

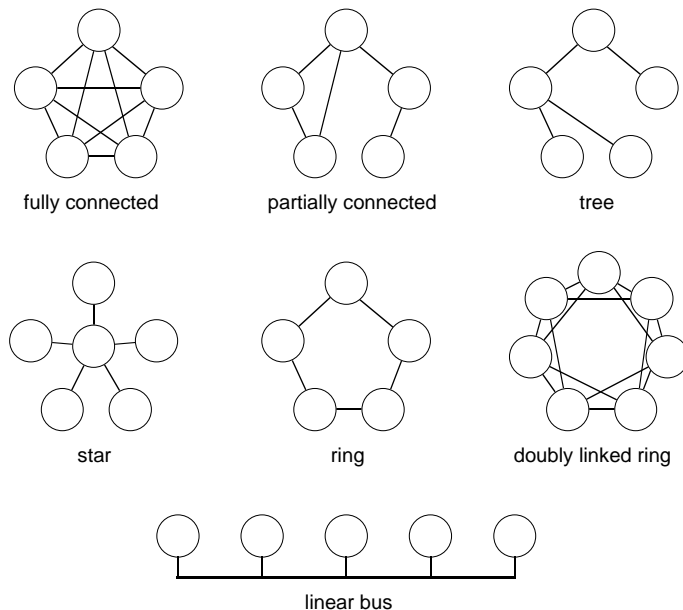
Networks

- A *network* is a communication system that provides correct, efficient, and robust data exchange between 2 or more hosts
- *Local area network* (LAN) —connects nodes in a small geographic area (e.g., single building, single campus)
 - Must be fast with low error rate
 - Media — twisted-pair, coaxial cable, fiber optic cable
- *Wide area network* (WAN) —connects nodes in a wide geographic area (e.g., across the country)
 - May be slower with higher error rate
 - Media — leased telephone lines (T1 & T3 service), microwave links, satellite channels

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Network Topologies



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Network Topologies (cont.)

- Point-to-point — links to specific nodes
 - Fully connected — each node connects to all other nodes
 - ✓ Each message is fast; it takes only a single “hop” to reach its destination
 - ✓ Failure of any one node does not affect communication except to it
 - ✗ Expensive!
 - Partially connected — each node connects to some, but not all, nodes
 - ✓ Less expensive
 - ✗ A message may have to go through several other nodes
 - ✗ Less tolerant to failure
 - Tree — network hierarchy
 - ✓ Messages between direct descendants are fast
 - ✗ Messages between “cousins” must go up to a common ancestor and back down
 - ✗ Not tolerant of failures

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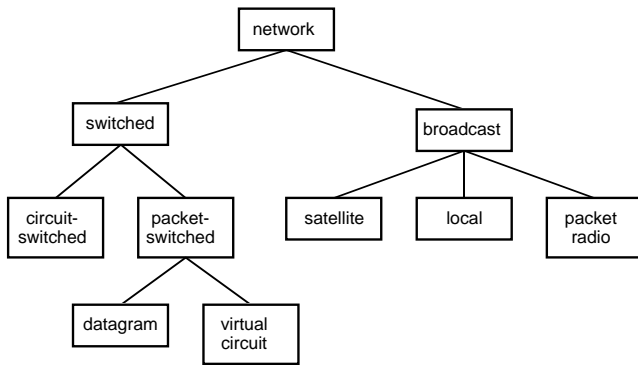
Network Topologies (cont.)

- Star— all nodes connect to a single centralized node
 - ✓ Inexpensive
 - ✓ Each message takes only two hops
 - ✗ Failure of central node disconnects entire network
- Ring — all nodes connect in a circle
 - One directional ring — each node can send in only one direction
 - ✓ Inexpensive
 - ✗ Message may need to take n hops
 - ✗ Not tolerant of failures
 - Bi-directional ring — send either way
- Bus — all nodes connect to common network
 - ✓ Inexpensive, linear in number of nodes
 - ✓ Tolerant of node failures
 - ✗ Only one node can send data at a time

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Network Communication



- **Connection-oriented communication**
 - Information delivered as a *stream* of bytes, in correct order
 - Connect, exchange data, release
- **Connectionless communication**
 - Information delivered as a set of *packets*
 - Packets may be delivered out of sequence, must be reassembled

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Switching Technologies

- In a *broadcast* (or *multiaccess*) network, all hosts directly connect to a single shared communication medium
 - Each host check the destination address on every message to decide whether or not to read that message
- In a *switched* network, there is a partially-connected topology, and there may be multiple paths between two hosts
 - Messages may have to pass through intermediate nodes to reach destination
- **Circuit switching** — a dedicated communication path is reserved, and then used to send the entire message
 - Connection occupies a fixed capacity (not necessarily entire capacity) of each link for the entire lifetime of the connection
 - Connection-oriented communication

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Switching Technologies(cont.)

- **Packet switching** — data is broken up into a sequence of fixed-size *packets*
 - Each packet is passed through the network from source to destination along some (possibly different) *route* (path)
 - At each node, the entire packet is received, stored briefly, and then forwarded to the next node
 - **Datagram package switching**
 - Packets are called *datagrams*
 - Each packet is routed independently
 - A sequence of packets can be received out of order
 - Connectionless communication
 - **Virtual circuit package (message) switching**
 - All packets from one packet stream are sent along the same path (= *virtual circuit*)
 - Guarantees packets are received in sequence
 - Connection-oriented communication

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Routing

- **Routing** software decides *which* path to use to move a message from the destination to source
- Routing is usually *hop-by-hop*, meaning each host chooses the next host to send the message to
- **Static (fixed) routing** — routing tables are stored, and change very infrequently (e.g., after major the network changes)
 - ✓ Low setup cost, packets arrive in order
 - ✗ Can't react to changes in network load
- **Dynamic routing** — routing tables are updated frequently
 - ✓ Can react to changes in network load
 - ✗ Higher setup cost for each packet
 - ✗ Packets can arrive out of order

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