

CUET · COMPUTER SCIENCE · CLASS XII · CODE 308

Data Communication

CUET unit: Data Communication

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Snapshot

- The foundational vocabulary of data communication: what data is, what communication means, and how the two combine to form networked information exchange.
- Every data communication system has five core components (sender, receiver, message, medium, protocol), which form the basis for nearly all subsequent networking theory.
- Three communication modes (simplex, half-duplex, full-duplex), two switching techniques (circuit and packet), and a detailed taxonomy of transmission media (wired and wireless) are all direct CUET question banks.
- Wireless technologies (Bluetooth, Wi-Fi/WLAN), mobile generations (1G–5G), and key application-layer protocols (HTTP, FTP, PPP, SMTP, TCP/IP) are covered — NTA regularly tests protocol full-forms, properties, and use-cases from this section.
- Data communication concepts are prerequisite for Chapter 12 (Networking) and are tested both as isolated recall and as scenario-based MCQs.



Detailed Notes

2.1 Core concepts

- **Data Communication defined:** The term comprises "Data" (text, image, audio, video, multimedia files) and "Communication" (act of sending or receiving data). Data communication refers to the exchange of data between two or more networked or connected devices capable of sending and receiving data over a communication medium. (NCERT §11.1, p. 203)
- **Five components of data communication:** Every data communication system has exactly five components — Sender, Receiver, Message, Communication medium (also called transmission media), and Protocol. (NCERT §11.2, p. 204)
- **Sender:** A computer or device capable of sending data — e.g., computer, mobile phone, smartwatch, walkie-talkie, video recording device. (NCERT §11.2, p. 204)
- **Receiver:** A computer or device capable of receiving data — e.g., computer, printer, laptop, mobile phone, television. Sender and receiver are called nodes in a network. (NCERT §11.2, p. 204)



- **Message:** The data or information to be exchanged — text, number, image, audio, video, multimedia. (NCERT §11.2, p. 205)
- **Communication medium:** The path through which the message travels between source and destination; also called medium or link; can be wired or wireless (e.g., television cable, telephone cable, ethernet cable, satellite link, microwaves). (NCERT §11.2, p. 205)
- **Protocol:** A set of rules that communicating parties must follow for successful and reliable communication. Examples: Ethernet, HTTP. (NCERT §11.2, p. 205)
- **Bandwidth (§ 11.3.1):** The capacity of a channel is the range of frequencies available for data transmission. Higher bandwidth means higher data transfer rate. Bandwidth = maximum frequency – minimum frequency in composite signals. Unit: Hertz (Hz). 1 KHz = 1000 Hz; 1 MHz = 1000 KHz = 1,000,000 Hz. (NCERT §11.3.1, p. 205)
- **Data Transfer Rate (§ 11.3.2):** Number of bits transmitted between source and destination in one second; also called bit rate. Measured in bits per second (bps). Higher units: 1 Kbps = 2^{10} bps = 1024 bps; 1 Mbps = 2^{20} bps = 1024 Kbps; 1 Gbps = 2^{30} bps = 1024 Mbps; 1 Tbps = 2^{40} bps = 1024 Gbps. Note: MBps = Megabyte per second; Mbps = Megabit per second. (NCERT §11.3.2, p. 205)
- **Types of Data Communication (§ 11.4):** Data communication happens in the form of signals between two or more nodes over point-to-point or multipoint channels. Three broad types: Simplex, Half-duplex, Full-duplex. (NCERT §11.4, p. 206)
- **Simplex:** One-way/unidirectional. One device is always sender, other is always receiver. Full link capacity used in one direction. Examples: keyboard input, audio sent to speaker, IoT home appliance control. (NCERT §11.4.1, p. 206)
- **Half-duplex:** Two-way/bidirectional but NOT simultaneous. Both devices can send and receive, but not at the same time. The direction of transmission can be switched. Example: walkie-talkie with push-to-talk button. (NCERT §11.4.2, p. 206–207)
- **Full-duplex:** Two-way/bidirectional AND simultaneous. Both devices send and receive at the same time. Examples: mobile phones, landline telephones. Achieved via two simplex lines or shared channel capacity. (NCERT §11.4.3, p. 207)
- **Switching Techniques (§ 11.5):** An alternative to dedicated connections; data is routed through various nodes, forming a temporary route. Two main techniques: (NCERT §11.5, p. 208)
- **Circuit Switching:** A dedicated path is identified before communication starts. This path is a connected sequence of links between network nodes. All packets follow the same path. Example: traditional telephone call. (NCERT §11.5.1, p. 208)
- **Packet Switching:** Messages broken into smaller pieces called packets, each with a header (destination address) and message part. Packets transmitted independently; different packets may take different routes. Reassembled at destination. Channel

occupied only during packet transmission — efficient for shared networks. Example: Internet data transmission. (NCERT §11.5.2, p. 208)

- **Transmission Media (§ 11.6):** A transmission medium carries signals/data between source (transmitter) and destination (receiver). In data communication, transmission media are the links that carry messages between communicating devices. Classified as: (NCERT §11.6, p. 209)
- **Guided (wired):** Physical link made of wire/cable — signals propagated between nodes. Examples: twisted pair cable, coaxial cable, fiber-optic cable. Also called wired media. (NCERT §11.6, p. 209)
- **Unguided (wireless):** Data travels in air as electromagnetic waves using an antenna. Also called wireless media. (NCERT §11.6, p. 209)
- **Wired Transmission Media (§ 11.6.1):** Three commonly used types: (NCERT §11.6.1, p. 210)
- **Twisted Pair Cable:** Two copper wires twisted like a DNA helical structure, insulated with plastic. Twisted configuration minimises electrical interference. Most commonly used in telephone lines and LANs. Two types: UTP (Unshielded Twisted Pair) and STP (Shielded Twisted Pair). (NCERT §11.6.1(A), p. 210–211)
- **Coaxial Cable:** Copper wire core surrounded by insulating material, further surrounded by an outer conductor (copper mesh), all wrapped in plastic cover. Better shielded and higher bandwidth than twisted pair. Used for higher frequency signals over longer distances. (NCERT §11.6.1(B), p. 211)
- **Optical Fibre:** Carries data as light signals. Thin transparent glass strand at centre covered with less dense glass cladding, outer jacket of PVC or Teflon. Uses refraction to direct light. Light-weight, high bandwidth, high data transfer rate, immune to electromagnetic noise, used in backbone networks. Drawback: expensive and unidirectional — two cables needed for full duplex. (NCERT §11.6.1(C), p. 212)
- **Wireless Transmission Media (§ 11.6.2):** Electromagnetic spectrum range 3 KHz to 900 THz. Divided into 4 categories — Radio Waves, Microwaves, Infrared Waves, and Visible/Light Waves. Three useful for wireless communication: (NCERT §11.6.2, p. 212–213)
- **Radio Waves:** 3 KHz–1 GHz; omni-directional; susceptible to interference; 3–300 KHz can penetrate walls; used in AM/FM radio, television, cordless phones.
- **Microwaves:** 1 GHz–300 GHz; unidirectional; require line-of-sight; cannot penetrate walls; used in radar and satellite; very high information-carrying capacity.
- **Infrared Waves:** 300 GHz–400 THz; cannot penetrate walls; used for short-distance point-to-point communication (e.g., TV remote, mobile-to-printer, Bluetooth devices). (NCERT Table 11.1, p. 213)
- **Wireless Technologies (§ 11.6.3):** (NCERT §11.6.3, p. 213–215)
- **Bluetooth:** Short-range wireless; uses unlicensed 2.4 GHz frequency band; range 10 metres; speed 1–2 Mbps. Devices within 10 m form a piconet in master-slave

- configuration; master can communicate with up to 7 active slaves; supports up to 255 devices in the network (8 active at a time). (NCERT §11.6.3(A), p. 213–214)
- **Wireless LAN (Wi-Fi):** IEEE standard 802.11; uses Access Points (APs) connected to a wired network; devices connect to the Internet through an AP. Benefits: extends/replaces wired infrastructure, increases mobile access, easy internet access in public places. (NCERT §11.6.3(B), p. 214–215)
 - **Mobile Telecommunication Technologies (§ 11.7):** Architecture of mobile networks evolved through generations: (NCERT §11.7, p. 215–216)
 - **1G (~1982):** Analog signals; voice calls only.
 - **2G (~1991):** Digital signals; improved call quality; encryption; SMS and MMS introduced.
 - **3G (~2001 commercially):** Digital voice + data; Internet access via radio towers; faster data transfer.
 - **4G:** Much faster than 3G; supports interactive multimedia, voice, video, wireless internet; very different technology from 3G.
 - **5G (under development at time of writing):** Expected to support M2M (Machine to Machine) communications; data transfer in Gbps; supports IoT and connected vehicles. (NCERT §11.7, p. 215–216)
 - **Protocol (§ 11.8):** A set of standard rules that sender, receiver, and all intermediate devices must follow. Needed for flow control (speed mismatch between sender/receiver), access control (which node accesses shared channel), addressing, data format conversion, packet ordering, and ensuring data integrity. (NCERT §11.8, p. 216)
 - **Key Protocols (§ 11.8.2–11.8.6):**
 - **HTTP:** HyperText Transfer Protocol; primary protocol to access the World Wide Web; developed by Tim Berners-Lee at CERN in 1989 with IETF and W3C; request-response (client-server) protocol running over TCP; formats and transmits hypertext between browser and web server. (NCERT §11.8.2, p. 217)
 - **FTP:** File Transfer Protocol; used for transferring files from one machine to another; client-server model; handles differences in file naming conventions, data representation formats, and directory structures. (NCERT §11.8.3, p. 218)
 - **PPP:** Point-to-Point Protocol; establishes dedicated direct connection between two communicating devices; defines authentication and direct link establishment. Example: two routers with direct connection; home computers connecting to ISP through a modem. Requires duplex mode; maintains data integrity. (NCERT §11.8.4, p. 218)
 - **SMTP:** Simple Mail Transfer Protocol; used for email services; uses message header (like envelope) containing email addresses of recipients; sender program takes mails from outgoing queue and transmits to destination(s); receiver program accepts mail and places in appropriate user mailbox. (NCERT §11.8.5, p. 219)

- TCP/IP: Transmission Control Protocol/Internet Protocol; set of standardised rules using client-server model. IP assigns unique IP address to every node on the Internet. TCP breaks data into IP packets, routes them through the network, and guarantees delivery and sequential ordering at the destination. (NCERT §11.8.6, p. 219–220)

2.2 Definitions to memorise

Term	Definition	Page
Data Communication	Exchange of data between two or more networked/connected devices capable of sending and receiving data over a communication medium	203
Sender	A computer or device capable of sending data over a network	204
Receiver	A computer or device capable of receiving data from the network	204
Message	The data or information to be exchanged between sender and receiver (text, number, image, audio, video, multimedia)	205
Communication Medium	The path (wired or wireless) through which the message travels between source and destination	205
Protocol	A set of rules to be followed by communicating parties for successful and reliable data communication	205
Bandwidth	Range of frequencies available for data transmission through a channel; measured in Hz	205
Data Transfer Rate	Number of bits transmitted between source and destination per second; also called bit rate; measured in bps	205
Simplex Communication	One-way (unidirectional) communication where one device is always the sender and the other is always the receiver	206
Half-duplex Communication	Two-way communication where both devices can send and receive, but not simultaneously	206
Full-duplex Communication	Two-way communication where both devices can send and receive simultaneously	207
Circuit Switching	Switching where a dedicated path is established between sender and receiver before communication begins; all packets follow the same path	208
Packet Switching	Switching where messages are broken into packets transmitted independently; different packets may take different routes and are reassembled at destination	208
Guided Transmission Media	Wired transmission media with a physical link (wire/cable) — e.g., twisted pair, coaxial, optical fibre	209
Unguided Transmission Media	Wireless transmission media where data travels as electromagnetic waves through air	209

Term	Definition	Page
UTP	Unshielded Twisted Pair cable — twisted pair without a metal shield	211
STP	Shielded Twisted Pair cable — twisted pair with an additional metal shield to reduce interference	211
Piconet	A personal area network formed by Bluetooth devices within a range of 10 metres, working in master-slave configuration	214
HTTP	HyperText Transfer Protocol; primary protocol for accessing the World Wide Web; developed at CERN in 1989	217
FTP	File Transfer Protocol; used for transferring files between machines on a network; uses client-server model	218
PPP	Point-to-Point Protocol; establishes dedicated direct connection between two communicating devices for data exchange	218
SMTP	Simple Mail Transfer Protocol; protocol used for email services	219
TCP/IP	Transmission Control Protocol/Internet Protocol; standardised rules for Internet communication; IP addresses nodes, TCP ensures reliable packet delivery	219
Hz, KHz, MHz, GHz	Frequency units; 1 KHz = 1000 Hz, 1 MHz = 1000 KHz, 1 GHz = 1000 MHz	205
bps, Kbps, Mbps, Gbps	Data-transfer rate units; 1 Kbps = 1024 bps (chapter convention)	205
Radio Waves	EM band 3 KHz–1 GHz; omnidirectional; used in AM/FM radio, TV	213
Microwaves	EM band 1 GHz–300 GHz; unidirectional; line-of-sight; radar/satellite	213
Infrared	EM band 300 GHz–400 THz; short-range; cannot penetrate walls	213
Access Point (AP)	Device that connects wireless clients to the wired network in a Wi-Fi LAN	214
Master-slave (Bluetooth)	Bluetooth communication model where one device coordinates up to 7 active slaves	214
Flow control	Protocol function that addresses speed mismatch between sender and receiver	217
1G/2G/3G/4G/5G	Generations of mobile telecommunications	215-216
M2M	Machine-to-Machine communication, key 5G feature	216
Client-server model	Communication model used by HTTP, FTP, TCP/IP	217-219
Encryption (2G+)	Security enhancement introduced from 2G onwards	215

2.3 Diagrams / processes to remember

- **Figure 11.1 (p. 203):** Simple network of computing devices — shows central server, switch, sharing printer connected to switch, and computers forming a network. Illustrates the concept of communication media connecting devices.
- **Figure 11.2 (p. 204):** Components of data communication — shows Sender → Transmission Media → Receiver with message depicted above. The five-component model is a frequent exam question.
- **Figure 11.3 (p. 206):** Simplex communication — dish antenna transmitting one direction to a television set; illustrates unidirectional flow.
- **Figure 11.4 (p. 207):** Half-duplex communication — two walkie-talkies; at any moment only one direction arrow is active; the other is crossed.
- **Figure 11.5 (p. 207):** Full-duplex communication — arrows in both directions simultaneously between two computers A and B.
- **Figure 11.7 (p. 210):** Classification of communication media tree — Communication Media splits into Wired Media (Twisted Pair, Co-axial, Fiber-Optic) and Wireless Media / Electromagnetic Waves (Radio Waves, Micro Waves, Infrared Waves). This tree diagram is a very common MCQ target.
- **Figure 11.9 (p. 211):** UTP vs STP cables — UTP has only a plastic cover; STP has an additional metal shield inside the plastic cover.
- **Figure 11.10 (p. 211):** Coaxial cable cross-section — copper core → insulating material → braided outer conductor → protective plastic covering.
- **Figure 11.11 (p. 212):** Fiber optic cable — sender and receiver at ends; light travels by refraction inside the glass fibre; cladding of less dense material surrounds the glass core.
- **Figure 11.12 (p. 213):** Electromagnetic waves spectrum (3 KHz to 900 THz) — Radio Waves | Microwaves | Infrared | Light Waves in ascending frequency order.
- **Figure 11.13 (p. 214):** Access point creating a wireless LAN — Access Point connected to wired network; Tablet, Laptop, Smartphone, Desktop connecting wirelessly.
- **Figure 11.14 (p. 217):** Speed mismatch between computers A (1024 Mbps) and B (512 Mbps) resulting in packet loss — illustrates why flow control protocol is needed.
- **Table 11.1 (p. 213):** Classification of transmission waves — Radio Waves (3 KHz–1 GHz, omni-directional), Microwaves (1–300 GHz, unidirectional, line-of-sight), Infrared (300 GHz–400 THz, short-distance) — memorise frequency ranges and key properties for each.

2.4 Common confusions / NTA trap points

- **Half-duplex vs Full-duplex:** Students often confuse half-duplex (bidirectional but NOT simultaneous — walkie-talkie) with full-duplex (bidirectional AND simultaneous

- phone call). NTA distractors will swap the examples (e.g., list a mobile phone as half-duplex).
- **Mbps vs MBps:** The NCERT explicitly notes that MBps = Megabyte per second while Mbps = Megabit per second (p. 205). NTA options often mix upper/lower case to create a trap.
- **Bandwidth unit vs Data Transfer Rate unit:** Bandwidth is measured in Hz (frequency range); data transfer rate is measured in bps. Students conflate the two. NTA may ask "what is the unit of bandwidth?" and offer bps as a distractor.
- **Bluetooth piconet numbers:** The NCERT states up to 255 devices in the network, 8 can communicate at the same time (1 master + 7 active slaves). NTA distractors often swap 7 and 8, or state that the master communicates with 8 slaves.
- **Circuit switching vs Packet switching — channel occupancy:** In circuit switching, the channel is dedicated for the entire duration of the connection. In packet switching, the channel is occupied only during packet transmission and released afterwards — this distinction is a classic NTA trap.
- **Optical fibre is unidirectional (NCERT § 11.6.1(C), p. 212).** Two cables needed for full-duplex.
- **HTTP is the WWW protocol; SMTP is for email (NCERT § 11.8.2, § 11.8.5).** Don't confuse the two.
- **Bluetooth uses 2.4 GHz unlicensed (NCERT § 11.6.3(A), p. 213).** Not 5 GHz, not licensed.
- **Microwave needs line-of-sight (NCERT Table 11.1, p. 213).** Cannot bend; satellite/radar use it.
- **TCP ensures sequencing, IP routes (NCERT § 11.8.6, p. 219).** Distinct roles inside TCP/IP suite.
- **Packet switching is more efficient for shared networks (NCERT § 11.5.2, p. 208).** Channel free between packets.
- **Twisted pair: UTP vs STP (NCERT § 11.6.1(A), p. 211).** STP adds a metal shield.

 **Practice MCQs**

Q1. Which of the following is NOT one of the five components of data communication as described in NCERT Chapter 11?

- A. Sender
- B. Protocol
- C. Router
- D. Transmission Media

Q2. A composite signal contains frequencies between 200 MHz and 500 MHz. What is the bandwidth of this signal?

- A. 700 MHz
- B. 500 MHz
- C. 300 MHz
- D. 200 MHz

Q3. Consider the following statements about communication modes: 1. In simplex communication, the full capacity of the link is used in one direction. 2. In half-duplex communication, both devices can transmit simultaneously. 3. Walkie-talkie is an example of half-duplex communication. 4. Mobile phone calls use full-duplex communication. Which of the above statements are correct?

- A. 1, 2, and 4 only
- B. 1, 3, and 4 only
- C. 2, 3, and 4 only
- D. 1, 2, 3, and 4

 **12 more MCQs + answer key**

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PYQ Alignment

Chapter 11 (Data Communication) is one of the consistently tested chapters in CUET Computer Science, with questions appearing every year primarily on protocol full-forms and uses, types of communication (simplex/half-duplex/full-duplex with examples), transmission media properties, bandwidth/data-transfer-rate calculations, and wireless technology characteristics (Bluetooth frequency/range, Wi-Fi standard number). NTA particularly favours match-the-following and statement-correction formats drawn from the transmission media classification table and the switching techniques distinction. See [PYQ archive for Computer Science](#).

