

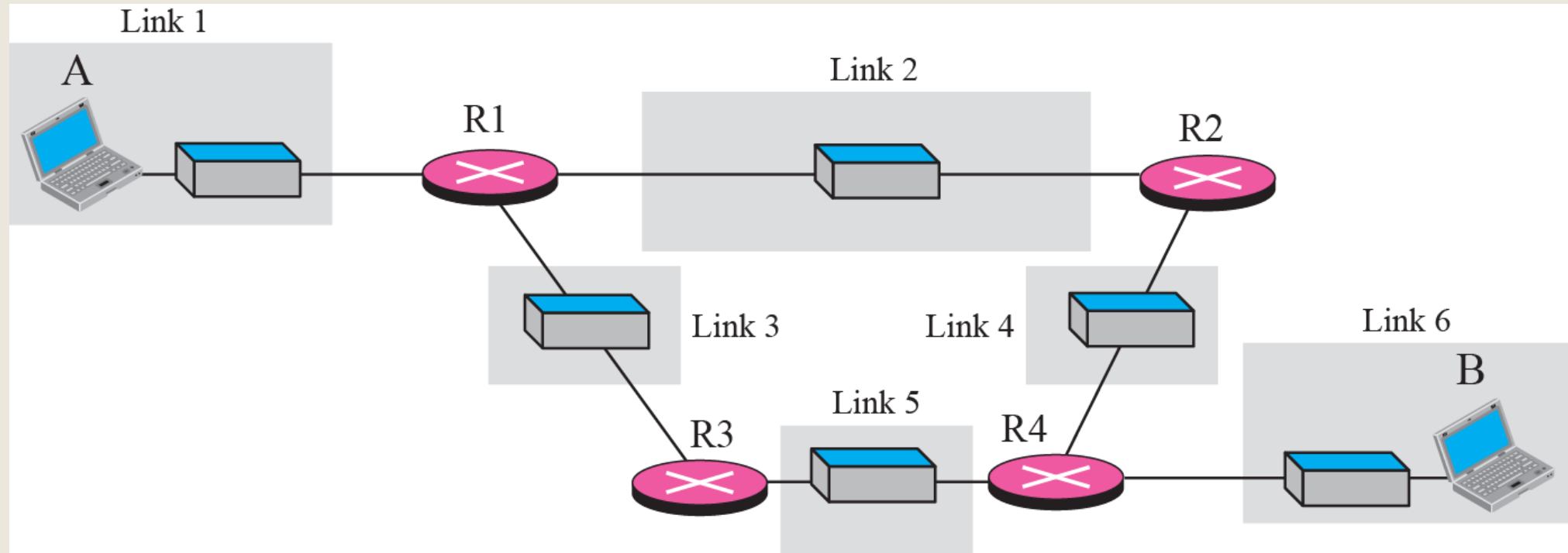
# DATA COMMUNICATION AND NETWORKING

# 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

# Computer Network



# PROTOCOL LAYERS

- 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.

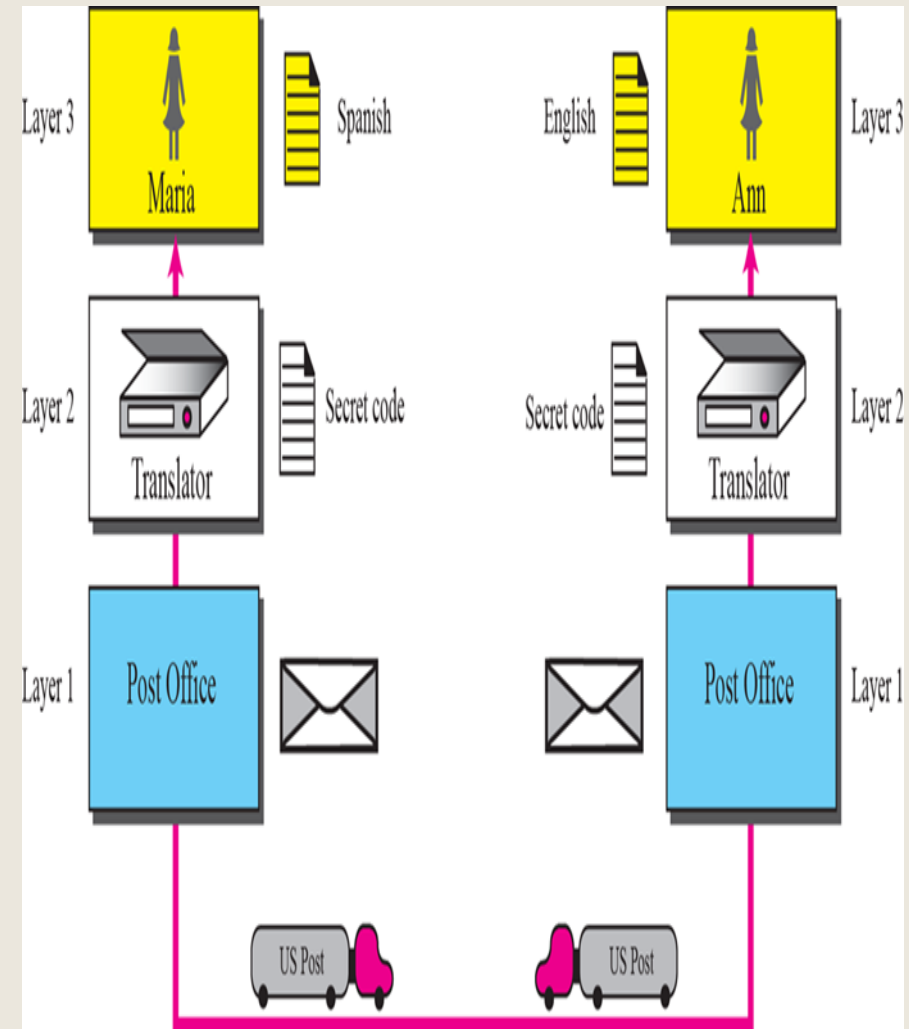
# Example 1

- 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.



# Example2

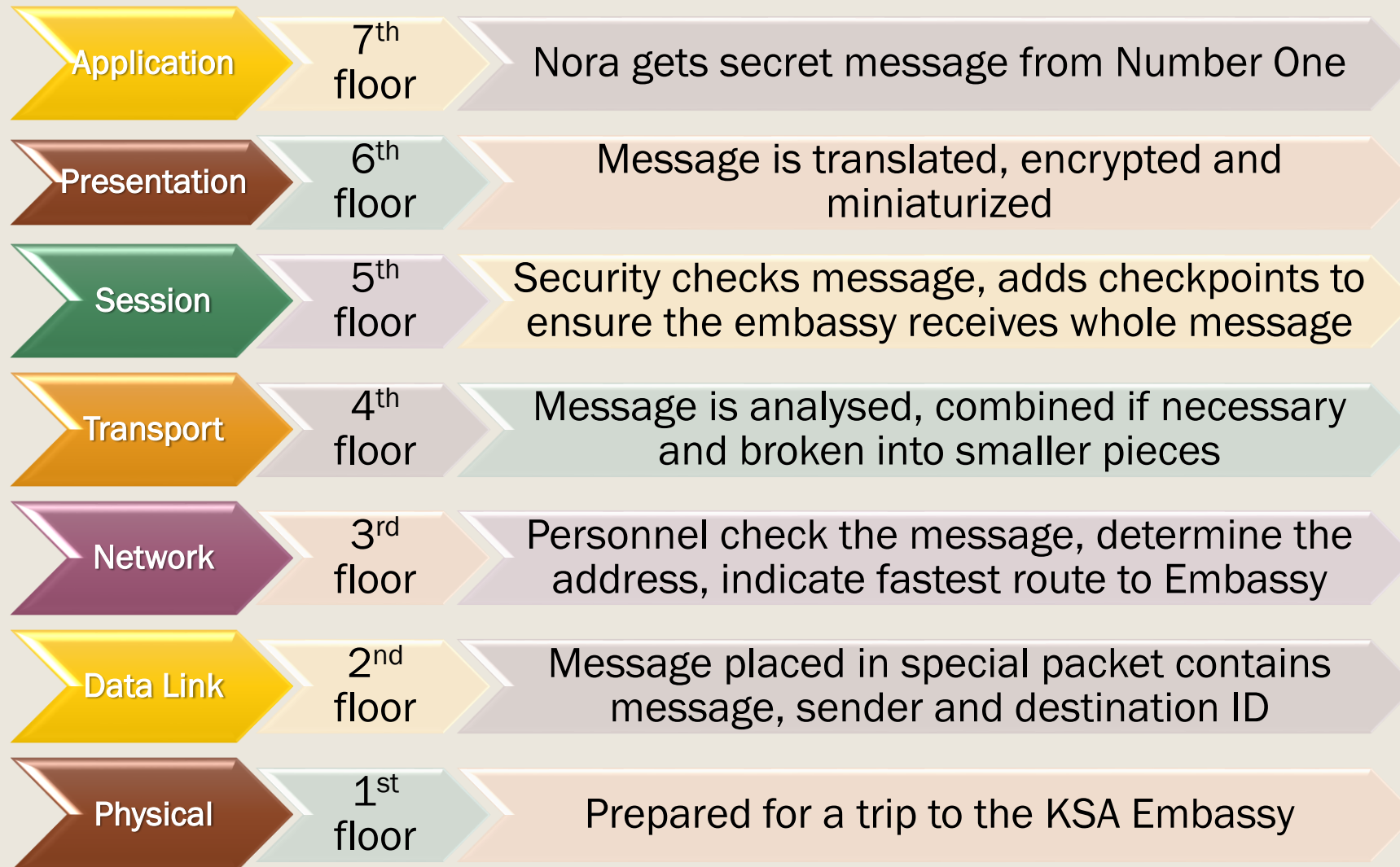
- Now assume that Ann has to move to another town because of her job. Before she moves, the two meet for the last time in the same cafe.
- Although both are sad, Maria surprises Ann when she opens a packet that contains two small machines.
  - *The first machine can scan and transform a letter in English 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.

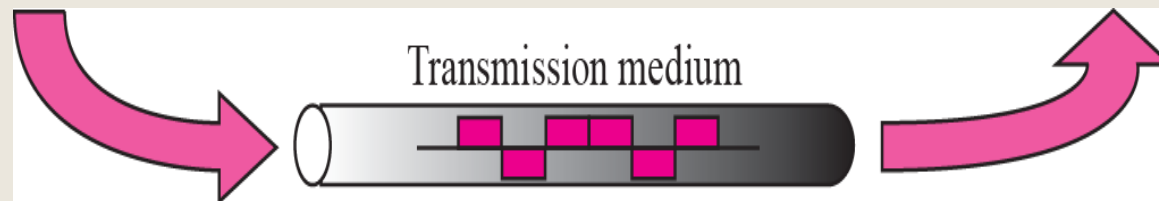
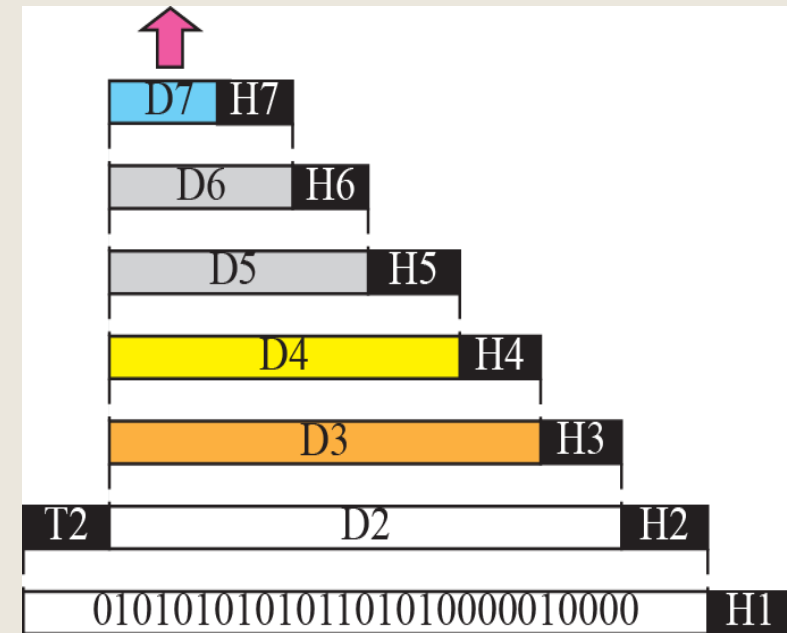
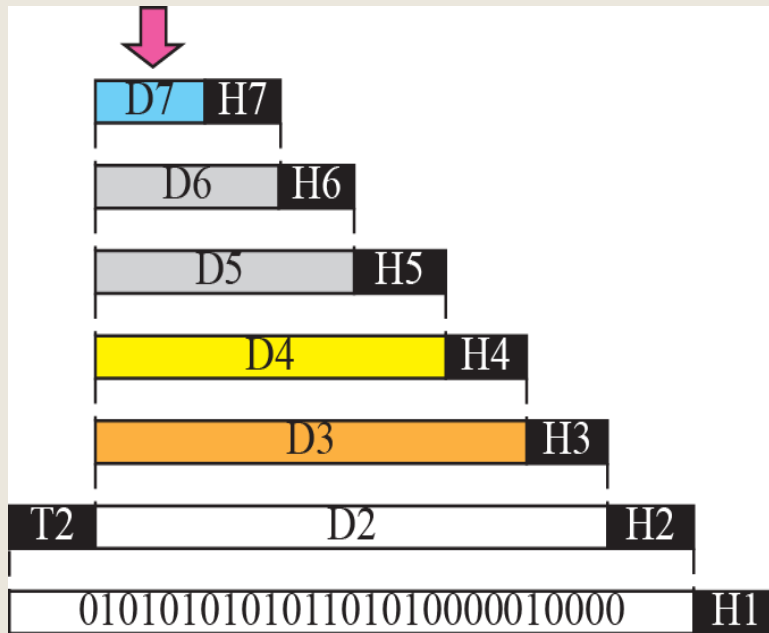
# OSI Model and Nora







# An exchange using the OSI model ( Encapsulation)



# LAYERS IN THE OSI MODEL

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



*Note*

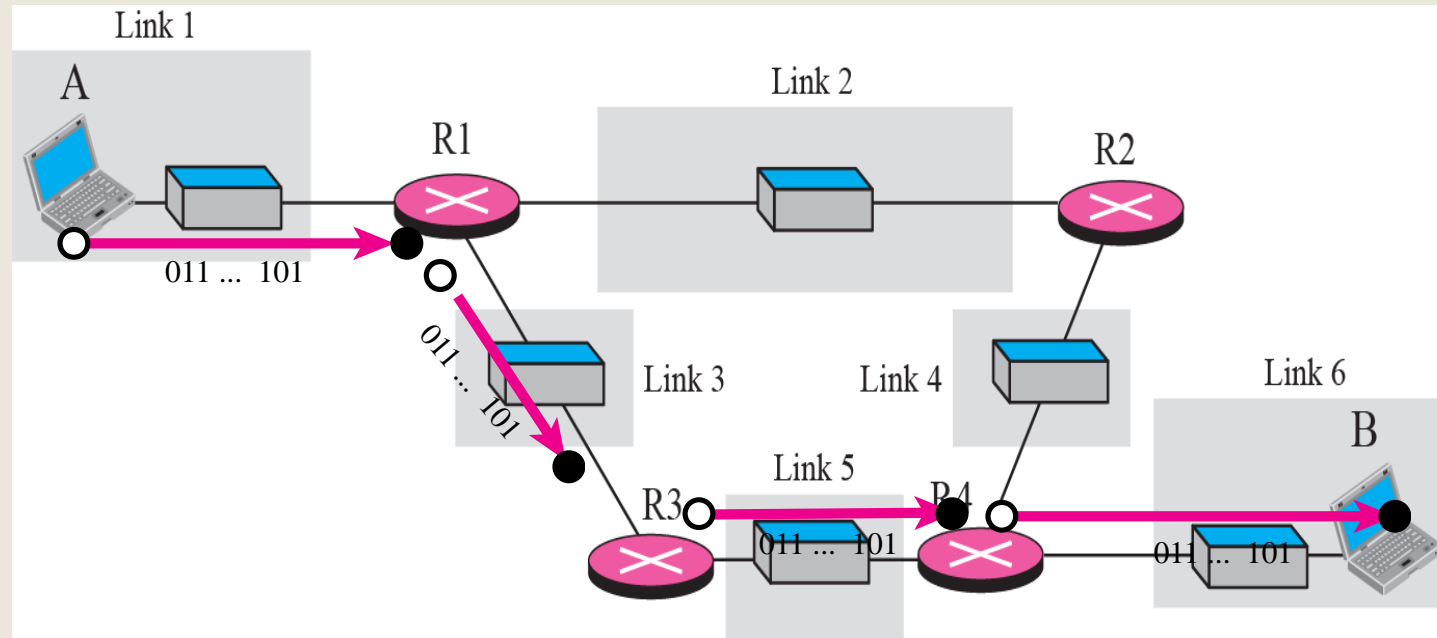
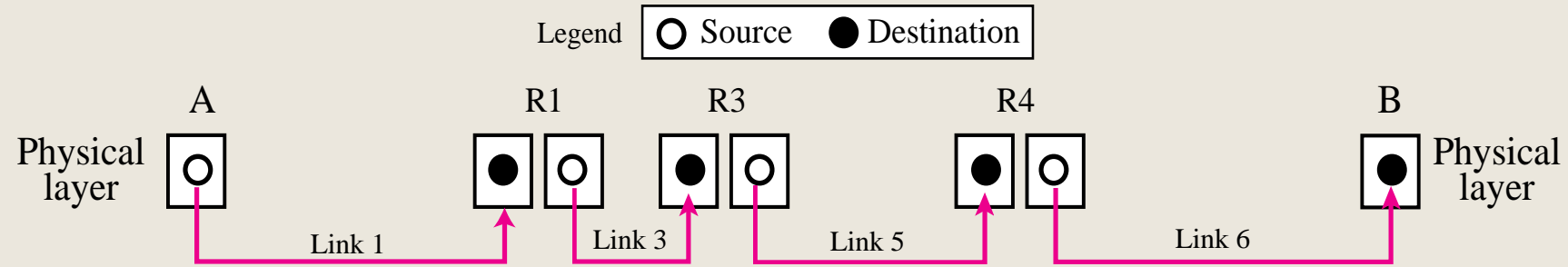
***The physical layer is responsible for moving individual bits from one (node) to the next.***

# 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*



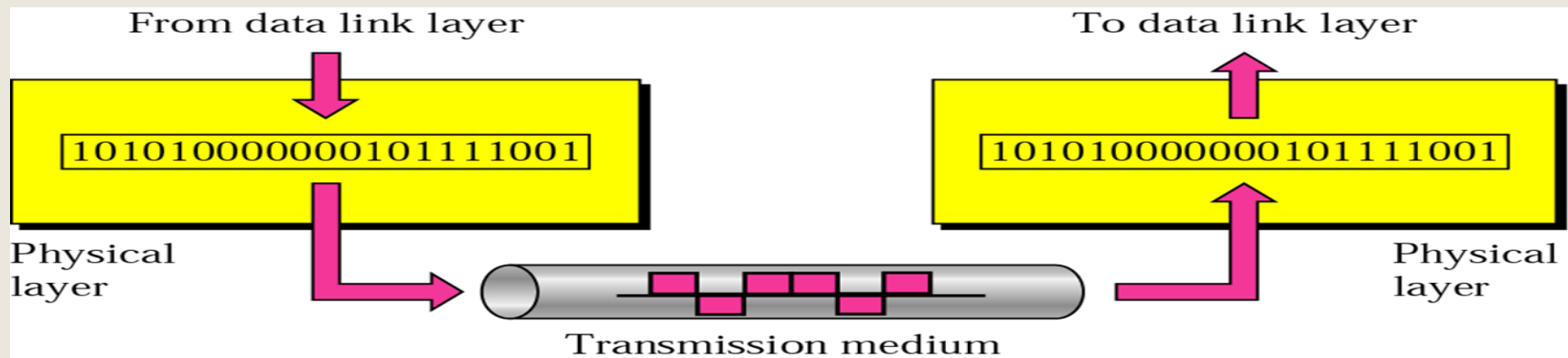
## Communication at the physical layer





*Note*

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



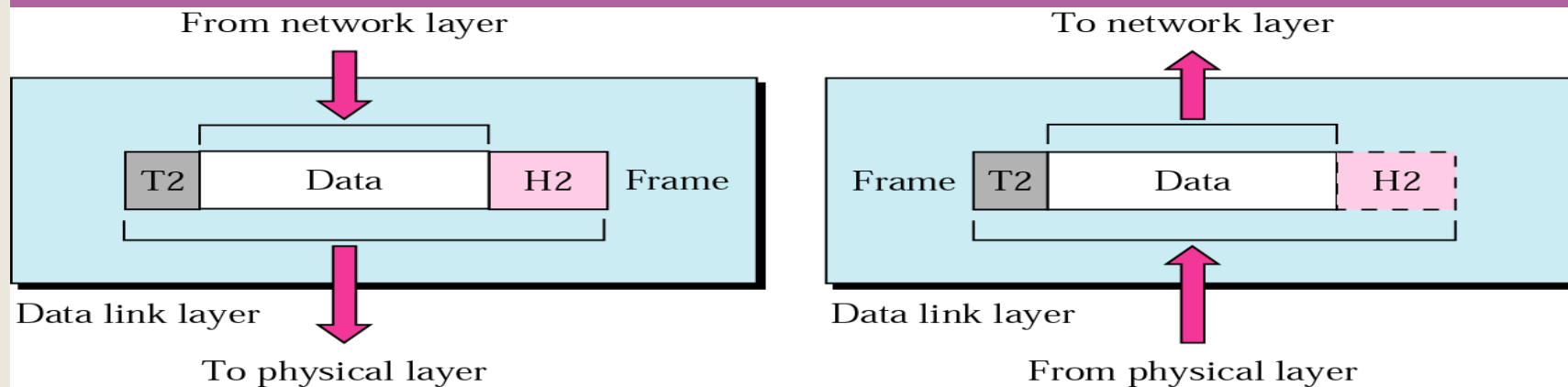
# Data Link Layer

- 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.*



*Note*

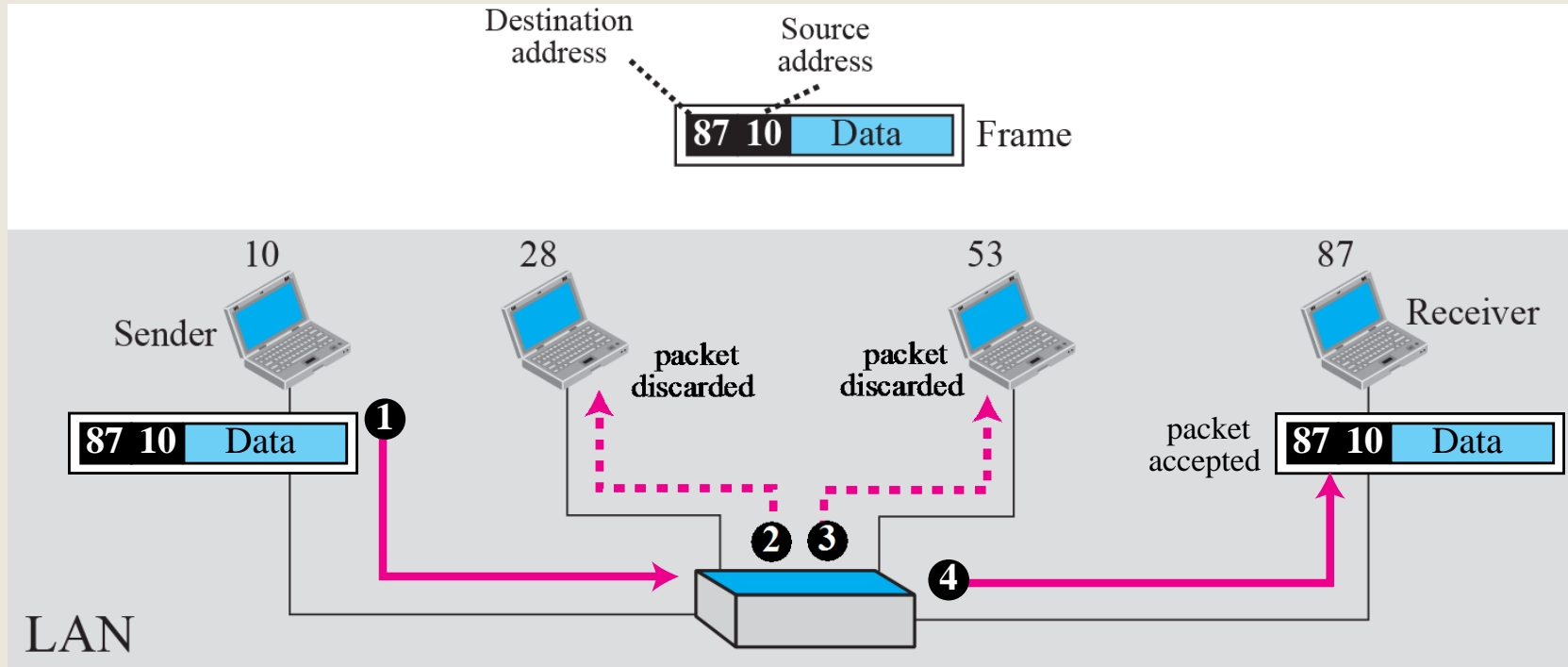
***The unit of communication at the data link layer is a frame.***





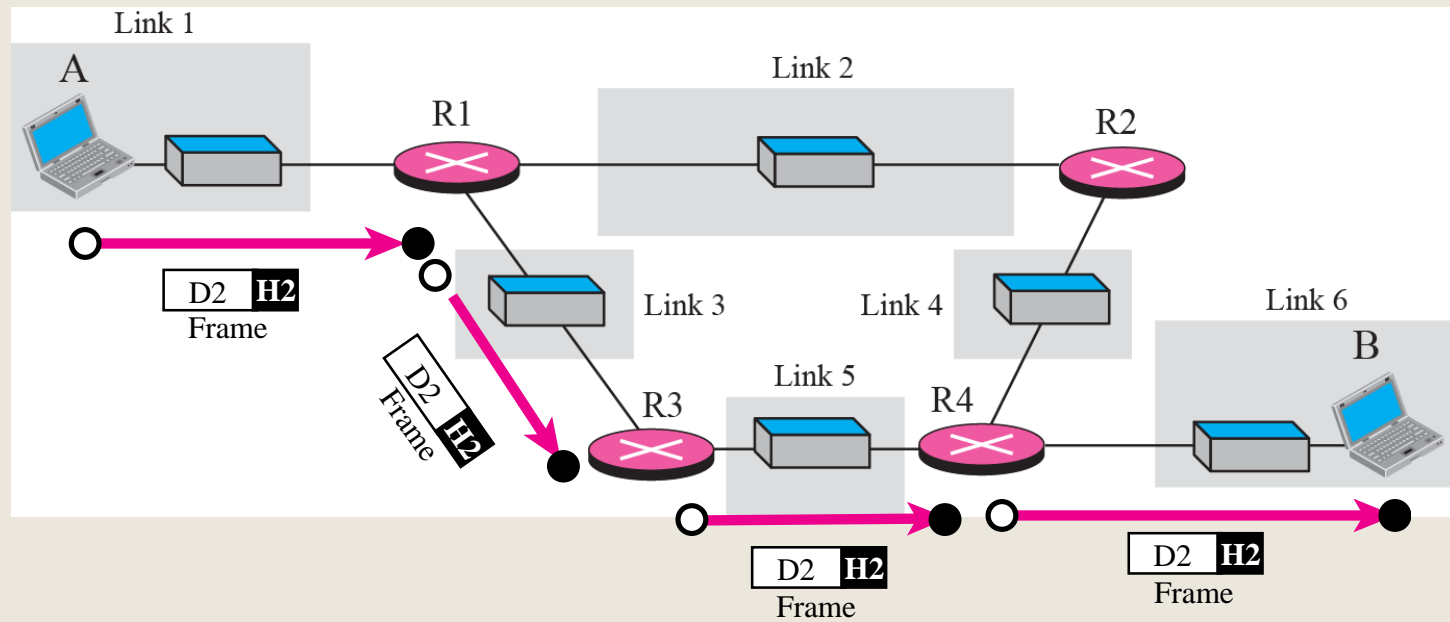
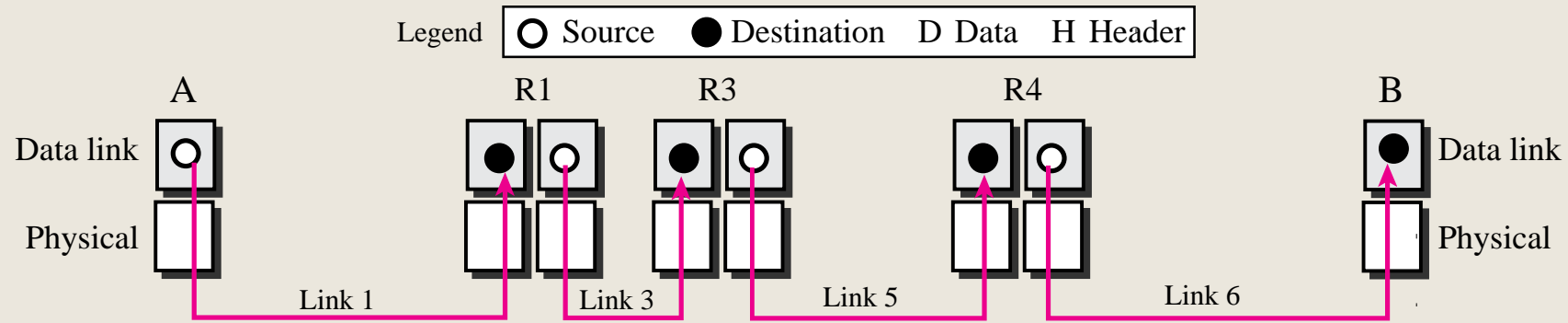


## Example 1: physical addresses





## Communication at the data link layer



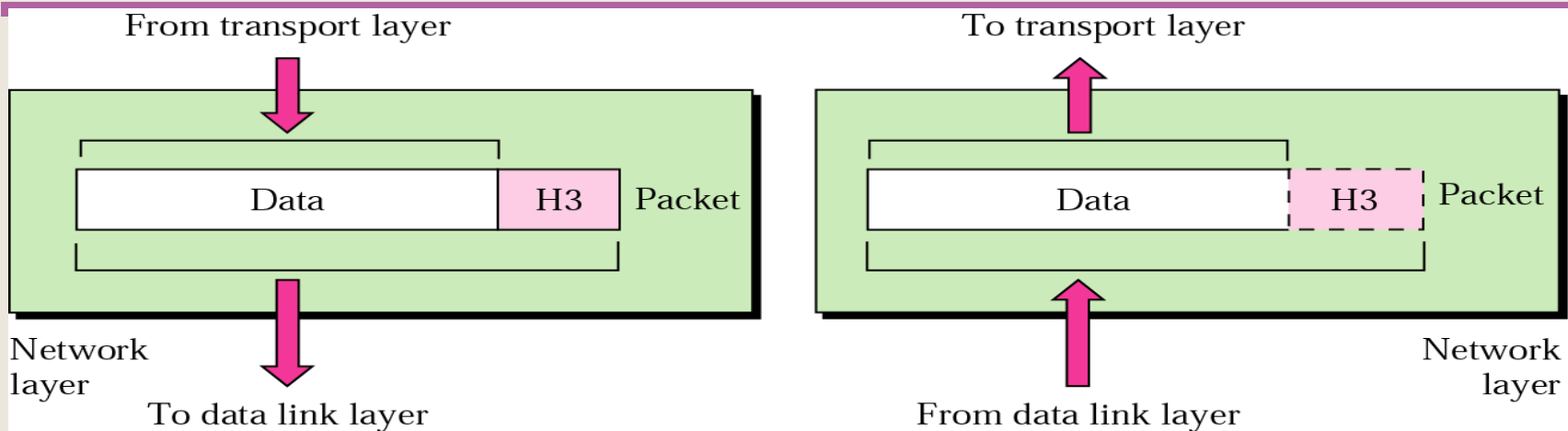
# Network Layer

- 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.*



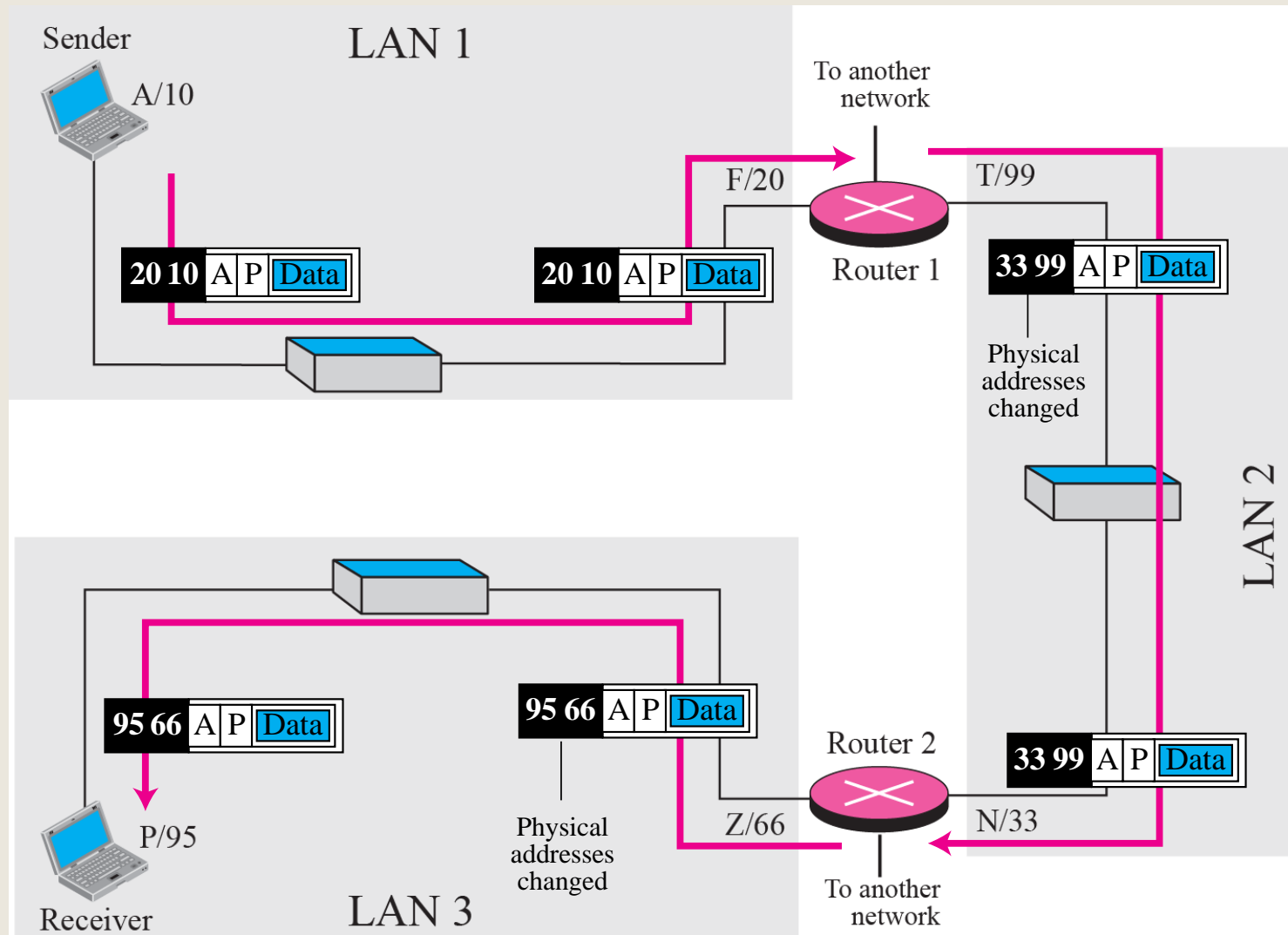
*Note*

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





## Example 2: logical addresses



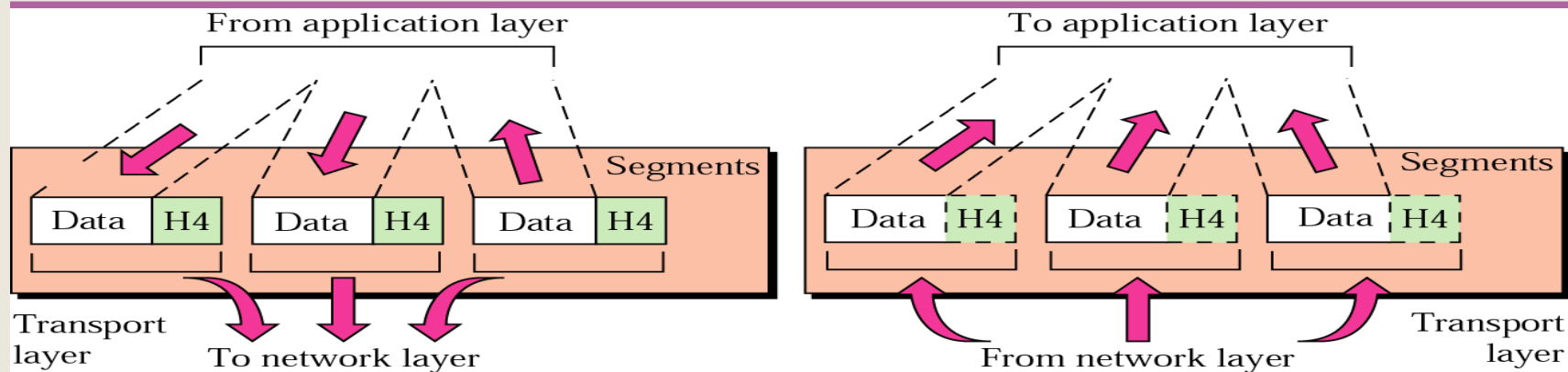
# Transport Layer

- 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*



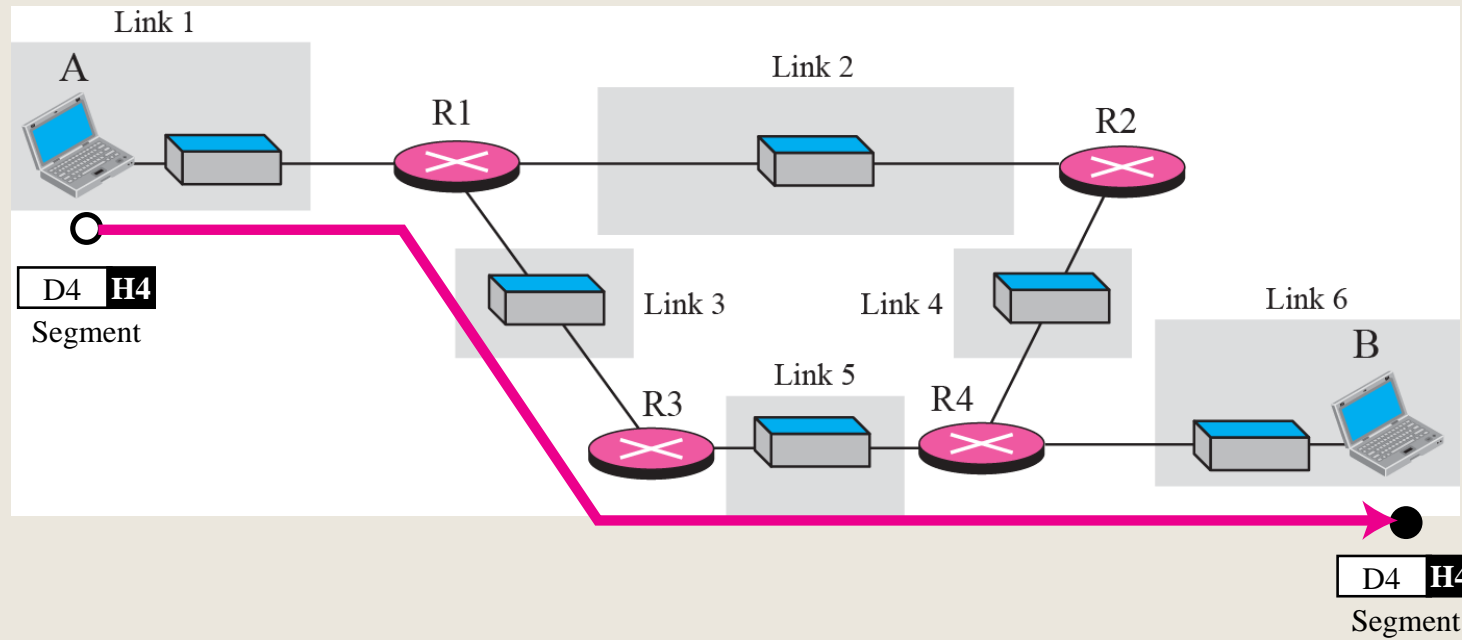
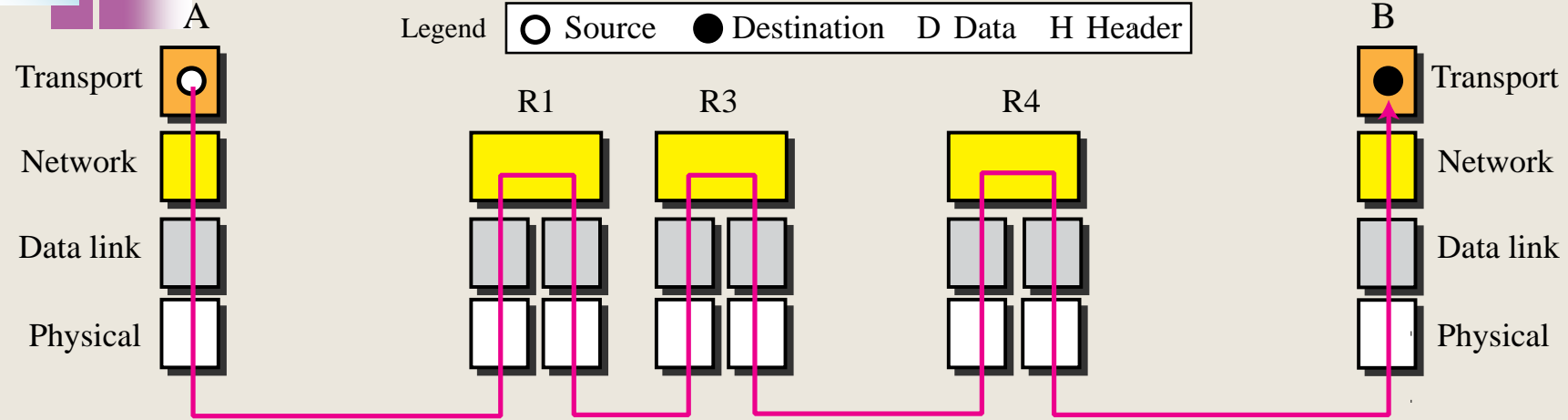
## Note

*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.*





## Communication at transport 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.



## Summary of OSI Layers

Application	To allow access to network resources	7
Presentation	To translate, encrypt, and compress data	6
Session	To establish, manage, and terminate sessions	5
Transport	To provide reliable process-to-process message delivery and error recovery	4
Network	To move packets from source to destination; to provide internetworking	3
Data link	To organize bits into frames; to provide hop-to-hop delivery	2
Physical	To transmit bits over a medium; to provide mechanical and electrical specifications	1