Computer Networks

Exchange of Information, sharing of thoughts, it is some way of achieving communication.

A protocol is a set of rules that governs the communication in an interface. Eg: IP, TCP, UDP, FTP, SMTP, DNS.

components
1) Message - Text, Image, Audio, Video
2) Sender
3) Reciever
4) Medium - Wired or Wireless
5) Protocol

For the implementation of communication → computer network
Computer Network - It is a collection of autonomous computers /communications which are interconnected by some means in a localized manner in order to share or exchange information.

autonomous: that cannot be forcibly started or stopped by giving some remote instruction.

9/1/23

Computer Networks
(based on area coverage)
LAN MAN WAN

- Rate of Transfer Speed (Data transfer speed)
  Highest → LAN
- Error rate → minimum (because distance is minimum)

Repeater → low energy signal (input) rejuvinates the signal to the near original strength (output) by removing the residual noise to a great extent.

MAN → network spans within a city.
Eg: Distributed Queue Dual Bus (DQDB)

WAN: (Wide Area Network) connection between two countries. Eg: Internet.
Adv: Maximum area coverage
Disadv: Data transfer speed is slowest.
Error rate is highest.

(Based on Accessibility) (computer network)

Internet — (network of different computer network)

Intranet — (organisation uses private network)

Extranet. (identical to internet, but some private resources)

* either a network can be made public only under the supervision of the network administration).

Network Criteria

Performance

* Transit time → lower the transit, higher the perf
* Response time
* Throughput → amount of data transmitted through a reference point per unit time.

Time required for a corresponding message to reach back to its source.

lower the response time, perf is higher

Topology

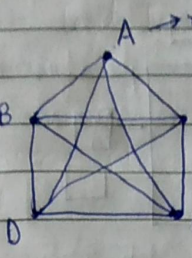
↓

physical structure of network

→ How computers in a network are connected

1. Mesh
2. Star
3. Bus
4. Ring

① Mesh:



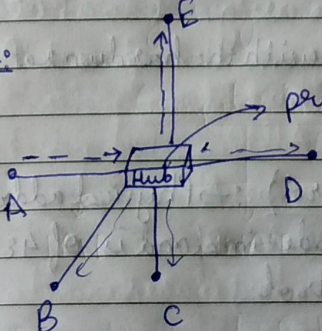
Advantage:

1. All connections are dedicated data transfer - fastest error rate → minimum
2. Connection is robust → If a connection is torn apart then it will not affect the other connections since it is dedicated and end to end connection.

Disadvantages:

1. Installation cost is highest → least popular

② Star:



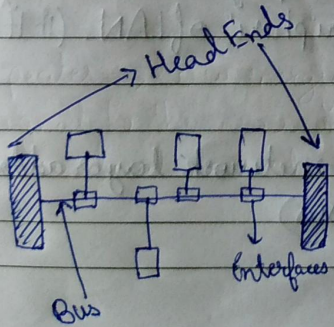
→ provides end to end connectivity

Connectivity is direct connectivity

Disadvantage:

1) No data security → no end to end connection
2) If hub fails, all computers connected comes to a standstill

③ Bus:



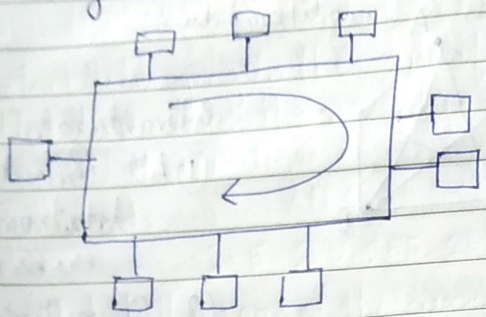
BUS → Bit Unification System

↳ serial mode of communication

↳ at a time only single bit can be transferred.

① No data security
② Collision: If two system generate data at the same time then the data collides and is irretrievable.
Most popular topology → minimum installation cost.

④ Ring: → Ring will ~~also~~ always be in unidirectional.



There is a master station that has the responsibility of generating a token and will pass it as circum navigate. It will generate domain, and whoever comes the ~~tod~~ domain first, token will be transmitted

Addressing : Addresses must be unambiguous
Two types:
① Physical → comes with the hardware
② Logical

NIC → (Network Interface Card) :→ Physical address is implemented with this
Address is coded in hexadecimal and is of 48 bits.
MAC → Medium Access Control

Requirement of PA
If a machine equipped with physical address can start communication within the periphery of LAN. (If it has NIC with MAC address)

LA → assigned by software → network layer addresses
Network protocol (IP addresses)

A5-3C-01-BB-9D-EF : MAC address

1 hexadecimal digit = 4 binary digit

12 ——— = 4*12 = 48 bits

(IPv4) Addressing → Addresses allocated to a computer is of 32 bits.

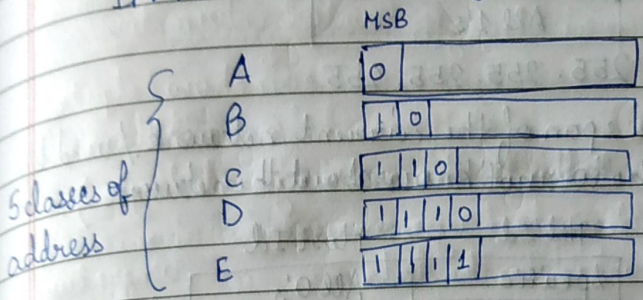
11010001	00011000	11000011	00001101
125	78	59	120

this addresses

A user friendly notation is accessed by subdividing into groups of equal length.

They are seperated by '.' known as

IPv4: 125.78.59.120 } Dotted decimal notation



	Decimal	$\frac{2^{31}}{2^{32}}$ = 50%
A	0 – 127	
B	128 – 191	25%
C	192 – 223	12.5%
D	224 – 239	6.25%
E	240 – 255	6.25%

A, B, C } Host Identification

D → Multicasting

E → Future use

A message to be delivered to every host → broadcast

Multicast.

NetId	Host Id

↓

For class A → the leftmost byte (1) and rest (3)

41. 220.38.191

0-127 ↓

class A Host Id

↑

netId

For class B → (2) (2)

For class C → (3) (1)

Special Addresses:

① Loopback addresses : 127.0.0.1
used to perform network diagonistic operation

② Directed broadcast address:

Net Id	Host Id
Specific	All 1's

All the host belonging to the specific network will be entitled to receive the message.

③ Limited Broadcast: All 1's
255.255.255.255
limited to the span of the current network / used by some one who does not know about the network)

④ Network Address:

Net Id	Host Id
Specific	All 0's

class c 205.36.89.0
Address of the 1st host on the network is the network address

⑤ Network Mask: It cannot be assigned to a host. The purpose is masking the host bit from the network IP.

net Id	host Id
All 1's	All 0's

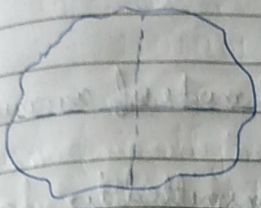
Default mask : 255.0.0.0 } class A
255.255.0 } class B
255.255.255.0 } class C

IPv4 A.B.C.D
^1 ^0

⑥ Private address:

Subnetting

When a network is logically subdivided into smaller network it is subnetting. • Division is done internally.



Subnet Mask: NOM | All 1's | All 0's

Subnet Id

All 1's	All 1's (N/H)	All 0's

255.255.192.0

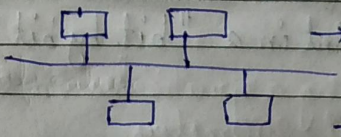
Types of Connection

- Point to Point
- Multipoint

Common example: Internet

It is the client who requests for a server.

Multipoint:

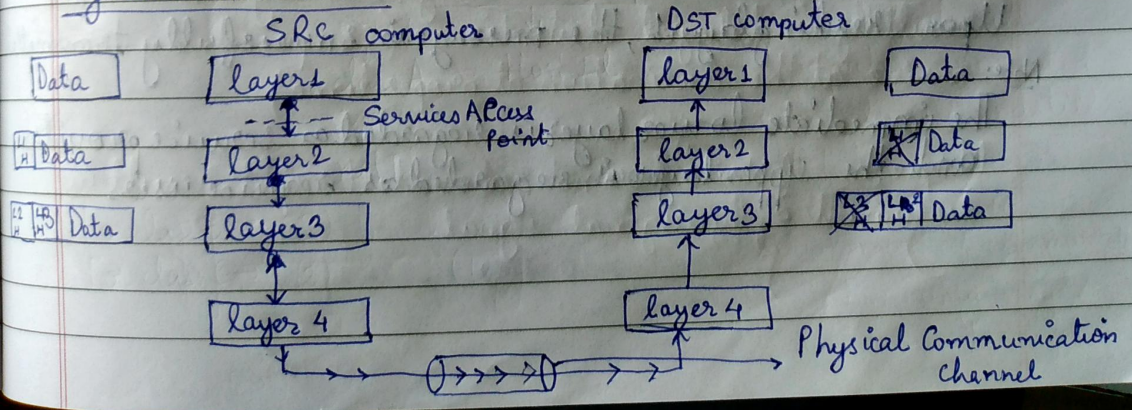


→ Example: mass communication

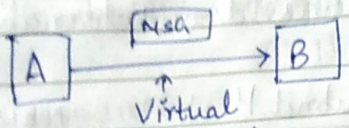
→ No dedicated connection between any 2 parties
→ common connection is used.

Network Software

Layered Architectures



Layer can be regarded as an active entity that is able to transmit data inorder to achieve communication



mode = (Not actual mode of communication)

Msg is generated at layer 1 and transmitted to layer 2. Layer 2 will attach some additional information inorder to build (L1H)+(Data)

additional information → Control information → somehow helps to forward the message

Now layer 3 is provided with the message at layer 2 → where two headers are attached

layer 4 is the penultimate layer.

No headers are attached to the data bcoz it directly communicates with the physical medium (communication channel)

It will be transmitted in a "bit by bit" manner.

In lower most layer 4 of destination computer, the data is transmitted in upward direction. Now in layer 3, the layer 3 header is removed since the purpose gets diminished

In layer 2, the layer 1 header is removed to convert the message in original form.

Upon reaching layer 1, the message is successfully transmitted

Note:

The immediate lower layer is regarded as service provider and the upper layer is regarded as service user.

Purpose of SAP:

Physical Communication channel includes some errors which cannot be removed from the DSI computer.

The noise that cannot be removed from a channel is called white noise. It cannot be removed completely.

Recivers needs to acknowledge what errors are included in the message so the sender does not have to resend saving valuable time. → Error correction by re-transmission → (automatic repeat request) ARQ scheme.

Error → Error detection
→ Error correction

Flow Control : Communication between two comps having significant speed difference, where recieving speed is much lesser than sending speed (problem).
Use of buffer takes place, that stores the message for a finite amount of time.
Copy of the sender buffer is kept in order to transmit it again and again to recover from the error.
When a sender sends a message by starting a timer. It acknowledges message is sucessfully recieved by analysis the Acknowledged time (re-transmission time)

OSI Reference Model → Open Systems Interconnection

Physical Layer

Design Issues : Deal with the problem related to a specific layer.
Breach the difference in operation.

Physical layers uses some devices to breach the operation gap.

Transmission Impairment
1. Attenuation
2. Delayed Distortion
3. Noise

Attenuation

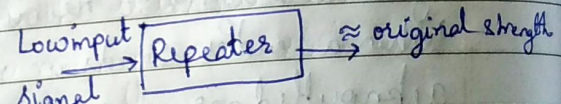
1) In order to overcome stiffness of the medium, some energy is converted from electrical to heat energy, some information gets distorted. — attenuation → loss of signal strength. *when*

2) If the signal travels over a longer distance, there may be weakness in the signal strength.

* The metallic wire offers a stiff resistance to the transmission of the signal and in order to overcome this resistance, some amount of electric energy will be converted to heat energy, so thereby if a signal needs to traverse after a while it may become big and at some point of time it will become unrecognisable.

(to Attenuation)

Solution: Installing a specific device called repeater at a distance interval of 200 meters.



Delayed Distortion: $S(t) = A_1 \sin \omega t + A_2 \sin \omega t + \ldots$

Different fourier components travel at different speed taking different time, there may be delay in them, thus resulting in delayed distortion. (components do not arrive at the destination at proper time)

Noise: If Noise ~~does~~ is not removed, it might result in distorment of the original signal.

IP Addressing

A company has been granted a site address 201.70.64.0
The company needs to have 6 subnets. Design the subnets.

8 subnets
256/8 = 32 addresses → Each subnet
1st sub → 201.70.64.0 → 201.70.64.31

NetId	Sub	Host
24	3	5

- The problem of address space depletion.
- Countering measure

Supernetting : Using class C addresses to satisfy the needs of the organisation

Classless Addressing

CIDR Notation

Classless Inter Domain Routing

A.B.C.D/n → prefix → those bits that doesn't change

prefix = 32 - suffix

167.199.170.82/27 → 2^{suffix} = no. of addresses
→ starting and last address.

01010010
01000000 → S
01011111 → L

167.199.170.64 → S
167.199.170.95 → L

a) An organization is granted a block 130.34.12.64/26
The organization needs 4 subnets. Design the subnets.

prefix = 26
suffix = 6
address space = 64

256 256 256 P1100

Each subnet 64/4 = 16

1st subnet → S → 64/28 S
→ L → 79/28 L

80
97
98
113
114
129
130
146

Q) An ISP is granted a block 190.100.0.0/16. The ISP needs granted to distribute the addresses into three groups of customers as follows:

i) The 1st group consists of 64 customers, each needs 256 addresses

ii) The 2nd group consists of 128 customers each needs 128 addresses

iii) The 3rd group " " of 128 customers each needs 64 customers

Design the subblocks and give the slash notation for subblock. Find out the how many are still available after these allocation.

$2^8 = 256$

i) Suffix = 8

190.100.0.0/24
190.100.0.255/24

256 × 64 = 16384

ii) Suffix = 8

190.100.1.0/24
190.100.1.255/24

iii) Suffix = 8 190.100.2.0/24
190.100.2.255/24

6 3.0/24
6 3.255/24

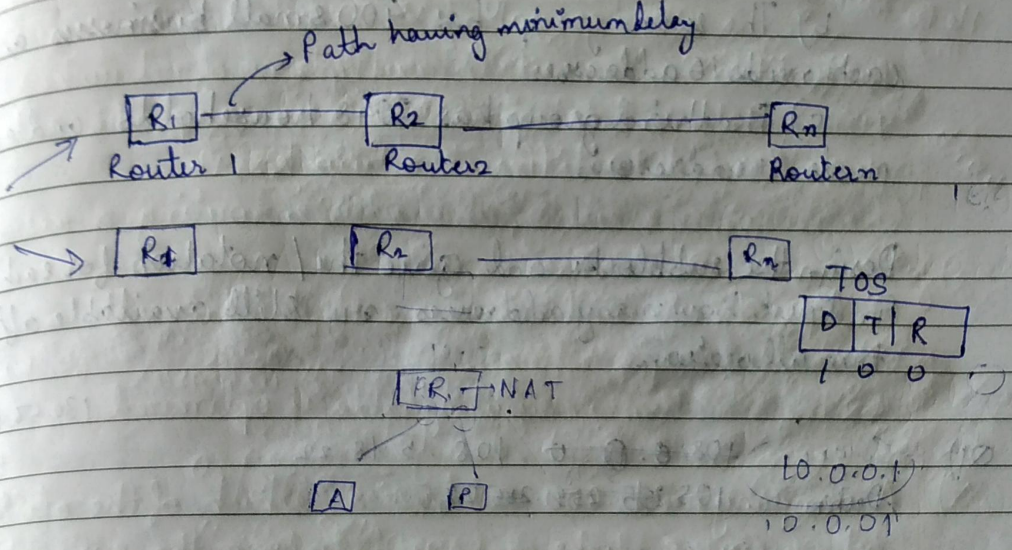
OSI Reference Model

① Network Layer

② Routing - Routing decision that must be taken by a device called a router.

Routing is a process of choosing a route from source to destination when the number of alternate routes are available in order for choosing a particular route, the router must take collective decision so that the traffic along that route at that point of time is optimal and the route chosen must also be the optimal route one based on several criteria:

① Data Transfer Speed ② Reliability ③ Throughput



Q1) A router has an IP address 108.5.18.22. It sends a directed broadcast packet to all hosts in the network
What are the source and destination IP addresses used in the packet?

Q2) In a class C subnet we know the IP address of one of the host and the mask as given below

IP address: 182.44.82.16

Mask: 255.255.255.192

What is the network address and the broadcast address in this subnet.

28
64
92

11 above

Q3) An organization is granted the block 130.56.0.0. The administrator wants to create 1024 subnets.
For
a) Find the subnet mask
b) Find the number of addresses in each subnet
c) Find the 1st and the last addresses in the 1st subnet
d) Find the 1st and the last " in the last subnet.

Q4) An ISP is granted a block of addresses starting with 150.80.0.0/16. The ISP wants to distribute this blocks to customers as follows:
a) The first group has 200 medium size businesses and each needs 128 addresses.
b) The second group has 400 small businesses and each needs 16 addresses
c) The third group has 2048 households and each needs 4 addresses.

Design the subblocks and give the / notation for each subblock. Find out how many addresses are still available after this allocations.

Q1) Soure: ~~108.0.0.0~~ 108.5.18.22
Destin: 108.~~255.255.255~~ 255

Q2) 182.44.82.16
$2^6 = 64$
182.44.82.0 → network
182.44.82.64 → broadcast.

Q3) ~~No. of hosts / subnet~~ = 2^{10}
$(16 + 10) = 26$
$32 - 26 = 6$
255.255.11111111.11000000
a) 255.255.255.192
b) $2^6 = 64$

150.80.0.0/16

2^9

- 150.80.0.0/25 → 150.80.0.127/25
- 150.80.0.128/25 → 150.80.0.255/25
- 150.80.199.128/25 → 150.80.199.255/25.

200×128

16

2^4

150.80.100.0/24 → 150.80.100.15/28

150.80.199.0/28 → 150.80.14.15/28.

150.80.199.0/25 → 150.80.124.255

2^2

150.80.125.0/30 → 150.80.125.3/30

150.80.125.4/30 → 150.80.125.7/30

150.80.156.252/30 → 150.80.158.255/30

Transport layer

1) Process-to Process Delivery
2) Error Control
3) Flow Control
4) Connection Control
5) Cogestion Control
6) Segmentation & Reusability

Port No:- IANA

[Internet Assigned Numbers Authority]

A Email process is assigned to port No: 25, upload/download of FTP: 21, 20.

1-1023 → registered for well known processes.

1024-49064 → registered for users port.

HTTP: 80

By port no. we can identify the generator and recievor of messages.

Mail Server helps in operating an email process.
Ephimeral ports exist at the client side.

int hist[256] = {0}

Supernetting

If an organization wants 1000 addresses then, by allocating 4 blocks of class c addresses then 768
1024 - total addresses can be provided to suffice their needs.

The significant advantage:

A Router can connect to multiple no. of networks. - by using different interface. Through a specific address it can connect to different network.
Router has routing table → for enrouting a message

The process of combining class c blocks to create a supernet is called supernetting
→ Information in routing table is optimized.

Q) A company needs 600 addresses, which of the following set of class c blocks can be used to form the supernet for this company?

(a) 198.47.32.0 - 198.47.33.0 - 198.47.34.0

(b) 198.47.32.0 - 198.47.42.0 - 198.47.52.0 - 198.47.62.0

(c) 198.47.31.0 - 198.47.32.0 - 198.47.33.0 - 198.47.34.0

(d) 198.47.32.0 - 198.47.33.0 - 198.47.34.0 - 198.47.35.0

(5) A superset has a 1st address of 205.16.32.0 and a supernet mask of 255.255.248.0. A router recieves 3 packets with the following destination address.

a) 205.16.37.44
b) 205.16.42.56
c) 205.17.33.76

Which packet belongs to supernet?

(6) A supernet has a first address of 205.16.32.0 and a supernet mask of 255.255.240.0 How many blocks are there in this supernet and what is the range of addresses.

~~Error Cont~~

Connection Control

i) Dedicated
ii) End to End

Connection Control consists of 3 major steps :→

1. Establishment
2. Maintaining
3. Termination

Cogestion Control

Congestion Window - The intermediate network recieves several package. The router recieves 3 for example 3 packets but router recieves 4, then it will not arrive because of the window size.

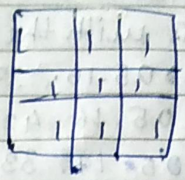
Order window size will be min (CW, SW)

Session Layer

1. Dialog control
2. Synchronization.

Neighbourhood Processing

Image

When all coffiicient are equal to 1  then it is called average.

When there exists some values in the kernel other than all 1's then it is weighted average.

9+1+6+2+2+1+4+2+4+1

41

17 | 41 | 3-2

37

25/9

Presentation layer

1. Implementation of security
2. Data Compression.

Encryption key

Encryption Algorithm

Compression: Run length Encoding

Error Detection

Methods:
1. Simple Parity Check → This method can detect all single bit errors. Burst method affecting odd no. of bits can be detected
2. 2D parity check
3. Cyclic Redundancy Check (CRC)
4. Checksum

→ 0 0 1 0 1 1 0 [1]

0 0 0 1 1 1 0 [1]

$x^{16}+x^{12}+x+1$

$(-1)^{16}+(-1)^{12}-1+1$

$=2$

Private Networks

ClassA	
10.0.0.0 to 10.255.255.255	Private Address Range
ClassB	
172.16.0.0 to 172.16.31.255	
Class C	
192.168.0.0 to 192.168.255.255	

Tunneling

Socket Programming

Client uses Ephemeral Port No.
Server uses fixed Port No.
Registered Port No : {1-1023
Used as Ephimeral Port No <49068

What is the difference btwn Parent Server Child Server ?

Echo Server Port No: 7

Multicast: Transmission of a message to multiple parties.

Ping a.b.c.d -t↵
PACKET INTERNET GROFER

javap java.net.InetAddress > a.txt↵

Q) Program to access the IP address of local machine

```
import java.net.*;
class CheckIP
{ public static void main(String args[]) throws
                                UnknownHostExeption
  {   InetAddress test = InetAddress
                          .getLocalHost();
      Sout("IP Address is: "+test);
  InetAddress test1 = InetAddress.getByName
                          ("abcd.com");
  } } Sout("IP A= "+test1);
```

Data Link Protocol

1) Error Control
2) Flow Control

1) Stop and Wait ARQ

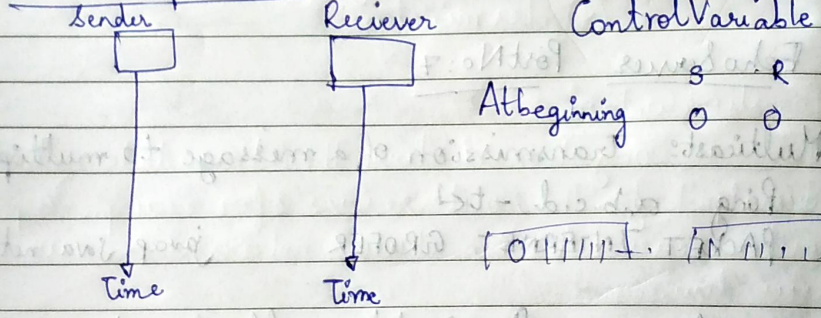
Characteristics

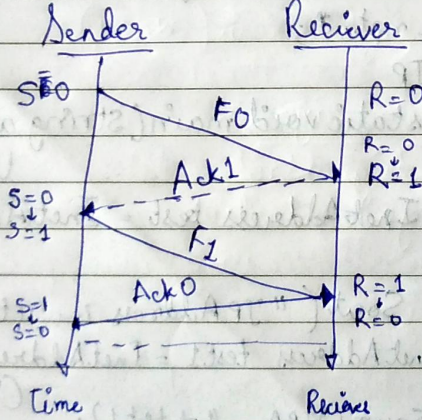
1. Sequence No = 1 bit field → 0/1
Sender sends one frame at a time and waits for the receiver to send the acknowledgement frame.
2. Acknowledgement No.

Sequence Serial F0 F1 ...
Acknowledgement Ack 1 Ack 0 ...

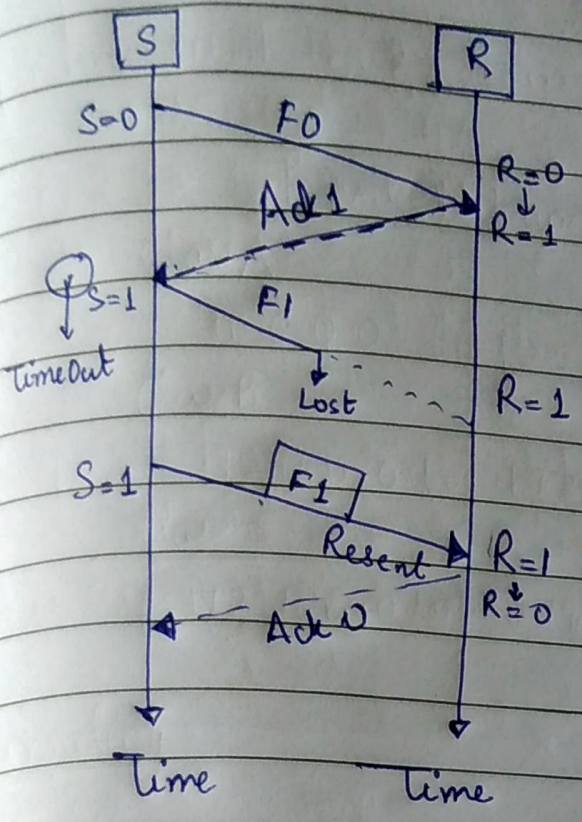
Acknowledgement signal or frame must be transmitted to the sender within a stipulated period of time.
Retransmission time: equipped with time needed for the receiver to retransmit
Time = 2 × RTT (Round Trip Propagation time)

1) Normal Operation

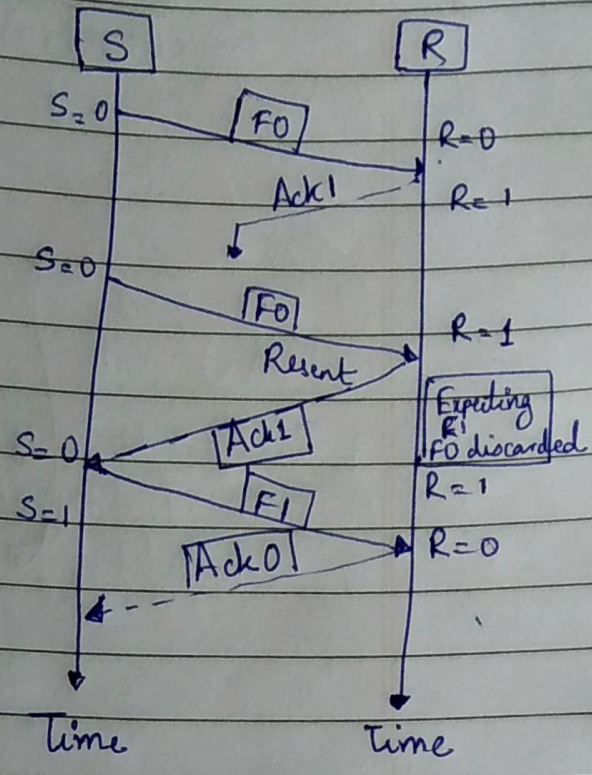




Lost Frame



Lost Acknowledgement



Socket Programming