

Chapter 2: Communication and networking technologies.

Networking devices:

- Hub: Connects devices and forwards data from one port to every port.
- Switch: Connects devices and forwards data from one port to another specific port.
- Router: Directs data between networks.
- Gateway: Connects networks with different protocol.
- Bridge: Connects networks-segments with same protocol.
- Network Interface Card(NIC): Available on end-sytem. Has ports for LAN.
- Repeater: Receives signal and generates a new full-strength signal.
- Wireless Access Point(WAP): Central Device in WiFi LAN. Needs WNIC.

Network based on size

- LAN(Local area network): Small, owned by an organization or company within a site or branch, single switch/hub. Eg. Office network.
- MAN(Metropolitan area network): Larger, over longer distance. Eg. Traffic control CCTV network.
- WAN: Large organization, spread over large distance. Eg. Internet.

There isn't a fixed rule for LAN, MAN and WAN.

Network Architecture/Model

- Client-Server Model: Some computers provide service(servers) and some request and use features(clients).
 - Thin client: Client just takes input and shows output. Server runs application.
 - Thick client: Clieent can do some processing but relies on server for **heavy** work.

Another type is peer to peer where each computer has equal responsibility. (Discussed in paper 3.)

- Peer to peer model is often used for file sharing where each peer(computer) can send and receive file from each-other. But if security and control is of main priority, client-server is used.

Server can be: File server, DNS server, etc.

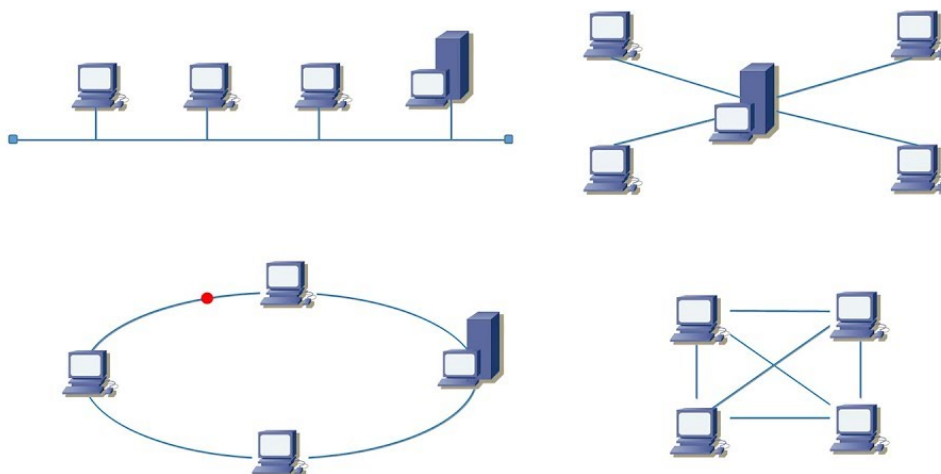
Transmission modes:

- Simplex: One way data transfer
- Half-duplex: Both way but not simultaneously
- Full-duplex: Both way simultaneously
- Unicast: One-to-one communication
- Multicast: One-to-many communication
- Broadcast: One-to-all communication

Network Topologies

Network topology is the layout of computers in LAN.

- Bus topology: A central link(bus) with several drop lines to connect to end-systems.
 - Advantages:
 - Simple to setup
 - Simple to add nodes
 - Disadvantages:
 - If the central link fails, network fails. (But not if one drop line fails or node fails)
 - Broadcast
- Mesh topology: Each pair of computer is connected.
 - Advantages:
 - Fast
 - No single point of failure.
 - Disadvantages:
 - Lots of wires
- Star topology: Each end-system is connected to a central hub or switch(mostly switch).
 - Advantages:
 - Adding and removing nodes is easy
 - Central device can be used to connect to internet(or other network).
 - Disadvantages:
 - Single point of failure
- Ring topology: Connected in a ring, data flows in one direction(clockwise or anti-clockwise)
 - Not used as it has single point of failure, privacy issue, need to disrupt network to add device.



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[
    bus, star,
    ring, mesh
]
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Hybrid topology is also used.

Transmission media

- Wired:
 - Twisted pair (RJ-45 connector)
 - Co-axial (BNC connector)
 - Fibre-optics (SC connector)

	Twisted pair	Coaxial	Fibre-optic
Cost	Lowest	Higher	Highest
Bandwidth or data rate	Lowest	Higher	Much higher
Attenuation at high frequency	Affected	Most affected	Least affected
Interference	Worst affected	Less affected	Least affected
Need for repeaters	More often	More often	Less often

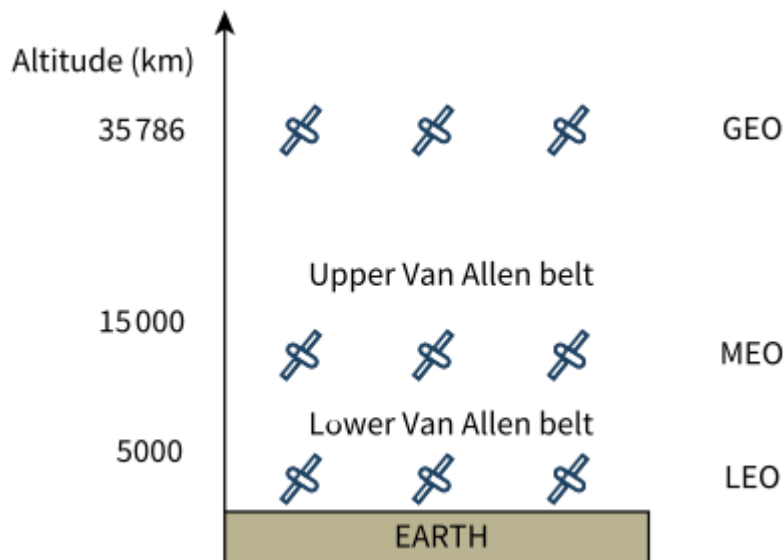
- Wireless:
 - Radio
 - Microwave
 - Infrared

Frequency range	Radio 3kHz–3GHz	Microwave 3–300 GHz	Infrared 300 GHz–400 THz
Bandwidth or data rate	→		
Attenuation (mainly due to rain)	→		
Need for repeaters	→		
Directional focusing capability	→		
Penetration through a wall	←		
Interference	There is no systematic trend		

Radio, microwave and infrared are all electromagnetic radiation with different frequency. Higher frequency => lower penetrative power.

- Wired for faster, reliable, less interference.
- Wireless for ease of use (mostly).
- Satellite:
 - Geostationary Earth Orbit: For long distance telephone and network communication. (3 for global coverage)
 - Medium Earth Orbit: GPS. (10 for global coverage)

- Lower Earth Orbit: Supplement mobile phone networks. (50 for full global coverage)



Van allen belts are areas in atmosphere with high levels of electrically charged particles, which interfere with satellite.

Ethernet and Collision.

Ethernet is wired standard(IEEE 802.3) which is primarily focused on LANs.

- Shared medium => if two end-system transmit at once, it can result in **collision**.
- CSMA/CD(Collision Sense Multiple Access with Collision Detection):
 - Check voltage on medium for activity
 - If activity, wait for random time.
 - If no activity, start transmission
 - Continuously check for collision
 - If not detected, continue sending and done.
 - If detected, stop, transmit jamming signal(high voltage) and try again after random time.

Modern Ethernet is switched with buffering capacity, which doesn't require CSMA/CD.

IP Addressing:

Internet Protocol addressing is used to define from where and to where data is being transmitted.

- IPv4 addressing:
 - uses 32 bits => 2^{32} different addresses.
 - Not enough.
 - In original scheme, different classes existed with different number of IPs.
 - CIDR(Classless interdomain routing) retains concept of netID and hostID but doesn't enforce number of bits like in classful approach.
 - Subnetting allows for organization to take a larger class and split it into smaller parts.
 - Network Address Translation(NAT): Organizations use special IPs for private network and NAT box translates it. This is abstracted.

Class	Class identifier	Number of bits for netID	Number of bits for hostID
Class A	0	7	24
Class B	10	14	16
Class C	110	21	8

Dynamic IP changes regularly for device whereas Static doesn't. (and static is costly.)

- IPv6:
 - 128 bits is used
 - Will not be depleted.
 - Still not being used everywhere.

Domain Names

People can remember words and letters(URL), IP addresses are numbers. Domain Name Service/System(DNS) server translates that.

- DNS is also hierarchical.
- Looking up IP based on domain name is called **name resolution**.

Terms:

- ISP: Internet Service Provider. Provides internet connection.
 - PSTN: Public Switched telephone network. **Dial-up** connection that used telephone wire and modem.
 - WWW: World wide web. Distributed application which is available on the internet.
 - Cloud computing: Accessing computing service via internet. **Private cloud** is established by a company by either taking full responsibility, outtsourcing partially or fully. **Public** cloud is created, managed and owned by third party service provider.
 - Cloud computing services include infrastructure, platform or software.
 - Bit streaming:
 - On demand: Incoming data are buffered and received as they are **used**
 - Real time: live transmission
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