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Research Paper

Comparative Analysis of OSI and TCP/IP Models in Network Communication

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ABSTRACT:*The idea of OSI and TCP/IP reference models emphasizes the connection and connection-connectionless compatibility respectivelyof network communication between the sender and the receiver in error detection, retransmission and error recovery as well as encapsulation and de- capsulation of data.The OSI Model handles the error detection while the TCP/IP models handle packet delivery and error recovery of the network interface. The two models developed a set of protocols for packet delivery and interconnection of networks either through connected or internet-wise. OSI and TCP/IP models was developed to handle efficient packet delivery in network routing and addressing thereby preventing network traffic and congestion.*
KEYWORDS: *OSI Model, TCP/IP Model, Networking, Sender, Receiver, Encapsulation and De-capsulation*

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I. INTRODUCTION

The TCP/IP and OSI are network reference models. The process of developing both models began in the early 1970s and ended in the late 1970s. Both models were published in the early 1980s. Manufacturers manufactured devices to support one model or both models in the 1990s. As at late 1990s, the TCP/IP model became a common option and the OSI model was refuted due to a slower formal standardization process than the TCP/IP model. Trending manufacturers abandoned their proprietary networking model in favour of the TCP/IP model in the 2000s. Currently, only the TCP/IP model is used. Almost all modern computer networks are built using the TCP/IP model. All modern networking devices support the TCP/IP model.

The preference for fewer layers and use of different protocols to handle data transmission is a bane to the continued existence of the original OSI model. Cognizant of this, TCP/IP model is more widely used, so networking tech advancements evolve with it. This means that it is more practical to develop systems with the TCP/IP model in mind instead of trying to reinvent OSI to tap on its advantages [6].

A network is a connection with a large number of devices. These devices are different from one to another. That can create compatibility issues. To avoid that, all devices in the network use the standard network model for data communication. One major network model is TCP/IP model. These models consist of a number of layers. The data which should be sent to a new location should go through each layer. When reaching each layer, the information is added to the data. It is called encapsulation. When the data reaches the destination, in each layer the added information is unpacked. That process is known as de-capsulation. The difference between encapsulation and de-capsulation is that, in encapsulation, the data is moving from upper layer to the lower layer, and each layer includes a bundle of information called a header along with the actual data while in de-capsulation, the data is moving from the lower layer to the upper layers, and each layer unpacks the corresponding headers to obtain the actual data.

II OSI Model and TCP/IP Model

The OSI Model is a logical and conceptual model that defines network communication used by systems open to interconnection and communication with other systems. The Open System Interconnection (OSI Model) also defines a logical network and effectively describes computer packet transfer by using various layers of protocols [1].

TCP/IP stands for Transmission Control Protocol/ Internet Protocol. It is specifically designed as a model to offer highly reliable and end-to-end byte stream over an unreliable internetwork.
TCP/IP helps you to determine how a specific computer should be connected to the internet and how you can transmit data between them [3]. It helps you to create a virtual network when multiple computer networks are connected together.
TCP/IP is about end-to-end data communication, providing the specifics on how data should be transmitted, addressed, packetized, routed, and ultimately received. It involves four layers, namely the application, transport, internet, and link layers. Its technical standards were developed and are maintained by the Internet Engineering Task Force (IETF) [6].

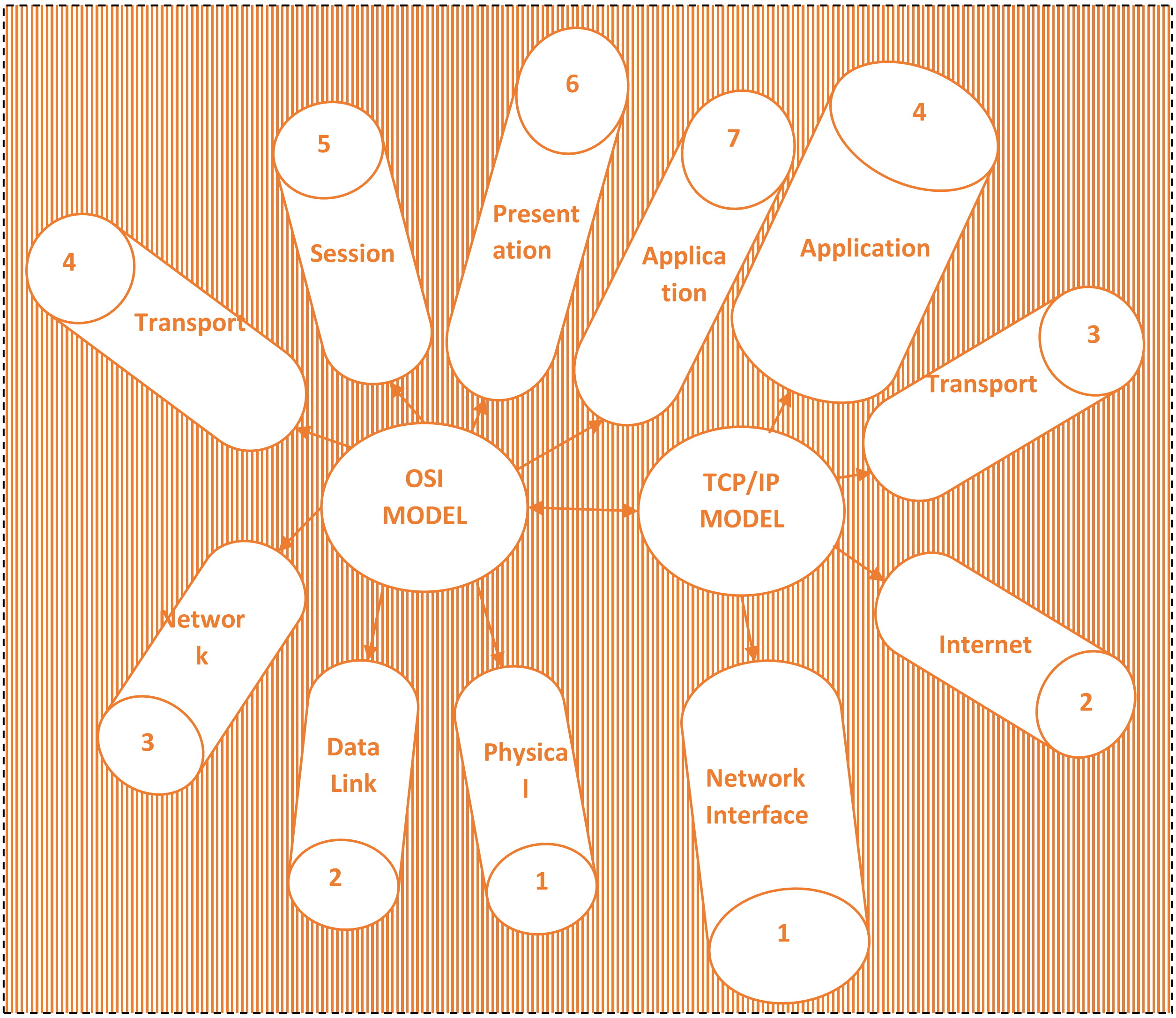

Figure 1:OSI and TCP/IP MODELS Architecturewith their Layers

Both OSI and TCP/IP reference models are based on the concept of a stack of protocols. The functionality of the layers is almost similar. In both models, the layers are there to provide an end-to-end network- independent transport service to processes wishing to communicate with each other [2].

2.1 Similarities between TCP/IP and OSI Models

- ✓ Both are logical models.
- ✓ Both define standards for networking.
- ✓ Both provide a framework for creating and implementing networking standards and devices.
- ✓ Both divide the network communication process into layers.
- ✓ In both models, a single layer defines a particular functionality and sets standards for that functionality only.

- ✓ Both models allow a manufacturer to make devices and network components that can coexist and work with the devices and components made by other manufacturers.
- ✓ Both models simplify the troubleshooting process by dividing complex functions into simpler components.
- ✓ Instead of defining the already defined standards and protocols, both models referenced them. For example, the Ethernet standards were already defined by IEEE before the creation of these models. So instead of defining them again both models used them as IEEE Ethernet standards.

2.2 Overview of Their Differences

OSI has 7 layers whereas TCP/IP has 4 layers.

The OSI Model is a logical and conceptual model that defines network communication used by systems open to interconnection and communication with other systems. On the other hand, TCP/IP helps you to determine how a specific computer should be connected to the internet and how you can be transmitted between them. The OSI model provides reliability while TCP/IP deals reliability as an end-to-end problem. Each layer of OSI architecture detects and handles error whereas in TCP/IP, transport layer handles all error detection and recovery [1], [4].

- OSI header is 5 bytes whereas TCP/IP header size is 20 bytes.
- OSI refers to Open Systems Interconnection whereas TCP/IP refers to Transmission Control Protocol.
- OSI follows a vertical approach whereas TCP/IP follows a horizontal approach.
- OSI model, the transport layer, is only connection-oriented whereas the TCP/IP model is both connection-oriented and connectionless.
- OSI model is developed by ISO (International Standard Organization), whereas TCP Model is developed by ARPANET (Advanced Research Project Agency Network).

OSI model helps you to standardize router, switch, motherboard, and other hardware whereas TCP/IP helps you to establish a connection between different types of computer. The full highlights of the network models are shown in table 1-6 below.

Table 1: OSI LAYERS AND THEIR FUNCTIONS

S/N	OSI LAYERS	EXAMPLES	FUNCTIONS
1.	Physical	cable, RJ45	It connects the entity to the transmission media through which bits are sent; error-free delivery of data on a hop
2.	Data Link	Media Access Control (MAC), switches	It provides error control (and retransmission in the event of an error) over a single transmission link; it is responsible for getting the data packaged and onto the network cable) and synchronization for the physical layer.
3.	Network	IP, routers	It handles routing of the data and the movement of packets from the sender to the receiver
4.	Transport	TCP and the User Datagram Protocol (UDP), port numbers	It provides end to end communication control and error checking as well as packet delivery
5.	Session	Syn/Ack	It is used to establish, manage and terminate the sessions.
6.	Presentation	encryption, ASCII, PNG, MIDI	It is responsible for translation, compressions and encryption
7.	Application	Protocols: The Hypertext Transfer Protocol (HTTP), the File Transfer Protocol (FTP),The Simple Mail Transfer Protocol (SMTP), Telnet, The Domain Name System (DNS), The Simple Network Management Protocol (SNMP); interfaces: Windows Sockets and NetBIOS.	This layer provides the services to the user

Table 2:CHARACTERISTICS OF OSI MODEL AND TCP/IP MODEL

OSI Model Characteristics	TCP/IP Model Characteristics
✓ A layer should only be created where the definite levels of abstraction are needed.	✓ Support for a flexible architecture
✓ The function of each layer should be selected as per the internationally standardized protocols.	✓ Adding more systems to a network is easy.
✓ The number of layers should be large so that separate functions should not be put in the same layer. At the same time, it should be small enough so that architecture doesn't become very complicated.	✓ In TCP/IP, the network remains intact until the source and destination machines were functioning properly.

✓ In the OSI model, each layer relies on the next lower layer to perform primitive functions. Every level should able to provide services to the next higher layer.	✓ TCP is a connection-oriented protocol.
✓ Changes made in one layer should not need changes in other layers.	✓ TCP offers reliability and ensures that data which arrives out of sequence should put back into order.
	✓ TCP allows you to implement flow control, so the sender never overpowers a receiver with data.

Table 3:COMPARISON BETWEEN OSI MODEL AND TCP/IP MODEL

OSI Model	TCP/IP Model
It is developed by ISO (International Standard Organization)	It is developed by ARPANET (Advanced Research Project Agency Network).
OSI model provides a clear distinction between interfaces, services, and protocols.	TCP/IP doesn't have any clear distinguishing points between services, interfaces, and protocols.
OSI refers to Open Systems Interconnection.	TCP refers to Transmission Control Protocol.
OSI uses the network layer to define routing standards and protocols.	TCP/IP uses only the Internet layer.
OSI follows a vertical approach.	TCP/IP follows a horizontal approach.
OSI layers have seven layers.	TCP/IP has four layers.
In the OSI model, the transport layer is only connection-oriented.	A layer of the TCP/IP model is both connection-oriented and connectionless.
In the OSI model, the data link layer and physical are separate layers.	In TCP, physical and data link are both combined as a single host-to-network layer.
Session and presentation layers are a part of the OSI model.	There is no session and presentation layer in the TCP model.
It is defined after the advent of the Internet.	It is defined before the advent of the internet.
The minimum size of the OSI header is 5 bytes.	The minimum header size is 20 bytes.
OSI is less reliable	TCP/IP is more reliable

Table 4:BENEFITS AND DRAWBACKS OF OSI MODEL

OSI MODEL	
Benefits	**Drawbacks**
✓ Helps standardize router, switch, motherboard, and other hardware. ✓ Reduces complexity and standardizes interfaces ✓ Facilitates modular engineering ✓ Ensures interoperable technology ✓ Accelerates the evolution ✓ Protocols can be replaced by new protocols when technology changes. ✓ Provide support for connection-oriented services as well as connectionless service. ✓ It is a standard model in computer networking. ✓ Supports connectionless and connection-oriented services. ✓ It offers flexibility to adapt to various types of protocols.	✓ Fitting of protocols is a tedious task. ✓ Can only be used as a reference model. ✓ It doesn't define any specific protocol. ✓ In the OSI network layer model, some services are duplicated in many layers such as the transport and data link layers ✓ Layers can't work in parallel as each layer need to wait to obtain data from the previous layer.

Table 5:BENEFITS AND DRAWBACKS OF TCP/IP MODEL

TCP/IP MODEL	
Benefits	**Drawbacks**
✓ Establishes/sets up a connection between different types of computers. ✓ It operates independently of the operating system. ✓ It supports many routing-protocols. ✓ It enables the internetworking between the organizations. ✓ TCP/IP model has a highly scalable client-server architecture. ✓ It can be operated independently. ✓ Supports several routing protocols. ✓ It can be used to establish a connection between two	✓ TCP/IP is a complicated model to set up and manage. ✓ The shallow/overhead of TCP/IP is higher-than IPX (Internetwork Packet Exchange). ✓ In this, model the transport layer does not guarantee delivery of packets. ✓ Replacing protocol in TCP/IP is not easy. ✓ It has no clear separation from its services, interfaces, and protocols. ✓ You can't use for broadcast or multicast transmission.

computers.	

2.3 Attributes of TCP

- Delivery Acknowledgements
- Re -transmission
- Delays transmission when the network is congested
- Easy Error detection

Table 6: OSI SPECIFIC PROTOCOLS PROFILE CLASSES

OSI LAYER	PROFILES			
	CLASS A	**CLASS B**	**CLASS C**	**CLASS E**
APPLICATION	STMF	STMF	Telnet FTP SNMP	Telnet FTP SNMP
PRESENTATION	NULL	NULL	NULL	NULL
SESSION	NULL	NULL	NULL	NULL
TRANSPORT	UDP	NULL	TCP	TCP
NETWORK	IP	NULL	IP	
DATA LINK	PMPP	PMPP	PMPP	PPP
PHYSICAL	EIA 232E FSK	EIA 232E FSK	EIA 232E FSK	EIA 232E FSK

STMF = Simple Transportation Management Framework. IP = Internet Protocol SNMP = Simple Network Management Protocol .PPP = Point-to-Point Protocol FTP = File Transfer Protocol. PMPP = Point-to-Multipoint Protocol. UDP = User Datagram Protocol EIA 232E = standard modem interface. TCP = Transmission Control Protocol FSK = Frequency shift keying

2.4 ENCAPSULATION AND DE-CAPSULATION OF OSI AND TCP/IP MODEL

Data Encapsulation is the process in which some extra information is added to the data item to add some features to it. We use either the OSI or the TCP/IP model in our network, and the data transmission takes place through various layers in these models. Data encapsulation adds the protocol information to the data so that data transmission can take place in a proper way. This information can either be added in the header or the footer of the data.

Data De-encapsulation is the reverse process of data encapsulation. The encapsulated information is removed from the received data to obtain the original data. This process takes place at the receiver’s end. The data is de-encapsulated at the same layer at the receiver’s end to the encapsulated layer at the sender’s end. The added header and trailer information are removed from the data in this process [8].

As data is transferred from upper layer to lower level of TCP/IP protocol stack (outgoing transmission) each layer includes a bundle of relevant information called a header along with the actual data. The data package containing the header and the data from the upper layer then becomes the data that is repackaged at the next lower level with lower layer's header. Header is the supplemental data placed at the beginning of a block of data when it is sent. This supplemental data is used at the receiving side to extract the data from the encapsulated data packet. This packing of data at each layer is known as data encapsulation as seen in Figure 2 below. The reverse process of encapsulation (or de-capsulation) occurs when data is received on the destination computer. As the data moves up from the lower layer to the upper layer of TCP/IP protocol stack (incoming transmission), each layer unpacks the corresponding header and uses the information contained in the header to deliver the packet to the exact network application waiting for the data [7].

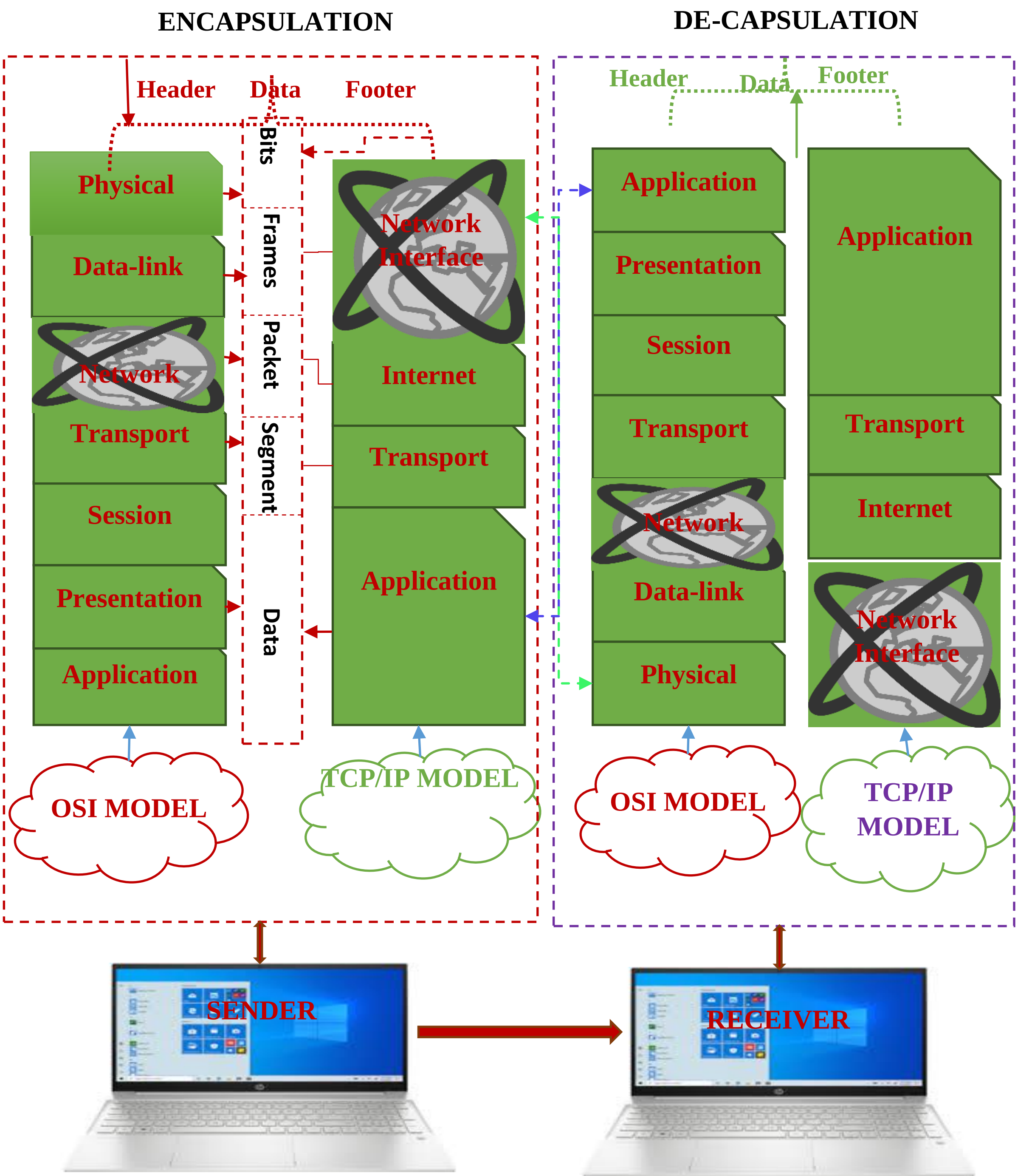

Figure 2: ENCAPSULATION AND DE-CAPSULATION OF OSI AND TCP/IP MODEL

III. CONCLUSION

This paper presented the ideal differences between the OSI and TCP/IP models in their areas of the number of layers, header sizes and their connection interface. More so, the OSI model encapsulates at the sender's side from upper layer(Application layer) to lower layer(Physical layer) while the TCP/IP model de-capsulates at the receiver's side from lower layer(network interface/link) to the upper layer(Application layer). The trending model used due to their availability and low-cost is the TCP/IP model because of the featured connection and connectionless interface in routing and addressing support in their network interface.

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