Chapter 1

☆ Lecture 1

- hosts: clients & servers
- transmission rate: bits per second
- frequency Division multiplexing (FDM): different channels transmitted in different frequency bands.
- hybrid fiber coax: (HFC) 40 Mbps – 1.2 Gbps downstream transmission rate, 30–100 Mbps upstream trans. rate.

} Cable based access

 # Lecture 2

- packets have length (L) of bits & transmission Rate (R)

} link capacity /bandwidth

- packet transmission Delay (D_{trans}) = $\dfrac{L \text{ (bits)}}{R \text{ (bits/sec)}}$

- bit propagates between transmitter/receiver pairs
- physical link: what lies between transmitter & receiver
- guided media: signals propagate in solid media (copper, fiber)
- unguided media: signals propagate freely (radio)

Physical medias ⟹

- Twisted Pair (TP): Two insulated copper wires
- (a) Coaxial cable: ① two concentric copper conductors.
  - ② bidirectional
  - ③ broadband: multiple frequency channels on cable. 100's Mbps channel
- (b) fiber optic cable: ① glass fiber carries light pulses
  - ② high speed operation point to point transmission (10's -100's Mbps)
  - ③ low error rate
- (c) wireless radio: ① signal carried in electromagnetic spectrum
  - ② no physical connections, wires
  - ③ propagation environment effects: reflection/obstruction by objects / interference & noise

① - Radio link types:-
- wireless LAN (wiFi) : 10's-100's Mbps , 10's of meters
- wide are (4G cellular) : 10's Mbps , 10 km
- bluetooth : cable replacement, short distances & limited rate
- terrestrial microwave:- point to point, 45 Mbps channels
- sattelite : 45 Mbps per channel , 270 msec end-end delay.
  geosynchronous versus low earth orbit.

* Packet switching : hosts break application layer messages to packets and they get forwarded from one router to the next on path from source to destination & they get transmitted at full link capacity.

* Network core functions
  ① forwarding (local) : moves arriving packets from current router to router appropriate output link. (the destination address arriver as the packets header)
  ② Routing (Global) : determine source-destination paths taken by packets (routing algorithims)

* entire packed should arrive at router to be transmitted on next link.

* Packet queuing & loss :- happens when arrival rate exceeds & transmission rate
  - packets start queuing and wait to be transmitted to output links.
  - if memory (buffer) in routers fillup packets can be dropped

-circuit switching :- ① no shoring - dedicated resources
② the segment idles if not used by call
③ mostly used in telephone companies

Types
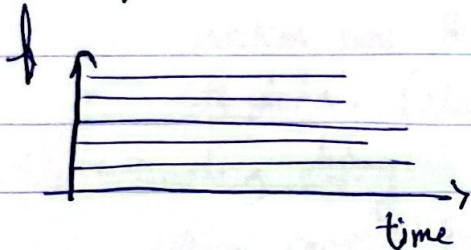
①
- FDM
frequency division Multiplexing
• electromagnetic frequencies
  divided into narrow frequency
  bands.

• each call has its own frequency
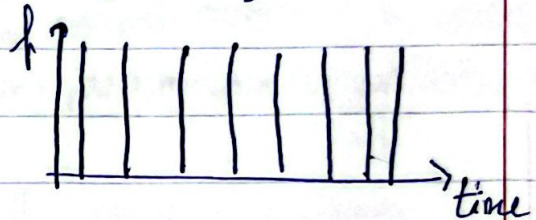 band and can transmit max
  rate of that band

time

②
TDM
Time Division Multiplexing
• time is divided
• each call has its own
  time slot
• can transmit at max
  rate of wider frequencies
  but only during its time slot

time

• packet switching: pros - great for bursty data
                         - shares resources
                         - simpler, no call setup
              cons   - congestion is possible:
                         packets can be delayed
   and even lost due to
                         buffer overflow.
                       - needs protocols for reliable
                         data transfer & congestion
                         control

Internet structure

- there exists local & global transit
  ISP (Internet server providers)
- costumer & provider ISPs have an economic agreement
- IXP (Internet exchange point) is to
  exchange data between to diff. ISPs that
  are in two diff global ISPs.

- packets queue in router buffers.
- when rate of input link exceeds
  output link capacity -> packet loss

Tier 1 ISPs
↳
IXP
↳
Regional ISP
↳
access ISP
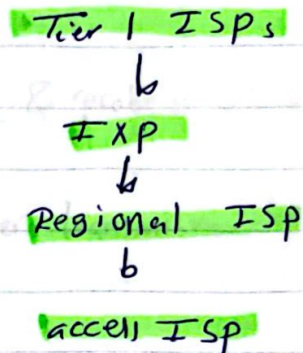
Delay types

① transmission Delay: Ptrans
   when the packet is dropped from the device to the link. (L/R)

② Processing delay:
   makes sure the packet has arrived completly & checks
   its data. (check bit errors, determines output link, < msec)

③ queuing delay:
   delay caused by waiting for previous packets
   to be transmitted to the link. (depends on congestion)

④ Propagation delay: dprop
   delay of packets travelling through the link to
   the destination. $d_{prop} = d/s$
   ↗   ↘ 2×10^8
   link
   lenght

$$d_{nodal} = d_{pross} + d_{queue} + d_{trans} + d_{prop}$$

Lecture 4

- **packet queuing delay**

  a : avg packet arrival rate

  La/R ⤳ ≈0   small queue delay

  ↝ →1   large // //

  ↘ >1   out of service

- **traceroute program** : measures delay from source to router

  along end to end internet path towards destination.

- **Note :**   s 60   why delays decrease ??

  - in tracerouting * * * means no response & probe's lost & router
    is not replying.
  - the larger the packet size is, the larger transmission
    delay is

- **throughput** : rate at which bits are sent from sender
  to reciever

  it can be insti. or avg

- **bottleneck link** : link on end-end path that constraints
  end-end throughput

- ~~Exs~~ **malware causes :**
  - **virus** : self replicating infection by exculing
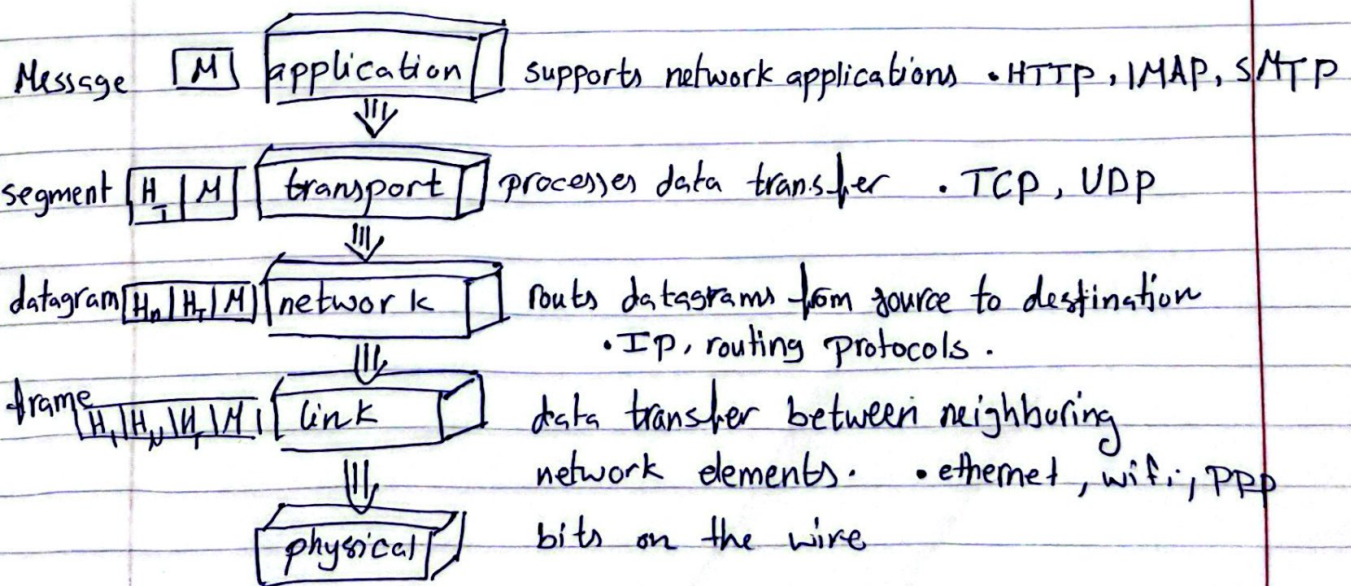   an object
  - **worm** : self replicating infection by passively
    recieving object that gets itself executed

- **spyware malware** : records keystrokes, website history,
  uploaded info to collection site.

Lecture 5

- botnet : group of devices (hosts) that are infected are enrolled and used for spam or (DDOS) Distributed denial of service

- DOS: attackers make resources (servers, bandwidth) unavailable to legitimate traffic by overwhelming resources with bogus attackers traffic
  (users not attackers)

* packet sniffing: happens in broadcast media (ethernet, wifi) where promiscuous network interfaces read/record all packets passing by.

- wireshark software is a free packet sniffer

- IP spoofing : send packets with false source address.

* why is layering used in networks ??
  - explicit structure allows identification of relationships of complex system's pieces.
  - modularization eases maintenance & updating of system

- internet protocol stack

Message	[M]	application	supports network applications · HTTP, IMAP, SMTP
segment	[H_t | M]	transport	processes data transfer · TCP, UDP
datagram	[H_n | H_t | M]	network	routs datagrams from source to destination · IP, routing protocols.
frame	[H_l | H_n | H_t | M]	link	data transfer between neighboring network elements. · ethernet, wifi, PPP
		physical	bits on the wire

- in Encapsulation
  - source & destination go through all layers
  - switches go through physical & link
  - routers go upto Network

- ISO/OSI have two layers in addition to the one in internet protocol stack:
  1. presentation: allows applications to interpret data, (encryption, compression, ...)
  2. session: synchronization, checkpoints, recovery of data exchange.