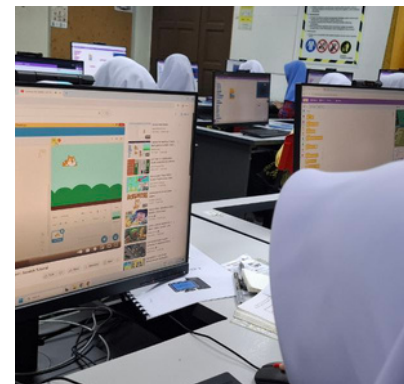
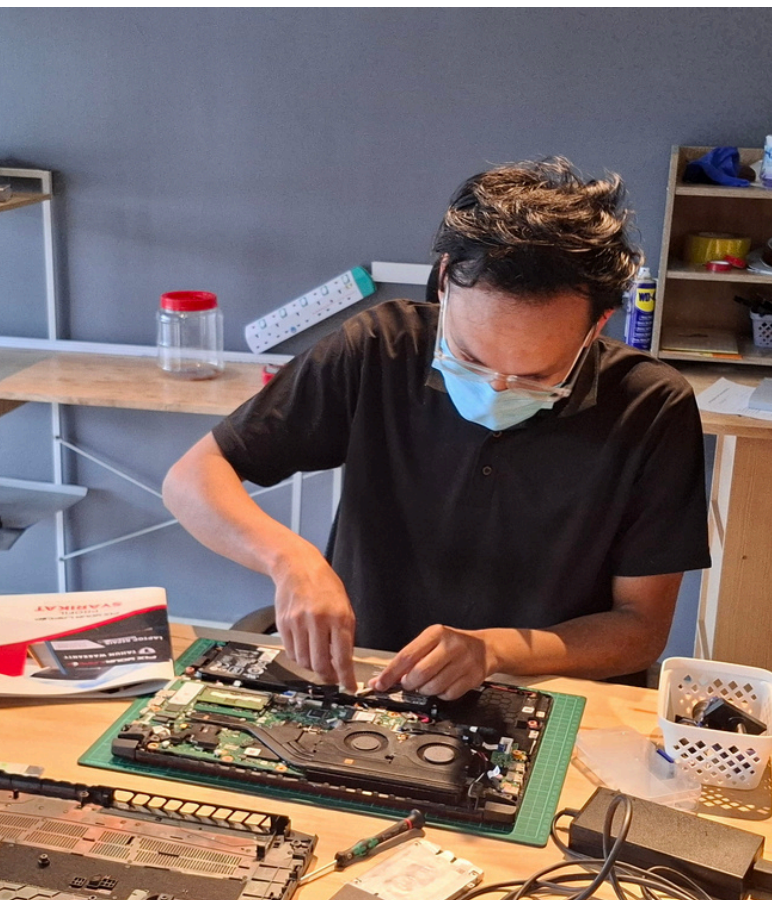


# NETWORK & DATA COMMUNICATION

## Introduction to Data Communication

Network & Data Communication introduces students to the basic concept of data communication and computer networks



**CERTIFICATE IN INFORMATION TECHNOLOGY**

# **NETWORK AND DATA COMMUNICATION**

Introduction to Data Communication

**AINUL BARIAH TALIB  
AIDA FAIZURA BINTI AMAUDDIN  
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# Preface

In today's world, communication is no longer limited to face-to-face conversations or simple phone calls. Whether it's video chatting with family, streaming content, attending online classes, or connecting to Wi-Fi at a café, data communication and networking are what make it all possible.

This ebook, "Introduction to Data Communication and Networking", has been prepared to give students a solid foundation in this important field. It is designed to be clear, simple, and practical, so that even beginners can follow along and build their understanding step by step.

The book begins with the importance of data communication and how information is represented in digital form. From there, it explains the basic components of communication systems, different transmission methods such as simplex, half-duplex, and full-duplex, and moves into the world of telecommunication technologies. You will also explore the evolution of communication—from traditional telephone networks and fiber optics to wireless technologies like Wi-Fi, Bluetooth, and modern mobile networks.

Special attention is given to mobile communication technologies such as GSM, GPRS, EDGE, HSDPA, WiMAX, LTE, and 5G, which are at the core of how we connect today. By studying these, you will see how communication has advanced over time and continues to shape the way we live, learn, and work.

This ebook is meant to be more than just theory—it connects concepts to real-life applications, showing you why understanding networking matters in today's digital age. Each chapter is written in a straightforward manner, with examples to make technical topics easier to grasp.

It is hope that this ebook will not only help you understand how data communication and networking work, but also inspire you to explore further, as this field is constantly evolving with new innovations. Remember, every network you use—whether on your phone, computer, or any other device—is built on the concepts you will learn here.



# Getting the Most Out of This eBook

This isn't just any eBook. It's interactive, smart, and made just for learners like you! Throughout the chapters, you'll see special icons that open up extra content. Here's what each one means:

- **AR Experience**

Icon:



**What it does:**

If you see this AR symbol, that means there's an Augmented Reality element you can scan using the **Artivive** or **Asseblr** web player. Just point your phone at the marker, and watch the content come to life in 3D or animation!

- **YouTube Video Link**

Icon:

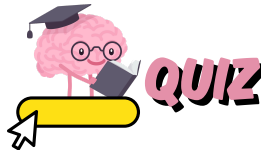


**What it does:**

Tap or click this icon to watch a video explanation on **YouTube** app. It's perfect if you want to understand the topic in more detail with animations, real examples, or walkthroughs.

- **Quick Quiz**

Icon:



**What it does:**

This icon leads you to a short online quiz. Use it to test your understanding, revise quickly, or just challenge yourself. Most quizzes are auto-graded, so you get instant feedback!

- **Fun Fact**

Icon:



**What it does:**

This is your signal for a bite-sized Fun Fact. Interesting, surprising, or just cool to know. These aren't exam questions, but they'll make you sound extra smart.

**SO WHENEVER YOU SEE THESE ICONS, DON'T IGNORE THEM**

They're designed to enhance your learning, your way!



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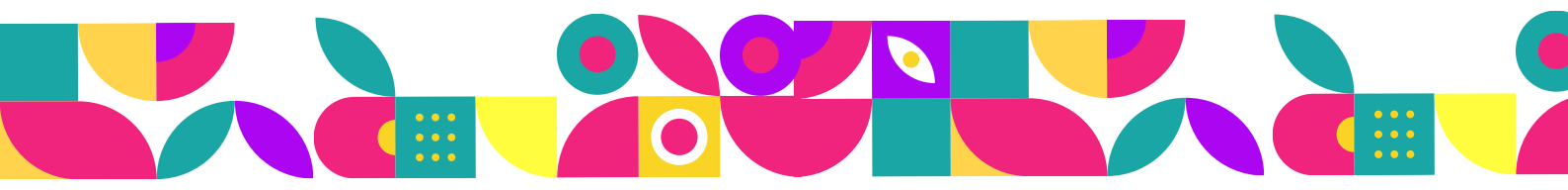
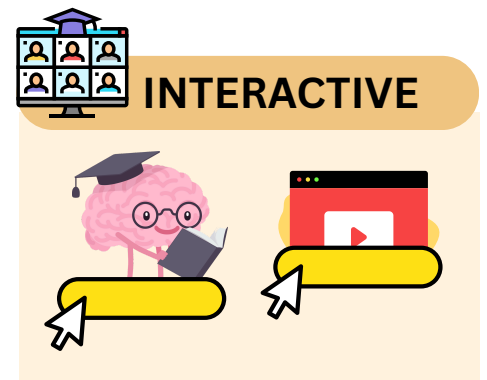
# 1.0 Introduction to Data Communications

Data communication refers to the process of exchanging data between devices using transmission media. It plays a crucial role in modern technology by enabling communication over various distances. Data communication systems ensure that information is transmitted efficiently, securely, and accurately between users. These systems are the foundation of modern networking, supporting everything from simple email exchanges to complex cloud computing environments. It is important to understand that data communication is similar to everyday human communication. Just like when people talk to each other using a common language, devices communicate by sending and receiving information using specific rules known as protocols.

Data communication can happen over short distances, like between a computer and a printer, or over long distances, like when making an international phone call. The goal of data communication is to transfer information from one place to another as quickly and accurately as possible.

Some common real-world examples of data communication include:

- Sending an email from one computer to another
- Accessing a website from a mobile phone
- Streaming a video online
- Making a phone call using a mobile network





QR CODE



MARKER



AR

This eBook includes Augmented Reality (AR) features to make your learning journey more exciting, interactive, and immersive. To access these elements, we'll be using **Artivive WebAR**. No app download required!

All you need is your smartphone and an internet connection.

### How to Access the AR Content:

1

#### Scan the QR Code

Find the QR code provided. Use your phone's camera to scan the code.

2

#### Open the Link in Your Browser

After scanning, your phone will show a link. Tap the link to open the WebAR player directly in your mobile browser.

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#### Allow Camera Access

Your browser will ask for permission to use your camera. Choose "Allow" so it can detect the AR marker on the page.

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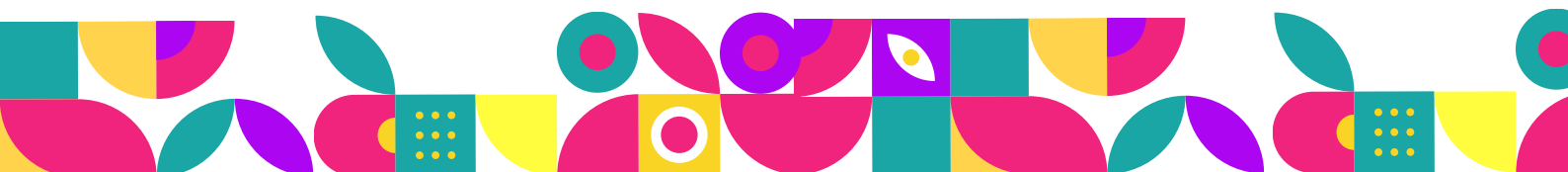
#### Point Your Camera at the AR Marker

Now, point your phone at the image marker in the book.

5

#### Experience the Animation

Keep your phone steady and make sure the full marker is visible. The AR content will appear on your screen.





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## Importance of Data Communication

Data communication is essential in today's world for the following reasons:



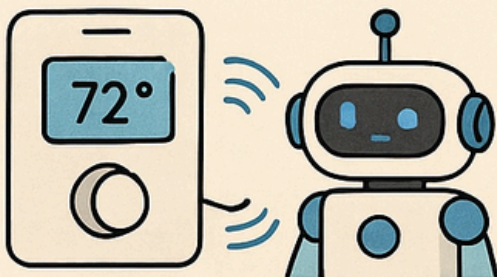
### Enables Global Connectivity

Data communication allows people and systems to connect across the globe, breaking down geographic barriers. From video calls with someone across the world to accessing websites hosted continents away. None of it would be possible without reliable data flow.

Companies rely on data communication for everything: emails, video conferencing, inventory systems, cloud storage, and more. It enables real-time collaboration, faster decision-making, and streamlined operations.



### Boosts Business Efficiency



### Powers Automation and Smart Systems

Automated machines, IoT devices, and AI systems all depend on seamless data communication to work properly. For example, a smart thermostat adjusts temperatures based on sensor data and that's all through constant communication.



## Importance of Data Communication

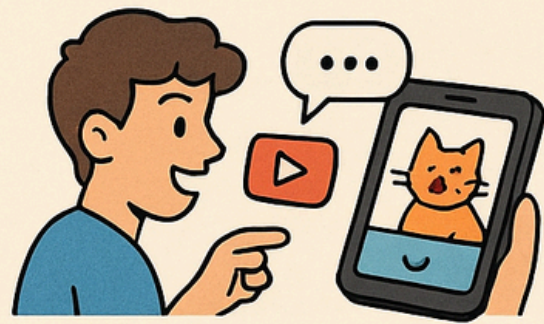
Data communication is essential in today's world for the following reasons:



### Enhances Learning and Access to Information

E-learning platforms, digital libraries, and online courses are only functional because of data communication. It supports remote education, making learning accessible to more people, regardless of location.

Social media, instant messaging, and streaming services like Netflix or YouTube rely on constant data transmission. It's how we share memes, stream cat videos, or cry over long-distance video calls with our besties.

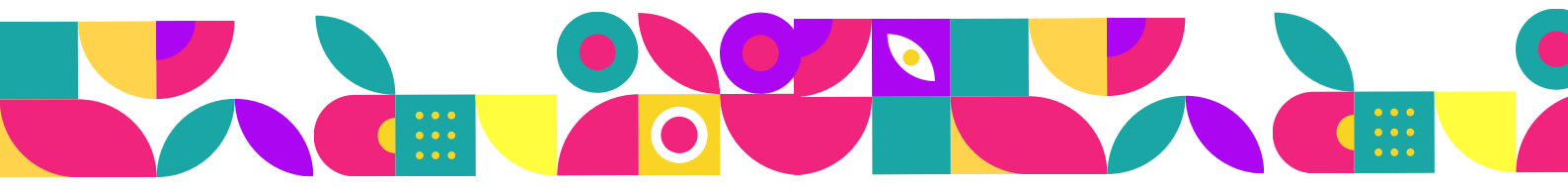


### Facilitates Social Interaction



### Critical for E-Commerce and Online Banking

Secure data transmission is the backbone of online transactions. Whether you're buying snacks online or transferring millions between banks. The data communication must be fast, reliable, and secure.



## Importance of Data Communication

Data communication is essential in today's world for the following reasons:

### Supports National Access to of Information



Modern defense systems rely on high-speed, encrypted communication networks. Real-time sharing of intelligence and remote operation of systems are made possible through advanced data communication.

Modern life depends heavily on real-time geospatial data communication, which powers location-based apps across transportation, delivery, and navigation. These services use Global Positioning System (GPS) satellites to pinpoint your location, then exchange data with app servers to deliver live updates, directions, and status tracking.

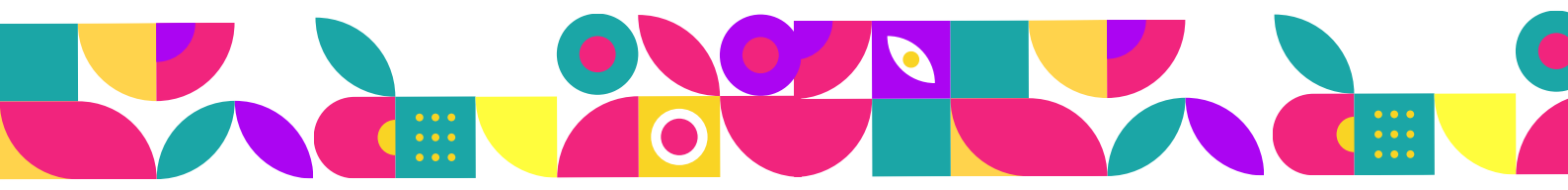
### Geospatial Data Communication



### FUN FACT!

#### Data Communication in Real-World

- Navigation Apps (e.g. Waze, Google Maps): Track your live location, calculate routes, reroute due to traffic, and offer ETA updates.
- Food Delivery Platforms (e.g. GrabFood, FoodPanda, Mau Tapau): Process orders, assign nearby riders, send live tracking, and offer delivery status in real time.
- E-Hailing Services (e.g. Grab, Uber, Maxim, InDrive): Use GPS to match drivers with passengers, estimate fares, and update routes dynamically based on traffic and location.



## Data Representation

Data representation refers to the way information is symbolically represented inside a computer so it can be processed, stored, and transmitted. Since computers only understand binary (0s and 1s), everything from your selfies to your Spotify playlist is turned into a long parade of bits.

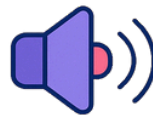
### Types of Data Representation



Text  
Representation



Numeric Data  
Representation



Audio  
Representation

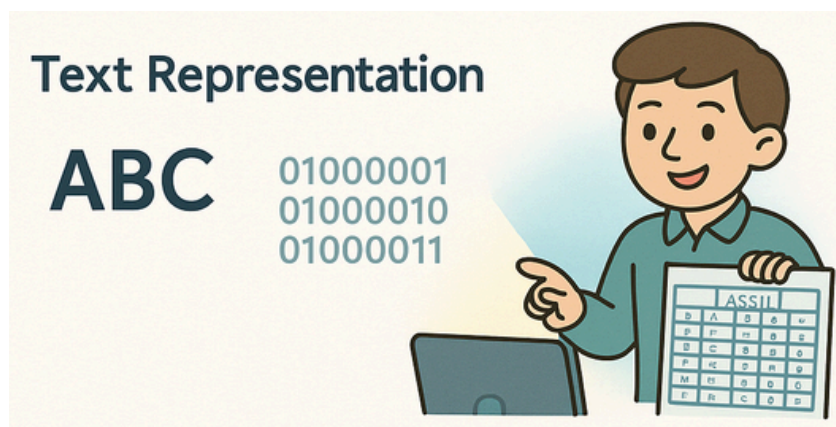


Image  
Representation



Video  
Representation

1

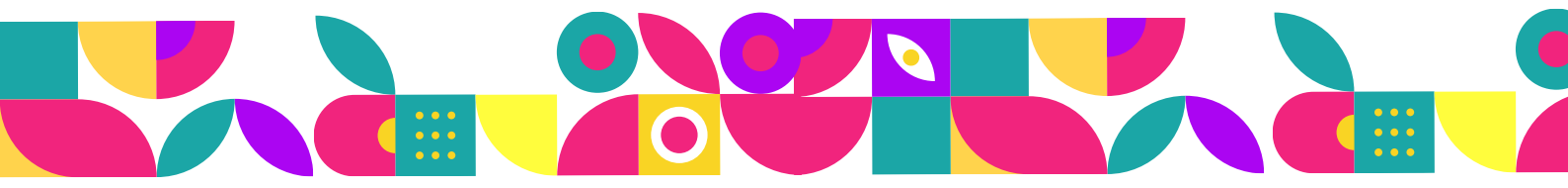


ASCII (American Standard Code for Information Interchange)

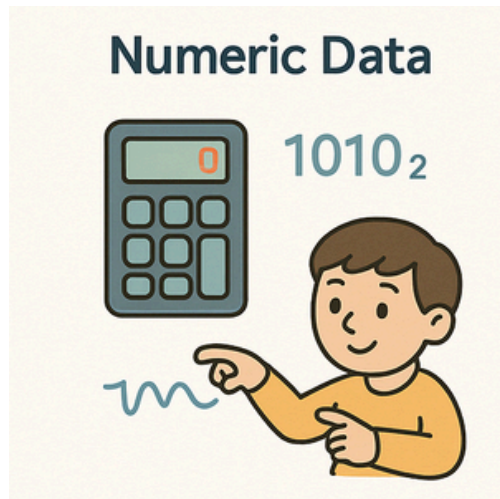
- Each character (letter, number, symbol) is represented by a unique 7- or 8-bit binary number.
- Example:
  - 'A' = 01000001
  - 'a' = 01100001

Unicode

- Expands ASCII to include symbols, emojis, and characters from other languages (Chinese, Arabic, Tamil, etc.).
- Example:
  - "Hello" in ASCII = 01001000 01100101 01101100 01101100 01101111



2



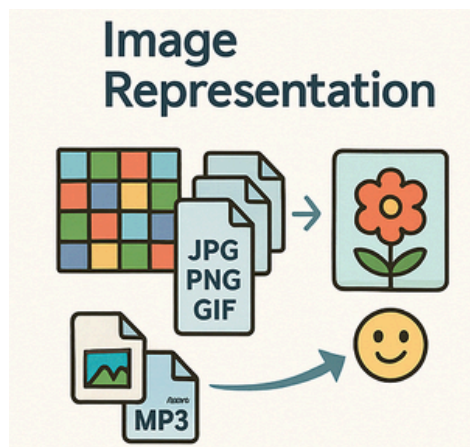
### Binary Numbers

- Like base-10, but uses base-2.
- Example:
  - 1101 = 13 in decimal

### Floating Point Representation

- For decimals and large/small numbers using IEEE 754 standard.
- Example:
  - 3.14 ≈ a 32-bit floating-point binary value.

3



### Bitmaps (Raster Images)

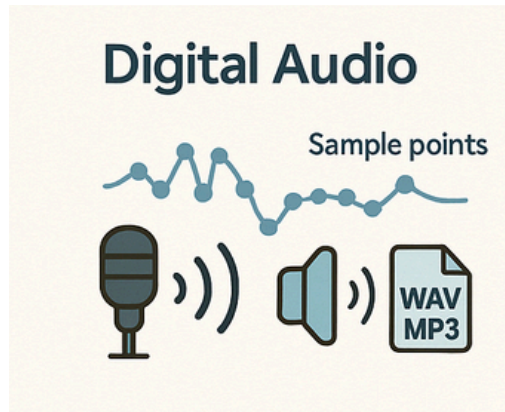
- Images are broken into pixels, and each pixel is represented by color codes (RGB values).
- A color image might use 24 bits per pixel (8 bits each for R, G, and B).

### Compressed Formats

- JPEG, PNG, and GIF compress this data for storage.
- Lossy (JPEG) vs lossless (PNG) encoding affects quality.



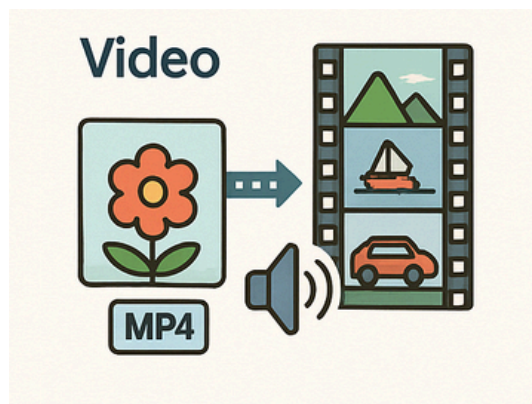
4



### Digital Audio

- Sound waves are sampled at regular intervals (sampling rate) and each sample is converted into binary.
- Example:
  - CD quality audio: 44.1kHz sampling rate, 16-bit depth
  - That's 44,100 samples per second, each sample being a 16-bit number!
- WAV files are raw; MP3s are compressed but efficient.

5



### Frames + Audio + Compression

- A video is a sequence of images (frames) + audio track.
- Each frame is represented like an image, and then it's all compressed using codecs like H.264, MP4, AVI.
- Example:
  - 30 FPS video = 30 images per second + synced sound!

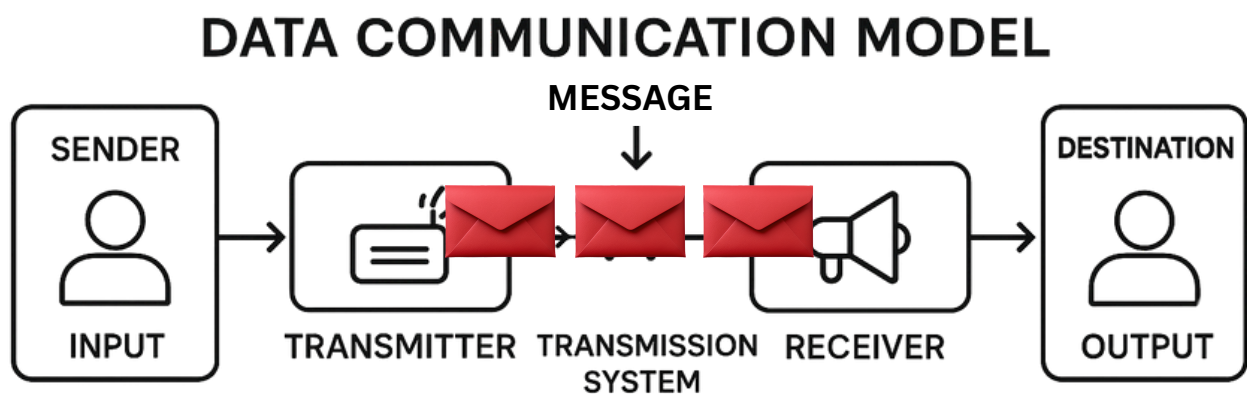
## 1.1 Basics of Communications

Communication is the process of transferring information from one entity to another. In data communication, this involves the transmission of digital or analogue data between two or more devices. Effective communication requires a sender, a message, a transmission medium, a receiver, and protocols to ensure successful data transfer.

Example: Sending an email from one person to another involves a sender, the email content, the internet (media transmission), the recipient's email server (receiver), and the SMTP protocol.

## 1.2 Data Communication Components

Data communication involves various components working together to facilitate the exchange of data.



### SENDER

The device or person transmitting the message or data, such as a computer or a smartphone.

### MESSAGE

The data being transmitted can be in the form of text, images, or videos.

### TRANSMISSION SYSTEM

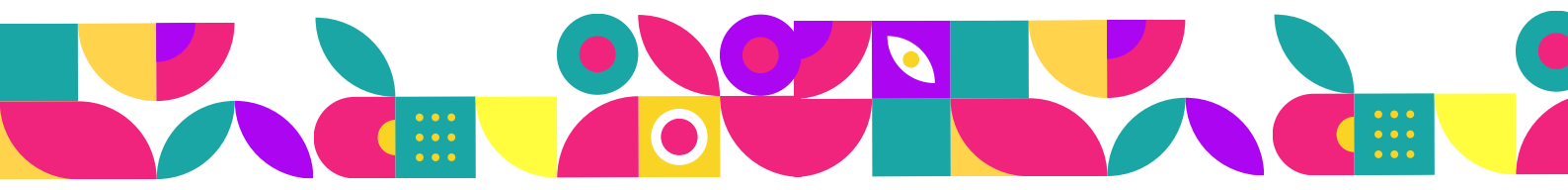
The channel through which the message travels (e.g., wired or wireless connections).

### RECEIVER

The device that receives the data, such as a server or another computer

### PROTOCOL

A standardised set of rules that govern how data is formatted, transmitted, and interpreted between devices across a network.

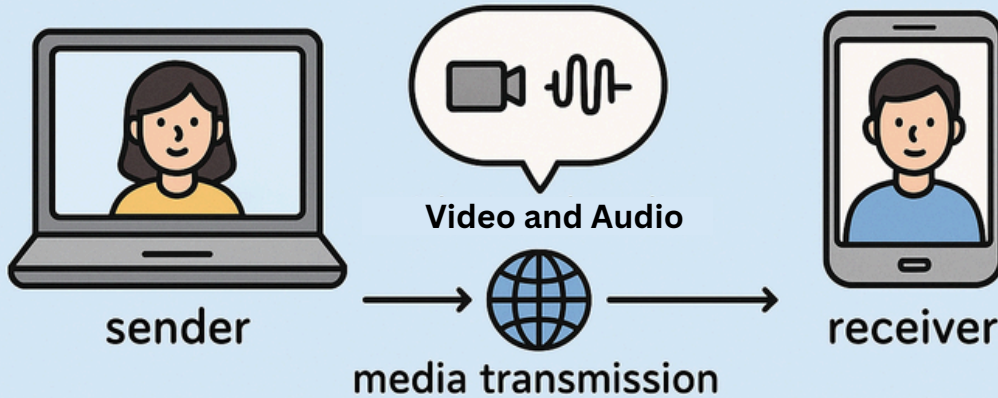




## FUN FACT!

# PROTOCOL

Set of rules that dictate how data is transmitted and received.



Examples include TCP/IP, HTTP, and FTP



## FUN FACT!

# MEDIA TRANSMISSION

The channel through which the message travels (e.g., wired or wireless connections).

## Guided

Wired media such as twisted pair, coaxial cable, and fiber optic



Uses physical cables to transfer data

**Examples:** Ethernet cables, fiber optics, coaxial cables

**Advantages:** Reliable, high-speed, and secure

**Disadvantages:** Expensive to install

## Unguided

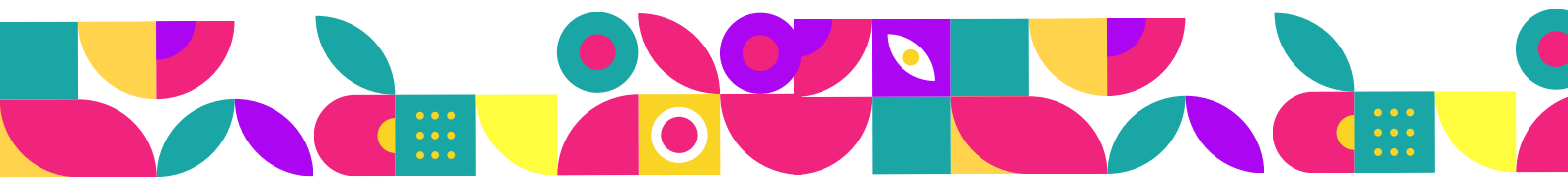
Wireless media such as radio waves, microwaves, and infrared



Uses electromagnetic waves to transmit data

**Examples:** Wi-Fi, Bluetooth, cellular networks

**Disadvantages:** Difficult to install, maintain, less flexible



## 1.3 Transmission Systems

Data transmission a.k.a Data Flow can occur in different modes based on the direction of communication.

### 1.3.1 Simplex

Simplex transmission is a one-way communication system where data flows in only one direction. The sender transmits data, and the receiver only receives it without sending any response. This mode is efficient for applications where feedback is not required.

**Example:**

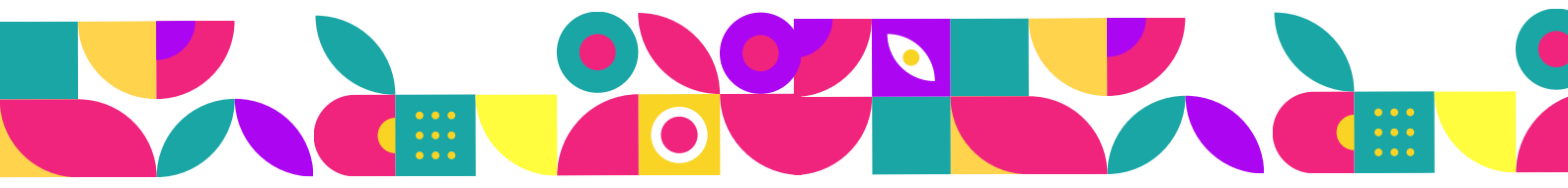
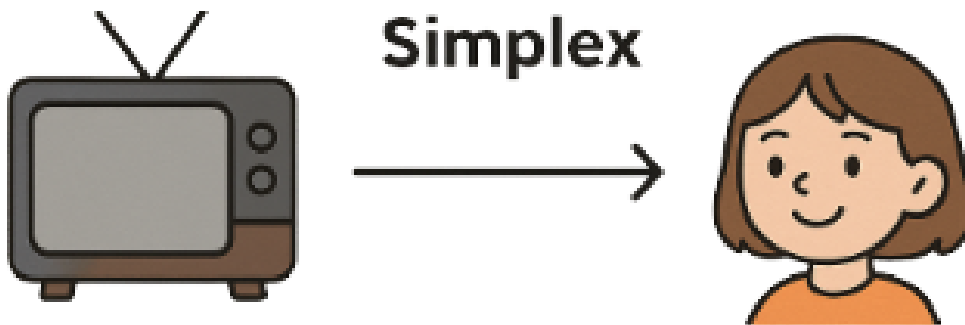
- Television broadcasting – A TV station sends signals to the audience, but the audience cannot respond back.
- Radio broadcasting – A radio station transmits audio, but listeners do not send information back.
- Keyboard to Monitor Communication – When typing on a keyboard, data is sent to the monitor for display, but no information is sent back to the keyboard.

**Advantage:**

Simple and cost-effective.

**Disadvantage:**

No feedback or acknowledgment from the receiver.



### 1.3.2 Half-Duplex

Half-duplex transmission allows data to flow in both directions, but only one direction at a time. The sender and receiver take turns in transmitting and receiving data. This system is useful in environments where alternating communication is sufficient but simultaneous transmission is unnecessary.

**Example:**

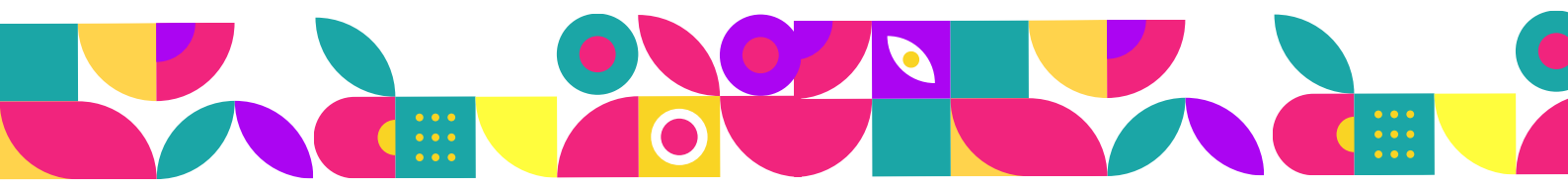
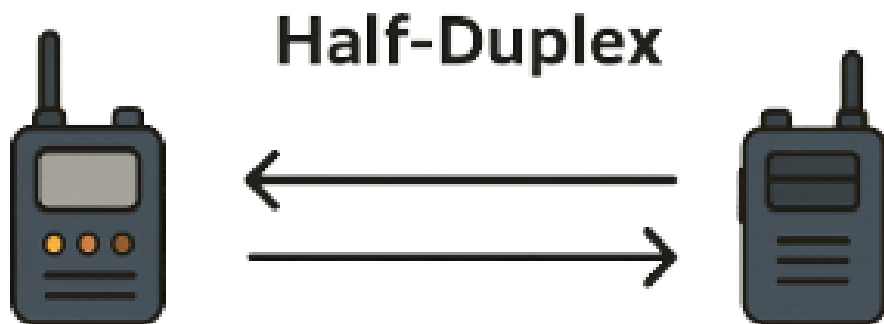
- Walkie-talkies – Users can speak alternately by pressing a button, but both cannot talk at the same time.
- Two-way radio systems – Used in emergency services, where a person speaks, and the other waits before responding.
- Shared Ethernet networks – In traditional network hubs, only one device can send data at a time to prevent collisions.

**Advantage:**

Utilizes bandwidth more efficiently than simplex systems.

**Disadvantage:**

Communication delay as only one device can transmit at a time.



### 1.3.3 Full-Duplex

Full-duplex transmission enables data to flow in both directions simultaneously. Both sender and receiver can transmit and receive data at the same time ensuring faster and more efficient data exchange.

**Example:**

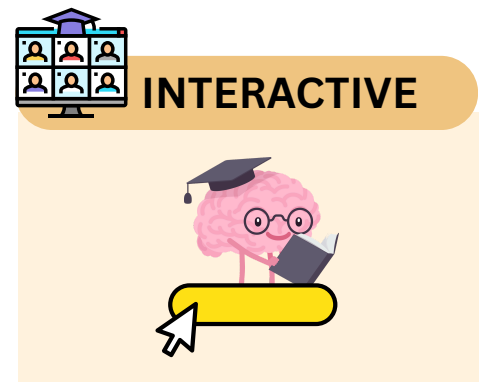
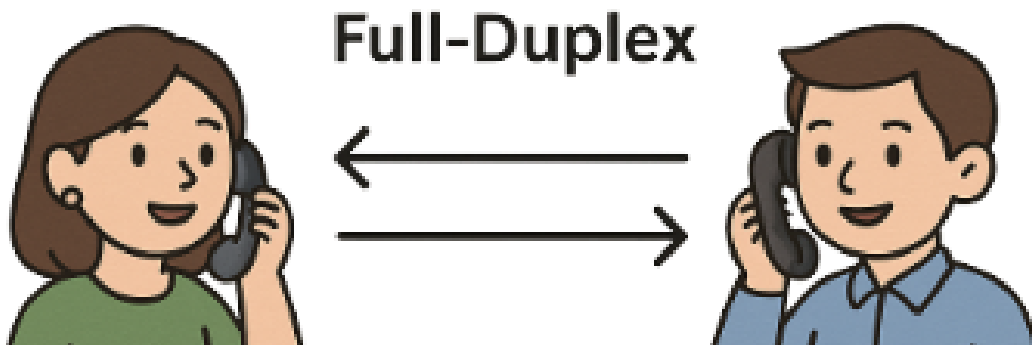
- Telephone communication – Both parties can speak and listen at the same time without interruption.
- Modern Ethernet networks – Full-duplex mode allows simultaneous data transmission and reception, improving network efficiency.
- Video calls – Services like Zoom and Skype enable real-time two-way audio and video communication.

**Advantage:**

Faster and more efficient communication.

**Disadvantage:**

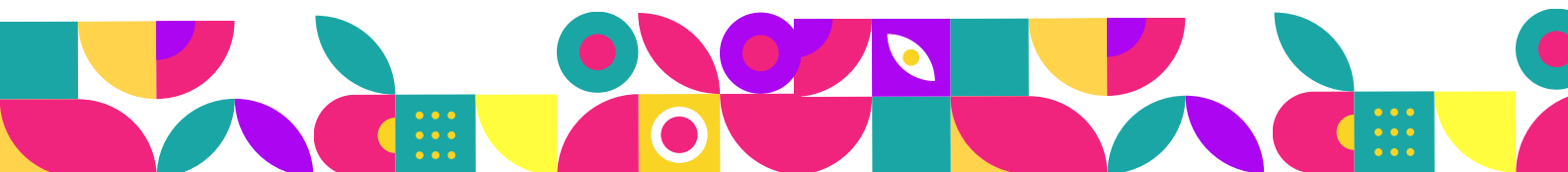
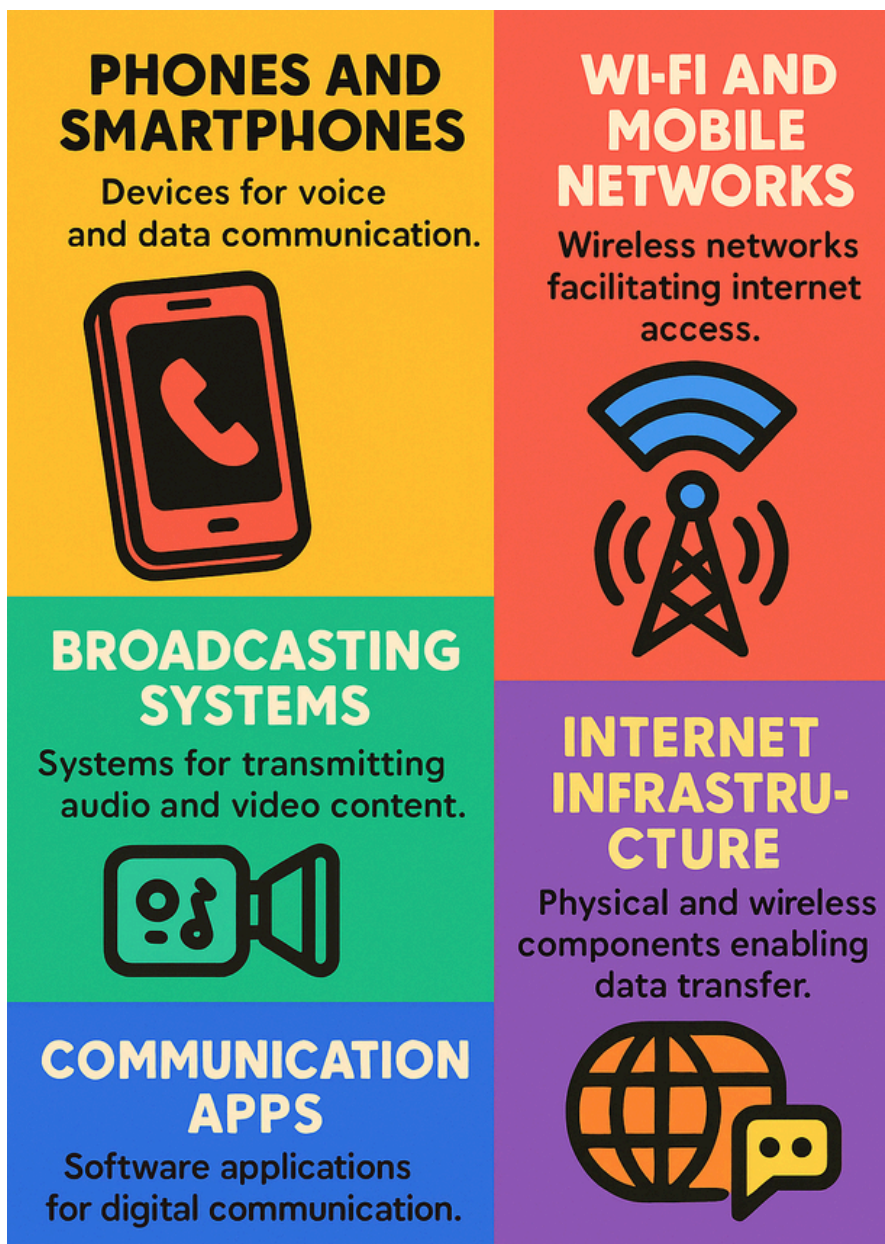
Requires more complex and expensive infrastructure..



## 1.4 Telecommunication Technology

Telecommunication technology refers to electronic systems used to transmit data over long distances. These technologies enable global communication, supporting industries such as business, education, and healthcare. The technology involves the **electronic transmission of information** over distances. This could be **voice, data, text, audio, or video**, using wired or wireless systems.

These technologies are like the nervous system of modern society, constantly transmitting signals and information across the globe.,



### 1.4.1 Advantages of Telecommunication Technology

#### Fast and Efficient Communication



Instant messaging, video conferencing, and cloud services enhance business operations

- **Fast and Efficient Communication**

Instant messaging, video conferencing, and cloud services enhance business operations. Then: Letters took days or weeks. Now: You can ping someone on the other side of the world in 0.2 seconds.

Tools like Zoom, Slack, WhatsApp, Google Meet have made business meetings, classroom discussions, and even long-distance relationships practically frictionless.

⚡ **Real-World Example:** A multinational team can collaborate on a shared document in real time via Google Docs while video conferencing on Teams.

- **Cost Savings:**

Reduces the need for physical travel and postal services. No more expensive international calls or waiting weeks for contracts to be couriered. Reduces commuting and travel expenses, especially for businesses that go hybrid or remote.

✉ For businesses, telecommunication reduces overhead costs significantly fewer office spaces, travel reimbursements, and printed materials.

#### Cost Savings



Reduces the need for physical travel and postal services.

#### Global Connectivity

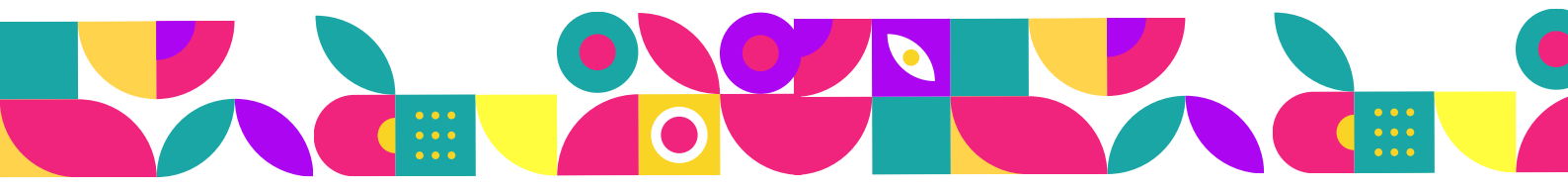


Connects people and businesses worldwide

- **Global Connectivity**

Connects people and businesses worldwide. Borders? What borders? With mobile networks and internet infrastructure, you can attend conferences in Berlin, order supplies from China, or teach students in Africa all from your laptop in Malaysia.

🌐 With the rise of the global gig economy, platforms like Upwork and Fiverr thrive because telecommunication makes distance irrelevant.



### 1.4.1 Advantages of Telecommunication Technology

#### Enhanced Productivity



Remote work and collaboration tools improve workflow efficiency

- **Enhanced Productivity**

Remote work and collaboration tools improve workflow efficiency. Access to real-time data, instant feedback, cloud-based systems (like Trello, Monday.com), and quick file sharing improves the speed of decision-making and task completion. Collaboration is smoother, even when team members are in different time zones.

🚀 Remote teams are now proving they can be as productive than traditional office setups.

- **Scalability**

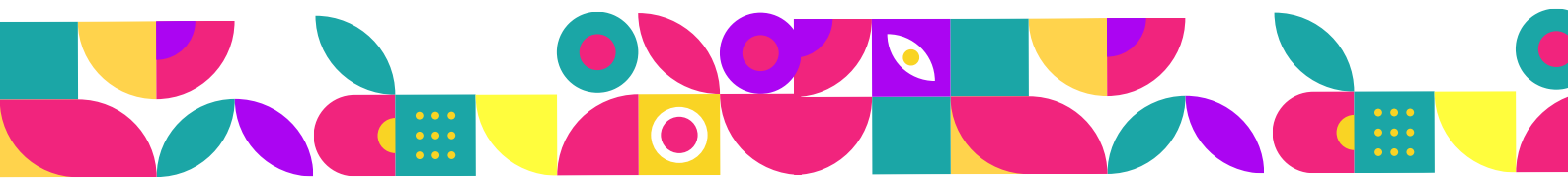
Supports the expansion of businesses and networks without geographical constraints. Whether you're growing from 10 to 10,000 employees or from local to global, telecom tech supports that growth without needing to physically expand. Tools like cloud communication platforms (Zoom, VoIP) and scalable network infrastructures can adapt as your business or institution grows.

📶 Telecom tech = elastic. It stretches with your needs without snapping your budget.

#### Scalability



Supports the expansion of businesses and networks without geographical constraints.



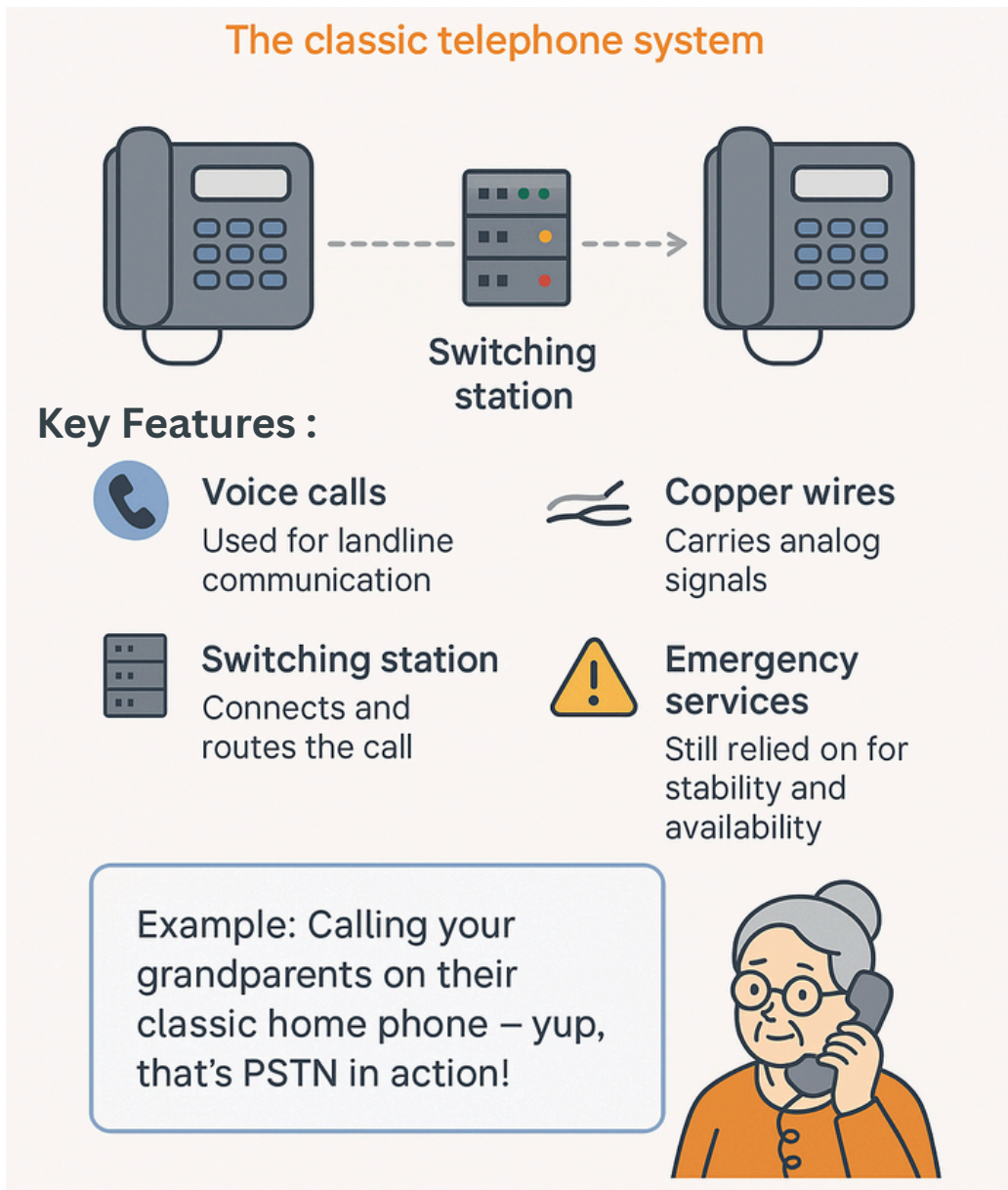
## 1.5 Types of Telecommunication Technologies

Telecommunication is all around us. From voice calls and video chats to satellite TV and lightning-fast internet. But how exactly do all these technologies work together to keep us connected?

Here's a breakdown of the main types of telecommunication technologies you need to know explained clearly, with real-world relevance.

### 1.5.1 Public Switched Telephone Network (PSTN)

The PSTN is the traditional telephone network used for landline calls. It's a circuit-switched system, which means a dedicated line connects two phones during a call.



## 1.5 Types of Telecommunication Technologies

### 1.5.2 Cellular Networks

Cellular networks divide areas into "cells" covered by towers. These towers use radio waves to connect your mobile phone to the network. As you move, your phone automatically connects to different towers so you stay connected on the go.

The reason your mobile phone works anywhere



#### Key Features :



Supports  
2G to 5G

Mobile voice, SMS,  
data



Works  
when you  
travel



On-the-go  
access

Always connected, even  
while moving

**Example:** You're streaming Spotify using 4G while walking through city – your phone seamlessly hops between towers without dropping a beat.



Spotify



## 1.5 Types of Telecommunication Technologies

### 1.5.3 Satellite Communication

Satellite communication uses artificial satellites in space to send and receive signals. It's ideal for areas where cable or tower infrastructure is limited or impossible.

#### Space-powered communication for remote places



#### Key Features :

- 🌐 Global coverage – even in remote areas
- ✈️ Used for GPS, satellite TV, internet in rural zones
- 🕒 Slightly higher latency (signal delay)

#### Example :

Using Satellite phones in the jungle or high sea, or watching satellite TV in a village far from any city

## 1.5 Types of Telecommunication Technologies

### 1.5.4 Fiber Optic Communication

Fiber optic communication is a method of transmitting data using light pulses through extremely thin strands of glass or plastic fiber. These fibers carry data in the form of light signals fast, efficient, and perfect for long distances with almost no loss of quality.

#### The fastest data highway

Fiber optics use thin glass or plastic fibers to transmit data as light signals. This allows for extremely fast and high-capacity internet connections.



#### Key Features :



Ultra-fast internet  
(up to gigabits per second)



Reliable and secure



Used in backbone networks,  
homes, and businesses



#### Example :

Am able to stream Netflix  
4K with no lag. Thanks to  
fiber optics for that

## 1.5 Types of Telecommunication Technologies

### 1.5.5 Voice over Internet Protocol (VoIP)

VoIP lets you make phone calls using the internet instead of traditional phone lines. Instead of sending your voice through copper wires or radio waves, VoIP converts your voice into digital data, sends it across the internet, and reassembles it on the other end — all in milliseconds.

#### Phone calls through the internet

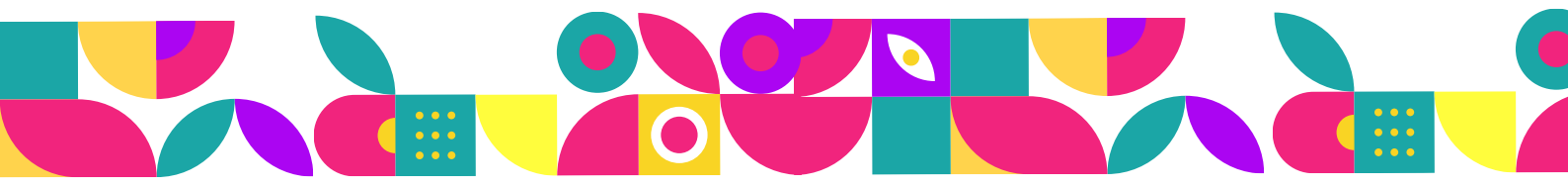


#### Key features:

- ✓ Requires internet access (Wi-Fi or mobile data)
- 💰 Cost-effective, especially for international calls
- 📺 Supports both voice and video

#### Real-world example:

Joining an online class on Zoom or FaceTiming a friend overseas.

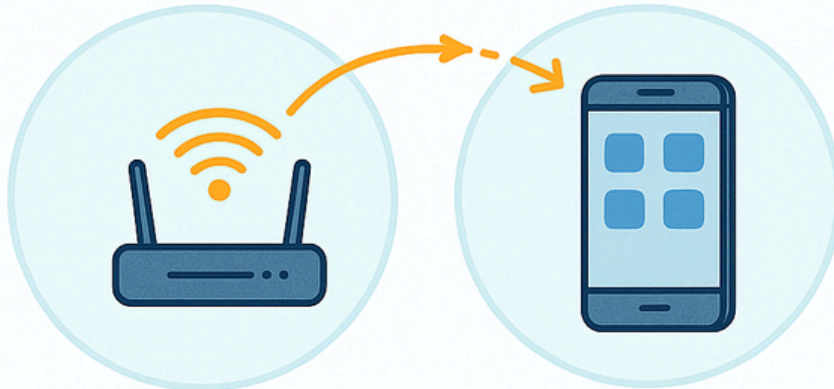


## 1.5 Types of Telecommunication Technologies

### 1.5.6 Wireless Networks (Wi-Fi & Bluetooth)

Wi-Fi and Bluetooth allow devices to communicate wirelessly over short distances.

#### Short-range champions of convenience



- **Wi-Fi:** Connects devices to the internet through a router.
- **Bluetooth:** Pairs devices like headphones, keyboards, and smartwatches directly.

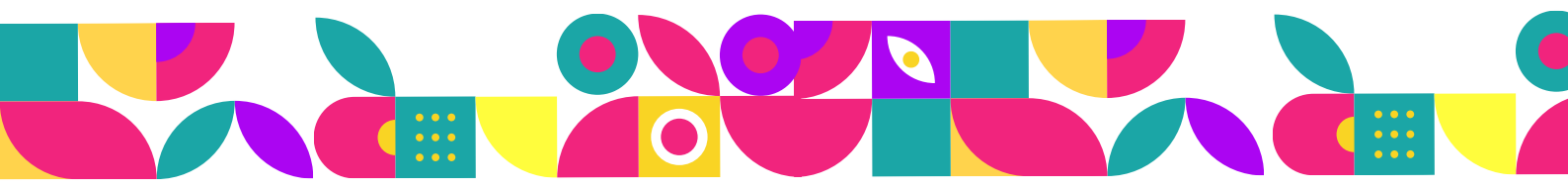
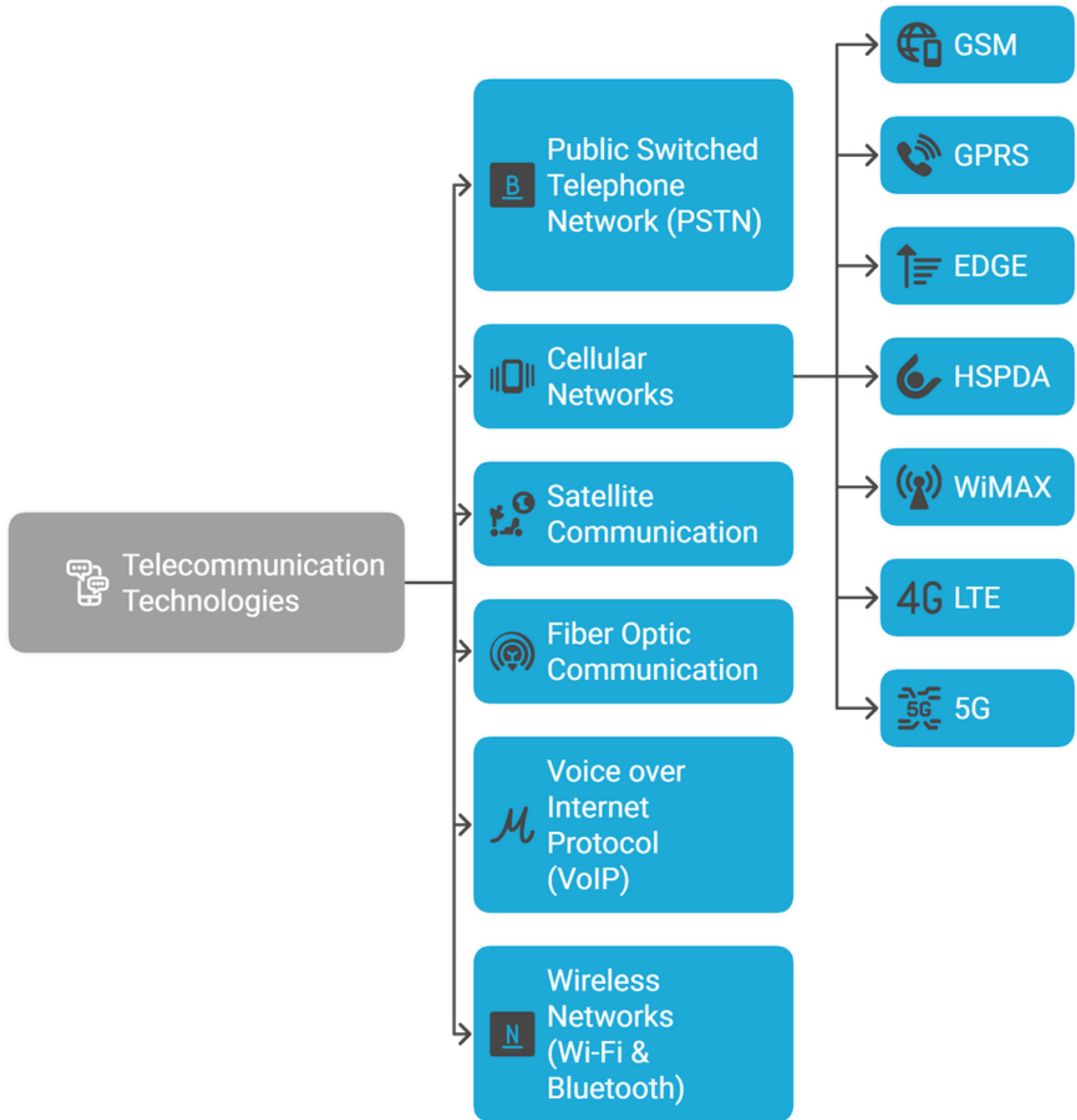
#### Key features:

- ✂ No cables required
- 🏠 Common in homes, schools, and public spaces
- 📍 Essential for mobile productivity

**Real-world example:** Connecting your phone to public Wi-Fi at a café, or pairing Bluetooth earbuds before class.



# 1.5 Types of Telecommunication Technologies

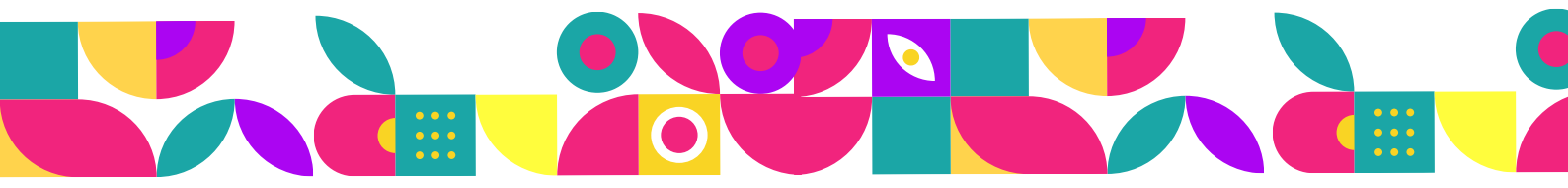


## 1.5 Types of Telecommunication Technologies

### The Big Picture: How a Phone Talks to the World

Your mobile phone works by turning your voice, texts, or data into radio signals. These signals travel through the air to the nearest cell tower, which then connects you to the rest of the world, whether it's through a phone call, a WhatsApp meme, or a GPS ping.

Ever wondered how your mobile phone actually works? Like—how does this tiny slab of glass let you talk to someone across the world, stalk your ex, and order bubble tea all at once?



## What Happens When You Use Your Phone?

That cell tower passes your signal through a huge network of servers, wires, and maybe even satellites – until it reaches your friend’s phone. And boom – you’re talking.



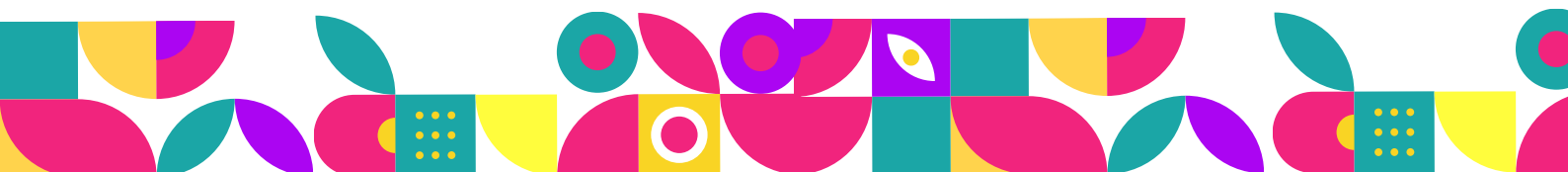
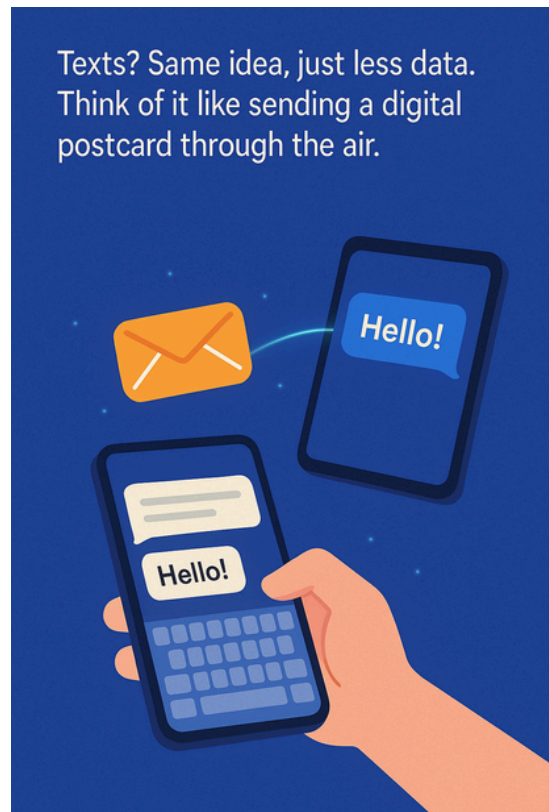
### 📞 Making a Call:

1. You dial a number.
2. Your phone converts your voice into digital data.
3. That data gets sent via radio waves to the nearest cell tower.
4. The tower sends the data to a switching center, which finds the destination (the other person’s phone).
5. It routes the call through more towers, satellites, or cables, and rings the other person.

### 💬 Sending a Text:

1. Your SMS is sent like a tiny digital postcard to a nearby tower.
2. It’s routed through the cellular network to the recipient’s phone even if they’re on the other side of the globe.

Texts? Same idea, just less data. Think of it like sending a digital postcard through the air.



## What Happens When You Use Your Phone?

Browsing the internet, watching videos, or stalking memes? That's your phone sending data to your mobile provider, which connects you to the internet and back.



### 🌐 Browsing or Streaming (Data):

1. You open YouTube.
2. Your phone sends a data request (via radio waves) to your network provider.
3. The request reaches the internet, grabs the video, and sends it back.
4. Your phone decodes it and shows it to you usually with a few ads on top. 😞

## Cellular Networks: The Backbone

Depending on where you are and how fancy your network is, your phone could be using:

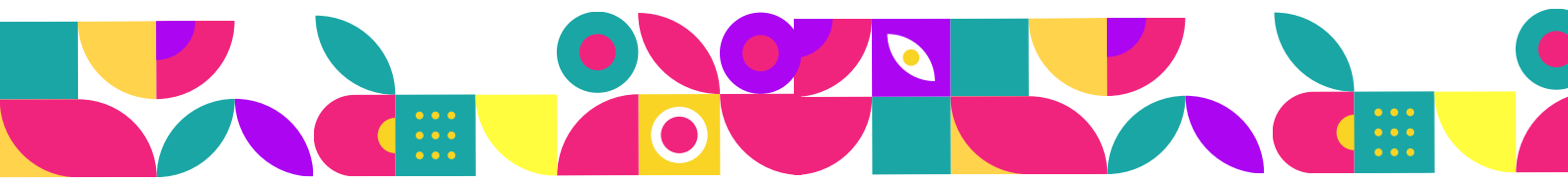
- 2G (GSM): Voice & text
- 3G (HSDPA): Moderate-speed data
- 4G (LTE): Fast browsing, streaming
- 5G: Ultra-fast, low latency, supports smart cities & IoT

Each "G" is like a new highway lane faster and bigger.

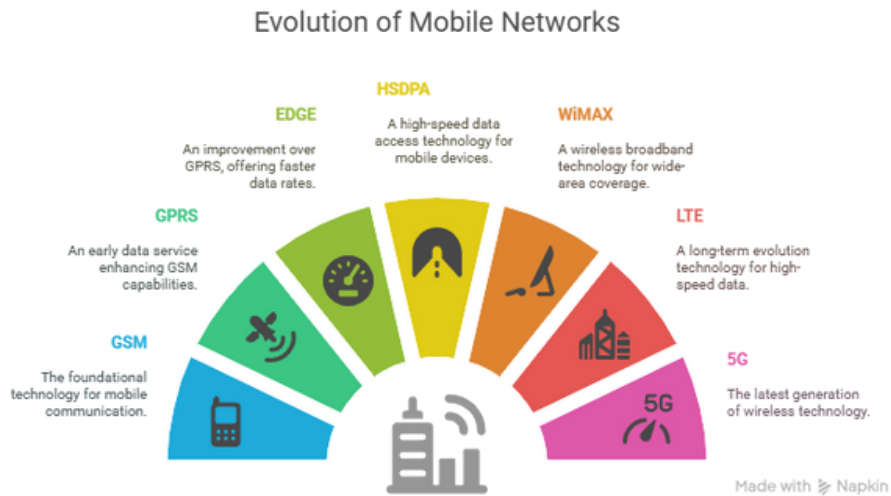


### FUN FACT!

When you speak on a phone, your voice is converted to digital code, travels wirelessly, maybe passes through a fiber optic cable under the ocean, and gets reassembled into sound all in less than a second.



## 1.6 Technologies for mobile communication.



### 1.6.1 GSM – Global System for Mobile Communications

GSM is one of the most widely adopted mobile communication standards in the world. It enables users to make voice calls and send SMS (Short Message Service) messages using a SIM card over cellular networks. Thanks to its support for international roaming, users can stay connected while travelling across countries, as long as there's a partner network.

#### Key Features:

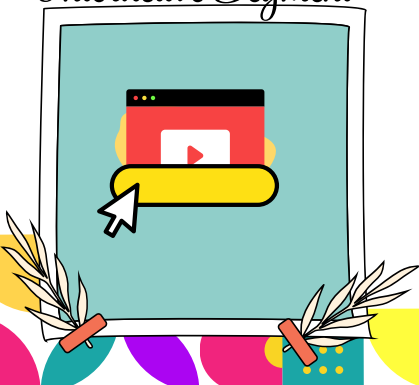
- Operates on multiple frequency bands (900 MHz, 1800 MHz, etc.)
- SIM card-based identification
- Global coverage with roaming agreements
- Basic services: voice calls and SMS
- Introduced in the early 1990s (hello, Nokia bricks!)

#### Real-Life Example :

“Zafran is vacationing in Paris. Even though he’s using a Malaysian SIM card, he can still call home and update his family via SMS all thanks to GSM’s international roaming support.”

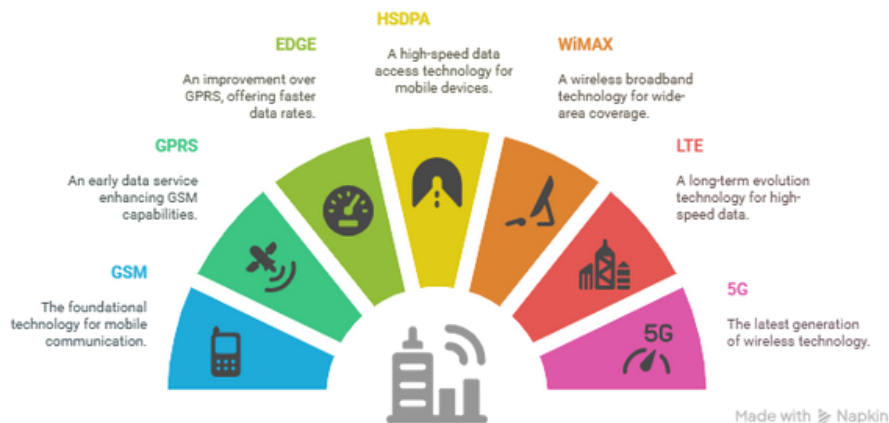


#### Interactive Segment



## 1.6 Technologies for mobile communication.

### Evolution of Mobile Networks



### 1.6.2 GPRS – General Packet Radio Service

GPRS was the game-changing upgrade to GSM that introduced mobile data capabilities. It uses packet-switching to allow users to browse the internet, send MMS (Multimedia Messaging Service), and access email all on the go. Often dubbed "2.5G," GPRS laid the foundation for mobile apps and online access before full 3G rolled in.

#### Key Features:

- Always-on data connection (no need to dial in like old modems!)
- Internet access at ~56–114 Kbps (it was fast for its time)
- Enables MMS, WAP browsing, and push email
- Seamless integration with GSM networks
- First step toward modern mobile apps



#### Real-Life Example :

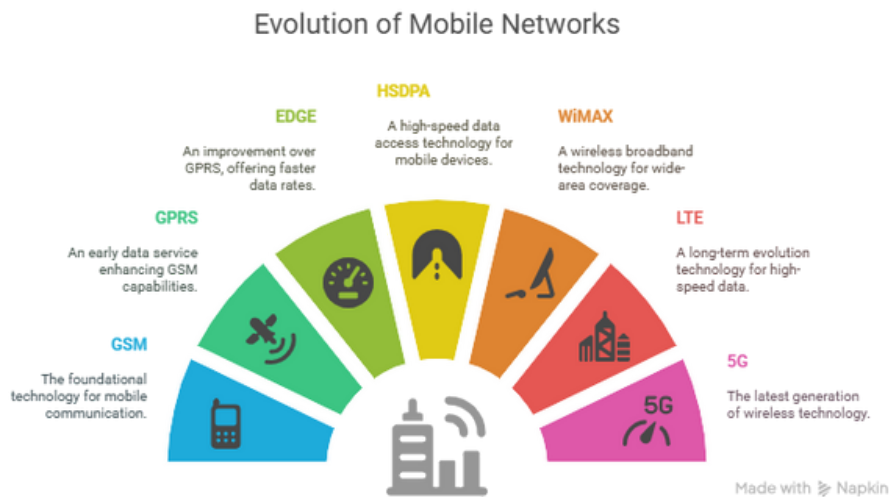
"While waiting for the bus, Amni checks her mobile banking app on her classic phone. It's a bit slow, but the transaction goes through powered by GPRS technology."



**INTERACTIVE**



## 1.6 Technologies for mobile communication.



### 1.6.3 EDGE – Enhanced Data Rates for GSM Evolution

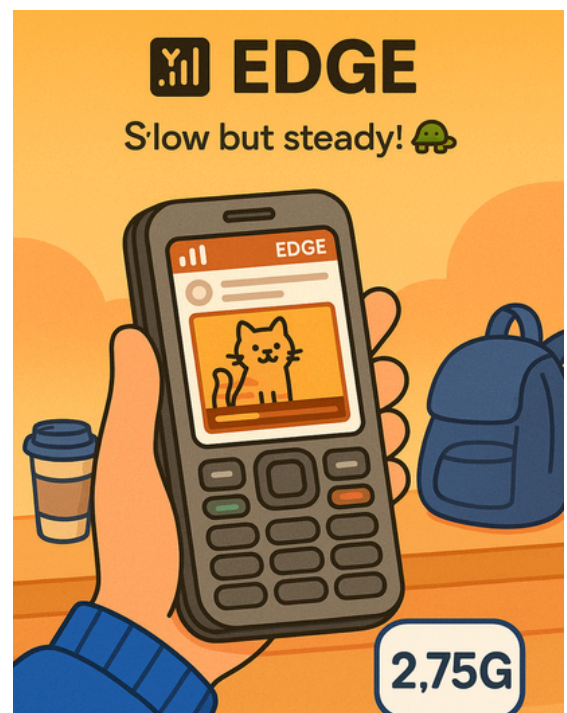
EDGE is a data transmission upgrade to the GSM and GPRS networks, often referred to as 2.75G. It provides faster internet access than GPRS, allowing users to access social media, send emails, and stream low-quality videos. All on early mobile internet-capable phones.

#### Key Features:

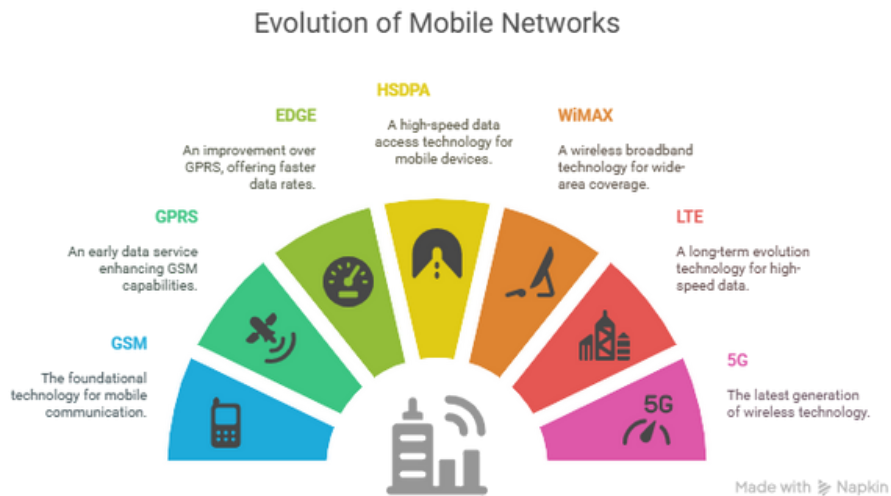
- Peak speeds up to ~384 kbps
- Uses existing GSM infrastructure with improved data coding
- Ideal for light internet use on older phones
- Acts as a bridge between 2G and 3G technologies

#### Real-Life Example :

“While waiting for the bus, Adlina checks her Facebook feed and watches a short cat video thanks to EDGE technology.”



## 1.6 Technologies for mobile communication.



### 1.6.4 HSDPA – High-Speed Downlink Packet Access

HSDPA is a 3G mobile technology that boosts download speeds, making mobile broadband significantly faster and more reliable than earlier generations. It allows users to stream videos, browse the web, and download content without painful buffering or snail-speed loading.

#### Key Features:

- Part of the 3G family (sometimes called 3.5G)
- Significantly faster than EDGE or GPRS
- Optimized for fast downlink data (downloads)
- Ideal for video streaming, web surfing, mobile apps
- Enhances user experience on smartphones and tablets



#### Real-Life Example :

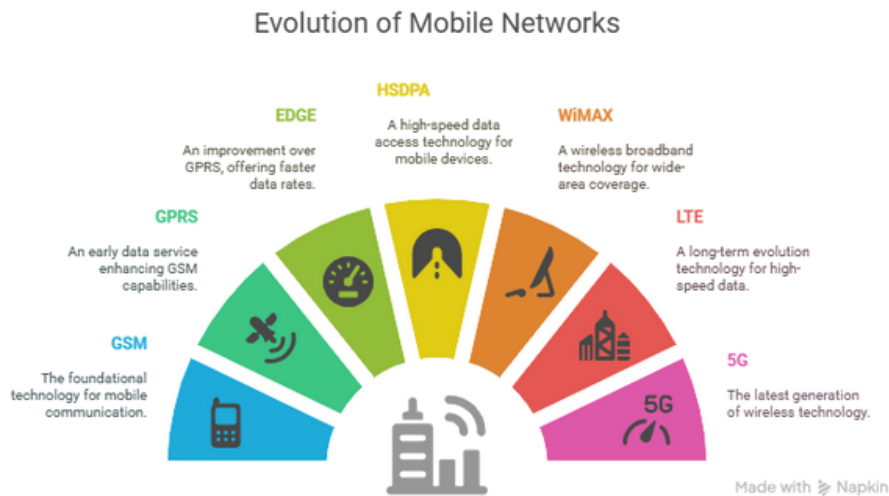
“Muhammad's catching up on vlogs during his commute. Despite only having a 3G signal, his YouTube video loads quickly and plays without interruption that's HSDPA at work!”



**INTERACTIVE**



## 1.6 Technologies for mobile communication.



### 1.6.5 WiMAX – Worldwide Interoperability for Microwave Access

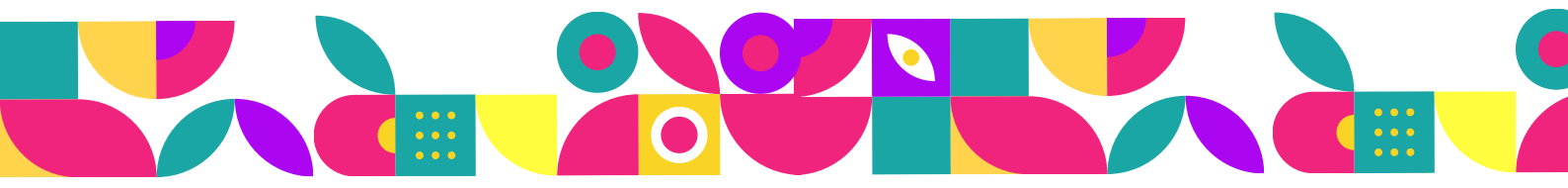
WiMAX is a wireless broadband technology designed to deliver high-speed internet access over long distances. Unlike traditional fiber or cable networks, WiMAX doesn't need extensive physical infrastructure, making it ideal for rural and remote areas. It functions like a giant Wi-Fi network, offering a wireless solution where laying cables isn't feasible.

#### Key Features:

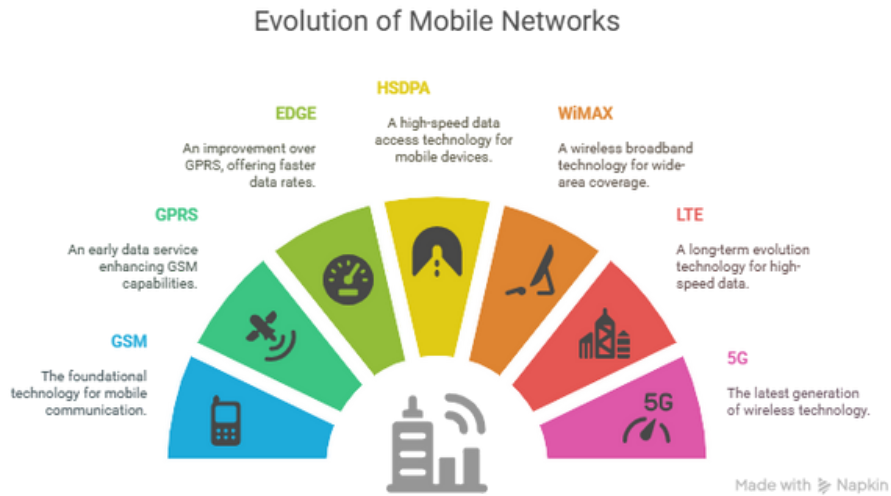
- Covers large geographic areas (up to 50 km radius in ideal conditions)
- Fixed and mobile versions available
- Supports voice, video, and high-speed data services
- Great alternative where fiber/cable isn't practical
- Based on IEEE 802.16 standard

#### Real-Life Example :

“A small village without fiber optic lines uses a WiMAX tower to connect dozens of homes to the internet. Students can now attend online classes and farmers can access real-time weather updates.”



## 1.6 Technologies for mobile communication.



### 1.6.6 LTE – Long-Term Evolution

LTE is a 4G wireless communication standard that offers high-speed internet access for mobile devices. It significantly reduces latency, increases bandwidth, and delivers seamless streaming, online gaming, and real-time app usage. LTE is the engine behind most of today's high-quality mobile internet experiences.

#### Key Features:

- Blazing-fast download and upload speeds
- Ideal for video streaming, mobile gaming, HD video calls
- Low latency, great for real-time communication (think: Zoom or PUBG)
- Used globally in 4G networks
- Bridges the gap between 3G and 5G

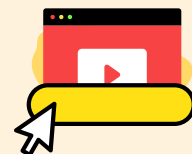


#### Real-Life Example :

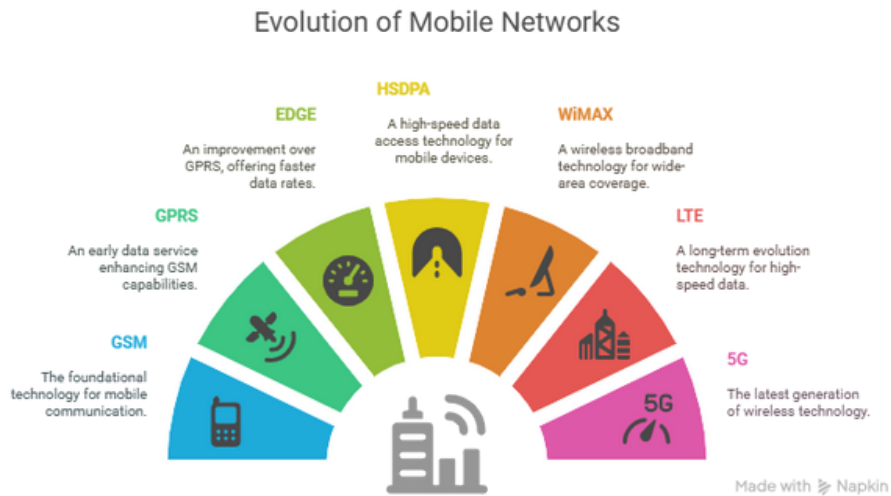
“Adrian is on a bus watching his favorite K-drama on Netflix in full HD no lag, no buffering. That’s LTE in action, delivering high-speed internet wherever he goes.”



**INTERACTIVE**



## 1.6 Technologies for mobile communication.



### 1.6.7 5G – Fifth Generation Wireless Technology

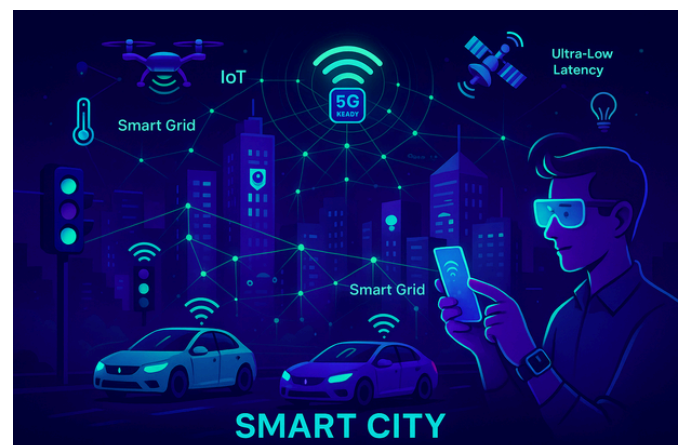
5G is the latest generation of mobile network technology. It delivers ultra-fast speeds, extremely low latency, and massive device connectivity. This tech is the backbone for the Internet of Things (IoT), autonomous vehicles, real-time remote surgery, smart factories, and futuristic smart cities.

Key Features:

- Speeds up to 100x faster than 4G
- Latency as low as 1ms (almost instant response!)
- Supports thousands of devices per square kilometer
- Ideal for data-heavy apps like AR/VR, gaming, and live HD streaming
- Enables autonomous transport and intelligent infrastructure

#### Real-Life Example :

“In a 5G-powered city, Aisy’s car talks to traffic lights, his smartwatch sends real-time vitals to his doctor, and his fridge reorders milk before she runs out all at lightning speed!”



**INTERACTIVE**





## FUN FACT!

### VoLTE (Voice over LTE)



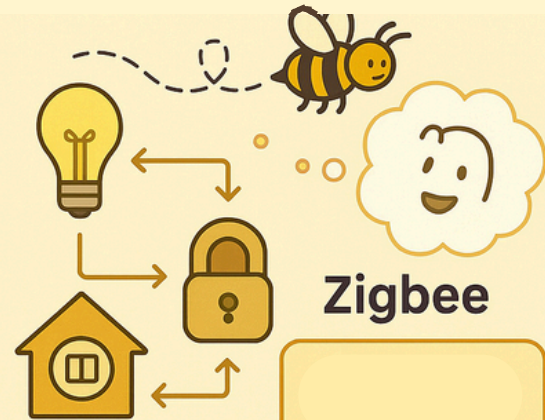
Like calling while watching YouTube – smooth and fast!

#### VoLTE = Voice over 4G

- Clearer phone calls
- Call + internet at the same time
- Faster connection



It's a calling while watching YouTube – smooth and fast!



### Zigbee

#### Zigbee = Smart device talk

- Connects without Wi-Fi
- Super low power
- Great for smart homes



## FUN FACT!

### How Do We Measure Our Network?



Measuring your internet is like checking your superhero stats!



Download speed = how fast you catch things (videos, memes, cat pics)



Upload speed = how fast you throw things back (selfies, TikToks)



Ping = how quick your reflexes are in a game

And data? That's your energy bar - don't run out!





# Measuring the Internet



## Internet Speed

### Download speed

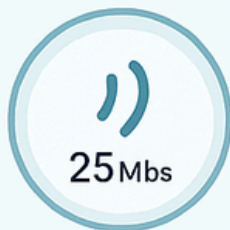
How fast you receive data

### Upload speed

How fast you send data



Download speed



Upload speed

Like calling while watching YouTube – smooth and fast!



## Data Usage



### Examples accur

Browsing ~150 MB

YouTube HD ~1 GB

Netflix 4K ~7 GB

## Signal Strength



### Excellent

-30 to -67 dBm



### Good

-68 -85 dBm



### Weak

-150 ms

## Latency



### Excellent

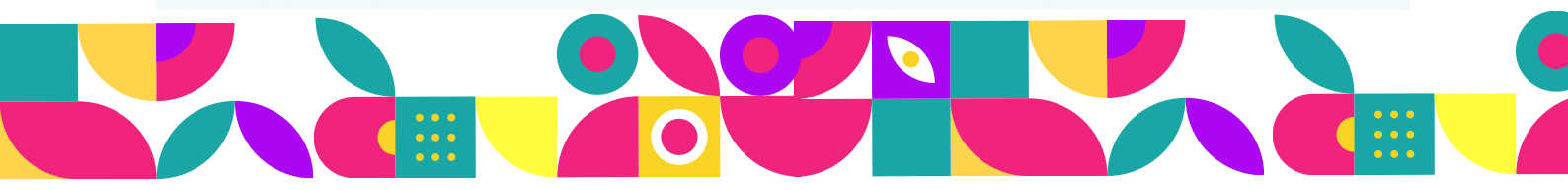
<50ms

### Good

50-100 ms

### Laggy

> 150 ms





## FUN FACT!

1

### YOU TALK, IT TRAVELS THOUSANDS OF KILOMETERS



“A video call from Malaysia to New York can bounce through undersea cables in milliseconds!”

2

### WI-FI WAS INVENTED BY ACCIDENT



“The core technology behind Wi-Fi was discovered while trying to detect black holes!”

3

### YOUR DATA TRAVELS IN PACKETS

Like digital postcards, your messages are broken into tiny packets and reassembled at the other end.



4

### LIGHT IS FASTER THAN ELECTRICITY



Fiber optic cables transmit data using light – at nearly 300,000 km per second!”

5

### SATELLITES HELP US COMMUNICATE... DELAYED



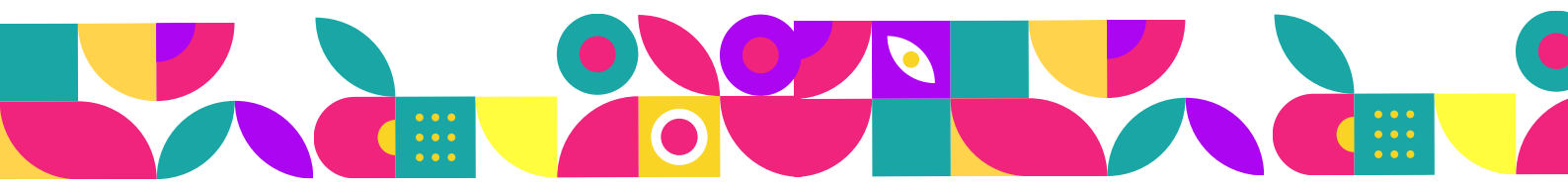
Data sent via satellite can take longer – you might notice a slight lag during live international TV interviews

7

### YOUR SMARTPHONE TALKS TO 4+ NETWORK



Every time you use your phone, you're likely connected to Wi-Fi, mobile data, Bluetooth, and GPS – all at once!





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