layer** it appends the **Session ID**. At this point the information is still one block of data.

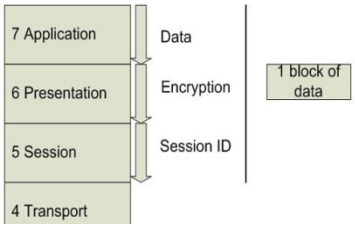

Figure 5: Session Layer

Next, data goes down to the **Transport layer**. The Transport layer breaks the data into blocks of data which we call **Segments**. Every Segment also gets the Port number to identify which upper layer application needs to receive the data on the destination device.

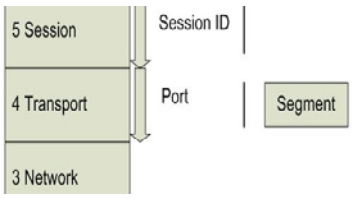

Figure 6: Transport Layer

The Segment is then passed to the **Network layer**. The Network layer takes the Segment, which includes the Port number, and appends the source and destination IP address. At that point the Segment becomes a **Packet.**

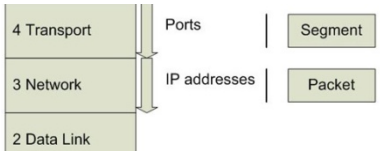

Figure 6: Network Layer

The Packet is then passed to the **Data Link layer** where the source and destination MAC address and the CRC is added. At this point we have a **Frame**.

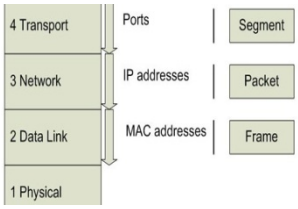

Figure 7: Data Link Layer

The Frame then is sent to the physical device where it is translated into some kind of a signal, whether it's electrical, radio wave, light or other signal [8]. This Frame then becomes some kind of a signal that represents a series of zeros and ones. This is why at the **Physical layer** we often call it **Bits**. The Network Interface Card (NIC) prepares those signals and sends it out on the transmission medium.

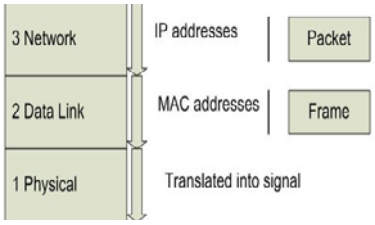

Figure 8: Physical Layer

B. De-encapsulation at the Destination Device:

The destination device receives series of bits and interprets them as a Frame. It then examines the MAC addresses and CRC. If everything is OK, it removes MAC addresses and the CRC, and passes the data up to the Network layer. At this point the IP addresses within the packet are examined. If the IP addresses are OK, they are removed and the Packet is forwarded up to the Transport layer where the Segment is then examined [9]. The Port number is looked at and the Segment gets forwarded up the to the appropriate application specified by the Port number. At this point the Session ID is used, any encryption may be removed, and the data in its original form is presented to the application that needs to interpret it [10].

How data moves through the OSI Model

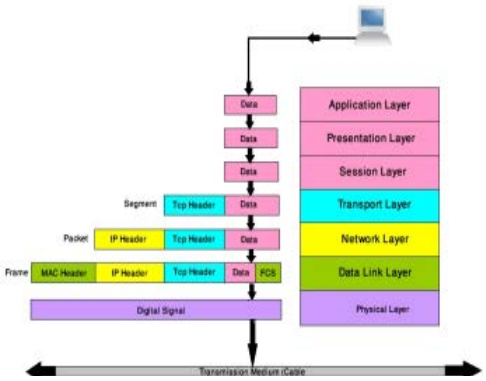

Figure 9: Data moving process in OSI Model

Each layer of OSI model except physical adds its own header to the data that originated from the operating system.

1. Adds own header in front of the header from the previous layer.
2. Header contains information that describes what each layer of the OSI model should do with the data.

Data link layer also adds a trailer.

Data as it moves through OSI layers sent by one computer and receives by another:

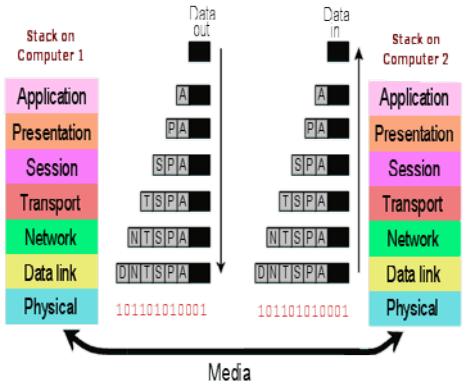

Figure 10: Data moving process from one computer to another computer

Functions of OSI Reference Model

1. Physical Layer

The physical layer is the lowest layer of the OSI model. It describes the electrical/optical, mechanical, & functional interfaces to the physical medium. It carries the signal for the entire higher layer. It is concerned with transmitting raw bits over a communication channel.

Representation of bits

The physical layer data consist of stream of bits with no interpretation. It to be transmitted bits must be encoded into signals electrical or optical. The physical layer defines the type of encoding. It deals with transporting bits between two machines.

Data Rate

The transmission rate it defines the duration of a bits which is how long is last. The number of bit sent each second is also defined by the physical layer.

Synchronization of bits

The senders and receiver not only must use the same bit rate but also must be synchronized at the bit level. In other words, the sender and the receiver clocks must be synchronized.

Line Configuration

The physical layer is concerned with the connection of devices of the media.

Point-to-Point Configuration

In a Point-to-Point configuration of two devices are connected through a dedicated link.

Multipoint Configuration

In a multipoint configuration, a link is shared among several devices.

Topology

Topology is the arrangement or mapping the element of a network. Network topologies are connected to two types.

Physical Topology

It refers to configuration of cable and network.

Logical Topology

This method use to pass information between work stations.

Transmission Mode

The physical layer also defines the direction of transmission between two devices i.e. simplex, half duplex or full duplex.

Simplex

In a simplex, only device can send, the other can only receive. The simplex mode is a one-way communication.

Half Duplex

In a half duplex, two devices can send and receive but not at the same time.

Full Duplex:

In a full duplex, two devices can send and receives at the same time.

Transmission Media

The media over which the information between two computer systems is sent called transmission media.

Guided media

All communication wires/cable are guided media such as UTP, Coaxial Cable, and fiber optics. In this media, the sender and receiver are directly connected and the information is send through it.

Unguided media:

Wireless or open air space is said to be unguided media, because there is no connectivity between the sender and receiver.

2. Data Link Layer

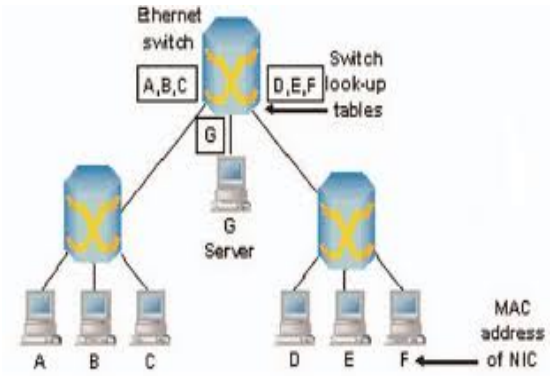

Figure 11: Data Link Layer Function

It provides the error free transfer of the data frames from one node to another over the physical layer. Other responsibilities of Data Link Layer are as follows:

Framing:

The data link layer divides the streams of bits received from the network layer into manageable data units called frame.

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 receiver of the frame. If the frame is intended for a system. Outside the sender's network, the receiver address is the address of the device that connect thee network to the next one.

Error Control

When data frame is transmitted, there is a probability that data frame may be lost in the transmit or it is received corrupted. In both cases, the receiver the correct data frame and sender doesn't know anything about any loss. In such case both sender and receiver are equipped with some protocols which help them to detect transmit errors such as loss of data frame [11]. Hence, either the sender retransmits the data frame or the receiver may request to resend the previous data frame.

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

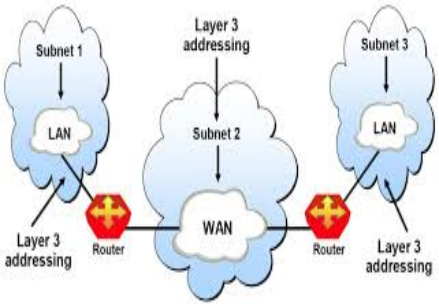

Figure 12: Network Layer Function

This layer provides switching and routing technologies creating logical path known as virtual circuits for transmitting data from node to node. It must identify the network but Data Link Layer must specify the host [12]. The network layer is responsible for the delivery of individual packets from the source host to the destination host.

Logical Addressing

The physical addressing implemented by the data link layer handles the addressing problem locally. If a packet passes the network boundary, we need another addressing system to help distinguish the source and destination systems [13]. The network layer adds a header to the packet coming from the upper layer that, among other things, includes the logical addresses of the sender and receiver.

Routing:

When independent networks or links are connected to create internetworks or a layer network, the connecting devices called routers route or switch the packet to their final destination.

4. Transport Layer

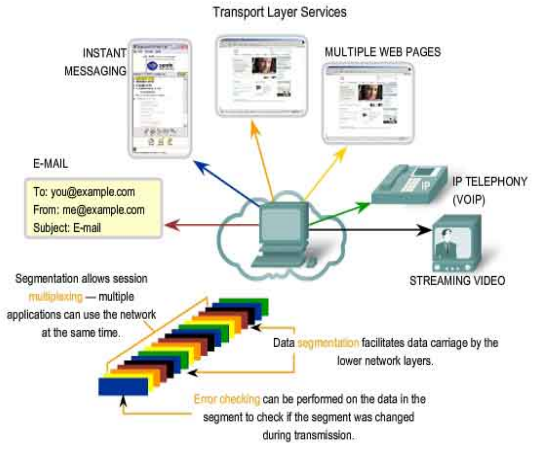

Figure 13: Transport Layer Function

The Transport layer is responsible for process-to-process delivery of the entire message. It offers end-to-end communication between end devices though a network. It depending on the application, the transport layer either offers reliable, connection –oriented or connection less, best-effort communications.

Service-Point addressing

There may be number of programs running at the same time on a computer. For this purpose, source-to-destination delivery should also include process-to-process delivery. Data must be transferred from a specific process on one computer to a specific process or another computer and to accomplish this, port address is required [14]. Thus, transport layer includes service- point address in the header using these port addresses transport layer delivers the packets to the correct process.

Segmentation and Reassembly

A message is divided into segments with each segment having a sequence number. When the message arrives at the destination, with the help of the sequence number, the transport layer reassembles the message correctly. Sequence number also enable transport layer to determine and replace the segments that were lost in the transmission.

Connection Control

Transport layer provides either connection-oriented or connection less service. In connection oriented service, transport layer establish a connection with the transport layer at the destination before transmitting segments and terminates the connection when all the date is transferred. In connectionless service transport layer treats each segment as individual packet and transmit it to the transport layer at destination.

Error Control

When data frame is transmitted, there is a probability that data frame may be lost in the transmit or it is received corrupted. In both cases, the receiver the correct data frame and sender doesn't know anything about any loss [15]. In such case both sender and receiver are equipped with some protocols which help them to detect transmit errors such as loss of data frame. Hence, either the sender retransmits the data frame or the receiver may request to resend the previous data frame.

Flow Control

When a data frame is sent from one host-to-another over a single medium flow control is required that the sender and receiver should work at the same speed. That is, sender sends at a speed on which the receiver can process and accept the data [16]. If sender is sending too fast the receiver may be overloaded and data may be lost.

5. Session Layer

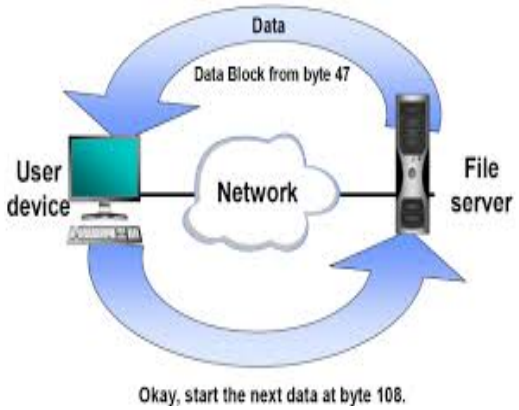

Figure 14: Session Layer Function

The session layer is the network dialog controller. This layer establishes, manages and terminates connections between applications. The session layer is responsible for dialog control and synchronization.

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.

Synchronization:

The session layer allows a process to add checkpoints, or synchronization points to a stream of data. For example If a system is sending a file of 2000 pages, it is advisable to insert checkpoints after every 100 pages to ensure that each 100 page unit is received and acknowledged independently. In this case if a crash happens during the transmission of page 523, the only pages that need to be resent after system recovery are pages 501 to 523.

6. Presentation Layer

Figure 15: Presentation Layer Function

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

Translation:

Networks can connect very different types of computer together PCS, Macintoshes, Unix System and Mainframes can all exist on the same network. Before being transmitted, information in the forms of characters and number should be changed to bit streams.

Compression:

Data compression reduces the number of bits contained in the information. Data compression is important in transmitting multimedia such as audio, video, text, etc.

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

7. Application Layer

It provides user interfaces and support for services such as electronic mail, remote file access and transfer shared DBMS and other types of distributed information services.

CONCLUSION:

In this research papers to show the analysis process of OSI model with use of its different types of layers. That defines the different characteristics, function and data moving process from one computer to another computer system this based on OSI layer.

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