

CSc 450/550

Computer Networks

TCP Variants and UDP

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Review: TCP

- Connection management
 - packet handshake
- Flow control
 - sliding window
- Error control
 - error detection and recovery
- Congestion control
 - slow start and congestion avoidance

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TCP Tahoe

- “Old” TCP
- TCP Tahoe
 - slow start
 - when $cwnd < ssthresh$, exponential increase
 - congestion avoidance
 - when $cwnd \geq ssthresh$, linear increase
 - timeout
 - $ssthresh = cwnd/2$, $cwnd = 1 \text{ MSS}$
 - fast retransmit

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Fast retransmit

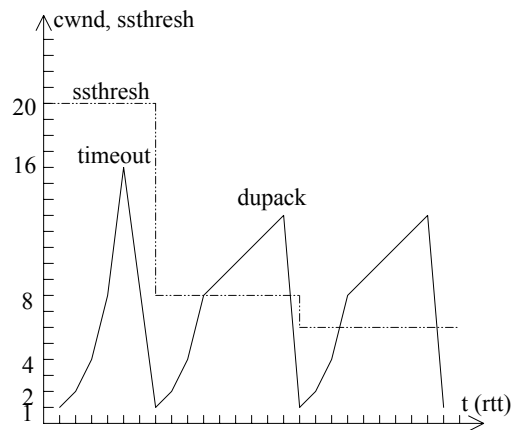
- Duplicate acknowledgment
 - example
 - rcv: [0, 499], [500, 999], [1500, 1999], [2000, 2499], [2500, 2999]
 - ack: 500, 1000, 1000, 1000, 1000 (3rd dupack)
- Congestion control (fast retransmit)
 - on 3rd dupack: $ssthresh = cwnd/2$; $cwnd = 1 \text{ MSS}$
- Error control
 - retransmit: [1000, 1499]

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Fast retransmit: cwnd



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TCP Reno

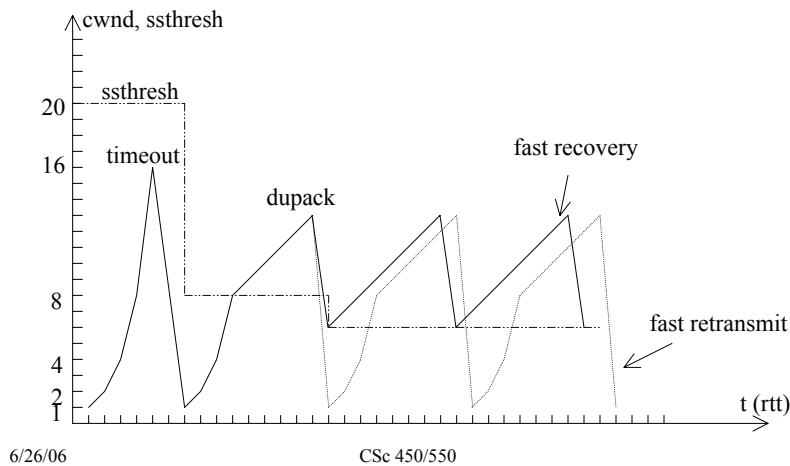
- TCP Reno
 - slow start
 - congestion avoidance
 - timeout
 - on 3rd dupack, fast recovery
 - $ssthresh = cwnd/2$
 - $cwnd = ssthresh$
 - cwnd inflate

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Fast recovery: cwnd



More TCP variants

- TCP NewReno
 - partial acknowledgment (for multiple losses)
 - now popular over the Internet
- TCP SACK
 - selective acknowledgment
- TCP Vegas
 - delay-based congestion control
 - increased delay indicates network congestion

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Challenges on TCP

- TCP over high-speed (long-delay) networks
 - limited sequence space
 - limited window size
 - TCP big window
 - “slow” congestion recovery
 - cwnd: linear increase per RTT
 - high-speed TCP, FAST, etc
 - <http://www.icir.org/floyd/longpaths.html>

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Challenges on TCP: more

- TCP over wireless
 - packet loss
 - transmission error vs network congestion
 - <http://bbcr.uwaterloo.ca/~jpan/tcpair>
 - local retransmission
 - link-layer retransmission
 - reduced packet loss ratio
 - increased variability: effective bandwidth and delay
 - http://www.icir.org/floyd/tcp_small.html

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UDP

- User Datagram Protocol (UDP)
 - connectionless
 - no connection management
 - unreliable
 - no flow, error, congestion control
 - TCP-friendly congestion control
- Why UDP?
 - sometimes TCP is an overkill
 - e.g., multimedia

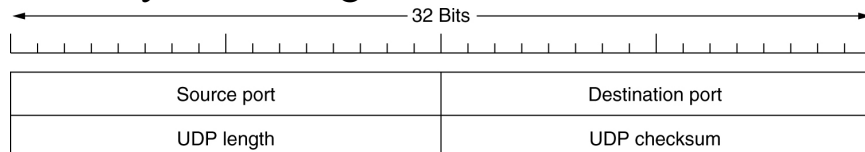
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UDP header

- Multiplex
 - source/destination port number
- Error checking (optional)
 - checksum (TCP/IP-style)
- Why “UDP length”?



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This lecture

- TCP
 - fast retransmit
 - fast recovery
- UDP
- Explore further
 - CSc 461 (multimedia), CSc 462 (distributed), Topics (advanced networks, mobile computing) and many more

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Next lecture

- The Internet Protocol
 - read CN Section 5.6

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