Computer Networks

- Internet
- LAN, WAN
- Router, switches
- RFC (Internet Engineering task Force)
- Packets
- ISP
- Bandwidth
- throughput
- Protocol

Protocol Layering:

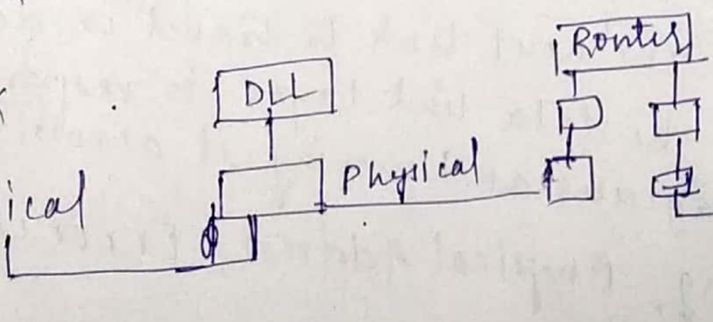
Airplane trip example:

Ticket (purchase)
↓
Baggage (check)
↓
Gates (load)
↓
Runway take off
↓
Airplane routing ⟶

Ticket (complain)
↑
Baggage (claim)
↑
Gates (unload)
↑
Runway landing
↑
Airplane routing

TCP/IP Protocol suite

Application
↓
Transport
↓
Network
↓
Data link
↓
Physical



Application
↑
Transport
↑
N/W
↑
DLL
↑
Physica

Application Layer :-

* Message communication (exchange)
* communication is between two programs running
* Protocols : HTTP, SMTP, FTP, DNS, TELNET.

Transport Layer :-

* End to End communication between two processes.
* Transport layer gets data from application layer and encapsulate it with transport layer header.
* Port number is used for process to process delivery.
* Protocol : TCP , UDP (User datagram protocol)
* Difference between above two is handshaking and reliability.

Network Layer:

* Host to Host communication through IP addresses.
* The router in the path are choosing the best route for packet.
* Best effort delivery
* Protocol : IP (Internet Protocol).
* No flow control, no congestion control, no error control.
* ICMP, IGMP help IP in its delivery.

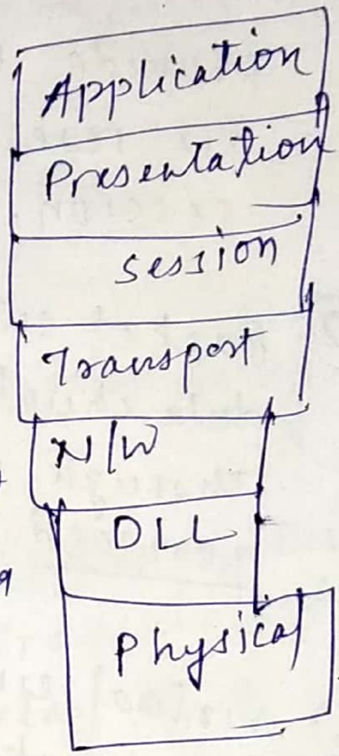
Data Link Layer :-

* When the next link to travel is determined by the router, the data link layer is responsible for taking the datagram and moving it across the link.
* Framing, Physical Address, Error control, Flow control

Physical Layer -

* Responsible for carrying individual bits in a frame across the link.
* Responsible for actual physical connection.
* functions: Bit rate control, Transmission mode, physical topologies.

OSI Reference Model



OSI layer

session layer:-

* Responsible for establishment of connection maintence of session, authetication.
* synchronization - This Layer allows a process to add checkpoints which are considered as synchronization points into the data. These synchronization point help to identify the error so that the data is re-synchronized properly.

*. Dialog control: The session layer determine which device will communicate first & amount of data that will be sent.

Presentation layer:

* Translation: For ex., ASCII to EBCDIC
* Encryption / Decryption
* compression.

Switching (Network core)

There are two fundamental technique to move data through a network of links and switches;

① circuit switching. ② Packet switching

circuit switching :- In circuit switching, the resources needed along a path (buffer, transmission rate) to provide communication b/w the end systems are reserved for the duration of the communication session.

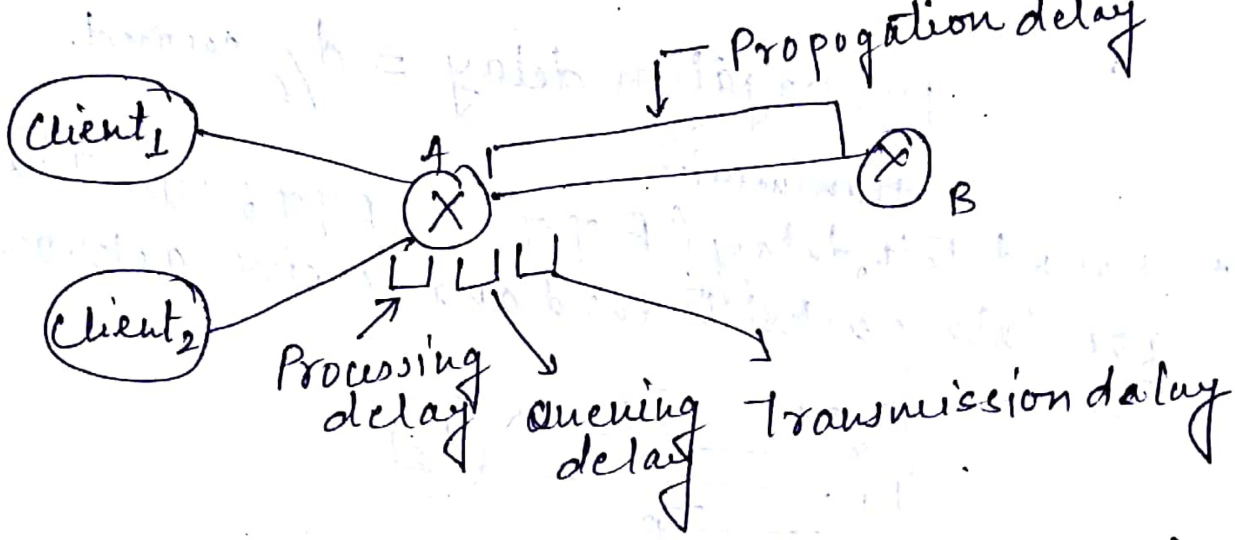
② Packet switching : source breaks each message into data chunks, called packets. Each packet travel through communication links. It uses <u>store and forward mechanism.</u>

Virtual circuit switching : Virtual circuit switching

3) Virtual circuit switching is a packet switching technology whereby a path is established b/w source and the final destination through which all the packets will be routed. This path is called virtual circuit because to the user, the connection appears to be a dedicated circuit. However the parts of the same path may also be sharing other communication

Types of delays:- (Packet switching N/w)

① Processing Delay: The time required to examine the packet's header and determine where to direct the packet is part of processing delay. The processing delay can also include other factors, such as time needed to check for bit level error in the packet.



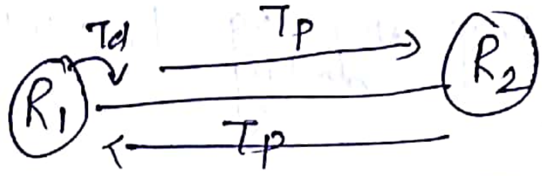
② Queuing delay: At the queue, the packet experiences a queuing delay, as it waits to be transmitted onto the link. The length of queuing delay of a specific packet will depend on the number of earlier arriving packets that are queued and waiting for transmission onto the link.

③ Transmission delay: This is the amount of time required to push all the packets bits into the link. Suppose length of packet is L bits, and transmission rate of the link from router A to B is R bits/sec. then transmission delay = L/R sec

④ Propagation delay: The time required to propogate from the beginning of the link to router B is the propagation delay. The propagation speed depends on the physical medium of the link. If ~~is~~ d is distance between two routers and s is propagation speed then

$$\text{propagation delay} = d/s \text{ second.}$$

* Round trip transmission delay (RTT): RTT is the time required for data packet to send and receive acknowledgement



$$\boxed{RTT = T_d + 2 * T_p}$$

* Bandwidth delay product: The amount of data that can be in transit in the network. It is the product of the available bandwidth and the latency or RTT.

$$\boxed{BDP = \text{Bandwidth} \times RTT}$$

(Q) Calculate the total time required to transfer a 1.5 MB file in the following cases, assuming a RTT is 80 ms, a packet size of 1 KB data, and initial 2*RTT of handshaking before data is sent:

ⓐ The Bandwidth is 10 Mbps and data packet can be sent continously.

(b) The bandwidth is 10Mbps but after we finish sending each data packets we must wait two RTT before sending the next packet.

(a) Transmission time $= \frac{\text{Packet size}}{\text{Bandwidth}} = \frac{1.5 \times 2^{20} \times 8}{10 \times 10^6}$

$= 1.25s$

Total time $= 2 * RTT + T_d + T_p$

$= 2 \times 80ms + 1.25s + 40ms$

$= 1.45s$

(b) No of packets $= \frac{1.5 \times 2^{20} \times 8}{1 \times 2^{10} \times 8} = 1536$

Total time $= 1535 \times 2 \times 80ms + 1.45s$

$= 247.05s$

(2) Suppose a 128 kbps point to point link is setup between earth and a rover on mars. The distance from the earth to mars is 55 Gm, and data travels over the link at the speed of light 3×10^8 m/s.

(a) calculate minimum RTT of link.

(b) Calculate the delay bandwidth product.

(c) A camera on the rover takes picture of its surrounding and sends these to the earth, How quickly can it reach mission control on earth? Assume each image is 5Mb in size.

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Sol^n →

(a) Propogation delay: $\frac{55 \times 10^9}{3 \times 10^8} = 184$ sec.

As packet size is not given:

$RTT = 2 * T_p$
$= 2 * 184 = 368$ sec

(b) delay bandwidth product = RTT × Bandwidth
= ~~23.5Mb~~ 46 Mb

(c) Time to reach mission control = $T_t + T_p$
$= \frac{5\,Mb}{128\,kbps} + 184s$
= ~~40~~ + 184
= ~~2008~~ 224 sec

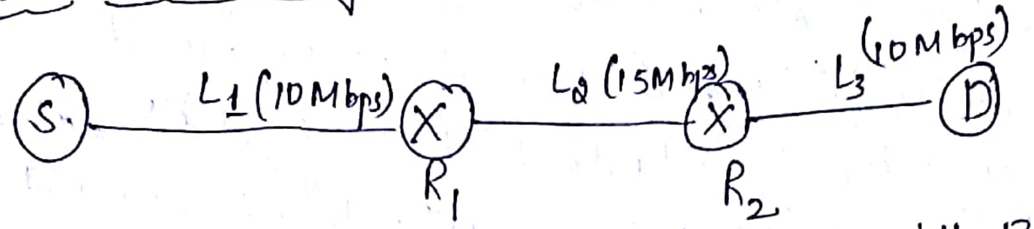
(1) How Long does it take a packet of length 1000 bytes to propagate over a link of distance 2500 km, propagation speed 2.5×10^8 m/s and transmission rate 2 Mbps? Does this delay depend on transmission rate?

(2) Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rate R_1 = 500 kbps, R_2 = 2 Mbps, R_3 = 1 Mbps.

a. Assuming no other traffic in the network, what is the throughput for the file transfer?

b. Suppose the file is 4 Million bytes, Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

Packet switching example



Suppose there is a file of 1000KB, with packet size 320 including 20 bytes of header.

I → Divide the file into packets.

II → transmit all the packets.

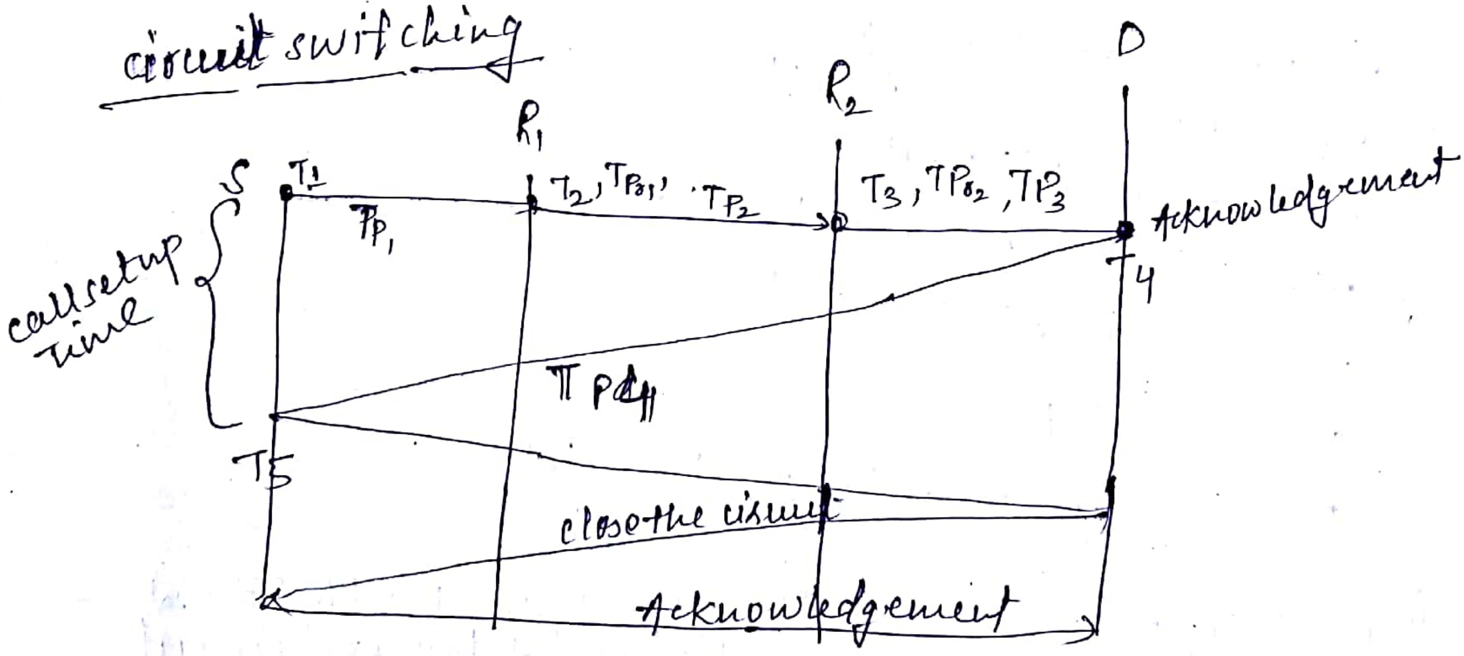
III → R_1 receives the packet and starts back to back transmission. No queuing delay in R_1.

IV → R_1 transmits last packets, & add propagation delay of last packet.

V → R_2 will get packets beyond its capacity so R_2 will face queuing delay.

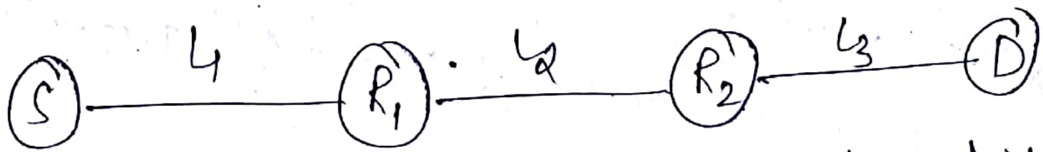
VI → R_2 transmits last packets and add propagation delay of L_3.

circuit switching



(1) Consider a file size of 1500 KB being sent from source S to destination D along a path composed of source destination, three links and two store & forward switches. Consider links L1, L2, L3 having (d, R) values as (10,15), (15,20), (15,15) respectively where units are (Kms, Mbps). Consider propagation speed 2×10^8 m/s processing delay 1 ms, call setup request and acknowledgement packet size is 2 KB. Data packet size is 420 KB, of which header is 20 KB. If switches support both packet switch & circuit switch, calculate total time required to transmit the file.

a. Circuit switch
b. Packet switch



(2) Define the following parameters for switching n/w:
between two given end system

N = No. of hops b/w two given end system
L = message length in bits
B = data rate (bps)
P = packet size (fixed in bits)
H = overhead (header)
S = call setup time
D = Propagation delay per hops (s)

for N=4, L=3200, B=9600, P=1024, H=16, S=0.2, D=0.001, compute end to end delay for circuit switching, packet switching & virtual circuit packet switching

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circuit switching = 0.537 s
Packet switching = 0.752 s
virtual circuit = 0.952 s