Chapter 2: OSI Model & TCP/IP

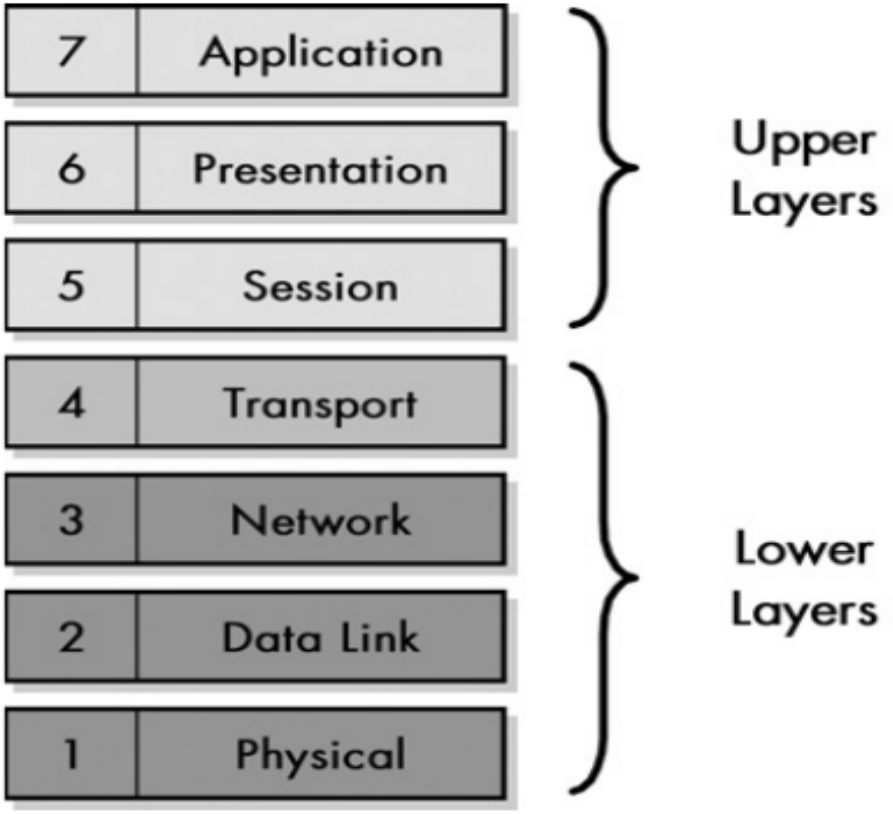
Objectives:

- To discuss the idea of multiple layering in data communication and networking.
- To discuss OSI model and its layer architecture.
- To briefly discuss the functions of each layer in the OSI model.
- To introduce the TCP/IP protocol suite and compare its layer with the ones in the OSI model.
- To show functionality of each layer in the TCP/IP protocol with some examples.
- To discuss the addressing mechanisms used in some layers of the TCP/IP protocol suite for the delivery of a message from the source to the destination.

History of the OSI Reference Model

- The International Standards Organization (ISO) created a model called the Open Systems Interconnection (OSI), which allows diverse systems to communicate. The seven-layer OSI model provides guidelines for the development of universally compatible networking protocols.
- The model defines a set of layers and a number of concepts for their use that make understanding networks easier.
- It was first introduced in the late 1970s by International Organization for Standardization (ISO).

OSI Model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Application
6
Presentation
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Session
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Transport
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Network
2
Data Link
1
Physical
Upper Layers
Lower Layers

Physical Layer (L1)

Physical Layer Functions:

- **Definition of Hardware Specifications:** Operation of cables, connectors, wireless radio transceivers, network interface cards are generally a function of the physical layer.
- **Encoding and Signaling:** Transform the data from bits that reside within a computer or other device into signals that can be sent over the network.
- **Data Transmission and Reception:** Transmits the data, and receives it.

Data Link Layer (L2)

Data Link Layer Functions:

- **Logical Link Control (LLC):** Refers to the functions required for the establishment and control of logical links between local devices on a network.
- **Media Access Control (MAC):** This refers to the procedures used by devices to control access to the network medium.
- **Data Framing:** The DDL is responsible for the final encapsulation of higher-level messages into frames that are sent over the network at the physical layer.
- **Addressing:** Each device on a network has a unique number, called a hardware address or MAC address, that is used to ensure that data intended for a specific machine gets to it properly.
- **Error Detection and Handling:** Handles errors that occur at the lower levels of the network stack. For example, a cyclic redundancy check (CRC) field is often employed to allow the station receiving data to detect if it was received correctly.

Network Layer (L3)

Network Layer Functions:

- **Logical Addressing:** Every device that communicates over a network has associated with it a logical address. Called Internet Protocol (IP) address.
- **Routing:** Moving data across a series of interconnected networks is probably the defining function of the network layer.
- **Datagram Encapsulation:** Encapsulates messages received from higher layers by placing them into datagrams (also called packets) with a network layer header.

Network Layer (L3) Cont'd

Network Layer Functions:

- **Fragmentation and Reassembly:** If the packet that the network layer wants to send is too large, the network layer must split the packet up, send each piece to the data link layer, and then have pieces reassembled once they arrive at the network layer on the destination machine.
- **Error Handling and Diagnostics:** Special protocols are used at the network layer to allow devices that are logically connected, or that are trying to route traffic, to exchange information about the status of hosts on the network or the devices themselves.

Transport Layer (L4)

Transport Layer Functions:

- **Process-Level Addressing:** Addressing is also performed at the transport layer, where it is used to differentiate between software programs. The best example of transport-layer process-level addressing is the TCP and UDP port number.
- **Segmentation, Packaging and Reassembly:** Segments the large amounts of data it sends over the network into smaller pieces on the source machine, and then reassemble them on the destination machine.
- **Connection Establishment, Management and Termination:** Connection-oriented protocols are required to establish a connection, maintain it as data is sent over it, and then terminate the connection when it is no longer required.

Session Layer (L6)

Session Layer Functions:

- It establishes, maintains and synchronizes the interaction between communicating systems.
- **Dialog Control:** It allows the communication between two process to take place in either half duplex or full-duplex mode.
- **Synchronization:** Example, if a system is sending a file of 2,000 pages, it is advisable to insert checkpoints after every 100 pages to ensure that each 100-page unit is received and acknowledged independently.

Presentation Layer (L6)

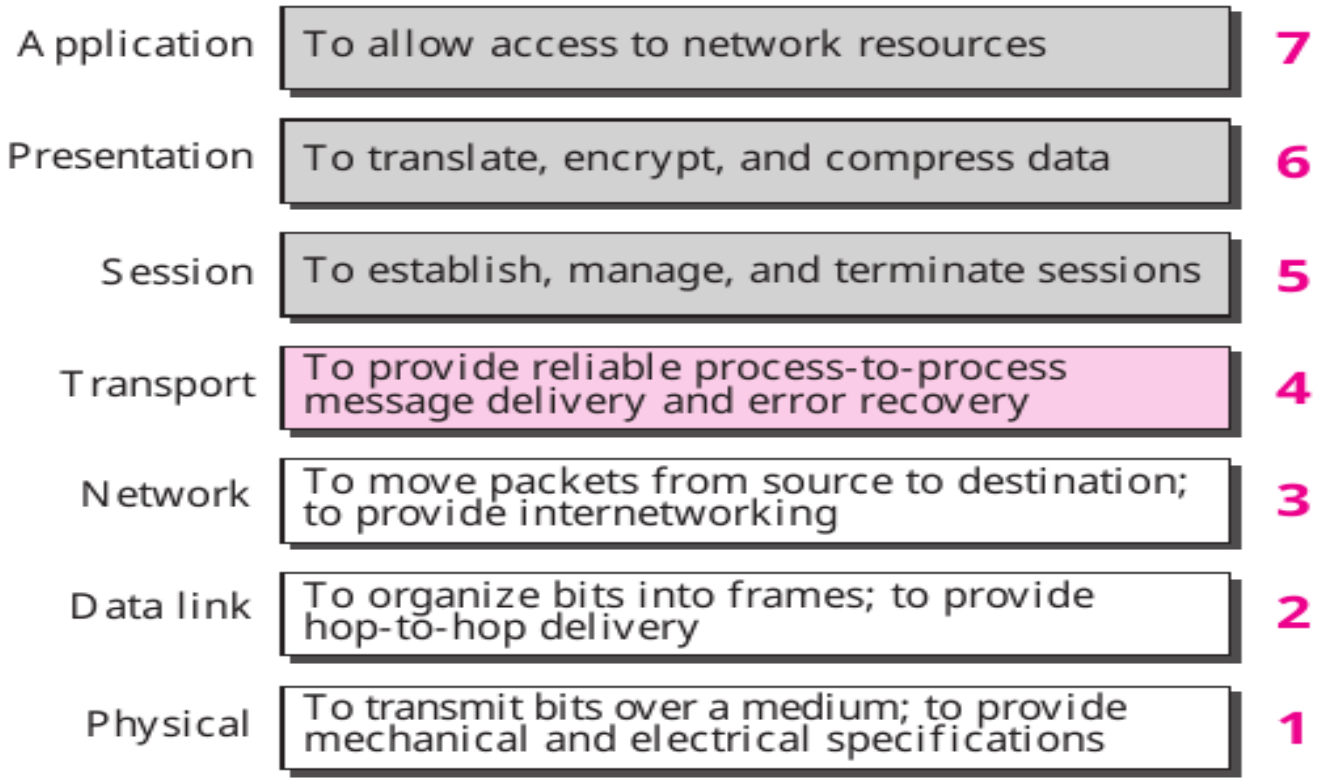
Presentation Layer Functions:

- **Translation:** Different types of computers together: PCs, Macintoshes, UNIX systems. These systems have many distinct characteristics and represent data in different ways. This layer handles the job of hiding these differences between machines.
- **Compression:** Compression (and decompression) may be done at the presentation layer to improve the throughput of data.
- **Encryption:** Some types of encryption (and decryption) are performed at the presentation layer. This ensures the security of the data as it travels down the protocol stack.

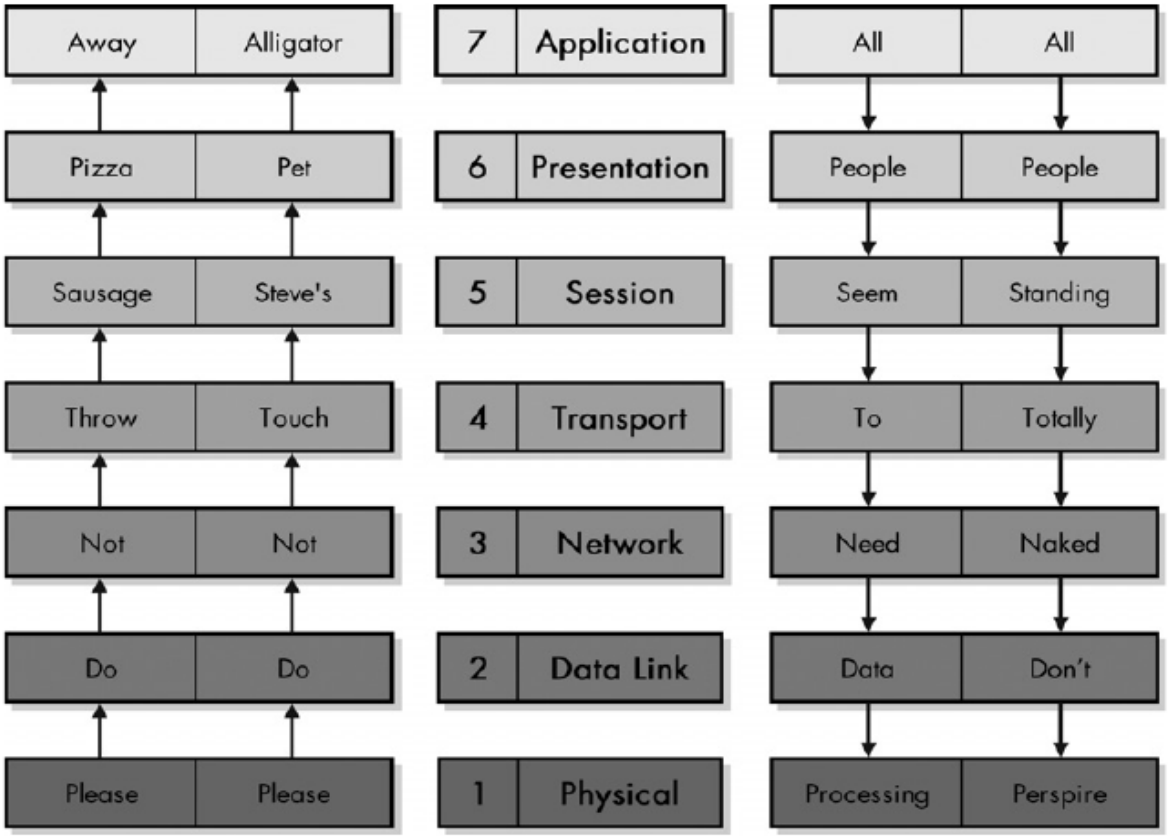
Application Layer (L7)

- The application layer enables the user, whether human or software, to access the network. It provides user interface and support for services such as electronic mail, remote file access and transfer, shared database management.
- There are dozens of different application layer protocols that enable various functions at this layer. Some of the most popular ones include HTTP, FTP, SMTP, DHCP, SSH, Telnet, SNMP, POP3 and NTP.

Summary of OSI Layers



OSI Reference Model Layer Mnemonics



Part 1 is Done :)