OSI Reference Model

The main objectives of lecture 4:

To discuss the idea of multiple layering in data communication and networking and the interrelationship between layers.

To discuss the OSI model and its layer architecture and to show the interface between the layers.

To briefly discuss the functions of each layer in the OSI model.

Principles of Protocol Layering

There are two principles of protocol layering:

First Principle: Each layer must be able to perform two opposite tasks, one in each direction. For example: The six layer needs to be able to encrypt and decrypt in OSI.

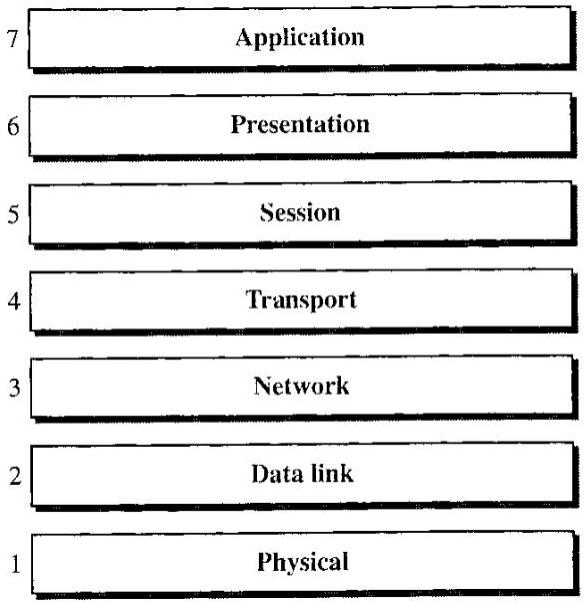
Second Principle: The second principle that we need to follow in protocol layering is that the two objects under each layer at both sites should be identical.

OSI Model:

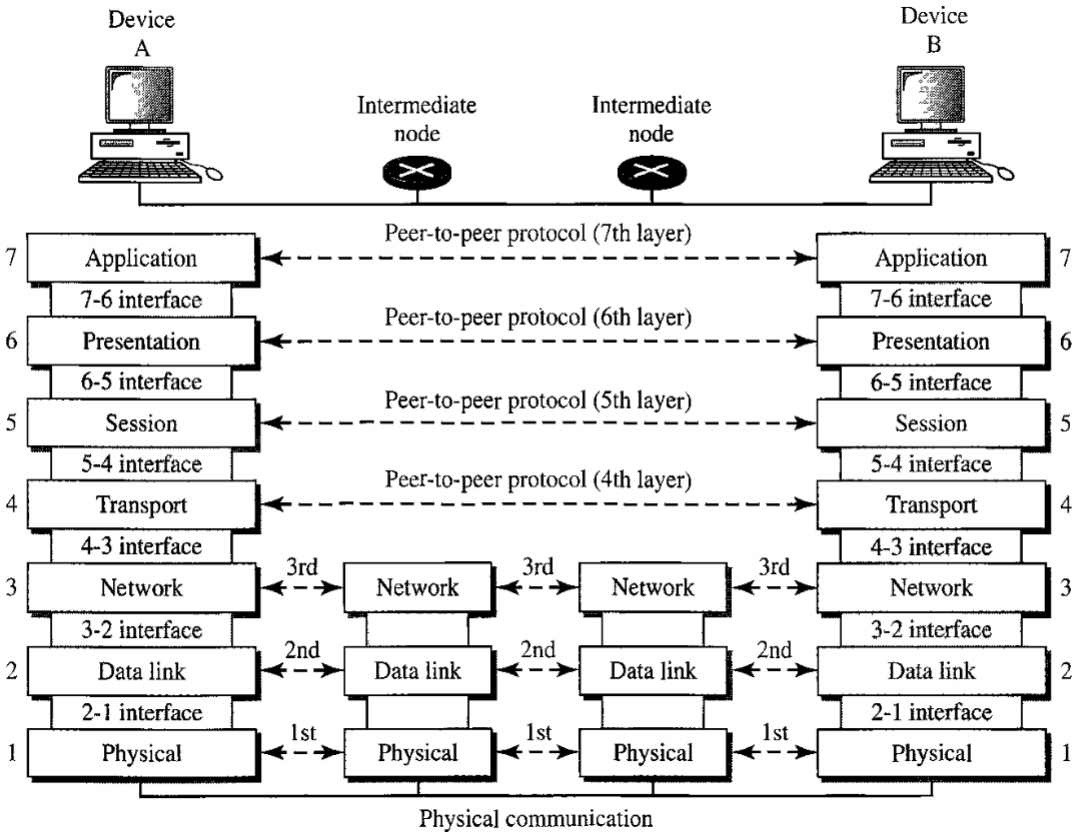
An *open system* is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture.

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***.

It consists of seven separate but related layers, each of which defines a part of the process of moving information across a network (see the following figure).

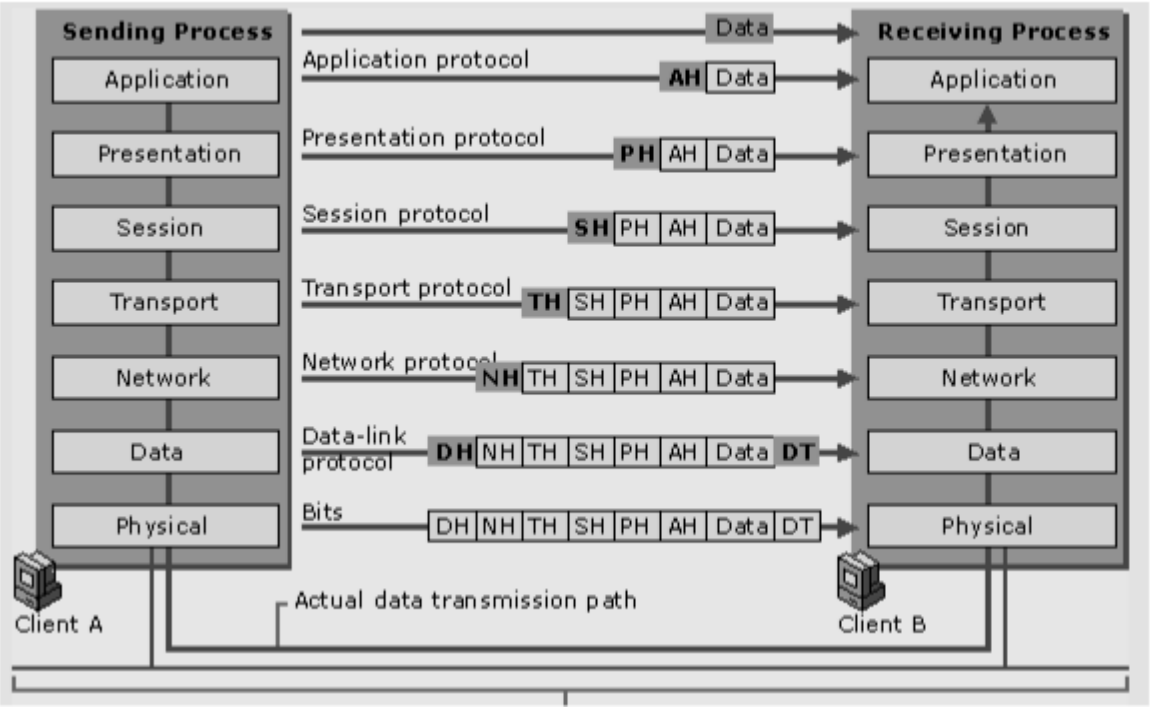


Let sender A and receiver B want to communicate with each other then the scenario of the communication can be shown in the next figure. As the message travels from A to B, it may pass through many intermediate nodes. These intermediate nodes usually involve only the first three layers of the OSI model. Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole package to the layer just below it. At layer 1 the entire package is converted to a form that can be transmitted to the receiving device. At the receiving machine, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it.



Organization of the Layers:

The following figure gives an overall view of the OSI layers, D7 means the data unit at layer 7, D6 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, or possibly a trailer, can be added to the data unit. Commonly, the trailer is added only at layer 2. 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.



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. Each packet at level 7 is encapsulated in a packet at level 6. The whole packet at level 6 is encapsulated in a packet at level 5, and so on. This concept is called encapsulation. Depending on the encapsulation, level N-1 is not aware of which part of the encapsulated packet is data and which part is the header or trailer. For level N- 1, the whole packet coming from level N is treated as one integral unit.

4. Layer in OSI Model:

In this section, we will explain in brief the functions of each layer:

Physical layer: the main functions of this layer can be summarized as 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**—the number of bits sent each second—is also defined by the physical layer. In other words, the physical layer defines the duration of a bit.
- Synchronization of bits.
- Line configuration (**point-to-point configuration** or **multipoint configuration**).
- Physical topology.
- Transmission mode (simplex, half-duplex, or full-duplex).

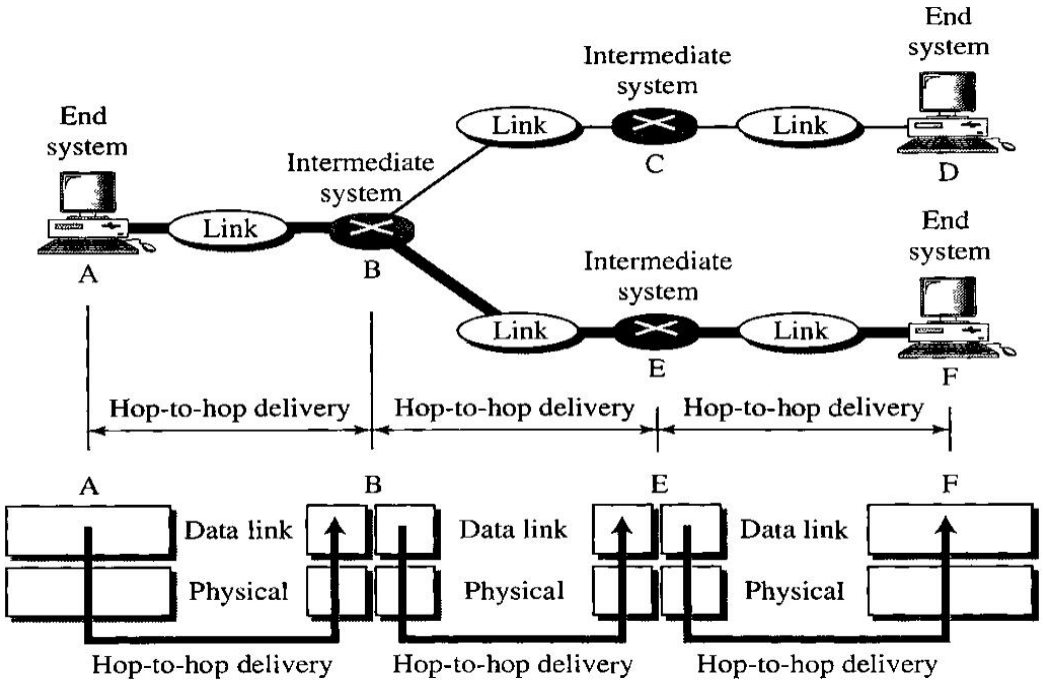
Data Link Layer: The data link layer is responsible for moving frames from one hop (node) to the next. To do that there are some functions:

- Framing: The data link layer divides the stream of bits received from the network layer into manageable data units called frames.
- Physical addressing. If frames are to be distributed to different systems on the network by using physical address.
- Flow control: it is used to avoid overwhelming the receiver once the transmission rate is greater than the receiving rate.

Error control.

Access control: When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time.

The following figure shows communication at the data link layer occurs between two adjacent nodes. Note that the frames that are exchanged between the three nodes have different values in the headers.



Network Layer: it is responsible for the source-to-destination delivery of a packet, possibly across multiple networks (links). to do that there are some services:

Logical addressing.

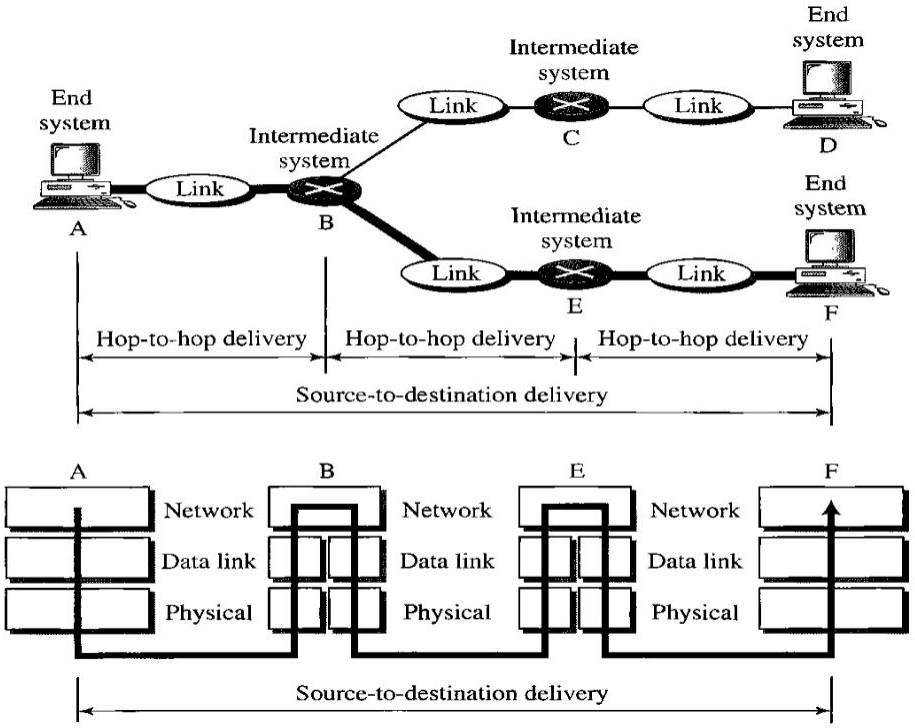
Routing: it is the mechanism that routes or switches the packets to their final destination.

Congestion control.

Provisioning of QoS.

Note that if two systems are connected to the same link, there is usually no need for a network layer.

The following illustrates end-to-end delivery by the network layer:



Transport Layer: The transport layer is responsible for process-to-process delivery of the entire message. Other functions:

Ensuring that the whole message arrives intact and in order.

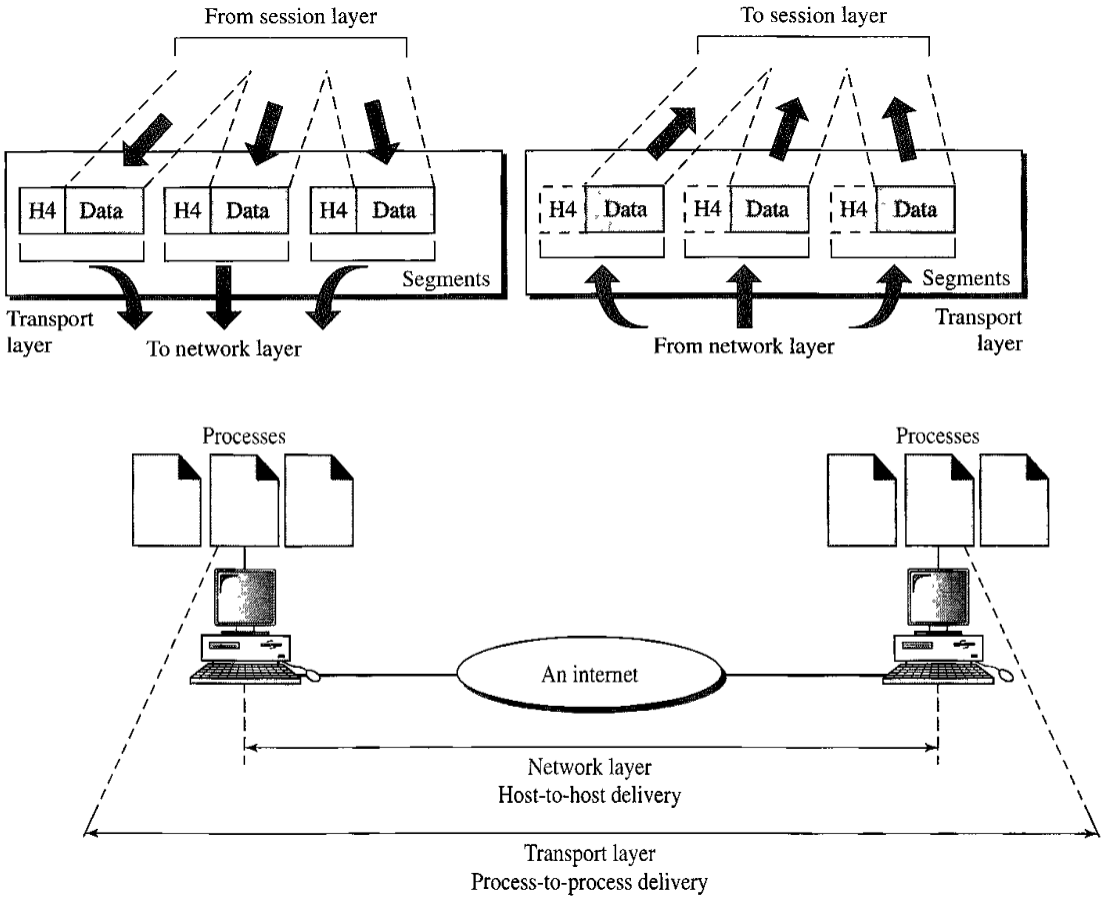
Service-point addressing: a program on the source machine carries on a conversation with a similar program on the destination machine, using the message headers and control messages (true end-to-end layer).

Segmentation and reassembly: A message is divided into transmittable segments, with each segment containing a sequence number.

Connection control: (connectionless or connection-oriented).

Flow control: end to end flow control.

Error control: error control at this layer is performed process-to-process rather than across a single link (damage, loss, or duplication).

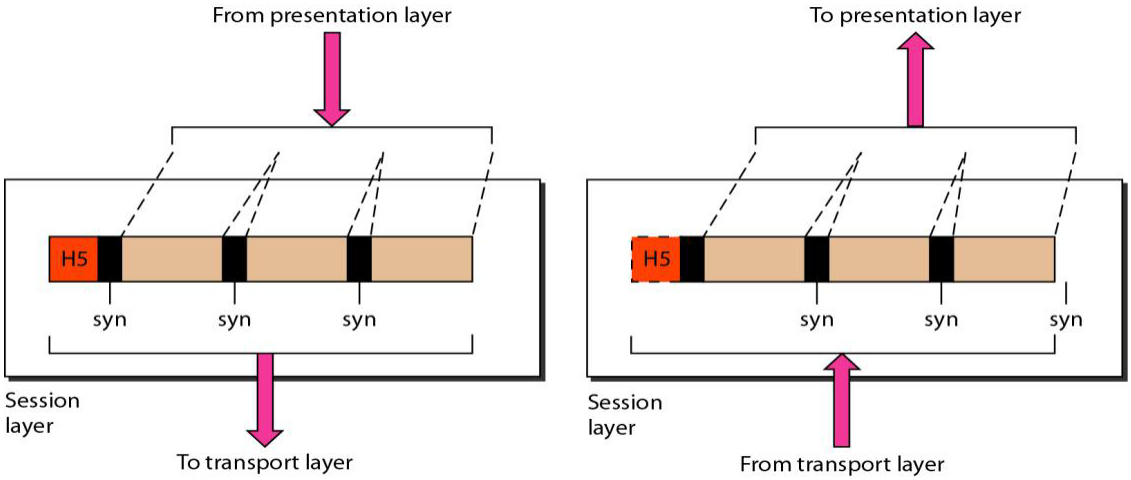


The session layer: it is the network dialog controller. It establishes, maintains, and synchronizes the interaction among communicating systems. Specific responsibilities of the session layer include the following:

Dialog control: it allows the communication between two processes to take place in either half-duplex (one way at a time)

or full-duplex (two ways at a time) mode.

Synchronization: it allows a process to add checkpoints, or synchronization points, to a stream of data.



The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems. Specific responsibilities of the presentation layer include the following:

Translation: the presentation layer at the sender changes the information from its sender-dependent format into a common format. The presentation layer at the receiving machine changes the common format into its receiver-dependent format.

Encryption: the sender transforms the original information to another form and sends the resulting message out over the network. Decryption reverses the original process to transform the message back to its original form.

Compression: data compression reduces the number of bits contained in the information.

Application Layer: it enables the user, whether human or software, to access the network. It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared database management, and other types of distributed information services.

The summary of the functions of each layer shown in the following figure: