TCP Throughput

- Instantaneous throughput (S)
- Average throughput (S_{avg})

- Assume TCP congestion window (CW) of W segment
  - CW = cwnd
- Assume no slow start. (operating in AIMD)
  - congestion avoidance phase
- Round-trip time of RTT seconds
- Segment size of MSS bytes/segment

Q: What is the average throughput of TCP?

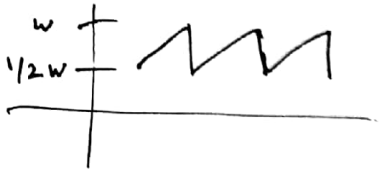
A: at $CW = W$, sending rate (S)

$$S = \frac{W \cdot MSS}{RTT} \quad \text{bytes/sec}$$

at $CW = W$ $\Rightarrow$ Triple duplicate ack (TDA)

$\Rightarrow$ mult decrease $\Rightarrow$ $CW = W/2$

$$S' = \frac{1}{2} S$$



Avg. Throughput:

$$S_{avg} = \frac{S + 1/2\,S}{2} = \frac{3}{4} S$$

$$= \frac{\frac{3}{4} W \cdot MSS}{RTT} \quad \text{bytes/sec}$$

TCP over fast links

Link capacity = 10 Gbps = 1.25 GBps

MSS = 1500 bytes / segment

RTT = 100 ms = 0.1 sec

Q: what is the required window size ?

$$S = \frac{W \cdot MSS}{RTT} \quad \text{bytes/sec}$$

$$W = \frac{S \cdot RTT}{MSS} \quad \text{segments}$$

$$= 83,333 \text{ segments}$$

Resource allocation

Q. 3 users, 90 Mbps link (3 users are competing for 90Mbps)

U1 → 50 Mbps
U2 → 50 Mbps
U3 → 10 Mbps

} user request or requirement

Fair allocation : ?? It depends!!

Fair
- equal (30, 30, 30)
- proportional (41, 41, 8)
- max-min (40, 40, 10)

Fair, efficient, good, optimal, best

→ have to give them meaning.

TCP-fair : (30, 30, 30)

TCP Reno with SS/AIMD

SS: CW = 2 MSS

ssthresh = 8

Timeout → 5th Tx

CW = ? after 10th Tx

Tx 1: CW = 2

Tx 2: CW = 4

Tx 3: CW = 8

} Slow start

Tx 4: CW = 9

Tx 5: CW = 10

} AIMD

Tx 6: CW = 2 ← Timeout ssthresh = 5

Tx 7: CW = 4

} SS

Tx 8: CW = 5

Tx 9: CW = 6

} AIMD

Tx 10: CW = 7 ✓