CPE314 Data Communication and Computer Networks

Lecture 2: Data Communication, Networks, and Quality Foundations

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Lecture Agenda

What is Data?

Definition

Data is a representation of information agreed upon by communicating entities.

- Text, numbers
- Images and video
- Audio and sensor data

Key idea

Communication is meaningless unless both sides agree on **what data means**.

What is Data Communication?

Definition

Data communication is the exchange of data between two devices through a transmission medium.

- Local vs remote communication
- Telecommunication = communication over distance
- Requires hardware and software together

Characteristics of Data Communication

- **Delivery** – data reaches the correct destination
- **Accuracy** – data arrives without errors
- **Timeliness** – data arrives when needed
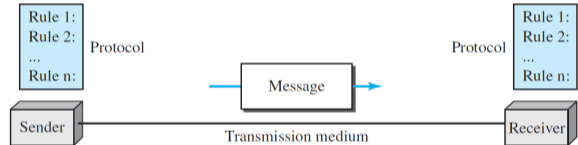- **Jitter** – variation in packet arrival time

Important

These are **communication-level characteristics**, not network design goals.

Components of a Data Communication System

- Message
- Sender
- Receiver
- Transmission Medium
- Protocol

Protocol

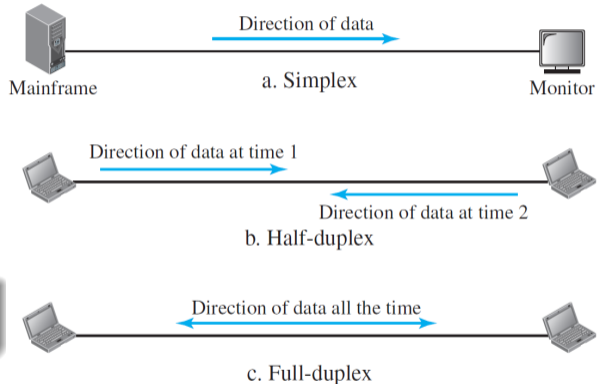Without agreed rules, connected devices cannot communicate.

Physical Structure: Data Flow Directions

- **Simplex** – one-way only
- **Half-Duplex** – both directions, not simultaneously
- **Full-Duplex** – simultaneous two-way communication

Example
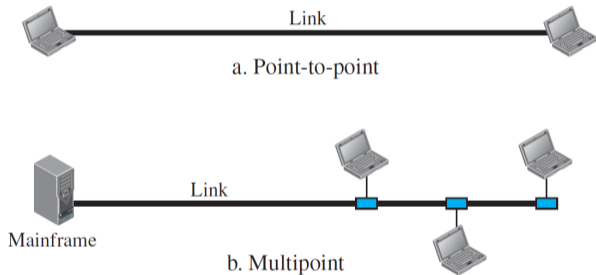Telephone networks are full-duplex systems.

Direction of data

Mainframe   a. Simplex   Monitor

Direction of data at time 1

Direction of data at time 2

b. Half-duplex

Direction of data all the time

c. Full-duplex

Types of Connections

- **Point-to-Point** – dedicated link between two devices
- **Multipoint** – multiple devices share a link
    - Spatial sharing
    - Time sharing

a. Point-to-point

b. Multipoint

What is a Computer Network?

Definition
A computer network is an interconnection of devices capable of communication.

- Hosts (end devices)
- Connecting devices (routers, switches)
- Wired and wireless media

Basic Network Terminology

- **Host / End device**
- **Node** – any connected device
- **Link** – communication pathway
- **Hop** – traversal from one node to another

Network Criteria

- **Performance**
- **Reliability**
- **Security**

Clarification

Criteria describe how we **evaluate** a network.

Performance: Throughput and Delay

- **Throughput** – rate of successful data delivery
- **Delay** – time taken for data to travel end-to-end

Trade-off

Increasing throughput often increases delay due to congestion.

Reliability and Security

Reliability

- Frequency of failures
- Recovery time
- Robustness

Security

- Confidentiality
- Integrity
- Availability

Network Capabilities

- Scalability
- Mobility
- Energy efficiency
- Cost efficiency
- Coverage
- Flexibility and reconfigurability

Key distinction

Capabilities describe what a network is **designed to support**.

From Communication Properties to Network Quality (3Cs)

Measuring Network Quality

Network quality does not arise directly. It emerges progressively as:

- **Data communication characteristics:** (delivery, accuracy, timeliness, jitter)
- **Network evaluation criteria** (performance, reliability, security)
- **Network capabilities** (scalability, mobility, energy efficiency, cost, flexibility)

Key Insight

Quality is an outcome of how communication properties are supported, evaluated, and extended by the network design.

Mapping Network Properties to Quality Concepts

- **Quality of Service (QoS)**
  - Primarily driven by **communication characteristics** and **network criteria**
  - Example: Timeliness and jitter affect delay; performance criteria determine throughput

- **Quality of Experience (QoE)**
  - Influenced by **QoS** plus **network capabilities**
  - Example: A mobile user may experience poor video quality even if QoS metrics are acceptable

- **Quality of Business (QoBiz)**
  - Driven mainly by **capabilities** such as scalability, cost, and energy efficiency
  - Example: A highly reliable network may still be unsustainable due to high operational cost

Integrated View of Network Quality

Modern Perspective

Different quality notions exist because networks serve multiple stakeholders.

- **QoS** focuses on network behavior (network-centric)
- **QoE** reflects user perception (user-centric)
- **QoBiz** represents operator and business objectives (business-centric)

Quality of Everything (QoX)

QoX is an umbrella concept that considers network performance, user experience, and business goals together – multiple stakeholders

SLA and KPIs

- **SLA** – contractual quality guarantees
- **KPIs** – measurable indicators

Modern networks
Quality is negotiated, measured, and enforced.

From Network Quality to SLA and KPIs

Why Formalization is Needed

Quality expectations must be explicitly defined and verified.
Quality is negotiated, measured, and enforced.

- **Service Level Agreement (SLA)**
  - Formal agreement based on QoS, QoE, and QoBiz expectations
  - Defines what level of quality is promised

- **Key Performance Indicators (KPIs)**
  - Quantitative metrics derived from network criteria and characteristics
  - Used to verify SLA compliance

Connection

SLAs translate quality goals into commitments; KPIs translate commitments into measurable values.

Summary

- Communication enables networks
- Capabilities shape behavior.
- Quality aligns technology with users and business.