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)

- packet transmission Delay (D_{trans}) = $\frac{L \text{ (bits)}}{R \text{ (bits/sec)}}$ (link capacity / bandwidth)

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

Physical media ⟹

- 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

ⓓ - 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) : determines 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 sharing - dedicated resources
(2) the segment idles if not used by call
(3) mostly used in telephone companies

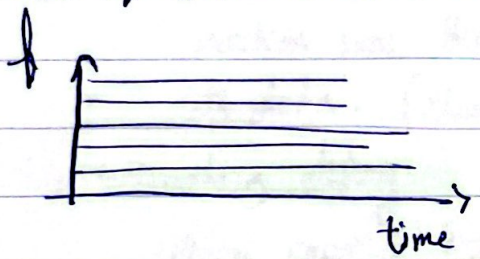
Types

(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

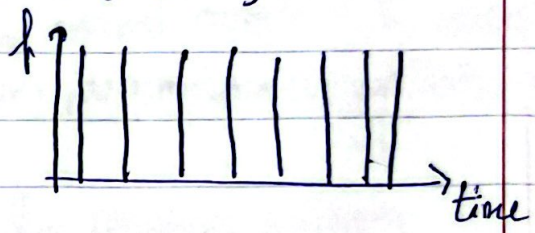


(2)

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



- 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
↓
accesi ISP

- Delay types

(1) transmissionDelay: 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. $d_{prop} = d/s$ (d: link lenght, s: 2×10^8)

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

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 traceroute * * * 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 inst. or avg
- bottleneck link : link on end-end path that constraints end-end throughput

- Ex: malware causes :
  - virus: self replicating infection by exciting 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

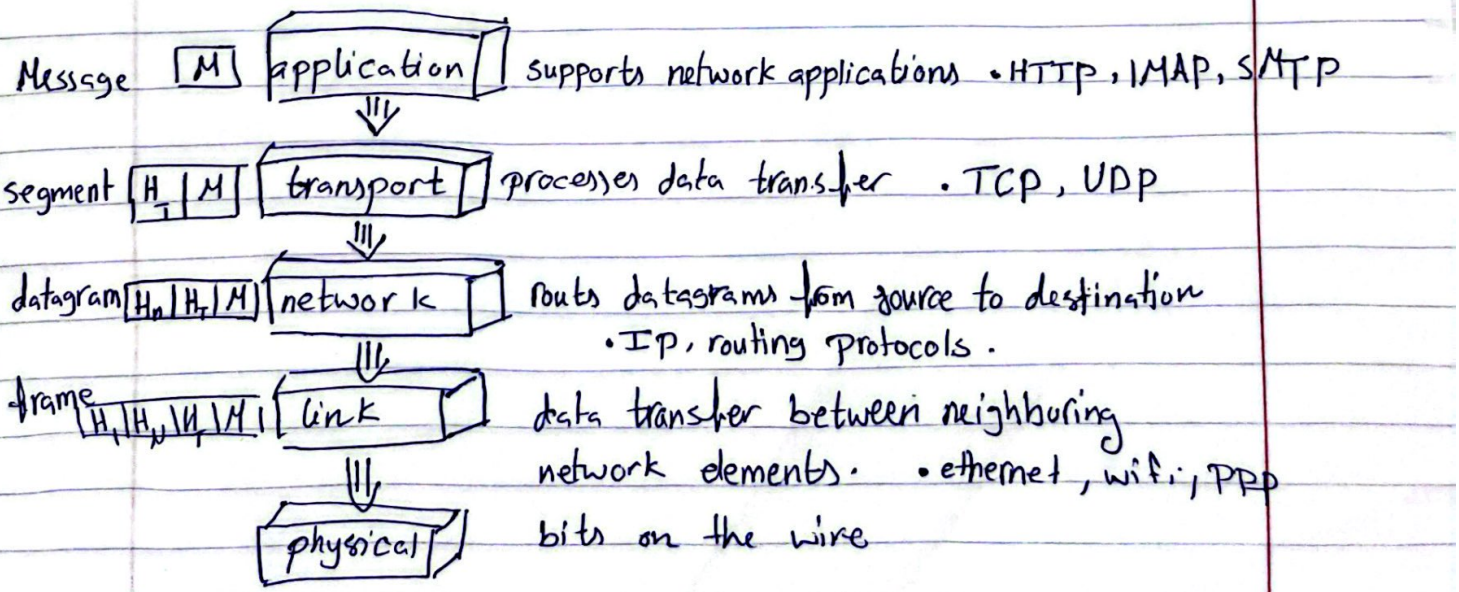
- DOS: attackers make resources (servers, bandwidth) unavailable to legitimate (users not attackers) traffic by overwhelming resources with bogus traffic

* 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



- 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.