Cubic Quiescence: Not So Inactive

Jana Iyengar
QUIC
Quick UDP Internet Connections

- A reliable, multiplexed transport over UDP
- Always encrypted
- Reduces latency
- Runs in user-space
- Open sourced in Chromium
What is QUIC?

HTTP/2
TLS 1.2
TCP
QUIC
UDP
HTTP/2 API
IP
Deployment over the last year

Used by the vast majority of Google services and Chrome
QUIC and the decade old Cubic Bug

- Cubic is the default congestion control in Linux
- QUIC has an independent implementation of Cubic
- QUIC also uses Cubic by default

*Both* had a bug that rapidly increased the congestion window during idle.
QUIC and the decade-old Cubic bug

From the Cubic paper:

More specifically, the congestion window of CUBIC is determined by the following function:

\[ W_{cubic} = C(t-K)^3 + W_{max} \]  

where \( C \) is a scaling factor, \( t \) is the elapsed time from the last window reduction, \( W_{max} \) is the window size just before the last window reduction, and \( K = \sqrt[3]{W_{max} \beta / C} \), where \( \beta \) is a constant multiplication decrease factor applied for window reduction at the time of loss event (i.e., the window reduces to \( \beta W_{max} \) at the time of the last reduction).
QUIC and the decade-old Cubic bug

- Reduced QUIC (and TCP) retransmit rates dramatically
QUIC and the decade-old Cubic bug

- Reduced QUIC (and TCP) retransmit rates dramatically
  - by over 30% for QUIC
QUIC and the decade-old Cubic bug

- Reduced QUIC (and TCP) retransmit rates dramatically
  - by over 30% for QUIC
  - by about 20% for TCP
QUIC and the decade-old Cubic bug

- Reduced QUIC (and TCP) retransmit rates dramatically
  - by over 30% for QUIC
  - by about 20% for TCP

- Improved CPU efficiency for QUIC noticeably
  - fewer packets sent
  - fewer NACKs processed

- TCP Cubic fix upstreamed to Linux
A couple of takeaways

Running in userspace helps
- Bug discovered via packet-level logs inspection
- Cheap userspace memory allows detailed logging
A couple of takeaways

Running in userspace helps
- Bug discovered via packet-level logs inspection
- Cheap userspace memory allows detailed logging

Cubic is a complex beast
- And its benefits for the Internet are not exactly clear-cut
  - many differences from NewReno, not all useful
  - some parts may be helping, should be isolated