Wired and Wireless Communication
Moving Data: Bandwidth and Modems

• **Communications**
  o Process of sending and receiving messages electronically between two points
  o **Sending device**—initiates the transmission
  o **Receiving device**—accepts the transmission and responds

• **Communications channel**
  o Path to send and receive messages
Moving Data: Bandwidth and Modems

• **Analog signals**
  - Continuous waves

• **Digital signals**
  - Discontinuous, discrete pulses

• **Converters**
  - Translate signals:
    - Analog-to-digital converter (ADC)
    - Digital-to-analog converter (DAC)
Moving Data: Bandwidth and Modems

- Digital signal sampling
Moving Data: Bandwidth and Modems

- **Bandwidth**
  - The maximum amount of data transmitted through a communication channel at one time

- **Throughput**
  - The actual amount of data transmitted
Moving Data: Bandwidth and Modems

• **Broadband**
  - Any transmission medium that carries several channels transporting data at high speeds

• **Streaming**
  - The ability to hear or see content while it is being downloaded from a Web site
Moving Data: Bandwidth and Modems

• Modem
  o A communication device used to send and receive data
  o The term *modem* comes from *modulate* and *demodulate*.
    • The sender uses modulation to transmit digital signals.
    • The receiver uses demodulation to return signals to digital form.
Moving Data:
Bandwidth and Modems

Telephone lines use analog transmission
Moving Data: Bandwidth and Modems

- **Types of modems**
  - Analog
  - Digital subscriber line (DSL)
  - Cable
  - Integrated Services Digital Network (ISDN)

- **Data transfer rate**
  - Rate at which two modems exchange data
  - Measured in bits per second (bps)

- **Baud**
  - Number of signaling elements per second

.bit Rate and Baud Rate

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Wired Transmission Media

- **Wiring closet**
  - Houses wiring that supports most types of data transfer needed
Wired Transmission Media

- **Twisted-pair wire**
  - Copper wire used for telephone and data communication
    - Two pairs of interweaved wires twisted together
    - Inexpensive, but bandwidth too low for video, voice, and data at the same time
    - Support up to **100 Mbps**
    - Maximum distance **100m**
Wired Transmission Media

- **Key variations of twisted-wire pair**
  - **Category 5 (Cat-5)**
    - Support up to 1000 Mbps
  - **Category 5 enhanced (Cat-5e)**
  - **Category 6 (Cat-6)**
    - Have four pair of copper wires
    - Support up to 1Gbps
    - Available bandwidth 200MHz
Wired Transmission Media

- **Coaxial cable**
  - Consists of copper wire surrounded by insulation and braided wire
    - **Broadband** communication
    - Cable TV
    - 10 Mbps transfer rate
Wired Transmission Media

• **Fiber-optic cable**
  - Consists of thin strands of glass or plastic that carry data through pulses of light
    • **Broadband communication**
    • 10 Gbps transfer rate
Wireless Transmission Media

• **Infrared**
  - Wireless transmission medium that carries data through the air using light beams
  - Sending and receiving devices must be in line of sight
  - Uses an **IrDA port** to enable data transfer
Wireless Transmission Media

• **Radio transmission**
  - Enables music, photos, and voice to travel through the air as radio frequency or radio waves
  - **Bluetooth**—radio transmission enables devices within 30 feet to communicate wirelessly
  - Does not require direct line of sight
Wireless Transmission Media

- **Microwaves**
  - Transmit data via electromagnetic radio waves with short frequencies
Wireless Transmission Media

• **Satellites**
  - Microwave relay stations in space that transmit data through microwave signals
  - **Direct broadcast satellite (DBS)**—consumer satellite technology that receives digital TV signals through a reception dish
  - Requires the computer system to have a special communications device called a **network access point**—sends and receives data between computer that contain wireless adapters
Wired Communication via the PSTN

• Public switched telephone network (PSTN)
  - Worldwide telephone system used for data and voice communications
  - Primarily digital

• Subscriber loop carrier (SLC)
  - Links home and business telephones
  - Accommodates analog devices

• Local loop
  - Area served by an SLC

• Local exchange switch
  - Digital device capable of handling thousands of calls
  - Located at the local telephone’s central office
Wired Communication via the PSTN
Wired Communication via the PSTN

- **Digital telephony**
  - Telephones and transmissions are digital
  - Companies—use a **private branch exchange** (PBX)

- **Multiplexing**
  - Allows multiple calls over a single line
  - Long-distance carriers—transmit many calls in digital format in a single circuit
Wired Communication via the PSTN

- **Last-mile problem**
  - Inability to access the PSTN’s high-speed, fiber-optic cables
  - Bottleneck of data on the last mile of twisted-pair phone lines

- **Last-mile technologies**
  - Provide solutions for bottlenecks
  - Used while local loops are upgraded
Wired Communication via the PSTN

• Last-mile technologies (con’t.)
  o Integrated Services Digital Networking (ISDN)
    • Standard that provides digital telephone and data service
    • No lengthy dial-in procedures or connection delay
    • Requires an **ISDN adapter/digital modem** to connect computers to ISDN lines
    • May be the only broadband solution in rural areas
Wired Communication via the PSTN

• Last-mile technologies (con’t.)
  o Digital subscriber line (DSL) (Also called xDSL)
    • Broad term for group of technologies offering high-speed access
      o ADSL (asymmetric digital subscriber line)
      o SDSL (symmetric digital subscriber line)
      o HDSL (high bit-rate digital subscriber line)
      o VDSL (very high bit-rate digital subscriber line)
    • Requires DSL modem—modulate and demodulate analog and digital signals
    • More expensive than dial-up—cheaper than other broadband options
Wired Communication via the PSTN
Wired Communication via the PSTN

- **Last-mile technologies (con’t.)**
  - **Cable-based broadband**
    - Provides Internet access through cable TV connections
    - Uses *cable modems* to obtain higher speeds than DSL
  - **Leased lines**
    - Specially conditioned telephone lines between two points
      - Example: **T1 lines**
      - **1.54 Mbps**
Wired Communication via the PSTN

• Last-mile technologies (con’t.)
  o T2 and T3 lines
    • Data rate up to 44.7 Mbps
    • Cost: $3000 per line
  o SONET (synchronous optical network)
    • Between 52Mbps – 20Gbps
  o MMDS (Multichannel multipoint distribution service)
    • Coverage area 35 mile
    • Data rate: 1Gbps
  o WiMAX (Worldwide interoperability for microwave access)
    • Coverage: 30 miles