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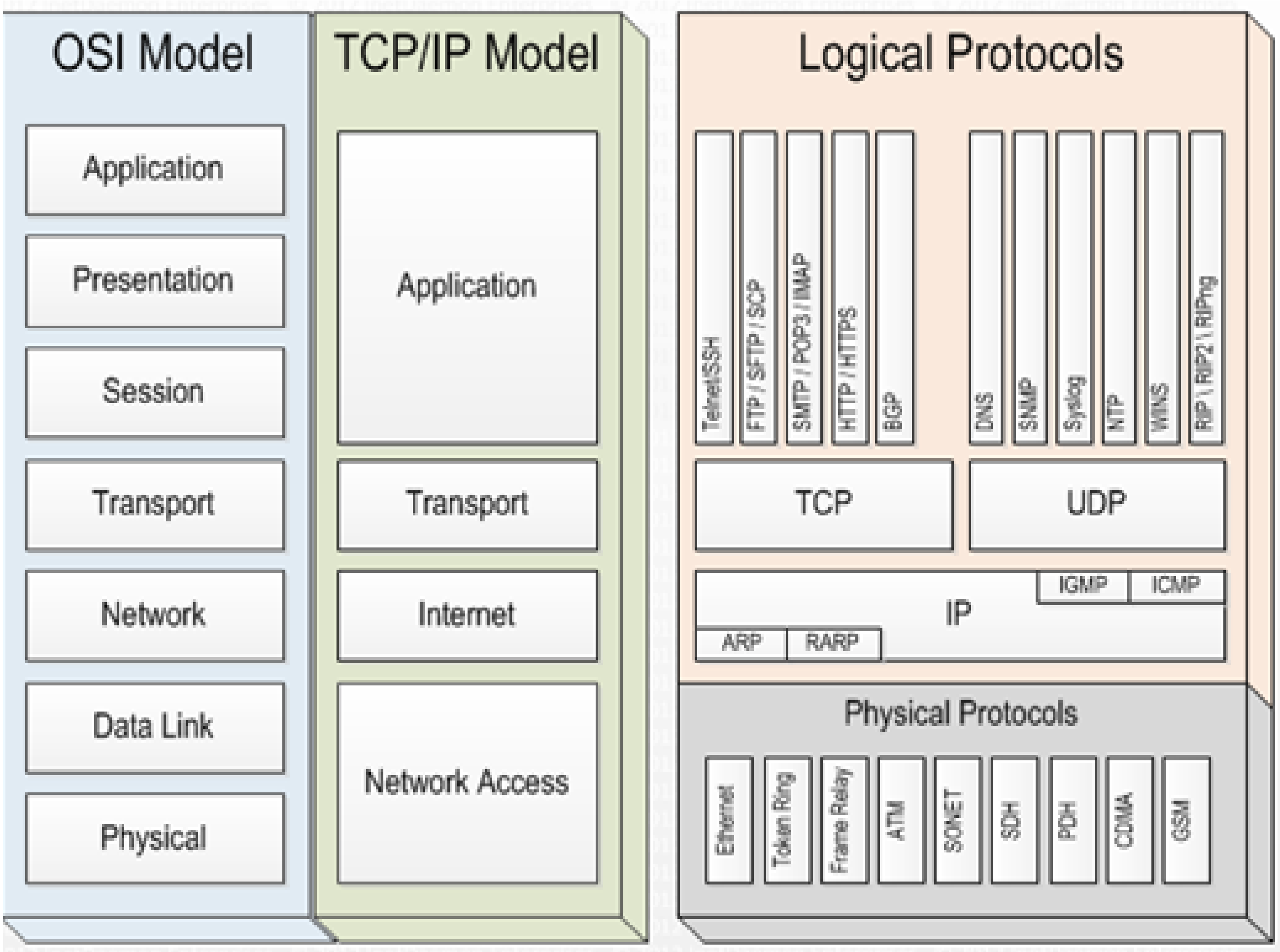
Computer Networks

Part 2

(The OSI Model and the TCP/IP Protocol Suite)



2.1 The Open Systems Interconnection (OSI) model

Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards. An ISO standard that covers all aspects of network communications is the Open Systems Interconnection model. It was first introduced in the late 1970s. An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture. The purpose of the OSI model is to show how to facilitate communication between different systems without requiring changes to the 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 is flexible, robust, and interoperable. The OSI model is a layered framework for the design of network systems that allows communication between all types of computer systems. It consists of seven separate but related layers, each of which defines a part of the process of moving information across a network as shown in figure 2.1. An understanding of the fundamentals of the OSI model provides a solid basis for exploring data communications.

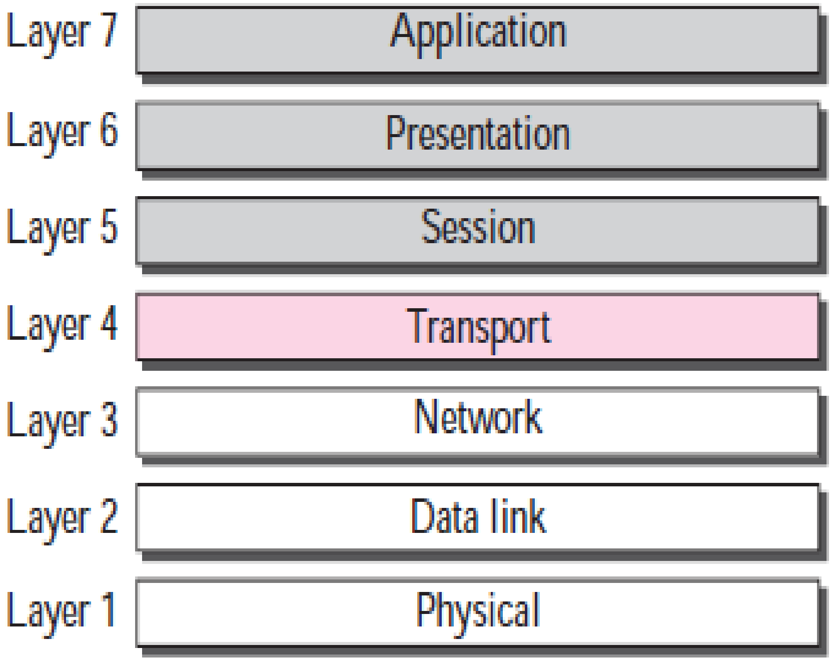


Figure 2.1 The OSI model

2.2 Organizing of the Layers

The OSI model is composed of seven ordered layers: physical (layer 1), data link (layer 2), network (layer 3), transport (layer 4), session (layer 5), presentation (layer 6), and application (layer 7). The seven layers can be thought of as belonging to three subgroups. Layers 1, 2, and 3—physical, data link, and network—are the network support layers; they deal with the physical aspects of moving data from one device to another (such as electrical specifications, physical connections, physical addressing, and transport timing and reliability). Layers 5, 6, and 7—session, presentation, and application—can be thought of as the user support layers; they allow interoperability among unrelated software systems. Layer 4, the transport layer, links the two subgroups and ensures that what the lower layers have transmitted is in a form that the upper layers can use. The upper OSI layers are almost always implemented in software; lower layers are a combination of hardware and software, except for the physical layer, which is mostly hardware. In figure 2.2, which gives an overall view of the OSI layers, D7 data means the data unit at layer 7, D6 data means the data unit at layer 6, and so on. The process starts at layer 7 (the application layer), then moves from layer to layer in descending, sequential order. At each layer, a header can be added to the data unit. At layer 2, a trailer may also be added. When the formatted data unit passes through the physical layer (layer 1), it is changed into an electromagnetic signal and transported along a physical link.

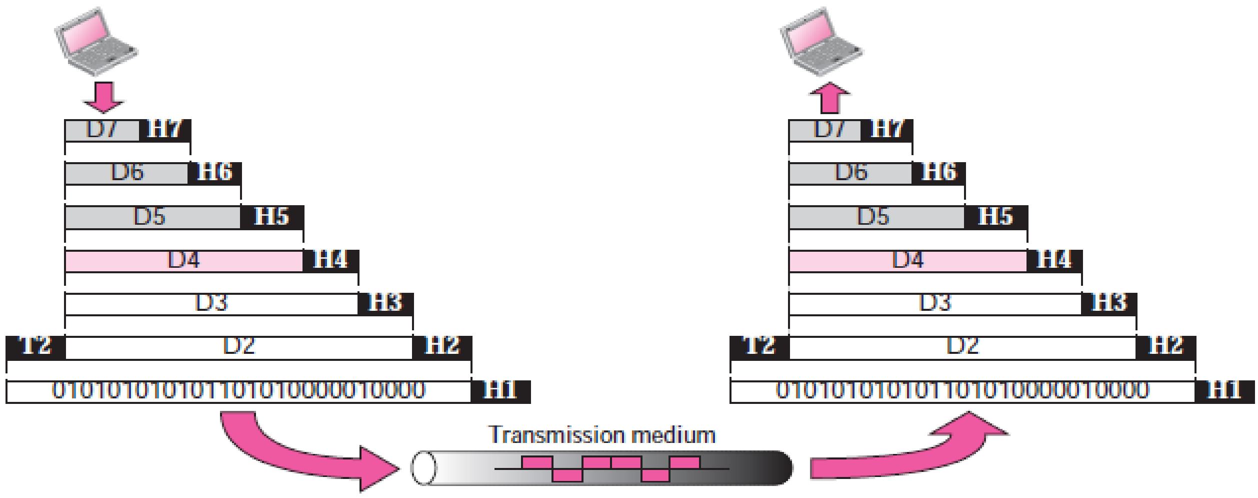


Figure 2.2 An exchange using the OSI model

Upon reaching its destination, the signal passes into layer 1 and is transformed back into digital form. The data units then move back up through the OSI layers. As each block of data reaches the next higher layer, the headers and trailers attached to it at the corresponding sending layer are removed, and actions appropriate to that layer are taken. By the time it reaches layer 7, the message is again in a form appropriate to the application and is made available to the recipient.

2.3 DATA ENCAPSULATION & DECAPSULATION IN THE OSI MODEL

Figure 2.2 reveals another aspect of data communications in the OSI model: encapsulation. A packet at level 7 is encapsulated in the packet at level 6. The whole packet at level 6 is encapsulated in a packet at level 5, and so on. In other words, the data part of a packet at level N is carrying the whole packet (data and overhead) from level $N + 1$. The concept is called ***encapsulation*** because level N is not aware what part of the encapsulated packet is data and what part is the header or trailer, figure 2.3 shows Data Encapsulation & Decapsulation in the OSI model.

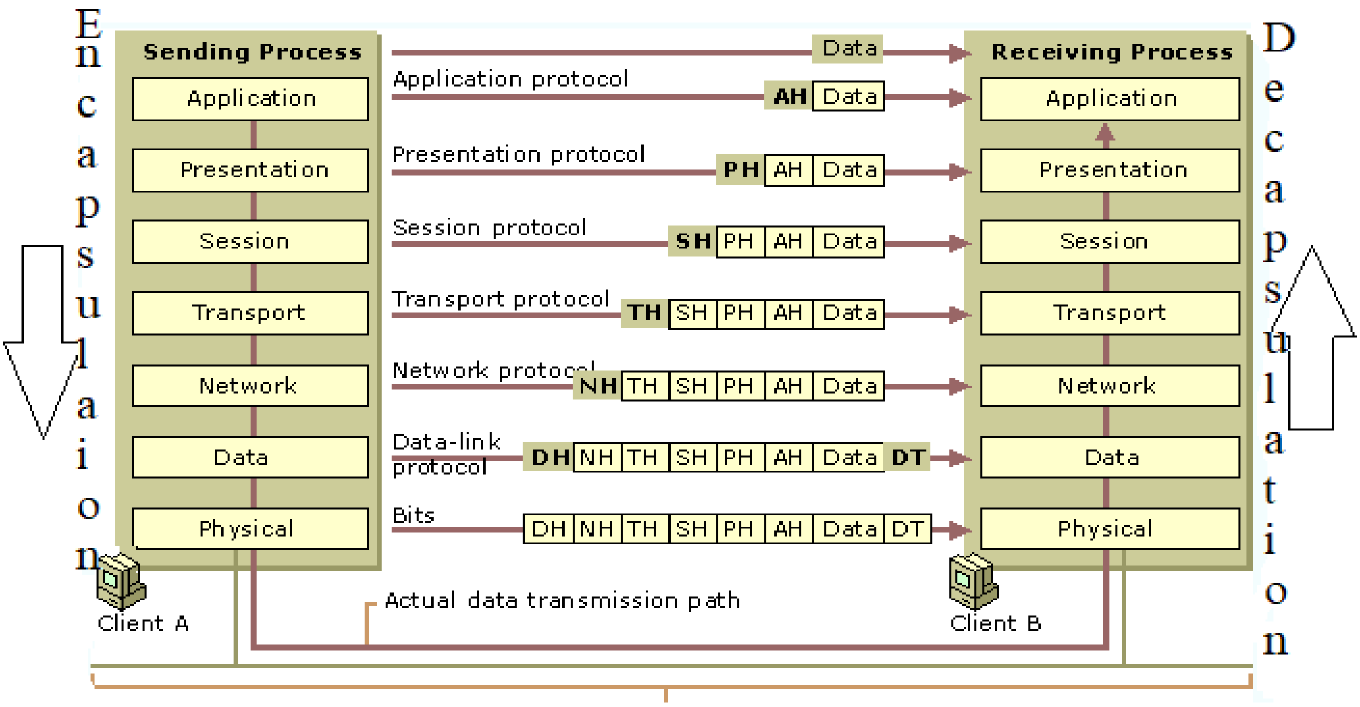


Figure 2.3 Data Encapsulation & Decapsulation in the OSI model

The ***Encapsulation*** process describes the headers and trailers that are added by the layers, while ***Decapsulation*** is the process of removing the header and trailer information from a packet, as it moves toward its destination as shown in the figure 2.4. The destination device receives the data in its original form.

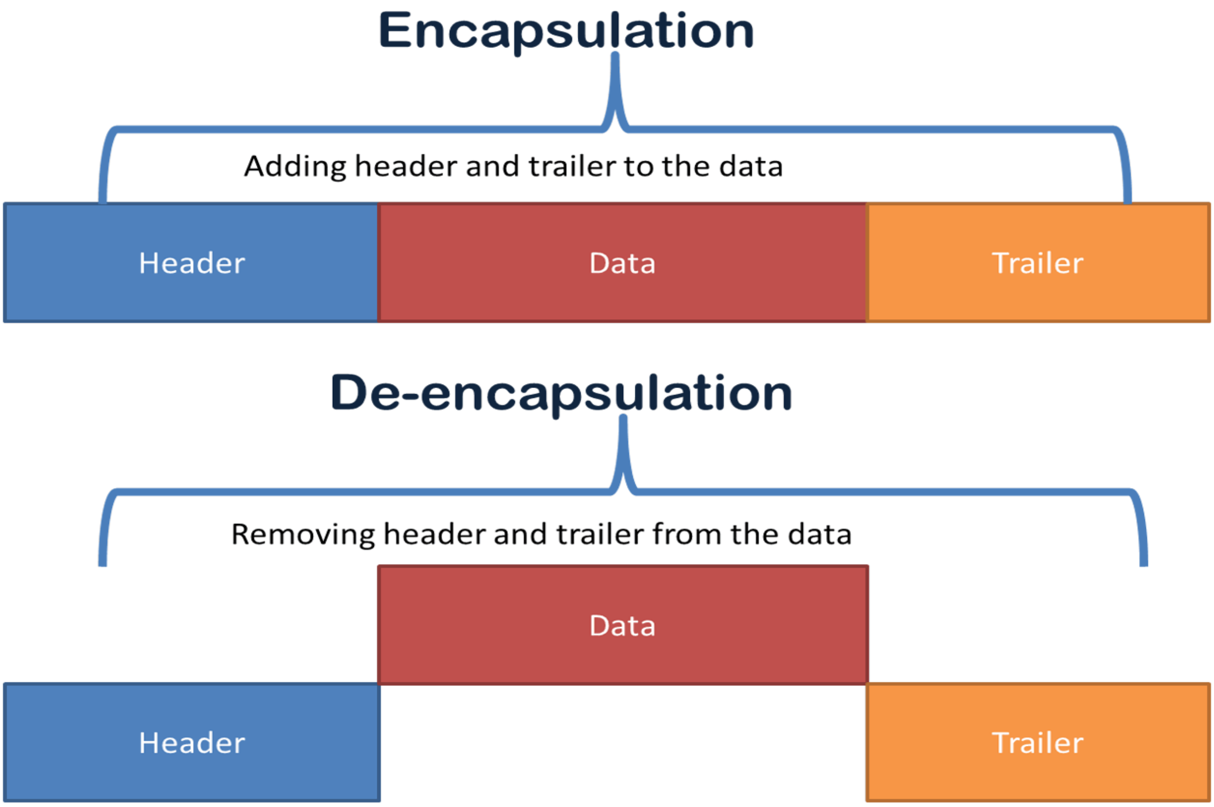


Figure 2.4 Diagrams of Data Encapsulation & Decapsulation.

2.4 Layers in the OSI Model

This section describes briefly the functions of each layer in the OSI model.

2.4.1 Physical Layer

The physical layer coordinates the functions required to carry a bit stream over a physical medium. It deals with the mechanical and electrical specifications of the interface and transmission media. ***The physical layer is responsible for moving individual bits from one (node) to the next***. The physical layer is also concerned with the following:

- **Physical characteristics of interfaces and media.** The physical layer defines the characteristics of the interface between the devices and the transmission media. It also defines the type of transmission media.

- **Representation of bits.** The physical layer data consists of a stream of bits (sequence of 0s or 1s) with no interpretation. To be transmitted, bits must be encoded into signals—electrical or optical. The physical layer defines the type of encoding (how 0s and 1s are changed to signals).
- **Data rate.** The transmission rate is the number of bits sent each second, it is also defined by the physical layer. In other words, the physical layer defines the duration of a bit, which is how long it lasts.
- **Synchronization of bits.** The sender and receiver must not only use the same bit rate but must also 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 to the media. In a point-to-point configuration, two devices are connected together through a dedicated link. In a multipoint configuration, a link is shared between several devices.
- **Physical topology.** The physical topology defines how devices are connected to make a network. Devices can be connected using a mesh topology (every device connected to every other device), a star topology (devices are connected through a central device), a ring topology (each device is connected to the next, forming a ring), or a bus topology (every device on a common link).
- **Transmission mode.** The physical layer also defines the direction of transmission between two devices: simplex, half-duplex, or full-duplex.