* Why need networking ?
- World without boundaries
- Global communities
- human network.

* Networking : Networking refers to the practice of connecting multiple devices and systems together to enable communication, resource sharing and collaboration.

Host : Every computer (device) on a network

End device : An end device specifically refers to the devices at the edge of a network that interact directly with users.

- Data originate
- flows through network
- Data recieve

Ex: Router, switch → host but not end device

All end device → host

not all host → end device

Server : Computers that provide info to end devices.

3 types:
1) Email
2) web
3) ~~Server~~ File

Senven type	What senven uses	what client use	Access what
Email	email senven s/w	client s/w	Email
Web	web senven s/w	browsen s/w	web pages
File	stones componate and usen file	componate and usen file	files

- **Clients**: computons that send neqvests to the senvens to netrieve infonmation.

- **Peen-to-peen Netwonk (P2P)**: P2P netwonk is a distributed netwonk anchitecture in which participants (often nefenned to as peens) communicate and shane nesounces directly with each othen without the need for a centna-lized senven on authonity.

Pros:

- Easy to set up
- Less complex
- Lower cost
- used for simple tasks
  - transfer file
  - share prints

Cons

- no centralized administration
- not secured
- not scalable
- slower performance

Intermediary Device: interconnects end devices.

- regenerate and retransmit data signals.
- maintain info about existing pathways
- notify other device about errors / communication failures.

Ex: Router, LAN switch, multilayer switch, firewall appliance, Router

(5)

Network media: allows message to travel from source to destination

- carries communication

ISOC – Internet Society

IRTF – Internet Research Task Force

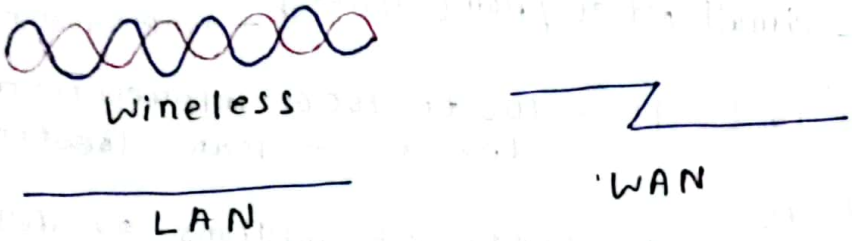
IANA – Internet Assigned Numbers Authority manages → IP Address, Domain Name, TCP/UDP Port Number

(3) types of Network media

Cables (Copper) → Metal wire — Electrical impulses

Fiber optic cable — light

Wireless — specific frequencies of electromagnetic waves



Network / Topology Diagram: use symbols to represent devices within network.

NIC (Network Interface Card): hardware component that enables a computer to connect to a network.

- provide necessary interface between computer and network medium
- establish and maintain network communication

Physical port: physical connecton on a device

Interface: connection point between device and network / another device

Networks types (based on size) — (4)

1) Small home — few computers and internet
2) SOHO - [Small office / Home office] - remote office - corporate network
3) Medium to Large — 100 to 1000 interconnected devices — many locations
4) World Wide — hundreds of millions of devices

* Network infrastructe depends on / vary in terms of:

1) Size of the area covered
2) No. of connected users
3) No. and types of available services
4) Area of responsibility.

EIA - Electronic Industries Alliance
TIA - Telecommunications Industry Association

* Types of Networks (based on area) - (2)

LAN → Network Infrastructure ← WAN

Local Area Network	Wide Area Network
- spans a small geographical area	- spans a wide geographical area
- interconnect end devices in a limited area	- interconnect LANs over wide geo. areas
- administrated by a single org. / individuals	- administrated by 1 or more service providers.
- provide high-speed bandwidth to internal devices	- provide slower speed links between LANs

Internet: worldwide ~~conn~~ collection of interconnected LANs and WANs.

LANs use WANs
WANs use copper wires / Fiber optic cable / wireless transmissions

to connect with each other.

IETF - Internet Engineering Task force
ICANN - Internet Corporation for Assigned Names and Numbers
IAB - Internet Architecture Board
→ maintain structure of internet

collection of LANs and WANs

Intranet: private network accessible only to authonized individuals within an org. (only company)

Extranet: accessible to

- authonized individuals within an org.
- company
- suppliens
- collaborators
- customens can access
- external users outside org.
  - Limited permission of access

Home and Small office (SOHO) Internet Connections

1) **Cable:**
   - high bandwidth
   - always on
   - provided by cable tv service provider

2) **DSL** (broad band digital subscriber Line)
   - high bandwidth
   - always on
   - runs over a telephone line

3) **cellular**
   - use cell phone network

4) **Satelite**
   - no internet service providers needed
   - rural areas

ITU-T → International Telecommunications Union Telecommunication Standardization Sector

5) Dial-up telephone (modem)
   - low bandwidth
   - not expensive

Business internet connections
- higher bandwidth
- dedicated connection
- managed services needed

1) Dedicated Leased Line
2) Ethernet WAN
3) DSL (Ex: SDSL (Symmetric))
4) Satellite

Converged networks: deliver data/voice/video over the same network infrastructure
- uses same set of rules and standards

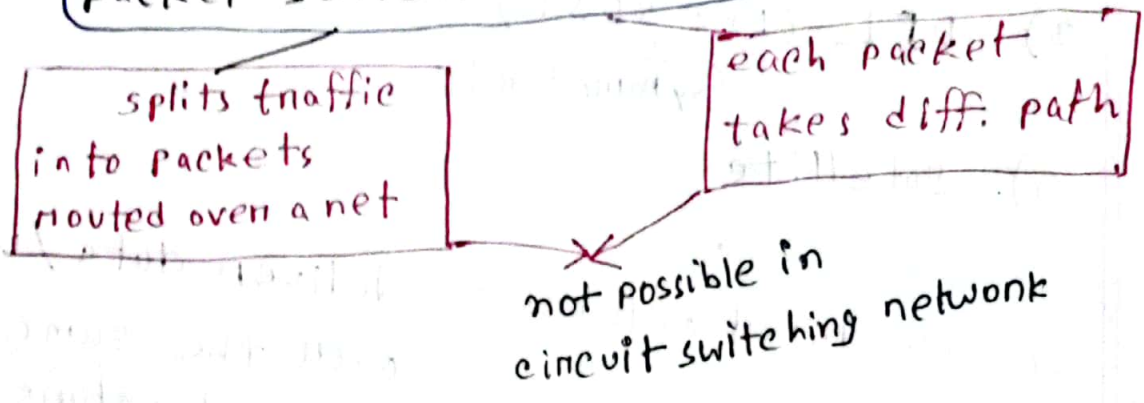
Network Architecture: refers to the technologies that support the infrastructure that moves data across the network.

* characteristics of Reliable Network (4)
1) Fault tolerance
2) Scalability
3) QoS (Quality of Service)
4) Security

1) Fault tolerance: refers to the network's ability to limit the impact of a failure by limiting the number of affected devices.

how works? – multiple paths needed

– provide redundancy by implementing a packet switched network



why redundancy needed?

→ when a link/device fails

→ allow alternative path

→ unaffected network

2) Scalability: - expand networks quickly
- support additional devices to be connected to network
- doesn't affect performance of services
- follow accepted standards/protocols

3) QoS: primary mechanism used to ensure reliable delivery of content for all users
- managed by routers
- set priorities — web page - lower priority
voice over call - higher priority
- need smooth/uninterrupted service

Ex: Live video - pause and break continuously
- bandwidth demand > available
- QoS not configured

4) Network security : (2 types)

Network infrastructure security	Information security
– security of network devices	– protect info.
– prevent unauthorized access to device	

3 goals: 1 Confidentiality 2 Integrity 3 Availability

* Network Trends (4)

1) BYOD – Bring Your Own Device

allows end users to use their own devices which give them more opportunities and greater flexibility to access information.

2) Online Collaboration: work with others over network

Tool: Cisco WebEx Teams

– joint project

send msg post image etc

3) Video Communication:

Tool: Cisco TelePnesence Powens

4) Cloud Computing:

- stone pensonal files / backup data on senvens oven intennet
- smallen companies
  - not affond own data centen
  - lease senven and stonage from langen data centen ong.

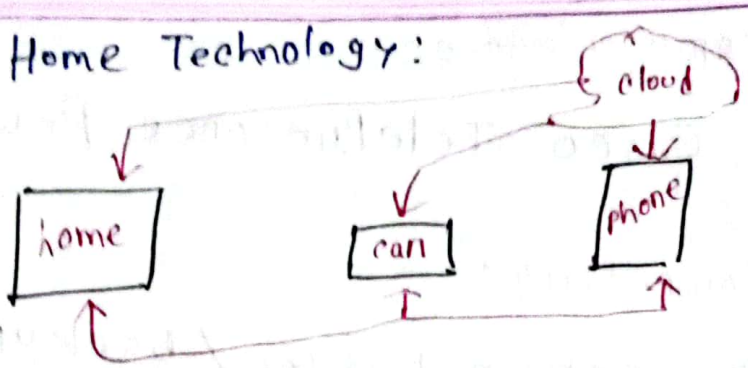
(4) types

1) Public: available to public
   - paid on free
2) Pnivate: fon specific ong
3) Hybnid: combo of 2 on mone types of clouds
   - some pant custom
   - " " public

Each pant ~~अलग~~, but connected using the same anchitecture

4) Custom: built fon specific ong.

Smart Home Technology:



Powerline Networking:

- when wireless communication not possible
- device connect to LAN
- use standard powerline adapter.

Wireless Broadband: home / small business use

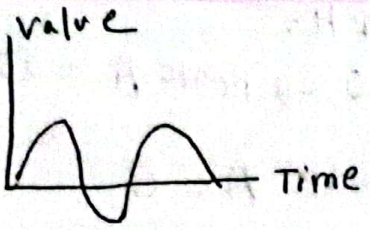
- antenna is installed

WISP — Wireless Internet Service Provider

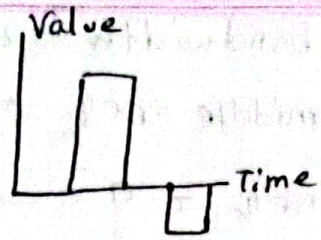
- is an ISP that connects user to designated access points or hotspots.

1 character — 8 bit

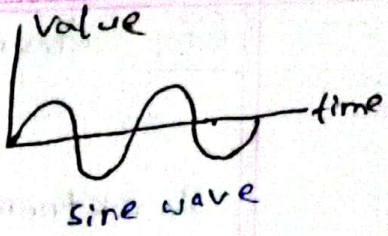
Chap — 3



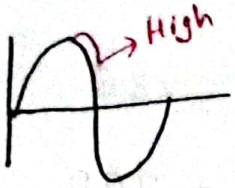
Analog Signal

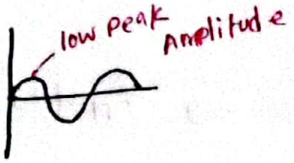


Digital signal



sine wave



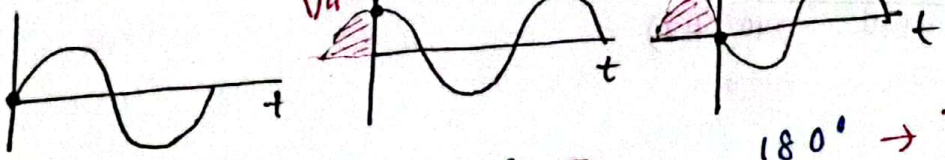


Period, $T = \frac{1}{f}$ → Frequency
(s) (Hz)

Wavelength, $\lambda = vT$
(m) $= \frac{v}{f}$

v → propagation speed

Phase: (same amplitude and f) with



phase = 0° → T=0

0 amplitude
↓
increase

not shifted

90° → T/4

peak amplitude
↓
decrease

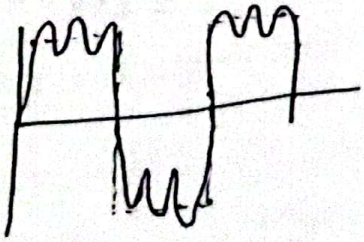
shifted to left by 1/4 cycle

180° → T/2

0 amplitude
↓
decrease

shifted to left by 1/2 cycle

Composite signal.



* Bandwidth, $B = f_H - f_L$
* Medium frequency, $f_0 = \frac{f_H + f_L}{2}$
* No. of bits per level $= \log_2$ (no. of levels)
* Bit rate = amount of data / time

Ex: Given, bandwidth = 200 kHz

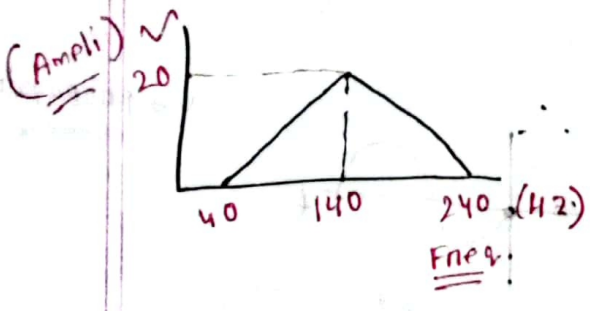
middle freq = 140 → peak A = 20 V

2 extreme freq = ? → peak A = 0.

(both low and high) Find freq of them.

Soln: $\frac{f_H + f_L}{2} = 140 \rightarrow f_H + f_L = 280$

Again, $f_H - f_L = 200$



$\therefore f_H = 240, f_L = 40$ Hz

Ex: download text document at the rate of 100 pages per minute, where

1 page → 24 line

1 line → 80 chars.

Soln:

bit rate = (100 × 24 × 80 × 8)

= 1536000 bps

= 1.536 mbps

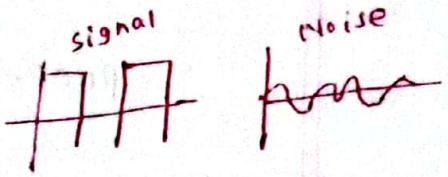
For noiseless channel,

* Bit rate = 2 × bandwidth × $\log_2$(level) → Nyquist theonem
* Bit length = propagation speed × bit duration
* Bandwidth (Hz or bps): $B = \frac{f}{2}$ (Harmonic 1st)

$B = \frac{3f}{2}$ (3rd harmonic)

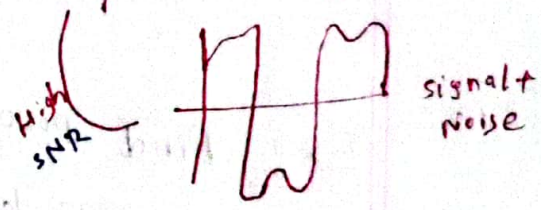
$B = \frac{5f}{2}$ (5^{th})

* decibel: $dB = 10 \log_{10} \frac{P2}{P_1}$
* Signal to Noise Ratio: $SNR = \frac{\text{avg. signal power}}{\text{avg. noise power}}$



* $SNR_{dB} = 10 \log_{10}(SNR)$

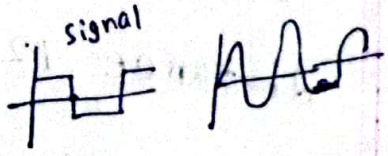
high low



* when noiseless → ideal/ not possible in real

$SNR = \frac{\text{signal power}}{0} = \infty$

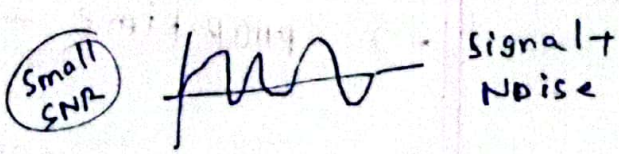
$SNR_{dB} = 10 \log_{10}(\infty) = \infty$



* For noisy channel (Shannon capacity)

$C = B \log_2(1 + SNR)$

$= B \times \frac{SNR_{dB}}{3}$



* Transmission time (s) = $\frac{\text{packet length (bits)}}{\text{Bandwidth (bps)}}$ (message size)

* Latency (s) = processing time + queuing time + transmission time + propagation time

$t = \frac{s}{v} = \frac{\text{dist.}}{\text{prop. speed}}$

* Throughput = am. of data / time

* bit length = $v \times$ bit duration

$= \frac{s}{t} \times$ bit u

s → distance

t → propagation time

$\therefore$ prop. time = $\frac{s \times \text{bit duration}}{\text{bit length}}$

Ex: Find propagation time and transmission time for a 2.5 kbyte message, bandwidth = 1 Gbps, distance 12000 km, speed = 2.4×10^8 m/s

→ prop time = $\frac{\text{dist.}}{\text{prop. speed}} = \frac{12000 \times 10^3}{2.4 \times 10^8} =$ s

trans. time = $\frac{\text{message size}}{B} = \frac{2.5 \times 10^3 \times 8 \text{ bits}}{1 \times 10^9 \text{ bps}} =$ s

Analog signal: continuous waveforms where the signal's amplitude, frequency and phase can take on any value within a given range.

Digital signal: a signal that represents data as a sequence of discrete values.

Periodic signal: a signal that repeats its waveform over time at regular intervals. (T fixed)

Non-periodic signal: a signal that doesn't repeat its waveform over time in a regular interval.

Peak amplitude: The peak amplitude of a signal is the absolute value of its highest ~~ent~~ intensity, proportional to the energy it carries.

Period: refers to the amount of time, a signal needs to complete 1 cycle.

Frequency: refers to the no. of periods in 1 s.

Phase: describes the position of the waveform relative to time 0.

Wavelength: refers to the distance between two consecutive points of the same phase on a wave.

Single frequency sine wave → make sound
→ not send data

Composite signal: A signal made of many simple sine waves with diffenent f, A and phases.

periodic/non periodic
T → same or diff.

periodic composite signal —decomposition→ discrete frequency (series of signals)

non-periodic → continuous frequency (combo of sine waves)

Bandwidth: range of frequencies contained in a composite signal.

Bit rate: no. of bits sent in 1 s.

Bit length: distance one bit occupies on the transmission medium.

Broadband Transmission/ modulation: digital signal → analog

Decibel: measures the relative strengths of 2 signals on 1 signal at 2 different points.

→ energy loss
negative → signal decreases (attenuated)
positive → " amplified → energy gain

Distortion: means that the signal changes its form/shape.

condition
- composite signal
- different f

Impairment: the signal beginning of medium ≠ " end " "

3 cause
- Distortion (form change)
- Attenuation (energy loss)
- Noise

Throughput: how fast send data (bps)

Delay: refers to the time it takes for a packet to travel from source to destination

Transmission time: time to transmit a data packet over a network link.

Propagation time: refers to time it takes for a signal to propagate through a physical medium.

Queuing/waiting time: time a packet spends in a queue before it can be transmitted.

Processing time: time needed by network devices to process and handle packets.

Communication Elements: [3]

1) senden
2) Receiven
3) media

Protocols: nules that communication follows.

↳ Requinements: (4)

1) An identified senden and neceiven
2) common language and gnamman
3) Speed and timing of deliveny.
4) confinmation on acknowledgement

have –
1) own function
2) " fonmat
3) " nules

Common computen protocols agneement's nequinements: (5)

1) message encoding
2) message fonmatting and encapsulation
3) " size
4) " timing
5) " delivery options (3)

- Flow ctnl – nate of data transmission / speed / how much info
- Response timeout – how long wait when no neply neceived
- Access method – determines when msg send

Message has specific fonmat
depends on
– type of msg
– deliveny channel

Unicast – 1 to 1 | Mulicast – 1 to many | Bnoad – 1 to all
IPV4 network

message → (converted) bits → (encoded) light/ sound/ electnical impulse → (decode signals) destination

lossy
interprete msg

Collission: more than on device send traffic at the same time → message conupted

reverse

Encoding: process of converting information into another acceptable form for submission

Decoding: process of interpreting and extracting meaningful information from encoded data.

More about protocols:

Protocol Data Unit (PDU) → steps

Data segment packet ↓ Frame Bits ↓ (All 5 are top to bottom)

Types: (4)

1) Network communication: how many device communicate
2) " Security: secure data, authentication, integrity encryption
3) Routing: (exchange route info → compare path info → select best path
4) Service Discovery: auto detect service

6 functions:

1) Addressing - identify senden and receiven
2) Reliability - guaranteed delivery
3) Flow Control - ensure data flow at efficient rate
4) Sequencing - uniquely labels each transmitted segment of data
5) Error Detection - determines if data corrupted
6) Application Interface - p2p communication
   ↓
   Process to process

4 Layers of TCP/IP

diffenent protocols: (message delivery format)

* HTTP — web server → web client → App layer
* TCP — individually handle → Transport layer
* IP — sender → receiver (globally) → Internet layer
* Ethernet — NIC → NIC (same LAN) → Network Access Layer

2 layers: - Higher
- Lower → move data
→ provide service to higher layers

Protocol suite: set of ~~procols~~ protocols that work together to provide network communication and services.

* TCP/IP — most common
— maintained by IETF
* OSI — developed by ISO and ITU
* Apple Talk — developed by Apple Inc. released
* Novell Netware — developed by Novell Inc

middle ↗

OSI Model Layer (7)	TCP/IP Protocol suit	TCP/IP Model Layer (5)
7. Application – contains Protocols used for P2P communication		
6. Presentation	HTTP/DNS/ DHCP/FTP	Application
5. Session		
4. Transport	TCP/UDP	Transport
3. Network	IPv4/IPv6/ ICMPv4/ICMPv4	Internet / Network
2. Data Link – exchange data frame method	Ethernet/WLAN/ SONET/SDH	Network Access
1. Physical		

Right sign ekhn

TCP - connection oriented
UDP - connectionless

~~Data Bits (0+1)~~ Physical, Data Link

* Segmenting: process of breaking up messages into smaller units

2 pros →
1) speed increase
2) Efficiency ↑

* multiplexing: process of taking multiple streams of segmented data and interleaving them together.

* Sequencing: process of numbering the segments so that the message may be reassembled at the destination.

TCP does this

আবার একত্রিত করা

* 6 benefits of using layered model:
1) modular design 2) Interoperability 3) Abstraction 4) Easy troubleshooting
5) standardization and compatibility 6) Easy implementation

Application → Data

Transport → Segment Header | Data

Internet → Packet Header | Seg Header | Data

Data Link → Fname Header | Pack Head | Seg Hea | Data | Fname trailer

Physical → Data (0 and 1 only)

Left ⇒ TCP/IP

Right ⇒ Data Encapsulate and De-encapsulate

উপর থেকে নিচে → Encapsulate

নিচ থেকে উপরে → De-encapsulate