CS 224: Computer Networks

Protocols used in current internet

↳ Rules for transmission and formatting of data

Text Book: Peterson & Davie, "Computer Networks - A systems approach", 5th Ed.

Others: Kurose & Ross

Marking Scheme:

End-Sem: 40
Mid-Sem: 25
Quiz: 10
Assignments: 25

Moodle, Email

MS Teams: To store recorded lectures

&

Google Drive

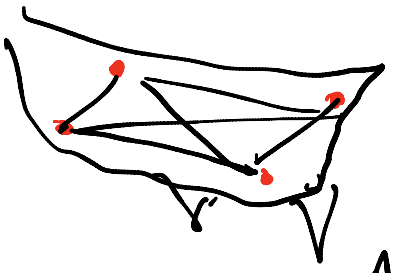
CLASS NOTES on MS Teams

"Whiteboard"

INTERNET

ARPANET late 1960s

↳ Govt. (US)



Wired / Wireless

Apps: telnet/rlogin, FTP

Two people

A → Wired ① B

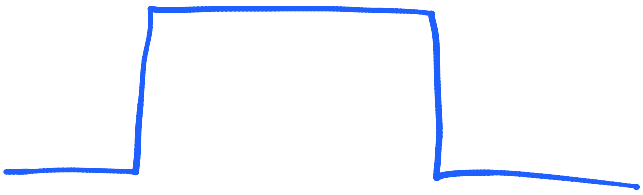
Wireless ②

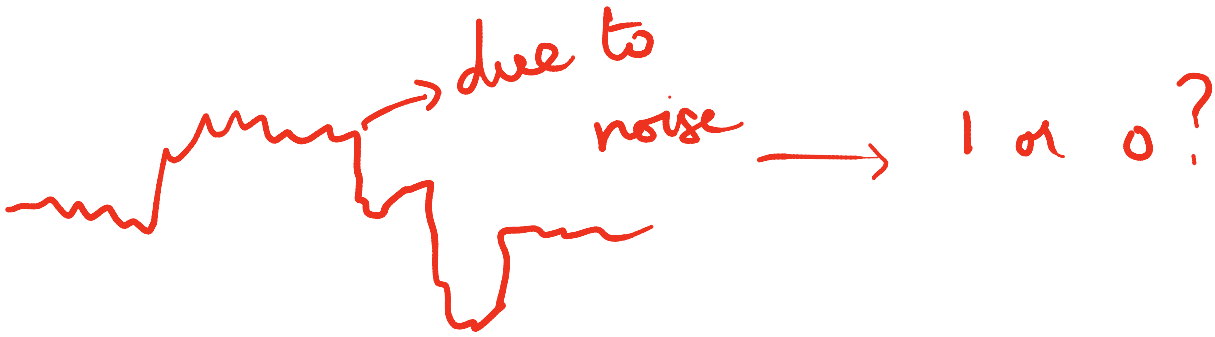
data/information → bits → signals

Example:

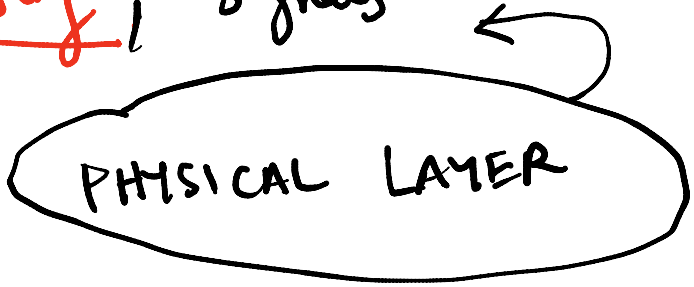
1: +5V, 0

0: 0, -5V





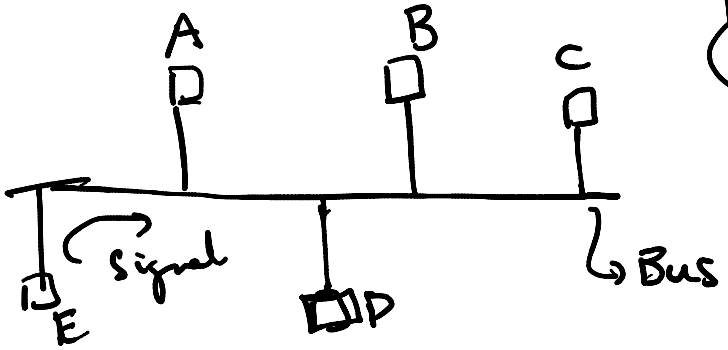
Denoising : Signals



DATA LINK LAYER

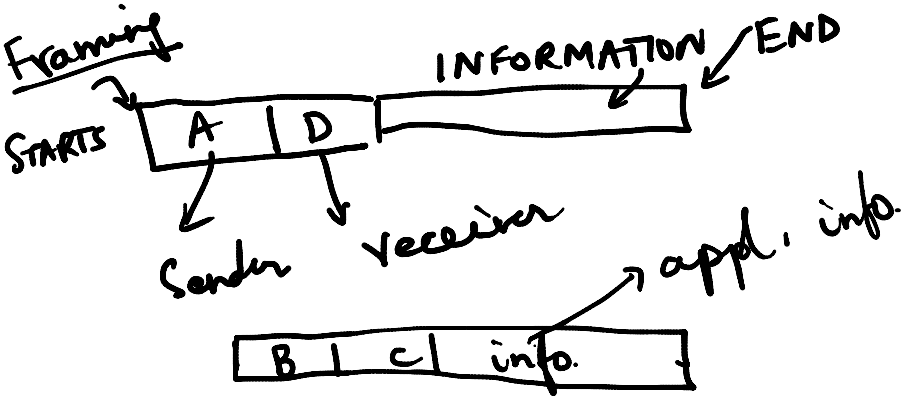
MEDIUM ACCESS

5 people



A → D

A must indicate D is receiver

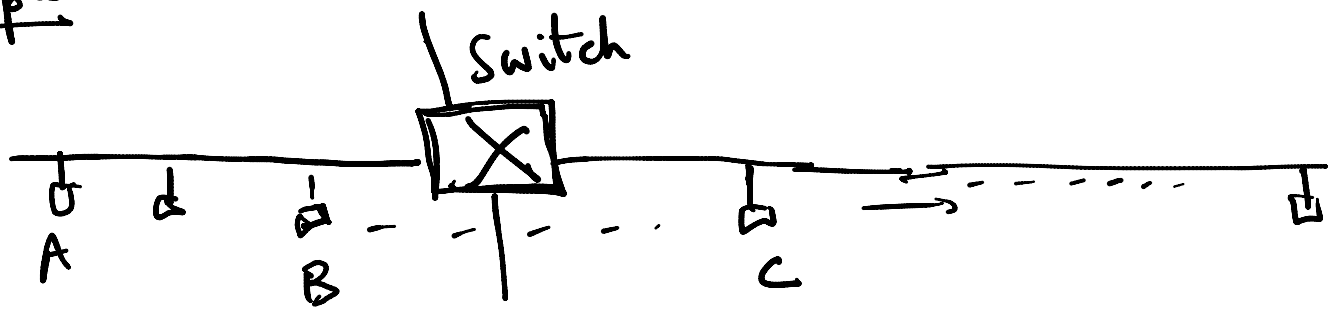


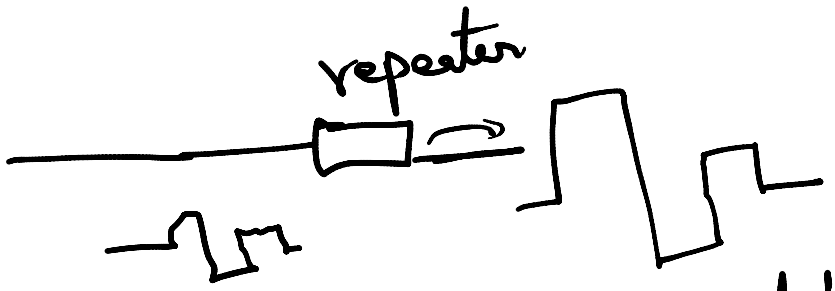
B → C +

Interfere

100s people

"repeater" → amplifies signal

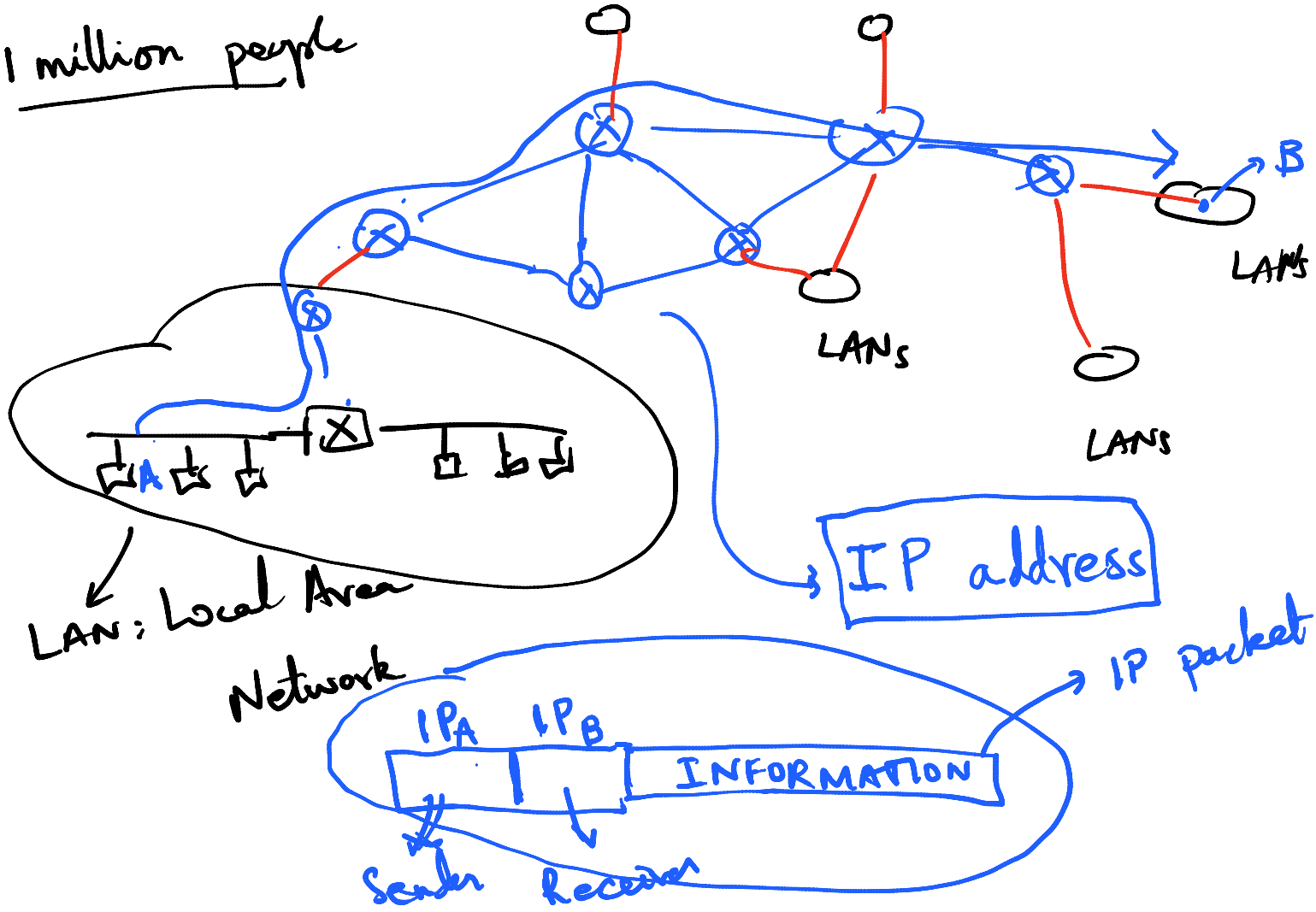


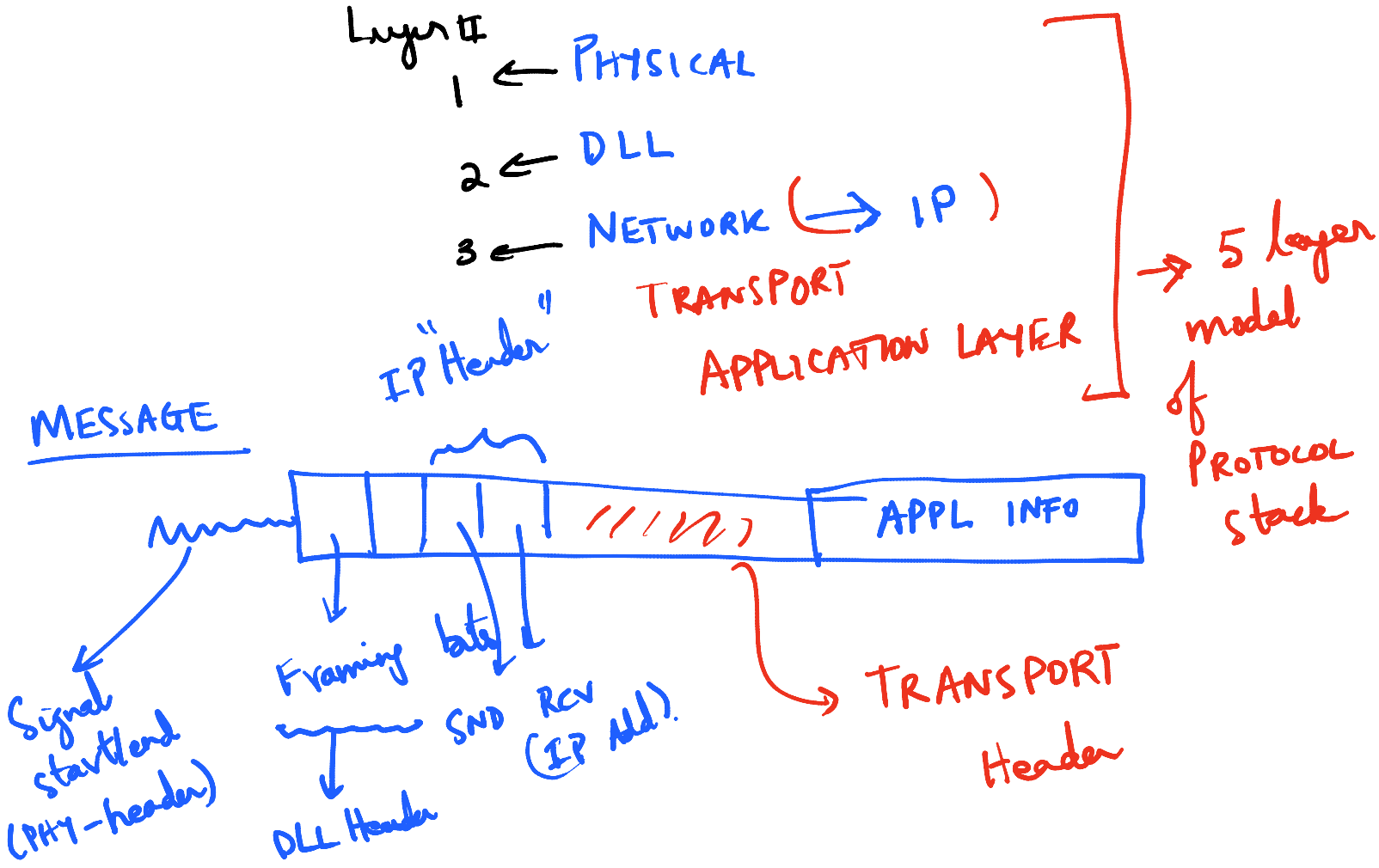


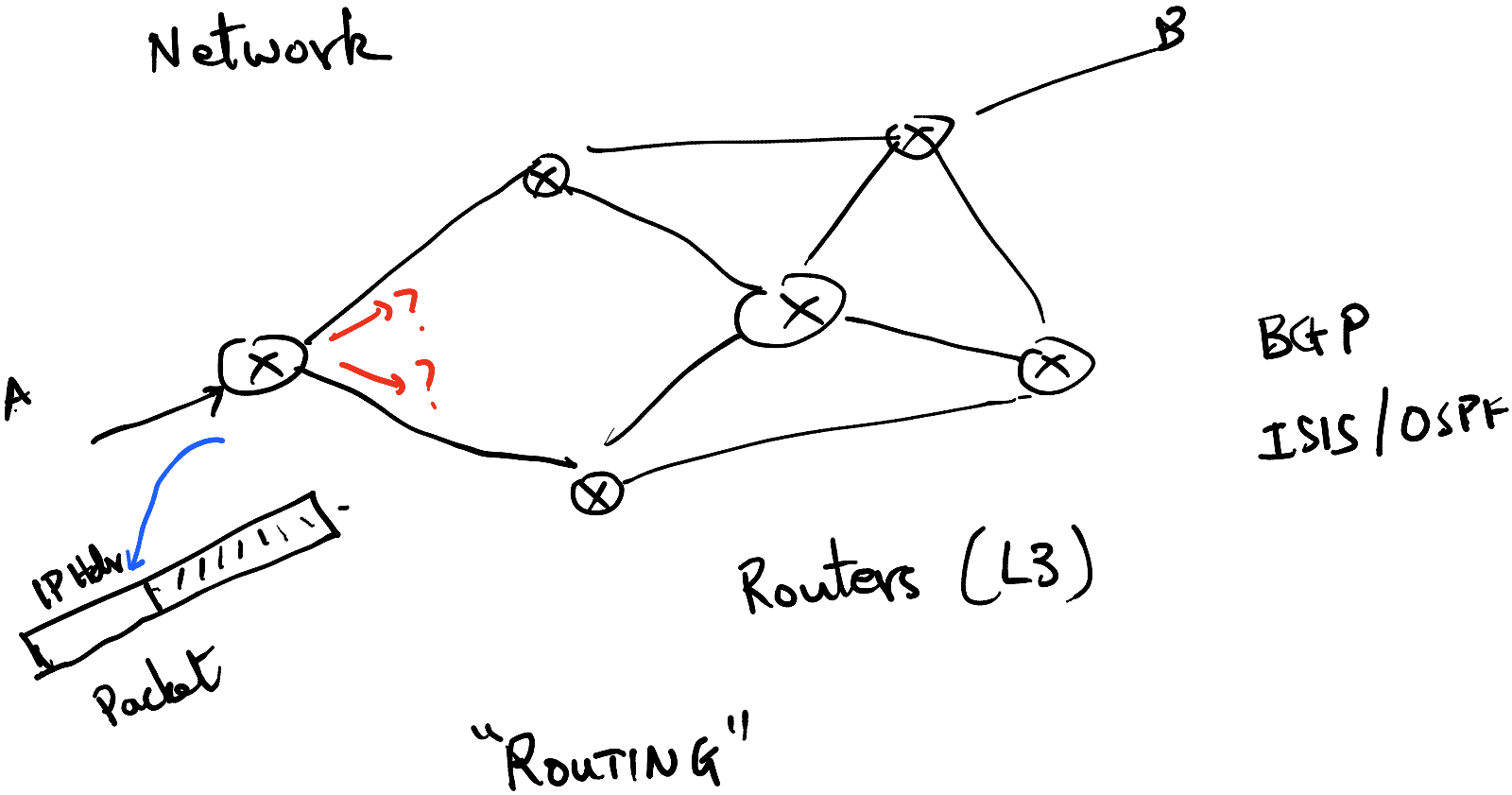
Data Link Layer.

Layer-2 Switch (L2)

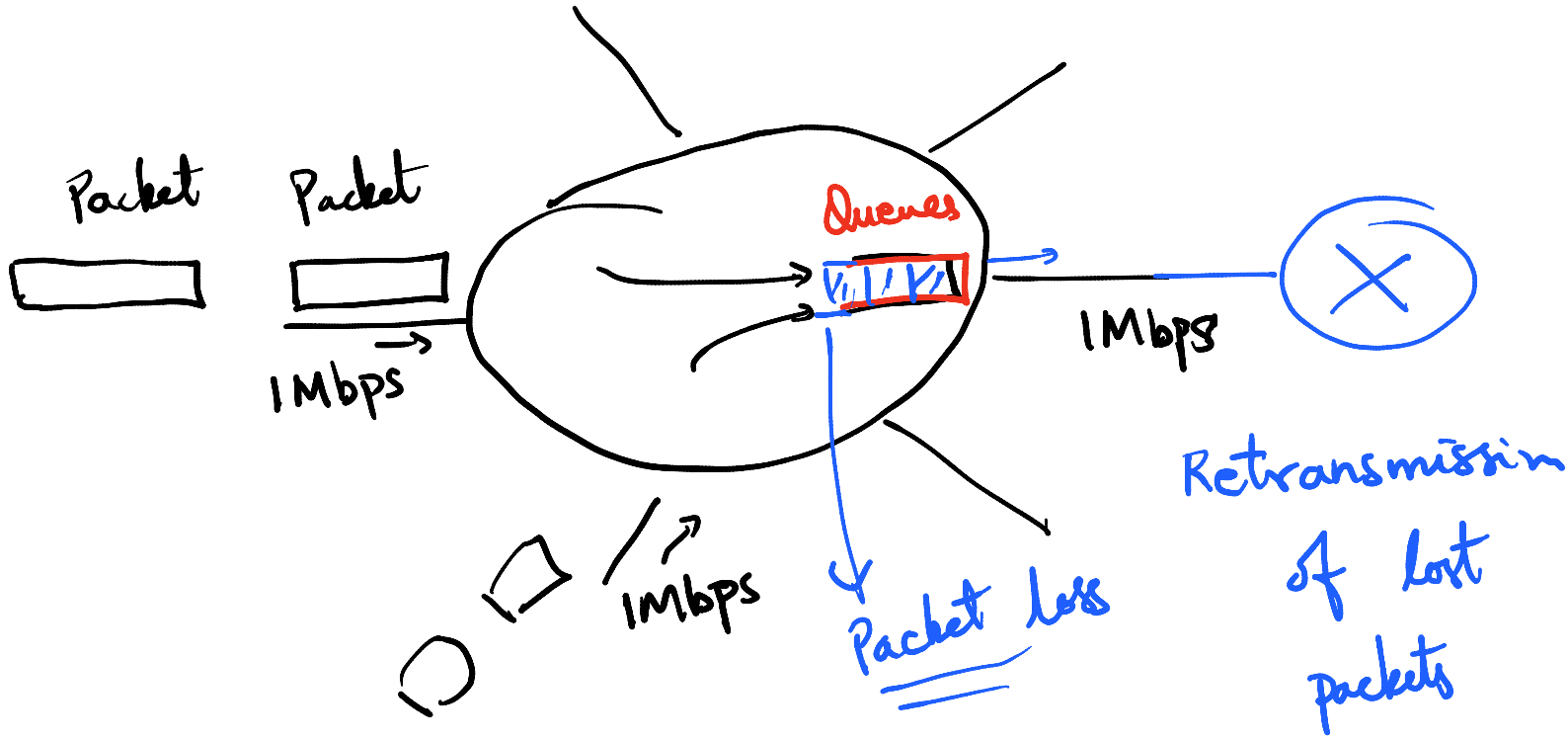
Layer-3 "Switch" ← "Routers"


1 million people
B
LANs
LANs
LANs
A
b
LAN: Local Area Network
IP address
IP packet
IP_A
IP_B
INFORMATION
Sender
Receiver

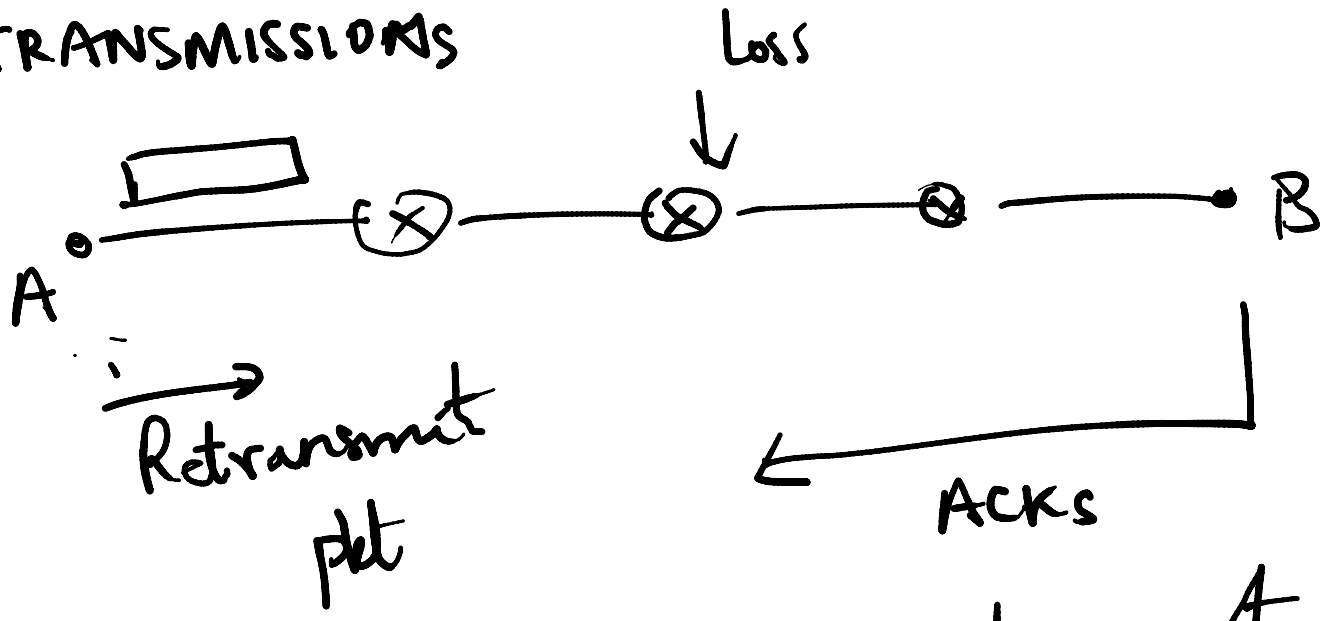

Layer #
1 ← PHYSICAL
2 ← DLL
3 ← NETWORK (→ IP)
TRANSPORT
APPLICATION LAYER
→ 5 layer model of PROTOCOL stack
IP "Header"
MESSAGE
APPL INFO
Signal start/end (PHY-header)
Framing
DLL Header
SND
RCV (IP Add).
TRANSPORT Header


Network
B
A
?
?
BGP
ISIS / OSPF
IP Hdr
Packet
Routers (L3)
"ROUTING"

Zoom into Router



RETRANSMISSIONS

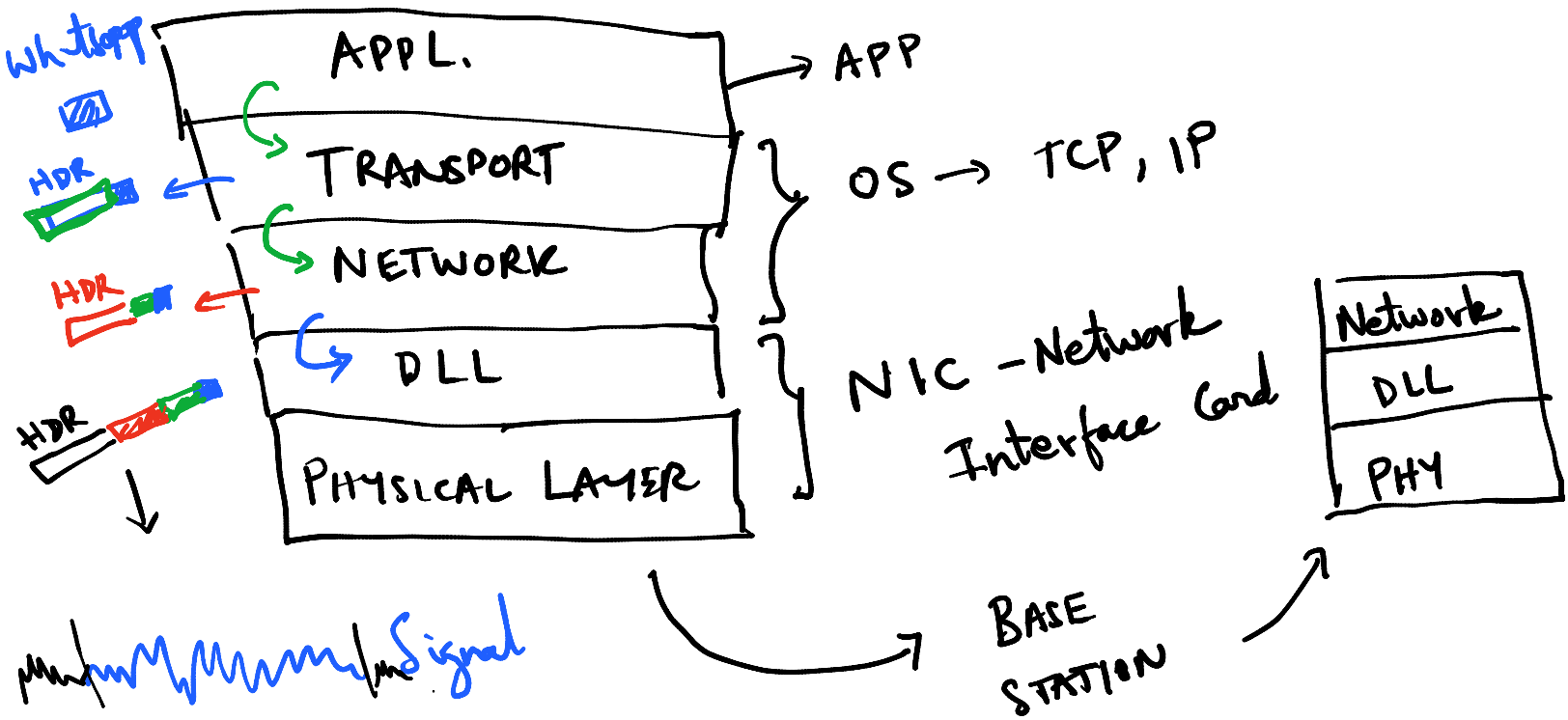


A: detect / infer loss, retransmit

TRANSPORT LAYER: TCP
UDP

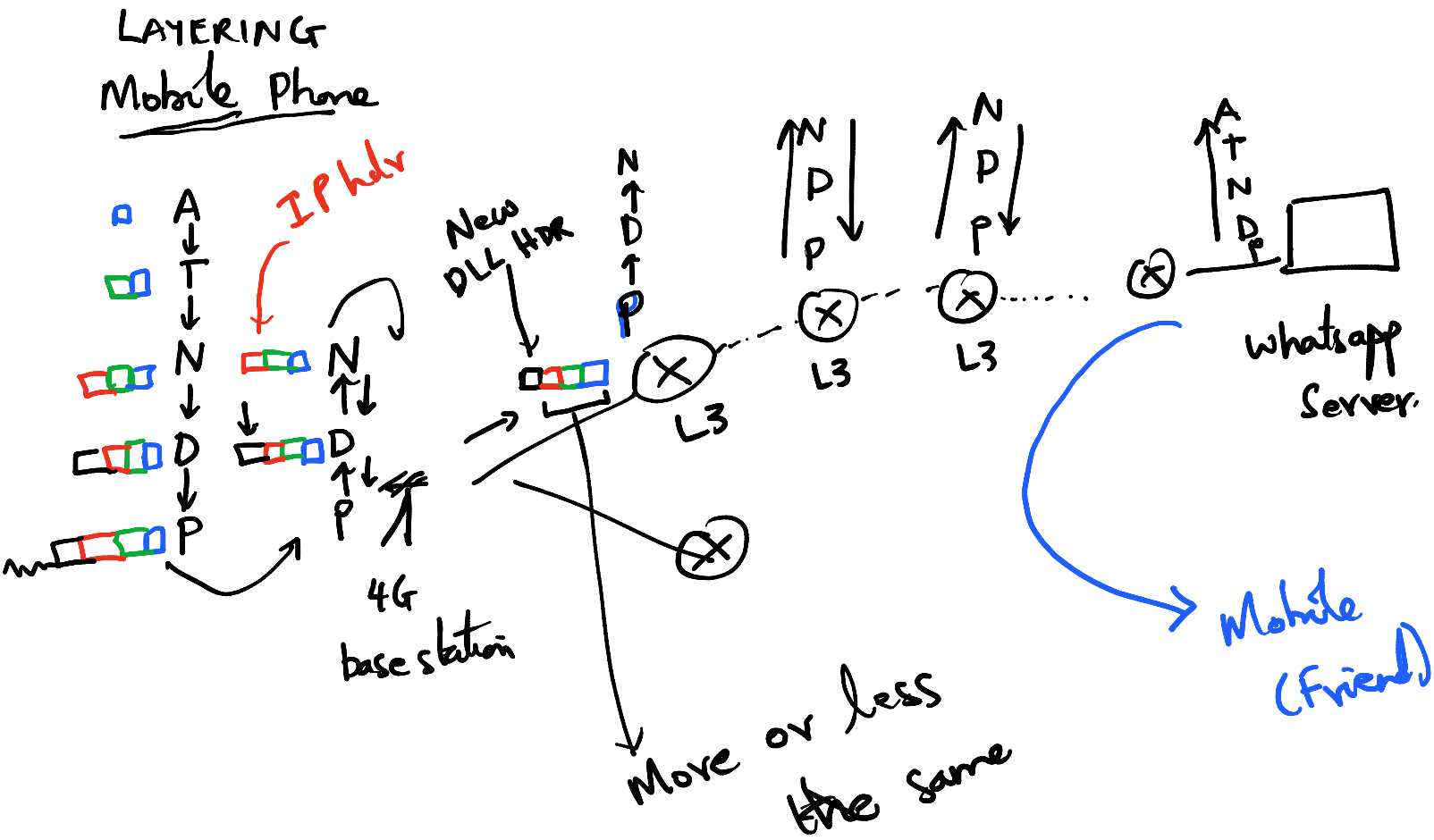
PROTOCOL LAYERING

OSI-7 layer



Repeaters

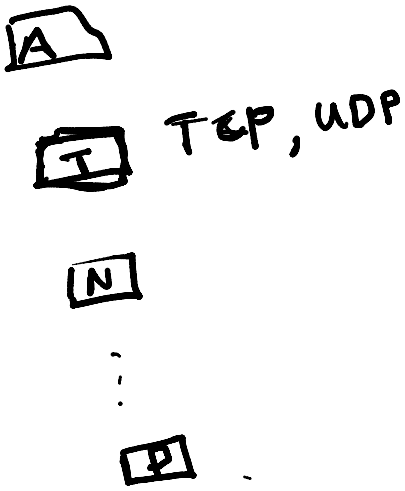
L2-Switches


LAYERING
Mobile Phone
A
T
N
D
P
IP hdr
N
D
P
4G
base station
New
DLL HDR
N
D
P
L3
N
P
P
L3
N
P
P
L3
A
T
N
D
P
whatsapp
Server.
Mobile
(Friend)
Move or less
the same

ADV. & DISADVANTAGES OF PROTOCOL LAYERING

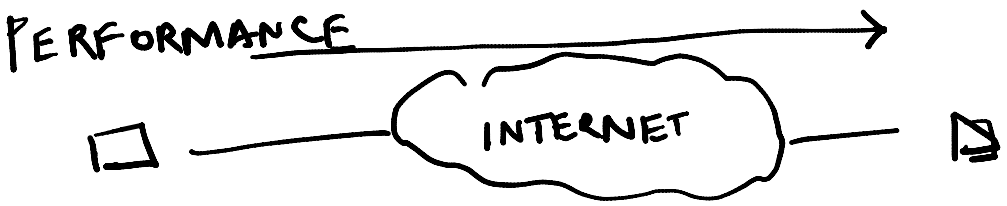
1. DECOMPOSE THE ENTIRE
Networking problem into smaller ones

2. Modular Design



DISADVANTAGES

Transport → Retransmission



Voice Call

Throughput: Avg. data rate sent from sender to receiver

~ 64Kbps

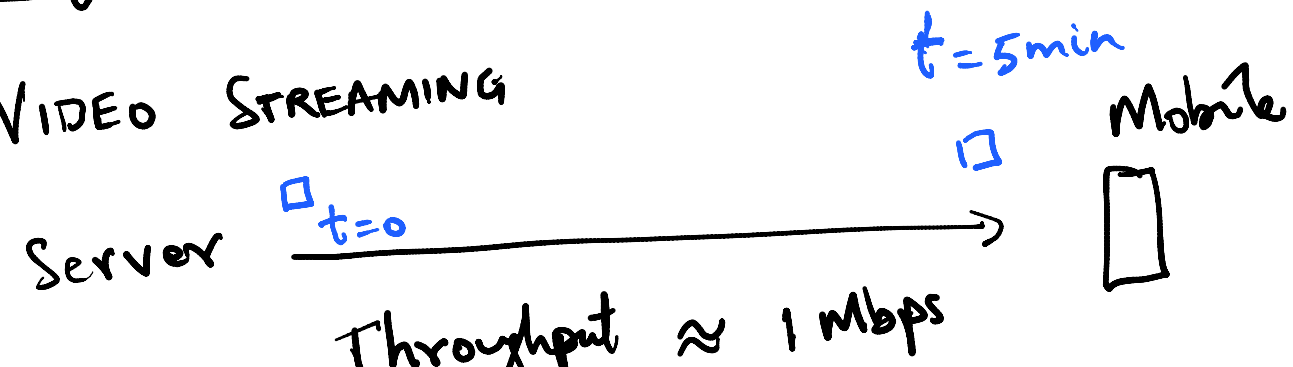
Latency: Delay of a message across the network

~ 100 ms of one-way latency

RTT: round trip time

QoS
Quality of Service

2) Video Streaming



Throughput ≈ 1 Mbps

Latency? Few seconds - One Way Latency (Cricket match live)

3) File transfer

1GB file

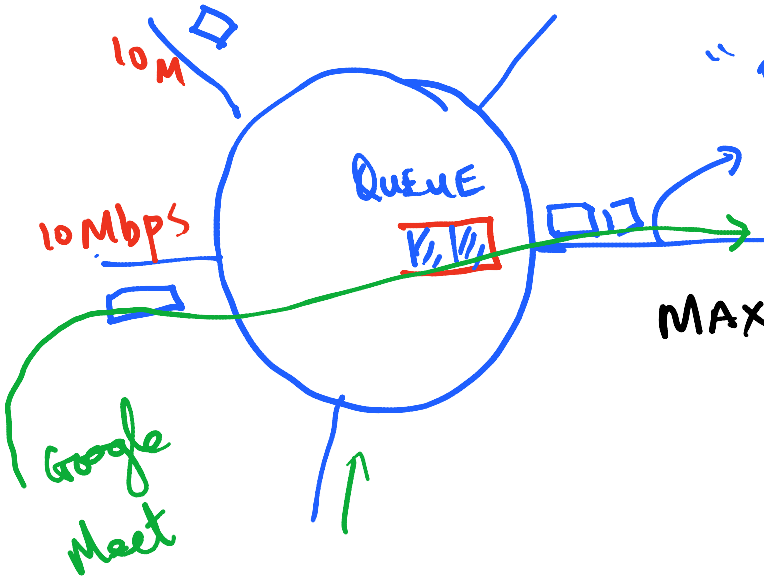
Throughput → The more the better

BEST EFFORT QoS

→ No QoS guarantees from network

→ transfer data as "best" as it can.

INTERNET designed as "Best Effort".



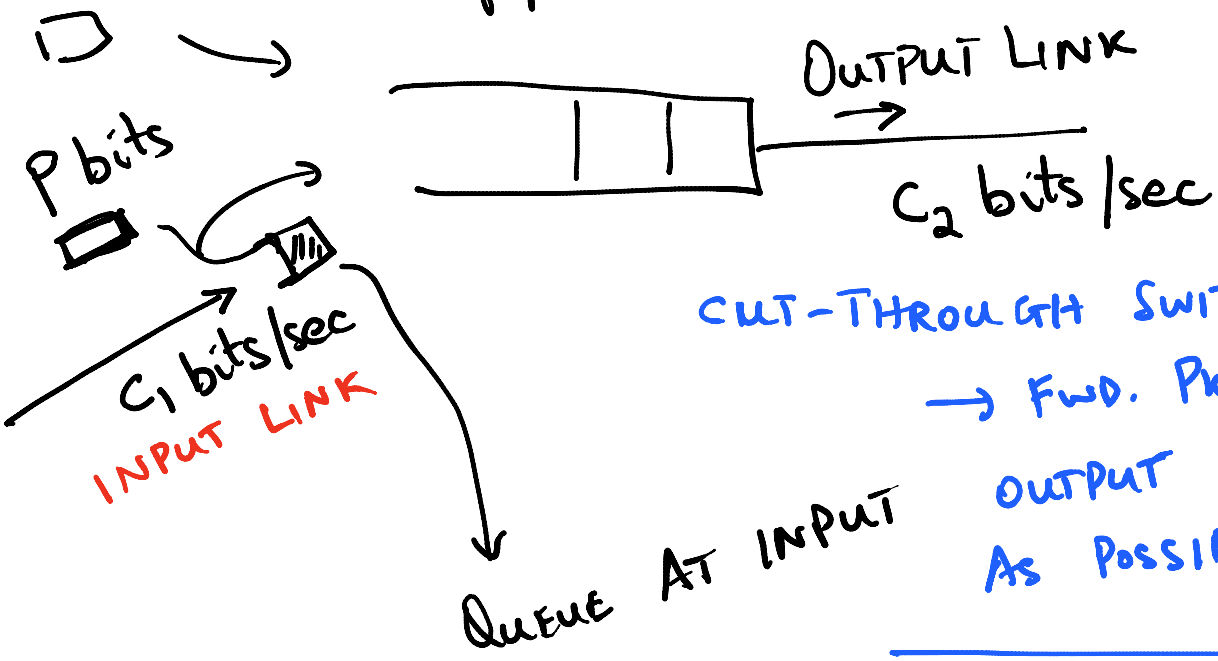
"BANDWIDTH" → LINK CAPACITY (WIRED LINKS)

10Mbps

MAX. DATA RATE OF TRANSMISSION ON A WIRED LINK

LATENCY

t_0 = time at which 1st bit of pkt. recd. at input



CUT-THROUGH SWITCHING → FWD. PKT TO OUTPUT AS SOON AS POSSIBLE

STORE & FORWARD : WAIT TILL FULL PACKET RECD. AT INPUT & THEN FWD. TO OUTPUT QUEUE.

$t_0 \rightarrow$ 1st bit at input

$t_1 \rightarrow$ last bit recd. at input

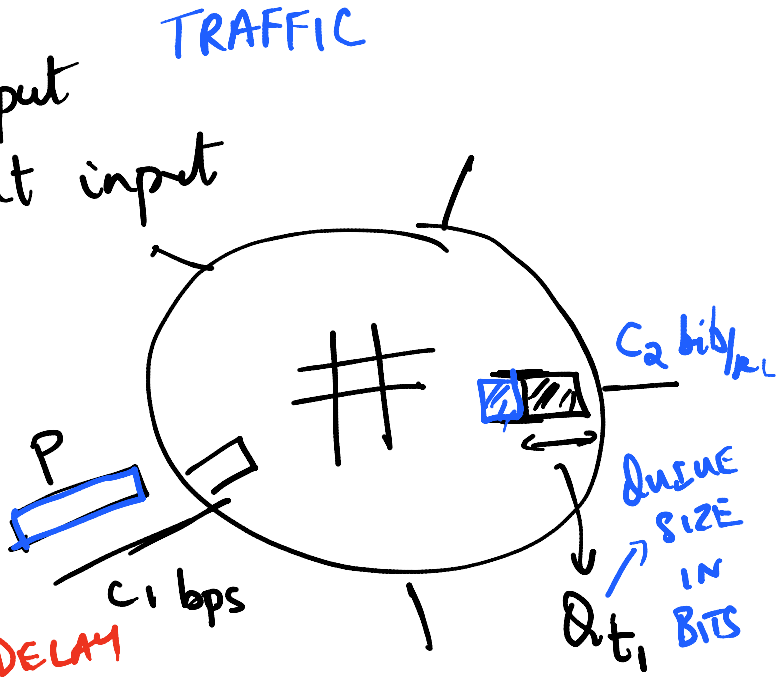
$$t_1 = t_0 + \frac{P}{C_1}$$

$t_2 \rightarrow$ 1st bit sent on output link

$$t_2 = t_1 + \frac{Q_{t_1}}{C_2}$$

$t_3 \rightarrow$ last bit sent on o/p link

$$t_3 = t_2 + \frac{P}{C_2}$$



QUEUING DELAY

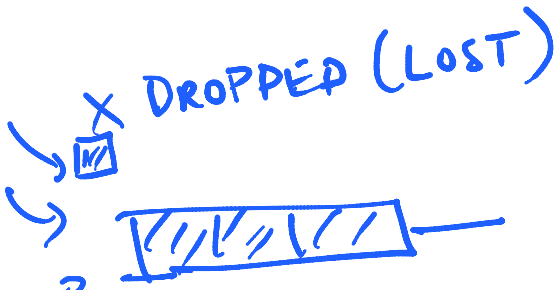
$$= t_0 + \frac{P}{C_1} + \frac{Q_{t_1}}{C_2} + \frac{P}{C_2}$$

$$= t_1 + \frac{Q_{t_1}}{C_2} + \frac{P}{C_2}$$

TRANSMISSION DELAY

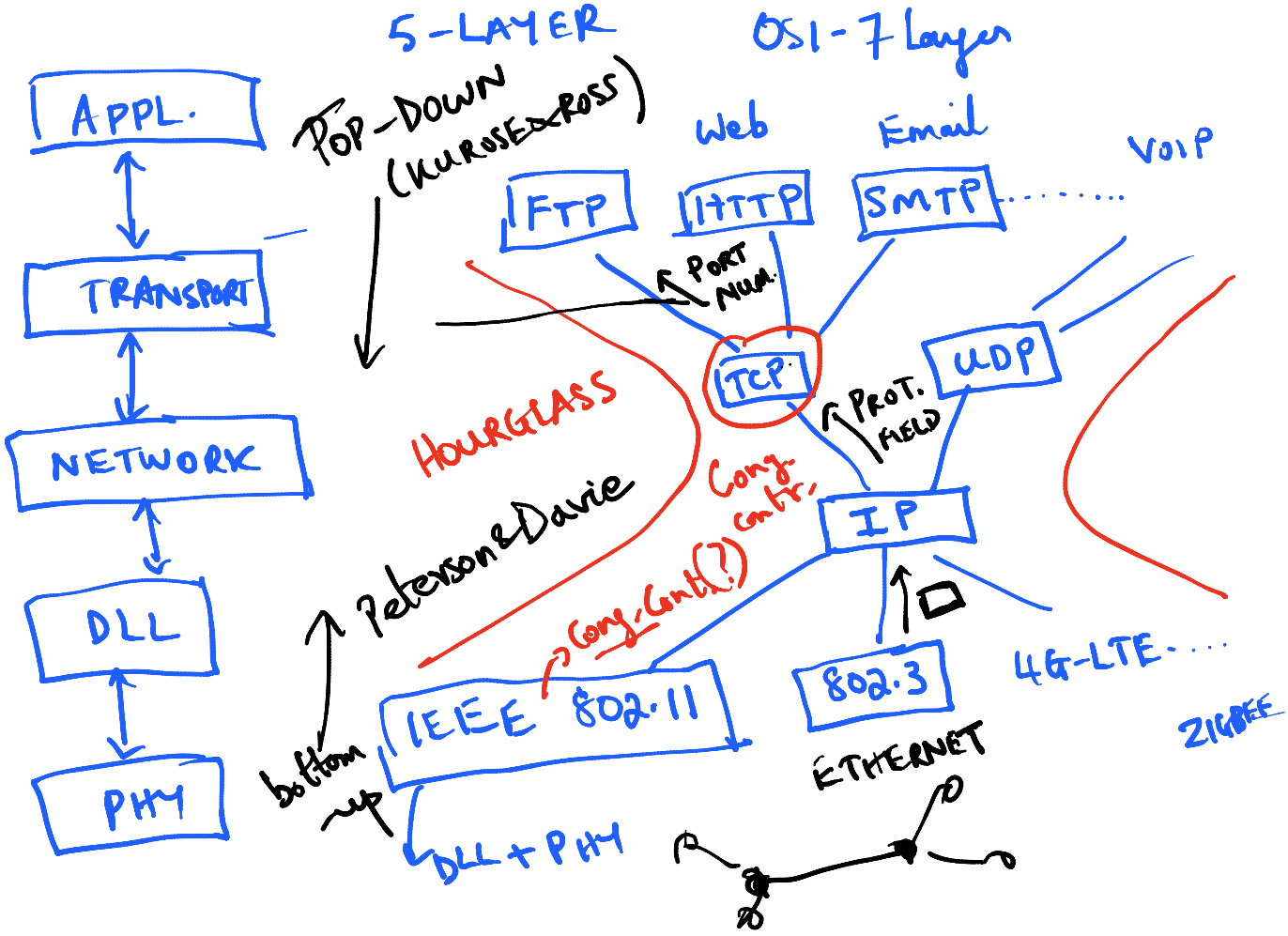
CROSS-TRAFFIC : TRAFFIC (PKTS)
OTHER THAN ONE'S OWN PACKETS

CONGESTION CONTROL



CONGESTION : QUEUE
BUILD AT A ROUTER

→ Handled by TRANSPORT LAYER (TCP)
↳ also may be handled by lower layers (eg. DLL, PHY)


5-LAYER
OSI-7 Layer
APPL.
TRANSPORT
NETWORK
DLL
PHY
Top-Down
(Kurose&Ross)
Web
Email
VoIP
FTP
HTTP
SMTP
Port Num.
TCP
UDP
Prot. Field
IP
HOURGLASS
Peterson&Davie
Cong. Cntr.
Cong. Cntl(?)
802.3
4G-LTE
ZIGBEE
IEEE 802.11
ETHERNET
bottom up
DLL+PHY