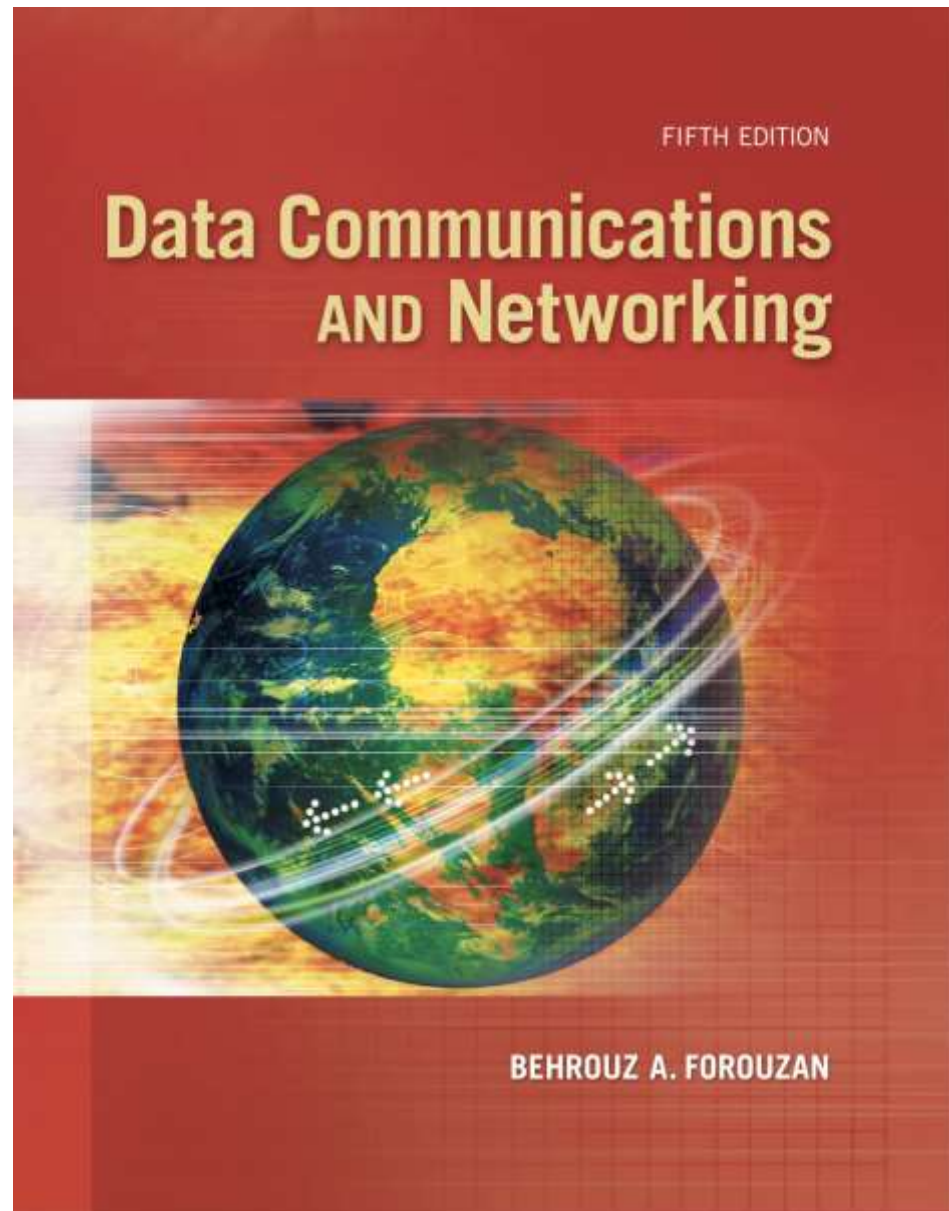


Chapter 2

Network Models





Chapter 2: Outline

2.1 Protocol Layering

2.2 TCP/IP Protocol Suite

2.3 OSI Model

2-1 PROTOCOL LAYERING

- A *protocol* defines the rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively.
- When communication is simple, we may need only one simple protocol; when the communication is complex, we need a protocol at each layer, or protocol layering.

A single-layer protocol



A single-layer protocol



Set of rules:

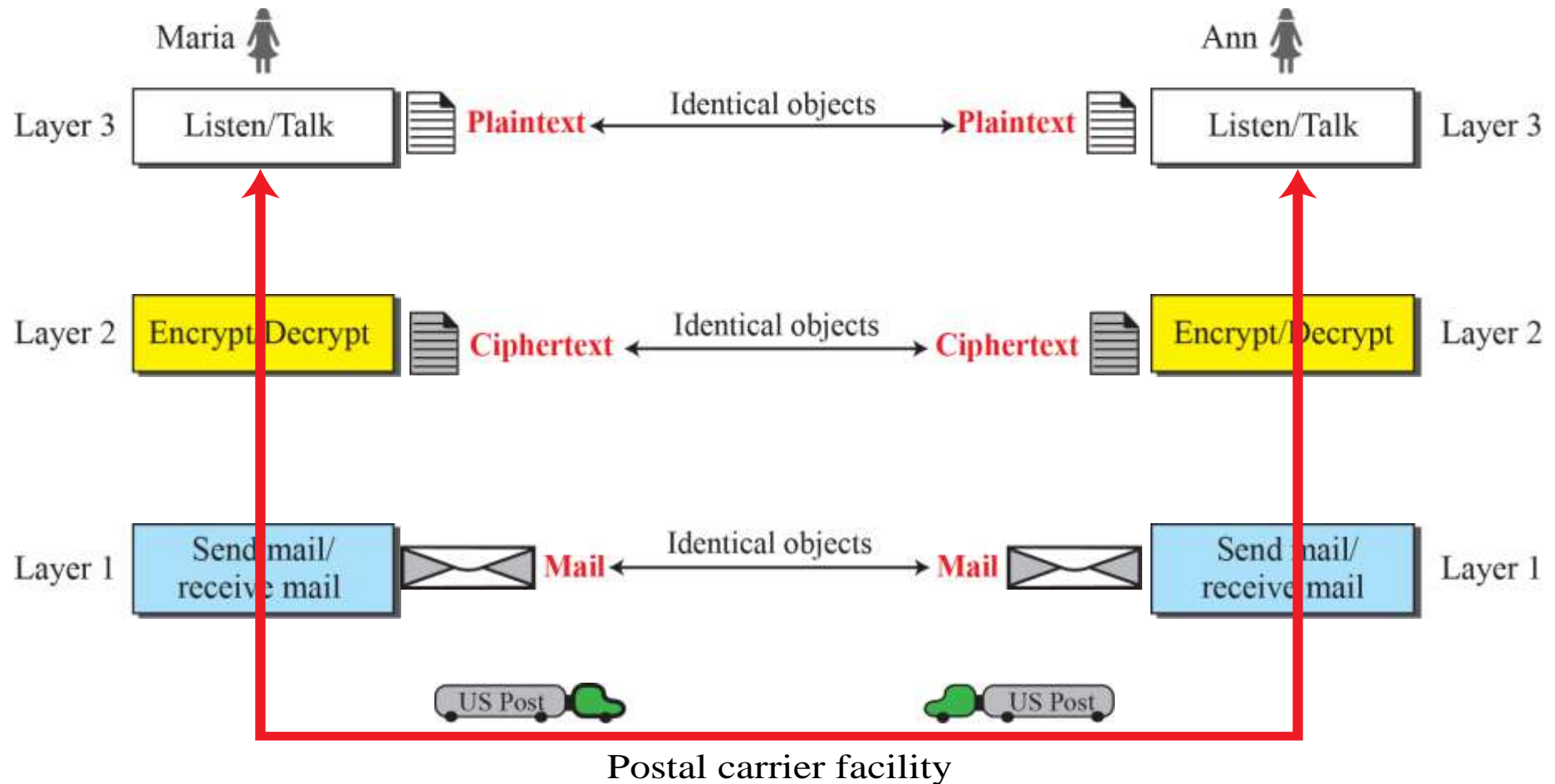
- *Greet each other*
- *Same language*
- *Same level of formal vocabulary*
- *Not speak at the same time when the other speaks*
- *Dialog: allow other person to speak*
- *Good bye exchange*

A single-layer protocol

What set of rules should we follow in a class consisting of a professor and students?

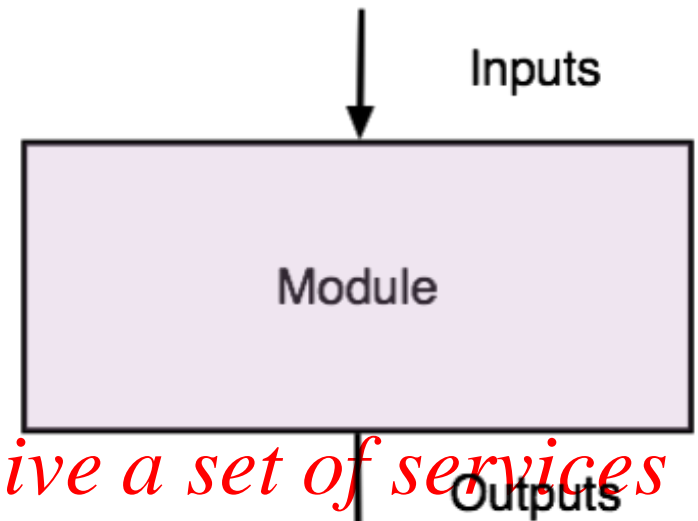
Answer:

A three-layer protocol



Advantages of protocol layering

- *Enables division of a complex task into smaller and simpler tasks*
 - *Modularity: independent functional modules*
- *Allows separation of services from implementation*
- *Ability to implement intermediate systems (to be covered later)*



A layer needs to be able to receive a set of services from the lower layer and to give the services to the upper layer; we don't care about how the layer is implemented.

Principles of protocol layering

First Principle

In bidirectional communication, each layer should be able to perform two opposite tasks, one in each direction.

e.g. talk and listen, encrypt and decrypt.

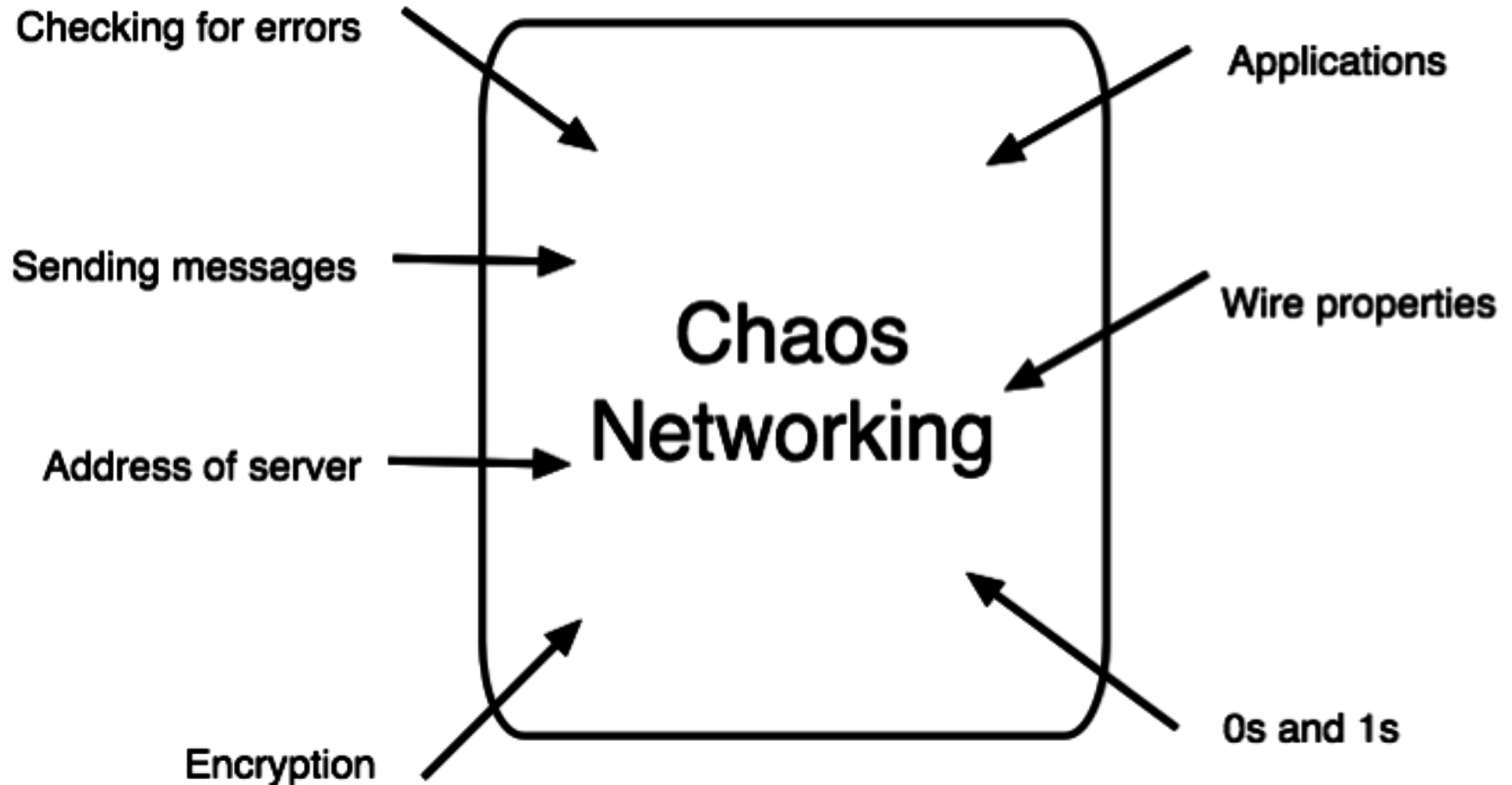
Second Principle

Objects under each layer at both sites should be identical.

2-2 OSI MODEL

- *The International Organization for Standardization (ISO) established Open Systems Interconnection (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 OSI** is to show how to facilitate communication between two different systems without requiring changes of hardware & software.*
- *The **OSI model** is a layered framework for the design of network systems that allow communication between all types of computer systems.*

Without the OSI model

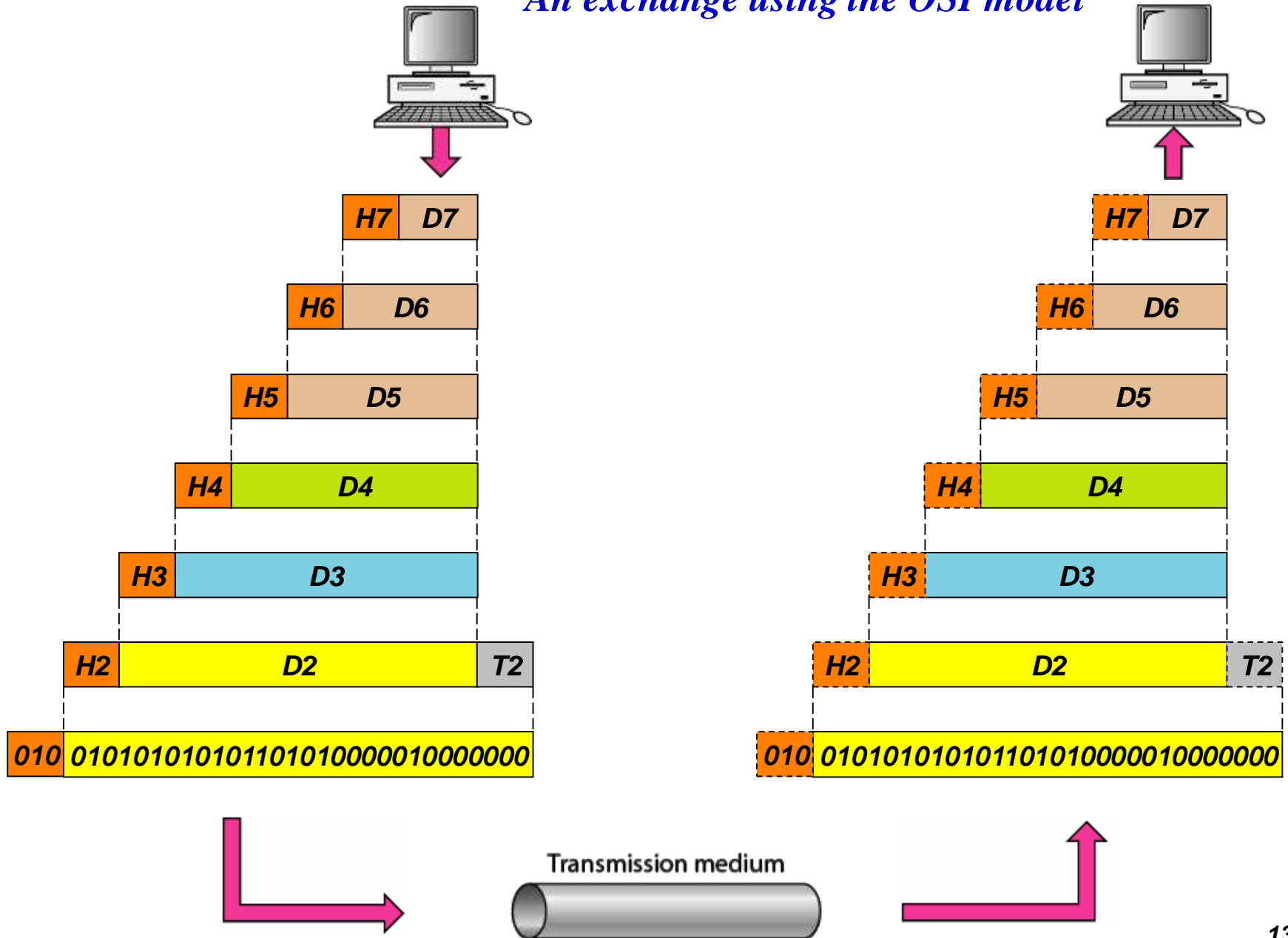


*Networks would be very difficult to understand and implement (**complete disorder and confusion**)*

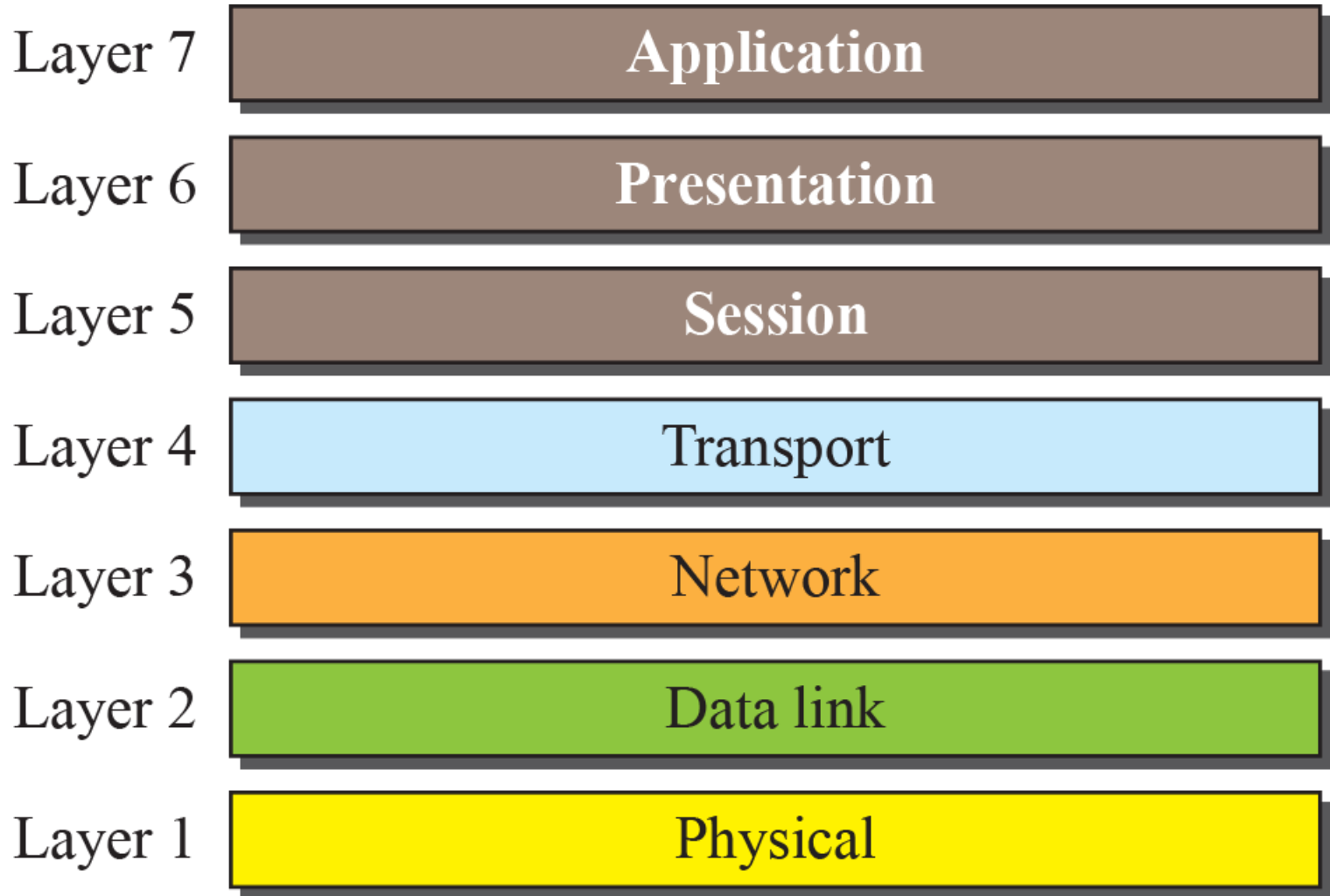
OSI model: A Layered Network Model

- *The process of breaking up the functions or tasks of networking into layers reduces complexity.*
- *Each layer provides a service to the layer above it in the protocol specification.*
- *Each layer communicates with the same layer's software or hardware on other computers.*
- *The lower 4 layers (transport, network, data link and physical —Layers 4, 3, 2, and 1) are concerned with the flow of data from end to end through the network.*
- *The upper three layers of the OSI model (application, presentation and session—Layers 7, 6 and 5) are orientated more toward services to the applications.*
- *Data is Encapsulated with the necessary protocol information as it moves down the layers before network transit.*

An exchange using the OSI model



The OSI model



Networks can be broken into manageable pieces with specific functions and a common language

Benefits of the OSI model

OSI model allows all network elements to operate together, no matter who created the protocols and what vendor supports them.

Main benefits:

- *Helps understand the big picture of networking*
- *Helps understand how hardware and software elements function together*
- *Makes troubleshooting easier*
- *Defines terms that allows us to compare basic functional relationships on different networks*
- *Helps understand new technologies as they are created*
- *Helps understand vendor explanations of the functions of a product*

OSI Layers – Physical Layer

- *Provides physical interface for transmission of information.*
- *Defines rules by which bits are passed from one system to another on a physical communication medium.*
- *Covers all - mechanical, electrical, functional and procedural - aspects for physical communication.*
- *Such characteristics as voltage levels, timing of voltage changes, physical data rates, maximum transmission distances, physical connectors, and other similar attributes are defined by physical layer specifications.*

OSI Layers – Data Link Layer

- *Attempts to provide reliable communication over the physical layer interface.*
- *Breaks the outgoing data into frames and reassemble the received frames.*
- *Handle errors by implementing an acknowledgement and retransmission scheme.*
- *Implement flow control.*
- *Supports points-to-point as well as broadcast communication.*
- *Supports simplex, half-duplex or full-duplex communication.*

OSI Layers – Network Layer

- *Implements routing of packets through the network.*
- *Defines the most optimum path the packet should take from the source to the destination*
- *Defines logical addressing so that any endpoint can be identified.*
- *Handles congestion (crowding) in the network.*
- *Facilitates interconnection between networks*
- *The network layer also defines how to fragment a packet into smaller packets to accommodate different media.*

OSI Layers – 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.*

OSI Layers – Session Layer

- *Session layer provides mechanism for controlling the dialogue between the two end systems. It defines how to start, control and end multiple conversations (called sessions) between applications.*
- *This layer requests for a logical connection to be established on an end-user's request.*
- *Any necessary log-on or password validation is also handled by this layer.*
- *Session layer is also responsible for terminating the connection.*
- *This layer provides services like dialogue discipline which can be full duplex or half duplex.*

OSI Layers – Presentation Layer

- *Presentation layer defines the format in which the data is to be exchanged between the two communicating entities.*
- *Also handles data compression and data encryption (cryptography).*

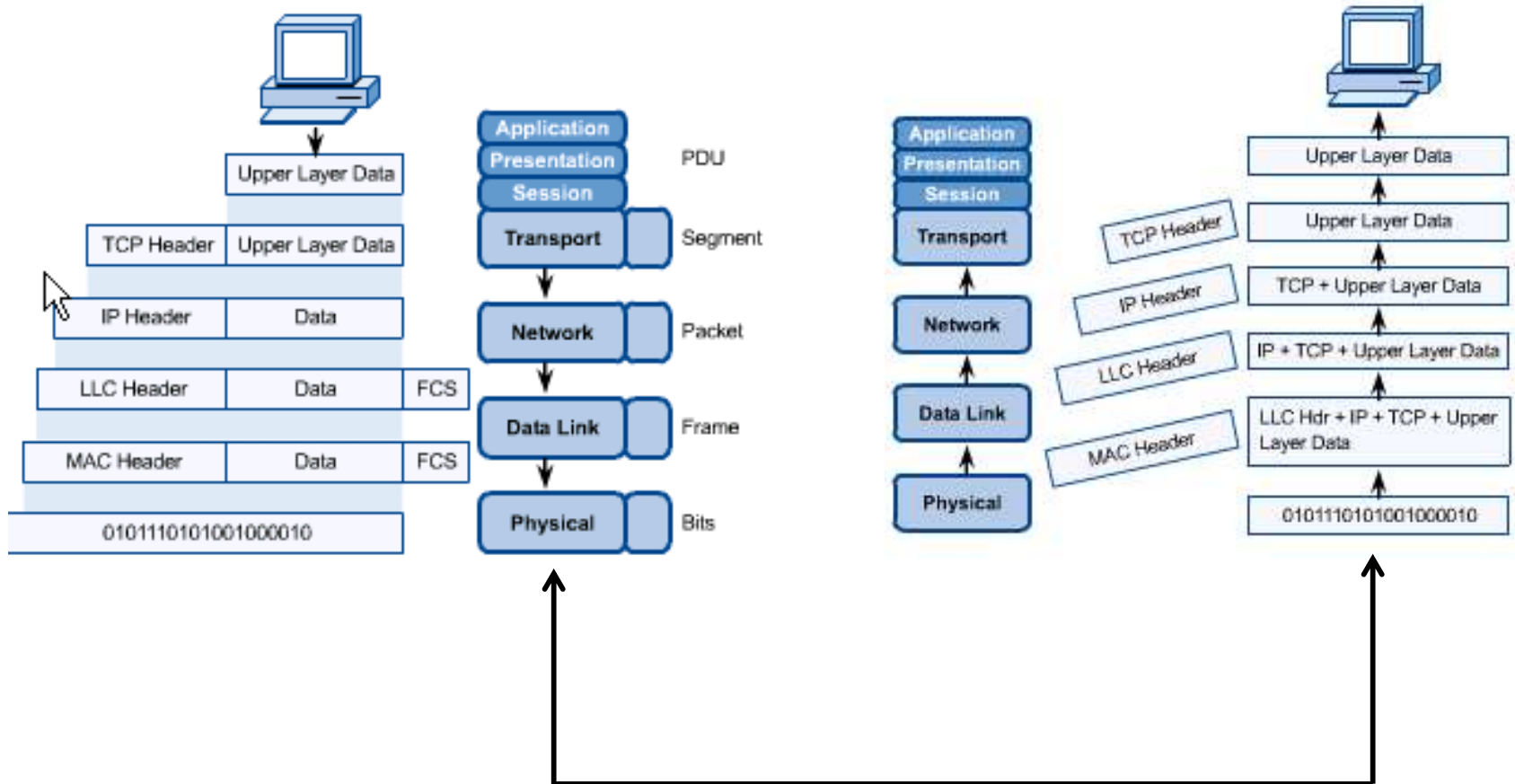
OSI Layers – Application Layer

- *Application layer interacts with application programs and is the highest level of OSI model.*
- *Application layer contains management functions to support distributed applications.*
- *Examples of application layer are applications such as file transfer, electronic mail, remote login etc.*

OSI Model in Action

- *A message begins at the top application layer and moves down the OSI layers to the bottom physical layer.*
- *As the message descends, each successive OSI model layer adds a header to it.*
- *A header is layer-specific information that basically explains what functions the layer carried out.*
- *Conversely, at the receiving end, headers are striped from the message as it travels up the corresponding layers.*

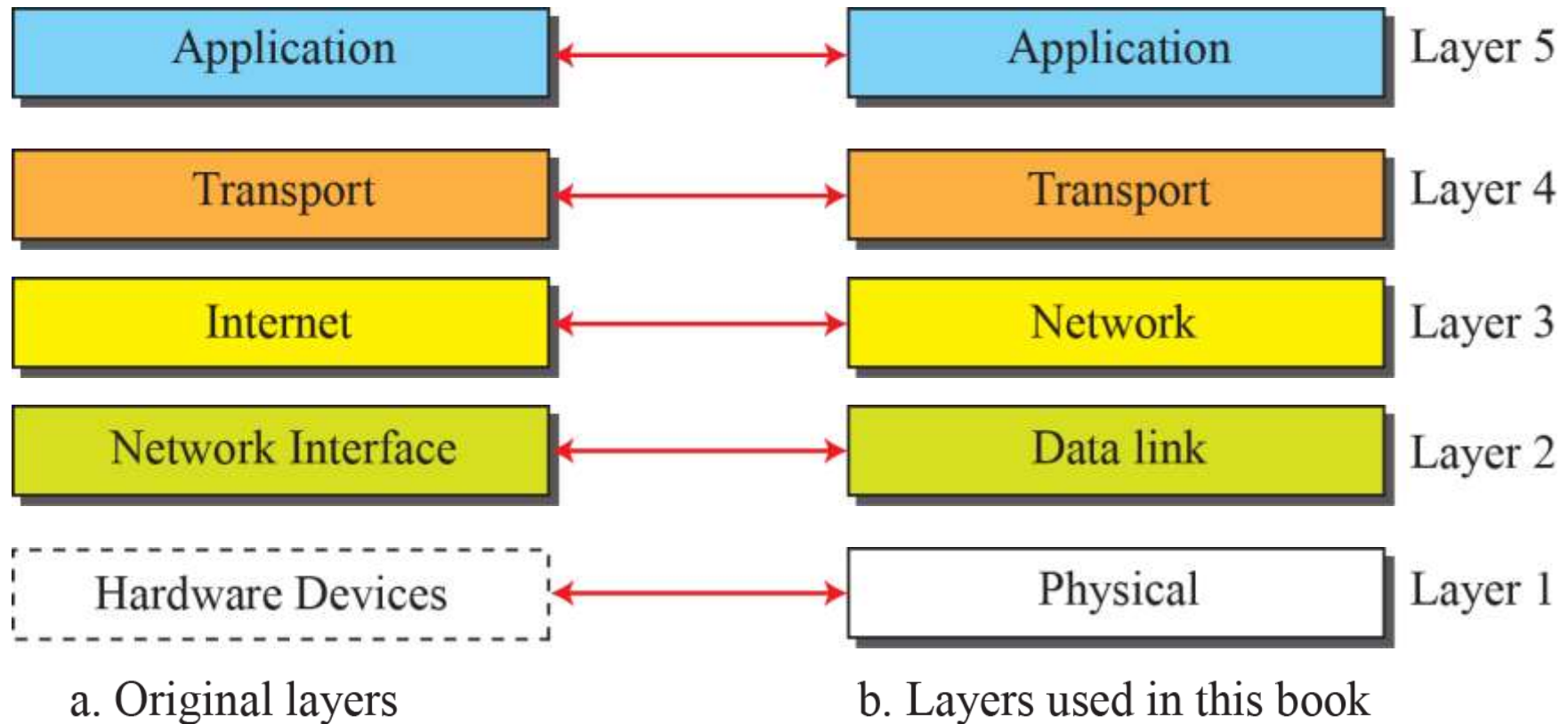
OSI Model in Action



2-3 TCP/IP PROTOCOL SUITE

- *TCP/IP (Transmission Control Protocol/Internet Protocol).*
- ***TCP/IP** is a protocol suite; a set of protocols organized in a different layers, used in the Internet today.*
- *It is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality.*

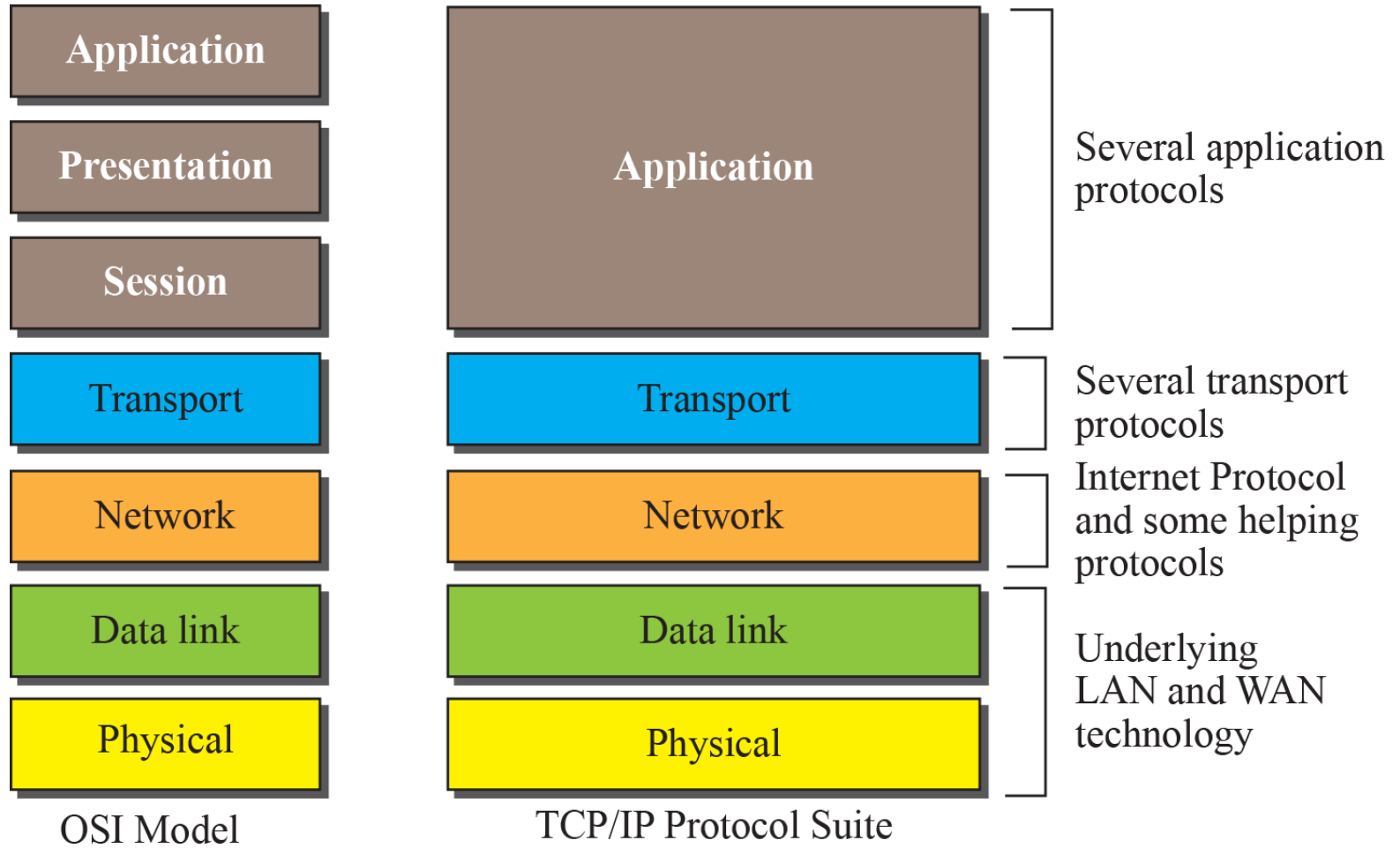
Figure 2.4: *Layers in the TCP/IP protocol suite*



The original TCP/IP protocol suite was defined as four software layers built upon the hardware.

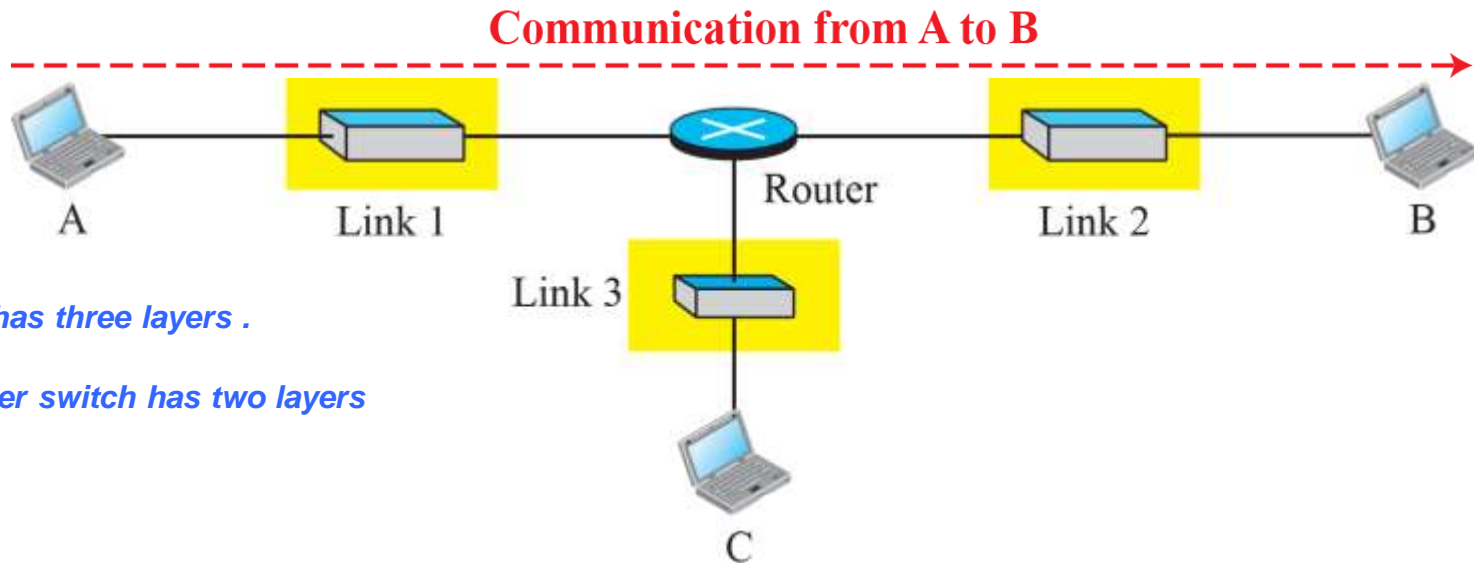
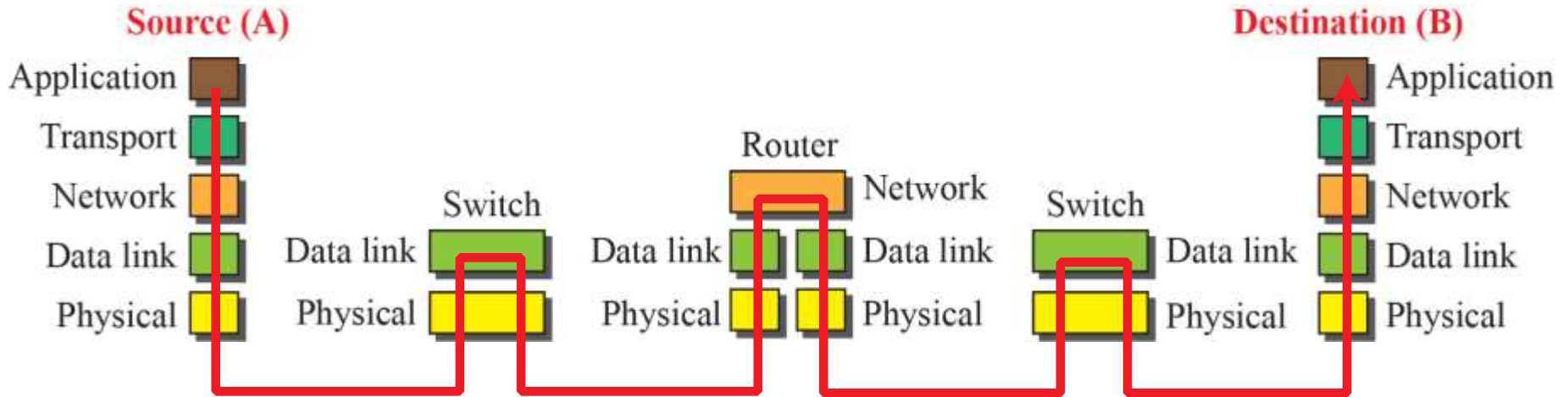
Today, TCP/IP is thought of as a five-layer model.

TCP/IP and OSI model



Communication through an internet

To show how the layers in the TCP/IP protocol works, we assume that we have following internet



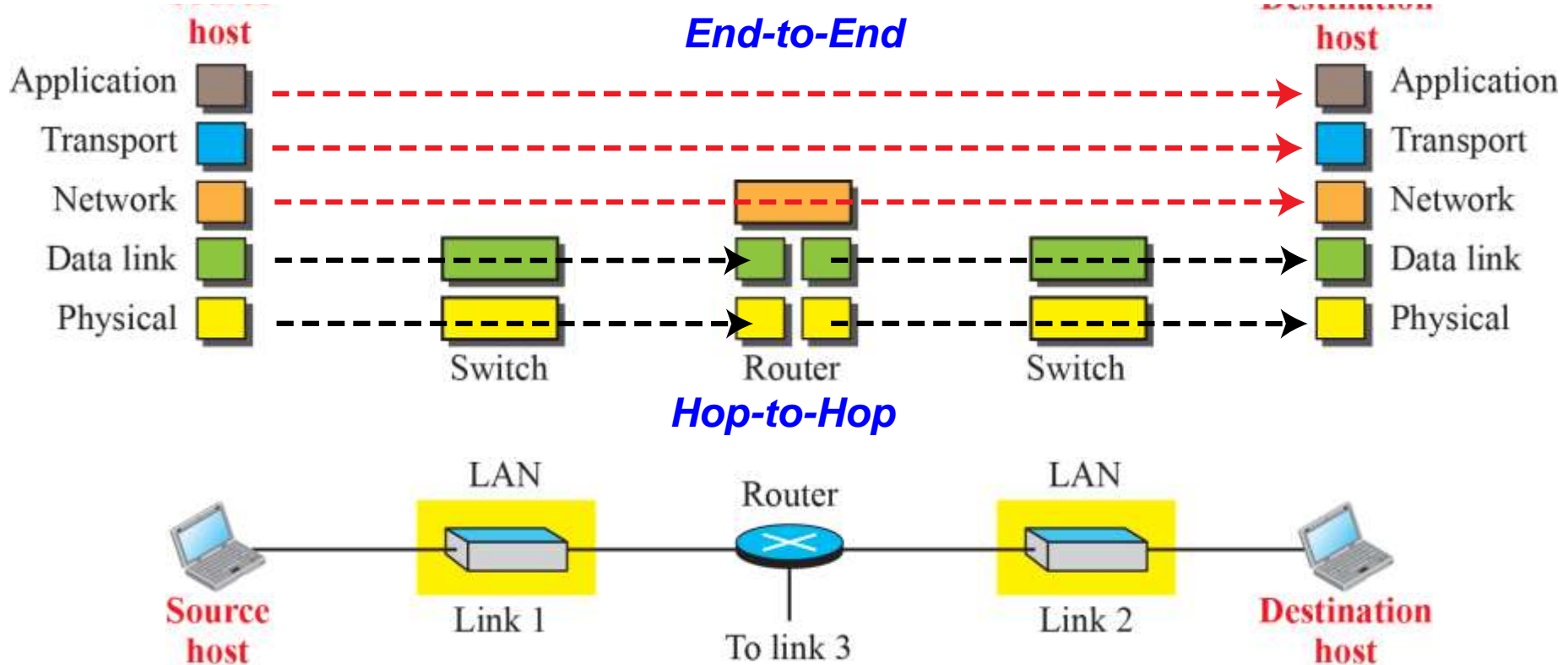
The router has three layers .

The link-layer switch has two layers

Logical connections between layers in TCP/IP

Logical connections

To understand the duty of each layer, we need to think about the logical connections between layers.

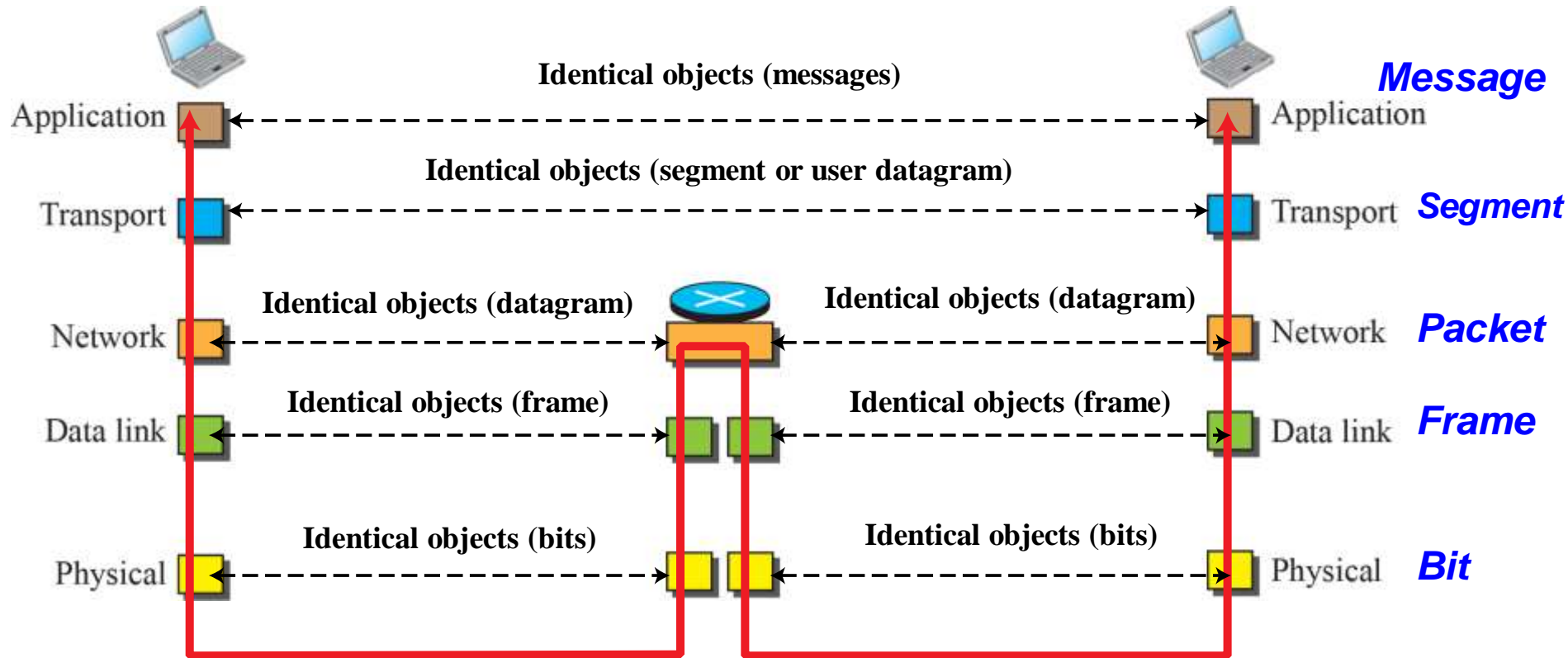


The duty of the application, transport, and network layers is end-to-end. Their domain of duty is the internet.

The duty of the data-link and physical layers is hop-to-hop, hop is a host or router. Their domain of duty is the link.

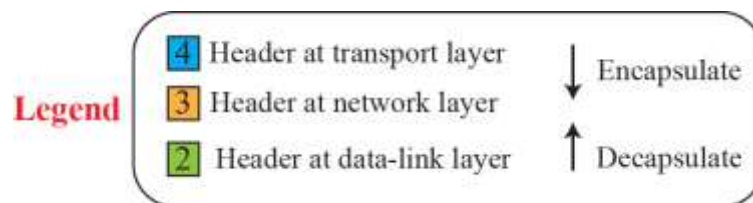
Identical objects in the TCP/IP protocol suite

Notes: We have not shown switches because they don't change objects.

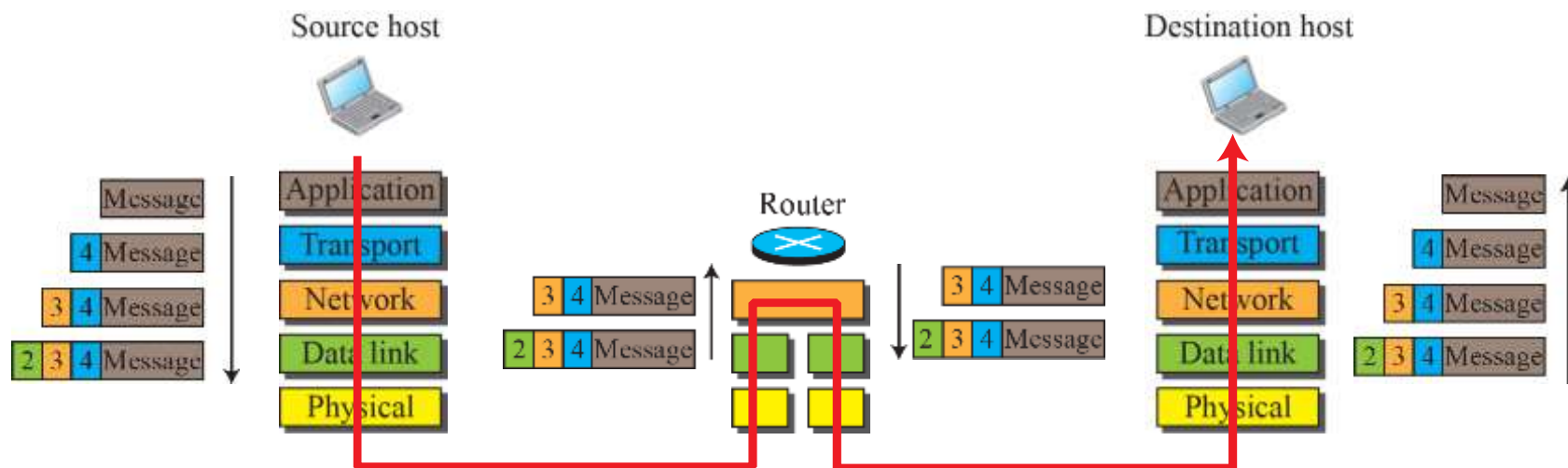


the second principle: identical objects below each layer related to each device.

Encapsulation / Decapsulation



One of the important concepts in protocol layering in the Internet is encapsulation/decapsulation. Figure 2.8 shows this concept for the small internet in Figure 2.5.





2.2.5 Addressing

It is worth mentioning another concept related to protocol layering in the Internet, addressing. As we discussed before, we have logical communication between pairs of layers in this model.

Any communication that involves two parties needs two addresses: source address and destination address.

Although it looks as if we need five pairs of addresses, one pair per layer, we normally have only four because the physical layer does not need addresses; the unit of data exchange at the physical layer is a bit, which definitely cannot have an address.

Addressing in the TCP/IP protocol suite

Packet names

Layers

Addresses

Message

Application layer

Names

Segment / User datagram

Transport layer

Port numbers

Datagram

Network layer

Logical addresses

Frame

Data-link layer

Link-layer addresses

Bits

Physical layer

References

home.iitk.ac.in/~navi/sidbinetworkcourse/lecture2.ppt

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