TCP Versions: Reno

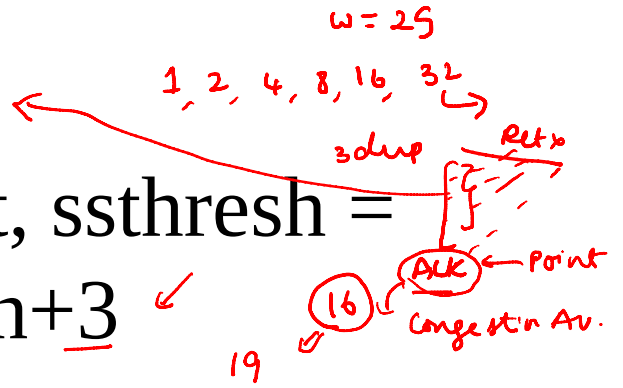
Kameswari Chebrolu

Break

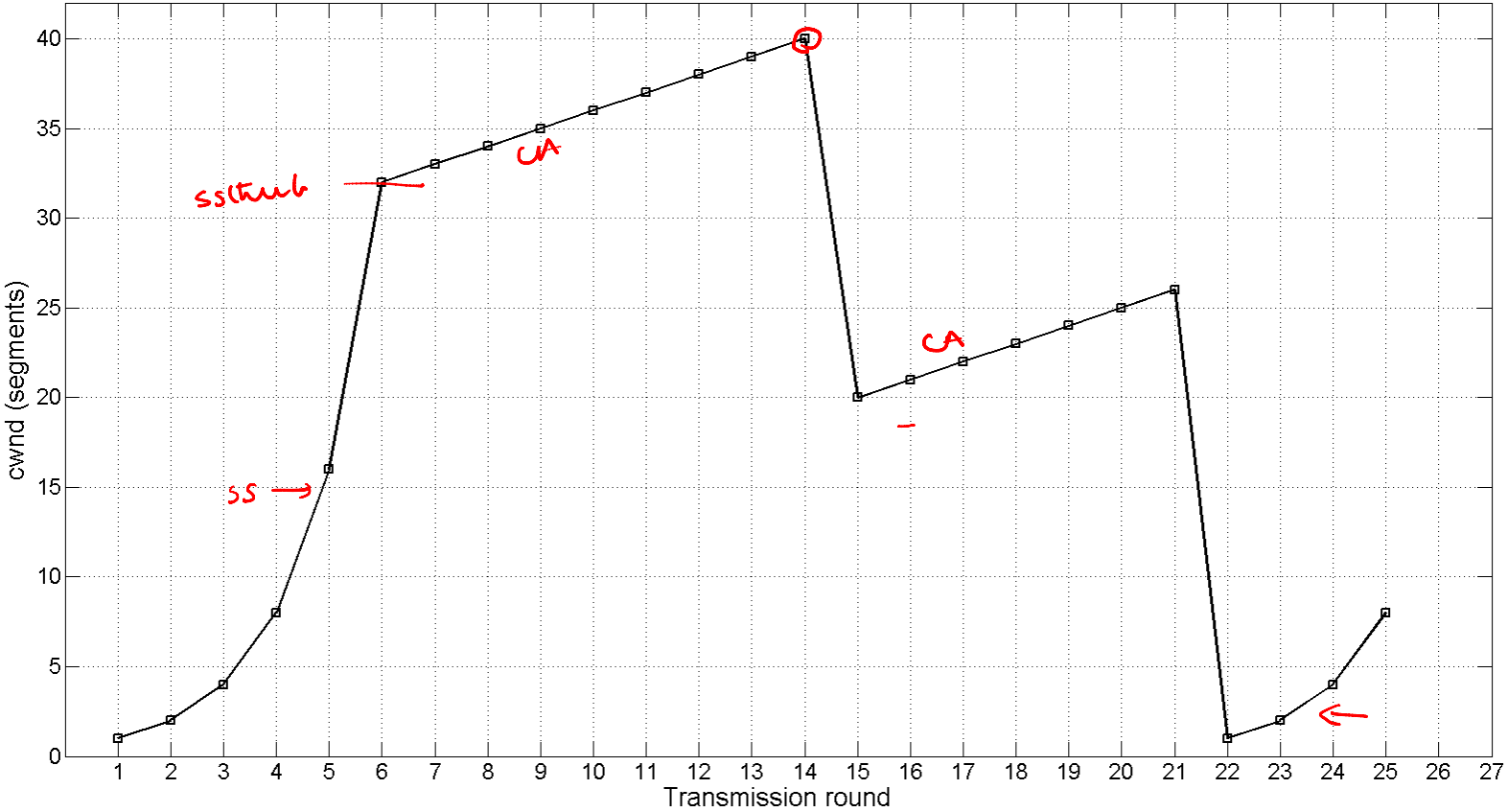
TCP Reno

- Incorporates two new mechanisms: Fast Retransmit and Fast Recovery
- Fast Retransmit: Retransmit packet at sender after 3 duplicate acks
  - Cut the window by half (loss event)
  - Avoids having to time-out which keep the link idle for longer duration

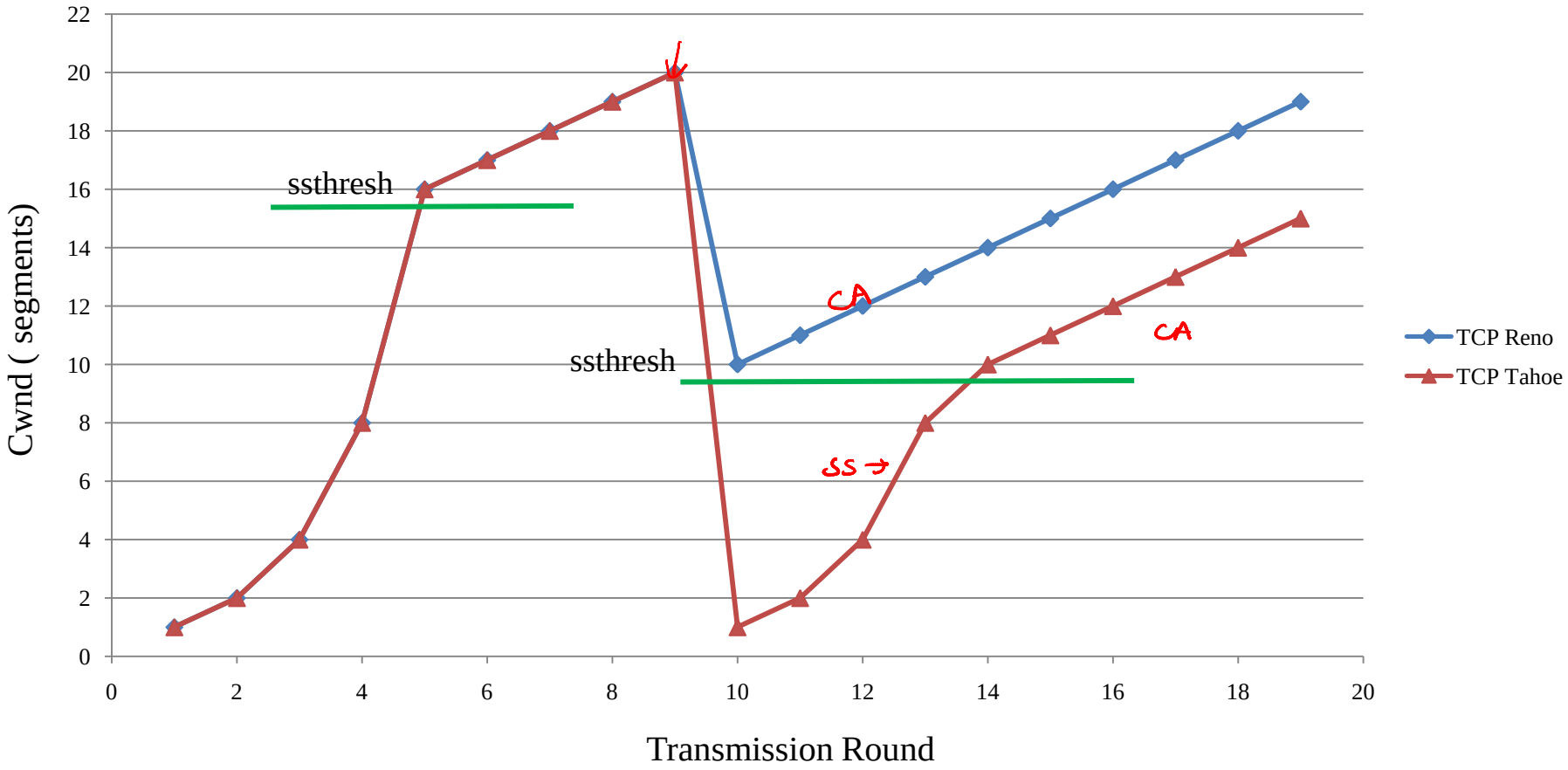
Fast Recovery

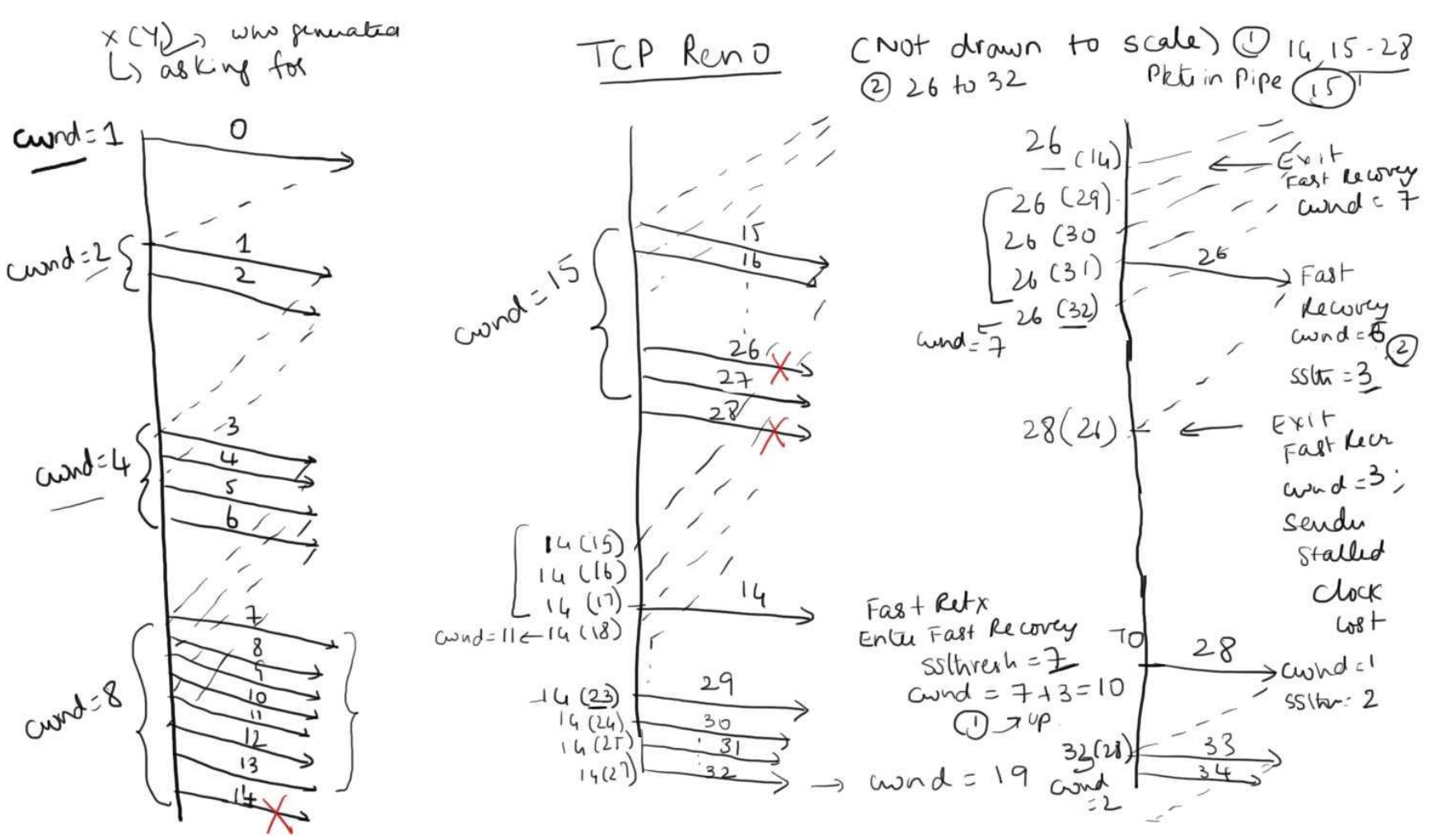


- On 3rd dupack, retransmit packet, ssthresh = max (cwnd/2,2); cwnd = ssthresh+3
- Another dupack, cwnd = cwnd +1; transmit packet if allowed by cwnd
- On ack acknowledging new data, cwnd = ssthresh, invoke congestion avoidance (linear increase in cwnd now on)


cwnd (segments)
Transmission round
0
5
10
15
20
25
30
35
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
ssthresh
CA
SS
CA

Comparison


Cwnd (segments)
Transmission Round
ssthresh
ssthresh
CA
CA
SS →
TCP Reno
TCP Tahoe
0
2
4
6
8
10
12
14
16
18
20
22


x (4) → who generated
↳ asking for
TCP Reno
(Not drawn to scale) ① 14, 15-28
② 26 to 32
Pkts in Pipe 15
cwnd = 1
0
cwnd = 2
1
2
cwnd = 4
3
4
5
6
cwnd = 8
7
8
9
10
11
12
13
14
cwnd = 15
15
16
26
27
28
14 (15)
14 (16)
14 (17)
cwnd = 11 ← 14 (18)
14
14 (23)
14 (24)
14 (25)
14 (27)
29
30
31
32
→ cwnd = 19
Fast + Retx
Enter Fast Recovery
ssthresh = 7
cwnd = 7 + 3 = 10
① → up
26 (14)
26 (29)
26 (30)
26 (31)
26 (32)
cwnd = 7
Exit Fast Recovery
cwnd = 7
26
Fast Recovery
cwnd = 5
② ssthr = 3
28 (21)
Exit Fast Recv
cwnd = 3;
Sender Stalled
Clock lost
TO
28
cwnd = 1
ssthr = 2
32 (28)
33
34
cwnd = 2

Other Versions

- TCP NewReno: Handles multiple losses per congestion window better (high loss rate scenarios)
- TCP Vegas: Uses packet delay to signal congestion than loss event
- TCP SACK: Employs selective acknowledgments

Summary

- TCP Tahoe: Go-back-N with slow start and congestion avoidance
  - Loss recovery slow; timeouts drain pipe
- TCP Reno: improves upon Tahoe
  - Better loss recover via duplicate acks (fast retransmit)
  - Prevents draining of pipe after fast retransmit (avoids slow-start)
- Ahead: Sliding window, flow control, and other miscellaneous things