

Review: Network link technologies

1. What happens when client send packets back-to-back?
 - ▶ What happens when the network is saturated?
2. What about bandwidth/latency/jitter?
3. Nature of packet loss?
 - ▶ Ethernet: CSMA/CD - collisions
 - ▶ Wireless LAN: CSMA/CA - wireless channel
 - ▶ Wireless Cellular - handovers
 - ▶ Point-to-point - dialup -
 - ▶ Token-Ring - 4/16 Mbps - fair access
 - ▶ ATM - cell based - 155 Mbps - pre-determined



TCP components

- ▶ Sliding window protocol to achieve reliable transmission
 - Ideally, bandwidth x delay product worth window
 - RTT estimation algorithms
 - Advertised window for flow control - receiver restriction
 - Congestion window for congestion - network restriction
 - Basically, advertised window and congestion window reduces the amount of data that we can send
- ▶ TCP uses end-point probing to learn about network
 - Causing congestion creates implicit feedback - cannot expect explicit feedback in the Internet
 - Nice = slow to detect network limits, fast = congestion
 - When congestion happens, be nice and backoff



TCP congestion response

- ▶ AIMD - increment slowly to probe network, backoff multiplicatively when congestion happens
- ▶ Slow Start - increment multiplicatively -> causing congestion sooner
- ▶ Using hybrid, slow start to quickly catchup (like in the beginning) and then use AIMD when fine tuning



Other TCP mechanisms

- ▶ Sequence number space is important to avoid packets from previous (independent) TCP connections
 - Initial sequence no. chosen to be less likely to overlap
 - Sequence number space (+ newer timestamp)
 - SYN+SYN/ACK
 - FIN can be initiated by either side
- ▶ SACK and D-SACK are newer mechanisms to allow the receiver to let the sender know what packets have been received (to avoid unnecessary retransmissions in the case of loss)



TCP and Networks

1. Sequence number management
 - ▶ Initial sequence number
 - ▶ total space
 2. Handshakes
 3. AIMD or Slow-Start
 4. SACK/D-SACK
-
- ▶ Ethernet
 - ▶ Wireless LAN
 - ▶ Cellular
 - ▶ Token Ring
 - ▶ ATM
 - ▶ dialup



TCP scenarios

- ▶ High speed web server clients:
 - Dialup user - bandwidth is low
 - Wireless lan user
 - Network errors are bursty
 - Networks can be lossy
 - ADSL user
 - TCP paces itself with ACKs
 - Downlink != uplink
 - Cellular user
 - Handoff delays can throw off TCP
 - Satellite user
 - Assymetric
 - High bandwidth x delay networks

