

Network Models

Course Code: COE 3201

Course Title: Data Communication



Dr. Amirul Islam
Assistant Professor, EEE
Email: amirul@aiub.edu

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Lecture Outline



1. Layered Tasks
2. Introduction to OSI Model
3. Introduction to TCP/IP Model
4. Data Encapsulation

Layered Tasks

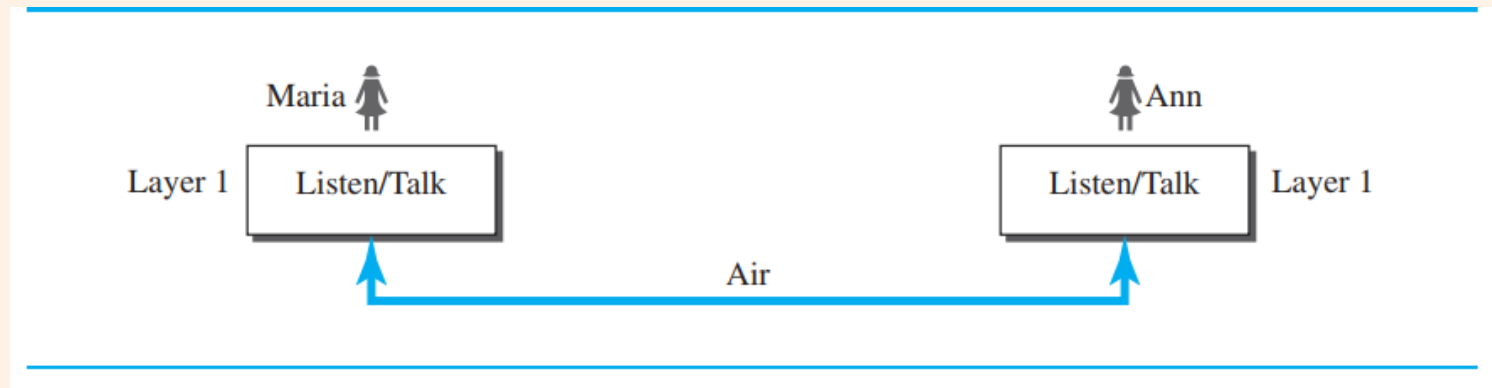


Fig: Tasks involved communication between two user in single layer

Layered Tasks



We use the concept of layers in our daily life. Protocol layering enables us to divide a complex task into several smaller and simpler tasks.

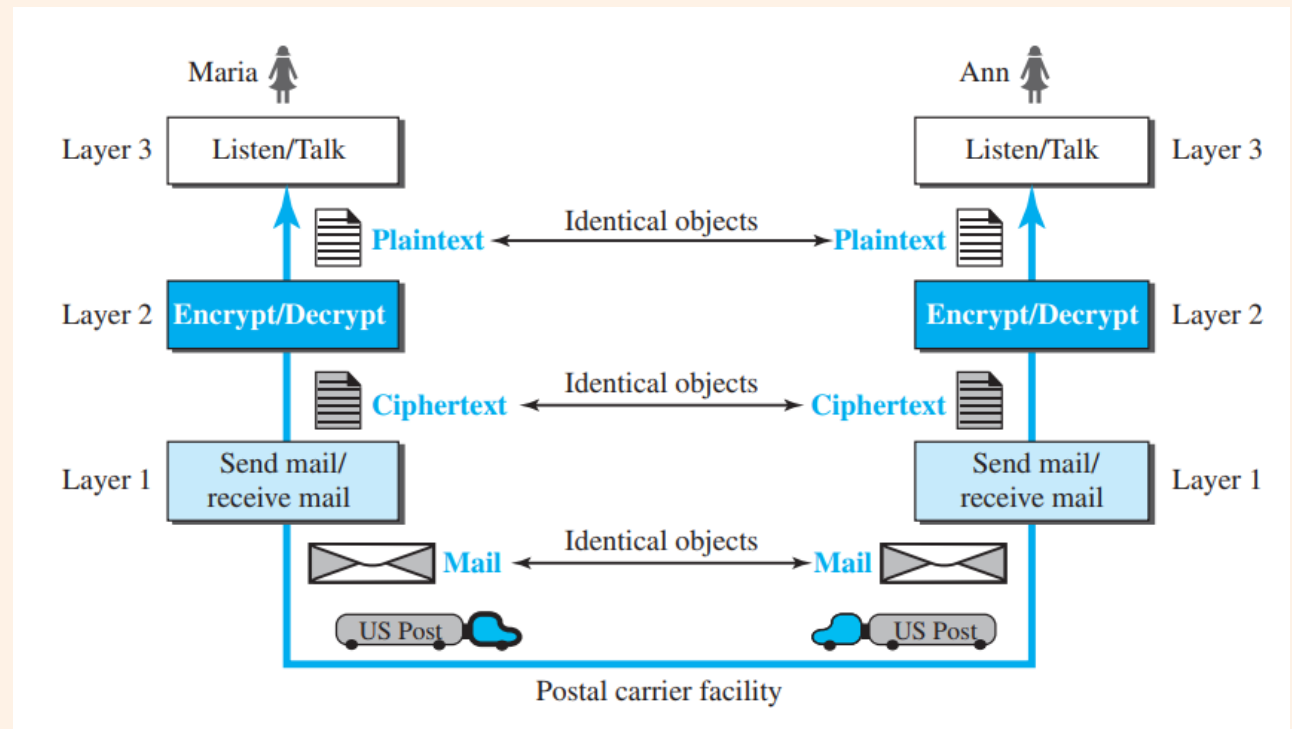


Fig: Tasks involved in sending a message in multiple layer



Importance of Layering

Troubleshooting: The protocols, actions, and data contained in each layer of the model relate only to the purpose of that layer. This enables troubleshooting efforts to be pinpointed on the layer that carries out the suspected cause of the problem.

Standards: Probably the most important reason for using a layered model is that it establishes a prescribed guideline for interoperability between the various vendors developing products that perform different data communications tasks.

Change: When changes are made to one layer, the impact on the other layers is minimized. If the model consists of a single, all-encompassing layer, any change affects the entire model.



Introduction to OSI Model

- ❑ The **Open System Interconnection Reference Model** (OSI Reference Model or **OSI Model**) is an abstract description for layered communications and computer network protocol design.
- ❑ It divides network architecture into seven layers which, from top to bottom, are the Application, Presentation, Session, Transport, Network, Data Link, and Physical Layers. It is therefore often referred to as the **OSI Seven Layer Model**.
- ❑ In 1978, the International Standards Organization (ISO) began to develop its OSI framework architecture.



International
Organization for
Standardization



Introduction to OSI Model

OSI Model	
Data unit	Layer
Data	7. Application
	6. Presentation
	5. Session
Segments	4. Transport
Packet	3. Network
Frame	2. Data Link
Bit	1. Physical



Application Layer

- ❑ The application layer is the OSI layer closest to the end user, which means that both the OSI application layer and the user interact directly with the software application.
- ❑ Some examples of application layer implementations include
 - ❑ Hypertext Transfer Protocol (HTTP)
 - ❑ File Transfer Protocol (FTP)
 - ❑ Simple Mail Transfer Protocol (SMTP)



Presentation_Layer

- ❑ Before being transmitted, information in the form of characters and numbers should be changed to bit streams. The presentation layer is responsible for interoperability between encoding methods as different computers use different encoding methods. It translates data between the formats the network requires and the format of the computer.
- ❑ This layer provides independence from differences in data representation, such as – Encryption, Compression

Session Layer

- ❑ Session layer provides mechanism for controlling the dialogue between the two end systems. It defines how to start, control and end conversations (called sessions) between applications.
- ❑ Any necessary log-on or password validation is also handled by this layer.
- ❑ Session layer is also responsible for terminating the connection.



Transport Layer

- ☐ Purpose of this layer is to provide a reliable mechanism for the exchange of data between two processes in different computers.
- ☐ Ensures that the data units are delivered error free.
- ☐ Ensures that data units are delivered in sequence.
- ☐ Ensures that there is no loss or duplication of data units.
- ☐ Provides connectionless or connection-oriented service.
- ☐ Provides for the connection management.
- ☐ Multiplex multiple connection over a single channel.



Network Layer

- ❑ **Routing:** The network layer protocols determine which route is suitable from source to destination. This function of network layer is known as routing.
- ❑ **Logical Addressing:** In order to identify each device on internetwork uniquely, network layer defines an addressing scheme. The sender & receiver's IP address are placed in the header by network layer. Such an address distinguishes each device uniquely and universally.

Data Link Layer

- ❑ The data link layer is responsible for the node to node delivery of the message. The main function of this layer is to make sure data transfer is error free from one node to another, over the physical layer. The data link layer is divided into two sub-layers -
 1. Media Access Control (MAC)
 2. Logical Link Control (LLC).
- ❑ MAC is lower sub-layer, and it defines the way about the media access transfer, such as CSMA / CD /CA (Carrier Sense Multiple Access /Collision Detection /Collision Avoidance)
- ❑ LLC controls the synchronization, flow control, and error checking functions of the data link layer



Services of Data-Link Layer

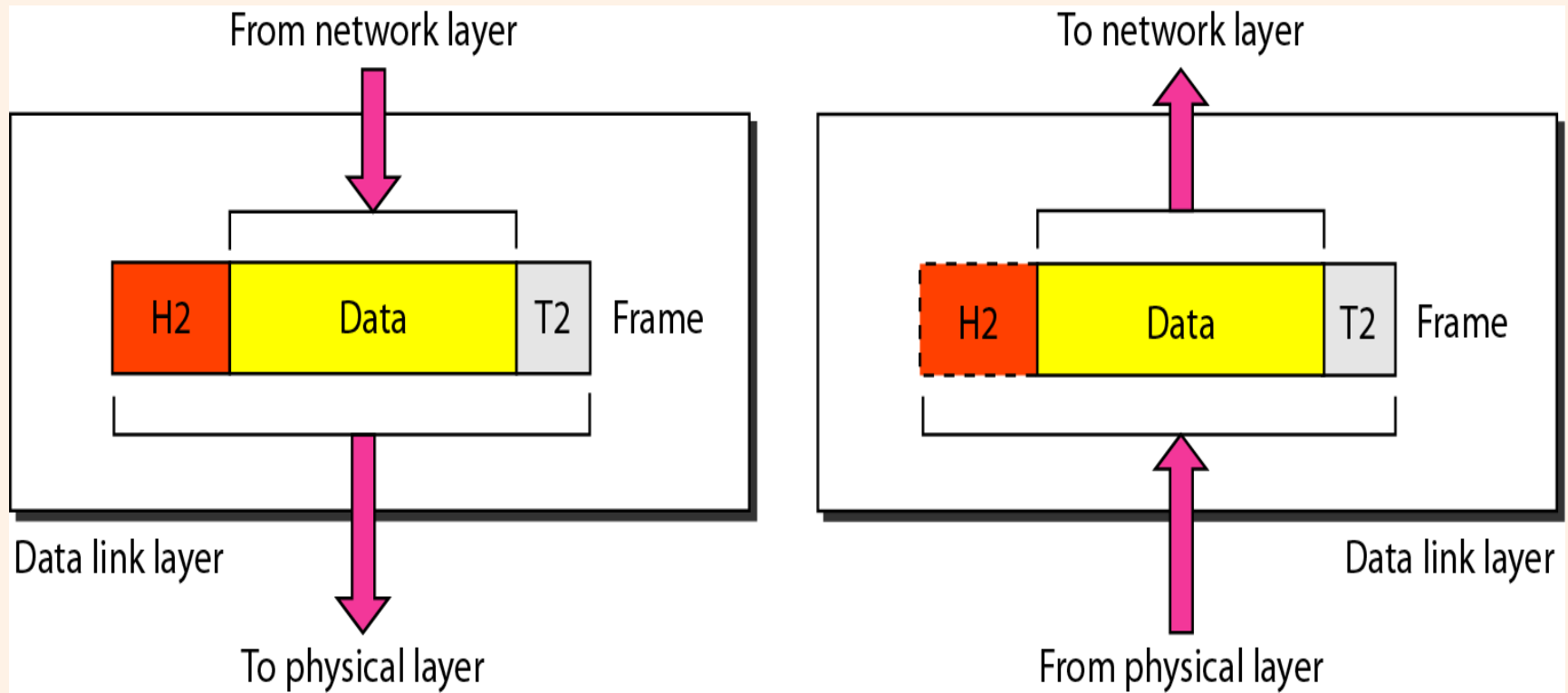
- ❑ **Framing:** The data link layer divides the stream of bits received from the network layer into manageable data units called frames.
- ❑ **Physical addressing:** The Data Link layer adds a header to the frame in order to define physical address of the sender or receiver of the frame.
- ❑ **Flow control:** If the rate at which the data are absorbed by the receiver is less than the rate at which data are produced in the sender, the data link layer imposes a flow control mechanism to avoid overwhelming the receiver.



Services of Data-Link Layer - Contd.

- ❑ **Error control:** The data link layer adds reliability to the physical layer by adding mechanisms to detect and retransmit of damaged or lost frames. It also uses a mechanism to recognize duplicate frames. Error control is normally achieved through a trailer added to the end of the frame.
- ❑ **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.

Data Link Layer - Frame



The data link layer is responsible for moving frames from one hop (node) to the next



Physical Layer

- ❑ **Bit synchronization:** The physical layer provides the synchronization of the bits by providing a clock. This clock controls both sender and receiver thus providing synchronization at bit level.
- ❑ **Bit rate control:** The Physical layer also defines the transmission rate i.e. the number of bits sent per second.
- ❑ **Physical topologies:** Physical layer specifies the way in which the different, devices/nodes are arranged in a network i.e. bus, star or mesh topology.
- ❑ **Transmission mode:** Physical layer also defines the way in which the data flows between the two connected devices. The various transmission modes possible are: Simplex, half-duplex and full-duplex.

Summary

7. Application

- Provides a user interface

6. Presentation

- Presents Data
- Handles encryption and decryption

5. Session

- Maintains distinction between data of separate applications
- Provides dialog control between hosts

4. Transport

- Provides End-to-End connections
- Provides reliable or unreliable delivery and flow control

3. Network

- Provides Logical Addressing
- Provides Path determination using logical addressing

2. Data Link

- Provides media access and physical addressing

1. Physical

- Converts digital data so that it can be sent over the physical medium
- Moves data between hosts

Introduction to TCP/IP Model



- ❑ The Internet Protocol Suite (commonly known as TCP/IP) is the set of communications protocols used for the Internet and other similar networks.
- ❑ It is named from two of the most important protocols in it:
 - ❑ the Transmission Control Protocol (TCP) and
 - ❑ the Internet Protocol (IP), which were the first two networking protocols defined in this standard.

TCP/IP Model in relation to OSI Model:

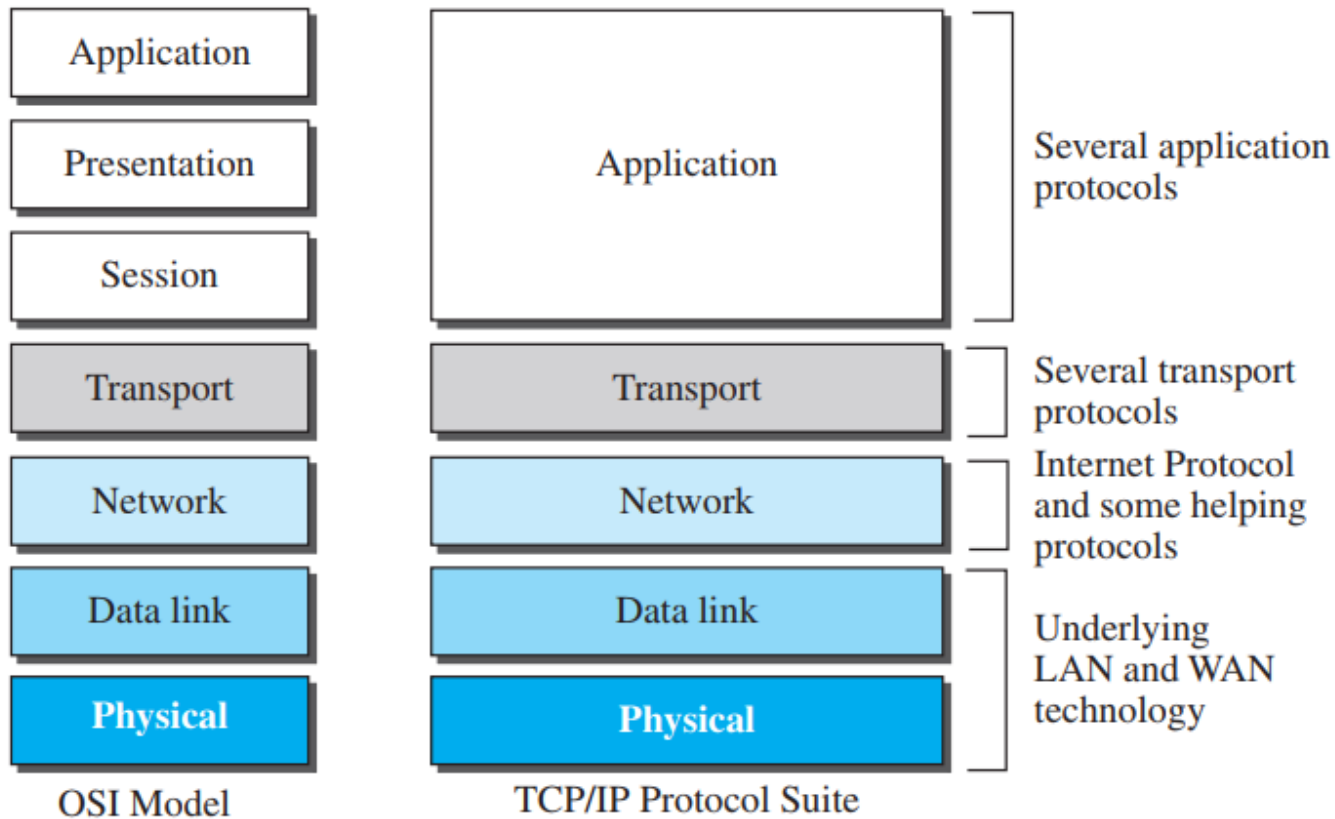


Fig: TCP/IP and OSI model

Data Encapsulation



The term encapsulation is used to describe a process of adding headers and trailers around some data. This process can be explained with the four-layer TCP/IP model, with each step describing the role of the layer.

For example, here is what happens when you send an email using your favorite email program (such as Outlook or Gmail):

1. The email is sent from the Application layer to the Transport layer.
2. The Transport layer encapsulates the data and adds its own header with its own information, such as which port will be used and passes the data to the Internet layer
3. The Internet layer encapsulates the received data and adds its own header, usually with information about the source and destination IP addresses. The Internet layer then passes the data to the Network Access layer
4. The Network Access layer is the only layer that adds both a header and a trailer. The data is then sent through a physical network link.

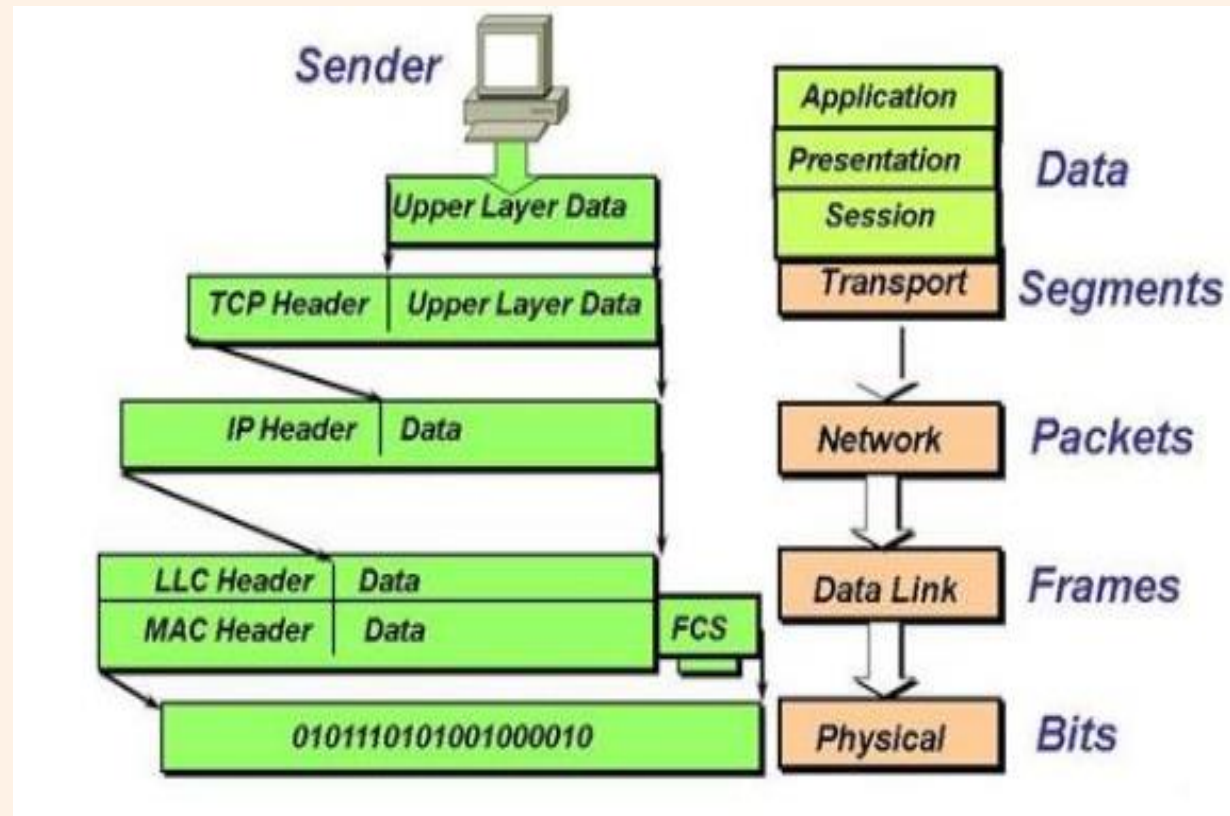


Figure: Data Encapsulation

Frame header	IP header	TCP header	Data	Frame trailer
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Data Decapsulation



Decapsulation is the inverse of the encapsulation process. Encapsulation is the process of wrapping the data while the Decapsulation process is a process of opening packs.

The process was reversed from the encapsulation process. Encapsulation process starts from the uppermost layer (Application Layer) to the lowest layer (Physical layer) while the Decapsulation process starts from the lowest layer (Physical Layer) to the uppermost layer (Application Layer).

Legend

- 4 Header at transport layer ↓ Encapsulate
- 3 Header at network layer ↑ Decapsulate
- 2 Header at data-link layer

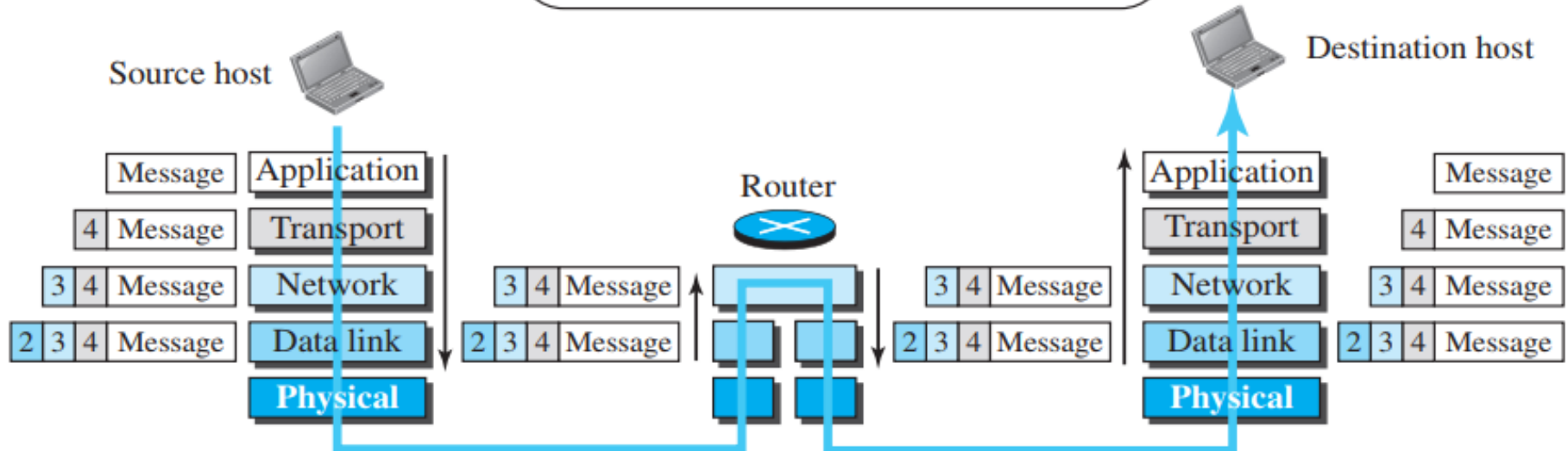


Figure: Encapsulation and decapsulation process



Books

1. Forouzan, B. A. "Data Communication and Networking. Tata McGraw." (2005).
2. Prakash C. Gupta, "Data communications", Prentice Hall India Pvt.



References

1. Prakash C. Gupta, "Data communications", Prentice Hall India Pvt.
2. William Stallings, "Data and Computer Communications", Pearson
3. Forouzan, B. A. "Data Communication and Networking. Tata McGraw." (2005).