

## Chapter 15: Distributed Structures

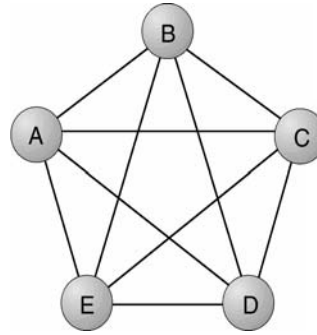
- Topology
- Network Types

## Topology

- Sites in the system can be physically connected in a variety of ways; they are compared with respect to the following criteria:
  - **Basic 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.

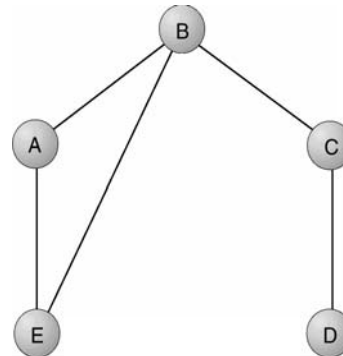
## Fully Connected Network

- Each site (node) is directly linked with all other sites in the system.
- Basic cost is high, since a direct communication line must be available between every two sites.
- Messages between sites can be sent fast.
- Reliable, since many links must fail for the system to become partitioned.



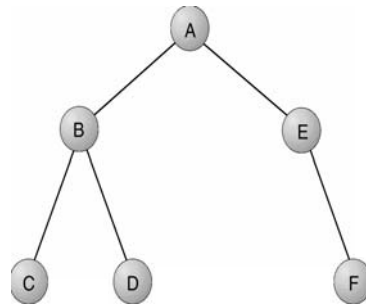
## Partially Connected Network

- Direct links exist between some, but not all pairs of sites.
- Basic cost is lower than of fully connected network.
- Slower communication (for example: a message from site A to site D must sent through sites B and C).
- Not reliable as a fully connected network, because the failure of one link may partition the network (for example: if the link from B to C fails then the network is partitioned into two subsystems; one subsystem contains sites A, B, and E and the second subsystem includes sites C and D).



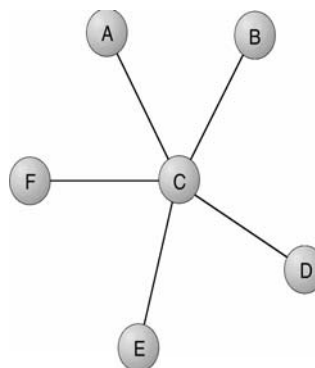
## Hierarchical Network

- The sites are organized as a tree.
- Basic cost is less than that of the partially connected scheme.
- A parent and child communicate directly (for example: A and E).
- If a parent site fails, then its children can no longer communicate with each other.
- The failure of any node (site) (except a leaf) partitions the network into several disjoint sub trees.

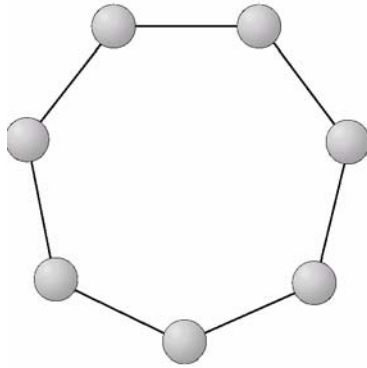


## Star Network

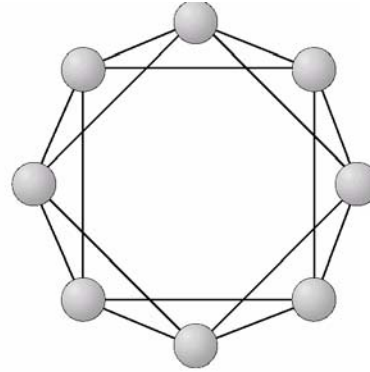
- In a star network, one of the sites in the system is connected to all other sites, and none of the other sites are connected to any other.
- Basic cost is linear in the number of sites.
- Communication cost is low, because messages from process A to B requires at most two transfers (from A to the central site, and then from central site to B).
- May not ensure speed, since the central site may become a bottleneck.
- If the central site fails, the network is completely partitioned.



## Ring Networks



(a)



(b)

- Ring networks: (a) Single links. (b) Double links

## Ring Networks (Cont.)

- Each site is physically connected to exactly two other sites.
- The ring can be unidirectional or bi-directional.
- In an unidirectional architecture, a site can transmit information to only one of its neighbors, and all sites must send information in the same direction.
- In a bi-directional architecture, a site can transmit information to both of its neighbors.
- Basic cost of ring is linear in the number of sites.
- Communication cost can be high (a message from one site to another travels around the ring until it reaches its destination).

## Ring Networks (Cont.)

- In an unidirectional this process could require  $n-1$  transfers.
- In a bi-directional ring, at most  $n/2$  transfers are needed.
- In a bi-directional, two links must fail before the network will partition.
- In an unidirectional ring, a single site failure would partition the network.

## Multi-access Bus Network

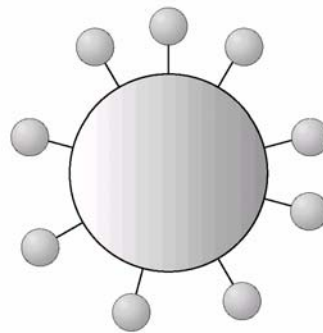


(a)

Bus network:

(a) Linear bus.

(b) Ring bus.



(b)

## Multi-access Bus Network (Cont.)

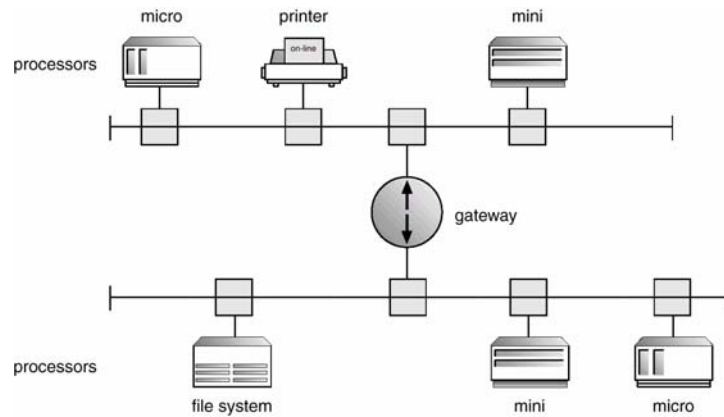
- In a multi-access bus network, there is a single shared link (the bus).
- All the sites in the system are directly connected to that link, which may be organized as a straight line or as a ring.
- Basic cost is linear in the number of sites.
- Communication cost is low, unless the link becomes bottleneck.
- Failure of one site does not affect communication among the rest of sites.
- If the link (bus) fails the network is partitioned completely.
- Ethernet Bus (example).

## Network Types

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

## Network Types (Cont.)

- Depiction of typical LAN:



## 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  $\approx$  100 kilobits/second.
  - Broadcast usually requires multiple messages.
  - Nodes:
    1. usually a high percentage of mainframes

## Communication Processors in a Wide-Area Network

