Quality of Outcome

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Authors:

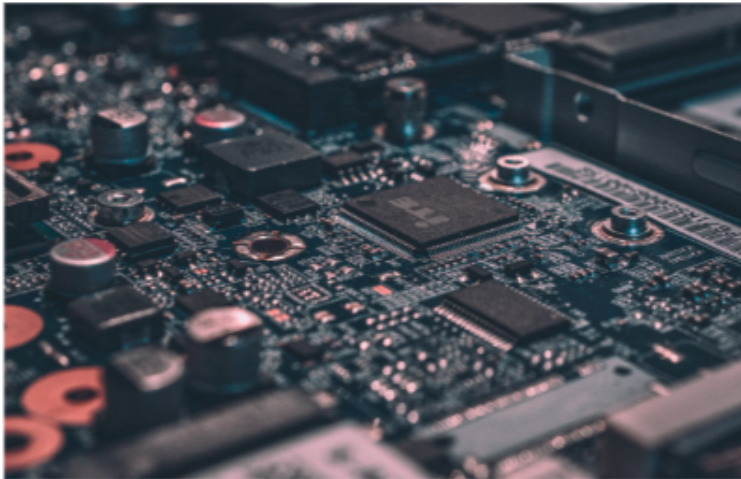| Name	Affiliations	Address	Phone	email
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Abstract

Quality of Outcome is a work-in-progress network quality score under development in the IETF. We present positive feedback on QoO from a user-trial with customers, and data showing the impact of WiFi latency on QoO scores.

Agenda

- **What is Quality of Outcome?**

- **Results from user trial with Comcast customers. Feedback on:**

  - Accuracy of QoO

  - Comparing QoO scores to other types of network information

  - QoO on WiFi vs. other last-mile technologies

- **What's causing latency on WiFi?**

Quality of Outcome:

One Network Quality framework - three audiences

Vendors and Operators

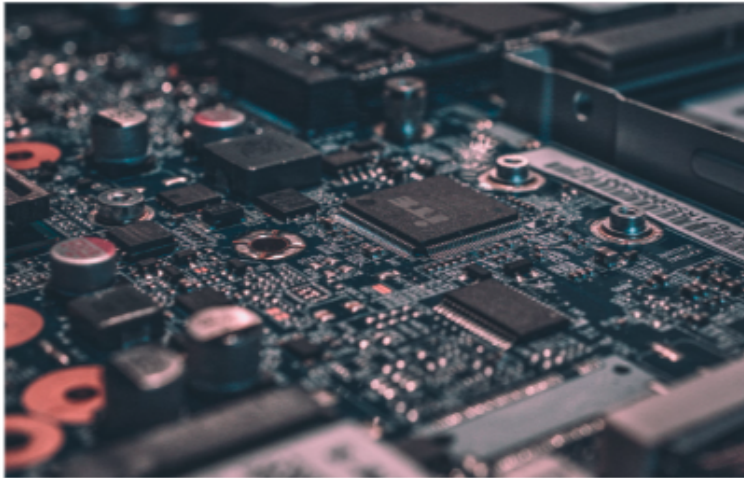Precision

Repeatability

Composability

Applications

Want network to not cause problems

Want to help the end user succeed

The end user

Is the network causing problems?

If yes, how do I fix it ASAP

Quality of Outcome:
One Network Quality framework - three audiences

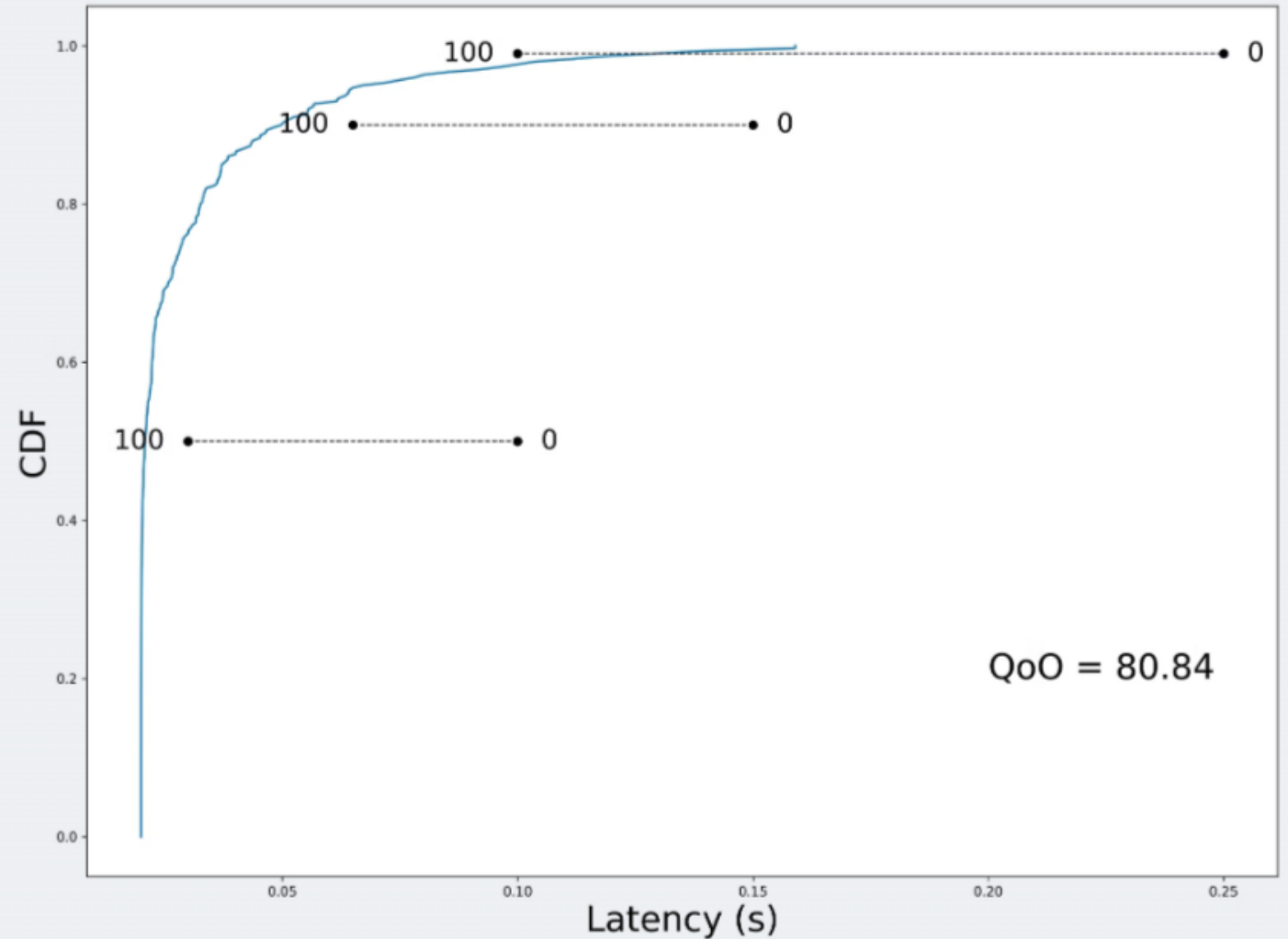| **Vendors and Operators**	**Applications**	**The end user**
Precision	Want network to not cause problems	Is the network causing problems?
Repeatability	Want to help the end user succeed	If yes, how do I fix it ASAP
Composability		
Quality attenuation (TR-452.1)	Expected stability + root cause analysis	QoO score + root cause analysis

How QoO is calculated

Advantage of standardizing QoO. We get help!

Network requirements through projects with:

- Meta (Video Conf and Streaming)
- GameBench (Gaming)

As well as a lot of manual testing

Methodology

- Email sent out to existing Comcast customers
  - Would you like to participate in study on app performance.
    - Note. High participation rate!
- They get: A new router, 200$ gift card, to be part of the study
- Initial questionnaire in intro email - 300 respondents
- Random selection of 25 participants
- New Router shipped, with instructions on setup.
- Normal usage for a week (no optimization or anything, only measurements)
- They had have at least 4 devices connected for a week to get the post-trial questionnaire
- Participants got the tool with a 1 min explainer video. Next they answer questionnaire.
- Report

Known Weaknesses:

- Selection Bias
  - Gift card is a tactic to avoid getting only "geeks" (a common problem for these types of studies) and to get a more representative population
- Low N
- Domos does not do device fingerprinting and many devices in the tool would only show up as mac address

Access Point details

- GL.inet GL-ax1800

- Dual-band WiFi 6

- 600Mbit/s + 1200Mbit/s peak througphut

- Firmware loaded with Domos agent for network quality measurements

What if? App Performance per Device

App performance varies by app type and time (due to location and usage). Use this tool to explore how different apps perform over time.

Select application type:
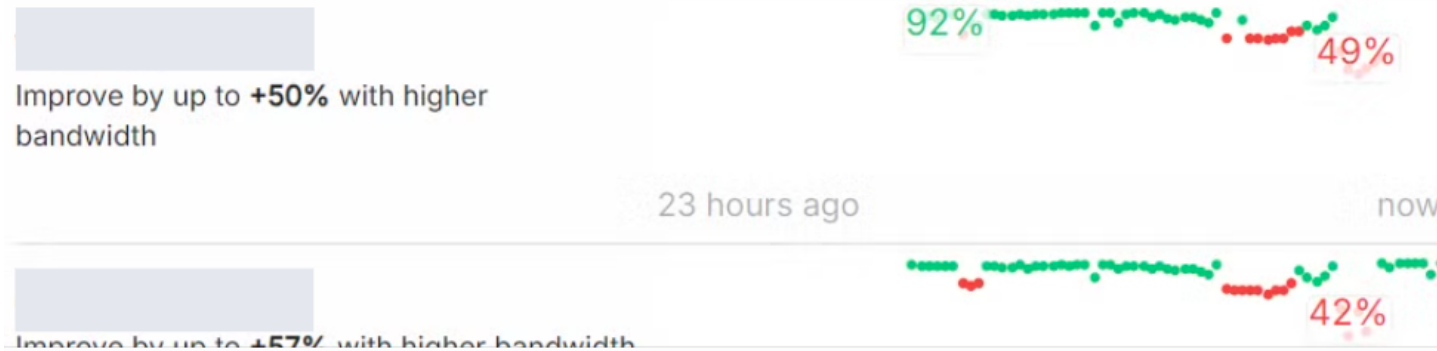
| VIDEO CONFERENCE | GAMING | STREAMING |

Select time period:

| HOUR | DAY | WEEK |

Top ways of improving your network

1. Improve **9** devices by up to **58%** each with **higher bandwidth**

2. Improve **3** devices by up to **13%** each with **a WiFi extender**

3. Improve **1** devices by up to **5%** each with **app prioritization**

92%   49%

Improve by up to **+50%** with higher bandwidth

23 hours ago   now

42%

Improve by up to **+57%** with higher bandwidth

Questionnaire — How did people like QoO?

People like QoO

86% | Says QoO more **accurately** reflects experience than their bandwidth
14% neutral - 0% negative

100% | Says the tool that showing network quality in QoO is **better** than speedtest
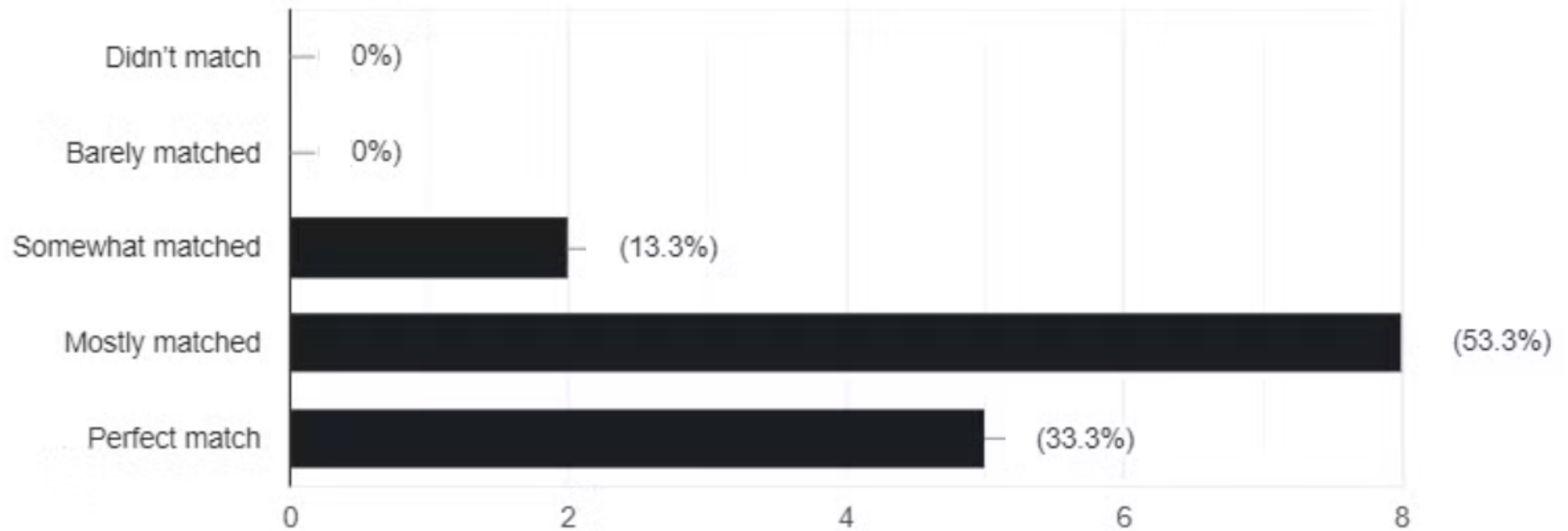and latency and jitter

86% | Says it is somewhat, very or extremely **important** that QoO is independent

86% | Would be likely or very likely to **recommend** the QoO tool
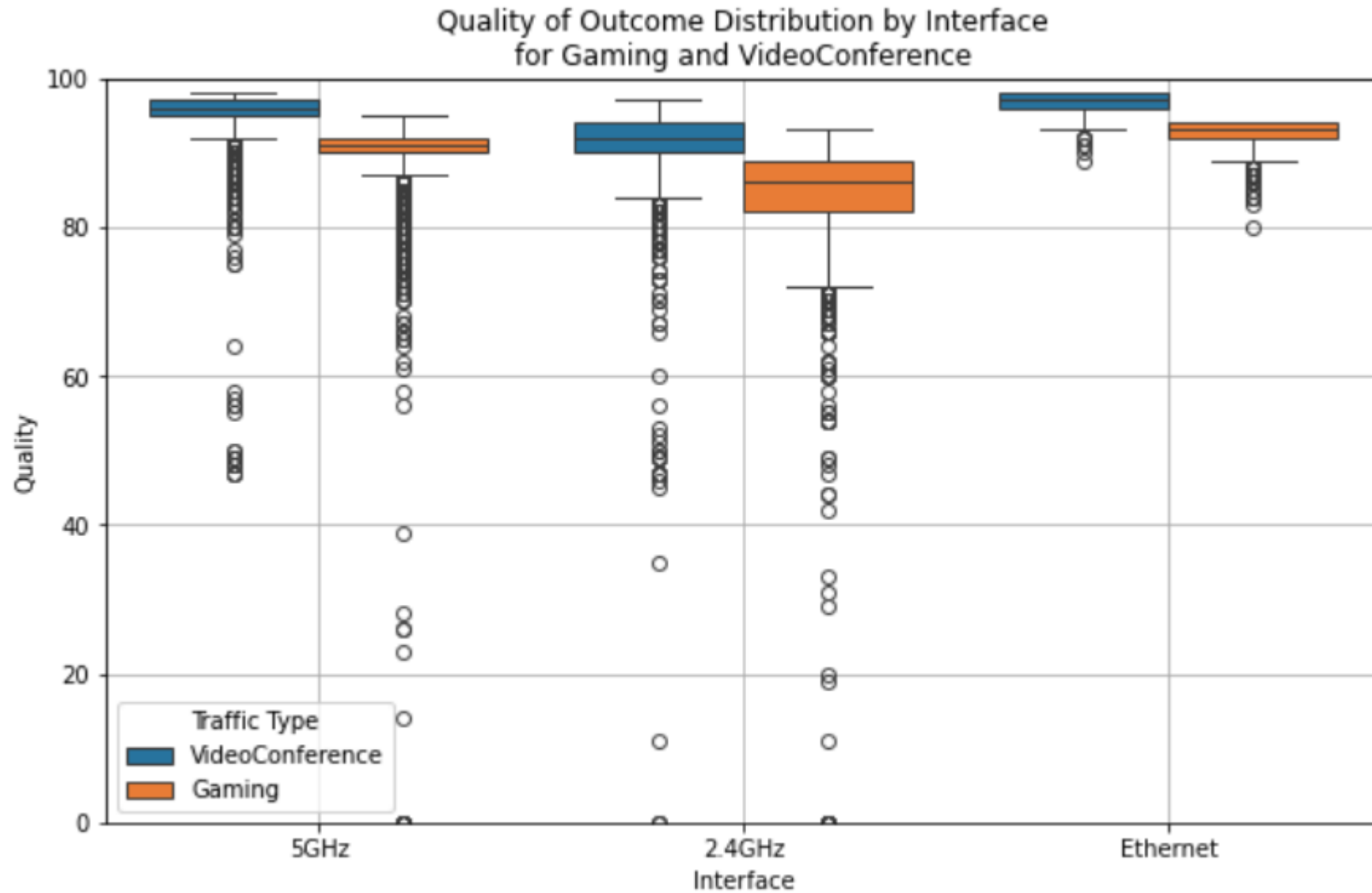to a friend or colleague

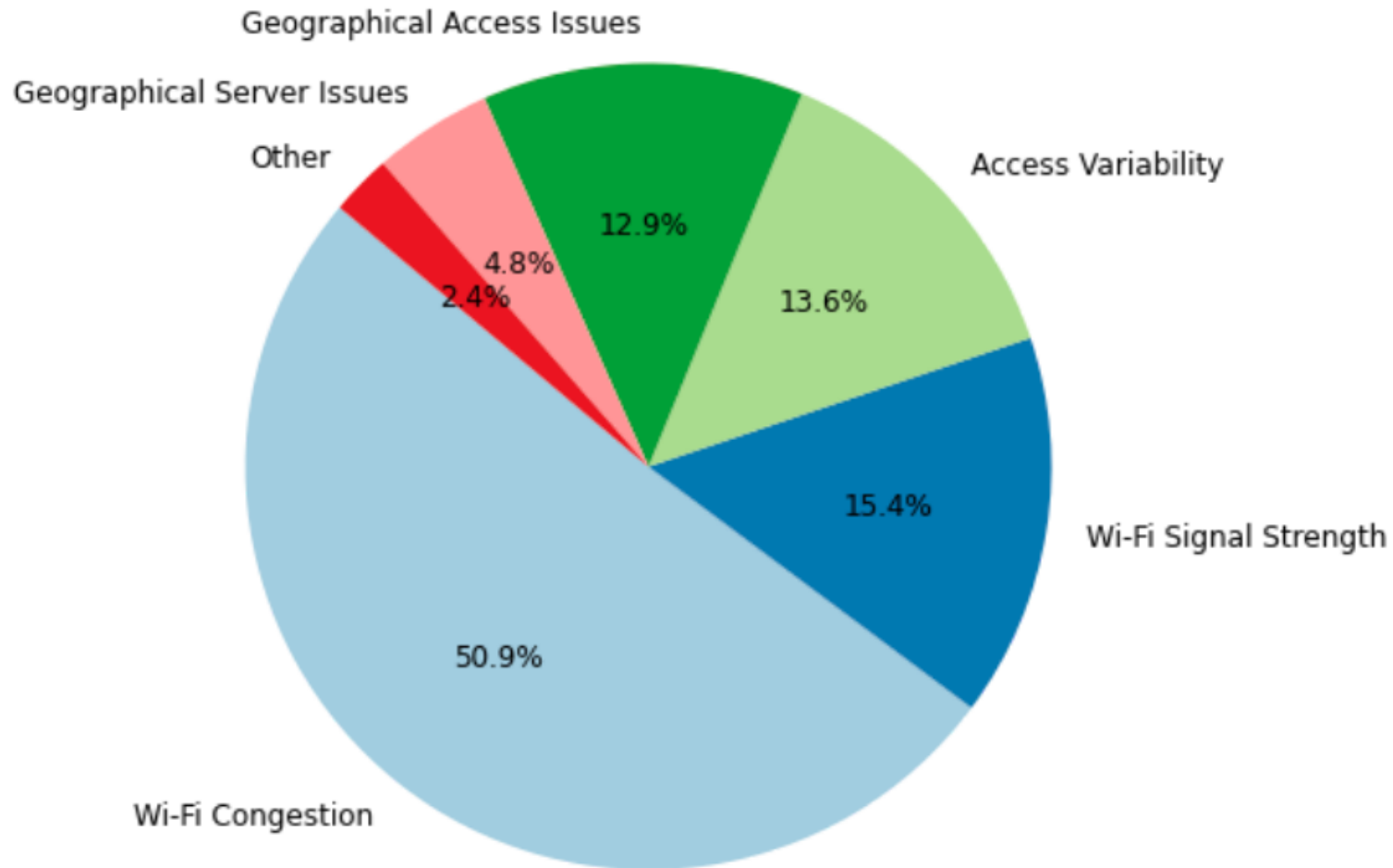# How well does QoO match your experience?

"

I like this tool because it gives a better understanding of what is functioning to which capacity and how to improve it rather than deal with "mystery" problems in connection/speed.
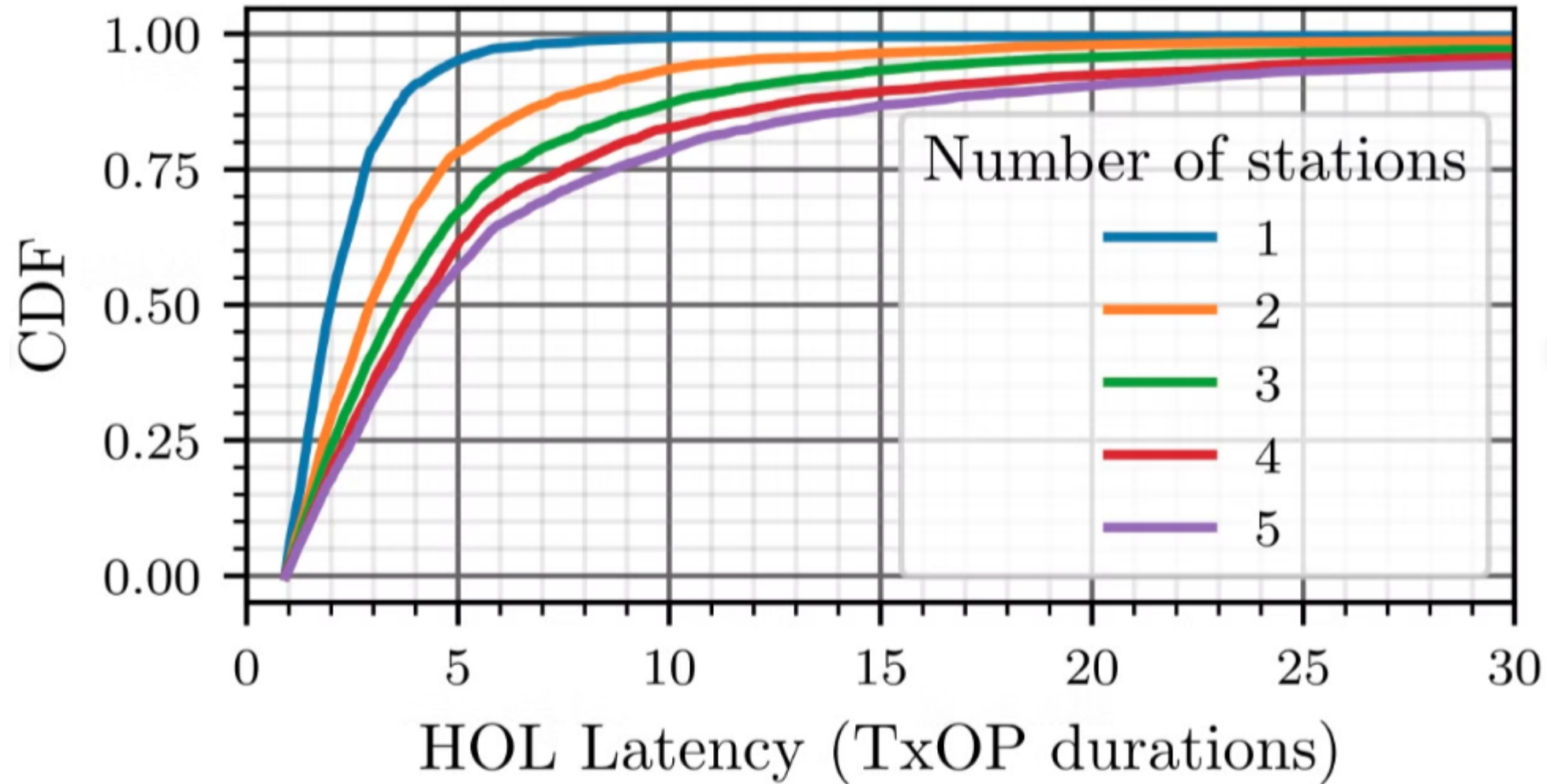
Participant

Quality of Outcome Distribution by Interface for Gaming and VideoConference

Root Cause Distribution When Gaming QoO < 80
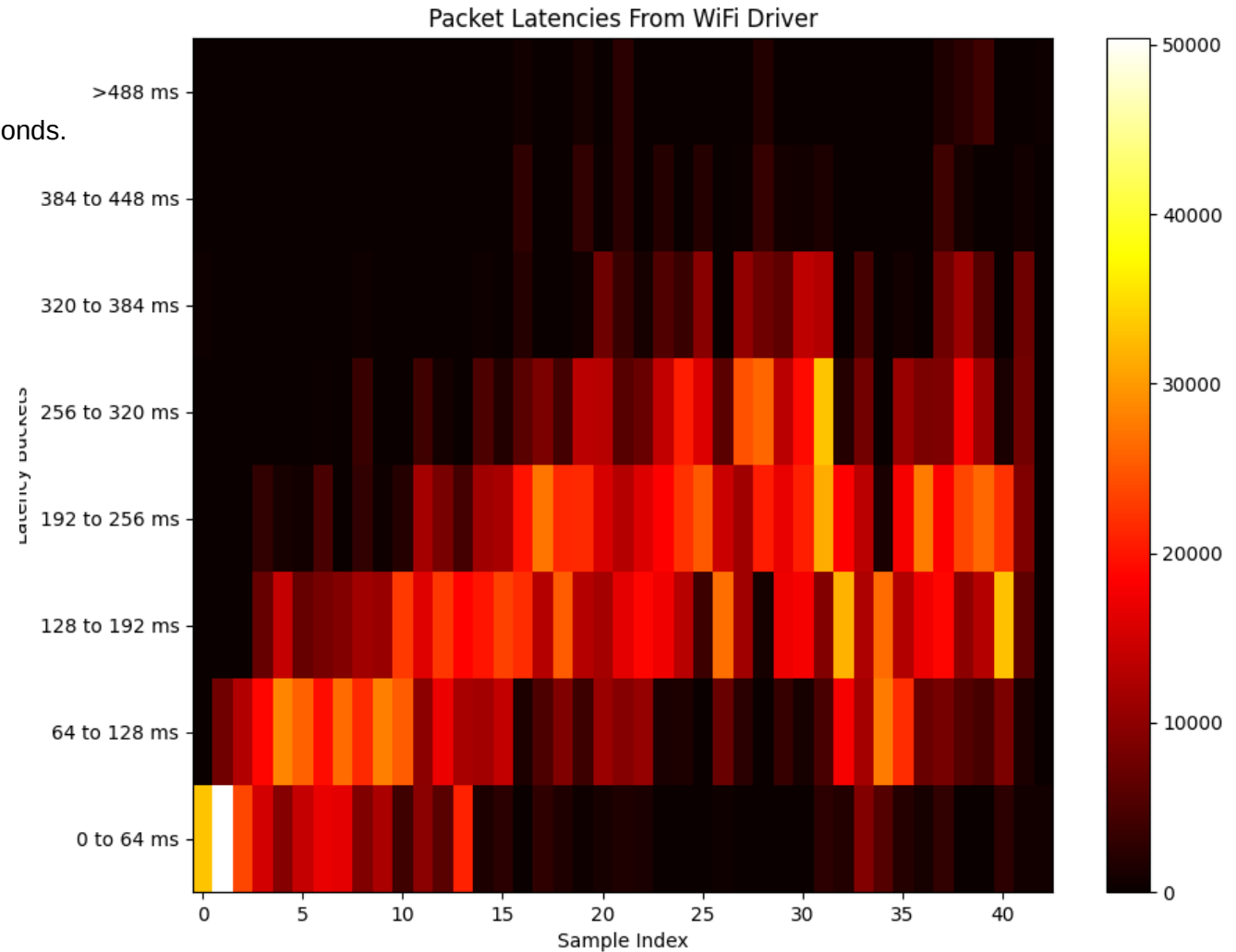
Latency when $\rho > 1$

Queuing delay

Running a speedtest (www.speedtest.net) over a
WiFi 7 WiFi link in the 5GHz spectrum. The WiFi driver
collects a histogram of packet sojourn times every 1 seconds.

Download from 0-25 seconds, then upload.

As you can see, the queuing delay is very significant.

Packet Latencies From WiFi Driver

References

- **Comcast trial report**

- **Bjørn Ivar Teigen, N. Davies, K. Olav Ellefsen, T. Skeie and J. Torresen, "Quantifying the Quality Attenuation of WiFi," 2022 IEEE 47th Conference on Local Computer Networks (LCN), Edmonton, AB, Canada, 2022, pp. 189-197, doi: 10.1109/LCN53696.2022.9843690.**

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