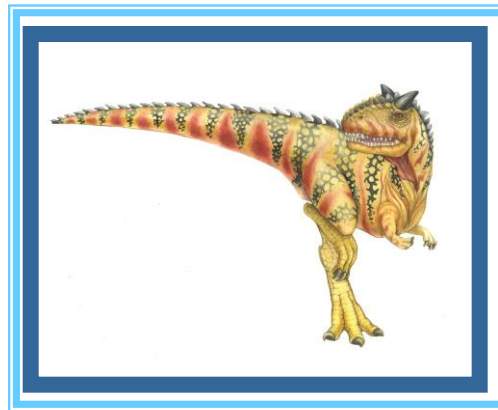


Chapter 17: Distributed System

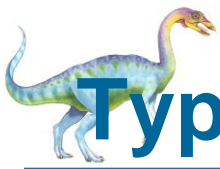




Motivation

- **Distributed system** is collection of loosely coupled processors interconnected by a communications network
- Processors variously called *nodes*, *computers*, *machines*, *hosts*
 - *Site* is location of the processor
- Reasons for distributed systems
 - Resource sharing
 - ▶ sharing and printing files at remote sites
 - ▶ processing information in a distributed database
 - ▶ using remote specialized hardware devices
 - Computation speedup – **load sharing**
 - Reliability – detect and recover from site failure, function transfer, reintegrate failed site
 - Communication – message passing





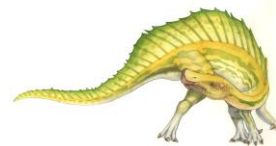
Types of Distributed Operating Systems

■ Network Operating Systems

- Users are aware of multiplicity of machines. Access to resources of various machines is done explicitly by:
 - ▶ Remote logging into the appropriate remote machine (telnet, ssh)
 - ▶ Transferring data from remote machines to local machines, via the File Transfer Protocol (FTP) mechanism

■ Distributed Operating Systems

- Users not aware of multiplicity of machines
 - ▶ Access to remote resources similar to access to local resources
- Data Migration – transfer data by transferring entire file, or transferring only those portions of the file necessary for the immediate task
- Computation Migration – transfer the computation, rather than the data, across the system





Network Structure

- **Local-Area Network (LAN)** – designed to cover small geographical area.
 - Multiaccess bus, ring, or star network
 - Speed \approx 10 – 100 megabits/second
 - Broadcast is fast and cheap
 - Nodes:
 - ▶ usually workstations and/or personal computers
 - ▶ a few (usually one or two) mainframes





Network Types (Cont.)

- **Wide-Area Network (WAN)** – links geographically separated sites
 - Point-to-point connections over long-haul lines (often leased from a phone company)
 - Speed \approx 1.544 – 45 megabits/second
 - Broadcast usually requires multiple messages
 - Nodes:
 - ▶ usually a high percentage of mainframes





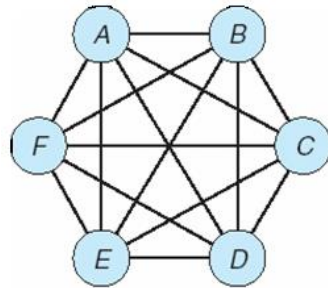
Network Topology

- Sites in the system can be physically connected in a variety of ways; they are compared with respect to the following criteria:
 - **Installation cost** - How expensive is it to link the various sites in the system?
 - **Communication cost** - How long does it take to send a message from site *A* to site *B*?
 - **Reliability** - If a link or a site in the system fails, can the remaining sites still communicate with each other?
- The various topologies are depicted as graphs whose nodes correspond to sites
 - An edge from node *A* to node *B* corresponds to a direct connection between the two sites
- The following six items depict various network topologies

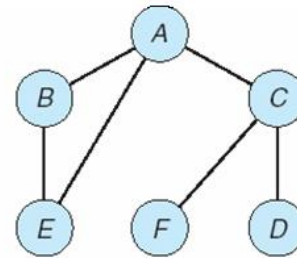




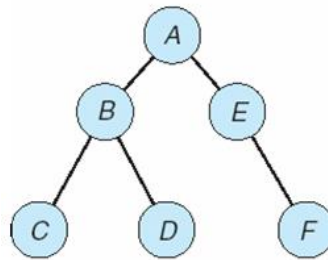
Network Topology



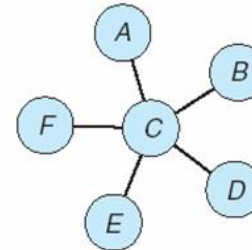
fully connected network



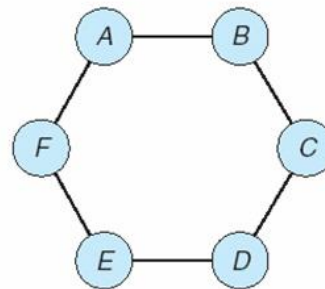
partially connected network



tree-structured network



star network



ring network





Communication Structure

The design of a *communication* network must address four basic issues:

- **Naming and name resolution** - How do two processes locate each other to communicate?
- **Routing strategies** - How are messages sent through the network?
- **Connection strategies** - How do two processes send a sequence of messages?
- **Contention** - The network is a shared resource, so how do we resolve conflicting demands for its use?





Connection Strategies

- **Circuit switching** - A permanent physical link is established for the duration of the communication (i.e., telephone system)
- **Message switching** - A temporary link is established for the duration of one message transfer (i.e., post-office mailing system)
- **Packet switching** - Messages of variable length are divided into fixed-length packets which are sent to the destination
 - Each packet may take a different path through the network
 - The packets must be reassembled into messages as they arrive
- Circuit switching requires setup time, but incurs less overhead for shipping each message, and may waste network bandwidth
 - Message and packet switching require less setup time, but incur more overhead per message





Contention

Several sites may want to transmit information over a link simultaneously. Techniques to avoid repeated collisions include:

- **CSMA/CD** - Carrier sense with multiple access (CSMA); collision detection (CD)
 - A site determines whether another message is currently being transmitted over that link. If two or more sites begin transmitting at exactly the same time, then they will register a CD and will stop transmitting
 - When the system is very busy, many collisions may occur, and thus performance may be degraded
- CSMA/CD is used successfully in the Ethernet system, the most common network system





Communication Protocol

The communication network is partitioned into the following multiple layers:

- **Physical layer** – handles the mechanical and electrical details of the physical transmission of a bit stream
- **Data-link layer** – handles the *frames*, or fixed-length parts of packets, including any error detection and recovery that occurred in the physical layer
- **Network layer** – provides connections and routes packets in the communication network, including handling the address of outgoing packets, decoding the address of incoming packets, and maintaining routing information for proper response to changing load levels





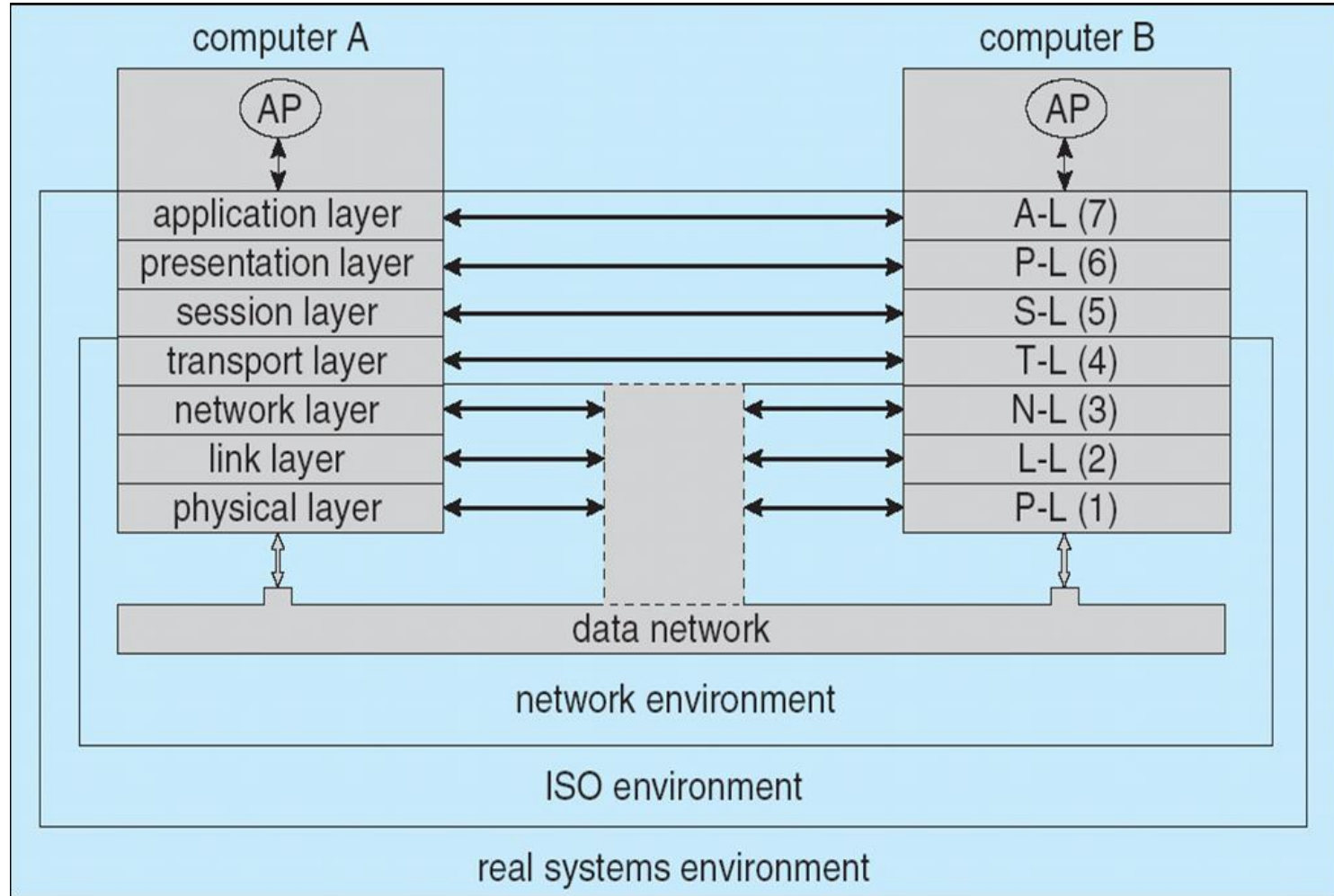
Communication Protocol (Cont.)

- **Transport layer** – responsible for low-level network access and for message transfer between clients, including partitioning messages into packets, maintaining packet order, controlling flow, and generating physical addresses
- **Session layer** – implements sessions, or process-to-process communications protocols
- **Presentation layer** – resolves the differences in formats among the various sites in the network, including character conversions, and half duplex/full duplex (echoing)
- **Application layer** – interacts directly with the users' deals with file transfer, remote-login protocols and electronic mail, as well as schemas for distributed databases



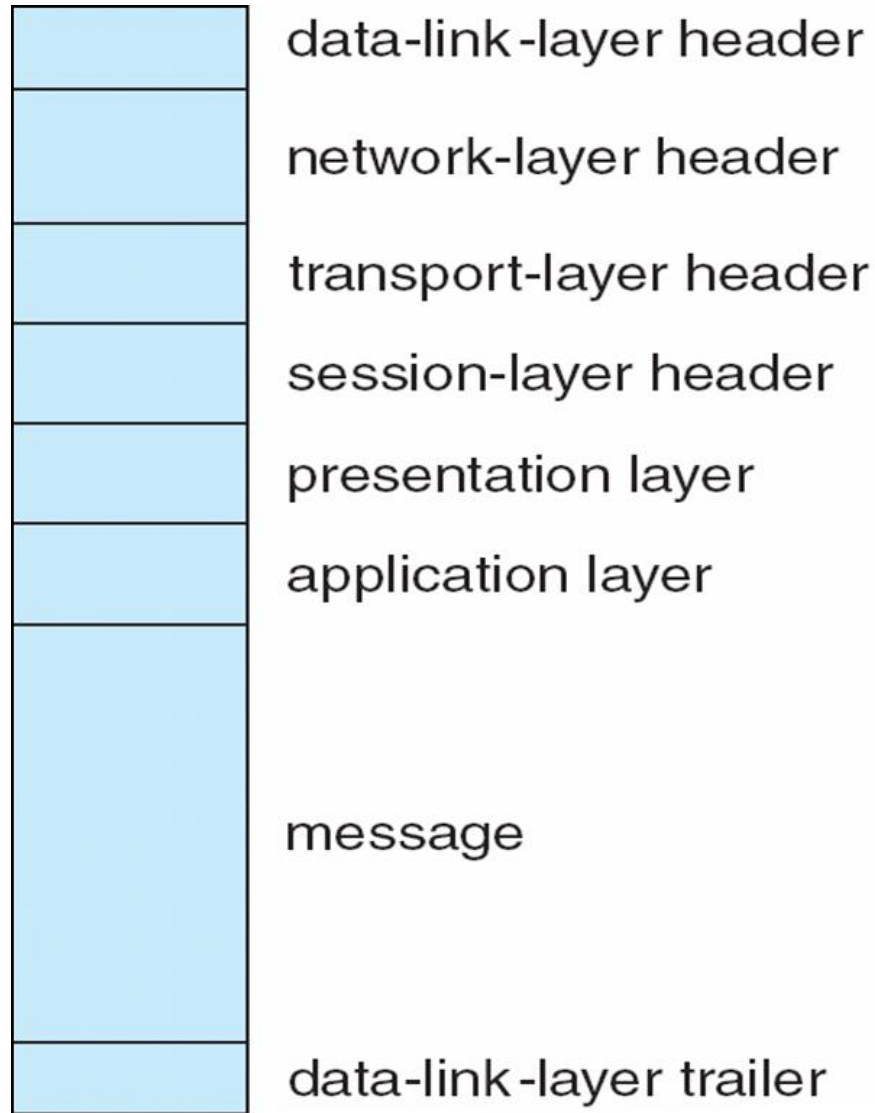


Communication Via ISO Network Model





The ISO Network Message





The TCP/IP Protocol Layers

