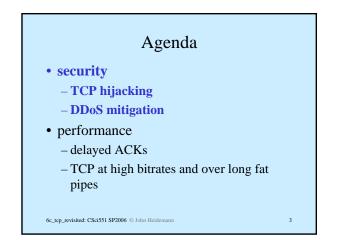
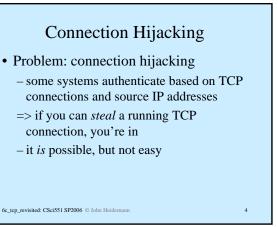


Agenda

- connection setup and teardown
- flow control
- congestion control theory
- congestion control practice (in TCP)
- loss recovery
- security
- performance
- 6c_tcp_revisited: CSci551 SP2006 © John Heidemann

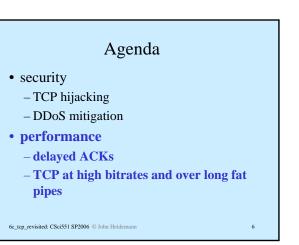




2

TCP Distributed Denial of Service

- Problem: lots of people have too much time on their hands
 - and lots of people don't have secure computers \Rightarrow bad people take over computers (*zombies*) and
 - have them all ask you at once
- mitigation: SYN cookies
 - rather than make a new TCB for a new (probably bogus) connection, encode the info in the ISN on the SYN-ACK
 - when you get the ACK, recreate the missing state
- but, sadly, there are other forms of DDoS...



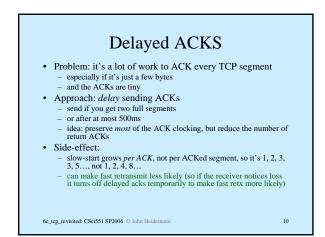
Bad Optimization: Just Send One Ack Per Flight of Packets idea: don't send ACKs frequently, just send

one after you get a whole bunch of packet – save bandwidth in reverse path (fewer acks)

• Problems

- if you lose the ACK, out of luck and have to wait RTO and retx a packet to get a new ACK saying it all really got there
- can't do RTT estimation if you don't get many acks
- destroy the steady pace of ACKs (the ACK clock) and makes TCP very bursty

6c_tcp_revisited: CSci551 SP2006 © John Heidemann



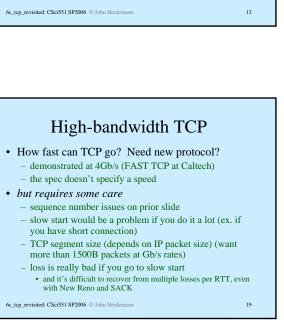
Problem: High BW Connections What about NACKs? · How many packets to keep in flight? just NACKs, or NACKs and ACKs must be > bw*delay product - actually NACKs + ACKs is like SACK - 10Mb/s * 100ms rtt = 1Mb ~ 100kB – 1Gb/s * 100ms rtt = 100Mb ~ 10MB! (select ACK) • Sequence number wraparound time vs. Link • pro: speed: • 1.5Mbps: 6.4 hours – much lower reverse path traffic • 10Mbps: 57 minutes • con: · 45Mbps: 13 minutes - no self-clocking · 100Mbps: 6 minutes · 622Mbps: 55 seconds - can't easily estimate RTT changes · 1.2Gbps: 28 seconds 6c_tcp_revisited: CSci551 SP2006 © John Heidemann 11

8

TCP Extensions for "Long, Fat Pipes"

- timestamp option + PAWS (Protection Against Wrapped Sequences)
 - endpoints swap timestamps on each pkt
 - allows better RTT estimation
 - provides effectively larger sequence space (reject packets with old timestamps)
- · window scaling
 - multiplicative factor on wnd
- to keep the pipe full 6c_tcp_revisited: CSci551 SP2006 © John Heidemann

14



<section-header><section-header><section-header><section-header><list-item><list-item><list-item><list-item></table-row></table-row><table-container><table-row></table-row></table-row><table-container>