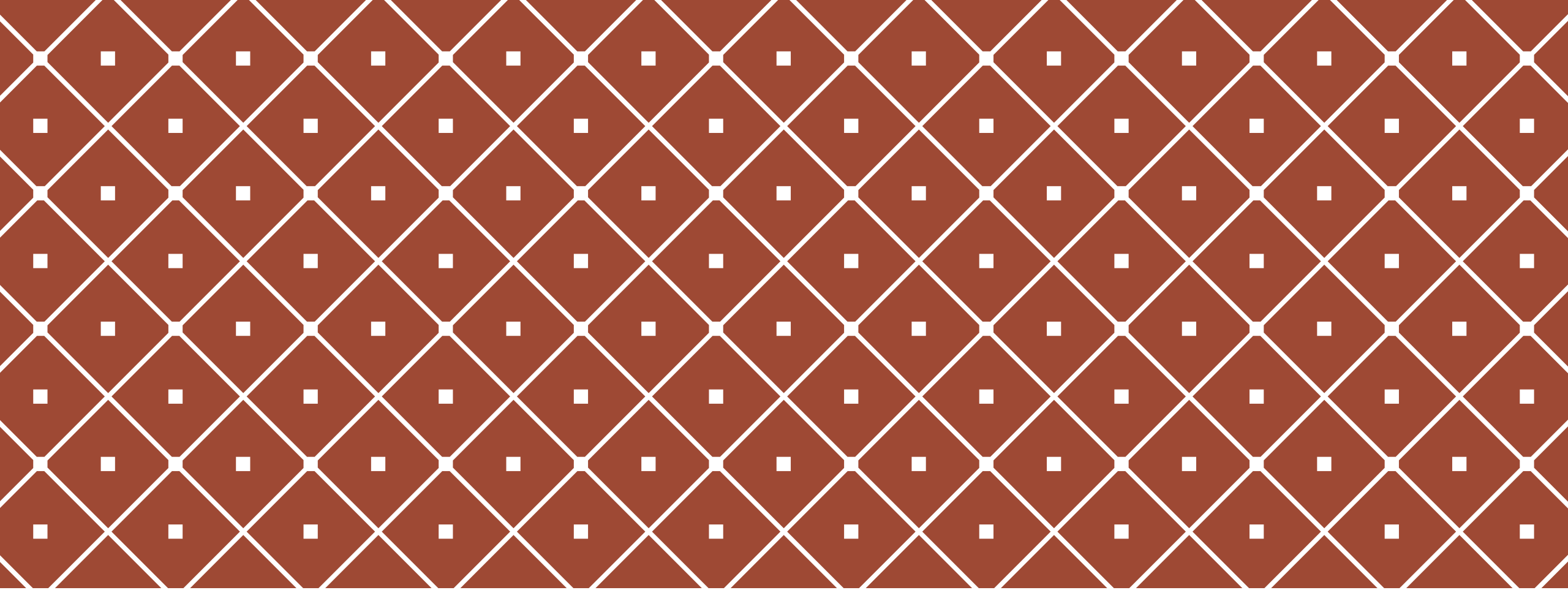


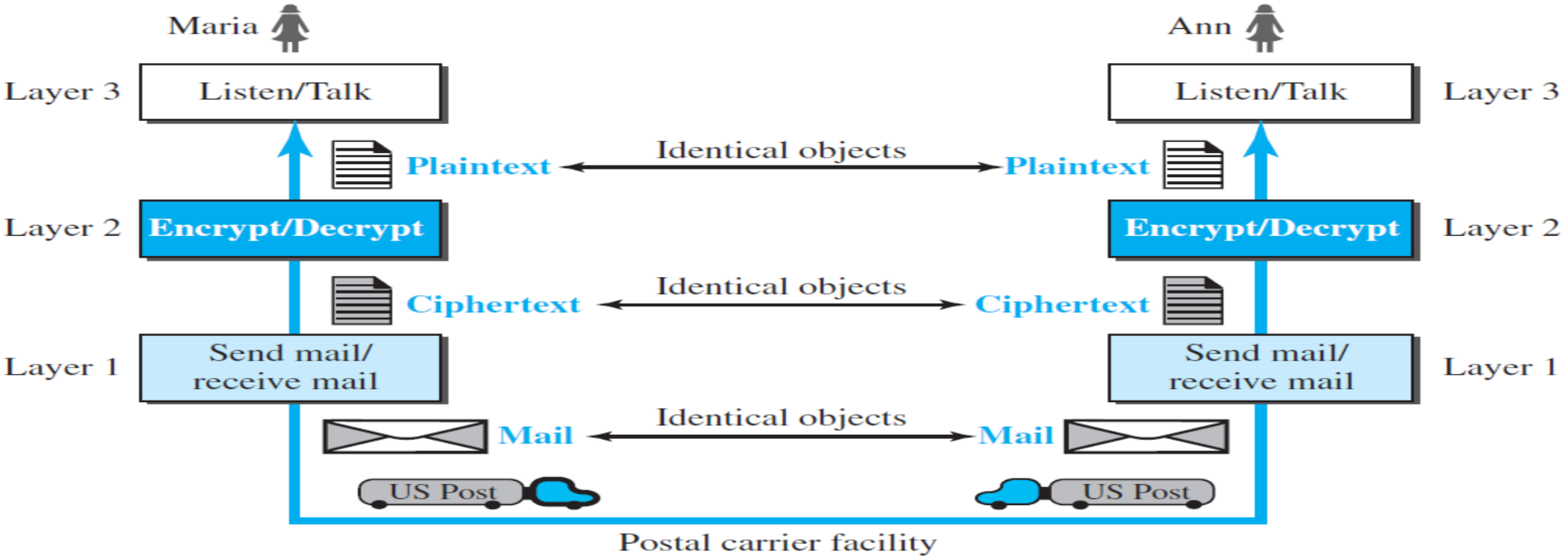
PROTOCOL LAYERING
TCP/IP PROTOCOL SUITE

PROTOCOL LAYERING

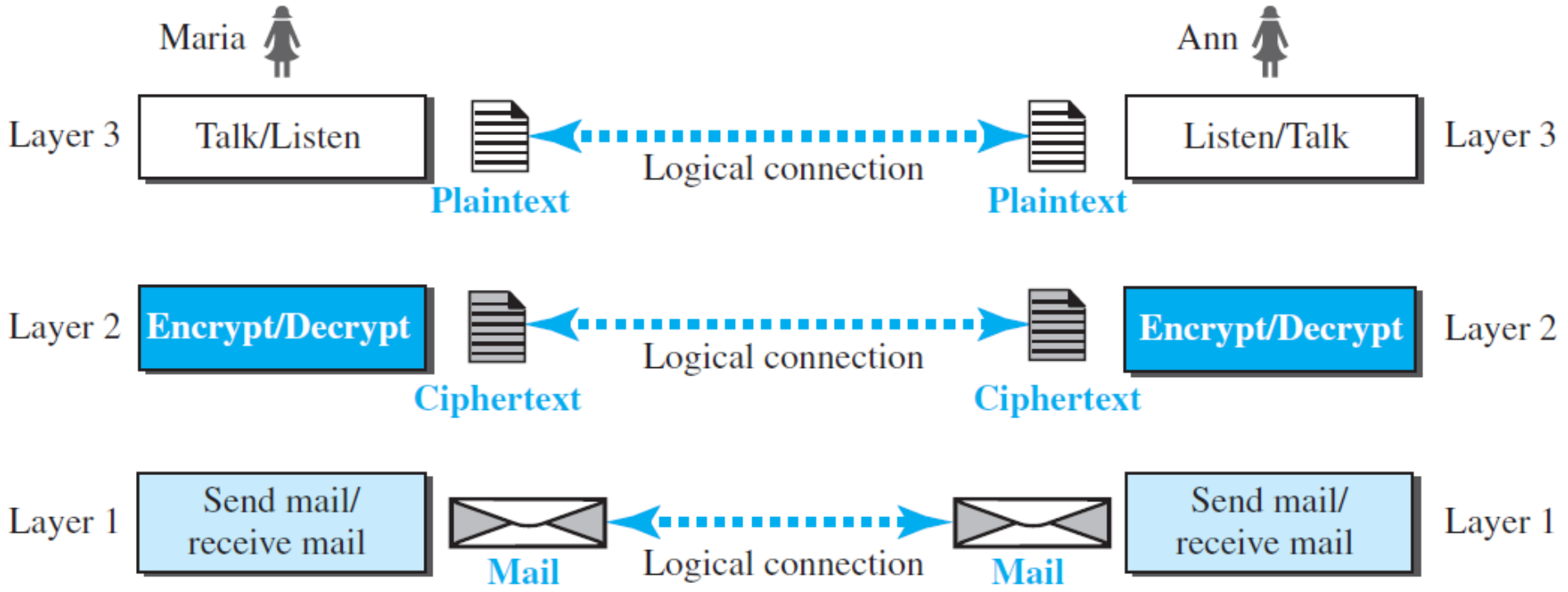
- The rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively.
- When communication is simple, we may need only one simple protocol; when the communication is complex,
- We may need to divide the task between different layers, in which case we need a protocol at each layer, or protocol layering.

PRINCIPLES OF PROTOCOL LAYERING

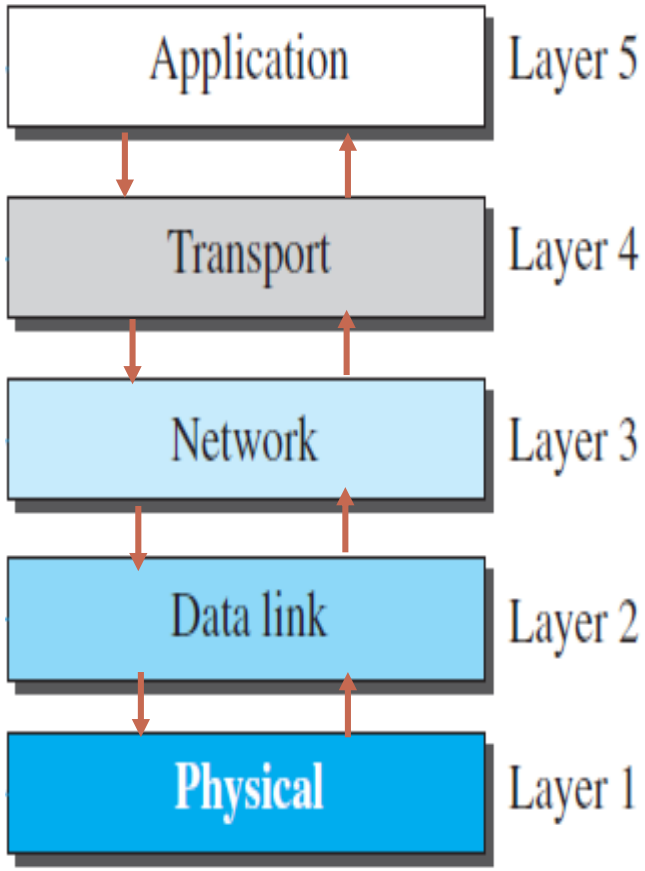
- Bidirectional communication between layers
- The two objects under each layer at both sites should be identical



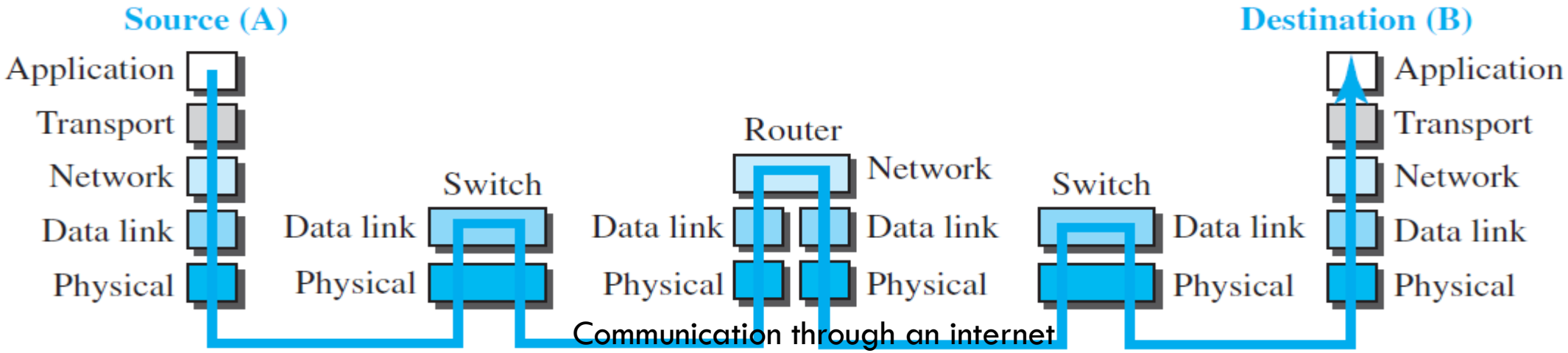
LOGICAL CONNECTION BETWEEN PEER LAYERS



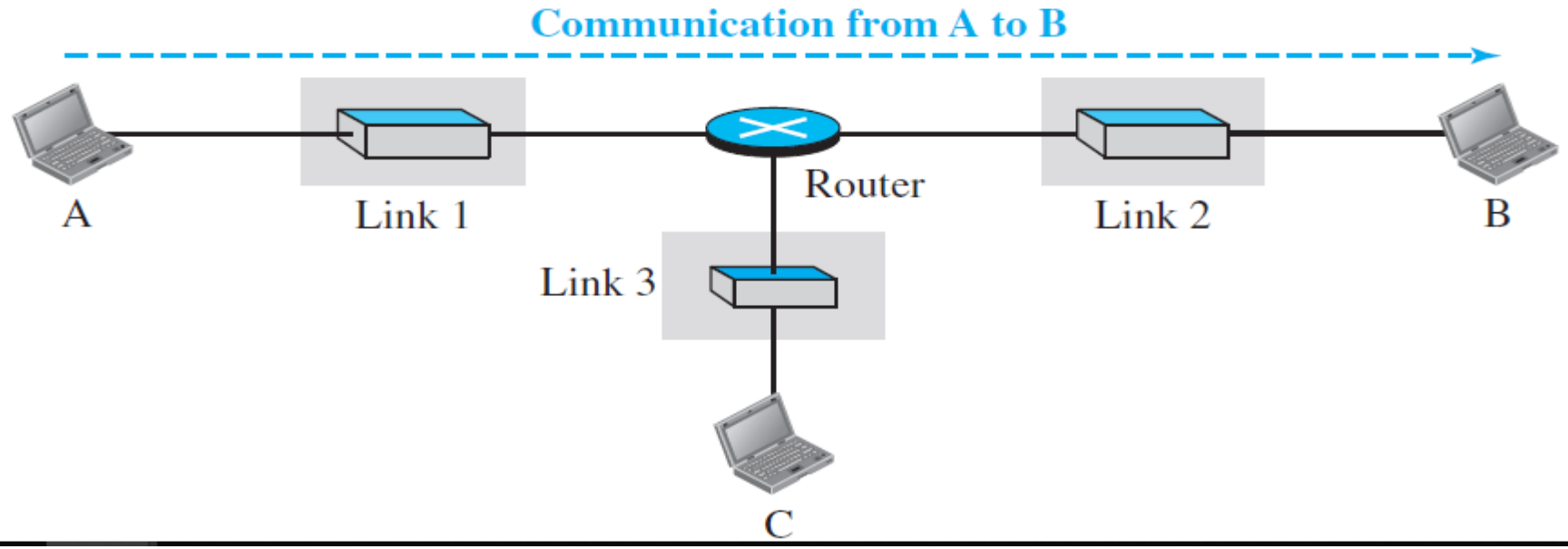
TCP/IP PROTOCOL SUITE



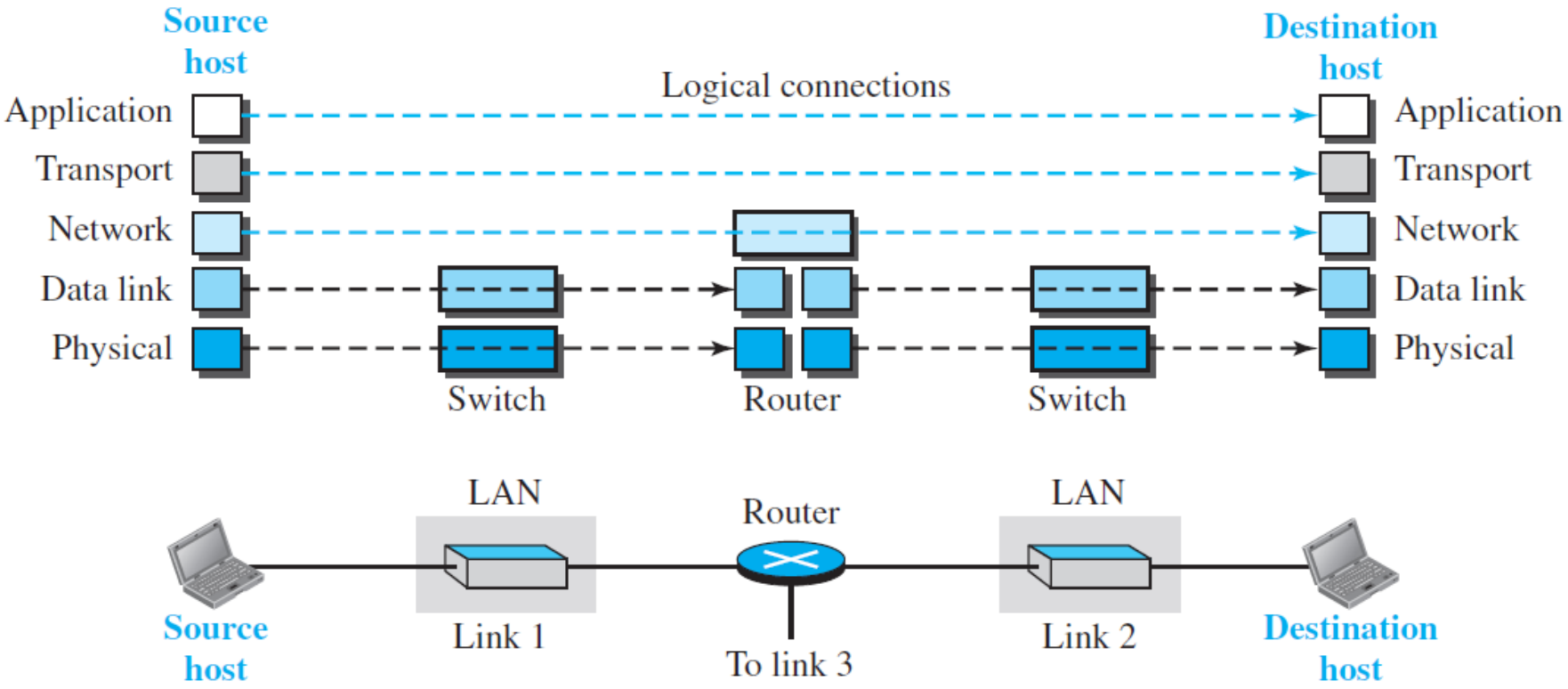
COMMUNICATION THROUGH AN INTERNET



Communication through an internet



LOGICAL CONNECTIONS BETWEEN LAYERS OF THE TCP/IP PROTOCOL SUITE



- The duty of the data-link and physical layers is hop-to-hop, in which a hop is a host or router.
- The domain of duty of the top three layers is the internet, and the domain of duty of the two lower layers is the link.

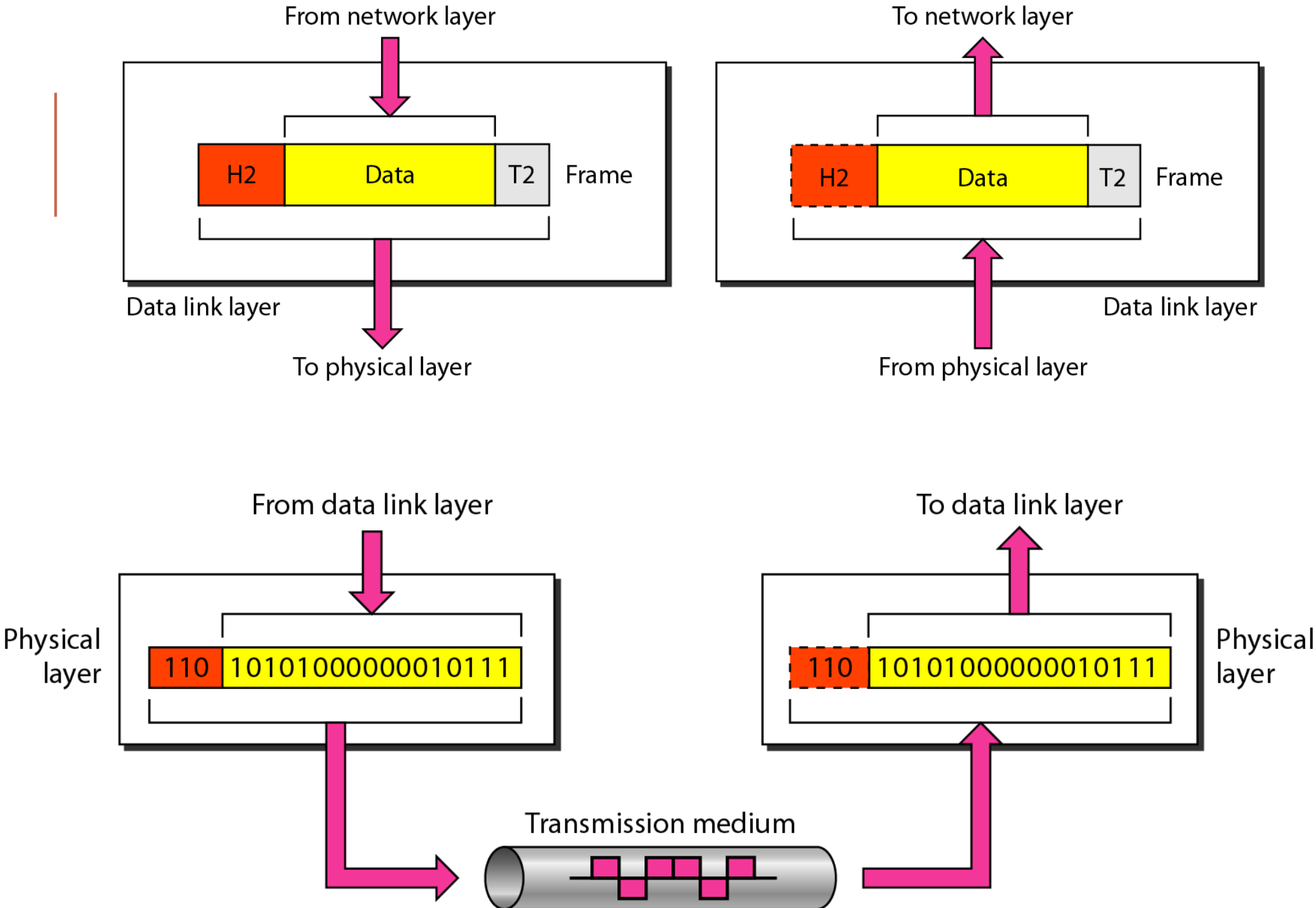
PHYSICAL LAYER, DATA-LINK LAYER

Physical layer

- Responsible for carrying individual bits in a frame across the link
- The transmission medium does not carry bits; it carries electrical or optical signals.
- Bits received in a frame from the data-link layer are transformed and sent through the transmission media

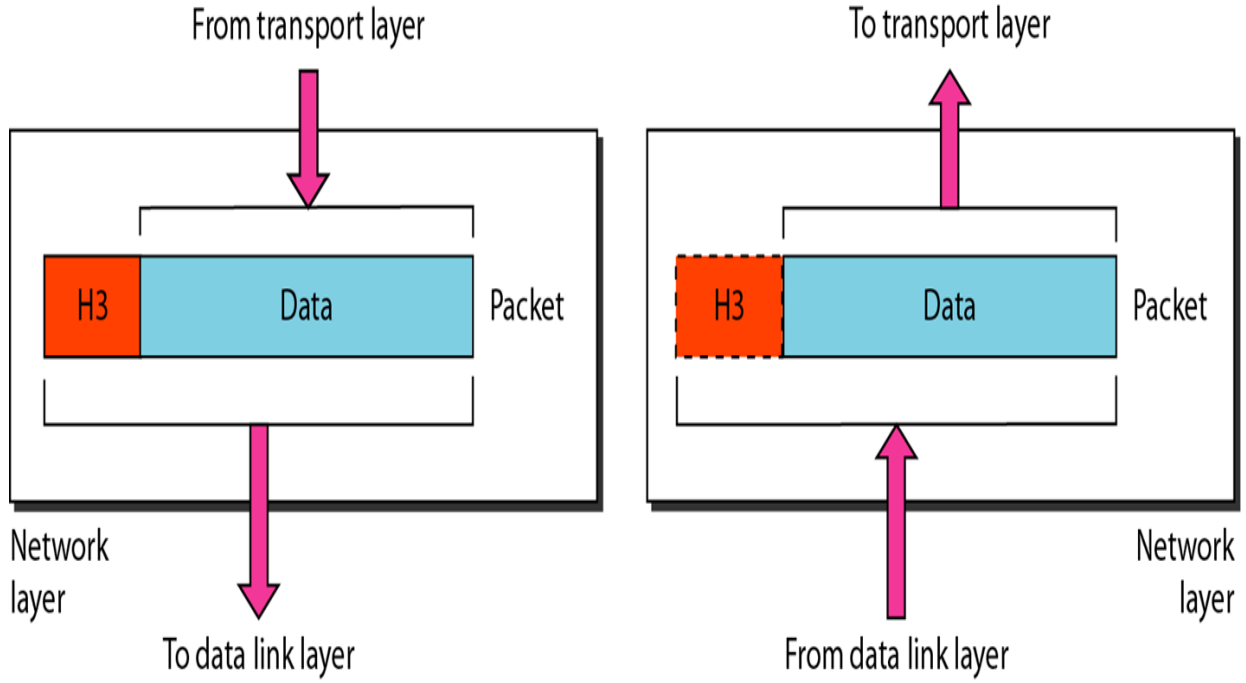
Data-link layer

- Responsible for taking the datagram and moving it across the link. The data link layer is responsible for moving frames from one hop (node) to the next.
- Data-link layer takes a datagram and encapsulates it in a packet called a frame.
- Provide complete error detection and correction


From network layer
H2
Data
T2
Frame
Data link layer
To physical layer
To network layer
H2
Data
T2
Frame
Data link layer
From physical layer
From data link layer
Physical layer
110
1010100000010111
To data link layer
Physical layer
110
1010100000010111
Transmission medium

NETWORK LAYER

- Responsible for creating a connection between the source computer and the destination computer.
- Responsible for host-to-host communication and routing the packet through possible routes.
- IP, ICMP, DHCP, ARP



TRANSPORT LAYER

- The logical connection at the transport layer is also end-to-end.
- The transport layer at the source host gets the message from the application layer, encapsulates it in a transport layer packet (called a segment or a user datagram in different protocols) and sends it, through the logical (imaginary) connection, to the transport layer at the destination host.
- Responsible for giving services to the application layer:
- Transmission control protocol (TCP): connection-oriented protocol that first establishes a logical connection between transport layers at two hosts before transferring data
- Provides flow control, error control, congestion control
- User datagram protocol (UDP): connectionless protocol that transmits user datagrams without first creating a logical connection.
- Does not provide flow, error, or congestion control.

APPLICATION LAYER

- Two application layers exchange **messages** between each other as though there were a bridge between the two layers
- Communication at the application layer is between **two *processes*** (two programs running at this layer).
- To communicate, a process sends a request to the other process and receives a response.
- Process-to-process communication is the duty of the application layer.
- HTTP, SNMP, IGMP, FTP, SSH, DNS, SMTP

ENCAPSULATION AND DECAPSULATION

Encapsulation at the source host

- Message→ packet/segment (payload + header)→ datagram(packet+ header)→ frame(+ link layer address)→physical layer

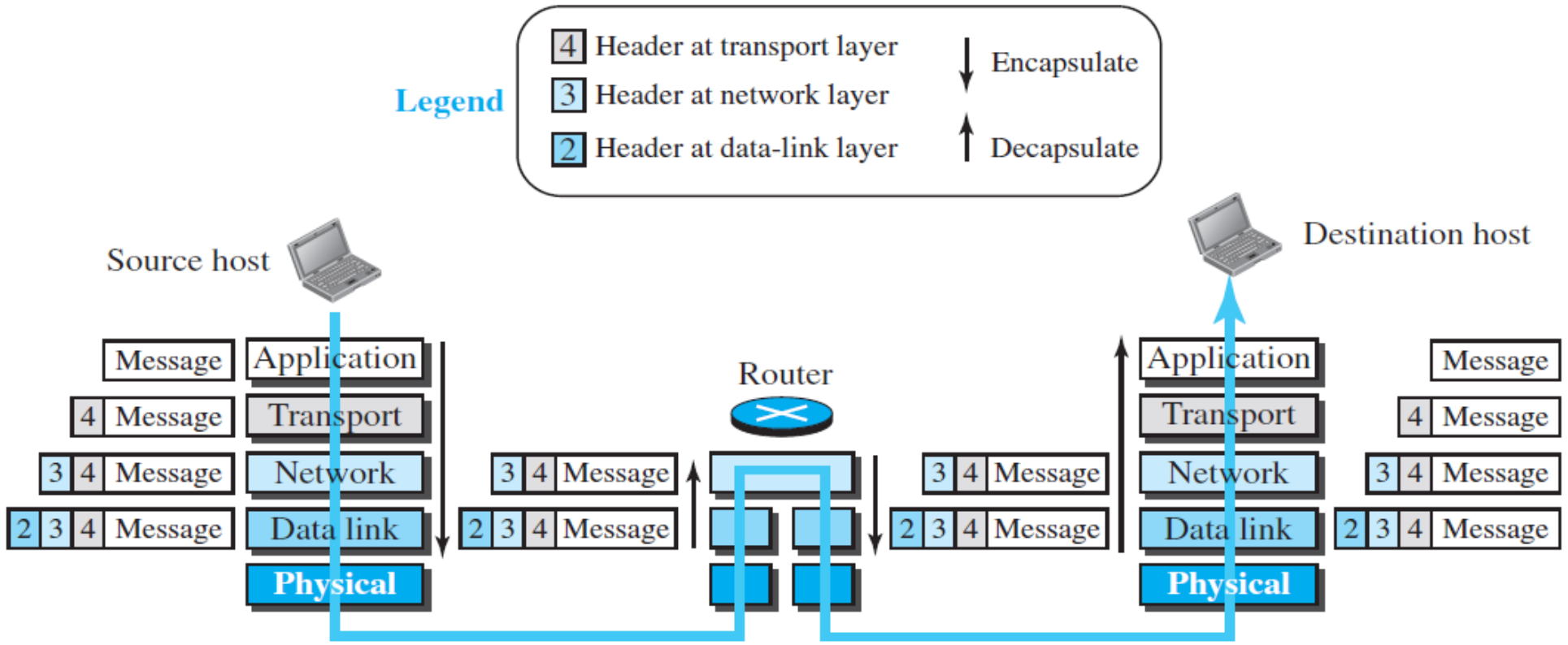
Decapsulation and encapsulation at the router

- Frame→datagram→data-link layer of the next link
- Data-link layer of the next link encapsulates the datagram in a frame and passes it to the physical layer for transmission.

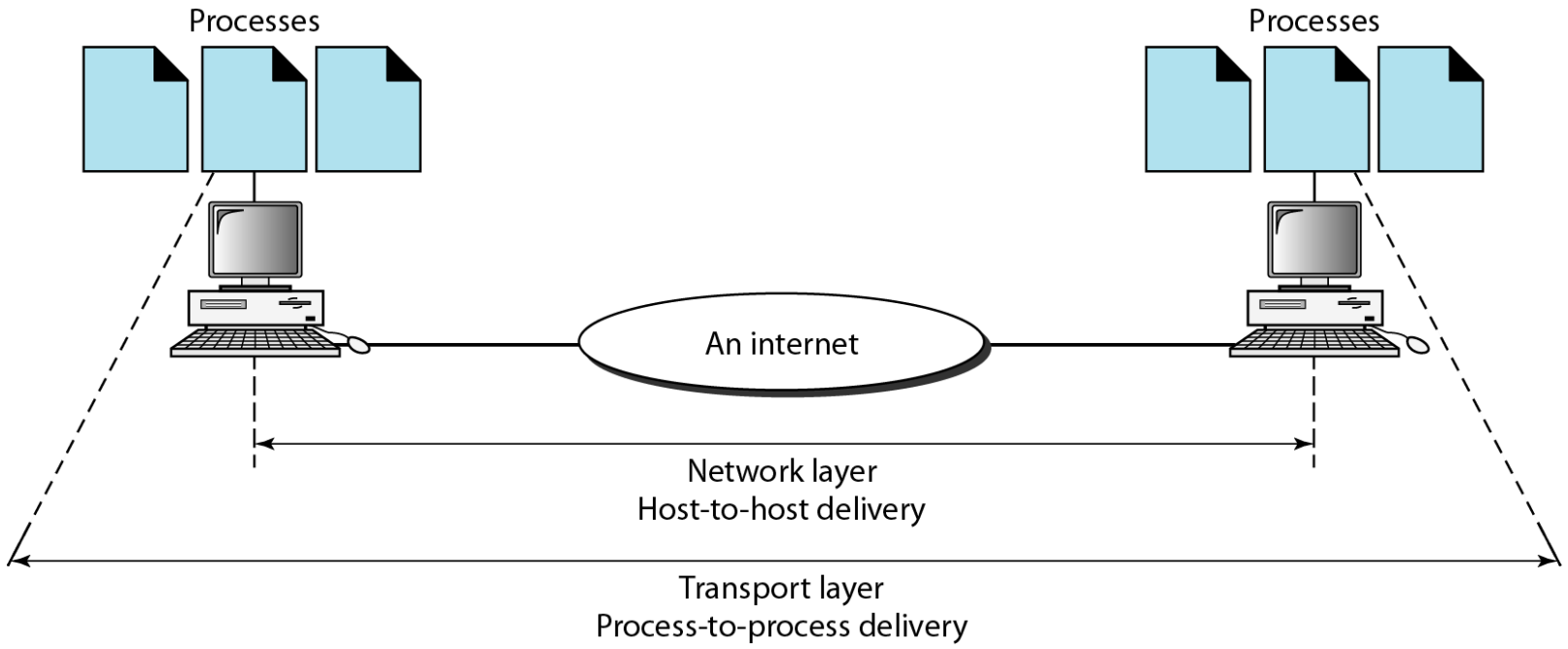
Decapsulation at the destination host

- Decapsulates the packet received, removes the payload, and delivers the payload to the next-higher layer protocol until the message reaches the application layer.
- Decapsulation in the host involves error checking.

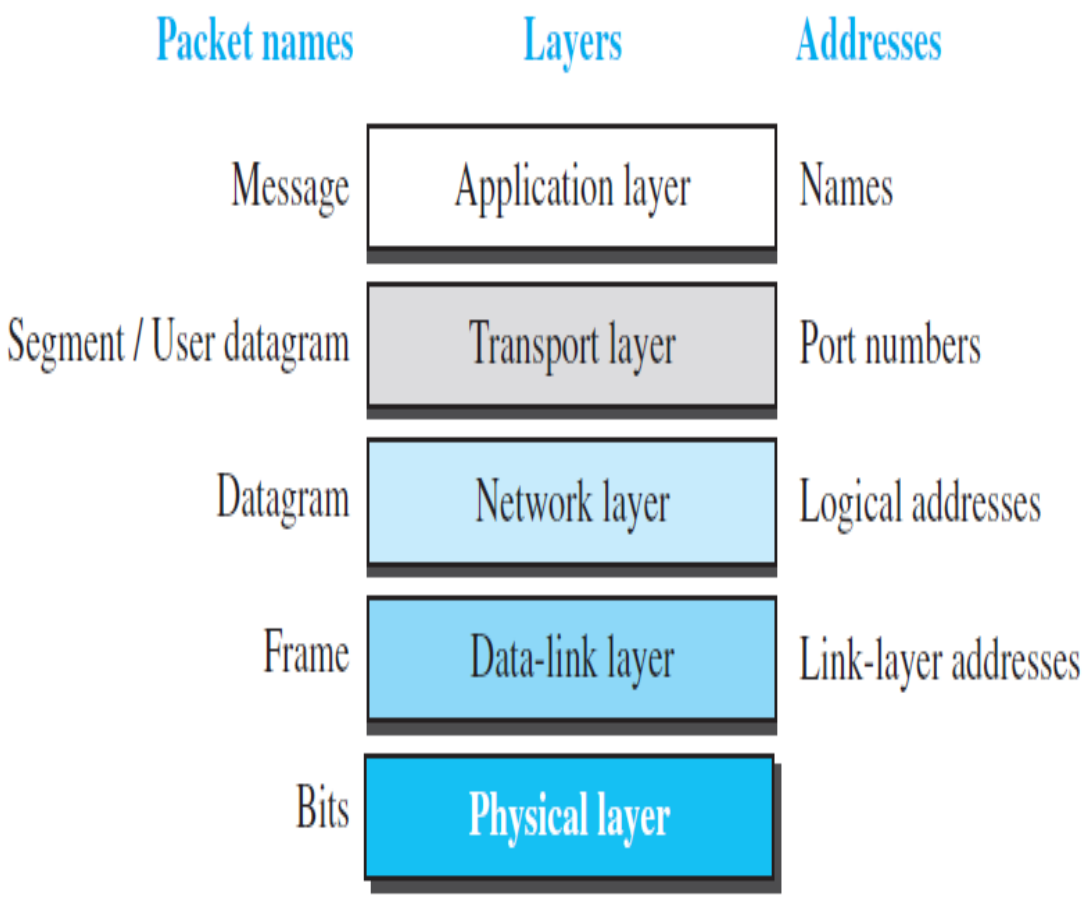
ENCAPSULATION AND DECAPSULATION



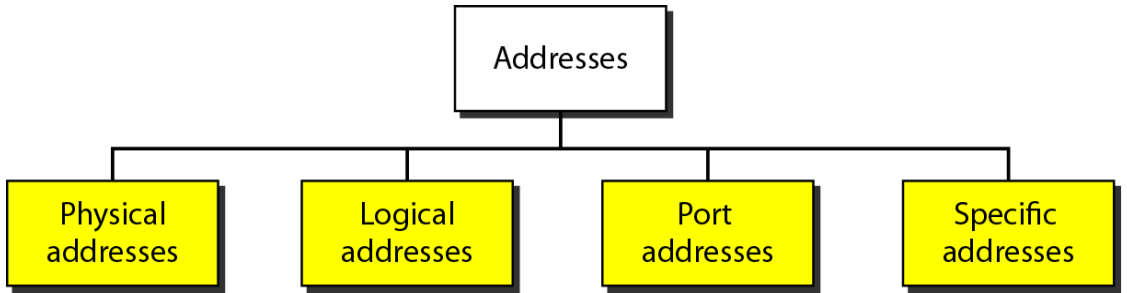
RELIABLE PROCESS-TO-PROCESS DELIVERY OF A MESSAGE



ADDRESSING



- At the application layer, we use names to define the site that provides services/ email
- At the transport layer, addresses are called port numbers, and these define the application-layer programs at the source and destination.
- Port numbers are local addresses that distinguish between several programs running at the same time.
- At the network-layer, the addresses are global, with the whole Internet as the scope.
- A network-layer address uniquely defines the connection of a device to the Internet.
- The link-layer addresses, sometimes called MAC addresses, are locally defined addresses, each of which defines a specific host or router in a network (LAN or WAN)

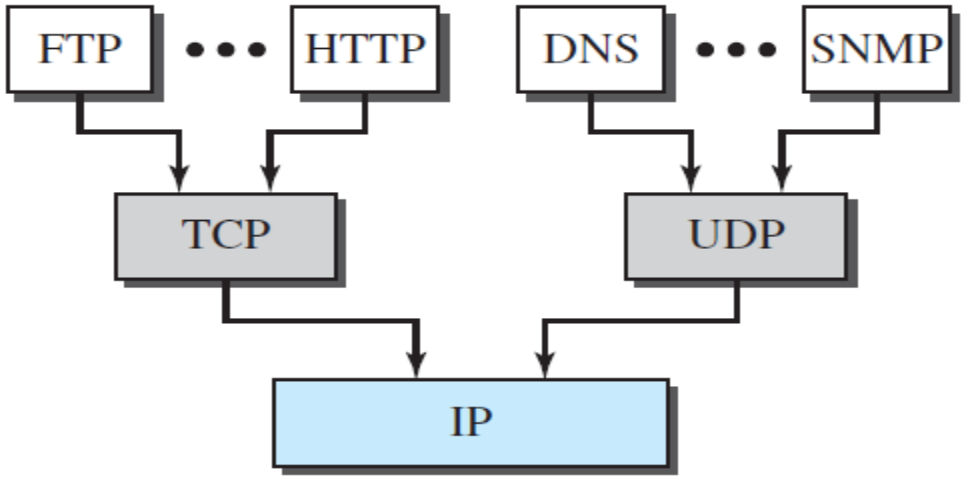


MULTIPLEXING AND DEMULTIPLEXING

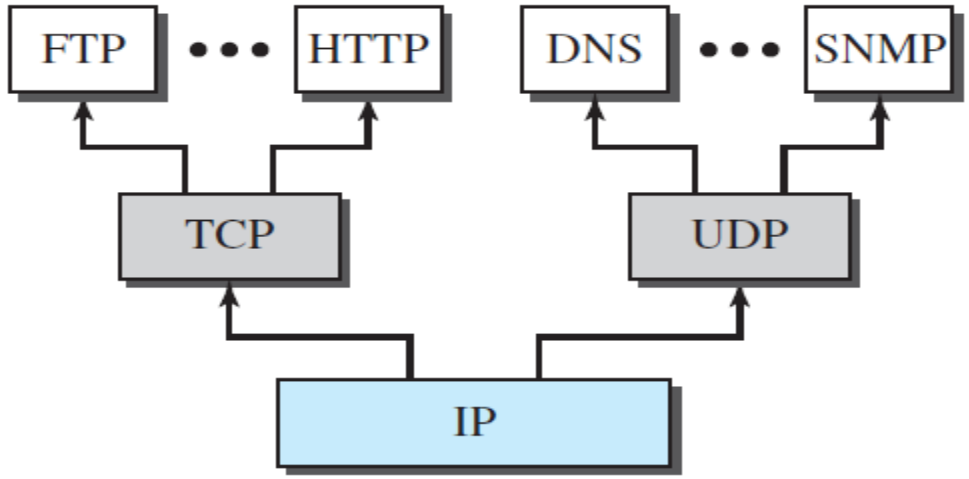
Multiplexing : a protocol at a layer can encapsulate a packet from several next-higher

layer protocols

Demultiplexing :a protocol can decapsulate and deliver a packet to several next-higher layer protocols



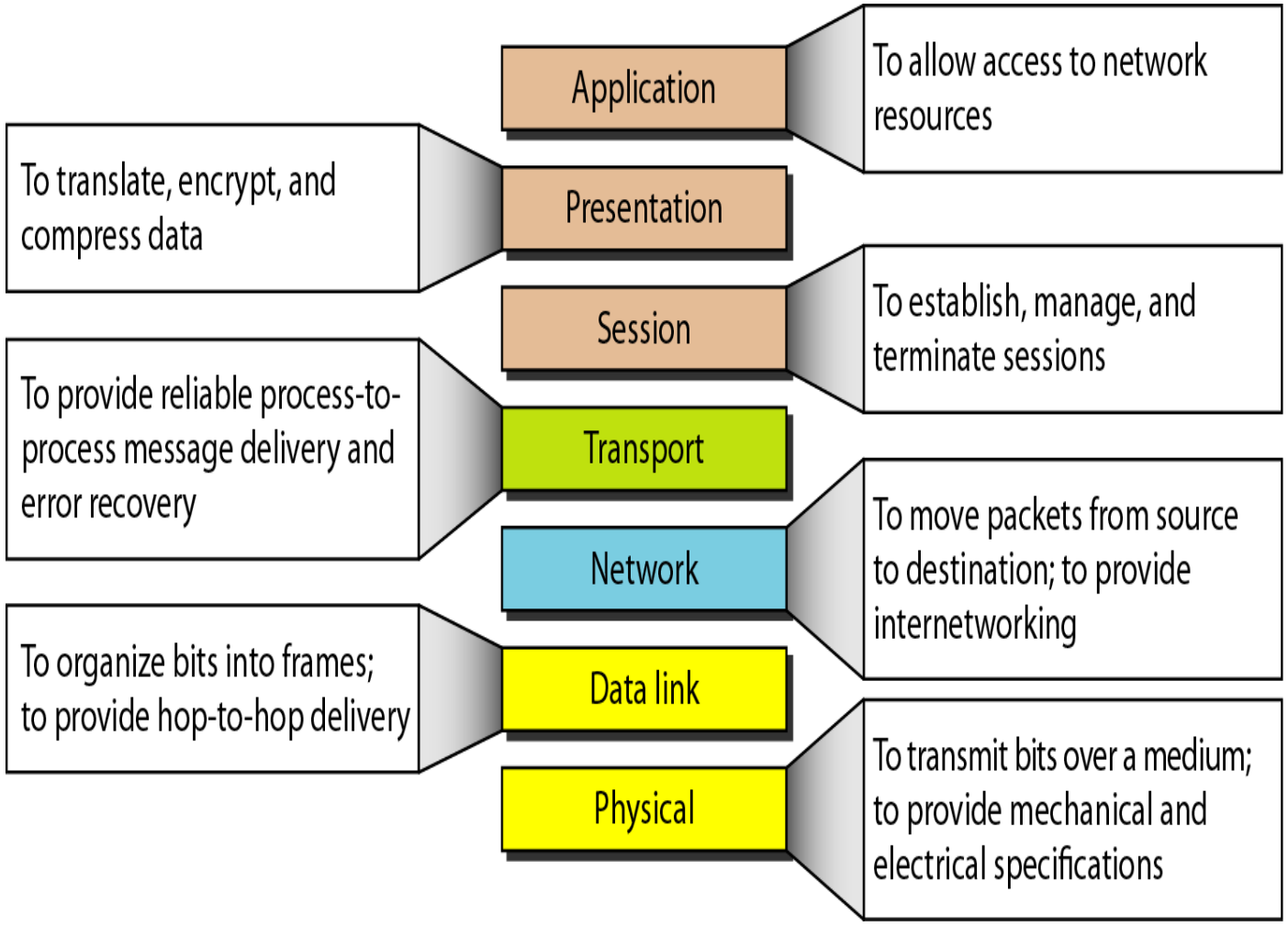
a. Multiplexing at source



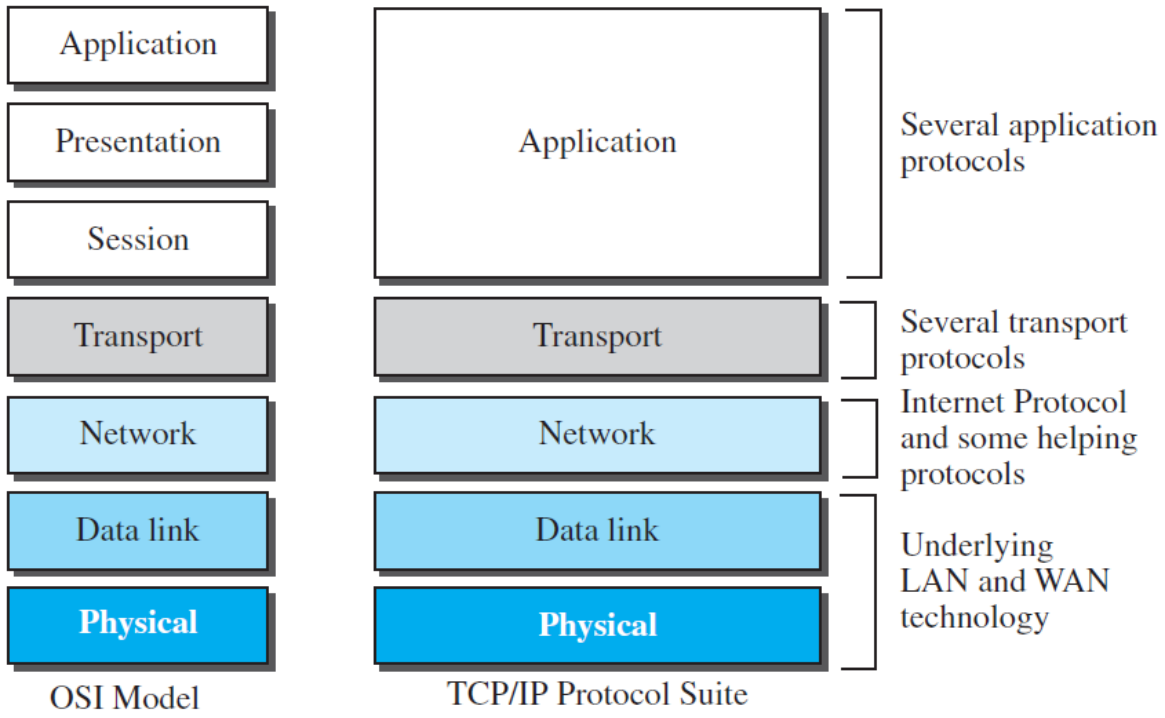
b. Demultiplexing at destination

THE OSI MODEL

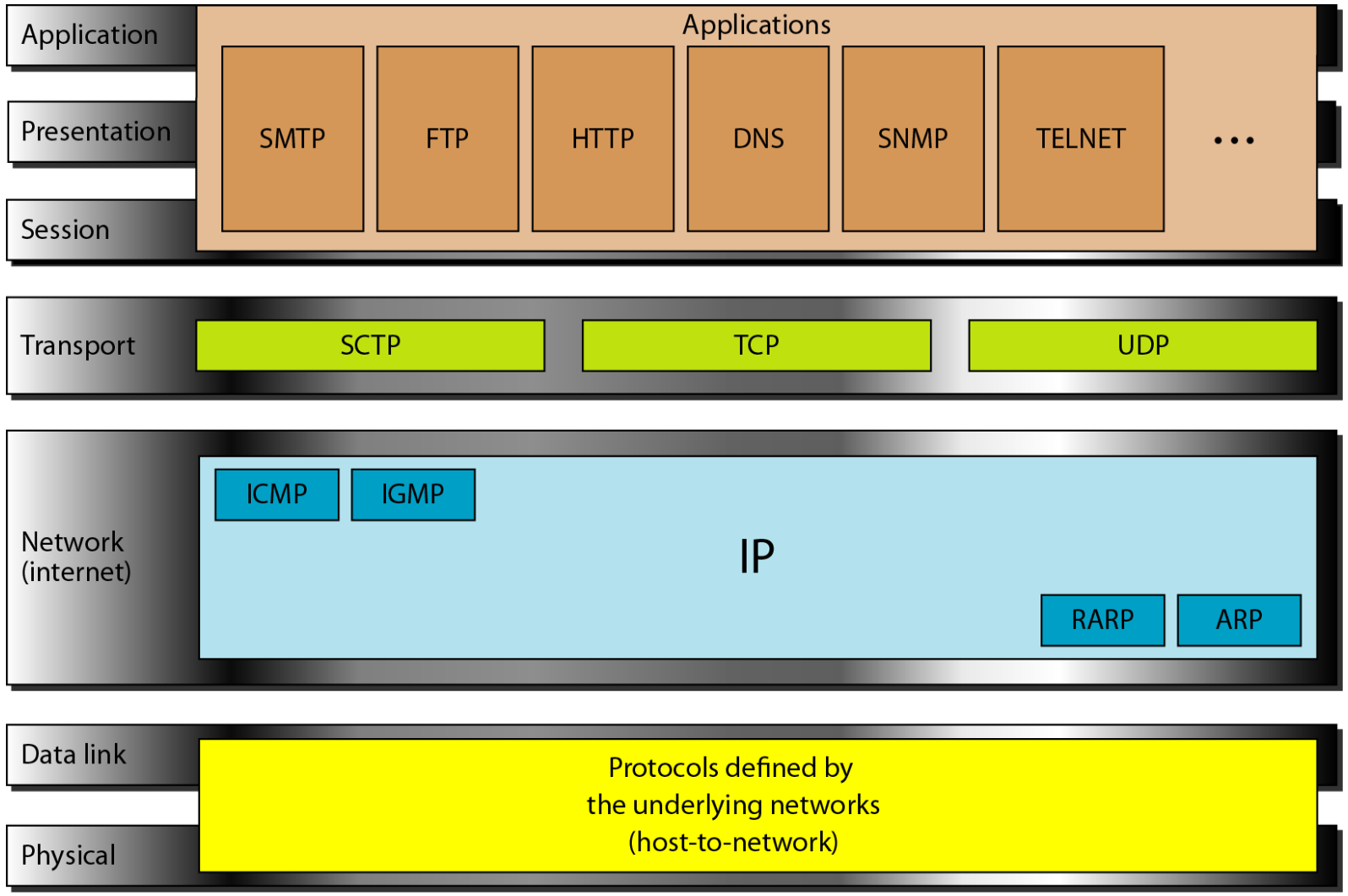
- An *open system* is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture
- It is a model for understanding and designing a network architecture that is flexible, robust, and interoperable.



OSI AND TCP/IP MODELS



TCP/IP and OSI model



SUMMARY

- A protocol is a set of rules that governs communication
- Two protocols at the same layer can have a logical connection; a physical connection is only possible through the physical layers
- TCP/IP is a hierarchical protocol suite made of five layers: physical, data link, network, transport, and application.
- Four levels of addresses are used in an internet following the TCP/IP protocols: physical (link) addresses, logical (IP) addresses, port addresses, and specific addersses
- Open Systems Interconnection (OSI) model

TEST YOUR UNDERSTANDING

- Which layers of the TCP/IP protocol suite are involved in a link-layer switch?
- Which of the following data units is encapsulated in a frame?
  a. a user datagram **b.** a datagram **c.** a segment
- List some application-layer protocols
- The *data link layer* is responsible for……
- What are the types of addresses (identifiers) used in each of the following layers?
  a. application layer **b.** network layer **c.** data-link layer