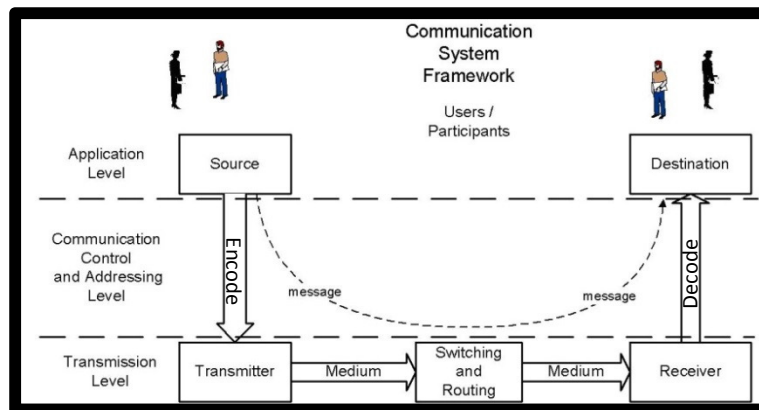


# COMMUNICATION SYSTEMS

## Characteristics of Communication Systems

**COMMUNICATION SYSTEMS AS BEING THOSE SYSTEMS WHICH ENABLE USERS TO SEND AND RECEIVE DATA AND INFORMATION** – Communication occurs between T&R I.T. over a network between nodes.



## FRAME WORK IN WHICH COMMUNICATION SYSTEMS FUNCTION

- The **data source** produces the message. The **transmitter** encodes it into a suitable signal and sends it along a **transmission media**. The **transmission media** is the channel or the means by which the data is sent. The **receiver** (hardware) decodes the message into the original state as it arrives to the **destination** (recipient).
- **Application level** – Creates and organises the data in a format understood by the receiving app. It then reorganises it to be suitable for transmission. [HTTP, DNS, FTP, SMTP, POP, IMAP and SSL]
- **Communication control and addressing level** – Establishes and maintains communication with network, directs data to destination, and ensures correct transmission of data. [IP addresses and routers]
- **Transmission level** – Defines how the transmission media is shared and performs the actual physical transfer, converting bits into signals to be transmitted. [Hardware (transmission media)]

## THE FUNCTIONS PERFORMED IN PASSING MESSAGES BETWEEN SOURCE AND DESTINATION

- **Message creation** – The message is compiled at the source, in preparation to be sent, by a software app
- **Organisation of packets at the interface between source and transmitter** – As the message descends the layers of protocols, it is wrapped with a header and trailer, which contains data relevant to the protocol (address and error checking). There will be multiple independent headers and trailers.
- **Signal generation by the transmitter** – The transmitter represents individual bits as a wave (which is determined by the rule of the TL protocol). Usually transmitters and receivers are held in same hardware. [NICs, switches, routers, ADSL, cable modems, mobile phones and Bluetooth devices]
- **Transmission** – Transmission occurs as the signal (as a waveform) travels through the medium. The transmitter creates each wave form and maintains it on the medium for a small period of time. Data is split into packets and aren't sent continuously. [Flow control]
- **Synchronising the exchange** – Common clocks are used to sync the exchange to ensure that each waveform (data packet) is detected by the receiver. The receiver is able to decode the signals whilst the transmitter keeps sending it. Two preambles are used to help sync the clocks.
- **Addressing and routing** – Data packets (forming a single file) pass through many different links. For each communication link, each packet will ascend its protocol level until it reaches the addressing and routing of protocol and then descend the level as it is prepared for transmission down the next path.
- **Error detection and correction** – As messages descend the levels prior transmission; many protocols calculate checksums or CRC values and include them in the headers and trailers. The receiver recalculates the value for data detection.
- **Security and management** – Many protocols restrict through usernames & passwords, and encryption.

## THE ROLES OF PROTOCOLS IN COMMUNICATION

- **Handshaking and its importance in a communication link**
  - **Protocol** – A formal **set of rules** that must be agreed to ensure successful and efficient data transfer.
  - **Handshaking** – It occurs when two or more devices **agree on protocols to ensure successful communication**. It commences when one device desires to communicate with another and is **successful when a connection is made**.
- **Functions performed by protocols at different levels**
  - Protocols define how a link is established, data is transmitted and error is detected.
  - **Application level** – Http, SMTP, SSL
  - **Communication control and addressing level** – TCP, IP, TCP/IP
  - **Transmission level** – Ethernet, token ring,
  - E.g. When transferring a webpage, HTTP, TCP, IP and Ethernet are involved.

## THE CLIENT-SERVER MODEL

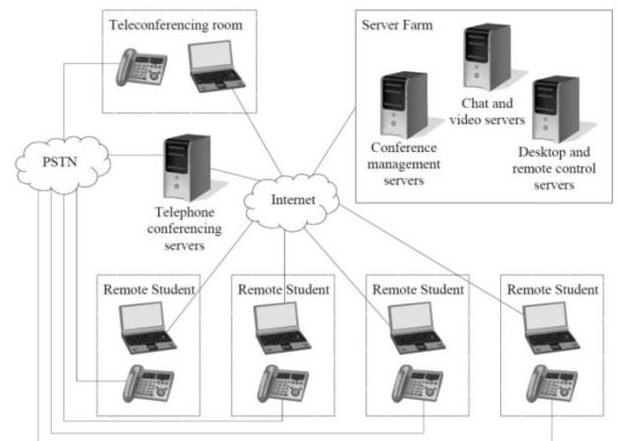
- **The role of the client and the server** – This is a form of **distributed processing**. Processes occur **sequentially**.
  - **Servers** – They don't understand the client's processes but still provides **resources and services**. [**File server, printer server, mail server, web server**]
  - **Clients** – Clients **request a service**, and **wait** for a response, while the **server is processing** the request. It provides the **user interface**, making users unaware of the server's role. A client can be a server to another. [**Web browsers, mail clients**]
  - **Advantages** – Manage **resources, access and data security** easily; share **I.T and network** across the network; can **access remotely**
  - **Disadvantages** – Become **high congested and overload** servers; dependability; greater measure of **security; expensive** to purchase, set up and maintain
- **Thin clients and fat clients**
  - **Thin client** – “Dumb” computers that don't carry out processes or store files. **Data input** is transmitted to a **centralised server**. It is a **network computer without a hard disk**.
  - **Fat client** – Performs the bulk of the **processing in client/server apps**. It can handle **higher bandwidth** and **OS**, and has its **own memory capabilities**.

## Examples of Communication Systems

**PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)** – PSTN (aka POTS) carries the **old telephone system** and is designed for **synchronous communication**. It is **connection-based/circuit switched**, meaning an individual circuit is **maintained** during each conversation.

**TELECONFERENCING SYSTEMS** – A **multi-location, multi-person, synchronous meeting** where audio, video and/or other is communicated in **real time** to all participants.

- **Need/purpose** – To **exchange info** among several people in multiple locations using I.T. (internet).
- **Participants** – Business people, educators, students
- **Data/Information** – Video, text (numeric), audio and graphics
- **Information technology** – Computer, video camera, microphone (headset), speakers, Internet connection, large monitors/data projectors, web conference software, teleconferencing server.

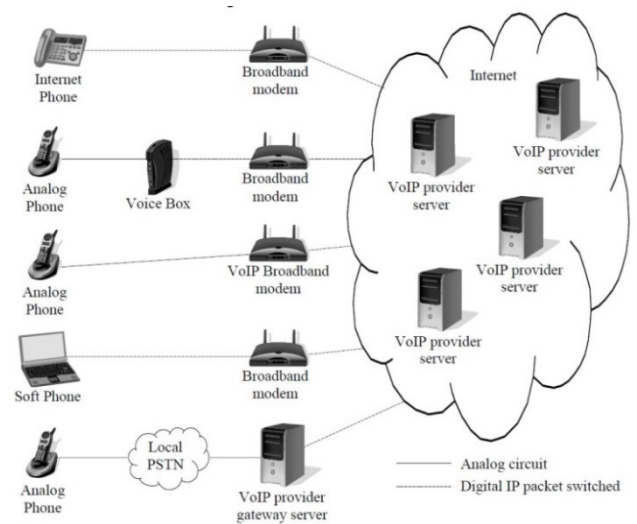


- **Transmitting and receiving data** – Raw video is collected and fed, in real time, through a **software-based codec**. The video is **compressed**, transmitted to **Chat and Video server** (determines transmission speed, frame rate and resolution). Video is **transmitted as data packets**, which is then **decompressed and displayed**.
- **Advantages** – Reduces **costs**; no additional **I.T**; simple to **set up**; regular **communication**.
- **Disadvantages** – Loss of **facial** and **body** language and close **relationships**; difficult to maintain long **calls**; low **internet speed** = lower quality.

## **MESSAGING SYSTEMS**

- **Telephones** – Real time voice communication between users in different locations. It uses **electronic switching** to maintain a **direct connection** during each conversation. Apart from the connection between telephones and their local exchange, it is **digital** (bit compressions & **having many convos simultaneously**).
- **Fax** – A fax machine scans the document and stores it as a **bitmapped image**. It is **compressed** and **sent via telephone lines**. The other fax machine **receives** the image, **decompresses** it and **prints** it out.
  - **Advantages** – Doesn't require the other person to be **present**
  - **Disadvantages** – Reduces confidence that the other people will **receive the message**
- **Email** – System where **electronic messages** are sent and received (with **different media types** attached).
  - **Envelope** – Data **used by SMTP servers to relay email** to other SMTP servers and then destination.
  - **Contents** – Contains the actual message and headers specifying **sender, receiver, data/time, subject and relationships with other messages**
    - Destination address field, originator field, identification field, informational fields and resent, trace and optional fields.
  - **T&R** – An **SMTP client** establishes a connection to the **SMTP server** and sends the email over. A **DNS lookup** is used to determine the **IP address** of their domain. The message is **sent to the machine**. The recipient's SMTP server passes it on to the **POP** and **IMAP** server. The server puts the message into the **mailbox**. The user logs into the server and retrieves the email.
  - **Advantages** – Fast **transmission**, capable of T&R **all media types** and **free** (except ISP fee).
  - **Disadvantages** – Only available to users with a **computer, internet** and **email address**; **viruses**.
- **Multipurpose Internet Mail Extensions (MIME)** – Used to send **non-textual data** and **attachments as ASCII** so it can be transmitted. Following encoding the bits with **64base**, SMTP **sends the text** as ASCII. The receiver **reads the MIME headers** and **formats the message** accordingly.
- **Voice mail** – The voice mail system (provided by a telephone service provider) **answers the call, plays an OGM** and **digitally records a message**, which is stored in the **voice mailbox**. The customer then **calls** the voice mail system, **identifies** themselves and **retrieves** the messages. It is designed as a **hierarchical storyboard** with each audio section as a screen.
  - **Information technology** – telephone, voice mail account, voice mail system
  - **Advantages** – Sends and receives **brief messages**; has **security** features; no extra **hardware**
  - **Disadvantages** – **Impersonal**; only available to users with **voice mail account**.
- **Voice over internet protocol (VoIP)** – VoIP transfers **voice calls via the internet** with **IP**. It allows for **interfacing to PTSN**. After data is digitalised, it passes through protocols (RTP, UDP & IP).
  - **Processes**
    - **RTP & UDP** – Real Time Protocol and User Datagram Protocol is similar to TCP/IP
    - **Gateways** – The VoIP provider maintains servers to translate **telephone numbers into IP addresses, and analogue calls to IP packets** (vice versa). Gateways are shared and installed **globally**. VoIP providers enter in a contract with local PSTN, allowing a circuit to be created for the duration of the call. The **VoIP gateway server** manages the **packet switched side of the connection and the conversion of data between the Internet and local PSTN**.
    - **Users signing up** – They commonly connect using their **existing broadband modem** (built-in support) and **internet connection**. **Soft phones**, where a VoIP software application operates on an existing Internet connected computer, can also be used.

- **Need/purpose** – To allow **voice calls** to be made **via broadband internet connection**
- **Participants** – Individuals, business people
- **Data/Information** – Audio
- **Information technology** – Computer, microphone, speakers, sound card, Internet, VoIP software, modem
- **Processes** – **Soundwaves**, recorded by microphone, is **compressed** and sent to **destination**. An **address** is put into each data packet. Received computer **decodes** the transmission for sound waves.
- **Advantages** – **cheaper** costs from anywhere in the world; no added **info tech**
- **Disadvantages** – **Distortion** due to **internet congestion**; no **power** = no calls, worse **QoS**



### OTHER SYSTEMS DEPENDENT ON COMMUNICATION TECHNOLOGY

- **E-commerce** – It is **financial transactions** that occur over an electronic network.
  - **Advantages** – more easily compare prices and products; less labour/paper and reduced waiting time
  - **Disadvantages** – Preference to not reveal financial and personal info; fraud, hacking, identity theft
- **Automatic Teller Machine (ATM)** – It is essentially a **computer** with **specialised peripheral devices**. **ATM networks** are all connected.
  - **Collection devices** – Magnetic stripe reader, keypad or touchscreens.
  - **Display devices** – Screen (usually CRT), receipt printer, speaker and cash dispenser.
  - **Transactions** – To approve transactions, all ATMs are connected to a network that is connected to the customer's bank.
    - **Banks** (Ethernet cord); **Shopping malls** (phone line); **service stations** (dial-up modem).
    - Different to EFTPOS, the host **verifies the pin prior transaction amount and account type** entered, allowing for **multiple transactions** without needing to re-enter pin.
  - **Advantages** – easier than manually **transfer funds** from bank branch; **secure** and **efficient**
  - **Disadvantages** – Not practical for **smaller items**; **fees** charged to use; some prefer to use **cash**.
- **EFTPOS (Electronic Funds Transfers at Point of Sale)** – EFTPOS is a standard equipment to **electronically pay** for goods with **debit or credit cards**. Both **customers** and **merchants** are charged each transaction. Merchants are in charge of **filling ATMs with cash**.
  - **Collection devices** – Keypad and magnetic stripe reader
  - **Display devices** – monochrome LCD screen and small thermal printer
  - **Transactions** – EFTPOS terminals t&r data on **PSTN via built in modem**. Wireless communicates via **mobile phone networks** and Ethernet versions via **internet**. **Two key encryption** is used.
- **Internet Banking** – Allow customers to **pay bills, transfer money** and other functions from the comforts of home. It is accessed via a **computer** connected to internet, with **user ID** and **password** as identification.
  - **SSL/Transport layer security (TLS)** – It is in CC&AL with **public key encryption**. HTTPS is used when connecting to server. A **padlock icon** is present when SSL is used.
  - **Server-side** – .shtml refers to HTML documents with **embedded SSI**. The server executes **programming codes**, to query the **bank DB**, and the **output is sent to the client**.
  - **Advantages** – available **24/7**; reduction of **time** and **cost**
  - **Disadvantages** – Not available for **computer illiterate** people or **without computers**; **phishing**, malicious software to record key stroke; **identity theft**

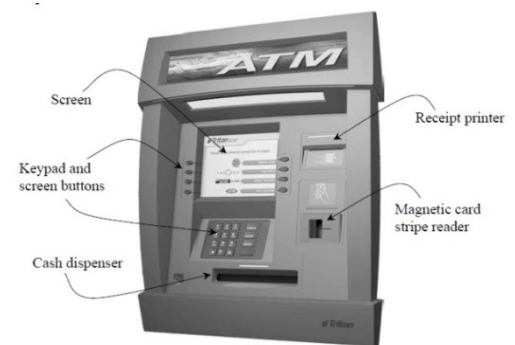


Fig 3.43  
Automatic teller machine (ATM) collection and display devices.

- **Trading over the internet** – This allows **small businesses to sell worldwide** and **buyers to compare products and prices easily**. E.g. Ebay and use of Paypal.
  - **Virtual businesses** – Organisation/business whose members are **geographically separated**. It works through **electronic communication** and removes the need for **shop fronts**.
    - **Issues** – Establishing **truth** and **loyalty** of customers; **security of purchasing transactions**.
    - **Paypal** – It is the world's most popular **payment service**. The **buyer deposits funds** into a Paypal account, which is transferred to **seller's Paypal**, then **bank account**. It maintains links to **banking systems** and **clearing houses**. **SSL** is used.
      - **Advantage** – **Sellers** don't need to create a certified payment service; accepts almost **all currency** and operates in almost **all countries**.

## Transmitting and Receiving in Communication Systems

### TRANSMISSION OF DATA

- **LAN** (local area network) – Network that **exists in an organisation**, building, etc.
- **WAN** (wide area network) – Communication between computers from **different LANs**
- **MAC (address)** (media access control) – Every piece of communication device is given a **unique MAC address during manufacturing**. It is a unique identifier.
- **Simplex** – Transmission of data in **one direction only**. E.g. radio
- **Half Duplex** – Allows transmission from **both directions**, but **not simultaneously**. E.g. walkie talkie
- **(Full) Duplex** – Transmission of data in **both directions** and **simultaneously**. E.g. telephones, VoIP
- **Synchronous** – Sends data all at same time as a constant flow. It requires clocks in sync.
- **Asynchronous** – Send data by identifying each byte with start and stop bits. E.g. internet
- **Parallel** – Transmission of data simultaneously using separate channels, causing data to arrive out of order
- **Serial** – Transmission of data one after another

### TRANSMISSION MEDIA

- **Wired transmission** – This **restricts the signal** so that it is **contained in the cable**.
  - **Twisted pair** – It is composed of **pairs of copper wire twisted together**, held in **plastic insulation** and an **outer sheath**. It is **twisted to lessen EM interference**. [telephone, LAN]
    - **UTP** – It is the **most common** and **economical of copper cable** for both LAN and telephone connections. There is **no physical shield**. It is composed of **four pairs of twisted cable**
      - UTP is classified into categories, where higher category cables support higher frequencies (high data transfer speeds). Most common is **Cat-5e**, with **125MHz**.
    - **STP or ScTP** – It includes a **metal shield** or screen and a **drain wire**. As it is **expensive**, it is limited to apps with **high levels of EM interference**.
    - **Advantages** – **Inexpensive**; readily **available**
    - **Disadvantages** – Susceptible to **EMI**; lower **bandwidth**; bad over **long distances** (100m)
  - **Coaxial cable** – **Steel>copper>nylon insulator surrounding core>aluminium foil>braided copper/aluminium>plastic black sheath** [Broadband apps, cable TV]
    - **Advantages** – Less susceptible to **EMI**, more **durable** and faster **data rates** than TP, **available**
    - **Disadvantages** – More **expensive**, **bulkier** and **less flexible** than UTP; slower **data rates**.
  - **Optic fibre** – It is composed of **one or more optical fibres**, where each fibre forms a **waveguide for containing (infrared) light waves**. The **light reflects off the inside of the cladding** that surrounds the core, where both are made of glass. The **cladding has lower refraction** index than the core, making **light reflected to mostly stay in the core**. [submarine cables, LAN backbones, international lines]
    - **Advantages** – Higher data rates over greater distances; immune to **EMI**; lightweight; secure
    - **Disadvantages** – Expensive in cost & service; specialised installation

- **LAN apps** – Each optical fibre is held in **protective plastic coating** like coaxial cables. The final cable is then enclosed in a **plastic sheath**.
- **Wireless transmission** – It uses the atmosphere as the medium to carry **EM waves (RF)** between nodes. It allows nodes to **move freely** within the **coverage area**. As it is **unbound**, it is **susceptible to interference** and **unsuitable for critical high speed** connections.
  - **Microwave – Point-to-point ground based (terrestrial)** microwave is used to relay **wireless signals** across **large distances**. Each transponder **receives the signal, amplifies** and **transmits** it to the next transponder. Transponders must be **physically located high** above the local ground. [**local TV**]
    - Advantages – Accurate; fast
    - Disadvantages – Expensive; line of sight
  - **Satellite** – It uses **microwaves** to carry **digital signals** to and from both **ground based stations** and **satellites**. Satellites contain (100s – 1000s) transponders that **receive, amplify** and **transmit microwaves** on a **different frequency**. Communication satellites are usually **geostationary**. [**Satellite TV/internet, broadband internet, GPS, LEOS**]
    - Advantages – Fast speeds; long distance
    - Disadvantages – Expensive; complex to setup and maintain
  - **Radio** – It is used in **Mobile phones, wireless LAN** and **Bluetooth**.
    - Advantages – Inexpensive for receivers; portability; readily available
    - Disadvantages – Security; costly for transmitters; interference; low speed transfer
  - **Infrared** – Infrared waves occur above microwaves and below visible light. A direct line of sight is required. [**TV remote, mobile phone data link**]
    - Advantages – Wireless features in devices; cheap; readily available
    - Disadvantages – Short range; limited bandwidth; line of sight limitation.

## CHARACTERISTICS OF MEDIA IN TERMS OF SPEED, CAPACITY, COST AND SECURITY

- **Speed of communication**
  - **Bits per second** – It is the **rate binary** is transferred
  - **Baud rate** – Number of **signal events** (change in transmission signal used to represent the data) occurring each second. This is equivalent to the number of **symbols/sec**.
  - **Bandwidth – Range of frequencies** (difference of highest and lowest) used by a transmission channel. Frequency is measured in Hz (cycles/sec). [**broadband, baseband, narrow band**]
- **Capacity** – Maximum rate that **data can be transmitted** over a communication path and **how much is stored**
- **Cost** – Cost to **set up** and **maintain**
- **Security** – Protection against **interference** and **tapping**. E.g. optic fibre – no EMI, no tapping.

## COMMUNICATION PROTOCOLS

- **Application level protocols**
  - **HTTP** (Hypertext Transfer Protocol - AL) – Used by **web browsers** to **communicate** and **retrieve files from webservers**. The three HTTP commands are HTTP GET, HEAD, POST
  - **SMTP** (Simple mail transfer protocol) – It is used to **send email**
  - **SSL** (secure sockets layer) – **Encrypting data** (two keys) for secure data transmission via internet.
- **Communication control and addressing level protocols**
  - **TCP** (Transmission Control Protocol) – TCP/IP are responsible with **correct transfer of data via internet**. TCP requires IP, but not vice versa. When **errors are encountered**, the **packet is discarded**. Each segment (576 B) includes a header with checksum (20 for TCP & IP each)
    - Sliding window – Control data flow and ensure data is acknowledged once it's received.
  - **IP** (Internet Protocol) – IP (4 bytes) **sends data packets from sender to receiver**. It doesn't guarantee its arrival nor acknowledge it. It is designed to work on **all networks and hardware**. A **router** is used to **determine the next path** (avoiding problem areas).



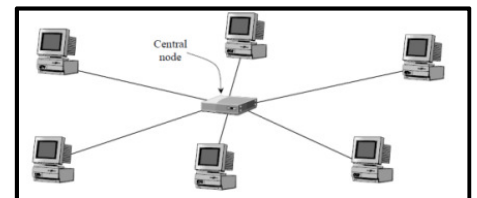
- IP address – **Every device** on the internet must have one or more IP addresses – **one IP for every network**. Routers **examine the destination IP address** in the **header of packets** to determine which network connection to retransmit it to. It can be **static** or **dynamic**.
  - Composed of **Network ID** (path to arrive) and **Host ID**. (destination device)
- Fragmentation – **Splits packets to suit the protocol** of the hardware it has hopped on. They are **combined upon the destination** and **preferably avoided**.
- Transmission level protocols
  - Ethernet – Controls the T&Ring of data in any transmission medium. Ethernet packets are frames.
    - Carrier Sense Multiple Access & Collusion Detection (CSMA/CD) – Makes nodes 'listen' when they require a transmission. It is made to counter collusions.

Preamble (8 bytes)	Destination MAC Address (6 bytes)	Source MAC Address (6 bytes)	Type (2 bytes)	Data (46 – 1500 bytes)	CRC (4 bytes)
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- Preamble – **Syncs the clocks**. The alternating 1s and 0s physically represent transitions from H-L and L-T, respectively.
- Destination/Source Mac Address – Every node on Ethernet network has a **6B MAC address**. Every node examines the MAC address and accepts if it's their own.
- Type – Indicates the **higher-layer protocol** used.
- Data – Includes **data packet of CCAL** level.
- CRC – For error checking. The sender **calculates the CRC based on the contents of the frame**. If the recalculated CRC matches, the frame is accepted, or the data is resent.
- Token ring – It is used to **send/receive data** in a **physical ring**. As the token circulates, **nodes attach packets to the token** and the token continues passing until the **recipient receives the message**. A **confirmation is then attached** to the token ring and sent back.

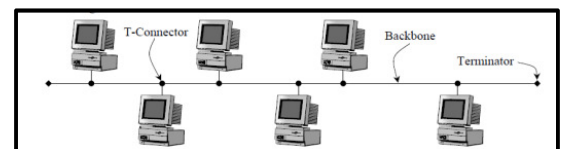
## NETWORK TOPOLOGIES

- Physical topology – The way nodes are connected (via wired cable/wireless).
- Central node – A device that connects all outlying nodes to enable ability to transmit and receive packets to each other.
- Star – All nodes **connect to a hub** (usually a switch) via their own **cable**. For **wireless LANs**, a **WAP** (Wireless Access Point) is used.



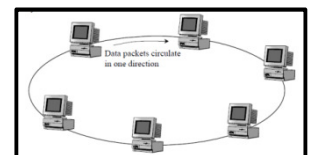
- Advantages – Nodes dis/connected **without affecting other nodes**; **Issues** more easily identified
- Disadvantages – **More cabling** required; if a **fault occurs at the hub**, the **network is down**.

- Bus – All nodes are connected to a **backbone** (cable that **carries data** to each node) via **T-connector**. **Terminators** prevent reflection of data signal back down the cable.



- Advantages – **Less cabling**; easy to **implement**
- Disadvantages – Can't accommodate lots of nodes; Break in the backbone disables the whole network; Collusions can occur when data is sent simultaneously.

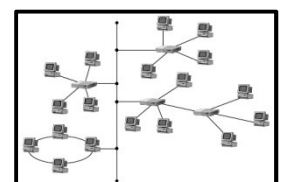
- Ring – Each node is **connected to another two nodes**. Thus, data packets circulate the ring in **one direction** using a **token ring**.



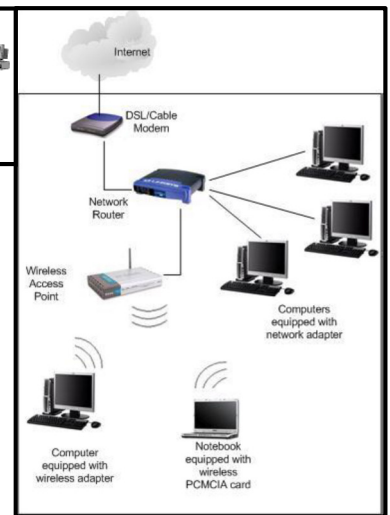
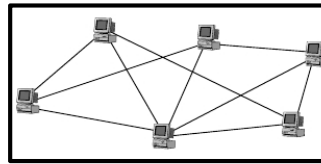
- Advantages – No data **collusion**; cheaper without needing a **hub**.
- Disadvantages – If a cable is **broken**, a **node is off** or **added/removed**, the **network is disabled**.

- Hybrid/tree – **One transmission between any two nodes** with **bus as backbone for stars** (usually).

- Networks – When two or more networks are connected, a **bridge** or **gateway** may be created.
- Advantages – Used when **different types of networks** are required.
- Disadvantages – **Expensive**; **Errors** are more difficult to detect.



- **Wireless network** – Data packets are **converted into RF** and **travel through air** to the **receiving node**. Each device has a **wireless card/adaptor** which contacts the **backbone via the router**.
  - **Advantages** – Cables aren't required; allowing use of **portable devices**.
  - **Disadvantages** – **Disconnections** are more common; **quality of transmission** is not as high; **devices not Wi-Fi-enabled** can't connect; **be intercepted by hackers**.
- **Mesh** – Includes **one or more paths** for each node. It is the topology for **internet** and **requires routers** to direct the packets. It used in **high-speed long distance connections** with few nodes.
  - **Advantages** – Highly fault tolerant as routers can reroute packets.



## THE FUNCTIONS PERFORMED BY THE HARDWARE COMPONENTS USED IN COMMUNICATION SYSTEMS

- **Hubs and switches**
  - **Hubs** – **Multi-port 'dumb' device** that provides a **central connection point** to all nodes. It transmits the **received data to all nodes**, **slowing down** the network. However, it is **cheaper**. It is **half-duplex**, making it **inefficient under high network traffic**.
  - **Switches** – **'Intelligent' device** which sets up a **direct connection** between a sender and receiver. It **identifies the destination** of the data and **sends it**. They can **simultaneously send and receive** data to multiple pairs of nodes. This **reduces network traffic**, making it have **faster data transfer speeds**. Additionally, it has **better security** and **reduces data collisions**.
- **Routers** – **Directs data** between **networks with similar protocols**. A router looks at the **data's destination** and **determines the quickest path**, rerouting around **problem areas**. It can **translate one protocol into another**. This overcomes I.T compatibility issues. It **connects networks** as it reduces **data collision**.
- **Modems** – Modems are used to **connect a computer to their local ISP** to provide **internet access** to a household or network. It connects through **USB, Ethernet** or **wireless connections** to the computer.
  - **Modulation** – **Digital signal** → **analogue signal** for the telephone line
  - **Demodulation** – **Analogue signal** → **digital signal** for computer use.
  - **Asymmetrical digital subscriber line (ADSL)** – **Copper telephone lines** to transmit high-speed data.
- **Network interface card (NIC)** – It is a **small chip** on the **motherboard** that allows for **wireless/wired network**. It **breaks down communication** into binary and **reassembles binary** into more complex data.
- **Mobile/cell phones** – It uses **radio waves** to **T&R data** to and from the **base station in each cell**. They provide **portable access to text and video messaging**, e-commerce and social networking sites.
  - **Cell** – Each base station in each cell is connected to the PSTN either **wire/wireless**. As users **roam** from one cell to another, the **current base station will pass onto the next**
- **Cables** – Transmission medium made of **copper or fibre optic glass**. They use **EM or light pulses**, respectively to **transmit 1s and 0s** from a transmitter to a receiver.
- **Wireless access points** – A **central node (hub)** to **connect wireless nodes to a wireless LAN**. It sends and receives data to all wireless nodes and **requires encryption** for security. The WAP must be **physically connected to the LAN** to allow wireless nodes to access wired nodes on the network.
  - **Advantages** – Devices can be **added without cabling**
  - **Disadvantages** – **Small range** for wireless signal; **suffers interference** from bad weather.
- **Bluetooth devices** – For **short-range transmission**, **replacing cables** that connect portable devices. It is available in mobile **phones, PDAs, computers, etc**. The **physical distance** between Bluetooth devices depend on the **power of the transmitter** in each device. **Error checking** is present in each data packet.



## SIMILARITIES AND DIFFERENCES BETWEEN THE INTERNET, INTRANETS AND EXTRANETS.

- **Internet** – A worldwide packet switched public network based on IP where all data moves between nodes in packets. It is “connectionless” and asynchronous, making data packets arrive out of sequence.
- **Intranet** – A private network maintained by a company or Gov. organisation and based on IP. Lines are leased to allow the amount of data transfer to be controlled by the intranet owners.
- **Extranet** – The extension of intranets to allow access to other users outside the organisation. It allows companies to share their services. The interface between the extranet and intranet must be secure.
  - **Both** – Virtual private networks (VPNs) use the internet infrastructure to provide secure and private connections to a company’s internal network.

Features	Internet	Intranet	Extranet
Purpose	Share information		
Ownership	Not owned by one particular body	Privately owned	Privately owned but can be hosted externally
Network	A world-wide network of computers, servers and LANs	Designate one computer as a server to client computers on a LAN	
Accessibility	Can be accessed by public via an ISP	Can only be accessed by specific users	Like an intranet, but external access also available to specified bodies
Protection	Little protection from viruses	Can be protected from intruders and viruses by security software	

### Other Information Processes in Communication Systems

#### COLLECTING AND DISPLAYING

- **The phone as the collection and display device with voice mail**
- **EFTPOS terminal as a collection and display device for electronic banking** – A keypad/board is used to collect data from the user. The EFTPOS terminal then collects data from the main bank server and displays it

#### PROCESSING

- **Encoding and decoding analog and digital signals** – For successful communication to occur, T&R must be successful. In transmitting, the message is encoded and transmitted over the medium. In receiving, based on the protocols agreed on in handshaking, the message organisation is understood and decoded. Encoding and decoding are essentially organising processes, utilizing ADC and DAC.
  - **Encoding** – Organises data into form suitable for transmission along the communication medium
  - **Decoding** – Changes organisation of received data into form suitable for subsequent info processes.
  - **Digital data** – Data that is represented using whole distinct numbers
    - **Digital signal** – digital data is encoded onto an analogue wave
  - **Analogue data** – Continuous data that usually originates from the real world
    - **Analogue signal** – analogue data is encoded onto an analogue wave.
  - **Analogue data to analogue signal** – E.g. telephone conversations – the system encodes speech and transmits it from sender to receiver.
  - **Digital data to analogue signal** – A series of 1s and 0s is converted into a series of waves. E.g. a modem modulates digital data into an analogue wave and when transmission is received, another modem demodulates it to be suitable for computer use.
  - **Digital data to digital signal** – A series of 1s and 0s is transmitted by sending it through a channel of on and off EM pulses. Nodes in a network can communicate. E.g. Digital data is encoded by a computer and decoded by another computer in a LAN.
  - **Analogue data to digital signal** – The analogue wave is encoded to a series of 0s and 1s through sampling with ADCs (sound cards, TV cards, scanners, cameras).
- **Formation of data packets** – A packet is the unit of data that is routed on a network. The structure depends on the type of packet it is and the protocol used. It has a header (Pg. 7 CS) payload and a trailer

- **Routing** – Selecting paths in a network along which **network traffic is sent**. It is performed for many kinds of networks and **maintains no permanent link**. This **improves security** and is **more efficient**.
- **Encryption and decryption** – For data security. *Pg. 4 IS&DBs*
- **Error checking** – Parity bit check < checksum < CRC

Protocols	Error Check Method	Response to Error
TCP	Checksum (in header of segment)	Only acknowledges the right packets
IP	Checksum (in header fields)	Drop the entire data packet
Ethernet	32-bit CRC (in frames)	Request for packet to be resent

- **Parity bit check** – **Parity bits** are single bits added after the data so the **total number of 1s** is either **even or odd**. During handshaking, even or odd is decided. It is used for **asynchronous transmission**.
  - Errors with corruption of **even number of 1s** are undetectable.
- **Checksum** – Checksum is the count of the **number of bits in a data packet** that is **included at the end of the packet** to allow the receiver to determine whether the packet is erroneous or not. The **accuracy** depends on the **length of the data packet** and **length of checksum**. It can't detect area of the error.
  - If the data sent is all **0s**, then the **checksum is 0** as well. Errors causing empty packets will be **undetectable**. To resolve, the **checksum is reversed to all 1s**.
    - Corrupt packets counted as valid are undetectable.
  - **Reversal of an even number of bits** causes undetectable errors.
- **Cyclic Redundancy Check (CRC)** – CRC is added in the **header or trailer**. With **polynomial division**, the **binary number** (entire message) is divided by a **predetermined number** (generator polynomial). The remainder is the CRC value.
  - It detects **most undetectable errors of checksum** and **all error bursts** less than or equal to the length of the generated CRC value.
  - The **type of errors** detected is **dependent on the generator polynomial used**.

### Issues Related to Communication Systems

- **Security** – Issue of the expanding internet
- **Globalisation** – Large companies can take advantage, moving forward, while smaller companies may not be able to take advantage of this process.
- **Changing nature of work** – May result in isolation, and need for new skills
- **Interpersonal relationships** – Due to electronic communication, misunderstandings may arise.
- **E-crime** – Identity theft, phishing and spam
- **Legal** – Copyright and ownership issues
- **Virtual community** – E.g. online dating sites, where there are major negative aspects

### ISSUES ASSOCIATED WITH THE USE OF COMMUNICATION SYSTEMS

- **Teleconferencing system** – Although communication can occur more freely, this **freedom can be abused**. **Work places must adapt** to teleconferencing as others have. **Interpersonal relationships** may be affected.
- **Messaging systems** – Emails, without **encryption**, can be read by anyone with admin rights in mail servers. This raises issues of **privacy**.
- **E-Commerce** – Issues of **identity theft** and **privacy, redeployment** and **redundancy**.
- **EFTPOS** – The increase of EFTPOS has resulted in **identity theft** (via the cards) and **changing in workplaces** (EFTPOS terminals are expected and organisations without it may feel disempowered).
- **Electronic banking** – Due to electronic banking, there is **changing nature of work** (issues of redeployment, redundancy and retraining). There are issues of **security** and **identity theft**.