



School of information systems

INTRODUCTION TO SYSTEMS AND NETWORKS

Assignment

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1. What is meant by a signal?

A signal is physical quantity that carries information from a source to a destination. A data signal is a form of transmission that conveys information between devices or locations. In the context of technology and computing, it refers to the electronic pulses or electromagnetic waves that carry data across networks, through wired connections like Ethernet cables or wireless methods such as Wi-Fi and Bluetooth.

Types of signals:

- **Analog signals** are continuous and can take any value within a range. Analog signals represent real-life, continuous phenomena. E.g. Our sound when we talk with our friends.
- **Digital signals** are discrete and can only be either a one or a zero, like a light switch being on or off. When your voice is recorded on a phone or computer, it is sampled and converted into digital data (like 10110101...). Computers, smartphones, and all digital systems store and process information in this binary form.

Because our computers store real life data; digital systems often start with analog inputs (like our voice) → then convert them into digital signals using ADC (Analog-to-Digital Converter).

- ✓ E.g. microphone in a smartphone converts sound waves (our voice) → digital audio data.

And because we often interact with real-world, continuous signals (analog), computers convert their digital data into analog signals using a DAC (Digital-to-Analog Converter).

- ✓ E.g. speaker output in a phone converts digital music → analog electrical signals → sound.

2. Write the types of data transmission media and the types of signals they propagate including the types of energy the signals are carried. Write also the encoding systems employed for each of the media described.

Transmission media is the path or medium through which data, signals, or information travel from a sender to a receiver in a communication system.

Transmission media are divided into two broad categories:

1. Guided (wired) media
2. Unguided (wireless) media

A. Guided Media

Guided media are physical paths that direct signals along a solid medium, typically made of copper or glass.

1. Twisted-Pair Cable (UTP/STP)

A twisted-pair cable consists of two insulated copper wires twisted together to reduce electromagnetic interference (EMI) and crosstalk (signal leakage between pairs).

- ❖ **Unshielded Twisted Pair (UTP):** No extra shielding around the twisted wires.
Relies on the twisting pattern itself to reduce noise.
- ❖ **Shielded Twisted Pair (STP):** Has an additional metallic shield surrounding each pair or the entire group of pairs. Provides extra protection against electromagnetic and radio frequency interference (EMI/RFI).

- Signal type: Electrical
- Energy carrier: Electrical energy
- Encoding systems: NRZ, Manchester, MLT-3, PAM-5

2. Coaxial Cable

A coaxial cable is a type of electrical cable designed to carry signals with minimal interference. A coaxial cable is made of several layers:

- **Inner Conductor** Usually copper or aluminum carries the signal.
- **Dielectric Insulator** Surrounds the inner conductor.
- **Outer Conductor (Shielding)** Made of braided copper or aluminum foil. Prevents **electromagnetic interference (EMI)** from external sources.
- **Outer Jacket** Plastic or rubber coating. Protects the cable from physical damage and environmental factors.

- Signal type: Electrical
- Energy carrier: Electromagnetic field between conductor and shield
- Encoding systems: QAM, baseband signaling

3. Fiber Optic Cable

A fiber optic cable is a type of cable that transmits data as light pulses instead of electrical signals. This allows it to carry large amounts of data over long distances at very high speeds, with minimal signal loss.

- Signal type: Optical (light pulses)
- Energy carrier: Light photons
- Encoding systems: OOK, NRZ, PAM-4, WDM, PSK, QAM

B. Unguided Media (Wireless)

Unguided media are communication channels where signals travel through the air or space without a physical conductor (unlike twisted-pair, coaxial, or fiber)

1. Radio Waves (Wi-Fi, Bluetooth)

- Signal type: Electromagnetic
- Energy carrier: RF radiation
- Encoding systems: OFDM, QPSK, FSK

2. Microwave and Satellite

- Signal type: High-frequency RF
- Energy carrier: Electromagnetic waves
- Encoding: QAM, PSK, OFDM

3. write Advantages and Disadvantages of Network Topologies

Topology	Advantages	Disadvantages
Bus Topology	Simple, low cost	Prone to collisions; single backbone failure can disrupt the network
Star Topology	Easy to manage, scalable	Failure of central device affects the entire network
Ring Topology	Predictable performance	Single break in the ring disrupts the network
Mesh Topology	Reliable, redundant	Expensive, complex to implement
Hybrid Topology	Flexible; combination of two or more topologies	Complex to design and maintain

4. Indicate the most popularly used data transmission media based on your practical observation

- Wi-Fi: Most common for wireless connections.
- Twisted Pair: Common wired medium. E.g. Earphone / Headphone, USB cable (to transfer data from PC to Mobile), HDMI cable (Projector).
- Coaxial: Used for TV and broadband.
- Cellular: Used for mobile networks (4G/5G).

5. Write the types of cables and their capacity to transmit signals, security level, and their cost.

1. Twisted Pair: Up to 10 Gbps, medium security, low cost.
2. Coaxial Cable: Up to several Gbps, moderate security, medium cost.
3. Fiber Optic: Up to Tbps, very secure, high cost.
4. Wireless: Up to multiple Gbps, low security without encryption, low installation cost.