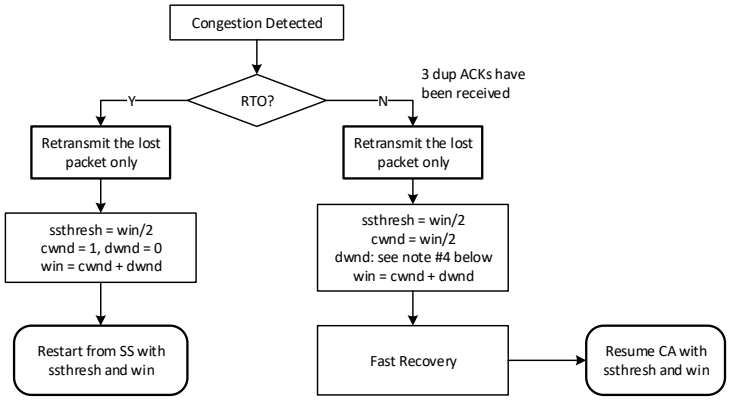
TCP Vegas

- TCP Vegas
  - It is a packet delay base congestion control scheme, in contrast to packet drop/loss-based congestion control schemes, such as TCP Tahoe, TCP Reno, or TCP New Reno
  - ActualTH = cwnd / SampleRTT
  - N = (SampleRTT – BaseRTT) * ActualTH
    - Estimated number of backlogged packets at intermediate routers
  - For example: during Congestion Avoidance phase
    - If N < α, cwnd = cwnd + 1, per RTT
    - If N > β, cwnd = cwnd – 1, per RTT
    - Else, cwnd remains unchanged
      - By default, α = 1 MSS, β = 3 MSS

TCP BBR

- TCP BBR (Bottleneck Bandwidth and Round-trip propagation time)
  - BDP (Bandwidth Delay Product) = B_{max} * RTT_{min}
  - Goal is to maintain cwnd approximately the same as BDP
  - Key idea:
    - Periodic bandwidth probing
    - Set cwnd size to [1.25, 0.75, 1, 1, 1, 1, 1, 1] * cwnd for the next eight RTTs
    - If B_{max} increases after setting cwnd = 1.25*cwnd, then stay at this new cwnd.
    - Else, set cwnd = 0.75*cwnd to drain the any queue built up during the previous RTT when cwnd was set to 1.25*cwnd.

Compound TCP (CTCP)



Notes:

1. Congestion window now has two components: win = cwnd + dwnd

2. During SS phase: dwnd = 0

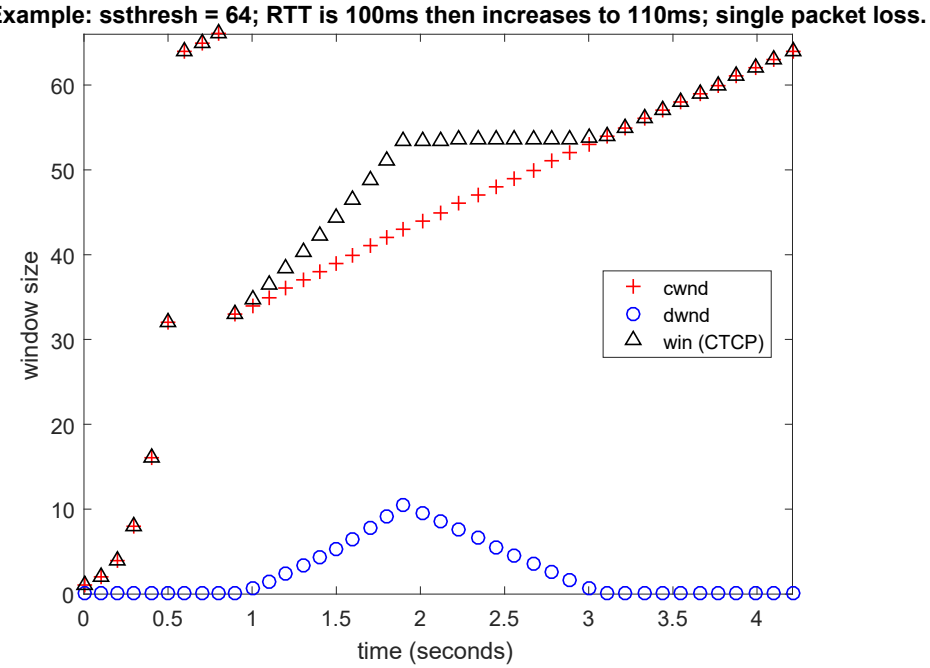
3. During CA phase:
Congestion window is set to win = cwnd + dwnd, where for each RTT:
- cwnd = cwnd + 1
- dwnd = dwnd + max($\alpha * win^{K} - 1$, 0) if diff < γ
- dwnd = max(dwnd – ζ *diff, 0) if diff ≥ γ

where:
- diff = win * (1 – baseRTT/sRTT)
- baseRTT is the minimal RTT observed so far
- sRTT is the moving average of the RTTs

4. Upon congestion detection with 3 dup ACKs:
Congestion window is set to win = cwnd + dwnd, where:
- cwnd = cwnd/2
- dwnd = (1 – β) * win – cwnd/2

5. Default parameters: K = ¾, α = 1/8, β = ½, γ = 30

CTCP Example



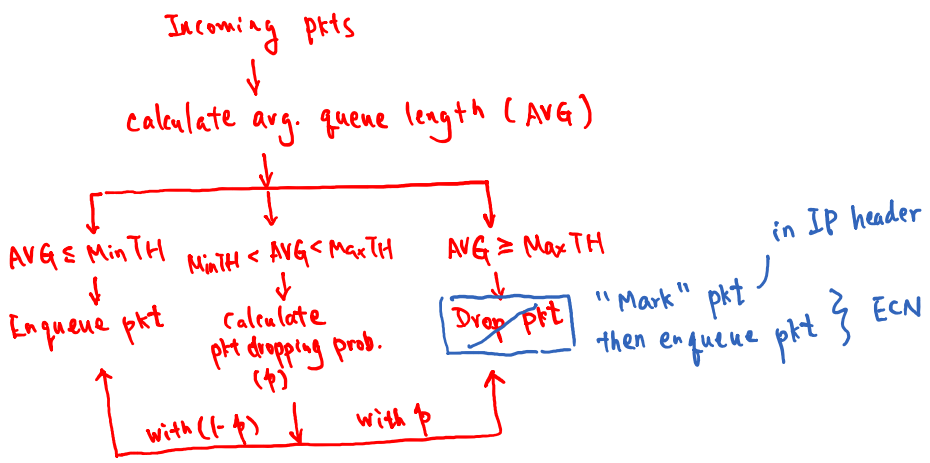
Tcp ECN:

- TCP: layer 4
- Routing: layer 3 (Router)

} cross-layer approach

Active Queue Management (AQM)

RED: Random Early Drop/Detection



TCP ECN

- TCP ECN (Explicit Congestion Notification)
  - Motivated by Active Queue Management (AQM) schemes such as Random Early Detection/Drop (RED)
  - At TCP sender: negotiation; react to notification
  - At intermediate routers: marking packets
  - At TCP receiver: notify the sender