ANALYSIS OF OPEN SYSTEMS INTERCONNECTION (OSI) MODEL AND LAYERED COMMUNICATION

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Abstract

In the early days computing, several devices/Hardware Companies had their own standard of data transfer via one device to the other. This actually creates a heavy network problem, as computer A produced by company A cannot have good interoperability with computer C produced by company C.

The International Standards Organization (ISO) now came up with a standard called Open Systems Interconnection (OSI) to enable systems have easy interconnectivity. The main idea in OSI is that the process of communication between two end points in a telecommunication network can be divided into seven layers, with each layer adding its own set of special, related functions. Each communicating user makes use of a program equipped with these seven layers of network communication models. This paper introduces the ideas and approaches of implementing the seven layers of the OSI model with emphasis on its importance in network communication.

Introduction

The Open Systems Interconnection (OSI) reference model describes how information from a software application in one computer moves through a network medium to a software application in another computer. The OSI reference model is a conceptual model composed of seven layers, each specifying particular network functions. The model was developed by the International Standards Organization, (ISO) in 1984, and it is now considered the primary architectural model for inter-computer communications. Cisco Systems, (2002). The OSI model divides the task involved with moving information between networked computers into seven smaller, more manageable task groups. A task or group of tasks is then assigned to each of the seven OSI layers. Each layer is reasonably self- contained so that the tasks assigned to each layer can be implemented independently. This enables the solutions offered by one layer to be updated without adversely affecting the other layers.

Importance of the OSI model

It would be difficult to overstate the importance of the OSI model. Virtually all networking vendors and users understand how important it is that network computing products adhere to and fully support the networking standards this model has generated. When a vendor's products adhere to the standards, which the OSI model has generated, connecting those products to other vendors' products is relatively simple. Conversely, the further a vendor departs from those standards the more difficult it become to connect that vendor's products to those of other vendors. In addition, if a vendor where to depart from the communication standards the model has approved, software development efforts would be very difficult because the vendor would have to build every part of all necessary software, rather than being able to build on the existing work of other vendors. Contest, (2005). The first two problems give rise to a third significant problem for vendors: a vendor's products become less marketable as they become more difficult to connect with other vendor's products.

The seven layers of the OSI model

Due to the fact that the task of controlling communications across a computer network is too complex to be defined by one standard, the ISO divided the task into seven subtasks, each of which illustrates a particular network function. Dividing the network into seven layers provides the following advantages:

1. It breaks network communication into smaller, more manageable parts
2. It standardizes network components to allow multiple vendor development and support.
3. It allows different types of network hardware and software to communicate with each other.

4. It prevents changes in one layer from affecting other layers.
5. It divides network communication into smaller parts to make learning it easier to understand. Miguel, (1999).

Each layer of the OSI model contains a logically grouped subset of the functions required for controlling network communications. Also each layer provides services to the one above it and uses the services of the one below it Okoroigwe, (1999). The seven layers of the OSI model, their Functions, Protocols and Network components, numbered from top to bottom are shown in table 1.0

Table 1.0 The OS Model

	Layer	Function	Protocols	Network components
	Application	*It is used for applications specifically written to run over the network. *Allow access to network services that support applications. *Directly represents the services that directly support user applications. * Handles Network access, flow control and error recovery. * Example apps are file transfer, e-mail, NetBIOS-based applications	**DNS; FTP; TFTP; BOOTP; SNMP;** Short for Simple Network Management Protocol, a set of protocols for managing complex networks. **RLOGIN; SMTP; MIME;** Short for Multipurpose Internet Mail Extensions, a specification for formatting non- ASCII messages so that they can be sent over the Internet. **NFS;** Abbreviation of Network File System, a client/server application designed by Sun Microsystems that allows all network users to access shared files stored on computers of different types. **FINGER;** a UNIX program that takes an e-mail address as input and returns information about the user who owns that e-mail address. **TELNET;** a terminal emulation program for TCP/IP networks such as the Internet. The Telnet program runs on your remote computer and connects it to a server on the network. **NCP;** acronym for Netware Core Protocol. It is the file-sharing protocol between server/client(s) on a Novell Netware network **APPC;** Short for Advanced Program-to- program Communications. Also known as LU **6.2** and based on IBM's SNA, it is a communication protocol that transaction programs in **a** distributed computing environment can use to talk to each other **AFP;** short for AppleTalk Filling Protocol, the	**Gateway**

		client/server file sharing protocol used in an AppleTalk network. **SMB** Short for Server Message Block, a message format used by DOS and Windows to share files, directories and devices.	r '{V
Presentation (Translation)	*This layer translates from application to network format and vice-versa. * All different format from all sources are made into a common uniform format that the rest of the OSI model can understand. *Responsible for protocol conversion, data encryption/decryption, expanding graphic commands; data compression. * Sets standards for different systems to provide seamless communication from multiple protocol stacks.		Gateway Redirection
Session (syncs and Sessions)	*Establishes, maintains and ends sessions across the network * Responsible for name recognition (identification) so that only the designated parties can participate in the session. * Provides synchronization services by planning checkpoints in the data stream. If session fails, only data after the most recent checkpoint need be transmitted. * Examples are interactive login and file transfer connections; the session would connect and reconnect if there was an interruption; recognize names in the session and register names in history.	**NetBIOS** This is short for Network Basic Input Output System, an API that augments the DOS BIOS by adding special functions for local-area networks (LANs). Names pipes Mail slots **RPC** which is an acronym for Remote procedure Call, a type of protocol that allows a program on one computer to execute a program on a server computer.	Gateway A
Transport (packet flow control and error handling)	*Additional connection below the session layer. *Manages the flow control of data between parties across the network Divides streams of data into chunks or packets; the transport layer of the receiving computer reassembles the message from packets. * “Train” is a good analogy; the	**TCP;** An abbreviation of Transmission Control Protocol, and pronounced as separate letters. TCP is one of the main protocols in TCP/IP networks **.ARP;** This is short for Address Resolution protocol, a network layer protocol used to convert an IP address into a physical address (called a DLC address), such as an Ethernet address. **RARP;** this	Gateway Advanced **cable** tester Brouter

	data is divided into identical units * Provides error-checking to guarantee: error-free data, delivery, with on losses or duplications.	can be used by a host to discover its IP address. In this case, the host broadcasts its physical address and a RARP server replies with the host's IP address. **SPX;** this is short for Sequenced Packet Exchange, a transport layer protocol (layer 4 of the OSI model) used in Novell Netware networks. **NW Link;** **Net BIOS/NetBElJI** pronounced net-booey, short for Net BIOS Extended User Interface. It is an enhanced version of the NetBIOS protocol used by network operating systems such as LAN Manager, LAN Server, and Windows for Workgroups, Windows 95 and Windows NT. **ATP.**	
Network (addressing routing)	* Translates logical network address and names to their physical address (e.g. computer name => MAC address) * Responsible for; zero addressing zero determining routes for sending. Zero managing network problems such as packet switching, data congestion and routing. * If routers can't send data frame as large as the source computer sends, the network layer compensates by breaking the data into smaller units. At the receiving end, the network layer reassembles the data. Think of this layer as stamping the addresses on each train car.	**IP;** short for Internet Protocol. It specifies the format of packets, also called datagrams, and the addressing scheme. Most networks combine IP with a higher-level protocol called Transmission Control Protocol (TCP), which establishes a virtual connection between a destination and a source., **ARP; RARP; ICMP;** This is short for Internet "Control message protocol, an extension to the Internet Protocol (IP) defined by RFC 792. ICMP supports packets containing error, control, and informational messages. **RIP; OSFP; IGMP;** Internet. Group Management Protocol is defined in RFC 1112 as the standard for IP multicasting in the Internet. It's used to establish host memberships in particular multicast groups on a single network. **IPC; NWLink; NetBEUT; OSI; DDP; DECNET**	Brouter Router Frame **Relay** Device ATM switch Advanced **cable** tester
Data Link Data frames to bits	*. Turns packets into raw bits 100101 and at the receiving end turns bits into packets handles data frames between the network and physical layers	Logical Link Control Error correction and flow control Manages link control and defines SAPS	Bridge Switch ISDN Router

—	* The receiving end packages raw data from the physical layer into data frames for delivery to the network layer * Responsible for error-free transfer of frames to other computer via the physical layer * This layer defines the methods used to transmit and receive data on the network. It consists of the wiring, the devices used to connect the NIC to the wiring, the signaling involved to transmit/receive data and the ability to defect signaling errors on the network media.	802.1 OSI Model 802.2 logical link Media Access Control *Communicates with the adapter card *Controls the type of media being used: 802.3 CSMA/CD (Ethernet) 802.4 Token Bus (ARC net) 802.5 Token Ring 802.12 Demand priority	Intelligent Hub NIC Advanced Cable Tester
Physical Hardware; raw bit stream	*Transmits raw bit stream over physical cable * Defines cables, cards, and physical aspects * Defines NIC attachments hardware, how cable is attached to NIC * Defines techniques to transfer bit stream to cable	IEEE 802 IEEE 802.2 ISO 2110 ISDN	Repeater Multiplex Hubs * Passive * Active TDR Oscilloscope Amplifier

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 interacts 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 layers* of the OSI model handle data transport issues. The physical layer and the data link layer ale 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. Cisco Systems, (2002).

Figure 1 illustrates the division between the upper and lower OSI layers.

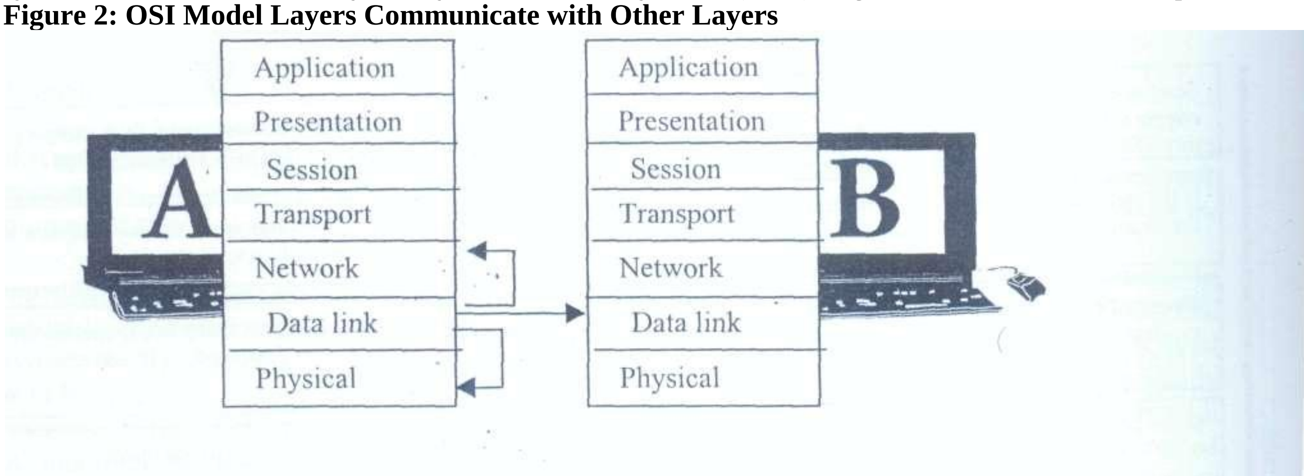
Figure 1: Two Sets of Layers Make Up the OSI Layers

	Application
	Presentation
	Session
	Transport
	Network
	Data link
	Physical

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. Cisco Systems, (2002). Figure 2. illustrates this example.

Figure 2: OSI Model Layers Communicate with Other Layers



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 (hat requests services from an adjaccnt 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. Cisco Systems, (2002).

Figure 3: Service Users, Providers, and SAPs Interact at the Network and Data Link Layers

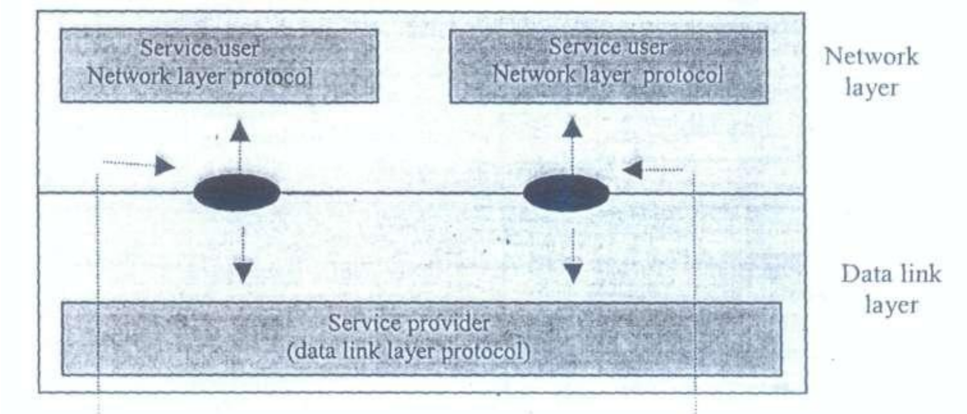


Figure 3 illustrates how these three elements interact at the network and data link layers.

Network Communication through the OSI model

Using the seven layers of the OSI model, the illustration below shows how data can be transferred between two networked computers. Novell's Networking Primer, (2005).

Figure 4: Networked Computers Communicating through the OSI model

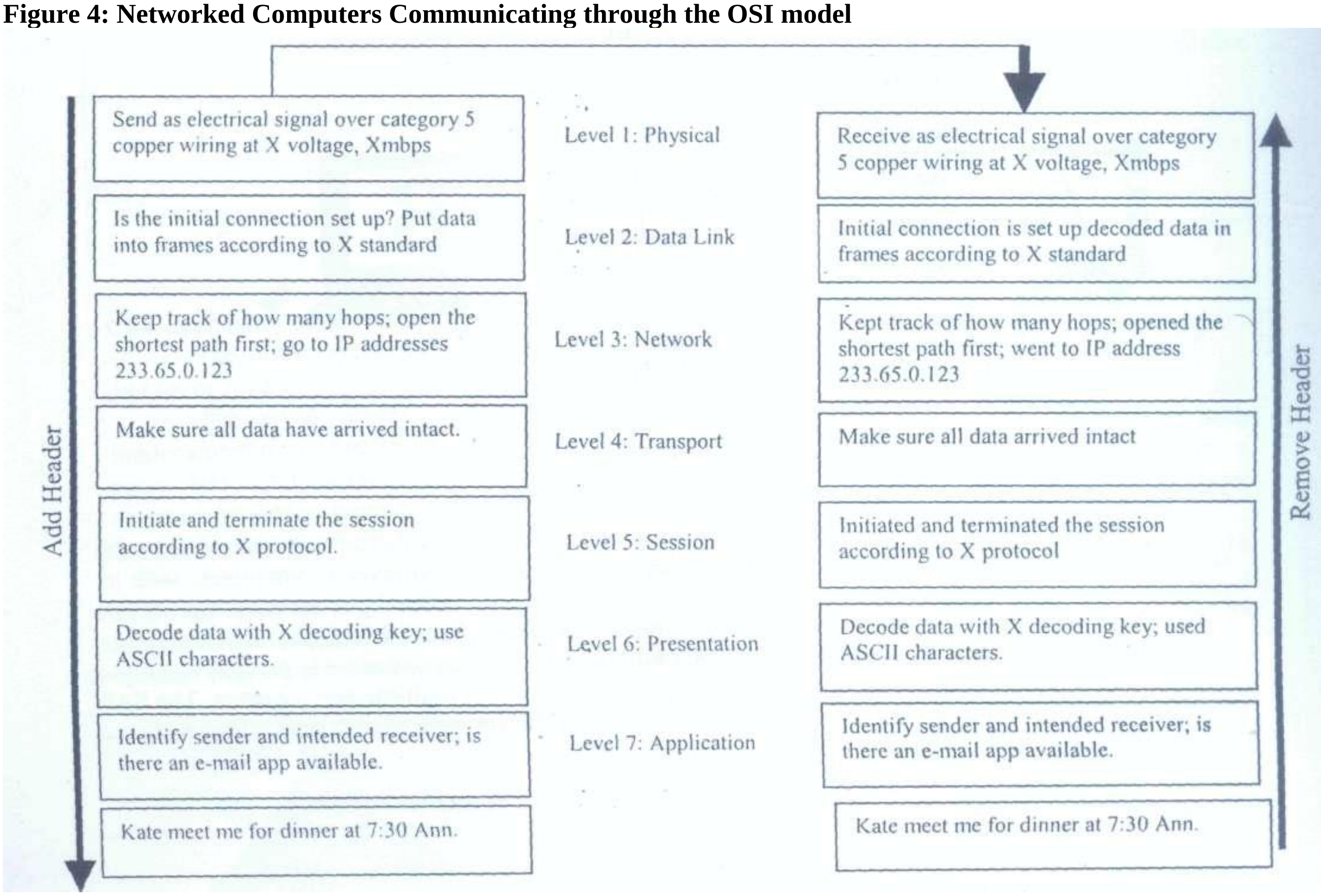


Figure 4. Represents two networked computers. They are running identical operating systems and applications and are using identical protocols (or rules) at all OSI layers. Working in conjunction the applications, the OS, and the hardware implement the seven layer functions described in the OSI model.

Discussion

Figure 4. Represents the transmission of brief message from Ann to Kate. The transmission starts when Ann types in a message to Kate and presses the "send" key. Ann's operating system appends to the message (Or "encapsulates") a set of application layer instructions (OSI layer 7) that will be read and executed by the application layer on Kate's computer. The message with its layer 7 header is then transferred to the part of the operating system that deals with presentation issues (OSI layer 6) where a layer 6 header is appended to the message The process repeats through all the layers until each layer has appended a header. The headers function as an escort for the message so that it can successfully negotiate the software and hardware in the network and arrive intact at its destination.

When the data link layer is added at layer 2, the data unit is known as a "frame". Novell's Networking Primer, (2005). The final header, the physical-layer header (OSI layer 1) tells the hardware in Ann's computer, the electrical specifies how the message will be sent (which medium, at which voltage, at which speed, etc). Although it is the final header to be added, the layer 1 header is the first line when the message travels through the medium to the receiving computer.

When the message with its seven headers arrives at Kate's computer, the hardware in her computer is the first to handle the message, it reads the instructions in the layer one header, executes them, and strips off the header before passing the message to the layer 2 components.

These layer 2 components execute those instructions, strip off the header, and pass the message to layer 3, and so on. Each layer's header is successively stripped off after its instructions have been read so that by the time the message arrives at Kate's e-mail application, the message has been properly received, authenticated, decoded, and presented.

Conclusion

The OSI model was never intended to foster a rigid unbreakable set of rules: It was expected that networking vendors would be free to use which ever standard for each layer they deemed most appropriate. They would also be free to implement each standard in the manner best suited to the purpose of their products.

However, it is clearly in a vendor's best interest to manufacture products that conform to the intentions behind the OSI model. To do this, a vendor must provide the services required at each OSI model layer in a manner that will enable the vendor's system to be connected to the system of other vendors easily. Systems that conform to these standards and offer a high degree of interoperability with heterogeneous environments are called open systems. Systems that provide interoperability with components from only one vendor are called proprietary system. These systems use standards created or modified by the vendor and are designed to operate in a homogenous or single-vendor environment.

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