Networking and Telecommunication

Network Fundamentals

A computer network consists of two or more computers linked together to exchange data and share resources.

- **LAN** – local area network (small geographic area)
- **WAN** – wide area network (large geographic area)
- **MAN** – Metropolitan Area Network (large city)

Networks Near and Far

Local-area network (LAN)
- Computers are linked within a building or cluster of buildings.
- Each computer and peripheral is an individual node on the network.
- Nodes are connected by cables which may be either twisted pair (copper wires) or coaxial cable.

LAN Topologies

- The physical layout of a LAN is called its topology.
- Topologies resolve the problem of contention, which occurs when multiple users try to access the LAN at the same time.
  - Collisions or corrupt data occur when different computers use the network at the same time.
  - Click to see examples.

- **Bus topology**
  - Called a daisy chain
  - Every workstation is connected to a single cable
  - Resolves collisions through contention management
  - Difficult to add workstations

- **Star topology**
  - Contains a hub or central wiring concentrator
  - Easy to add workstations
  - Resolves collisions through contention management

- **Ring topology**
  - All workstations are attached in a circular arrangement
  - A special unit of data called a token travels around the ring
  - Workstations can only transmit data when they possess a token

Wide Area Networks (WANs)

- **WANs** are similar to long-distance telephone systems
  - They have a local access number called a point of presence (POP)
  - They contain long-distance trunk lines called backbones

Backbones

- **Backbones**, high-capacity transmission lines, can be regional, continental, or transcontinental
- Internet backbones can carry 2.5 gigabits of data per second
Wide-Area Networks

- Made up of LANs linked by phone lines, microwave towers, and communication satellites.
- Bridges, routers, and gateways are hardware devices that pass messages between networks.

Bridges

- Bridges connect other networks (usually of same topology)
  - Switches in the bridges isolate each network from messages that do not involve their network
  - Messages broadcast only in own network unless sent to another network through bridge

Routers

- Routers connect same or different network topologies and determine the paths of the messages

Gateways

- Gateways connect networks of different protocols of different vendors
  - many gateways for the Internet

Bandwidth

- The amount of information that can be transmitted in a given amount of time
- Impacted by:
  - Physical media that make up the network
  - Amount of network traffic
  - Software protocols of the network
  - Type of network connection

Networks classified by Signal

- Baseband (narrowband)
  - employs entire bandwidth for one signal
  - Most LAN
- Broadband
  - multiple signals on the same channel simultaneously
  - channel is divided into separate frequency bands, each capable of carrying a signal
  - Ch 2 54-60MHz
  - Ch 13 210-216 MHz
  - Ch 61 444-450 MHz
  - Cable TV wants wider range so they can split into many different channels
- frequency range for standard telephone is 300Hz-3300Hz
  - bandwidth is 3000Hz
Advantages of Networks

- Reduced hardware costs
- Application sharing
- Sharing information resources
- Centralized data management
- Connecting people

Disadvantages of Networks

- Loss of autonomy
- Lack of privacy
- Security threats
- Loss of productivity

Networking Hardware
- Network interface card (NIC) – Provides the connection between the computer and the network
- Inserted into a computer’s expansion slot

Networking Software
- Operating system that supports networking (Unix, Linux, Windows, Mac OS)
- Additional system software

LAN Hardware and Software

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Peer-to-Peer Networks

- All computers on the network are treated as equal
- There are no file servers
- Users decide which files and peripherals to share
- Peer-to-peer is not suited for networks with many computers
- Peer-to-peer is easy to set up; example: home networks

Client-Server Networks

- Typical corporate networks are client-server
- Client-server requires various topologies or physical layouts
- The network requires file servers, networked computers (clients), and a network operating system (NOS)
- Clients send requests to servers for programs and data, and to access peripherals
Messages must typically be routed properly through intermediate nodes between transmitter and receiver.

There are two major switching techniques:
- Circuit switching
- Packet switching

Networks Classified by Switching

Circuit switching
- Networks create an end-to-end circuit between the sending and receiving computers (like a telephone connection)
- Electronic switches establish and maintain the connection

Packet switching
- Outgoing messages are divided into fixed-size data units called packets
- Packets are numbered and addressed to the receiving computer
- Routers examine the packets and send them to their destination (not always on the route)

Circuit Switching Continuous Connection
- A continuous connection or circuit is forged between transmitter and receiver
- Ordinary telephone connections are made by circuit switching

Packet Switching Connectionless
- In packet switching, the message is broken up into separate data packets each addressed to the destination
- Packets are transmitted over any available route to the destination, where the receiving node reassembles the message

Advantages and Disadvantages of Circuit and Packet Switching

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<tr>
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<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Circuit switching</td>
<td>Voice and real-time transmission</td>
<td>Costly</td>
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<tr>
<td></td>
<td>No delivery delays</td>
<td>A direct electrical connection between the computers is required</td>
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<tr>
<td>Packet switching</td>
<td>Efficient, less expensive, and reliable</td>
<td>Delays in receiving packets</td>
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<td>Will function if part of the network is down</td>
<td>Not ideal for real-time voice communication</td>
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Communication Software

Protocol - set of rules for the exchange of data between a terminal and a computer or between two computers
- TCP/IP, HTTP

Communication software establishes a protocol that is followed by the computer’s hardware
LAN technologies
- Ethernet – standard for large and small business
- LocalTalk – simplest LAN technology
- IBM Token Ring Network

Wi-Fi
- Wireless-fidelity
- Wireless LAN
- Use central server or access point
- Advantages
  - Fast (11 Mbps)
  - Reliable
  - Long range
  - Integrates with existing networks

Communication Software
- Many forms:
  - Network operating system (NOS) - handles communications between many workstations
  - Client/server model - one or more computers act as dedicated servers and all the remaining computers act as clients
  - Peer-to-peer model - every computer on the network is both client and server
  - Many networks are hybrids, using features of the client/server and peer-to-peer models

The Postal Alternative
- E-mail is fast.
- E-mail doesn’t depend on location.
- E-mail facilitates group communication.
- E-mail messages are digital data that can be edited and combined with other computer-generated documents.

Advantages of E-mail and Teleconferencing
- On-line communication is less intrusive.
- On-line communication allows time shifting.
- Teleconferences and e-mail promote teleworking.
- Teleconferences and e-mail emphasize the message over the messenger.

On-line Issues for E-mail and Teleconferencing
- Vulnerable to machine failures, network glitches, human errors and security
- Threat to privacy
- E-mail forgery
- Information overload
- Missing “human” elements of communication
Encryption and Data Security

- Cryptography is the art and science of keeping messages secret.
- Encryption converts data into a code for transmission.
- Decryption converts code back to original data upon receipt.

Encryption Keys

- MESSAGE
  - I LOVE YOU, FROM JIMMY
- Encryption Algorithm: Replace each letter with the letter N letters to the right.
  - Encrypted message for N = 1 (Secret/symmetric key)
    - J!MPWF!ZPR-GSPN!KJNNZ
- Decryption Algorithm: Replace each letter with the letter N letters to the LEFT.
  - I LOVE YOU, FROM JIMMY

Digital Communication Comes Home

- Digital communication lines will radically change services to our homes.
- Multi-person video phone conversations, universal e-mail, customized digital newspapers, automatic utility metering and unlimited entertainment options.