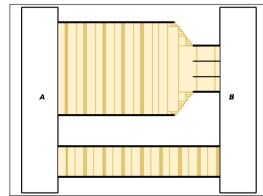


# xfinity 10G

Comcast L4S Field Trial Update

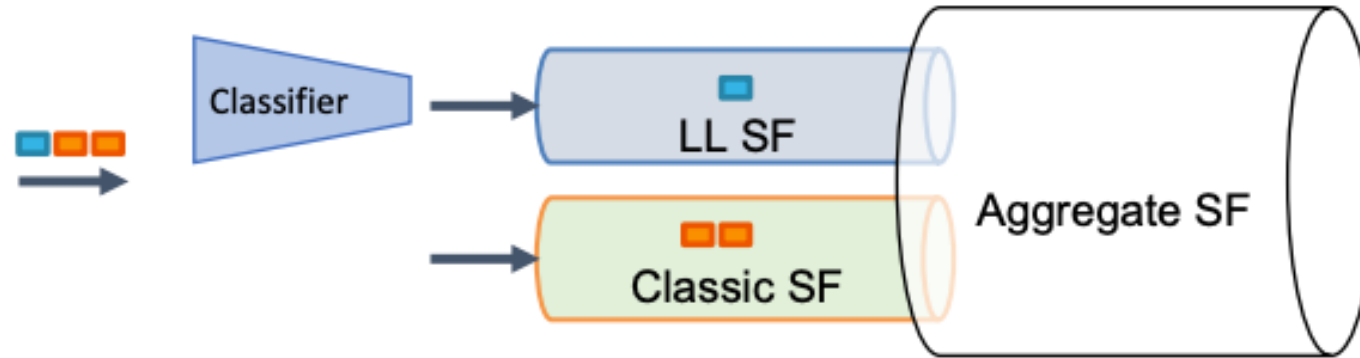
IETF 118 – November 2023



Presented by Jason Livingood

COMCAST

# Refresher: DOCSIS and L4S/NQB



- Both queues share the same **capacity**
- Both queues are best effort **priority**
- Classifier function examines ECN and DSCP fields of packet header to select queue & can also provide queue protection
- L4S and NQB are implemented in DOCSIS, but can also be implemented in any network (5G, LEO, DSL, FTTP, etc.)

# Low Latency Networking Trial: How

## Technical Requirements:

- User connected to virtual CMTS platform (vCMTS)
- Compatible cable modem, both ISP-provided and COAM:
  - Xfinity XB8 or XB7
  - Arris S33
  - Netgear CM1000v2
- Can be located anywhere in the network geographically
- Unprecedented customer interest – several thousand volunteers
- Several waves: employees, then customer waves 1 & 2 (July, August, October)

# Low Latency Networking Trial: High Level Timing

## Phase 1 – July to October 2023 (Upstream + US/DS WLAN)

- Upstream support in cable modem for L4S and NQB [1]
- Upstream & downstream support for WiFi LAN (WMM: AC\_VI) in XB devices [2]
- End-to-end marking use of ECN upstream & downstream – no bleaching [3]
- Manual provisioning of each cable modem (1.2 Gbps / 35 Mbps)
- Test end-to-end DSCP-45 with one network peer

## Phase 2 – November 2023 – February 2023 (Downstream + Automation + Peer Edge)

- Automated provisioning (re-provision all existing customers – wide range of tiers to be tested)
- Downstream support in CMTS for L4S and NQB [4]
- Expand DSCP-45 support to all peers

*[1] ECT(1), CE, and DSCP-40, 45, 46, 56 will trigger LL classification*

*[2] ECT(1), CE, and DSCP-45 initially, Q4 support for DSCP-40, 46, 56*

*[3] 100% of CMTS Service Class Names (SCNs) had to be fixed & fix DSCP leak (CS1->WMM AC\_BK). Initial ECN testing was upstream – issue was discovered downstream.*

*[4] Features spread across two software releases*

# Low Latency Networking Trial: How

## Customers Assigned Structured Weekly Activities:

1. Continue normal usage & report any issues
2. General performance tests & Apple network quality tests with L4S enabled
3. Mac: Facetime, Windows: LL DNS
4. Valve gaming, Xbox gaming

Customers submit survey forms with results for each test.

Customers also volunteered to host probes from RIPE Atlas, SamKnows, University of Chicago NetMicroscope, CableLabs.

See weekly test details at <https://github.com/jlivingood/IETF-L4S-Deployment>

# High Level Observations

- No classic queue starvation issues observed (open to additional test suggestions)
- Working as expected so far – one app has identified excessive CE marking that will be fixed in an app update
- Cloud-native interactive applications seem to improve more than “legacy” apps
- More field trial work planned the next 90 days...

*Next slides: some specific numbers...*

# Low Latency Networking Trial: **Milestones**

- 1<sup>st</sup> employee modem provisioned 7/11/23
- 1<sup>st</sup> customer modem 8/14/23
- 1<sup>st</sup> interdomain DSCP-45 packets 10/5/23 (with Valve)
- 2<sup>nd</sup> group of customers in Wave 2 added 10/11/23

*Bringing total to ~200 customers*

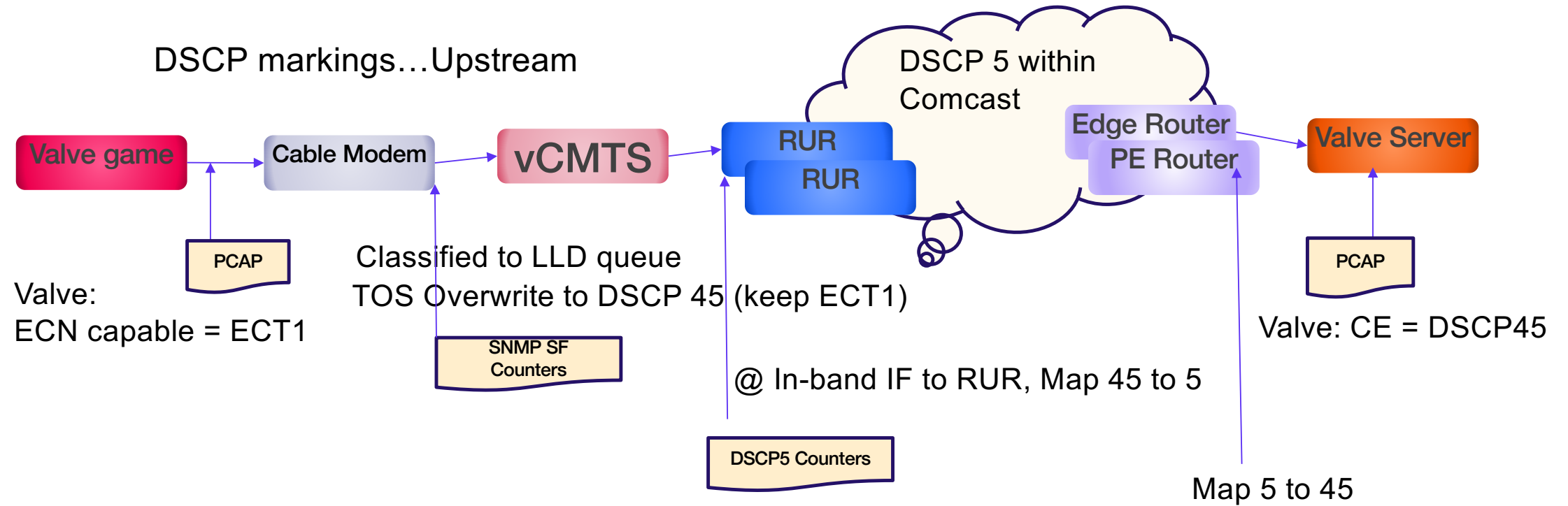
0xb7 = 101101 = NQB, DSCP-45 with CE mark

06:11:19.495711 IP (tos 0xb7, CE, ttl 108, id 64623, offset 0, flags [none], proto UDP (17), length 186)  
98.52.200.237.59119 > 205.196.6.213.27027: UDP, length 158

0xb5 = 10110101 = NQB, DSCP-45 with ECT(1) mark

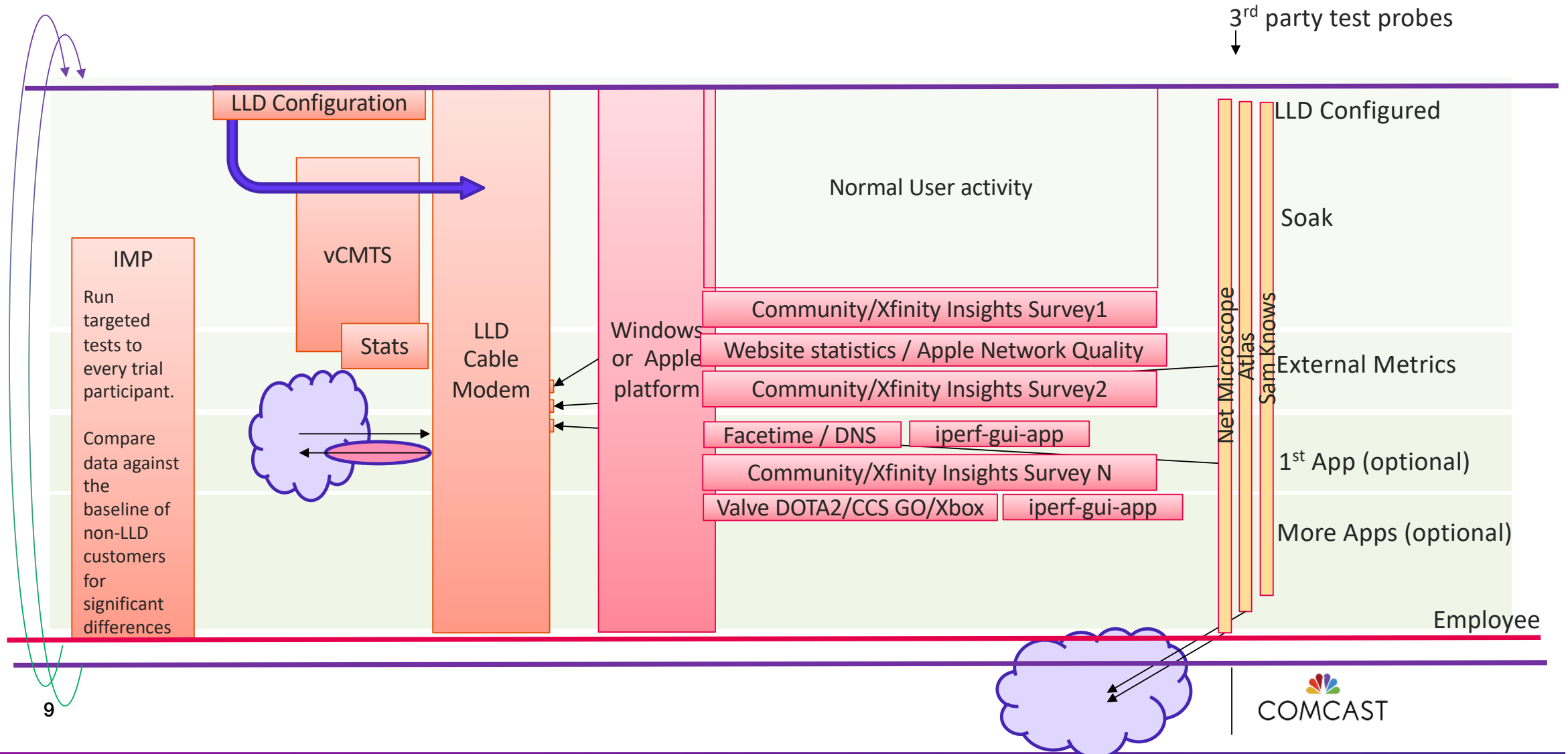
06:11:19.639254 IP (tos 0xb5, ECT(1), ttl 108, id 64627, offset 0, flags [none], proto UDP (17), length 186)  
98.52.200.237.59119 > 205.196.6.213.27027: UDP, length 158

# End-to-End NQB Marking Test (DSCP-45)

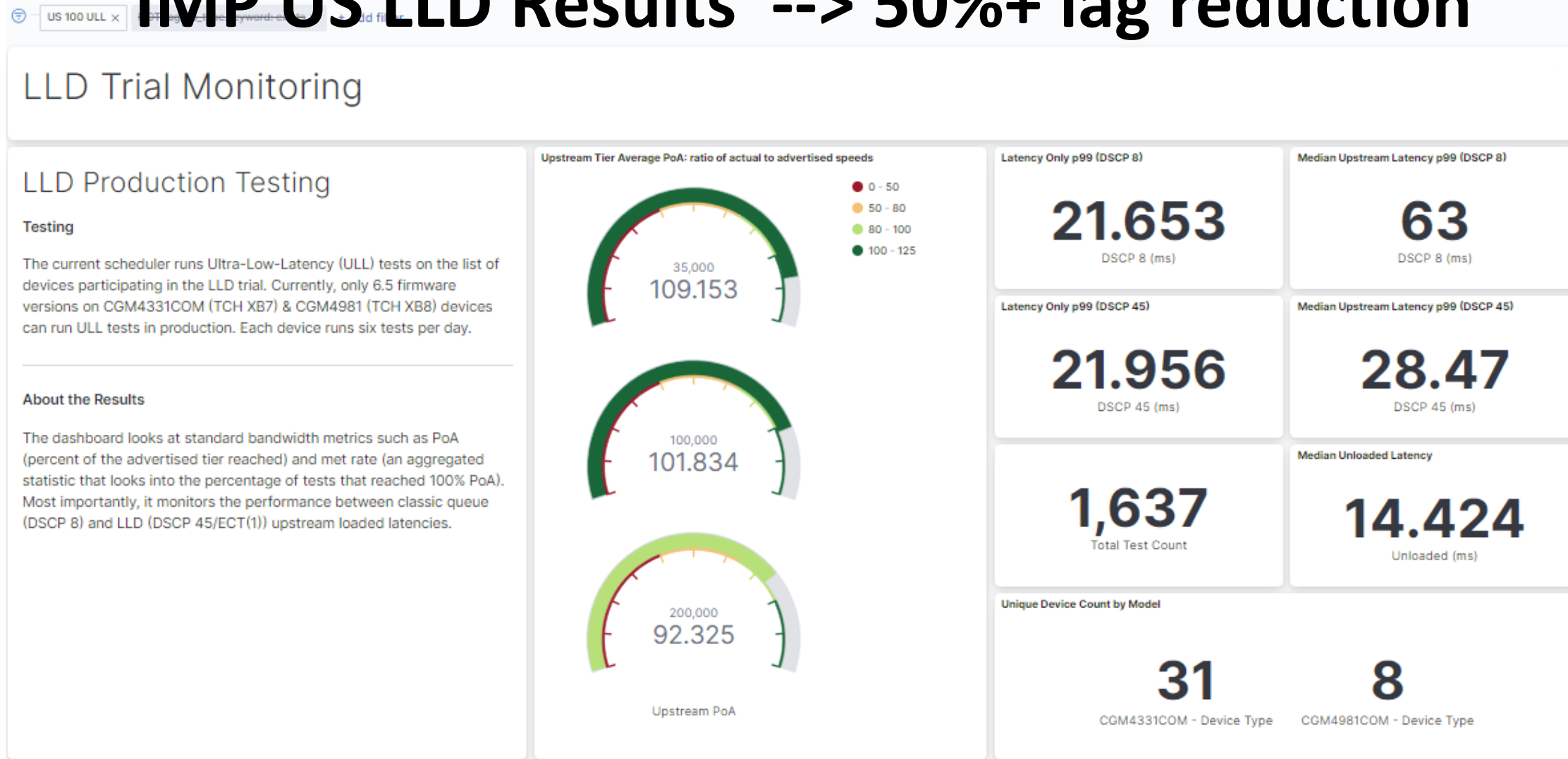




# Approach to Test & Measurement



# IMP US LLD Results --> 50%+ lag reduction





**GEFORCE  
NOW**

# Lag Spikes ~10 ms vs 225 ms!

**NVIDIA Working Latency**

## SUMMARY:

### NVIDIA EXPERIMENTS WITH DIFFERENT MARKING

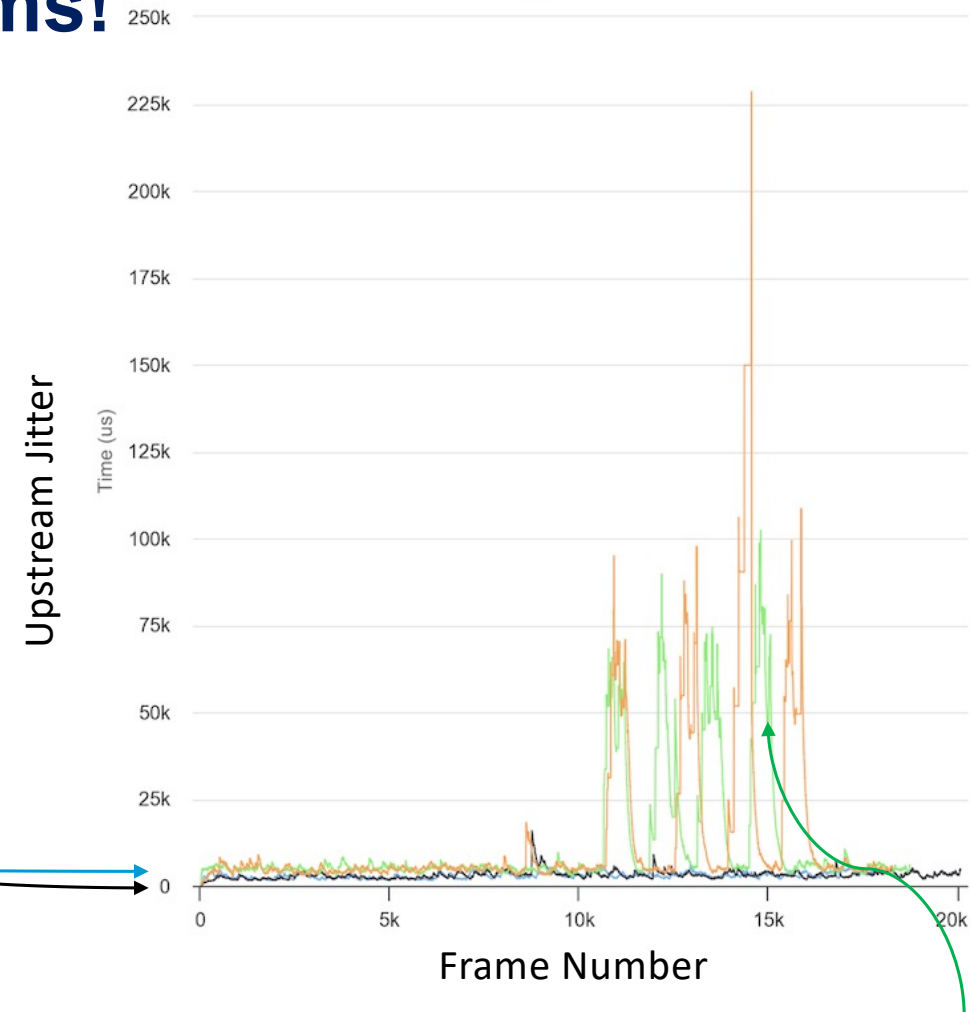
#### Low Latency Queue

- Significantly lower jitter – MUCH more consistent and reliable QoE
- Very low working latency for classic traffic AND low latency traffic
- Strong independent validation
- Makes cloud gaming truly viable

L4S ECT(1) flows show nominal latency increases

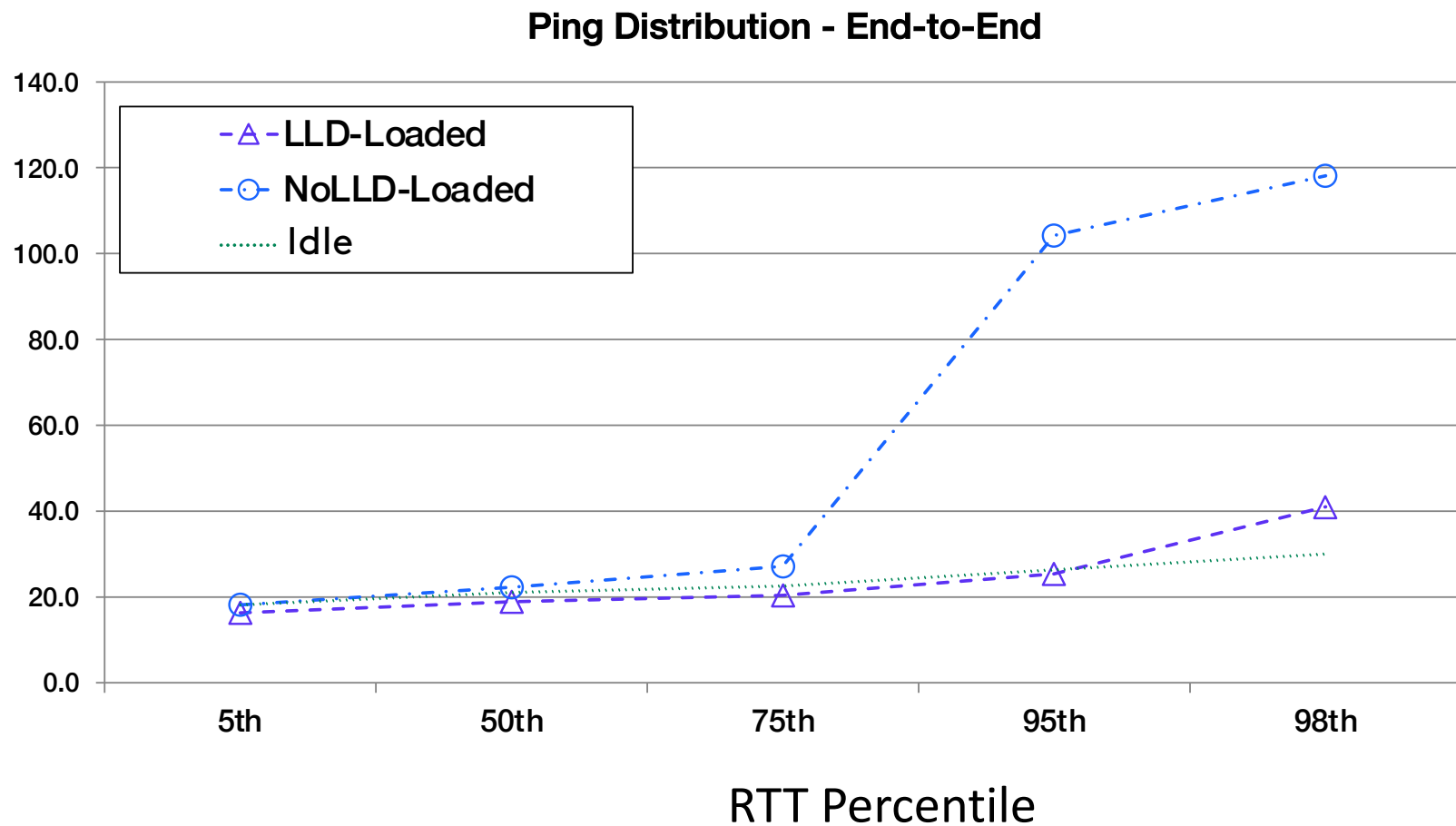
#### Flow Marking

Orange = Downstream no marking – normal working conditions  
Green = Upstream no marking – normal working conditions  
Black & Blue = DS & US with LLD marking – normal working conditions

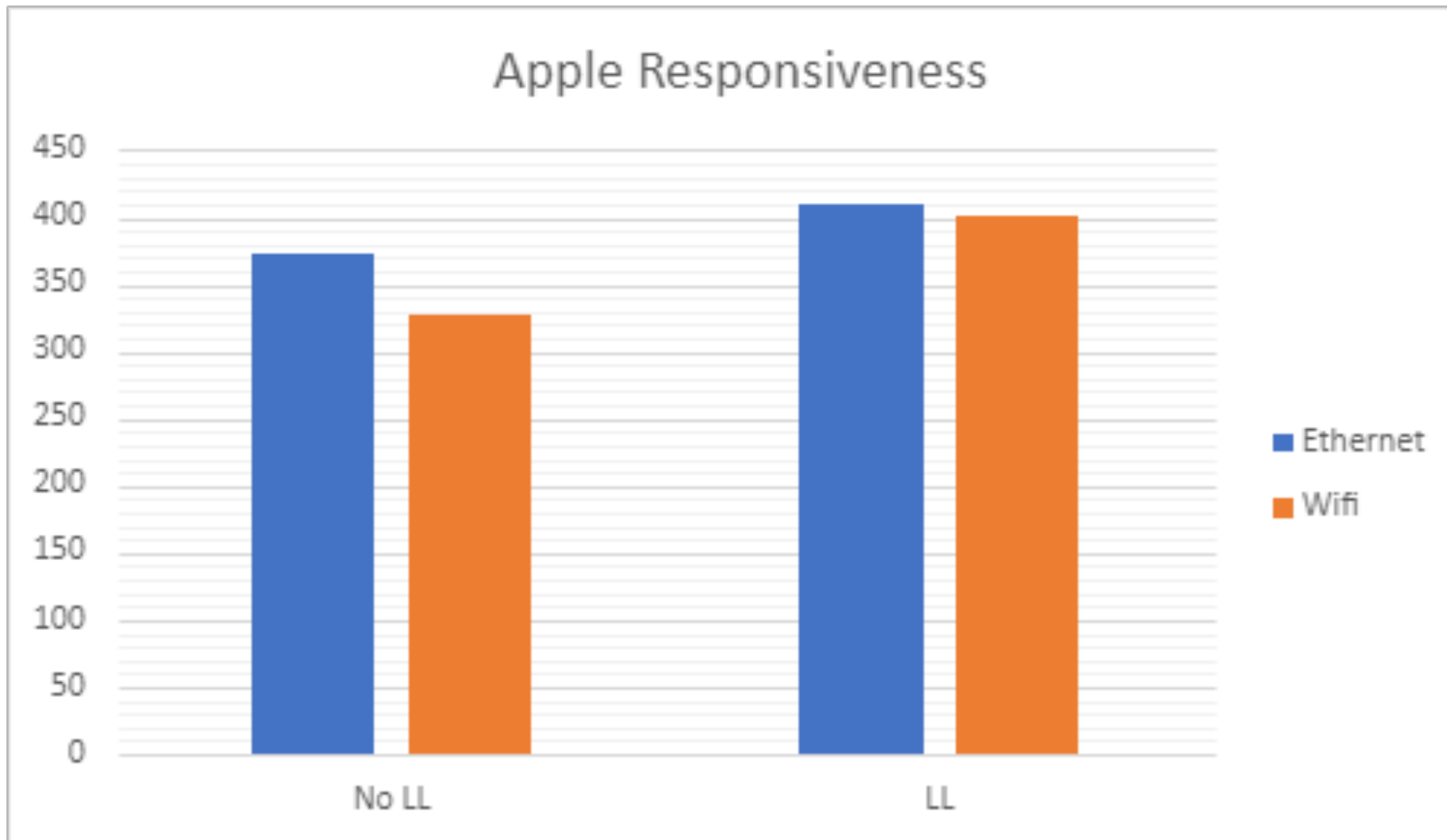


Flow loaded with classic queue traffic including several TCP file transfers with no L4S Congestion Experienced (CE) in DS vCMTS queues

# Valve/Steam *Counterstrike* Results – Down to Roughly Idle!



# Apple Network Quality Test



Classic queue testing

Working to collect L4S data

# University of Chicago NetMicroscope Platform

- Implemented a LUL test
- Pending implementation of DSCP or ECN marking to compare to baseline classic queue



# SamKnows Platform

- Implemented the Apple Network Quality test
- Future implementation of DSCP marking to compare to baseline classic queue

## Responsiveness - Uplink

Responsiveness - Uplink			
1st Percentile ↓↑	Median ↓↑	99th Percentile ↓↑	Sample Count ↓↑
877.00 RPM	1682.00 RPM	4138.00 RPM	1617

# Conclusions & Next Steps

- Testing to continue through February or March 2024
- Adding downstream dual queue, automated provisioning, etc.
- Still soliciting tests for users / applications – reach out if you'd like us to add something!
- Preparing to operationally scale to millions of users