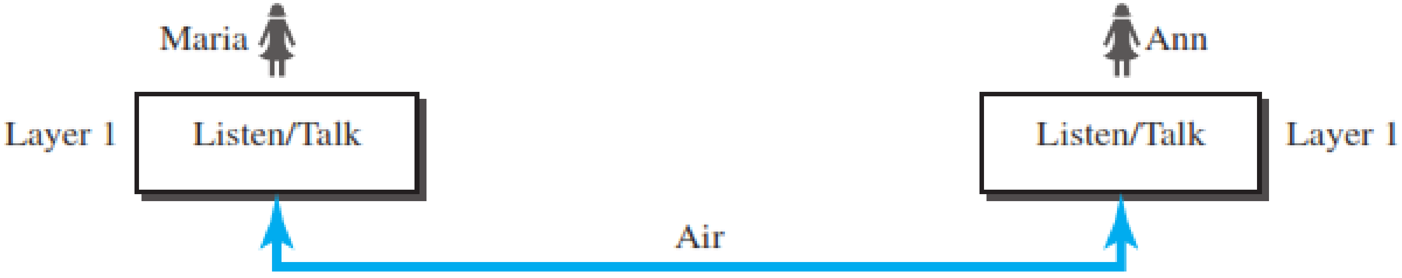
Network Models

Network Models

- Two models have been devised to define computer network operations:
  - TCP/IP protocol suite
  - OSI model

Protocol Layering

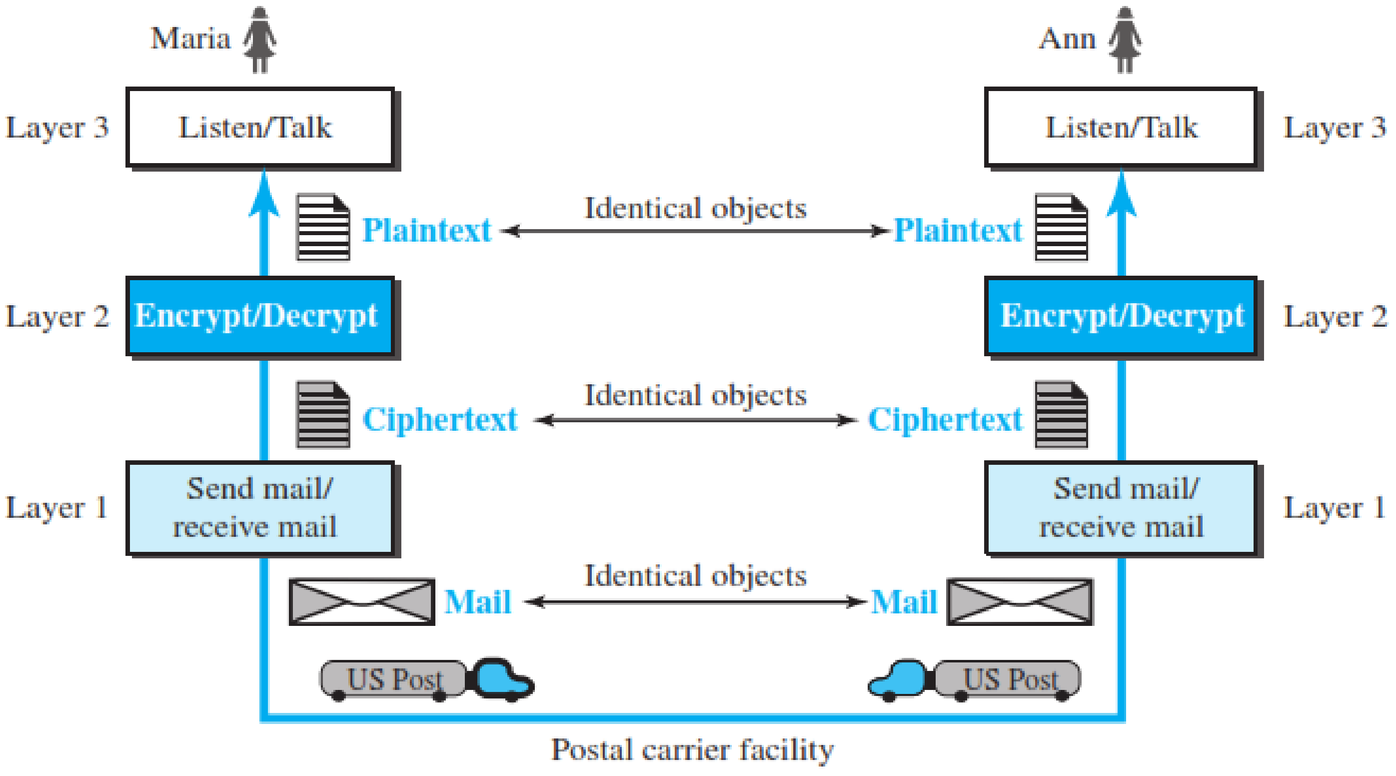
- When communication is simple, we may need only one simple protocol.



A single-layer protocol

Protocol Layering

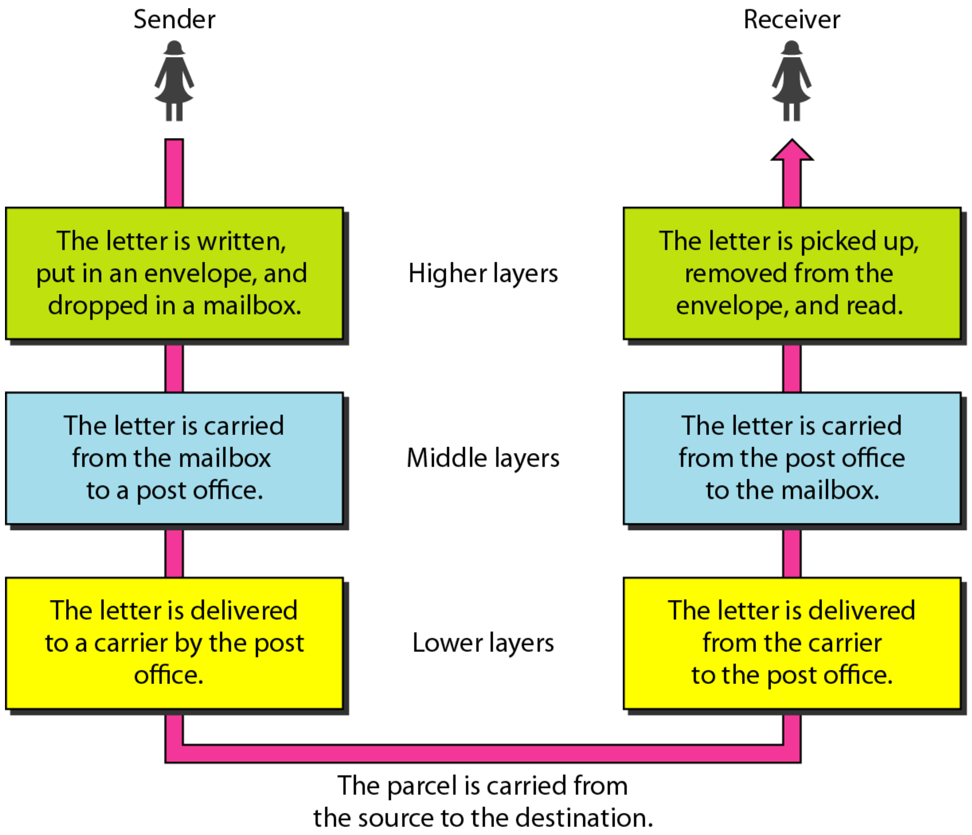
- When communication is complex, we may need to divide the task between different layers, in which case we need a protocol at each layer, or protocol layering.



A three-layer protocol

Layered Tasks

- We use the concept of **layers** in our daily life.
- 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.



Principles of Protocol Layering

First Principle

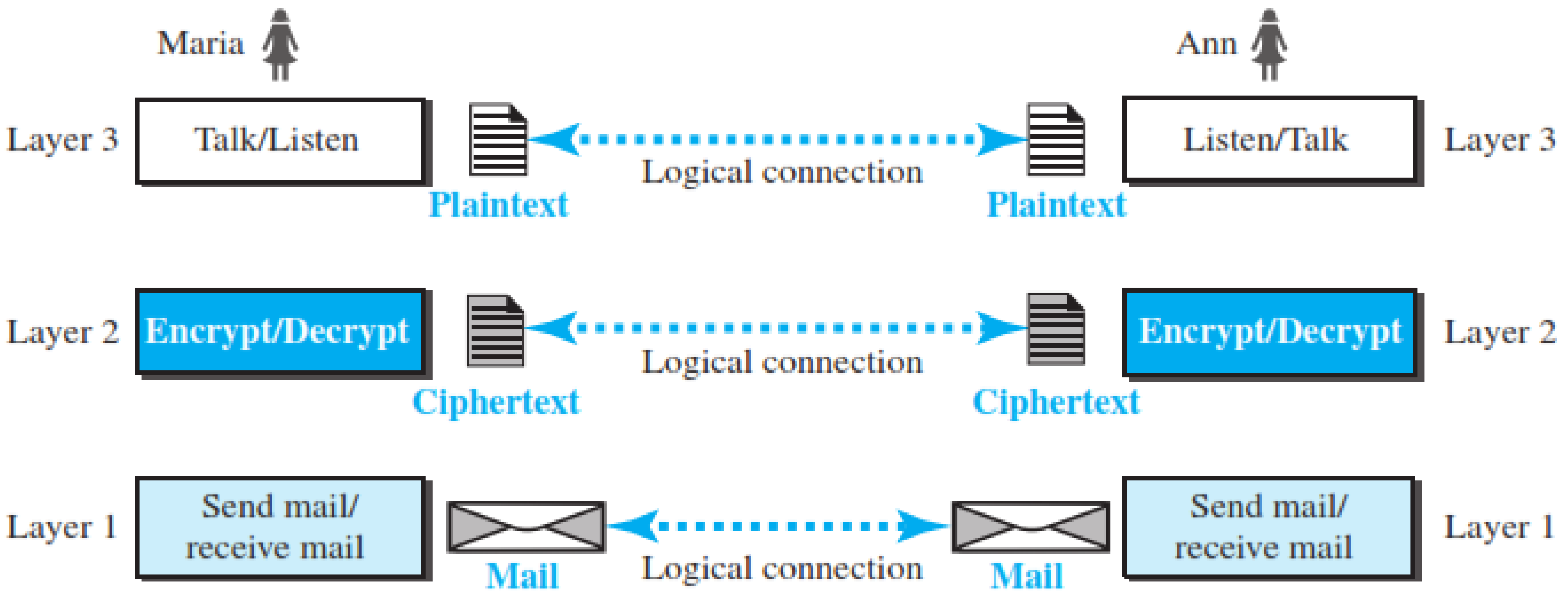
- It’s dictates that if we want bidirectional communication, we need to make each layer so that it is able to perform two opposite task.

Second Principle

- We need to follow in protocol layering is that the two objects under each layer at both sites should be identical

Principles of Protocol Layering

- Logical connection will help us better understand the task of layering we encounter in data communication and networking.

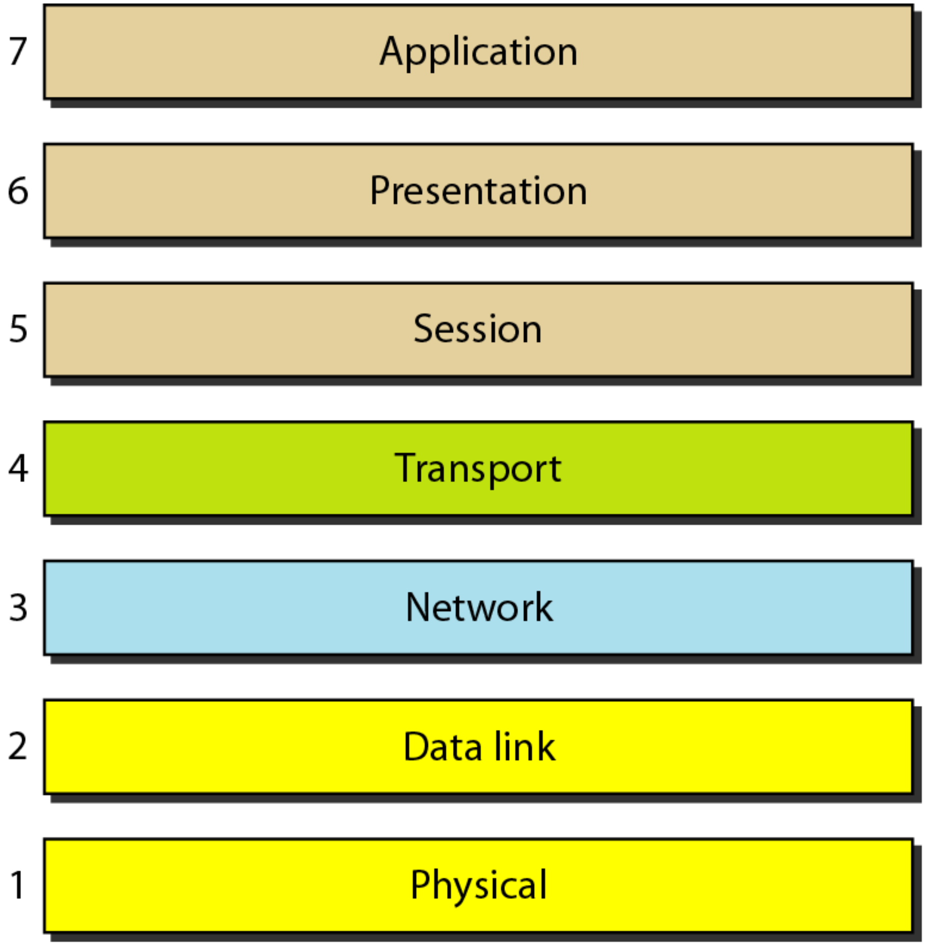


The OSI Model

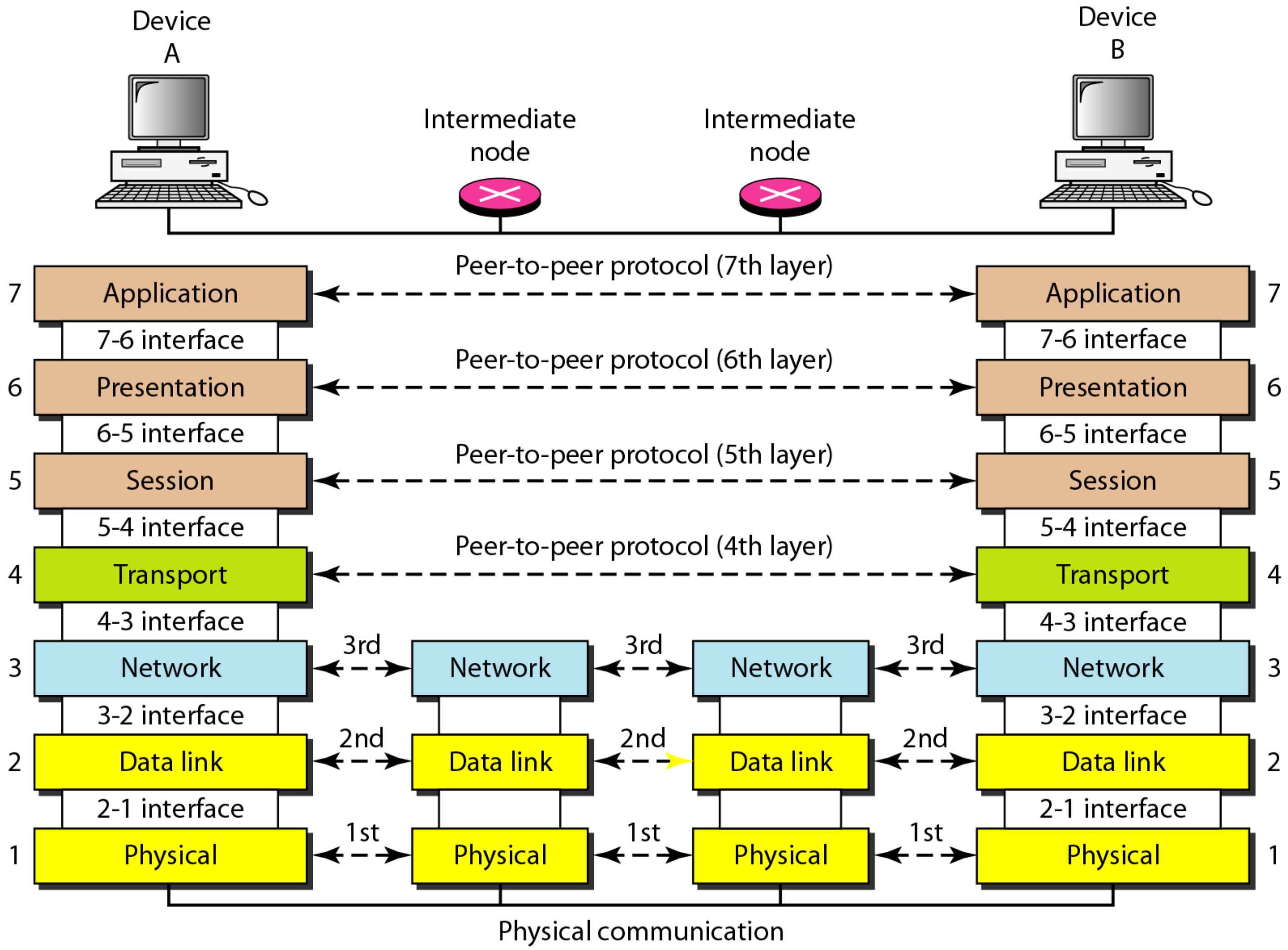
- These devices in a network are connected using wired or wireless transmission media.
- Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards.
- An ISO standard that covers all aspects of network communications is the Open Systems Interconnection (OSI) model. It was first introduced in the late 1970s.

ISO is the organization.
OSI is the model.

Seven Layers of OSI Model

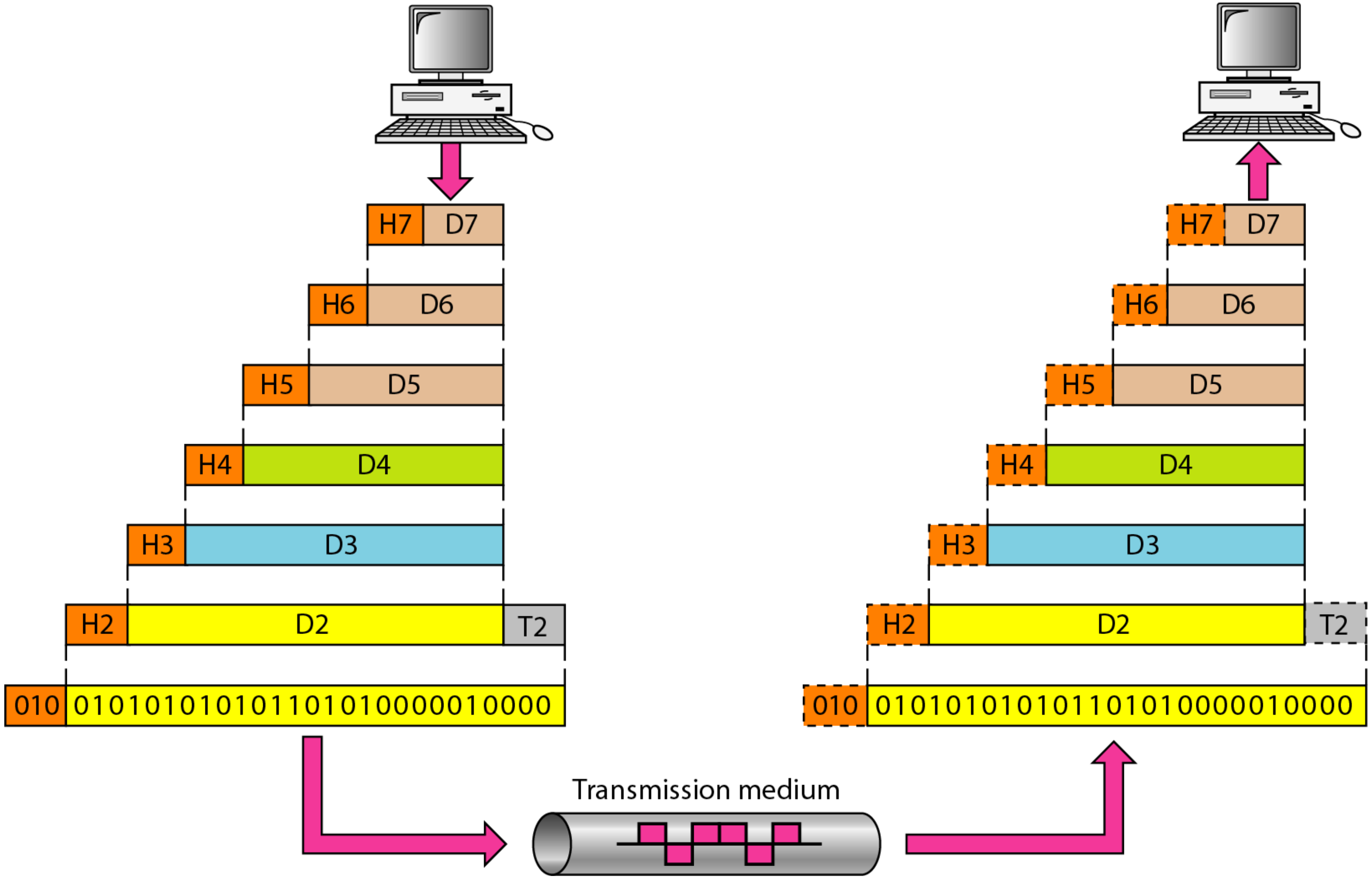


OSI Model



The interaction between layers in the OSI model

OSI Model

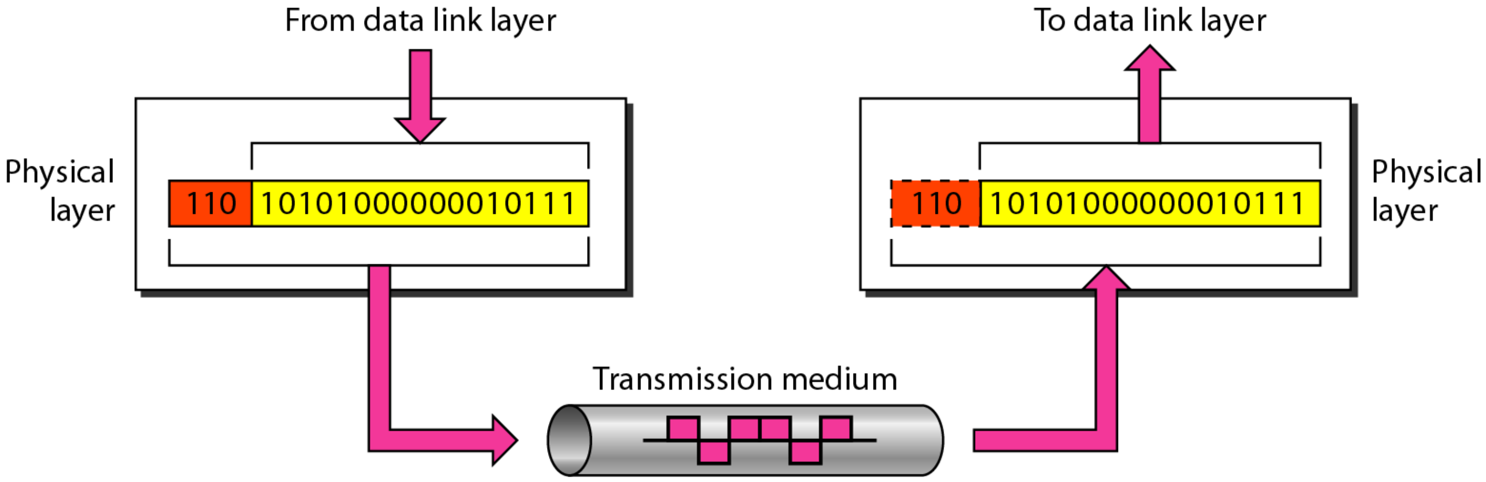


An exchange using the OSI model

Layers in the OSI Model

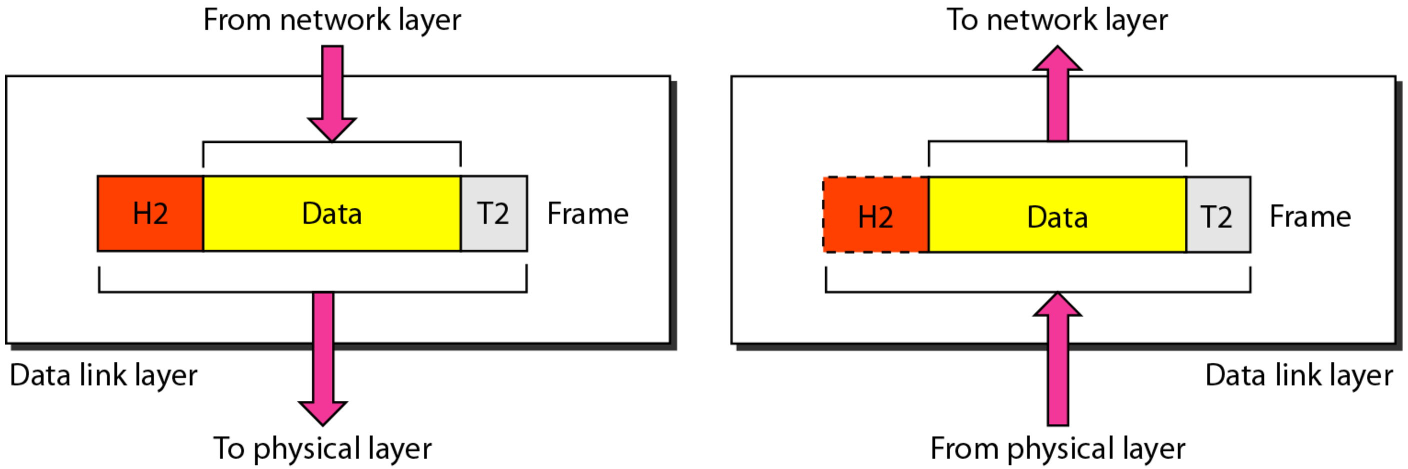
- Physical Layer
- Data Link Layer
- Network Layer
- Transport Layer
- Session Layer
- Presentation Layer
- Application Layer

Physical Layer



- It's coordinate function required to carry a bit stream over a physical medium.
- Its also deal with and mechanical and electrical specification of interface.
- Data rate - duration of a bit
- Synchronization of bits - sender and receiver clock
- Line configuration - P2P, MP2P, shared link
- Physical topology and Transmission mode

Data Link Layer



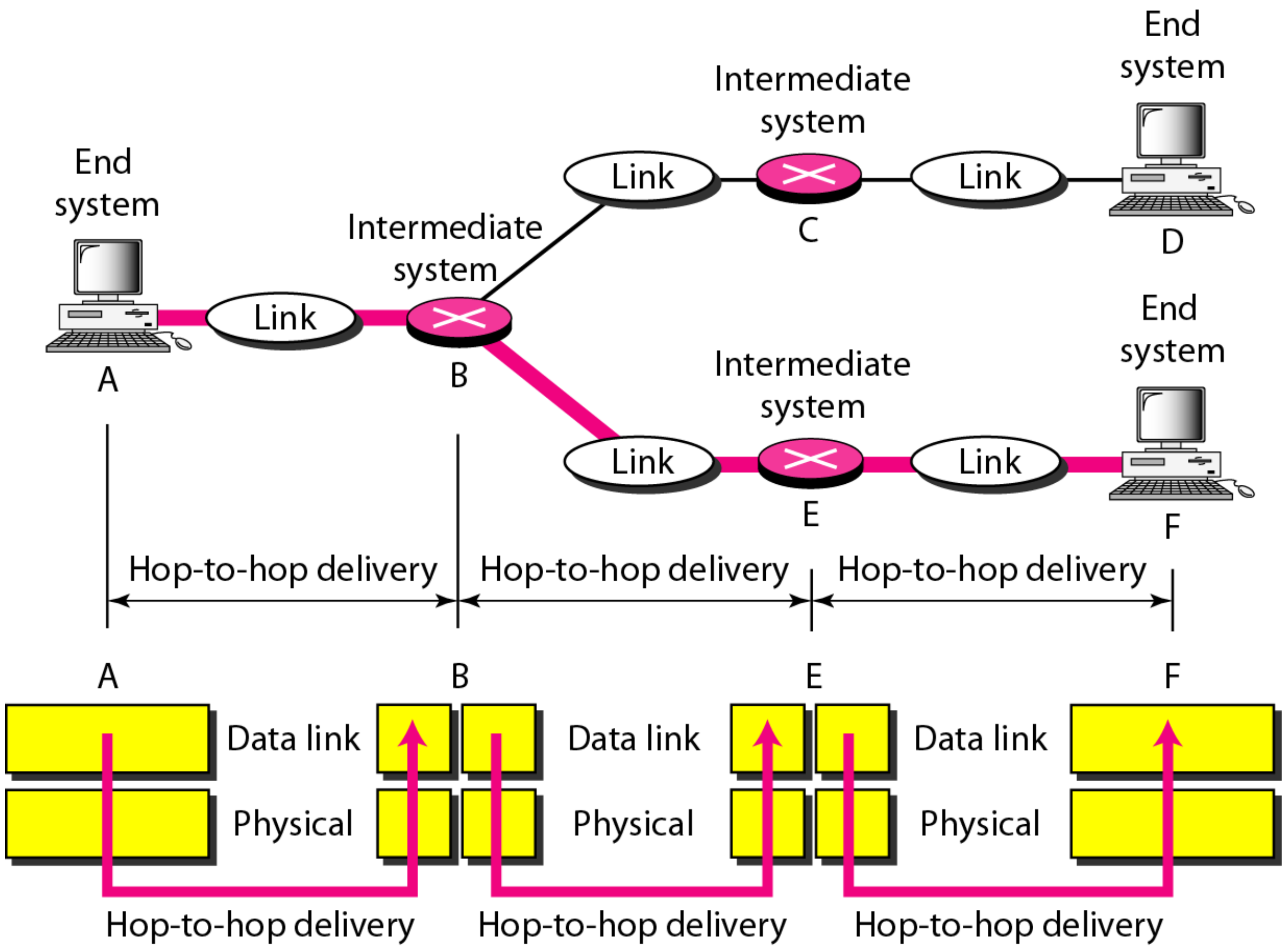
- The data link layer transform the physical layer, a raw transmission facility, to a reliable link.
- It's make the physical layer appear error – free to the upper layer (network layer).

Data Link Layer

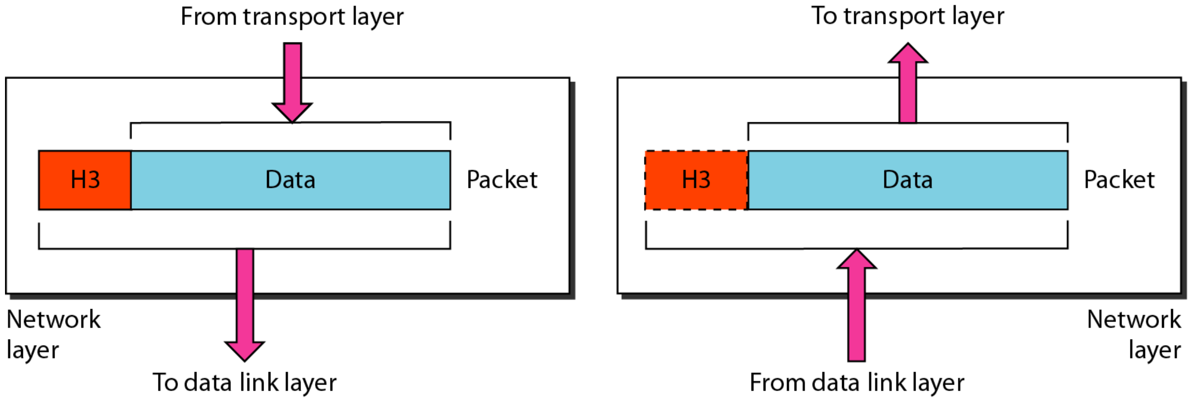
- **Framing:** its divides the stream of bits received from the network layer into manageable data units called frame
- **Physical Addressing :** if the frame is intended for a system outside the sender's network, the receiver address is the address of the device that connects the network to the next one.
- **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, this layer imposes a flow control mechanism to avoid overwhelming the receiver.
- **Error control :** detect and retransmit damaged or lost frames. It also uses a mechanism to recognize duplicate 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.
- **Hop to Hop Delivery:**

Data Link Layer

- **Hop to Hop Delivery**

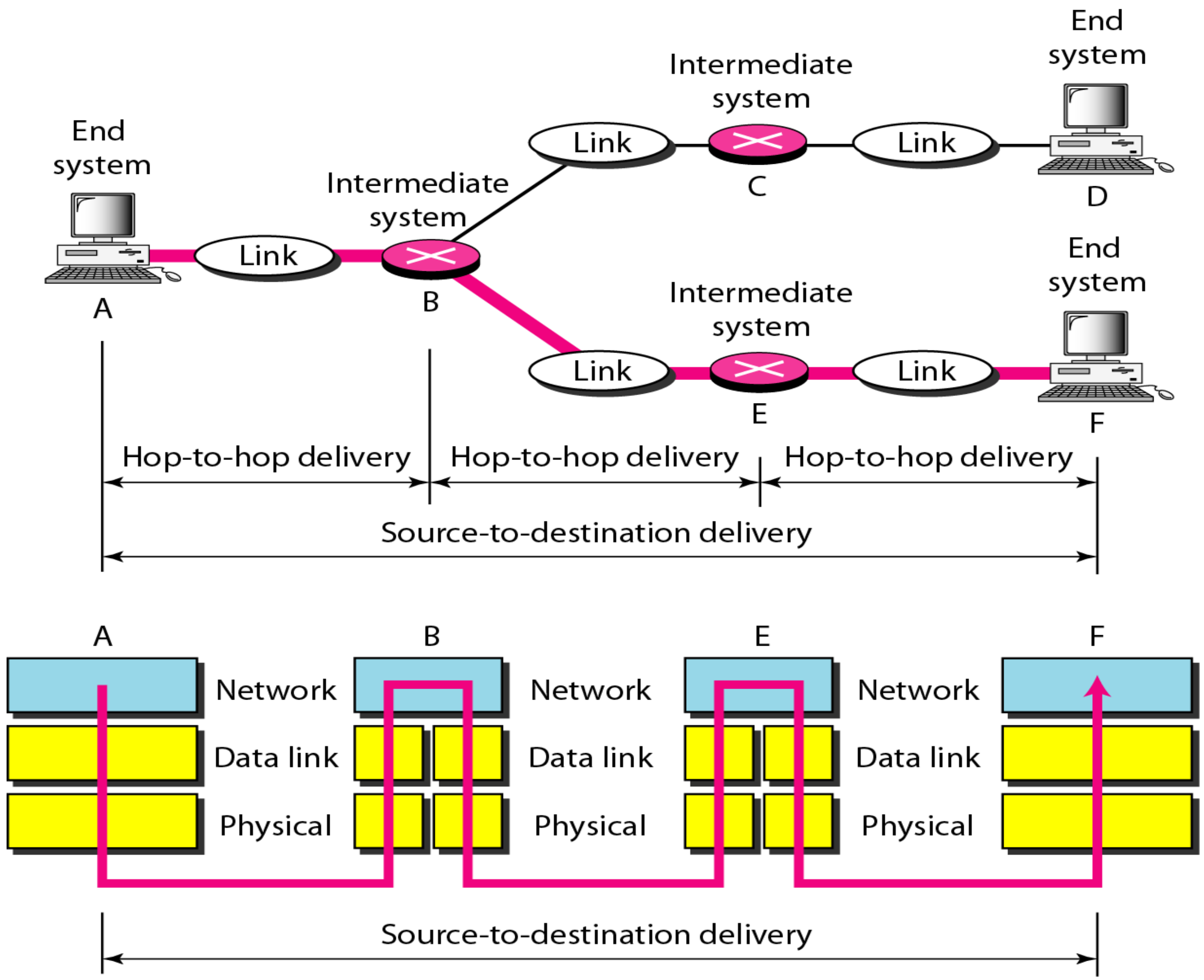


Network Layer

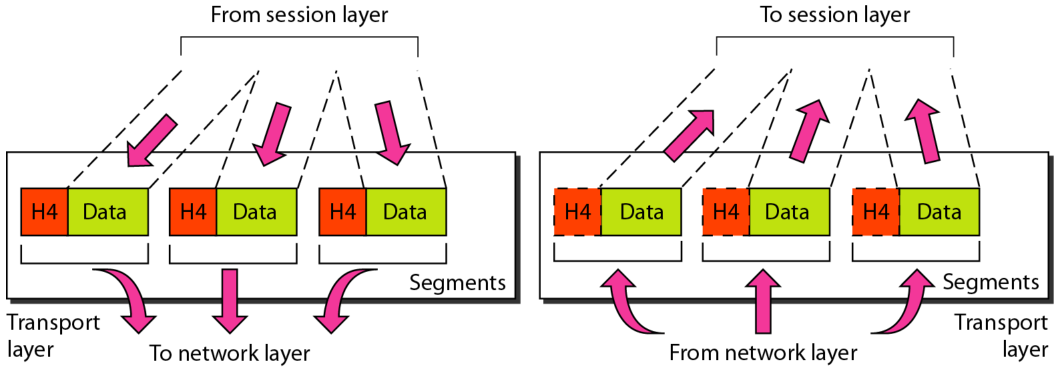


- The network layer is responsible for the delivery of individual packets from the source host to the destination host.
- **Logical Addressing:** if a packet passes the network boundary, we need another addressing system to help distinguish the source and destination systems.
- **Routing :** find path from source-to-destination message delivery

Network Layer



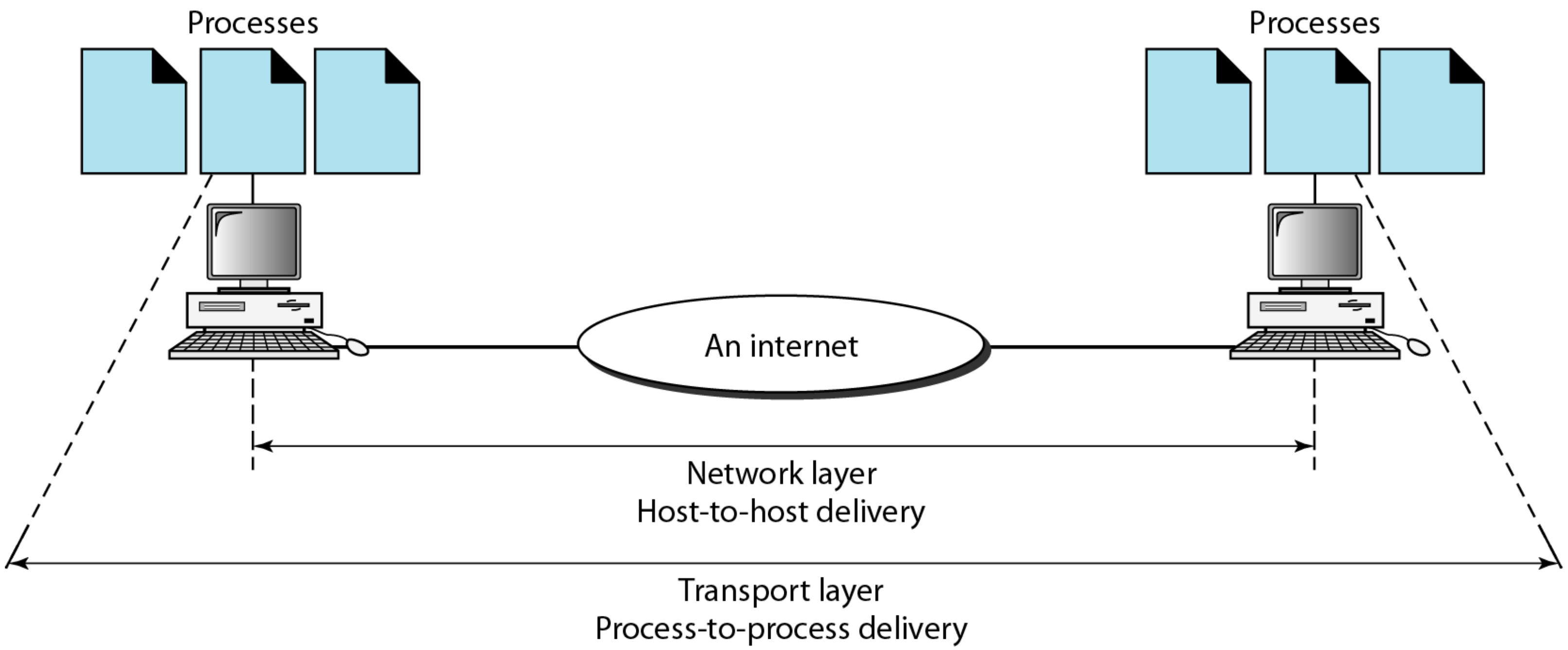
Transport Layer



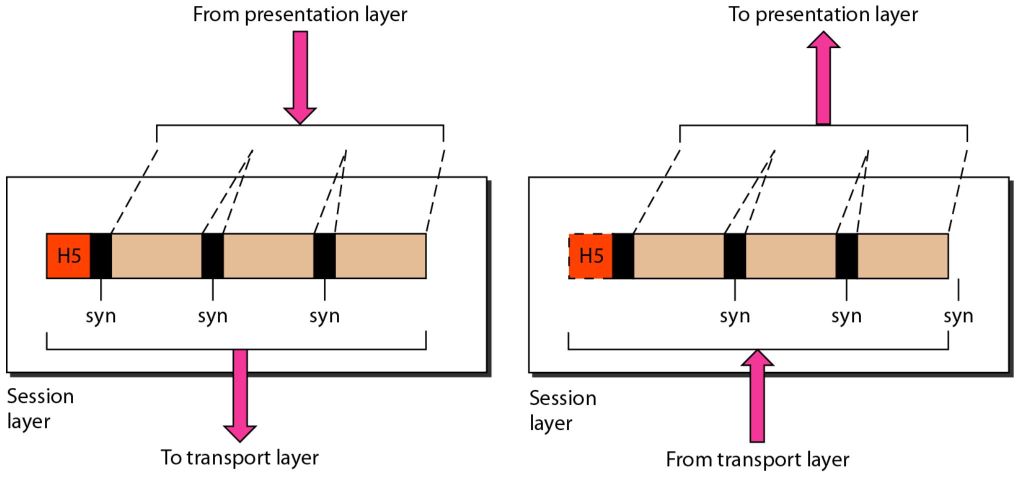
- It responsible for the process to process delivery of the entire message.
- Recognize relationship between packets.
- **Service point addressing :** port address
- **Segmentation and reassembly :** each segment containing sequence number for reassemble the message correctly upon arriving at the destination and to identify and replace
- **Connection control :**
- **Flow control and Error control:**

Transport Layer

Reliable process-to-process delivery of a message

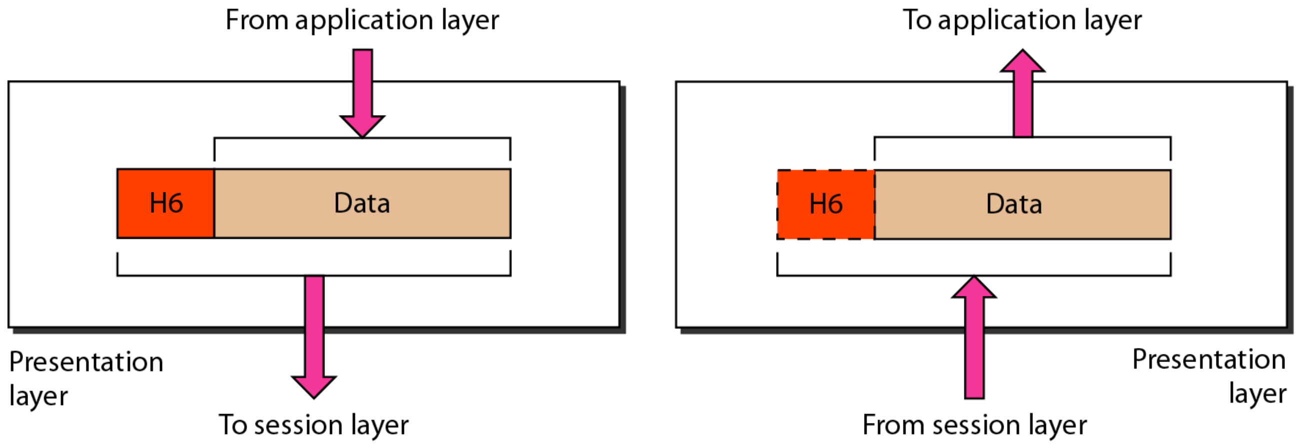


Session Layer



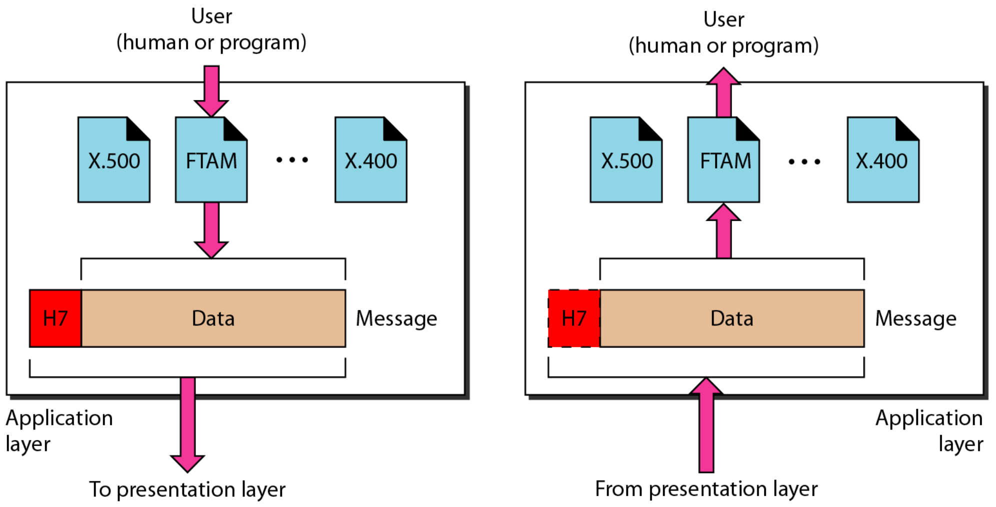
- It responsible for dialog control and synchronization
- **Dialog control :** it allow the communication between two processes to take place in either half duplex and full duplex mode
- **Synchronization :** it's allow a process to add checkpoints, or synchronization points, to stream of data

Presentation Layer



- It concern with syntax and semantics of the information exchanged between two systems
- **Translation :** Provide interoperability between different encoding methods
- **Encryption/ Decryption :** to carry sensitive information, a system must be able to ensure privacy.
- **Compression :** Data compression reduces the number of bits contained in the information.

Application Layer

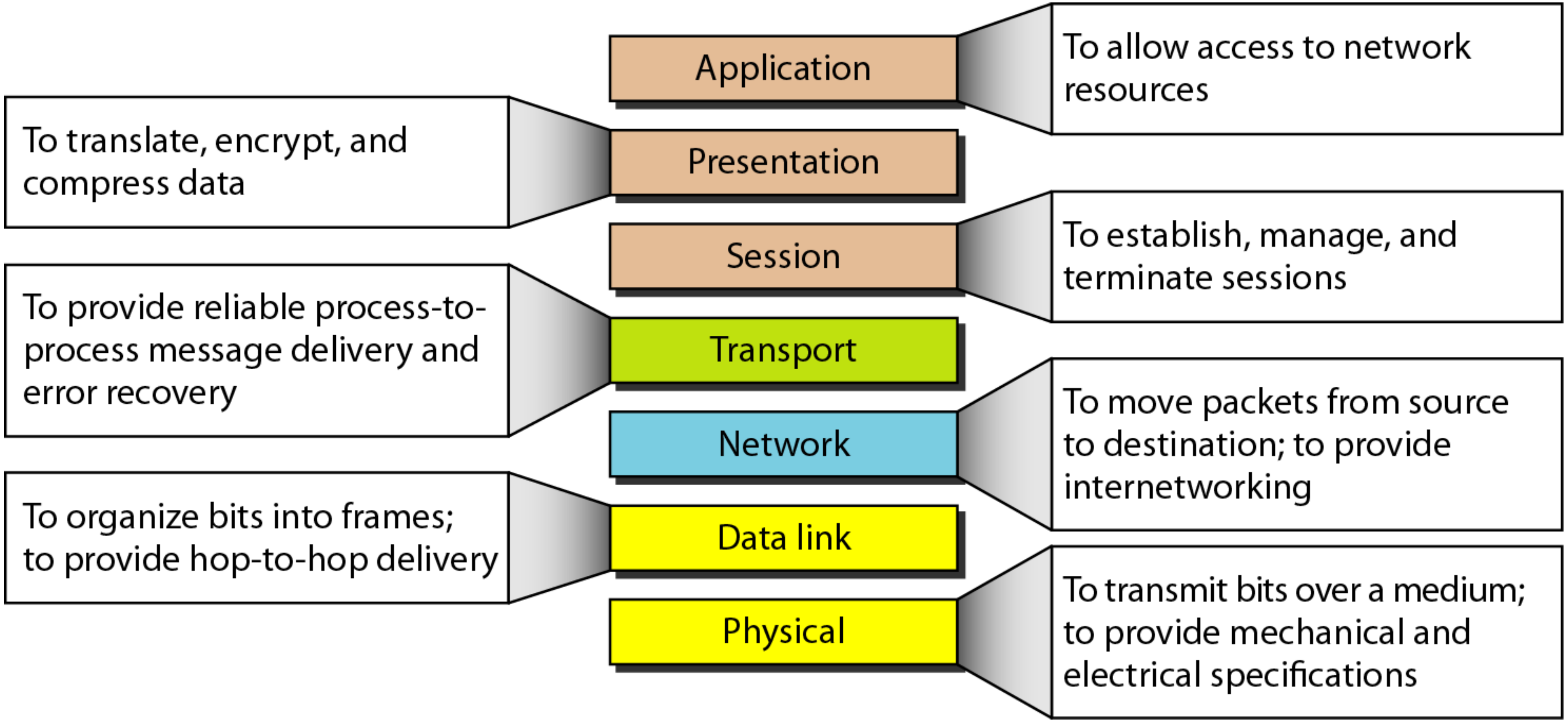


- It responsible for providing service to user.
- **Network virtual terminal :** allow user to log on remote host.
- **Mail services:**
- **Directory services** : Global information about various objects and services.

Summary of Layers

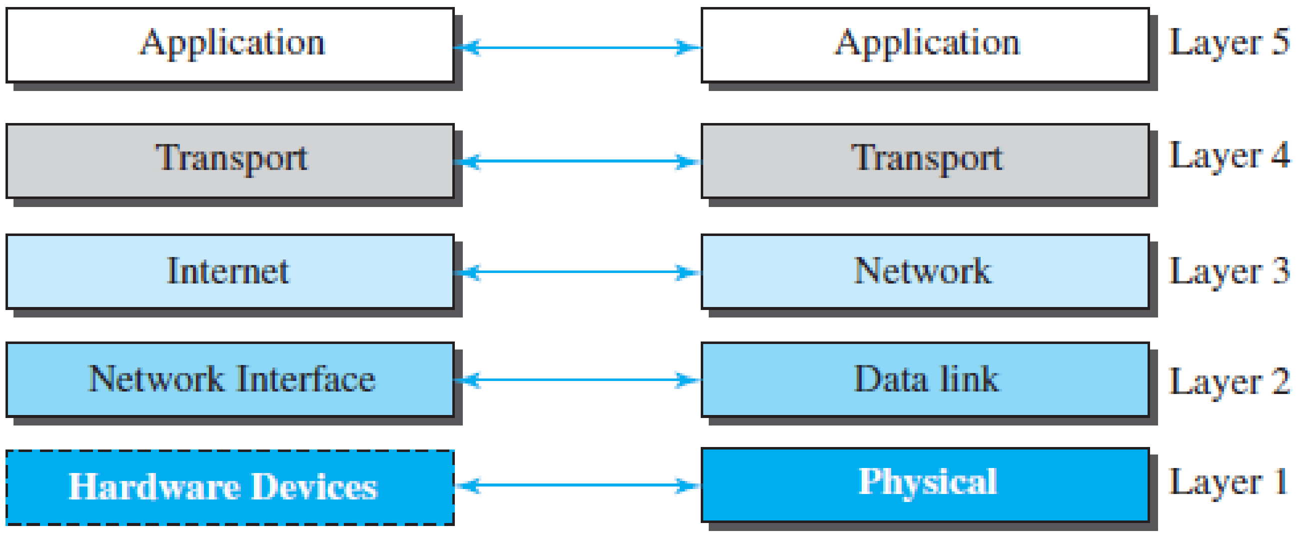
UPPER LAYERS	7	**Application Layer** ✓ Message format, Human-Machine Interfaces
	6	**Presentation Layer** ✓ Coding into 1s and 0s; encryption, compression
	5	**Session Layer** ✓ Authentication, permissions, session restoration
TRANSPORT SERVICE	4	**Transport Layer** ✓ End-to-end error control
	3	**Network Layer** ✓ Network addressing; routing or switching
	2	**Data Link Layer** ✓ Error detection, flow control on physical link
	1	**Physical Layer** ✓ Bit stream: physical medium, method of representing bits

Summary of Layers



The TCP/IP Protocol Suite

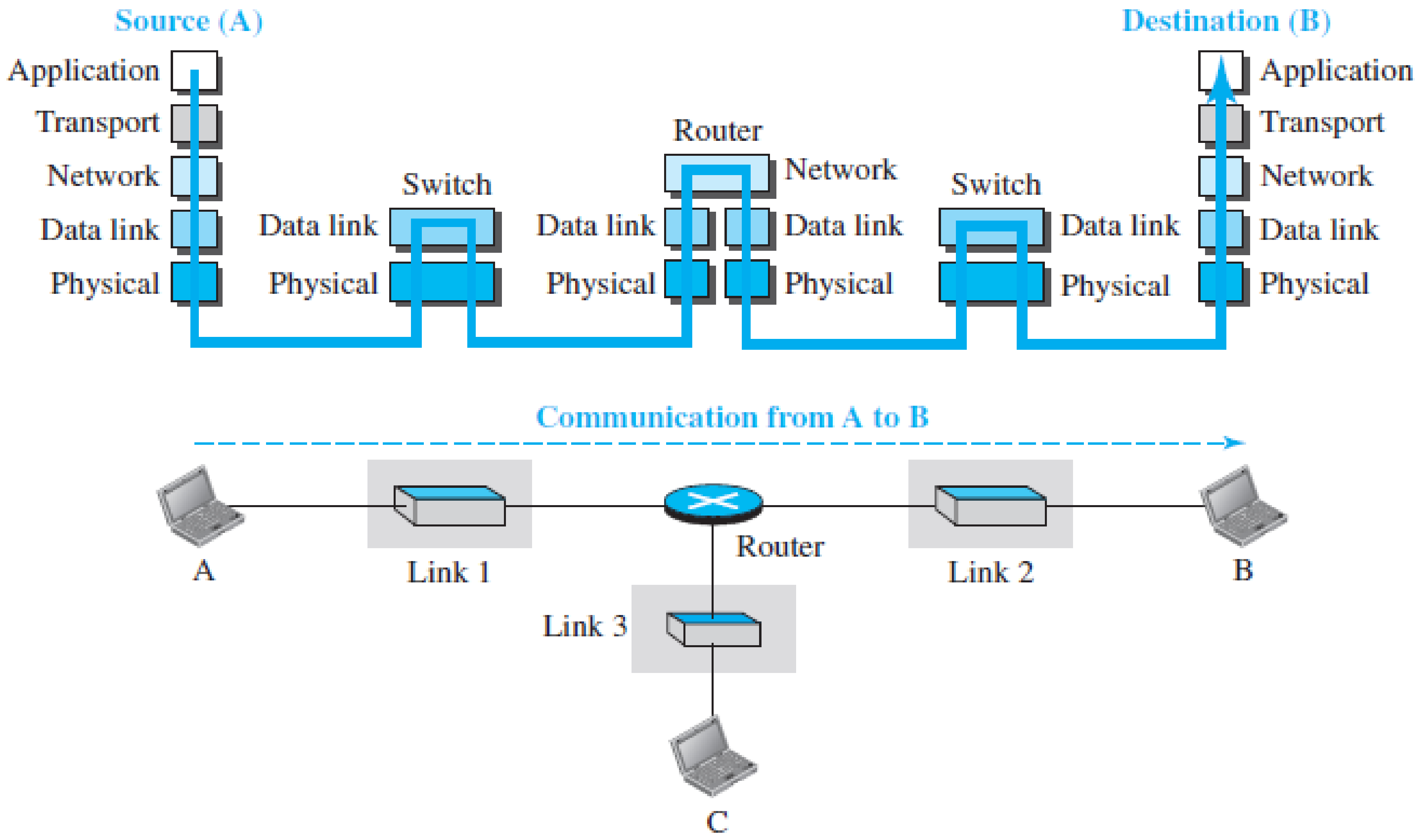
- It is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality. The term hierarchical means that each upper level protocol is supported by the services provided by one or more lower level protocols.
- The original TCP/IP protocol suite was defined as four software layers built upon the hardware.
- Today, however, TCP/IP is thought of as a five-layer model.



Original Layers

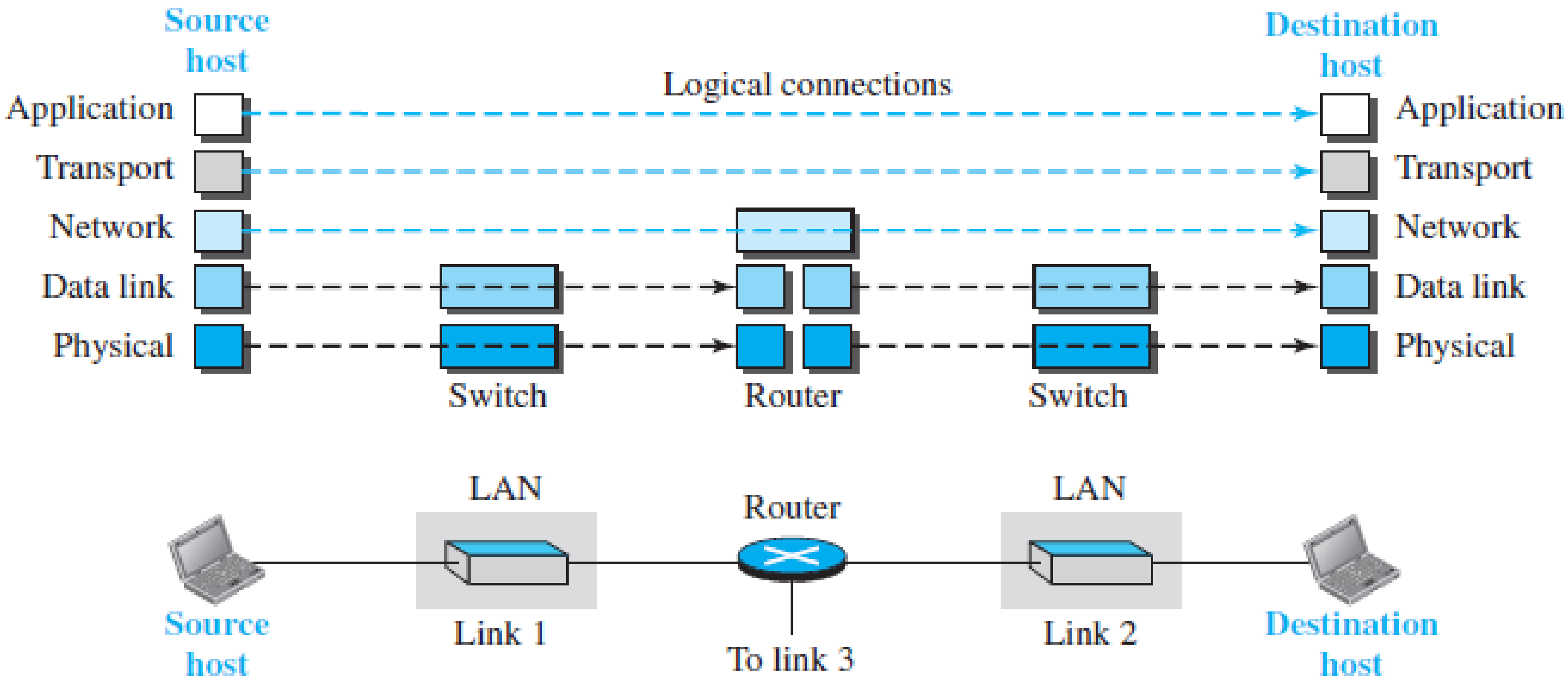
Layers used in book (FOROUZAN)

Communication though an internet



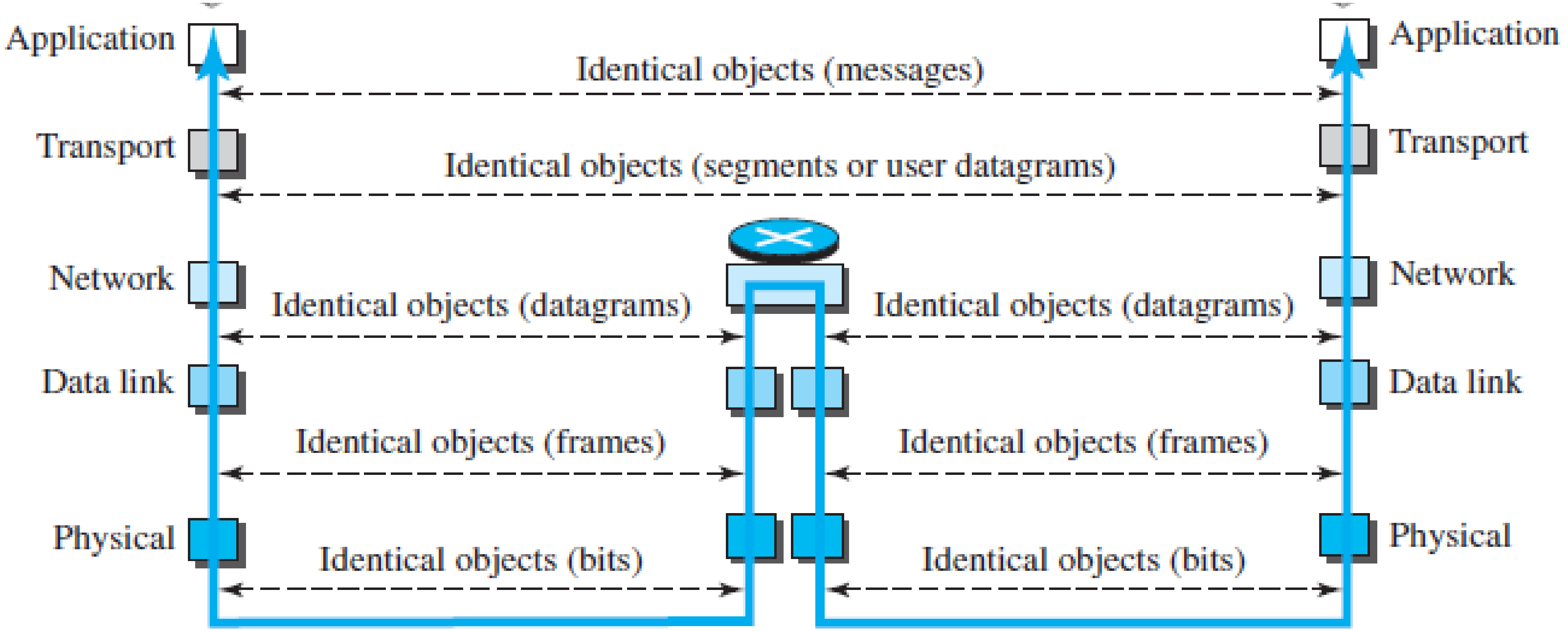
Layered Architecture of TCP/IP Model

- Logical Connection between layers of the TCP/IP protocol suite

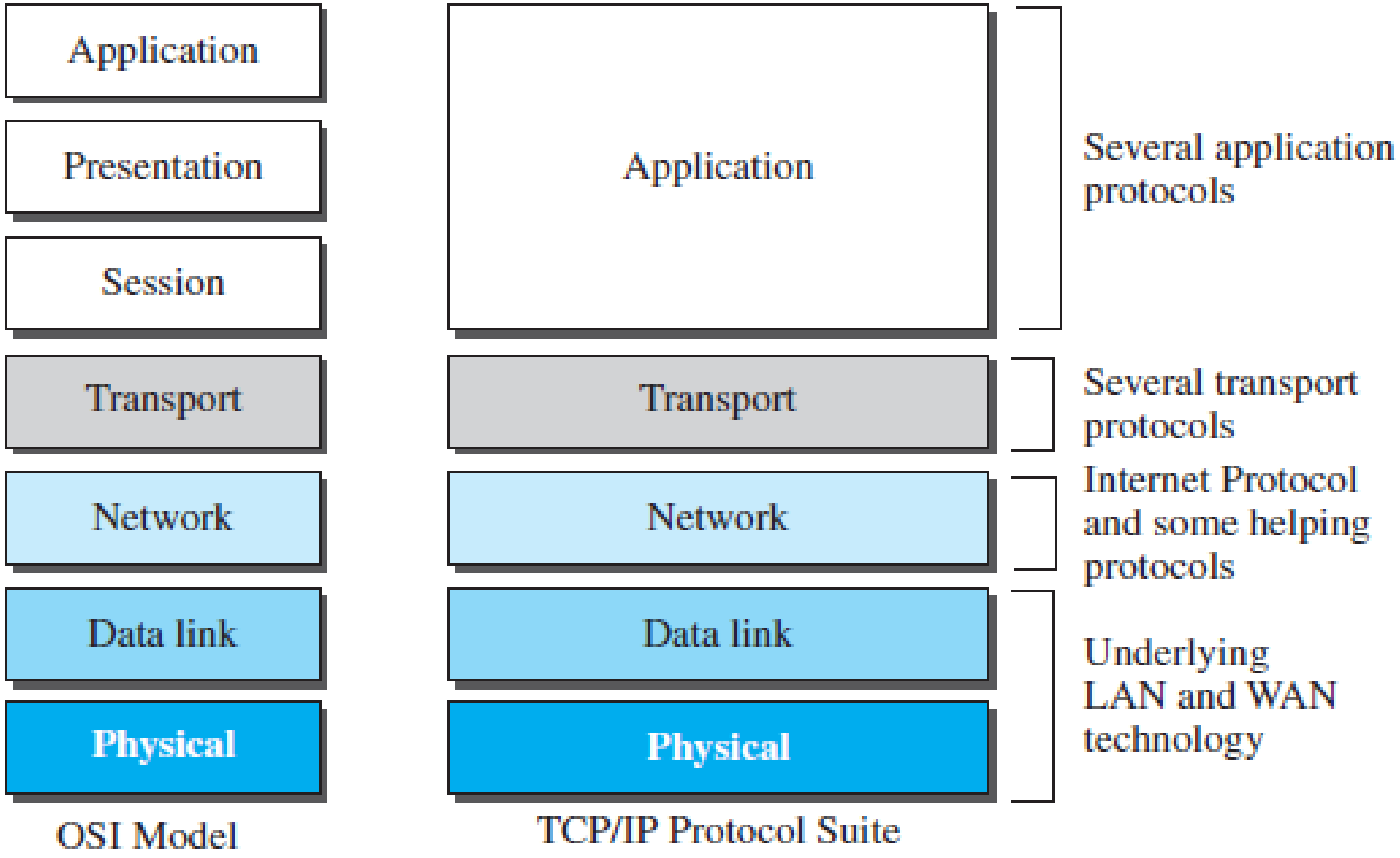


Layered Architecture of TCP/IP Model

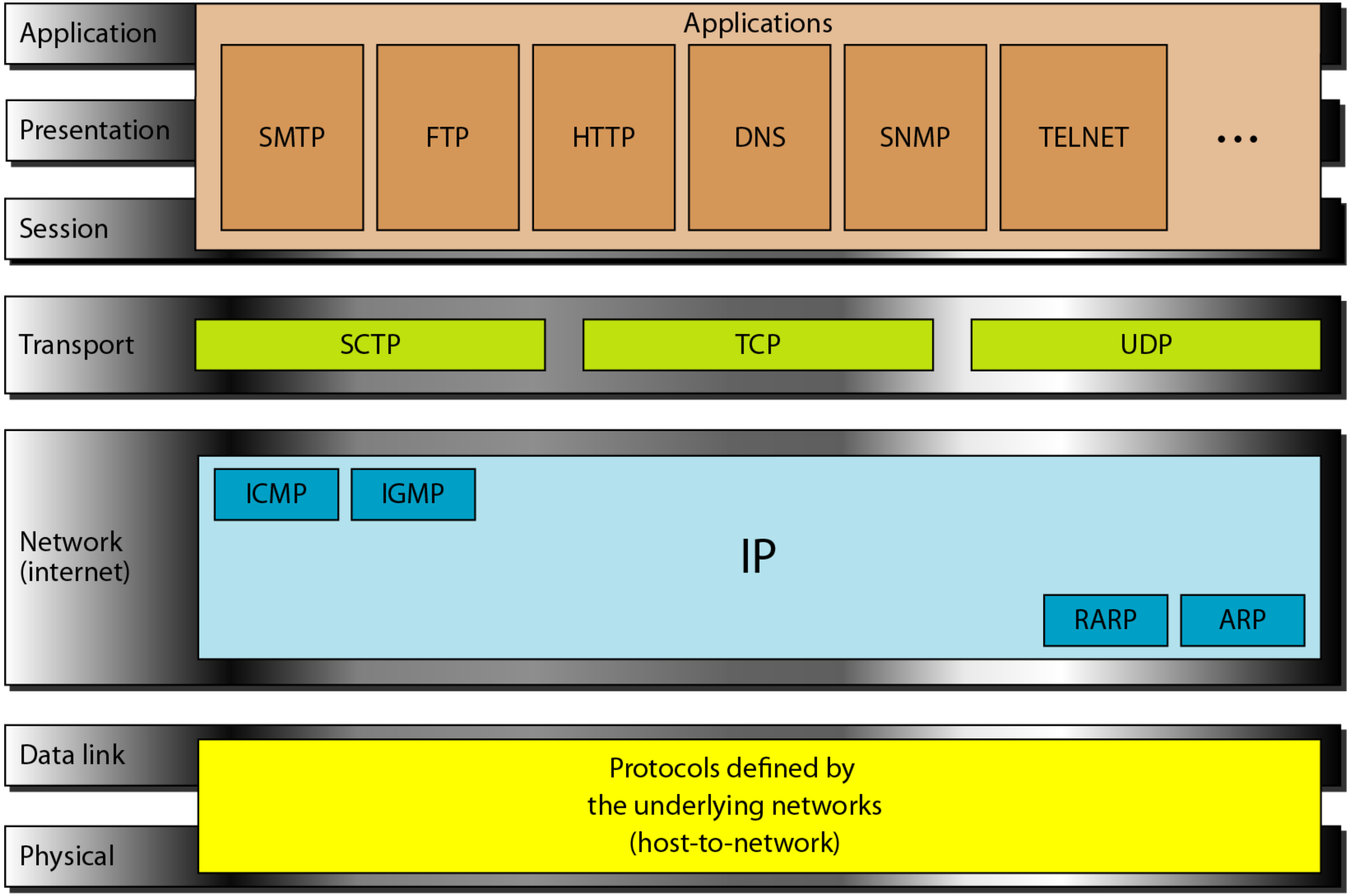
- Identical objects in the TCP/IP protocol suite



TCP/IP and OSI Model



TCP/IP and OSI Model



A Critique of the TCP/IP Reference Model

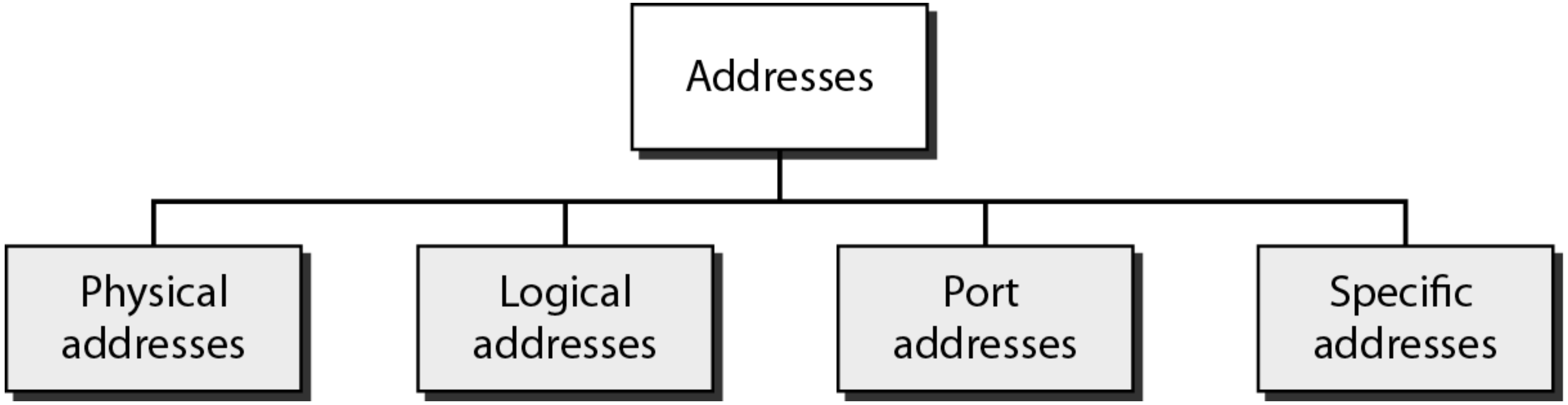
Problems

- Service, interface, and protocol not distinguished
- Not a general model
- Host-to-network “layer” not really a layer
- No mention of physical and data link layers
- Minor protocols deeply entrenched, hard to replace

Addressing

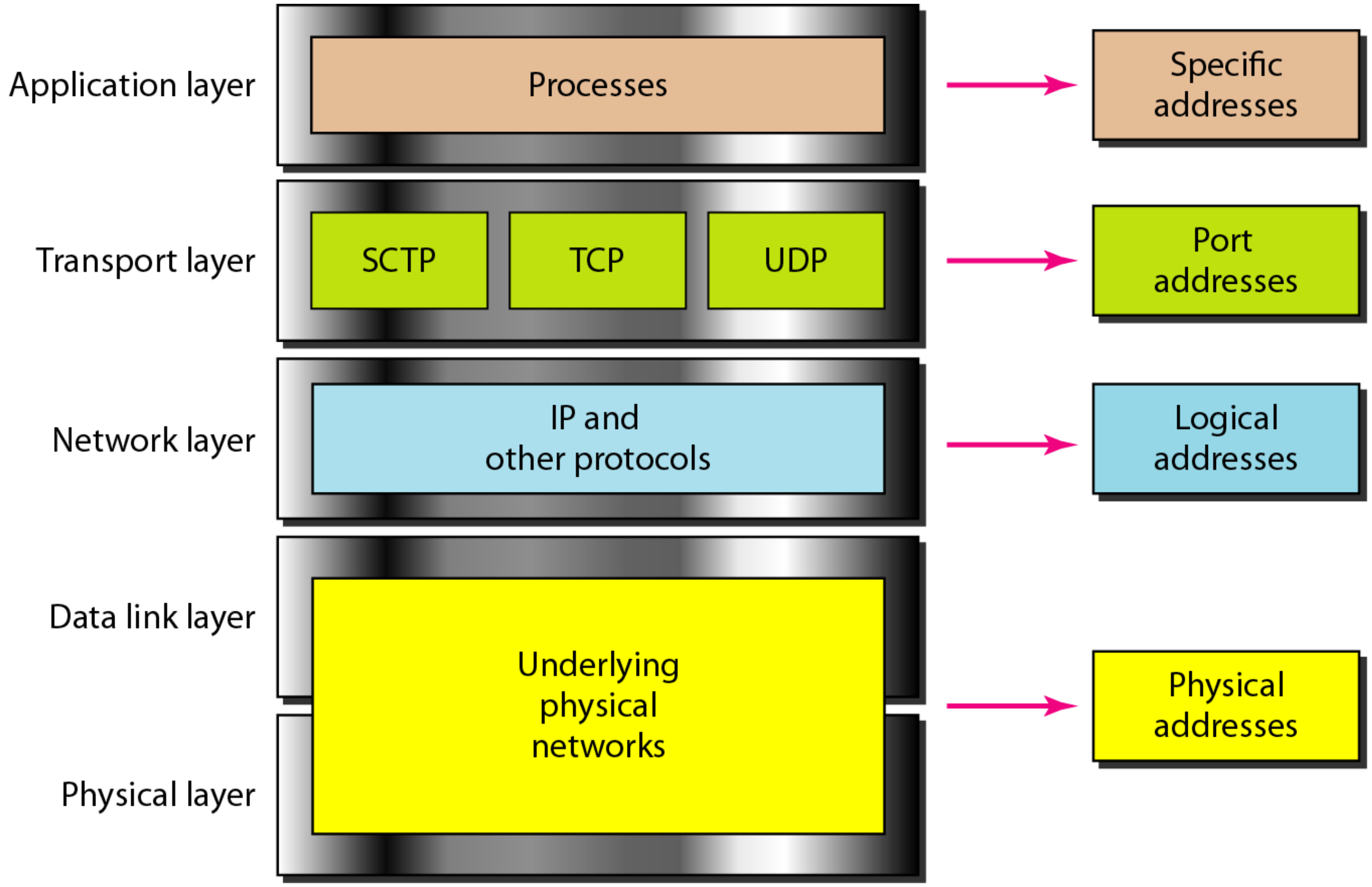
Four levels of addresses are used in an internet employing the TCP/IP protocols:

- Physical Address
- Logical Address
- Port Address
- Specific Address



Addresses in TCP/IP

Addressing

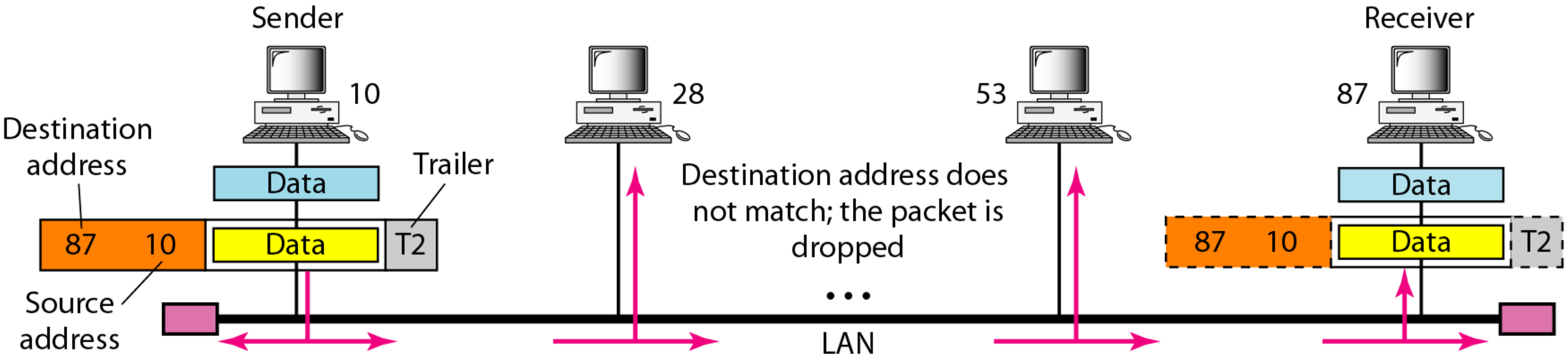


Relationship of layers and addresses in TCP/IP

Addressing

Example

- 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.



Physical Address

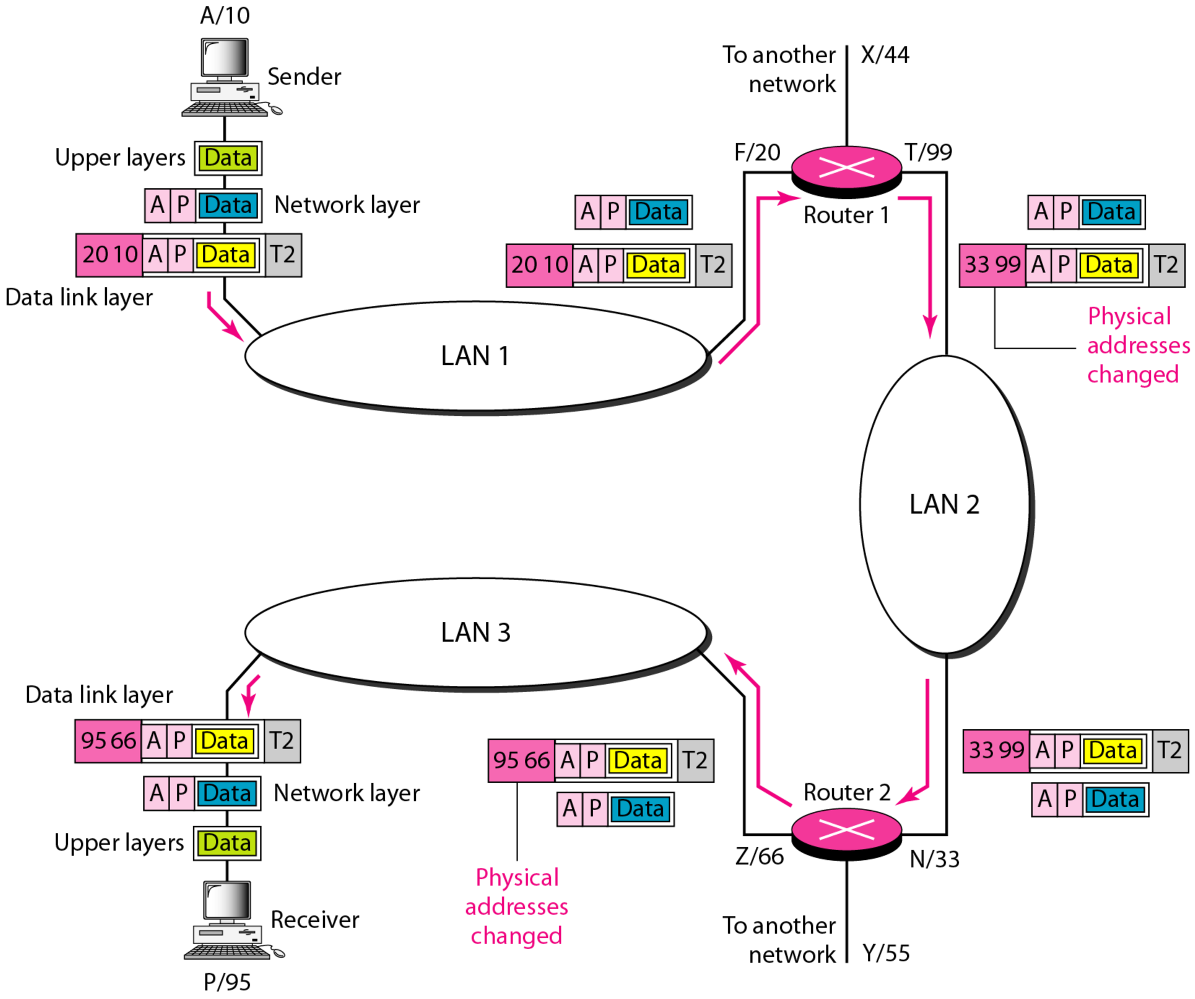
- Most local-area networks use a **48-bit** (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon, as shown below:

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

A 6-byte (12 hexadecimal digits) physical address.

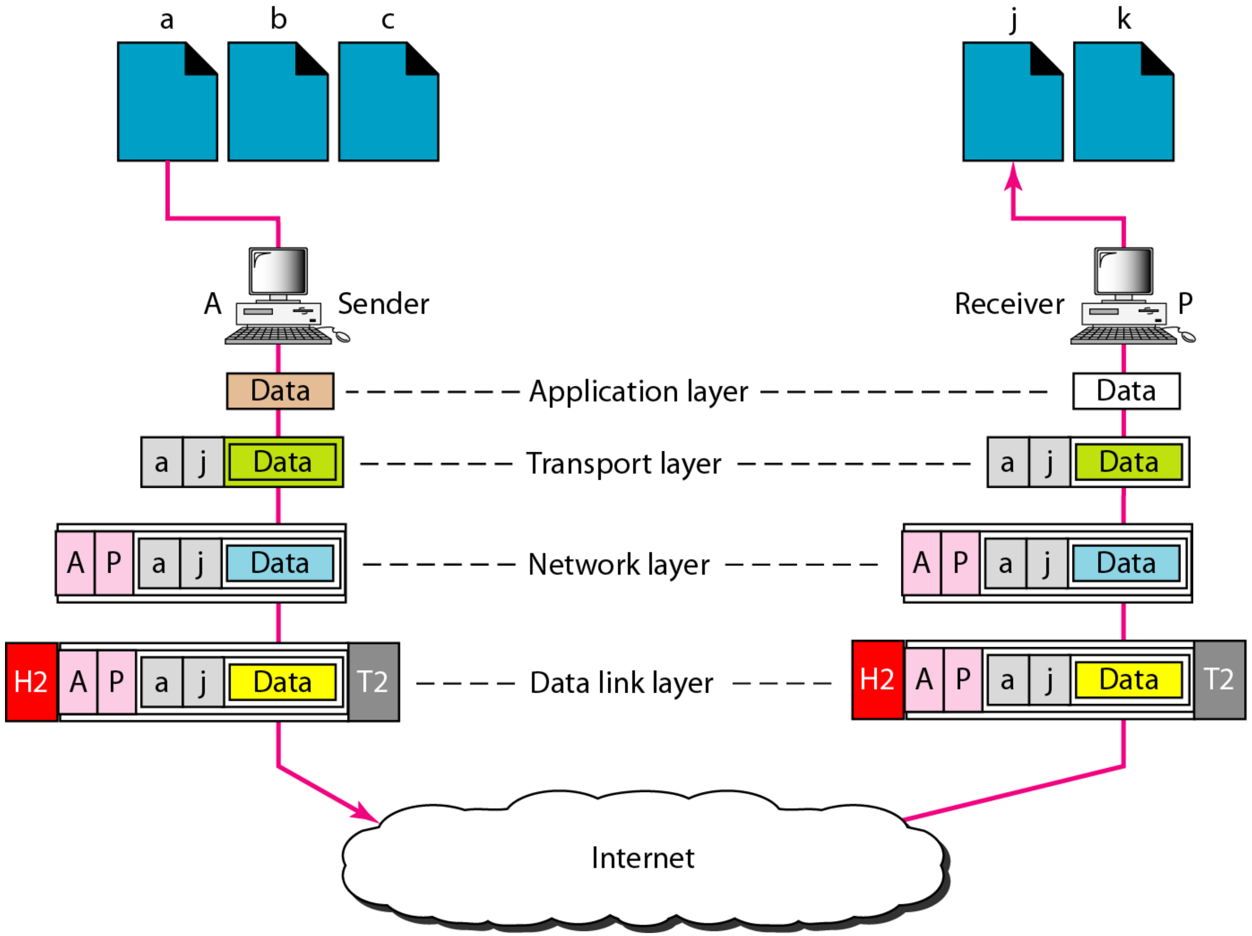
Logical Address

- 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 Address



Port Address

- 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.



Port Address

- A port address is a 16-bit address represented by one decimal number as shown.

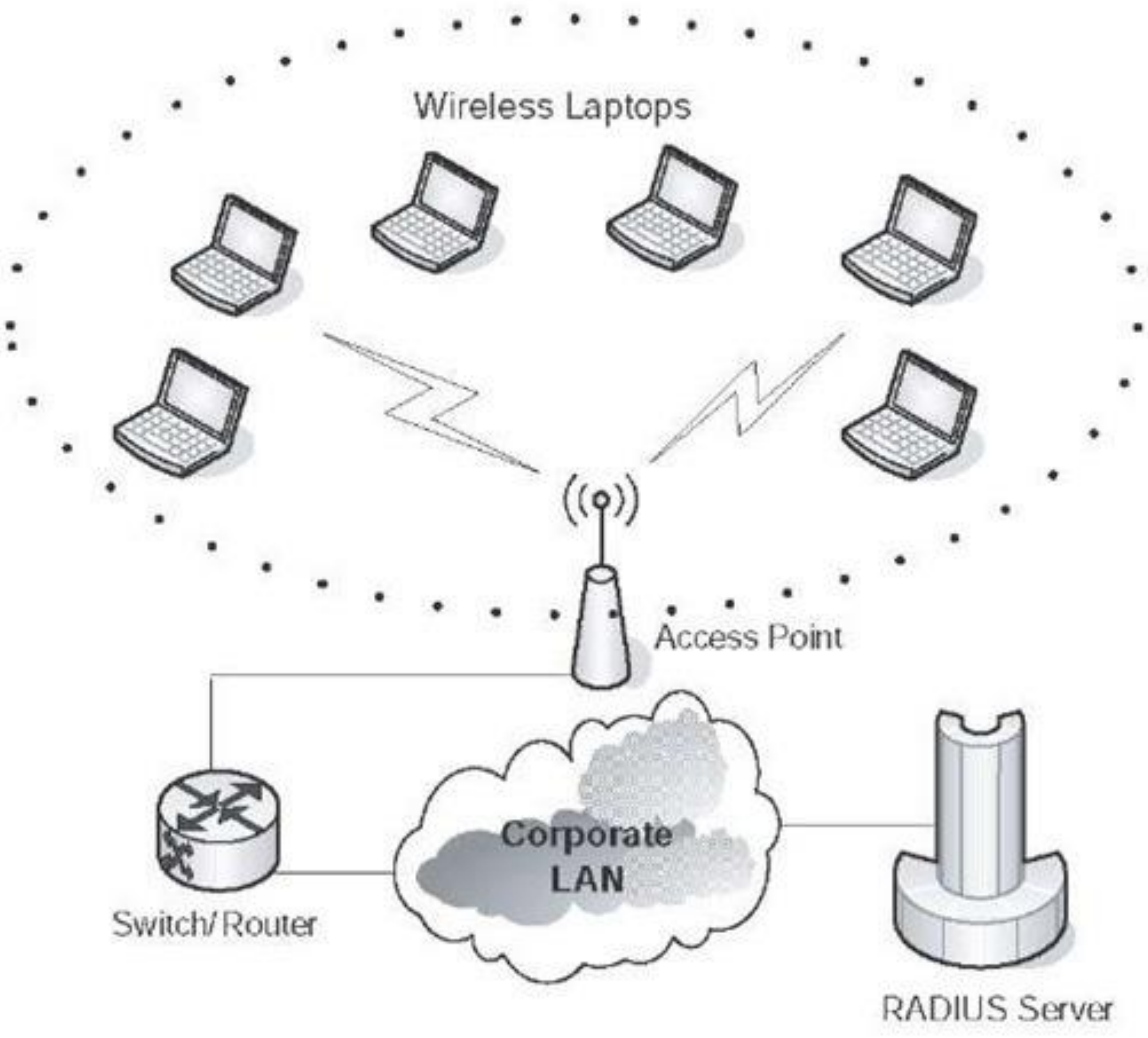
753

A 16-bit port address represented as one single number.

Network Hardware

- Local Area Networks
- Metropolitan Area Networks
- Wide Area Networks
- Wireless Networks
- Home Networks
- Internetworks

Wireless Network



Home Network

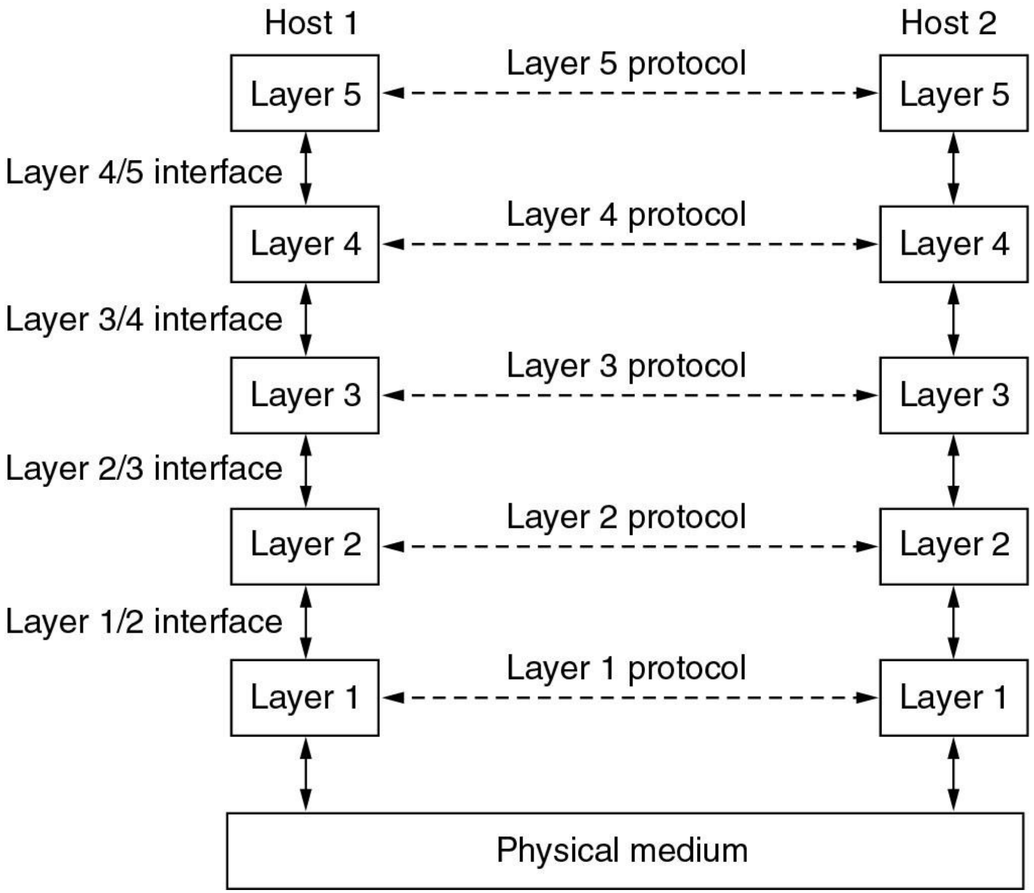
- Computers (desktop PC, PDA, shared peripherals
- Entertainment (TV, DVD, VCR, camera, stereo, MP3)
- Telecomm (telephone, cell phone, intercom, fax)
- Appliances (microwave, fridge, clock, furnace, airco)
- Telemetry (utility meter, burglar alarm, babycam)

Network Software

- Protocol Hierarchies
- Design Issues for the Layers
- Connection-Oriented and Connectionless Services
- Service Primitives
- The Relationship of Services to Protocols

Network Software

- Protocol Hierarchies



Network Software

- Design issues for the layers
  - Addressing
  - Error Control
  - Flow Control
  - Multiplexing
  - Routing

Network Software

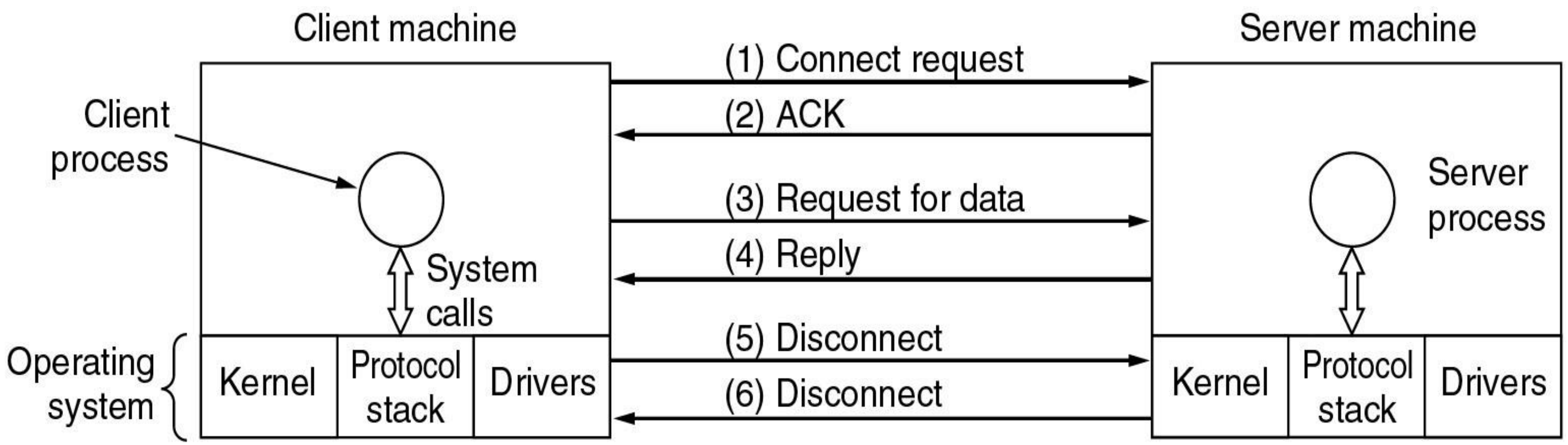
- Connection Oriented and Connection less services

	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

Network Software

- Service Primitives (connection oriented)

Primitive	Meaning
LISTEN	Block waiting for an incoming connection
CONNECT	Establish a connection with a waiting peer
RECEIVE	Block waiting for an incoming message
SEND	Send a message to the peer
DISCONNECT	Terminate a connection



Network Software

- The Relationship of Services to Protocols