DATA COMMUNICATION and NETWORKING

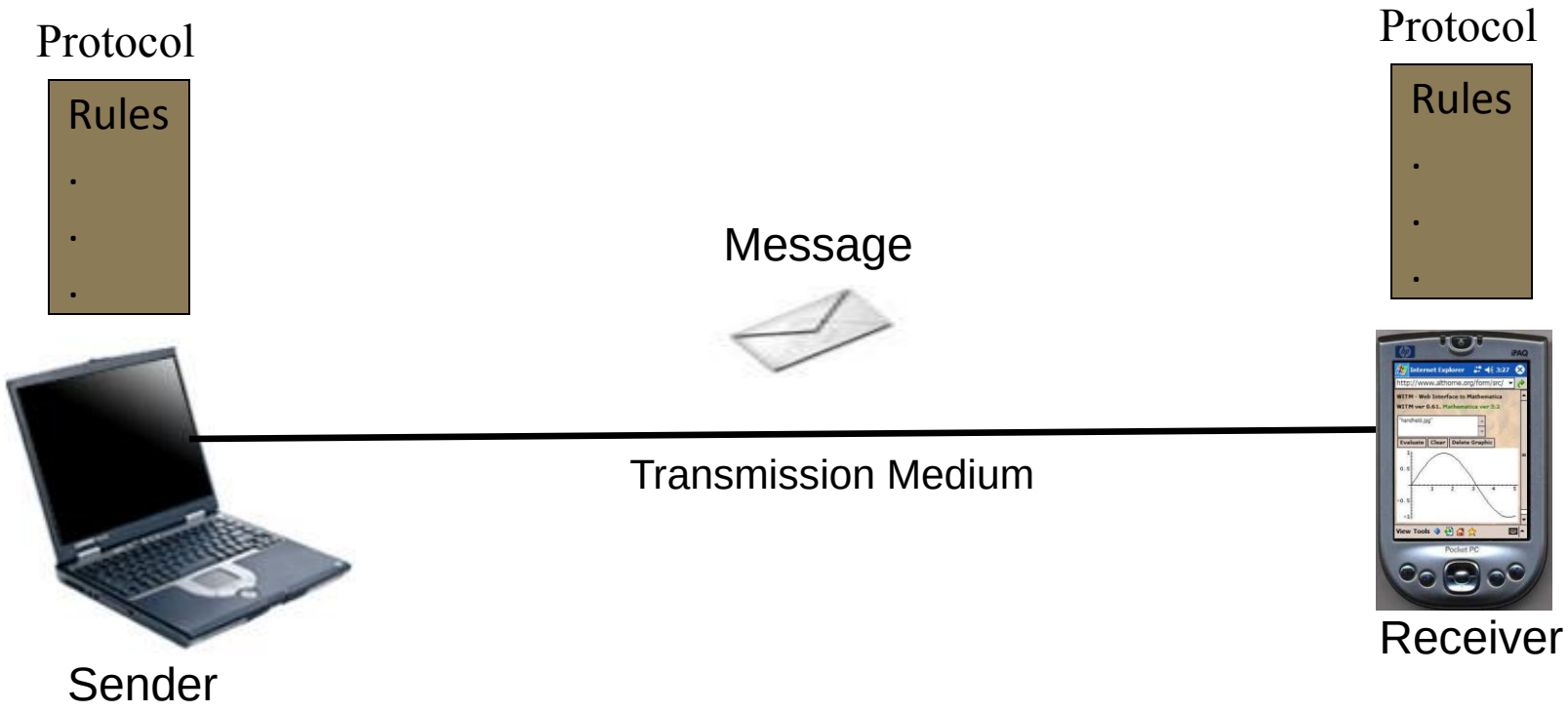
FARAZ AFROZ

Data Communication

Data Communications are the exchange of data between two devices via some form of transmission.

Author: Faraz Afroz

Components of Data Communication



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Components of Data Communication

1. **Message:** Data or Information.
2. **Sender:** The device that send the message.
3. **Receiver:** The device that receive the message.
4. **Transmission Medium:** The physical path between sender and receiver, the message travel.
5. **Protocol:** Is a set of rules that governs data communication. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.

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Data Communication Characteristics

1. **Delivery:** The system must deliver data to the correct destination.

2. **Accuracy:**
   - Data delivered accurately.
   - Altered data which left uncorrected are unusable.

3. **Timelines:**

   The system must deliver data in timely manner without delay (real-time).

4. **Jitter:**

   Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets.

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Data Flow in Communication

- **Simplex:** one direction only.

Remote Control

TV

- Always one side sender and another side receiver.

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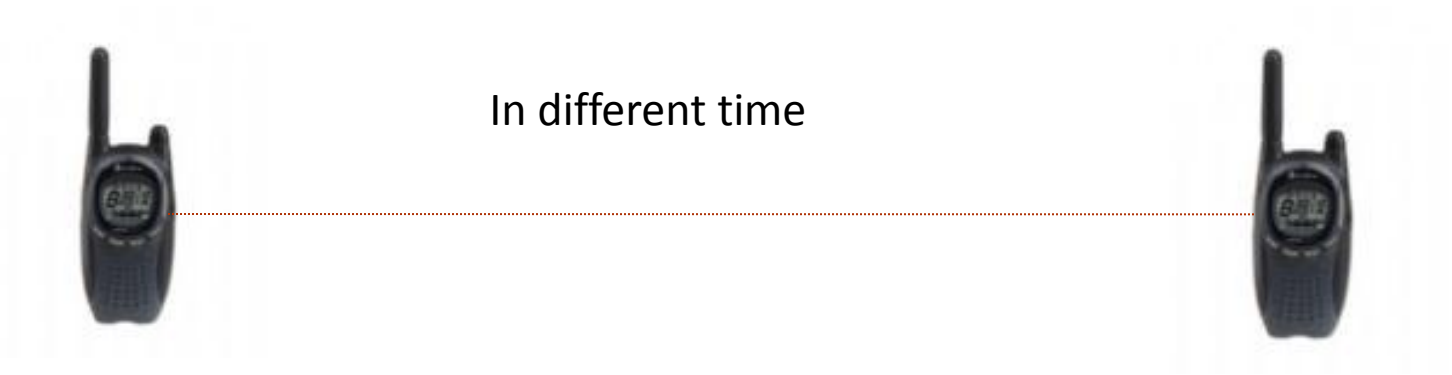
Data Flow in Communication cont..

- **Half-Duplex:** two-way alternate.

Walki-Talki



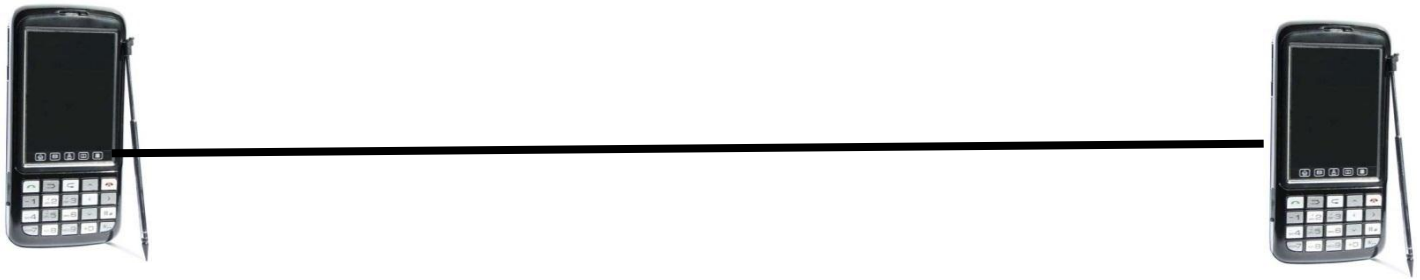
- Each side maybe sender or receiver but not a same time.

Data Flow in Communication cont..

- Duplex: two-way concurrent.

Computer network

Mobile Network



- Each side sender and receiver at same time.

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Block Diagram of a Communication Model

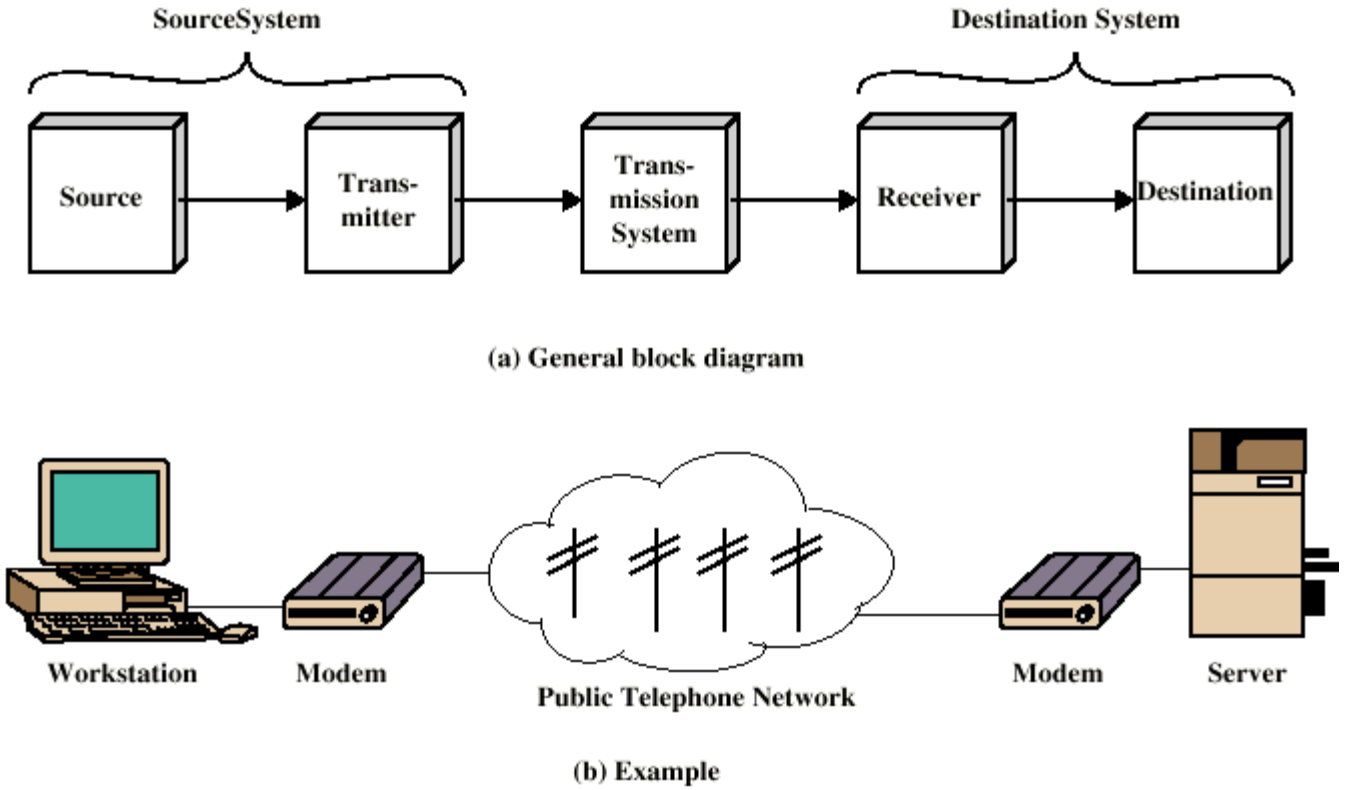

Figure 1.1 Simplified Communications Model

A Communication Model

- Source

  generates data to be transmitted
- Transmitter

  Converts data into transmittable signals
- Transmission System

  Carries data
- Receiver

  Converts received signal into data
- Destination

  Takes incoming data

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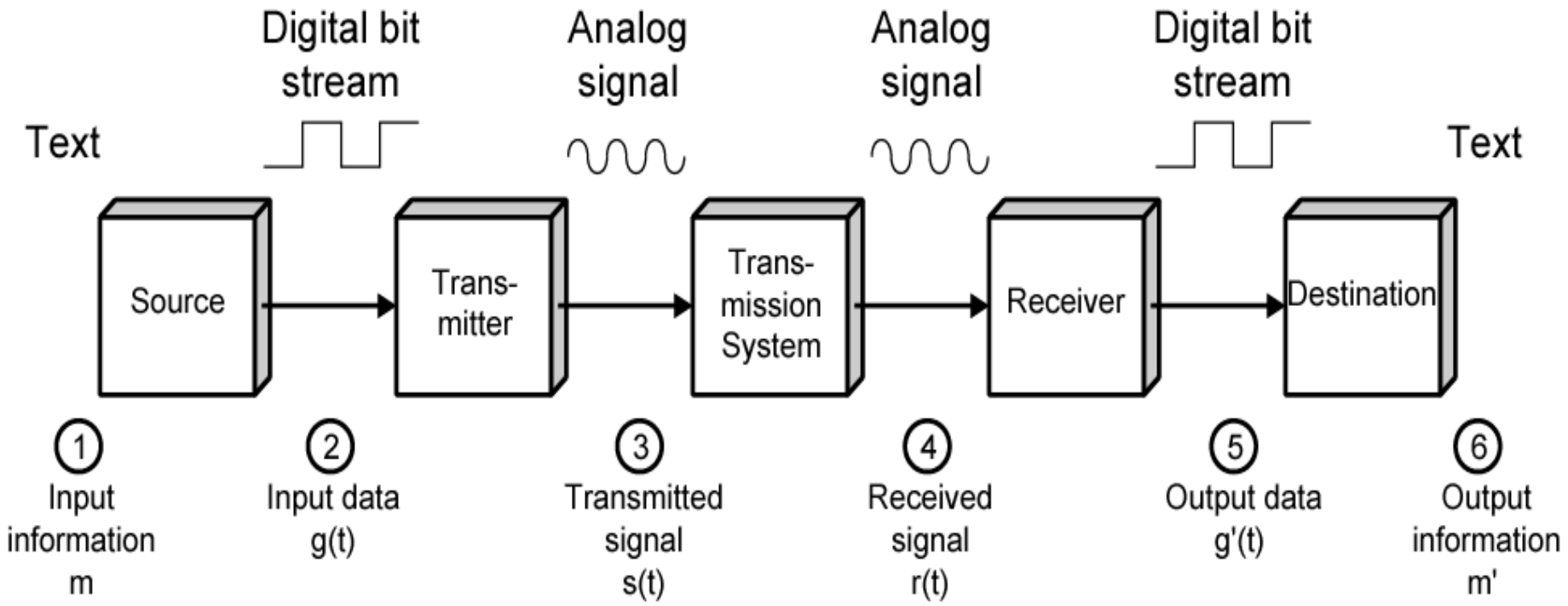
Simplified Data Communications Model



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Analog and Digital Data Transmission

- **Data**

  Entities that convey meaning
- **Signals**

  Electric or electromagnetic representations of data
- **Transmission**

  Communication of data by processing of signals

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Data

- **Analog**

  Continuous values within some interval

  e.g. sound, video

- **Digital**

  Discrete values

  e.g. text, integers

Signals

Means by which data are propagated (circulated).

- **Analog**

  Continuously variable

  Various media (wire, fiber optic, space)

  Speech bandwidth 100Hz to 7kHz

  Telephone bandwidth 300Hz to 3400Hz

  Video bandwidth 4MHz

- **Digital**

  Use two discrete value 0 or 1

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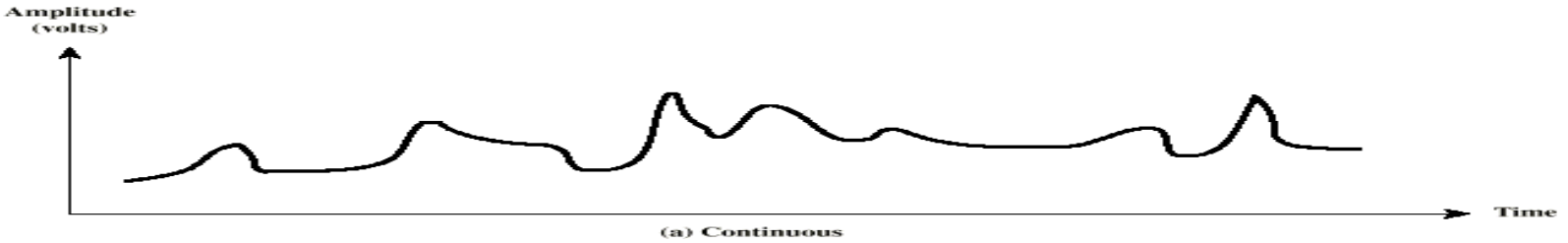
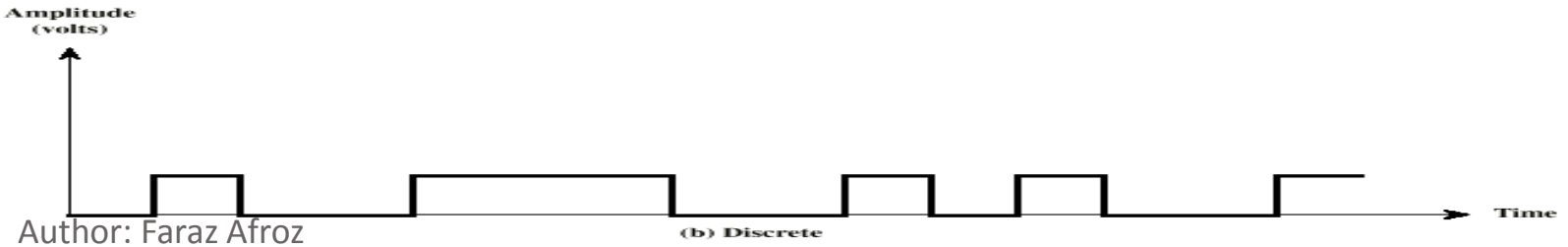
Analog and Digital

- To be transmitted, data must be transformed to electromagnetic signals i. e Digital or Analog.
- Data can be **analog** or **digital**. The term **analog data** refers to information that is continuous; **digital data** refers to information that has discrete states. Analog data take on continuous values. Digital data take on discrete values





Transmission Media

- Two main categories:
  - **Guided —** wires, cables
  - **Unguided —** wireless transmission
    e.g. radio, microwave, infrared, sound, sonar

- We will concentrate on guided media here:
  - **Twisted-Pair cables**
    Unshielded Twisted-Pair (UTP) cables
    Shielded Twisted-Pair (STP) cables
  - **Coaxial cables**
  - **Fiber-optic cables**

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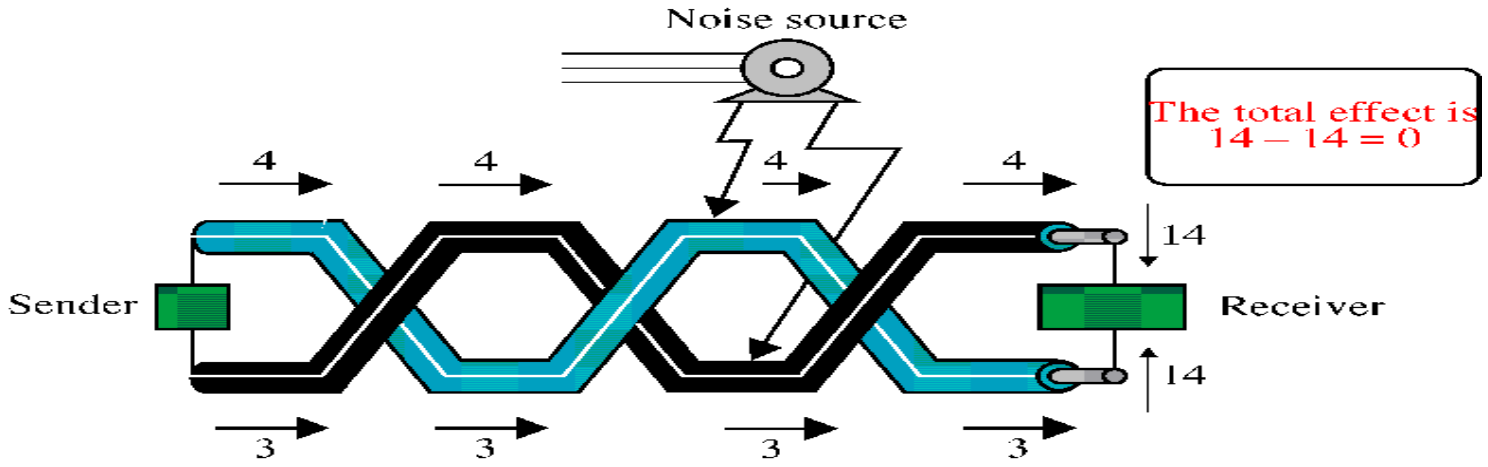
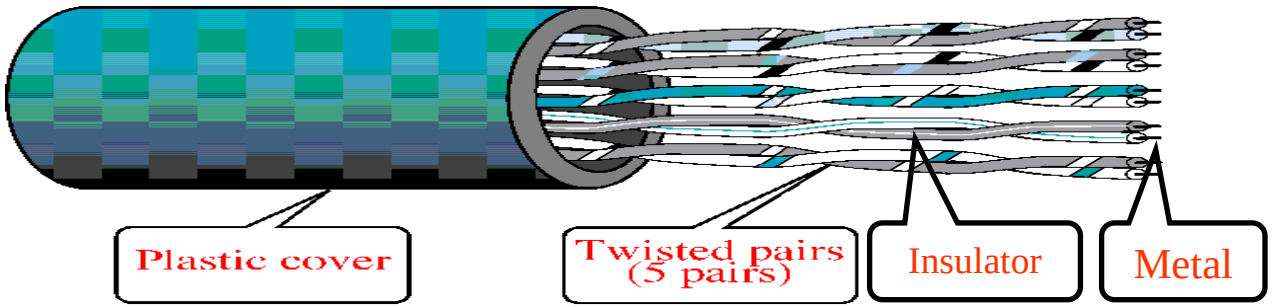
Twisted-Pair Cables

- If the pair of wires are not twisted, electromagnetic noises from, e.g., motors, will affect the closer wire more than the further one, thereby causing errors.



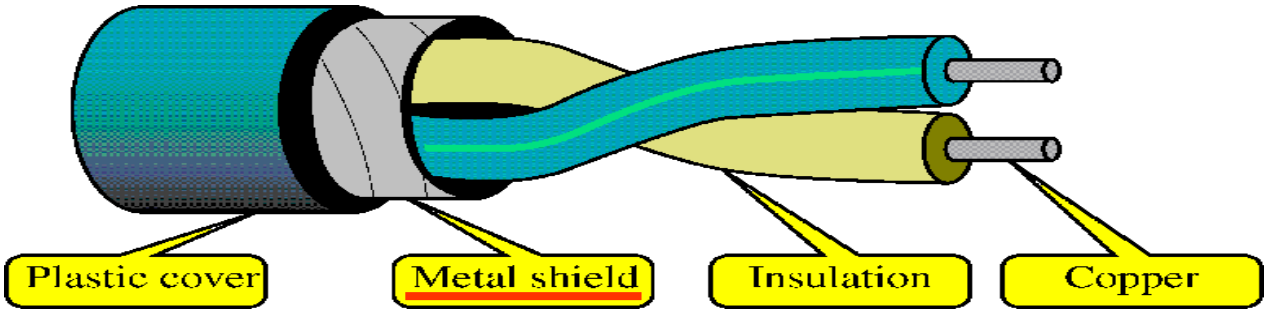
Unshielded Twisted-Pair (UTP)

- Typically wrapped inside a plastic cover (for mechanical protection)
- A sample UTP cable with 5 unshielded twisted pairs of wires.



Shielded Twisted-Pair (STP)

- STP cables are similar to UTP cables, except there is a metal foil or braided-metal-mesh cover that encases each pair of insulated wires.



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Categories of UTP Cables

- **Category 1** — the lowest quality, only good for voice, mainly found in very old buildings, not recommended now
- **Category 2** — good for voice and low data rates (up to 4Mbps for low-speed token ring networks)
- **Category 3** — at least 3 twists per foot, for up to 10 Mbps (common in phone networks in residential buildings)
- **Category 4** — up to 16 Mbps (mainly for token rings)
- **Category 5** (or 5e) — up to 100 Mbps (common for networks targeted for high-speed data communications)
- **Category 6** — more twists than Cat 5, up to 1 Gbps

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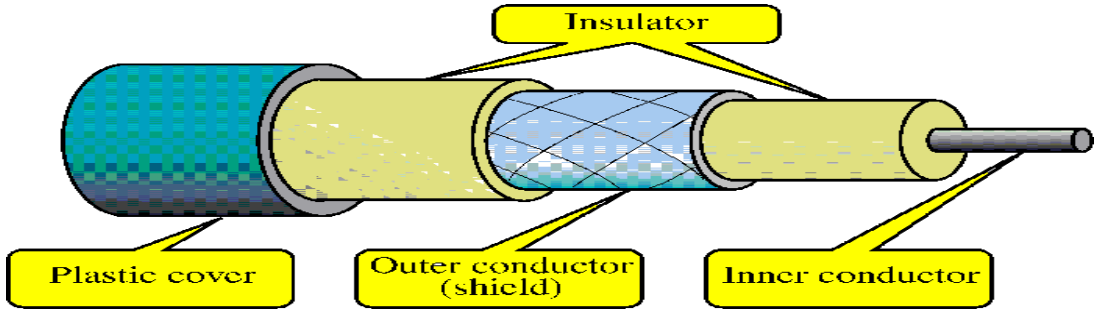
Coaxial Cables

- In general, coaxial cables, carry signals of higher frequency (100KHz–500MHz) than UTP cables
- Outer metallic wrapping serves both as a shield against noise and as the second conductor that completes the circuit



Data Encoding Techniques

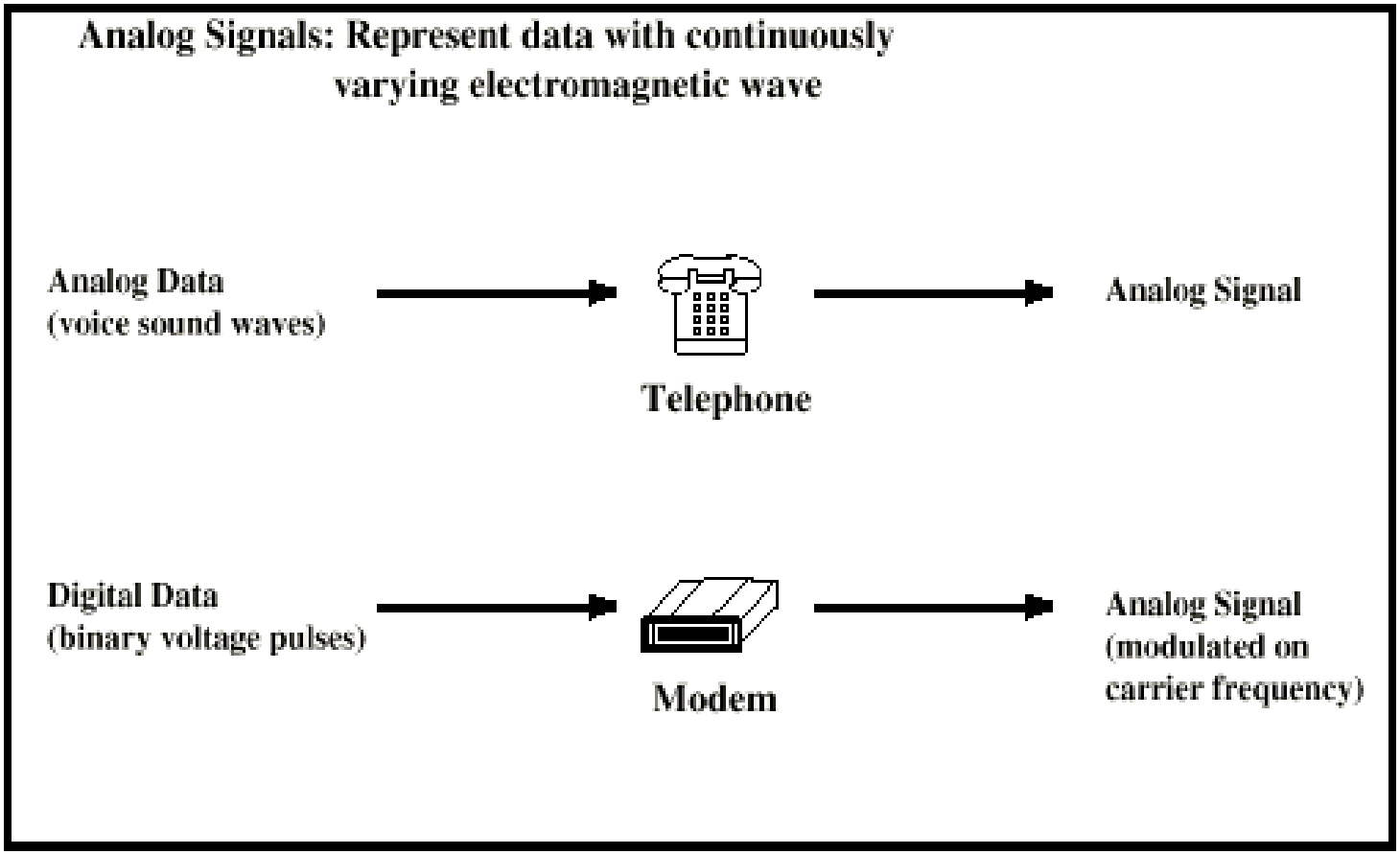
- Digital data, digital signal
- Analog data, digital signal
- Digital data, analog signal
- Analog data, analog signal

Data and Signals

Usually use digital signals for digital data and analog signals for analog data.

- Can use analog signal to carry digital data.
  Modem
- Can use digital signal to carry analog data.
  Compact Disc audio.

Analog Signals Carrying Analog and Digital Data



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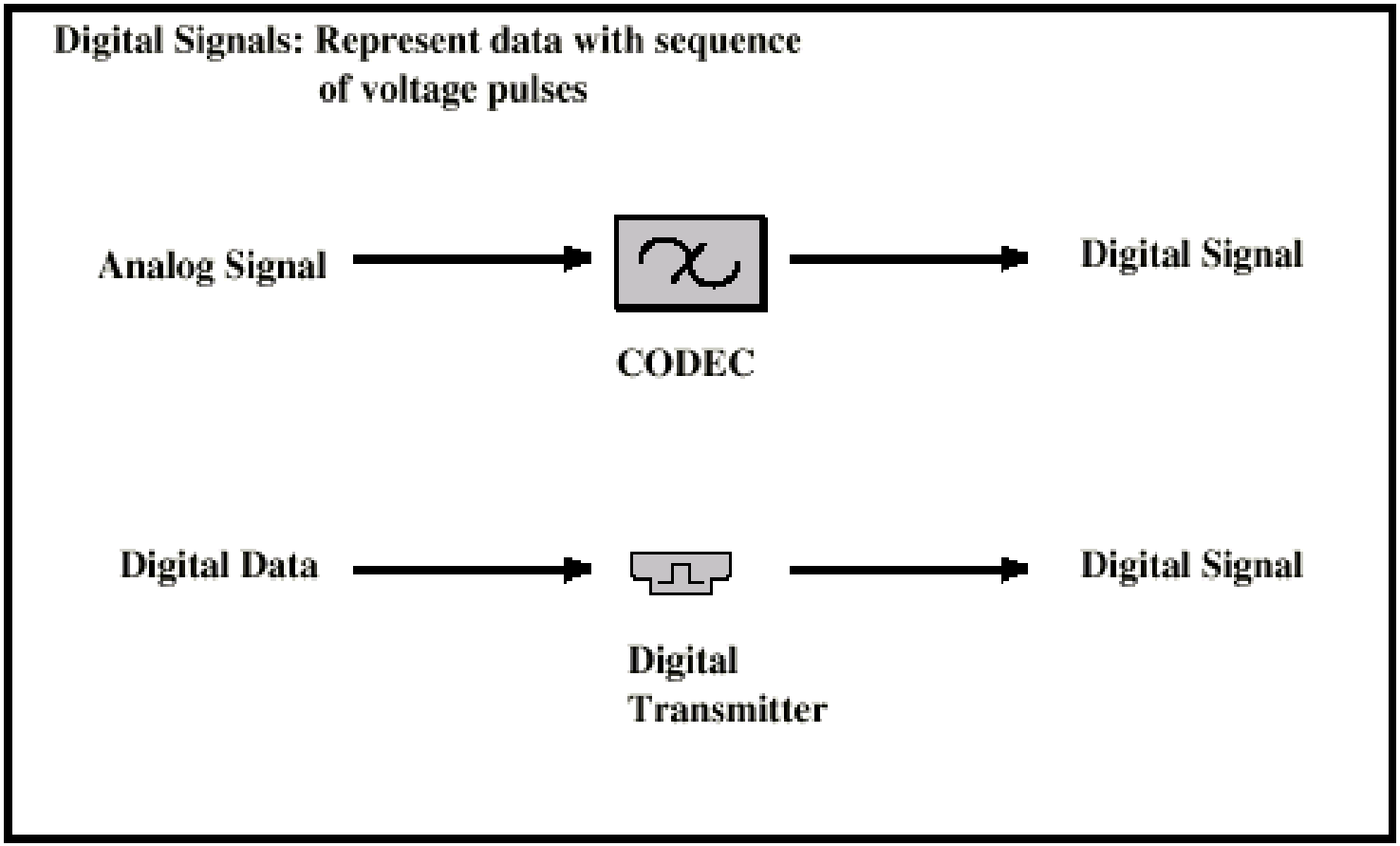
Digital Signals Carrying Analog and Digital Data



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Analog Transmission

- Analog signal transmitted without regard to content
- May be analog or digital data
- Attenuated over distance
- Use amplifiers to boost signal
- Also amplifies noise

Digital Transmission

- Concerned with content
- Integrity endangered by noise, attenuation etc.
- Extracts bit pattern
- Retransmits
- Attenuation is overcome
- Noise is not amplified

Transmission Impairments (Losses)

- Analog - degradation of signal quality
- Digital - bit errors - caused by
  - Attenuation and attenuation distortion
  - Delay distortion
  - Noise

Asynchronous & Synchronous Transmission

- Timing problems require a mechanism to synchronize the transmitter and receiver
- Two solutions exist
  - Asynchronous
  - Synchronous
- Both methods are concerned with timing issues
- How does the receiver know when the bit period begins and ends?
- Small timing difference becomes more significant over time if no synchronization takes place between sender and receiver.

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Asynchronous Transmission

- Used in serial communication
- Data transmitted 1 character at a time
- Character format is usually 1 start & 1+ stop bits, plus data of 5-8 bits
- Timing needed only within each character
- Resynchronization is accomplished with each start bit
- Uses simple, cheap technology
- Wastes 20-30% of bandwidth

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Synchronous Transmission

- Used in parallel communication
- Large blocks of bits transmitted without start/stop codes
- Data framed by preamble (opening)/ postamble (closing) bit patterns
- More efficient than asynchronous
- Overhead typically below 5%
- Used at higher speeds than asynchronous

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Synchronization Choices

- Low-speed terminals and PCs commonly use asynchronous transmission
  - Inexpensive
- Large systems and networks commonly use synchronous transmission
  - overhead too expensive; efficiency necessary
  - error-checking more important