The OSI Model and the TCP/IP Protocol Suite

Outline:

1. Protocol Layers
2. OSI Model
3. TCP/IP Model
4. Addressing

OBJECTIVES

- To discuss the OSI model and its layer architecture and to show the interface between the layers.
- To briefly discuss the functions of each layer in the OSI model.
- To introduce the TCP/IP protocol suite and compare its layers with the ones in the OSI model.
- To show the functionality of each layer in the TCP/IP protocol with some examples.
- To discuss the addressing mechanism used in some layers of the TCP/IP protocol suite for the delivery of a message from the source to the destination.

Computer Network Components

Components of a computer network:

- Computer with NIC (PCs, laptops, handhelds)
- routers & switches (IP router, Ethernet switch)
- Links" Transmission media" (wired, wireless)
- **protocols (IP, TCP, CSMA/CD, CSMA/CA)**
- applications (network services)
  i.e. Network Operating System (NOS)
- humans and service agents

PROTOCOL LAYERS

- we discussed that a protocol is required when two entities need to communicate.
- When communication is not simple, we may divide the complex task of communication into several layers.
- The sending computer must:
  - Recognize the data.
  - Divide the data into manageable chunks.
  - Add information to each chunk of data to determine the location of the data and to identify the receiver.
  - Add timing and error-checking information.
  - Put the data on the network and send it on its way.
- In this case, we may need several protocols, one for each layer.

PROTOCOL LAYERS

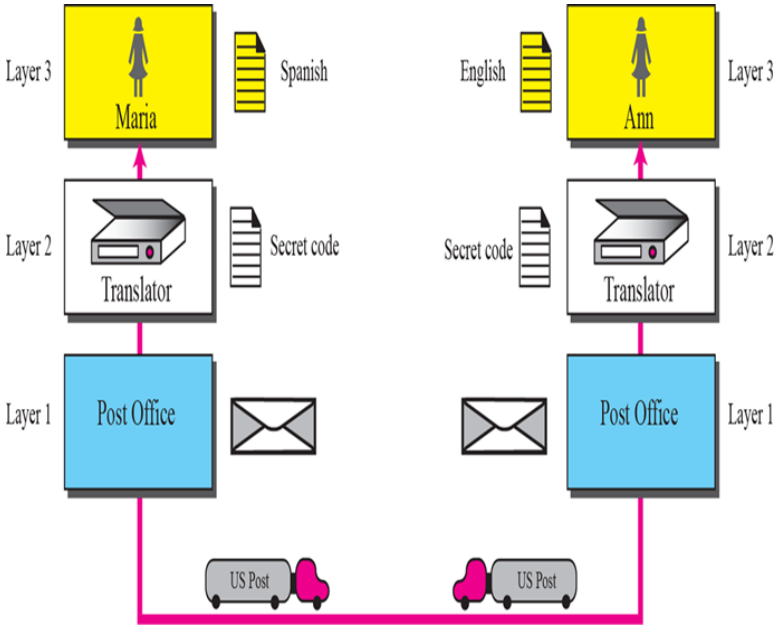
- Let us use a scenario in communication in which the role of protocol layering may be better understood.
- We use two examples. In the first example, communication is so simple that it can occur in only one layer.

Example 1

- Assume Maria and Ann are neighbors with a lot of common ideas. However, Maria speaks only Spanish, and Ann speaks only English.
- Since both have learned the sign language in their childhood, they enjoy meeting in a cafe a couple of days per week and exchange their ideas using signs.
- Occasionally, they also use a bilingual dictionary. Communication is face to face and Happens in one layer as shown in Figure.

Example 2

- Now assume that Ann has to move to another town because of her job. Before she moves, the two meet for the last time in the same cafe.
- Although both are sad, Maria surprises Ann when she opens a packet that contains two small machines.
  - The first machine can scan and transform a letter in English to a secret code or vice versa.
  - The other machine can scan and translate a letter in Spanish to the same secret code or vice versa.
- Ann takes the first machine; Maria keeps the second one.
- The two friends can still communicate using the secret code, as shown in Figure.



THE OSI MODEL

- Established in 1947, the *International Standards Organization (ISO)* is a multinational body dedicated to worldwide agreement on **international standards**.
- Almost three-fourths of countries in the world are represented in the ISO.
- 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.

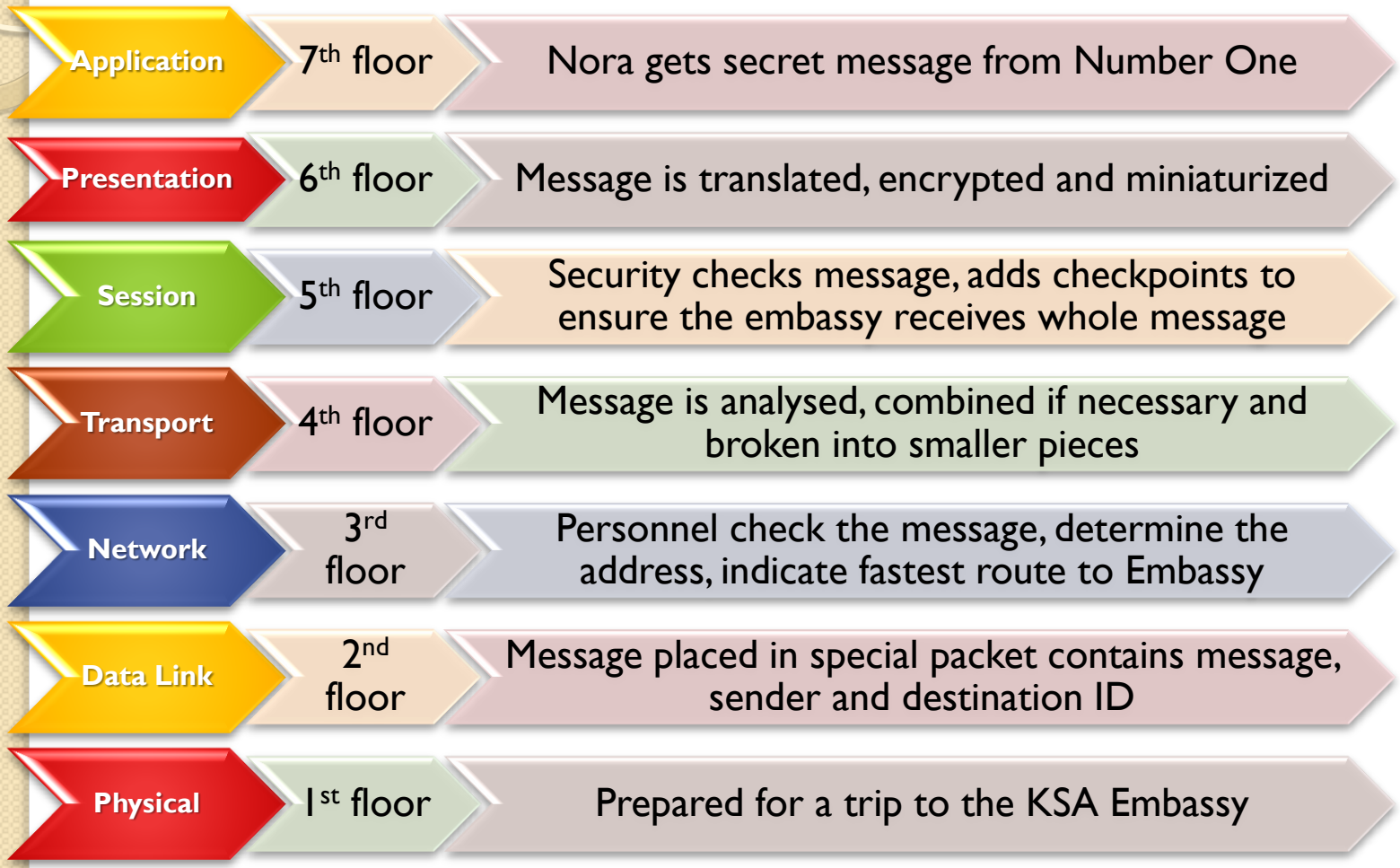
Topics Discussed in the Section

- Layered Architecture
- Layer-to-layer Communication
- Encapsulation
- Layers in the OSI Model

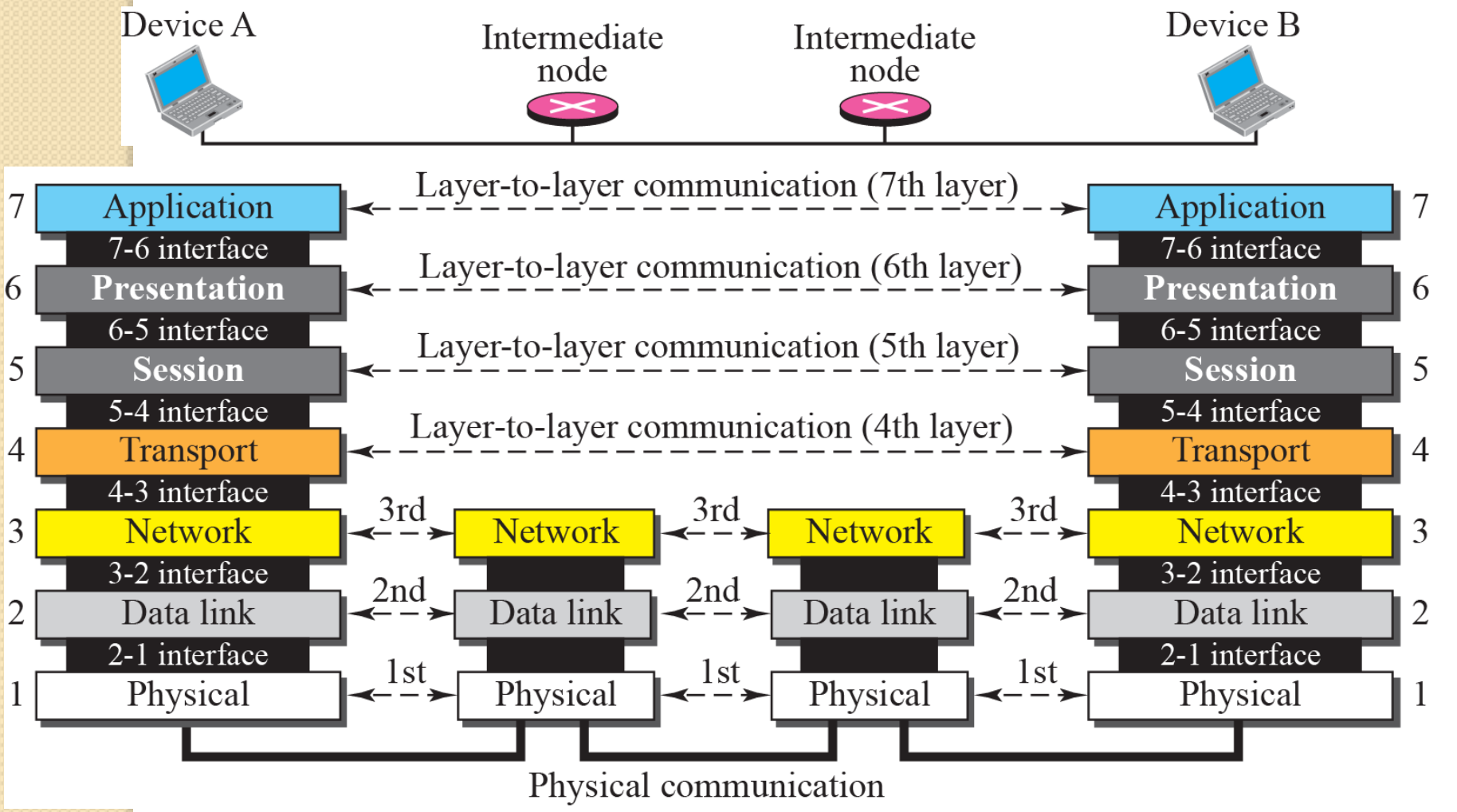
Note

ISO is the organization;
OSI is the model.

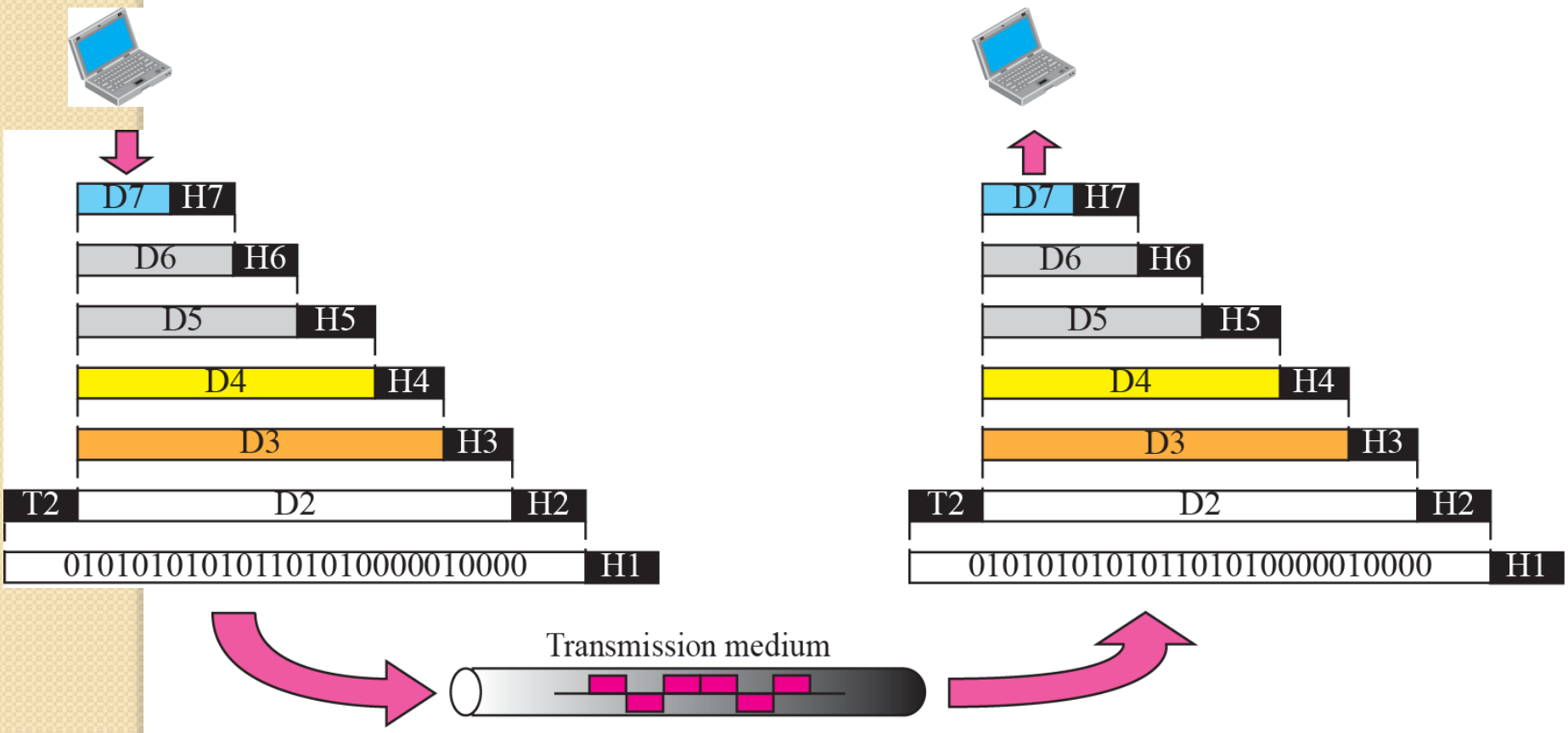
OSI Model and Nora



OSI layers


Device A
Intermediate node
Intermediate node
Device B
Layer-to-layer communication (7th layer)
Layer-to-layer communication (6th layer)
Layer-to-layer communication (5th layer)
Layer-to-layer communication (4th layer)
7 Application
7-6 interface
6 Presentation
6-5 interface
5 Session
5-4 interface
4 Transport
4-3 interface
3 Network
3-2 interface
2 Data link
2-1 interface
1 Physical
3rd
2nd
1st
Physical communication

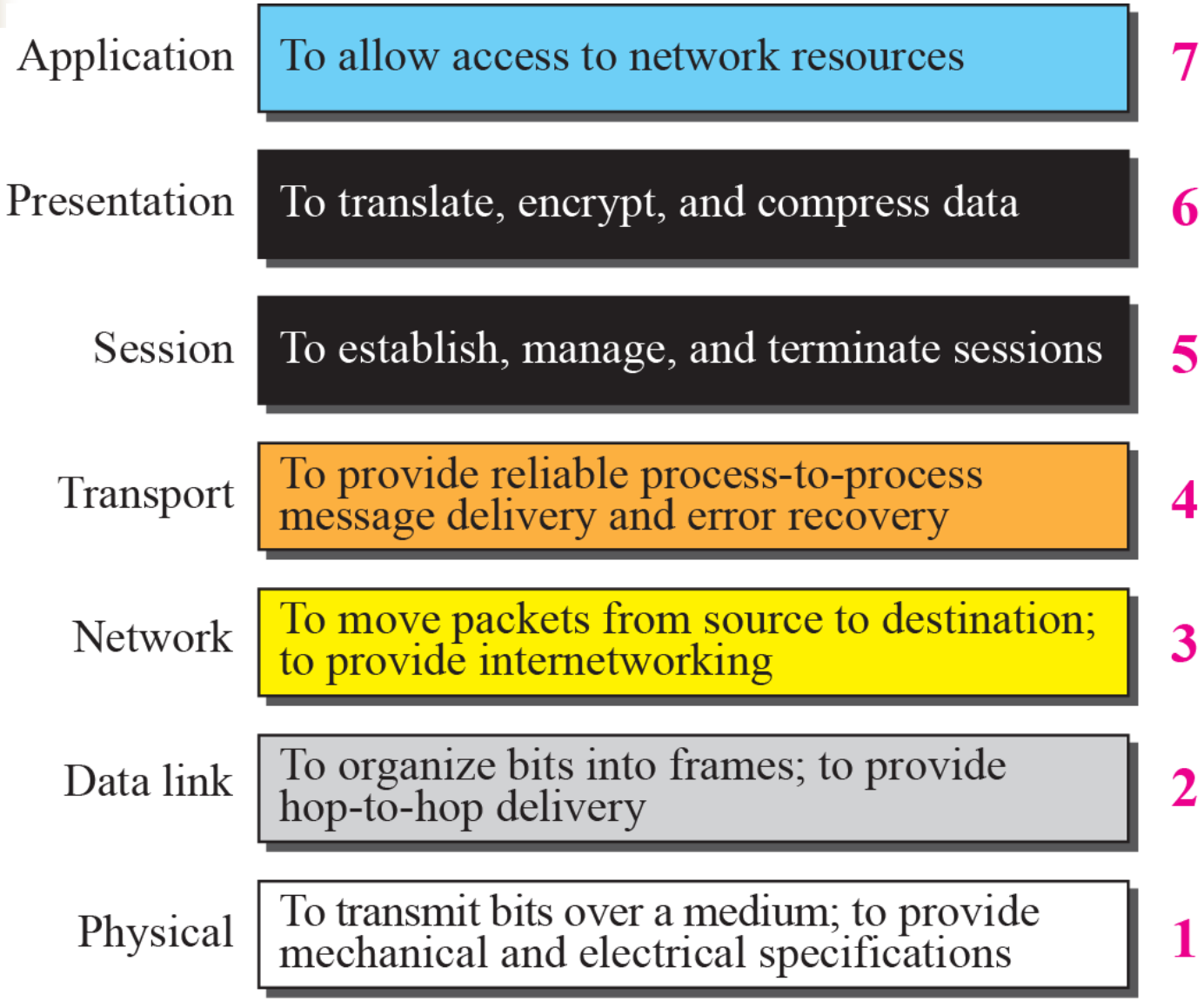
An exchange using the OSI model (Encapsulation)



Note

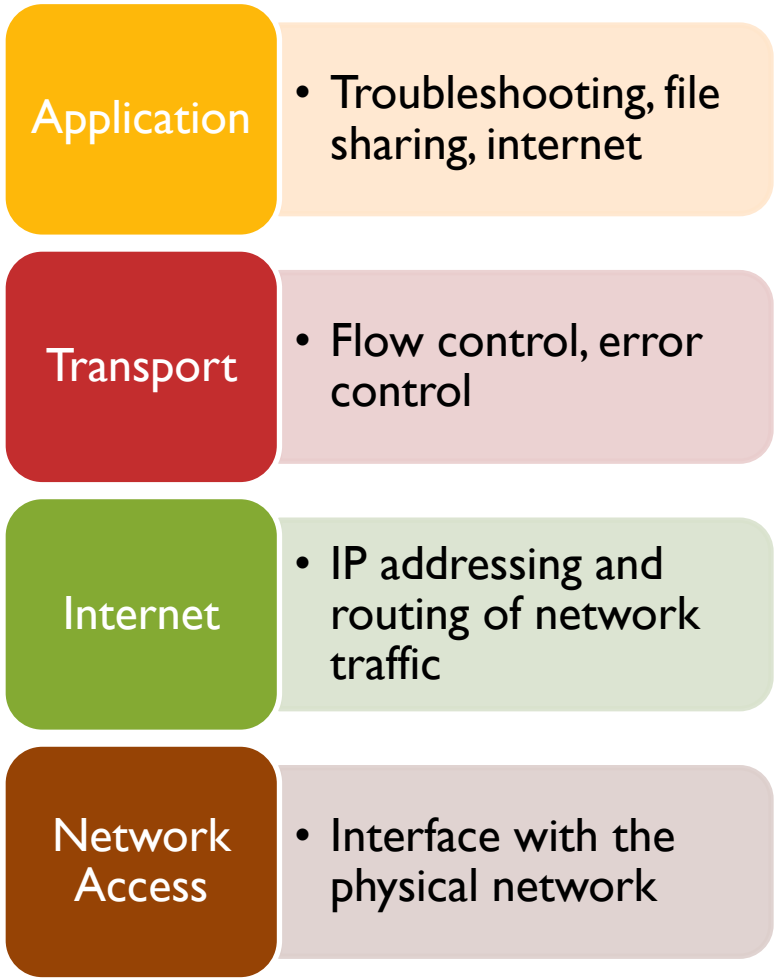
The physical layer is responsible for moving individual bits from one (node) to the next.

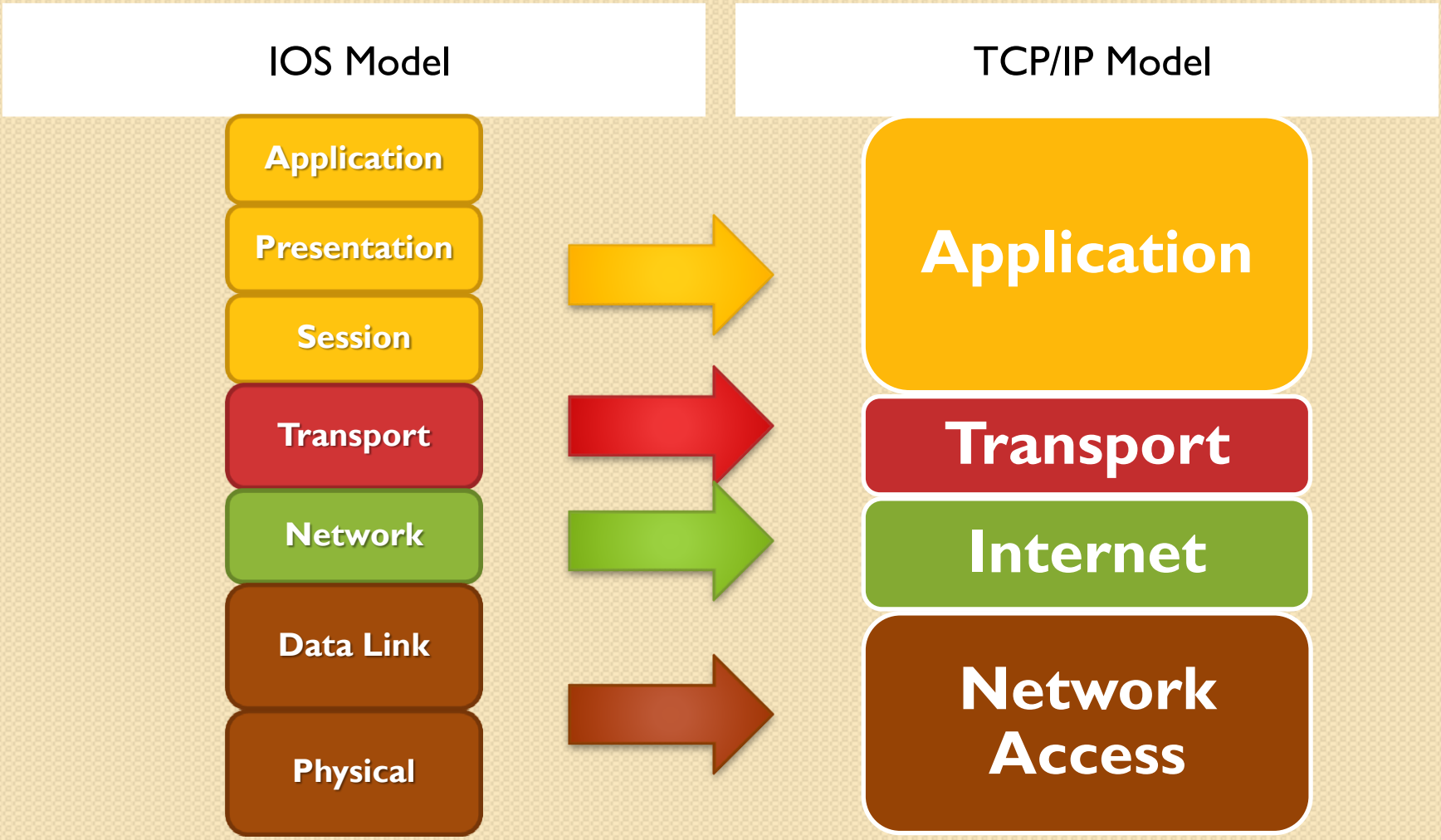
Summary of OSI Layers



TCP/IP Model

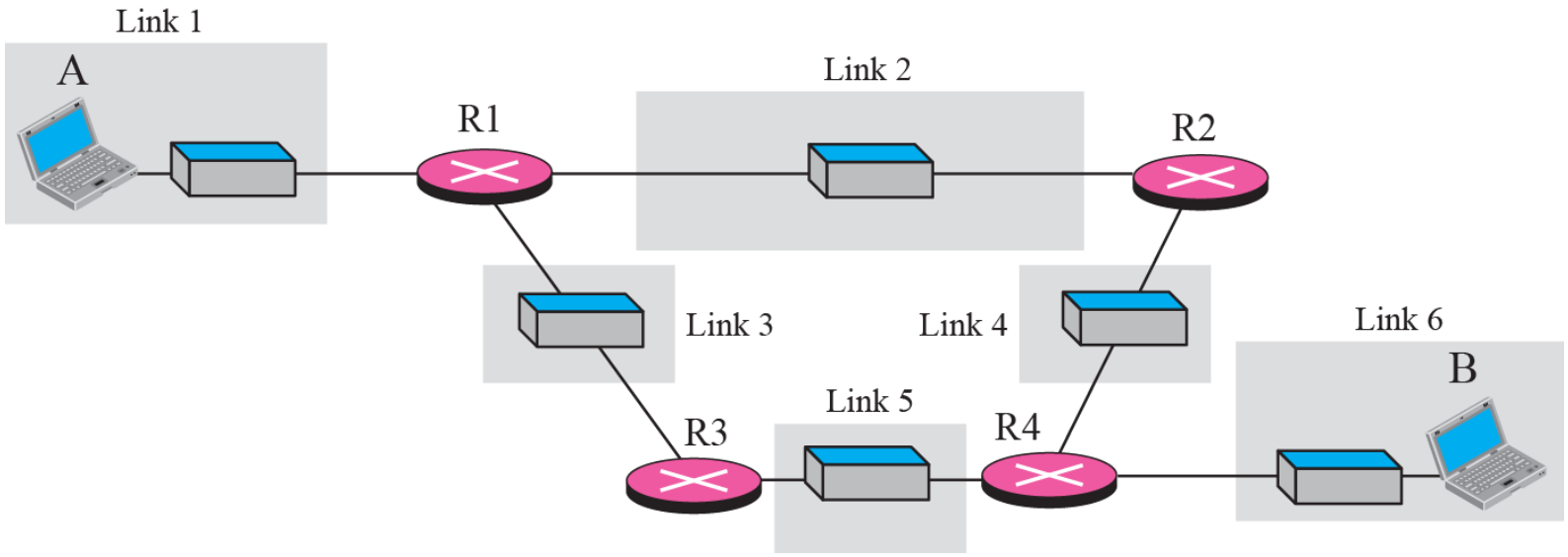
- The TCP/IP protocol suite was developed prior to the OSI model.
- Therefore, the layers in the TCP/IP protocol suite do not match exactly with those in the OSI model.





Comparison between OSI and TCP/IP

A private internet



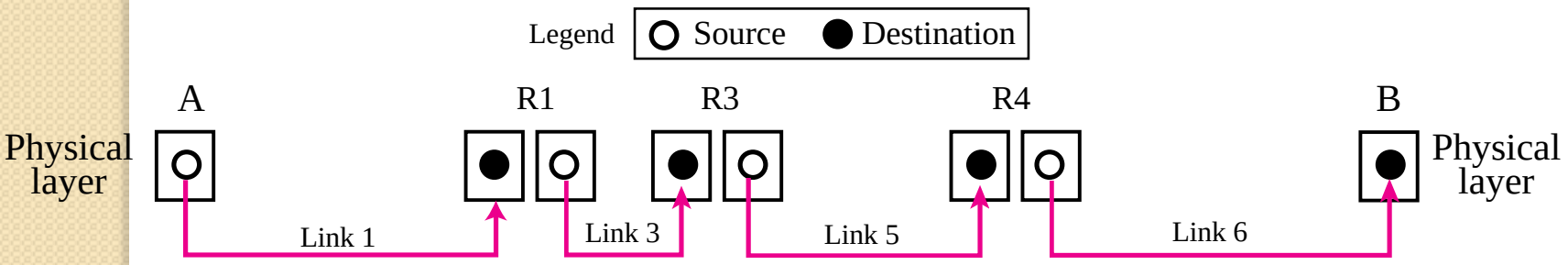
In this section we briefly describe the functions of each layer in the OSI model.

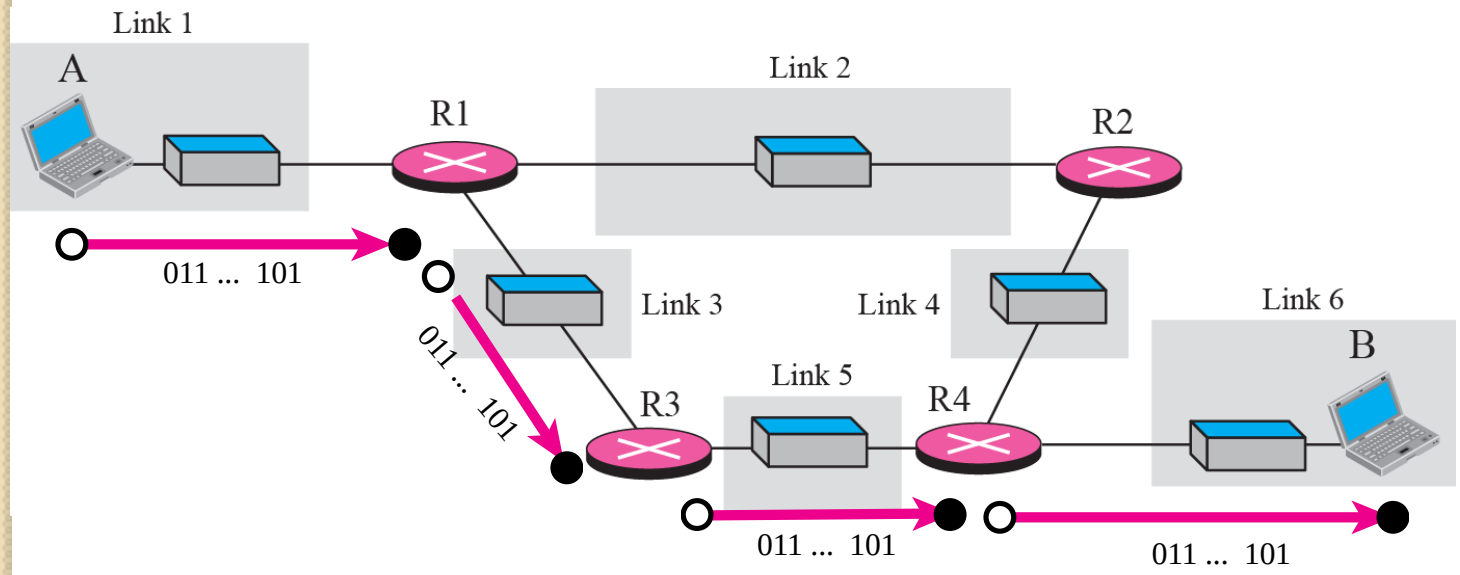
LAYERS IN THE OSI MODEL

Physical layer

- defines the procedures and functions that physical devices and interfaces have to perform for transmission occur.
- The physical layer is concerned with the following:
  - Physical characteristics of interfaces and media:
  - Representation of the bits
  - Data rate, the number of bits sent each second.
  - Line configuration, Point to point or multipoint configuration.
  - Physical topology
  - Transmission Mode : Simplex, half duplex or full duplex

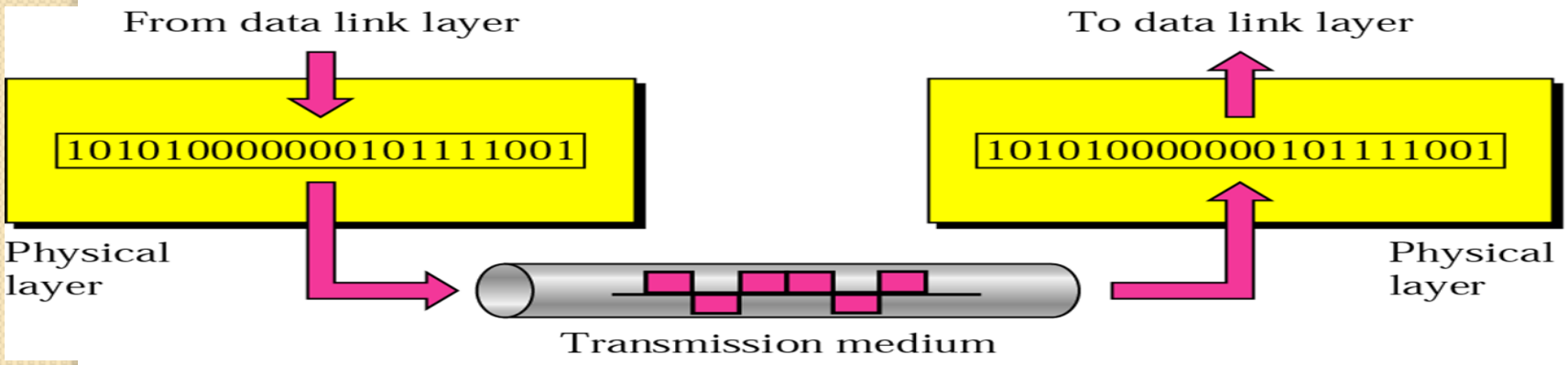
Communication at the physical layer





Note

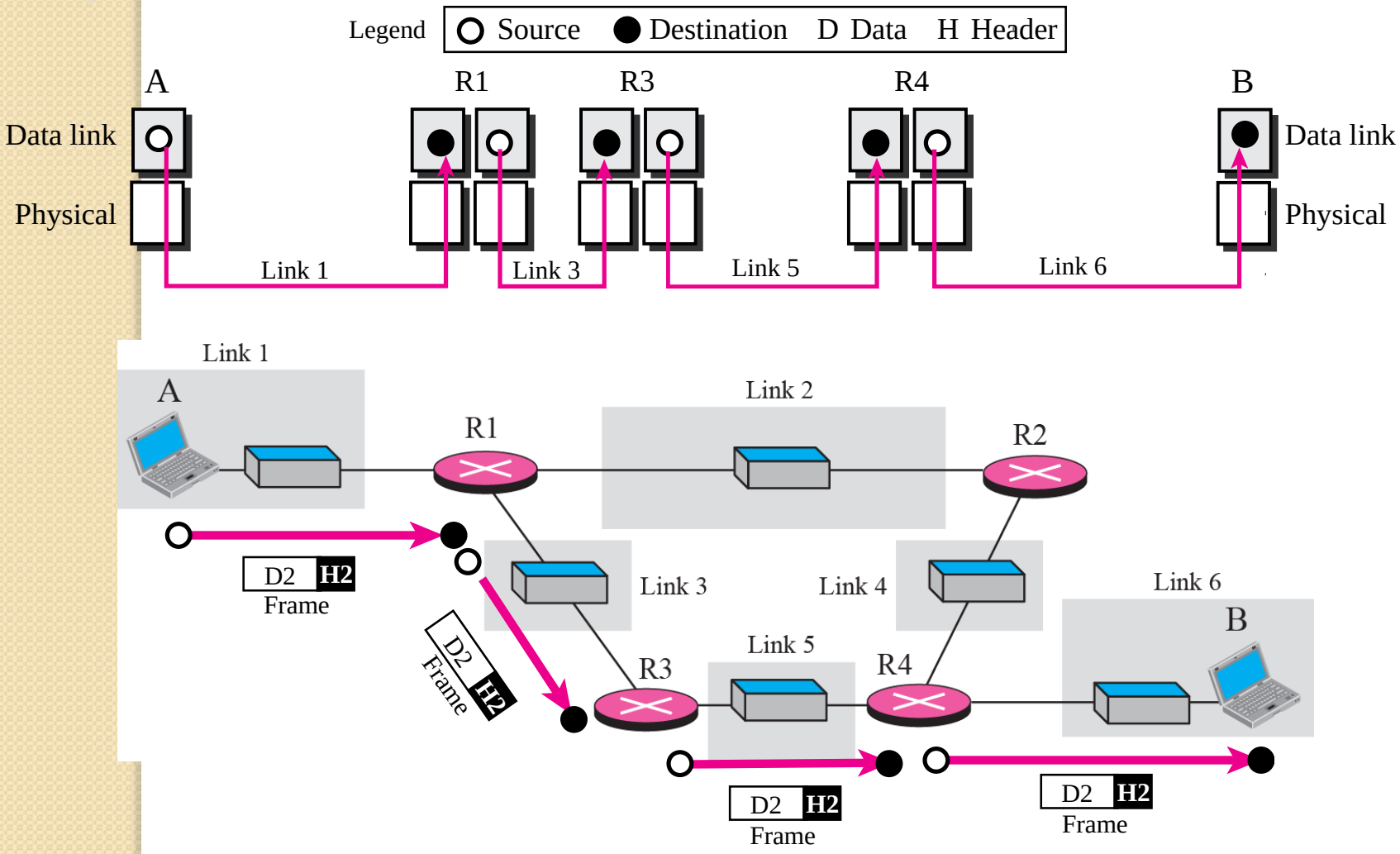
The unit of communication at the physical layer is a bit.



Data Link Layer

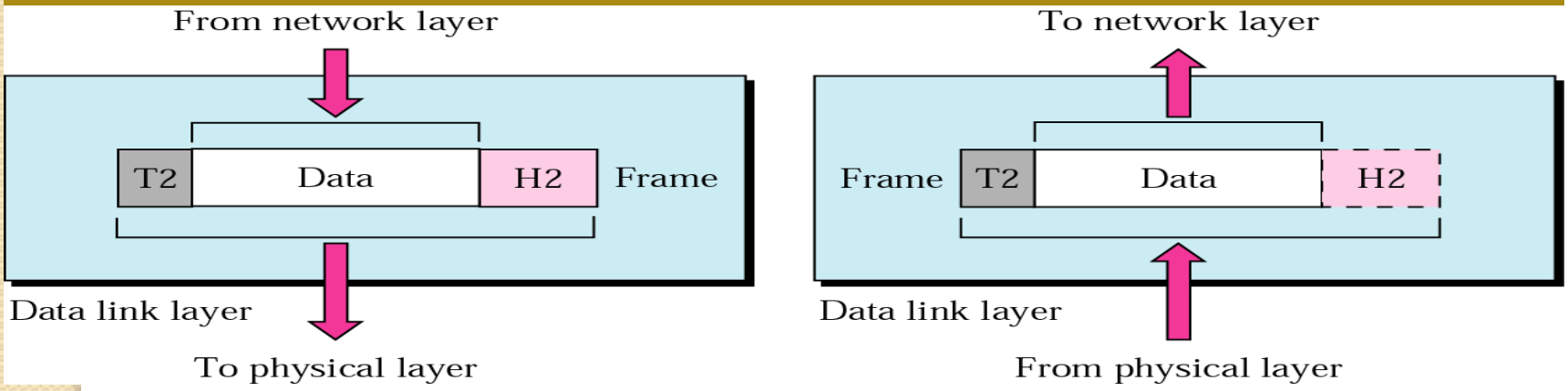
- The data link layer transforms the physical layer, a raw transmission facility, to a reliable link and is responsible for node-to-node delivery.
- The Data Link layer is concerned with the following:
  - Framing.
  - Physical addressing, each node has its unique address.
  - Flow Control.
  - Access Control.
  - Error control, normally achieved through a trailer to the end of the frame.

Communication at the data link layer



Note

The unit of communication at the data link layer is a frame.

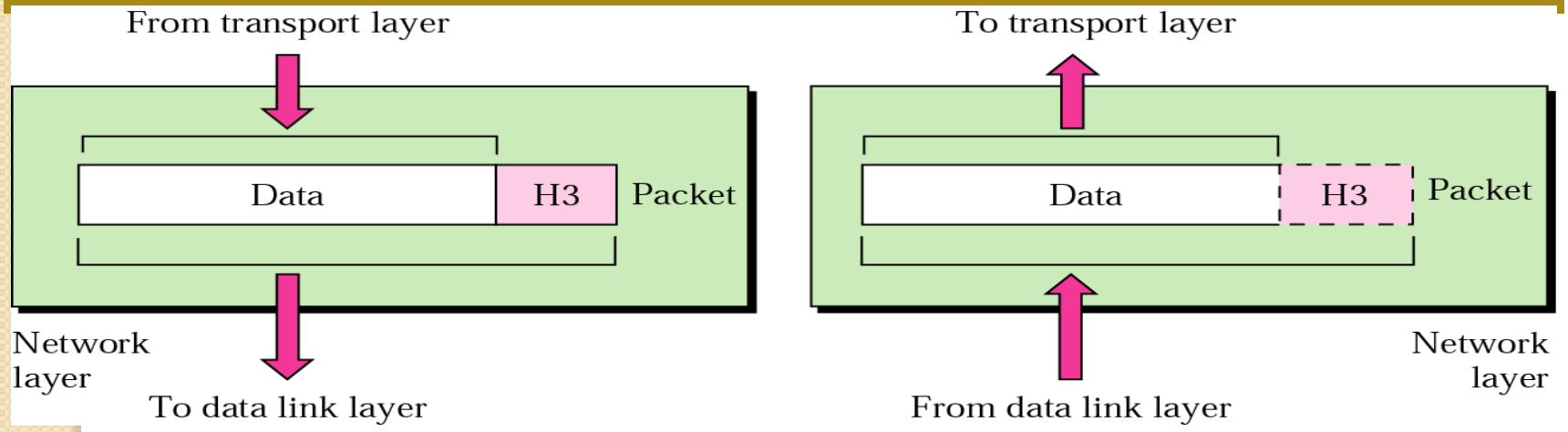


Network Layer

- Is responsible for the source-to-destination delivery of a **packet** possible **across multiple networks.**
- Functions:
  - Logical addressing.
  - Routing, It determines which path the data should take based on network conditions, priority of service, and other factors.

Note

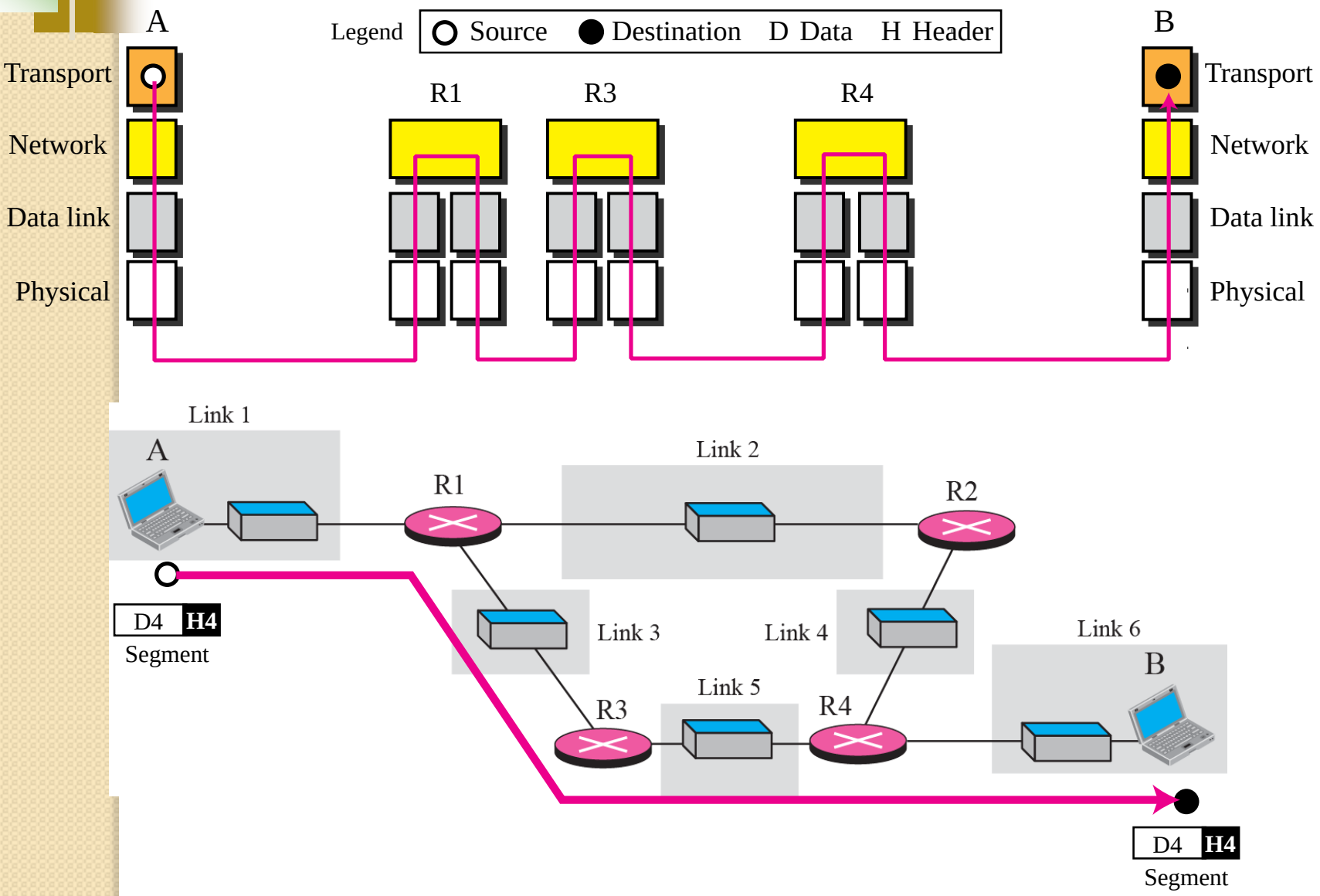
The unit of communication at the network layer is a datagram (Packet).



Transport Layer

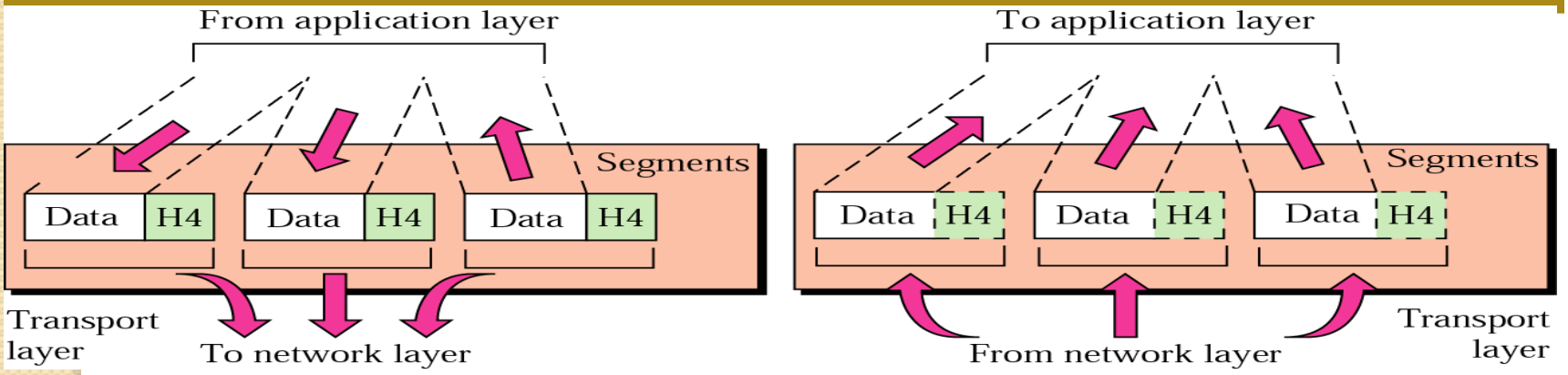
- The transport layer is responsible for process-to-process delivery of the entire message.
- Makes sure that the data arrives without errors, in the proper sequence and in a reliable condition.
- Functions:
  - Port addressing, The network layer gets each packet to the correct computer; the transport layer gets the entire message to the correct process on that computer.
  - Segmentation and reassembly: a message is divided into transmittable segments, each having a sequence number
  - Connection control: The transport layer can be either connectionless or connection-oriented.
  - Flow control
  - Error control

Communication at transport layer



Note

The unit of communication at the transport layer is a segment, user datagram, or a packet, depending on the specific protocol used in this layer.



Session Layer

- the *session layer*, allows two applications on different computers to open, use, and close a connection called a *session*.
  - (A session is a highly structured dialog between two workstations.)

- Functions:
  - **Dialog control**
    - It also makes sure the session is orderly, establishing which node transmits first, how long it can transmit, and what to do in case of an error.
    - It performs name-recognition and other functions, such as security, that are needed to allow two applications to communicate over the network.

  - **Synchronization**
    - The session layer synchronizes user tasks by placing **checkpoints** in the data stream.
    - The checkpoints break the data into smaller groups for error detection. It allows information of different streams, perhaps originating from different sources, to be properly combined or synchronized.
      - An example application is web conferencing, in which the streams of audio and video must be synchronous to avoid so-called lip synch problems. It ensures that the person displayed on screen is the current speaker.

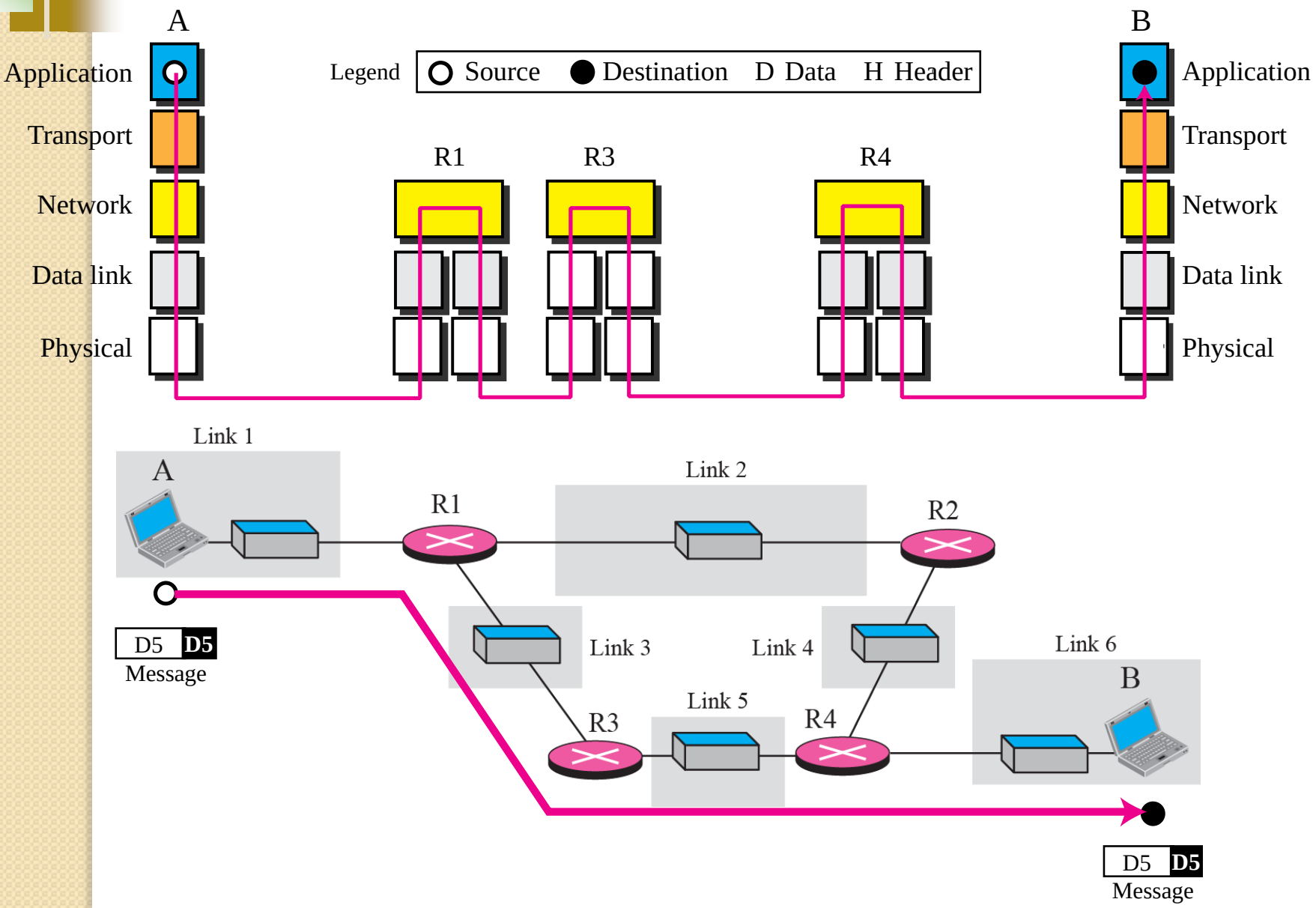
presentation layer

- The presentation layer is responsible for translation, compression, and encryption.
- **Deals with the actual formatting of the data.**
  - For example, data might be converted from EBCDIC to ASCII formatting so that the receiving node can understand it.

Application Layer

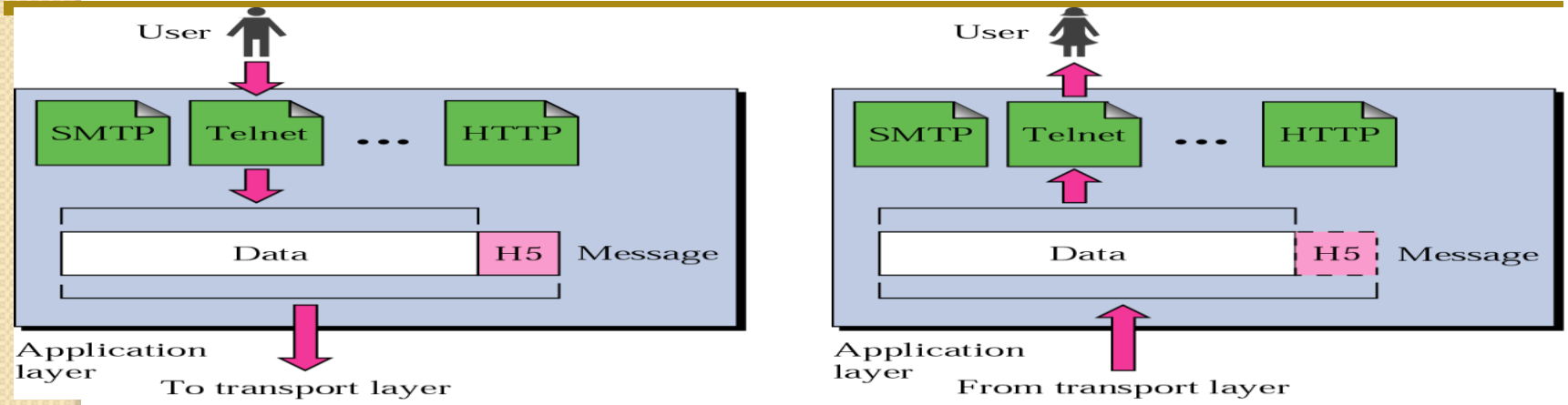
- This layer relates to the services that directly provide user interfaces support user applications or services, such as software for file transfers, database access, and e-mail.
- In other words, it serves as a window through which application processes can access network services.
- The application layer enables the user to access the network.
- This would be the layer that a programmer uses to allow his application to access a network service, such as linking into a database.

Communication at application layer



Note

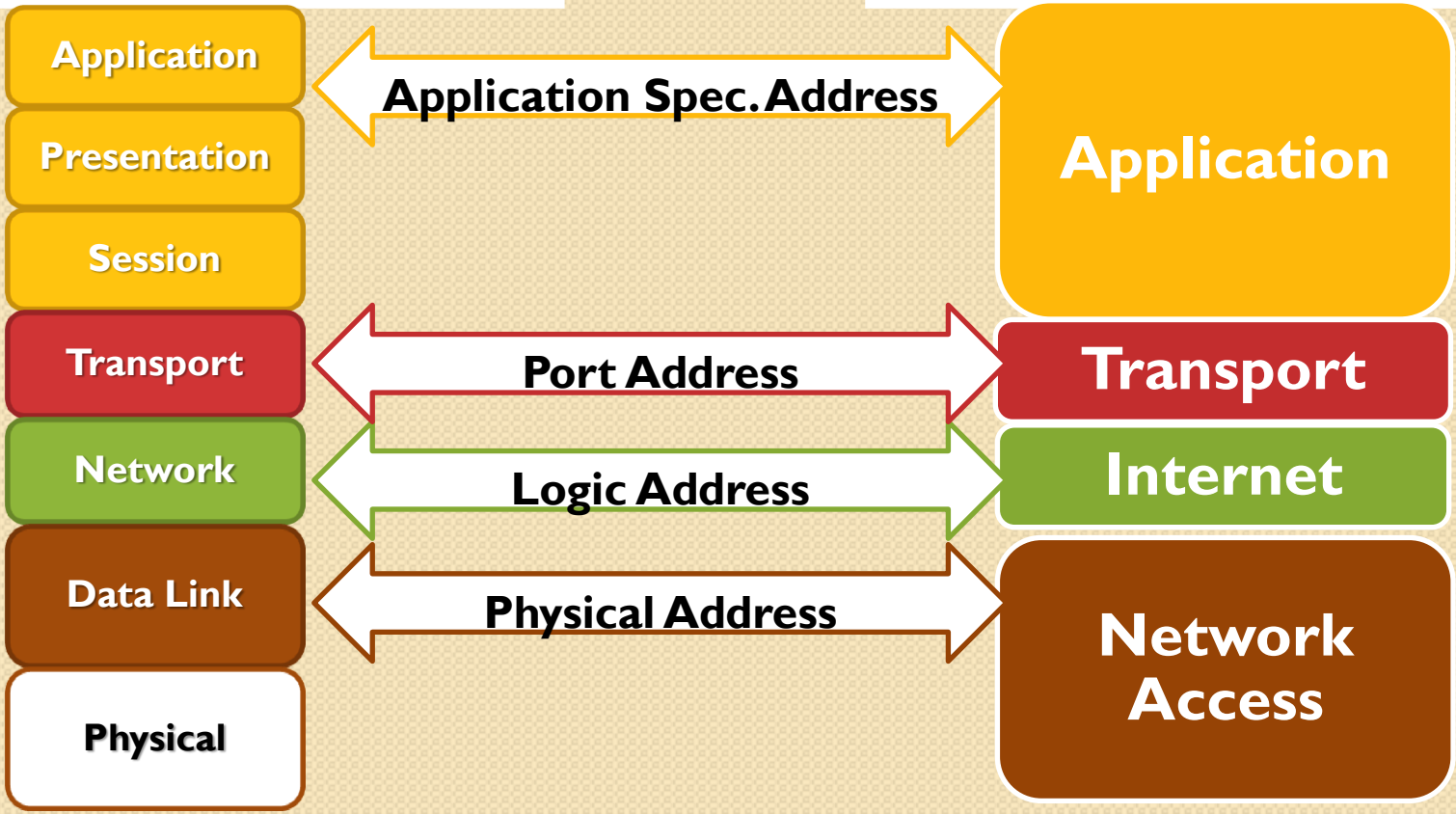
The unit of communication at the application layer is a message.



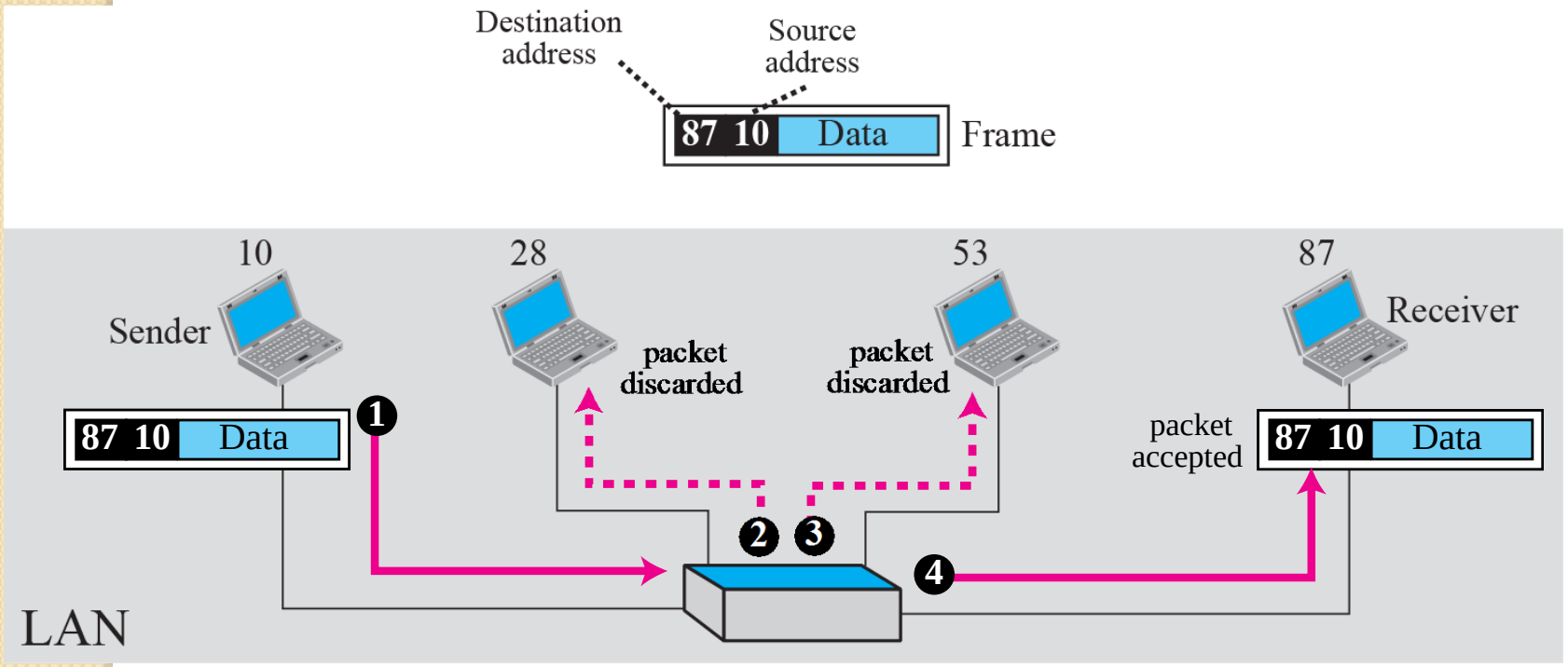
ADDRESSING

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

Each address is related to a one layer in the TCP/IP architecture, as shown in Figure.



Example 1: physical addresses



Example 1

As we will see later, most local area networks represent the physical address in two ways:

- IPv4
  - use a 32-bit (4-byte) physical address written as decimal digits; every byte (2 hexadecimal digits) is separated by a dot, as shown below

128.7.0.0

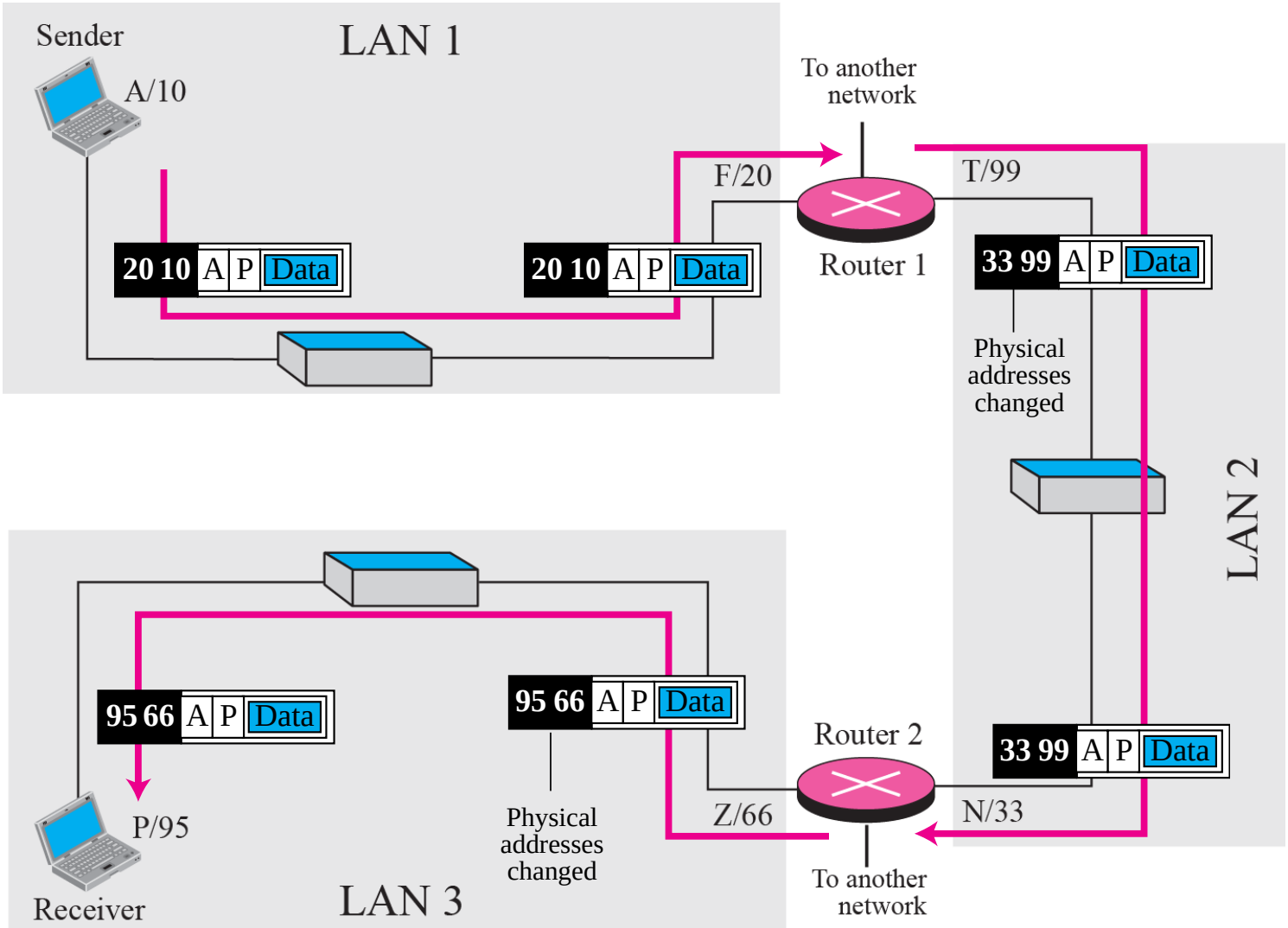
A 4-byte (a byte represent 8 bits called octet) physical address

- IPv6 (new version)
  - 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 2: logical addresses



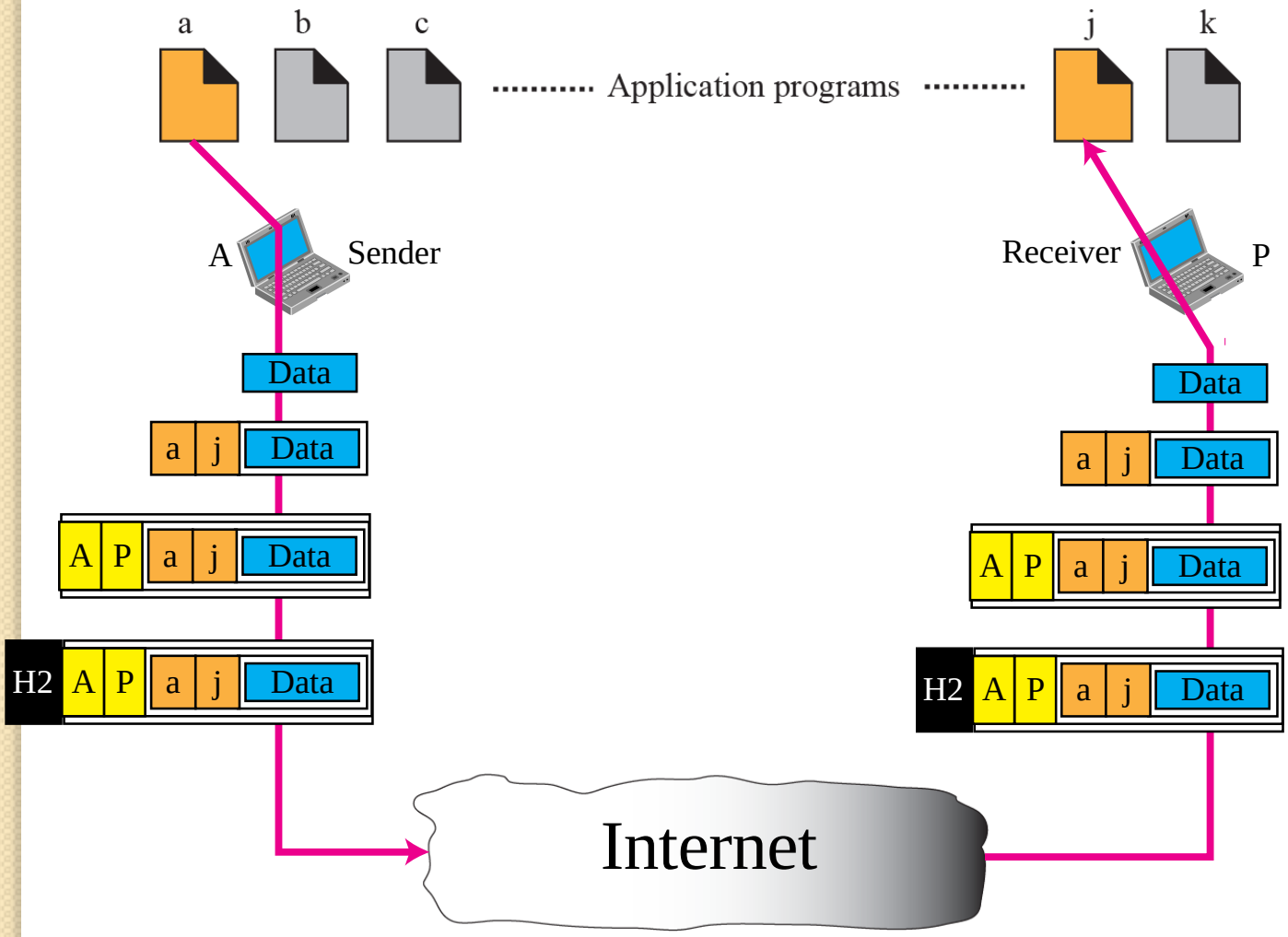
Note

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

Example 2

- the purpose of ports is to uniquely identify different applications or processes running on a single computer and thereby enable them to share a single physical connection to a packet-switched network like the Internet.

Example 3: port numbers



Note

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

Example 3

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

References

- http://pluto.ksi.edu/~cyh/cis370/ebook/ch05b.htm
- CSC 1202 2012-2013 Lecture Notes.
- Chapter 2 in TCP/IP Protocol Suite , 4th ed, Behrouz A. Forouzan