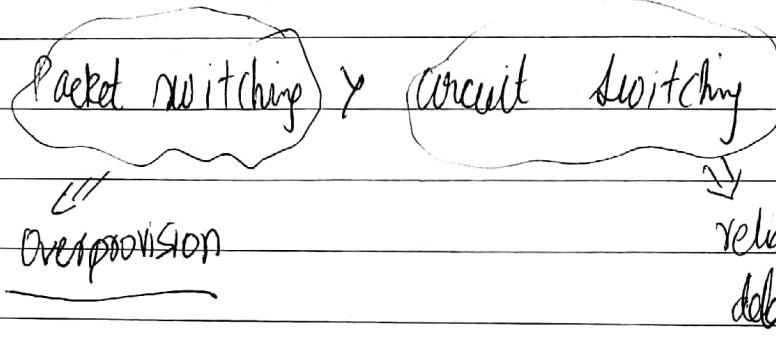


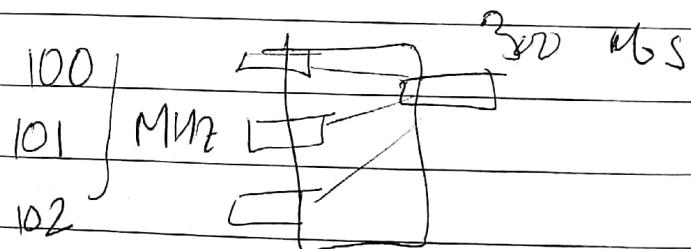
Reliability \rightarrow imp for email / fb
 \rightarrow not for skype

ΣQ_i variable

overhead of creating physical circuit



frequency division multiplexing



At most R nodes are active

$$\begin{aligned} (1-p)^n \cdot n! p^n (1-p)^{n-1} &\rightarrow n(2) p^2 (1-p)^{n-2} + \\ &\dots \\ &n(R) p^R (1-p)^{n-R} \end{aligned}$$

/ off

Get method body NULL
Post fill form

method	space	URL	version	carriage return <u>line field</u>	header ended
get	→ no body	/	Post header		

long wait : handshake : open TCP connection

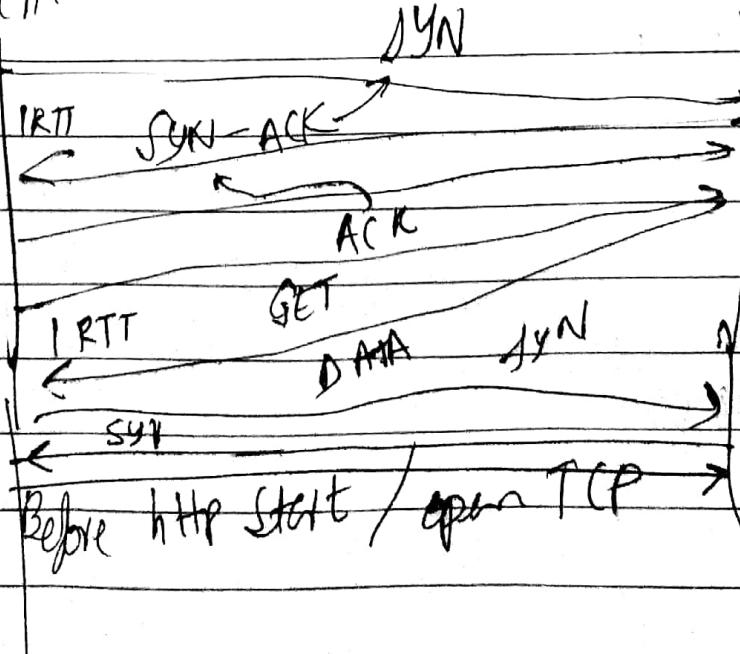
new Report → new TCP connection

multiple TCP connection to fetch pool of data.

Benefit of multiple objects on TCP? No overhead of
request same
syn, (syn, ack), ack.

Client

Server



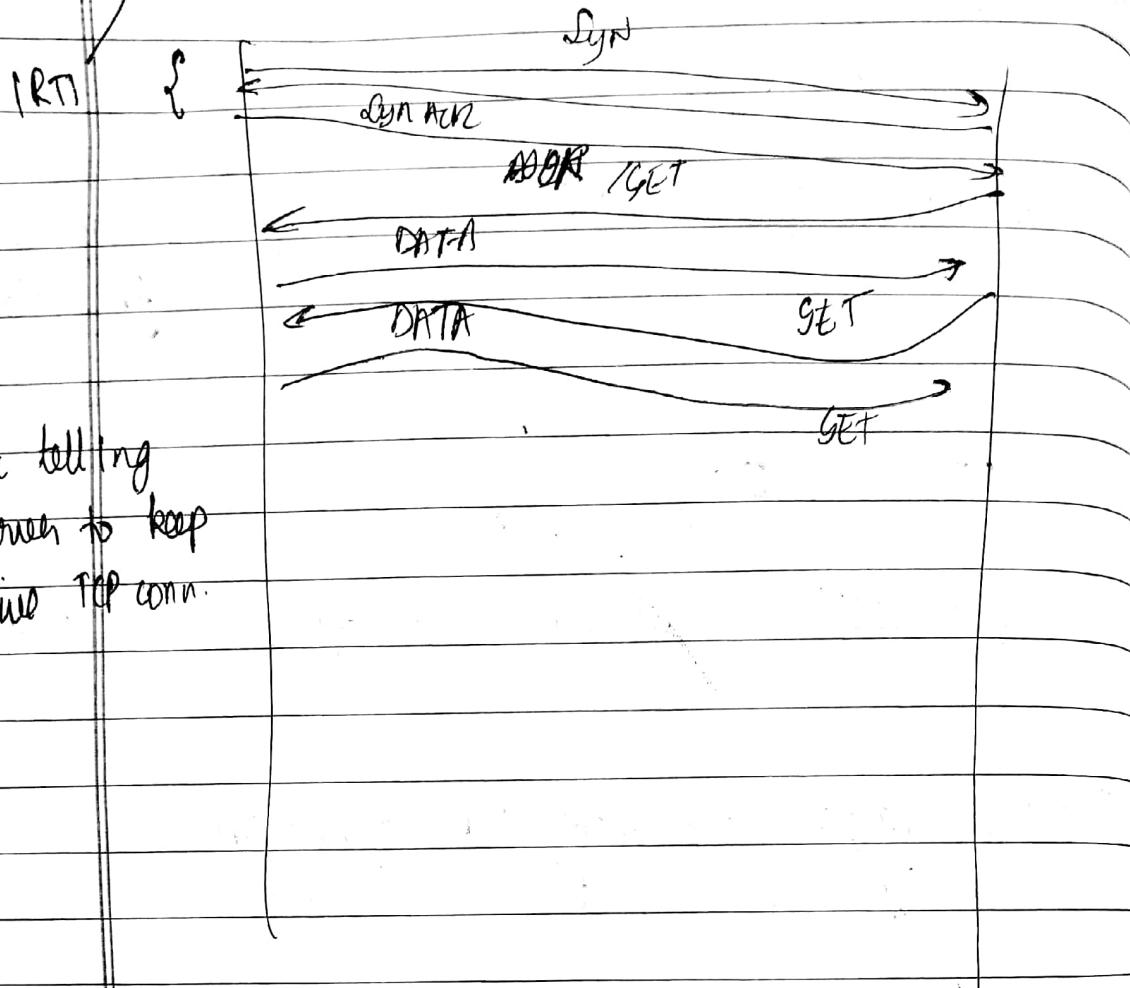
HTTP persistent connection

MIRAJ

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- Client telling server to keep alive TCP conn.

client
write ("Get--")

write
read

Cpt / HTTP

W/n

Get node.css

W/n

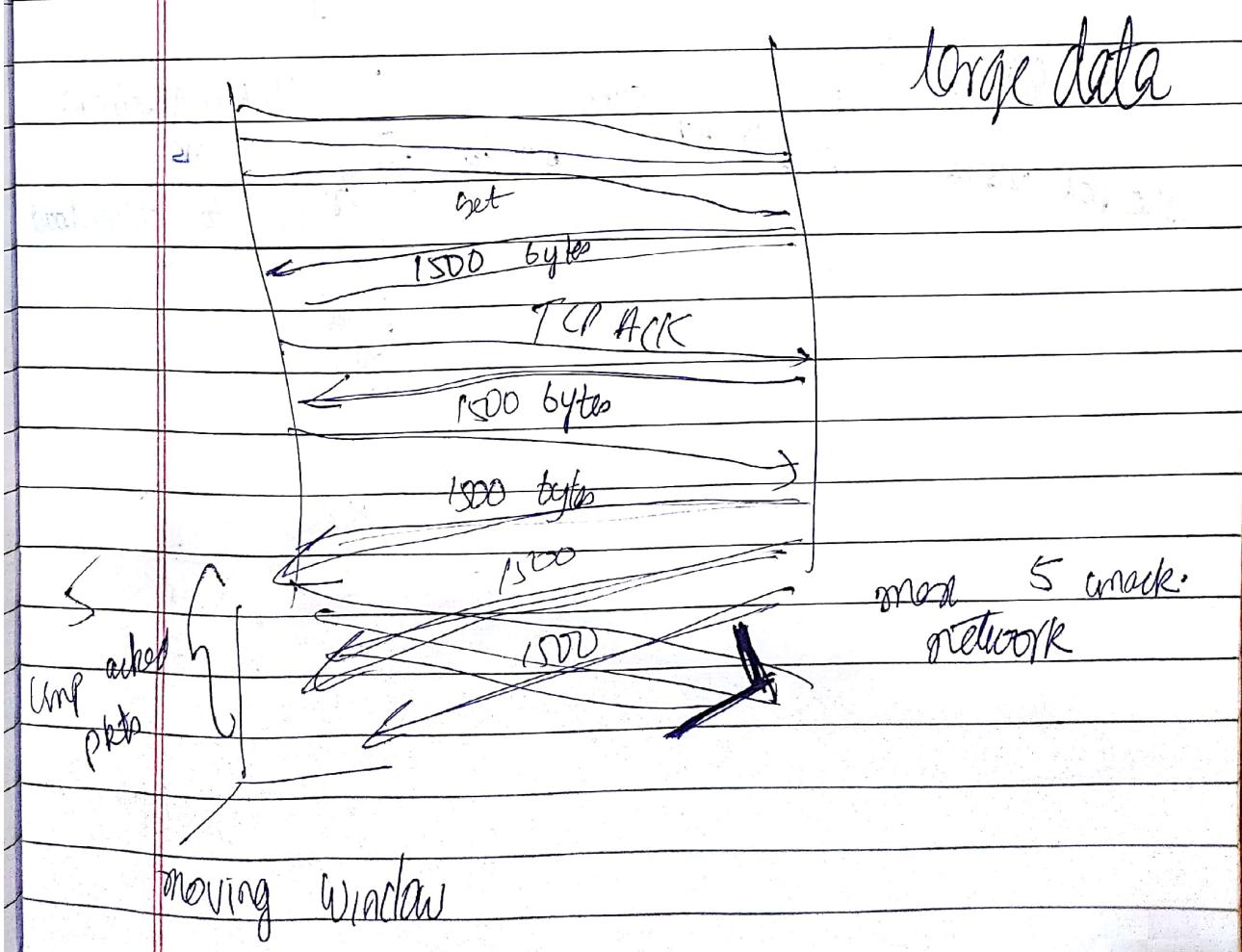
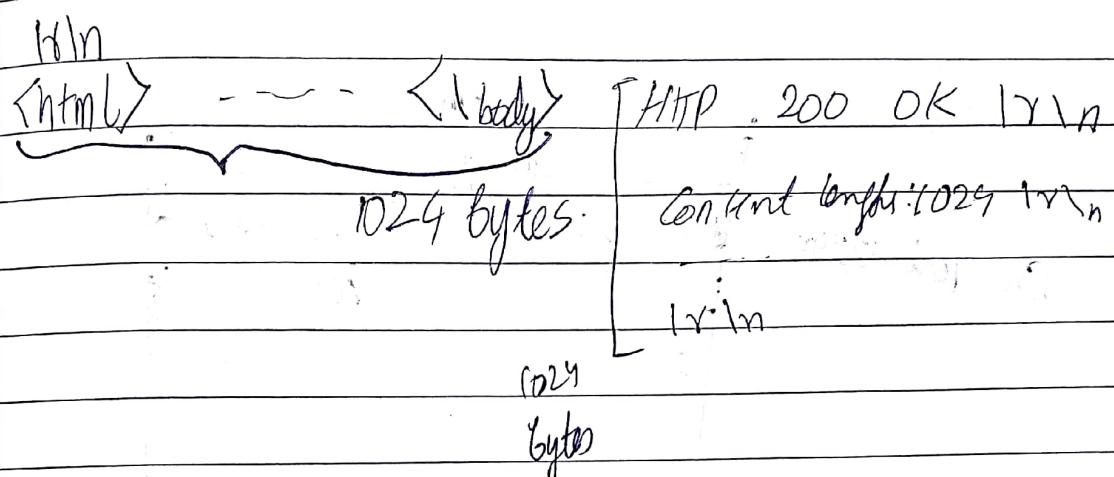
Cpt

→ Server is sending log of bytes.

→ Client receiving

HTTP 200 OK \r\n

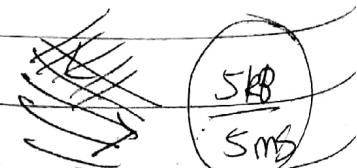
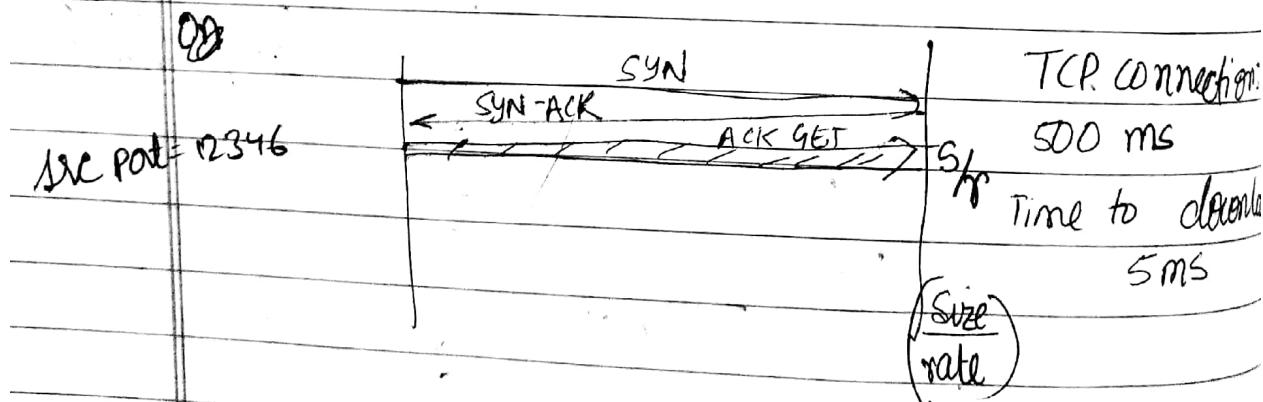
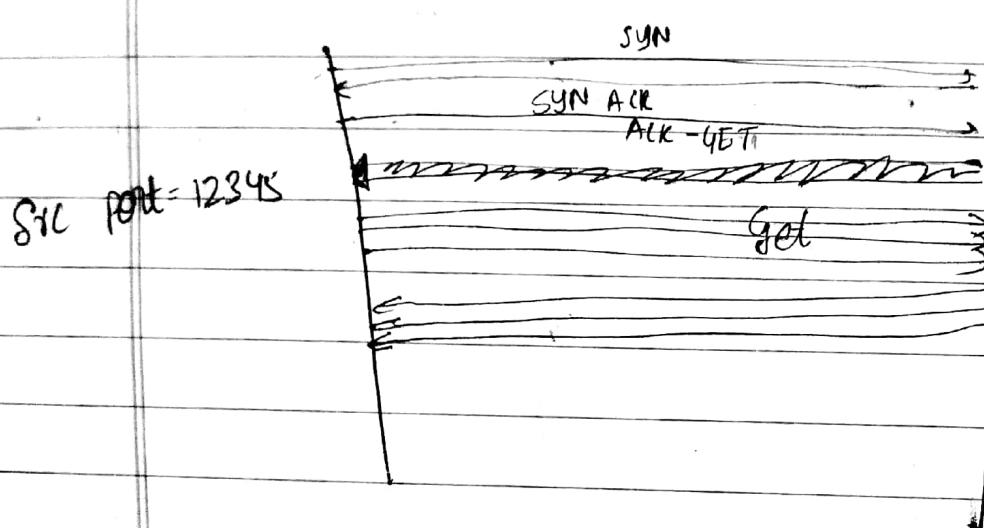
Content length: 17 \n



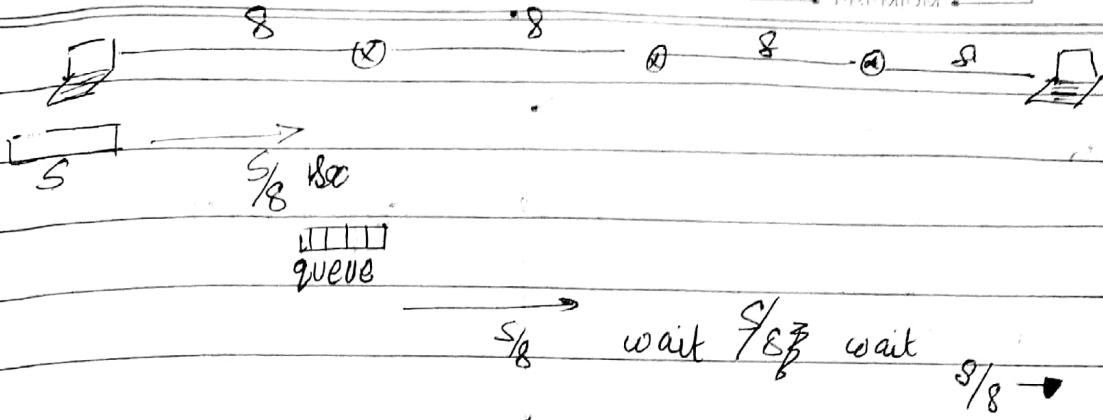
$$\text{Rate} = \frac{W \times P}{RTT}$$

Client

Server

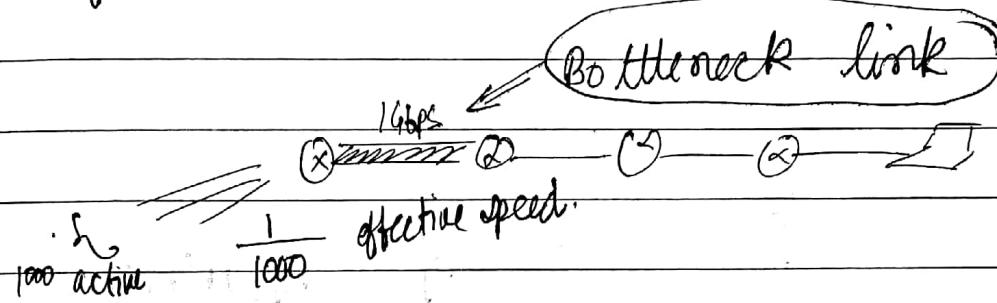


$$\begin{aligned} &= 5 \times 10^3 \times 8 \\ &= 5 \times 10^{-3} \\ &\approx 8 \text{ Mbps} \end{aligned}$$



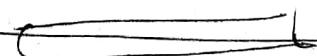
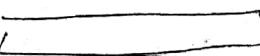
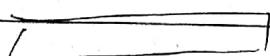
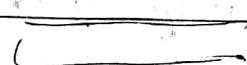
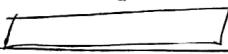
for webpage : Queue latency > sending data
200 Kbps

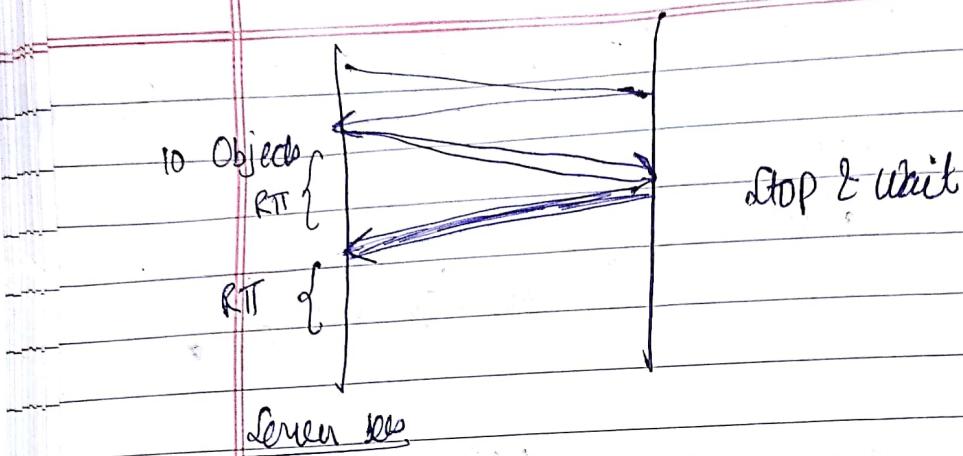
software download: sending data > queue latency



$$\text{effective speed} : \frac{5s}{\Delta} = 1 \text{ Mbps}$$

$$= 500 \text{ ms}$$





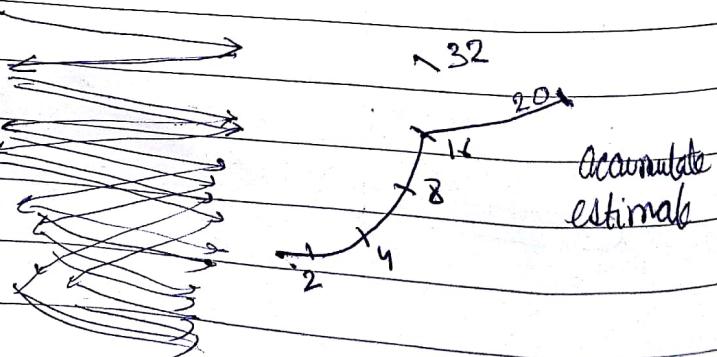
GET HTTP/1.1 \r\n HOST ... \r\n
 GET HTTP/1.1 \r\n HOST ... \r\n

Pipelining avoids
Round trip time
delays

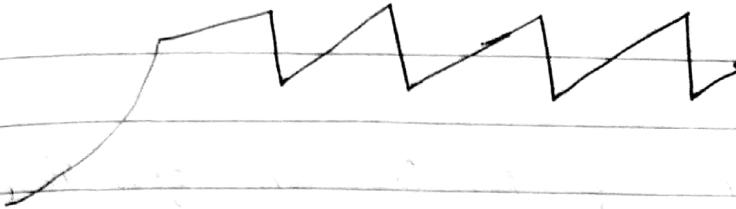
Pipelining

✓ Page Load Time :

TCP sliding window: how many unacked packets should I push.



RFC : Slides Proprietary protocols



TCP tries to find optimal ? (rate).

multiple TCP to exploit Bandwidth.

Carriage Return : Reset position

Date 26/8

Newspaper sites: ads published on content provider.
3rd Party Cookies

Customize ad: Get request to ad → ad agency can remember state for user and display corresponding ad for user.

Request

GET / HTTP/1.1

HOST: adweb.com

Cookie: 12345

Company → Pay adweb.com → Pay Content Providers

general size of Cache?

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- # Advertisements are Target Specific based on user exposure.
- # How much info per user can you add.

Cache

HTTP 200 OK

Expires Aug 30, 2017 23:55

ie.com

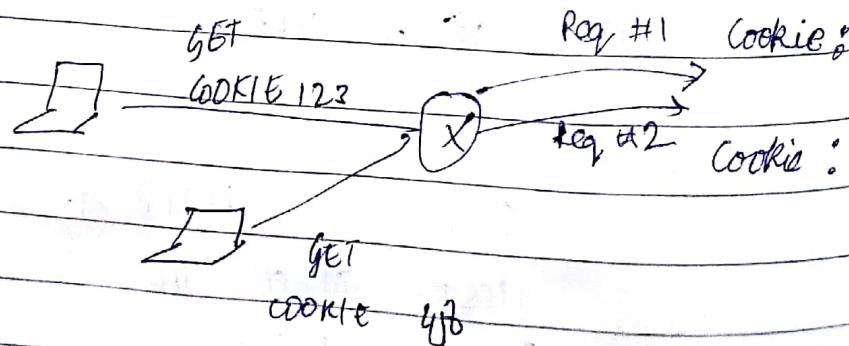
GET

If-modified-since:

Aug 30

PROXY SERVER : Helps caching / logging / track usage.

PROXY → BT uses Squid



why window?

MIRAS

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Date

google/ft end to end connection Port 443

ISNL/Intel

AT&T

AT&T

mediterranean

US

nyt.com

Cache:

Browser / Proxy

France

Atlantic

Akamai: It places CDN (partner with ISNL)
partner France ISP / Aust. ISP.

Ask NYT to pay money to Cache respective country.

In a sense, content is Akamaised.

① Reduced latency. ② NB ~~the~~ trouble of setting data centres / increasing bandwidths / serving many clients.

HTTP Redirect to akamaised server

HTTP 321

Redirect: nytimes.akamai.com

akamai: talks with DNS in ISP (running DNS) and asks them to redirect to nearest ISP.

Post Minor I

MIRAJ

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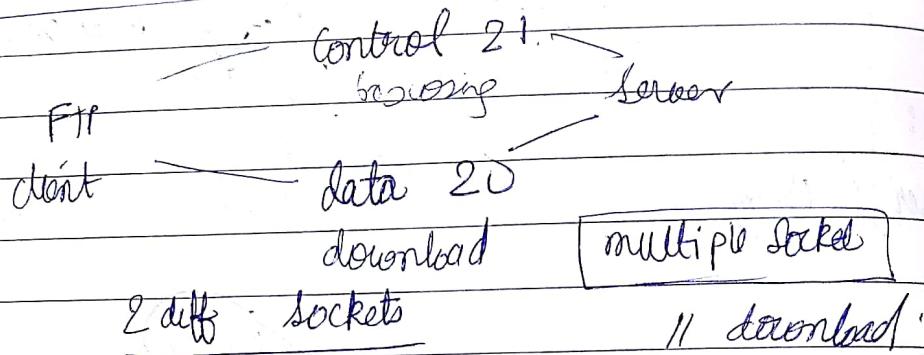
Date:

PREMIUM

5/9/17

FTP protocol: It own set of command

FTP RFCs



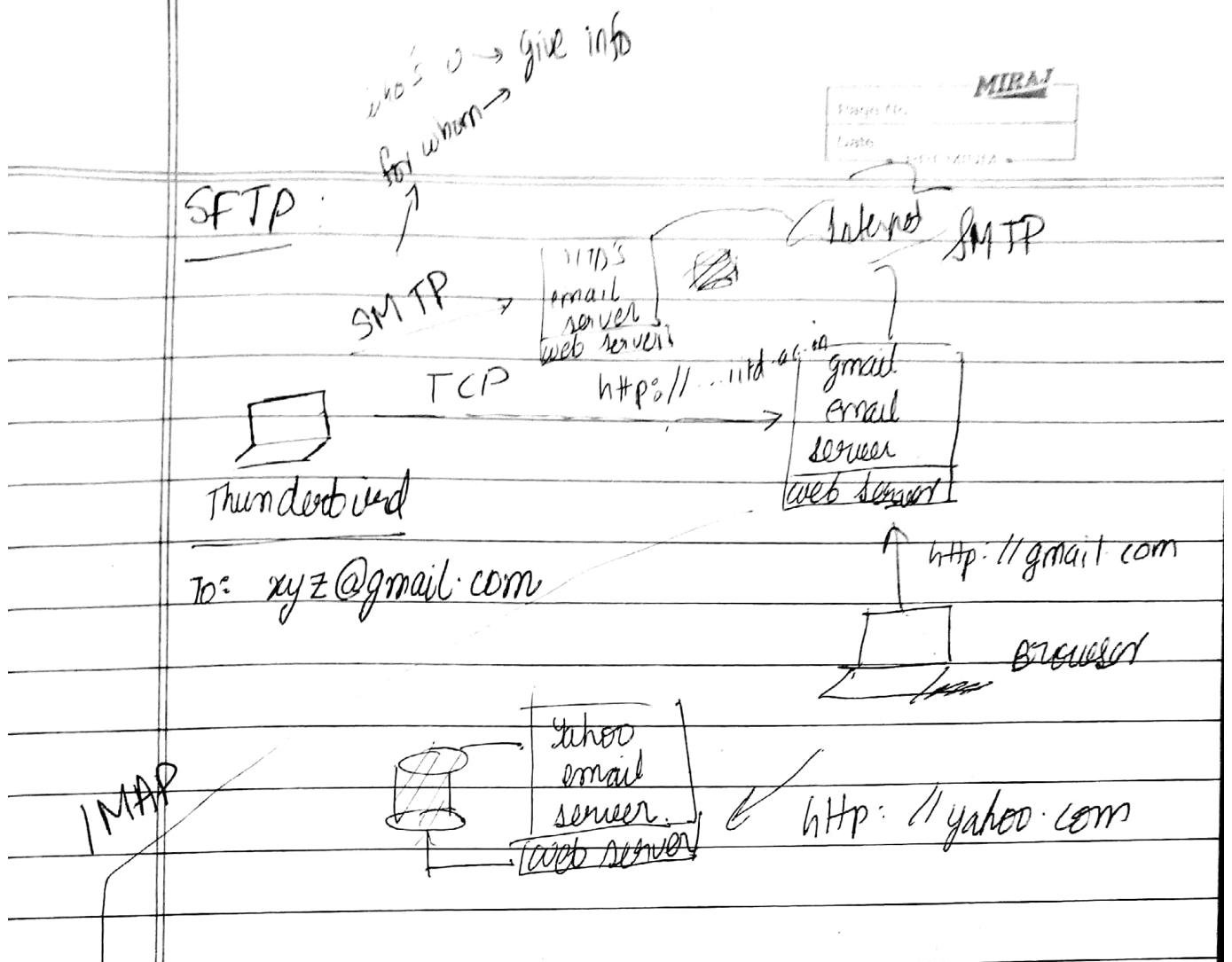
HTTP : control - data intertwined - Pipelines to improve but 1 channel

command on control socket → server expects
data on client data socket

TLS : Transfer Layer Security

Browser has decrypted everything so
all objects segregated (developer tool)

Wireshark looks at raw data



Client push mail → Server stores it in database →

[emails]

TB

Thunderbird Read either on http:// or use IMAP
to talk to email server

✓ Each user has incoming queue:

Mailstore . i.d.enet.n 993

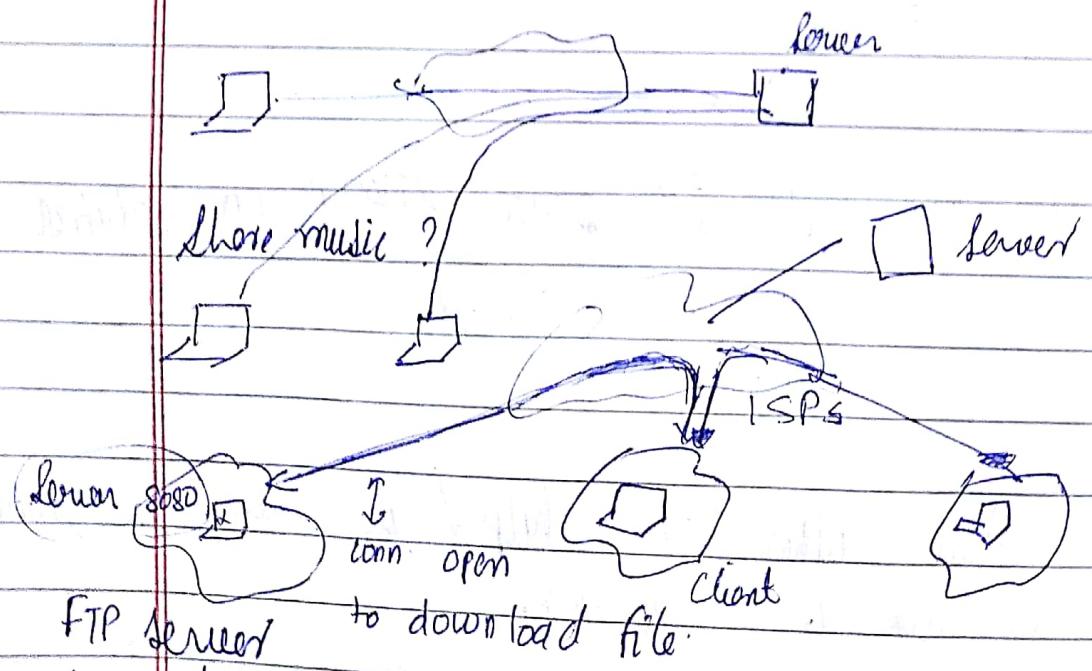
imap.googlemail . com

II Friend not let his email server online most of the time.

Upper h → id.ac.in

WAN → " "

P2P - peer to peer



o keep file

Content chunk of file

Part I Object 1 P1

Object 2 P2

P3

Part II a. Present Answer

b. Desired Answer

c. Help needed from others
b/w

Segment



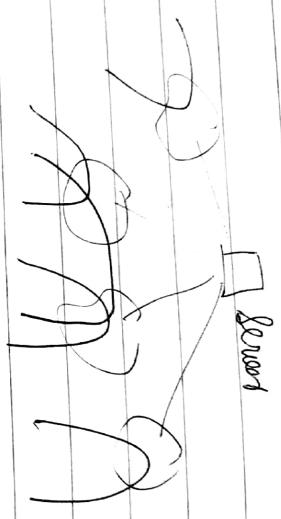
Original Version

CNN Version



Peer to peer

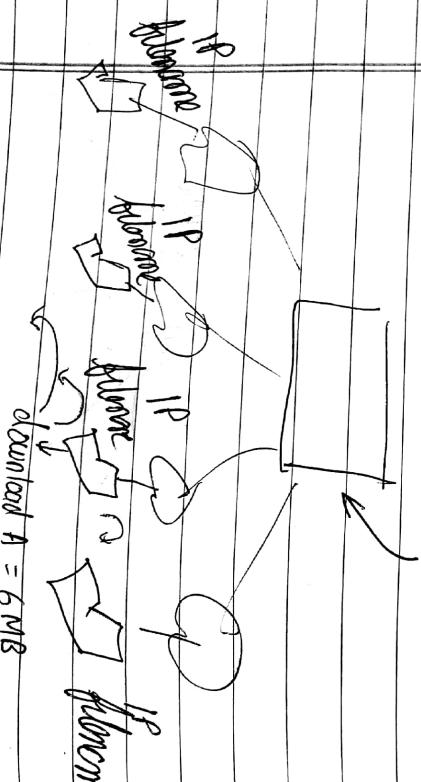
Date: PREMIUM



→ Server keeping money as initially
nodes paid to Server

where is content hosted?
how will nodes resolve

Maintain Central Directory:



download A = 6 MB

1-2 3-4 5-6

5

Part to (car)

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MENAJ

Bit torrent: ~~can't download until upload a chunk.~~
↓
store more

now

download hacker: which chunks are available with
which peers.

Notella - we don't use registry / rather peers
query each other.

query everywhere in connected component,
then just send data directly to query.

Probabilistic → tries connecting to nodes
switched on previous version.

dependence on registry reduced.

Karla to Zoo
always online.

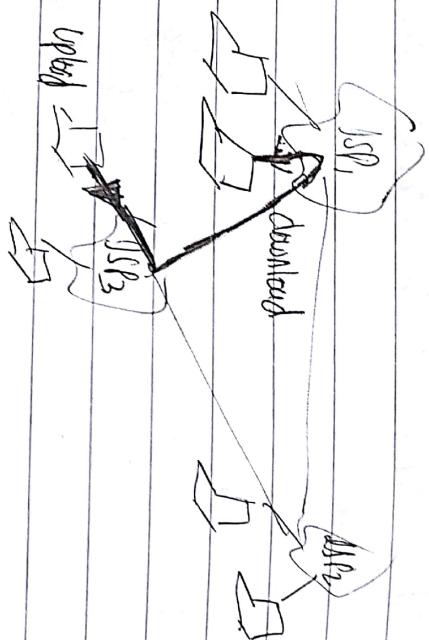
introduced
super peers.



super nodes main list of
(peers, filenames)

o John
limit every port.

= hierarchical



Plans:
512 kbps download
256 " upload

ISP
60% 40% peer to peer
download upload the report unused
upload bandwidth

After class
we download to distributor
done.

Home caching helps.

Part Solution

ISP perspective, download traffic data exchange local is beneficial, or else ISP, pay ISP2 for traffic

That's why we use Akamai within ISP.

Akamai → original servers
ISP ← Akamai

ISP friendly peer selection policies.

Throughput & L

Download Time

fake clicks

movies. is → advertisements → click fraud →

impressions ? \$23/1000

clicks = \$100

↓
[Dumb]

ads

leakage →

movies

flipkart → [A lot of copies] → ta.com

1 million → ↓ ht.com

so you → rythm.com

App Moving

MEMO
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✓ UDP - source & destination port

No syn, syn-ack, ack.

DNS is application
runs on UDP

↳ I want to find IP of www.google.com

UDP: High couple of time to DNS else reply
couldn't resolve.

✓ # no congestion control / reliability / handshakes

✓ UDP may share out TCP traffic

8/9/17

- ✓ Reliability → TCP
- ✓ In order delivery → TCP
- ✓ BW guarantees *
- ✓ Delay guarantees (Ensuring congestion)

voice over IP?

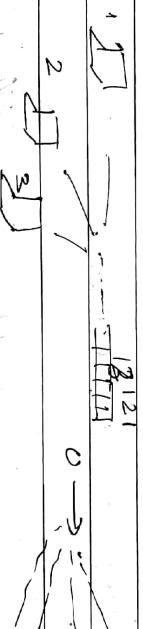
No IP ; 32-64 Kbps

150 ms

Reliability * 1% packet loss is OK.

DNS - UDP

TCP helps avoid congestion.



First come First Drop

Random dropoff : more fairness . I who

Sends more has higher probability of getting dropped.

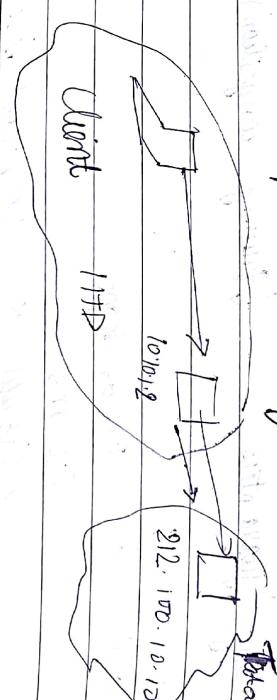
When my TCP connection loses packet → they react and slow down.

But UP doesn't slow no potential danger of starving TCP source traffic.

TCP vs UDP

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DNS uses distributed database - leverages spatial and temporal locality.



Org : created → new host

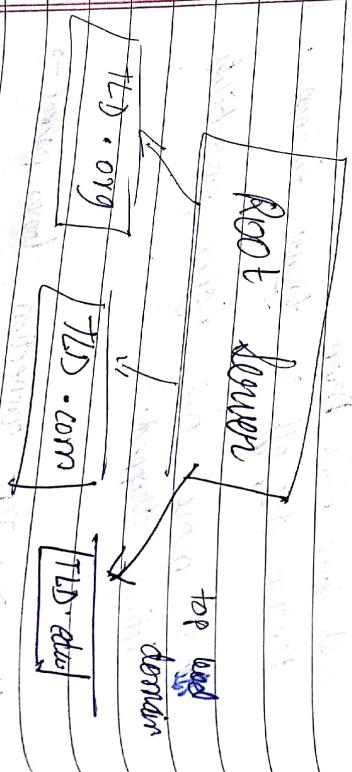
①

Client ask local DNS .

(DHCP gives IP of DNS server.)

Proxy to
Company [GV] • web
⇒ running apache
server on Port 80

② If not in L1L DNS, query to DNS .



domain name: ~~www~~.google.com

actual server: www.google.com

ceef

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✓ when I create website, I update TLD server.

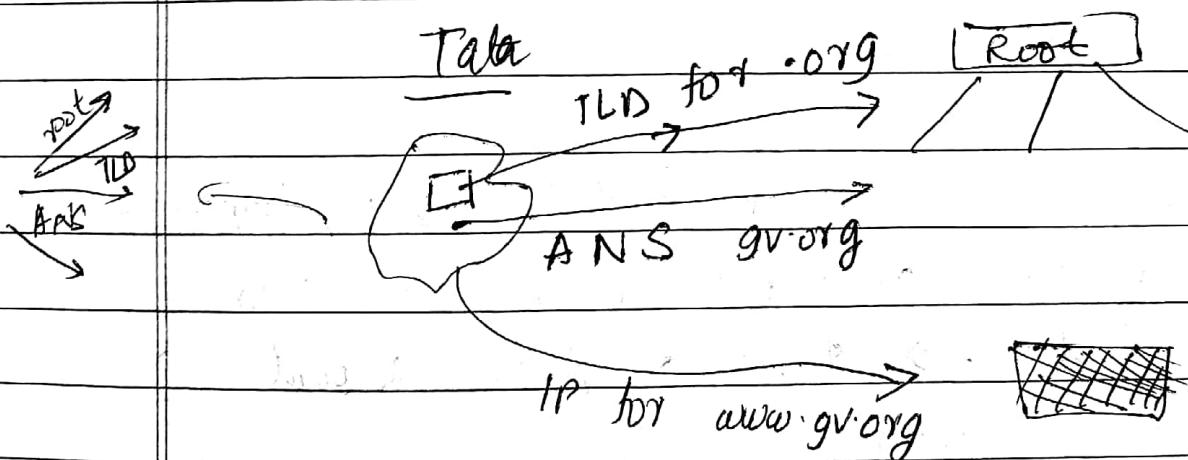
host name
www.gv.org
mail.gv.org
imtp.gv.org
imap.gv.org } = all on same IP different port

(ANS)

(NS)

Linode runs on authoritative name server

Updates TLD.org
Authoritative name
server for gv.org = 200.200. - - -



Send mail? send to MTA server →

Query what is mail server for gv.org? →

Similar querying

Caching at Tatta level • dont query for TLD

Server: Cache keeps getting enriched with local data.

scans

- Central db need to pull much info from multiple sites coming up tot of ANS

some time

1/day batch to synchronize

14 DNS optimization: Need name related data as well

Cache Poisoning → looks most website imitated

as same as HDFS. poison cache → instead of

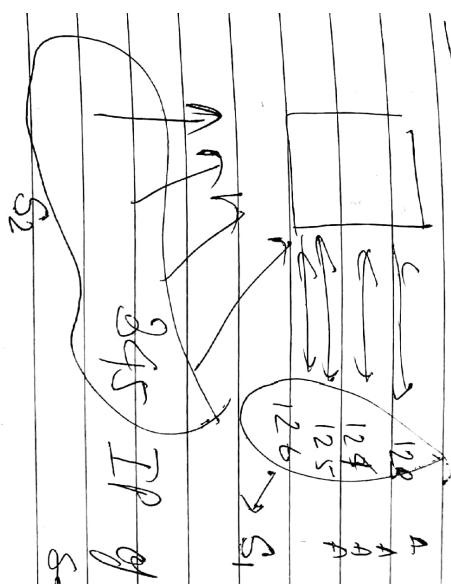
HDFS → direct to fake account → get credentials.

look for ratio tenure. • HDFS gets certificate

from Global Certificate issuer • Verisign.

Add exception ⇒ unauthorized Certificate

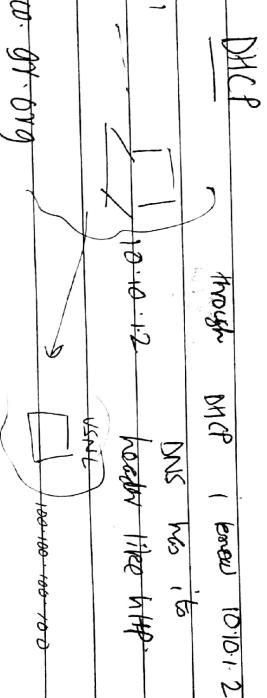
With permissions not encrypted, a spoof ID.
 (spoof reply)



$S_1 \cap S_2 \neq \emptyset \Rightarrow$ attack successful.

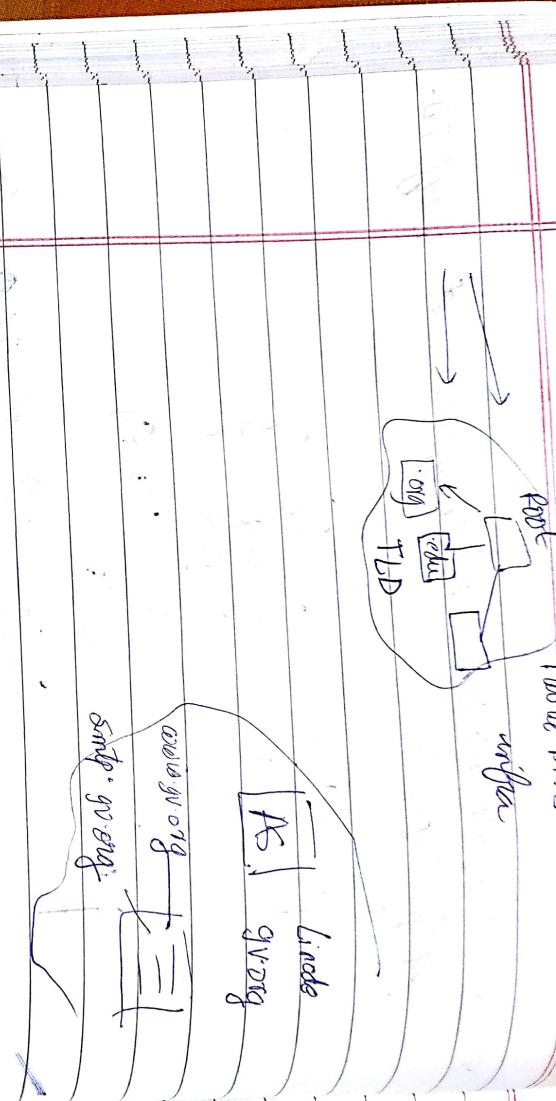
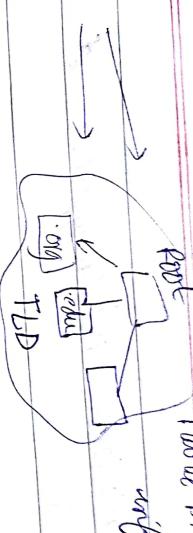
Something

245 IP of ~~gr@ng~~ is



A: www. gr.org ← Identification

As usual adds more confusion, they need to
 keep increasing size of DNS.



AS : Sends some more info apart from queried (www in mail) servers.

ip

all types of DNS requests & replies

DDoS Attacks

VS
Recon

Hacking into DNS most common just put in dummy website and trick passwrods

While talking to DNS, someone ~~comes~~ ~~comes~~ and send fake reply, although later might get correct reply

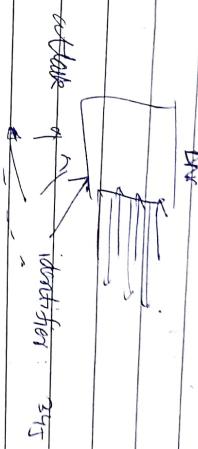
Blanchet
A: www.GV.org
Mr. GV.org

Photo: No.
Date: 09-09-2014
MIFARE

Birthday Attack:

such DNS request has unique \rightarrow ID (16 bits) ~ 65535

Try option 1



$$1 - (65535 / 65535 - 1) \dots (65535 - n)$$

65535 - n

$$1 - \left(1 - \frac{1}{t}\right)^{\frac{n(n-1)}{2}}$$

↓
reco.

$$\text{Select rand } 1 - \prod_{i=0}^{n-1} \left(1 - \frac{1}{t}\right)$$

Master Poll

- bit channel \rightarrow part spectrum allocated is small \rightarrow one for co-ordination \rightarrow set of all which mobile will up data \rightarrow large bandwidth allocated to Mta \rightarrow master poll \rightarrow who wants to send data \rightarrow co-ordination easily.

Other: hypothetical all participating thought of energy in space

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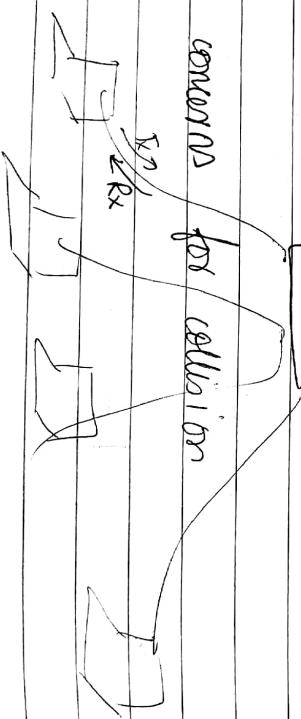
One slot are given \rightarrow under utilization may happen if it stops small amount of data.

Start time: Check others is functioning

14/9/17

switch

\rightarrow No concerns for collision



Transceiver for every single port switch to connect to.

Old day: Hub.

Q3

Hubs Other



(a)

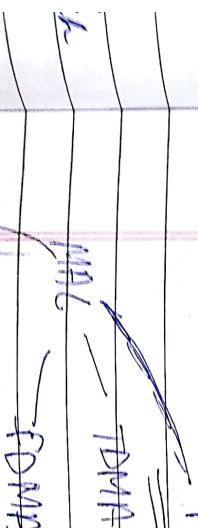
Fast packet transfer \rightarrow like wider \rightarrow ~~longer~~ acquisition. Need MAC's control.

(b) Token Ring : No chance of collision!

- \rightarrow Must use much cheaper (hubs/label)
- \rightarrow And less collision but slower of link.
by minimizing them.
- \rightarrow Economic Reason making about hubs.

MAC

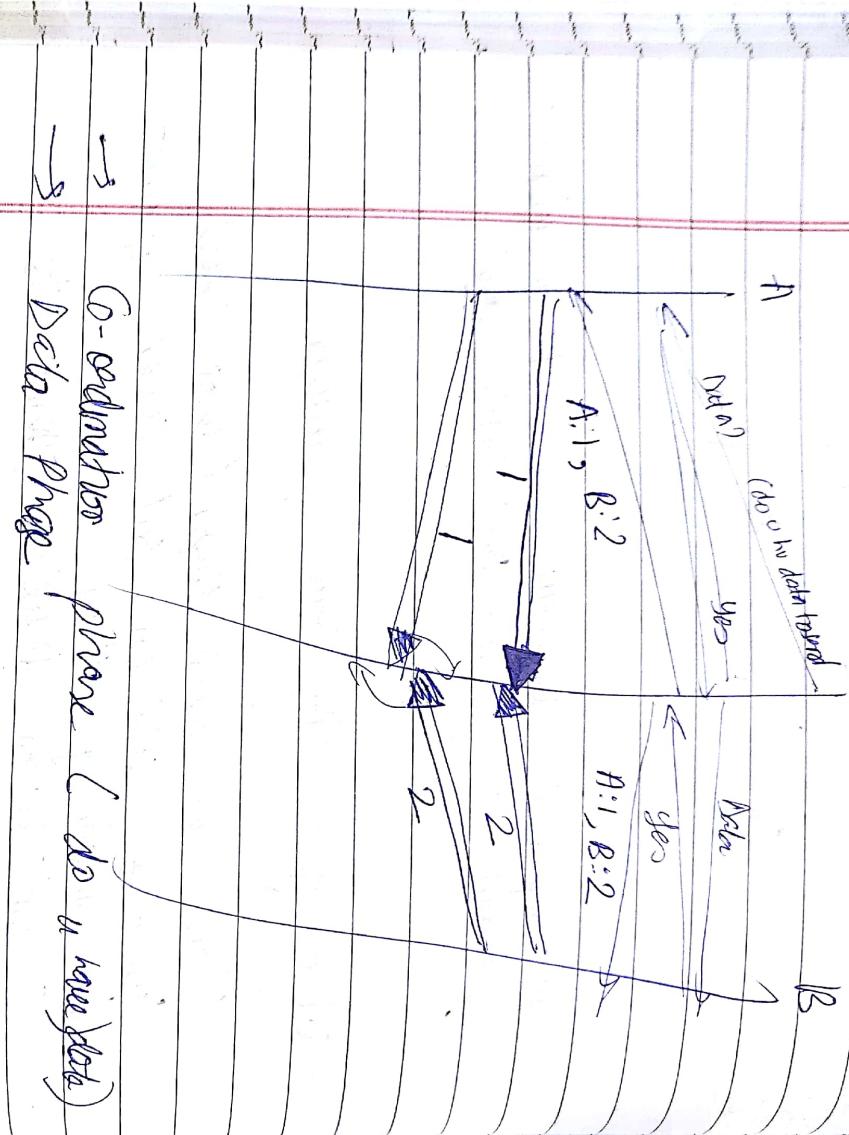
Each node is told when to transmit



\rightarrow Random Access : CSMA/CD, Aloha

\rightarrow Token Ring :

Concurrent Hub



→ Co-ordination phase (do u have data)
→ Data Phase

- 1 Avoid interference
- 1 Overhead of coordination phase.
- 1 Underutilisation → not sending much data

Cellular: They do TDMA.

- 1 freq data: Other freq: Polling
- Channel → u have data
 - o have data

(Nov)

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CDM : — ~~at~~ receive side. Controlled by

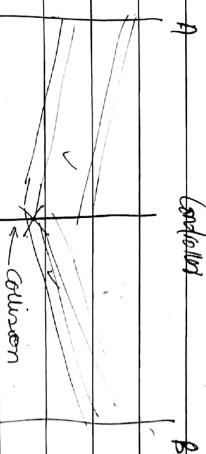
- Initiates hub sending data.

DMA : code division multiple access.

- Have 5 codes. Give 5 code to 5 diff paths.
- May vary from transmit. Code used for modulation of electrical signal in diff ways.
- Any eavesdropper will be forced to have of some interception.

Hub

Random access : ~~not~~ And slotted model.



$$P = \frac{1}{4}$$

$$Q_i = P(1-P)^{n-1} \rightarrow \text{prob when } P = \frac{1}{4}$$

now

now

36% of these transaction successful.

$$n-1: \frac{1}{4} \quad n: \frac{1}{4} \quad n+1: \left(\frac{1}{4}\right)^{n+1} \quad n+2: \left(\frac{1}{4}\right)^{n+2}$$

All in order for them each other.

Ethanol

All can heat all. Some carrier and divide.

Controllles



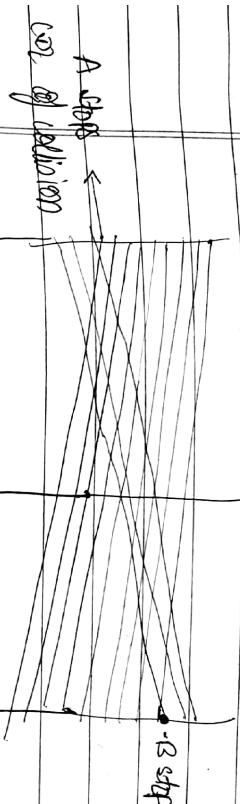
cost of prop delay, B
was unaware of A's

GRAD H
collision
formation.

What Collision and stop

With CD

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Slight improvement. Instead of
selected global just send, send carrying

medium and decide, take some
channel bandwidth. Both node detect
collision,

Ethernet class = random backoff \Rightarrow
at random interval; to give room to
other

Exponential random backoff

1st collision $\rightarrow \{0, 1\}$ keep increasing backoff time
2nd collision $\rightarrow \{0, 1, 2, 3\} \rightarrow 2^n - 1$ no of
3rd $\rightarrow \{0, 1, 2, \dots, 7\}$ nodes

$R \times 512$ bit times

Randomly chosen

bit time — time to write 1 bit on wire.

$$\frac{1}{10 \text{ Mbps}} = \frac{1}{10^3} \text{ s}$$

wait at start every message

frame size $\approx 48 \text{ bytes}$

A Controller

B



A thinks no packets went fine.

B realizes there had been collision. But they say and stand again -

A has misconception (cost of small piece of data), unless if A sends larger, then collision would have been detected by B as well.

No minimum size helps estimate collision

bit time = time to write 1 bit on wire.

$$10 \text{ Mbps} \quad \frac{1}{10^3} \text{ s}$$

solve at ~~at very memory~~

frame size ≈ 48 bytes

A. Controller B



A thinks ~~the~~ packets went fine.

B realises there had been collision. But why and again -

A has misconception (cost of small piece of data), when A sends larger, then collision would have been detected by A as well.

No minimum size helps estimate collision

Time for the answer

10Mbps



Ethernet wants to $\left(\frac{\text{join} \rightarrow 2d}{ID \geq C} \right)$

So that collision is actually detected.

No if really small msg, we had names with 0.

$$2d \approx 2^{100} \quad \text{min } \approx 10 \text{ bytes}$$

get to find:

~~2d~~ \approx ~~2¹⁰⁰~~

$$\text{Jmin} \Rightarrow \frac{4d}{C}$$

A

Controller

B

Processor

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$$\frac{S_{min}}{R} > \frac{W}{C} < ?$$

200 m

everyone can hear every!
Hub is just copying data from 1 side
to other.

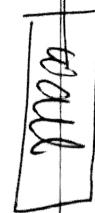
Wireless

A → CSMMA

hidden terminal

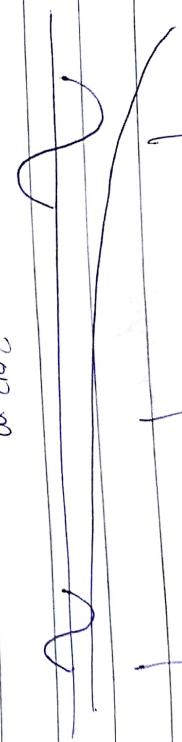
problem.

CSMA



A

$$\frac{S_{\min}}{R} > \frac{4\pi C}{R} \Leftrightarrow ?$$



Everyone can hear every!

Hub is just copying data from 1 side
to other.

Wireless

A \rightarrow B hidden terminal



problem.

B

→ Channel Partitioning : TDMA / Frame

→ Random Access : Aloha

↳

who is speaking when, and
u get chance (Toss a coin - each node)

↳ no co-ordination, decentralized

① Aloha — Slotted : Synchronise, when a slot starts and ends

↳ slotted

ends

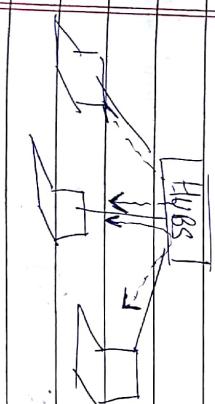
② CSMA : sends carrier

CSMA/CD : — random backoff.

(exponentially ↑)

↳ in ethernet we must have min frame size

↳ distance b/w over which ethernet is laid out



↳ Broadcast Medium

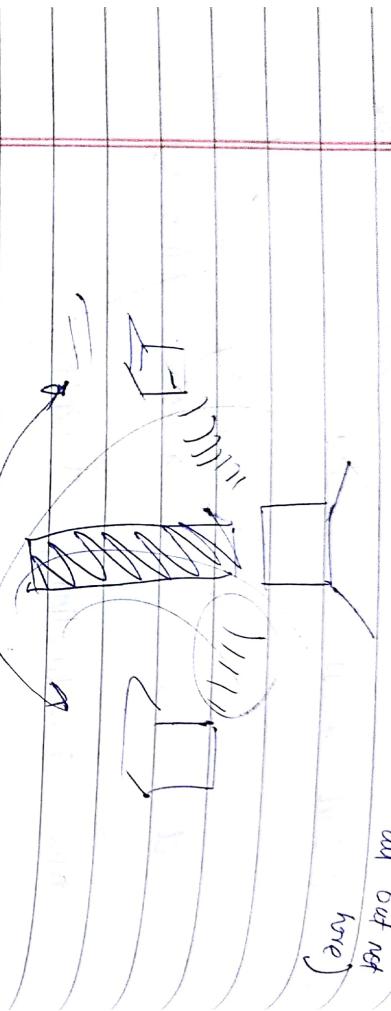
↳ Unlike TDMA, Frame, it is

Covert uncoordinated

Very simple : NO

Hidden Terminal Problem

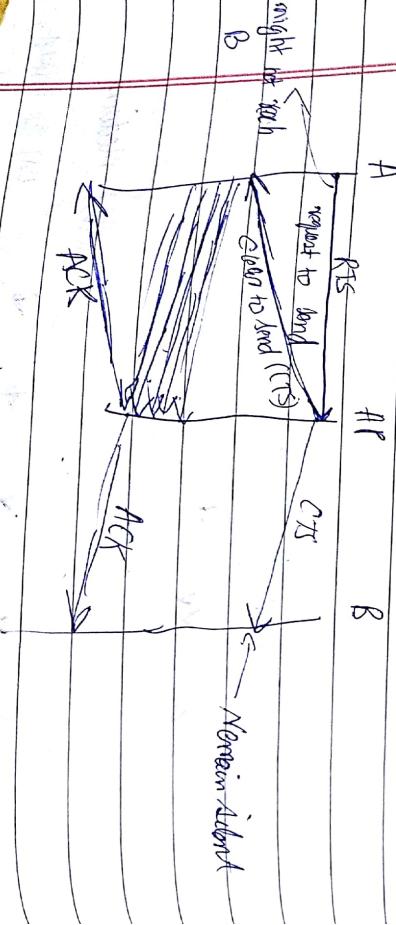
(Every can hear
all but not
here)



station A is transmit

Interference is happening at receiver.
Sending happens locally.

CSMA with CSMA :-

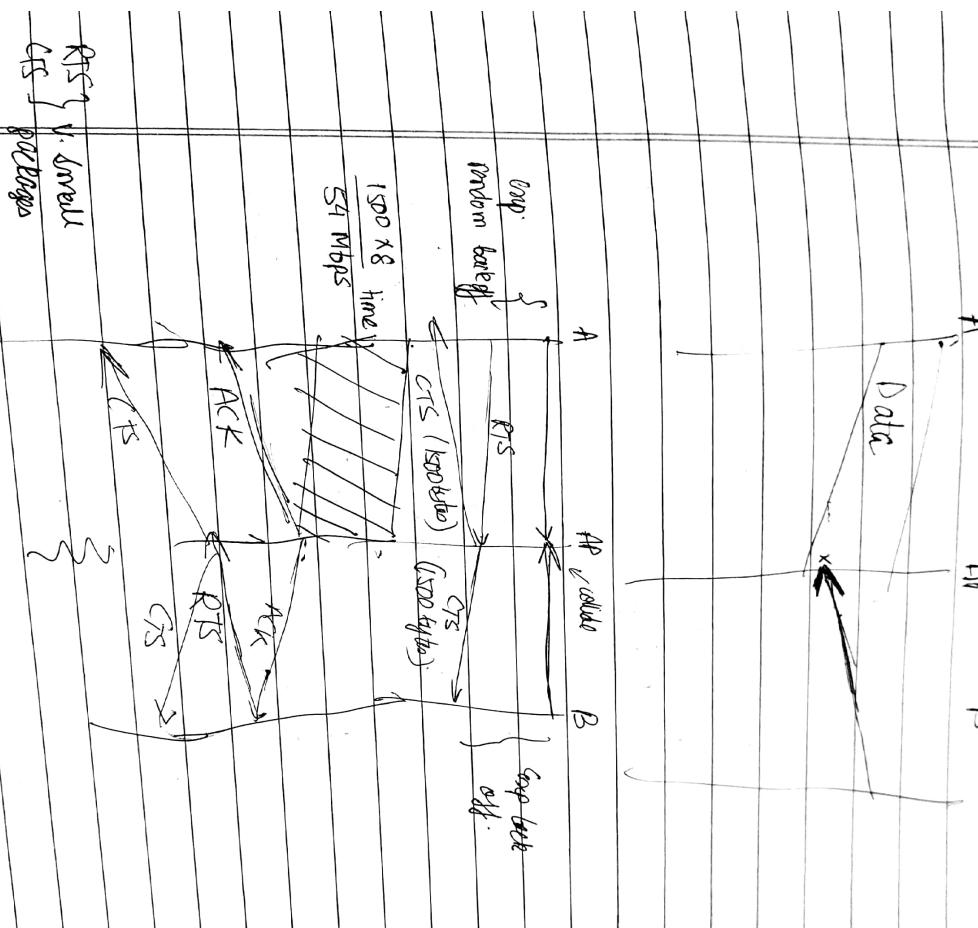


Avoiding overhead

A

B

Data



CSMA with Collision Avoidance

Collision

two to minimize collision

Ethernet tries to avoid collision overhead of

CSMA: completely avoids collision overhead

overhead packages

1/10/24/110 21 GHz

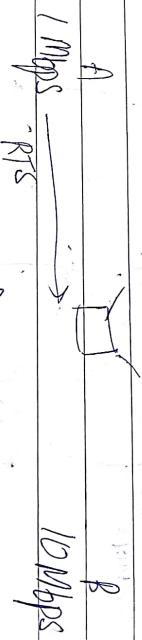
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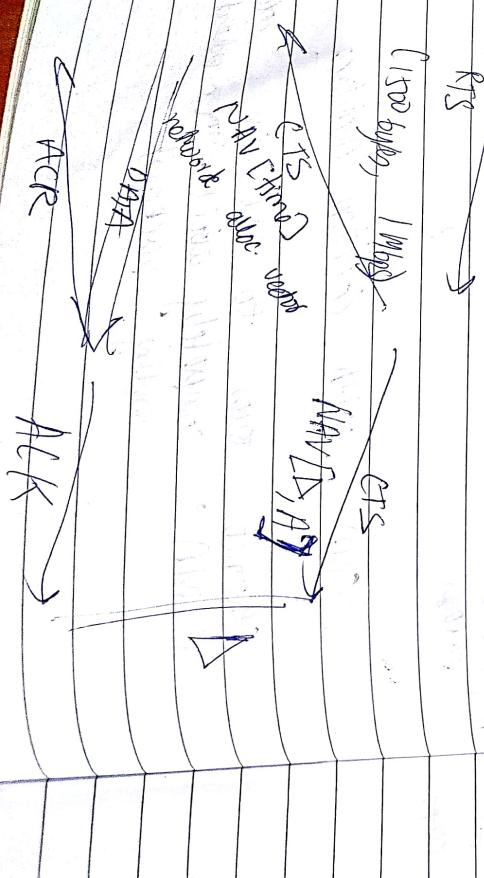
1 bit

way for

Q1: How do notes are from access point, signal strength



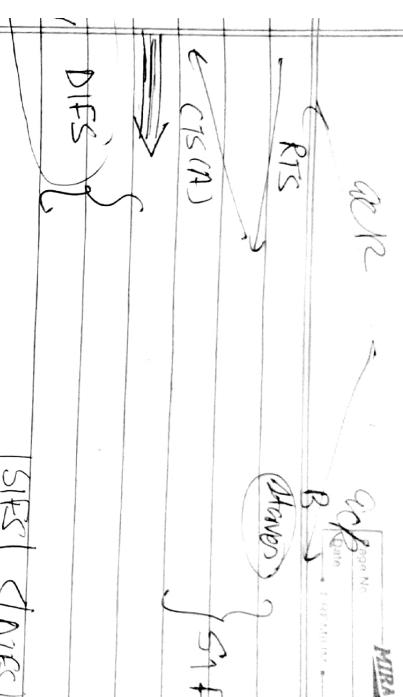
(1500 bytes / 1 Mbps)



AR

Arp
B
Shower

MRAJ



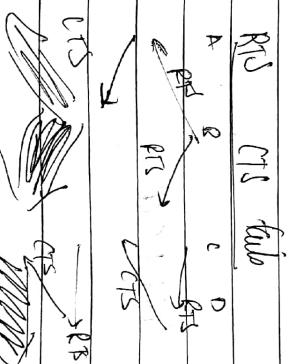
Save mobile battery - No carried hearing while A

then send RTS.

Exposure Problem

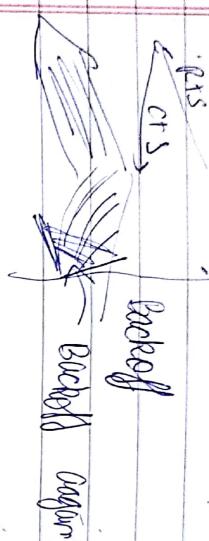


both B & C don't care about collision, do not
sense



{ Backoff

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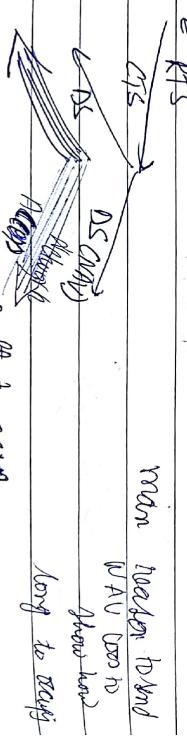


- ✓ Under capacity
- ✓ Node getting channel in previous round keeps getting channel again and gain.

RTS - CTS - DS *data send*

- Data

RTS - ACK



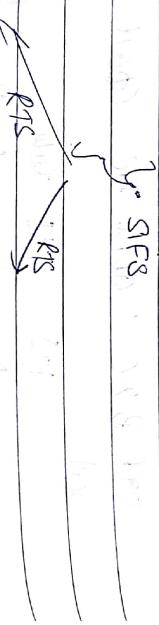
Main reason to send
WAV (short to
show how
long to occupy)

Although

Short CSMA

RTS

CTS



ad hoc network

C doortred A's NAV.
All doors

RIS no guarantee that Wong is  **MIRAS** 
Date: every Sunday

↳ packet is what carries NAV for telling C how long will packet channel will be occupied.

$\alpha \leftarrow \beta$ $\beta \leftarrow \gamma$

Again it

RPTS-RJS-CTS-DS-Mta-AcR

1999 MACAW Nadawur Bhongam.

$$f(x) = x^2$$

$$N_p(1-p)^{n-1}$$

$$\pi(1-p)^{N-1} = \pi(N-1)p$$

$$\frac{1-p}{p} + 1 = N \quad \text{at } N = 1$$

$$\frac{1}{N} \left(\frac{N}{N-1} \right)^{N-1} = \frac{1}{N} \left(\frac{N}{N-1} \right)^{N-1} = \frac{1}{N} \left(\frac{N}{N-1} \right)^{N-1}$$

We discussed wireless MAC protocol.

Ethernet - Sine detection - every packet of for
~~the~~ minimum area ether

lets try to minimise effect of collision
& size of ethernet network.

Wireless medium similar to ethernet but
hidden terminal problem.

Bauer follows inverse square law
CTS

can't do collision detection in wireless

so CSMA/CA :

Expose : cause starvation. RTS - CTS - DS

Billing vs Token Ring.

RJS-UIS-15

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Taking Turns protocol

→ Polling : some kind of co-ordination

→ Token Ring : who has token is allowed to send.

Only 1 to run in network.

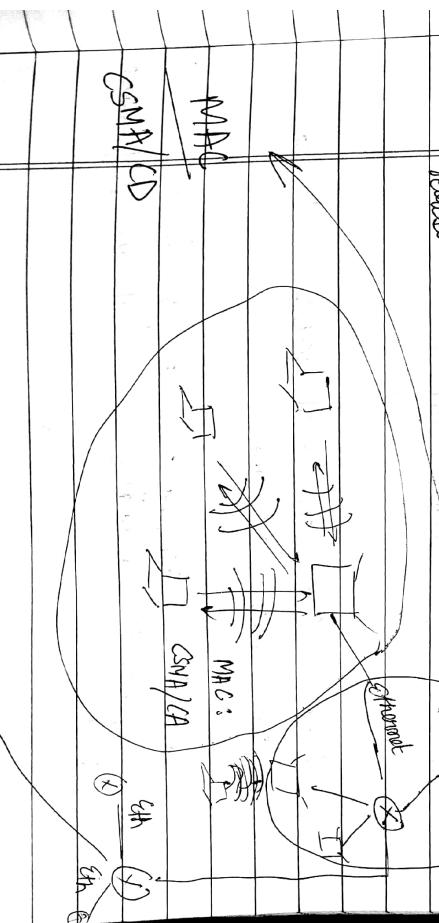
Send data (let 2 to 3). Then back to 4 to 5 to 1 to 2. Release token now.

data (1-5) = 1-2-3-4-5

Ack S-1 before

physically hub but its topology represents a ring.

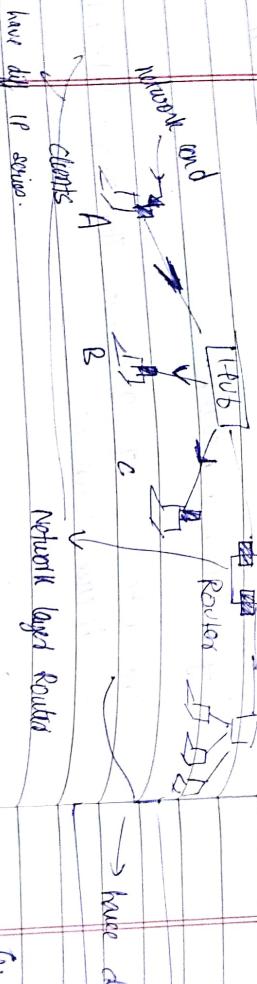
↙ Note become indicative - hold token and not release



1 MAC → MAC → MAC

Ghorout (more of a hub)

To



give

have diff IP servs.

✓ Two network card

When A send, Hubs sends to B, C and all
as Router

① Is the frame meant for me?

Give

Wi-Fi - all nodes receiving signal?

✓ P

P

Network card listening to all packets → has to
make quick decisions

IP - keeps changing → Adapter has to be
implemented in hardware or real time performance
needed.

To keep competition low, adapt

adpt. only phys.

→ base diff. (P frame)

Given: Adapter is hardware.

hardware address sent into adapter port.
MAC address.

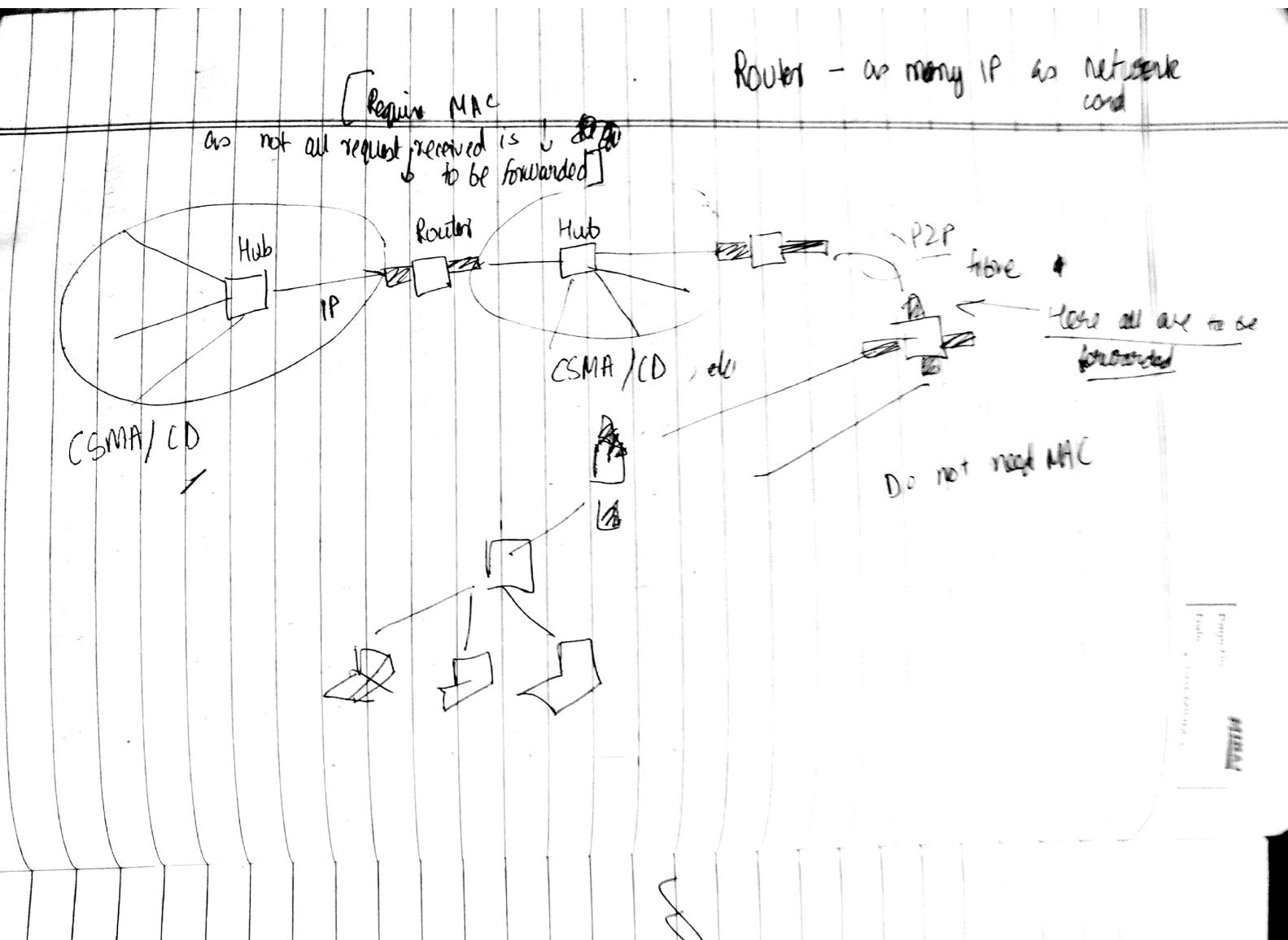
Just check its my own hardware address

✓ IP address changes apparently ~~on same~~ on different ports
plugged in

CISCO limit broadcast address inside chip

Adapters are listening to all packets on LAN, they have to filter out:

a) Alternate, check off IP always. ~~long~~
Computation expensive.



how Router know Client MAC A?
how Client know?

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LL → dest MAC = ab ab ab ab
Net IP = 200.200.200.200

TCP

Date

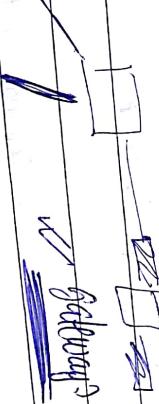
Router →

✓ Router do MAC address lookup

Router

(P2P we know Router to Router)

Router



✓ Gateway

2/9



DNS Cache
ARP Cache

MAC address # for receiving broadcast from.

- ✓ do computation for layer above
- ✓ 48 bit address.
- ✓ Broadcast MAC address: FFF FFF ... all 1's
- ✓ Endpoint of host endpoint is routed - called gateway
- ✓ DHCP server gives IP addr.
 - ↳ Also IP of DNS
- ↳ Also gateway IP addr.
- LL destination is hardware address of gateway route.

ARP sends ARP packet (broadcast), ask for MAC addr. of gateway (particular IP)

Router's hardware resolved using ARP protocol.

Network card of other nodes reject packet.

Link layer of Router has to add link layer Address. ARP query generated.

Link layer : SRC MAC
dst MAC of
ARP cache
Router facing
LAN

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Gateway is 1st exit point.

All ports other LAN

11.111.111.* to Lan1 222.222.222.* to Lan2

DNS, like DNS, app: layer protocol running on UDP.
↓ has pool of IP addrs.

UDP Port 67.

DHCP discover: only this is running DHCP on Port 67.

DHCP server

hardware
addr
(hosting)

why particular period? you may decide to walk out - without releasing the IP.

some IP allocated → resolution problem → whom to send?

have manual configuration, no DHCP request generated \Rightarrow

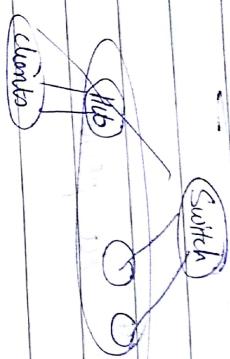
Hub — speed — privacy! ... it's... networks

how ~~per~~ switch knows other is correct?

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✓ Hubs : too much extra work \rightarrow If switch "played with"

hub, too much broadcast.

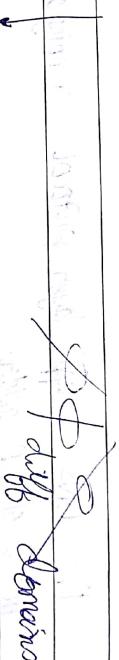


switch : self learning / build up memory.

which node

is where:

switch : Collision domains \rightarrow



Layer 2 device

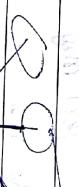
Hand off ~~switch~~ collision domain \rightarrow diff domains

~~Hand off~~ : What if I disconnect and connect to other place?

_expire

the dish while moving.

end user —



kind of ~~switch~~ \rightarrow the switch point to point.

what about spanning tree

Router IP-MAC
Switch MAC-link

Pragya MIRAJ
Date: 10-10-2018

Ethernet MST : Spanning tree protocol

Algorithm -

Switch learns which Hub network to send data to. # self learn

FFFF broadcast

ARP request to broadcast MAC.

partition LAN into different segments

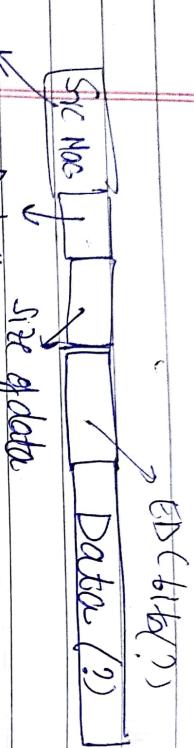
LAN

Switch

MST port of bridge

LAN's identify shortest switch route

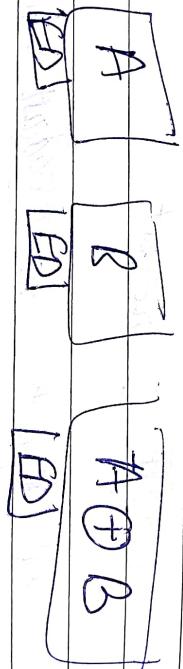
when lost error > wired transmission



48 bit
A data
MAC
Raddr

DS function

$EDC = f(Data)$



FEC: Forward Error Cor.



1001

1100 1000

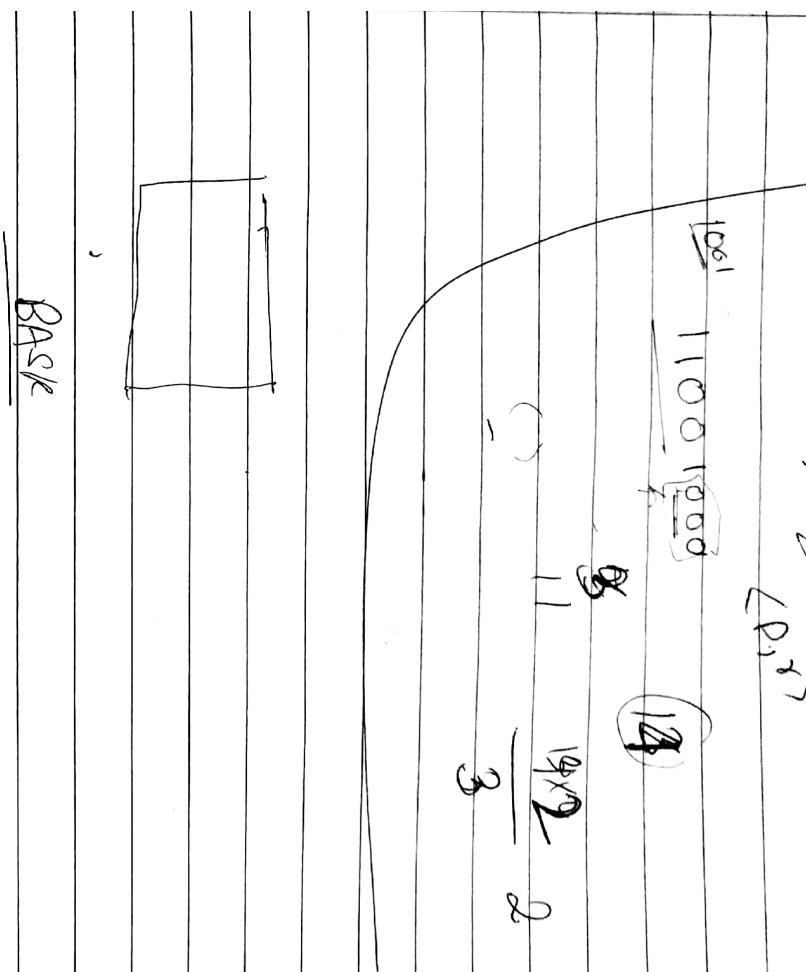
11

14x2

3

2

LP, 7



Binary Amplitude Shift Key-

Modulation controls bit rate (3 waveforms)
1 bit

Encoding: How to get synchronise clocks
at 2 ends of physical layer.

NB2 : new return to 0.

Not more than 3 consec. 0's in 4 bits

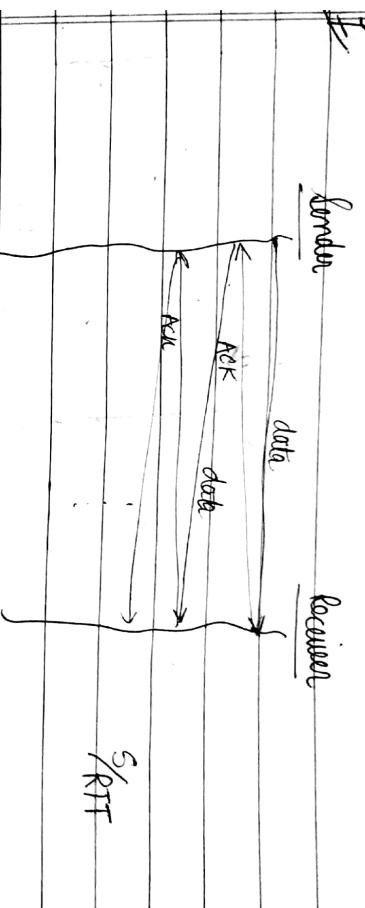
If lot of 0's re synchronisation of
receivers clock does NOT happen.

Predefined mapping

Pick and choose amongst 32, 16 such
that u don't have more than 3 consec.
0's.

Q3

find loss only when u recv ack.



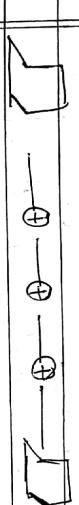
Nack more efficient

1 RPT per 3

$$\frac{3S}{RTT} = r$$

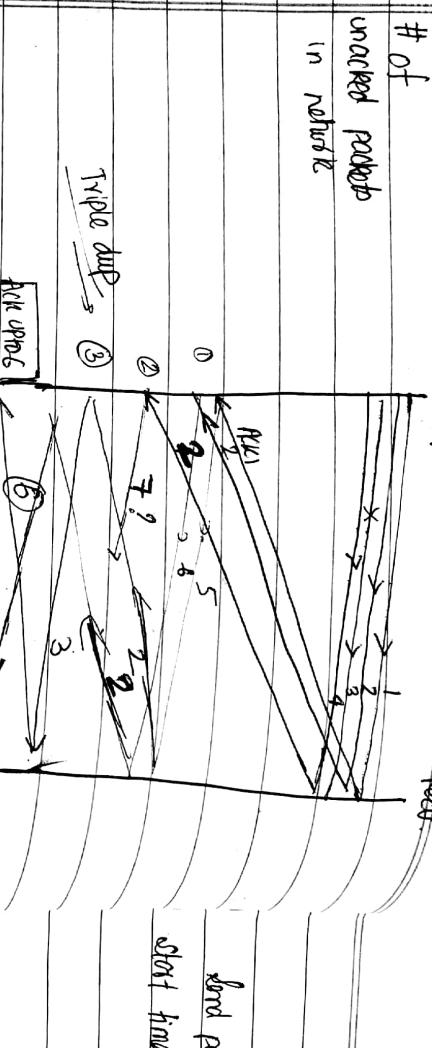
Mention 3 unacked packet

R/T



Sender
Receiver

of
unacked packets
in network



so Back N: Recv. keeps ack. b/c packet it recvd.
wont say recvd 4.

Selective: Recv would mention 4.

Sender realise → only Ack for 2, why?

Heuristic: Sender says if I recv 3 ack for some packet I believe that packet has been lost after that. / or it got reordered. ✓
(3 Acks ??) → [Triple Dup ACK]

More likely Pack 3 is lost

blending T is questionable for sender # how
congestion do I want to be.

→ Or slows down rather.

Timeout

Send packet,
Start times for H.



out in 3

Sender Receiver

Time

→ Triple dup: network delay but not v. vbad. (flaky but not terrible)

Timeout: whole bunch of packets lost.

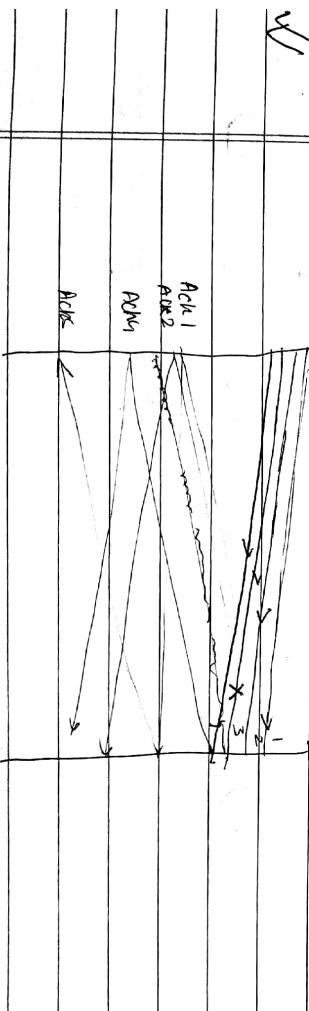
if 4, 5, 6, 7: all lost → no triple dup ack, timeouts

handy

→ faster because timeouts are very high.

Sender

Receiver



→ Fast return → triple dup ack

→ # of pkts sent after dupack.

→ Timeout? Dup keeps track of RTT

$$RTT_{avg} = \alpha RTT_{avg} + (1-\alpha) RTT_i$$

$$\alpha \approx 0.85$$

Round trip deviation : Timeout = $2 RTT_{avg} + 4 \tau$

standard deviation

+ TCP

Packet have sequence no \rightarrow 1000 byte

Sender receives

seq=0, len=1000

Ack = 1000 \Rightarrow 0 bytes

Ack = 1000

len = 1000

Ack = 1000

len = 1000

Network layer

(link layer)

1500 byte

Ethernet \square \circlearrowleft \square \circlearrowleft \square \circlearrowleft \square

old channel

Support 1500 bytes

What to do?

Network layer takes packet and chops it.
Send 500 at a time.

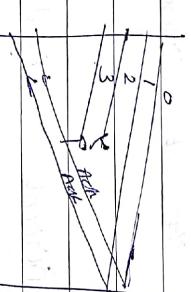
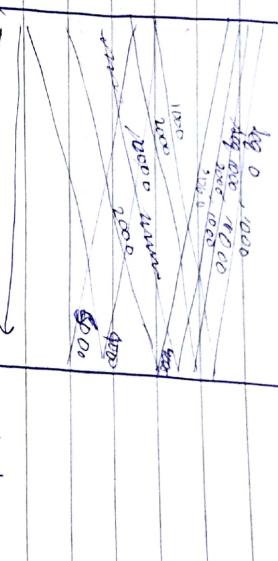
TCP putting byte no helps in chopping

How network layer do it / cheap

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Sender

Receiver



TCP Workers on divide and conquer style



✓ ✓ ✓ ✓ ✗

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Header

frame
16 bit
32 bit seg no [from whom starting seg no]

16 bit
32 bit seg no [from whom starting seg no]

//

If connection broken —

and if same 4 tuple → confusion.

Syn packet: starting seq no I use is
— (random) or

In case my flagging packed left,
they don't face confusion / ambiguity

w/
Full duplex protocol : send - receive

Acknowledge next No: acknowledge last byte

→ seq receive +1, what
if (sender) expect to receive next

Non TCP segments can't send/receive
(no bytes ? can I send)

Non segment size → part of TCP →
negotiation done at start.

Connection closure — Fyn packet

SYN Packet :- State maintenance

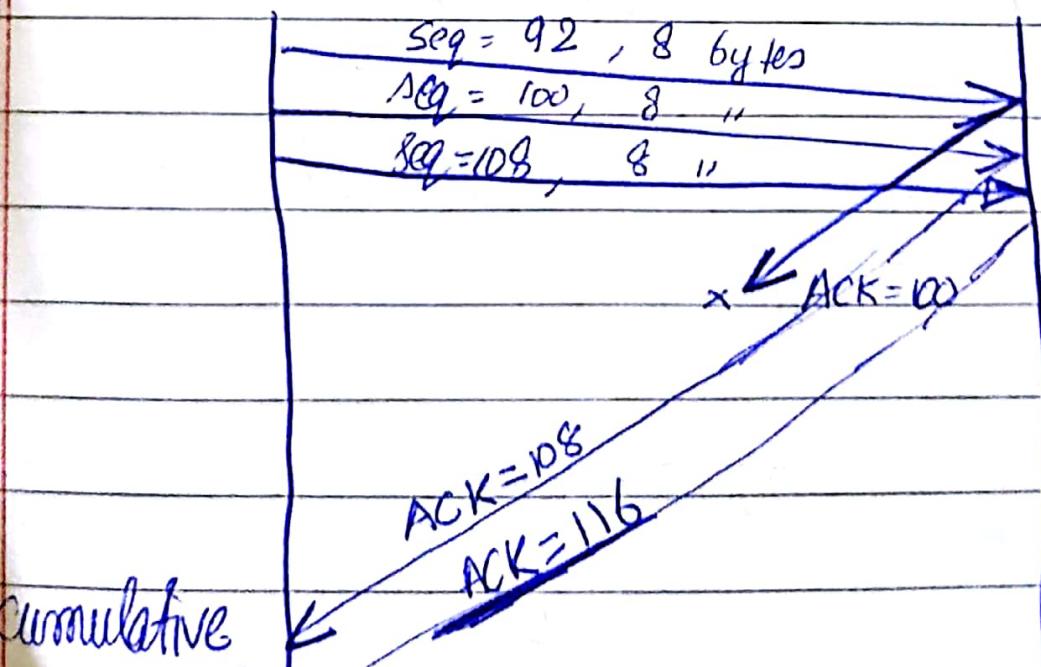
A sends to B: seq no imp. of A

Ack: Next byte B is waiting for.

Avoid separate data & Ack Packet

A: ack bit

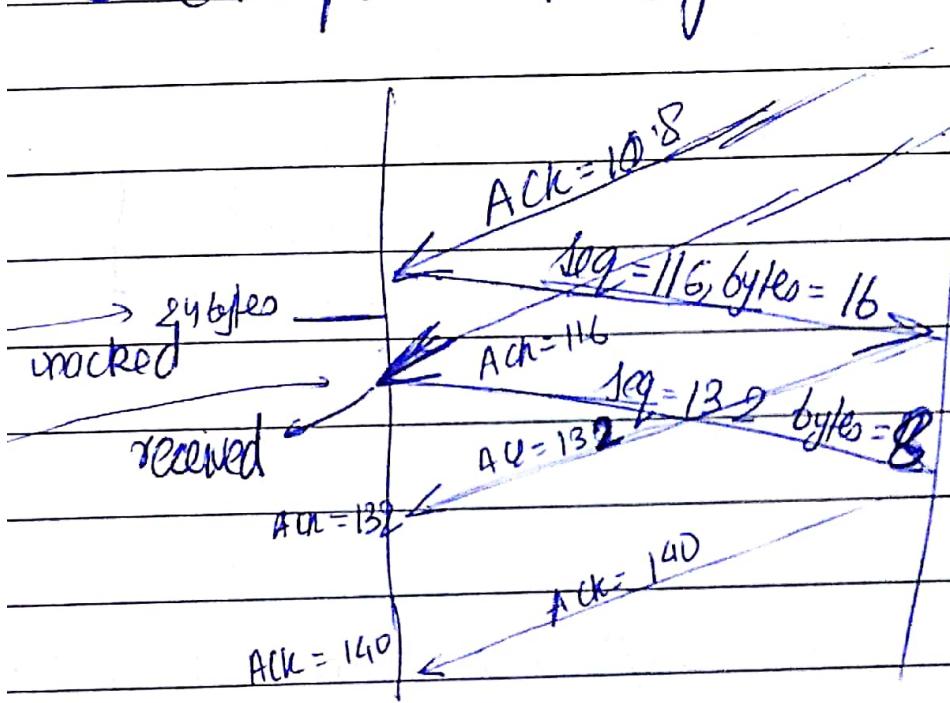
Dynamic RTT : Exponentially weighted moving averages \rightarrow dynamic timeout



TCP: how many unacked bytes:

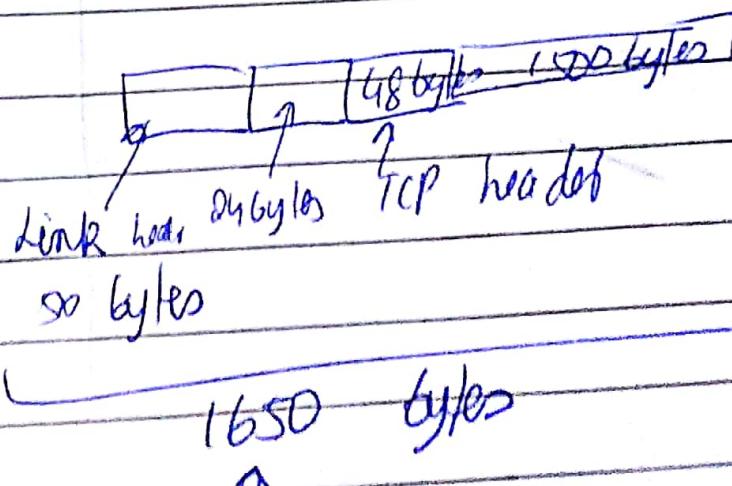
24 bytes in network

Ack for 108 \Rightarrow received 16 bytes \rightarrow bytes.
I can push 16 bytes.



If some preceding ack.

TCP has MSS: max. segment size
 $MSS \approx 1500$ bytes



\ hubs exist ? //



How long packet u should send so that bit errors are small.

BER: bit error rate = p
 Δ bits in packet

$$P(\text{Corrupt}) = 1 - (1-p)^n$$

$\sim SP$ Longer packet
 Higher correction chances

How large room size we need in LAN? net

④ ssh - character by character is sent
header >> data.

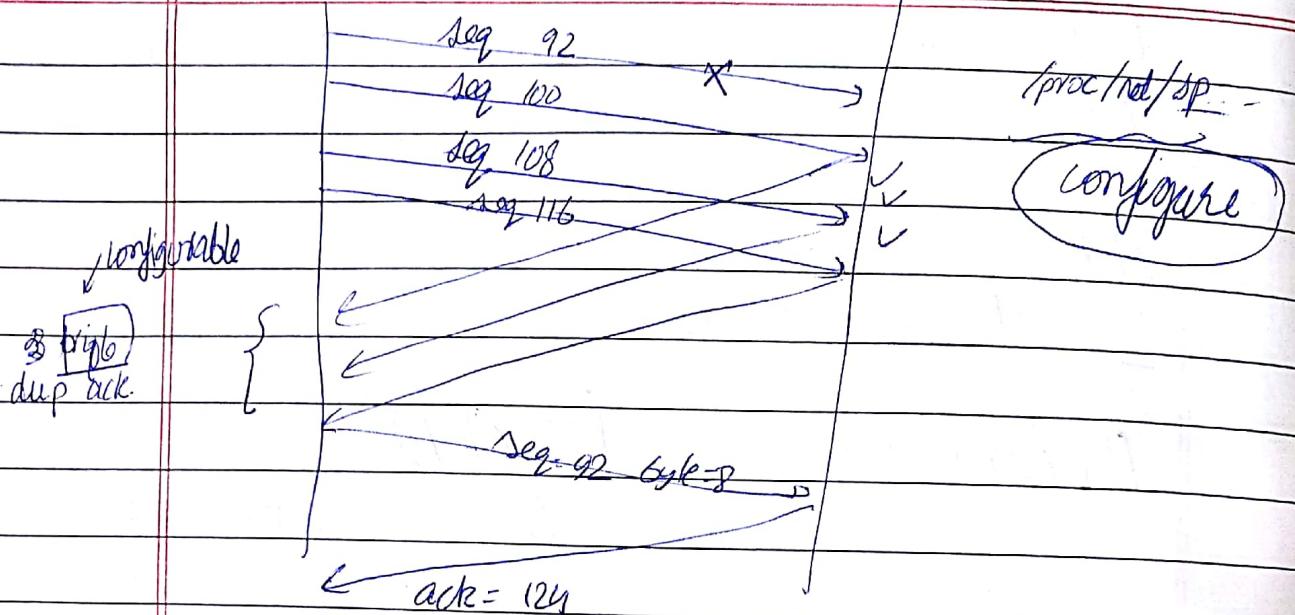
what is does while Ack's ?

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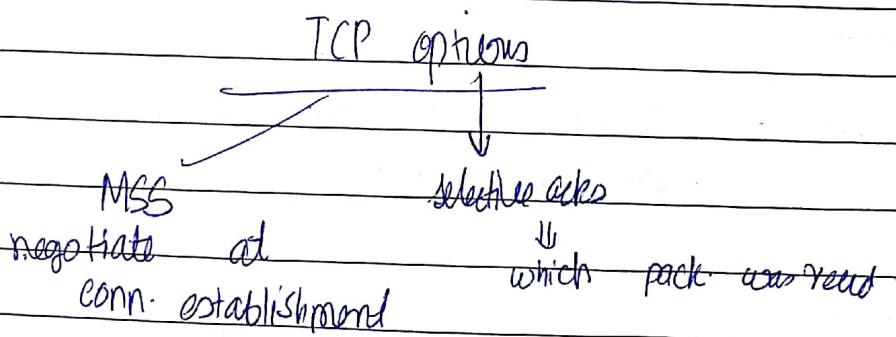
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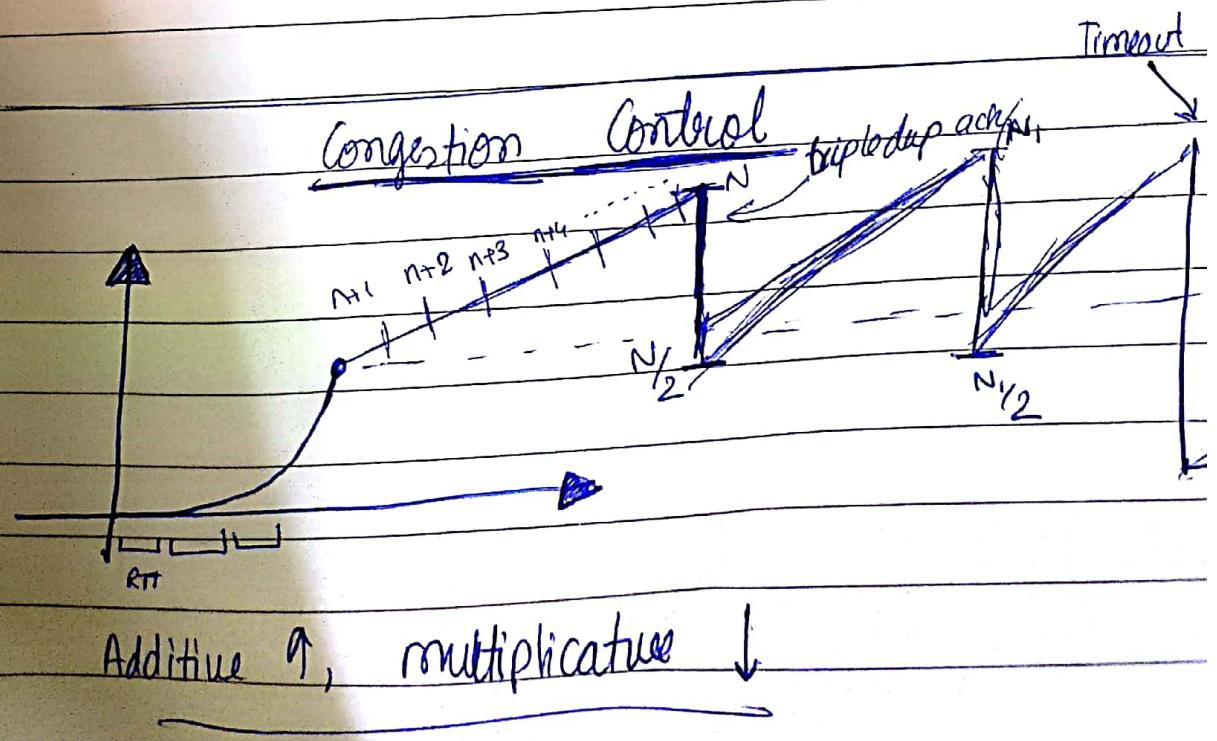
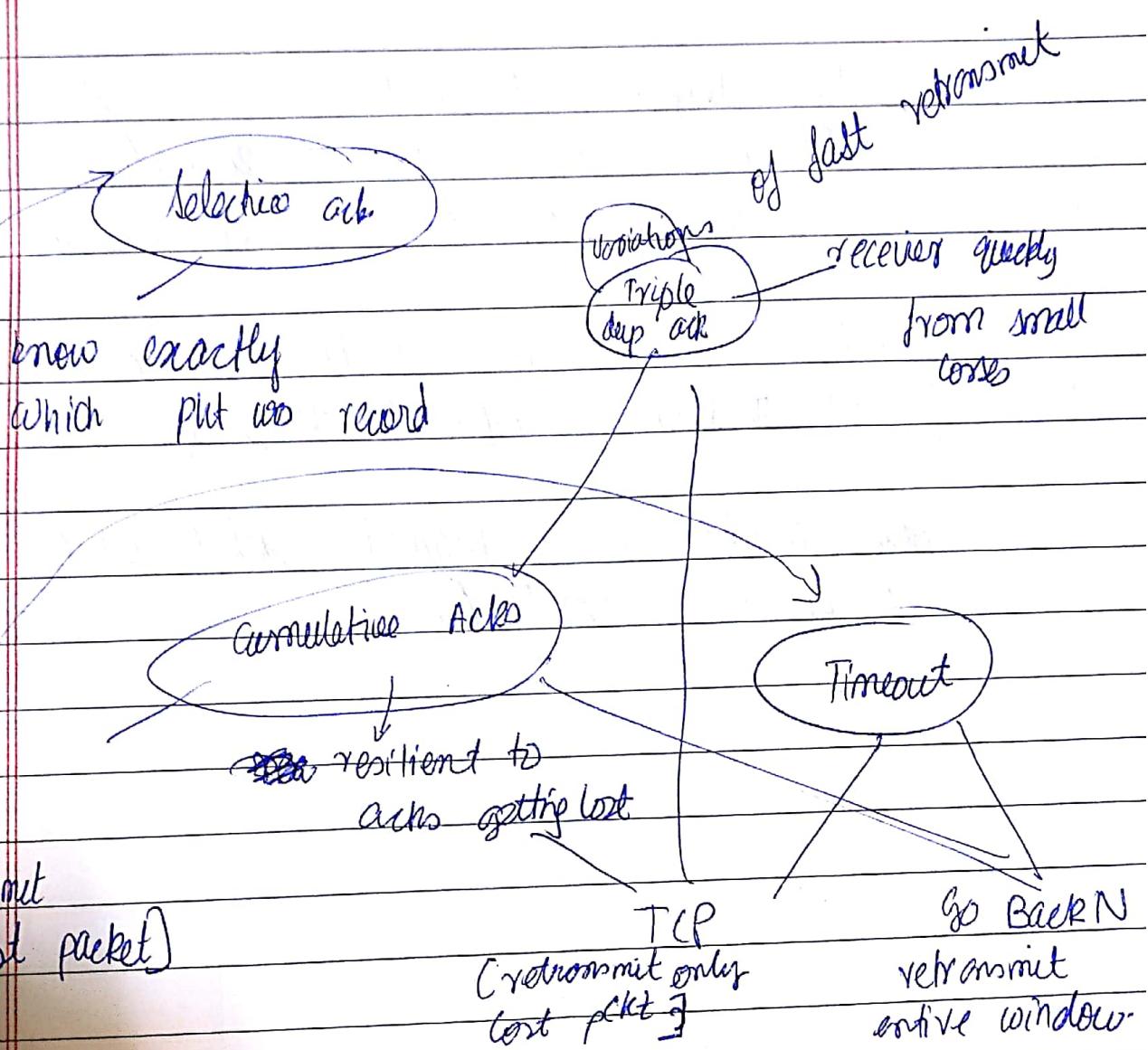


In cumulative we don't know what was acked



Selective ACK disabled \rightarrow dont know which was recvd.
(Packet was of diff sizes)

Cumul. Acknowledgments : If acks are lost :



$$\text{Bandwidth} \propto \frac{1}{\text{RTT}}.$$

Potential danger at TCP

↓ Benefit: use some signals used for reliability → exploiting signals ^{indications}

could be done in network layer -
[want to keep simple (router)]

~~Also~~ Would have helped detect UDP congestion control,