CableLabs L4S Interop Nov 18-24 2024 SCReAM evaluation

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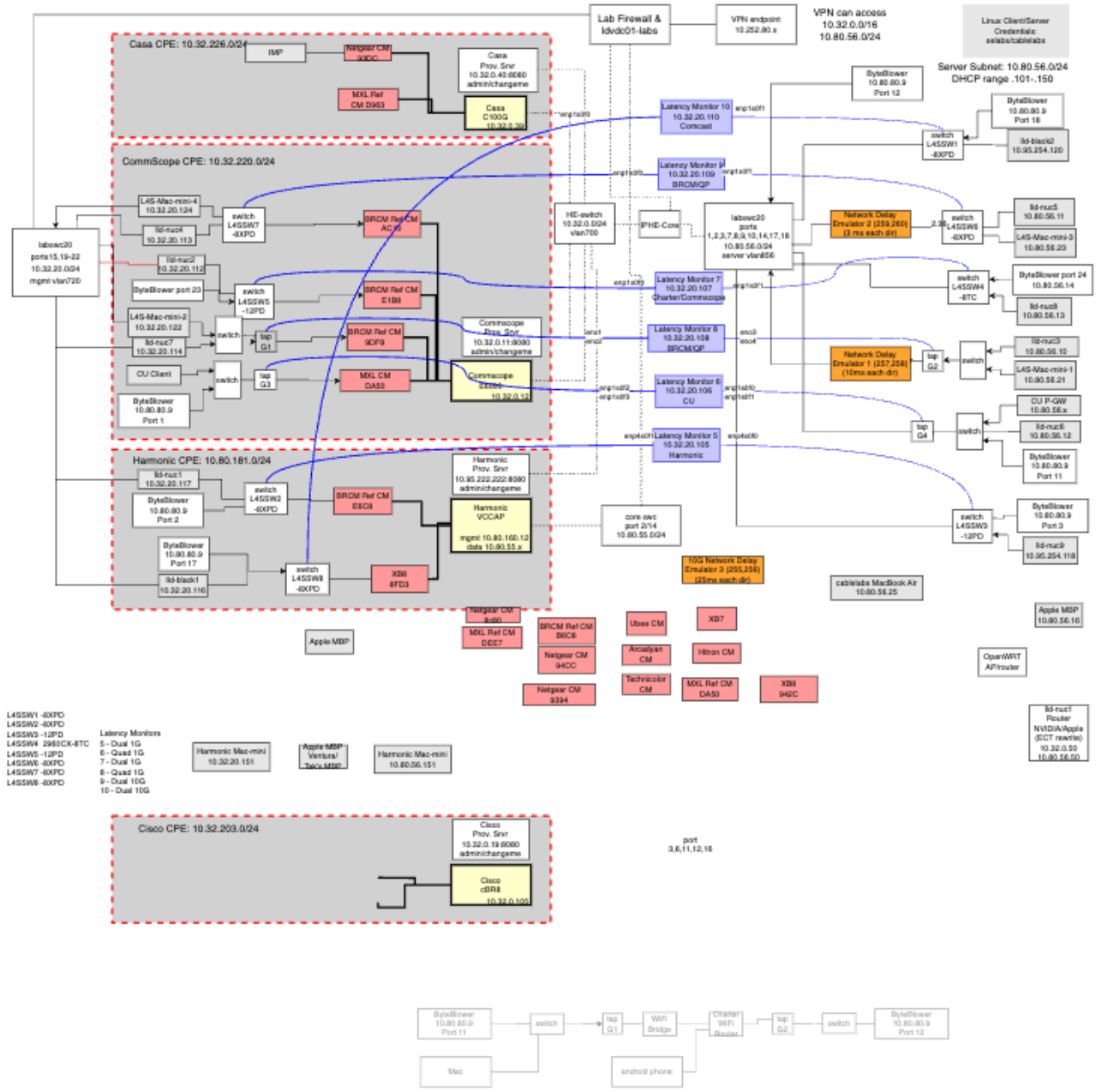
CableLabs KYRIO
INTEROP • LABS
Low Latency, Low Loss, Scalable Throughput

Intro

- https://www.cablelabs.com/event/interoplabs-l4s-nov-2024

- Test setup with DOCSIS equipment
  - Downstream/upstream configured to 100/10Mbps
  - Linux PCs (Ubuntu 22.04 w/ Prague kernel 5.15)
  - Apple MAC Mini PCs with apple-quic (Sequoia 15.1)

- SCReAM BW test from https://github.com/EricssonResearch/scream
  e0af5ef4613a38a84f99b7995eef38c69a5c08fa

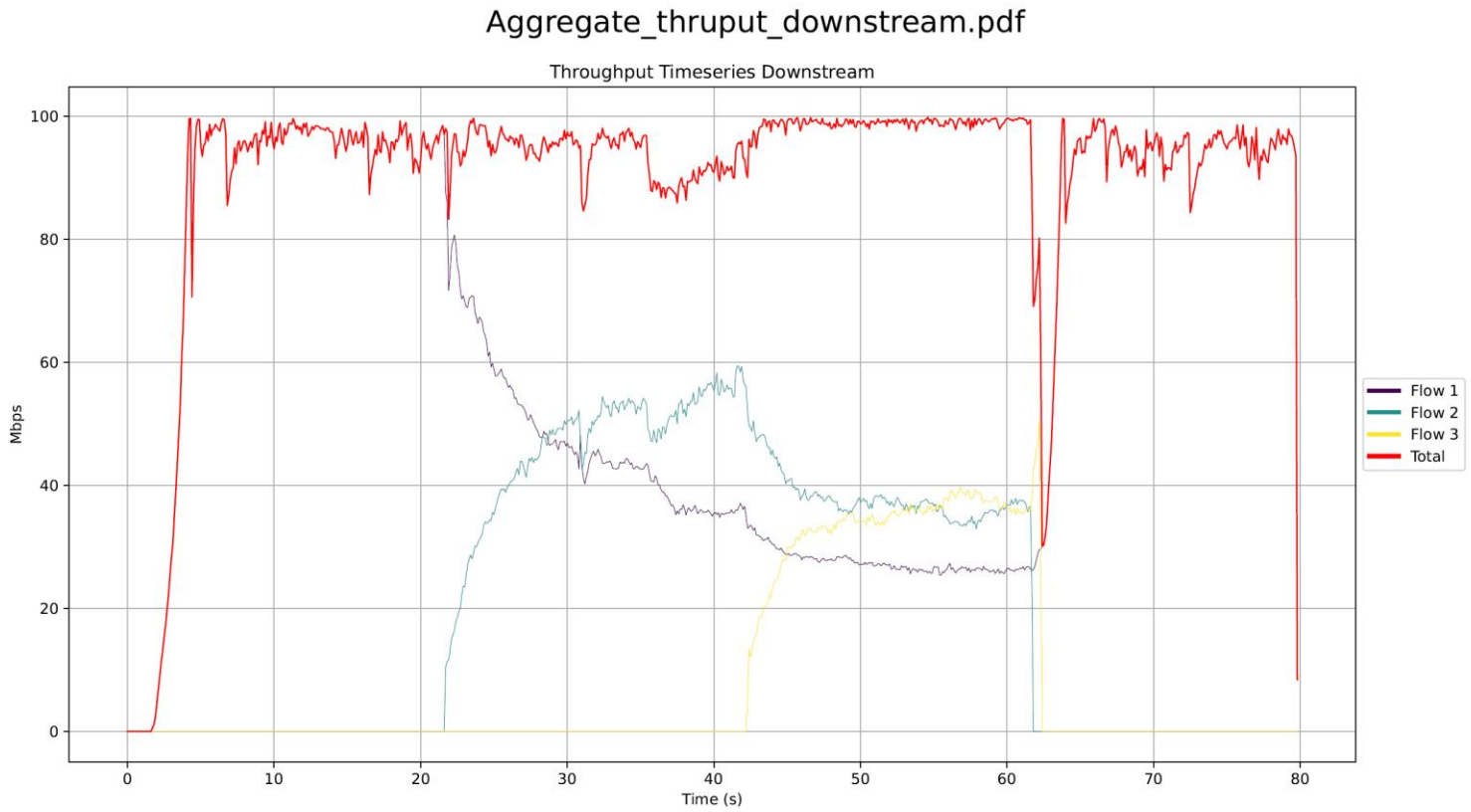

Lab Firewall & ldvdc01-labs
VPN endpoint
VPN can access
10.32.0.0/16
10.80.56.0/24
Linux Client/Server
Credentials:
cablelabs/cablelabs
Server Subnet: 10.80.56.0/24
DHCP range .101-.150
Casa CPE: 10.32.226.0/24
IMP
Netgear CM 90DC
MXL Ref CM D963
Casa Prov. Smr 10.32.0.40:8080 admin/changeme
Casa C100G 10.32.0.20
CommScope CPE: 10.32.220.0/24
L45-Mac-mini-4 10.32.20.124
lld-nuc4 10.32.20.113
lld-nuc2 10.32.20.112
ByteBlower port 23
L45-Mac-mini-2 10.32.20.122
lld-nuc7 10.32.20.114
CU Client
ByteBlower 10.80.80.9 Port 1
labsvc20 ports15,19-22 10.32.20.0/24 mgmt vlan720
switch L4SSW7 -8XPD
switch L4SSW5 -12PD
switch
tap G1
switch
tap G3
BRCM Ref CM AC36
BRCM Ref CM E1B8
BRCM Ref CM 9DF8
MXL CM DA50
Commscope Prov. Smr 10.32.0.11:8080 admin/changeme
Commscope 10.32.0.12
Harmonic CPE: 10.80.181.0/24
lld-nuc1 10.32.25.117
ByteBlower 10.80.80.9 Port 2
ByteBlower 10.80.80.9 Port 17
lld-black1 10.32.20.116
switch L4SSW2 -8XPD
switch L4SSW8 -8XPD
BRCM Ref CM D8C8
XB8 8FD3
Harmonic Prov. Smr 10.95.222.222:8080 admin/changeme
Harmonic VCCAP mgmt 10.80.160.12 data 10.80.55.x
Cisco CPE: 10.32.203.0/24
Cisco Prov. Smr 10.32.0.19:8080 admin/changeme
Cisco cBR8 10.32.0.105
HE-switch 10.32.0.0/24 vlan700
PHE-Core
labsvc20 ports 1,2,3,7,8,9,10,14,17,18 10.80.56.0/24 server vlan856
core swc port 2/14 10.80.55.0/24
Latency Monitor 10 10.32.20.110 Comcast
Latency Monitor 9 10.32.20.109 BRCM/QP
Latency Monitor 7 10.32.20.107 Charter/Commscope
Latency Monitor 8 10.32.20.108 BRCM/QP
Latency Monitor 6 10.32.20.106 CU
Latency Monitor 5 10.32.20.105 Harmonic
ByteBlower 10.80.80.9 Port 12
ByteBlower 10.80.80.9 Port 18
lld-black2 10.95.254.120
switch L4SSW1 -8XPD
Network Delay Emulator 2 (259.260) (3 ms each dir)
switch L4SSW6 -40XPD
lld-nuc5 10.80.56.11
L45-Mac-mini-3 10.80.56.23
switch L4SSW4 -8TC
ByteBlower port 24 10.80.56.14
lld-nuc8 10.80.56.13
Network Delay Emulator 1 (257.258) (10ms each dir)
tap G2
switch
lld-nuc3 10.80.56.10
L45-Mac-mini-1 10.80.56.21
tap G4
switch
CU P-GW 10.80.56.x
lld-nuc6 10.80.56.12
ByteBlower 10.80.80.9 Port 11
switch L4SSW3 -12PD
ByteBlower 10.80.80.9 Port 3
lld-nuc9 10.95.254.118
10G Network Delay Emulator 3 (255.256) (25ms each dir)
cablelabs MacBook Air 10.80.56.25
Apple MBP 10.80.56.16
OpenWRT AP/router
lld-nuc1 Router NVIDIA/Apple (ECT rewrite) 10.32.0.50 10.80.56.50
Apple MBP
MXL Ref CM DEE7
BRCM Ref CM D6C8
Netgear CM 94CC
Netgear CM 9394
Ubee CM
Arcadyan CM
Technicolor CM
XB7
Hitron CM
MXL Ref CM DA50
XB8 942C
L4SSW1 -8XPD
L4SSW2 -8XPD
L4SSW3 -12PD
L4SSW4 2960CX-8TC
L4SSW5 -12PD
L4SSW6 -40XPD
L4SSW7 -40XPD
L4SSW8 -40XPD
Latency Monitors
5 - Dual 1G
6 - Quad 1G
7 - Dual 1G
8 - Quad 1G
9 - Dual 10G
10 - Dual 10G
Harmonic Mac-mini 10.32.20.151
Apple MBP Ventura/ TeKo MBP
Harmonic Mac-mini 10.80.56.151
port 3,6,11,12,16
ByteBlower 10.80.80.9 Port 11
switch
tap G1
WiFi Bridge
Charter WiFi Router
tap G2
switch
ByteBlower 10.80.80.9 Port 12
Mac
android phone

SCReAM vs TCP Prague Downstream

- Downstream test
- Max 100Mbps throughput
- RTT 12ms
  - 32 and 52ms implemented as tc qdisc netem on feedback path
- SCReAM competes with TCP Prague over the L4S queue

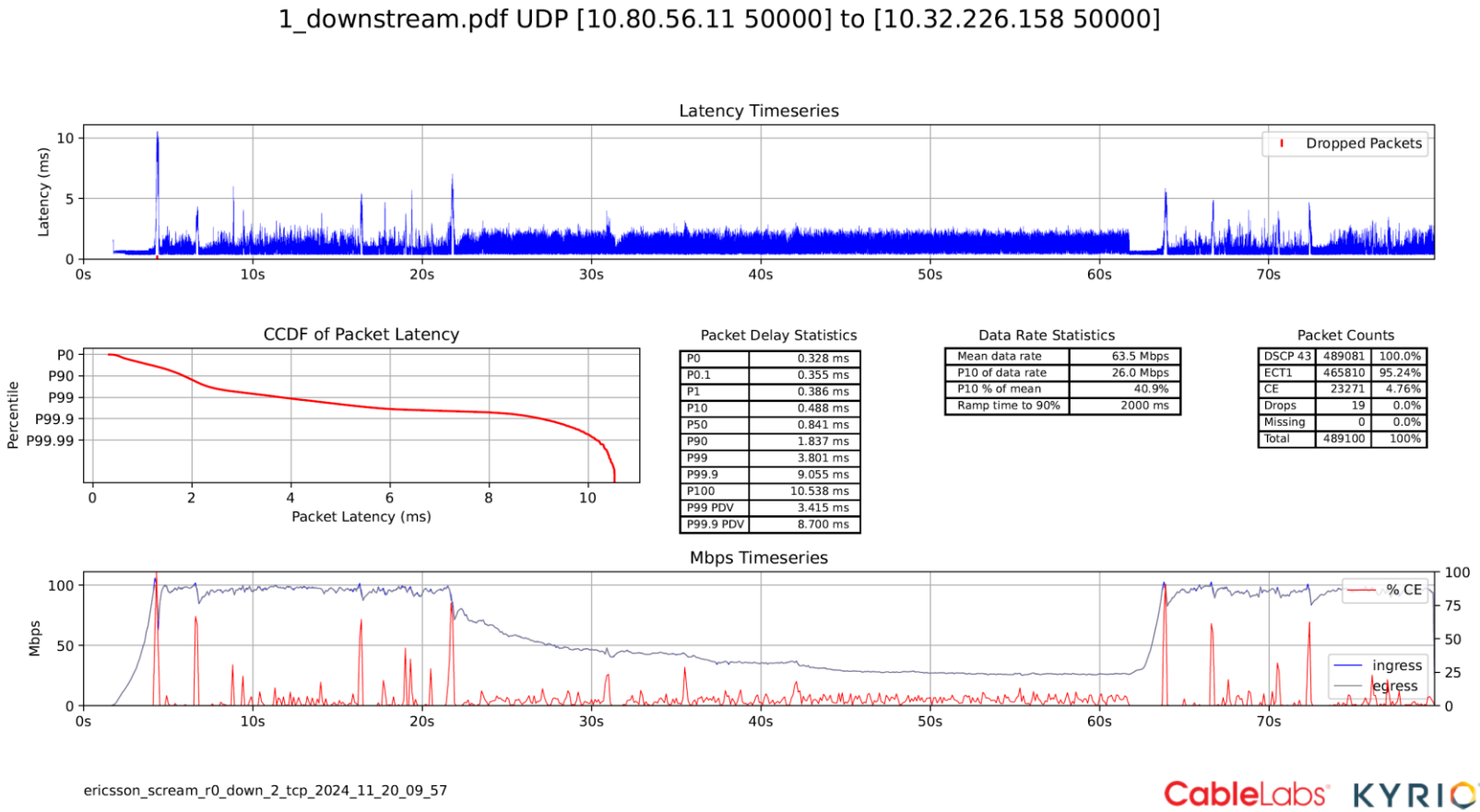
SCReAM
vs up to 2 TCP prague downstream (1/2)

- **RTT 12ms**
- SCReAM starts
- One TCP added efter 20s
- Another TCP added after 40s
- Both TCPs terminated after 60
- SCReAM has ~20% lower bitra than TCP



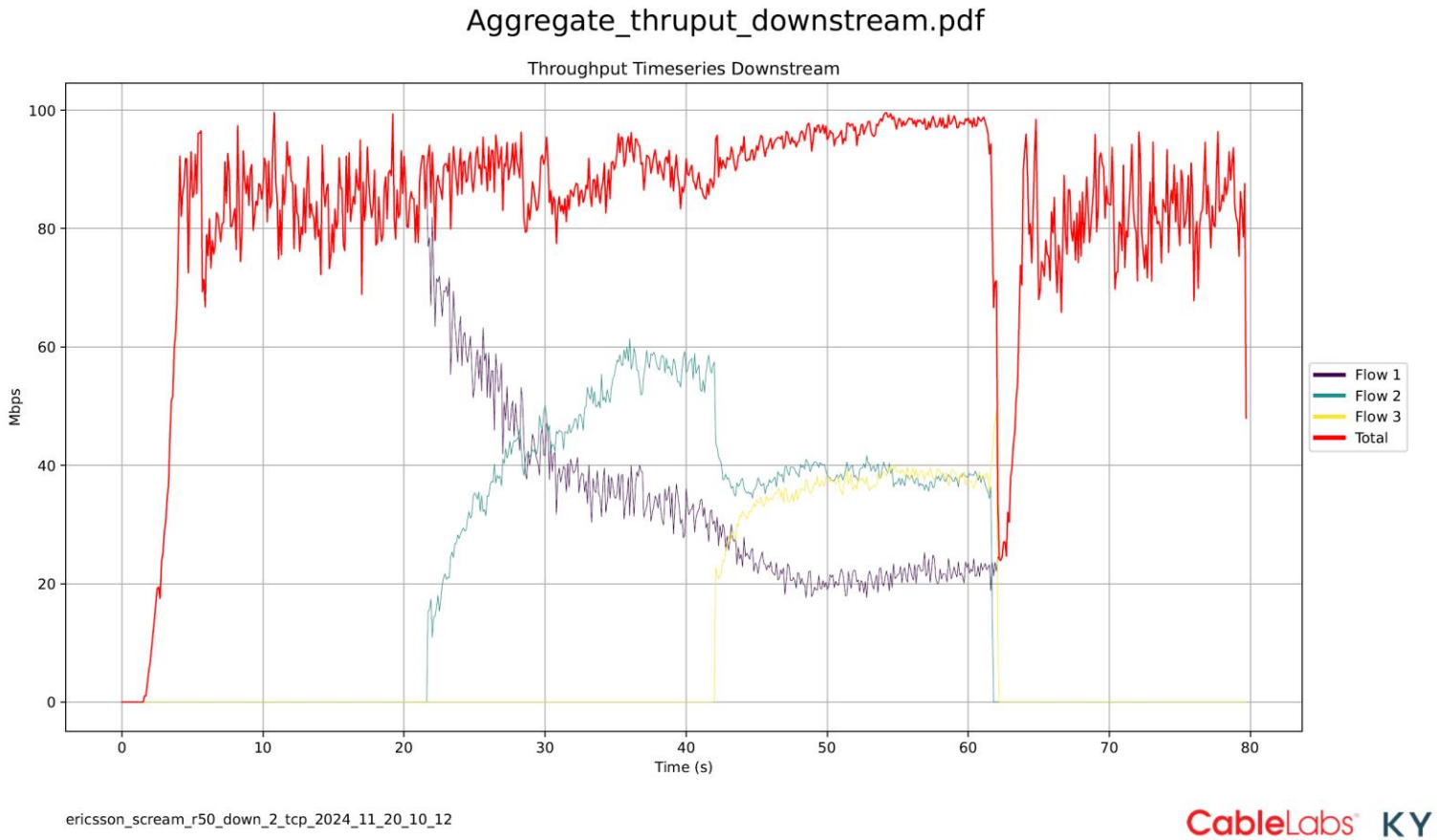
ericsson_scream_r0_down_2_tcp_2024_11_20_09_57

SCReAM vs up to 2 TCP Prague downstream (2/2)



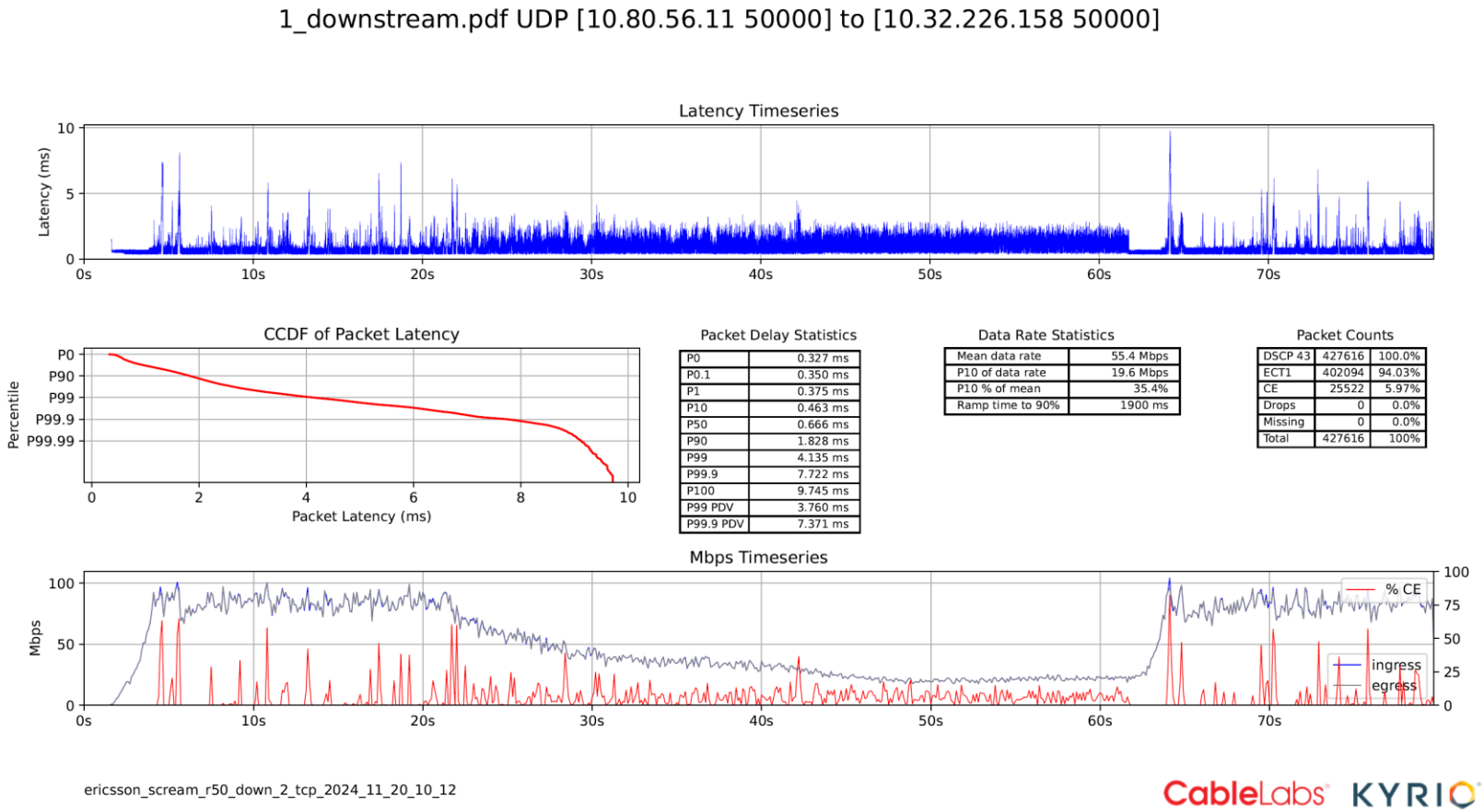
SCReAM variable video frame size vs up to 2 TCP prague downstream (1/2)

- As previous but SCReAM models variable frame sizes
  - -rand 50
- SCReAM adds extra headroom cope with varying frame sizes lower bitrate.
  - Intended behavior
- Slightly lower SCreAM bitrate with competing TCPs



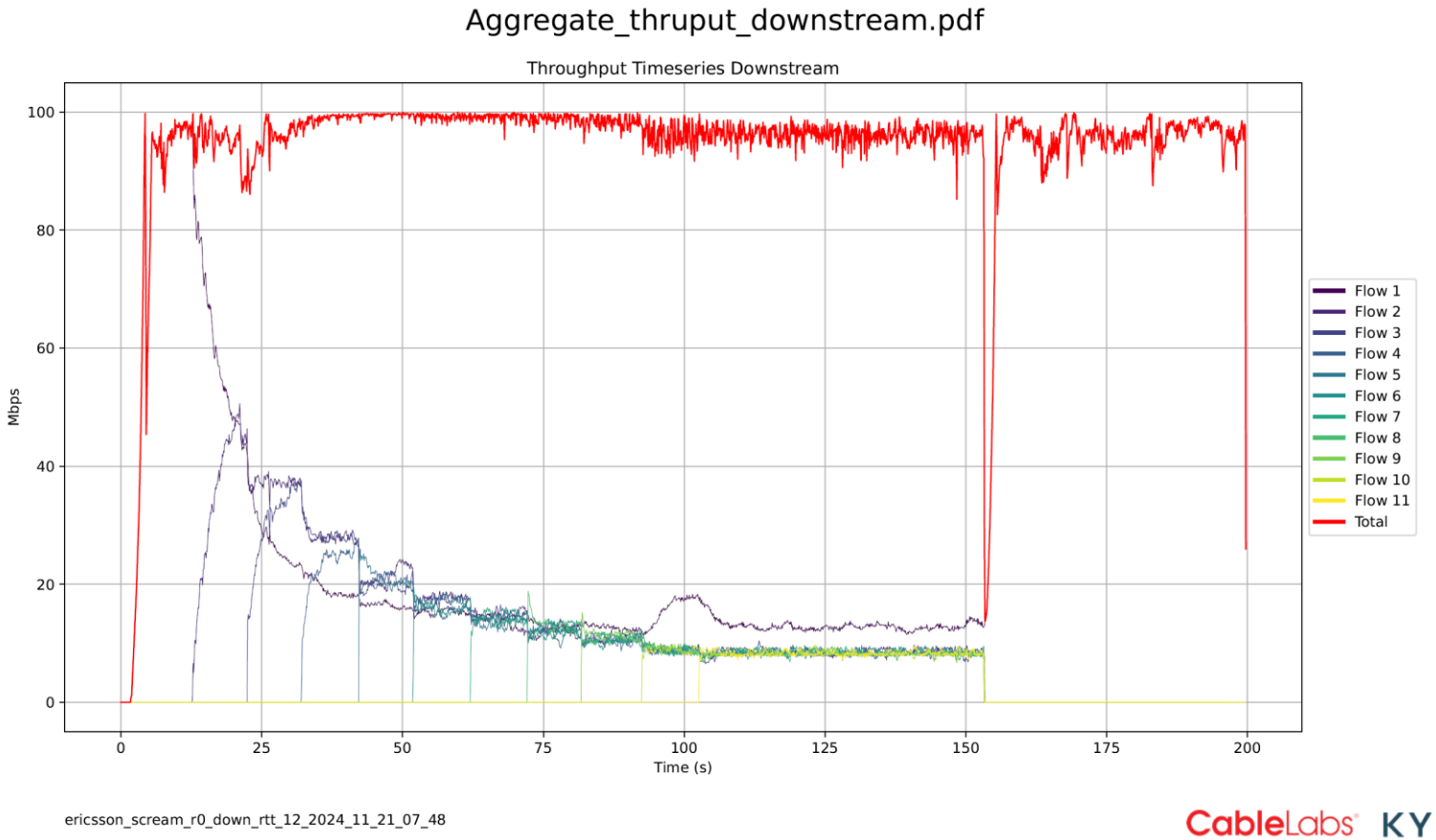
SCReAM variable video frame size vs up to 2 TCP prague downstream (1/2)

- Variable frame size gives slightly higher delay jitter, which is expected



SCReAM
vs up to 10 TCP prague downstream

- **RTT 12ms**
- SCReAM starts
- One TCP added every 10s
- All TCPs terminated after 150s
- SCReAM copes with many competing TCP Prague quite well



SCReAM variable video frame size vs up to 10 TCP prague downstream

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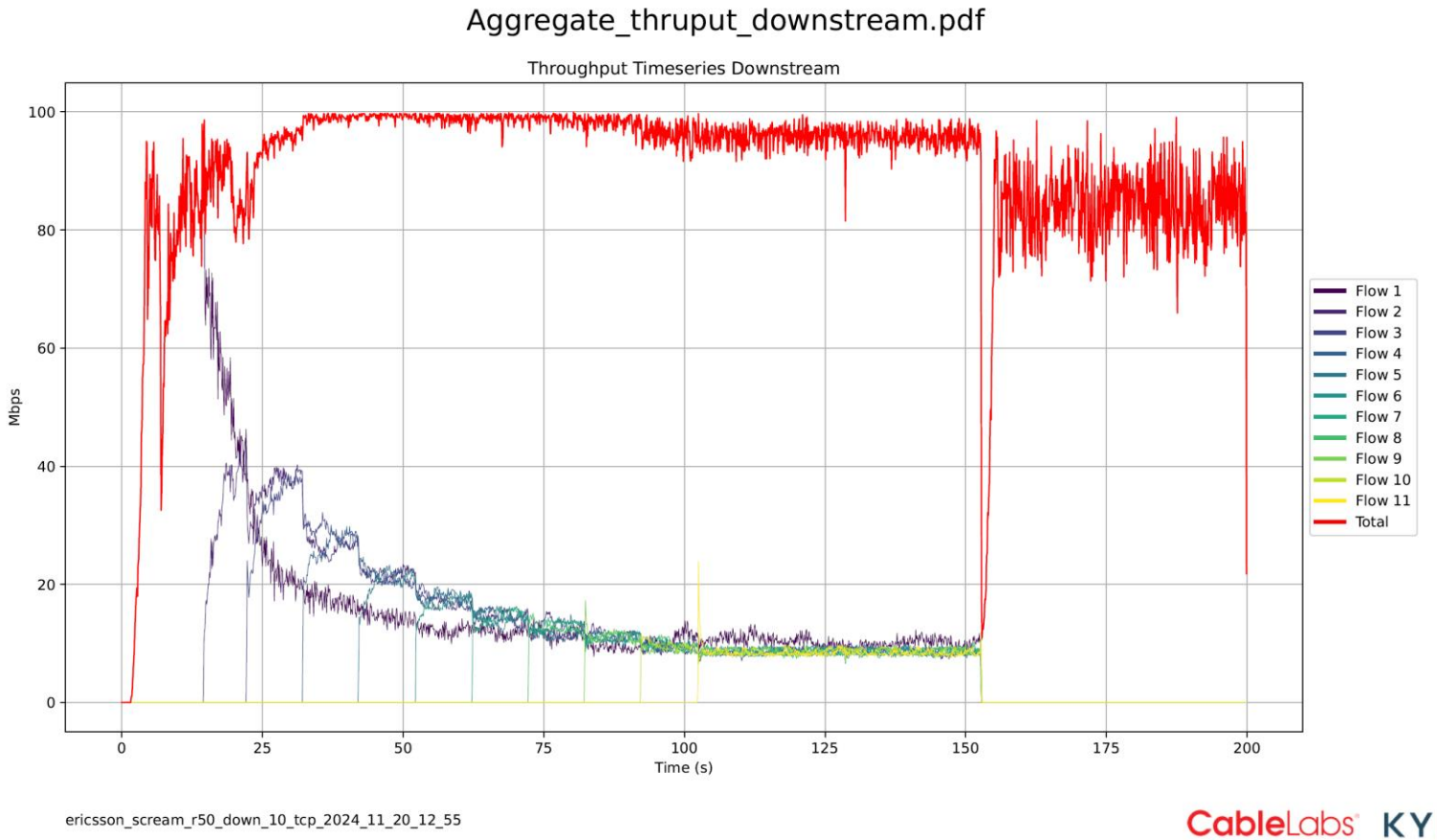
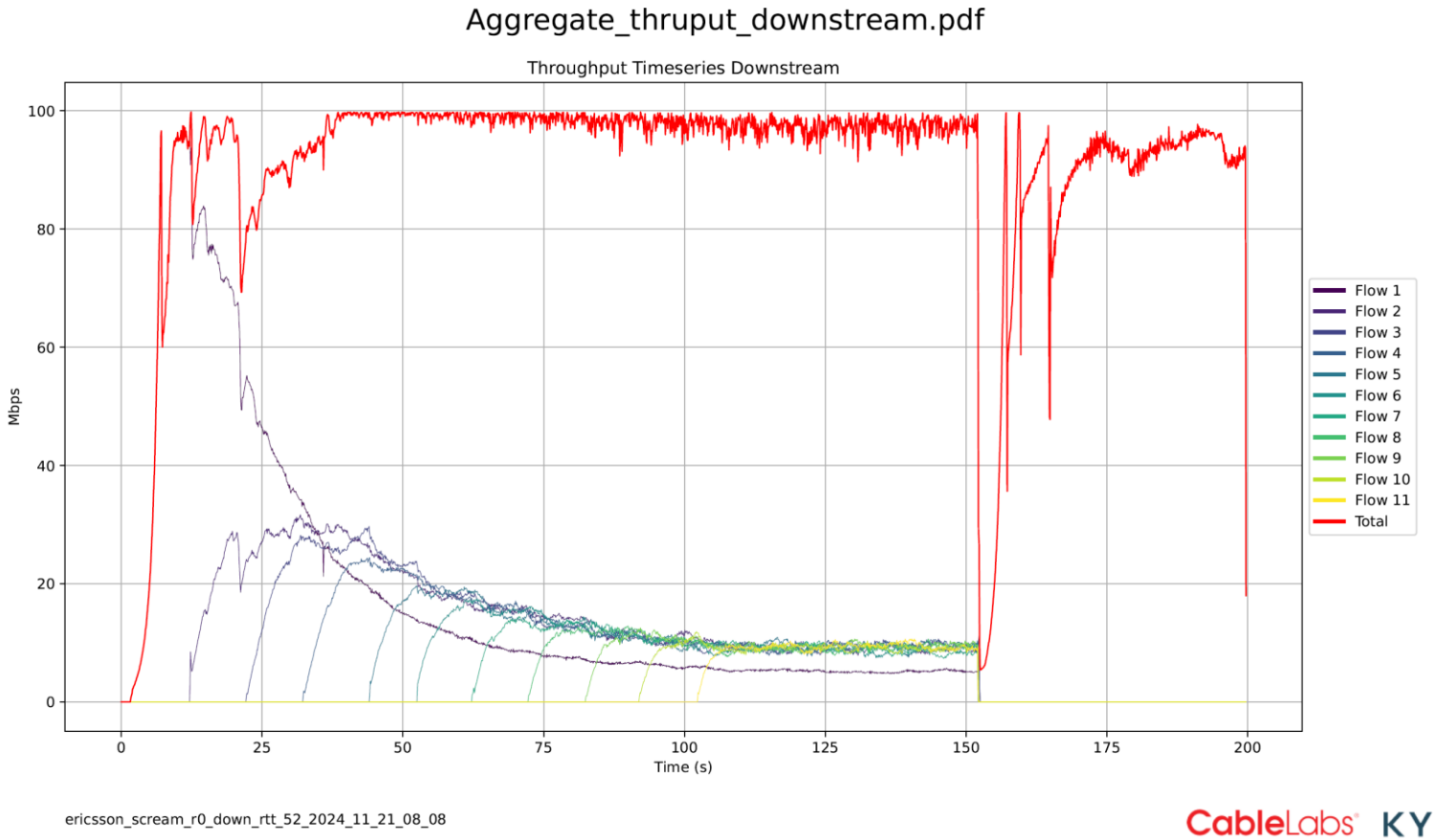


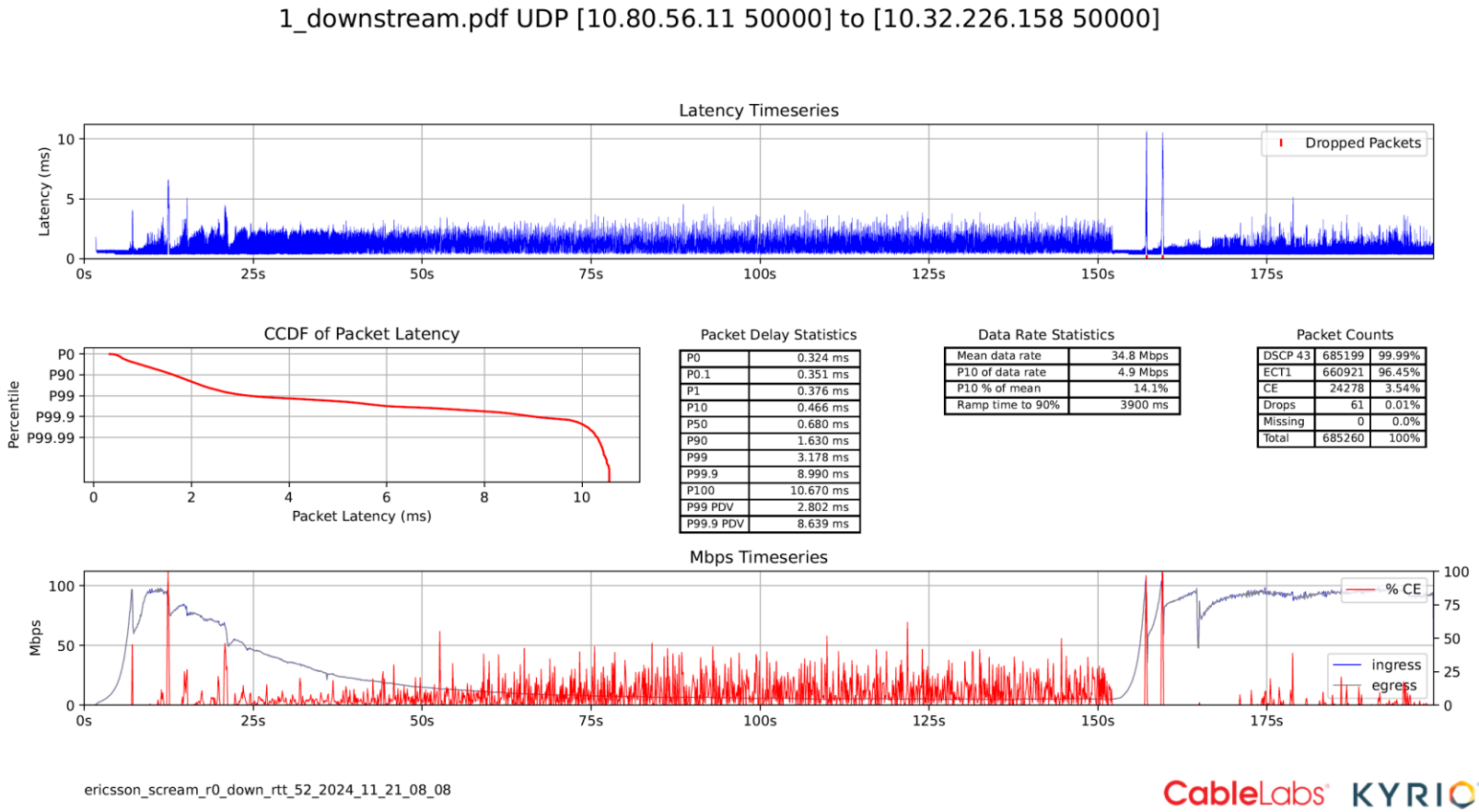
SCReAM vs up to 10 TCP prague downstream (1/4)

- **RTT 52ms**
- SCReAM starts
- One TCP added every 10s
- All TCPs terminated after 150s
- SCReAM gets roughly 40% lower bitrate
  - Possibly additional RTT compensation needed
- But SCReAM is not starved out



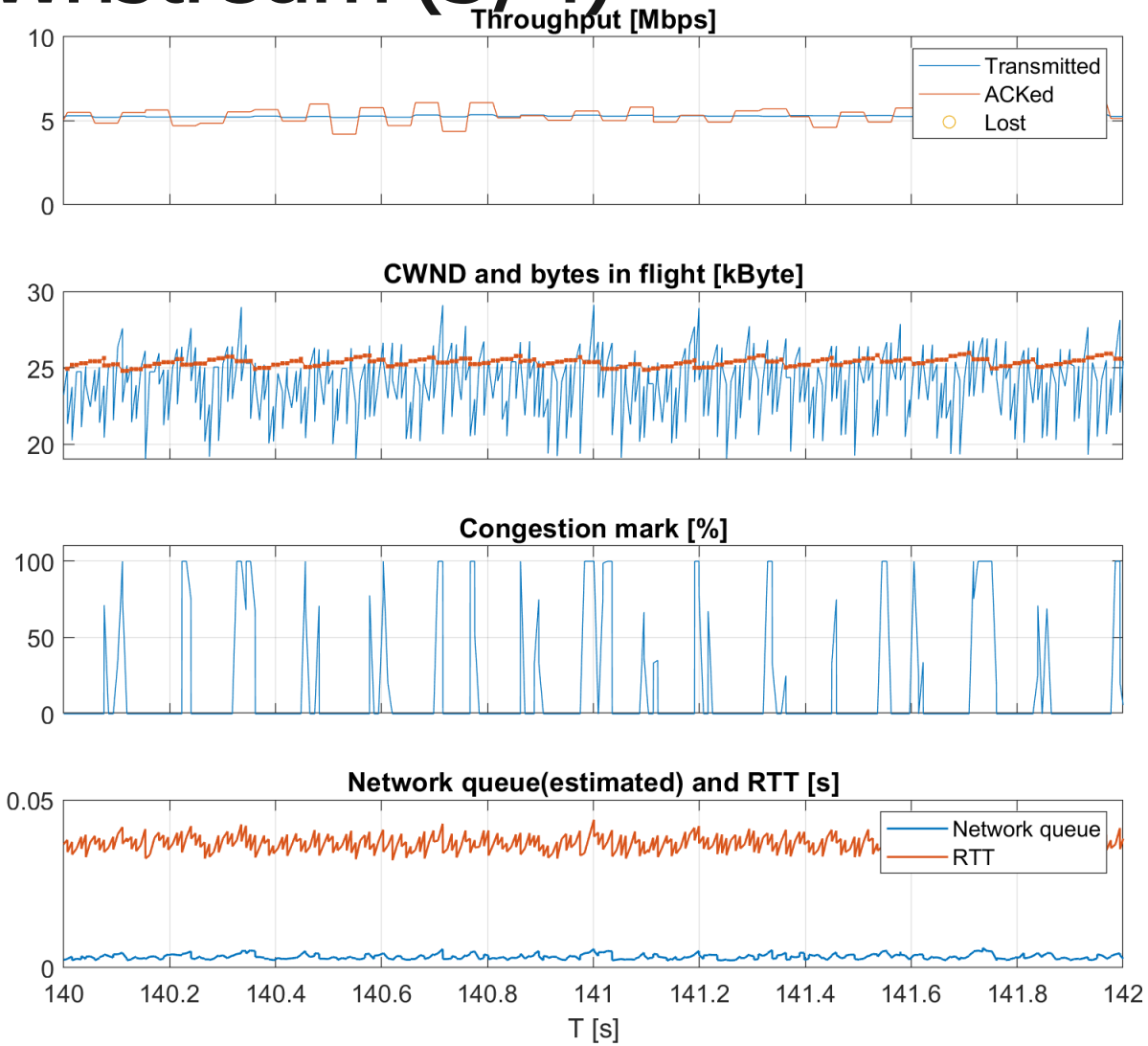
SCReAM vs up to 10 TCP prague downstream (2/4)

- RTT 52ms
- Overshoot when TCP load terminated leads to packet loss
- Possibly 5% multiplicative increase is a bit overoptimistic



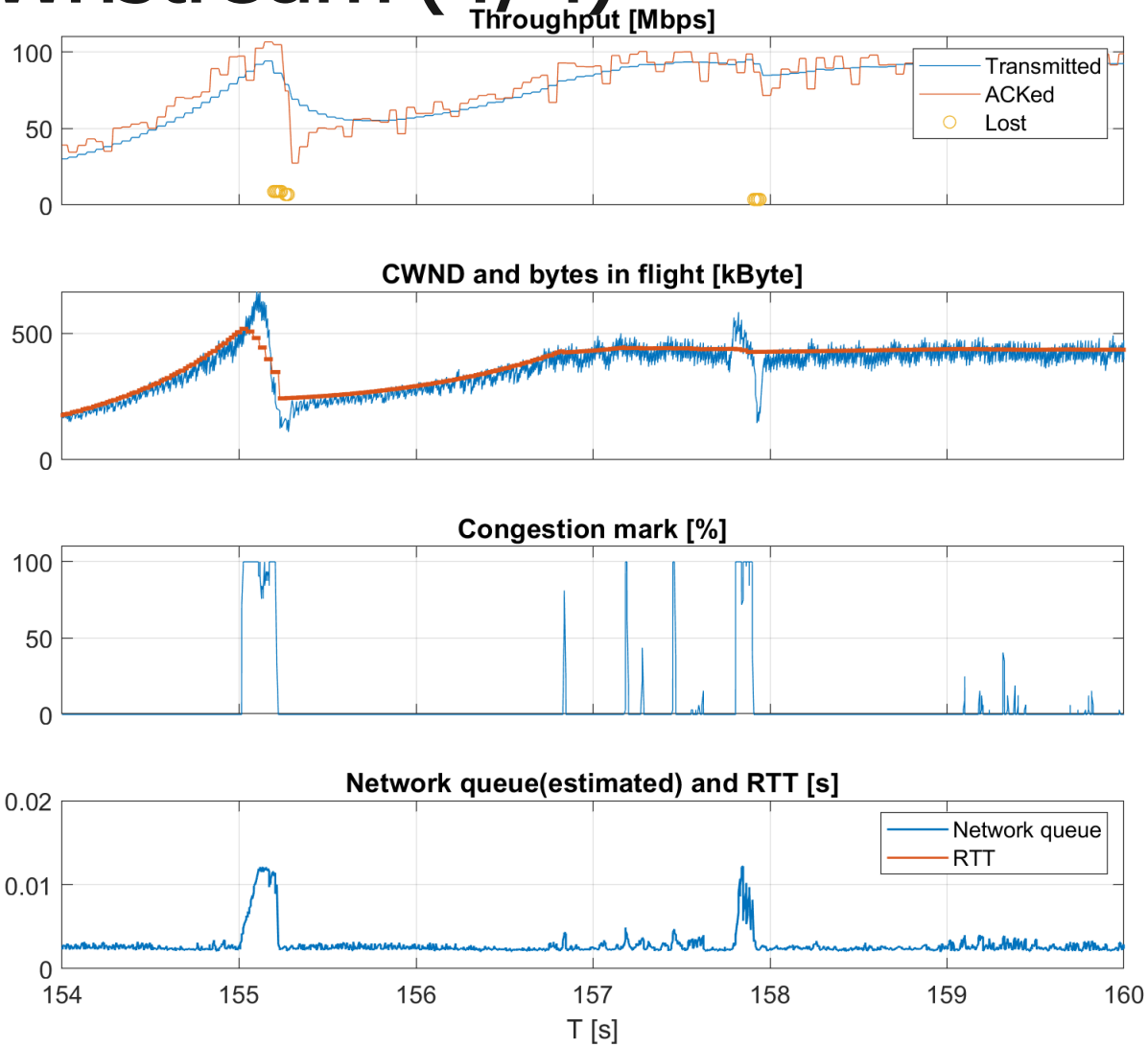
SCReAM
vs up to 10 TCP prague downstream (3/4)

- RTT 32ms
  - no data for 52ms RTT
- SCReAM + 10 TCP Prague
- SCReAM detailed log
  - -log option
- Packet marking appears to come in bursts
  - Possible synchronization in between flows ?
  - Burstiness may hit SCReAM more than Prague



SCReAM
vs up to 10 TCP prague downstream (4/4)

- RTT 32ms
  - no data for 52ms RTT
- SCReAM overshoot causes packet loss
- Possibly too low drop threshold for L4S queue ?
- 5% multiplicative increase in SCReAM may be too optimistic

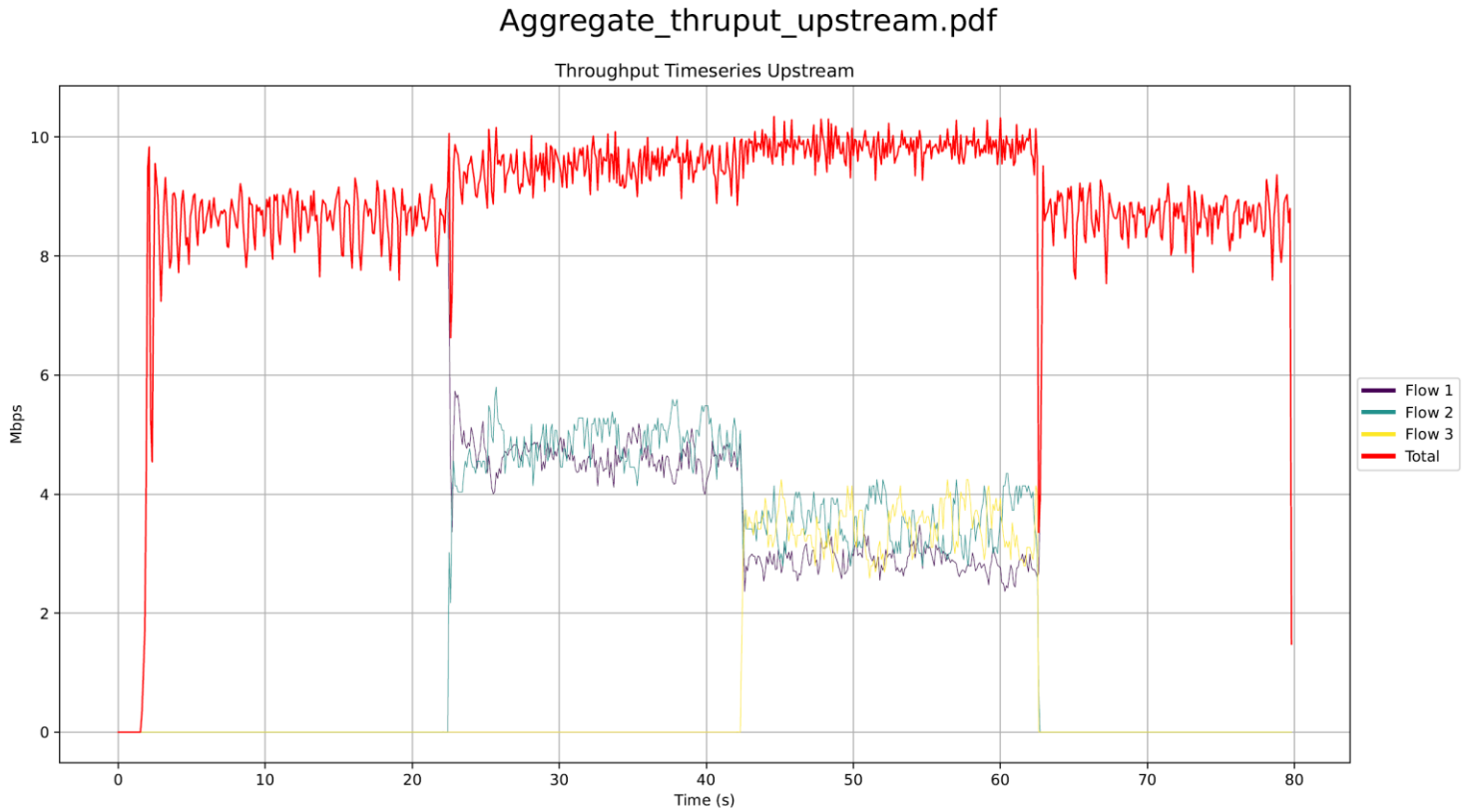


SCReAM vs TCP Prague Upstream

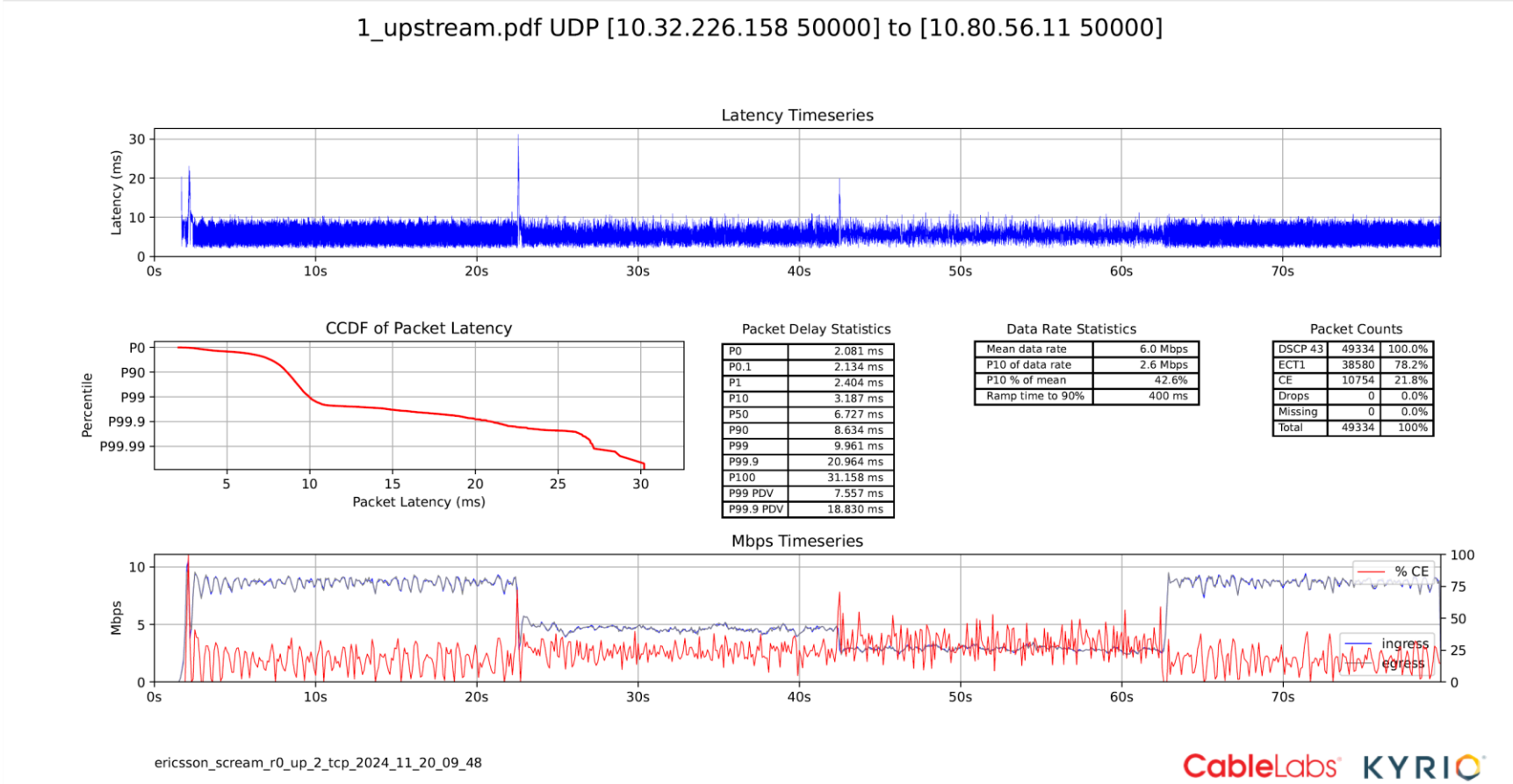
- Upstream test
- Max 10Mbps throughput
- RTT 12ms
- SCReAM competes with TCP Prague over the L4S queue

SCReAM
vs up to 2 TCP prague downstream (1/2)

- **RTT 12ms**
- SCReAM starts
- One TCP added efter 20s
- Another TCP added after 40s
- Both TCPs terminated after 60
- SCreAM alone does not reach full link ulitization
  - …but competes well with TC Prague

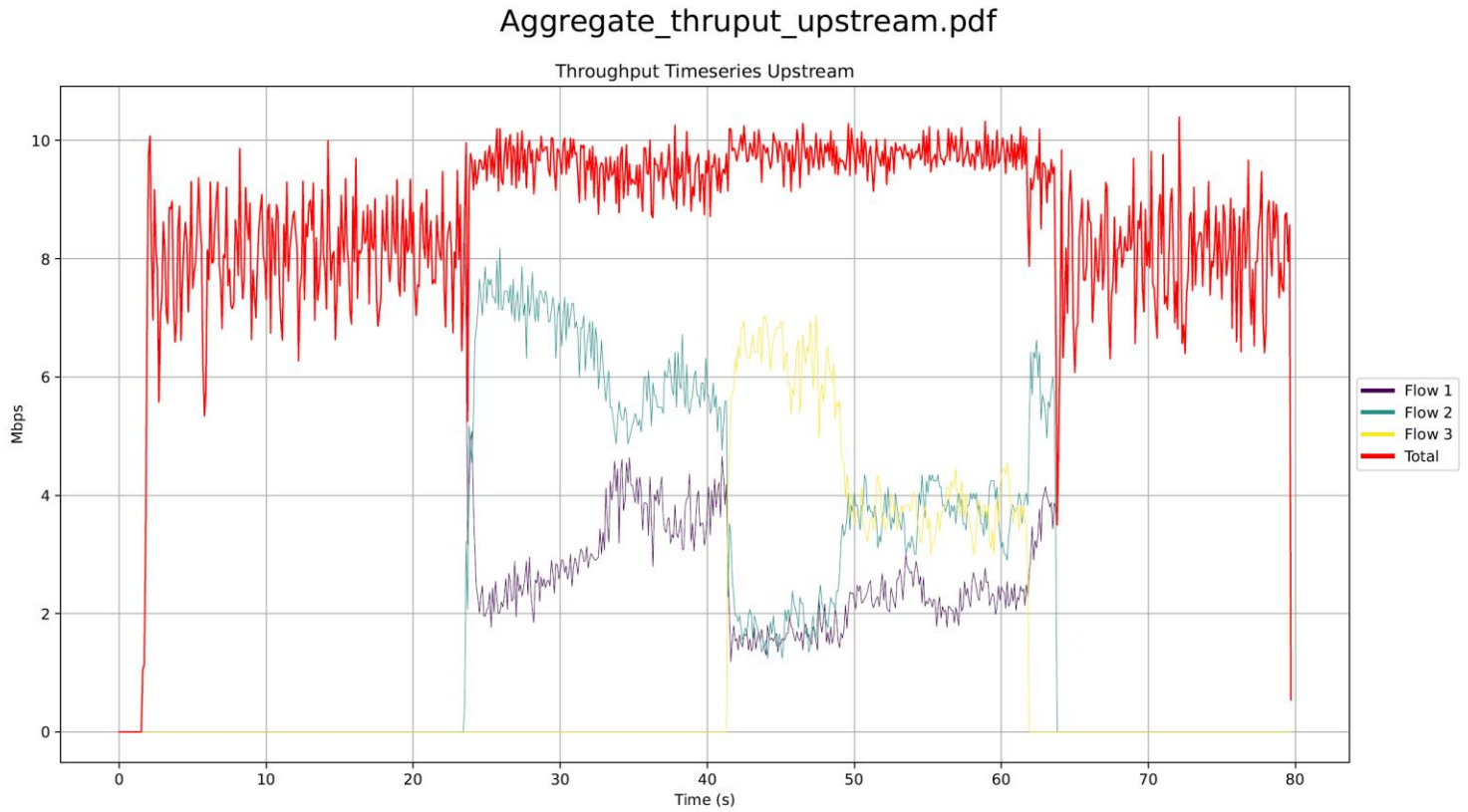


SCReAM vs up to 2 TCP Prague downstream (2/2)



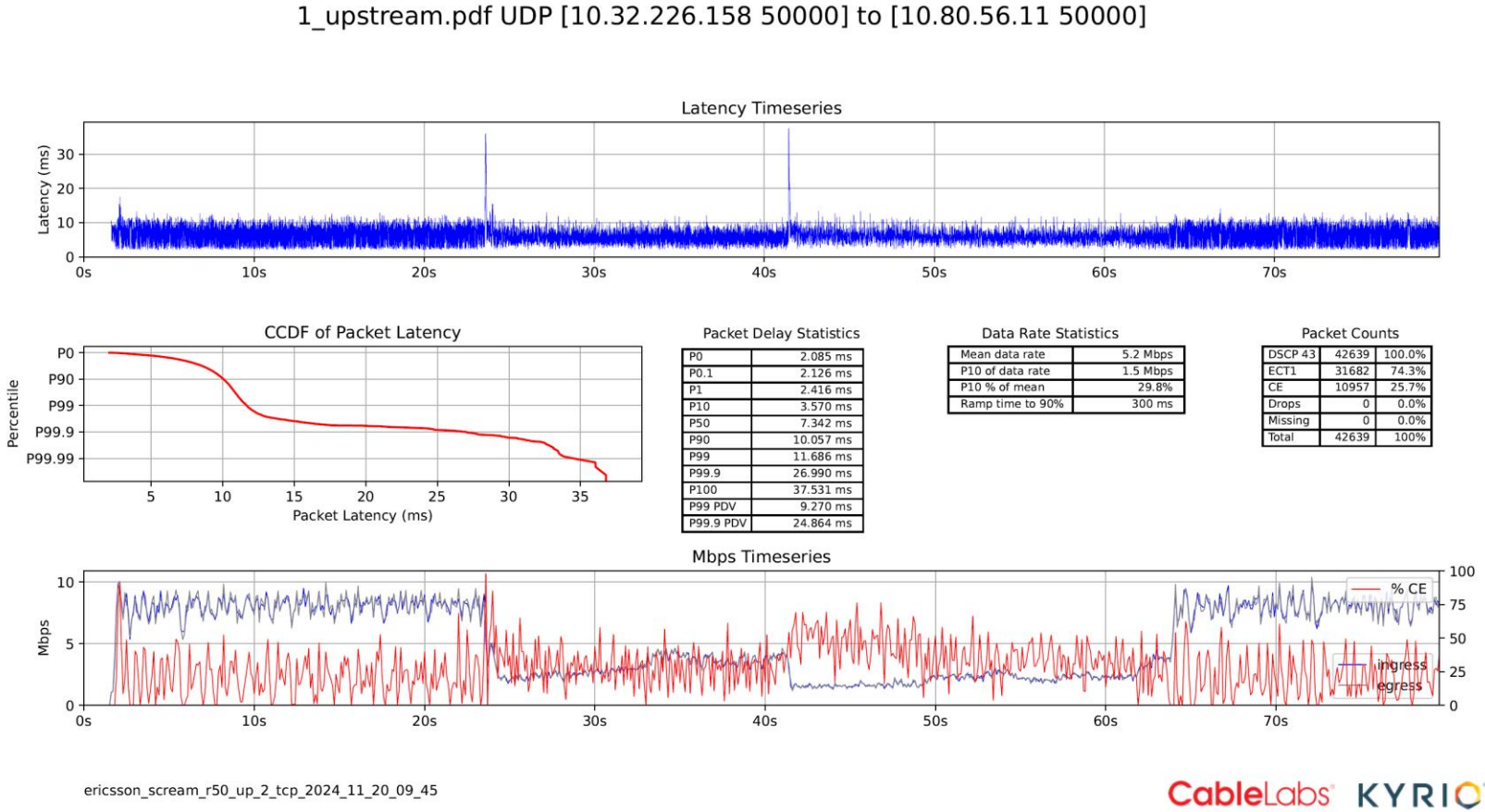
SCReAM variable video frame size vs up to 2 TCP prague downstream (1/2)

- As previous but SCReAM models variable frame sizes
  - -rand 50
- Lower SCreAM bitrate with competing TCPs
  - ...but no starvation



SCReAM variable video frame size vs up to 2 TCP prague downstream (1/2)

- Variable frame size gives slightly higher delay jitter which is expected

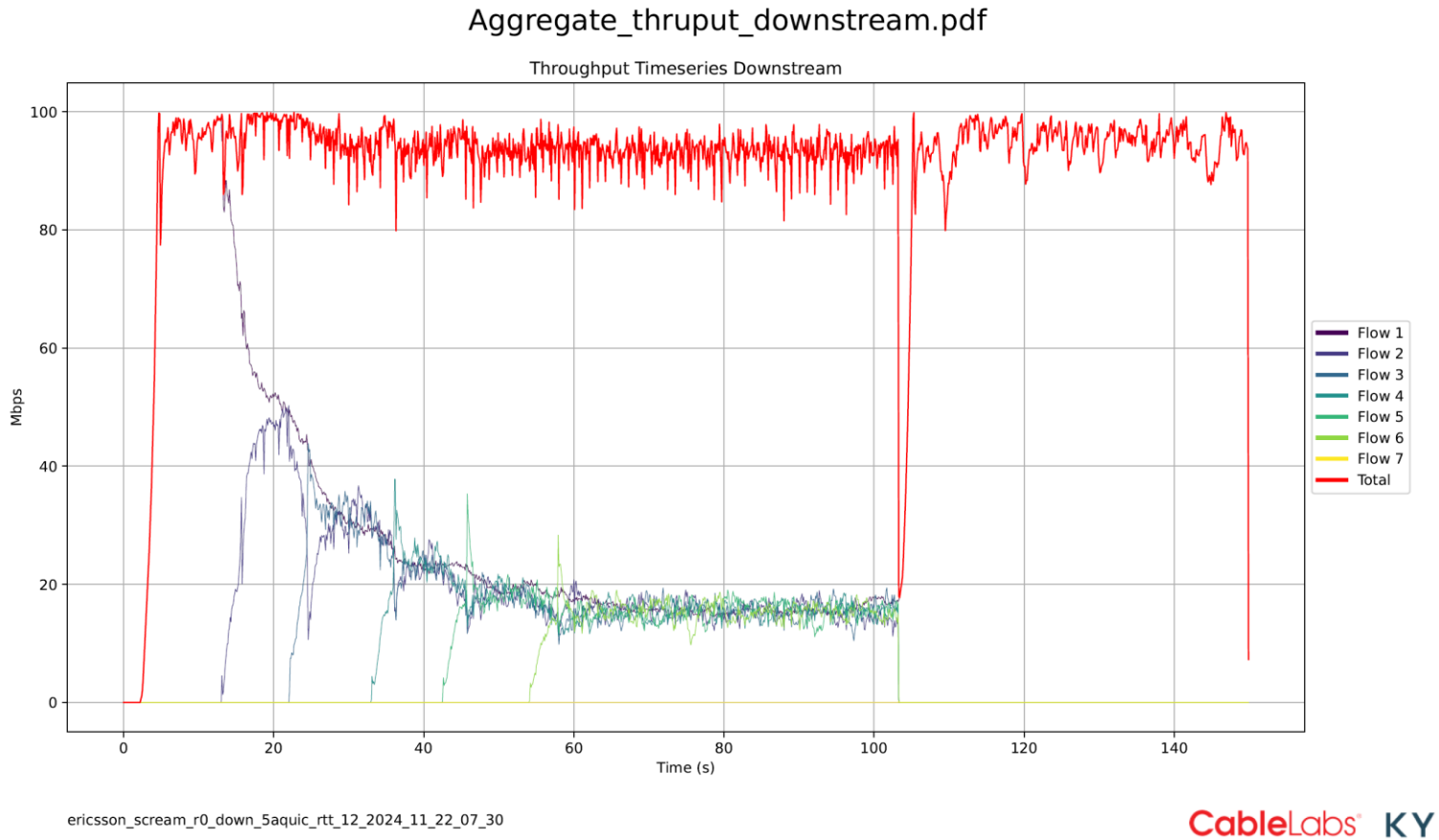


SCReAM vs Apple QUIC Downstream

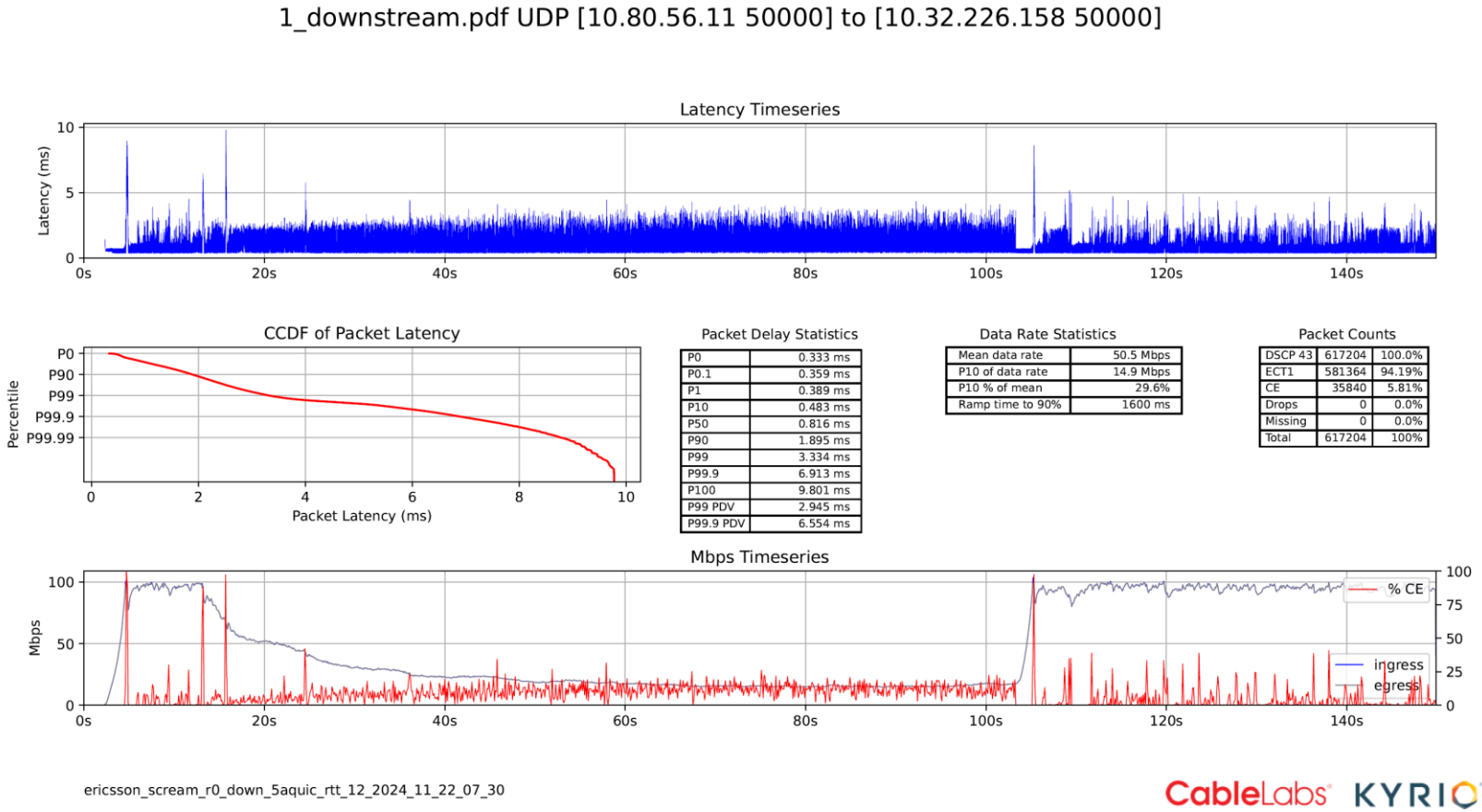
- Downstream test
- Max 100Mbps throughput
- RTT 12ms
- SCReAM competes with up to 5 Apple QUIC over the L4S queue
  - iperf3-darwin -i 0 -t 200 --apple-quic --apple-l4s –p PORT -c IP_ADDRESS

SCReAM
vs up to 5 Apple QUIC downstream (1/2)

- **RTT 12ms**
- SCReAM starts
- One QUIC added every 10s
- All QUICs terminated after 100s
- Near perfect sharing of capacity
- QUIC has more uneven rate than TCP Prague



SCReAM
vs up to 5 Apple QUIC downstream (1/2)



Summary

- Previous issues with SCReAM becoming starved out by TCP Prague appears to have been resolved
- SCReAM gets a lower share than TCP Prague when RTT is higher
  - Issue is not seen in https://github.com/EricssonResearch/scream/blob/master/test-record.md
  - Issue is perhaps related to synchronization between flows (bursty marking) ?
- SCReAM overshoot at increased capacity can give packet loss
  - Perhaps increase drop threshold in L4S queue ?.
  - 5% multiplicative increase in SCReAM may be overoptimistic.
- SCReAM performs fine with competing Apple QUIC flows.

- Over all very good test environment.