CSE-3101

Computer Networking

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Books

Computer Networks (7th Edition)
Andrew S. Tanenbaum

Data Communications and Networking (6th Edition)
Behrouz A. Forouzan

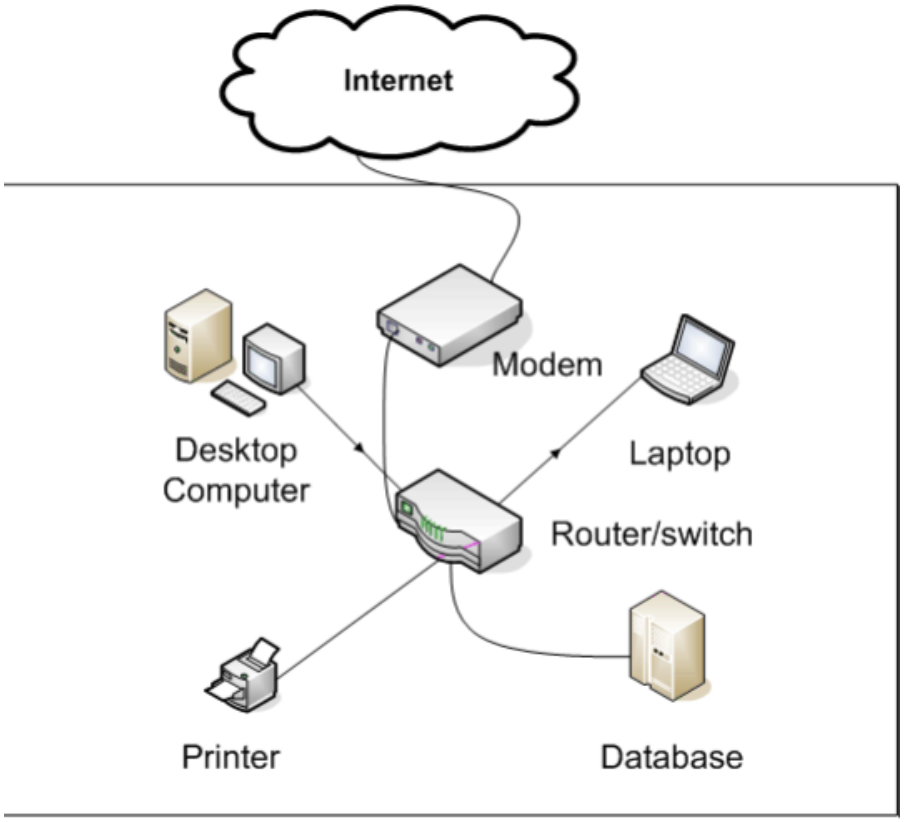
Data And Computer Communications
William Stallings

Computer Networks

✓The old model of a single computer serving all of the organization's computational needs has been replaced by one in which a large number of separate but interconnected computers do the job. These systems are called computer networks.

✓A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels and switches to facilitate communication and resource-sharing among a wide range of users.

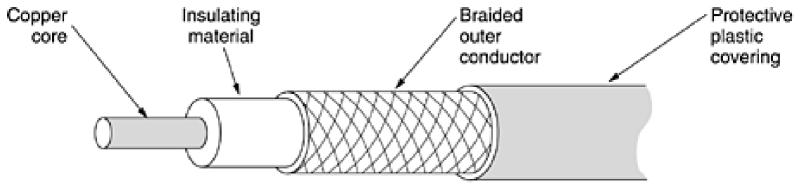
Components of Computer Network



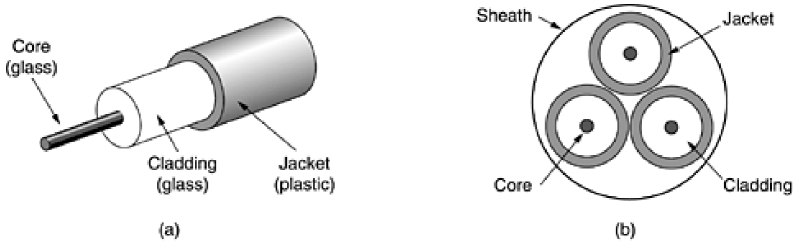
PC (Basically is a personal computer), NIC (Network Interface Card), Hub , Switch , Router, Cables, Connectors, Modems, connectors and physical transmission medium.

Physical Transmission Medium

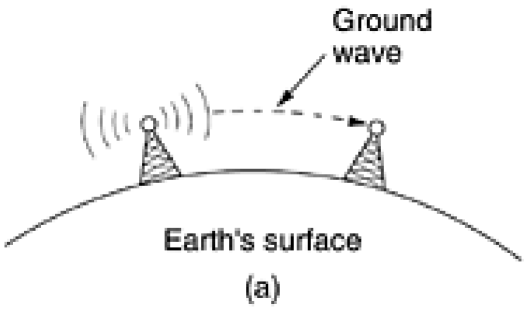
Unshielded Twisted Pair



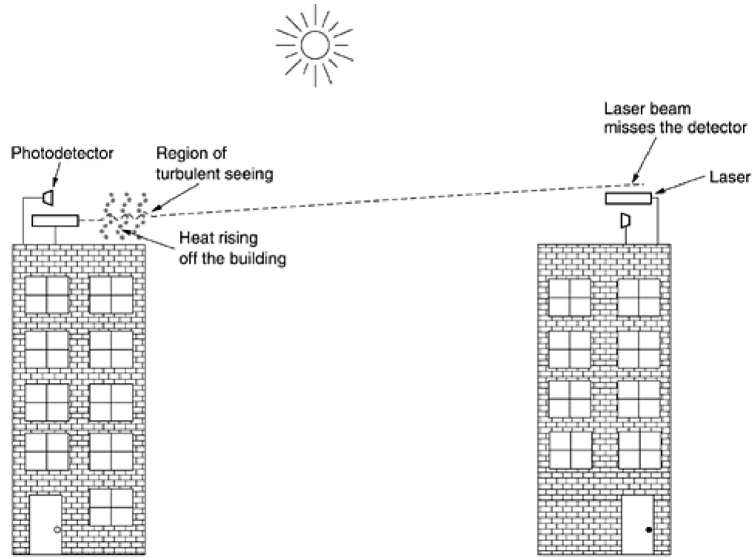
Coaxial Cable



Optical fibre

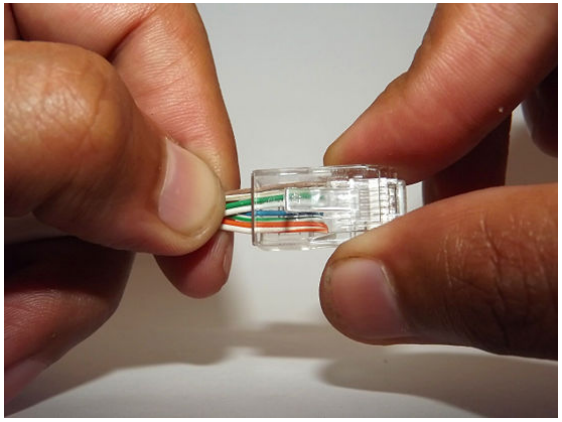


Wireless Communication



laser communication systems

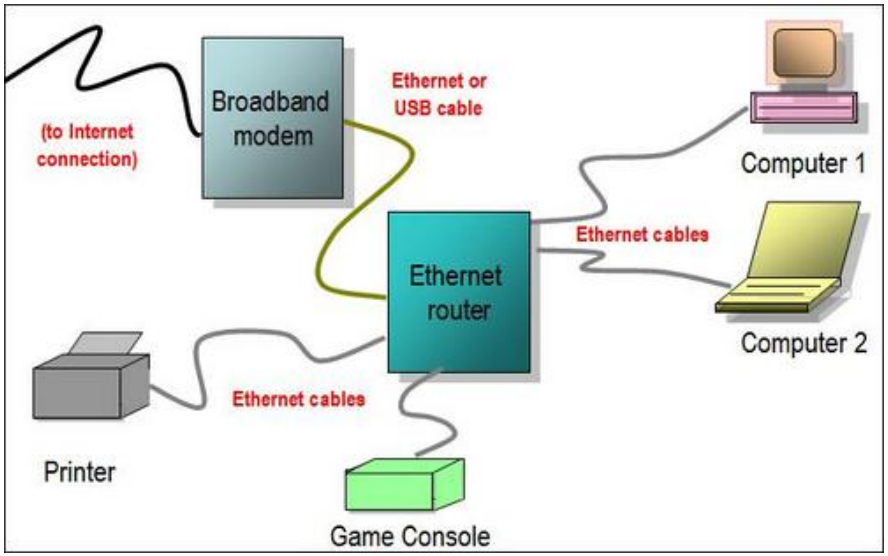
BNC
Connector



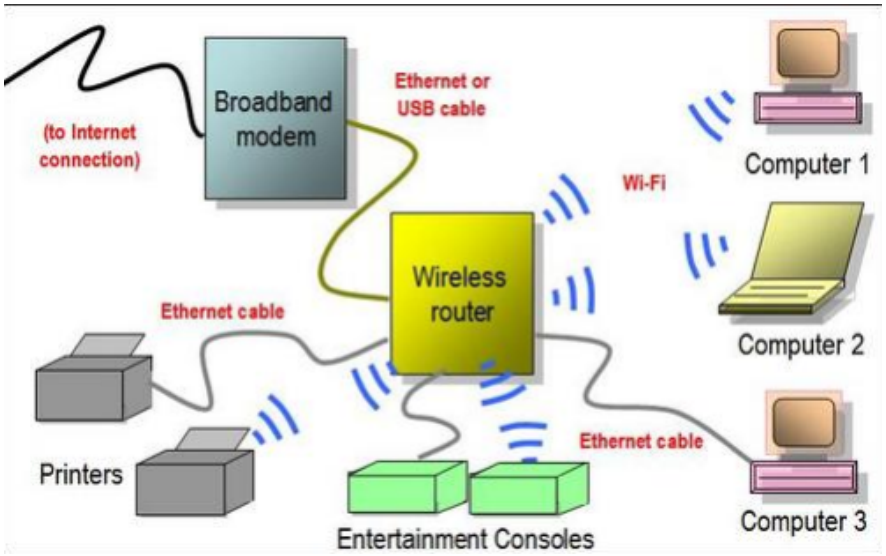
RJ45
Connector

Modem

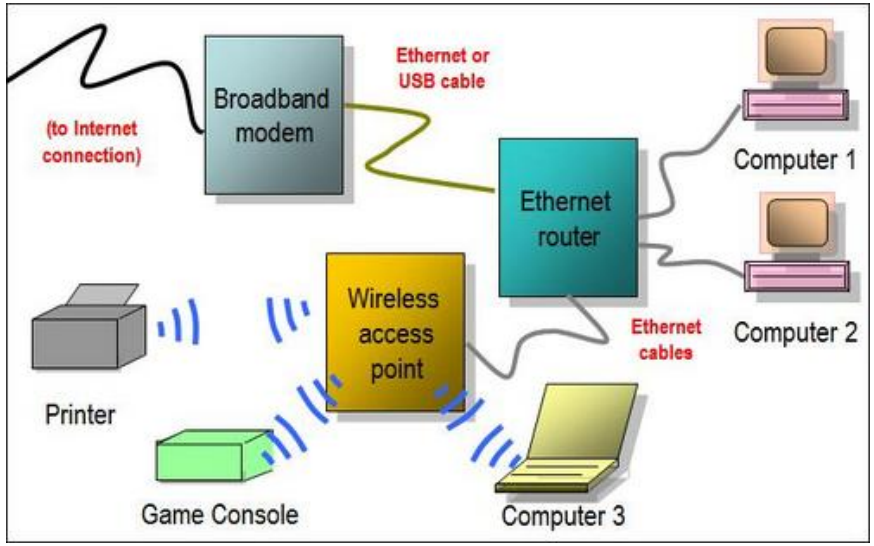
OLTE



Wired Network

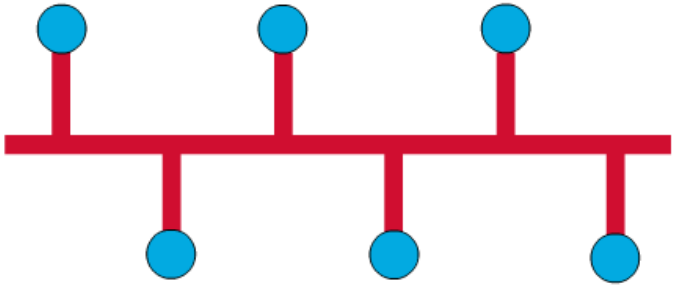


Wireless Network

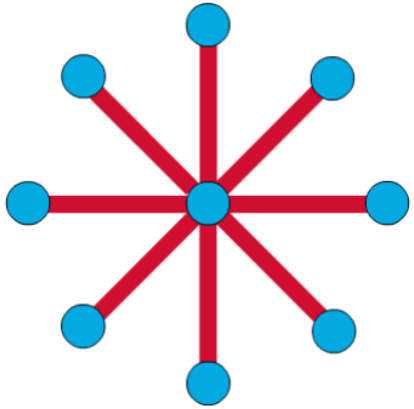


Hybrid Network

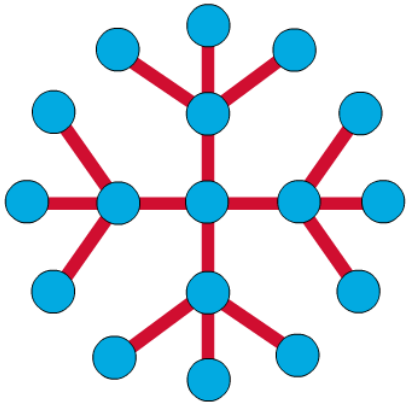
The **network topology** defines the way in which computers, printers, and other devices are connected.



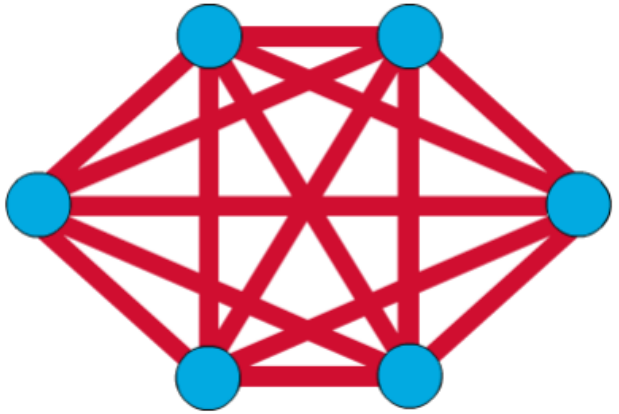
Commonly referred to as a linear bus, all the devices on a bus topology are connected by one single cable.



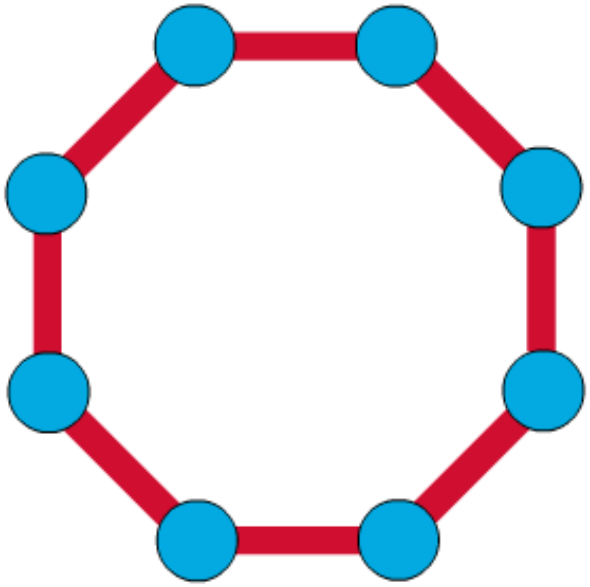
The star topology resembles spokes in a bicycle wheel

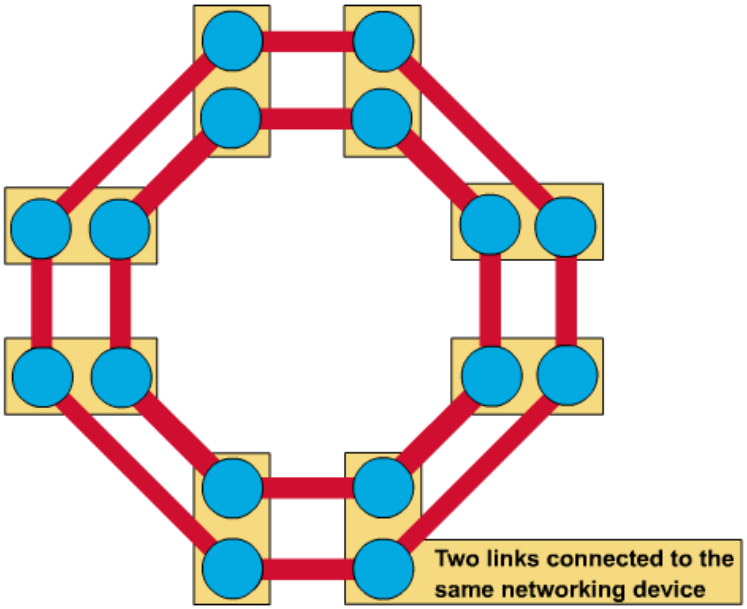


Larger networks use the extended star topology also called tree topology.



The mesh topology connects all devices (nodes) to each other





A frame travels around the ring, stopping at each node.

The dual ring topology allows data to be sent in both directions.

Protocol Hierarchies

✓To reduce design complexity, most networks are organized as a stack of layers or levels. The purpose of each layer is to offer certain services to the higher layers, shielding those layers from the details of how the offered services are actually implemented. In a sense each layer is a kind of virtual machine offering certain services to layer above it.

✓A protocol is an agreement between the communicating parties on how communication is to proceed.

Example-1

We use the concept of layers in our daily life. As an example, let us consider two friends who communicate through postal mail. The process of sending a letter to a friend would be complex if there were no services available from the post office.

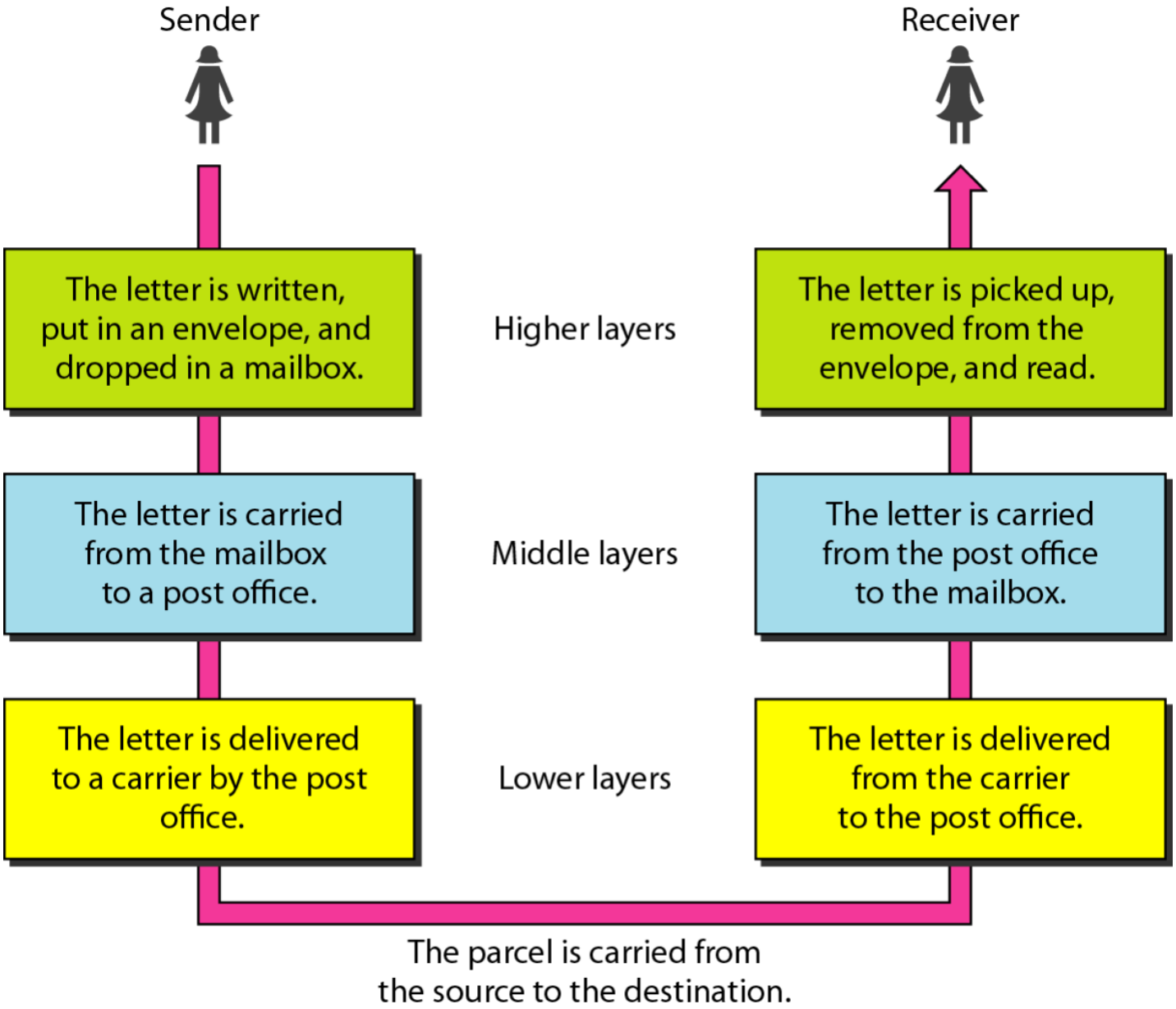


Fig.1 Tasks involved in sending a letter

A five-layer network is illustrated in fig.2. The entities comprising the corresponding layers on different machines are called peers. The peer may be process, hardware devices, or even human beings. In other words, it is the peers that communicate by using the protocol. A set of layers and protocols called network architecture.

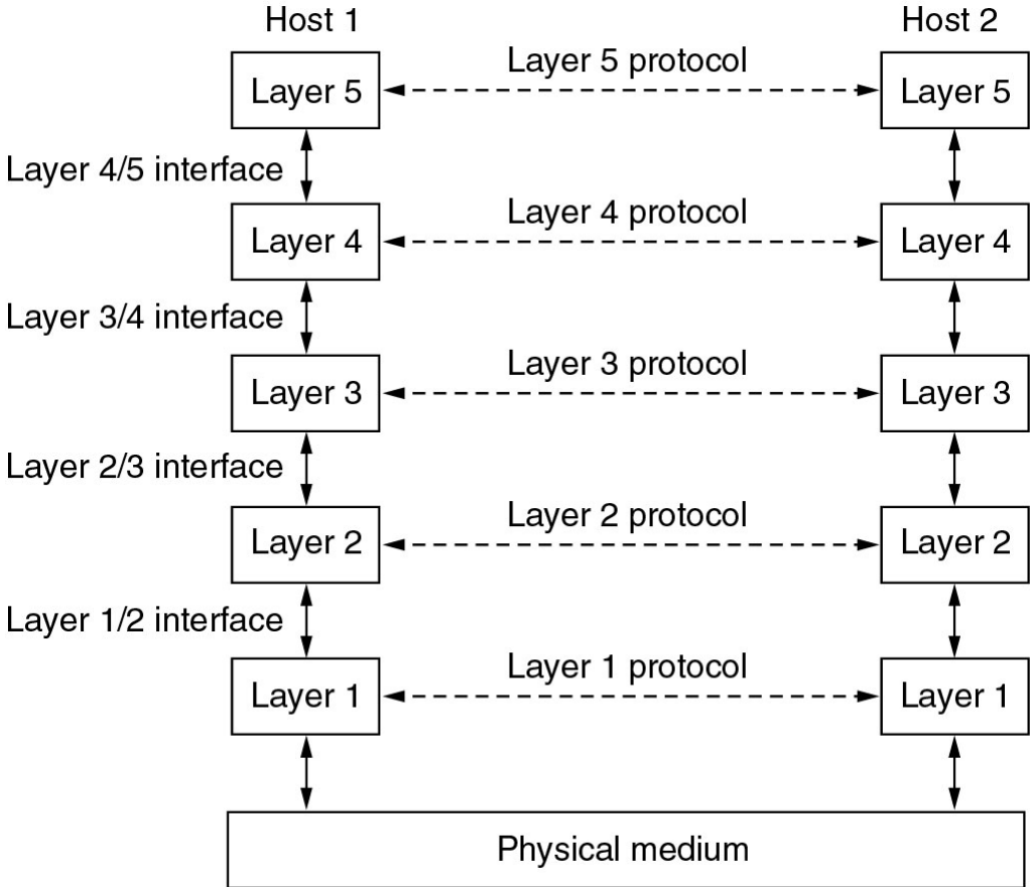


Fig.2 Layers, protocols, and interfaces

Example-2

An analogy may help explain the idea of multilayer communication.

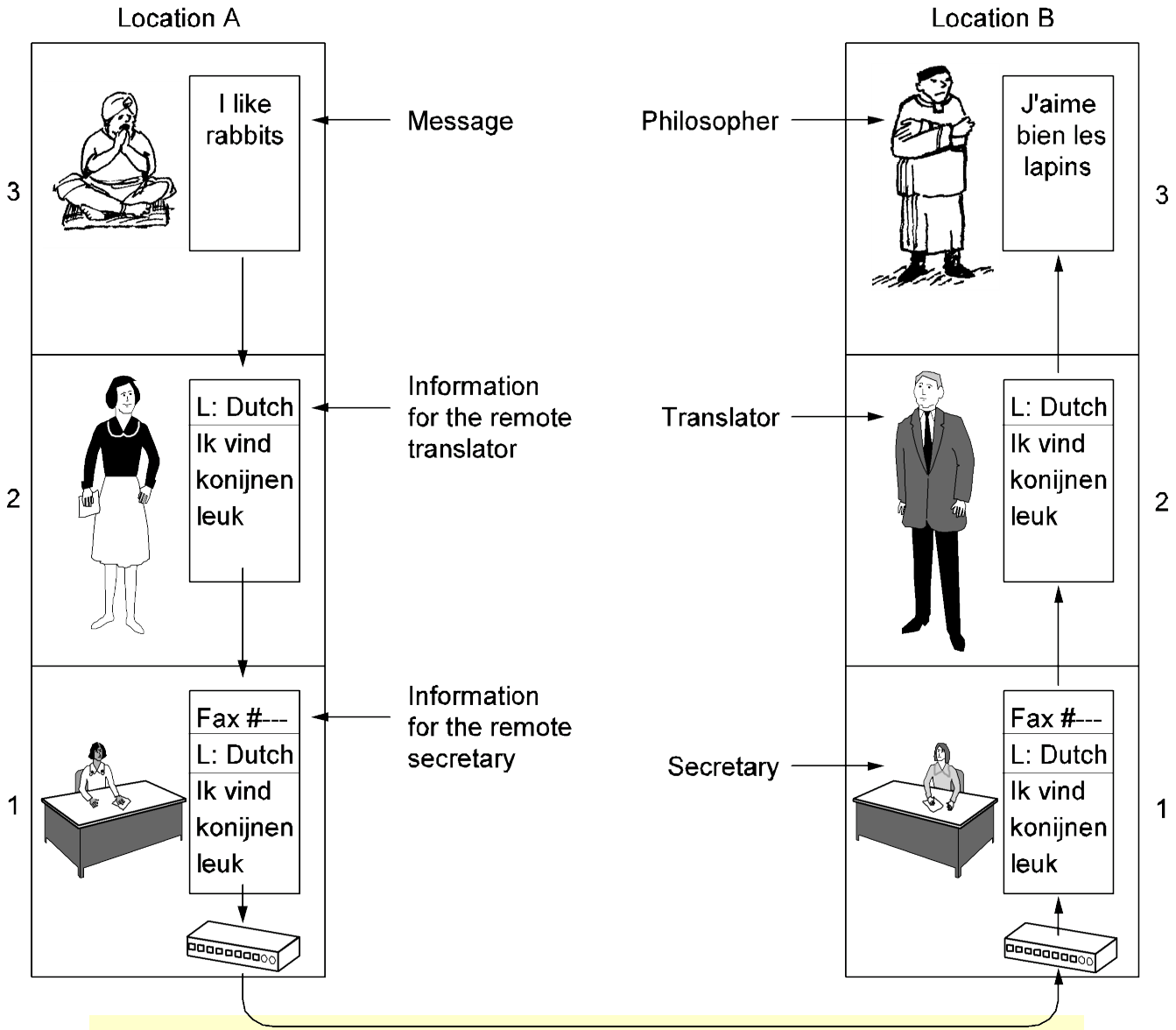


Fig.2 The philosopher-translator-secretary architecture

✓Imagine two philosophers (peer processes in layer 3), one of whom speaks Urdu and English and one of whom speaks Chinese and French.

✓Since they have no common language, they each engage a translator (peer processes at layer 2), each of whom in turn contacts a secretary (peer processes in layer 1). Philosopher -1 passes a message (in English) across the 2/3 interface to his translator, saying "I like rabbits," as illustrated in Fig. 1-14.

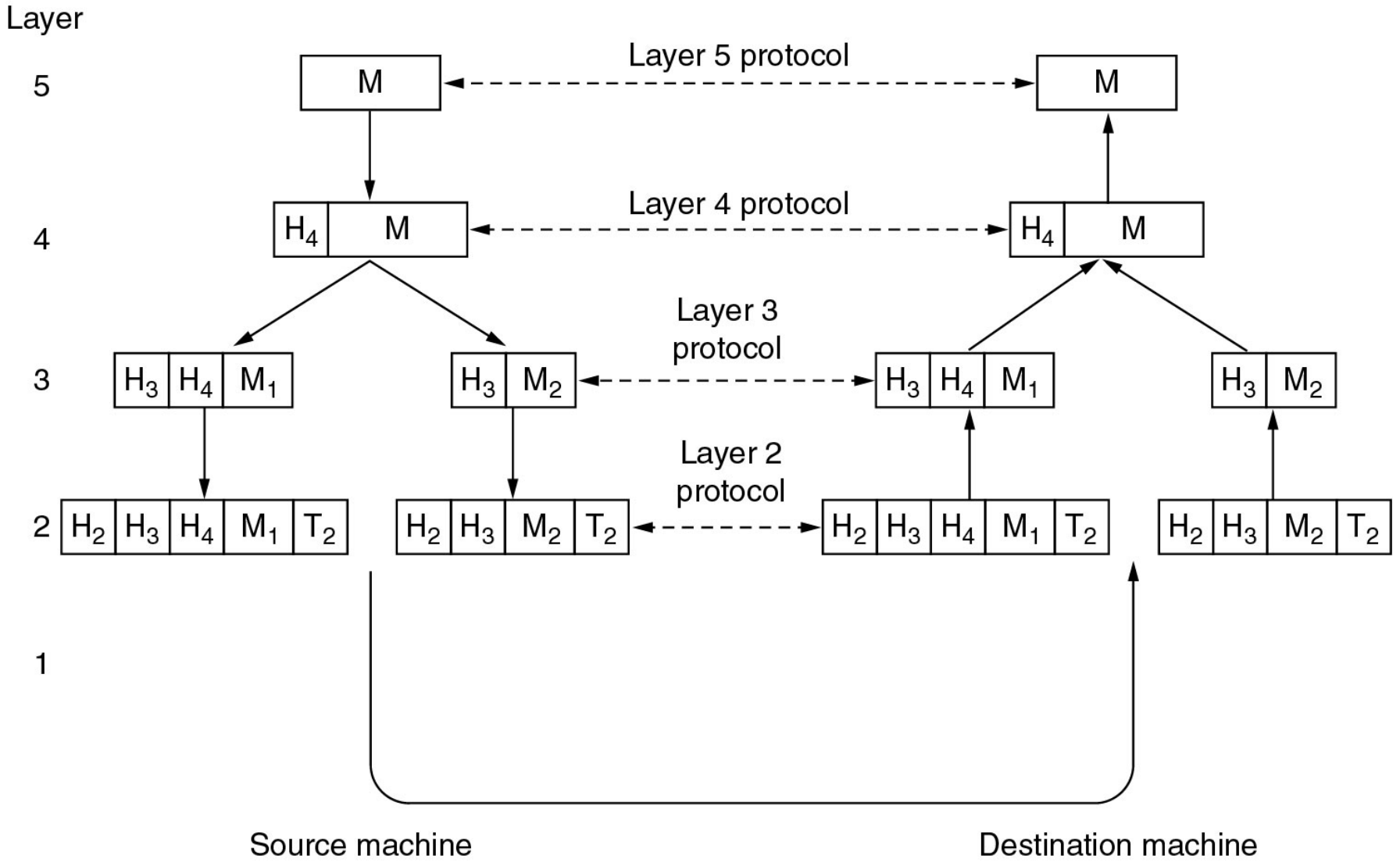
✓The translators have agreed on a neutral language known to both of them, Dutch, so the message is converted to "Ik vind konijnen leuk." The choice of language is the layer 2 protocol and is up to the layer 2 peer processes.

✓The translator then gives the message to a secretary for transmission, by, for example, fax (the layer 1 protocol). When the message arrives, it is translated into French and passed across the 2/3 interface to philosopher 2.

✓Note that each protocol is completely independent of the other ones as long as the interfaces are not changed. The translators can switch from Dutch to say, Finnish, at will, provided that they both agree, and neither changes his interface with either layer 1 or layer 3.

✓Similarly, the secretaries can switch from fax to e-mail or telephone without disturbing (or even informing) the other layers. Each process may add some information intended only for its peer. This information is not passed upward to the layer above.

Example information flow supporting virtual communication in layer 5



Layers of networks deals with:

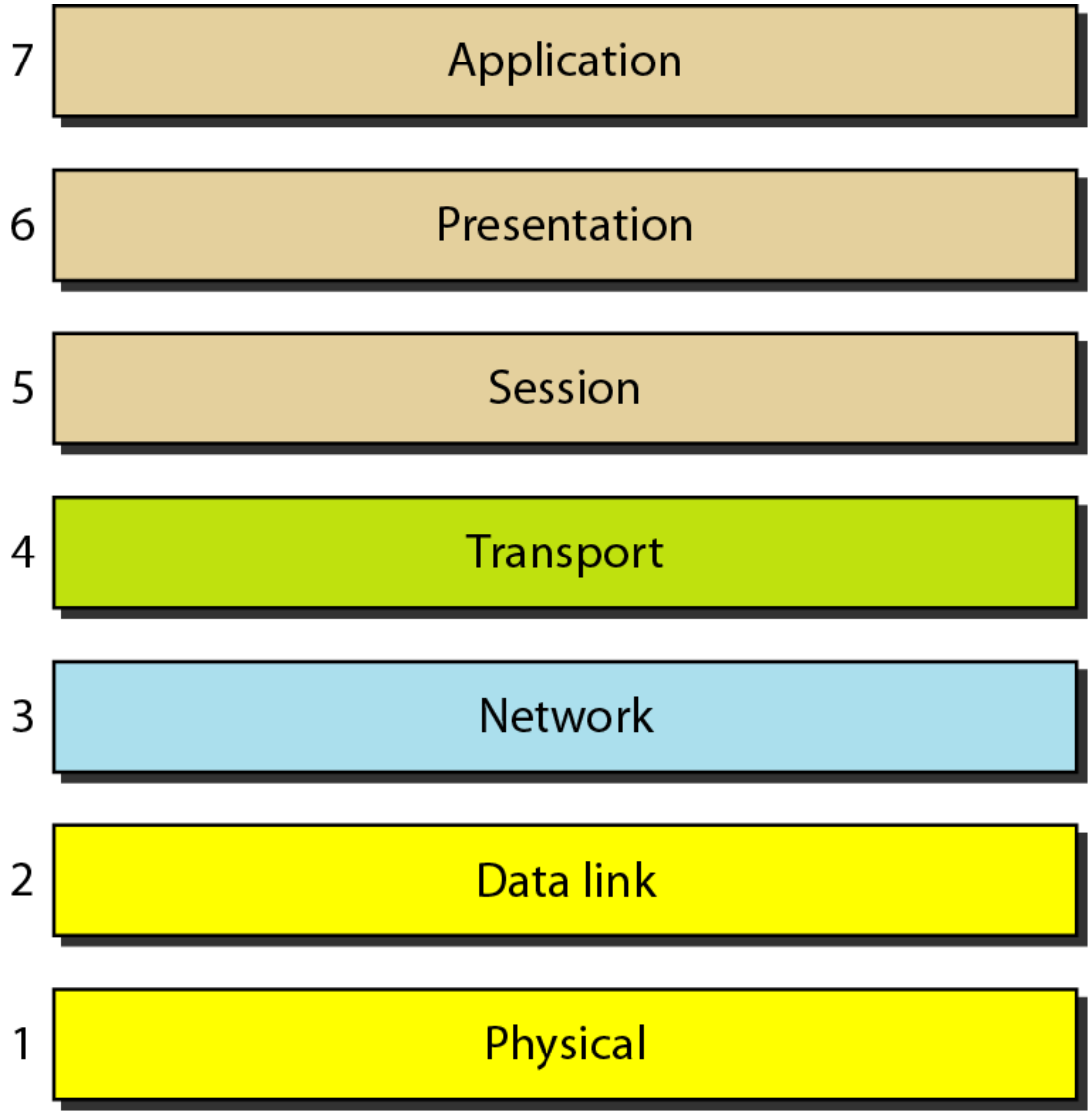
- Addressing
- Error control
- Flow control
- Multiplexing/De-multiplexing
- Routing

The OSI Reference Model

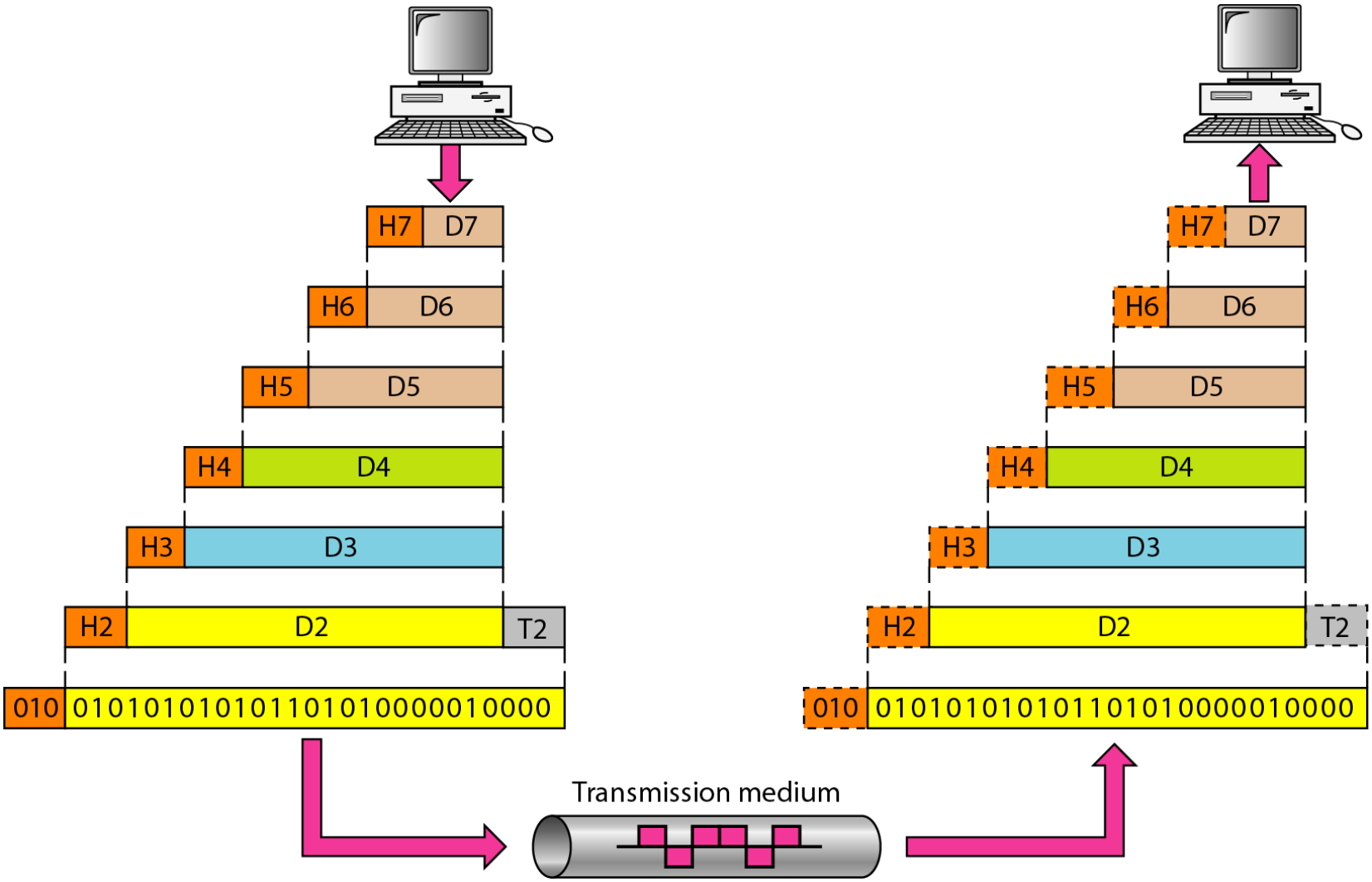
This model is based on a proposal developed by the international standard organization (ISO) as a first step toward international standardization of the protocols used in the various layers (1983).

It was revised in 1995 and the model become OSI (Open System interconnection) **Reference Model** because it deals with connecting open systems-that, systems that are open for communication with other systems.

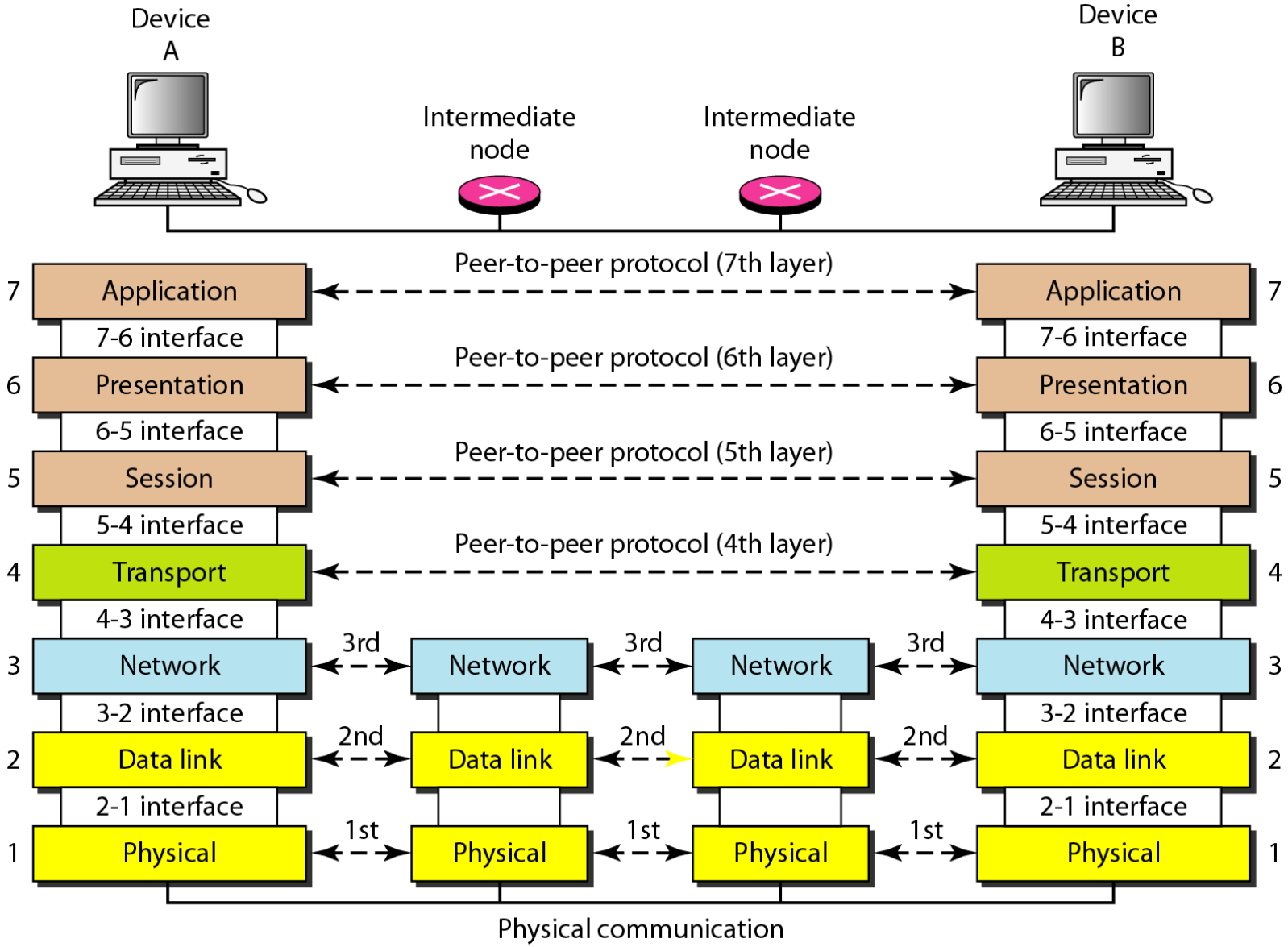
Seven layers of the OSI model



An exchange using the OSI model



The interaction between layers in the OSI model



Physical Layer

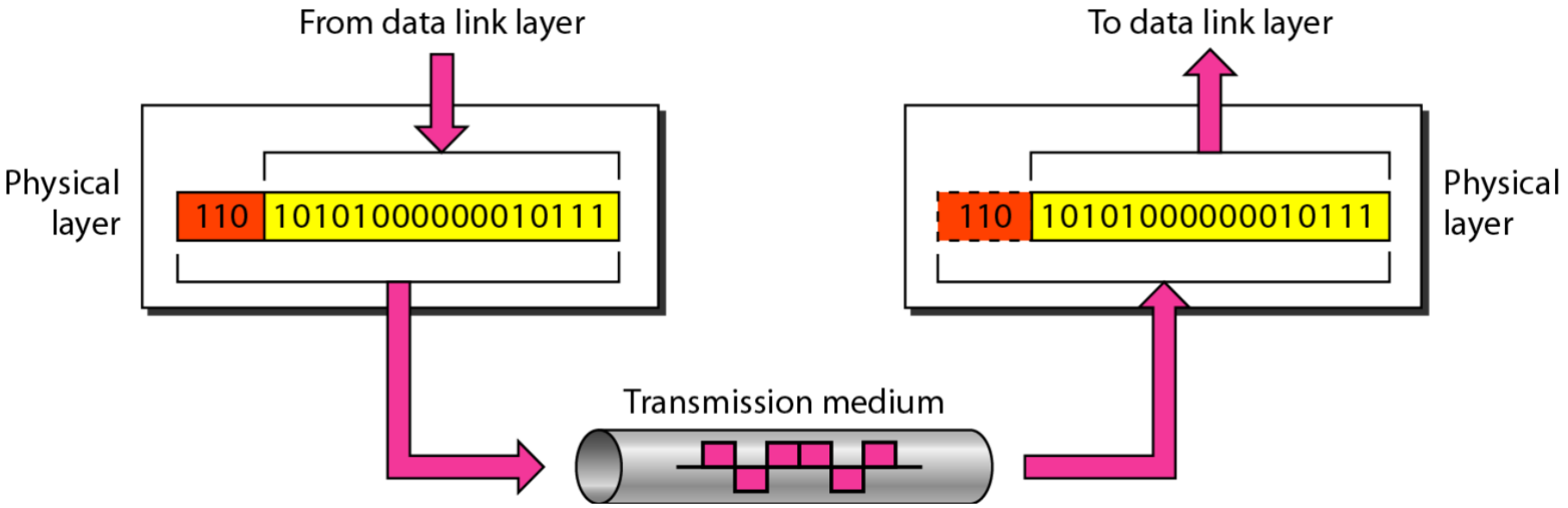
❖Starting at the bottom and working up, the *physical* layer handles the transmission of raw bits over a communications link.

❖The physical form (e.g., voltages, frequencies, timing) in which data bits (binary values 0 and 1) are represented.

❖The type of modulation to be used for transmitting digital data over analog transmission lines.

❖Interface to a transmission medium for example connector (RJ 45, BNC), MODEM/OLTE.

Physical layer



Data link layer

✓Frames are constructed from data string by adding special bit patterns to the beginning and end of each segment of data called frame. This allows the receiving end to detect where each frame begins and where it ends.

✓**Error detection:** Some form of error check is included in the frame header. This is constructed by the 'transmitting end' based on the contents of the frame, and checked by the receiving end.

✓**Error correction:** When a frame arrives and is corrupted or is lost for any reason in the network, it is retransmitted.

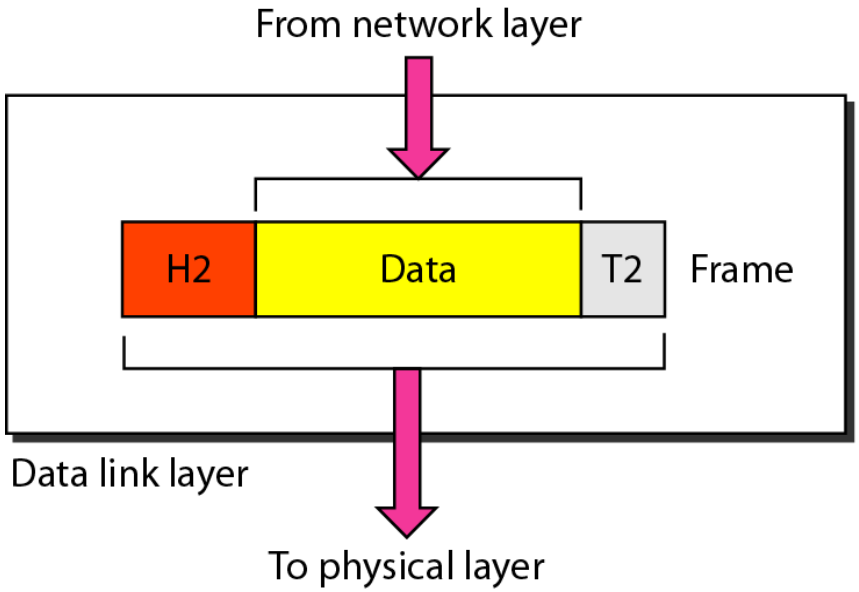
✓**Flow control:** In general, not all communication devices in a network operate at the same speed. Flow control provides a means of avoiding a slow receiver from being swamped by data from a fast transmitter using some buffer.

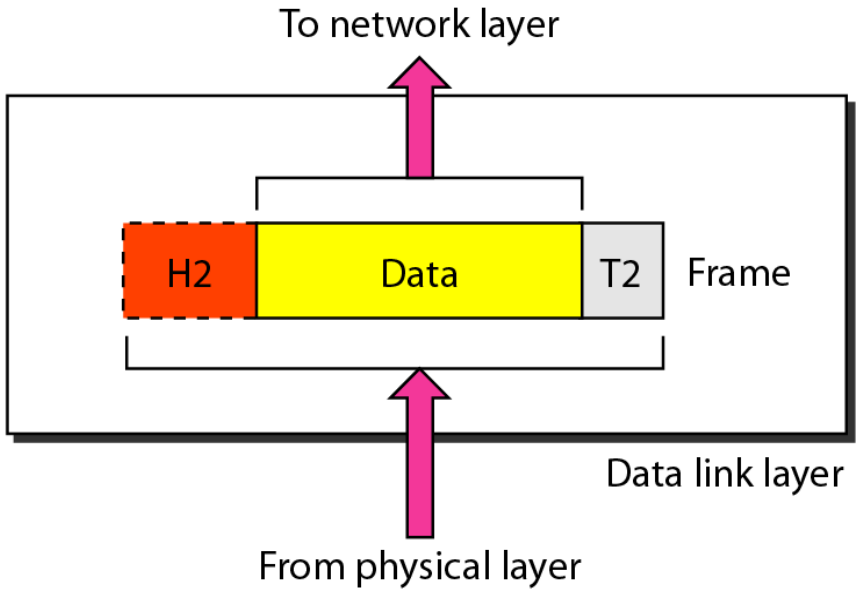
✓If sender fails to get ack (in case of noise) then the sender sends the same packet, therefore there will be duplication of packet at the receiver. The situation is tackled by this layer.

All the above jobs are done by LLC sub-layer.

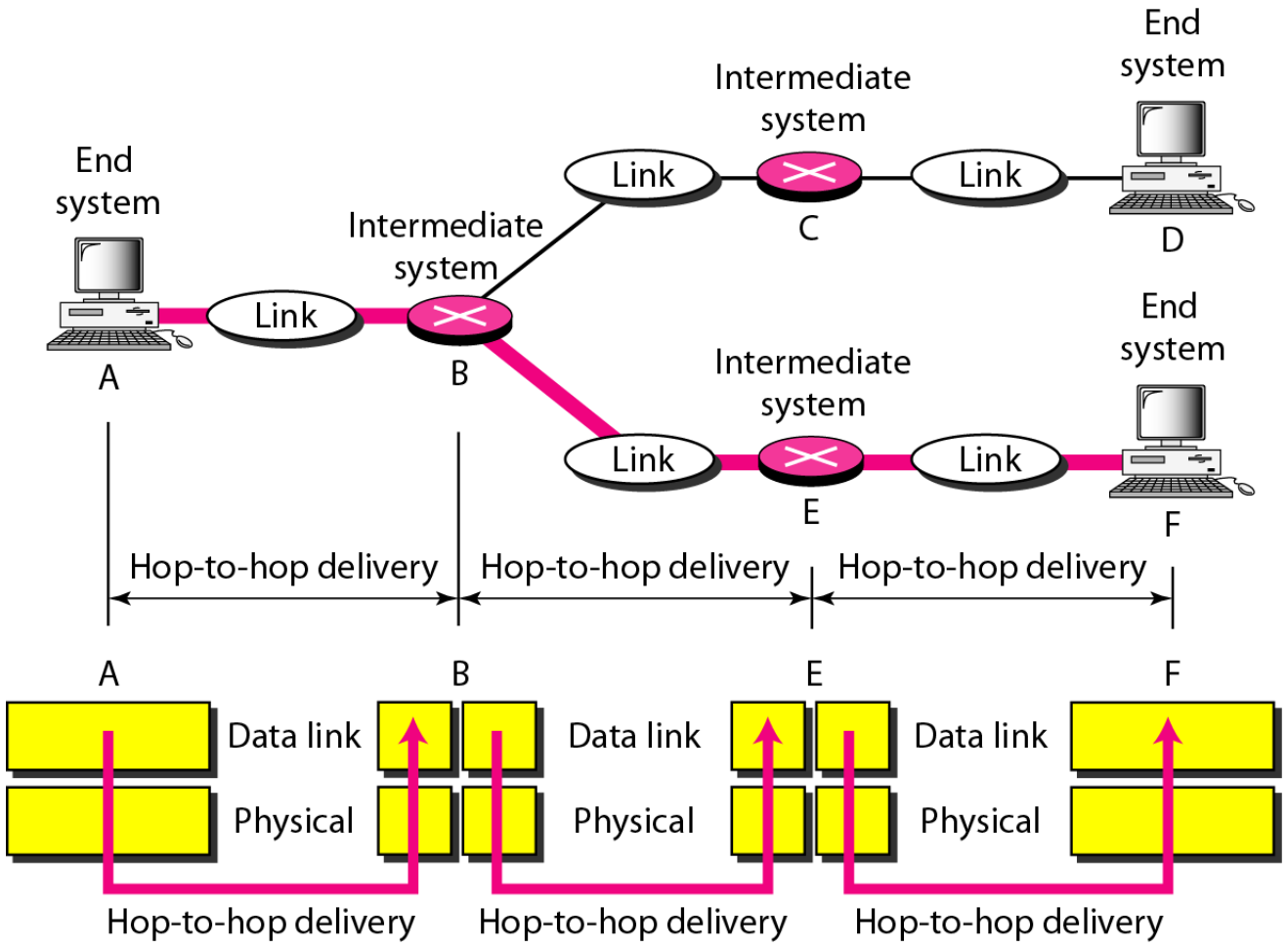
✓Channel sharing among users are done at MAC sub-layer.

Data link layer





Hop-to-hop delivery of Data Link Layer



The Network Layer

✓The *network* layer handles **routing** among nodes within a packet-switched network. At this layer, the unit of data exchanged among nodes is typically called a *packet* rather than a frame, although they are fundamentally the same thing.

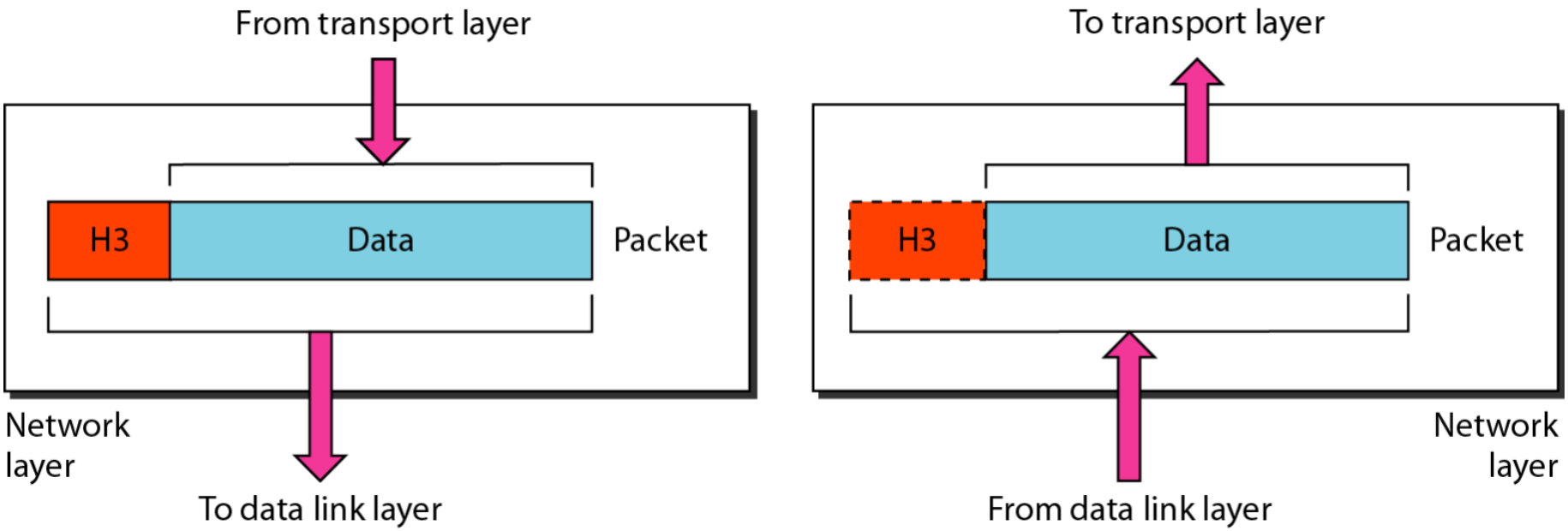
✓Correct ordering of packets to reflect the original order of data.

✓The control of 'traffic congestion' also belongs to the network layer.

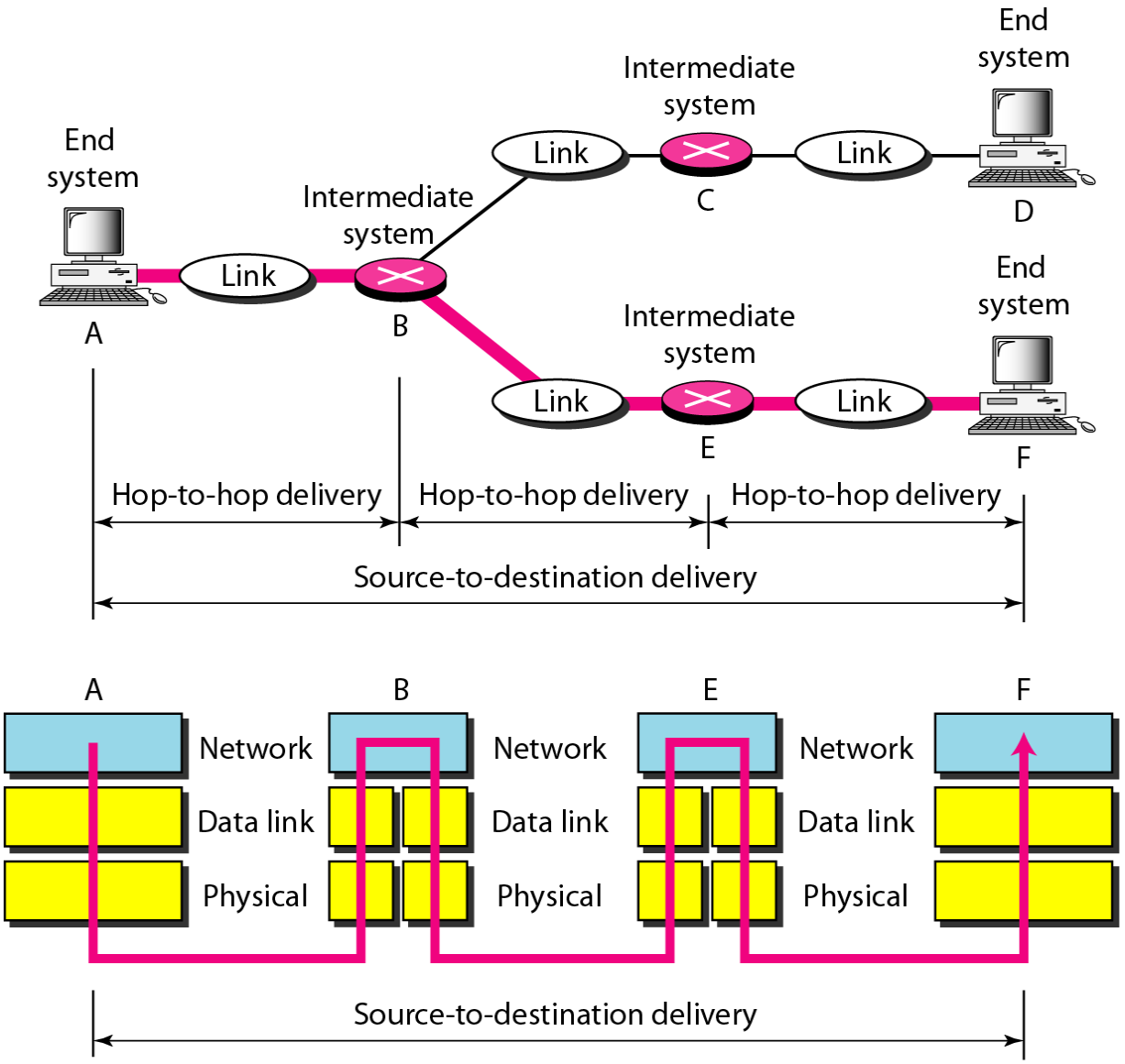
✓Internetworking: communication between two or more networks (BGP).

✓**Logical addressing:** The *physical addressing* implemented by the data link layer handles the addressing problem locally. If a packet passes the network boundary, we need another addressing system to help distinguish the source and destination systems. The network layer adds a header to the packet coming from the upper layer that, among other things, includes the *logical addresses* of the sender and receiver.

Network layer



Source-to-destination delivery



The Transport Layer

✓Efficient and cost-effective delivery of data across the network from one host to another. The transport layer and higher layers typically run only on the end hosts and not on the intermediate switches or routers.

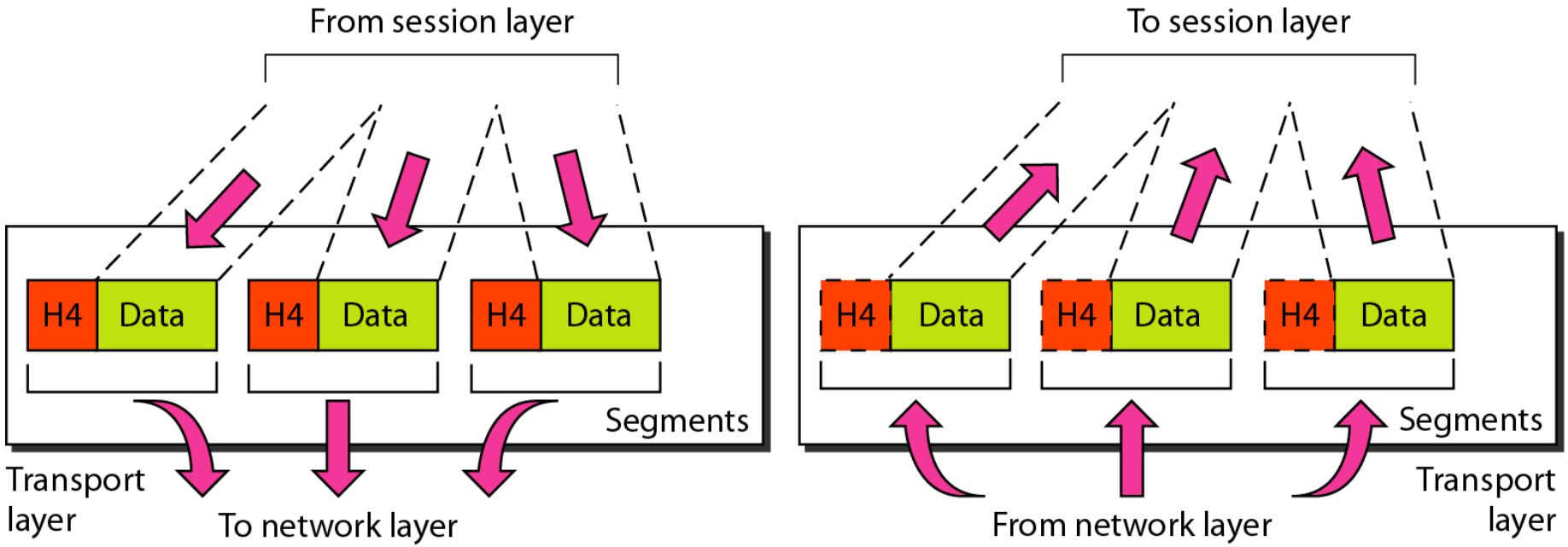
✓Divides the application data into segments of appropriately sized for the layers below it.

✓Flow control and error control between hosts.

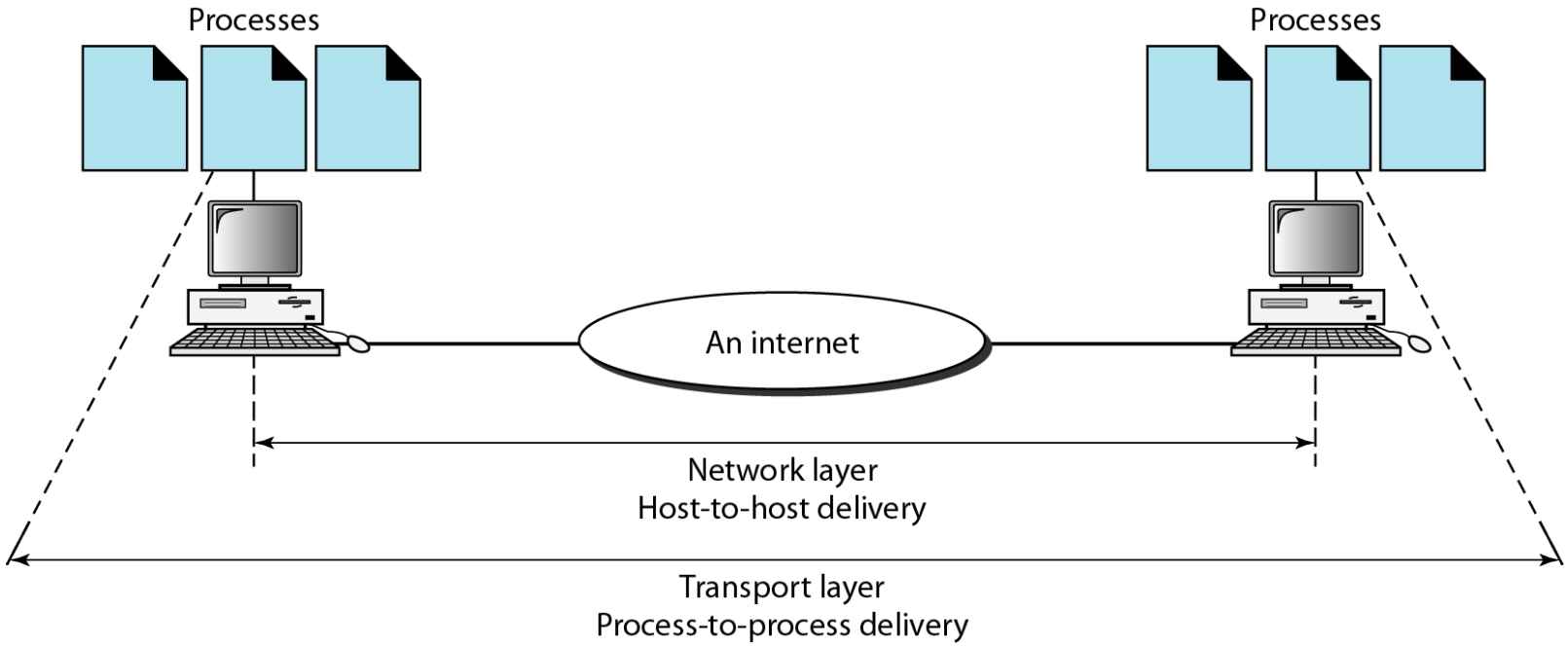
✓Splitting of data across multiple network connections, if necessary, to improve throughput, and recombining at the other end.

✓TCP and UDP are the example of protocol of this layer

Transport layer



The transport layer is responsible for the delivery of a message from one process to another



The Session Layer

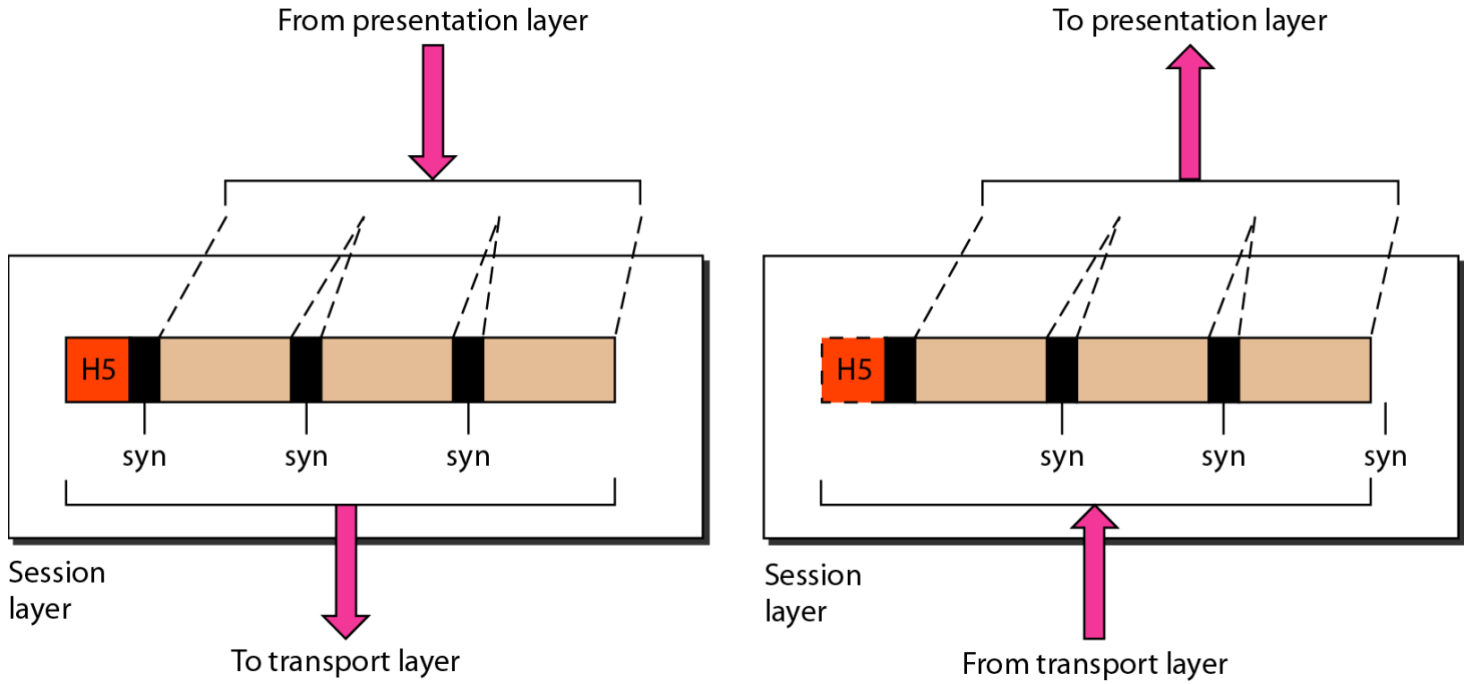
❖The session layer controls the dialogues (connections) between end terminals.

❖It establishes, manages and terminates the connections between the local and remote application.

❖It provides for full duplex, half duplex or simplex operation, and establishes checkpointing, adjournment, termination, and restart procedures.

❖Correct ordering of messages when this function is not performed by the transport layer.

The session layer provides: checkpoints or synchronization points to a stream of data, which is not usually used in the Internet Protocol Suite. During long transmissions sometimes a host becomes disconnected in the midst of communication then checkpointing allow them to continue from where they were crashed.



❖You can use your computer to open a browser window to your favorite Web site, then open a second window to the same server and follow different links in each browser. The window can act independently because the Web server and your computer have two independent sessions.

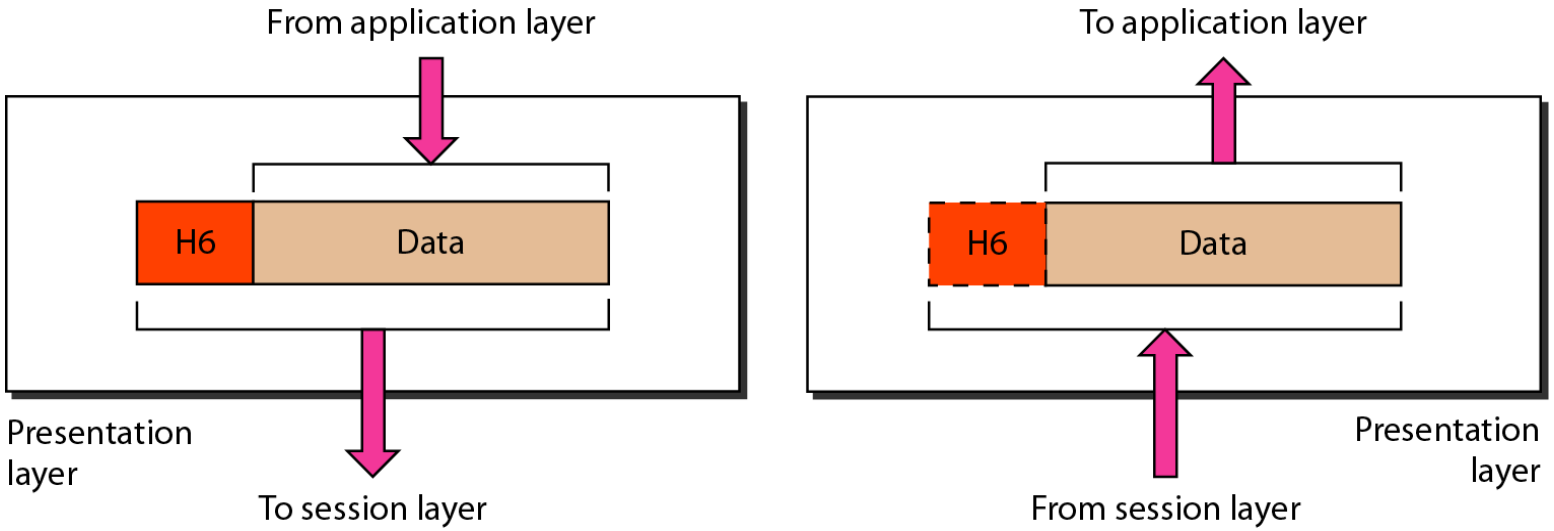
The Presentation Layer

❖The *presentation* layer is concerned with the format of data exchanged between peers, for example, whether an integer is 16, 32, or 64 bits long and whether the most significant byte is transmitted first or last, or how a video stream is formatted.

❖More explicitly, this layer is responsible for data translation into a standard format. Examples are ASCII (American Standard Code for Information Interchange, 7-bit character encoding) text, EBCDIC (Extended Binary Coded Decimal Interchange Code, 8-bit character encoding), JPEG pictures and MP3 music formats. Conversion between the binary representation of application data and a common format for transmission between peer applications.

❖For example, the Presentation Layer can apply sophisticated compression techniques so fewer bytes of data are required to represent the information when it's sent over the network.

❖This layer is also responsible for encryption and decryption for security purposes, as well as data compression. It is sometimes called the syntax layer.



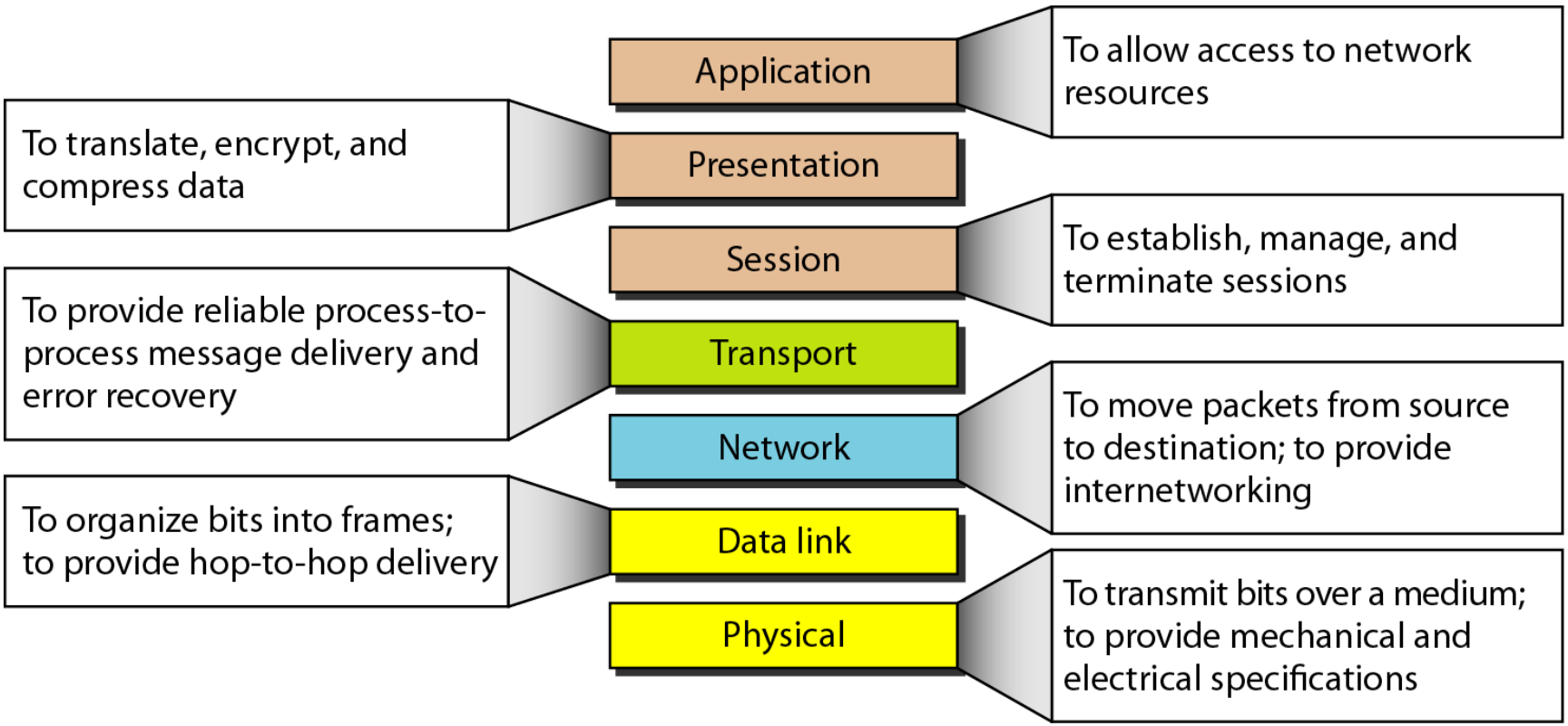
Application layer

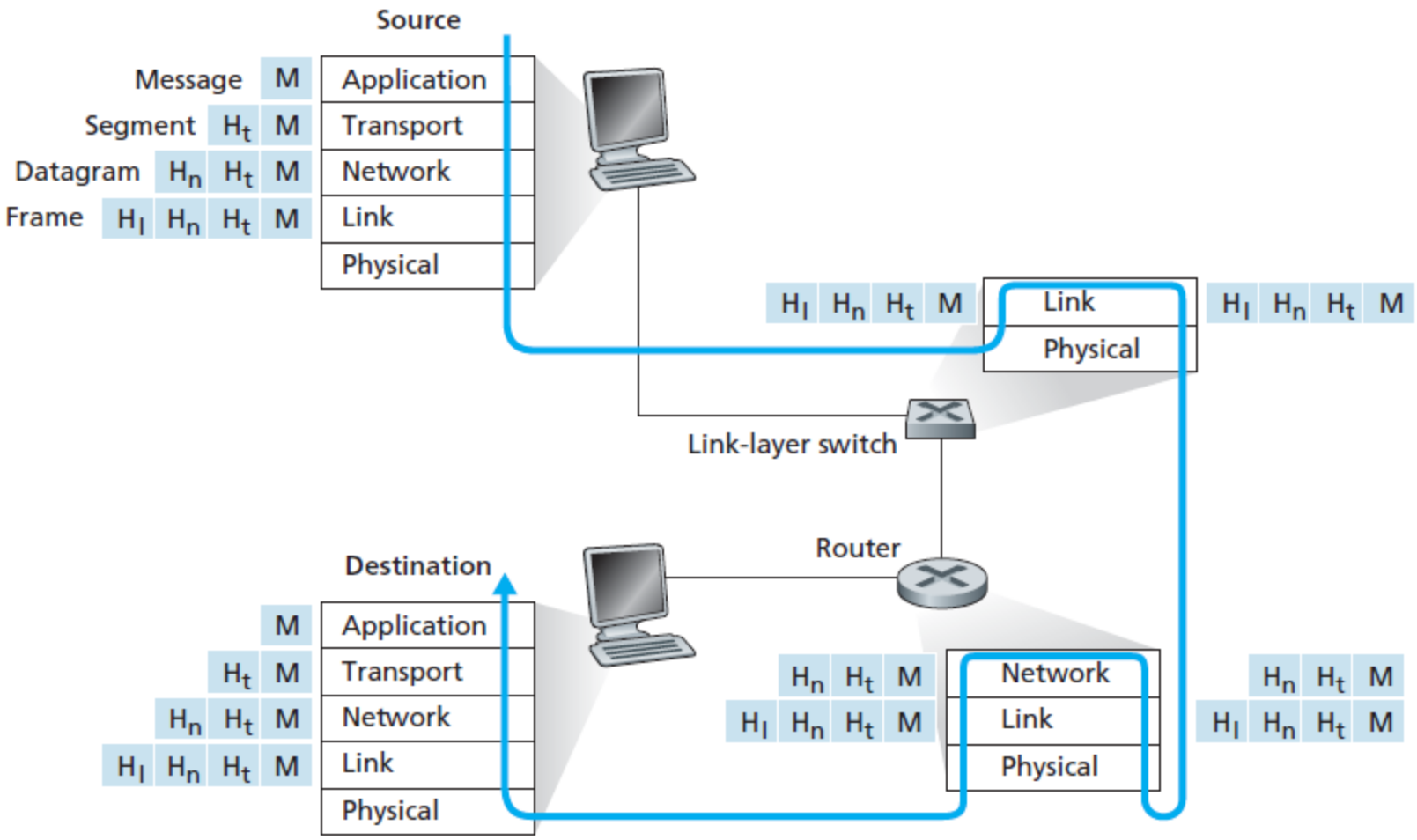
❖This layer provides a consistent interface to the network for all computer software i.e. provides OSI environment.

❖File transfer, web browser, e-mail etc are applications and implemented using some application layer protocols. Application layer protocols for above applications are File Transfer Protocol (FTP) to transfer file between two hosts, HTTP to fetch web page from a server, SMTP for e-mail.

❖This layer also provides security like cryptography, Digital signature, Firewall etc.

Summary of layers





Hosts, routers, and link-layer switches; each contains a different set of layers, reflecting their differences in functionality.