First L4S Interop Event
@ IETF Hackathon

IETF 114
23-26 July 2022
Philadelphia, Pennsylvania

Champions: Greg White (CableLabs), Jason Livingood (Comcast), Sebnem Ozer (Comcast), Vidhi Goel (Apple), Neal Cardwell (Google)
Hackathon/Interop Plan

• L4S Congestion Control & AQM Architecture
  • draft-ietf-tsvwg-l4s-arch
  • draft-ietf-tsvwg-ecn-l4s-id
  • draft-ietf-tsvwg-aqm-dualq-coupled
• Accurate ECN for TCP (QUIC supports accurate ECN natively)
  • draft-ietf-tcpm-accurate-ecn
• L4S involves three components
  – Congestion control @ sender
  – Congestion marking @ bottleneck
  – Marking feedback @ receiver
Hackathon/Interop Plan – cont.

• Friday afternoon – CMTS & Network setup
• Saturday – Setup continues, initial testing
• Sunday – testing continues
• Monday – readout in TSVWG
• Tuesday – complete testing & wrap up
Hackathon Implementations

• Congestion control
  – Apple QUIC Prague
  – TCP Prague
  – Google BBRv2
  – NVIDIA GFN
  – Nokia RT-Prague

• Marking Feedback
  – PicoQUIC
  – Apple QUIC
  – Google AccECN/TCP
  – FreeBSD AccECN/TCP
  – NVIDIA GFN client
Hackathon Implementations

• Seven bottleneck link implementations
  – Four Low Latency DOCSIS implementations
    • 2 cable modem chipsets (Broadcom, Maxlinear)
    • 2 CMTS (Casa, Commscope)
  – Google Nest WiFi AP
  – Nokia Beacon 6 WiFi AP
  – Nokia 5G/Fixed Network Emulator
Initial Interoperability Testing

- AppleQUIC / CommscopeLLD
- AppleQUIC / CasaLLD
- AppleQUIC / BroadcomLLD
- AppleQUIC / MaxlinearLLD
- Google BBRv2 Linux / FreeBSD AccECN TCP
- NVIDIA / Nokia WiFi
- NVIDIA / NokiaRT / Nokia 5G RAN emulator
- NVIDIA / CasaLLD
- BBRv2 / TCP Prague / NokiaRT / Nokia 5G RAN emulator
- Meta Netestno / TCP Prague / Nokia WiFi
- AppleQUIC / NokiaRT / CasaLLD
- NVIDIA / AppleQUIC / CommscopeLLD
- NVIDIA / BBRv2 / CommscopeLLD
- More coming...
Downstream Classic (DOCSIS & AppleQUIC)

Latency Timeseries

CCDF of Packet Latency

Packet Delay Statistics
- P0: 0.018 ms
- P90: 0.664 ms
- P99: 55.671 ms
- P99.9: 96.125 ms
- P99.99: Not applicable

Missing: 304 Packets
Drops: 1044 Packets

Data Rate Statistics
- Mean data rate: 98.4 Mbps
- P10 of data rate: 40.6 Mbps
- P10 % of mean: 41.3%
- Ramp time to 90%: 200 ms

PDV Statistics
- P99: 55.653 ms
- P99.9: 96.107 ms

DSCP and ECN Counts
- DSCP 3: 160268
- ECT0: 160267
- Not ECT: 1
- Total: 160268

Mbps Timeseries
Downstream L4S (DOCSIS & AppleQUIC)

Latency Timeseries

CCDF of Packet Latency

Packet Delay Statistics

Data Rate Statistics

PDV Statistics

DSCP and ECN Counts

DSCP 43 322777
DSCP 3 1
ECT1 320048
Not ECT 1
CE 2729
Total 322778

Mbps Timeseries
# Participating Organizations (15)

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<th>Apple</th>
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<td>CableLabs</td>
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Participants (32)

Shamim Akhtar
Radhouan Allani
Chris Box
Bob Briscoe
Justin Cardones
Neal Cardwell
Chia-Yu Chang
Stuart Cheshire
Koen De Schepper
Glenn Deen
Wesley Eddy
Bilgehan Erman
Vidhi Goel
Edward Grinshpun
Milap Rajeshkumar Joshi
Carl Klatsky
Jason Livingood
Colin McIntosh
Charles Moyer
Murat Mugan
Sebnem Ozer
Ram Ranganathan
Nicola Rustignoli
Dan Rice
Ermin Sakic
Richard Scheffenegger
Greg White
Max White
Guoye Zhang
Hongbiao Zhang
Shawn Zhang
Lei Zhou