First L4S Interop Event @ IETF Hackathon

IETF 114
23-26 July 2022
Philadelphia, Pennsylvania

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 – some initial results to share
- 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

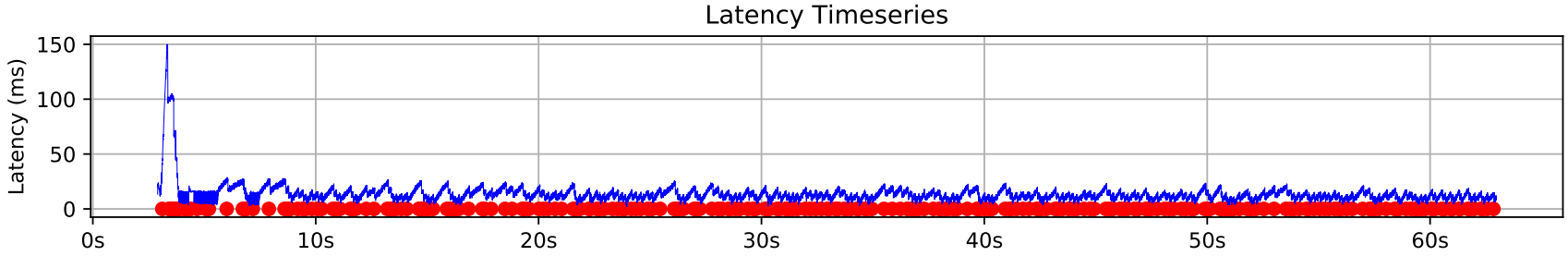
Hackathon Implementations

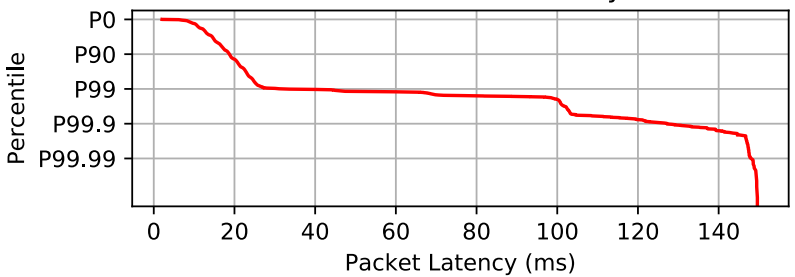
- Seven bottleneck link implementations
  - Four Low Latency DOCSIS implementations
    - 2 cable modem chipsets (Broadcom, Maxlinear)
    - 2 CMTS (Casa, Commscope)
  - Google Nest WiFi AP
  - Nokia Beacon 6 WiFi AP
  - Nokia 5G/Fixed Network Emulator

Initial Interoperability Testing

- AppleQUIC / Commscope LLD
- AppleQUIC / Casa LLD
- AppleQUIC / Broadcom LLD
- AppleQUIC / Maxlinear LLD
- Google BBRv2 Linux / FreeBSD AccECN TCP
- NVIDIA / Nokia WiFi
- NVIDIA / Nokia RT-Prague / Nokia 5G RAN emulator
- NVIDIA / Casa LLD
- BBRv2 / TCP Prague / Nokia RT-Prague / Nokia 5G RAN emulator
- Meta Netesto / TCP Prague / Nokia WiFi

Upstream Classic (DOCSIS & AppleQUIC)





Packet Delay Statistics

P0	2.051 ms
P90	18.728 ms
P99	32.073 ms
P99.9	127.196 ms
Drops	278 Packets
Missing	0 Packets

Data Rate Statistics

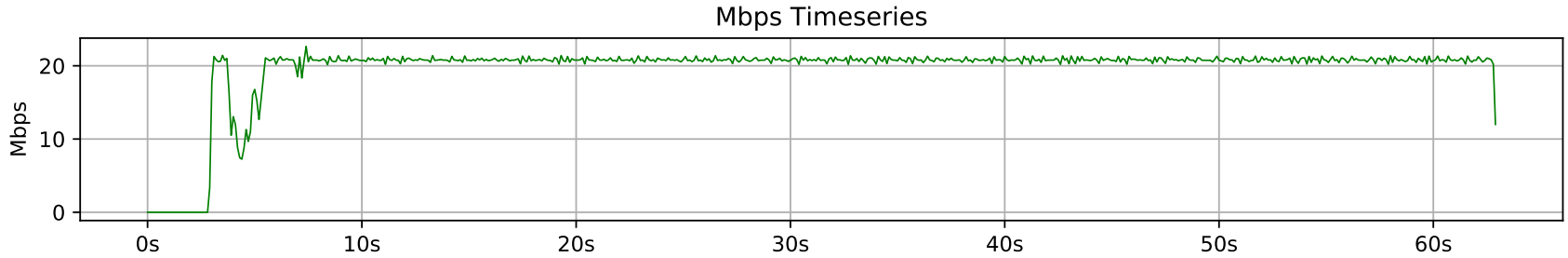
Mean data rate	20.8 Mbps
P10 of data rate	18.4 Mbps
P10 % of mean	88.5%
Ramp time to 90%	200 ms

PDV Statistics

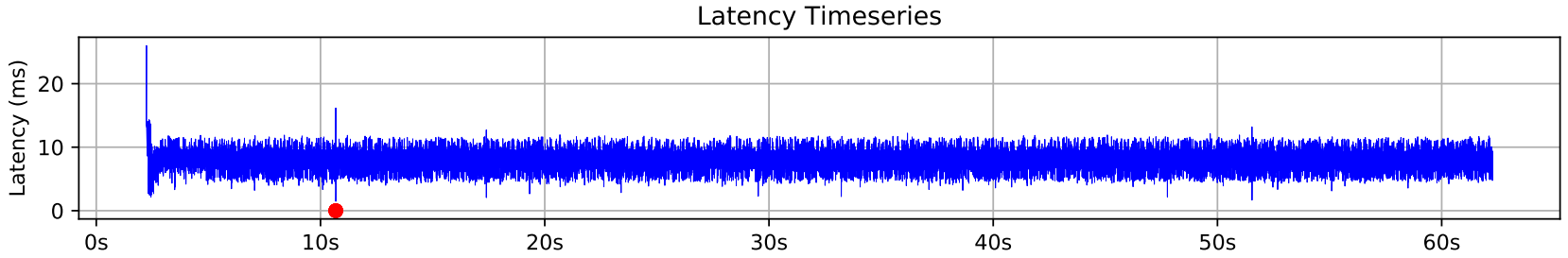
P99	30.022 ms
P99.9	125.145 ms

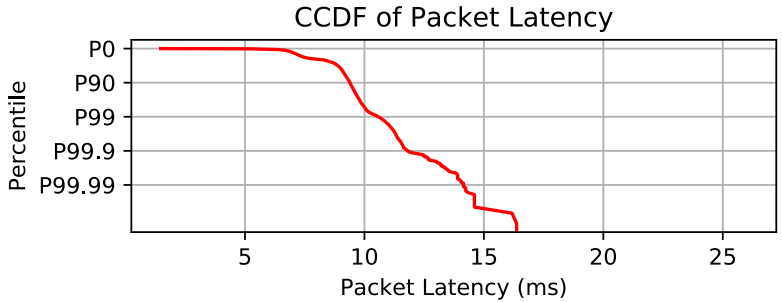
DSCP and ECN Counts

DSCP 3	132320
Not ECT	2
ECT0	132318
Total	132320



Upstream L4S (DOCSIS & AppleQUIC)





Packet Delay Statistics

P0	1.470 ms
P90	9.396 ms
P99	10.588 ms
P99.9	11.811 ms
Drops	4 Packets
Missing	4 Packets

Data Rate Statistics

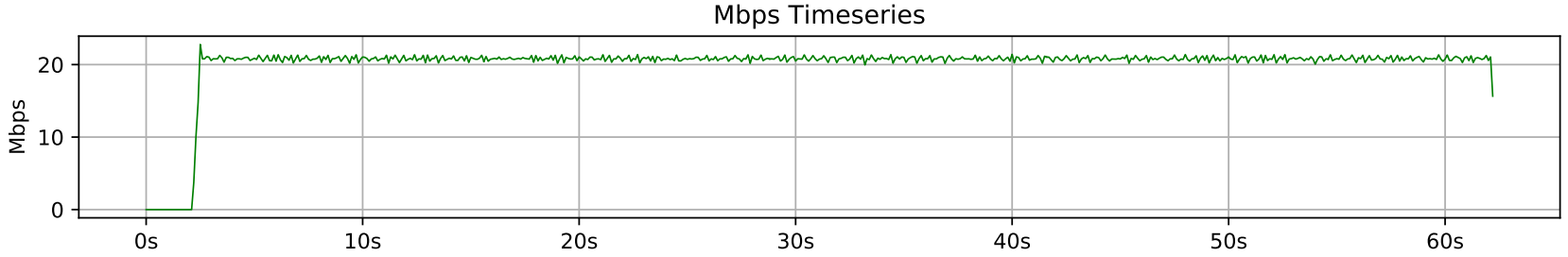
Mean data rate	20.6 Mbps
P10 of data rate	6.6 Mbps
P10 % of mean	32.0%
Ramp time to 90%	300 ms

PDV Statistics

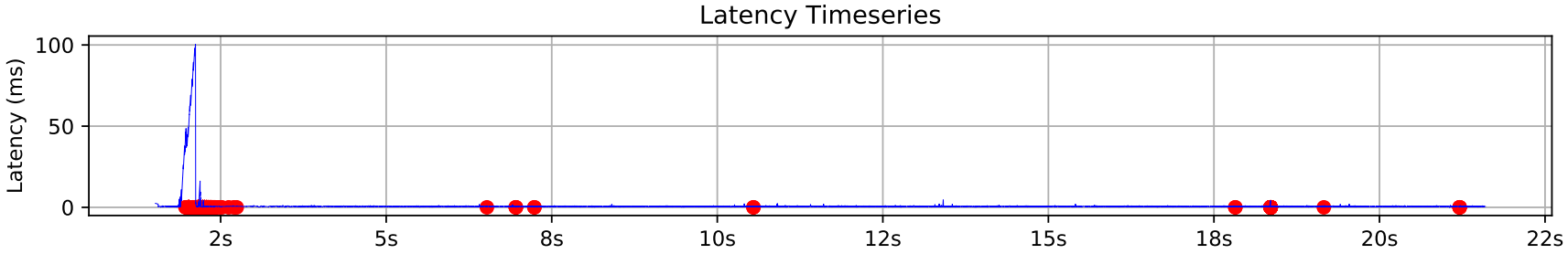
P99	9.117 ms
P99.9	10.341 ms

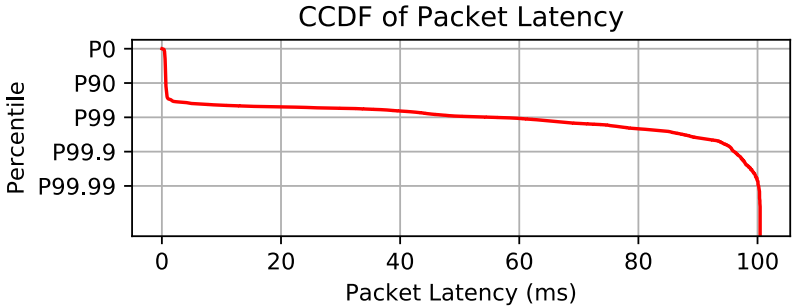
DSCP and ECN Counts

DSCP 3	2
DSCP 0	133760
Not ECT	2
ECT1	127643
CE	6117
Total	133762



Downstream Classic (DOCSIS & AppleQUIC)





Packet Delay Statistics

P0	0.018 ms
P90	0.664 ms
P99	55.671 ms
P99.9	96.125 ms
Drops	1044 Packets
Missing	304 Packets

Data Rate Statistics

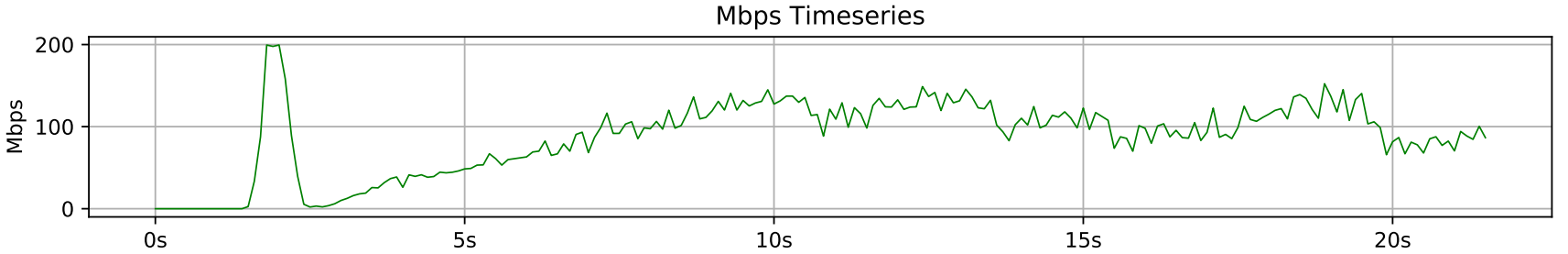
Mean data rate	98.4 Mbps
P10 of data rate	40.6 Mbps
P10 % of mean	41.3%
Ramp time to 90%	200 ms

PDV Statistics

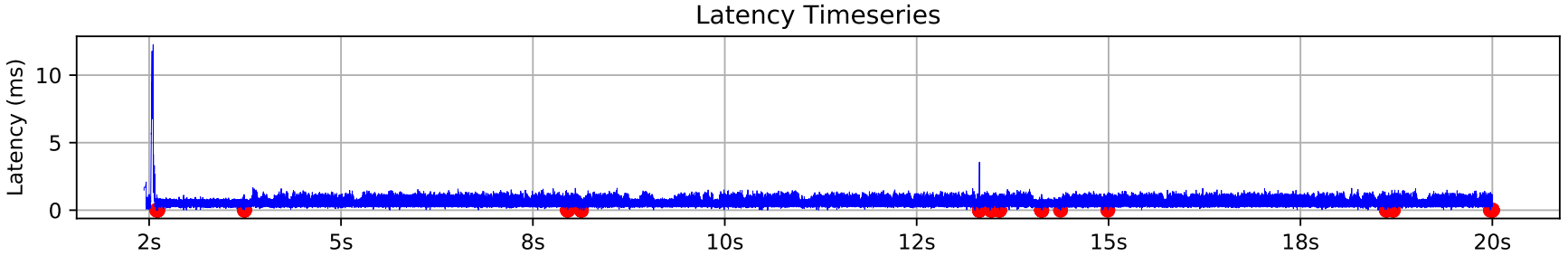
P99	55.653 ms
P99.9	96.107 ms

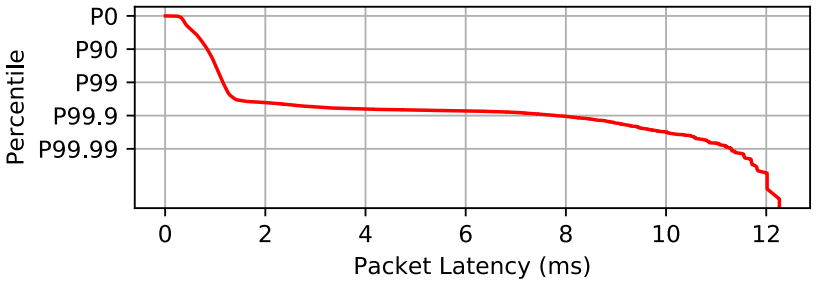
DSCP and ECN Counts

DSCP 3	160268
ECT0	160267
Not ECT	1
Total	160268



Downstream L4S (DOCSIS & AppleQUIC)





Packet Delay Statistics

P0	0.006 ms
P90	0.841 ms
P99	1.154 ms
P99.9	7.800 ms
Drops	96 Packets
Missing	86 Packets

Data Rate Statistics

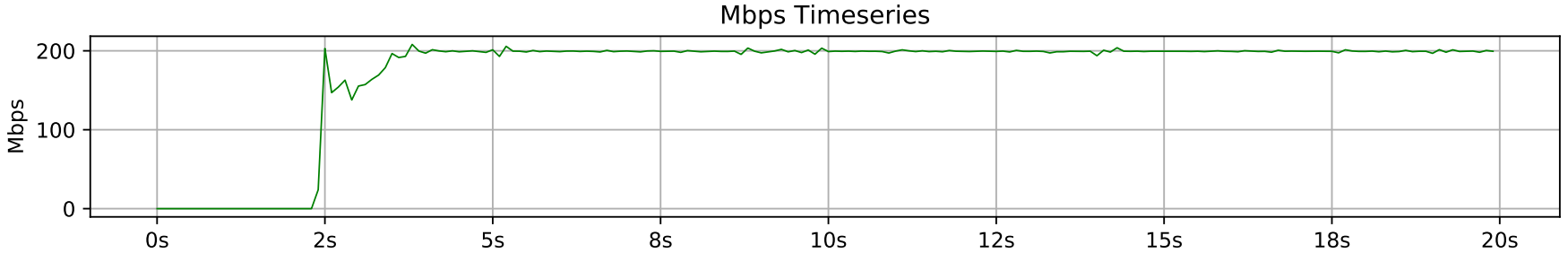
Mean data rate	199.4 Mbps
P10 of data rate	199.1 Mbps
P10 % of mean	99.8%
Ramp time to 90%	100 ms

PDV Statistics

P99	1.148 ms
P99.9	7.794 ms

DSCP and ECN Counts

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



Participating Organizations (15)

Apple
CableLabs
Casa
Charter
Comcast
Commscope
Google
Independent
Kyrio
Meta
Nokia
Netapp
Netflix
NVIDIA
ETH Zurich

Participants (31)

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
Guoye Zhang
Hongbiao Zhang
Shawn Zhang
Lei Zhou