Substantiation of claim "The UK's #1 5G Network"

Substantiation of Claims   **Last Review: 12.02.2021**

Claim:
   1.   **The UK's #1 5G Network**

Substantiation

RootMetrics Testing Methodology

RootMetrics uses a well-controlled "drive" test to perform a geographically and temporally diverse "apples-to-apples" comparison of the four major wireless operators' network performance. Testing is done simultaneously across all four operators to show a same-place, same-time view of performance differences between operators.

RootMetrics performs these tests using unmodified, off-the-shelf smartphones acquired from each operator. Testing in the second half of 2020 was done using the Samsung Galaxy Note 10+ 5G for EE, O2, Three, and Vodafone.

RootMetrics physically drives the phones around the country, to all four nations and extensively in the most populous 16 urban areas (which includes both the main city and surrounding towns within the Large Urban Zone), performing a variety of performance tests on each operators' network. To ensure that its data remain current, RootMetrics performs tests in each nation at least every six months.

In the second half of 2020, RootMetrics personnel drove over 25,856 miles around the United Kingdom. RootMetrics obtained approximately 644,546 tests, assessing each network's speed, reliability, and accessibility when calling, texting, or sending/receiving data.

RootMetrics tests data, call, and text performance by downloading and uploading files, downloading small files that represent web and app usage (secure and non-secure connections), making mobile-to-mobile phone calls, and sending and receiving text messages. Test data is categorised into "speed", "reliability", and "accessibility" measures (as, for instance, JD Powers might categorise and assess different aspects of auto performance or safety). Drive tests are conducted along motorways and motorways, major arterials, and residential streets where the population within a market generally lives and travels. Due to government restrictions and safety concerns caused by COVID-19, testing from the first half of 2020 does not include testing at indoor locations.

RootMetrics' drive-based methodology successfully controls for numerous variables that fundamentally distort the data obtained through certain alternative, "crowd"-based methodologies. In so doing, RootMetrics ensures that the results obtained accurately reflect the difference between operators' actual network performance and not—for example—differences in types of devices owned by different operator customers, differences in operator customer testing locations, or differences in a consumer's willingness to run a speed test at a particular moment. RootMetrics testing also includes calling and texting, which is completely lacking in crowd-based data.

RootMetrics' 5G rating calculation is based on the accepted, standard set of data points described above limited to tests that were conducted fully over a 5G network connection.

Rating methodology

The RootMetrics 5G rating framework is designed to measure progress towards the 5G standards outlined in IMT-2020, focusing on metrics that are most important to consumer experience and use case application. Recognizing that 5G technology is still in early stages and real-world experience

does not yet meet the theoretical potential, stars (points) are awarded in increments to show differentiation among operators as well as display progress towards expected 5G performance goals.

To provide an objective view of 5G performance, RootMetrics reviewed a variety of publications and sources in determining what metrics should be evaluated, as well as what performance thresholds should be considered. In addition to the IMT-2020 5G standards, RootMetrics compared recommended performance thresholds for a 5G use case (cloud gaming) and reviewed consumer survey results to better understand expectations from users. Taken together, this multi-faceted approach helped delineate what KPIs are most important while also providing key benchmarks for network comparisons.
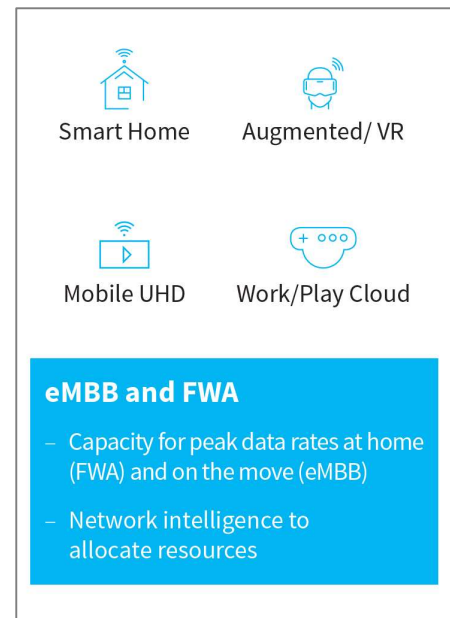
Context and current ecosystem overview

In parallel with the changes consumers are experiencing due to the Covid-19 pandemic, innovative technology teams around the world are releasing emerging technologies which will change the shape of communication interaction. For instance, Ofcom released a report on the 14th January 2021[1] shining a light on some of these emerging technologies, along with expectations of the type of network performance evolution that is required to support them in the real-life environment in the near term and longer term futures.

To further understand what consumers and business users expect from connectivity and these evolving mobile networks, RootMetrics undertook a User Perception Survey in October 2020. The framework was designed to help us understand consumer and enterprise decision-maker perceptions on future purchasing decisions. With 3,000 responses, the data indicated that both consumer and enterprise identified availability of 5G service and data throughput speeds as important factors influencing their next purchase.

5G offers a bright future, but 5G today is first and foremost beginning to address enhanced mobile broadband (eMBB) use cases. These eMBB usage scenarios will come with new application areas and requirements in addition to existing mobile broadband applications for improved performance and an increasingly seamless user experience.

In particular, a smartphone customer needs high levels of 5G availability to provide seamless coverage, with a much-improved user data rate compared with existing data rates. Hotspot use cases also exist, typically in an area with high user density; for these scenarios, very high traffic capacity is needed, the requirement for mobility is low, and the user data rate is higher than that of wide area coverage.

Source: RootMetrics "The promise and potential of 5G: Evolution or revolution?"[2]

Smart Home   Augmented/ VR

Mobile UHD   Work/Play Cloud

eMBB and FWA

– Capacity for peak data rates at home (FWA) and on the move (eMBB)

– Network intelligence to allocate resources

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[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0011/211115/report-emerging-technologies.pdf
[2] https://rootmetrics.com/en-US/content/the-promise-and-potential-of-5g-evolution-or-revolution

During these initial phases of 5G rollout, the end user will benefit from faster access to media content whilst on the go, resulting in an enhancement of data rates compared to 4G technology and an improved quality of experience, with content size no longer a barrier to access high quality content. Streaming video experiences, for instance, will have less buffering and content starting instantly.

Defining what constitutes a 5G experience and the importance of 5G availability

A consumer's 5G experience is built out of a combination of two broad pillars: 1) the network performance delivered while on 5G and 2) how often those 5G networks are actually available.

Assuring that both elements of this 5G equation are considered is especially critical during early rollouts and as networks continue to mature. Performance metrics are important but viewing performance without also factoring in availability can create a skewed picture of the 5G experience. After all, an amazing 5G speed only matters to consumers if they can actually access the network consistently.

To that end, the RootMetrics 5G rating framework first considers how well each network performs across key 5G KPIs (covering speed, reliability, and latency) and then uses the percentage of tests on 5G (availability) as a multiplier. This approach creates a balance that provides a clearer picture into the consumer's 5G experience. It rewards operators that offer the best combination of performance plus availability, while mitigating the impact of an operator excelling in *only* performance or *only* availability.

- An operator with fantastic performance but low availability will have its score impacted negatively by low availability (since, again, if a consumer cannot access the network, that performance is moot).
- Conversely, an operator with high availability but low performance will have its score impacted negatively by its weaker speed, reliability, or latency KPIs.
- An operator cannot score highly by focusing on performance across only a small area or on wide availability at the expense of stronger performance.
    - This type of mitigation is especially important as different spectrum bands of 5G become available: some spectrum favours broad coverage and some spectrum leads to faster speeds. A true 5G experience must consider both elements, not one at the expense of the other.
- Consumers are thus able to see which operator provides the best overall combination of performance plus availability.

Selection of performance metrics

Much of the conversation around 5G focuses on the potential for extremely fast speeds. A March 2020 survey[3] supports the idea that download speeds are at the top of consumers' minds when

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[3] https://www.ansys.com/-/media/ansys/corporate/resourcelibrary/brochure/ansys-5g-survey-infographic.pdf?la=en&hash=4A18E71A92731D76D4B52763E46CAC0AC5391A93

thinking about 5G. **For this reason, RootMetrics weights speeds slightly higher than reliability and latency when evaluating networks.**

While speed might be the first thing consumers think of when it comes to 5G, use cases including mobile gaming, augmented or virtual reality, and connected vehicles will also rely on 5G's promise of near-perfect reliability and low latencies.

To capture fully these consumer expectations and use case needs, the following metrics are considered when RootMetrics evaluates 5G networks:

- Download Throughput 5th Percentile (Speed)
- Download Throughput Median (Speed)
- Lite Data Secure Access Speed (Latency)
- Lite Data Secure Access Success (Reliability)
- Lite Data Secure Task Success (Reliability)

Each of these categories is then scored using a star system based upon the performance thresholds defined below.

Evaluating availability

5G availability is determined based upon the number of tests RootMetrics recorded on 5G compared to other network technologies:

- Percent of tests on 5G (Availability)

As mentioned above, availability functions as a multiplier within the RootMetrics framework. Once the above performance metrics have been evaluated and the corresponding number of stars awarded for each category, 5G availability rates are then factored in.

The equation is simple and straightforward: the total number of stars an operator earns across the performance categories is multiplied by the percentage of tests RootMetrics recorded on 5G.

Performance Thresholds

The expectation is that 5G technology will move towards ubiquity over the next couple of years. As networks expand and mature, RootMetrics expects performance to continue to improve. When evaluating 5G performance, RootMetrics has therefore taken into consideration key guidelines from IMT-2020[4], including:

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[4] https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Documents/060R1e.pdf and https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Documents/S01-1_Requirements%20for%20IMT-2020_Rev.pdf

- User experienced data rate of 100 Mbps downlink

- Control plane latency of 20 ms or less

- 99.9999% reliability

Thresholds for download throughput metrics in the 5G rating are based on the expectation of eventually achieving 100 Mbps at the 5th percentile for download throughput, and more generally the expectation that 5G speeds will be in the hundreds of Mbps (with peak speeds much higher than that). While networks are still rolling out 5G capability, however, this 100 Mbps threshold is used as a minimum to achieve stars for median download throughput in the rating system. The 100 Mbps mark matches with 5G-specific applications, such as the minimum throughput needed for entry-level VR experience as shown in the recent Ofcom report[5]. This threshold also maps to what RootMetrics has publicised[6], including information that shows consumers how these 5G speeds will impact typical mobile behaviour.
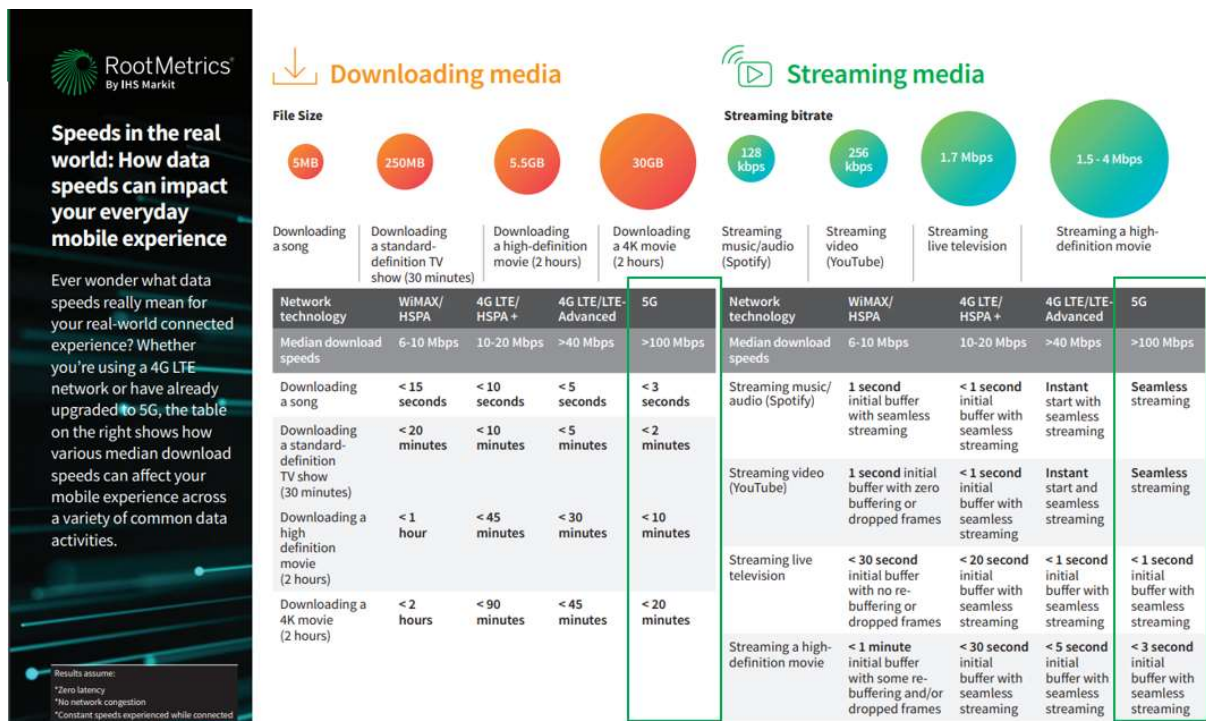
Source: RootMetrics "Speeds in the real world: what data speeds mean for your daily connected experience"[7]

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[5] https://www.ofcom.org.uk/__data/assets/pdf_file/0011/211115/report-emerging-technologies.pdf
[6] https://www.rootmetrics.com/en-US/content/speeds-in-the-real-world-infographic
[7] https://www.rootmetrics.com/en-US/content/speeds-in-the-real-world-infographic

The lower threshold used for the 5th percentile metric was determined by reviewing recommendations associated with mobile cloud gaming as a representative 5G use case. Research across Xbox[8], Google Stadia[9], and others suggests that a minimum speed of 10 Mbps is required to assure a smooth consumer experience for SD gaming. To provide opportunity for further differentiation of networks, a second threshold of 30 Mbps was established and represents a minimum speed needed to support more intensive performance needs for multi-player and/or HD games.

Thresholds for the latency measure of lite data secure access speed, are targeted towards the sub 20 ms goal outlined in IMT-2020 with the interim step at a half a star tied to current expectations for latency for smooth performance on mobile gaming platforms. Here too RootMetrics reviewed typical use case latency requirements. Current recommendations from Xbox, for instance, suggest a latency of less than 60 ms is required for smooth game play experience. In short, both independent recommendations—the ideal sub 20 ms from IMT-2020 and the more achievable 60 ms threshold from gaming recommendations—are captured within the RootMetrics star rating framework.

The reliability expectations in IMT-2020 are near perfect at 99.9999%. To account for the early stage of 5G and in acknowledgement that few consumers will have practical impacts from a slightly lower reliability in current use cases the threshold for the reliability metrics was set at 99.5% - still an impressive value when compared to network performance as a whole.

National aggregation

As of the second half of 2020, 5G rollout in the UK has been primarily concentrated in the metro areas. Due to lack of 5G seen in national drive route testing, the national rollup calculation for 5G metrics includes only testing from RootMetrics' Metro testing across UK's top 16 metros. All 5G data tests from across the 16 metros are used to calculate the national level metrics. There is no weight applied in this aggregation.

Rating Framework and quick metric summary

Availability: 5G availability is the gateway for consumers to access enhanced mobile network experience promised by this new technology and acts as a multiplier of the other performance metrics within the RootMetrics framework.

5th percentile: 5th Percentile speeds experienced on 5G provide a measure of minimum performance required to provide access great media content quickly or great gaming experiences on the go.

Median download throughput: Median download speeds > 100Mbps provide consumers faster access to higher quality media on the go, enable enterprise organisations to work from anywhere, and deliver enhanced mobile broadband to consumers in the home who may not have access to fixed broadband.

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[8] https://support.xbox.com/en-US/help/games-apps/cloud-gaming/about-cloud-gaming#about-cellular-gameplay
[9] https://support.google.com/stadia/answer/9607891?hl=en

LDRS and latency: Improved latency enables quicker responses and lag-free applications and sets the stage for future 5G use cases such as autonomous cars and more.

Reliability: A consistent user experience requires high access reliability to connect to the service and task reliability to receive the necessary data to operate the service.

Best 5G Network Rating

Metric Name	Performance Element	Max★	Units	Measure	0.5★	0.75★	1.0★	1.25★	1.5★
Download Throughput 5th Percentile	**Speed** (ubiquitously available throughput)	0.75★	Mbps	≥	10	30			
Download Throughput Median	**Speed**	1.25★	Mbps	≥	100	150	200	250	
LDRS Access Speed Median	**Accessibility** (latency)	1.5★	ms	≤	-	80	60	40	20
LDRS Access Success	**Reliability**	0.75★	%	≥	-	99.5			
LDRS Task Success	**Reliability**	0.75★	%	≥	-	99.5			
		5.0★							

2H 2020 UK-wide ratings

(Performance)(Availability) = Overall Score

Carrier	Download Throughput 5th Percentile	Download Throughput Median	LDRS Access Speed Median	LDRS Access Success	LDRS Task Success	Subtotal	Availability	Overall score
EE	24.51 (0.5)	129.48 (0.5)	37.50 (1.25)	99.63% (0.75)	99.57% (0.75)	3.75	36.79%	**1.38**
O2	50.89 (0.75)	128.61 (0.5)	28.00 (1.25)	99.88% (0.75)	99.90% (0.75)	4.0	6.83%	**0.27**
Three	19.89 (0.5)	100.62 (0.5)	22.00 (1.25)	99.80% (0.75)	99.80% (0.75)	3.75	13.25%	**0.50**
Vodafone	33.00 (0.75)	149.18 (0.5)	26.95 (1.25)	99.13% (0.0)	99.83% (0.75)	3.25	8.97%	**0.29**