4123702

Data Communications System

By

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Chapter 2 - Network Models

Network Models

- Networks require a combination of hardware and software to send data from one location to another
- To make communications efficient, many components are involved, each with a specific function or service

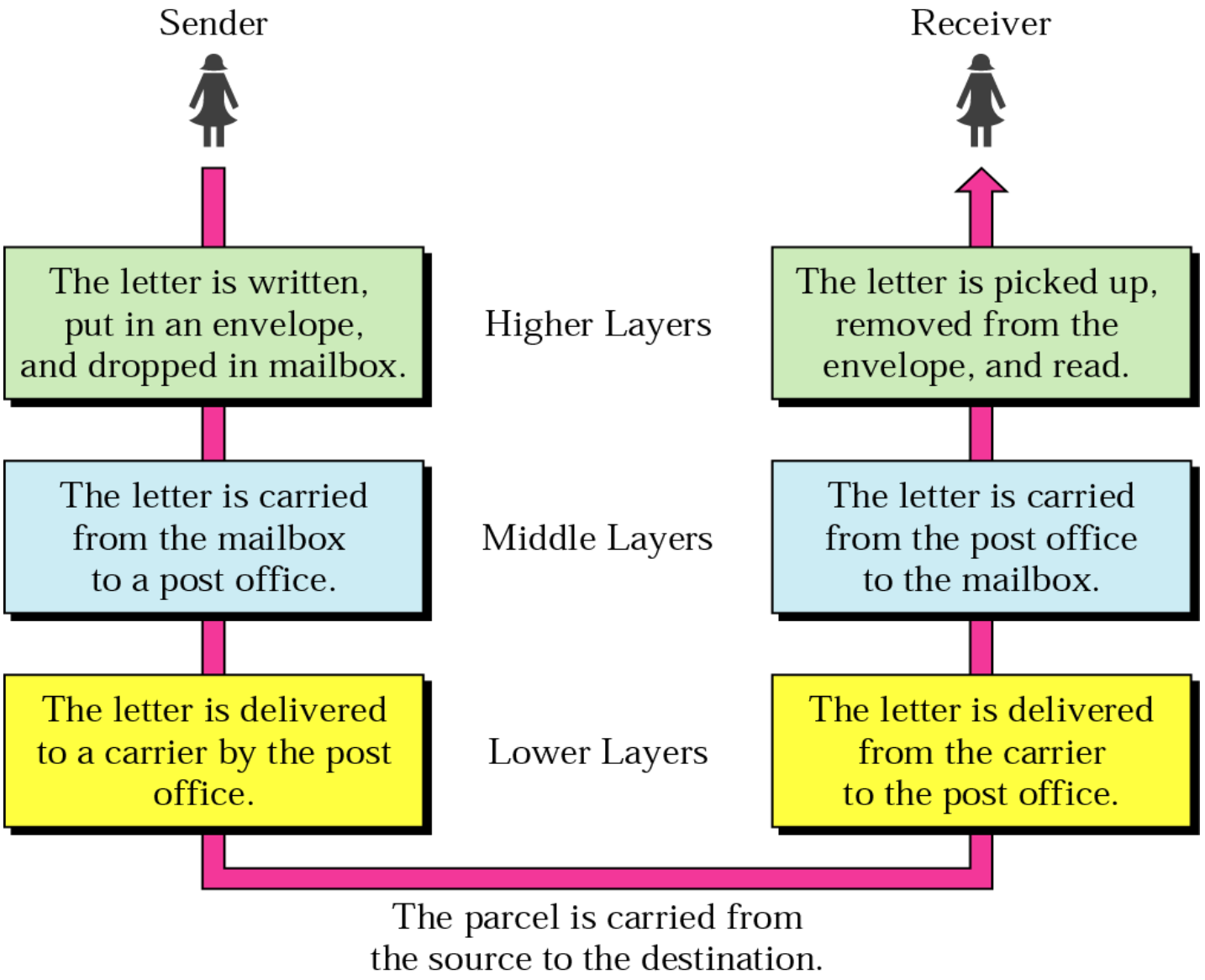
Layered Tasks

- Hierarchy
  - The complex task is broken into smaller subtasks
- Services
  - The higher layer uses the services of the lower layer

Example of Person-to-person communication

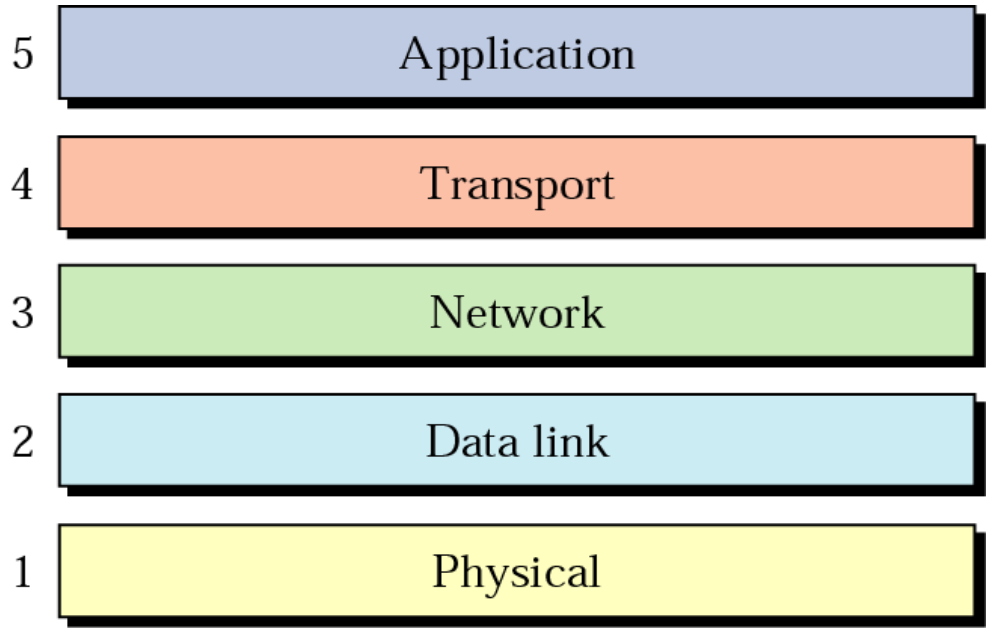
- Cognitive : Defines purpose of message exchange
- Linguistic : Provides common language
- Physical : Physically transmits information between users

Example of Sending a letter



Internet Model

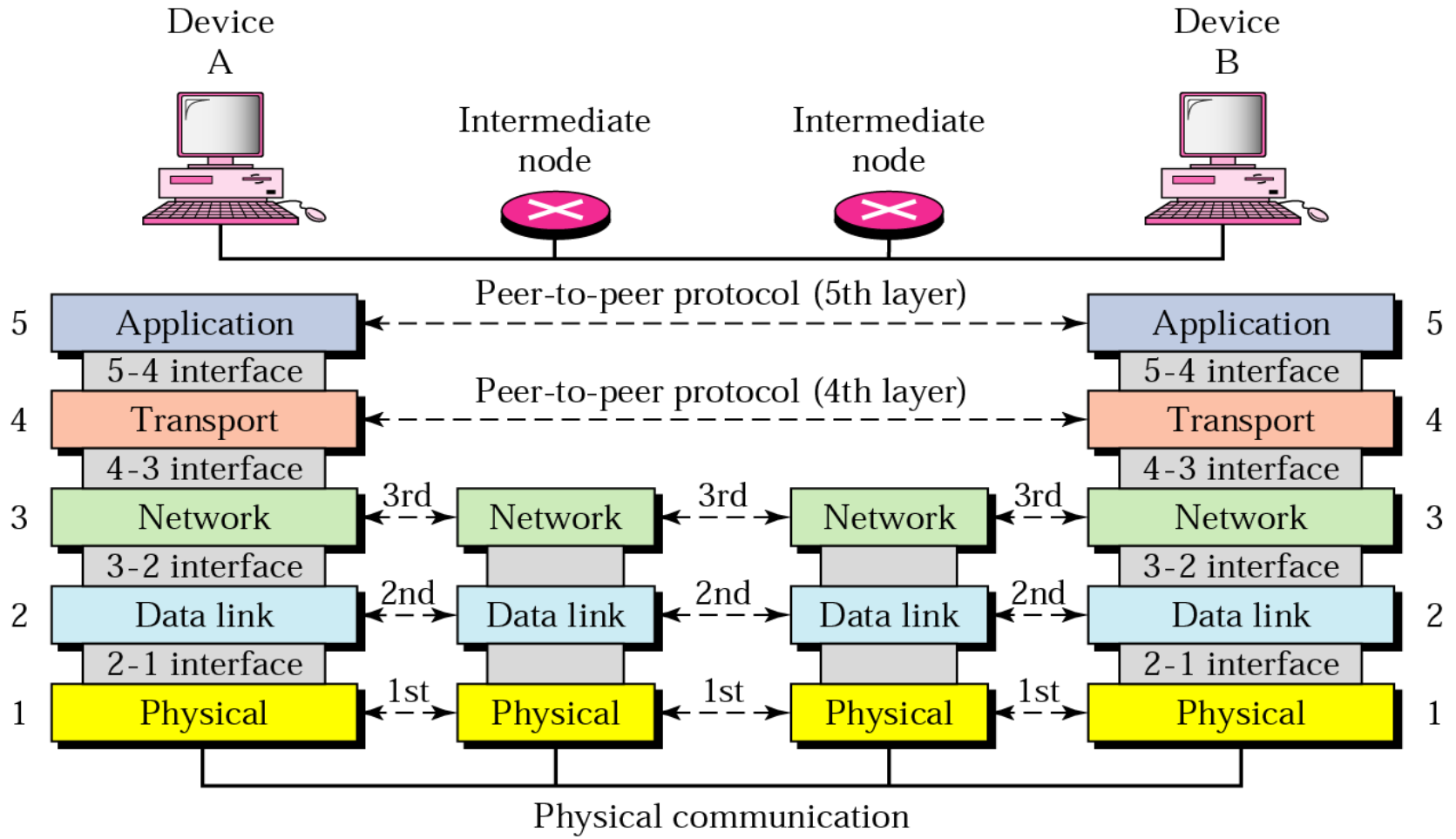
- Dominant model in data communications and networking
- 5 ordered layers; often referred to as TCP/IP protocol suite



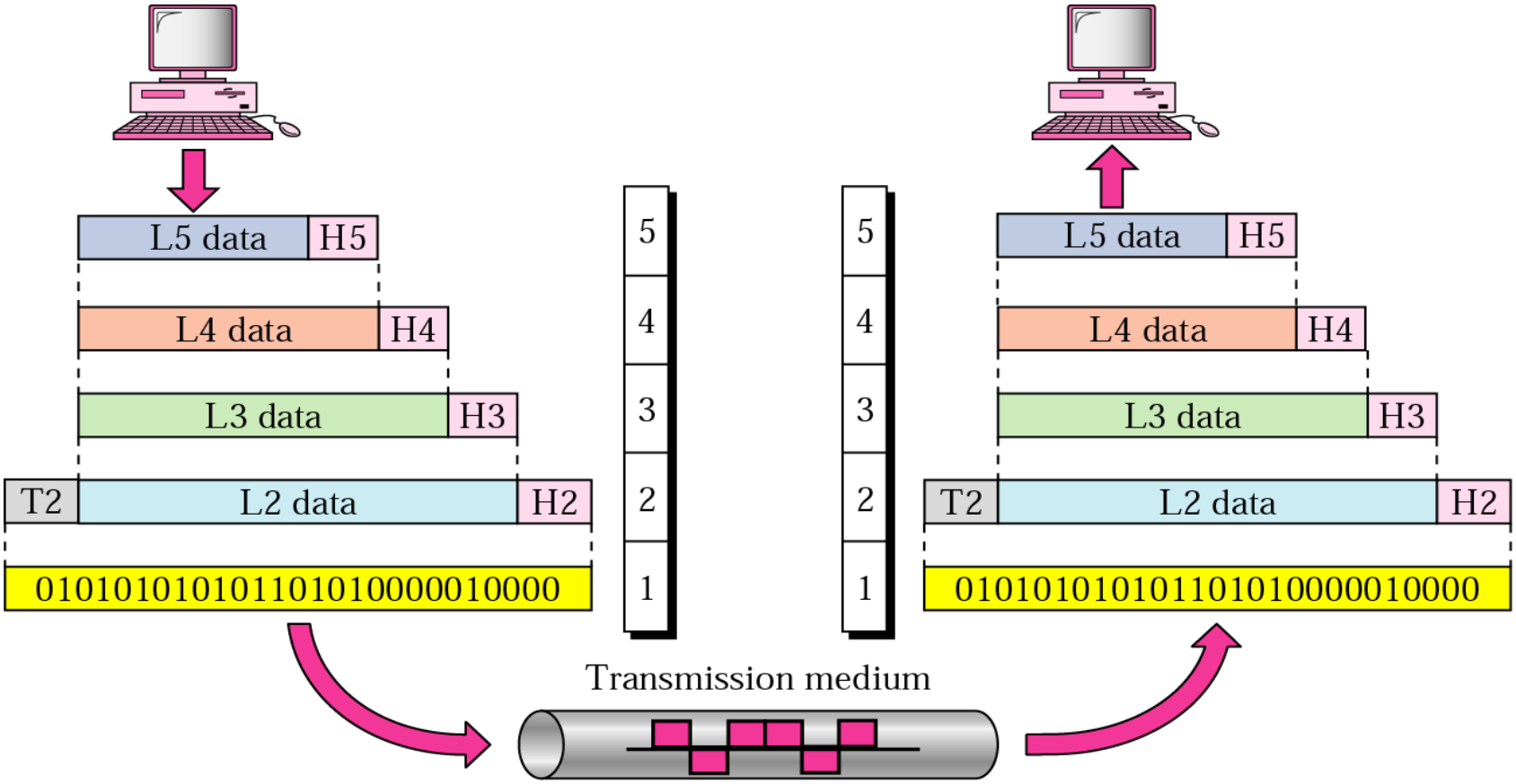
Internet Model Layers

- Each layer defines distinct functions
- Each layer calls services of layer just below and provides services to layer just above
- Between machines, corresponding layers communicate (i.e. network to network; transport to transport, etc.) are called peer-to-peer processes
- This communication is governed by protocols

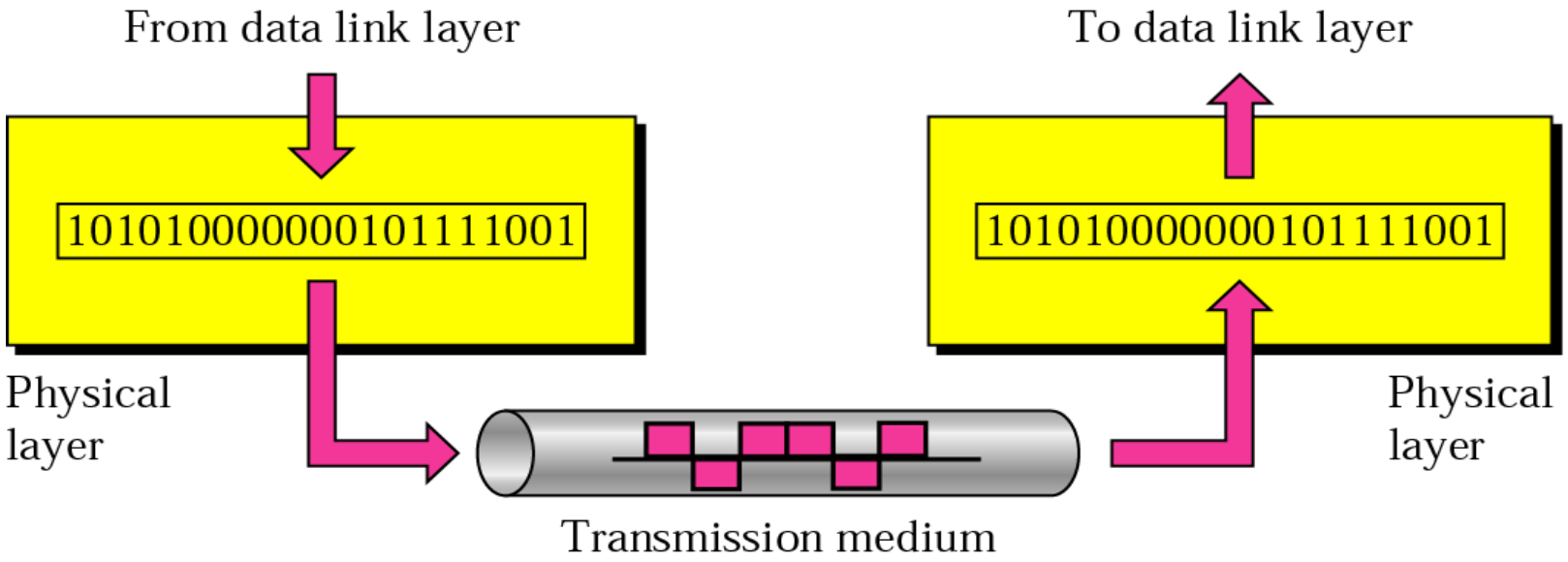
Peer-to-Peer Process



Data Exchange Between Two Devices



Physical layer



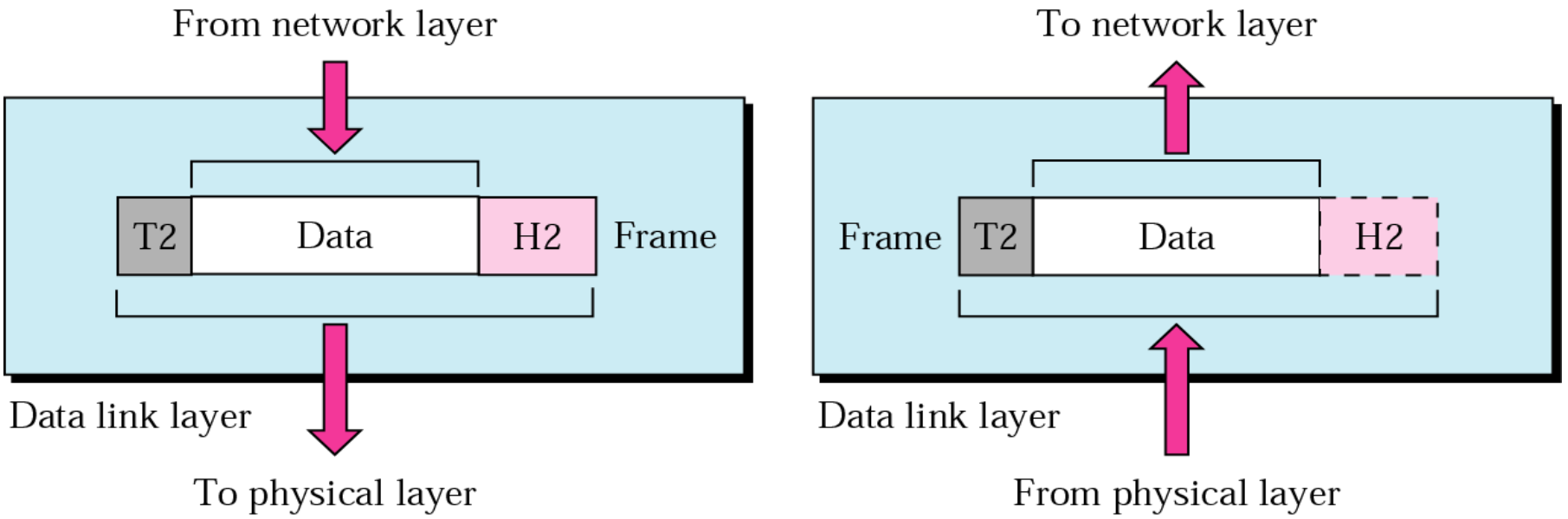
Physical Layer Responsibilities

- Physical characteristics of interfaces and media
- Representation of bits without interpretation
- Data rate: number of bits per second
- Synchronization of bits

Note:

The physical layer is responsible for transmitting individual bits from one node to the next.

Data link layer



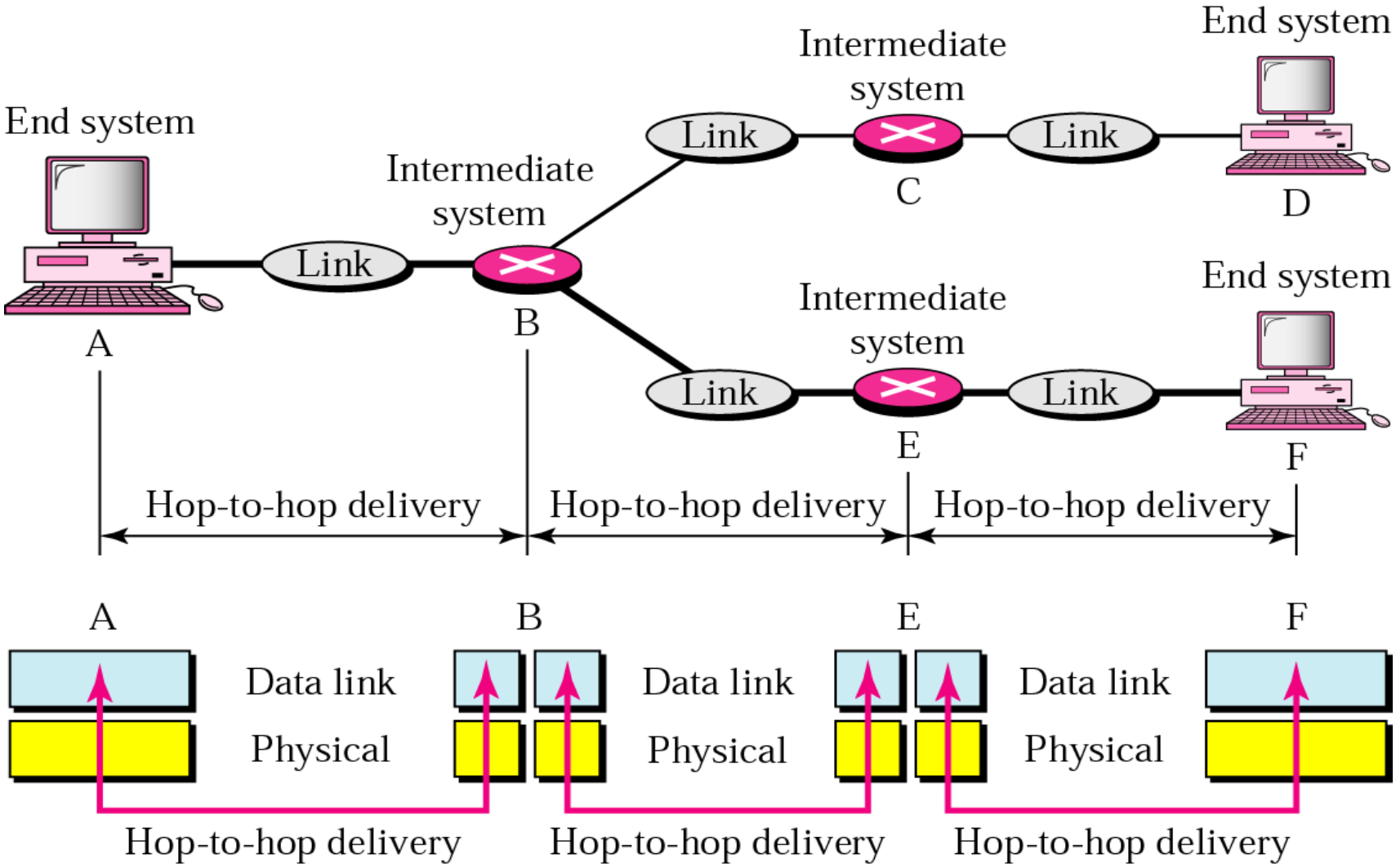
Data Link Layer Responsibilities

- Defines frames into manageable data units
- Physical addressing
- Flow control
- Error control
- Access control

Note:

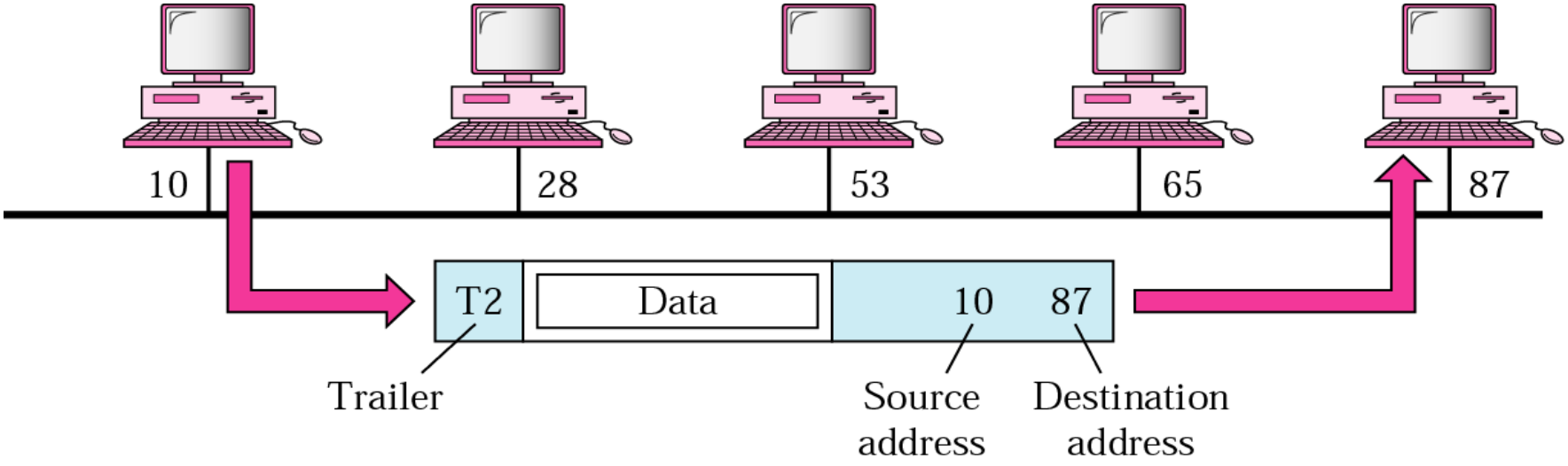
The data link layer is responsible for transmitting frames from one node to the next.

Node-to-node delivery

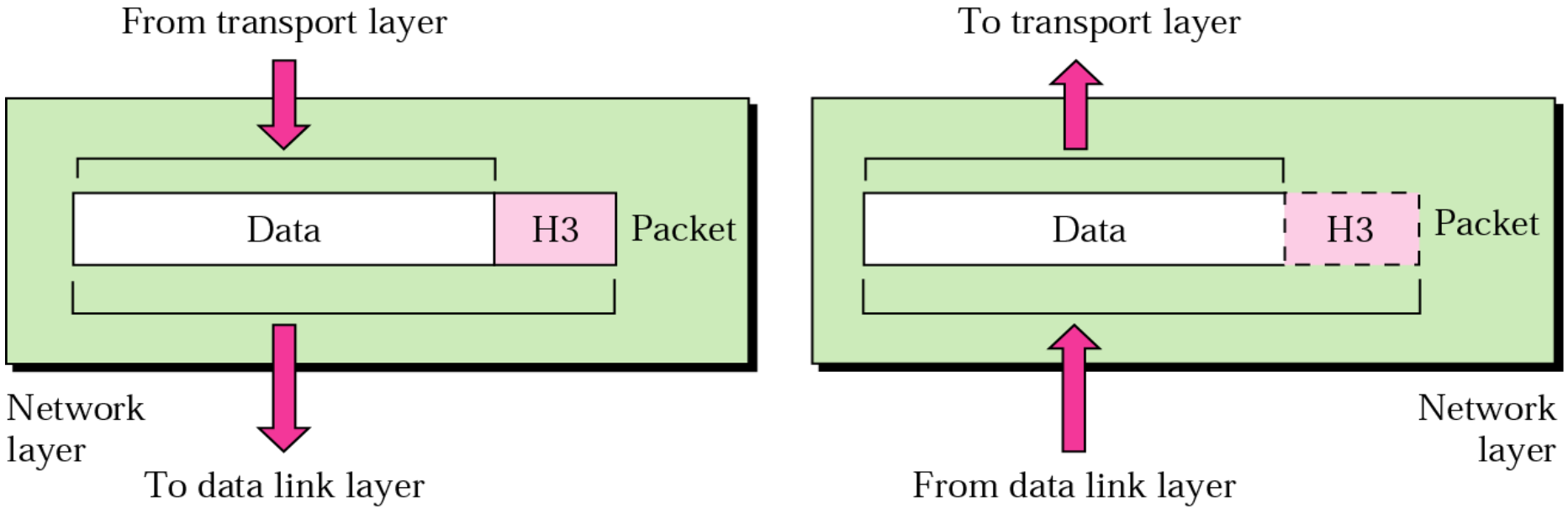


Example 1

In below figure a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link. At the data link level this frame contains physical addresses in the header. These are the only addresses needed. The rest of the header contains other information needed at this level. The trailer usually contains extra bits needed for error detection



Network layer



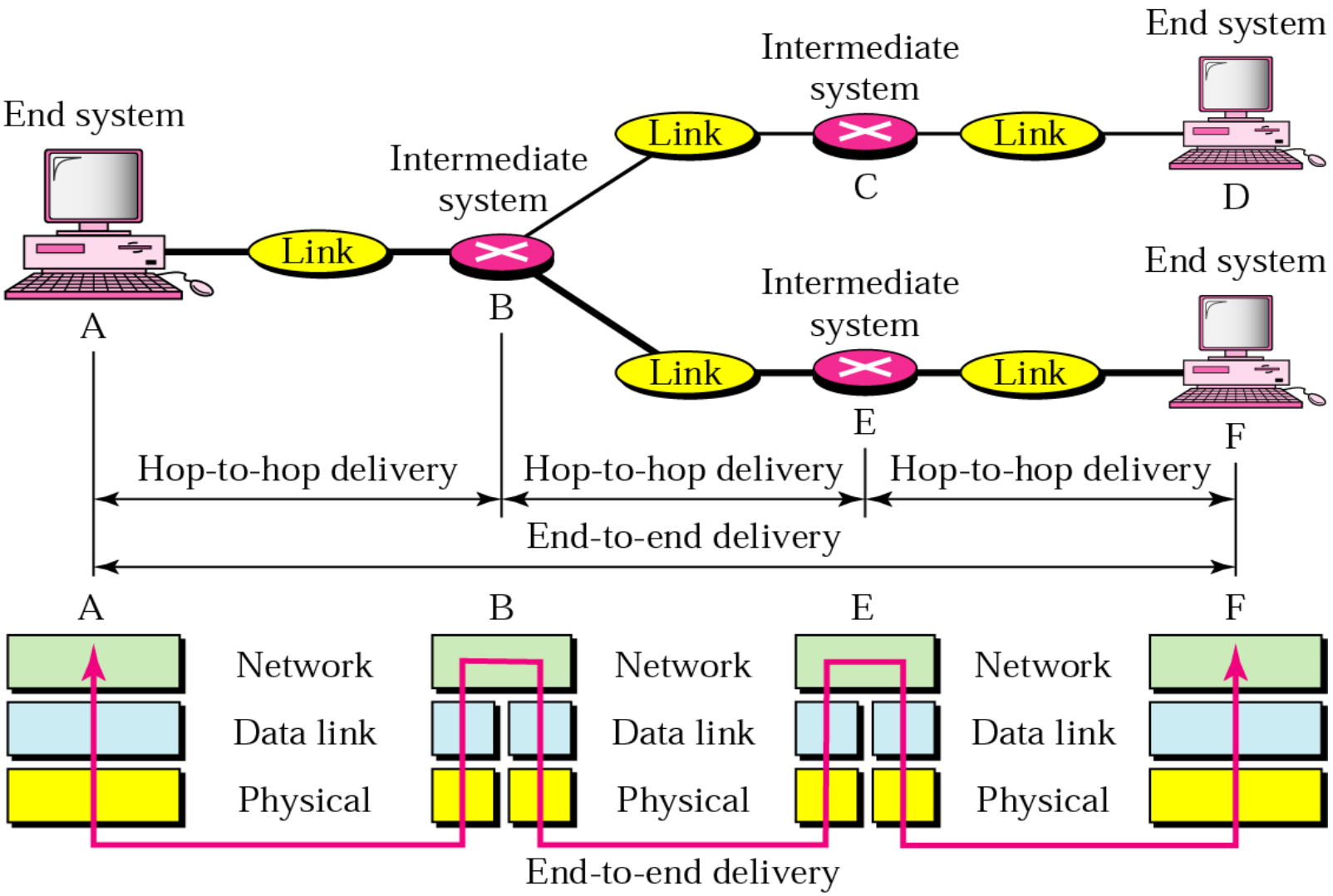
Network Layer Responsibilities

- If the two systems are attached to different networks with connecting devices between the networks, there is often a need for the network layer
- Source-to-destination delivery, possibly across multiple networks
- Logical addressing
- Routing

Note:

The network layer is responsible for the delivery of packets from the original source to the final destination.

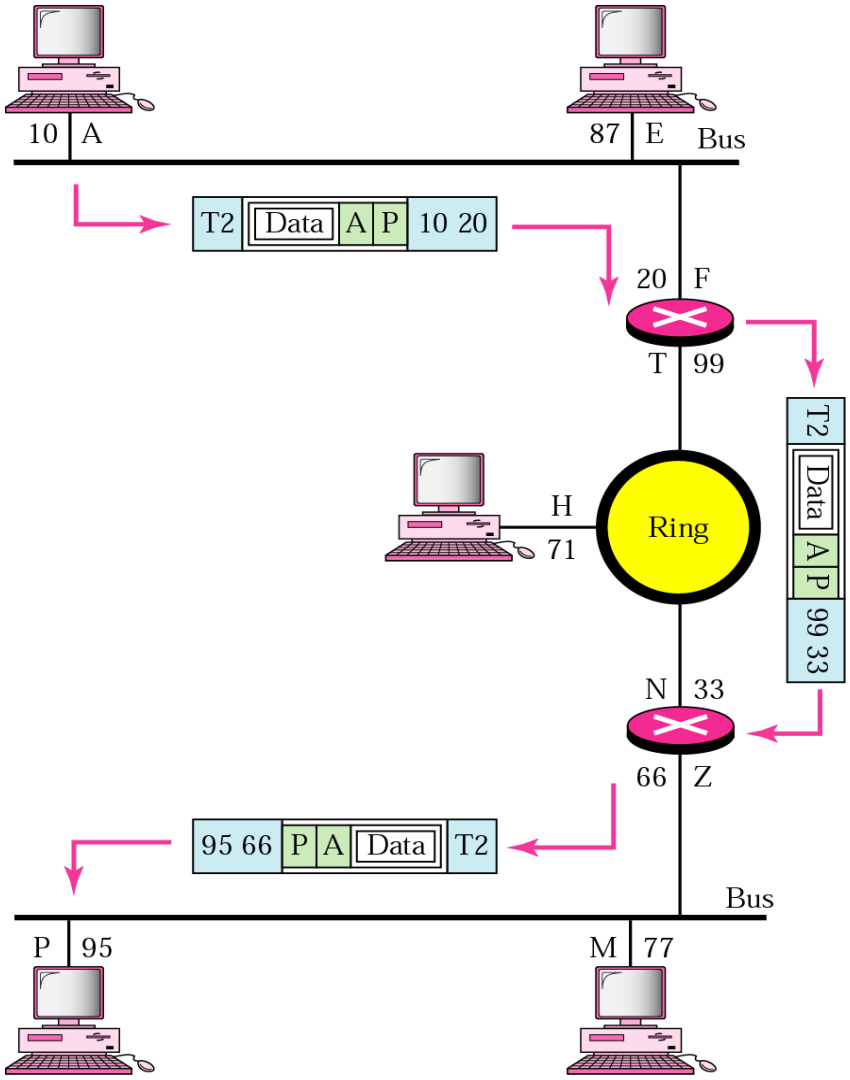
Source-to-destination delivery



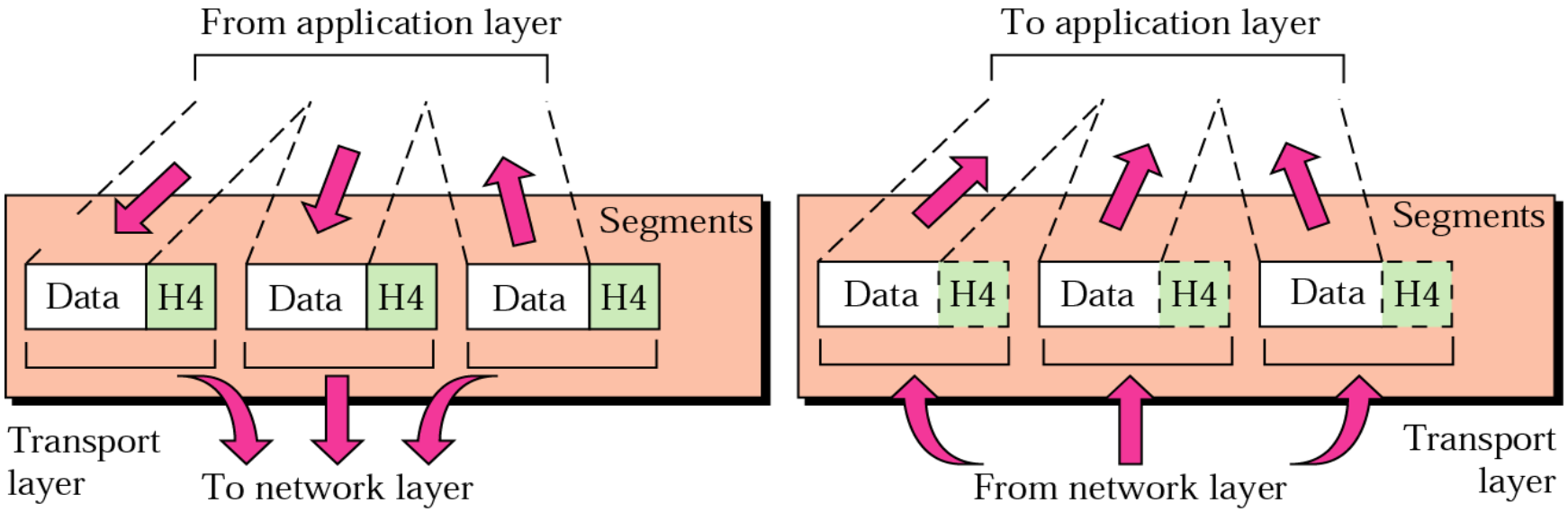
Example 2

In Figure 2.11 we want to send data from a node with *network address A* and physical address 10, located on one LAN, to a node with a *network address P* and physical address 95, located on another LAN. Because the two devices are located on different networks, we cannot use physical addresses only; the physical addresses only have local jurisdiction. What we need here are universal addresses that can pass through the LAN boundaries. The network (logical) addresses have this characteristic.

Figure 2.11 Example 2



Transport layer



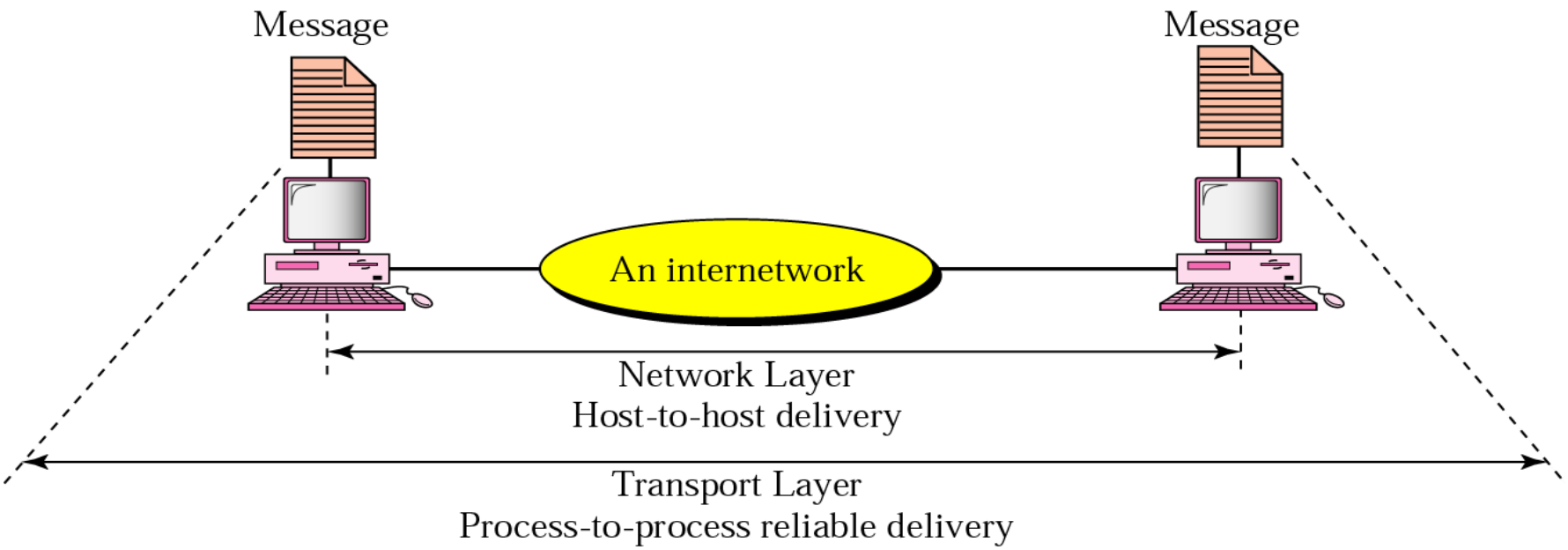
Transport Layer Responsibilities

- Process-to-process delivery of entire message
- Port addressing
- Segmentation and reassembly
- Connection control: connectionless or connection-oriented
- End-to-end flow control
- End-to-end error control

Note:

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

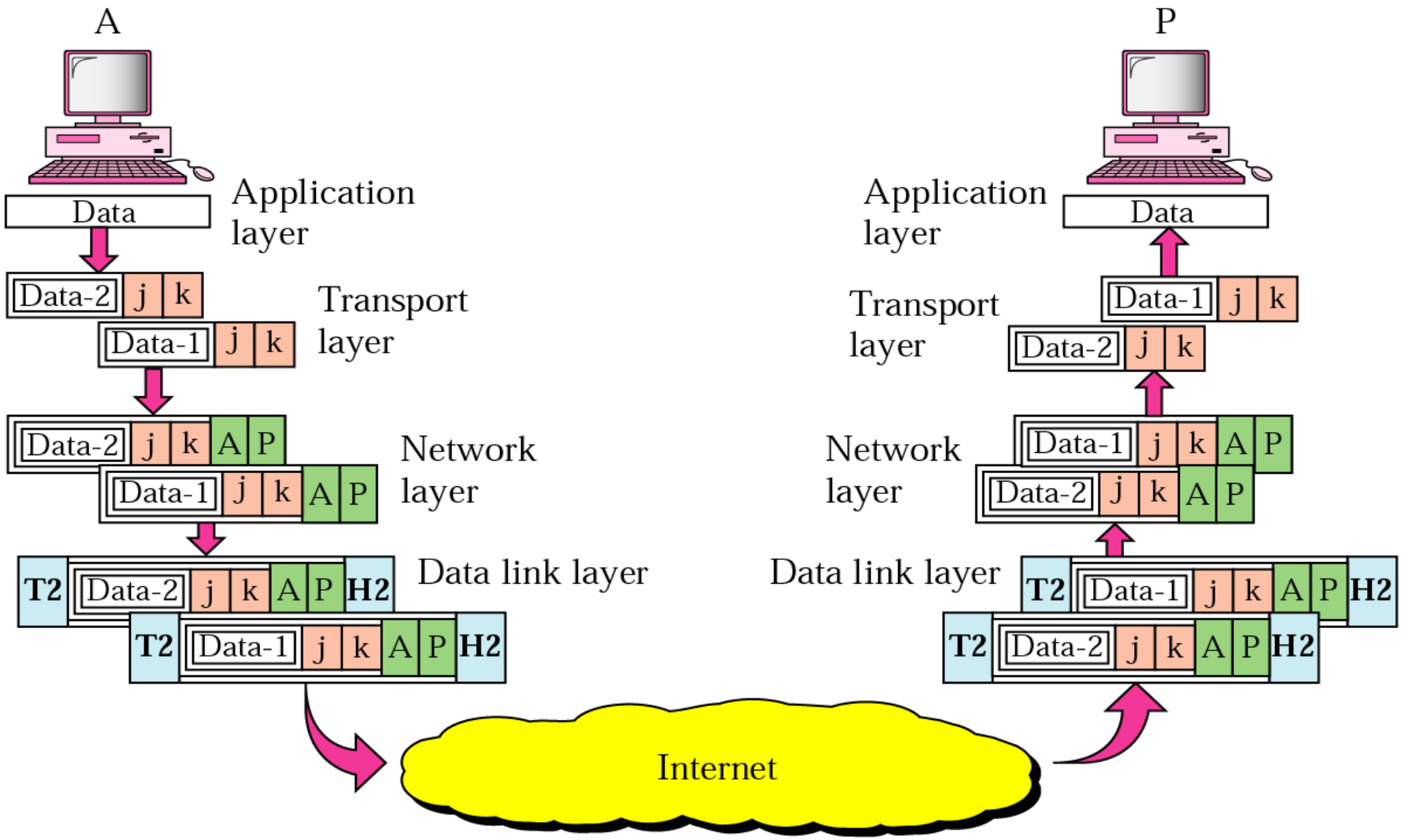
Reliable process-to-process delivery of a message



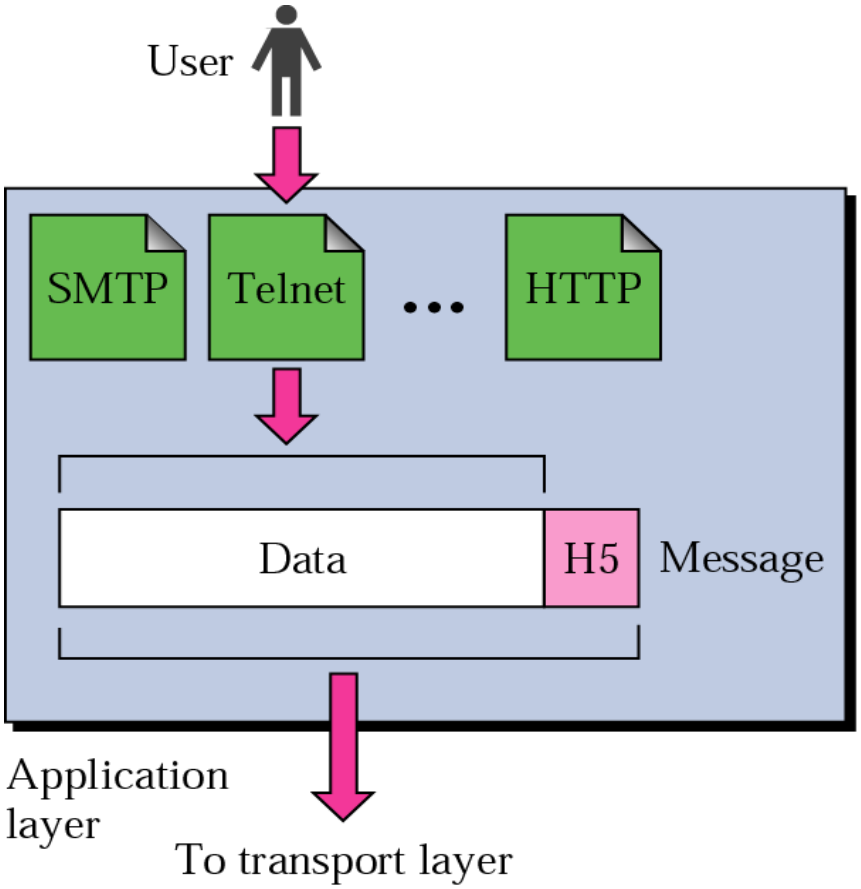
Example 3

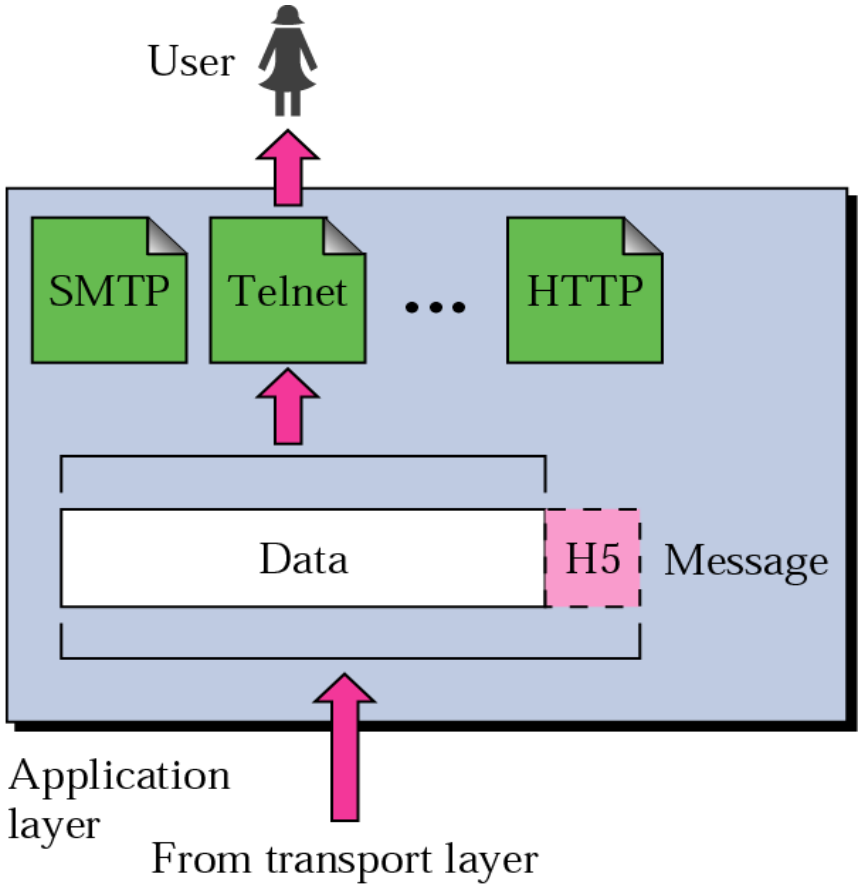
Figure 2.14 shows an example of transport layer communication. Data coming from the upper layers have port addresses j and k (j is the address of the sending process, and k is the address of the receiving process). Since the data size is larger than the network layer can handle, the data are split into two packets, each packet retaining the port addresses (j and k). Then in the network layer, network addresses (A and P) are added to each packet.

Figure 2.14 Example 3



Application layer





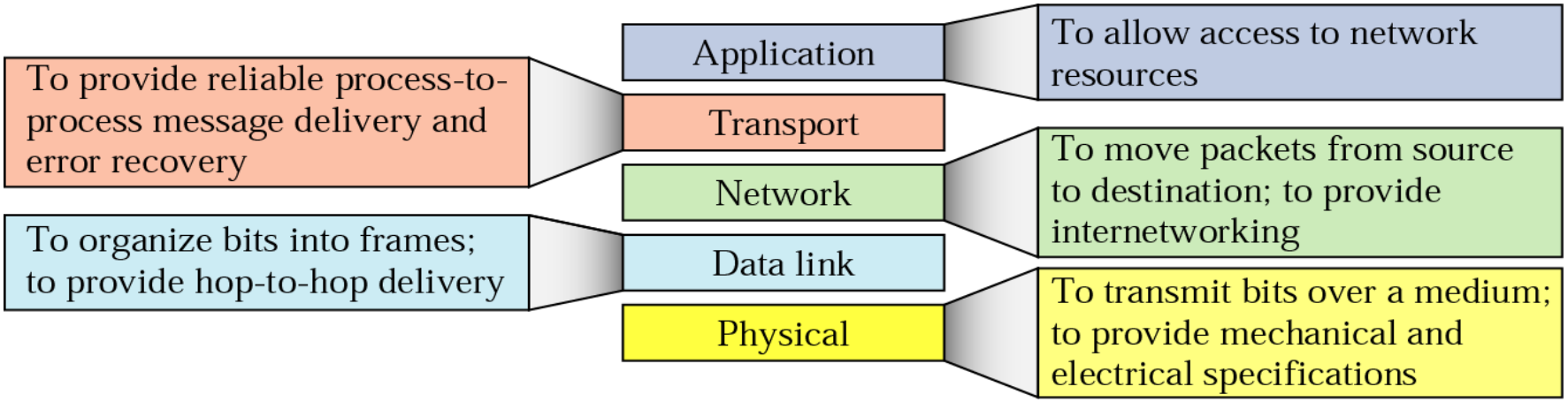
Application Layer Responsibilities

- Enables user access to the network
- User interfaces and support for services such as
  - E-Mail
  - File transfer and access
  - Remote log-in
  - WWW

Note:

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

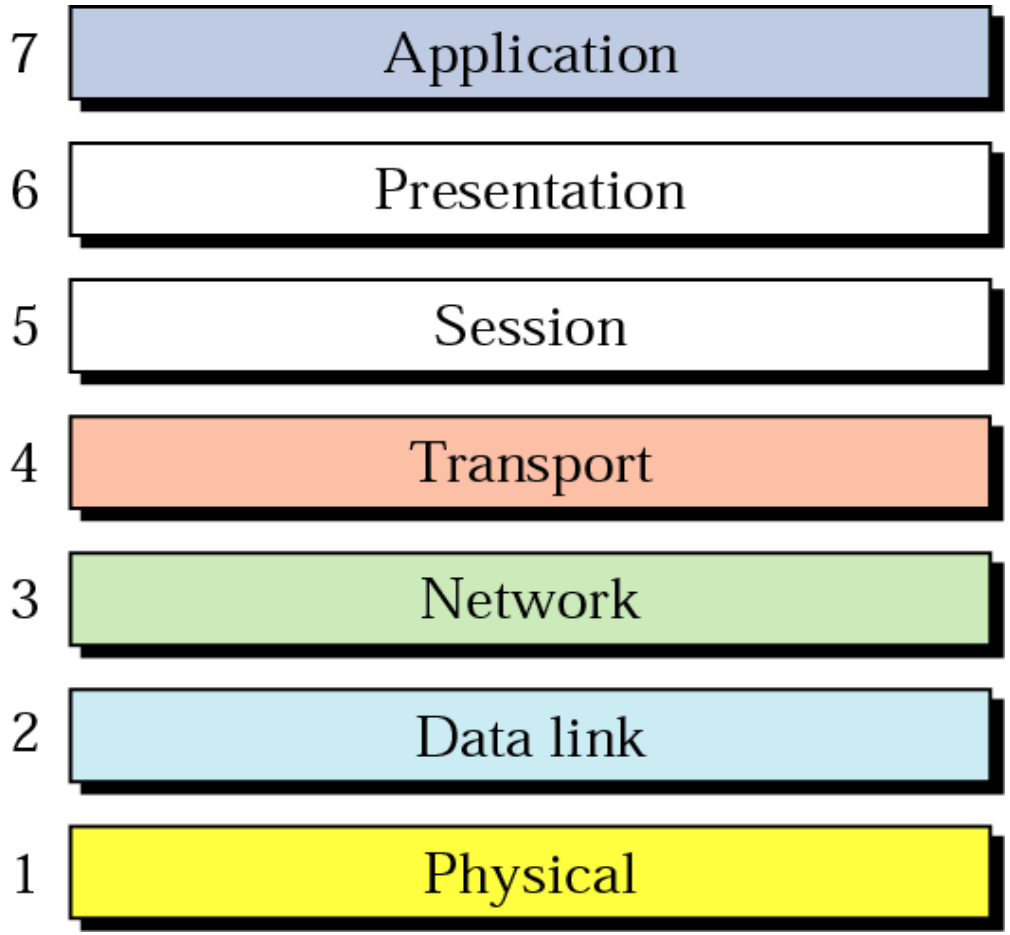
Summary of duties



OSI Model

- Open Systems Interconnection model
- 7 layer theoretical model of how a protocol stack should be implemented

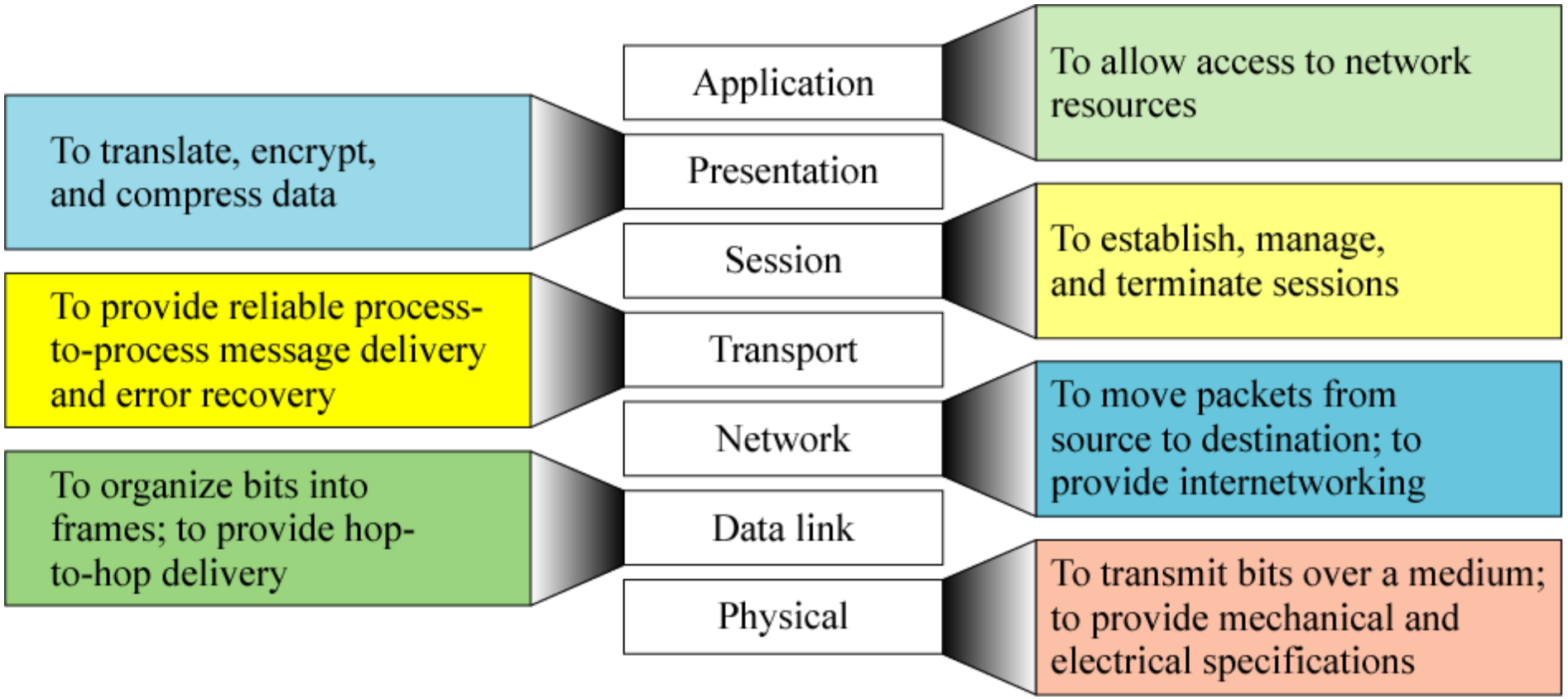
OSI model


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

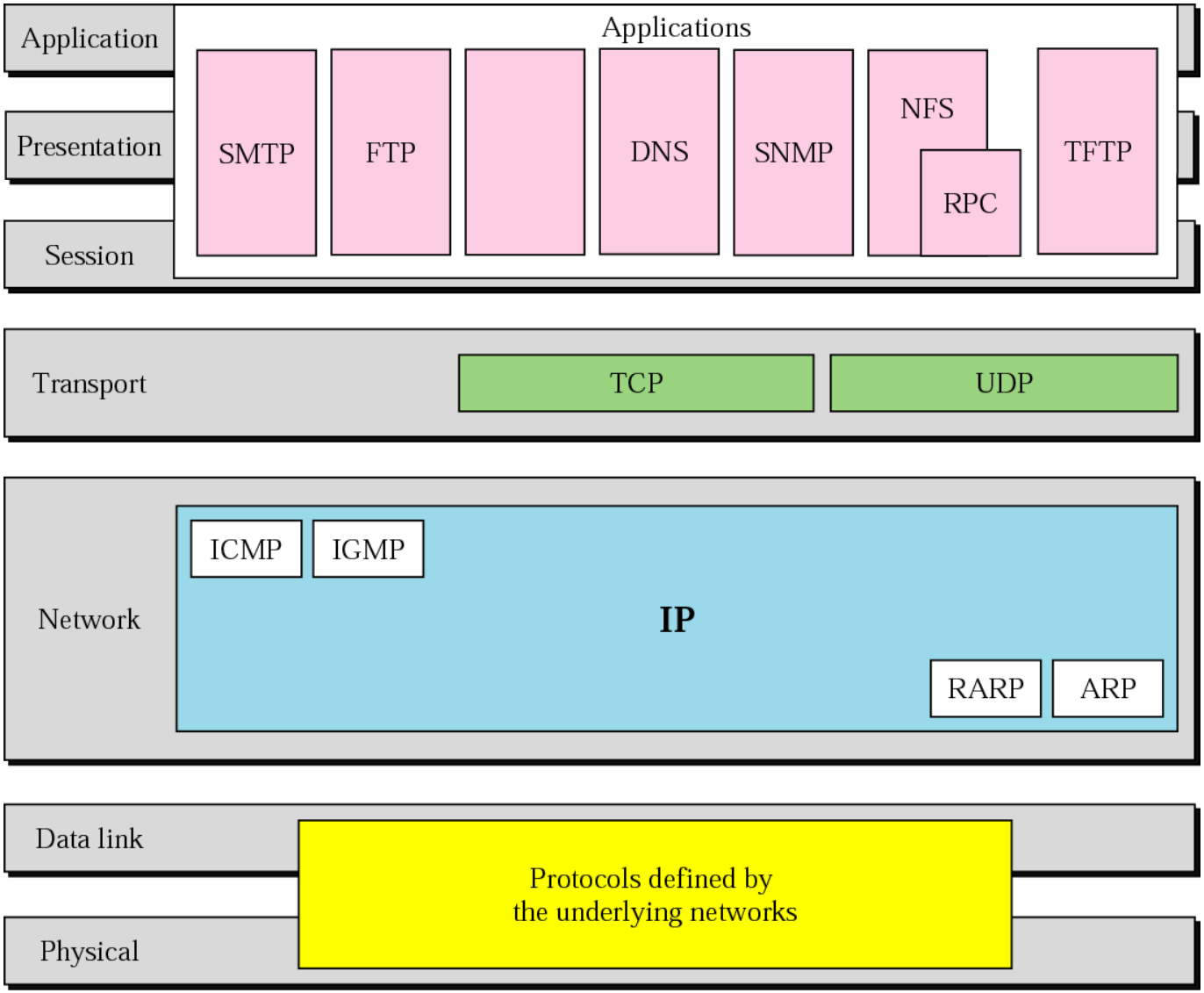
OSI model define two extra layers

- Session layer: network dialog controller; establish, maintain, and synchronize communications between systems
- Presentation layer: To handle the syntax and semantics of the information exchange between the two systems.
  - data translation
  - encryption/decryption
  - compression
- These duties are often handled by other layers now, hence the Internet model

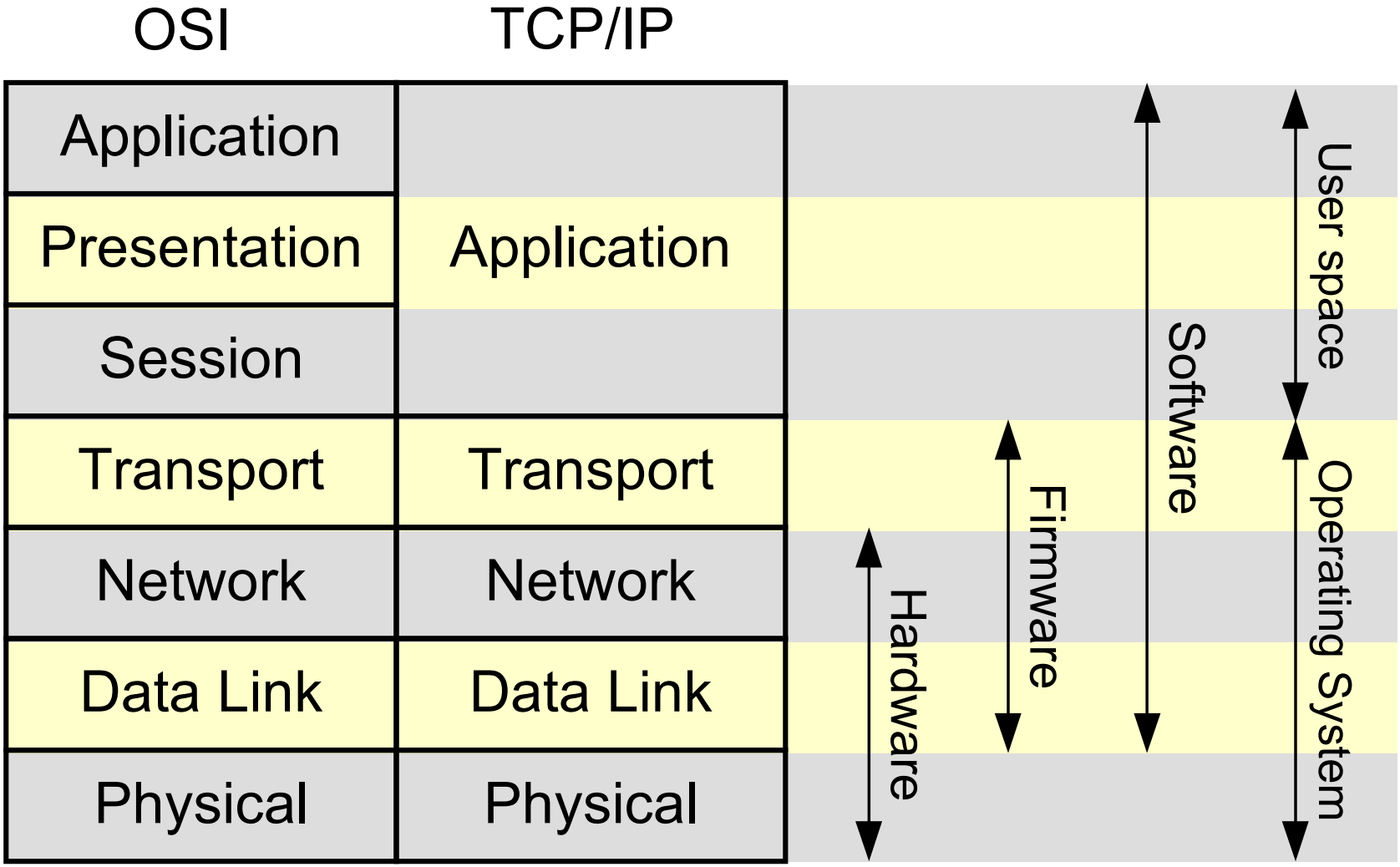
Summary of OSI model



TCP/IP and OSI model



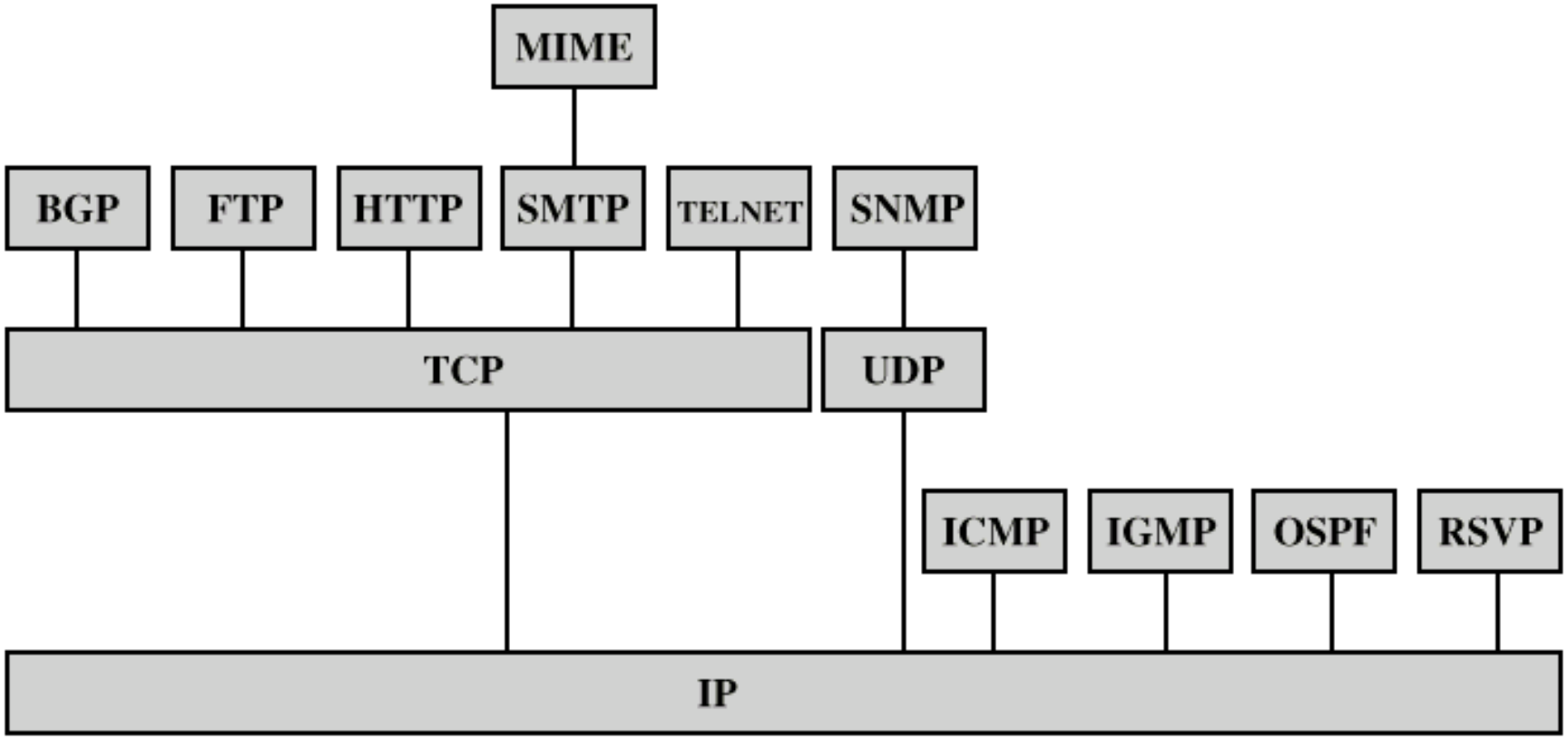
OSI vs TCP/IP


OSI
TCP/IP
Application
Presentation
Session
Transport
Network
Data Link
Physical
Application
Transport
Network
Data Link
Physical
Hardware
Firmware
Software
User space
Operating System

Some common data communications standards

Layer	Common Standards
5. Application layer	HTTP, HTML (Web) MPEG, H.323 (audio/video) IMAP, POP (e-mail)
4. Transport layer	TCP (Internet) SPX (Novell LANs)
3. Network layer	IP (Internet) IPX (Novell LANs)
2. Data link layer	Ethernet (LAN) PPP (dial-up via modem)
1. Physical layer	RS-232c cable (LAN) Category 5 twisted pair (LAN) V.92 (56 kbps modem)

Protocol Stacks

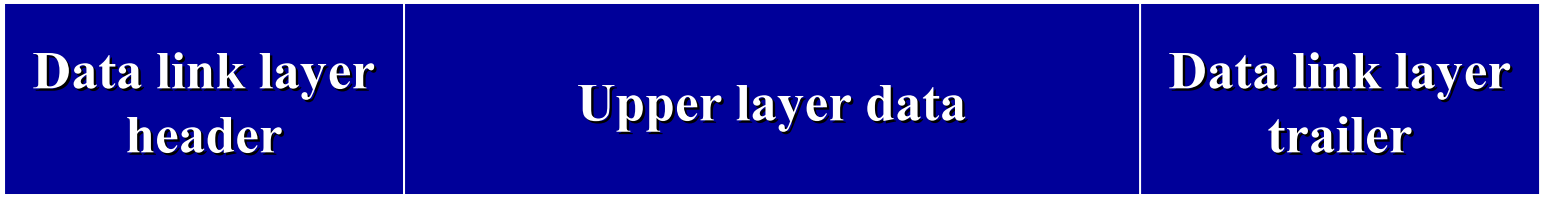


BGP = Border Gateway Protocol
FTP = File Transfer Protocol
HTTP = Hypertext Transfer Protocol
ICMP = Internet Control Message Protocol
IGMP = Internet Group Management Protocol
IP = Internet Protocol
MIME = Multi-Purpose Internet Mail Extension
OSPF = Open Shortest Path First
RSVP = Resource ReSerVation Protocol
SMTP = Simple Mail Transfer Protocol
SNMP = Simple Network Management Protocol
TCP = Transmission Control Protocol
UDP = User Datagram Protocol

Information Format

- Frame
  - An information unit whose source and destination are data link layer entities
  - Composed of the data link layer header (trailer) and upper-layer data

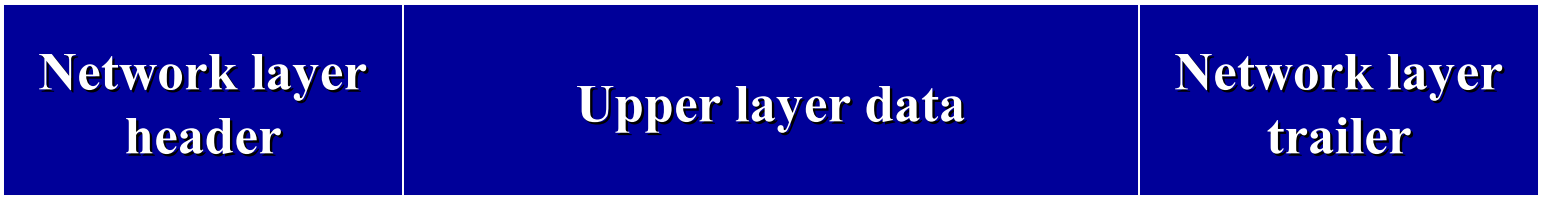
Frame



Information Format Layer (cont.)

- Packet
  - An information unit whose source and destination are network layer entities
  - Composed of the network layer header (trailer) and upper-layer data

Packet

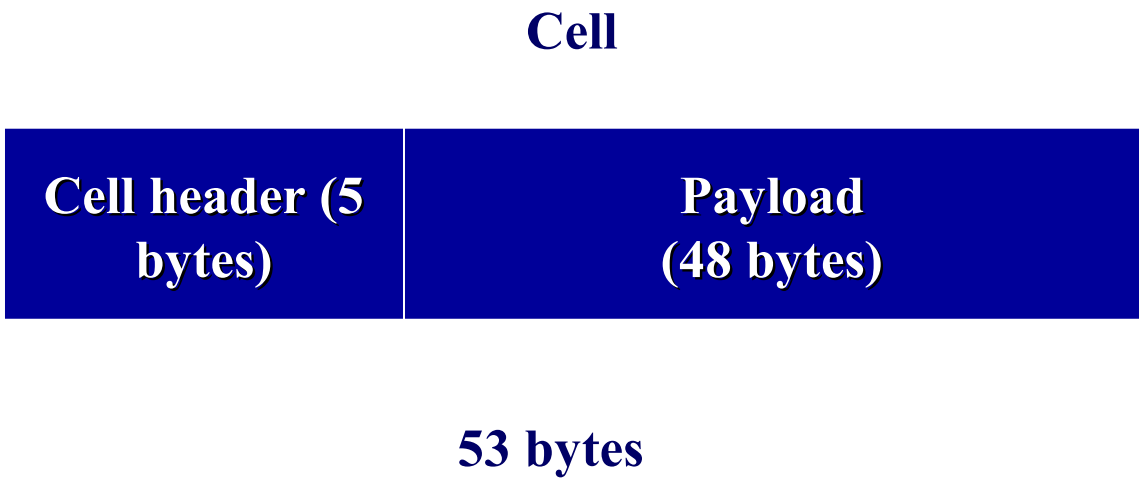


Information Format Layer (cont.)

- Datagram
  - Usually refers to an information unit whose source and destination are network layer entities that use connectionless network service
- Segment
  - Refers to an information unit whose source and destination are transport layer entities
- Message
  - An information unit whose source and destination entities exist above the network layer (often at the application layer)

Information Format Layer (cont.)

- Cell
  - An information unit of a fixed size whose source and destination are data link layer entities
  - Cells are used in switched environments, such as Asynchronous Transfer Mode (ATM) and Switched Multimegabit Data Service (SMDS) network.



Credits

- All figures obtained from publisher-provided instructor downloads

  Data Communications and Networking, 3rd edition by Behrouz A. Forouzan. McGraw Hill Publishing, 2004