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OSI Reference Model – A Seven Layered Architecture of OSI Model

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Abstract
Due to the urgency in the need for standards for heterogeneous computer networks, International Standard Organization (ISO) created a different subcommittee for "Open System Interconnection" (ISO/TC97/SC16) in 1977. The only priority of subcommittee 16 was to create an architecture for Open System Interconnection which could serve as a frame work for the definition of standard protocols. As a result, after 18 months of studies and discussions, SC16 adopted a layer of architecture consisting of seven layers (Physical, Data Link, Network, Transport, Session, Presentation, and Application layer). In July 1979 the specification of this architecture was passed under the name of "(OSI) Reference Model" to Technical committee 1997 "Data processing" along with the recommendations to start officially, on this basis of a set of protocols standardizations that have to start projects to cover the most urgent need. These recommendations were adopted by the TC97 in the end of 1979, as the basis for the following development of standards for Open System Interconnection(OSI) within ISO.

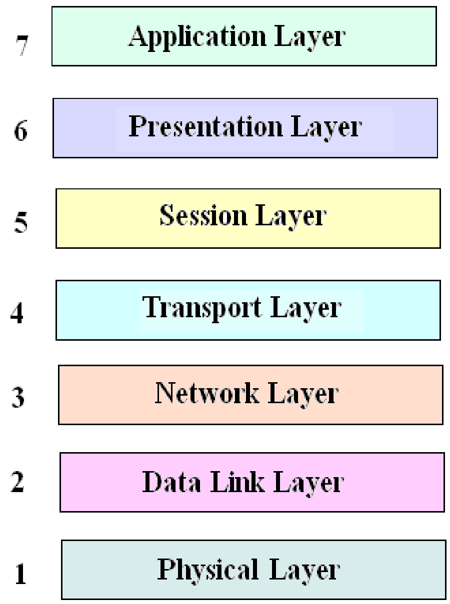
I. INTRODUCTION
The International Standard Organization (ISO) is a multinational body dedicated to world wide agreement on international standard which was established in 1947. The ISO proposed a model named as OSI (Open System Interconnection) in 1983, which covers all aspects of network communication. The purpose of OSI model is for open communication between different systems without requiring changes to logic of the underlying hardware and software. The OSI model is not a protocol, it is a model for understanding and designing a network architecture that flexible, robust and interoperable. In 1977, the International organization for Standardization (ISO) recognized the special and urgent need for standards for heterogeneous informatics networks and decided to create a new subcommittee (SC16) for "Open Systems Interconnection" [1], [2]. The universal need for interconnecting systems from different

manufacturers rapidly became apparent [3], leading ISO to decide for the creation of SC16 with the objective to come up with standards required for "Open Systems Interconnection". The term "open" was chosen to emphasize the fact that by conforming to those systems obeying the same standards throughout the world.

The first meeting of SC16 was held in March 1978, and initial discussions revealed [4] that a consensus could be reached rapidly on a layered architecture which would satisfy most requirements of Open Systems Interconnection with the capacity of being expanded later to meet new requirements. SC16 decided to give the highest priority to the development of standard Model of Architecture which would constitute the framework for the development of standard protocols. After less than 18 months of discussions, this task was completed, and the ISO Model of Architecture called the Reference Model of Open Systems Interconnection [5] was transmitted by SC16 to its parent Technical Committee on "Data Processing" (TC97) along with recommendations to officially start a number of projects for developing on this basis an initial set of standard protocols for Open Systems Interconnection. These recommendations were adopted by TC97 at the end of 1979 as the basis for following development of standards for Open Systems Interconnection within ISO. The OSI Reference Model was also recognized by CCITT Rapporteur‟s Group on Public Data Network Services. CCITT (Consultative Committee for International Telephony and Telegraphy) is a part of the ITU (International Telegraph Unit) which defined many important standards for data communications and it coordinates standards for telecommunications. The CCITT, now known as the ITU-T (for Telecommunication Standardization Sector of the International Telecommunications Union), is the primary international body for fostering cooperative standards for telecommunications equipment and systems.

II. RELATED WORK

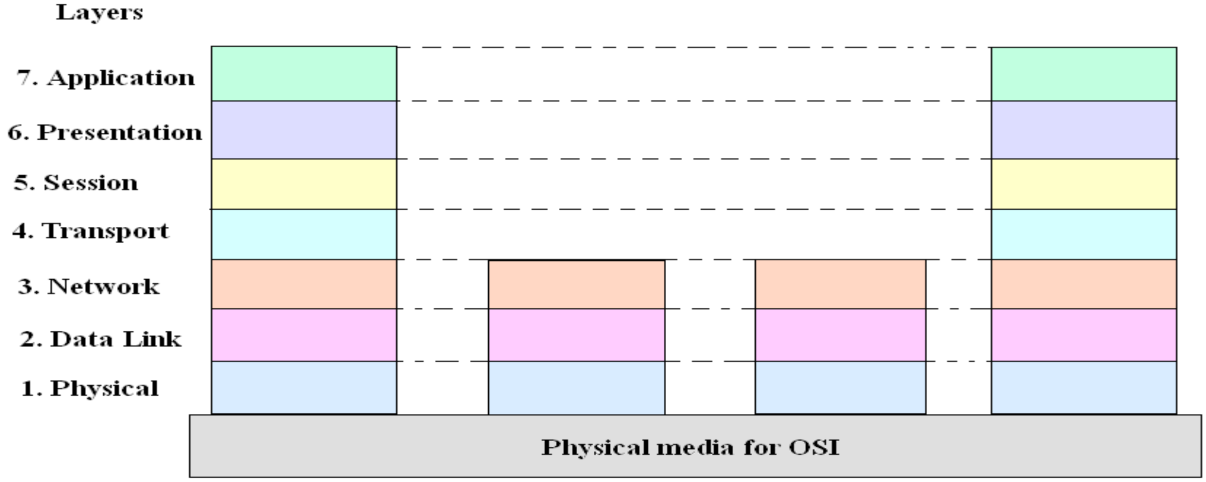
Considering the urgency of the need for standards which would allow constitution of heterogeneous computer networks, International Standard Organization (ISO) created a new subcommittee for "Open System Interconnection of 1977 .The objective of this standardised system was to develop an architecture for Open System Interconnection (OSI) which could serve as a frame work for the definition of standard protocol. As a result of 18 months of studies and discussions, SC16 was adopted a layered architecture comprising seven layers shown in figure(1).



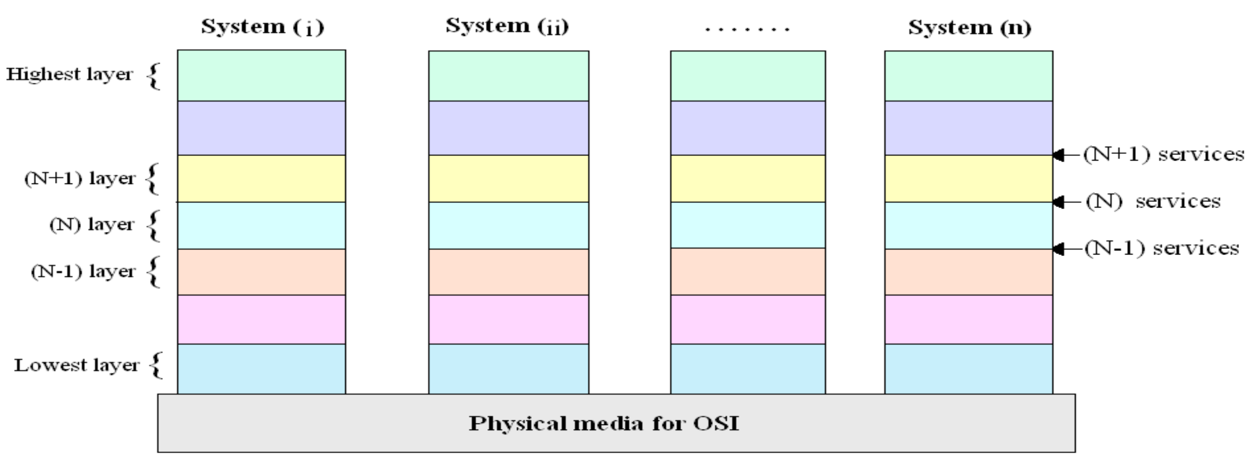
International Standard Organization (ISO) created a Subcommittee (SC16) whose basic objective is to standardize the rules of interaction between interconnected systems. Thus, only the external behaviour of Open Systems must conform to OSI Architecture, While the internal Organization and functioning of each individual Open System is out of scope of OSI standards since these are not visible from other systems with which it is interconnected [6]. It should be noted that the same principle of restricted visibility is used in any manufacturer‟s network architecture inorder to permit interaction of systems with different structures within the same network. These considerations lead SC16 to prefer the term of "Open Systems Interconnection Architecture" (OSIA) to the term of "Open System Architecture" which had been used previously and was felt to be possibly misleading. However, for unclear reasons, SC16 finally selected the title "Reference Model of Open Systems Interconnection" to refer to this Interconnection Architecture. The next section presents a description of OSI layering and principles of ISO for the seven layers of OSI Architecture followed by a brief explanation of how the layers were chosen. There after seven layers of OSI architecture and conclusion are presented in the subsequent sections, followed by an acknowledgement section and a summary of references for this manuscript.

III. OSI LAYERING

Layering is a structuring technique which permits the network of Open Systems to be viewed as logically composed of a succession of layers, each wrapping the lower layers and isolating them from the higher layers. The subcommittee (SC16) which is created by ISO has given an illustration of layering shown in figure (2) where successive layers are represented in a vertical sequence, with the physical media for Open Systems Interconnection at the bottom.



Each individual system alone is viewed as being logically composed of a succession of subsystems, each corresponding to the intersection of the system with a layer. In other words, a layer is considered as being logically composed of subsystems of the same rank of all interconnected systems. Each subsystem is viewed as being made of one or many entities. In other words, each layer is made up of entities, each belongs to one system. Entities in the same layer are termed as entities. In the OSI layering any layer is referred as the (N) layer, while its next layer and next higher layers are considered as the (N-1) layer and the (N+1) layer, respectively. The same notation is used to designate all the concepts relating to layers, e.g., entities in the (N) entities



The basic of layering is that each layer adds a value to services provided by the set of the lower layers in such a way that the highest layer is reffered to as the set of services needed to distribute applications. Layering thus divideall the total problem into smaller pieces. Another basic principle of layering is to ensure independence layer by defining services, provided to each layer to the next higher layer, independent of how these services are performed. These changes are made in such a way that a layer or a set of layers operate in a provided server but they still offer the same service to the next higher layer.

IV. PRINCIPLES OF ISO FOR THE SEVEN LAYERS OF THE OSI ARCHITECTURE

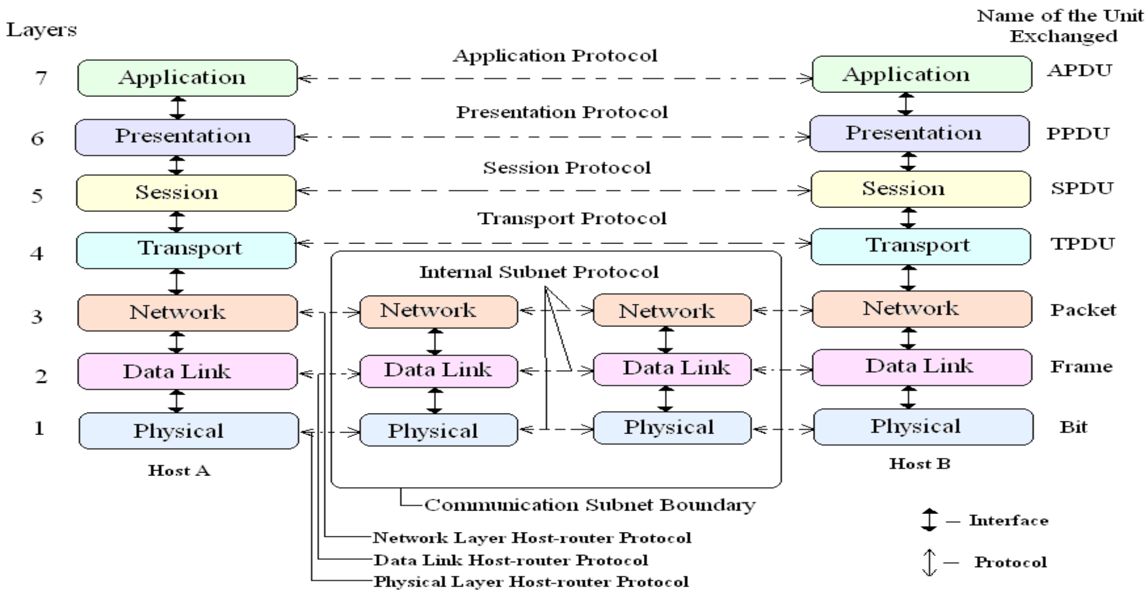
ISO determined a number of principles to be considered for defining the specific set of layers in the OSI architecture, and applied those principles to come up with the seven layers of the OSI Architecture. Principles to be considered are as follows- (i.) Do not create so many layers to make difficult the system engineering task describing and integrating these layers. (ii.) Create a boundary at a point where the services description can be small and the number of interactions across the boundary is minimized. (iii.) Create separate layers to handle functions which are manifestly different in the process performed or the technology involved. (iv.) Collect similar functions into the same layer. (v.) Select boundaries at a point which past experience has demonstrated to be successful. (vi.) Create a layer of easily localized functions so that the layer could be totally redesigned and its protocols changed in a major way to take advantages of new advances in architectural, hardware, or software technology without changing the services and interfaces with the adjacent layers. (vii.) Create a boundary where it may be useful at some point in time to have the corresponding interface standardized. (viii.) Create a layer when there is a need for a different level of abstraction in the handling of data, e.g., morphology, syntax, semantics. (ix.) Enable changes of functions or protocols within a layer without affecting the other layers. (x.) Create for each layer interfaces with its upper and lower layer only. (xi.) Create further subgrouping and organization of functions to form sublayers within a layer in cases where distinct communication services need it. (xii.) Create, where needed, two or more sublayers with a common, and therefore minimum, functionality to allow interface operation with adjacent layers. (xiii.) Allow by passing of sublayers.

V. BRIEF EXPLANATION OF HOW THE LAYERS WERE CHOSEN

(i.) It is essential that the architecture permits usage of a realistic variety of physical media for interconnection with different control procedures. Application of principles 3, 5, and 8 leads to identification of a physical layer as the lower layer in the architecture. (ii.) Some physical communications media (e.g., telephone line) require specific techniques to be used in order to transmit data between systems despite a relatively high error rate (i.e., an error rate not acceptable for the great majority of applications). These specific techniques are used in data-link control procedures which have been studied and standardized for a number of years. It must also be recognized that new physical communications media (e.g., fiber optics) will require different data-link control procedures. Application of principles 3, 5, and 8 leads to identification of Data link Layer on top of Physical Layer in the architecture. (iii.) In the Open Systems Architecture, some systems will act as final destination of data. Some systems may act only as intermediate nodes (forwarding data to other systems). Application of principles 3, 5, and 7 leads to identification of a Network Layer on top of Data link Layer. Network-oriented protocols such as routing, for example, will be grouped in this layer. Thus, the Network layer will provide a connection path (network connection) between a pair of transport entities. (iv.) Control of data transportation from source end system to destination end system (which need not be performed in intermediate nodes) is the last function to be performed in order to provide the totality of the transport service. Thus, upper layer in the transport-service part of the architecture is the Transport Layer, sitting on top of the Network Layer. This Transport layer relives higher layer entities from any concern with the transportation of data between them. (v.) Inorder to bind/unbind distributed activities into a logical relationship that controls the data exchange with respect to synchronization and structure, the need for a dedicated layer has been identified. So the application of principles 3 and 4 leads to the establishment of the Session Layer which is on top of Transport Layer. (vi.) The remaining set of general interest functions are those related to representation and manipulation of structured data from the benefit of application programs. Application of principles 3 and 4 leads to identification of a Presentation Layer on top of the Session Layer. (vii.) Finally, there are applications consisting of application processes which perform information processing. A portion of these application processes and the protocols by which they communicate comprise the Application Layer as the highest layer of the architecture. The resulting architecture with seven layers is illustrated in figure (4).

VI. SEVEN LAYERS OF OSI ARCHITECTURE

The following figure illustrates OSI Reference Model, a seven layered OSI Architecture



Seven layers of the OSI Architecture

(i.) Physical Layer: The physical layer is responsible for individual bits from one node to another. It coordinates the rule for transmitting bits. It launches the raw bits in the channel or link

This layer defines,

a. Physical network structures.
b. Mechanical and electrical specifications of the transmission medium.
c. Bit transmission encoding and timing rules.

The following network connectivity hardware are normally associated with physical layer are,

a. Hubs or Switches
b. Transmission media connectors
c. Modems

The major duties of physical layer is as follows,

a) Physical Characteristics of Interface and Media: It defines the characteristics of the interface between the devices and transmission medium. It also defines the type of transmission medium used.

b) Representation of Bits: The physical layer data consists of stream of bits(Sequence of 0"s and 1"s) without any interpretation. For transmission, bits are encoded into electrical or optical signals. The physical layer defines the type of representation (optical or electrical).

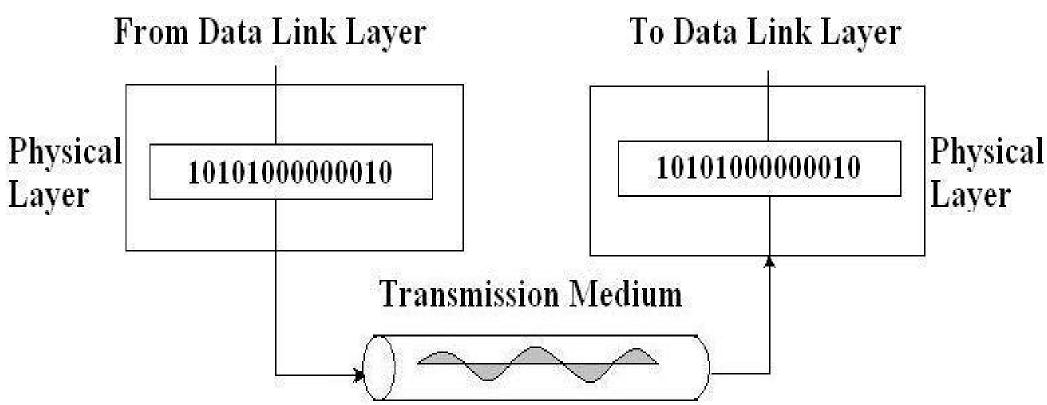
c) Data Rate (or) Transmission Rate: The Sender and receiver must be synchronized at bit level.

d) Synchronization of bits: The sender and receiver must be synchronized at bit level.

e) Line Configuration: This layer is concerned with the connection of devices to the media. In a point-to-point configuration, two devices are connected through a dedicated link. In a multipoint configuration, a link is shared among several devices.

f) Physical Topology: This defines how devices are connected to make a network. These devices can be connected by using a mesh, a star, a ring and bus topologies.

g) Transmission Mode: This layer also defines the direction of transmission between two devices. Those two devices are simplex, half-duplex or full-duplex. Only one devices can be send in simplex mode, the other can only receive. It is a one way communication. Two devices can be send in half-duplex mode, but not at the same time. Two devices can send and receive at the same time in full-duplex mode



(ii.) Data Link Layer

This layer is responsible for the two party communications by exchanging frames between the two nodes. It describes methods for moving information between multiple devices within the same logical network based on physical device addressing. It makes the physical layer, a raw transmission facility, to a reliable link. It makes the physical layer error free to upper layer (network). The basic purposes for Data Link Layer protocol implementations are,

a) Organize Physical Layers bits into logical groups of information called frames.

b) Detect errors.

c) Control data flow.

d) Identify computers on the network.

Data link layer protocols,

a) HDLC (High-Level Data Link Control)

b) Frame relay

The protocol packages the data into frames that contain source and destination addresses. These frames refer to the physical hardware address of each network card attached to the network cable. Ethernet, Token Ring, and ARCnet(Attached Resource Computer network) are examples of LAN(Local Area Network) data link protocols. If communication extends beyond the LAN onto the Internet, the network might use other data link protocols, such as Point-to-Point Protocol (PPP) or Serial Line Internet Protocol (SLIP). The data link layer sends block of data with necessary synchronization, bit error detection/correction error control, and flow control. This control of data flow controls approximately 70 percent of all error handling. Since the physical layer merely accepts and transmits a stream of bits without any regard to the meaning of the structure, it is up to the data link layer to create and recognize frame boundaries. This can be accomplished by attaching special bit patterns to the beginning and end of the frame as shown in figure (6) T2 (trailer of layer 2) and H2 (header of layer 2) are attached at the beginning and ending of the frame.

(iii.) Network Layer

The network layer is responsible for the delivery of packets from original source to final destination. Before receiving the packets to the respective destination, buffering of packets [7] [8] takes place in the network. This layer takes care of addressing and routing issues. It describes methods for moving information between multiple independent networks based on network layer addressing. The data link layer oversees the delivery of the packet delivery between two systems on the same network, whereas the network layer that each packet gets to the final destination. If systems are connected on same link, there is no need for network layer. If systems are attached to different networks then it is inevitable. This layer defines,

a) Logical Network structures and addressing.
b) Route discovery and selection.
c) Network layer flow control and error control.
d) The network connectivity hardware associated with network layer.
e) Routers.
f) Network layer protocols.
g) IP (Internet Protocol) etc.

(iv.) Transport Layer

The transport layer is responsible for delivery of a message from one process to another. It is responsible for process to process delivery of the entire message. The network layer ensures host to destination delivery of individual packets. It does not recognize the relationship between the packets. It does not recognize the relationship between the packets. So the transport layer ensures that the whole message arrives intact and in order, overseeing both error control and flow control at process-to-process level. It is responsible for end-to-end connection between the source and the destination. The name of the data unit in transport layer is TPDU (Transport Protocol Data Unit).

(v.) Session Layer

The session layer permits two parties to hold ongoing communications called a session across a network. The applications on either end of the session can exchange data or send packets to another for as long as the session lasts. The session layer handles session setup, data or message exchanges, and tear down when the session ends. It also monitors session identification so only designated parties can participate and security services to control access to session information. A session can be used to allow a user to log into a remote time-sharing system or transfer a file between two machines.

(vi.) Presentation Layer

The presentation layer is responsible for the format of the data transferred during network communications. This layer is concerned with the syntax and semantics of the information transmitted. For outgoing messages, it converts data into a generic format for the transmission. For the incoming messages, it converts the data from the generic form to a format understandable to the receiving application. Different computers have different codes for representing data. The presentation layer makes it possible for computers with different representation to communicate. The presentation layer provides common communication services such as encryption, text compression, and reformatting. The presentation layer is also concerned with other aspects of information representation. Data compression can be used to reduce the number of bits that have to be transmitted. Cryptography is frequently required for privacy and authentication

(vii.) Application Layer

The application layer enables the user, whether human or software to access the network. It provides user interface and support for services such as e-mail, remote file access and transfer, shared database management etc.

CONCLUSION

The development of OSI Standards is a very big challenge, the result of which will impact all future computer communication developments. If standards come too late or are inadequate, interconnection of heterogeneous systems will not be possible or will be very costly. The work collectively achieved so far by SC16 members is very promising, and additional efforts should be expended to capitalize on these initial results and come up rapidly with the most urgently needed set of standards which will support initial usage of OSI (mainly terminals accessing services and file transfers). Common standards between ISO and CCITT (Consultative Committee for International Telephony and Telegraphy) are also essential to the success of standardization, since new services announced by PTT‟s and common carriers are very similar to data processing services offered as computer manufacturer products, and duplication of now compatible standards could simply cause the standardization effort to fail. In this regard, acceptance of the OSI Reference Model by CCITT Rapporteur‟s Group on Layered Architecture for Public Data Networks Services is most promising. It is essential that all partners in this standardization process expend their best effort so it will be successful, and the benefits can be shared by all users, manufactures of terminals and computers, and the PTT‟s/common carriers

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