CS144
An Introduction to Computer Networks

Congestion

Basic Approaches

Nick McKeown
Professor of Electrical Engineering
and Computer Science, Stanford University

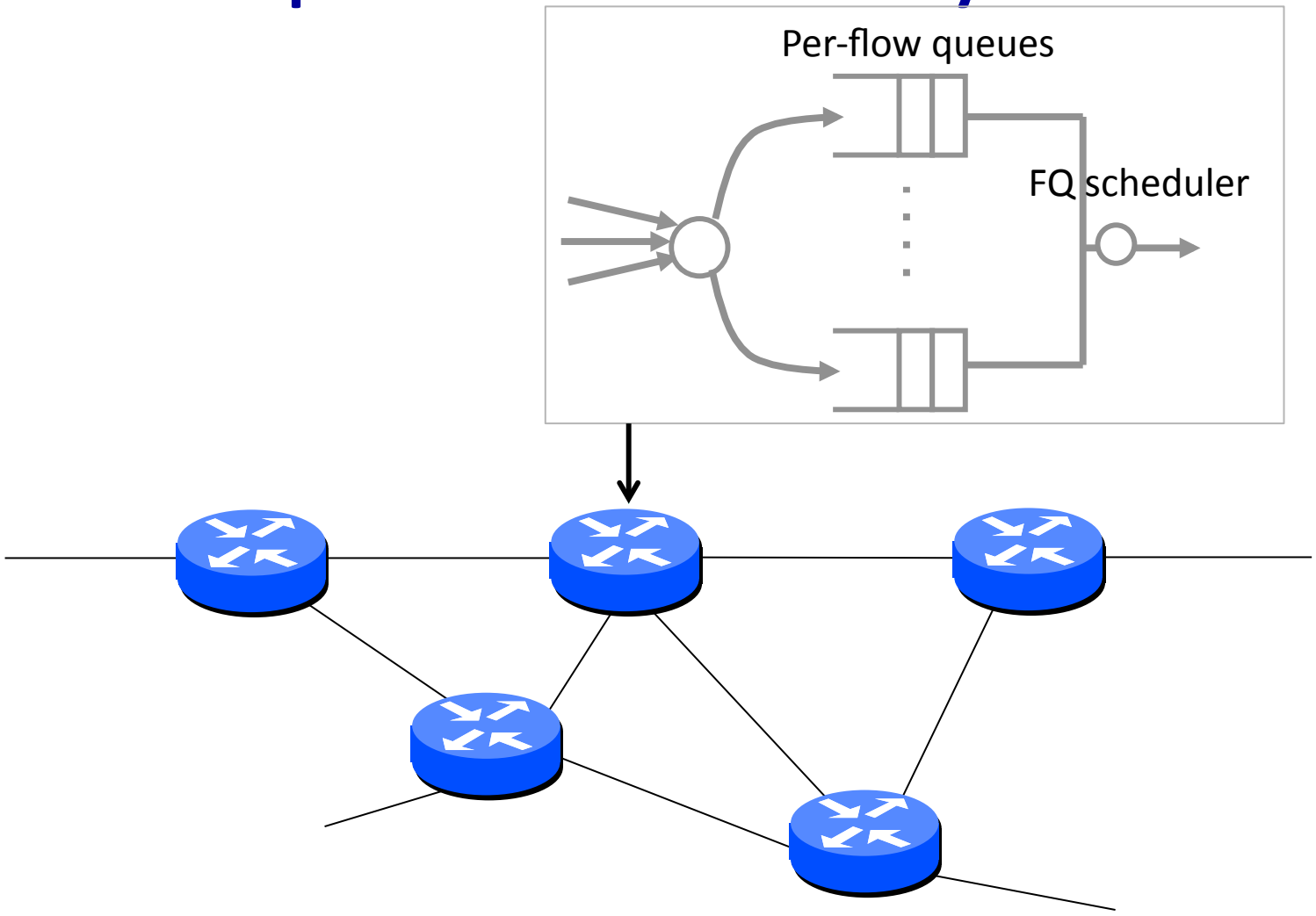
Outline

Where to put congestion control?

- Example: Fair Queueing at every router
- In the network
- At the end host

Sliding windows and AIMD

Example: FQ at every router



Network-based

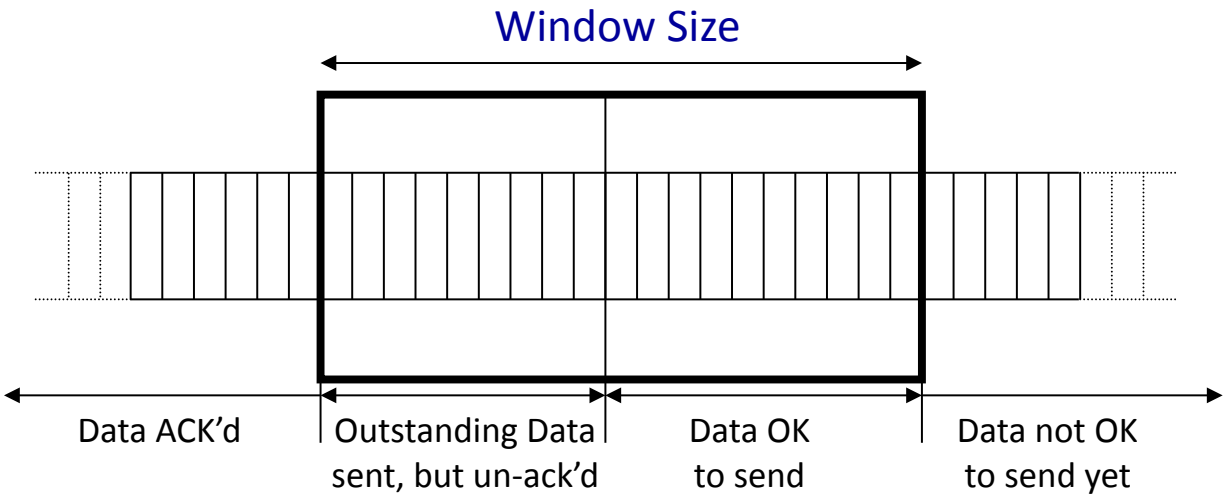
End-host based

TCP Congestion Control

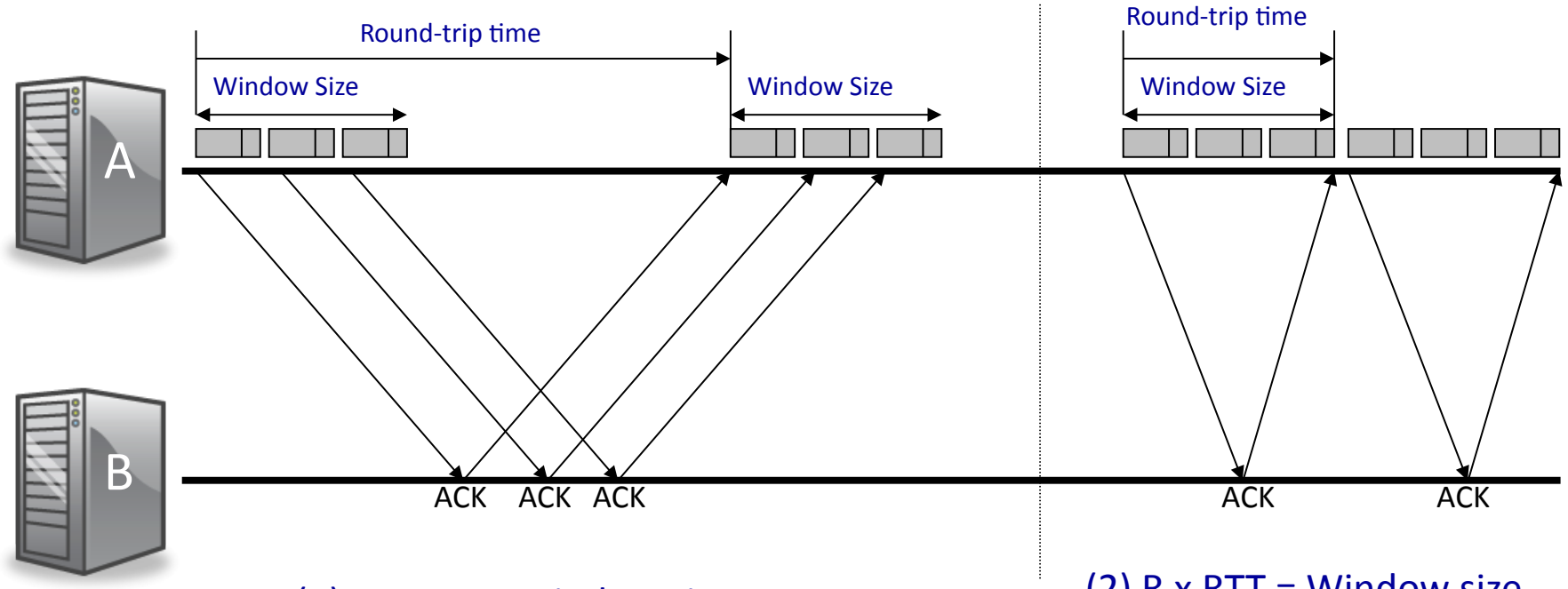
TCP implements congestion control at the end-host.

- Reacts to events observable at the end host (e.g. packet loss).
- Exploits TCP's sliding window used for flow control.
- Tries to figure out how many packets it can safely have outstanding in the network at a time.

Sliding Window



TCP Sliding Window



(1) R x RTT > Window size

(2) R x RTT = Window size

TCP Congestion Control

TCP varies the number of outstanding packets in the network by varying the window size:

Window size = min{Advertised window, Congestion Window}

Receiver — Transmitter ("cwnd")

How do we decide the value for cwnd?

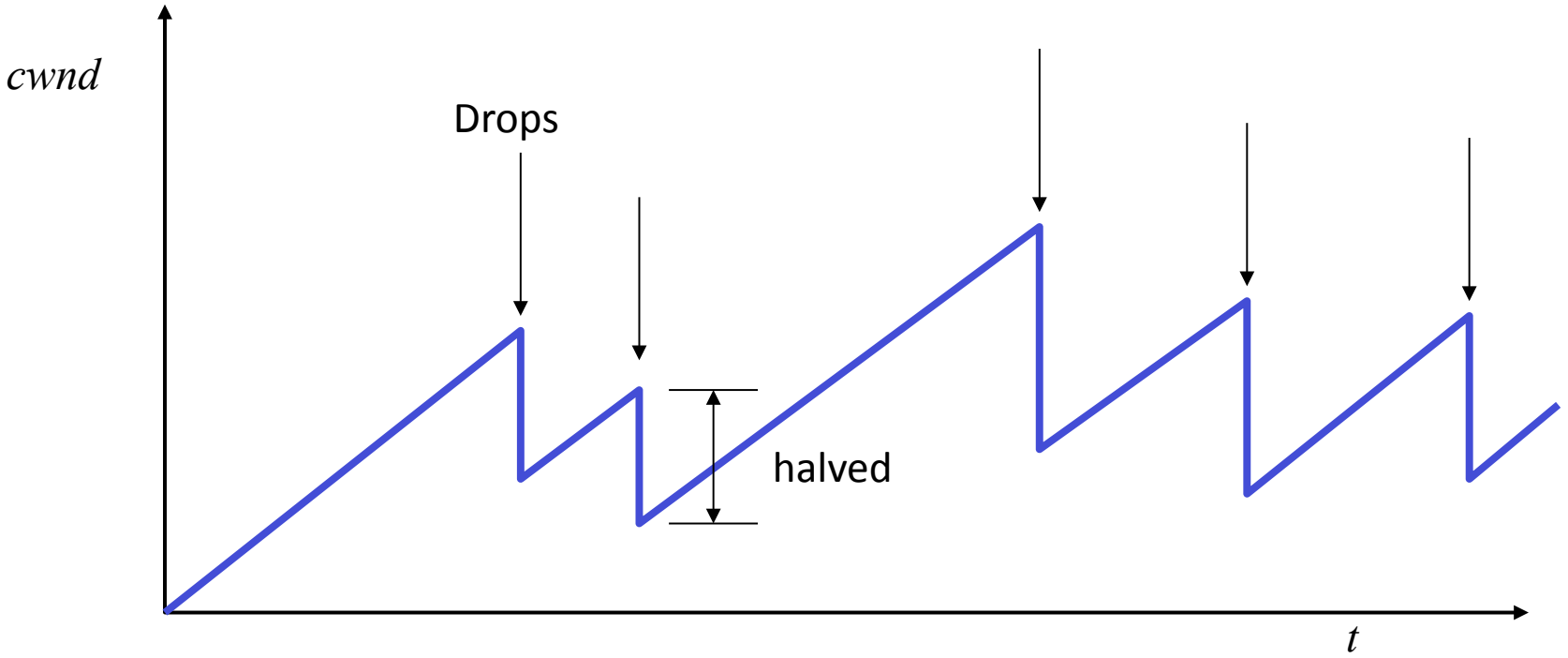
AIMD

Additive Increase, Multiplicative Decrease

If packet received OK: $W \leftarrow W + \frac{1}{W}$

If a packet is dropped: $W \leftarrow \frac{W}{2}$

Leads to the AIMD "sawtooth"



Summary

Choice: In the network, or at the end host?

TCP controls congestion from the end-host.

- Reacts to events observable at the end host (e.g. packet loss).
- Exploits TCP's sliding window used for flow control.
- Tries to figure out how many packets it can safely have outstanding in the network at a time.
- Varies window size according to AIMD.

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