

# Computer Networks

## History of TCP Congestion Control (§6.5.10)



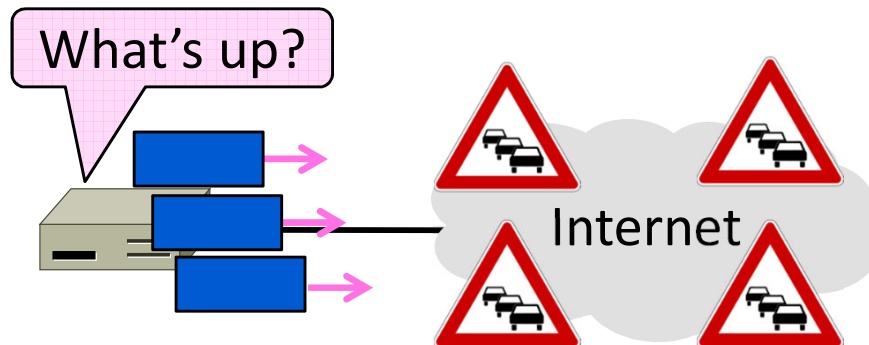
David Wetherall (djw@uw.edu)

Professor of Computer Science & Engineering

UNIVERSITY *of* WASHINGTON

# Topic

- The story of TCP congestion control
  - Collapse, control, and diversification

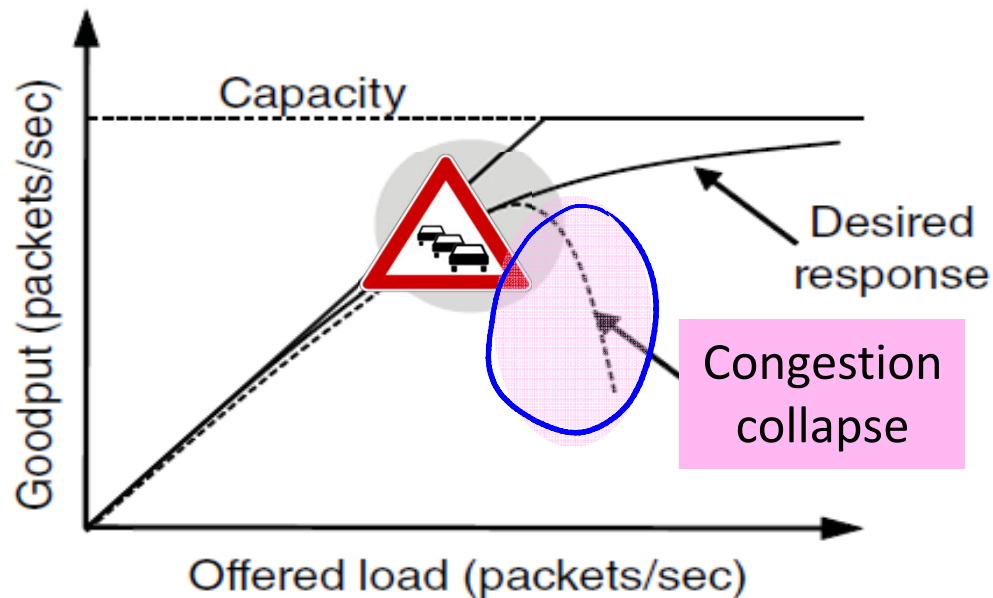


# Congestion Collapse in the 1980s

- Early TCP used a fixed size sliding window (e.g., 8 packets)
  - Initially fine for reliability
- But something strange happened as the ARPANET grew
  - Links stayed busy but transfer rates fell by orders of magnitude!

# Congestion Collapse (2)

- Queues became full, retransmissions clogged the network, and goodput fell





# Van Jacobson (1950—)

- Widely credited with saving the Internet from congestion collapse in the late 80s
  - Introduced congestion control principles
  - Practical solutions (TCP Tahoe/Reno)
- Much other pioneering work:
  - Tools like traceroute, tcpdump, pathchar
  - IP header compression, multicast tools



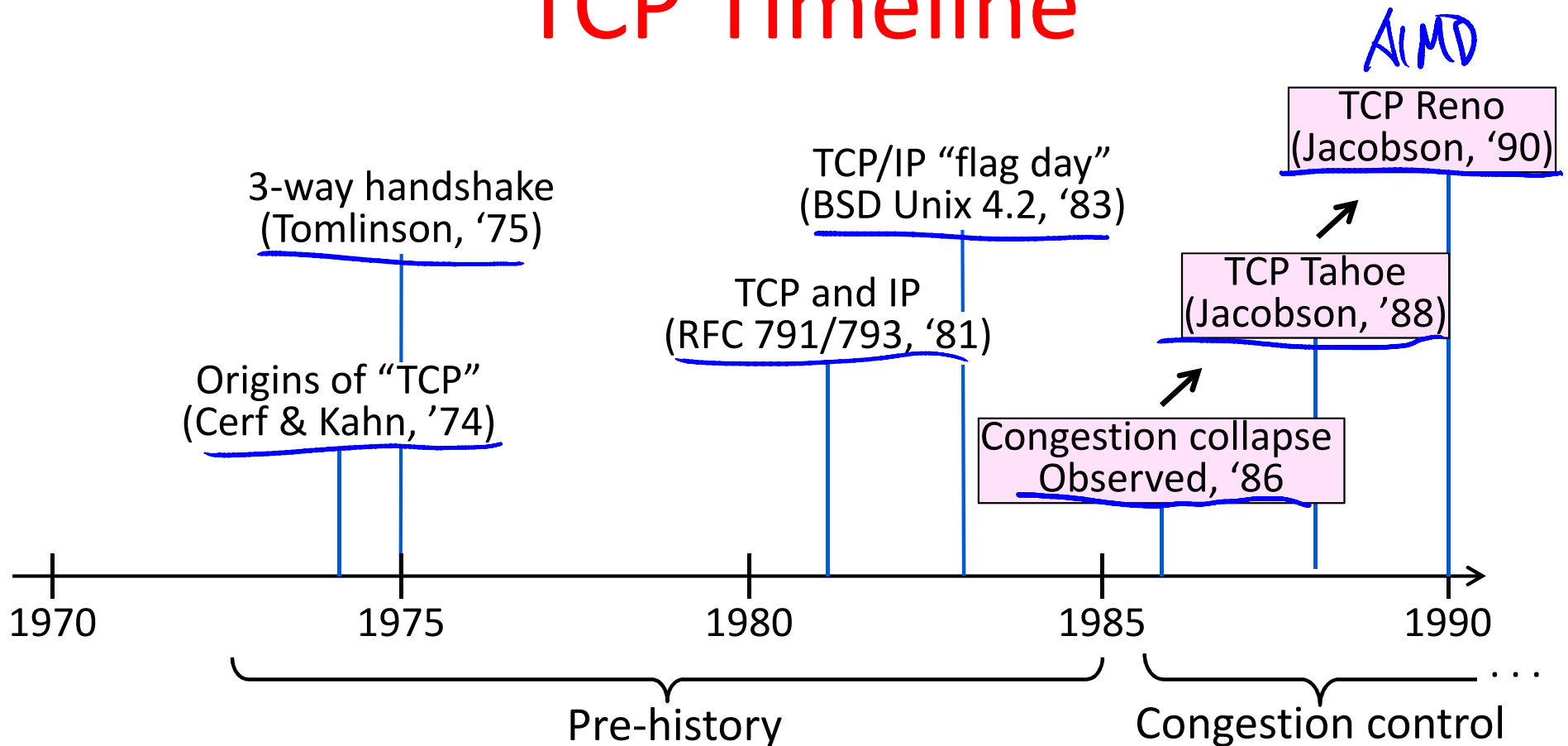
# TCP Tahoe/Reno

- Avoid congestion collapse without changing routers (or even receivers)
-  Idea is to fix timeouts and introduce a congestion window (cwnd) over the sliding window to limit queues/loss
-  TCP Tahoe/Reno implements AIMD by adapting cwnd using packet loss as the network feedback signal

# TCP Tahoe/Reno (2)

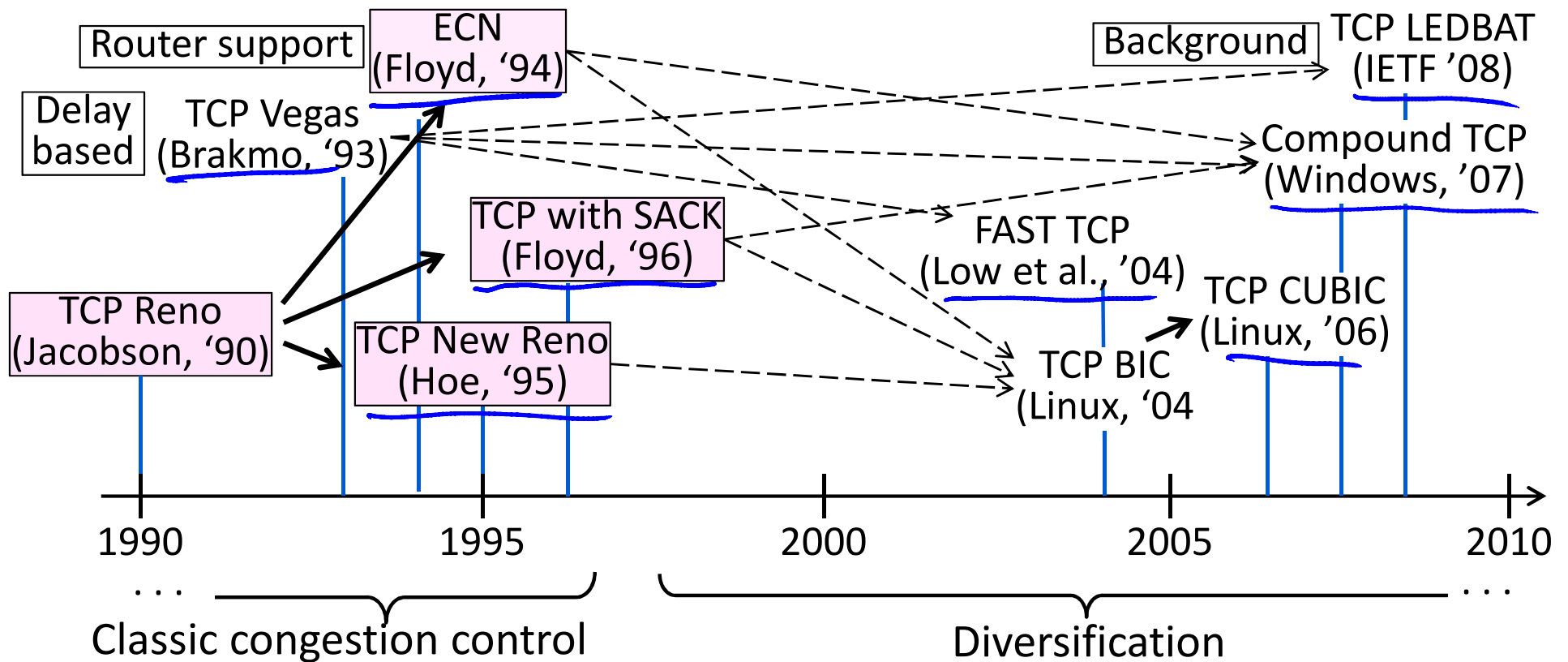
- TCP behaviors we will study:
  - ➔ ACK clocking
  - ✓ Adaptive timeout (mean and variance)
  - ➔ Slow-start
  - ➔ Fast Retransmission
  - ➔ Fast Recovery
- Together, they implement AIMD

# TCP Timeline





# TCP Timeline (2)



# END

© 2013 D. Wetherall

Slide material from: TANENBAUM, ANDREW S.; WETHERALL, DAVID J., COMPUTER NETWORKS, 5th Edition, © 2011.  
Electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, New Jersey