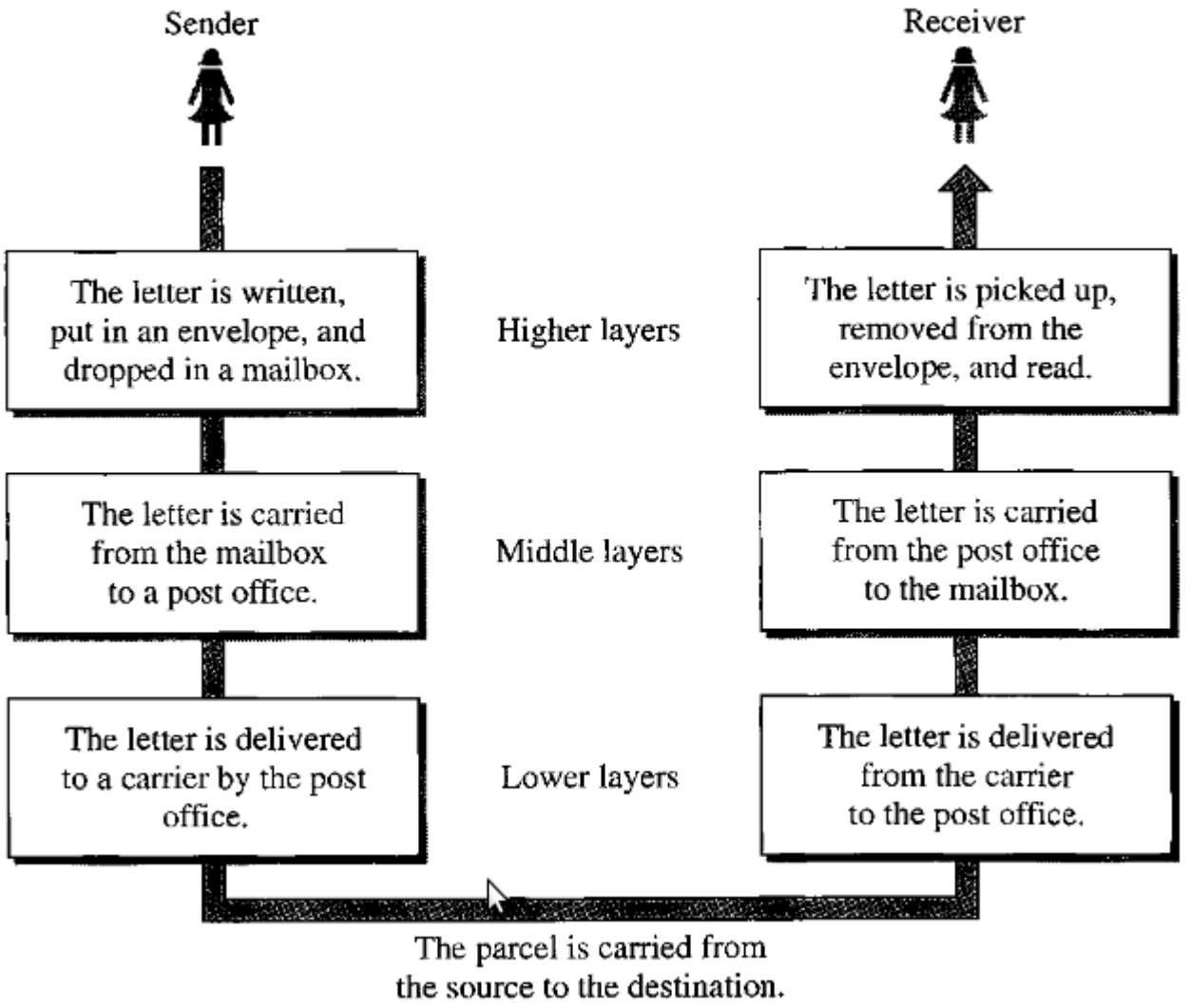
Chapter 2

Layered Tasks (1)

- Consider a person sending a letter to a friend using postal mail
- Post office provides the service to make it happen
- Sender site – sender drops letter to mailbox(H), letter brought by carrier to post office(M), another carrier transports the letter to another post office(L)
- Carrier – letter may go to a central office
- Receiver site – letter received at local post office of recipient(L), letter delivered to the recipient mailbox(M), friend reads the letter(H)

Layered Tasks (2)



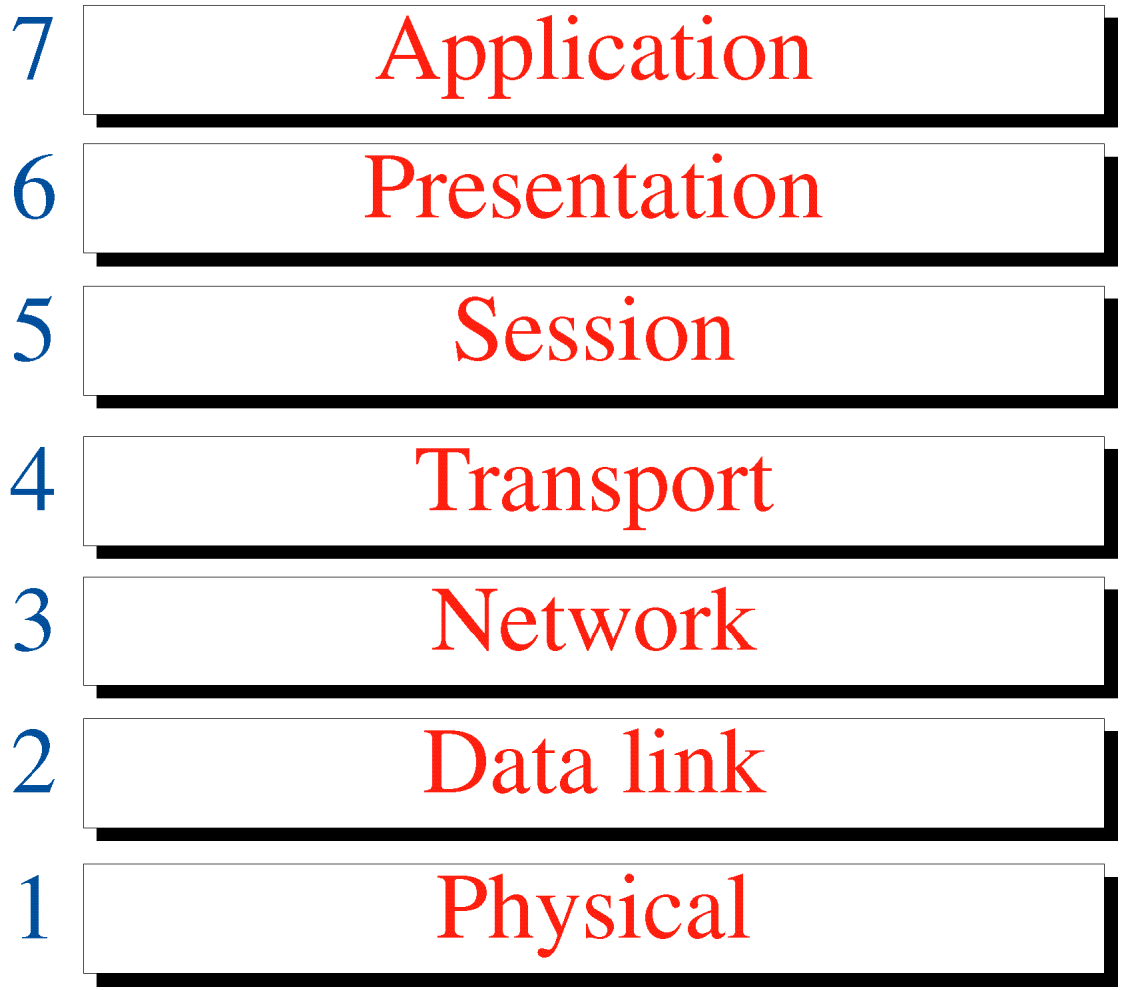
Hierarchy

- Tasks must be done in the order given in the hierarchy
- Each layer uses the services of the layer immediately below it
- Each layer provides services to the layer immediately above it

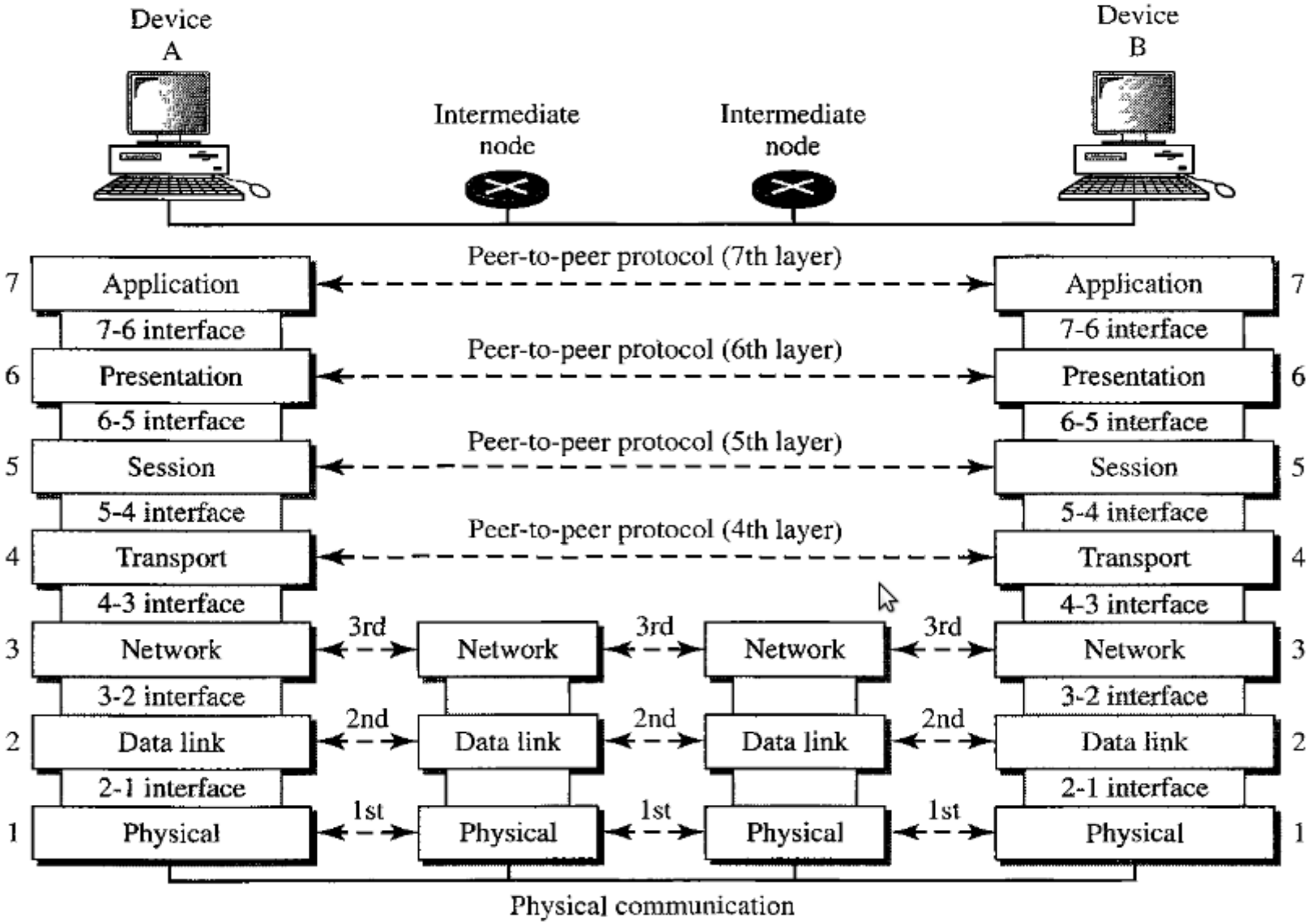
OSI

- Open Systems Interconnection, introduced in the late 1970's by ISO
- Open system – a set of protocols that allows any two different systems to communicate regardless of the underlying architecture
- OSI is not a protocol; it is model for understanding and designing a network architecture that is flexible, robust, and interoperable

OSI Layers (1)


7
Application
6
Presentation
5
Session
4
Transport
3
Network
2
Data link
1
Physical

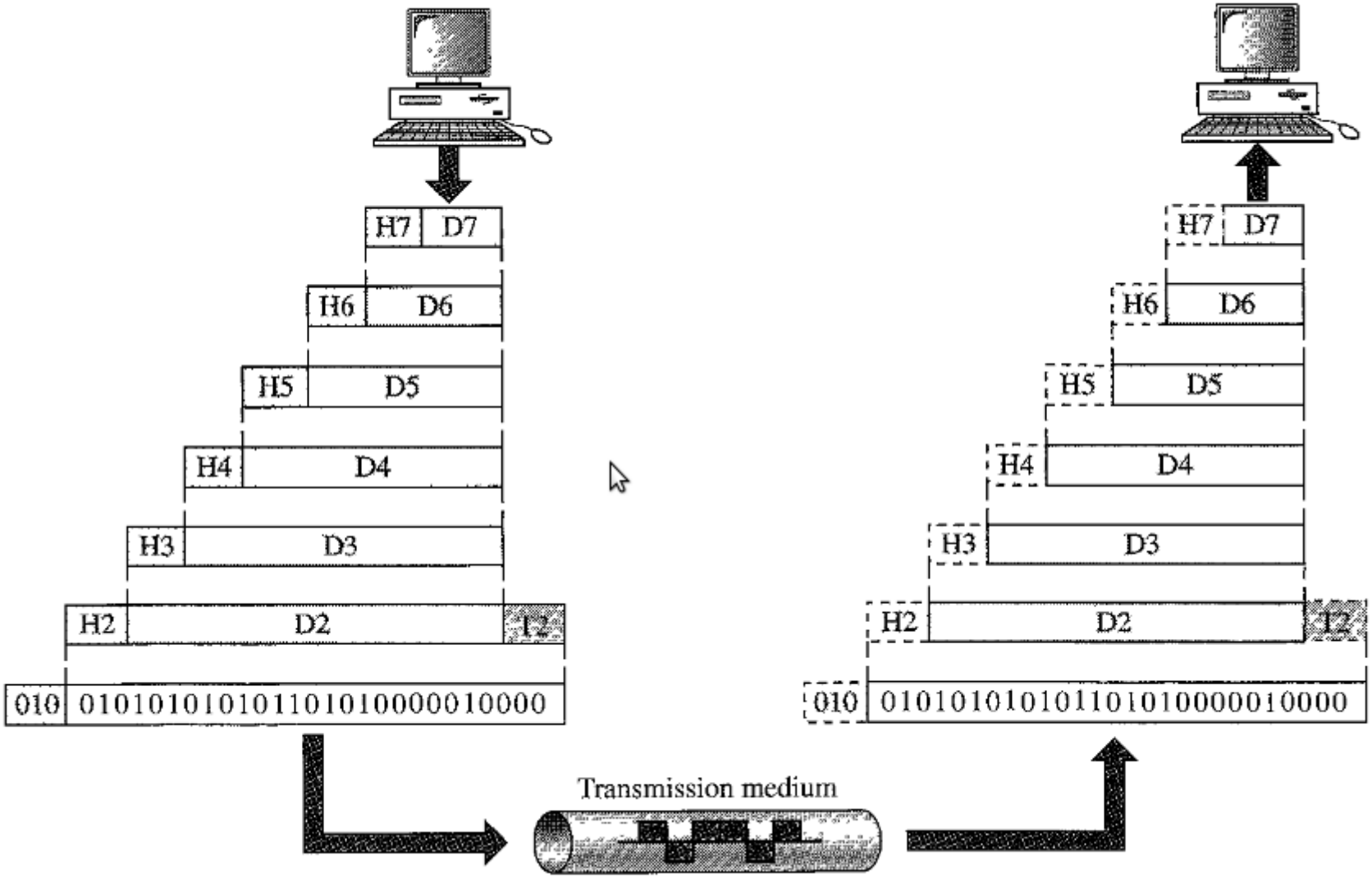
OSI Layers (2): Peer-to-Peer Processes



OSI Layers (3)

- [A]Network support layers – 1,2,3
  - Physical aspects of moving data
  - Implemented in hardware and software
- [B]User support layers – 5, 6, 7
  - Provides interoperability among unrelated software systems
  - Implemented in software
- Layer 4 links [A] and [B]

OSI Layers (4)


H7
D7
H6
D6
H5
D5
H4
D4
H3
D3
H2
D2
T2
010
0101010101011010100000010000
Transmission medium

Encapsulation

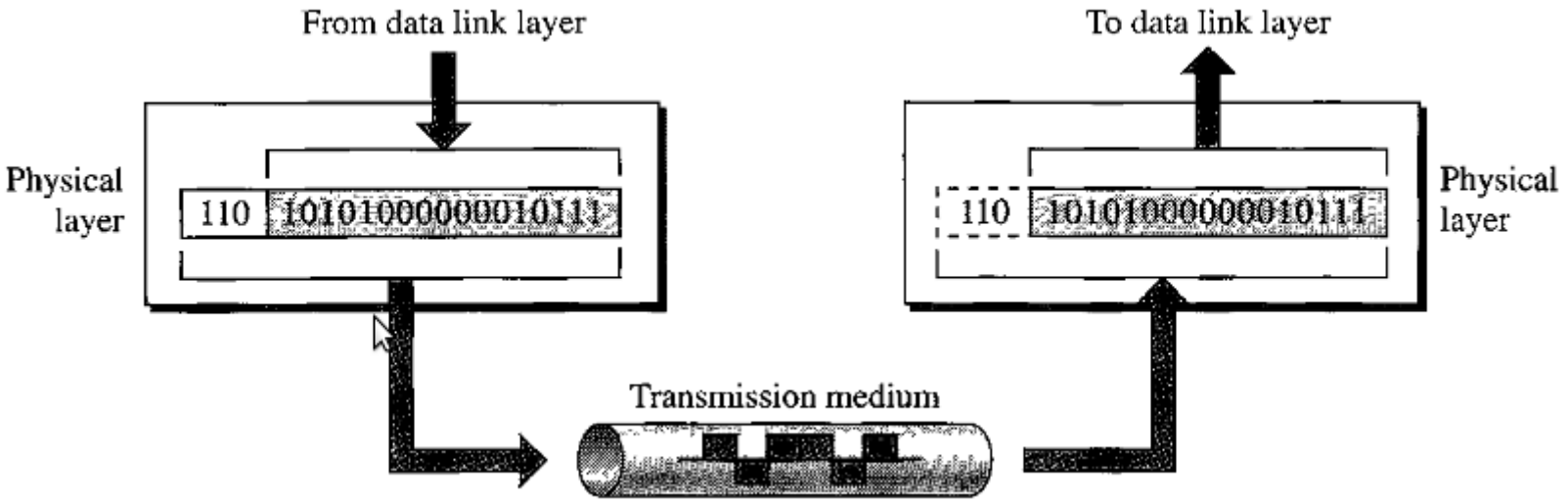
- A packet (header and data) at layer 7 is encapsulated in a packet at level 6
- A packet at layer 6 is encapsulated in a packet at level 5 and so on
- Data portion of a packet at layer N-1 caries the whole packet (data, header, trailer) from level N
- Layer N-1 has no idea which is data or header or trailer in the encapsulated packet

LAYERS IN THE OSI MODEL

[1]Physical Layer (1)

- Coordinates the functions required to carry a bit stream over a physical medium
- Deals with mechanical and electrical specifications of the interface and transmission medium
- Defines and procedures and functions needed for transmission to occur

[1]Physical Layer (2)



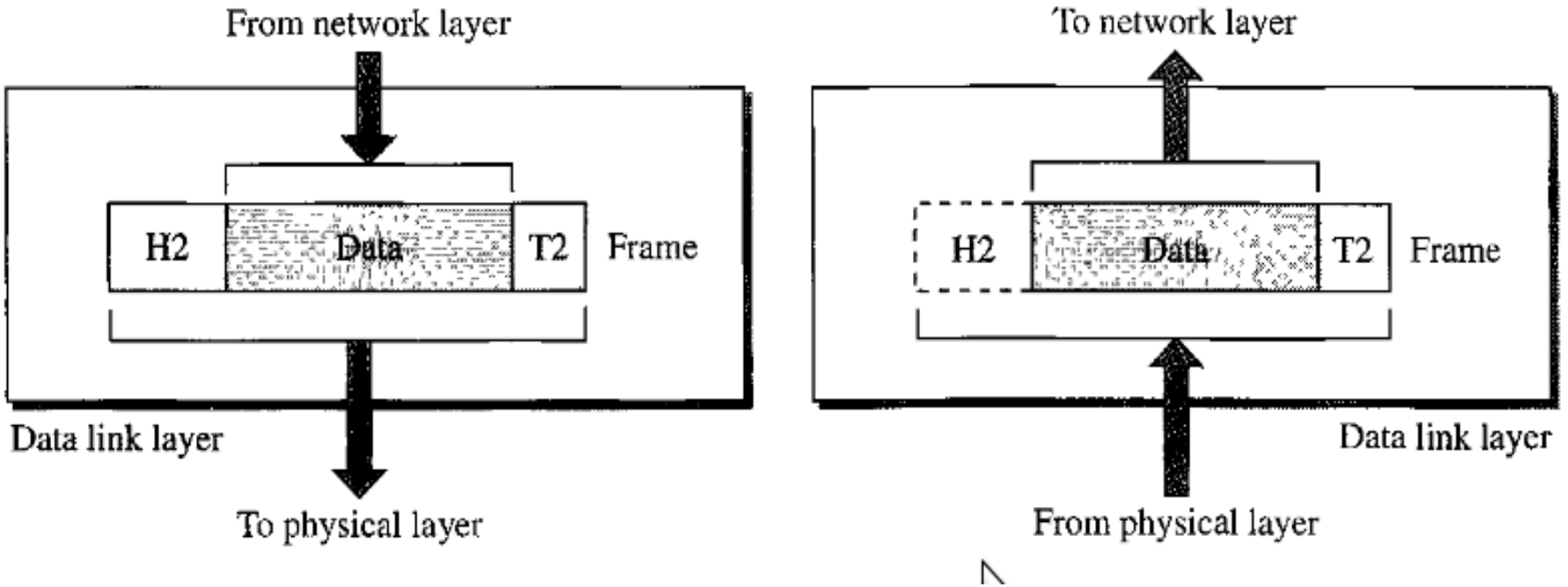
[1]Physical Layer (3)

- Physical characteristics of interfaces and medium
- Representation of bits - encoding
- Data rate -number of bits sent each second
- Synchronization of bits - timing
- Line configuration – point-to-point, multipoint
- Physical topology – bus, star, ring,mesh,hybrid
- Transmission mode – simplex, half-duplex, duplex

[2]Data Link Layer(1)

- Transforms the physical layer to a reliable link
- Makes the physical layer appear error-free to the upper layer

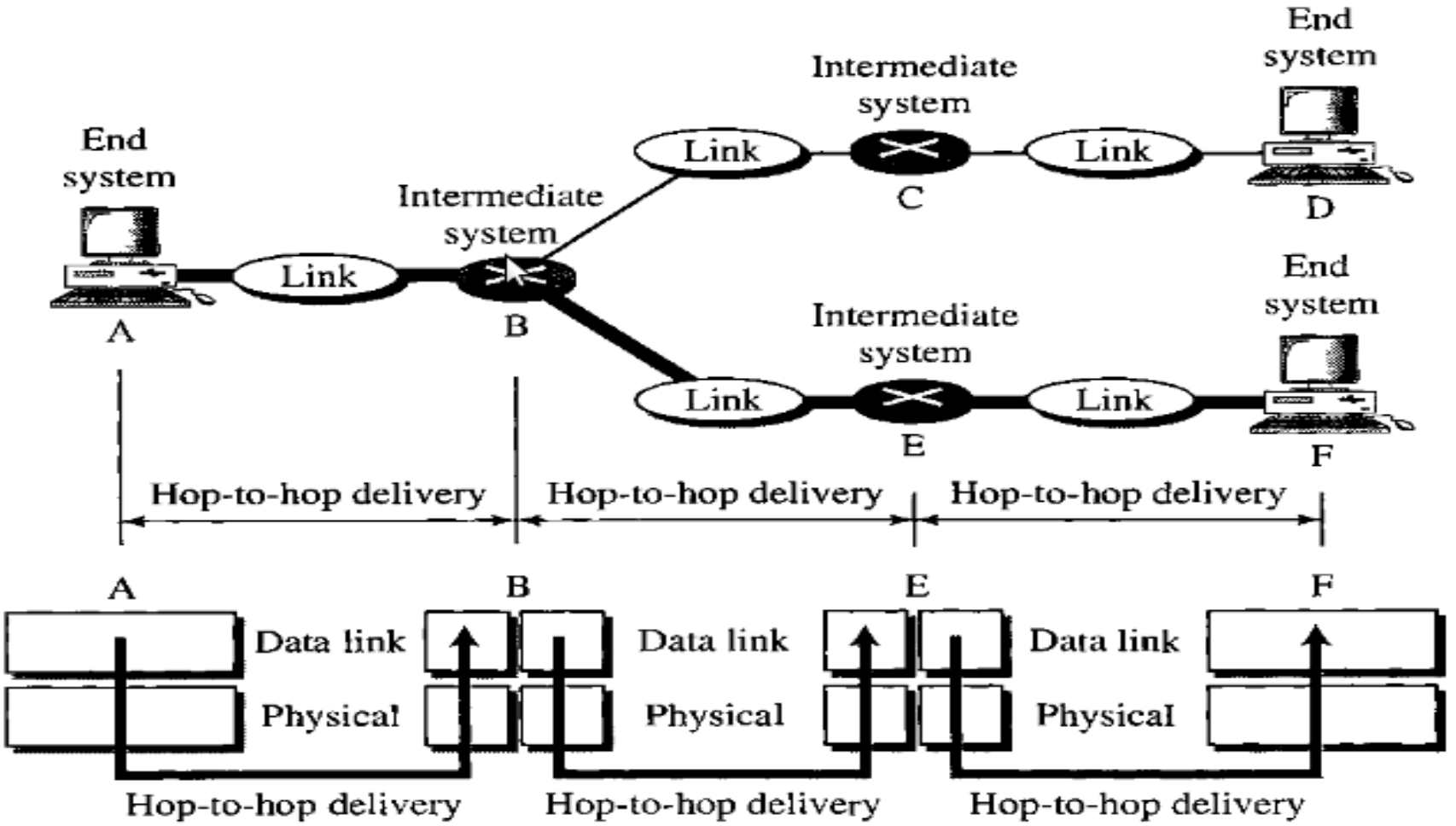
[2]Data Link Layer (2)



[2]Data Link Layer (3)

- Framing – defining frames
- Physical addressing – defines sender/receiver
- Flow control – prevents overwhelming the receiver
- Error control – detect and retransmit damaged or lost frames, use of trailers
- Access control – defines which device has control over the link when it is shared by devices

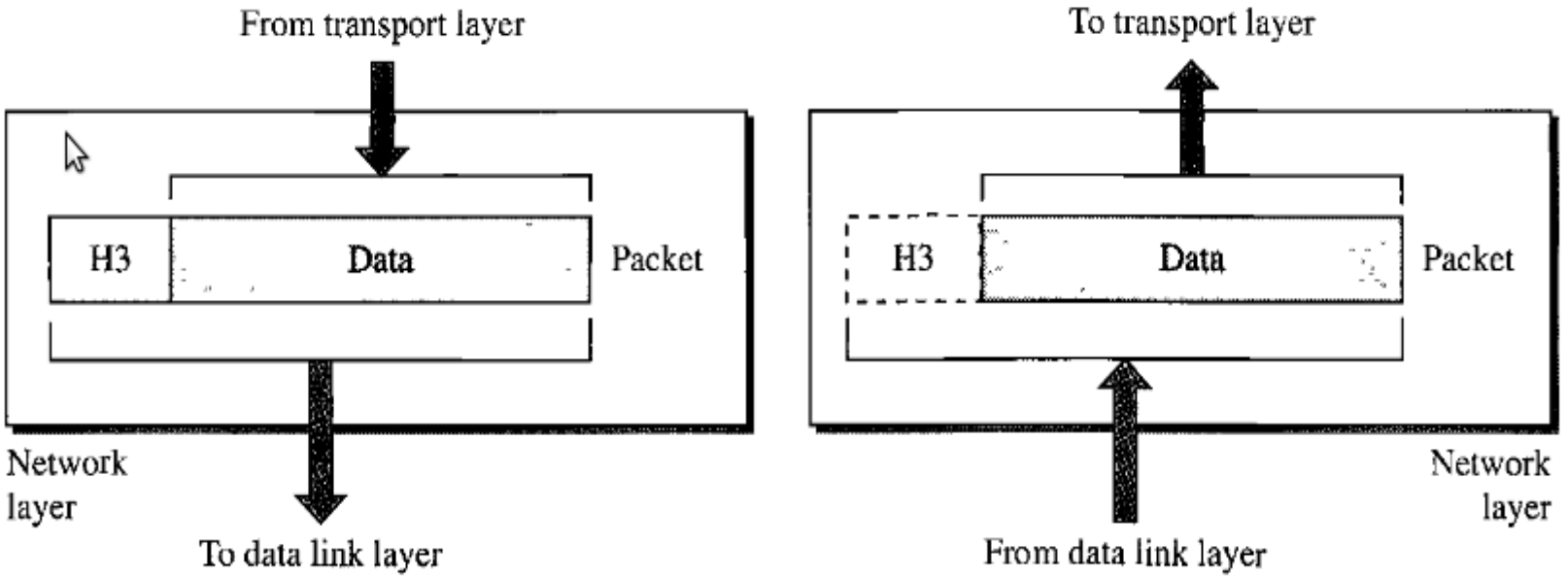
[2]Data Link (4)


End system
Intermediate system
End system
Link
Link
Link
C
D
A
B
Intermediate system
End system
Link
Link
E
F
Hop-to-hop delivery
Hop-to-hop delivery
Hop-to-hop delivery
A
B
E
F
Data link
Data link
Data link
Physical
Physical
Physical
Hop-to-hop delivery
Hop-to-hop delivery
Hop-to-hop delivery

[3]Network Layer (1)

- Source-to-destination delivery of packets, possibly across multiple networks
- No need for network layer if two systems are connected to the same link

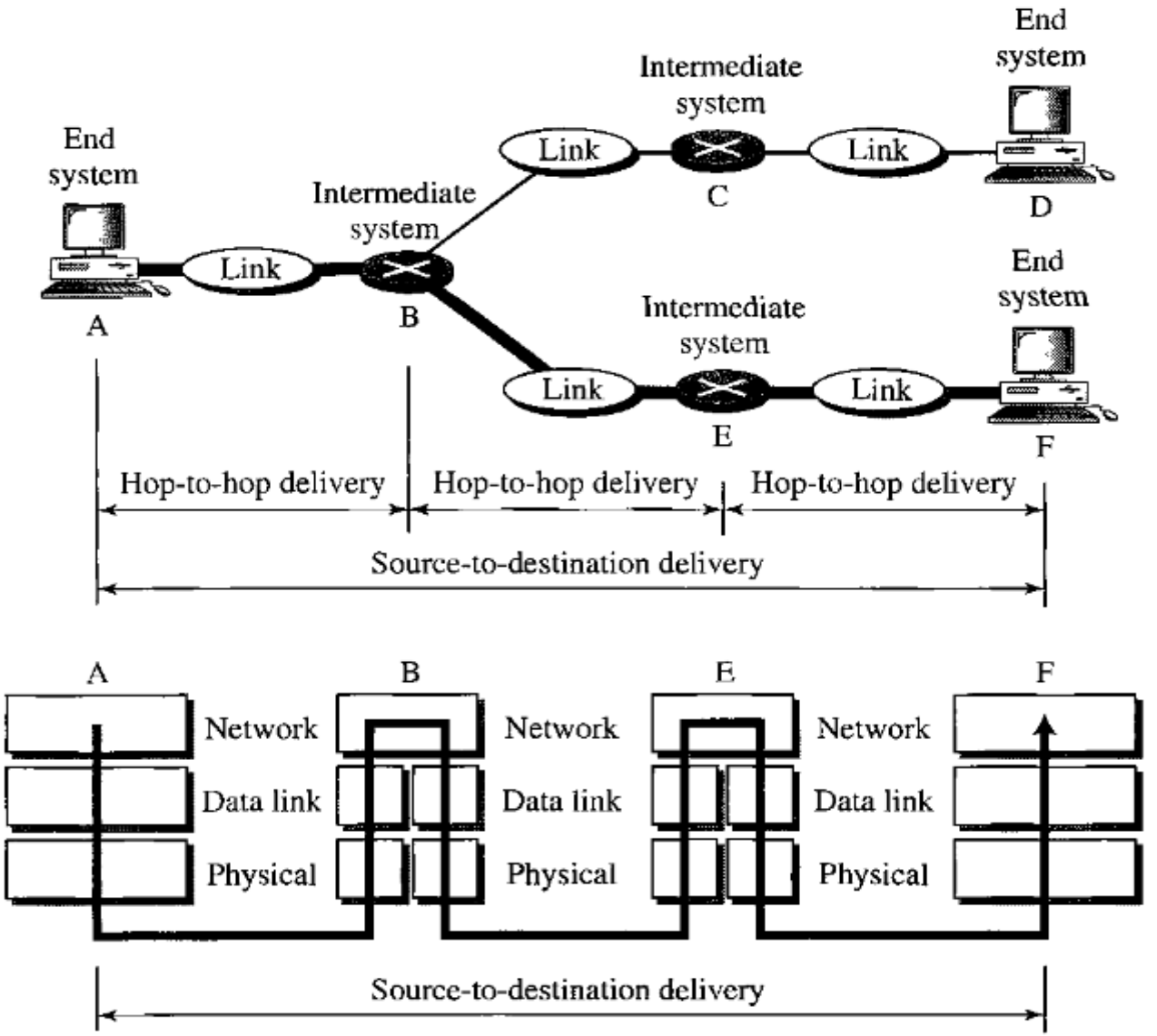
[3]Network Layer (2)



[3]Network Layer (3)

- Logical addressing – distinguish source and destination systems if packets pass network boundary
- Routing – makes possible the delivery of packets in internetworks, connecting devices are called routers and switches

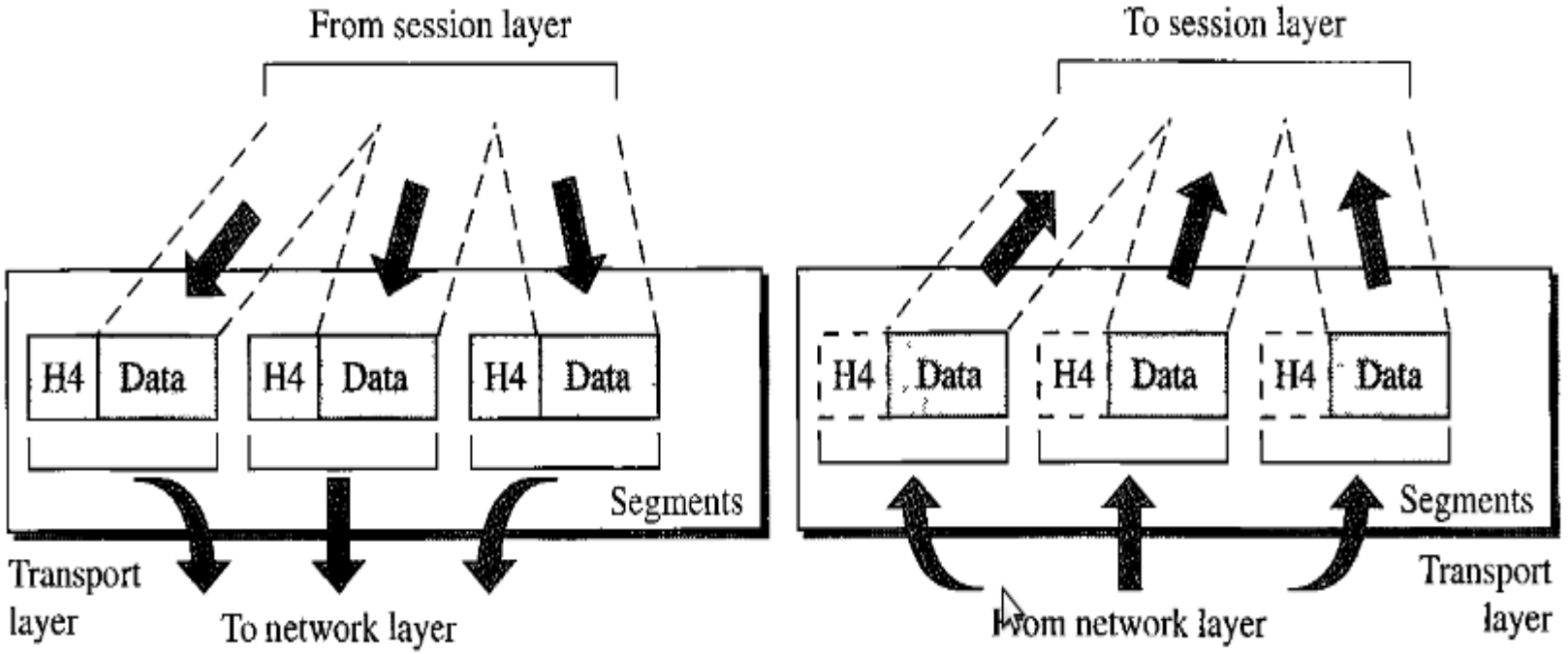
[3]Network Layer (4)



[5]Transport Layer (1)

- Responsible for process-to-process delivery
- Ensures that the whole message arrives intact and in order

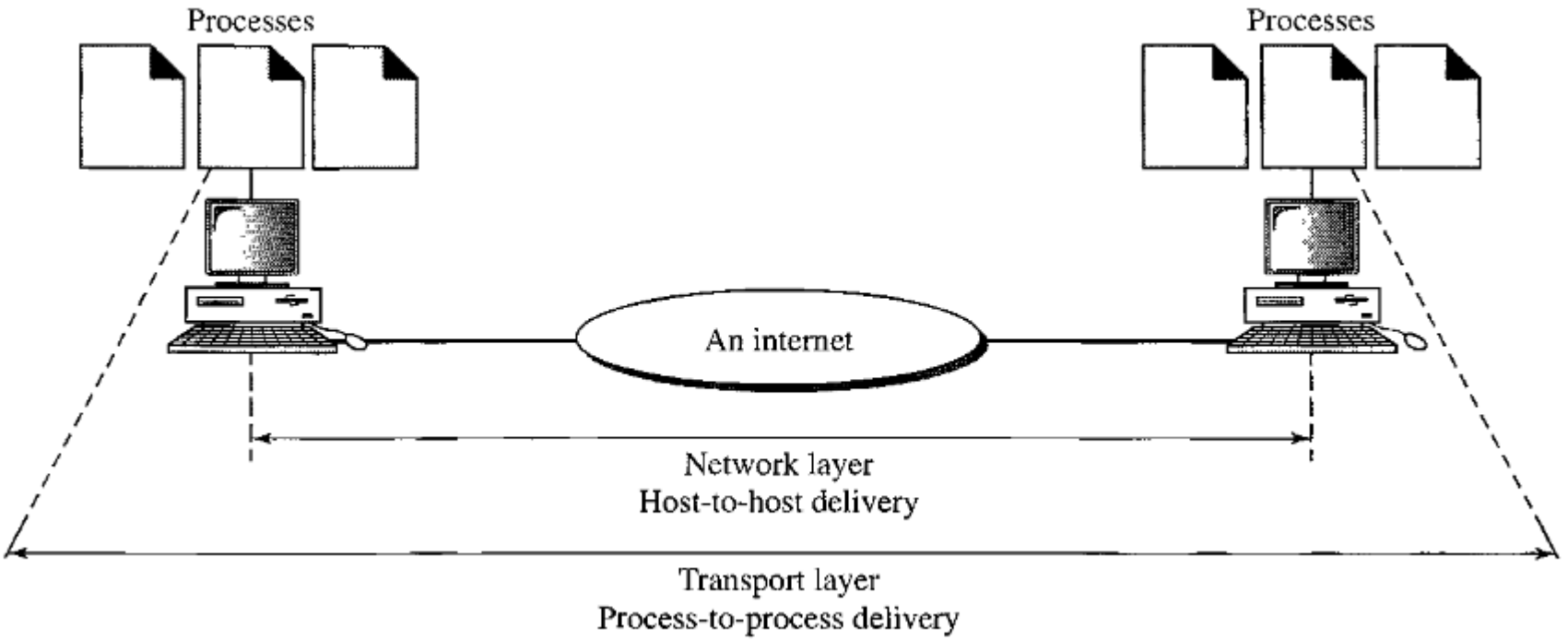
[5]Transport Layer (2)



[5]Transport Layer (3)

- Service-point addressing – several programs (entities) can use the network, uses ports
- Segmentation and reassembly – message divided into transmittable segments (uses sequence numbers)
- Connection control – maybe connectionless or connection-oriented
- Flow control – end-to-end flow control rather than a single link
- Error control – process-to-process flow control rather than single link

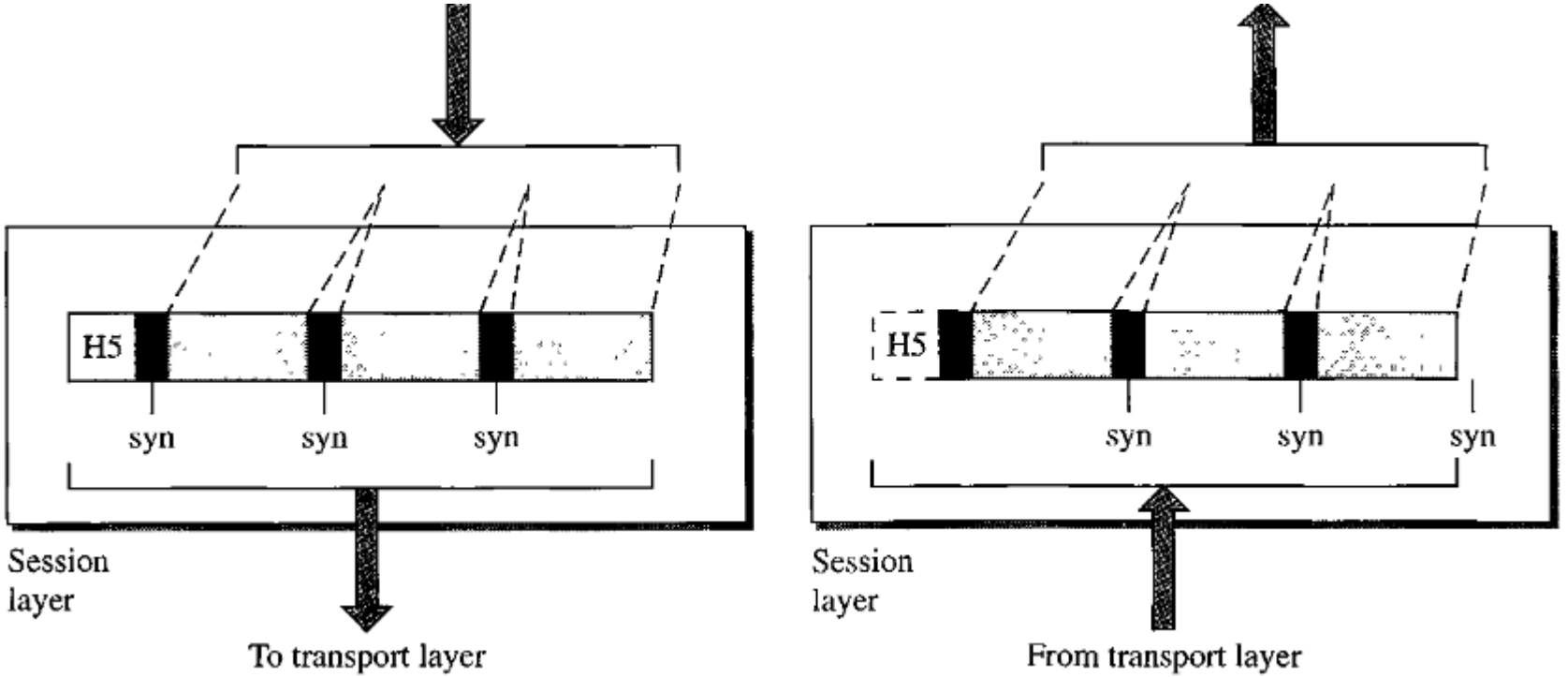
[5]Transport Layer (4)



[5]Session Layer (1)

- Network dialog controller
- Establishes, maintains, and synchronizes interactions among communicating systems
- Dialog control – dialog between two systems
- Synchronization – add checkpoints (similar to databases)

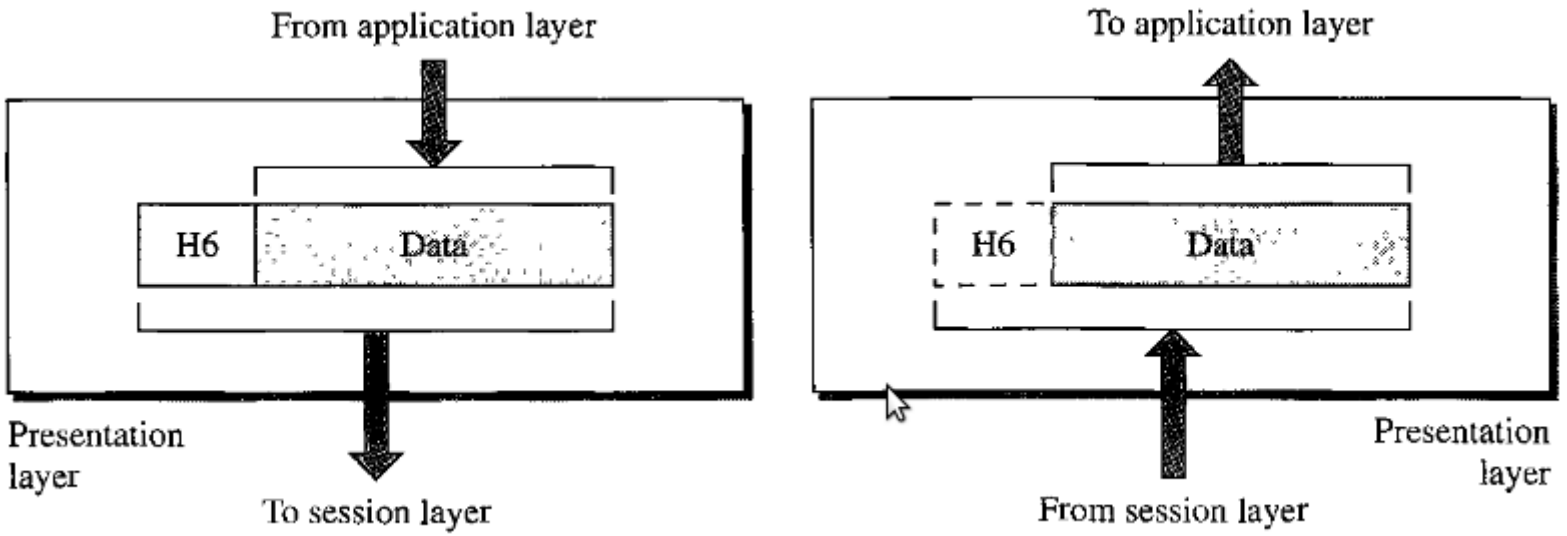
[5]Session Layer (2)



[6]Presentation (1)

- Concerned with the syntax and semantics of the information exchanged between two systems
- Translation – apply encoding schemes
- Encryption – provides privacy
- Compression – reduce the number of bits contained in the information

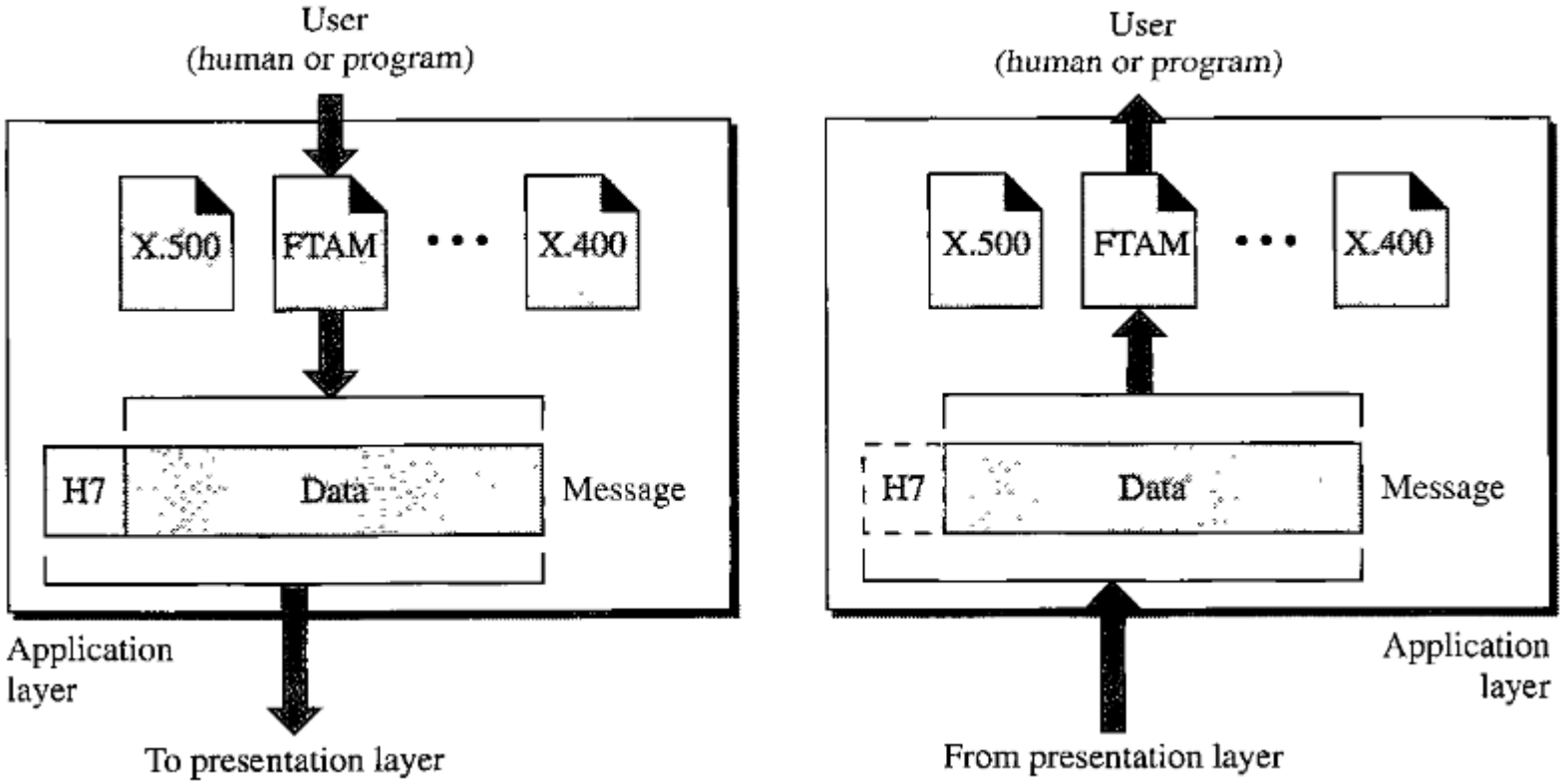
[6]Presentation (2)



[7]Application Layer (1)

- Enables the user (human or software) to access the network
- Provides user interfaces and support services: email, remote file access and transfer, shared DBM, distributed information services

[7]Application Layer (2)



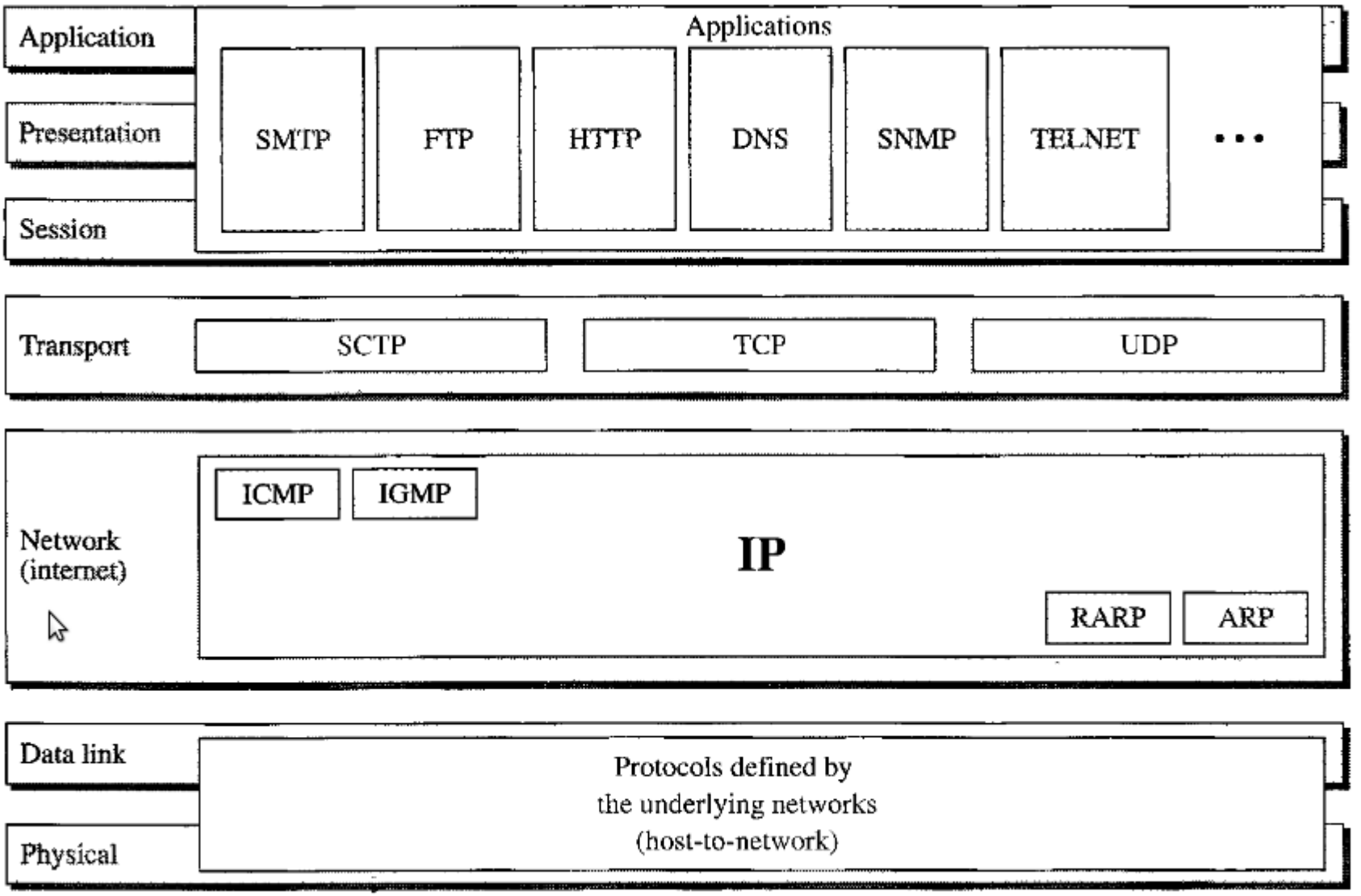
[7]Application Layer (3)

- Network virtual terminal – software version of a software terminal
- File transfer, access, and management – access files remotely
- Mail services – email forwarding and storage
- Directory services – distributed database sources

TCP/IP PROTOCOL SUITE (1)

- Developed prior to the OSI model
- Originally defined as having four layers: host-to-host, internet, transport, application
- DCN views it as having five layers: physical, data link, network, transport, application
- Hierarchical protocol made up of interactive modules – upper-level protocol is supported by one or more lower-level protocols

TCP/IP PROTOCOL SUITE (2)



TCP/IP: Physical and Data Link

- Does not define any specific protocol
- Supports all standard and proprietary protocols
- May be LAN or WAN

TCP/IP: Network Layer (1)

- Internet Protocol (IP)
  - unreliable and connectionless, best-effort delivery
  - Packets are called datagrams
  - Can follow different paths and arrive out of sequence or be duplicated
  - Limited functionality is not a weakness: provides bare-bones transmission functions (efficiency)

TCP/IP: Network Layer (2)

- Address Resolution Protocol (ARP)
  - Associates a logical address with a physical address
  - Used to find the physical address of the node when its Internet address is known
- Reverse Address Resolution Protocol (RARP)
  - Used to find the Internet address given the physical address
  - Used when a computer is connected to a network for the first time or when a diskless computer is booted

TCP/IP: Network Layer (3)

- Internet Control Message Protocol (ICMP)
  - Used by hosts and gateways to send notification of datagram problems back to sender
  - Sends query and reporting messages (the “ping” command uses ICMP)
- Internet Group Message Protocol (IGMP)
  - Facilitates simultaneous transmission of a message to a group of recipients

TCP/IP: Transport Layer (4)

- IP is host-to-host, UDP andTCP are process-to-process
- User Datagram Protocol (UDP)
  - Adds only port addresses, checksum error control, and length information
  - Connectionless, unreliable
- Transmission Control Protocol (TCP)
  - Provides full transport-layer services
  - Connection-oriented, reliable stream transport
  - Streams are divided into segments with sequence numbers
- Stream Control Transmission Protocol (SCTP) – best of TCP and UDP, VoIP

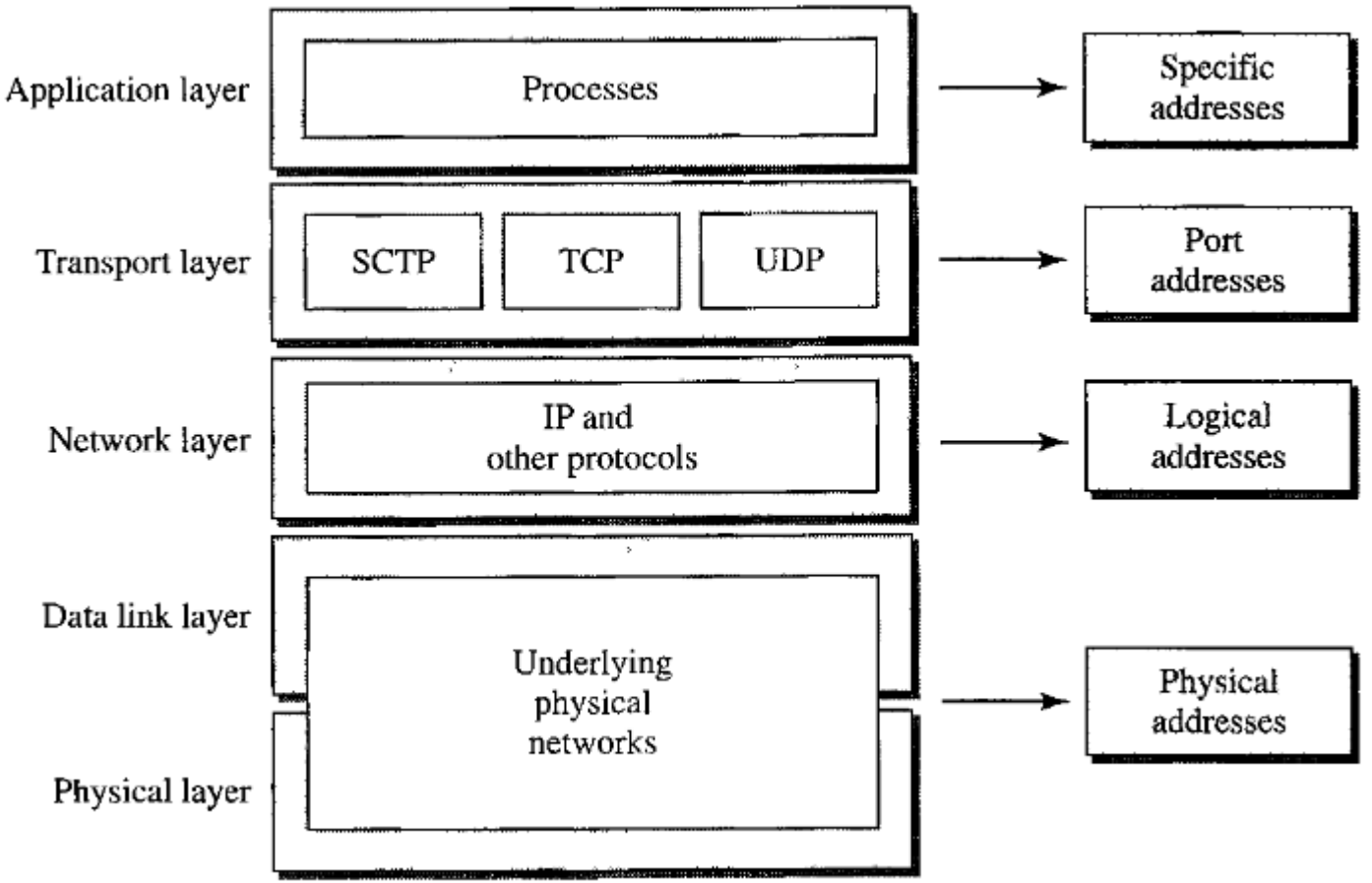
TCP/IP: Application Layer

- Combined Session, Presentation, and Application layers in the OSI model

TCP/IP ADDRESSES

- Physical (link) addresses
- Logical (IP) addresses
- Port addresses
- Specific addresses

TCP/IP ADDRESSES

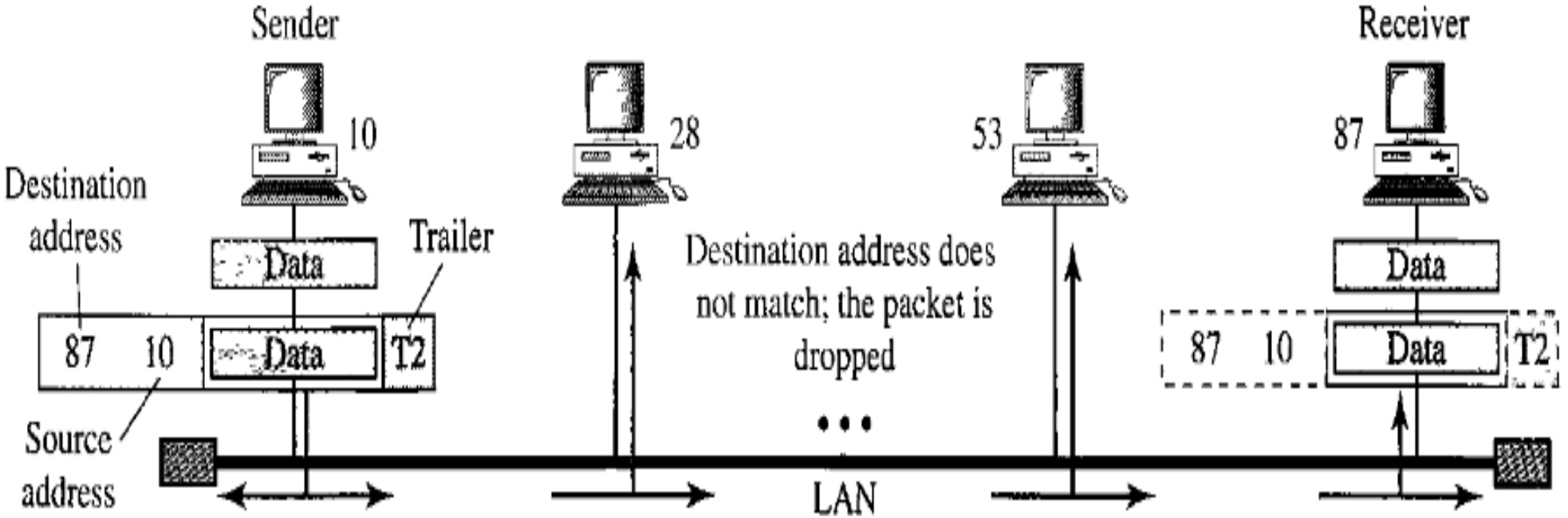


Physical Addresses (1)

- Lowest-level address defined by a node's LAN or WAN
- Size and format varies depending on network
  - Example: Ethernet uses 6-byte physical addresses written as 12 hexadecimal digits separated by a colon
    - 68:a3:c4:ce:8c:e2

Physical Addresses (2)

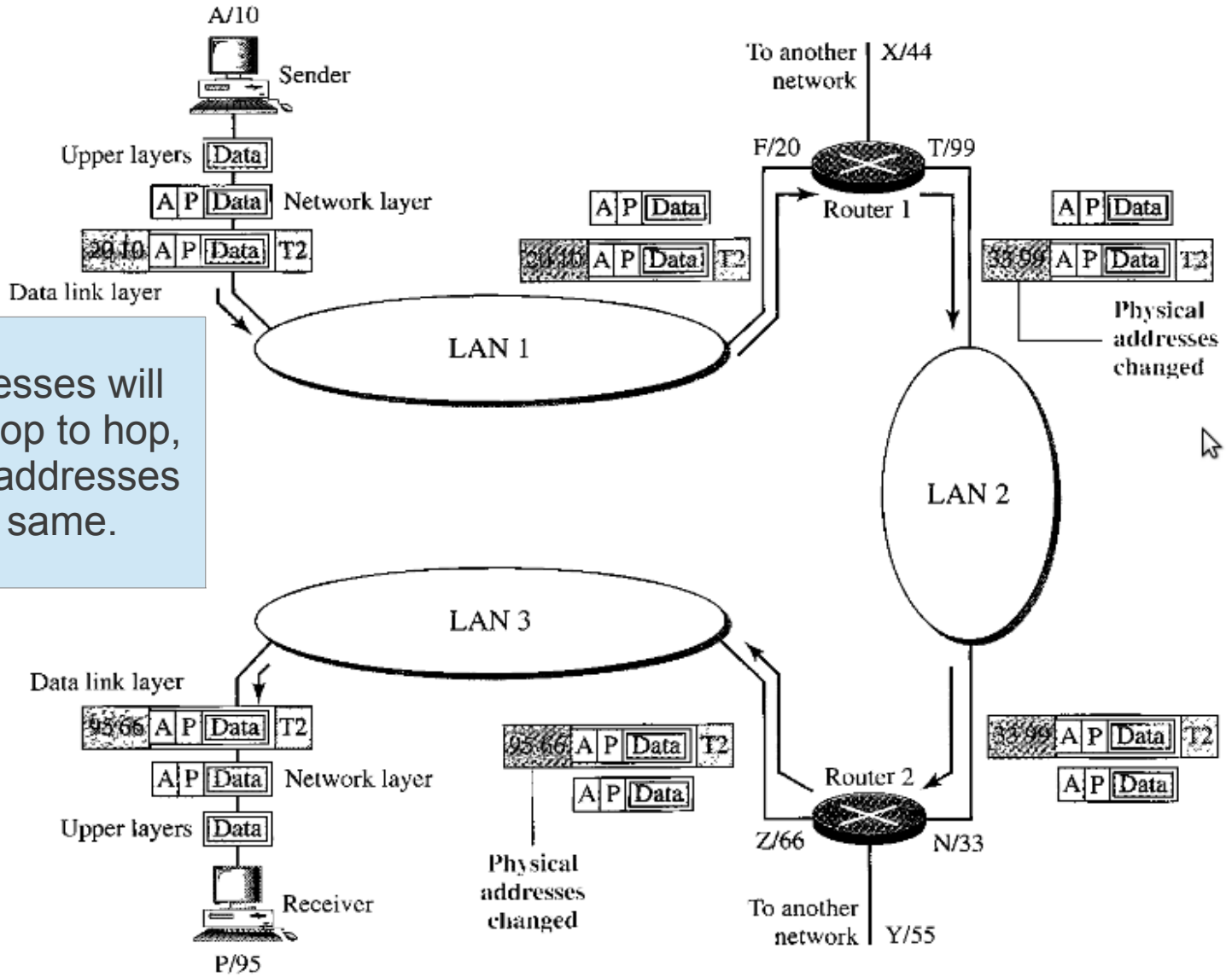
- Example



Logical Addresses

- Necessary for universal communications – internetworks
- Internet (IP) address is 32 bits
- No two publicly addressed and visible host on the Internet can have the same IP address

Logical Addresses (2)

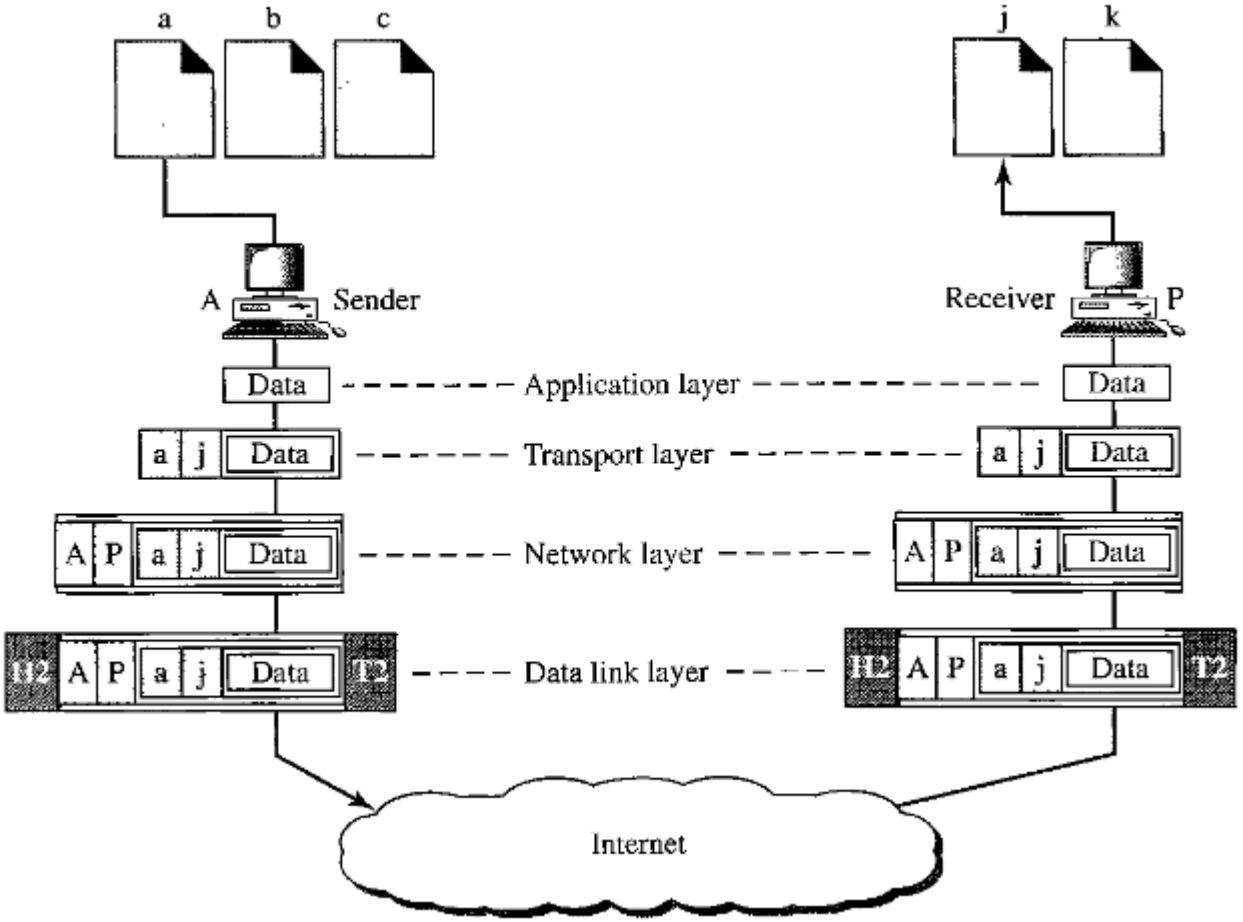


Physical addresses will change from hop to hop, but the logical addresses remain the same.

Port Addresses (1)

- Ultimate objective of Internet communication is a process communicating with another (peer) process running on a remote computer
- TCP/IP Port address – assigned to a process, 16 bits
  - Examples: 80, 23, 22, 21, 8080

Port Addresses (2)



Specific Addresses

- User-friendly addresses
  - Example: email addresses, URL
- Changed to corresponding port and logical addresses

Enjoy! :)