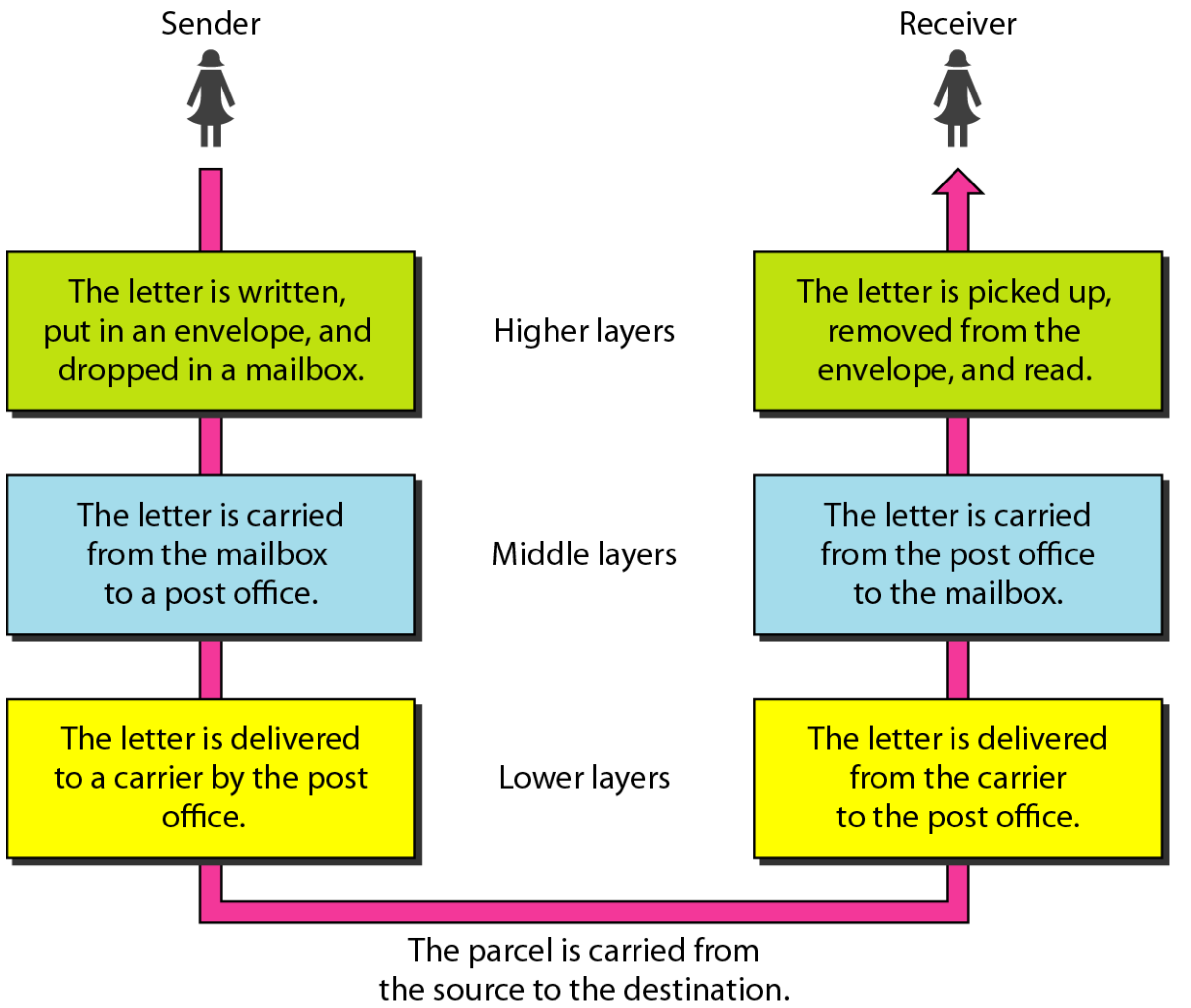
Layering Concepts

Tasks involved in sending a letter

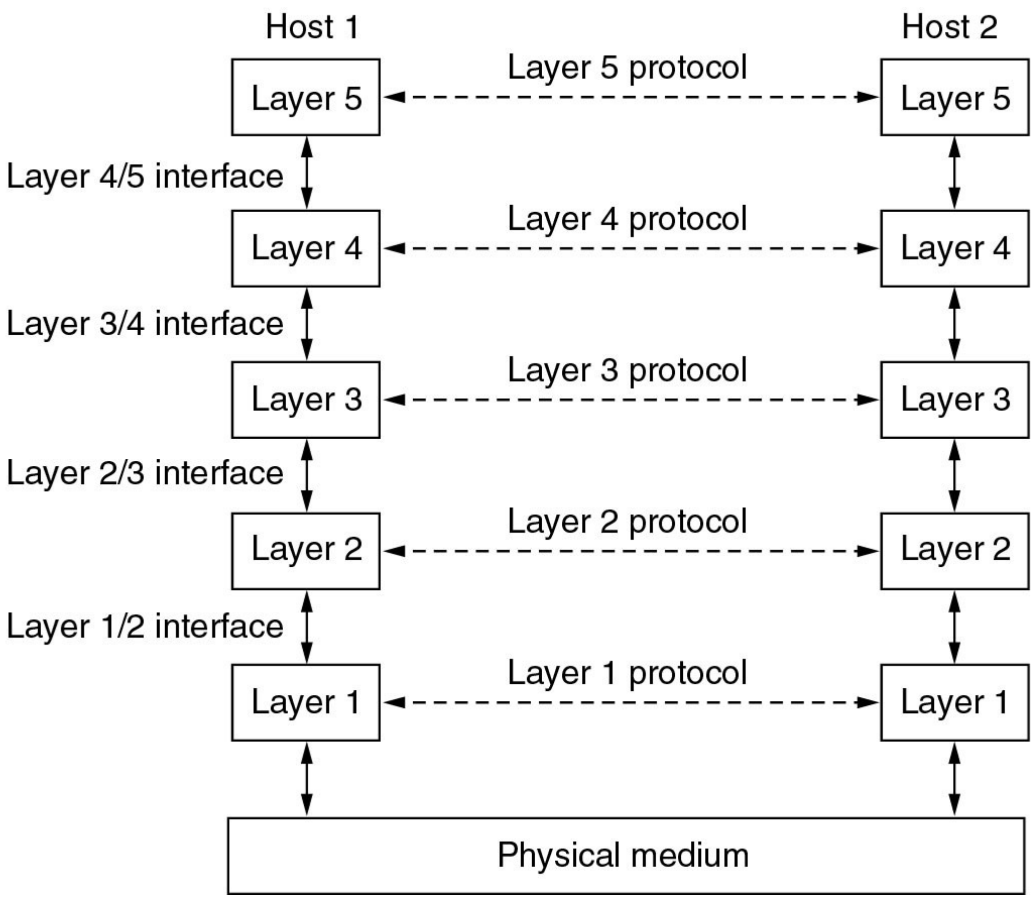


Reason of layering

- It decomposes the problem of building a network into more manageable components.
- It provides a more Modular design(can be added more service, and can be modified the functionality on layers)

Network Architecture = Layered approach + protocol stack

Network Software
Protocol Hierarchies



Layers, protocols, and interfaces.

Reference Models

- The OSI Reference Model
- The TCP/IP Reference Model
- A Comparison of OSI and TCP/IP

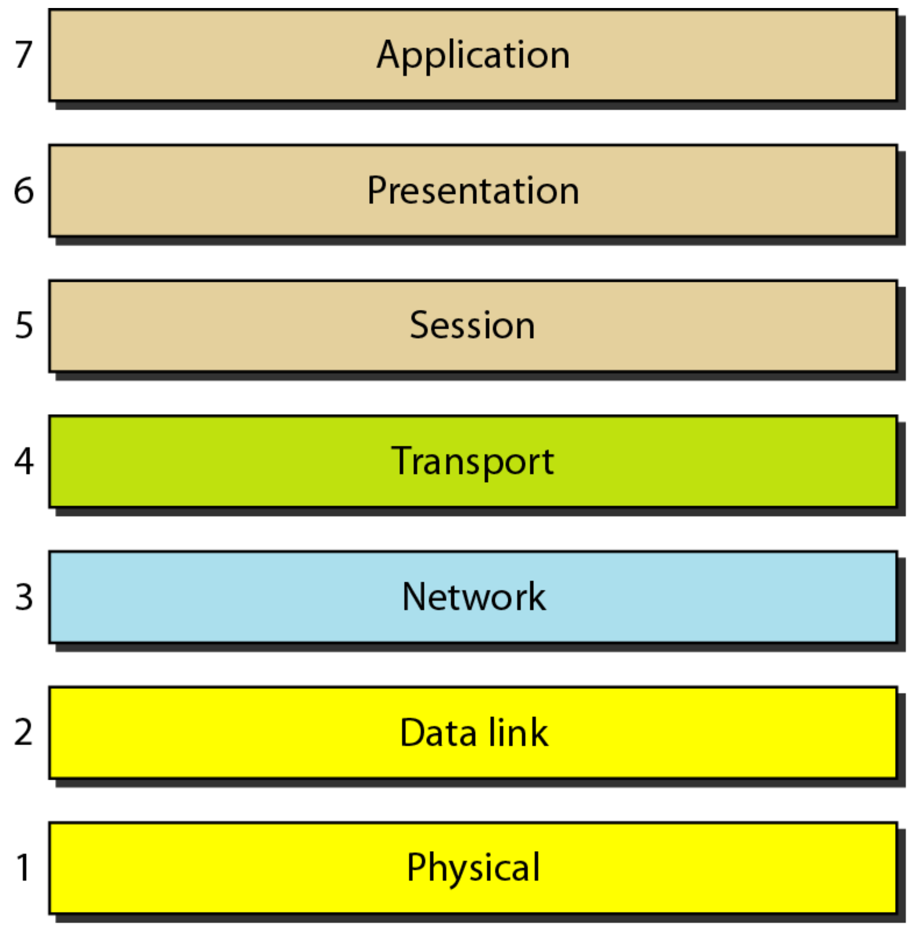
THE OSI MODEL

*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.*

Note

ISO is the organization.
OSI is the model.

Figure *Seven layers of the OSI model*



OSI Model layers

Plz Do Not Take Samossa Piza Away

Bottom to Top

Away: **Application layer ---------------7**

Pizza: **Presentation layer --------------6**

Samossa: **Session layer --------------------5**

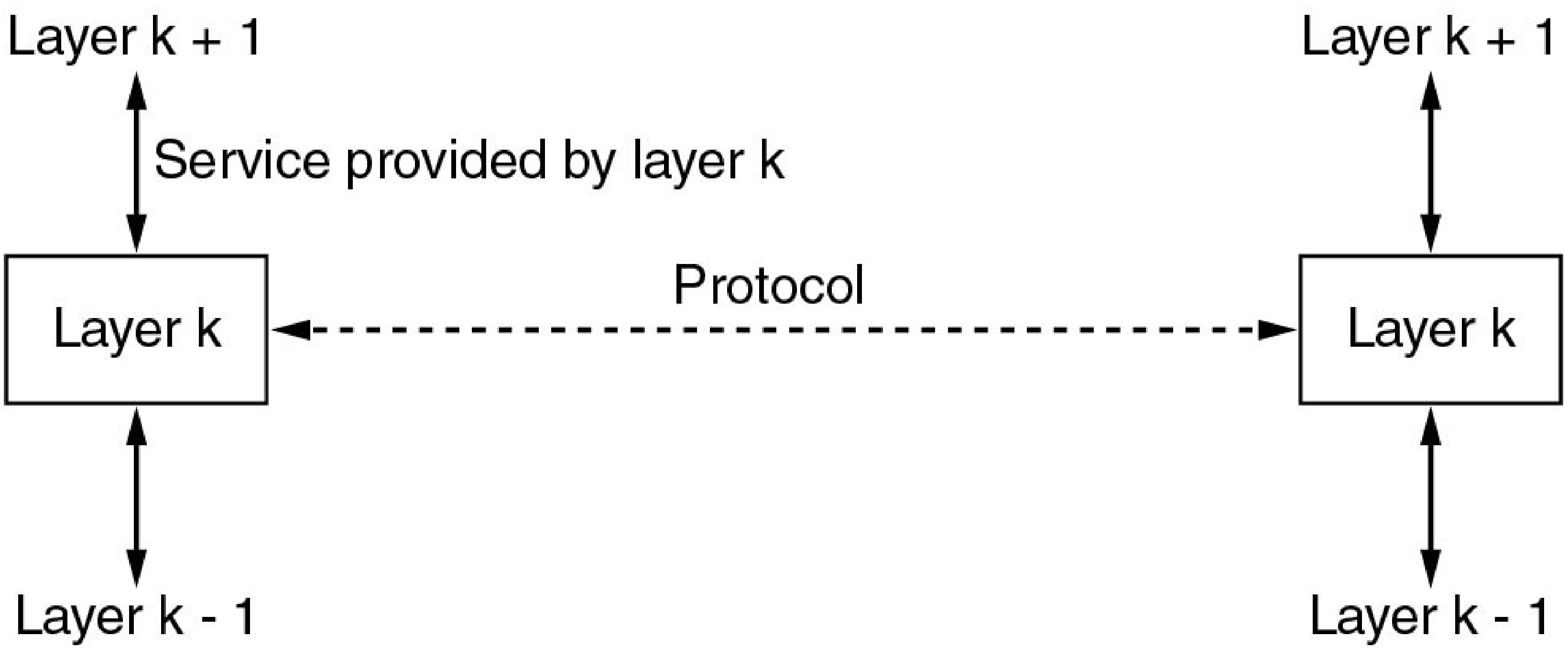
Take: **Transport Layer-----------------4**

Not: **Network Layer-------------------3**

Do: **Data Link Layer-----------------2**

Plz : **Physical layer--------------------1**

Services to Protocols Relationship

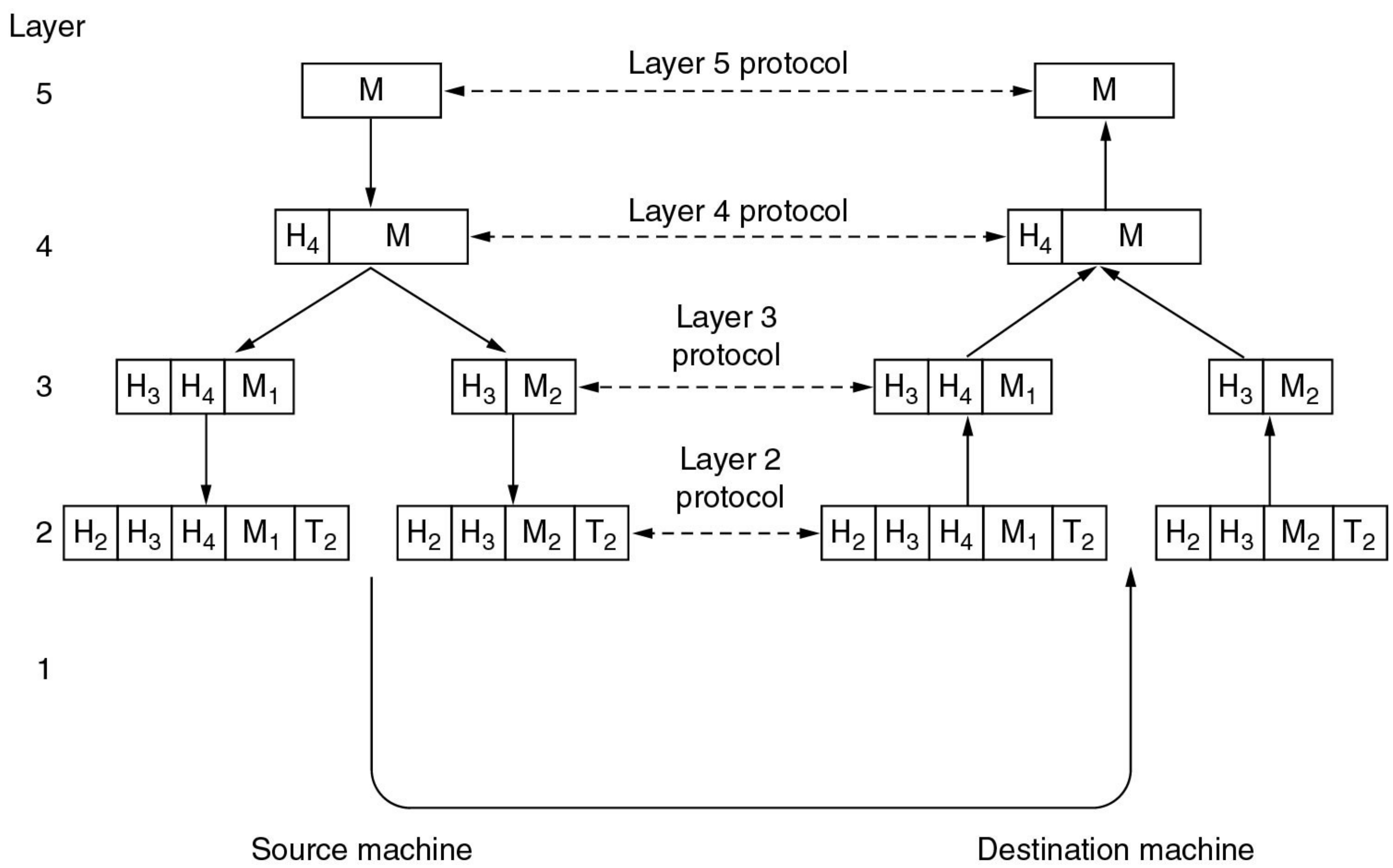


The relationship between a service and a protocol.

Network Software

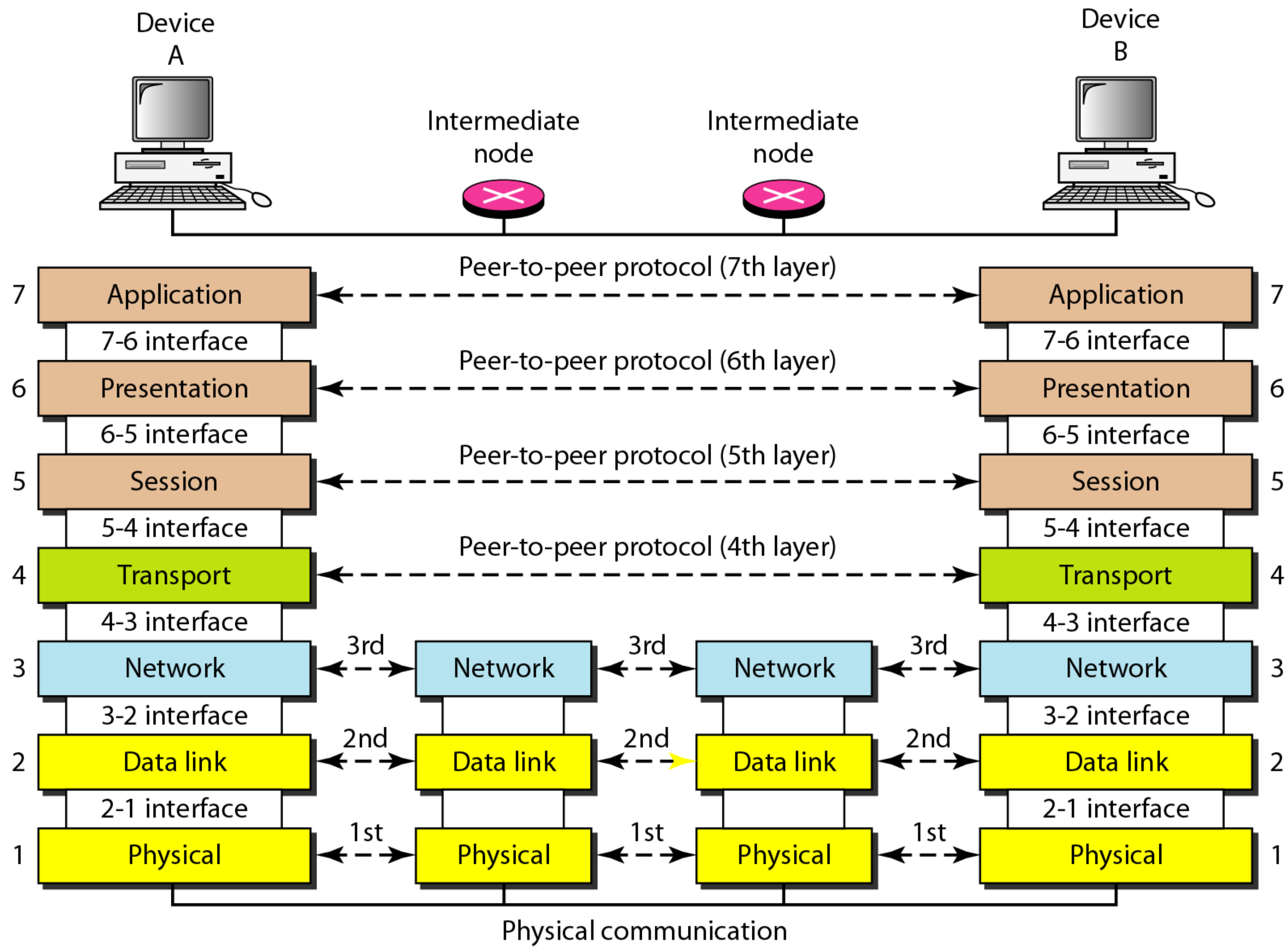
- Protocol Hierarchies
- Design Issues for the Layers
- The Relationship of Services to Protocols

Protocol Hierarchies (3)

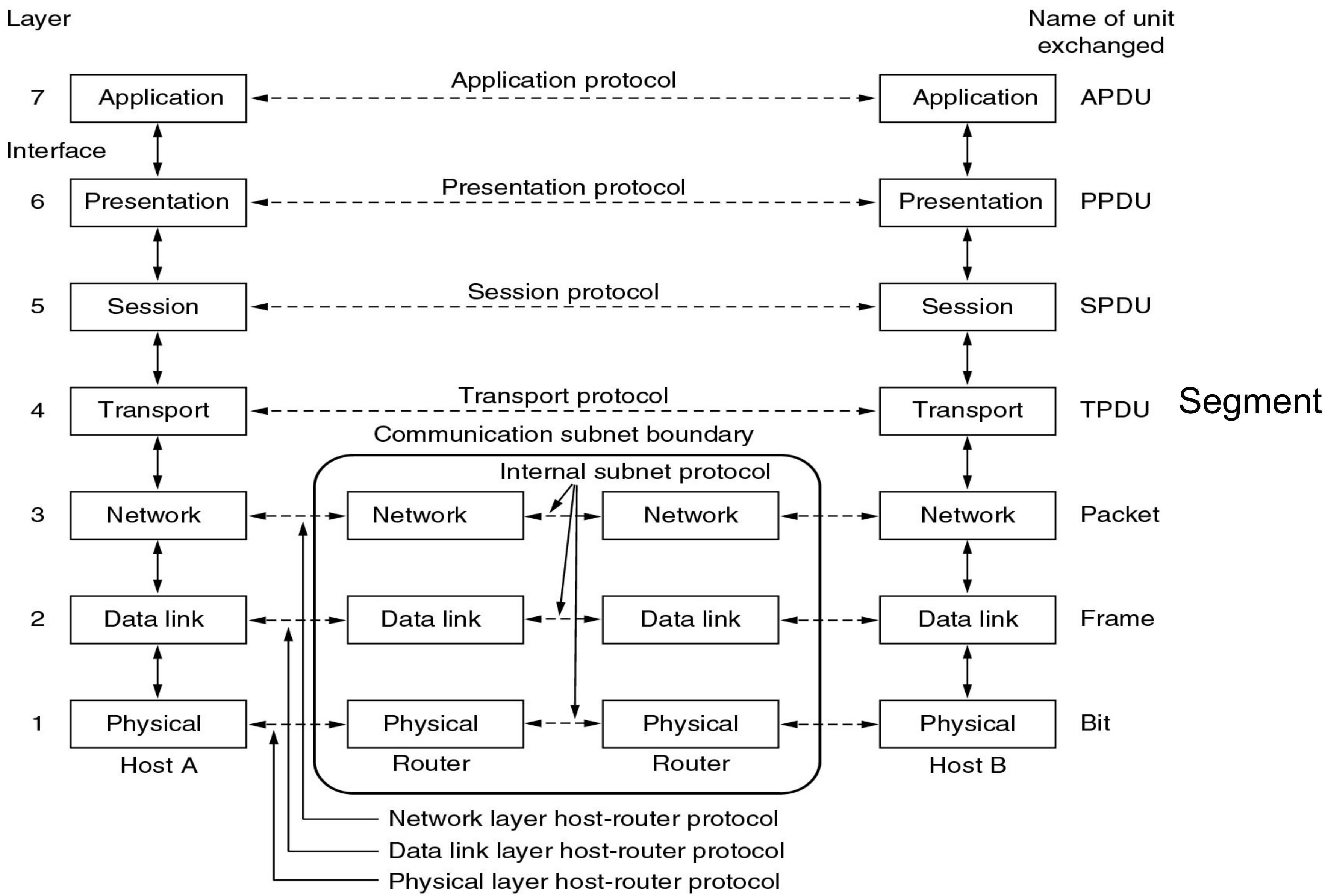


Example information flow supporting virtual communication in layer 5.

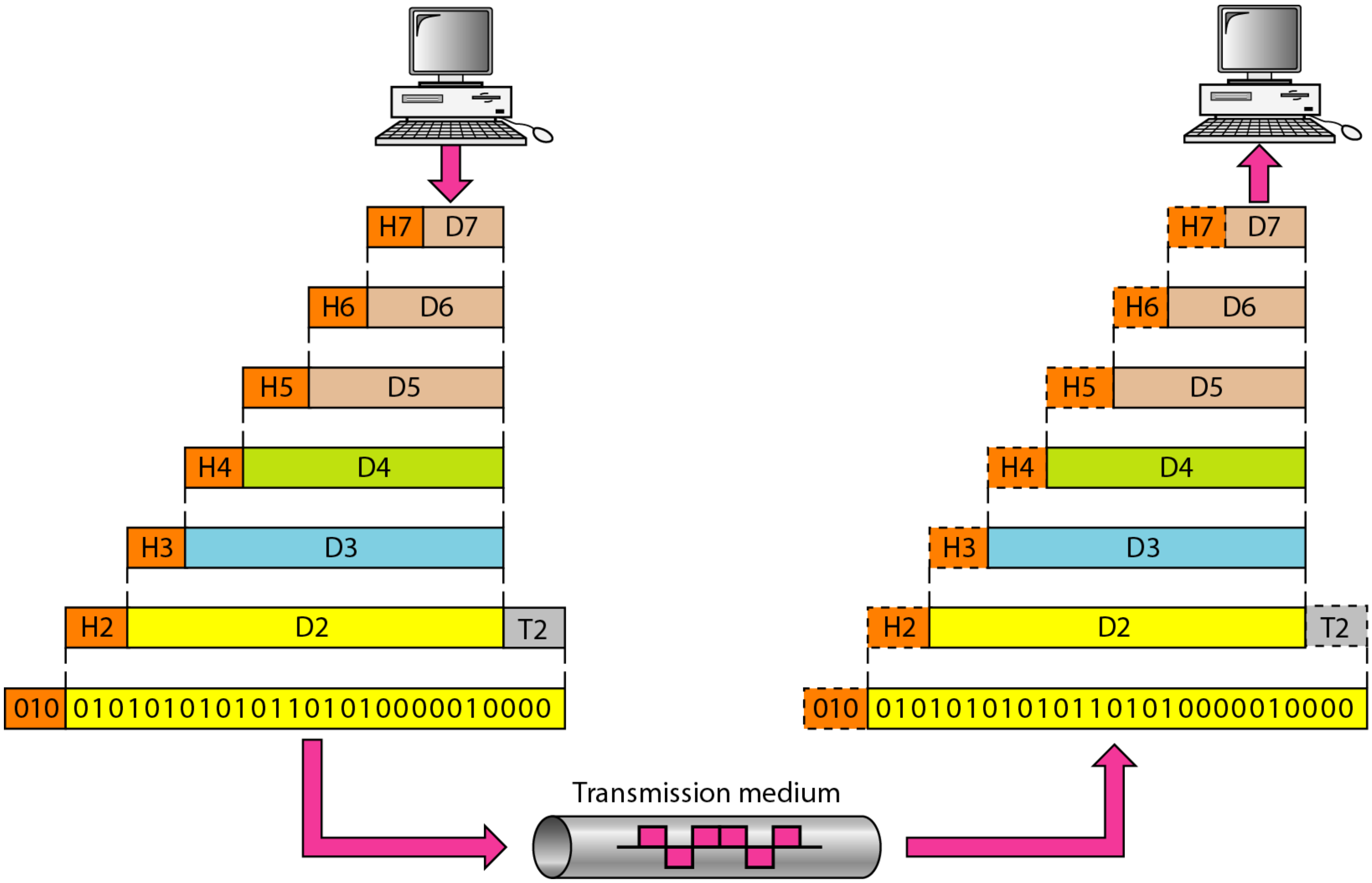
The interaction between layers in the OSI model



OSI Reference Models



An exchange using the OSI model



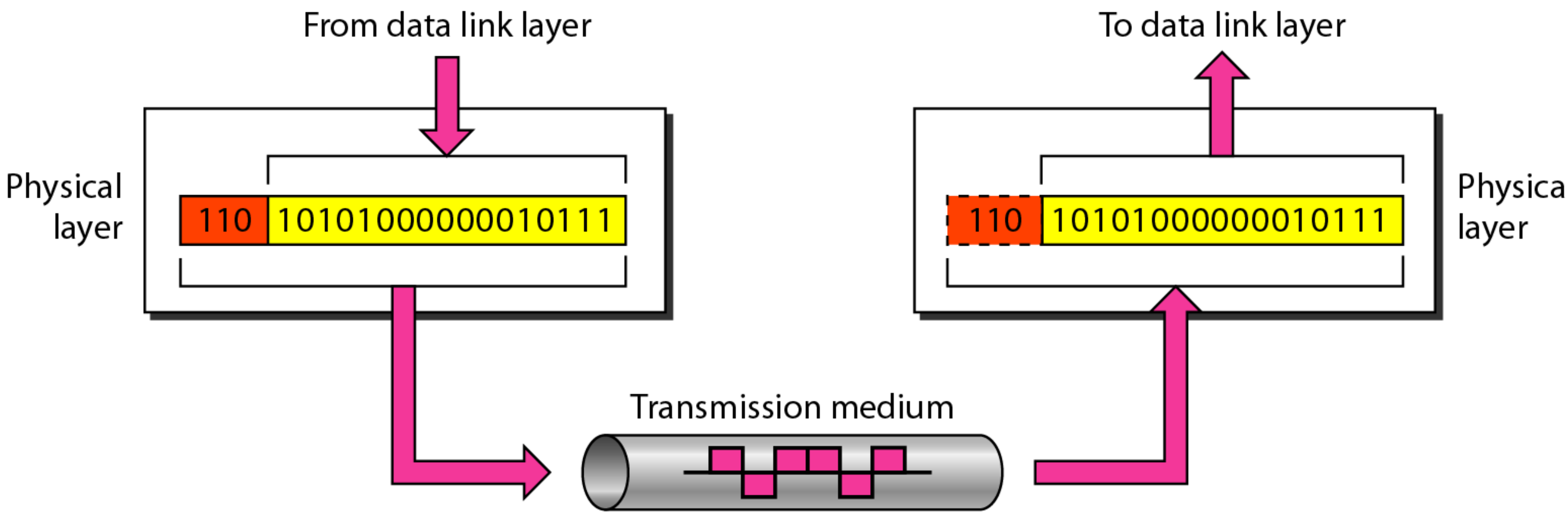
Physical layer

Responsibilities: This layer is responsible for movements of individual **bits** from one hop(node) to the next.

Issues:

- Transmission of raw bits
- Physical characteristics of interfaces and medium
- Representation of bits
- Data rate
- Line configuration
- Physical topology
- Transmission mode
- Synchronisation of bits

Physical layer



Data Link Layer

Responsibilities: It is responsible for moving **frames** from one hop(node) to the next hop(node) .

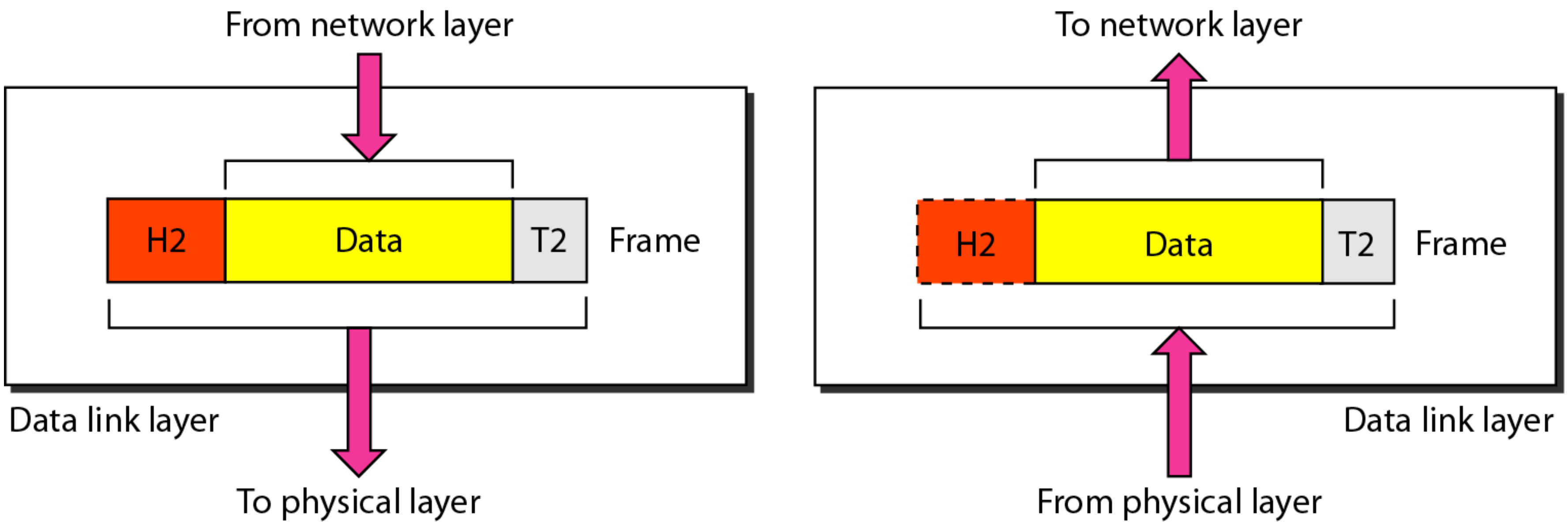
(Hop to Hop delivery or

Node to Node delivery)

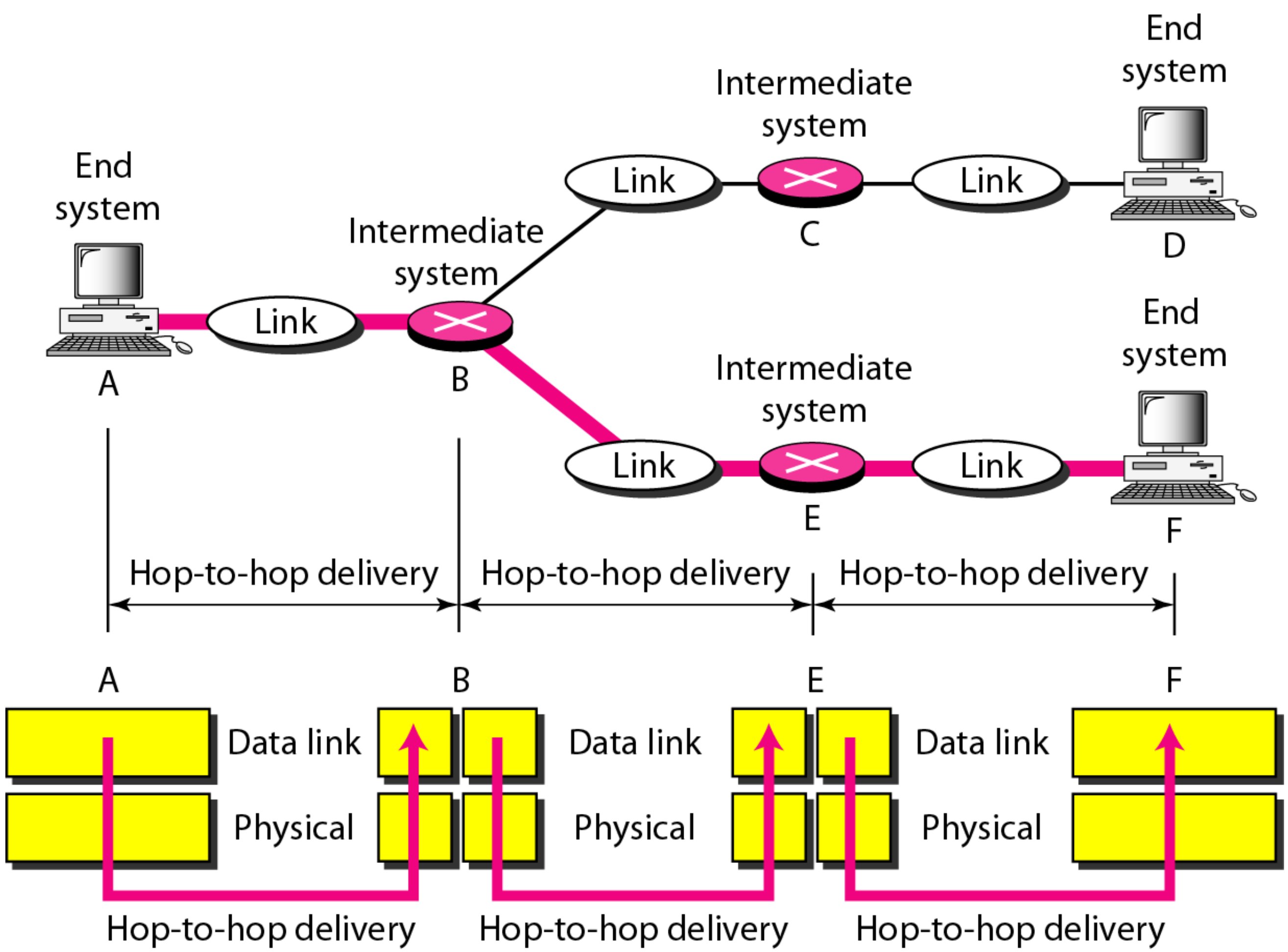
Issues:

- Framing
- Physical/MAC addressing
- Flow control
- Error control
- Access control

Data link layer



Hop-to-hop delivery in data link layer



Network Layer

Responsibilities: It is responsible for the delivery of individual **packets** from the source host to the destination host.

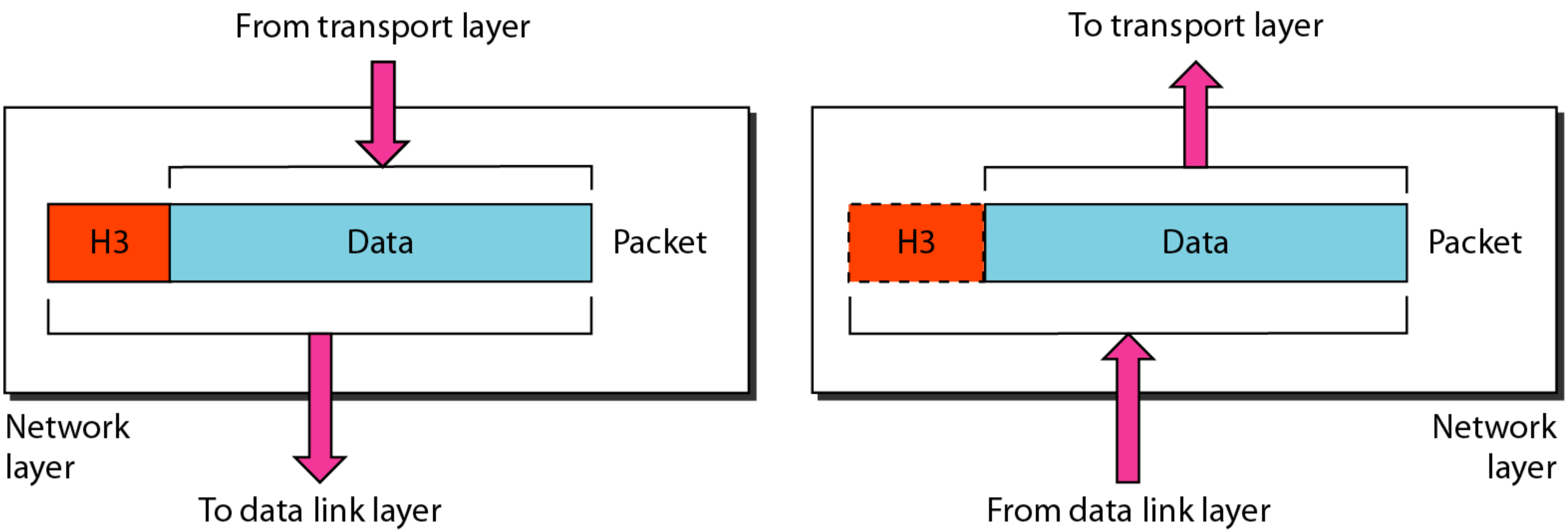
(source to destination delivery or

End to End delivery)

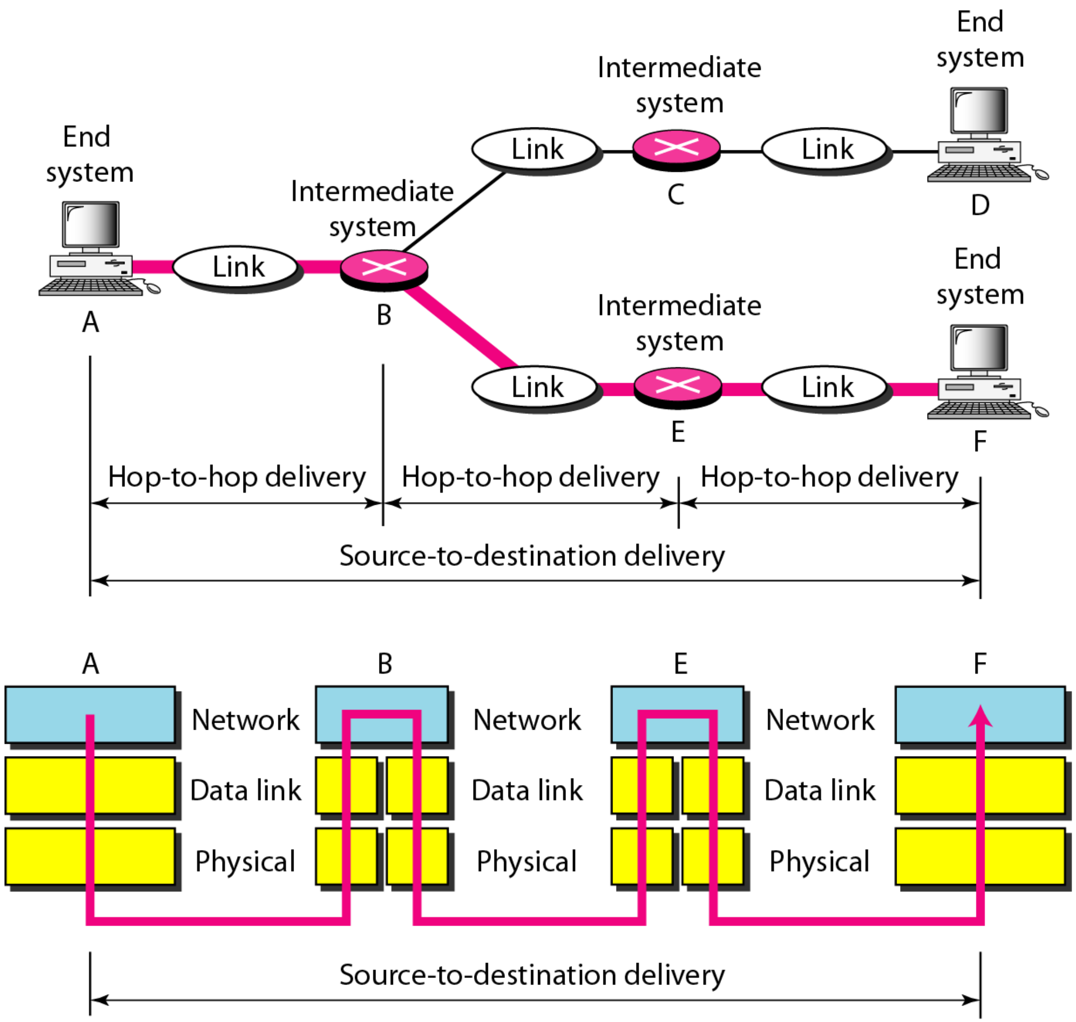
Issues:

- Logical addressing(IP addressing)
- Routing

Network layer



Source-to-destination delivery :Network Layer



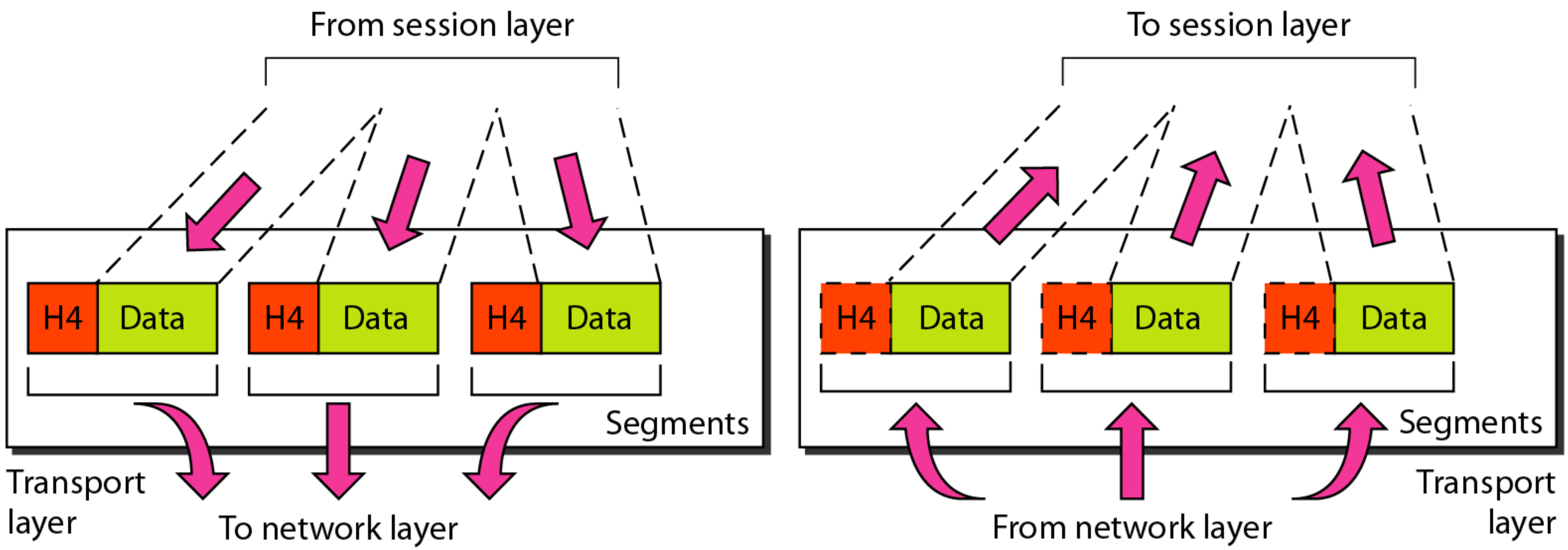
Transport Layer

Resposibilities: It is responsible for the delivery of a message from one process to another. (Process to process delivery)

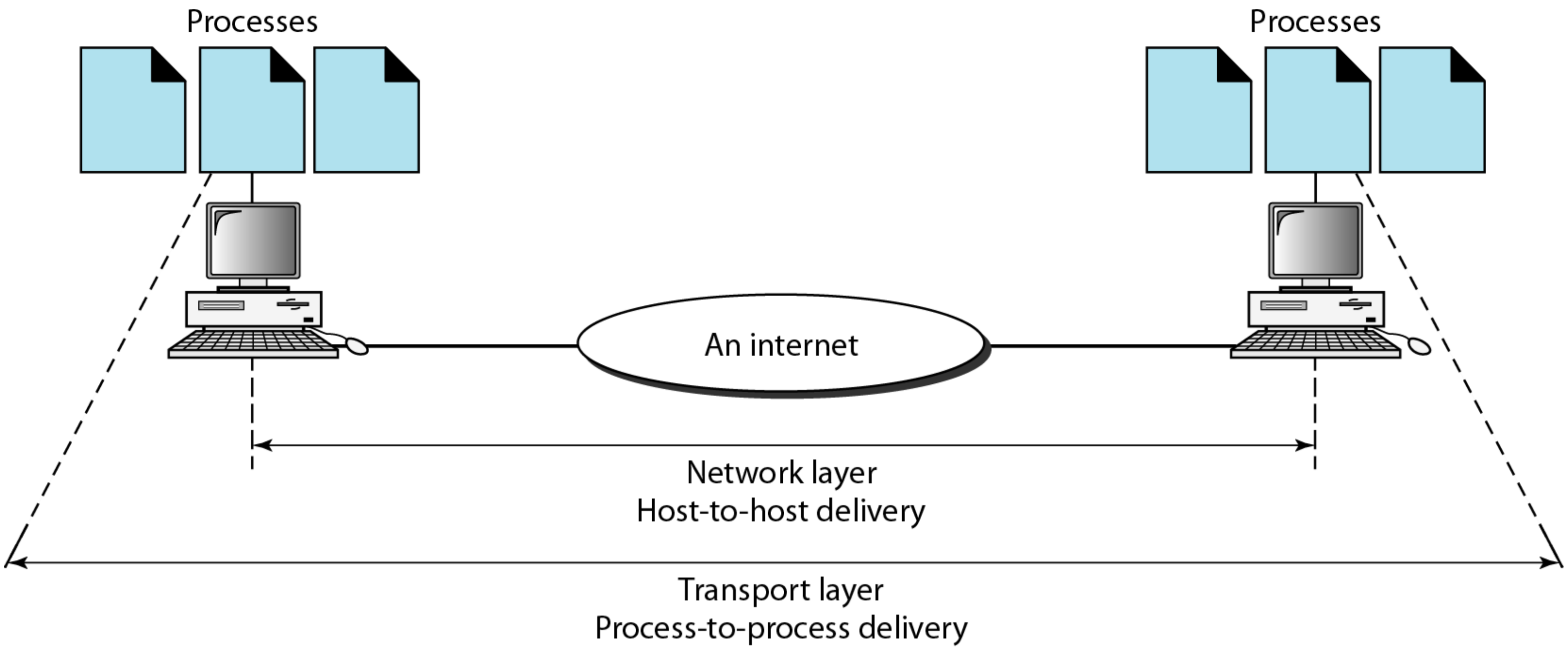
Issues :

- Port addressing
- Segmentation and reassembly
- Connection control
- Flow control
- Error control

Transport layer



process-to-process delivery of a message : Transport Layer



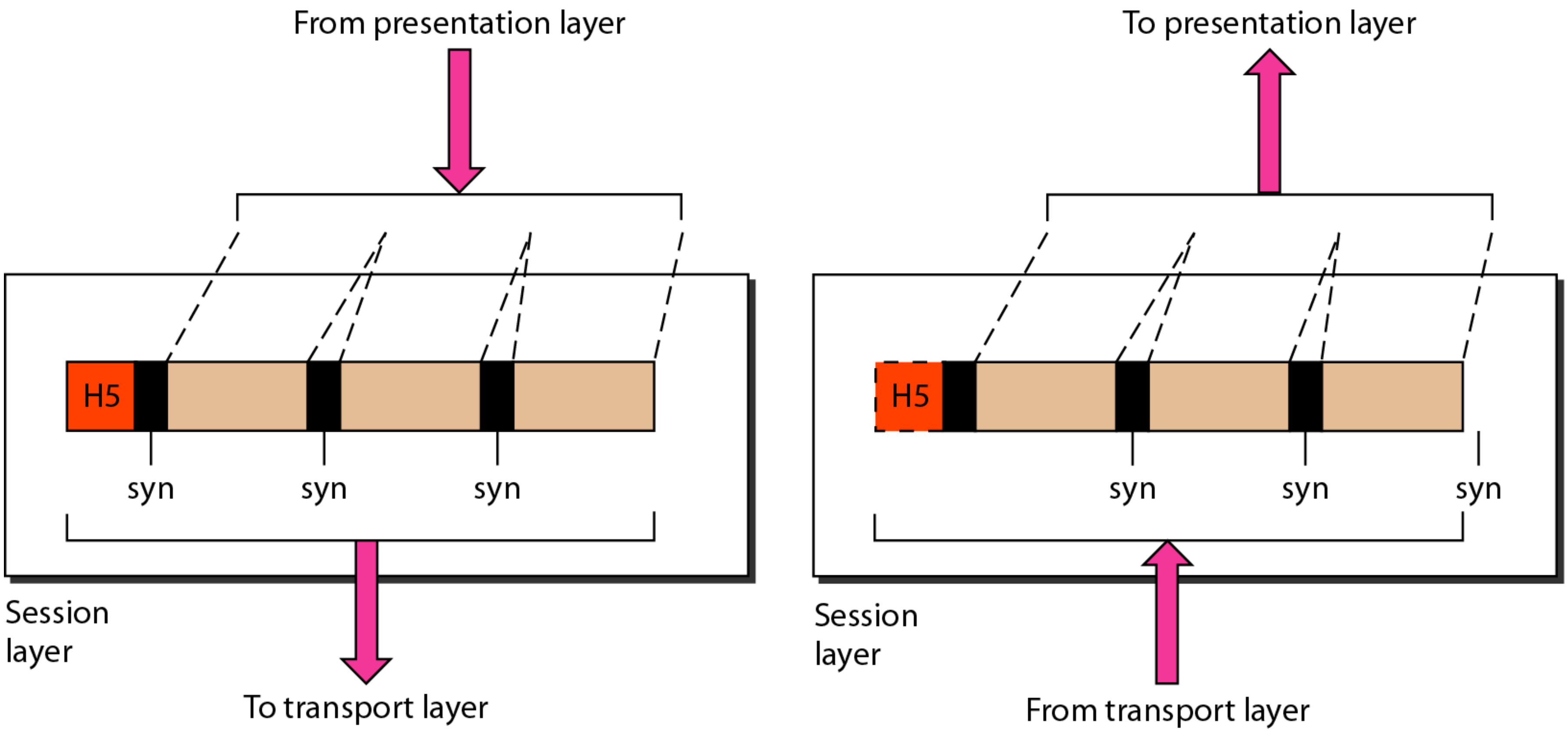
Session layer

Responsibility: It is responsible for dialog control and synchronisation

Issues:

- Dialog control
- Synchronisation

Session layer



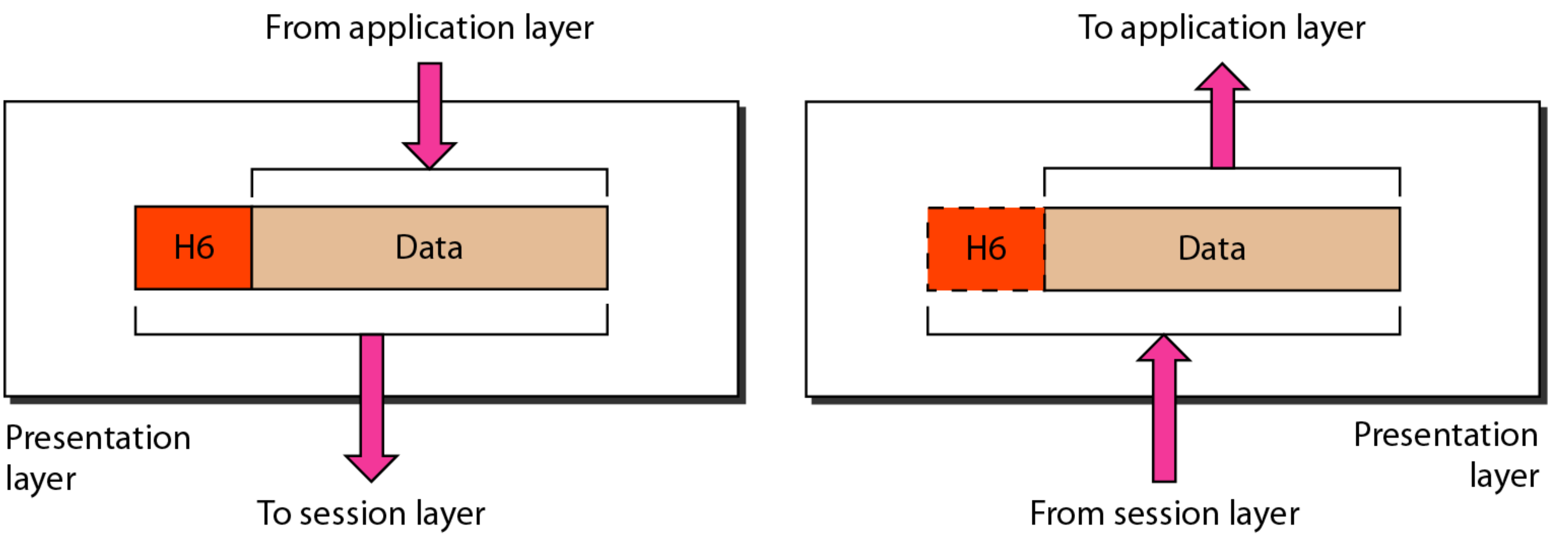
Presentation layer

Responsibilities: It is responsible for translation, compression, and encryption

ISSUES:

- Translation
- Ecryption
- Compression

Presentation layer



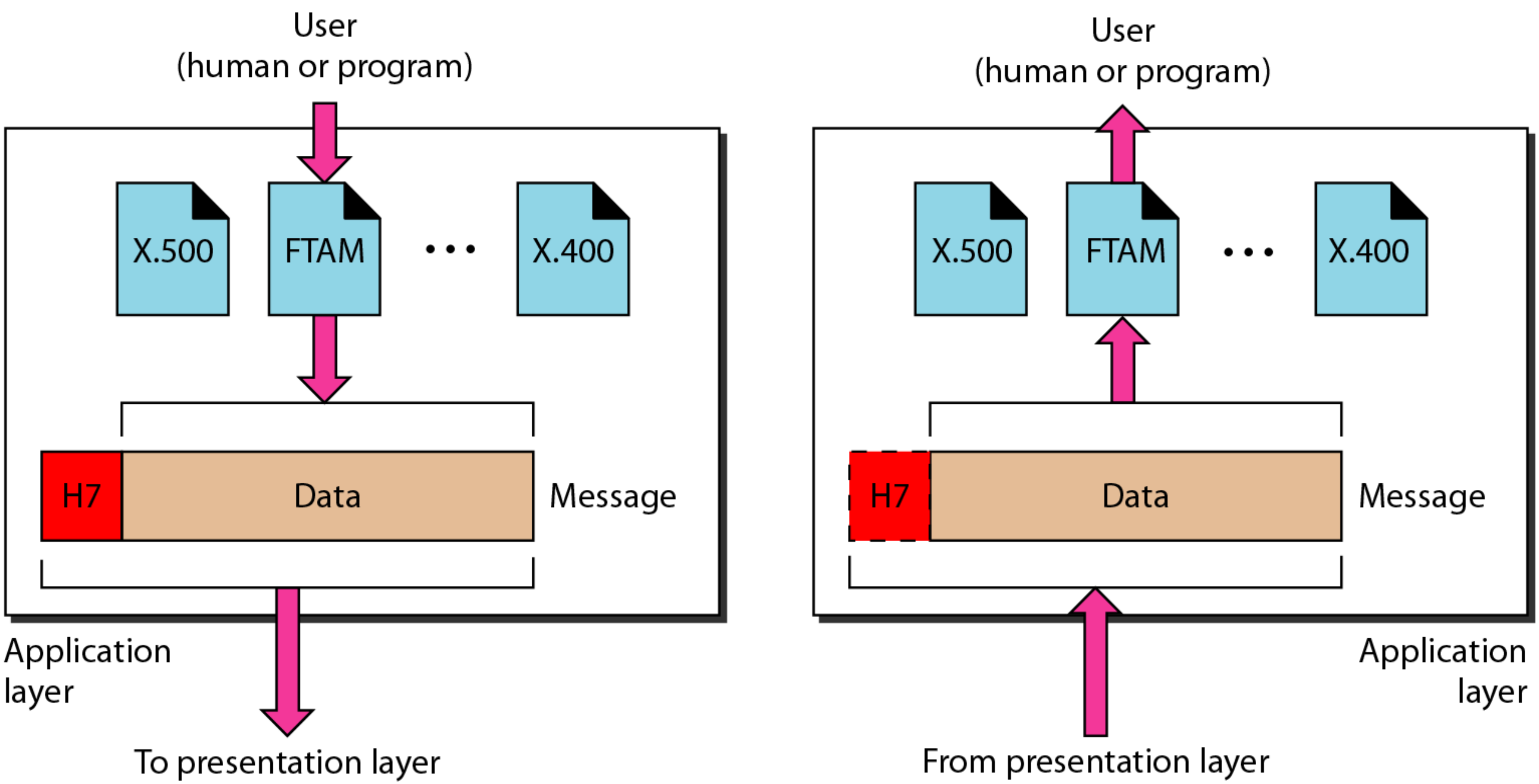
Application layer

Responsibilities: It is responsible for providing services to the user

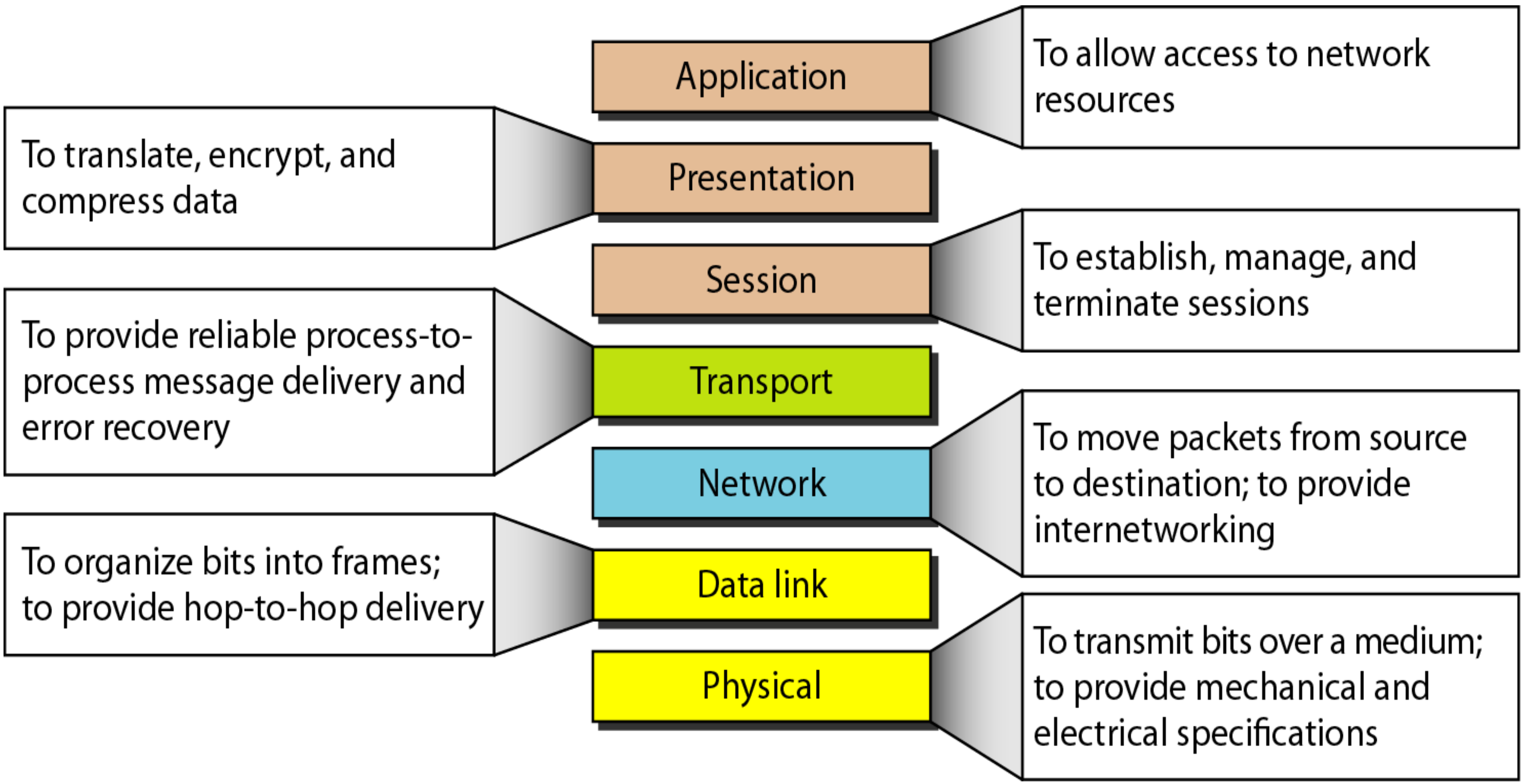
Issues:

- Network virtual terminal
- File transfer, access and management
- Mail services
- Directory services

Application layer



Summary of layers



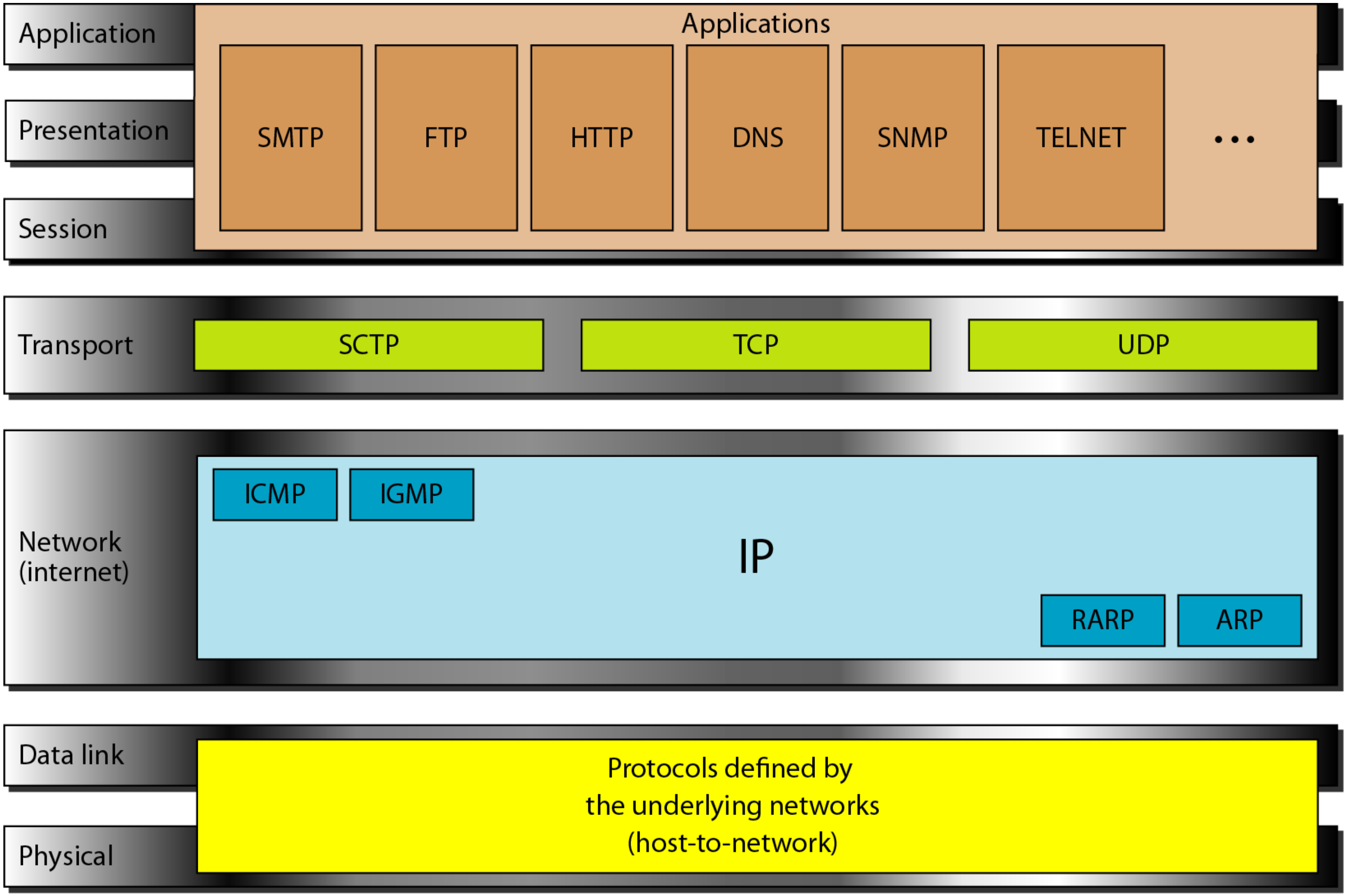
TCP/IP PROTOCOL SUITE

The layers in the TCP/IP protocol suite do not exactly match those in the OSI model. The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application. However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.

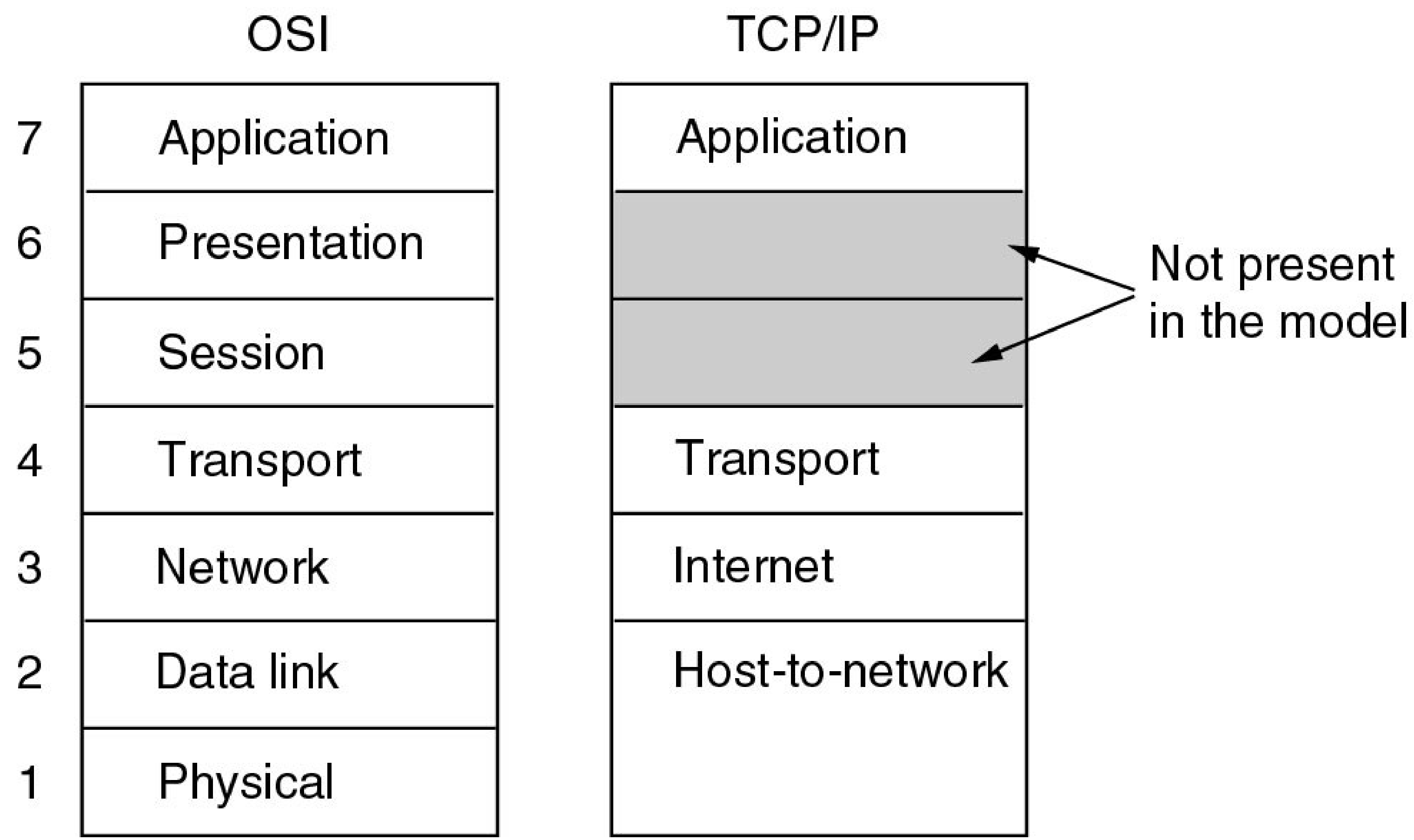
Topics discussed in this section:

Physical and Data Link Layers
Network Layer
Transport Layer
Application Layer

TCP/IP and OSI model



Reference Models



The TCP/IP reference model.

ADDRESSING

Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific.

Topics discussed in this section:

Physical Addresses
Logical Addresses
Port Addresses
Specific Addresses

Figure 2.17 *Addresses in TCP/IP*

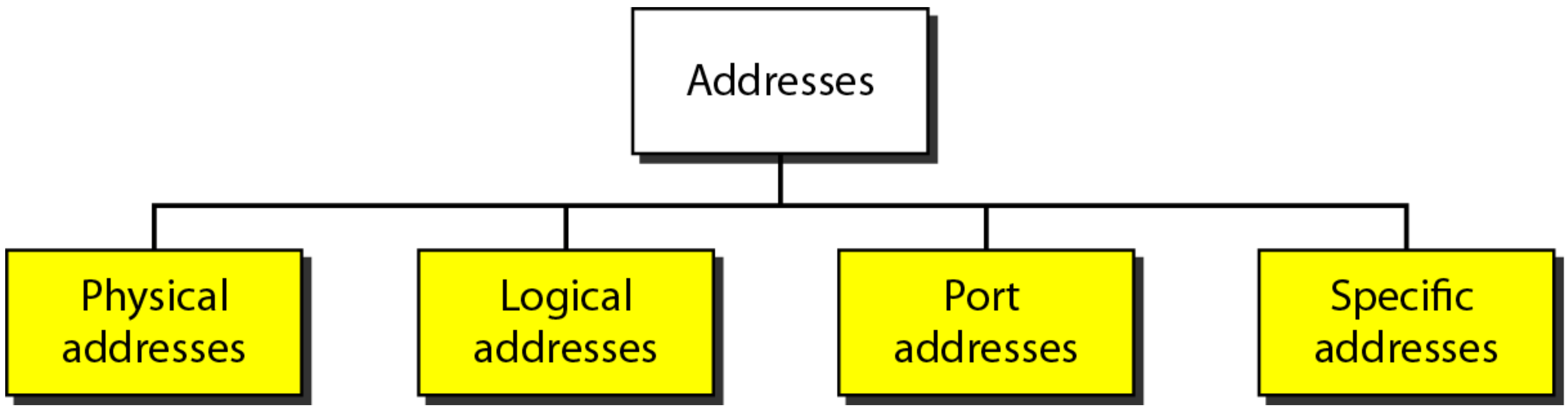
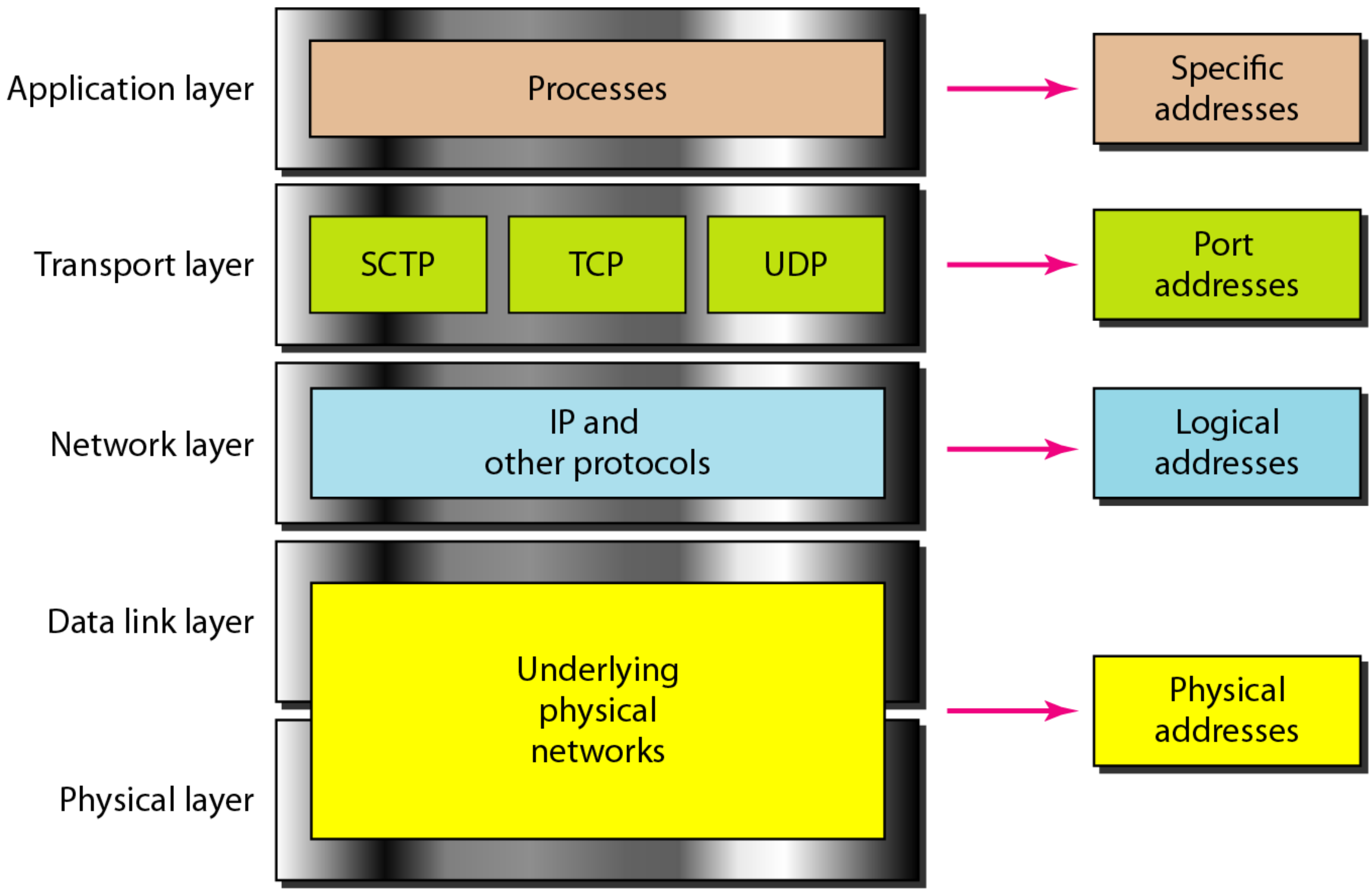
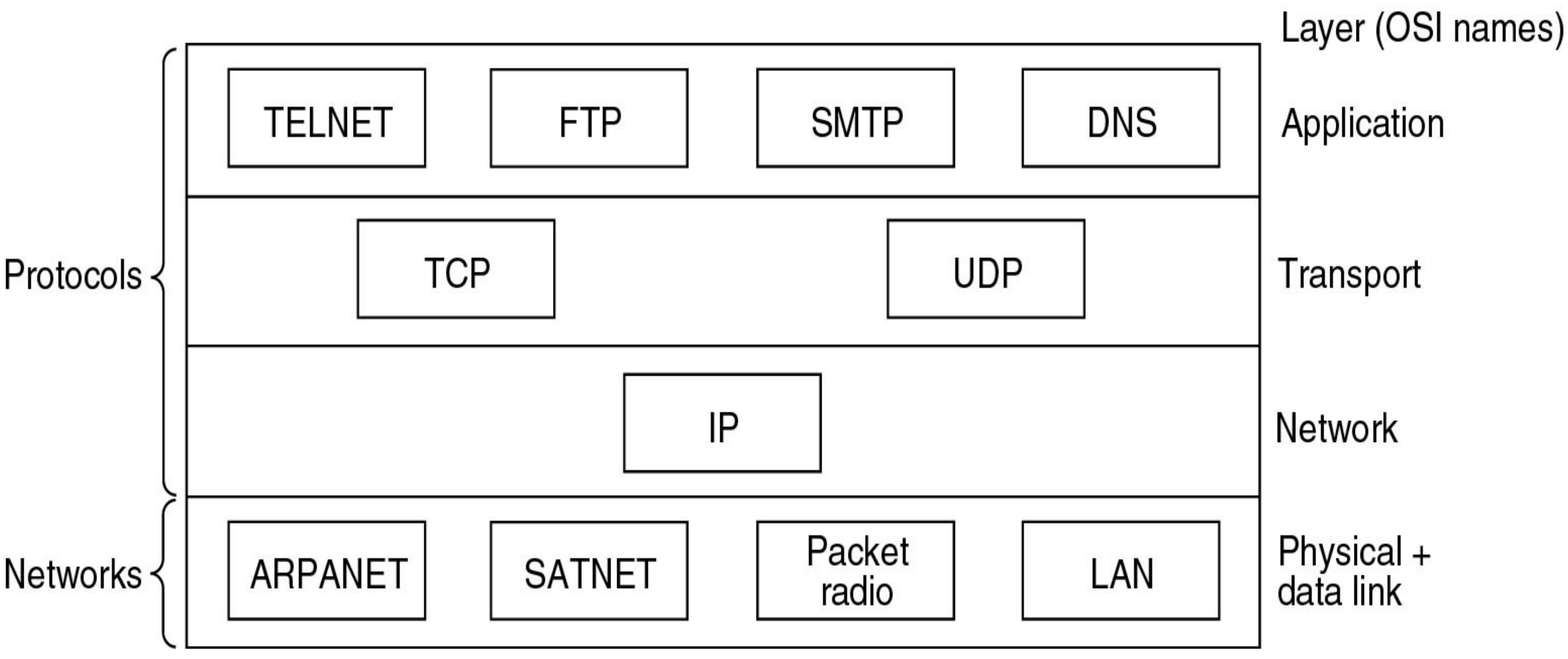


Figure 2.18 *Relationship of layers and addresses in TCP/IP*

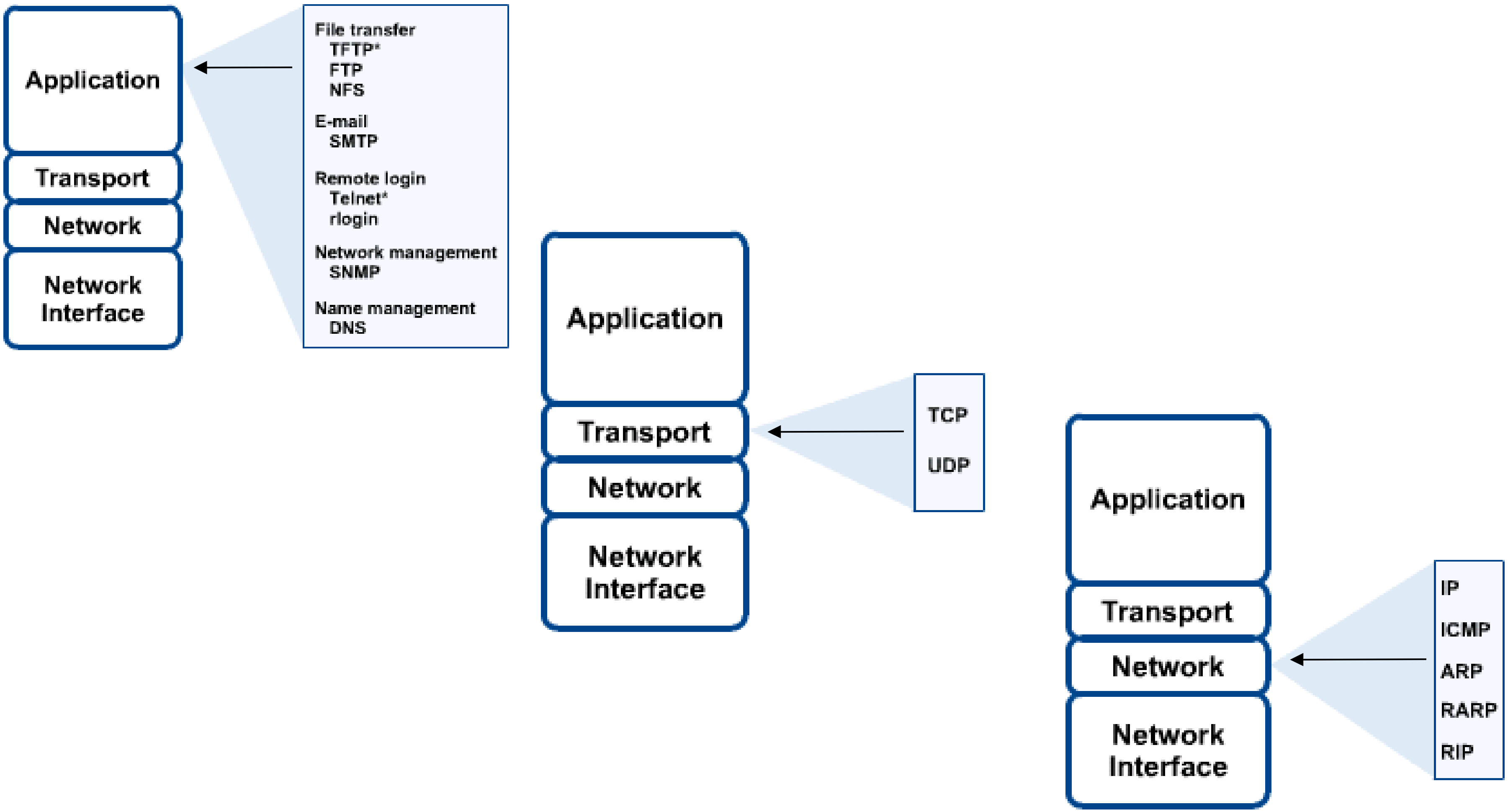


Reference Models

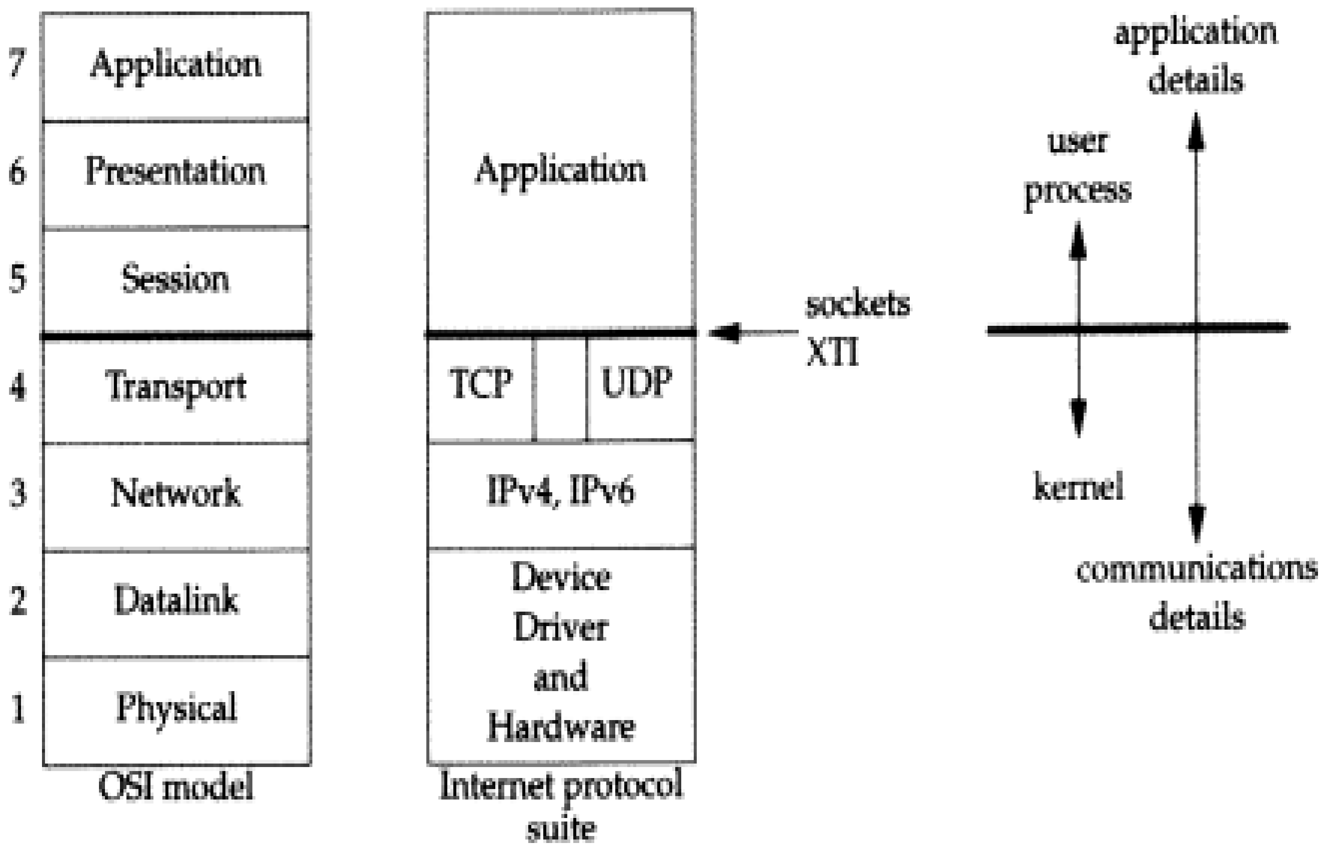


Protocols and networks in the TCP/IP model initially.

Networking Protocol: TCP/IP



Layers in OSI Model & TCP/IP model



Comparing OSI and TCP/IP Models

Concepts central to the OSI model

- Services
- Interfaces
- Protocols

A Critique of the TCP/IP Reference Model

Problems:

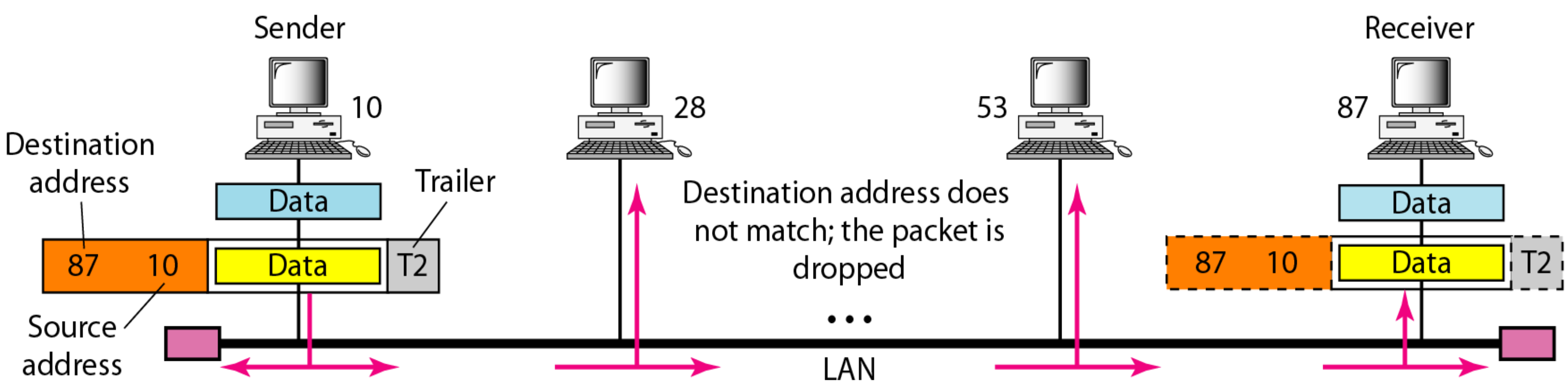
- Service, interface, and protocol not distinguished
- Not a general model
- Host-to-network “layer” not really a layer
- No mention of physical and data link layers
- Minor protocols deeply entrenched, hard to replace

Hybrid Model

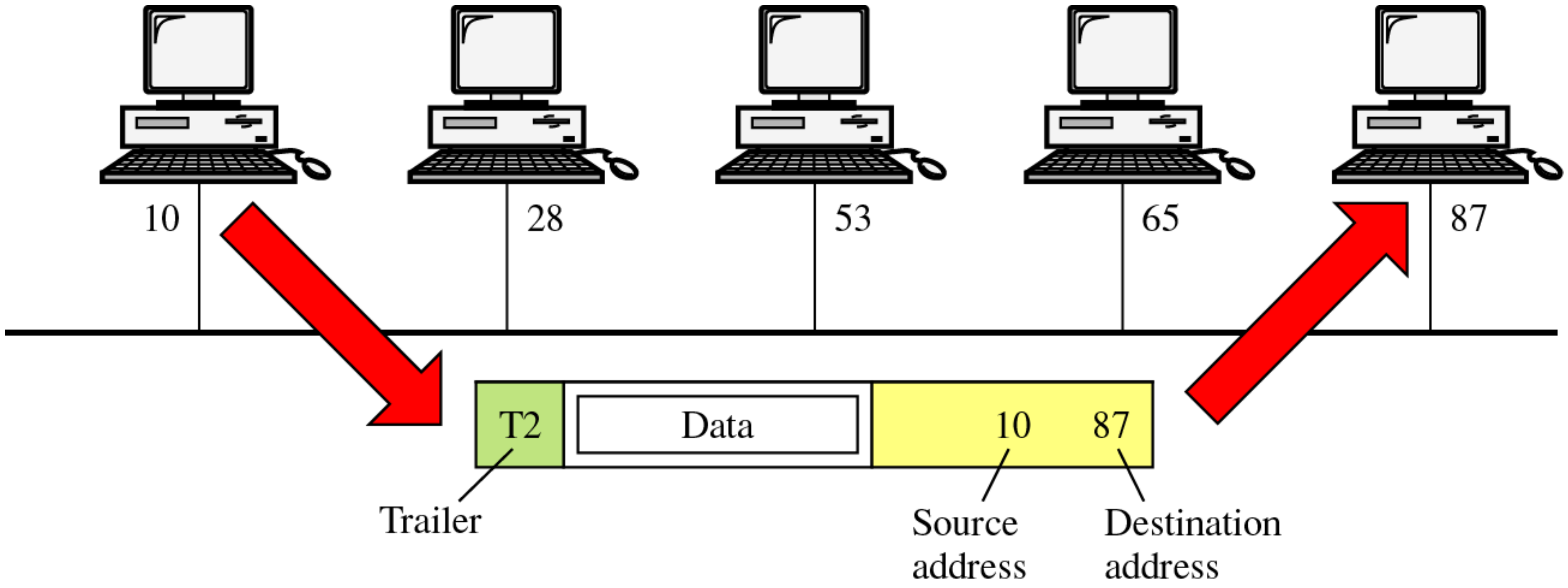
5	Application layer
4	Transport layer
3	Network layer
2	Data link layer
1	Physical layer

Example

In 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 (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 -1


10
28
53
65
87
T2
Data
10
87
Trailer
Source address
Destination address

NOTE

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:

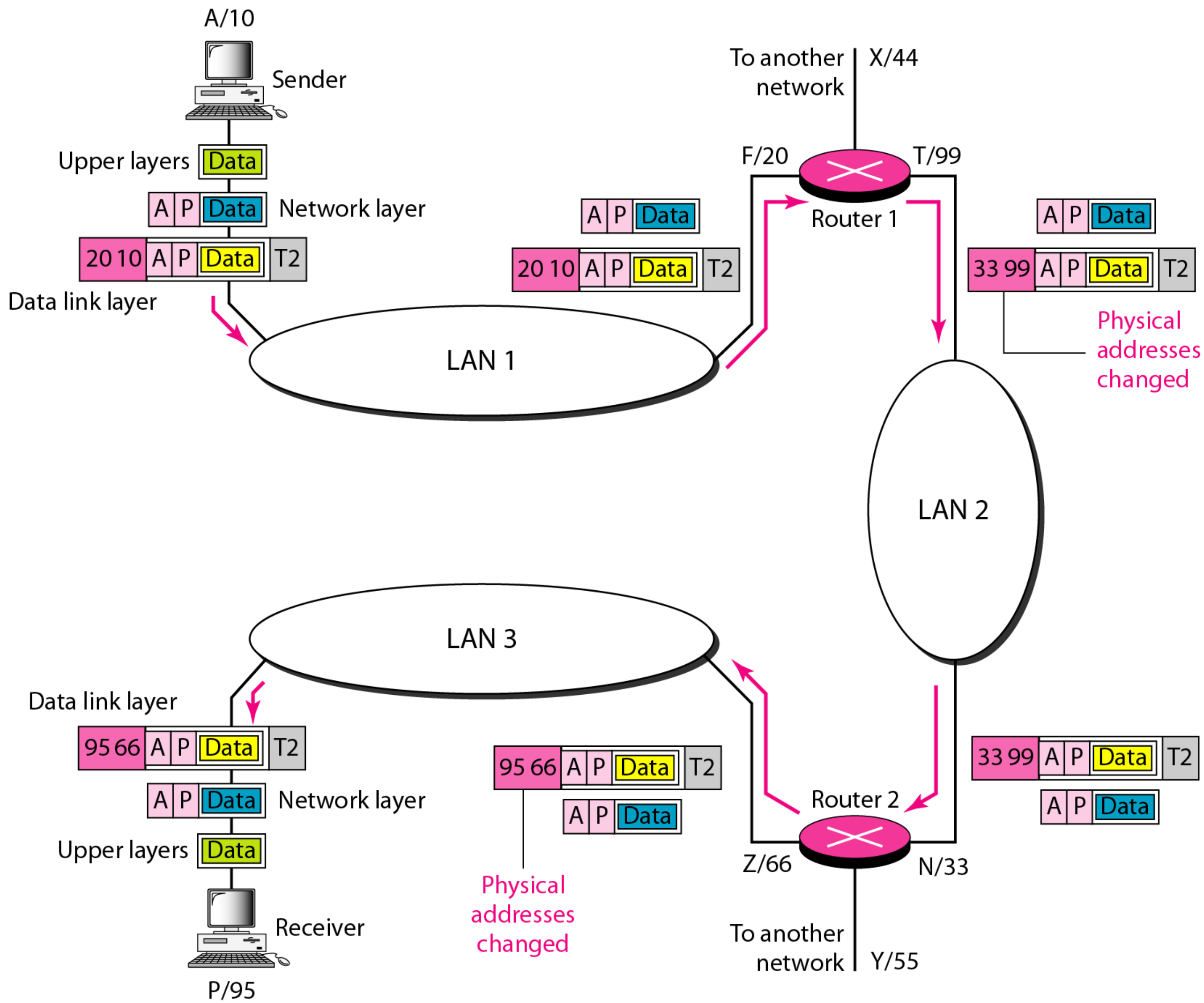
07:01:02:01:2C:4B

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

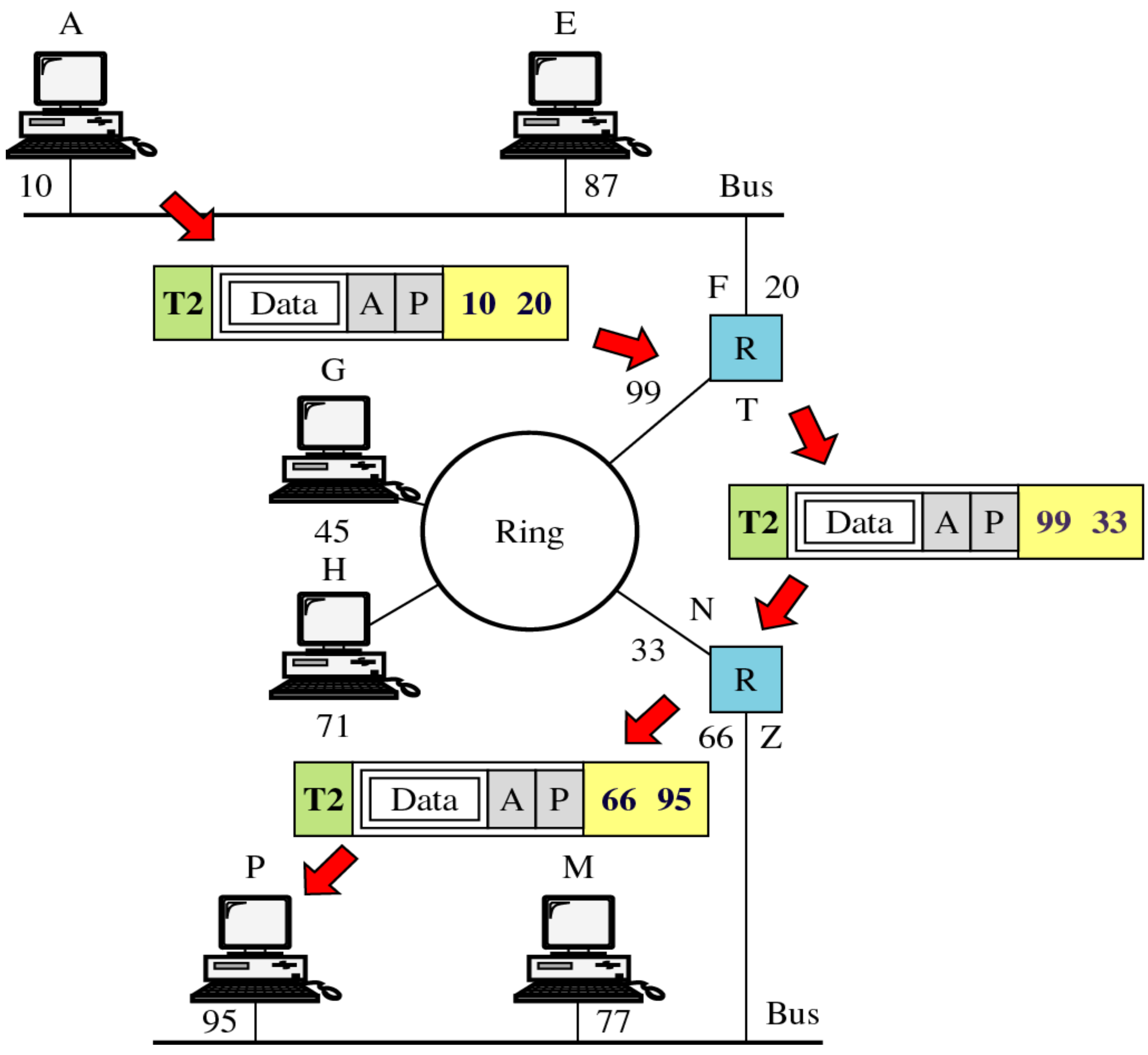
Example

Figure next slide 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.

Figure *IP addresses*



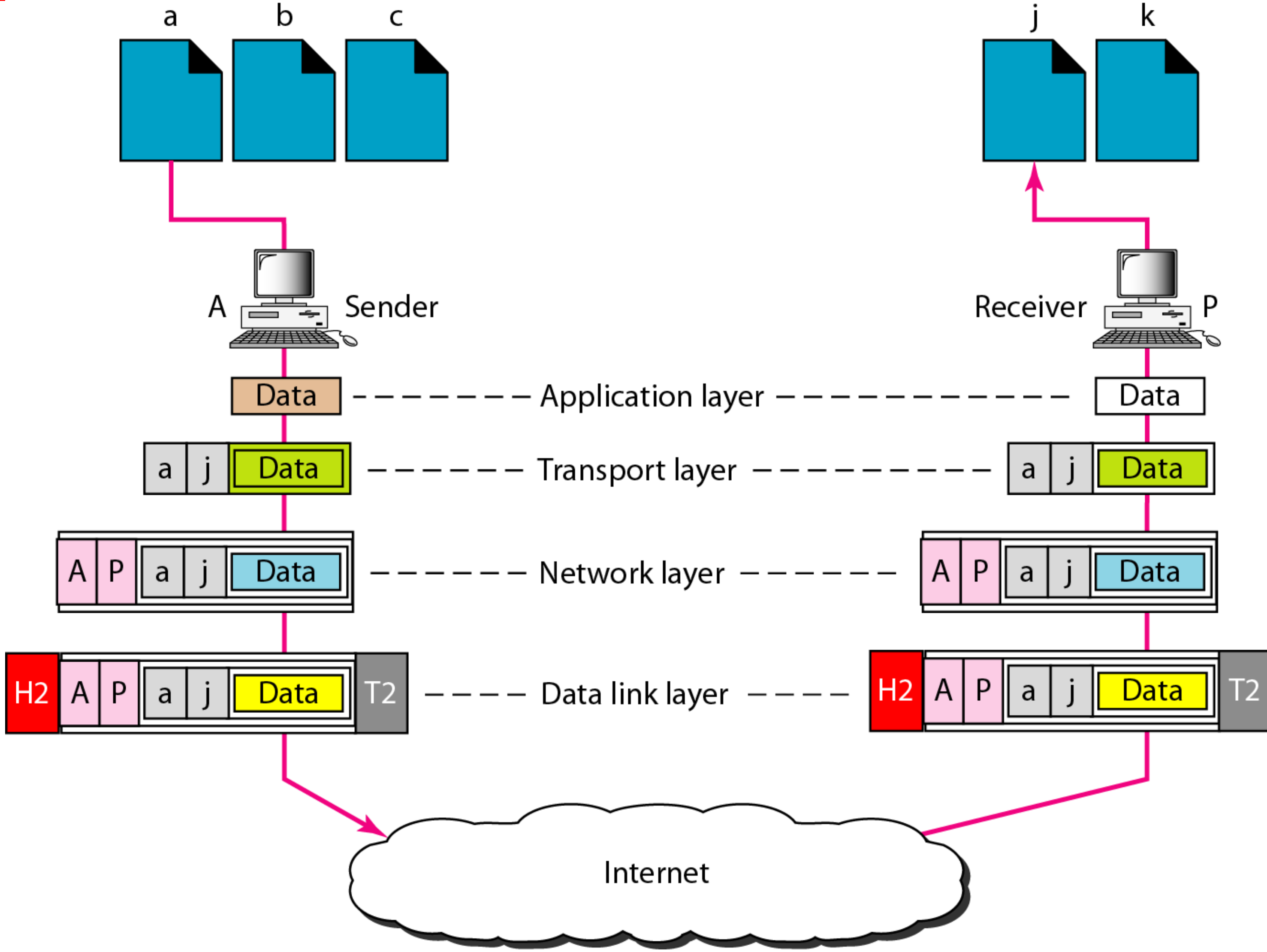
Example-2 (DATA from A to P)



Example: Port Address

Figure next slide 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.

Figure *Port addresses*



Example

As we will see in Chapter 23, 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.

Note

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

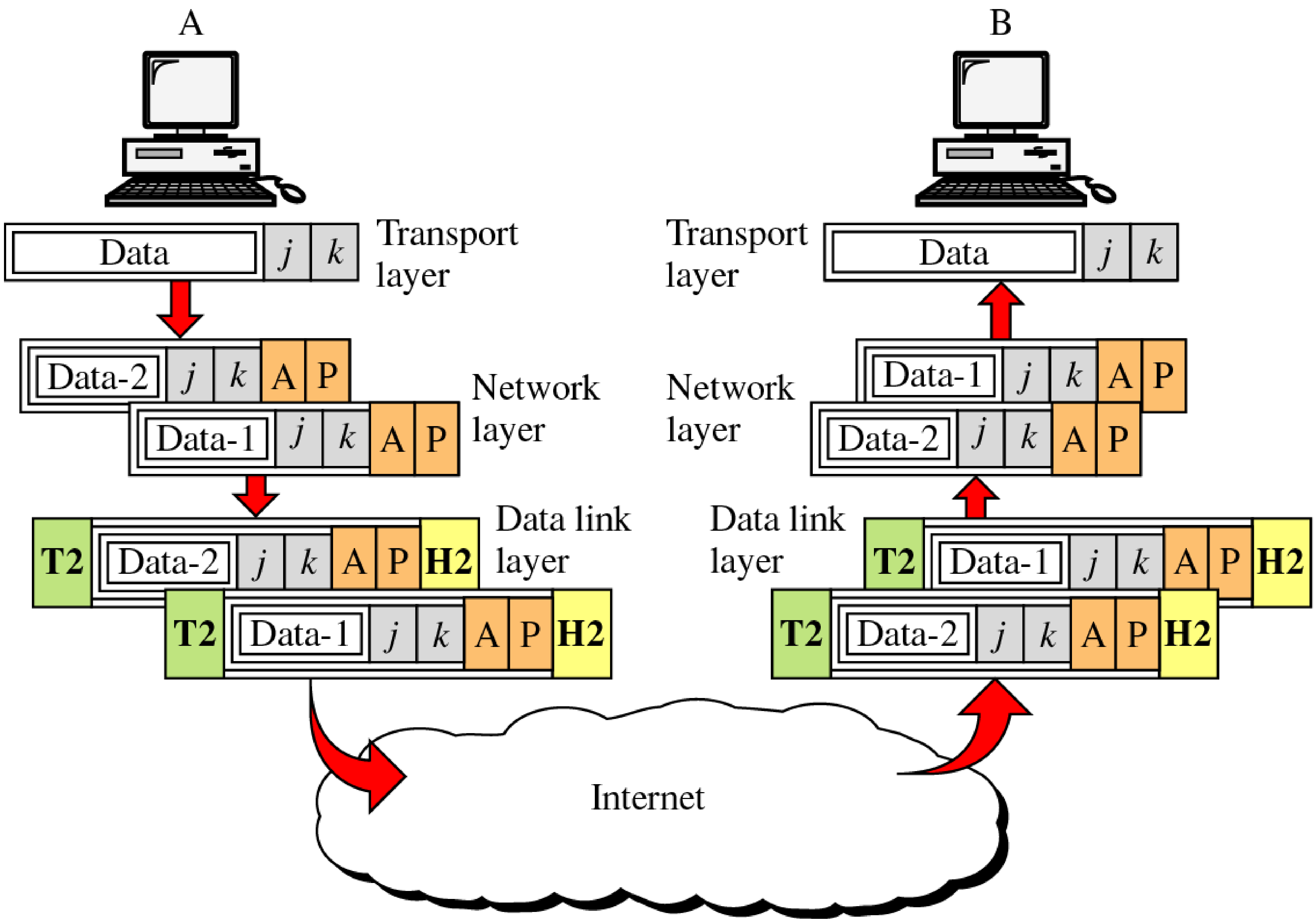
Specific addresses

Some applications have user-friendly addresses that are designed for that specific address.

- ***Example:***
  - ***e-mail address,***
  - ***URL(www.mmhe.com)***

- ***Theses addresses, however, get changed to the corresponding port and logical addresses by the sending computer.***

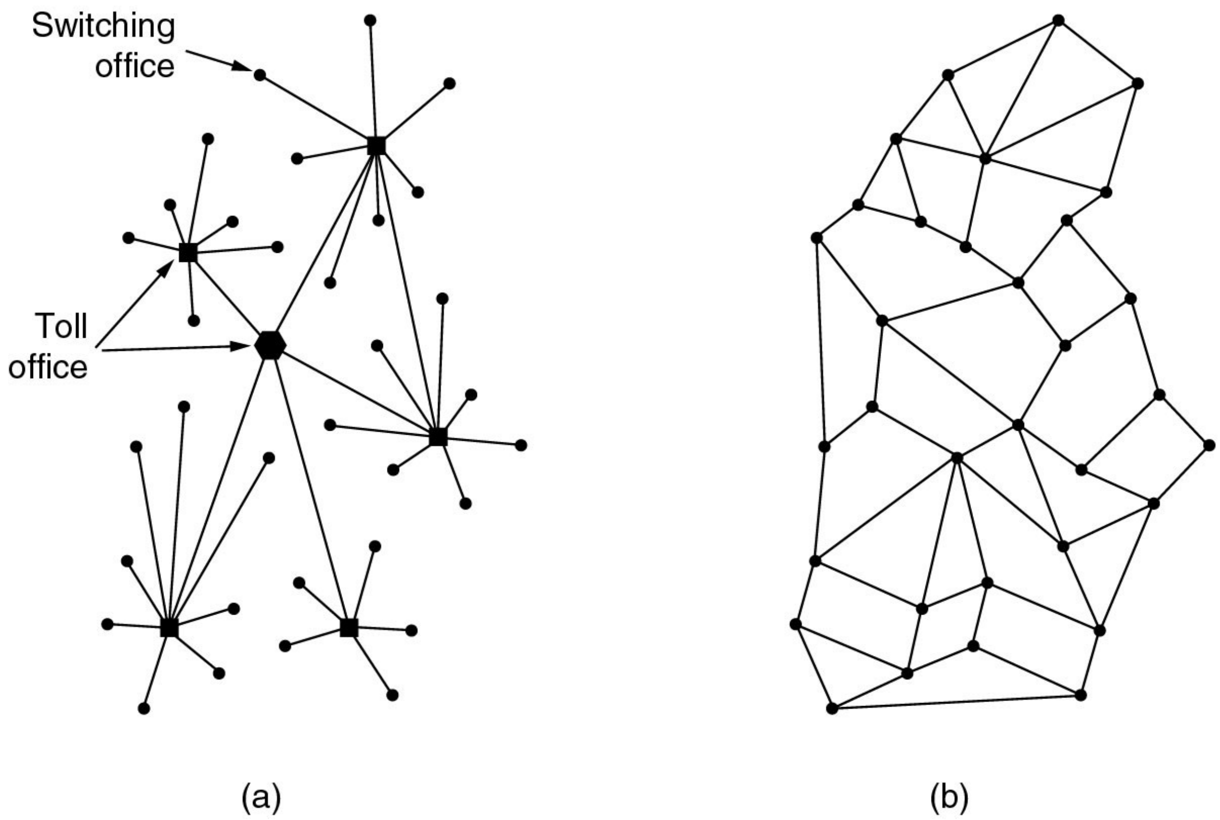
Example -3 (General Case)



Example Networks

- The Internet
- Connection-Oriented Networks:
  X.25, Frame Relay, and ATM
- Ethernet
- Wireless LANs: 802:11

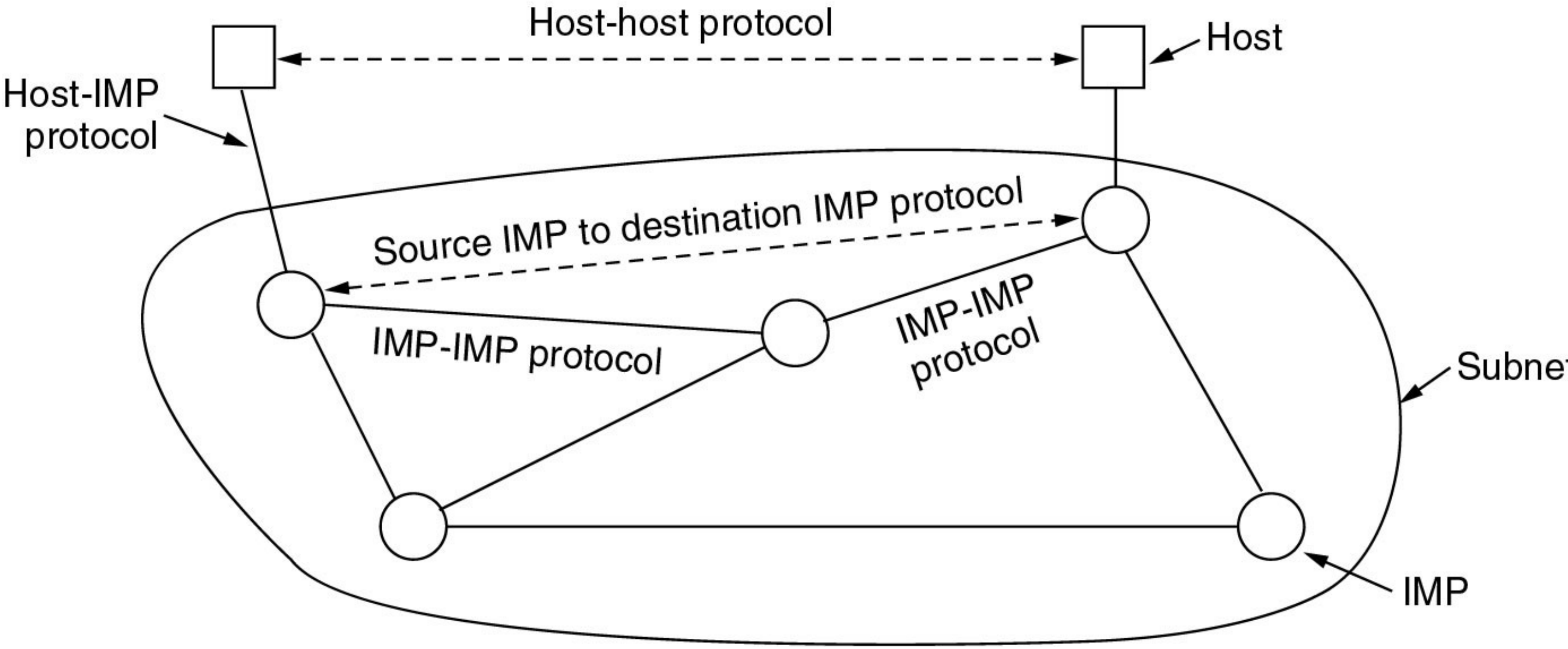
The ARPANET



(a) Structure of the telephone system.

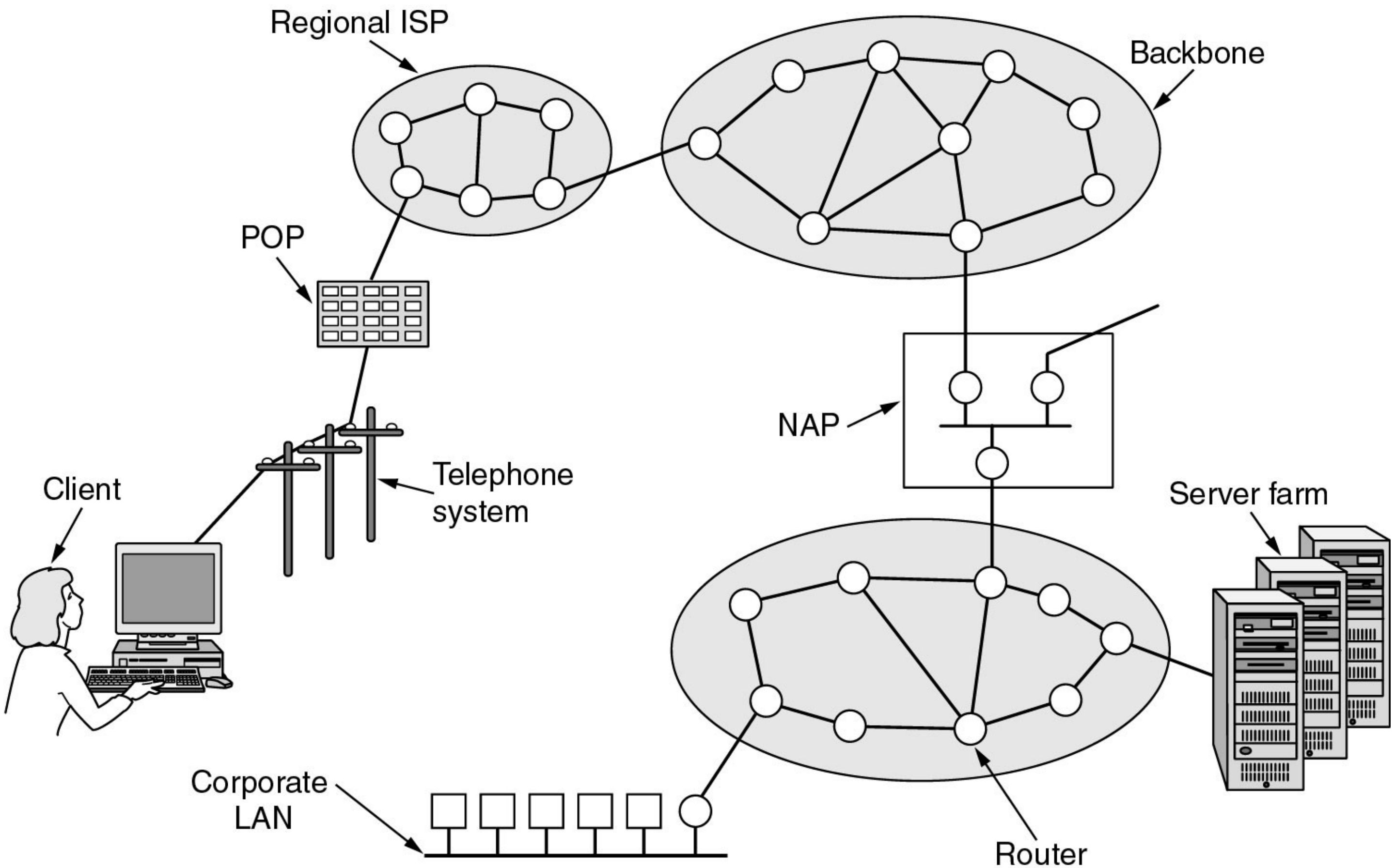
(b) Baran's proposed distributed switching system.

The ARPANET (2)



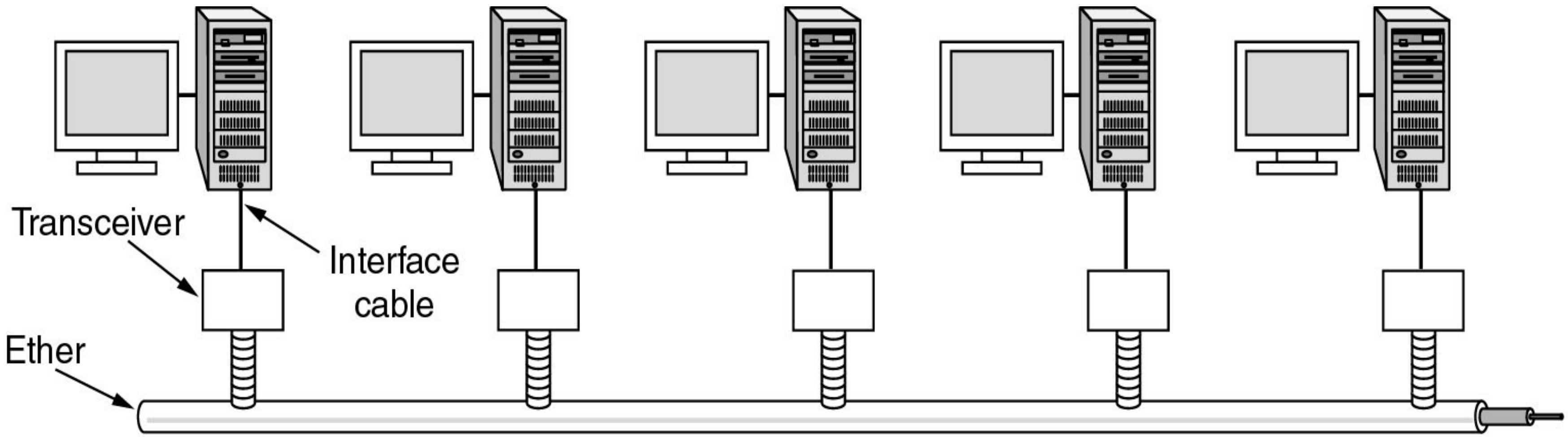
The original ARPANET design.

Architecture of the Internet



Overview of the Internet.

Ethernet



Architecture of the original Ethernet.

Network Standardization

- Who’s Who in the Telecommunications World
- Who’s Who in the International Standards World
- Who’s Who in the Internet Standards World

- ITU
- ISO
- ANSI
- IEEE
- EIA etc

ITU

- Main sectors
  - Radiocommunications
  - Telecommunications Standardization
  - Development
- Classes of Members
  - National governments
  - Sector members
  - Associate members
  - Regulatory agencies

IEEE 802 Standards

Number	Topic
802.1	Overview and architecture of LANs
802.2 ↓	Logical link control
802.3 *	Ethernet
802.4 ↓	Token bus (was briefly used in manufacturing plants)
802.5	Token ring (IBM's entry into the LAN world)
802.6 ↓	Dual queue dual bus (early metropolitan area network)
802.7 ↓	Technical advisory group on broadband technologies
802.8 †	Technical advisory group on fiber optic technologies
802.9 ↓	Isochronous LANs (for real-time applications)
802.10 ↓	Virtual LANs and security
802.11 *	Wireless LANs
802.12 ↓	Demand priority (Hewlett-Packard's AnyLAN)
802.13	Unlucky number. Nobody wanted it
802.14 ↓	Cable modems (defunct: an industry consortium got there first)
802.15 *	Personal area networks (Bluetooth)
802.16 *	Broadband wireless
802.17	Resilient packet ring

The 802 working groups. The important ones are marked with *. The ones marked with ↓ are hibernating. The one marked with † gave up.

Metric Units

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^{3}	1,000	Kilo
10^{-6}	0.000001	micro	10^{6}	1,000,000	Mega
10^{-9}	0.000000001	nano	10^{9}	1,000,000,000	Giga
10^{-12}	0.000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.0000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.0000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.0000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

The principal metric prefixes.

Questions

1. What are two reasons for using layered protocols?
2. If the unit exchanged at the data link level is called a frame and the unit exchanged at the network level is called a packet, do frames encapsulate packets or do packets encapsulate frames? Explain your answer.

   ANS: Frames encapsulate packets.

1. A system has an n-layer protocol hierarchy. Applications generate messages of length M bytes. At each of the layers, an h-byte header is added. What fraction of the network bandwidth is filled with headers?

   ANS: $hn/(M + hn)$

4. Which of the OSI layers handles each of the following:
   a) Dividing the transmitted bit stream into frames.
   b) Determining which route through the subnet to use.

Questions

1. A collection of five routers is to be connected in a point-to-point subnet. Between each pair of routers, the designers may put a high-speed line, a medium-speed line, a low-speed line, or no line. If it takes 100 ms of computer time to generate and inspect each topology, how long will it take to inspect all of them?

ANS: Call the routers *A, B, C, D, and E. There are ten potential lines: AB, AC,AD, AE, BC, BD, BE, CD, CE, and DE. Each of these has four possibilities* (three speeds or no line), so the total number of topologies is 4^{10} = 1,048,576.At 100 ms each, it takes 104,857.6 sec, or slightly more than 29 hours to inspect them all.

QUESTION

Q. A group of 2^n - 1 routers are interconnected in a centralized binary tree, with a router at each tree node. Router i communicates with router j by sending a message to the root of the tree. The root then sends the message back down to j. Derive an approximate expression for the mean number of hops per message for large n, assuming that all router pairs are equally likely.

ANS:The mean router-router path is twice the mean router-root path. Number thelevels of the tree with the root as 1 and the deepest level as *n*. *The path from* the root to level *n requires* $n - 1$ *hops, and 0.50 of the routers are at this level.* The path from the root to level $n - 1$ *has 0.25 of the routers and a length of* $n - 2$ *hops. Hence, the mean path length, l, is given by*

$$l = 0.5 \times (n - 1) + 0.25 \times (n - 2) + 0.125 \times (n - 3) + \ldots$$

Or $l = n\text{-}2$. *The mean router-router path is thus* $2n - 4$.