Advanced Computer Networking & Comm – CSC 815

Module 3 : Internetworking Models

By

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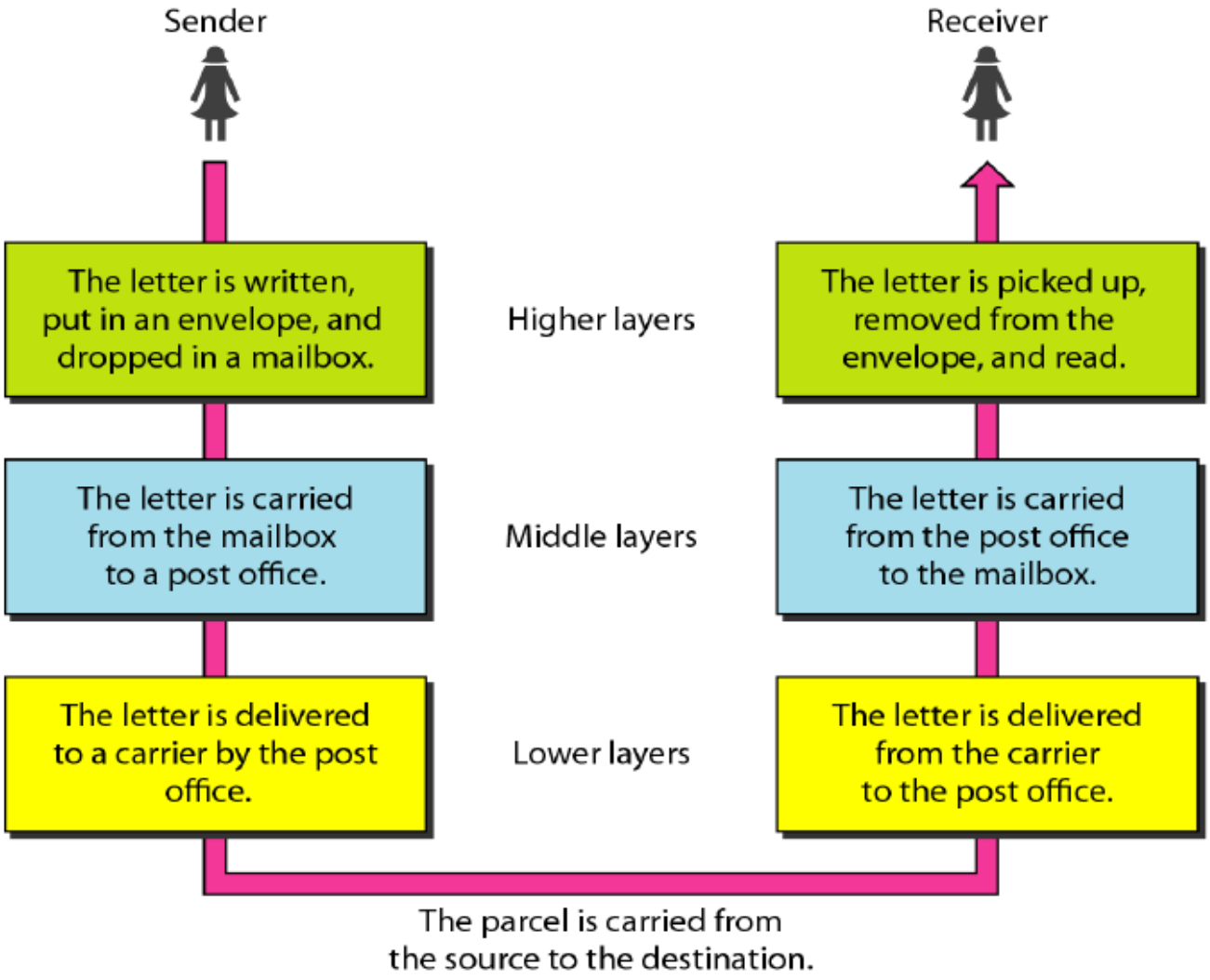
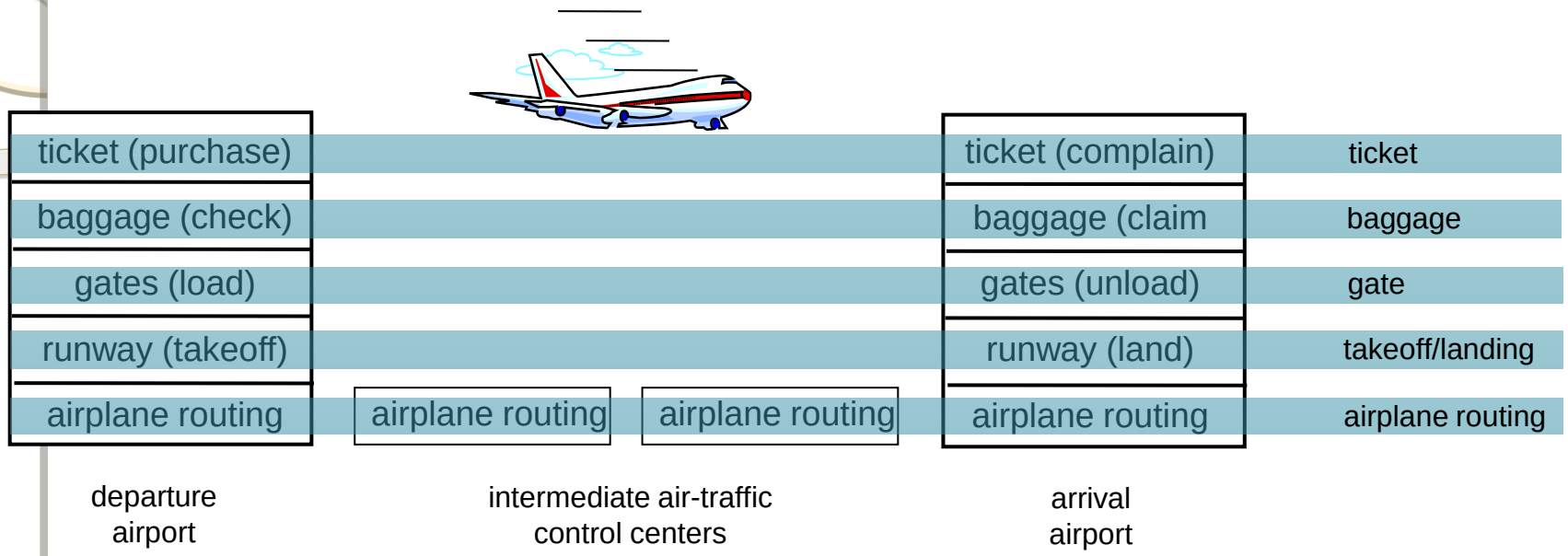
LAYERED TASKS

- 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.

Tasks involved in sending a letter



Layering of airline functionality



layers: each layer implements a service

- via its own internal-layer actions
- relying on services provided by layer below

Internetworking Models

The Layered Approach

A *reference model* is a conceptual blueprint of how communications should take place. It addresses all the processes required for effective communication and divides these processes into logical groupings called *Layers* When a communication system is designed in this manner, it's known as *layered architecture*

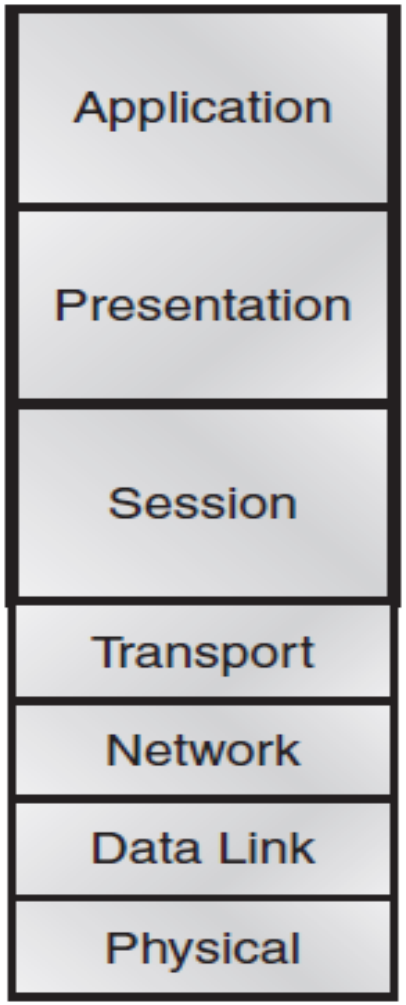
Advantages of Reference Models

- It divides the network communication process into smaller and simpler components, thus aiding component development, design, and troubleshooting.
- It allows multiple-vendor development through standardization of network components.
- It encourages industry standardization by defining what functions occur at each layer of the model.
- It allows various types of network hardware and software to communicate.
- It prevents changes in one layer from affecting other layers, so it does not hamper development.

THE 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 (OSI) model. It was first introduced in the late 1970s.

The OSI Reference Model

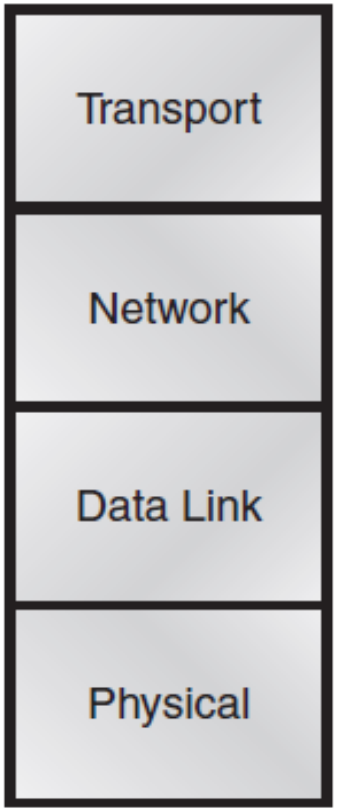


- Provides a user interface

- Presents data
- Handles processing such as encryption

- Keeps different applications' data separate

The OSI Model -The lower layers



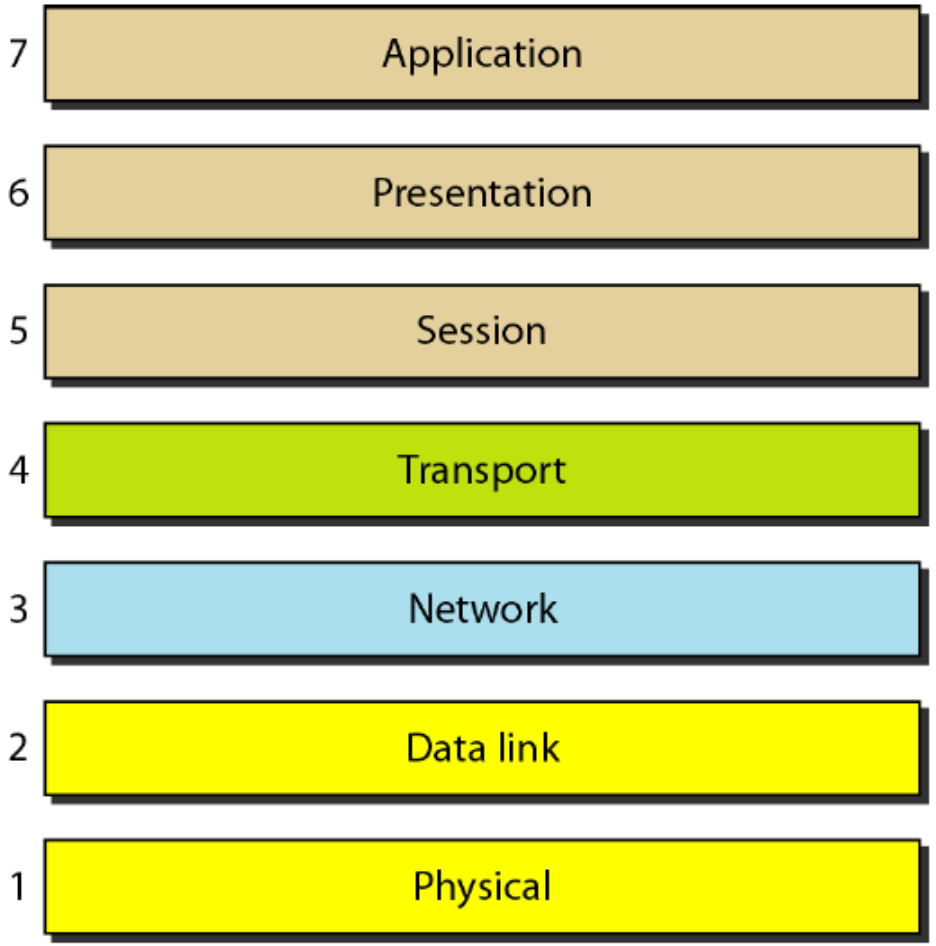
- Provides reliable or unreliable delivery
- Performs error correction before retransmit

- Provides logical addressing, which routers use for path determination

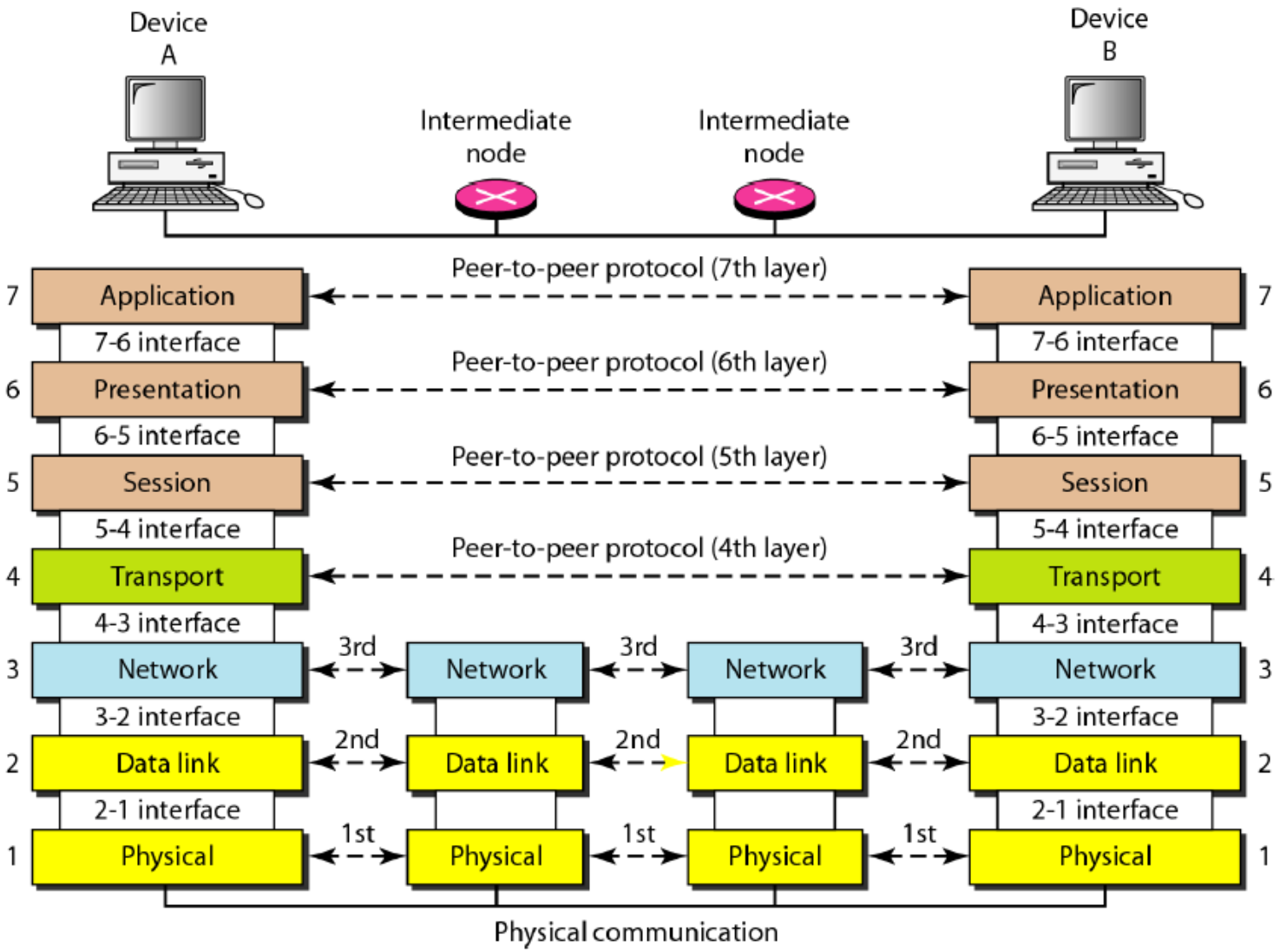
- Combines packets into bytes and bytes into frames
- Provides access to media using MAC address
- Performs error detection not correction

- Moves bits between devices
- Specifies voltage, wire speed, and pin-out of cables

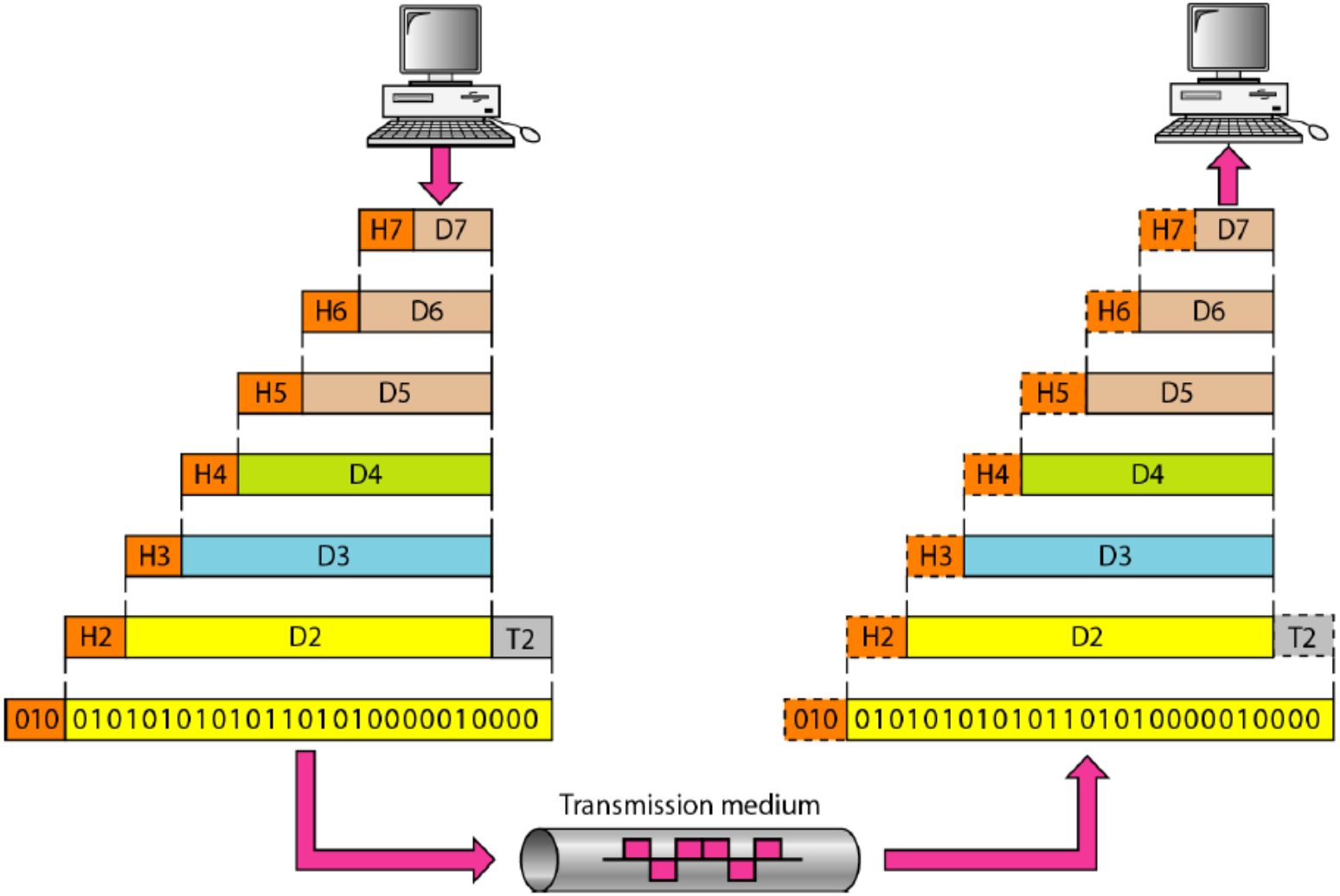
Seven Layers of the OSI



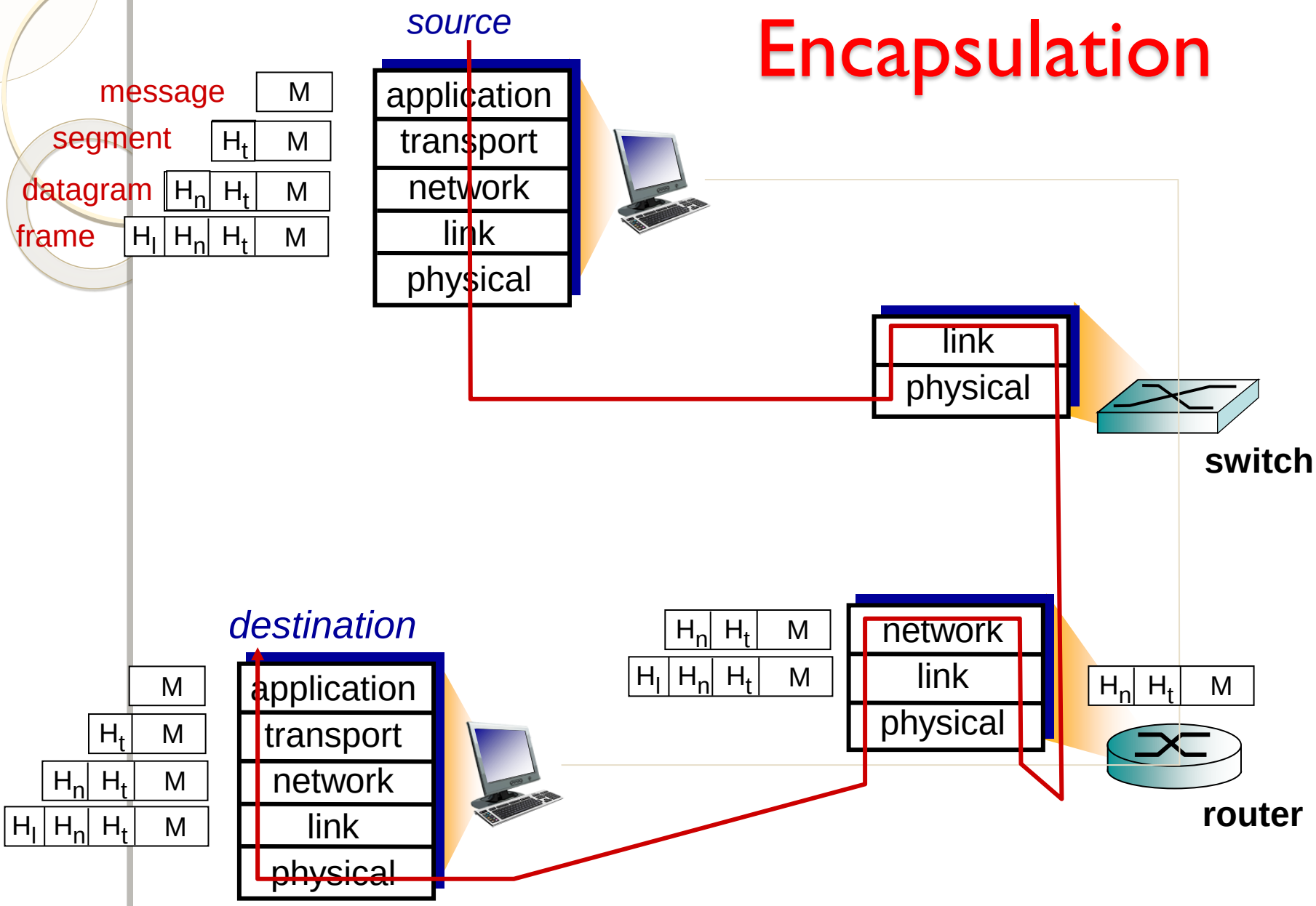
The interaction between layers in the OSI model



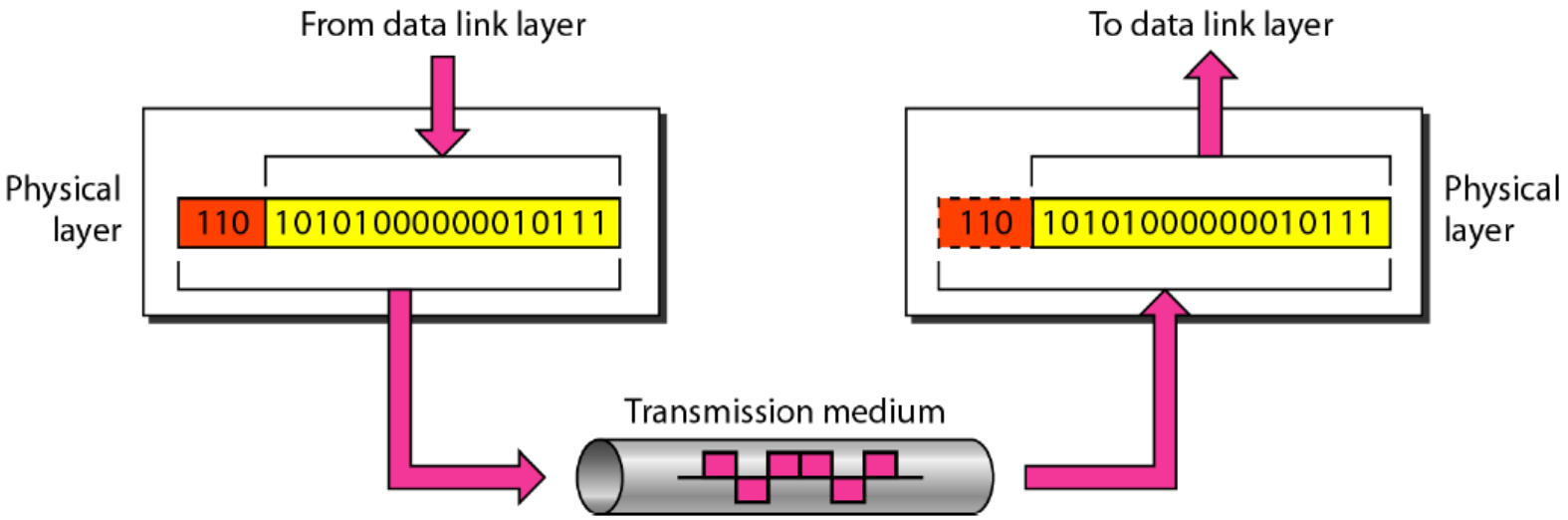
An exchange using the OSI model



Encapsulation



Physical layer

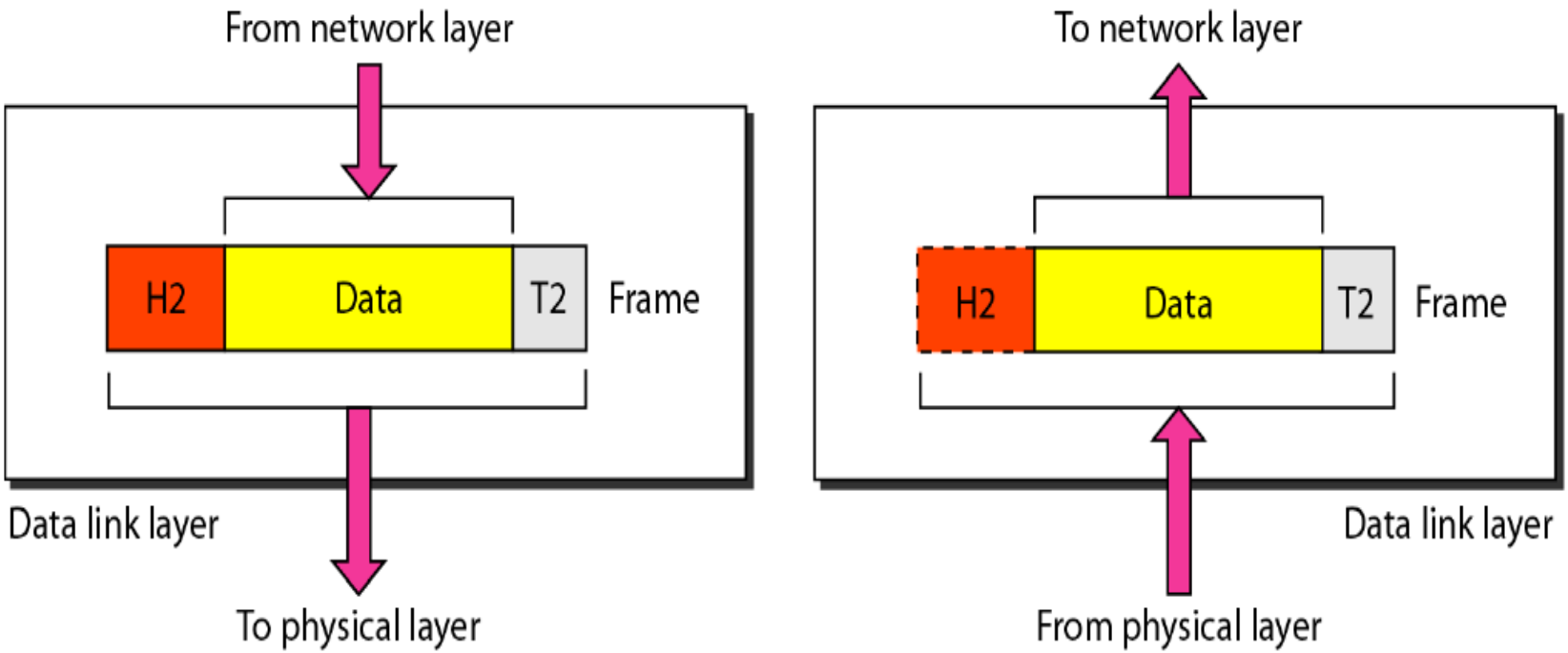


- It Defines the Procedures and Functions that physical devices and interfaces have to perform for Transmission to Occur.

Physical layer

- It deals with the:
  - Physical Characteristics of Interfaces and Medium (Characteristics of the interface and type of Transmission)
  - Representation of Bits
  - Data Rate (The Transmission Rate)
  - Synchronization of Bits (Sync'ingClocks of Sender and Receiver)
  - Line Configuration (Point to point or multipoint)
  - Physical Topology
  - Transmission Mode (Simplex, Half Duplex or Full Duplex)

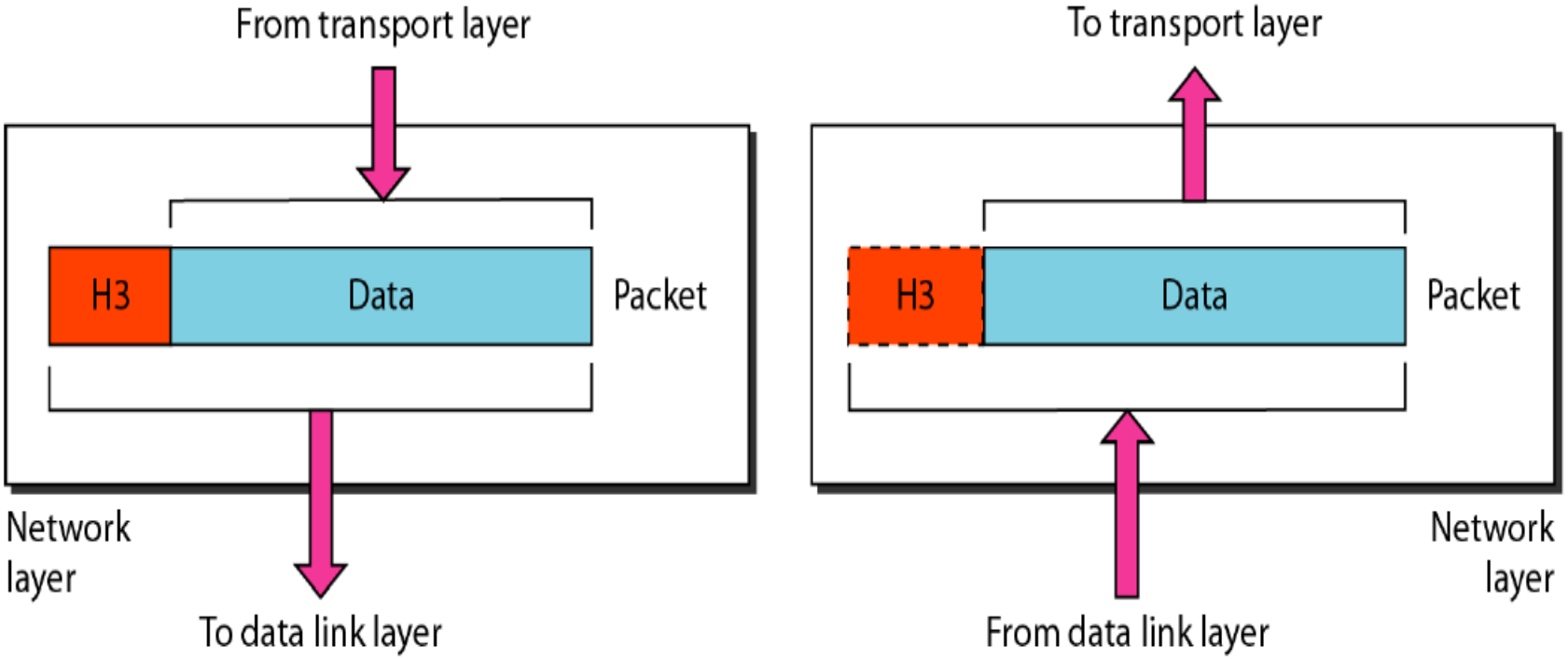
Data Link Layer



Data Link Layer

- The Jobs of Data Link layer are:
  - Framing (Manageable Data Units)
  - Physical Addressing
  - Flow Control (The rate at which data is received at the receiver)
  - Error Control (By adding a trailer to the frame the duplicate and erroneous frames are detected and it may request re-transmission)
  - Access Control

Network Layer

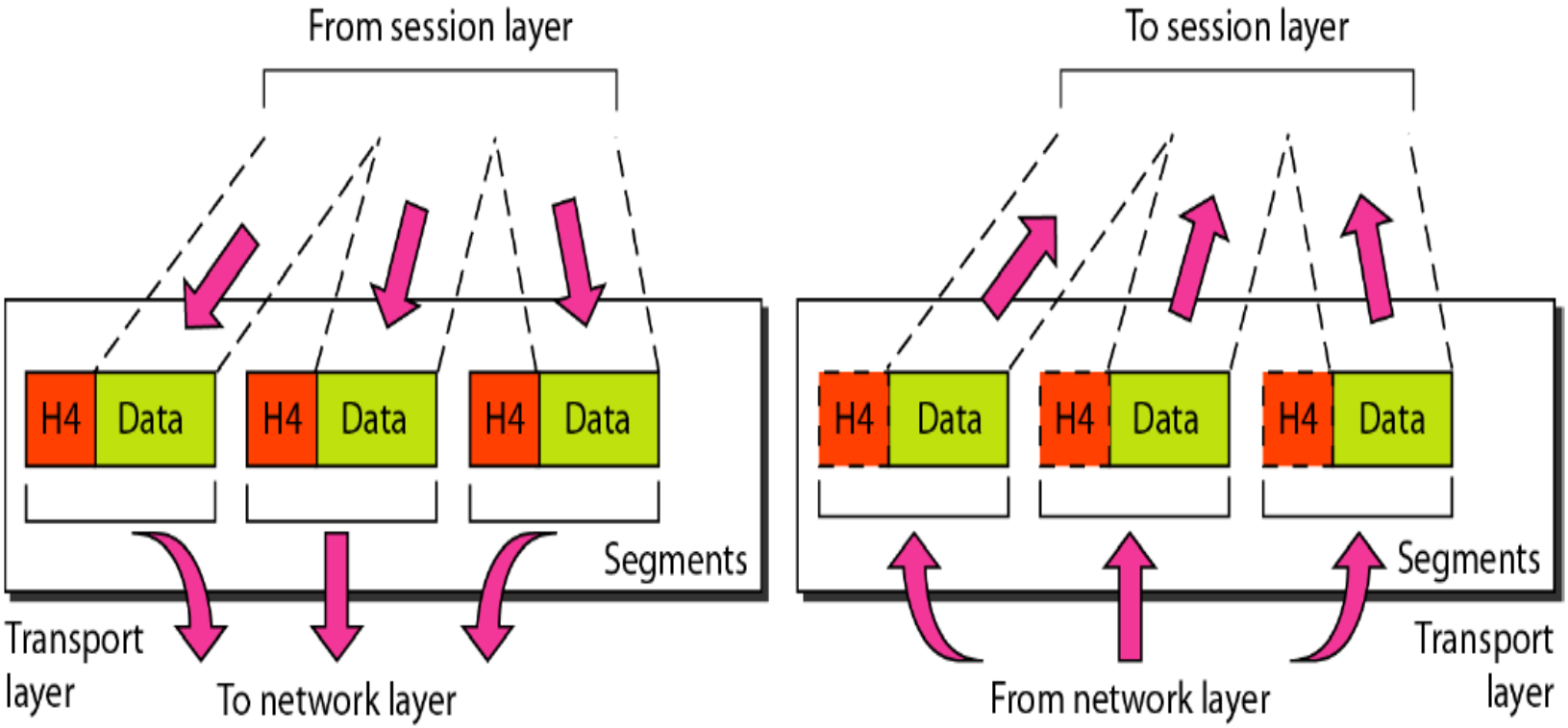


Network Layer

•The network layer is responsible for the delivery of individual packets from the source host to the destination host.

- Source to Destination delivery while data link layer is responsible for hop to hop delivery
- Logical Addressing (Different from that of data link layer addressing as this layer is working on an another level)
- Routing (To pass a packet through multiple networks using routers)
- http://en.wikipedia.org/wiki/Network_Layer

Transport layer



Transport layer

- Process to Process Delivery while the network layer oversees every packet as an individual piece while it recognizes the relationship among those packets, makes sure all the message is intact and in order along with error control and flow control.

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

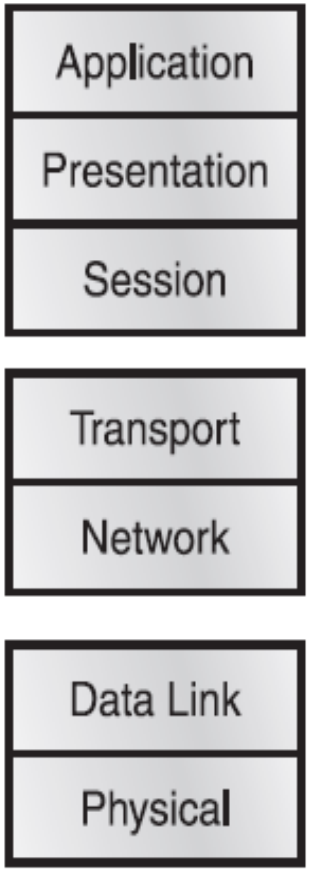
Transport Layer

- Its other jobs are:
  - Service Point Addressing: The network layer gets an entire packet to the destination computer while the Transport Layer gets it to the right process. Service Point Addressing is used to identify the exact port of an application.
  - **Segmentation and Reassembly**: A message is split in to transmittable segments with a sequence number for each segment by the transport layer and at the receiver using that sequence number the transport layer reassemble those segments.

Transport Layer

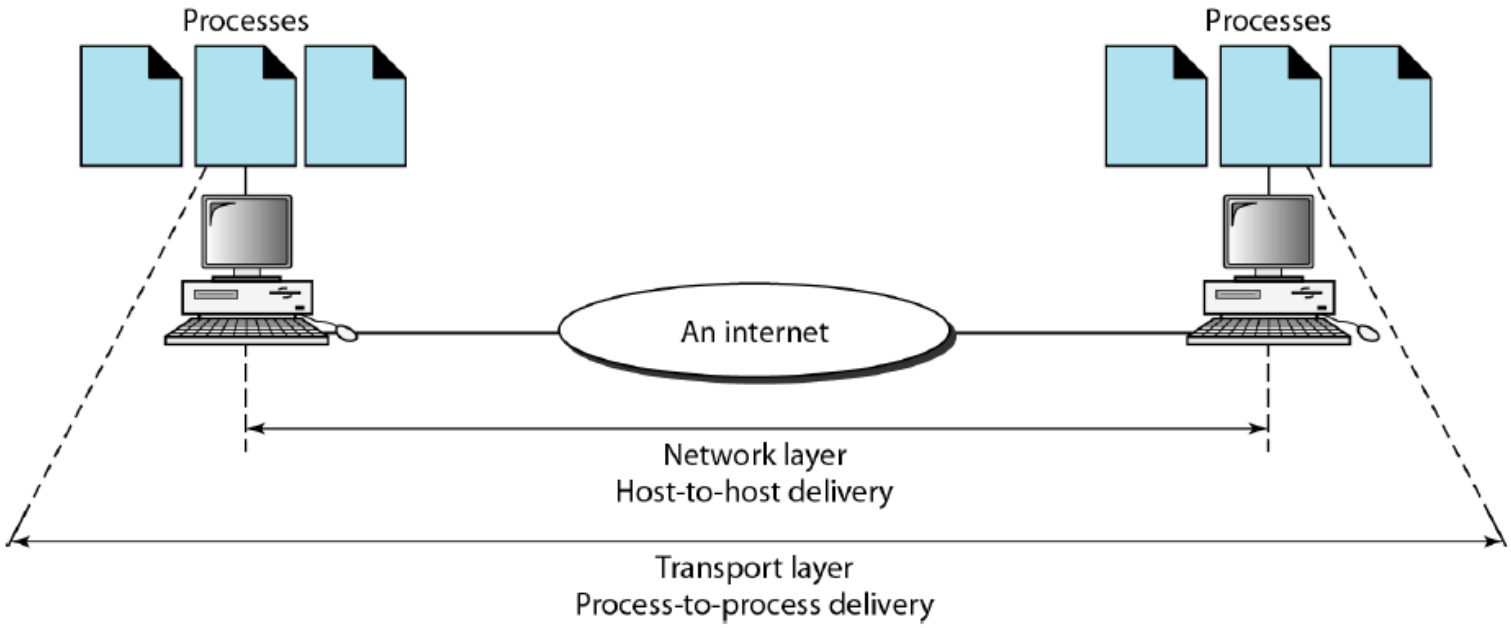
- Continued...
  - Connection Control: This layer can be either connection oriented or connection less. In the former type first of all a connection is established with the destination then segments are transmitted after all the transmission, the connection is terminated while in the later type each segment is sent individually.
  - Flow Control: Just like Data link layer this layer is also responsible for flow control however on this layer it is performed Process to Process
  - Error Control: Process to Process error control is also the responsibility of this layer the correction is achieved only by Re-Transmission.

Layers Function

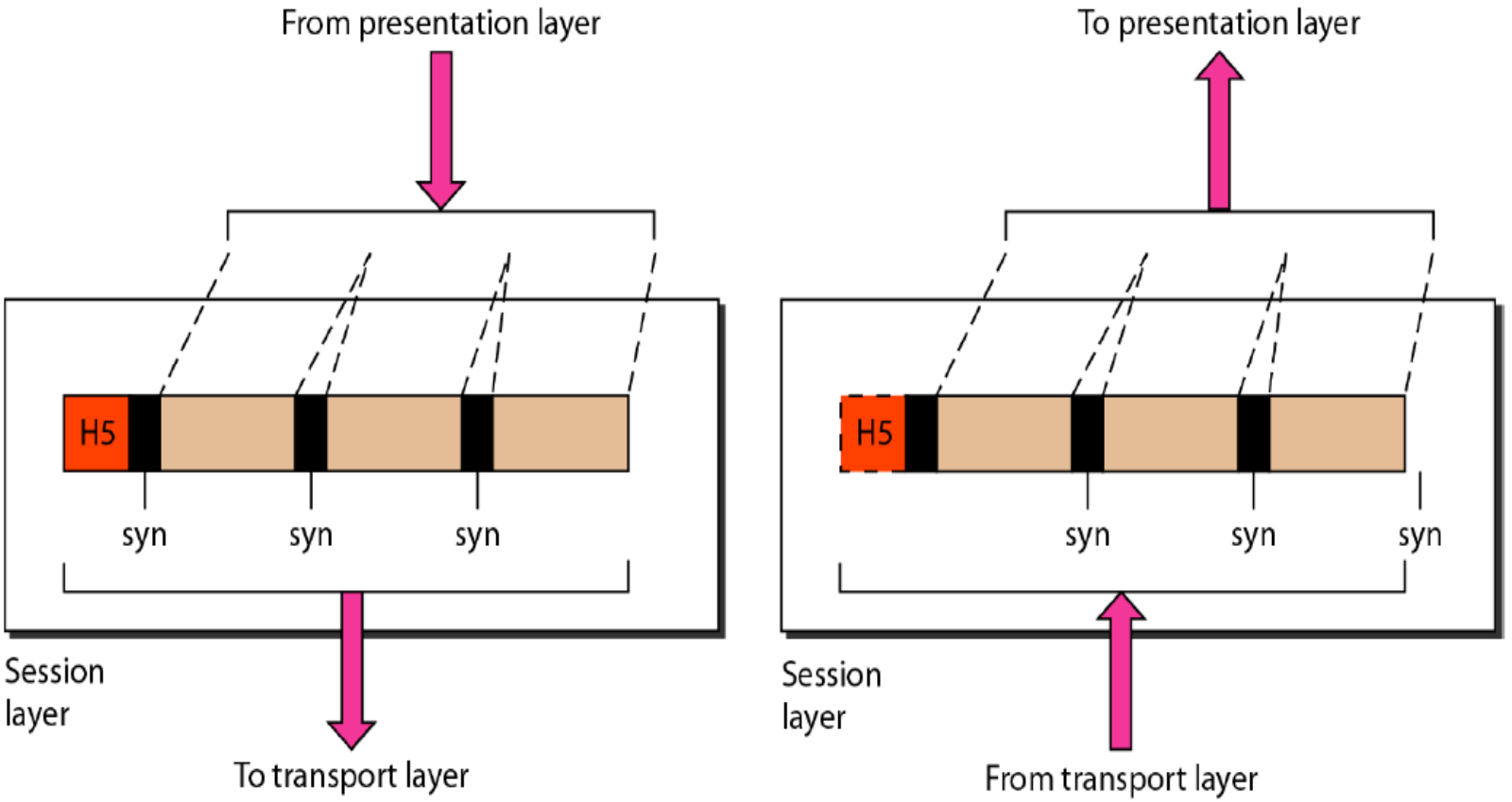


- File, print, message, database, and application services
- Data encryption, compression, and translation services
- Dialog control
- End-to-end connection
- Routing
- Framing
- Physical topology

Reliable process-to-process delivery of a message



Session Layer

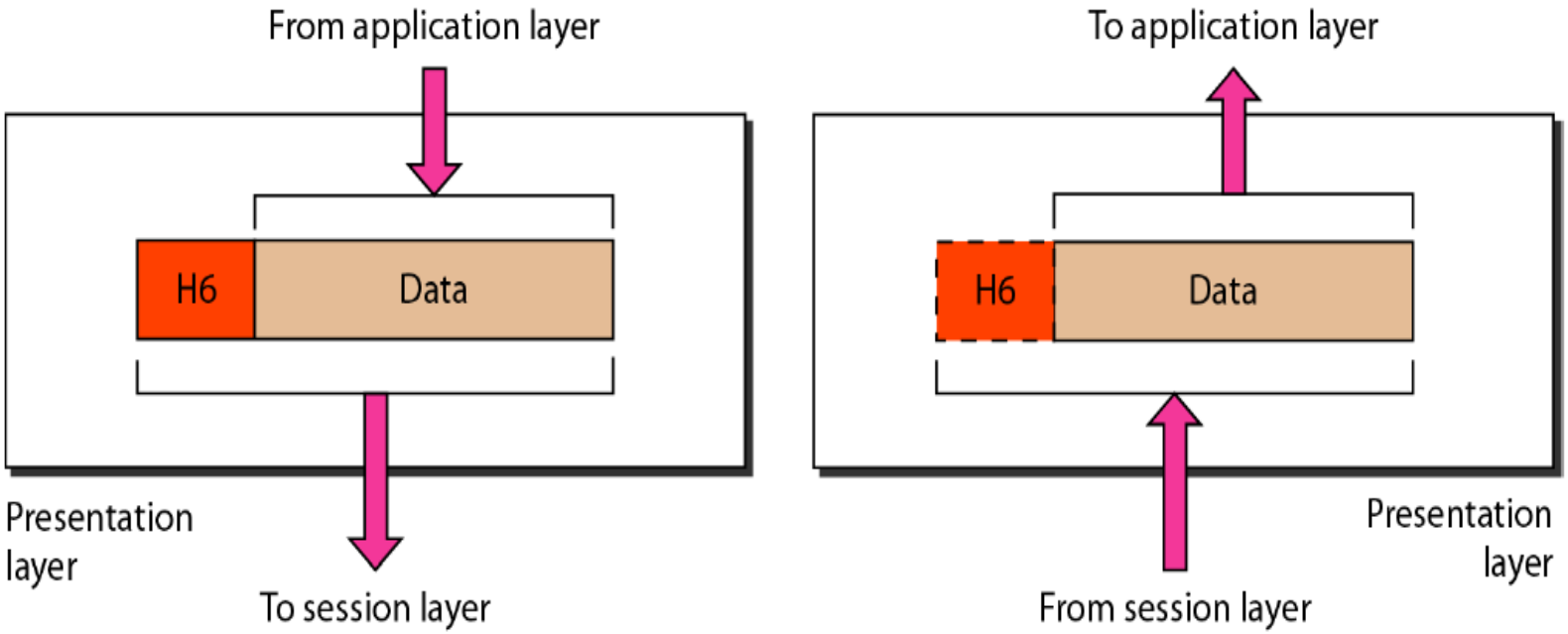


Session Layer

- It is used for:
  - Dialog Control: It allows two systems to enter in to a dialog by allowing them to communicate in either half duplex or full duplex.
  - Synchronization: It adds Sync'ing points to a stream of data i.e. if there is any problem in a unit (group) of data then instead of entire file re-transmission only that unit is retransmitted.

The session layer is responsible for dialog control and synchronization.

Presentation Layer

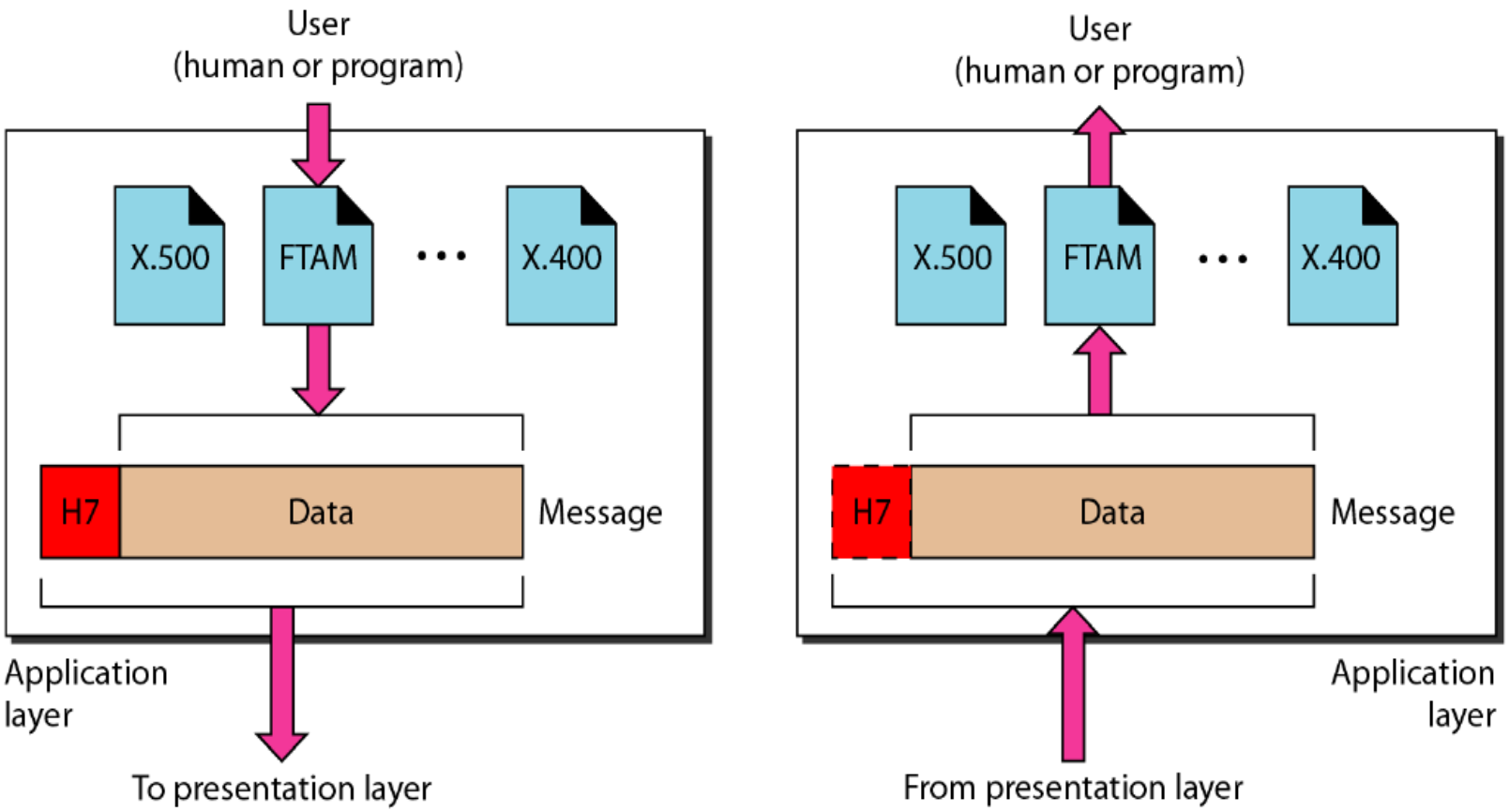


Presentation Layer

- It is used for:
  - Translation: It is responsible to transform any data from the sender dependent format to a standard format for transmission and then re-translating it at the receiver end from standard to receiver dependent format
  - Encryption: to protect the sender data over the network the source system transform i.e. encrypts the original data in to another form and then sends it over the network while at the receiver end the process is reversed.
  - Compression: To reduce the number of bits that are sent over the network this technique is used.

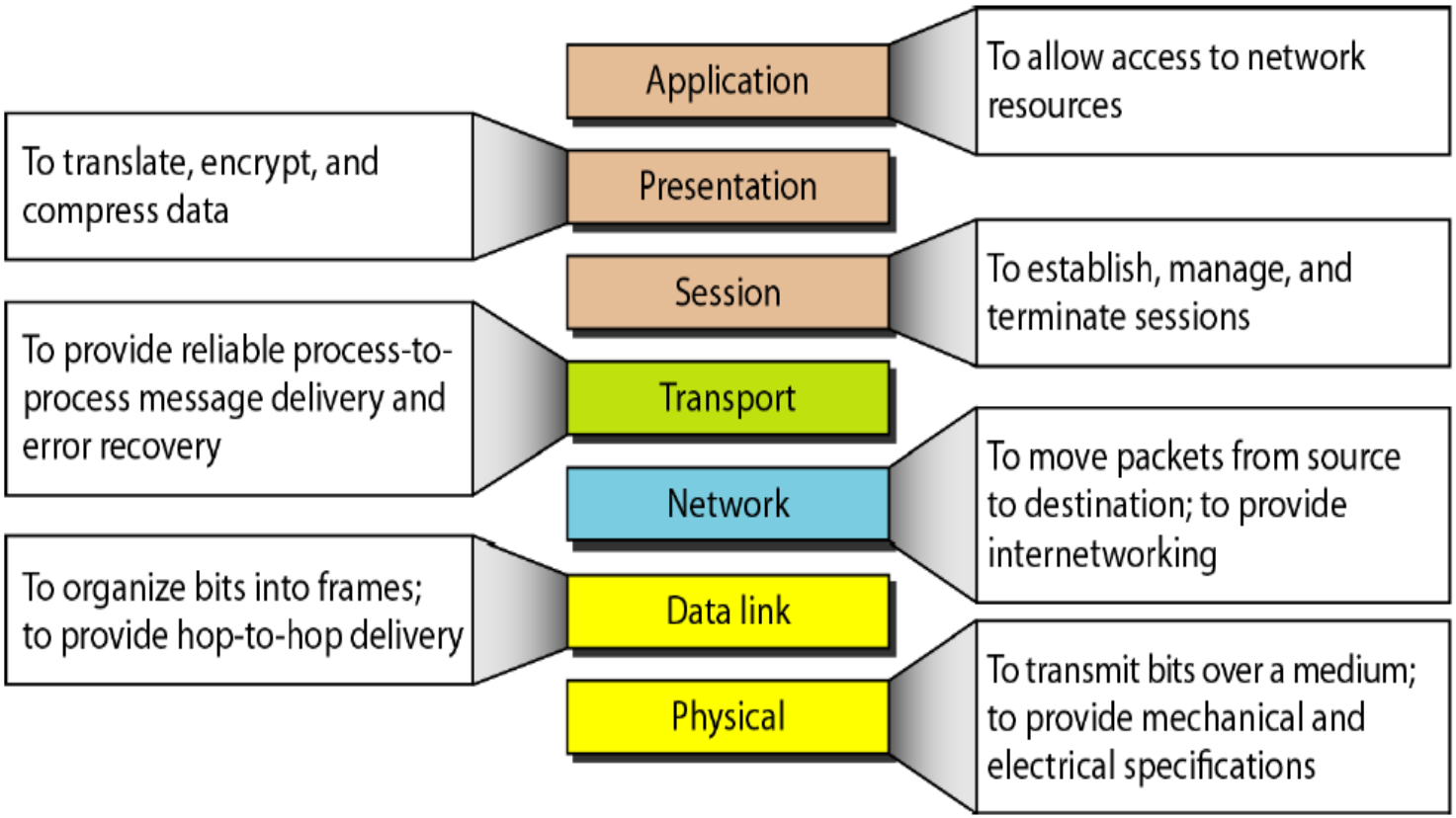
The presentation layer is responsible for translation, compression, and encryption.

The Application Layer



- The application layer is responsible for providing services to the user.

Summary of Layers



What's a protocol?

human protocols:

- "what's the time?"
- "I have a question"
- introductions

… specific msgs sent

… specific actions taken when msgs received, or other events

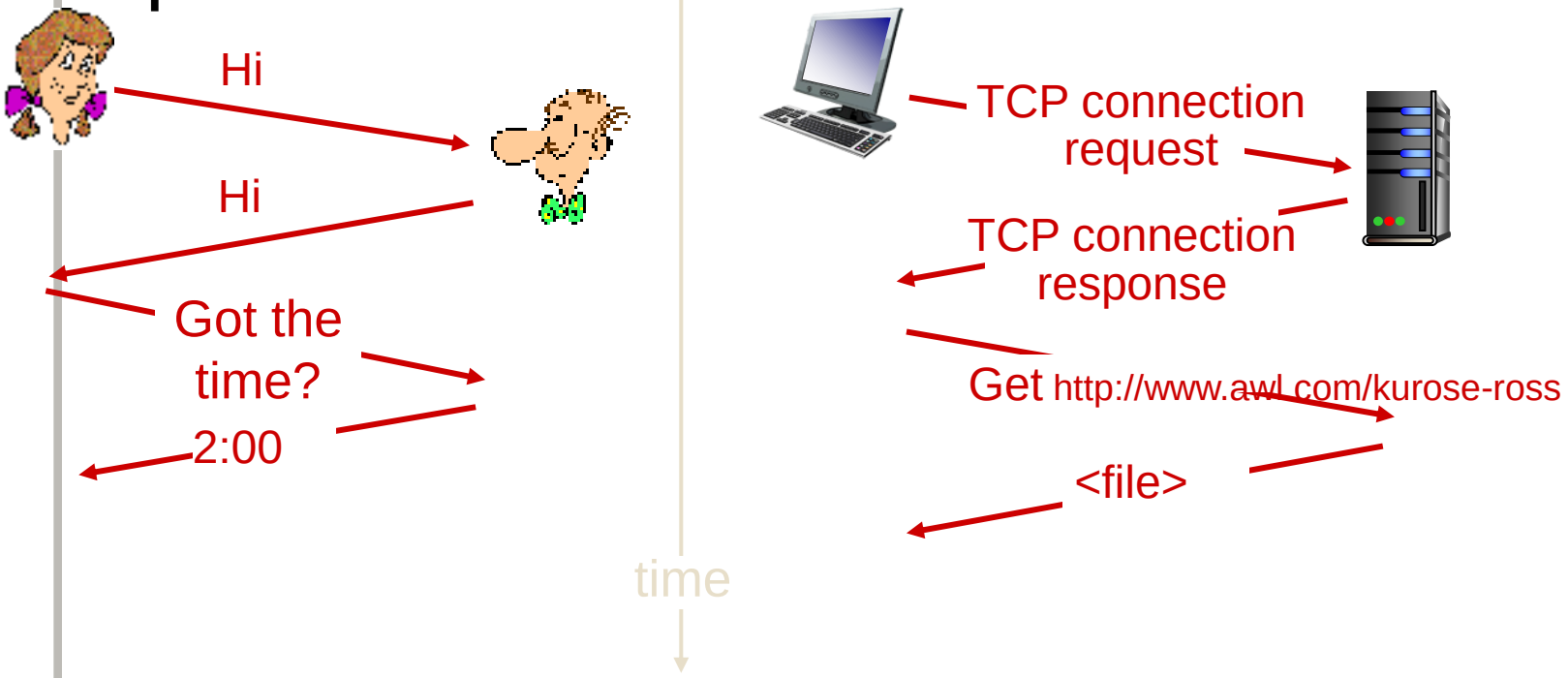
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

What's a protocol?

a human protocol and a computer network protocol:



Need For Protocol Architecture

- data exchange can involve complex procedures, cf. file transfer example
- better if task broken into subtasks
- implemented separately in layers in stack
  - each layer provides functions needed to perform comms for layers above
  - using functions provided by layers below
- peer layers communicate with a protocol

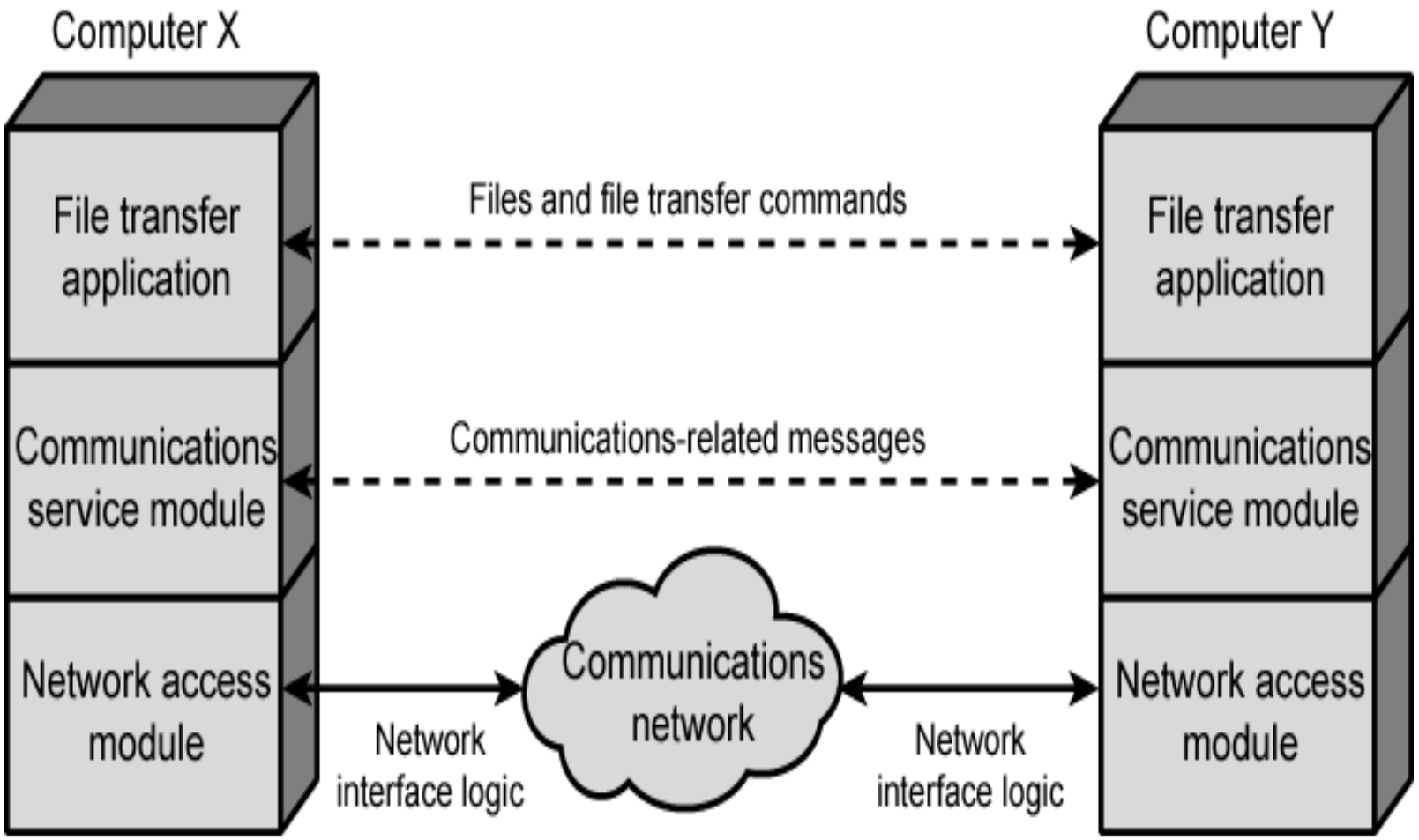
Key Elements of a Protocol

- syntax - data format
- semantics - control info & error handling
- timing - speed matching & sequencing

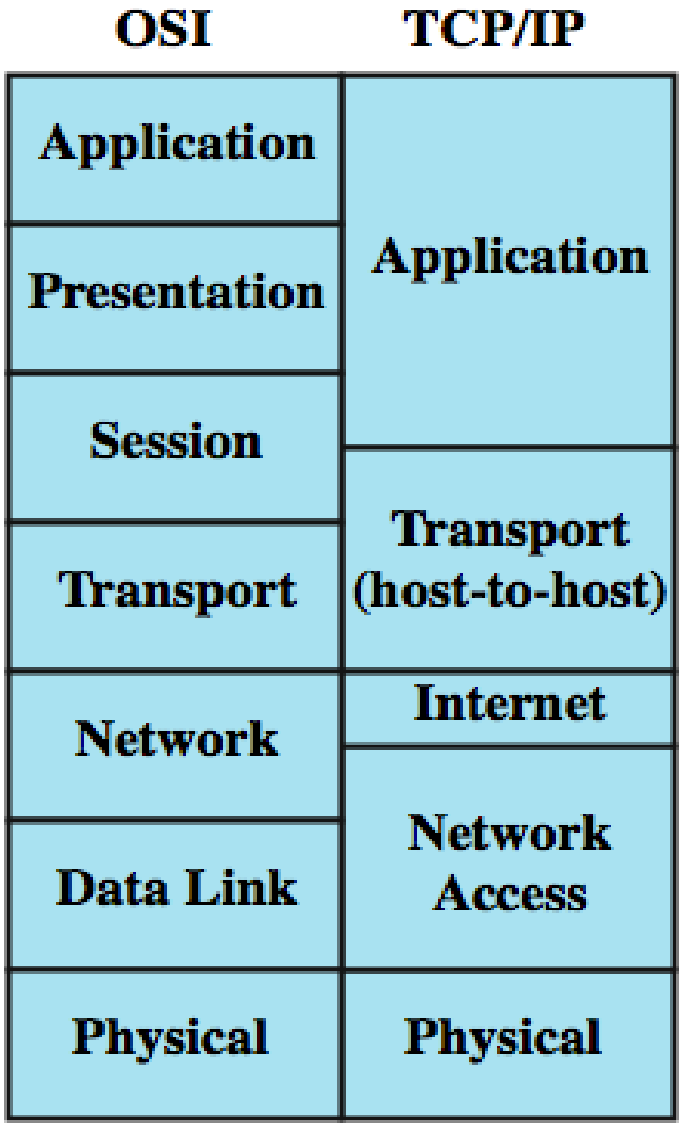
TCP/IP Protocol Architecture

- developed by US Defense Advanced Research Project Agency (DARPA)
- for ARPANET packet switched network
- used by the global Internet
- protocol suite comprises a large collection of standardized protocols

Simplified Network Architecture



OSI v TCP/IP


OSI
TCP/IP
Application
Presentation
Session
Transport
Network
Data Link
Physical
Application
Transport (host-to-host)
Internet
Network Access
Physical

TCP/IP Layers

- no official model but a working one
  - Application layer
  - Host-to-host, or transport layer
  - Internet layer
  - Network access layer
  - Physical layer

Physical Layer

- concerned with physical interface between computer and network
- concerned with issues like:
  - characteristics of transmission medium
  - signal levels
  - data rates
  - other related matters

Network Access Layer

- exchange of data between an end system and attached network
- concerned with issues like :
  - destination address provision
  - invoking specific services like priority
  - access to & routing data across a network link between two attached systems
- allows layers above to ignore link specifics

Internet Layer (IP)

- routing functions across multiple networks
- for systems attached to different networks
- using IP protocol
- implemented in end systems and routers
- routers connect two networks and relays data between them

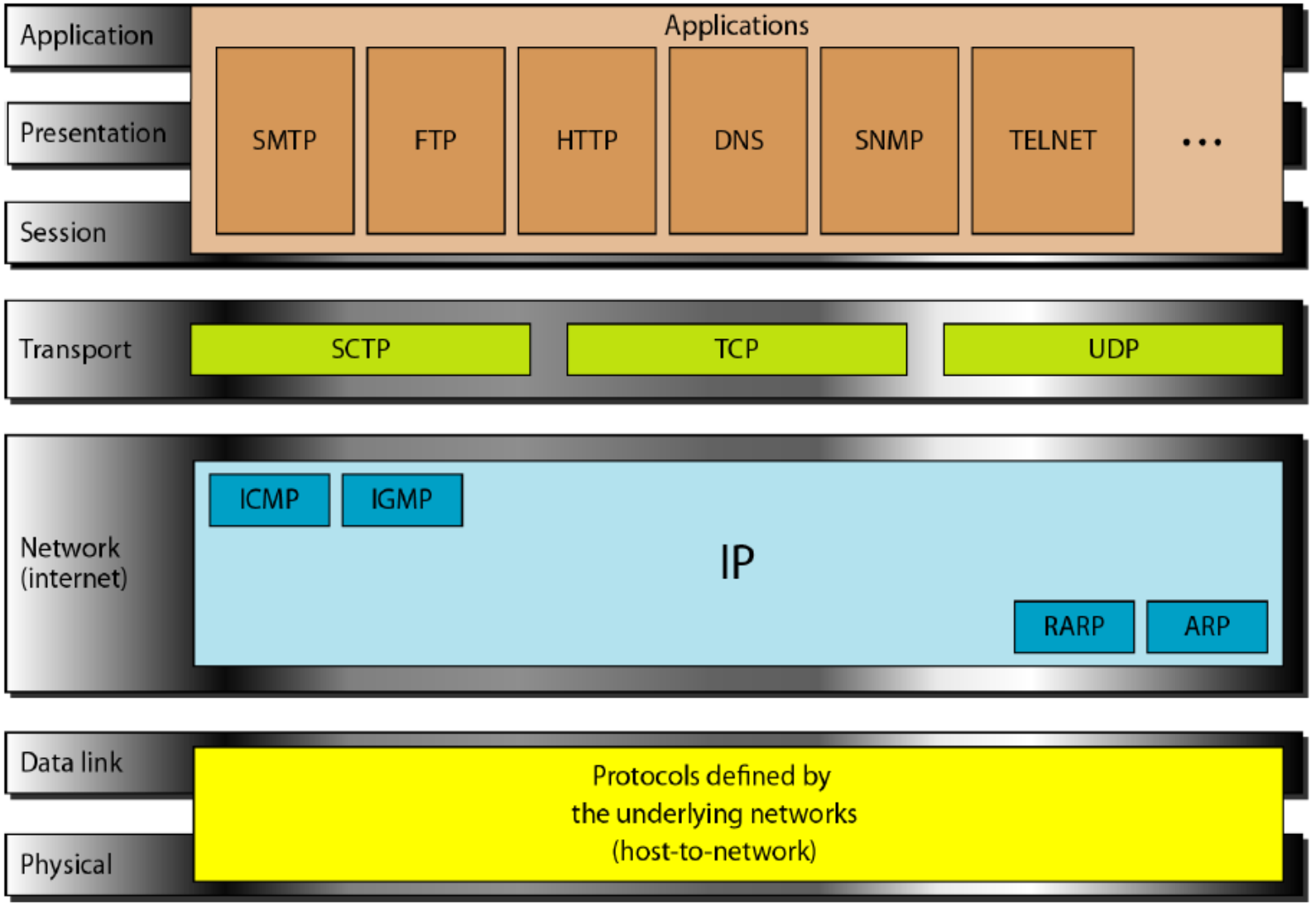
Transport Layer (TCP)

- common layer shared by all applications
- provides reliable delivery of data
- in same order as sent
- commonly uses TCP

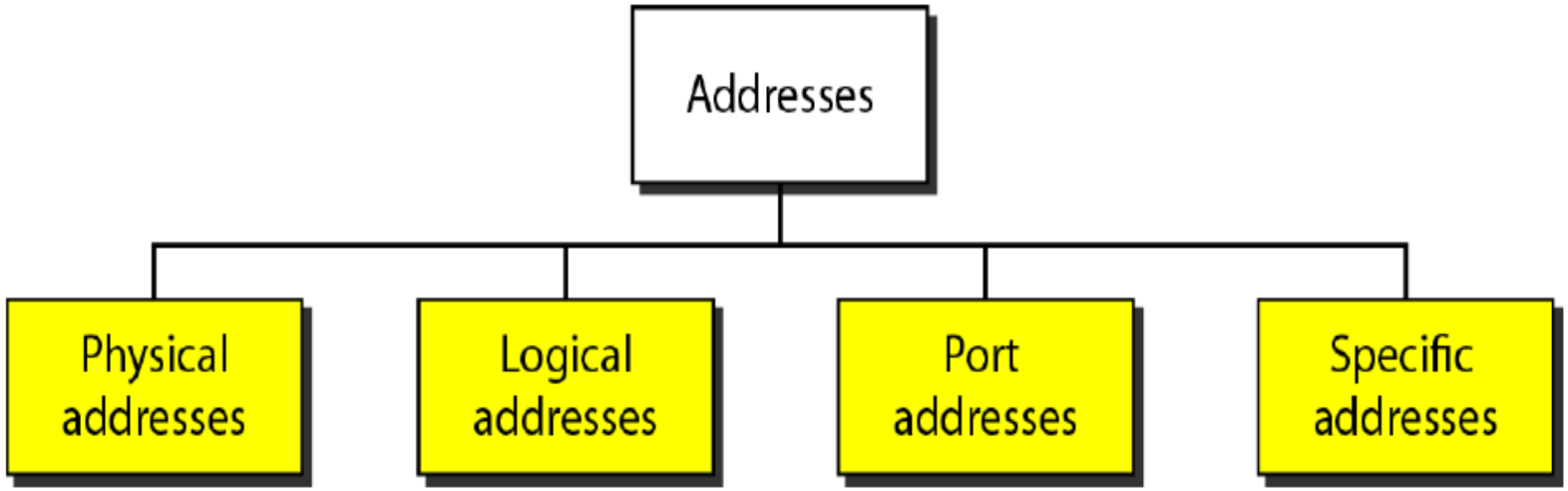
Application Layer

- provide support for user applications
- need a separate module for each type of application

TCP/IP and OSI model



Addresses in TCP/IP



TCP/IP Protocol Suite

- **Physical and Data Link Layers:**
  - For Transporting Bits and Frames along with Error Detection. TCP/IP model is designed in such a way that it can run on any hardware networking Technology
- **Network (Internet) Layer:**
  - Delivery of Packets from Sender to Receiver using IP, in turn it uses supporting Protocols as ARP, RARP, ICMP and IGMP
- *Internetworking Protocol:* It is the transmission protocol for TCP/IP protocol. It is an Unreliable and Connection less but *Best Effort Delivery* service which means it knows the unreliability of the underlying layers and makes its best effort for the reliable delivery but with no guarantees. It transports data in packets called Datagrams.

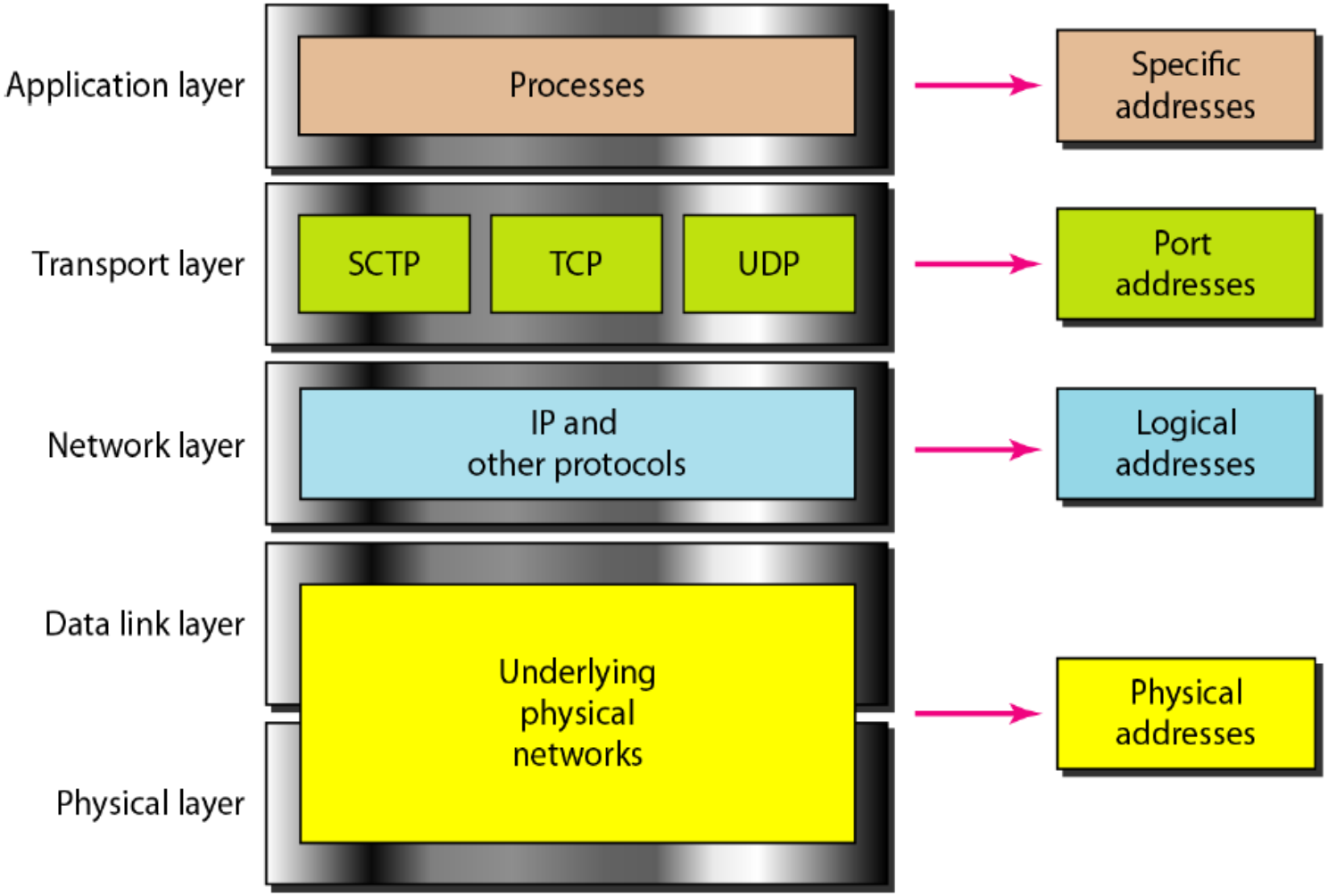
TCP/IP Protocol Suite (contd…)

- Address Resolution Protocol (ARP)
  - It associates the Logical Address to the Physical Address
- Reverse ARP(RARP)
  - To find out ones own logical address when Physical address is known.
- Internet Control Message Protocol(ICMP)
  - As IP uses the best effort delivery method but with no guarantees this protocol helps send back Acknowledgments to the sender from receiver
- Internet Group Message Protocol (IGMP)
  - Used when a message is to be delivered to a group.

TCP/IP Protocol Suite (contd…)

- **Transport Layer:**
  - Process to Process Delivery of a message. It uses TCP and UDP also a new protocol SCTP is also included in this layer now-a-days.
- User Datagram Protocol (UDP):
  - It is a process to process delivery protocol that adds only port number, checksum, error control. It is connection less protocol i.e. no resources are specified and/or reserved by this protocol for the packets.
- Transmission Control Protocol(TCP):
  - It is a connection oriented protocol converting the unreliable IP to a reliable communication protocol. Besides adding all the information like error control, checksum it also notifies the sender of any errors or packet loss at the receiver end.
- Stream Control Transmission Protocol (SCTP):
  - Meant for VoIP. Combines best features of TCP and UDP

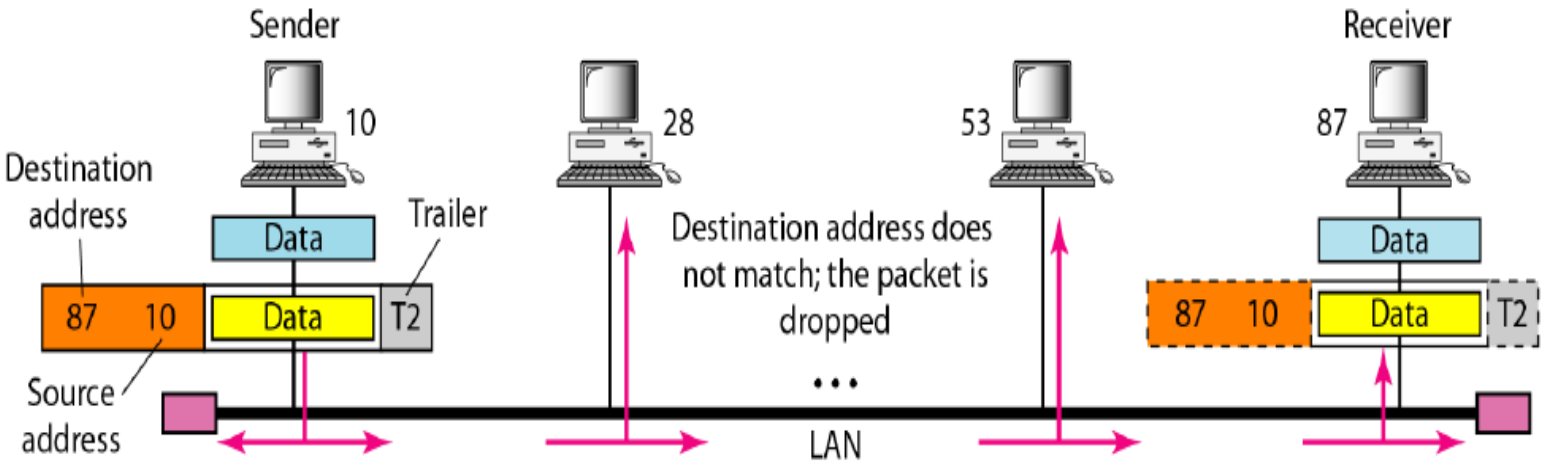
Relationship of layers and addresses in TCP/IP



Example 2.1

- In the Figure below, a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (bus topology LAN). As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver.

Example 2.1


Sender
Receiver
10
28
53
87
Destination address
Trailer
Data
87 10
Data
T2
Source address
Destination address does not match; the packet is dropped
LAN

Example 2.2

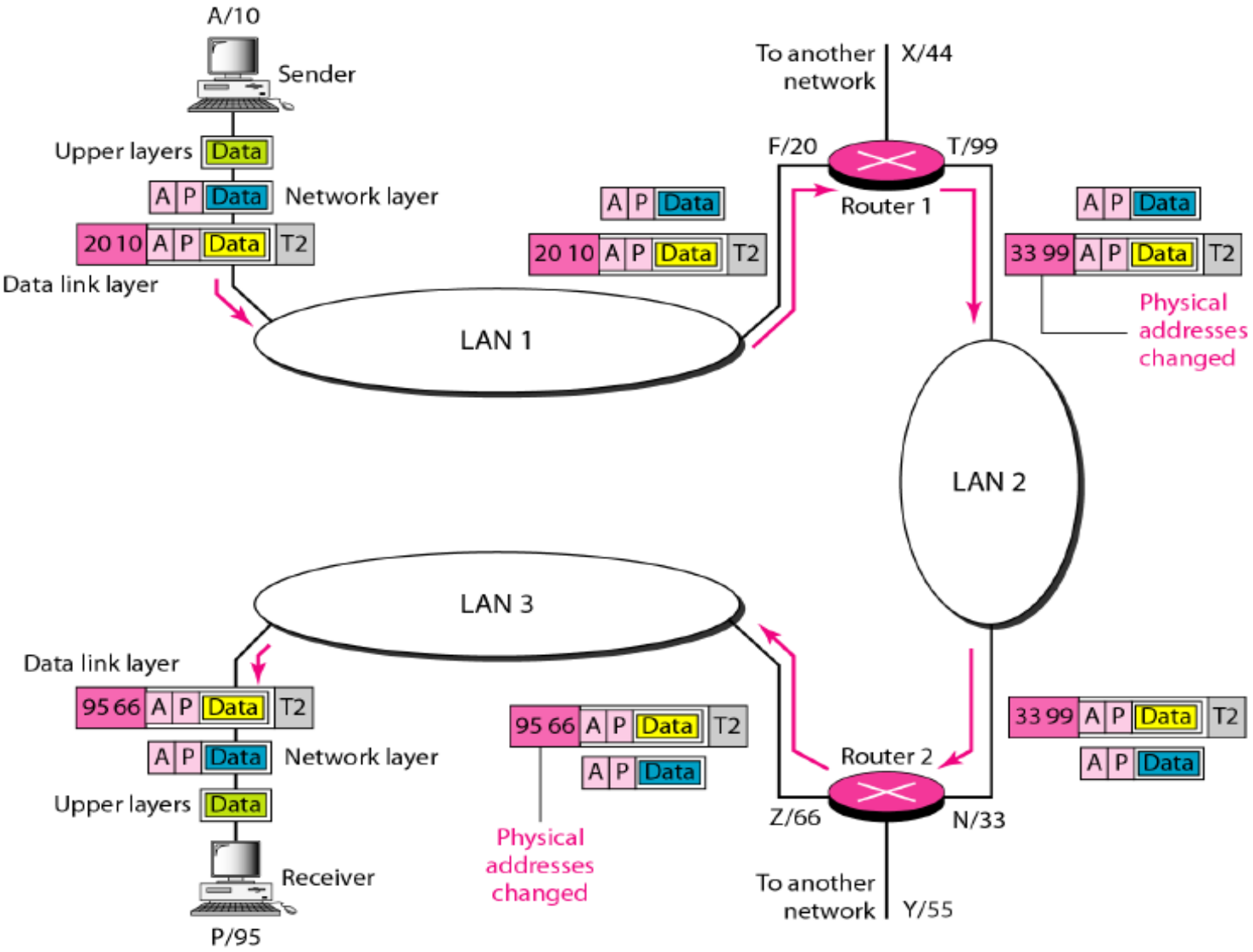
- As we will see later, most local-area networks use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon, as shown below:

07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address

- The next Figure shows a part of an internet with two routers connecting three LANs. Each device (computer or router) has a pair of addresses (logical and physical) for each connection. In this case, each computer is connected to only one link and therefore has only one pair of addresses. Each router, however, is connected to three networks (only two are shown in the figure). So each router has three pairs of addresses, one for each connection.

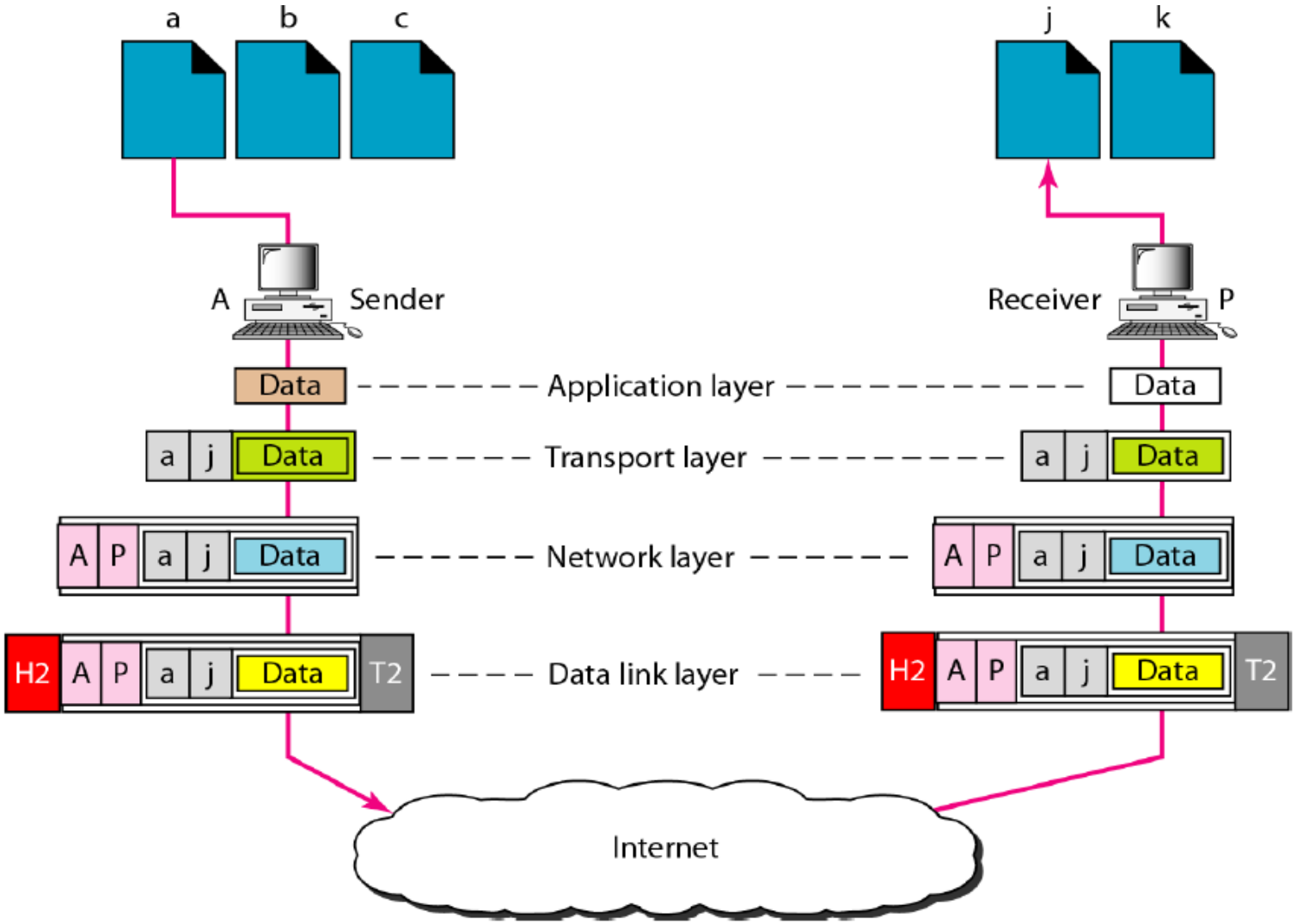
IP addresses



Addresses

- The next Figure shows two computers communicating via the Internet. The sending computer is running three processes at this time with port addresses a, b, and c. The receiving computer is running two processes at this time with port addresses j and k. Process a in the sending computer needs to communicate with process j in the receiving computer. Note that although physical addresses change from hop to hop, logical and port addresses remain the same from the source to destination. Example 2.4

Figure 2.21


a
b
c
j
k
A
Sender
Receiver
P
Data
Application layer
Data
a
j
Data
Transport layer
a
j
Data
A
P
a
j
Data
Network layer
A
P
a
j
Data
H2
A
P
a
j
Data
T2
Data link layer
H2
A
P
a
j
Data
T2
Internet

Adresses

- The physical addresses will change from hop to hop, but the logical addresses usually remain the same.

- End of Module