

# Networks

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# Categories of networks

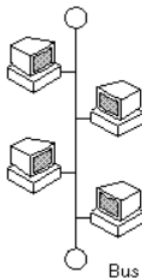
Categories are determined by size

- Local Area Networks (less than a few kilometers)
- Wide Area Networks (can be worldwide)
- Metropolitan Area Networks (size in between LANs and WANs)

# Local Area Networks

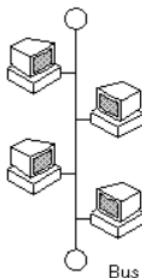
- Usually privately owned
- Links the devices in a campus, office or building
- Designed to allow resources to be shared between personal computers or workstations
- LANs are distinguished by their transmission media and topology
- –Only one transmission medium is used throughout
- topology refers to the way in which the endpoints, or stations, attached to the network are interconnected.
- –bus, tree, ring and star (star is the most common among contemporary LANs)

# Bus topology



- All stations attach, through appropriate hardware interfacing known as a tap, directly to a linear transmission medium, or bus
- Full-duplex operation between the station and the tap allows data to be transmitted onto the bus and received from the bus

# Bus topology



- A transmission from any station propagates the length of the medium in both directions
- It can be received by all other stations
- At each end of the bus is a terminator, which absorbs any signal, removing it from the bus

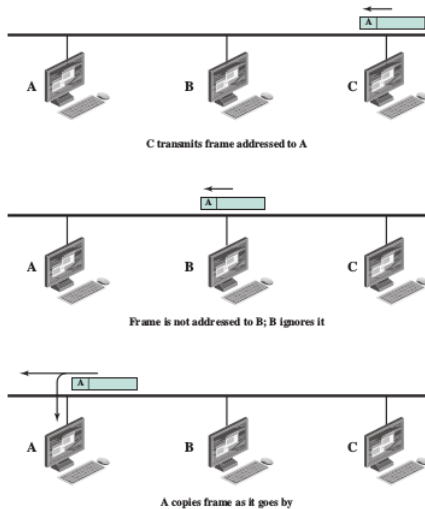
# Bus topology : Problems

- How to know for whom the transmission is intended?
- How to regulate transmission?
  - – two stations on the bus attempt to transmit at the same time
  - – one station decides to transmit continuously for a long period of time

# Bus topology : Solutions

- Stations transmit data in small blocks (frames)
- Frame: control information (frame header) and data
- Each station on the bus is assigned a unique address, or identifier
- The destination address for a frame is included in its header
- Stations take turns sending frames in some cooperative fashion

# Bus topology



**Figure 11.1** Frame Transmission on a Bus LAN



# Question

When a signal reaches the end of the bus,

- (A) it is absorbed by the terminator
- (B) it is sent back into the bus
- (C) neither of the above

# Star topology

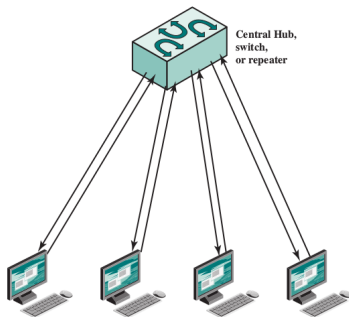


Figure 11.2 Star Topology

Typically, each station attaches to a central node via two point-to-point links, one for transmission and one for reception

# Star topology

- Option 1: The central node operates in a broadcast fashion (a hub: physically a star, logically a bus)
  - – A transmission from any station is received by all other stations
  - – only one station at a time may successfully transmit
- Option 2: The central node acts as a frame-switching device
  - – An incoming frame is buffered in the node and then retransmitted on an outgoing link to the destination station

# Protocols and Standards

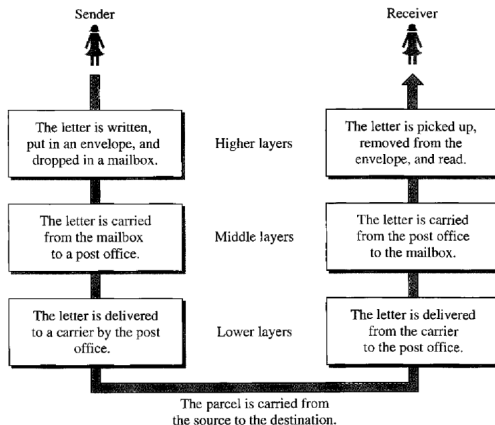
- Communication occurs between entities in different systems
- An entity is anything capable of sending or receiving information
- If two entities send bit streams to each other, they cannot understand each other
- For communication to occur, they must agree on a protocol
- Protocol : a rule that governs data communications
- A protocol defines what is communicated, how it is communicated and when it is communicated

# Elements of a protocol

- Syntax: The structure or format of the data (the order in which data are presented)
- –Example: The first 8 bits represent the address of the sender, the next 8 bits the address of the receiver and the rest of the bits the data
- Semantics: The meaning of each section of bits
- –How is a pattern to be interpreted and what actions must be taken based on that interpretation?
- –Example: Does an address identify the route to be taken or the final message destination?
- Timing: When data should be sent and how fast they can be sent
- –Example: A sender produces data at 100Mbps but a receiver can accept data only at 10 Mbps. The transmission will overload the receiver and some data will be lost

- Required to maintain an open and competitive market for equipment manufacturers
- Guaranteeing national and international interoperability
- Examples: International Standards Organisation (ISO), ANSI, Insititue for Electrical and Electronics Engineers (IEEE)

# Layered tasks



# Hierarchy and services

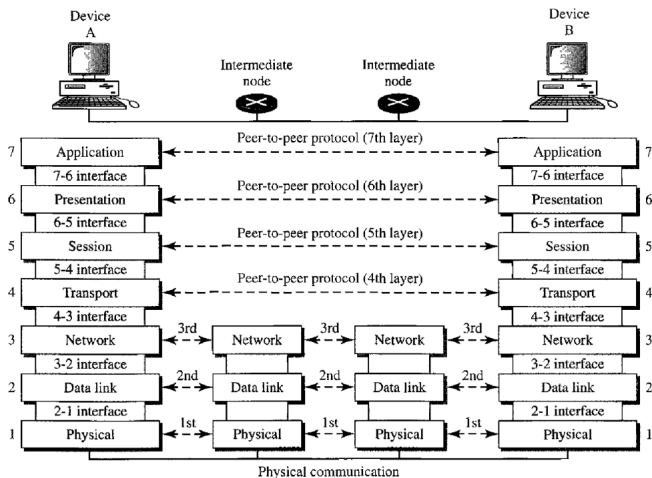
- Tasks must be done in the order given in the hierarchy
- – At the sender, the letter must be written, put in the envelope and put in the mailbox before it is sent to the post office
- Each layer at the sending side uses the services of the layer below it
- – The sender at the higher layer uses the services of the middle layer.
- – The middle layer uses the services of the lower layer
- – The lower layer uses the services of the carrier



# The Open Systems Interconnection (OSI) model

- Formulated by ISO
- Layered model for data communications
- Open system: a set of protocols that allow two systems to communicate regardless of their underlying architecture
- –Example: One system is coded in C, another in Python
- Purpose of the OSI model: How to facilitate communication between different systems without requiring changes to the logic of the underlying hardware or software
- Not a protocol
- A model to understand and design a network architecture that is flexible, robust and interoperable
- –Can use any mailbox to post a letter as long as a letter has an address
- Allows communication between all types of computer systems

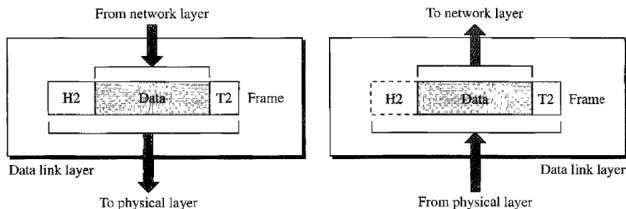
# Layers in the OSI model and their interactions



# Physical Layer

- Coordinates functions to carry a bit stream over a medium
- Mechanical and electrical interfaces and specifications of the interface and the medium
- Defines the procedures and functions that physical devices and interfaces have to perform
- Representation of bits - type of encoding
- Data rate
- Synchronization of bits
- Link configuration (point-to-point, multipoint)
- Physical topology
- Transmission mode (simplex, half-duplex, full-duplex)

# Data link layer

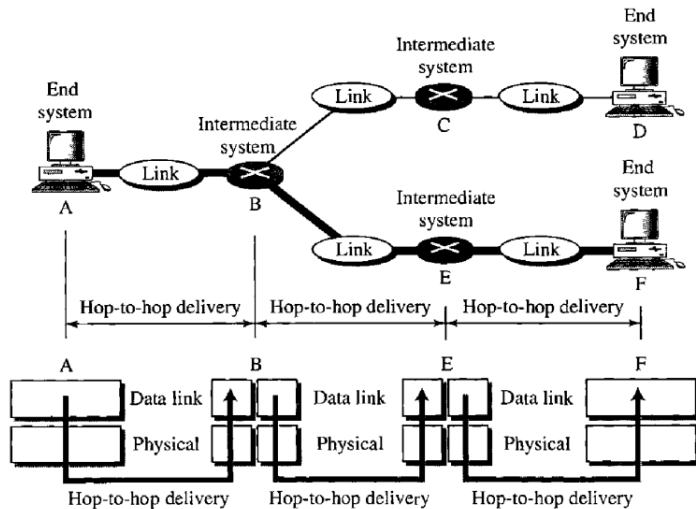


- Responsible for moving frames from one node to the next
- Transforms the physical layer to a reliable link
- – Makes the physical layer appear error-free to the upper layer (network layer)

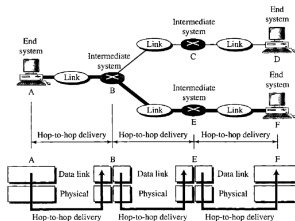
# Data link layer

- Framing: The data link layer receives the stream of bits received from the network layer into manageable data units called frames
- Physical addressing : to identify the sender and/or receiver of the frame
- Flow control: A mechanism to avoid overwhelming the receiver if the rate at which data are absorbed by the receiver is less than the rate at which data are produced in the sender
- Error control: Adds mechanisms to detect and retransmit damaged or lost frames, recognize duplicate frames (achieved through a trailer added to the frame)
- Access control: To decide which device has control over the link at any given time

# Hop-to-hop delivery



# Hop-to-hop delivery



- To send data from A to F: 3 partial deliveries are made
- A sends a frame to B. B sends a new frame to E and E sends a new frame to F
- The frames have different values in their headers: the frame from A to B has A as the source address and B as the destination address
- – The frame from B to E has B as the source address and E as the destination address
- The values of trailers can also be different if error checking includes the frame header

# Question

“100BASE-TX is the predominant form of Fast Ethernet, and runs over two wire-pairs inside a category 5 or above cable. Each network segment can have a maximum cabling distance of 100 metres (328 ft). One pair is used for each direction, providing full-duplex operation with 100 Mbit/s of throughput in each direction.” This is the description of \_\_\_\_\_ layer of Ethernet technologies.

- (A) physical
- (B) data link
- (C) network
- (D) none of the above