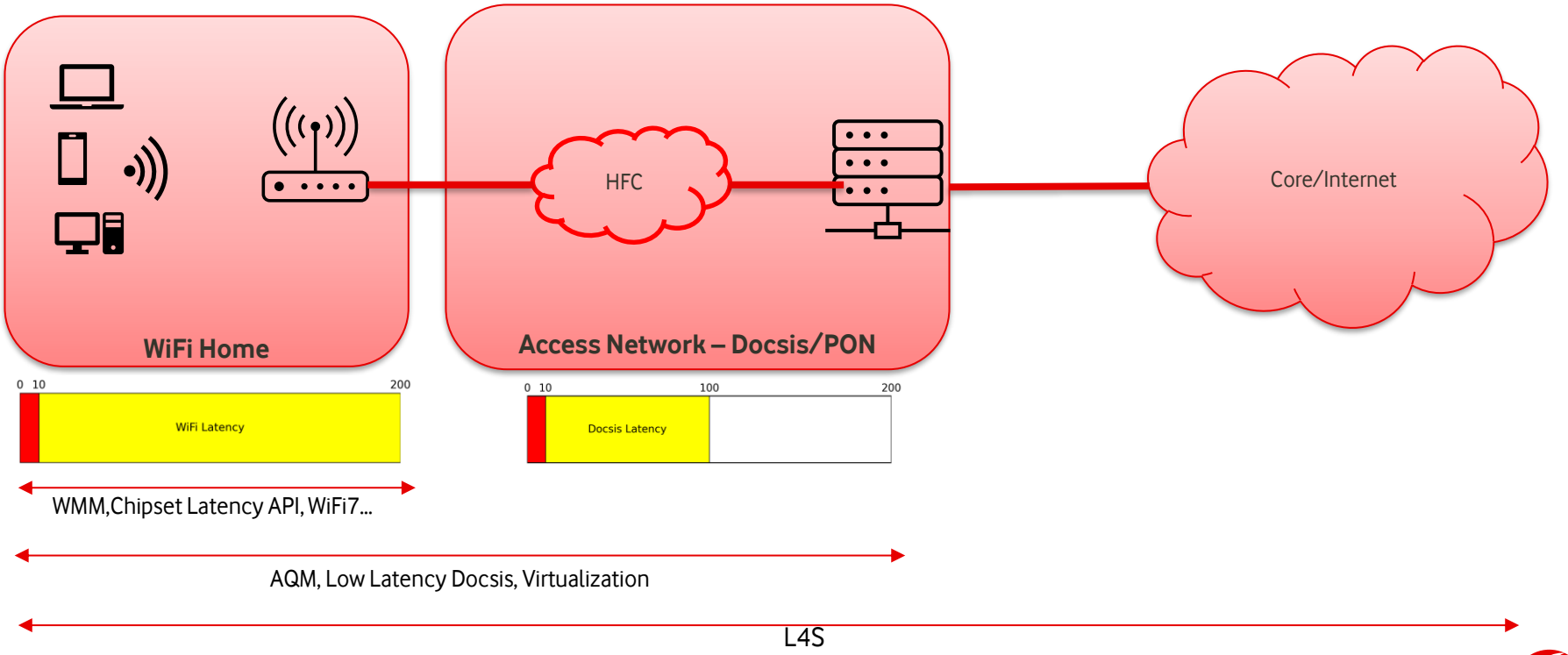
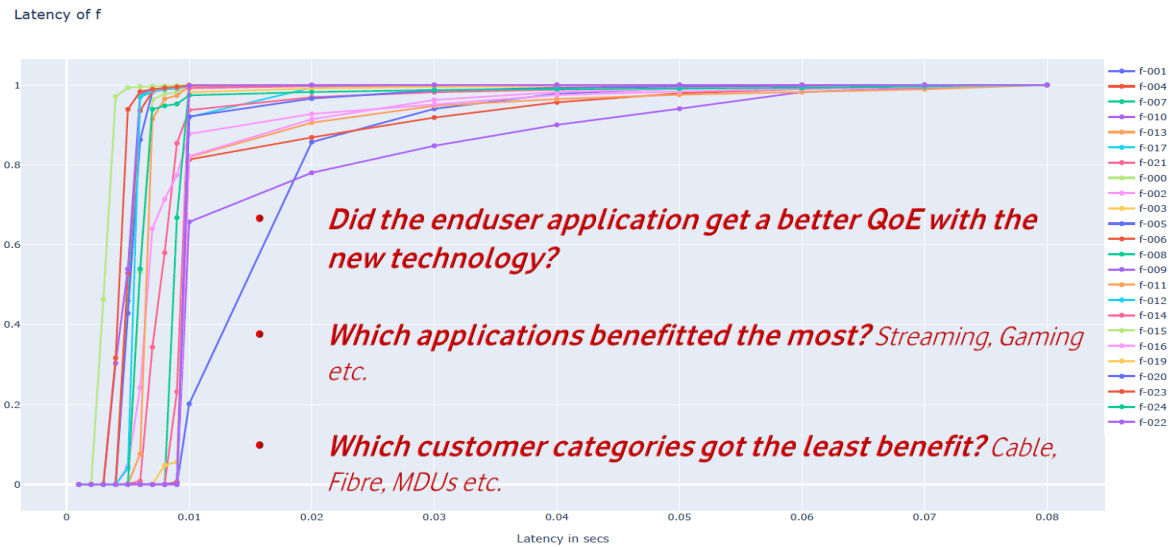
# Redefining Latency Testing in Labs

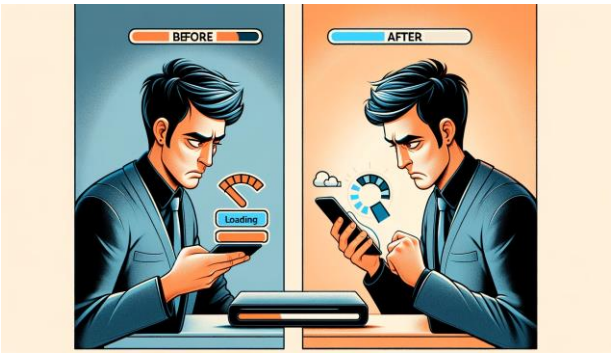
Mayur Channegowda
Fixed Access
Centre of Excellence
Vodafone (FACOE)
Broadband Architect
mayur.channegowda@vodafone.com

# Testing Latency improvement technologies



# Technology impact on application==customer QoE




Gauge IMPACT on customers

- Focused field trials
- More effectively assess customer impact
- Targeted technology investments

# What are we doing in lab?

- Investigate end user impact
  - Timeliness, Temporal, Spatial, Responsivity
  - QoE is E2E: Client+Network+Server
  - Reference QoE Models

**Video Streaming App**

- Temporal , Spatial, Timeliness aspects
- Initial Delay
- Stalls,
- Avg. Video Quality
- Switching

**Video Conference**

- Video + Audio
- Delay
- Distortion
- Echo levels

**Gaming**

- Encoding parameters (res, bitrate, frame loss)
- NetworK Performance (loss, latency thruput)
- Game Classification (temporal, spatial, delay sensitivity)

- Use realistic field data:
  - latency profiles for different access types and for different demarcation points

| Home X | Access Type | WIFi details | Latency Distribution | Profile Type |
|---|---|---|---|---|
| X1 Household type | VDSL Upload Download | WiFi7, 2 extenders, Avg Clients OBSS, | Wireless CDF X1 Wired CDF X1 Peak, Off peak | CustX VDSL |
| Y1 Household type | Fibre Upload Download | WiFi6, Avg Clients OBSS, | Wireless CDF X1 Wired CDF X1 Peak, Off peak | CustY FIBRE |
| X2 Household type | VDSL Upload Download | WiFi7, 2 extenders, Avg Clients OBSS, | Wireless CDF X1 Wired CDF X1 Peak, Off peak | CustX VDSL |
| Y2 Household type | Fibre Upload Download | WiFi7, 2 extenders, Avg Clients OBSS, | Wireless CDF X1 Wired CDF X1 Peak, Off peak | CustY FIBRE |

# What are we doing in lab to understand QoE-QoS relationship?

- Investigate impact of applications QoE : e.g: video streaming, video conf, gaming.
- Use realistic field data: latency profiles for different access types(Fibre, VDSL) and for different demarcation points( Home, Access etc.)
- Automate emulating field data: Congestion emulation

| Profile ID | Latency | Loss | Distribution | Profile Type |
|---|---|---|---|---|
| X1 | 40ms | 0.5 % | Pareto | CustX VDSL |
| Y1 | 10ms | 0% | Normal | CustY FIBRE |

Latency Profiles
Netem

**Applications:**
Dashjs, messenger etc,

Probes:
TWAMP, ping etc.

Traffic emulation:
IPERF, Spirent etc.

**LAB Home Network with Diff technologies**
WMM, SCS, L4S...

Congestion emulation:
WiFi, LAN, WAN

| Profile ID | Livestream | SFV | CloudGaming |
|---|---|---|---|
| X1 | GOOD | GOOD | BAD |
| Y1 | GOOD | GOOD | GOOD |
| Z1 | BAD | GOOD | BAD |

Before & After results

# TIP MRN: Linking Application QoE & Metrics to Network Performance

## Quality of Experience (QoE)

Degree of delight or annoyance of the user of an application, product or service such as audio/video fidelity in a video session

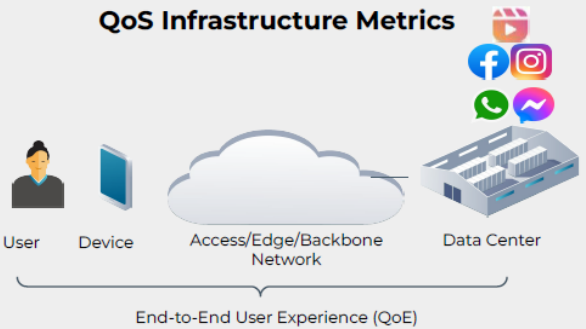
**Application/Product Metrics**
*e.g, user count, user retention, user watch time*

**QoE User Metrics**
*subjective impressions measured by metrics such as Mean Opinion Score (MoS),or overall satisfaction ratings, e.g. video/voice quality, rebuffering, stalls*

## Quality of Service (QoS)

Totality of characteristics of a network infrastructure and QoS mechanisms that bear on its ability to satisfy stated and implied needs of the user of the service

**QoS Infrastructure Metrics**




*e.g., throughput, latency, loss, jitter, congestion*

# TIP MRN Group work: QoE to QoS relationship

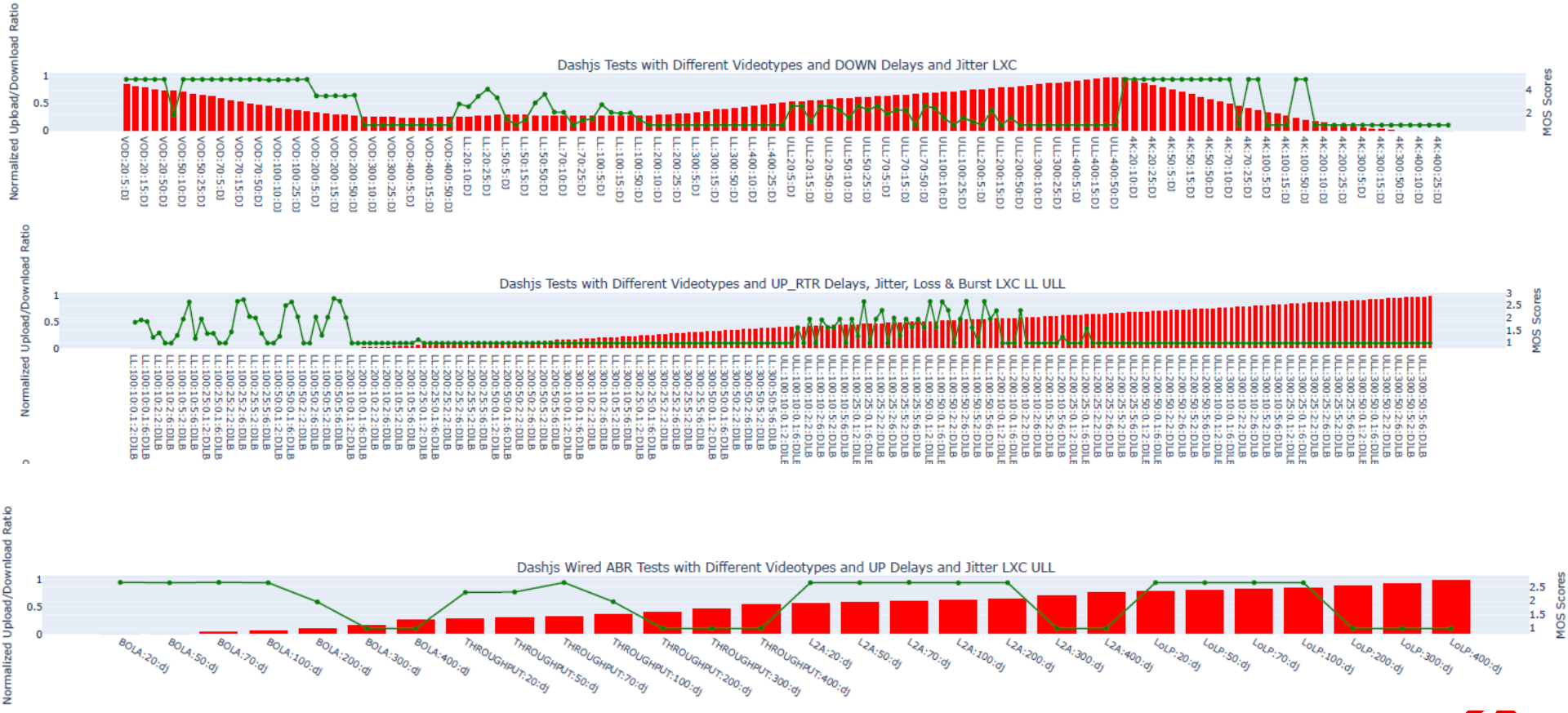
- Network design targets are grounded in user needs and experience for the services carried
- Adopt a user centric approach rather than the commonly followed network centric

| Application | QoE Metrics Examples |
|---|---|
| Conversational VoIP Call | **Voice QoE = f (Responsivity, Media Fidelity)**<br>One way delay<br>speech distortion, Synchro echo and sound level<br>Example of well accepted QoE metrics/measurement methods: MOS, PESQ (ITU-T P.862), POLQA(ITU-T P.863), E-model R-factor (ITU-T G.107) |
| Video | **Video QoE = f (Temporal video quality, Spatial video quality, Timeliness / Responsivity Context )**<br>fluidness/jerkiness<br>media fidelity, blur/blockiness,<br>initial loading, Stalls (#, duration, timing), one-way delay, A/V Synch (conversational)<br>content type<br>Example of well accepted QoE metrics/measurement methods: PSNR, SSIM, VMAF, ITU-T G.1070/71, ITU-P.1204 |
| Gaming | **Gaming QoE = f (Temporal video quality, Spatial video quality, Responsivity, Context, Human )**<br>fluidness/jerkiness<br>media fidelity, blur/blockiness,<br>action motion response Stalls (#, duration, timing)<br>game classification<br>frame Loss Sensitivity Delay sensitivity<br>Example QoE metrics/measurement methods: R-factor for cloud gaming (ITU-T G.1072/G.1032) |
| 3D VR//SR/XR | **3D Virtual Reality QoE = f (Temporal video quality, Spatial video quality, Responsivity, Context Human )**<br>fluidness/jerkiness<br>media fidelity, blur/blockiness,<br>motion- to-photon Stalls (#, duration, timing)<br>content interest, task type: collab or individual<br>Locomotion immersion, motion sensitivity degree of realism<br>Emerging/under development QoE metrics/measurement<br>2023 ITU-T PSTR-OQMXR "Objective quality modelling for XR services" |

*Figure 5: QoE Metrics per application categories with relevant industry standards references*

*https://telecominfraproject.com/tip-releases-qoe-measurement-framework-and-graduates-metaverse-ready-project-group/

# Video score against different latency conditions



# Summary

- Re-visit how to assess the “Before vs After” effect of technology on applications QoE
- QoE←→QoS relationship is key to understand technology impact & hence where to best target network investments to improve customer experience
- There are also opportunities for application developer to closely work with Network operators
  - Information exchange through APIs. (e.g: CAMARA Quality On Demand API, Cablelabs Quality by Design API etc.)