Transportation :

Seg 6

Transport Layer

Error and flow control:

flow control ensure that Sender doesn't send data faster than Riciver can process.

Error control ensures reliable data transfer by detecting and recovering from errors.

flow & error control mecanisum:

Checksum : Each frame includes a code to detect errors, If error found, retransmission requested

ARQ:

Ack : Sender Send Ack, if no is Ack from Sender then Sender Retransmits the packet

Stop & wait protocol : Sender Send one frame and wait for An Ack before Sending next.

Sliding window protocol: Sender send multiple frame before waiting Ack, Making Data transfer faster and more efficient.

Congestion Control: It prevents network over-load by dynamically adjusting the Sender transmis-sion rate.

Mechanism

Slow Start: Start with small congestion window. gradually increase the window as receives ack. So avoid overload

Congestion Avoidance: After slow start the Sender switches to congestion avoidance.

Fast retransmit: If lost packet are detected by Ack retransmit without wait for timeout

Fast recovery: After retransmission congestion window is reduced then increased again

Application of Tcp

Web browsing (HTTP/HTTPS)
email Service (SMTP, IMAP, POP3)
File transfer (FTP)
VPN
Database Communication
Secure Communication

UDP (User Datagram Protocol)

Connectionless protocol used in when reliability and security is less important than speed & size.

User Datagram protocol Characteristics.

- Connectionless – Send করার আগে কোনো Connection তৈরি করে না
Unreliable → guarantee করে না delivery
faster than Tcp → Sudu speed matter so that
No Congestion Control → কোনো Network condition adjust করে না।

UDP Application

Streaming media – YT, Spotify.

Voice over IP (VoIP) → ~~SIP~~ Skype, WP

Online gaming – CoC, CoD, fortnite

DNS – resolve domin name to ip address quickly using UDP for minimal delay.

SNMP → monitor network device.

IoT → used for fast data exchange

SCTP

Stream Control Transmission protocol

SCTP designed to provide reliable, massge oriented communication

here combine TCP & UDP features to effort better protocol for multimedia communication

SCTP Services

Reliable data transmission:

- It delivers discrete msg not byte stream like TCP
- granted data arrive without loss using re transmission & ack
- For fault tolerance support multiple IP Address

Multistreaming:

- Transmits multiple stream in one connection

Congestion & flow control:

manage data rate to avoid Congestion and ensure Riciver can handle incoming data.

Multihoming:

- use multiple network path for load balancing
- one fails switch another automatic.

ordered & unordered delivery:

- Ensure msg arrive same order in they send
- Allows out of order delivery for better efficiency

(RTP)

Real time protocol :

It used in communication for delivering audio & vedio over IP network (VOIP, vedio conferencing). It ensure low Latency and synchronization of multimedia Stream.

RTCP

Real time Control protocol :

Rtcp works with RTP to monitor and enhance media Stream Quality.

function RTCP

Quality feedback : It sends a control msg that provides feedback on the quality of RTP Stream msg include info of Stream performance like delay.

Synchronization : Ensured Audio, vedio delivered Sync during Playback.

Participant Identification: It can include sender reports and receiver reports so track participant & session & stream statistics

Flow Control: Adjust transmission rates to avoid Congestion.

Congestion & Delay Reporting: Detect network issues to maintain communication quality.

MPLS

MultiProtocol Label Switching:

It is a high performance network technology for fast and efficient data Routing.

Commonly used in large-scale networks to manage traffic effectively.

How MPLS Works:

Label Assignment:

- Data entry Short lvl by entry router
- Labels Specifies a predefined path for the packet

Forwarding with Labels:

Routers use a label for forward packets. without IP Lookup, making routes faster.

Label Removal:

when packet reach distination., Label is removed. and packet is processed in the usual way. (with final IP)

- This process improve Speed, Scability and traffic management in Complex networks.

Dynamic Buffer Management

- Allows variable-sized windows for data transfer
- Sender req buffer space and receiver grants based if it can manage

How it works

Initial Buffer req → Sender req no of buffer receiver grants some

Transmission: Sender use granted buffer to send data

Ack & Allocation: receiver send Ack and update buffer allocation via Control msg.

Retransmission: If segment lost, retransmit using small allocated buffer

Deadlock Prevention: To avoid deadlock caused by Lost control seg. the receiver periodically sends updates about Ack and buffer status.

To adapt Net Condition.

Dynamic use of buffer space.

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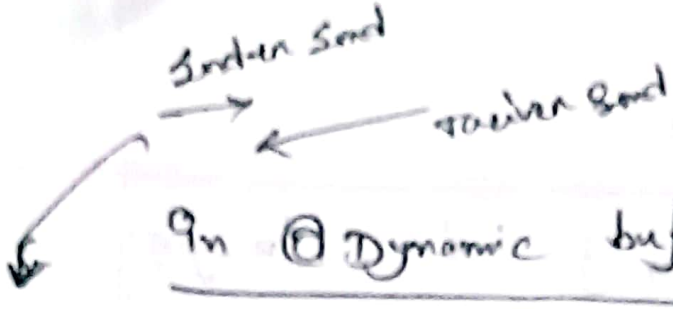
dynamic use of buffer space



9n @ Dynamic buffer Allocation Concepts

→ Req 8 buffers. → want 8 buffer
← <ack = 15, buf 4> → grants (0-3) msg only
→ <seq = 0 data m0> → 3 buffer left
→ seq = 1 data m1 → 2 " "
→ seq = 2 data m2 → msg lost think 1 left

Crash Recovery Transport Layer

- handle data issues if a server or router crashes, especially during long connection.

here Ack (A) → Confirm data received.
write (W) → writing output
Crash (C) → Stop work

Sln
- use unique id for data to detect duplicate
- Client retransmit un Ack data but on mechanism
- use Checkpoints & Logs to recd prog for recovery after crash.

Regulate flow

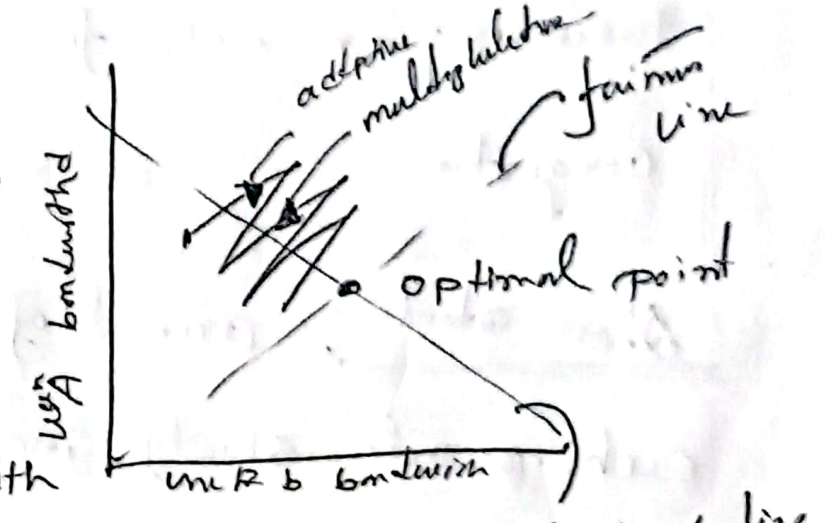
Regulating Sending Rate

used in TCP

AIMD

user additively increase bandwidth allocation and then multiplicatively decrease when congestion is occur

fairness line represent equal bandwith allocation



Step

- user increase bandwidth by fix amount
- operating point cross effeiency line Congestion occour
- then reduce bandwidth multiplicatively
- result covergence optimal op point. ensuring both. fairness and effeiency

Congestion window (cwnd)

It is a mechanism TCP that controls the amount of data a sender can send before receiving an ack from receiver. It prevent Congestion

Slow start: amount of data transmit each packet slowly increase data untill the capacity reached.

It's Congestion Control policy.

Silly window syndrome: It is a problem that occoun when data are passed to sending TCP entity in large blocks but receiving sides reads only 1 byte at a time

(poor implementation in TCP)