DATA COMMUNICATION CONCEPTS

CHAPTER 3

NETWORK MODEL

3.0 OBJECTIVES

At the end of this chapter, you should be able to:

1. Identify the layered tasks
2. Identify the TCP/IP layer and its function.
3. Identify the OSI Model
4. Identify the Networking and Internetworking Devices

3.1 Protocol Layering

- When communication is simple, need only one simple protocol.
- When the communication is complex, we may need to divide the task between different layers, in which case we need a protocol at each layer, or
- **Protocol layering**.

Examples: First Scenario

(A single layer protocol)

- Assume Maria and Ann are neighbors with a lot of common ideas.
- Communication between Maria and Ann takes place in one layer, face to face, in the same language

Figure 3.1: A single-layer protocol

Examples: Second Scenario
(A 3-layer protocol)

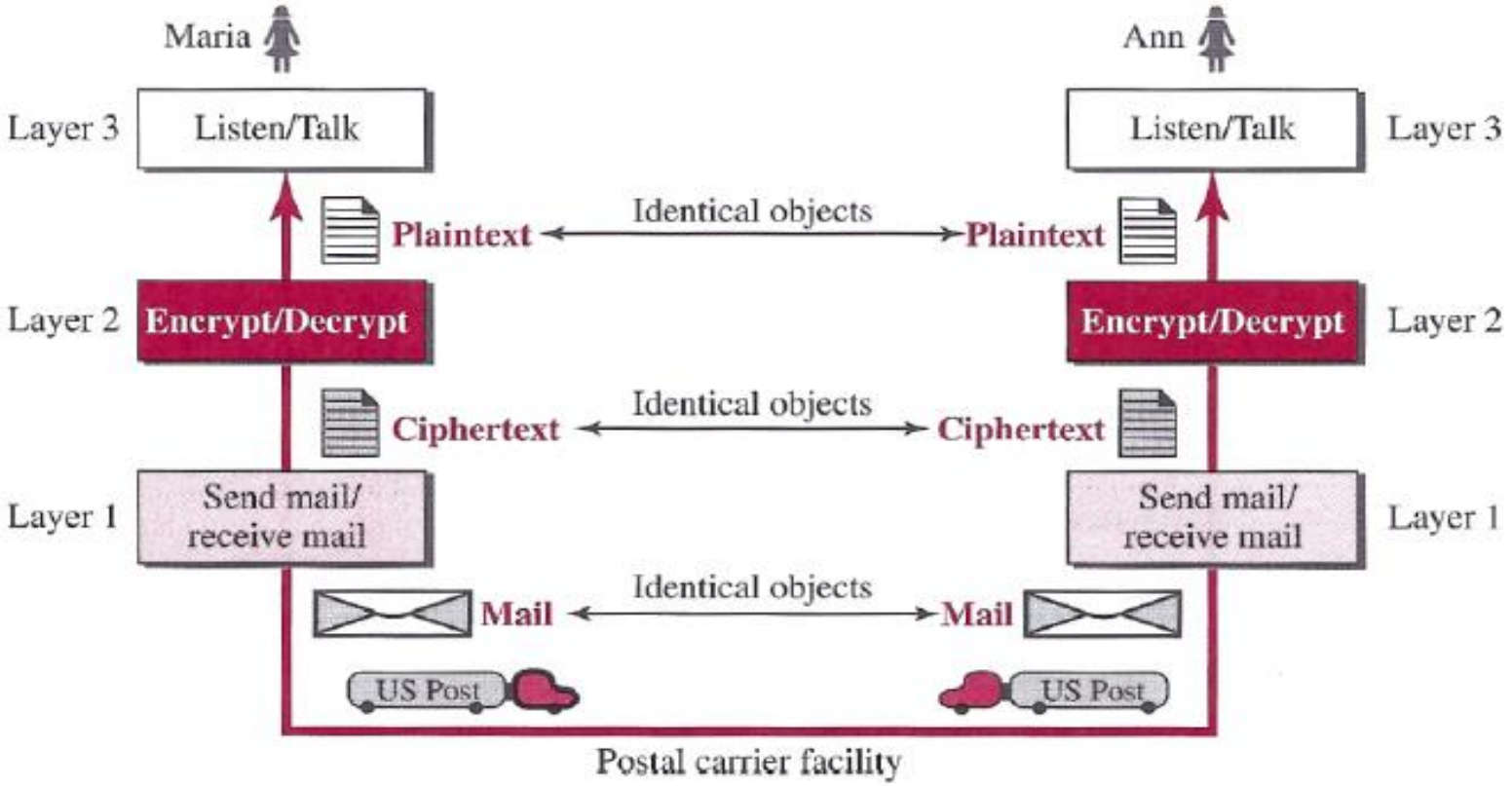

Figure 3.2: A three-layer protocol

3.2 TCP/IP PROTOCOL SUITE

- *TCP/IP is a protocol suite (a set of protocols organized* in different layers - 5) used in the Internet today.
- *Hierarchical* protocol made up of interactive modules, each of which provides a specific functionality.

TCP/IP LAYERS

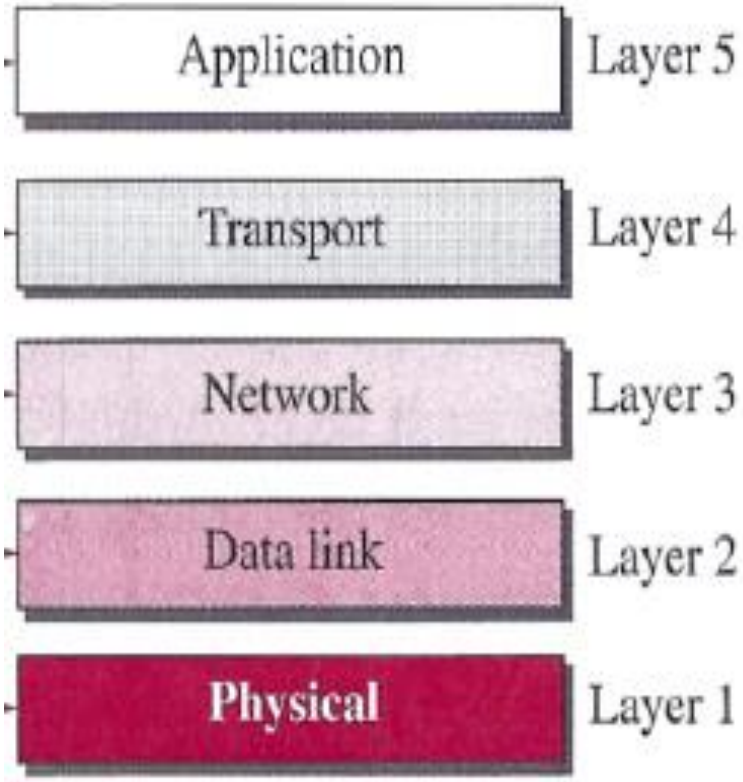

Figure 3.3: TCP/IP Layers

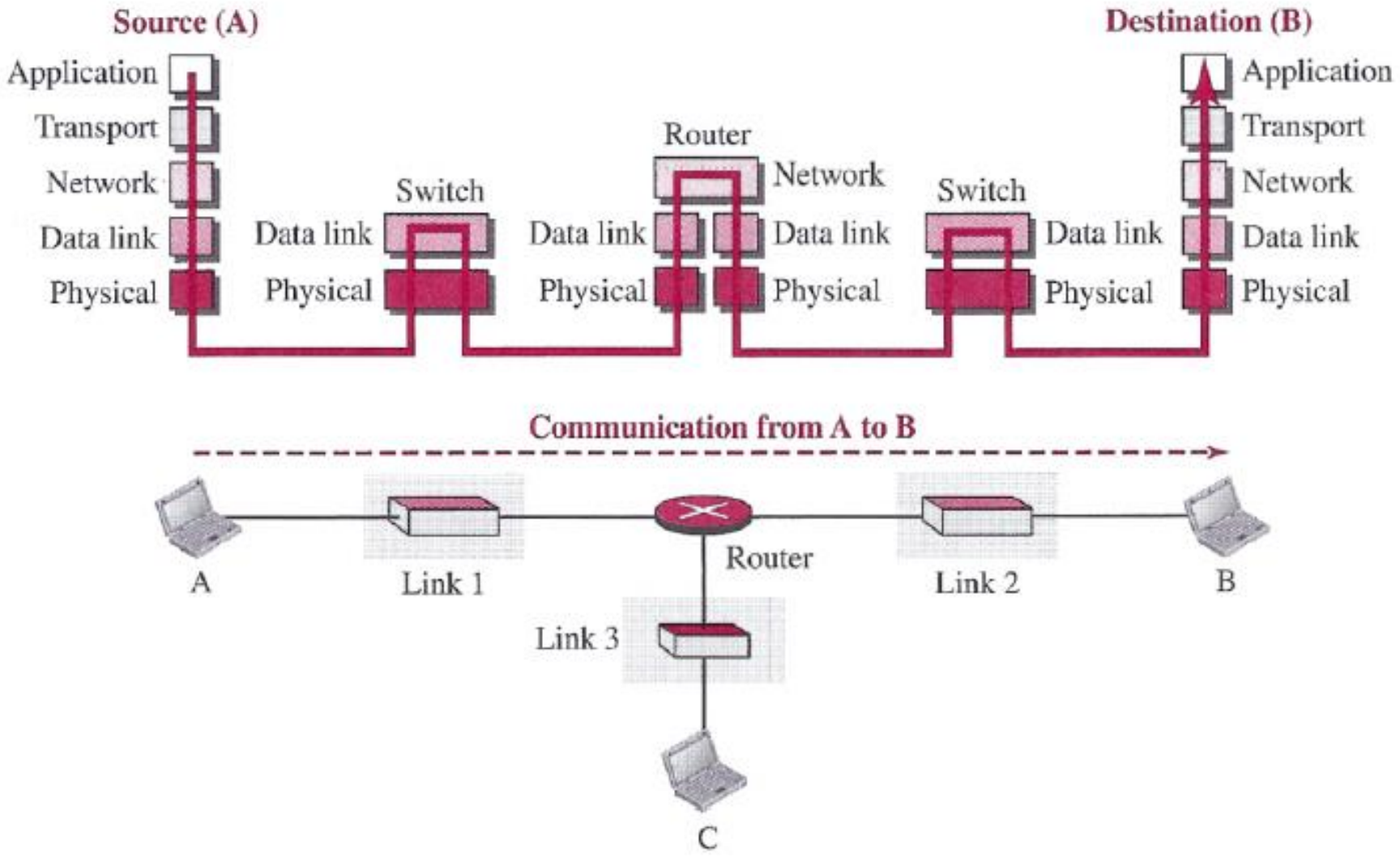

Figure 3.4: Communication through an internet

Function of Each Layer

Physical layer

- carrying individual bits in a frame across the link.
- Two devices are connected by a transmission medium (cable or air).
- We need to know that the transmission medium does not carry bits; it carries electrical or optical signals.

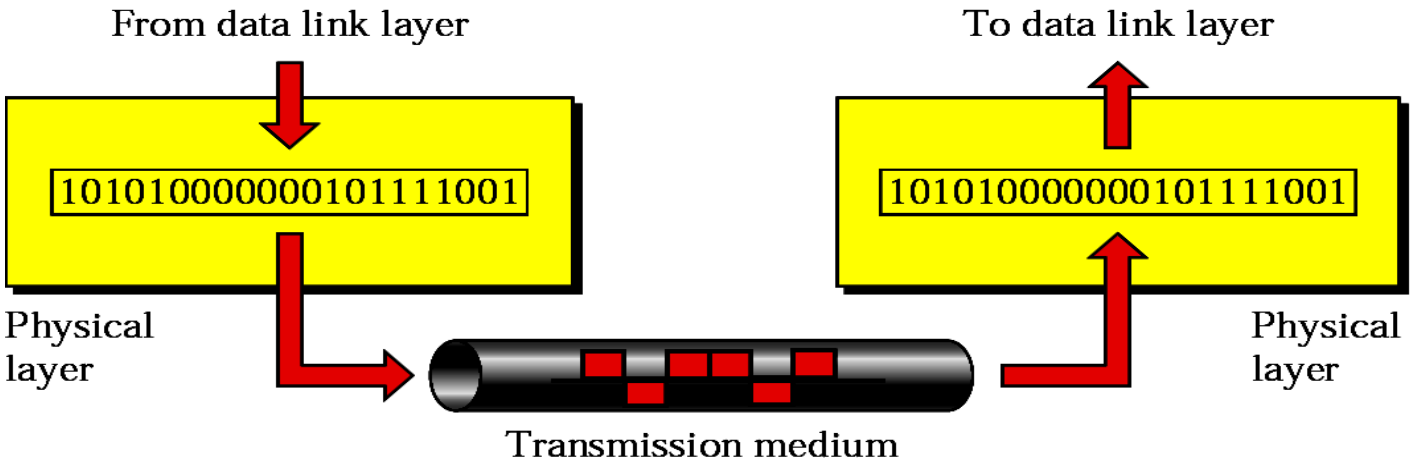

Figure 3.5: Physical Layer

Data-link Layer

- Routing
- moving the packet through the link.

Example 1

In Figure 3.6 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.

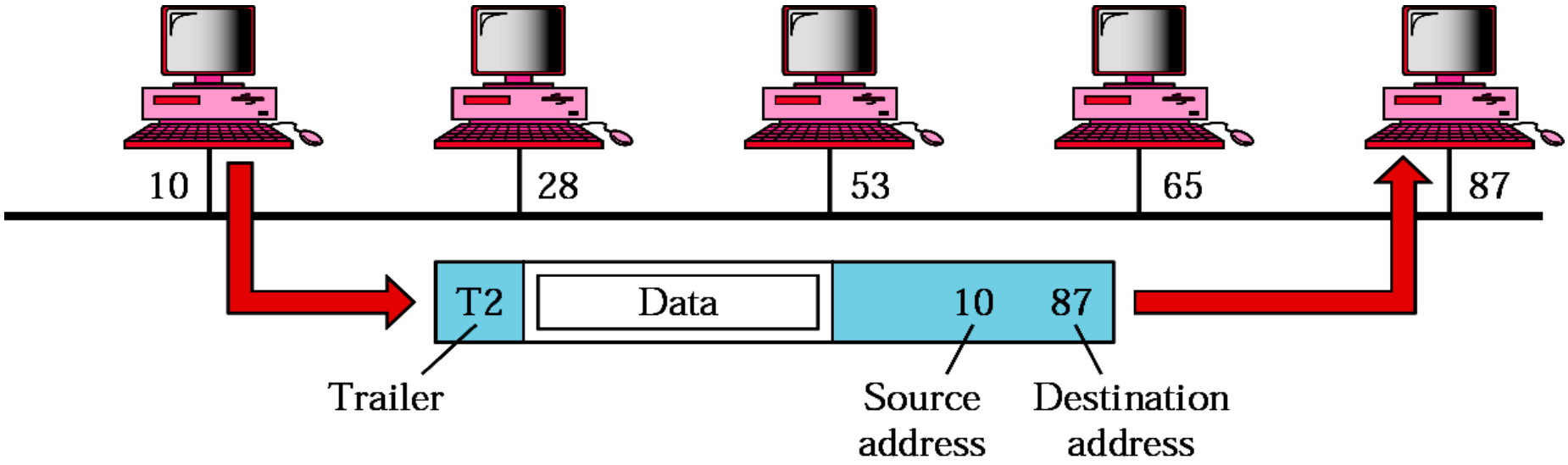

Figure 3.6: Example 1

Exercise

In Figure 3.7 a node with physical address 14 sends a frame to a node with physical address 12. Draw a frame for this transaction.

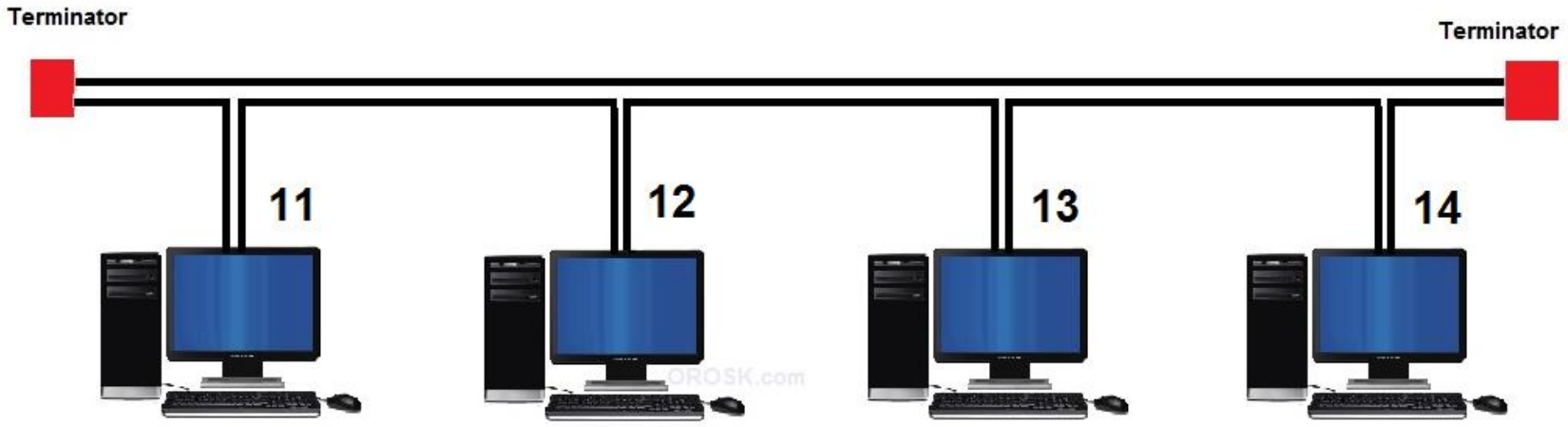

Figure 3.7

Network Layer

- create a connection between the source and the destination computers.
- main protocol, Internet Protocol(IP) - defines the format of the packet.
- ROUTING a packet from its source to its destination.
- Auxiliary Protocols – ICMP, IGMP, DHCP, ARP.

Example 2

In Figure 3.8 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.

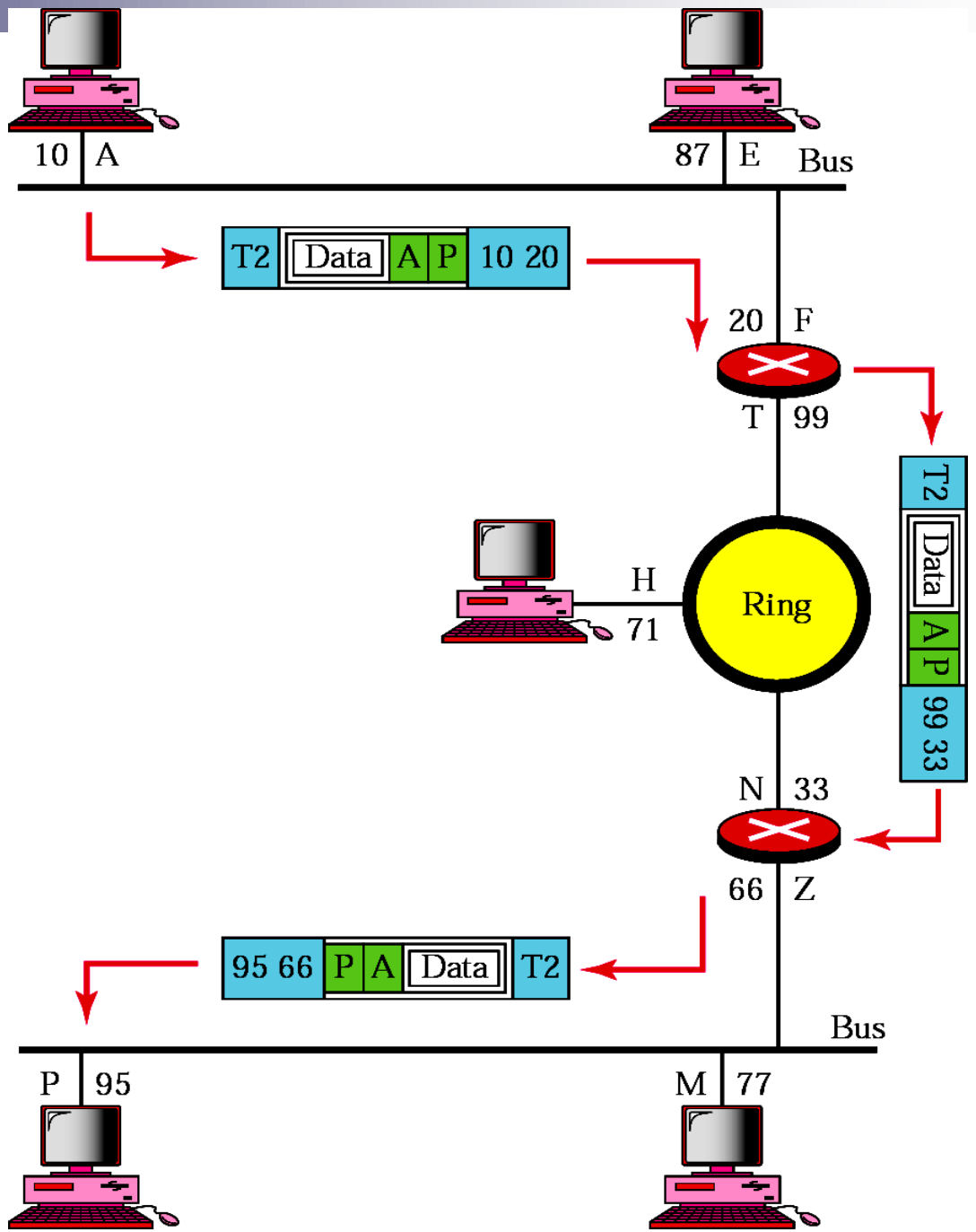

Figure 3.8: Example 2

Exercise

- In Figure 3.9 we want to send data from a node with network address M and physical address 77, located on one LAN, to a node with a network address E and physical address 87, located on another LAN. Draw an IP datagram for this transaction.

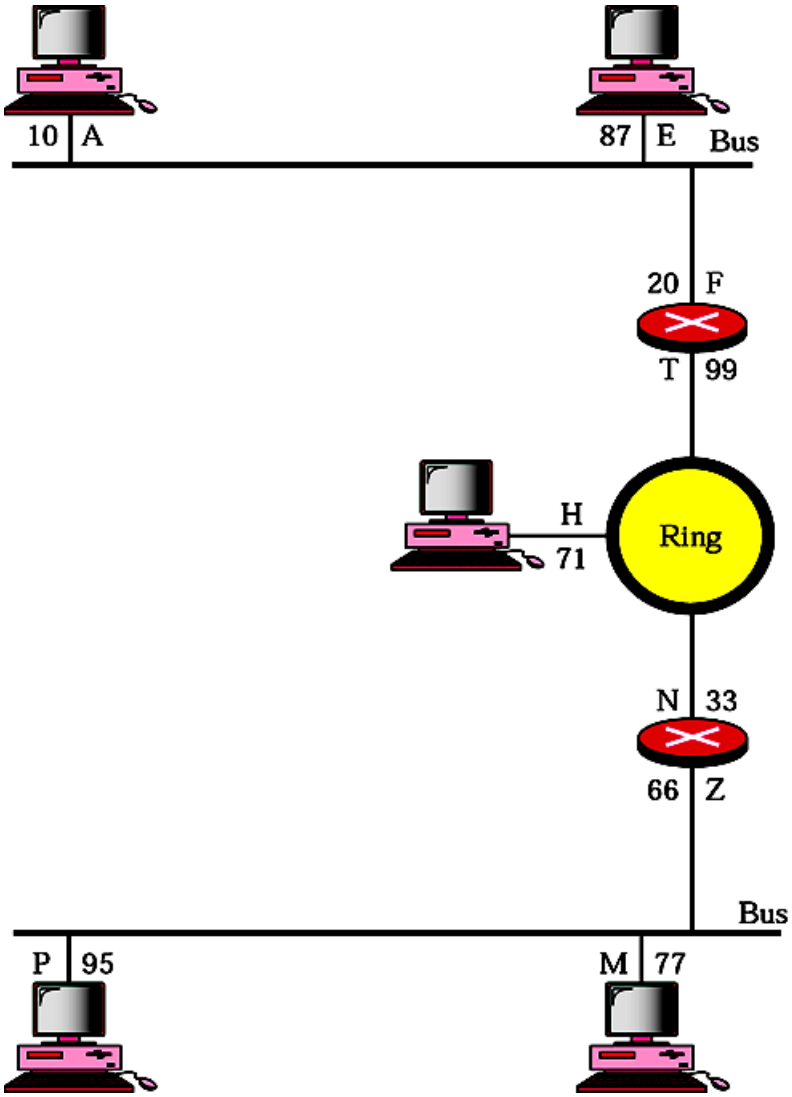

Figure 3.9

Transport Layer

- Get a message from an application (process) program running on the source host and deliver it to the corresponding application program on the destination host.
- Transmission Control Protocol (TCP) - connection-oriented protocol
- Provides error control, flow control, congestion control
- UDP – *connectionless protocol*

Application Layer

- Consists of application programs and user interfaces.
- Send an unbroken “data stream” to the Transport layer.
- Examples of protocols:
  - Telnet, FTP, SNMP, HTTP and SMTP.

Encapsulation and Decapsulation

Encapsulation

When a protocol on the sending host adds data to the packet header.

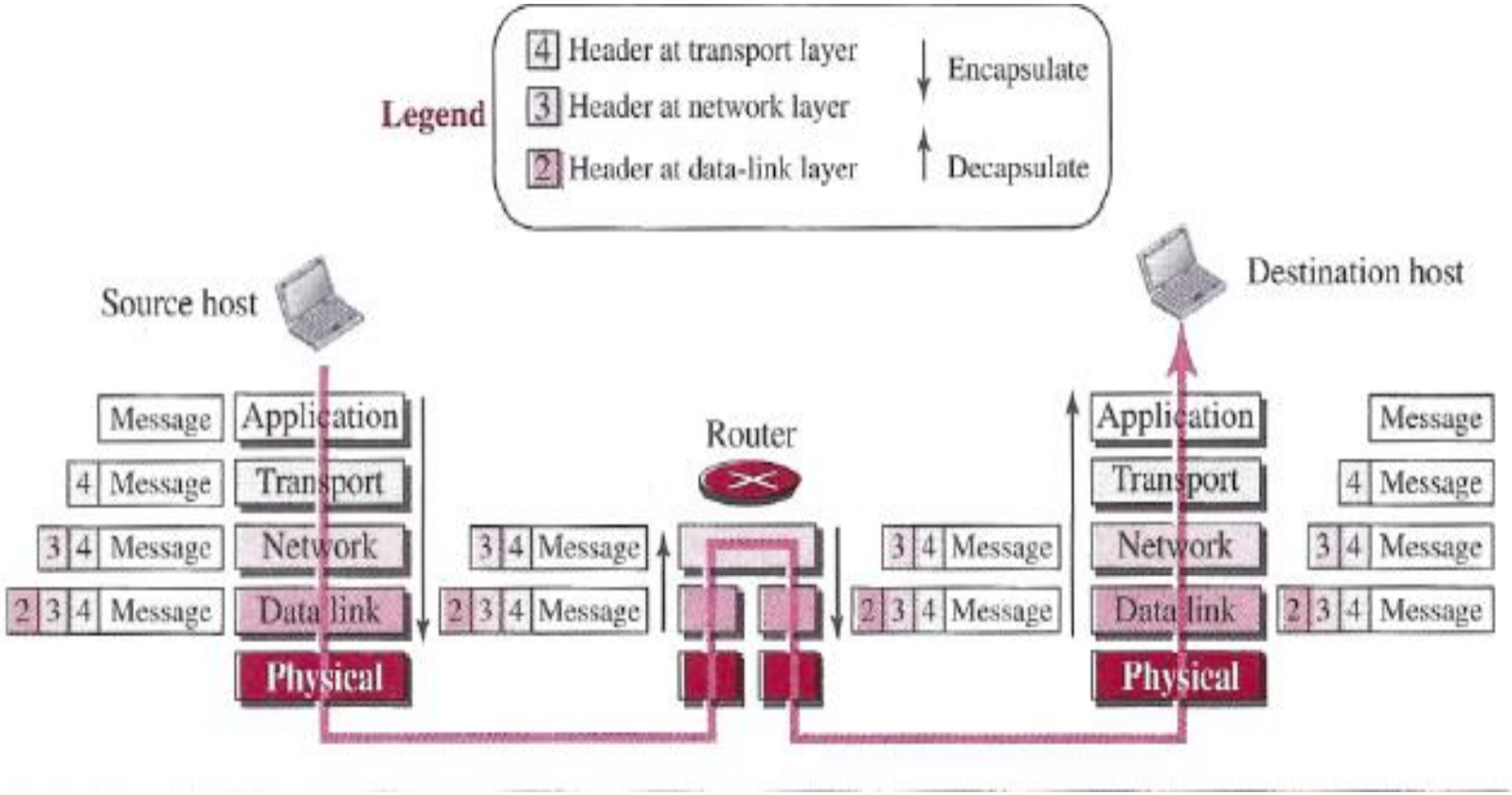

Figure 3.10: Encapsulation and Decapsulation

Addressing

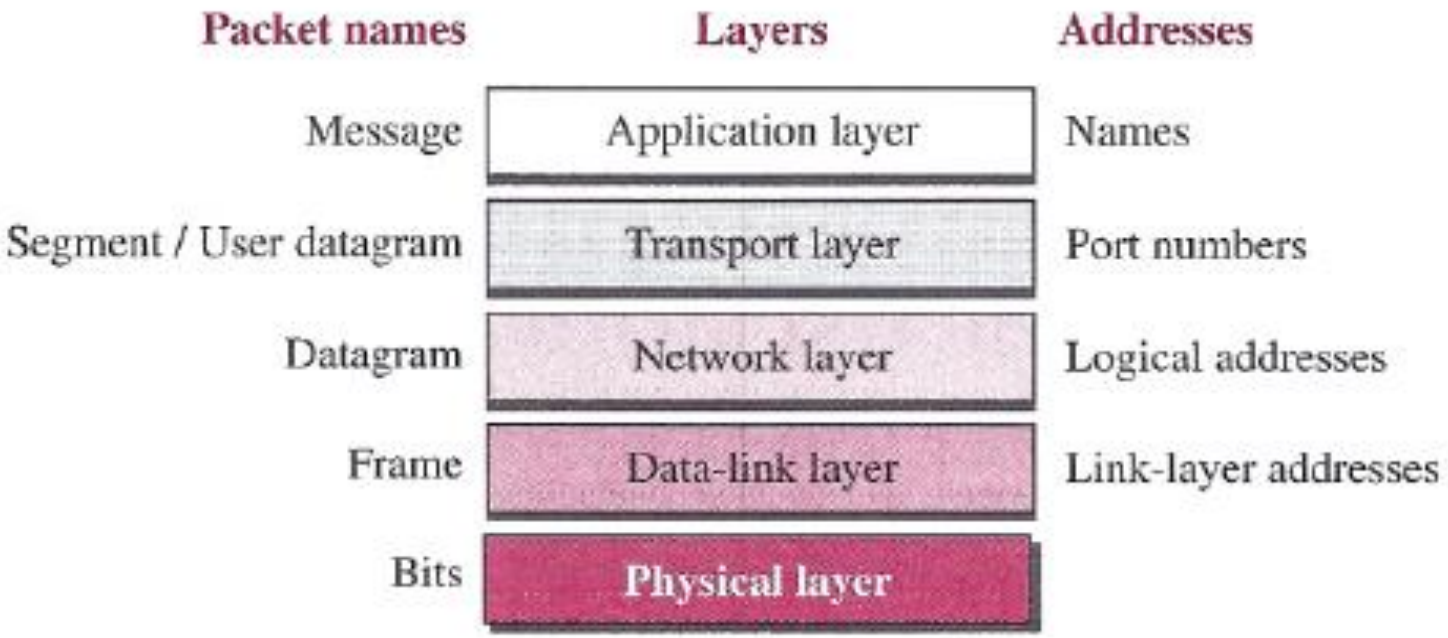

Figure 3.11: **Addressing in the TCP/IP protocol suite**

3.3 THE OSI MODEL: 7 LAYERS

- OSI reference model is designed as a standard to allow various “open” systems to communicate.
- Acts as the foundation to the implementation of protocols or rules of computer communicating in any network.
- The OSI Protocol Stack consists of 7 layers.
- First introduced in the late 70s
- The OSI model is not a protocol; it is a model for understanding and designing a network architecture that is flexible, robust, and interoperable.

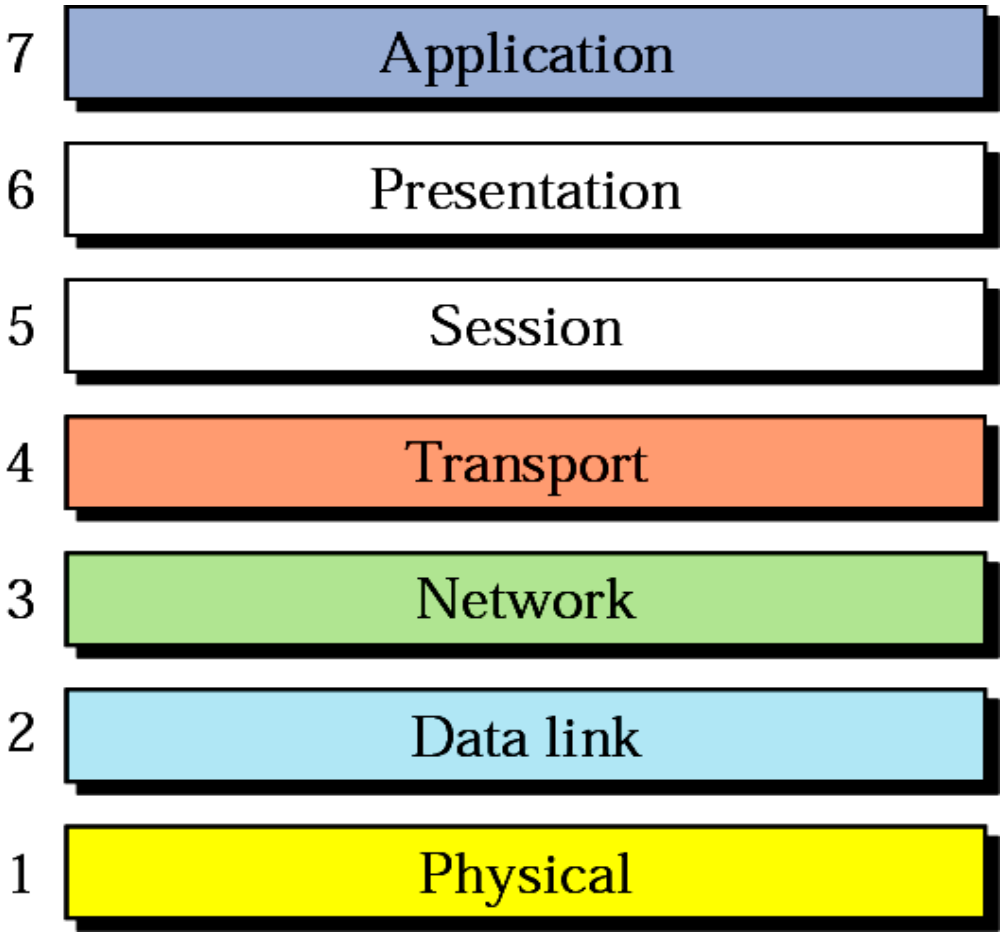

Figure 3.12: **OSI Layers**

OSI versus TCP/IP

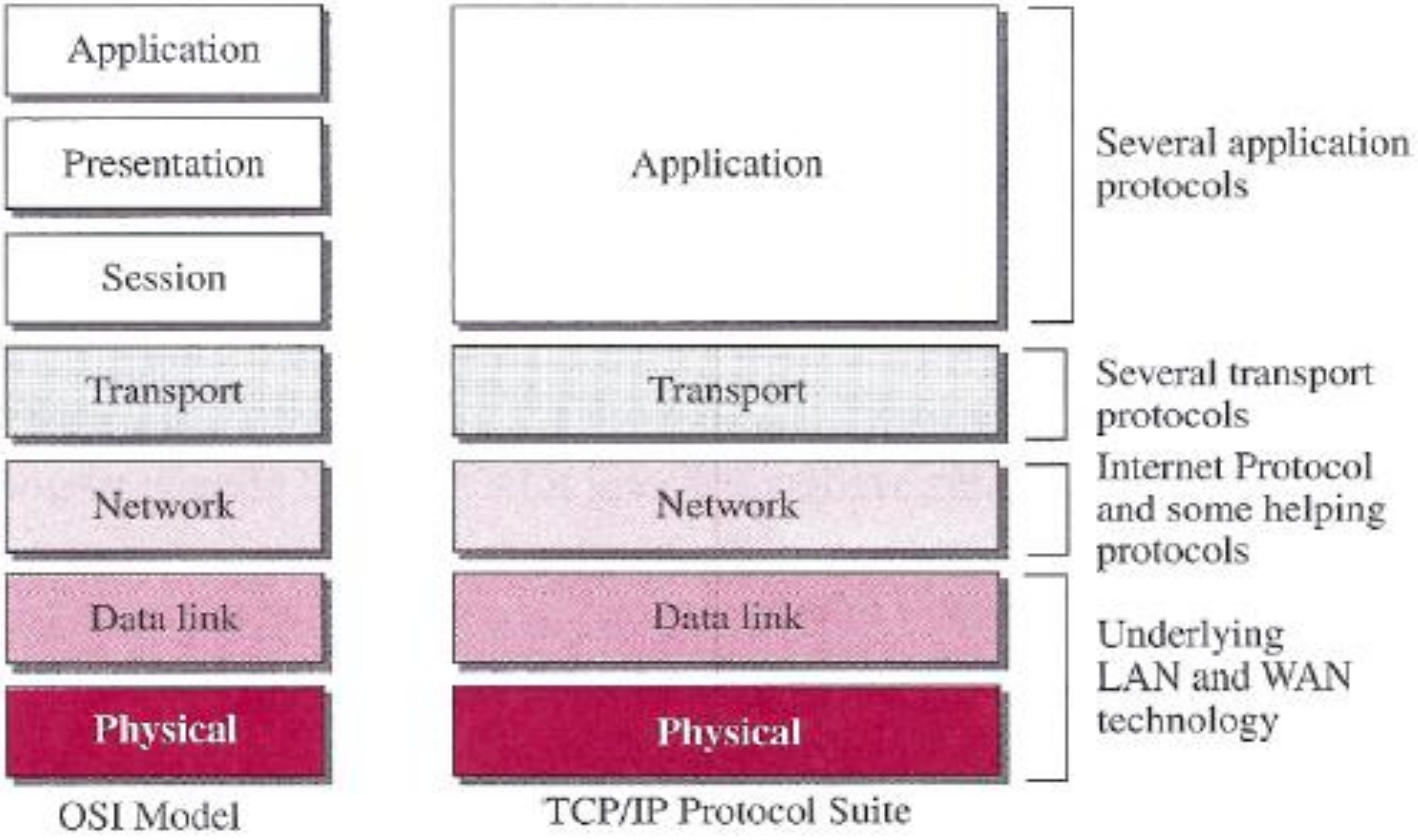

Figure 3.13: **Addressing in the TCPIIP protocol suite**

Lack of OSI Model's Success

The OSI model appeared after the *TCP/IP protocol suite.*

- OSI was completed when *TCP/IP was* fully in place and a lot of time and money had been spent on the suite;
- some layers in the OSI model were never fully defined.
- when OSI was implemented by an organization in a different application, it did not show a high enough level of performance to entice the Internet authority to switch from the *TCP/IP protocol suite to the OSI model.*

3.4 NETWORKING & INTERNETWORKING DEVICES

- When dissimilar networks are interconnected, the collection is an internet, and the individual networks are subnets.
- Networks are interconnected using bridges and routers.
- **Internet** (uppercase I):
  - the name of a specific worldwide network.
  - a global internet that uses the TCP/IP protocol suite.
- **internet** (lowercase i):
  - generic term used to mean an interconnection of networks.
  - a collection of networks connected by internetworking devices such as routers or gateways.

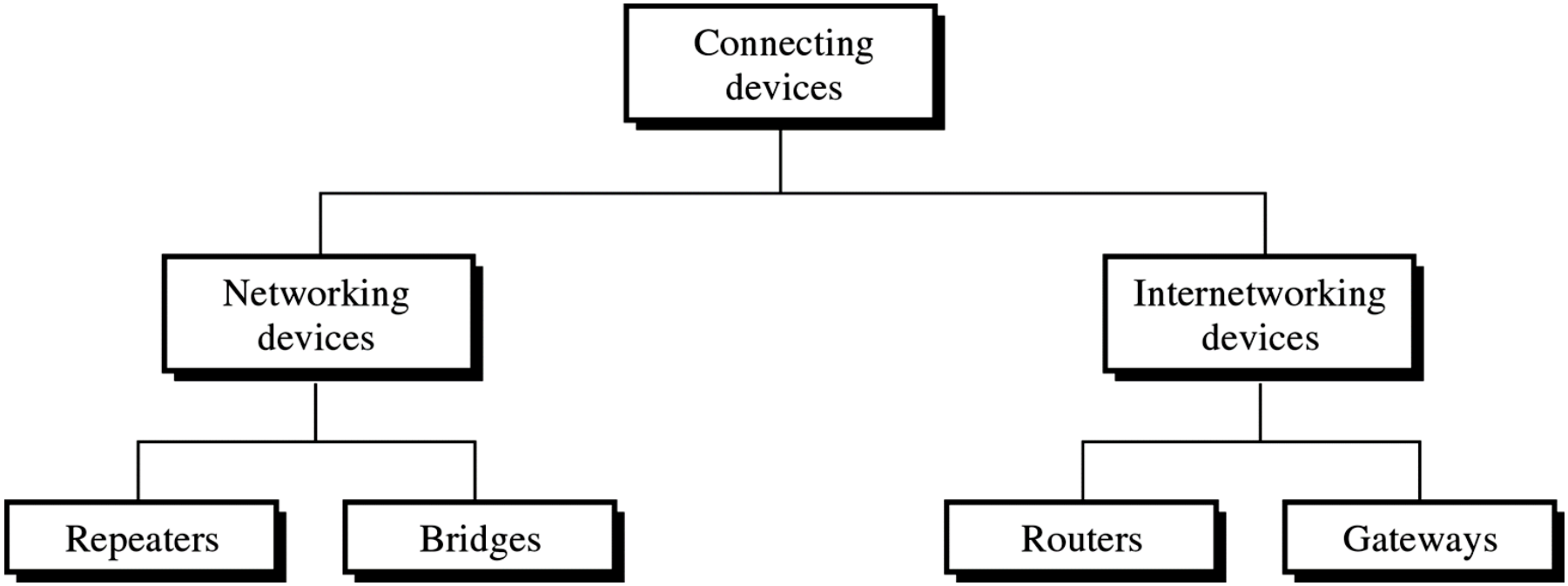

Figure 3.14: A Connecting Devices

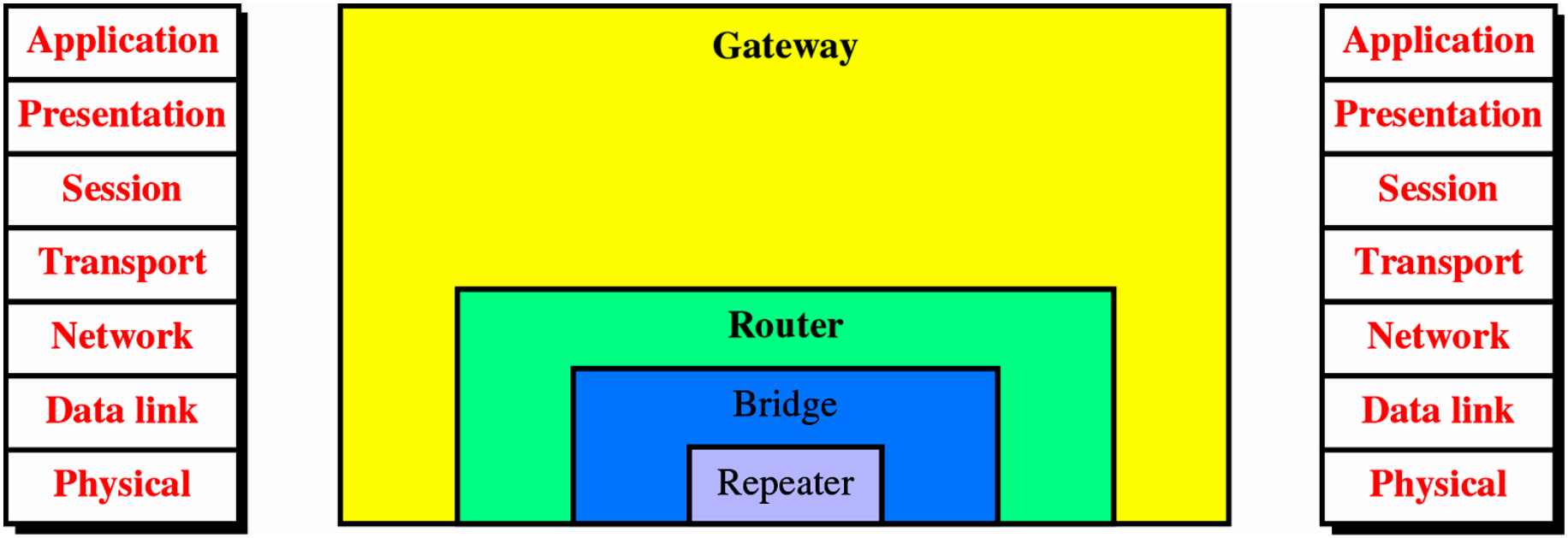

Figure 3.15: Connecting Devices in the OSI Model

REPEATERS

- Is not an internetworking device.
- Function: accepts a signal, regenerates it (does not amplifies) and passes it along at full strength.
- Operate at **Layer 1 (Physical Layer)** of the OSI reference model.
- Least expensive
- Used to join exactly identical LANs.

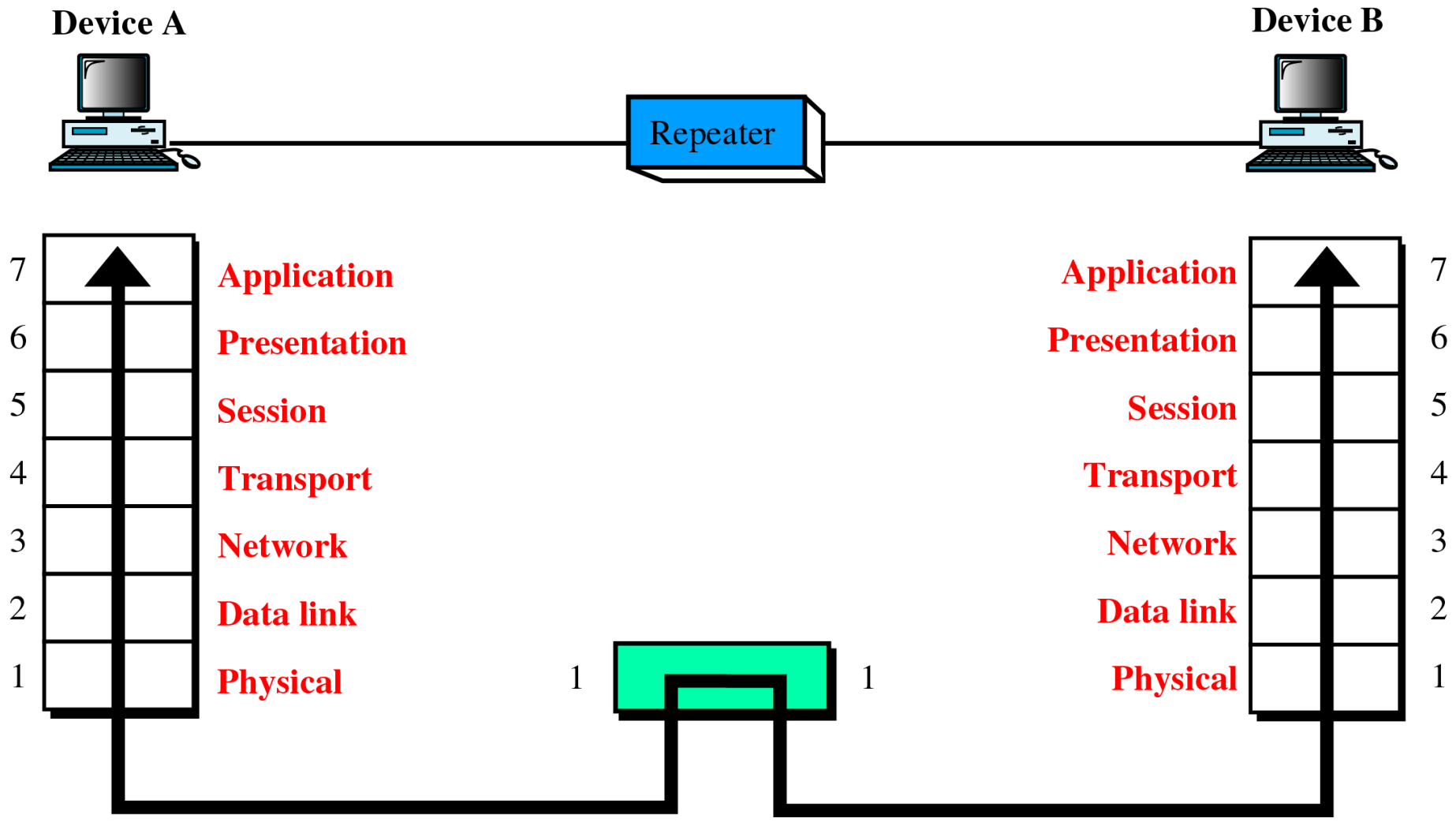

Figure 3.16: A Repeater in the OSI Model

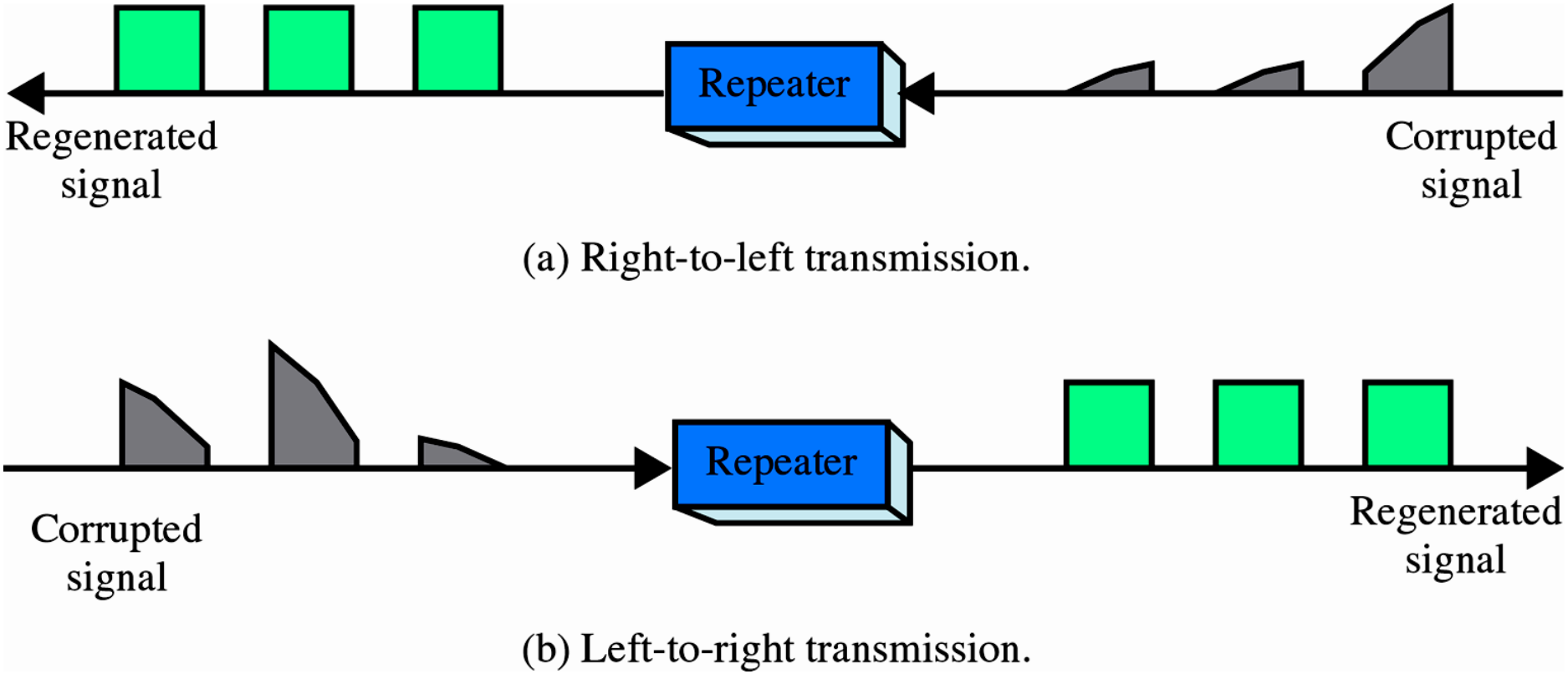

Figure 3.17: Function of Repeater

3.3.2 BRIDGES

- Is a device that connects TWO LANs using the same protocol such as Ethernet.
- Operates at both the **Physical (Layer 1)** and the **Data Link (Layer 2)** layers of the OSI model.
- Bridge function:
  - Read all frames from each network.
  - Accept frames from sender on one network that are addressed to a receiver on the other network.
  - Retransmit frames from sender using MAC protocol for receiver.

- Must have some routing information stored in order to know which frames to pass.

- 3 types of bridges:
  i. Simple bridges
  ii. Multi-port bridge
  iii. Transparent (learning) bridge

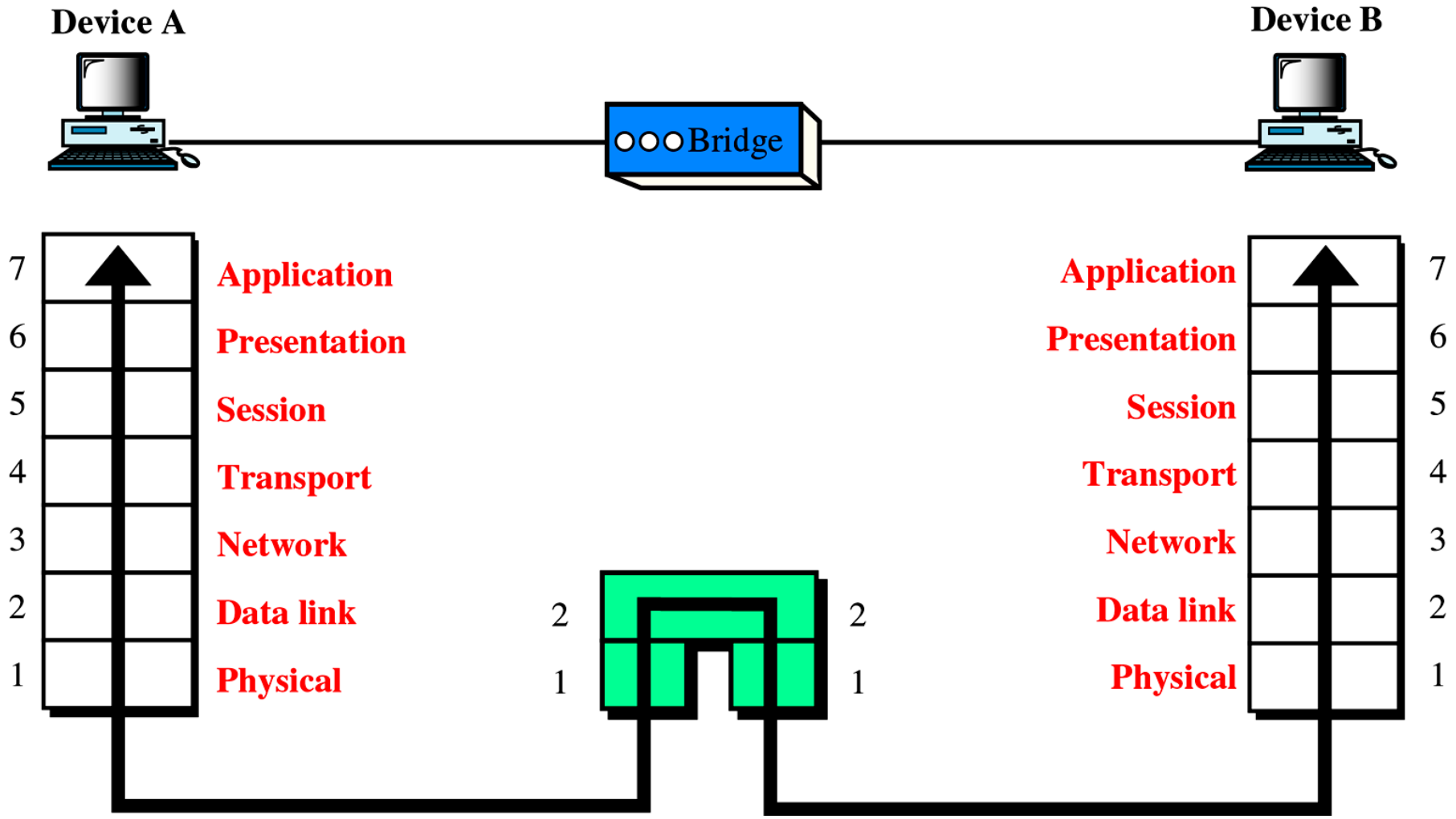

Figure 3.18: A Bridge in the OSI Model

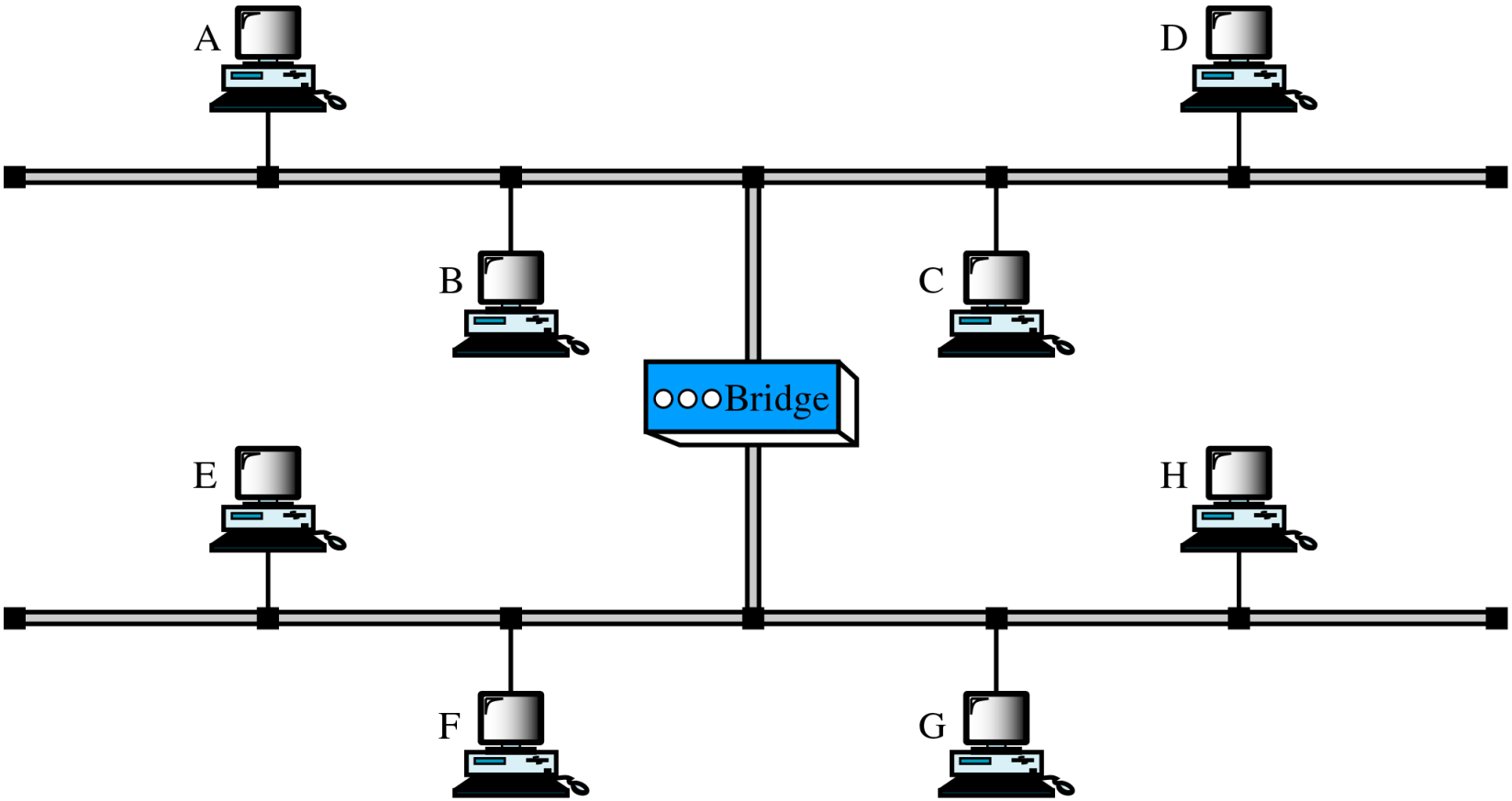

Figure 3.19: A Bridge

ROUTERS

- Is a device that connects multiple networks.
- Operate at the **Physical (Layer 1)**, **Data Link (Layer 2)** and **Network (Layer 3)** layers of the OSI model.
- Decide the path a packet should take.
- Three primary functions:
  - Provide a link between networks.
  - Provide for routing and delivery of data between nodes on different networks.
  - Provide services in a way that does not require modification of the subnets.

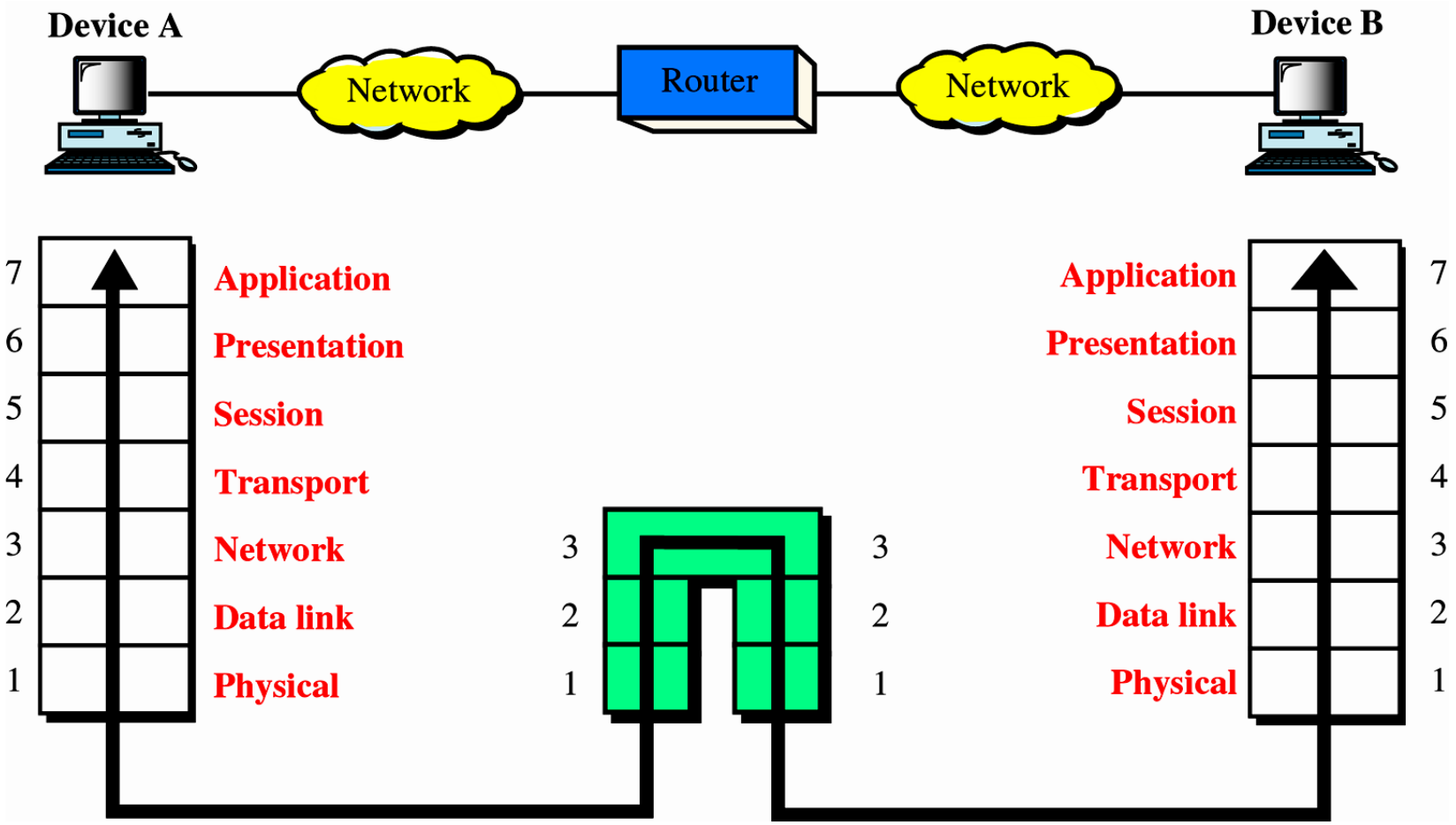

Figure 3.20: A Router in the OSI Model

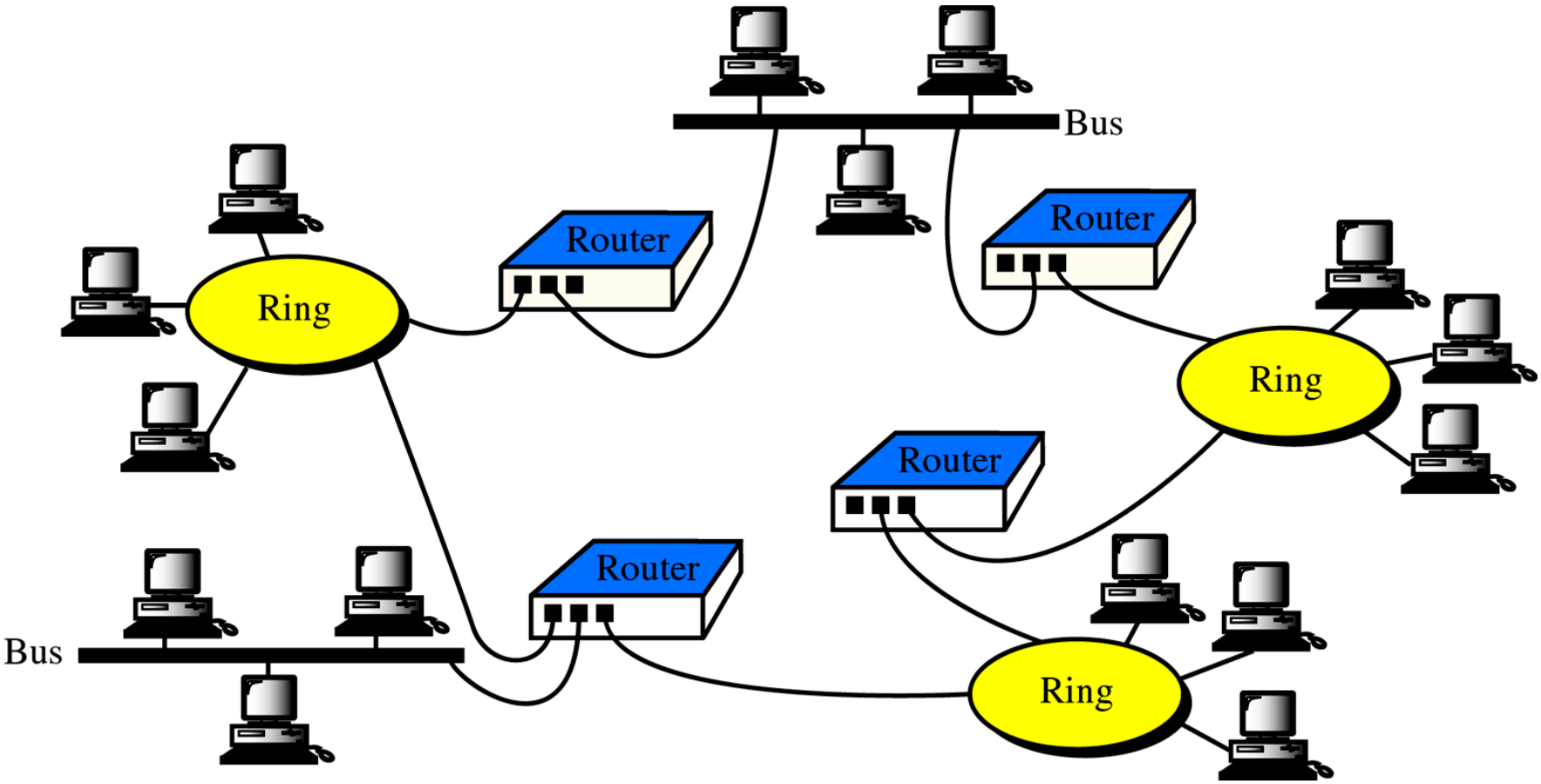

Figure 3.21: A Router in the Network

GATEWAYS

- A device used to connect TWO separate networks that use ***different communication protocols***.
- Operates in all seven layers of the OSI model.
- Function: Convert one protocol to another and can therefore connect two dissimilar networks.
- It is a “protocol converter”.
- E.g.: It accept a packet formatted for one protocol (AppleTalk) and convert it to a packet formatted for another protocol (TCP/IP) before forwarding it.

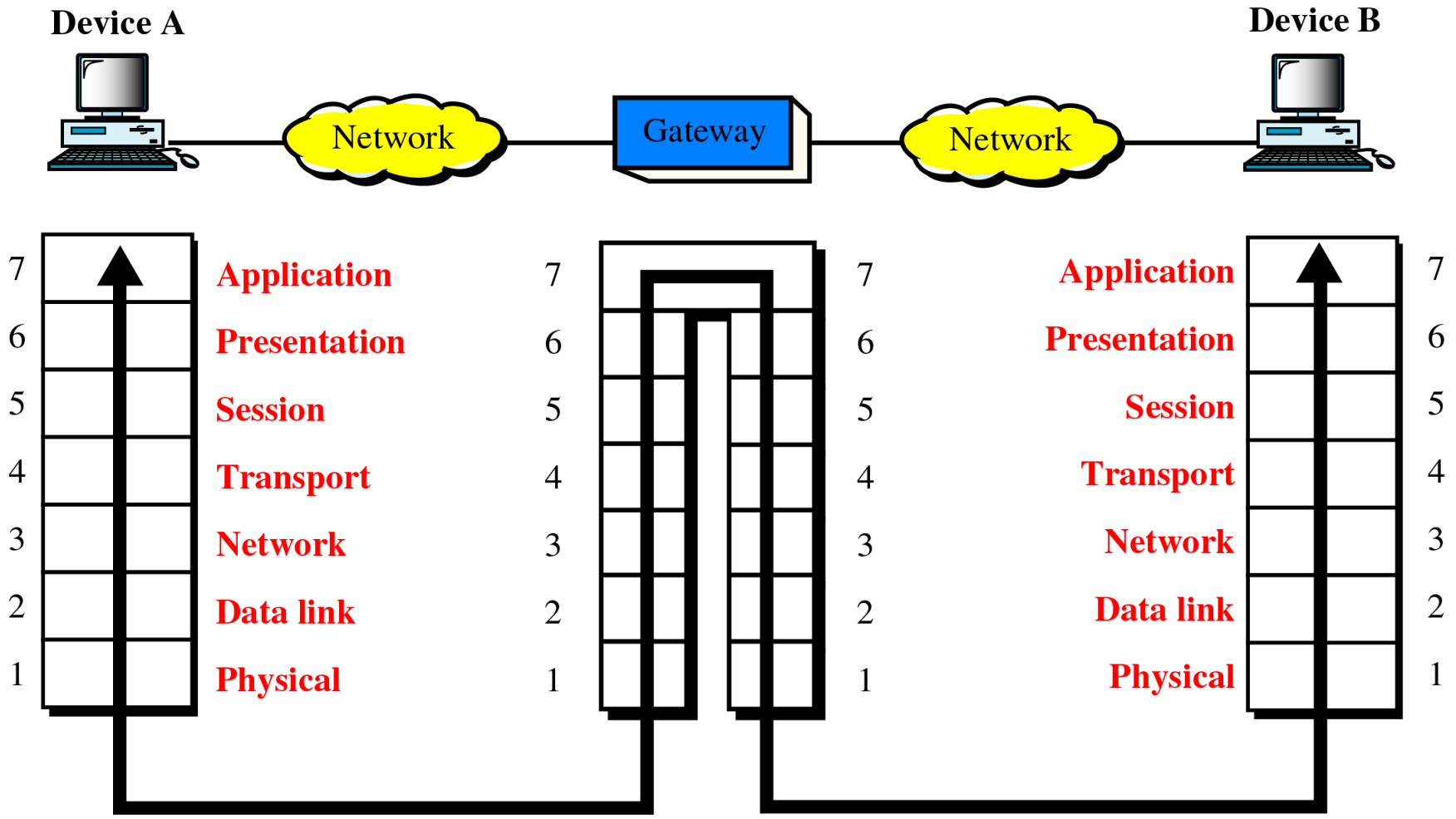

Figure 3.22: A Gateway in the OSI Model

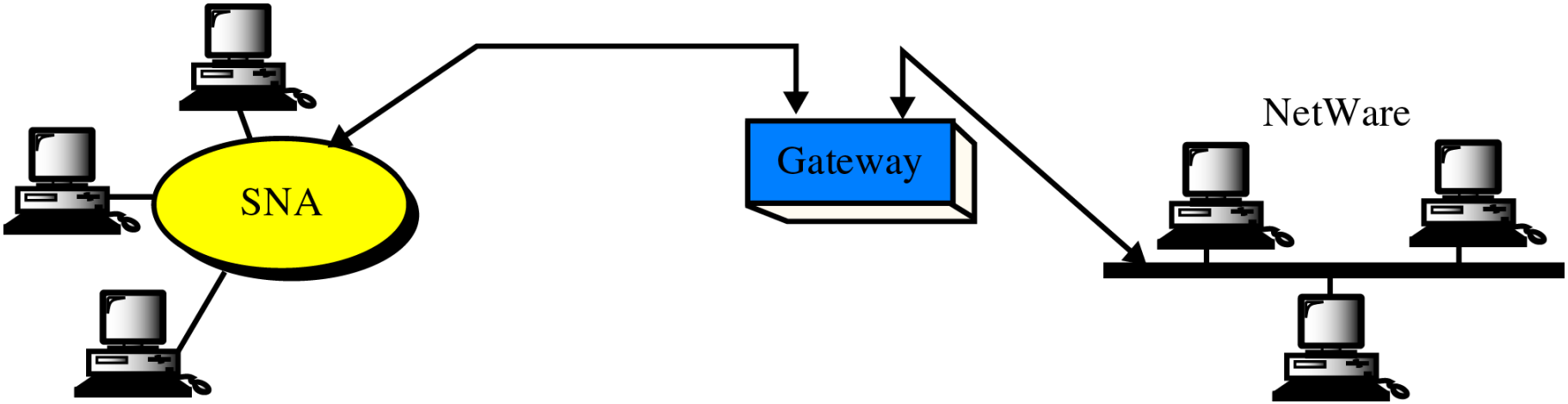

Figure 3.23: A gateway connecting an SNA network (IBM) to a NetWare network (Novell)