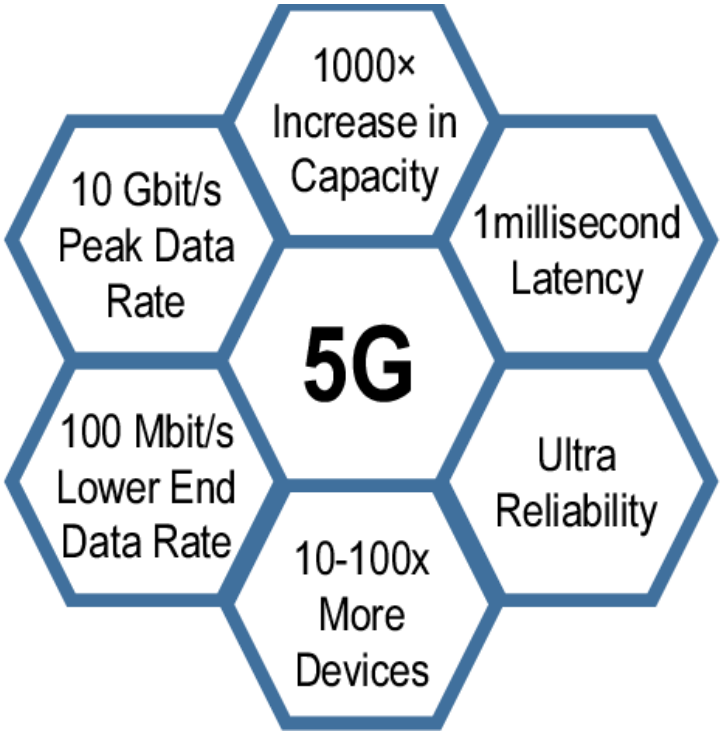
5G’s elusive quest for 1ms latency

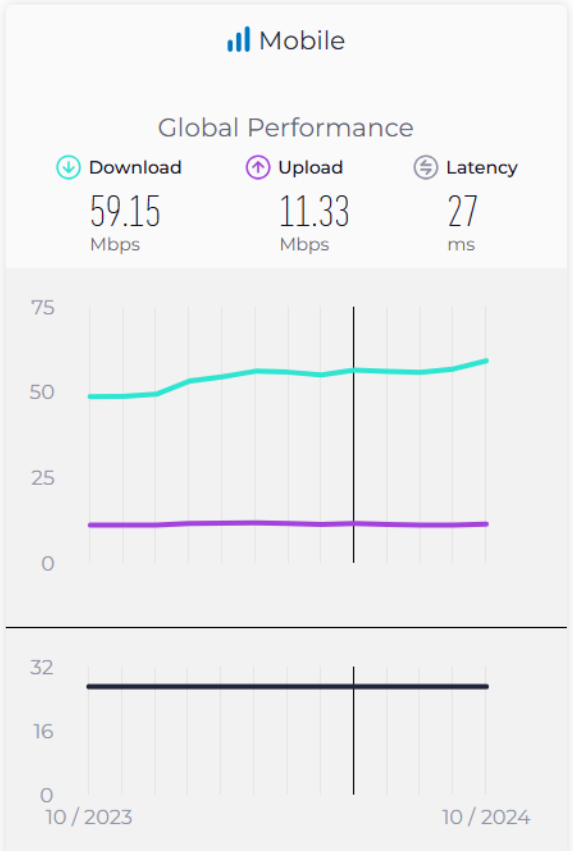
Professor William Webb

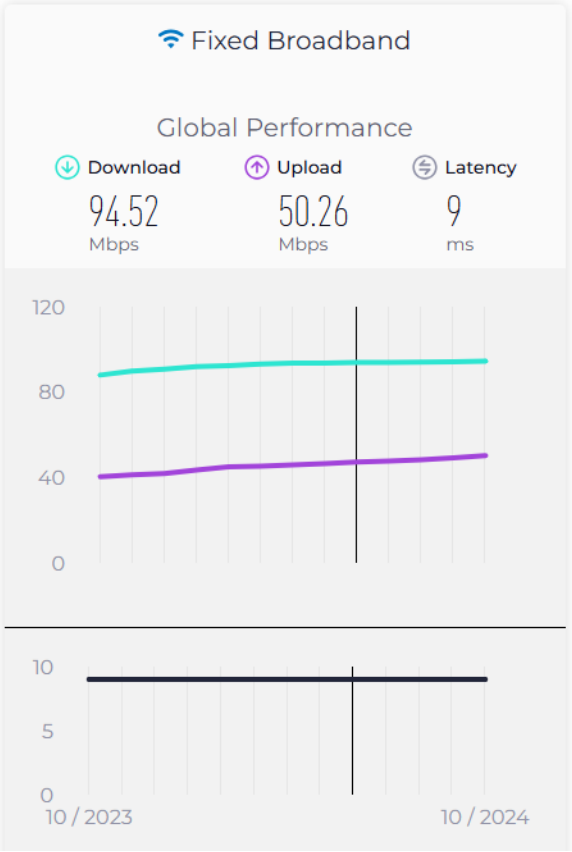
2024



Mobile is ~3-4x worse than fixed

- Mobile networks generally in the region 30-40ms
- Some improvements with 5G (40ms down to 30ms)



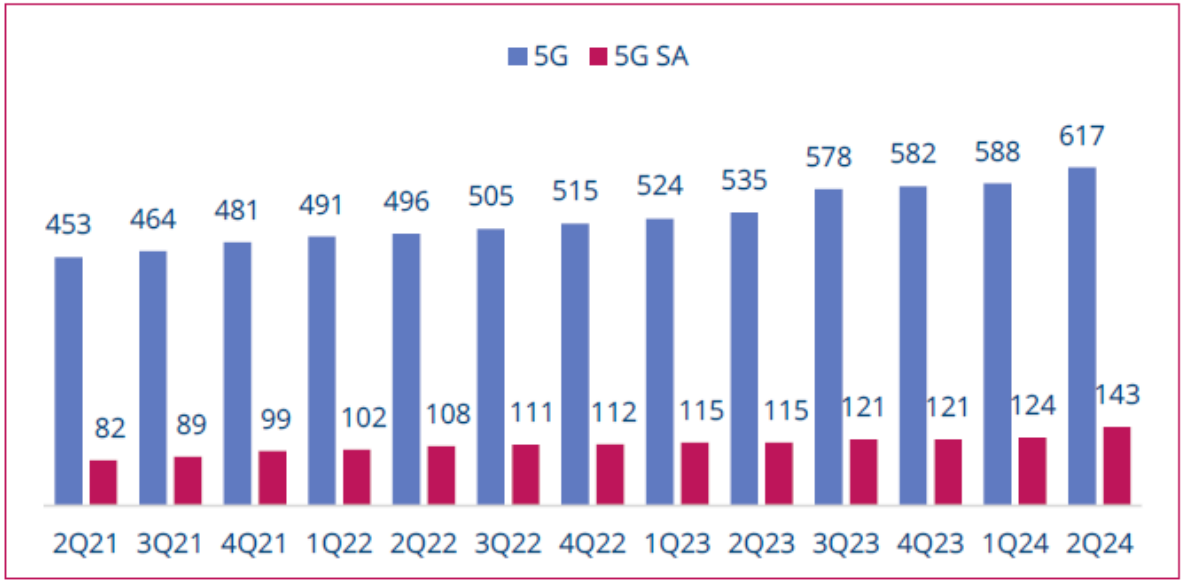


https://www.speedtest.net/global-index

5G needs SA to deliver low latency

- The 5G targets can only be met with standalone deployments
- But even where these have happened, latencies are not materially lower (eg T-Mobile in US 47ms versus others 55ms)
- SA deployments appear to be stalling

Figure 1. Number of operators investing in 5G SA for public networks and number investing in any 3GPP 5G network



https://gsacom.com/paper/5g-standalone-september-2024/

But there is no pressure for lower latency

- "Humans will hardly be able to tell – at least not appreciate much – the difference between a latency of **30 vs. 50 ms** when using their everyday apps on their smartphones. Even ambitious first-person shooter gamers would be happy with a reliable latency in the range of 30 – 50 ms.
- I have yet to find a sound research study that has tested humans who have been trained to react extremely fast, e.g., Olympic sprinters, race car drivers, or championship gamers. From what I have read so far, it seems that the lower limit of latency for this small fraction of the human population is not lower than 20 ms, i.e., for humans, lower latencies would not make a difference."

https://www.ericsson.com/en/blog/2022/8/who-cares-about-latency-in-5g

Low latency is VERY expensive to deliver

- In the worst case (small block size of 32 bytes) delivering 1Mbits/s of low latency traffic causes a drop of 60Mbits/s of conventional traffic
- With larger block sizes it is 10x
- Hence, a user wanting low latency **would need to pay at least 10x and probably closer to 50x** than a conventional user to make it financially attractive

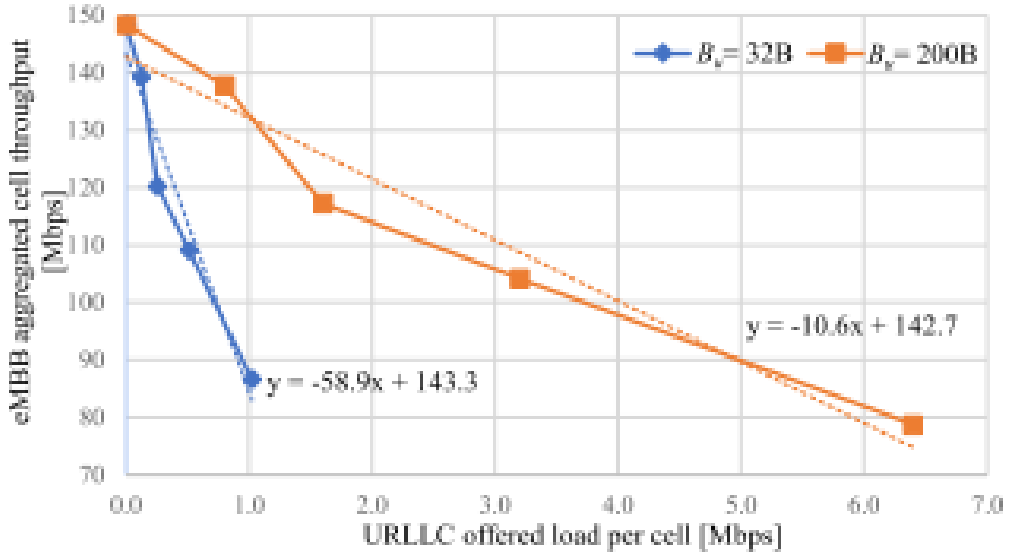
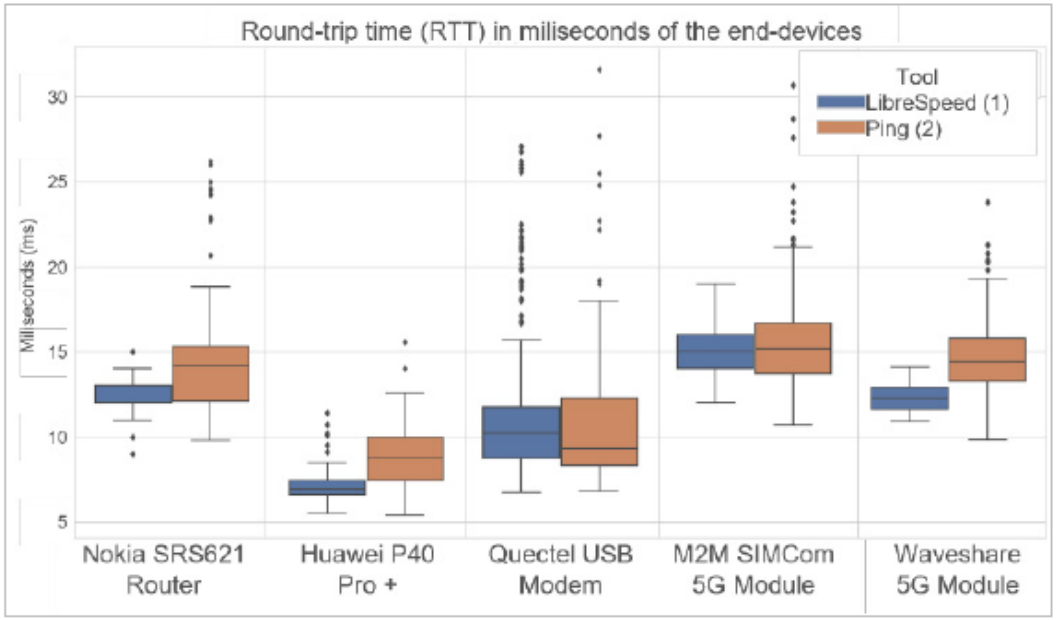


FIGURE 4. eMBB cell throughput vs URLLC offered load. Slope of the linear fit indicates the approximate cost ϕ of URLLC traffic as per (3).

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9732349

Perhaps there is value in private networks

- In a private network there *might* be a machine that needs <10ms latency
- And the loss of capacity *might* not be an issue
- But current private network deployments, while better, are still nowhere near the 1ms target, partly because they have to use TDD with 10ms frames
- **The key question is how many of these deployments actually exist – is this a material market?**



55th CIRP Conference on Manufacturing Systems, "Measurement and comparison of data rate and time delay of end-devices in licensed sub-6 GHz 5G standalone non-public networks", Thorge Lackner et al

Materially lowering latency in public mobile networks looks nonsensical and unlikely

1. No person needs <30ms latency, and mobile networks, on average, deliver this already.

2. Delivering latencies below 10ms is very expensive in terms of network resources and more – there would need to be substantial revenue to pay for the ~50x loss of capacity

3. 5G SA deployment is slow and may be stalling, but even where deployed it is not delivering materially lower latencies

4. There may be value in private 5G networks, but the number of these that need latencies lower than Wi-Fi/fixed can deliver is likely very small and hampered by TDD spectrum allocations

Hmmm….

6G Targets