

Computer Networks

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IT111 - Introduction to Information Technology



جامعة الجميع الذكية
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Objectives

- ☐ Describe local and wide area networks (LANs and Wans).
- ☐ Distinguish an internet from the Internet.
- ☐ Describe the TCP/IP protocol suite as the network model in the internet.
- ☐ Define the layers in the TCP/IP protocol suite and their relationship.

6.1 Introduction

- ❑ A network is a combination of hardware and software that sends data from one location to another.
- ❑ The hardware consists of the physical equipment that carries signals from one point in the network to another.
- ❑ The software consists of instructions that make the services that we expect from a network possible.

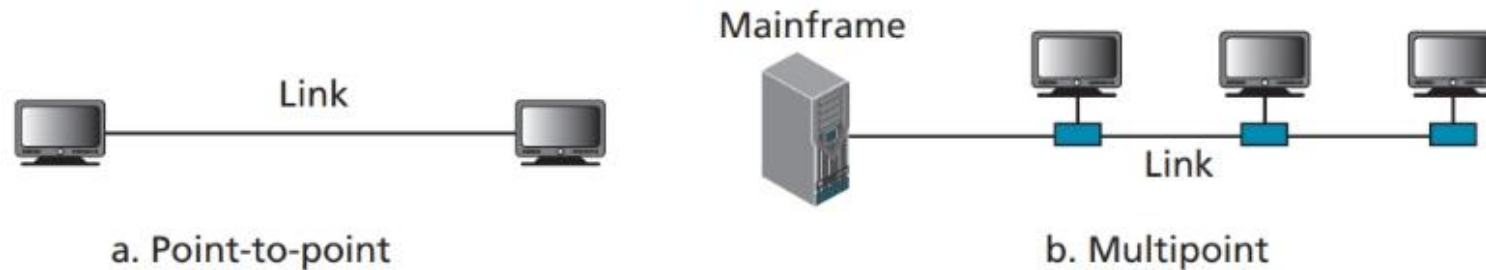


6.1.1 Networks

- A **network** is the interconnection of devices capable of communication.
- A device can be a **host** (such as a computer, desktop, laptop, workstation, mobile phone, or security system) and can be a **connecting device** such as a **router** connecting the network to other networks, a switch which connects devices together, a modem (modulator-demodulator) that changes the form of data, etc.
- These devices in a network are connected using wired or wireless transmission media.
- When connecting two computers, we have created a network, although very small.

Type of Connection

Figure 6.1 Types of connections: point-to-point and multipoint



A **point-to-point** connection provides a dedicated link between two devices, and the entire capacity of the link is reserved for transmission between these two devices.

A **multipoint connection** (also called multidrop connection) is one in which more than two specific devices share a single link (Figure 6.1.b). In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.

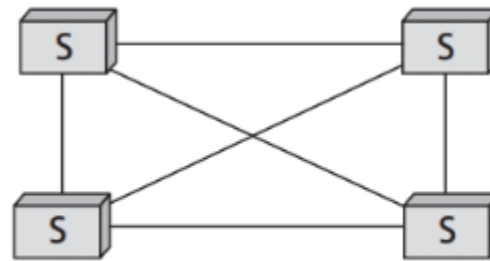


Physical topology

The term physical topology refers to the way in which a network is laid out physically. Two or more devices connect to a link; one or more links form a topology. The topology of a network is the geometric representation of the relationship of all the links and devices (usually called nodes) to one another. There are four basic topologies possible: mesh, star, bus and ring

Mesh Topology

In a mesh topology, every device has a dedicated point-to-point link to every other device.

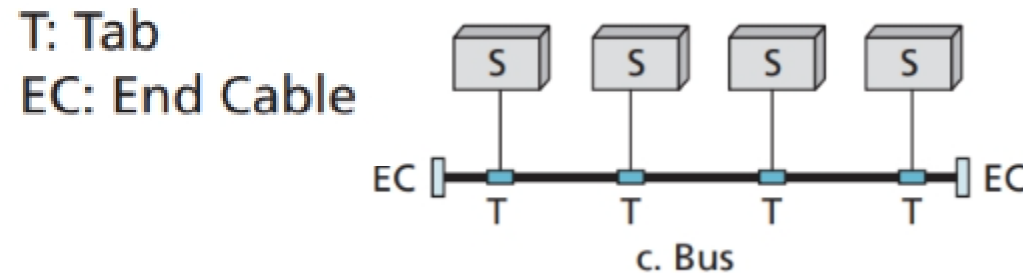


a. Mesh

S: Station

Bus Topology

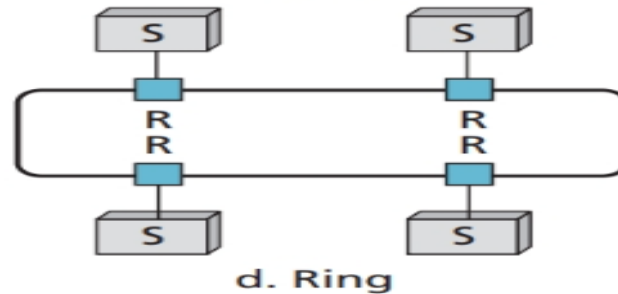
A bus topology uses a multipoint link. One long cable, called the bus, acts as a backbone to link all the devices in a network. Nodes are connected to the bus cable by drop lines and taps (connectors).



Ring Topology

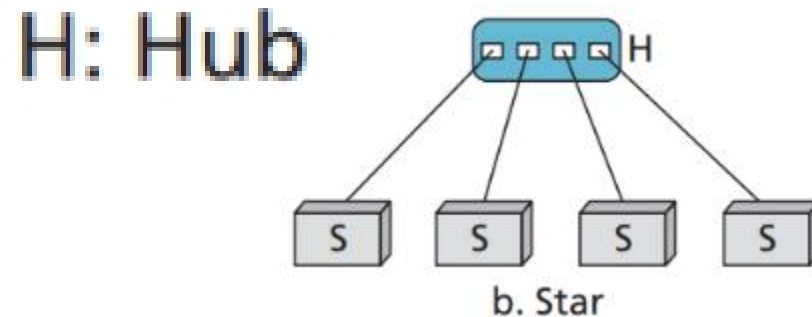
In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.

R: Repeater



Start Topology

In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub.



Categories of networks

Today networks can be divided into three broad categories:

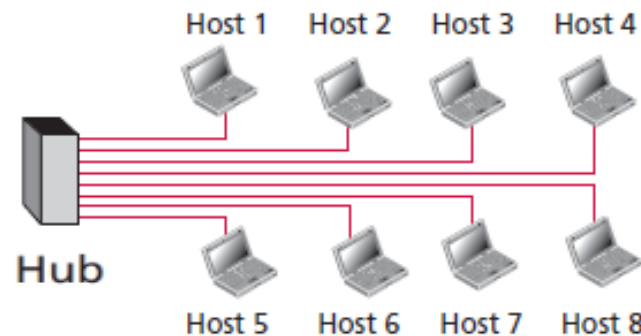
- 1) Local-area networks (LANs): A LAN normally covers a small area, while a MAN covers a small city or town.
- 2) Wide-area networks (WANs): a WAN can be worldwide
- 3) Metropolitan area networks (MANs): a MAN covers a small city or town.

Local area network

A **local area network (LAN)** is privately owned and connects hosts in a single office, building, or campus. LANs can be as simple as two PCs and a printer in someone's home office, or it can extend throughout a company and include audio and video devices.

Each host in a LAN has an identifier, an address, that uniquely defines them. A packet sent by a host to another carries both the source host's and the destination host's addresses.

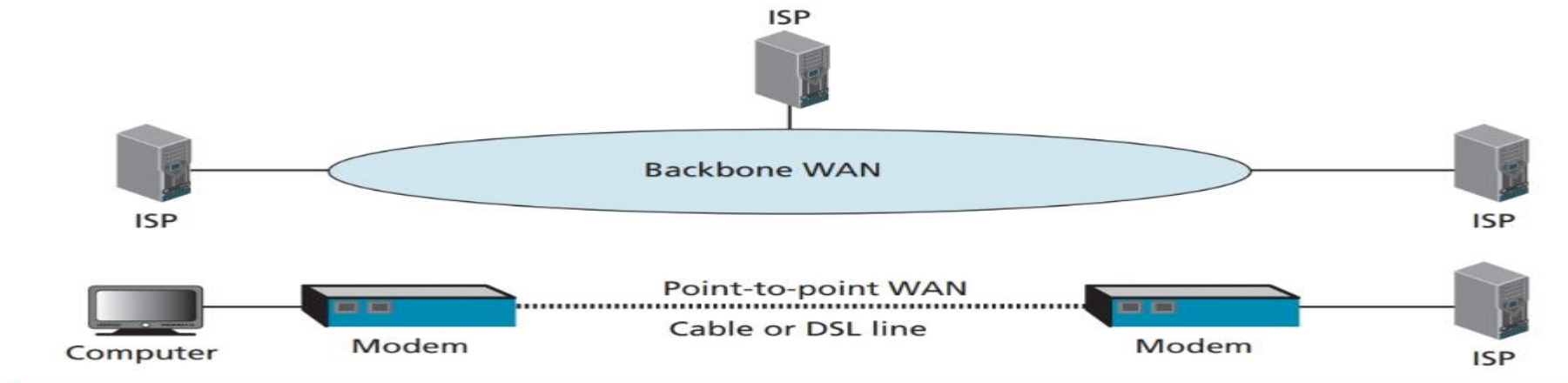
Figure 6.1 *Example of a LAN*



Wide area network

A wide area network (WAN) is an interconnection of devices capable of communication.

Figure 6.4 A point-to-point WAN and a backbone WAN



Metropolitan Area Networks

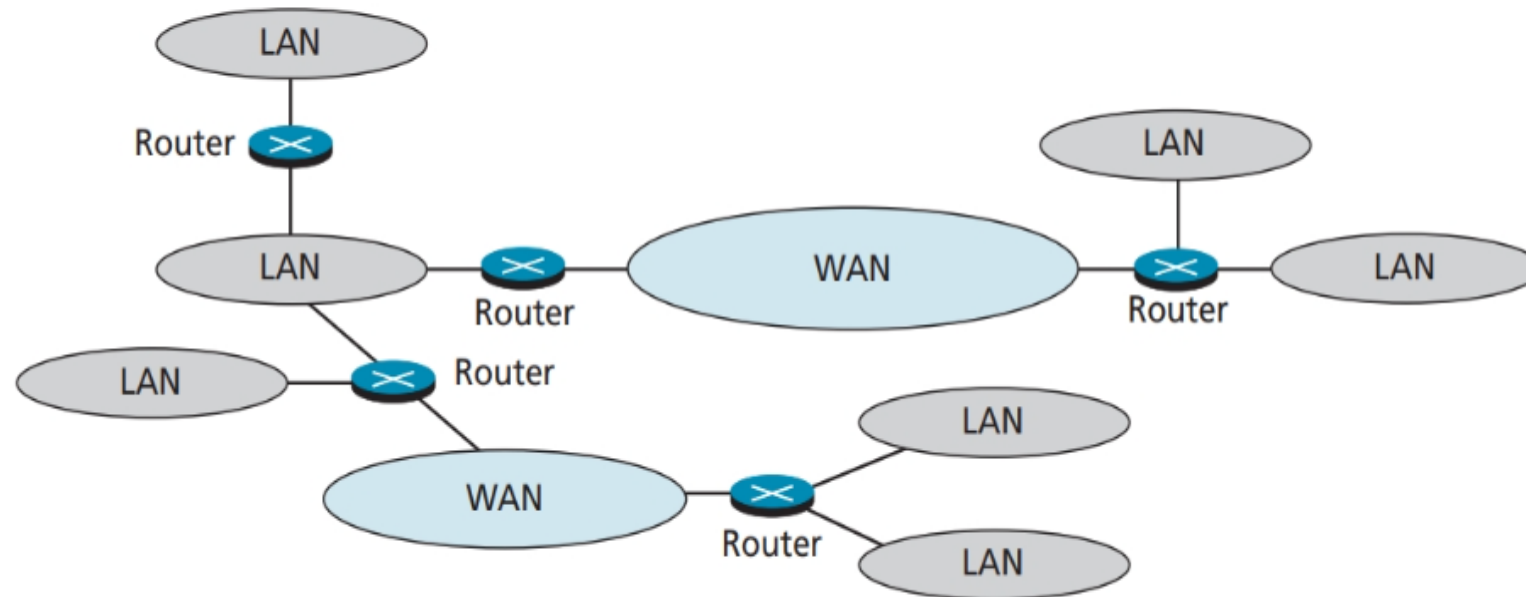
A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city. It is designed for customers who need high-speed connectivity, normally to the internet and has endpoints spread over a city or part of city. A good example of a MAN is that part of a telephone company's network that can provide a high-speed DSL line to the customer. Another example is the cable television network that was originally designed for cable television but today can also be used for high-speed data connection to the internet.

An internet

Today, it is very rare to see a network in isolation as networks are connected to one another. When two or more networks are connected, they become an internetwork, or an internet (lowercase 'i').

An example of an internet. In other words, a network is a group of connected communicating devices such as computers and printers while an internet is two or more networks that can communicate with each other.

Figure 6.5 *An internet made of WANs, LANs, and routers*



Seven LANs and two WANs.

6.1.2 The Internet

An internet is two or more networks that can communicate with each other. The most notable is **the Internet** which is made of thousands of networks.

It is difficult to give an accurate representation of the internet, because it is continually changing—new networks are being added and networks of defunct organizations removed. Today most end users who want an internet connection use the services of internet service providers (ISPs).

An ISP is an organization with one or more servers (high-capacity computers) that are connected to the internet through high-speed links. Individual internet users or small companies can be connected to the servers of a local ISP by establishing a service contract and paying a fee.

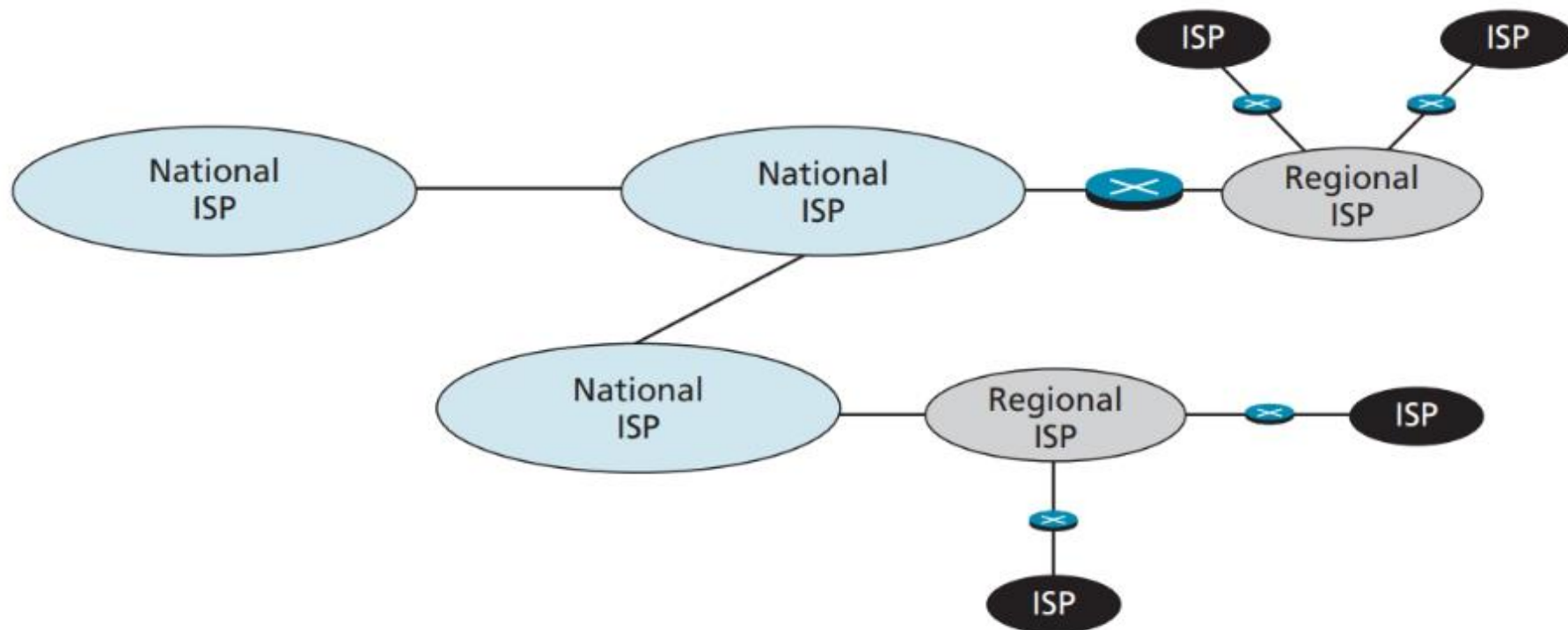
There are:

- international service providers,
- national service providers,
- regional service providers and
- local service providers.

The internet today is run by private companies, not the government.



Figure 6.6 *Hierarchical organization of the internet*



6.1.3 Hardware and software

For communication to happen both hardware and software are required.

This is similar to a complex computation in which both a computer and a program are needed.

These combinations are coordinated with each other using **protocol layering**.

6.2 TCP/IP PROTOCOL SUITE

Compare this to a service provided by a computer network. For example, the task of sending an email from one place in the world to another can be broken down into several tasks, each performed by a layer. Each layer uses the services of a lower layer. At the lowest layer, a signal or a set of signals, is sent from the source computer to the destination computer.

6.2 TCP/IP PROTOCOL SUITE

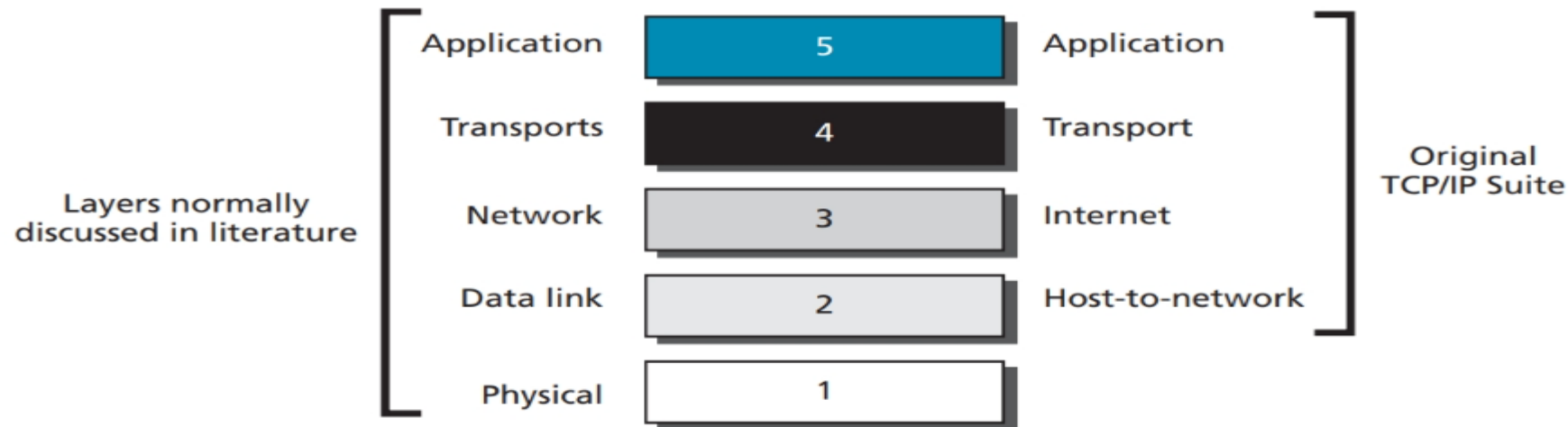
To divide the services required to perform a task, the internet has created a set of rules called protocols. These allow different local and wide area networks, using different technologies, to be connected together and carry a message from one point to another.

The set, or suite, of protocols that controls the internet today is referred to as the TCP/IP protocol suite. The abbreviations (TCP and IP) will become clear as we explain different protocols.

6.2 TCP/IP PROTOCOL SUITE

The original TCP/IP protocol suite was defined as having four layers: host-to-network (or link), internet (network), transport and application. However, the TCP/IP protocol suite today is normally considered as a five-layer model.

Figure 6.7 *The TCP/IP protocol suite*



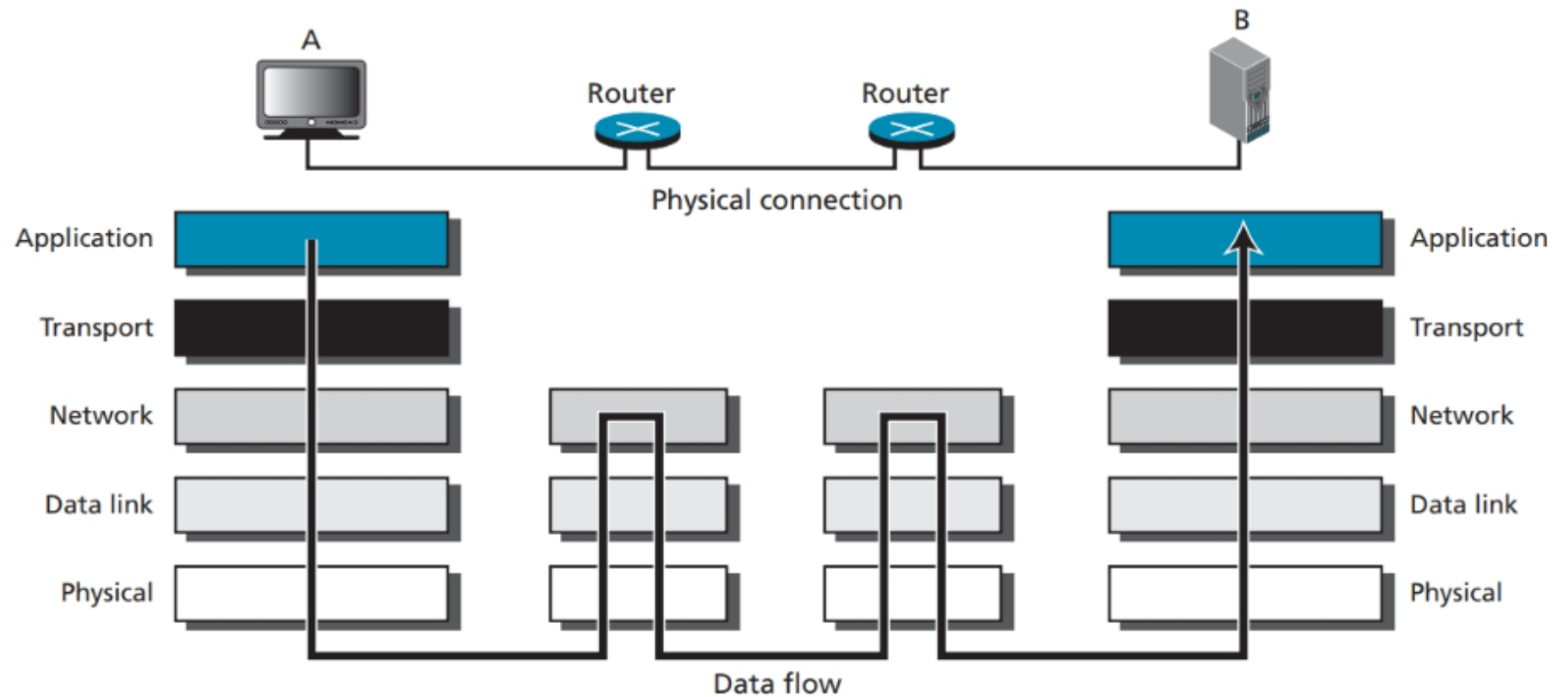
6.2 TCP/IP PROTOCOL SUITE

Figure 6.8 shows the layers involved when a message is sent from device A to device

B. As the message travels from A to B, it may pass through many routers.

Routers use only the first three layers. Within a single machine, each layer calls on the services of the layer immediately below it. Layer 3, for example, uses the services provided by layer 2 and provides services for layer 4.

Figure 6.8 *The interaction between layers in the TCP/IP protocol suite*



6.3 LAYERS

This section briefly describes the function of each layer in the TCP/IP protocol suite. We show how a message travels through the different layers until it reaches the physical layer and is sent by the transmission media.

6.3 LAYERS

Modularity in this case means Independent layers. A layer (module) can be defined as a black box with inputs and outputs, without concern about how inputs are changed to outputs.

Note: If two machines provide the same outputs when given the same inputs, they can replace each other.

Advantages:

- Separation of the services from the implementation. A layer needs to be able to receive a set of services from the lower layer and to give the services to the upper layer.
- Communication does not always use only two end systems; there are intermediate systems that need only some layers, but not all layers. If we did not use protocol layering, we would have to make each intermediate system as complex as the end systems, which makes the whole system more expensive.



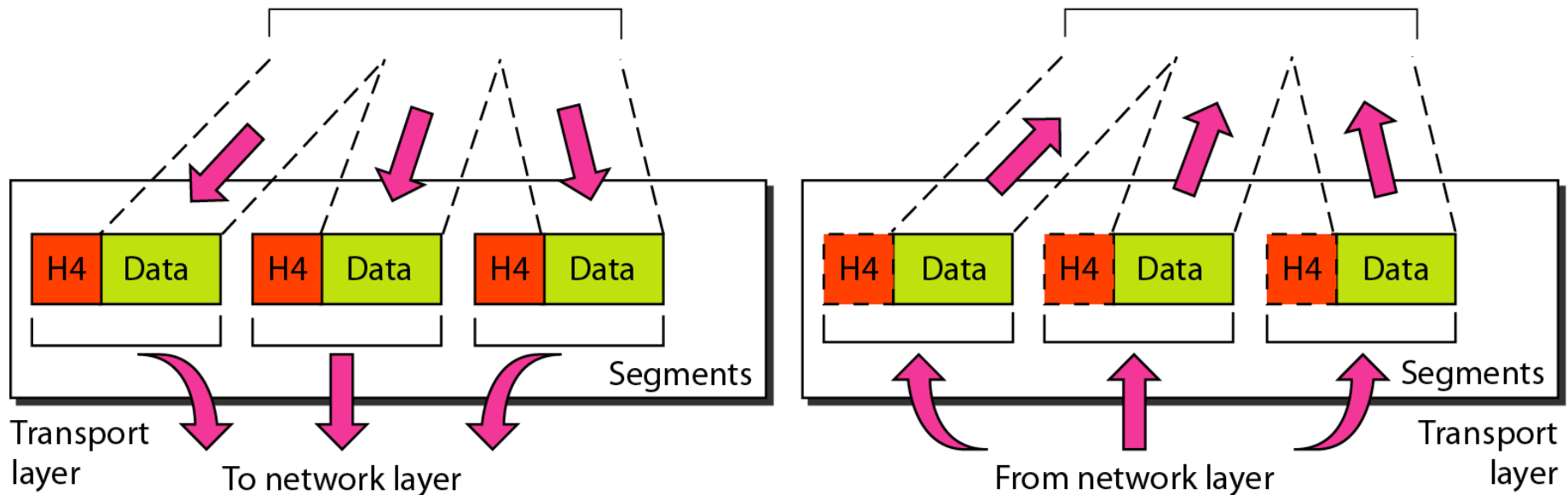
6.3.1 Application layer

The application layer enables a user, whether human or software, to access the network. It provides support for services such as electronic mail, remote file access and transfer, browsing the world wide web, and so on. The application layer is the only layer seen by most users of the internet.

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

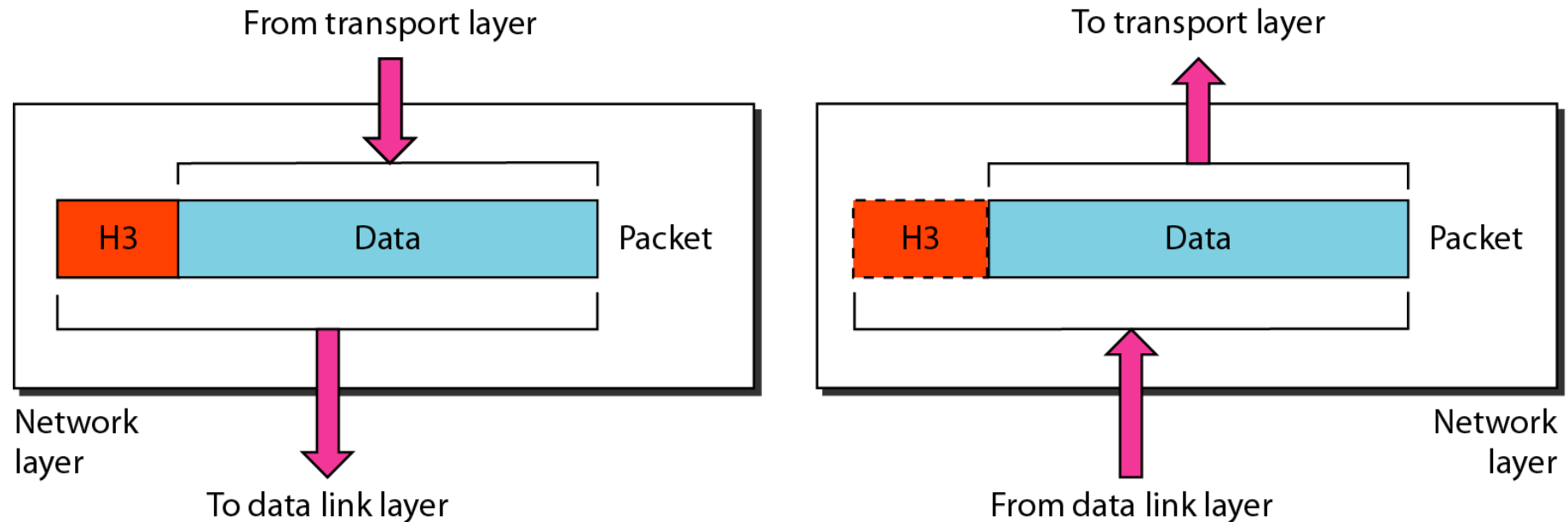
Layer 4: Transport layer

- Responsible for process-to-process delivery of the entire message.
- A process is an application program running on a host.
- It treats each packet as a separate message.



Layer 3: Network layer

- Responsible for the source-to-destination delivery of a packet, across multiple networks.
- If two systems are connected to the same link (network), there is no need for a network layer.



Layer 3: Network layer

The network layer is responsible for the delivery of individual packets from the source host to the destination host.

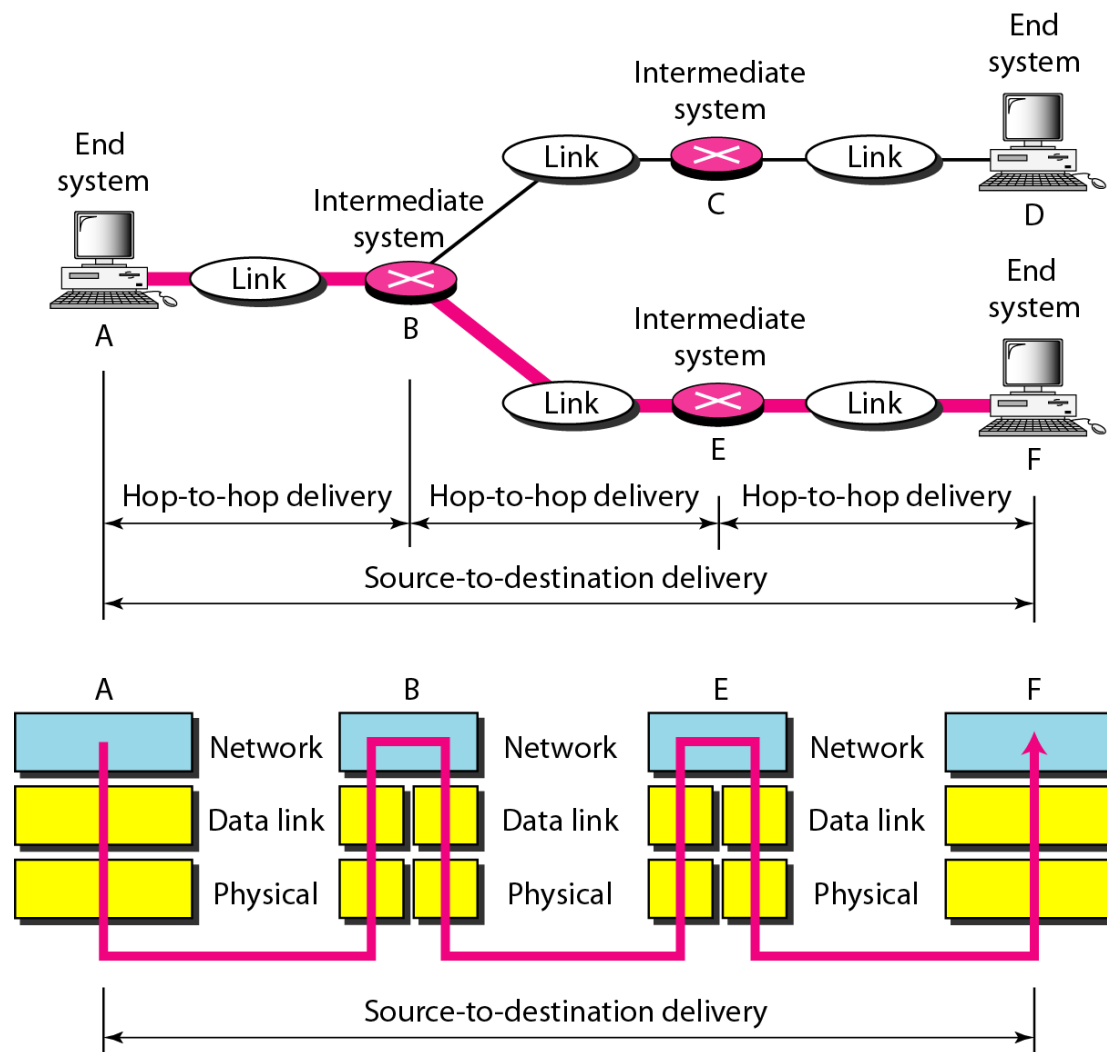
It also responsible for:

- **Logical addressing (IP)** for destination outside the network
- **Routing** : making decision based on the destination



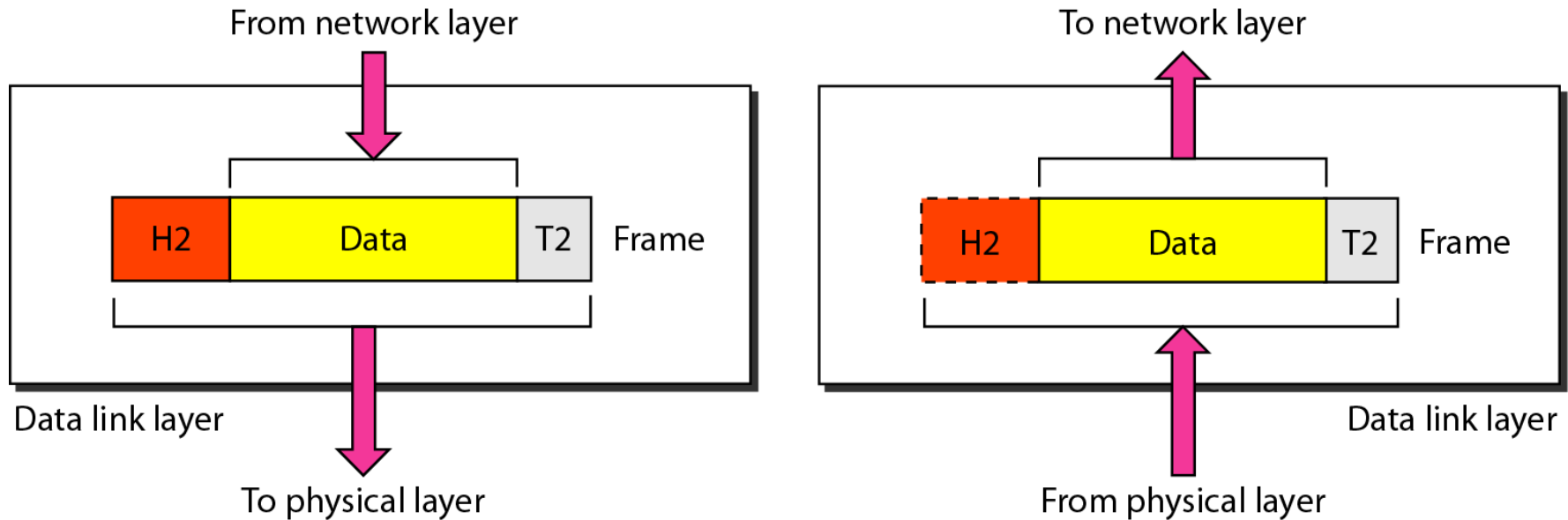
Layer 3: Network layer

Source-to-destination delivery



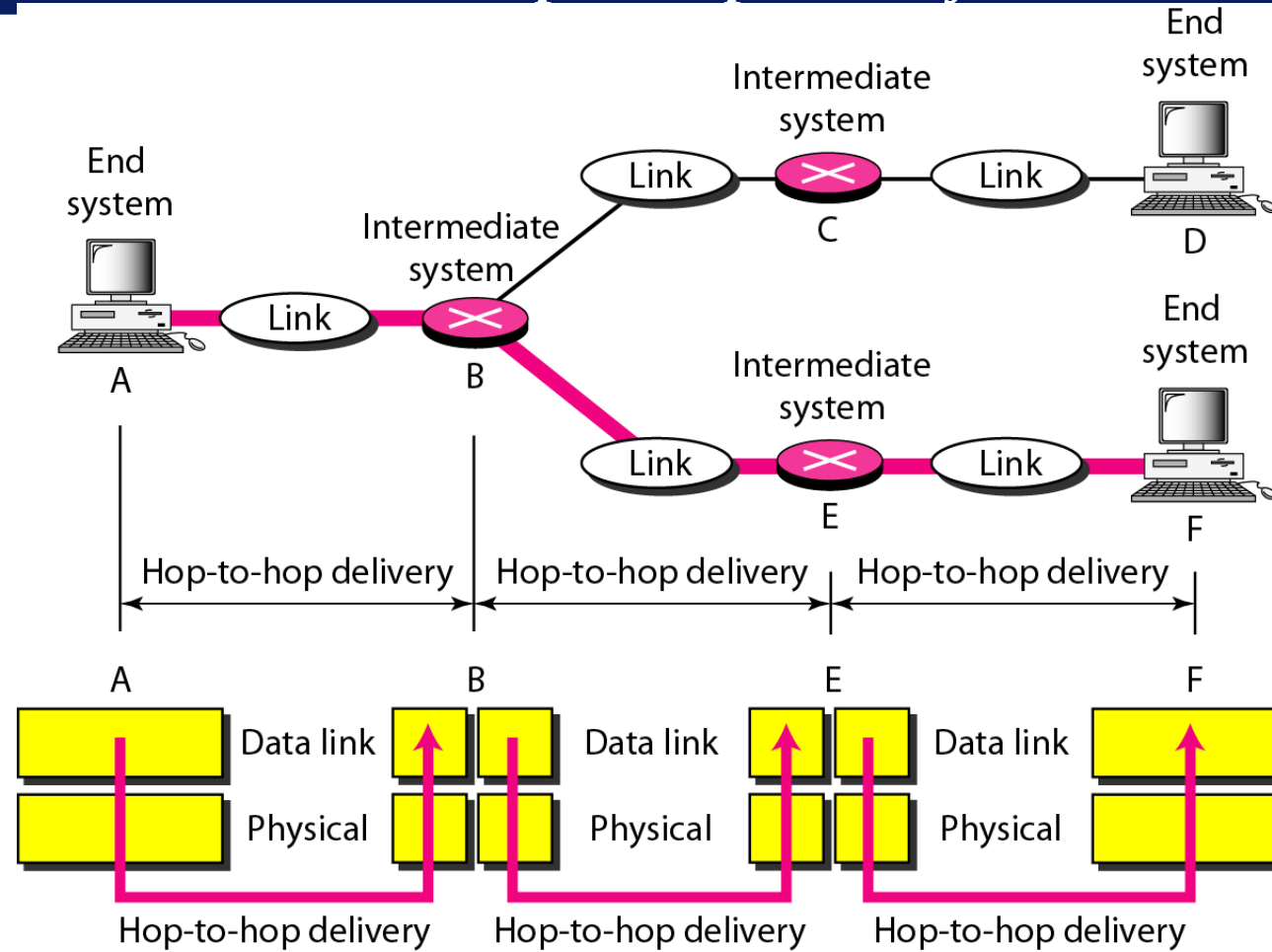
Layer 2: Data Link layer

- Transforms the physical layer to a reliable link.
- It make the physical layer appear error-free to the upper layer.



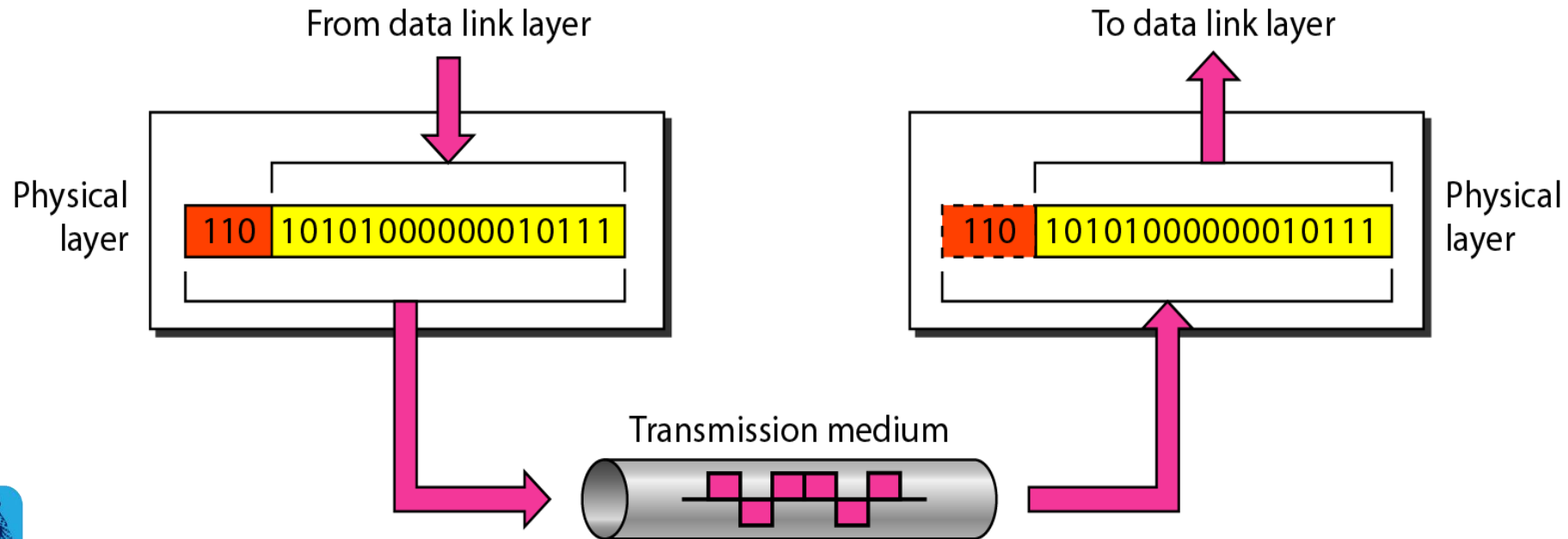
Layer 2: Data Link layer

Hop-to-hop delivery



Layer 1: Physical layer

- Coordinate the functions required to carry a bit stream over a physical medium.
- It also defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur.



Layer 1: Physical layer

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

It also responsible for:

- **Physical characteristics of interfaces and medium**
- **Representation of bits** (how 0,1 changes to signals)
- **Data rate** (num of bits sent each second)
- **Synchronization of bits** (using the same bit rate, same clock)
- **Line configuration** (type of connection: P2P, multipoint)
- **Physical Topology** (Bus/Star/Mesh/Ring)
- **Transmission mode** (simplex/Duplex)

Thank You 😊



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