RACK: a time-based fast loss recovery
Draft-ietf-tcpm-rack-03 updates

Yuchung Cheng
Neal Cardwell
Nandita Dukkipati
Priyaranjan Jha
Google

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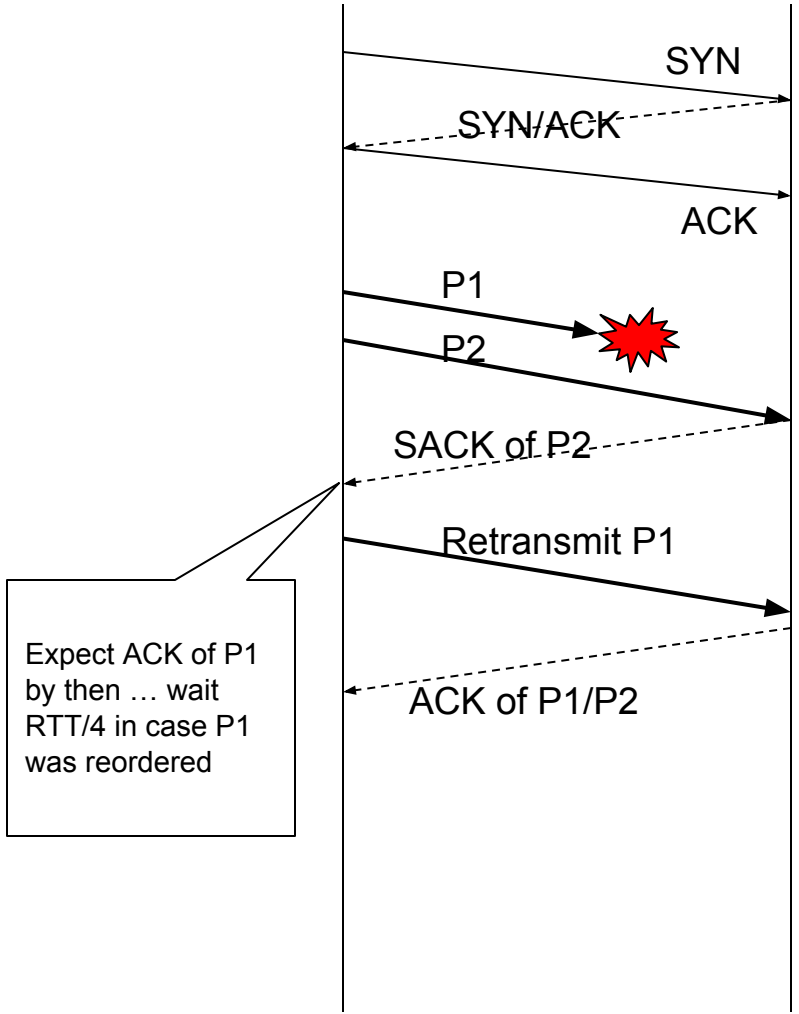
What's RACK (Recent ACK)?

Time-based loss inferences instead packet or sequence counting

Conceptually...

- Every sent packet has a timer
- All timers are constantly adjusted based on most recent RTT sample
- A packet is retransmitted after RTT + reo_wnd

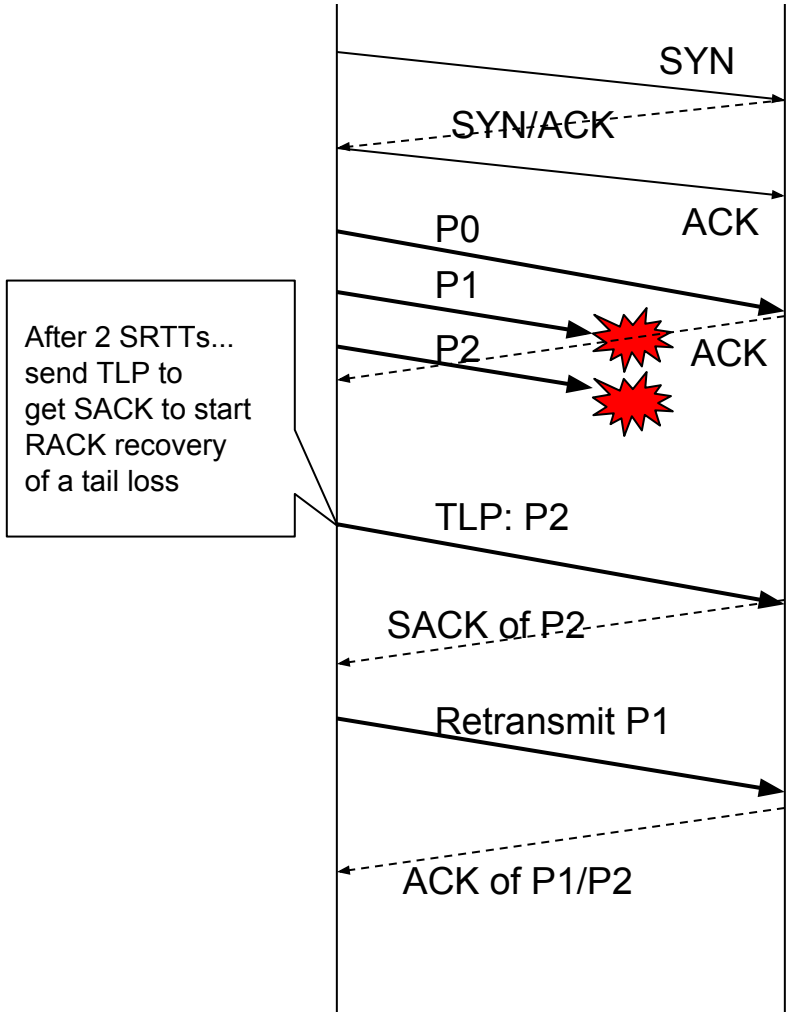
- RACK is about implementing this w/ one timer per connection and ACK events



Tail Loss Probe (TLP)

- Problem:
  - Tail drops are common on request/response traffic
  - Tail drops lead to timeouts, which are often 10x longer than fast recovery
  - 70% of losses on Google.com recovered via timeouts before TLP was deployed
- Goal:
  - Reduce tail latency of request/response transactions

- Approach:
  - Convert RTOs to fast recovery
  - Solicit a DUPACK by retransmitting the last packet in 2 SRTTs
  - Requires RACK to trigger fast recovery



Updates since IETF 100

- What's new in **draft-ietf-tcpm-rack-03**
  - Dynamic reordering window
  - DUPACK-threshold mode
  - Fast implementation example
  - Congestion control interactions
  - Cosmetic changes

- Deployment
  - RACK/TLP has now entirely replaced RFC6675 recovery in the latest Google/YouTube server TCP
    - Previously both RFC6675 and RACK/TLP were enabled to detect losses

Dynamic reordering window

- Previous RACK: reo_wnd = min_RTT/4
  - Spurious loss recoveries when reordering degree > reo_wnd
- Initial idea: precisely measure reordering degree in time
  - Complex
  - Requires remembering per-packet timestamp after the packet is ACKed and deallocated in the stack
- New idea: dynamically adapt reo_wnd using Duplicate SACK (DSACK; RFC2883)
  - DSACK signals spurious retransmission and implies reo_wnd is too small
  - Increase reo_wnd on DSACKs
  - Decrease reo_wnd gradually if no DSACKs
  - DSACK is supported by Linux, iOS, MacOS, and Windows

Dynamic reordering window details

Init: reo_wnd = min_RTT/4

For every round trip that receives some ACKs with DSACK option

    reo_wnd += min_RTT/4

After 16 loss recoveries without observing more DSACK options, reset state

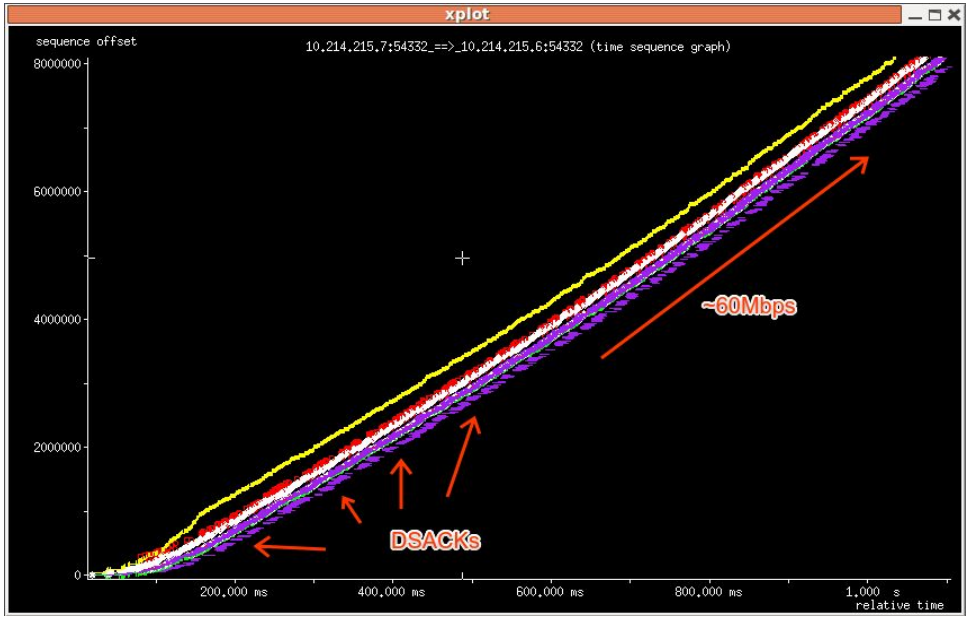
    reo_wnd = min_RTT/4

Temporarily set reo_wnd = 0 during loss recovery for prompt repair

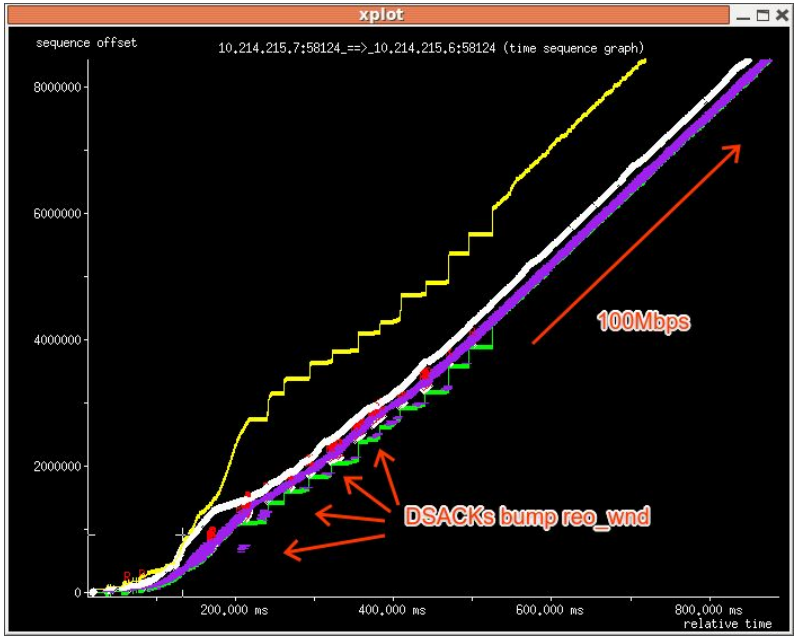
Always cap reo_wnd by SRTT (smoothed RTT from RFC6298)

Dynamic reordering window

Old: static reo_wnd (draft -02)



New: adaptive reo_wnd (draft -03)



White: data Green: ACK Purple: (D)SACK Red: (spurious) retransmission Yellow: recv-win limit

DUPACK-threshold emulation mode

DUPACK-threshold is useful with ultra-low RTTs (when RACK timer tick slower than RTT)

New: RACK support for DUPACK-threshold

If #DUPACKs >= 3, Then reo_wnd = 0

Subtle differences between RFC6675 and RACK:

1. RFC6675: a packet is lost when >=3 packets are SACKed and have higher sequence
2. RACK: a packet is lost when >=3 packets are SACKed and at least one has higher sequence
3. Example: send 10 packets, and packets 3, 5, 7 are SACKed
   RFC6675: packets 1, 2 lost
   RACK: packets 1, 2, 4, 6 lost

Interaction with congestion control

Potential burst interaction with Reno congestion control (i.e. RFC5681)

a. On a single ACK, RACK could mark a large number of packets lost
b. Inflight (aka pipe) drops suddenly
c. TCP retransmission bursts (cwnd - inflight) == (ssthresh - inflight)
d. Causes more drops

Recommendation

e. Use Proportional Rate Reduction [RFC6937] to pace via packet conservation or slow start
    i. Also helpful: a rate-based TCP pacing mechanism (e.g. Linux fq/pacing)

Conclusion

The development of RACK is near the end

1. Linux/FreeBSD/Windows support RACK
2. Authors consider draft-03 as complete and ready for final review

Questions? Concerns?