Substantiation of claim "The UK's Best 5G Network"

Substantiation of Claims   **Last Review: 18.05.2021**

Claim:
   1.   **The UK's Best 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, 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 categorized into "speed", "reliability", and "accessibility" measures (as, for instance, JD Powers might categorize and assess different aspects of auto performance or safety). Drive tests are conducted along freeways 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 5G star 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

The events of the COVID epidemic in 2020 have shown people need access to ever faster and more reliable data connections, whether to support remote education or the evolution to working from "anywhere" once the pandemic subsides.

In parallel with the changes consumers are experiencing right now, 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 of this work was as follows:

- In order to understand consumer perceptions of the 'best' performing carriers, we undertook an online survey lasting approximately 5 minutes with UK and US consumers – with a sample of 1000 respondents in each of these markets

- In addition to understanding consumer perceptions, RootMetrics also wish to understand the viewpoint of business enterprise users on who the best performing carriers are (again across both the UK and US)

- We also surveyed 500 enterprise users in each of the markets to ensure representation from a spread of different business sizes

When reviewing future purchasing decisions, both consumer and enterprise indicated availability of 5G service and data throughput speeds as important factors influencing their next purchase (see below table)

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[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0011/211115/report-emerging-technologies.pdf

CONSUMER AND ENTERPRISE CUSTOMER SURVEY RESULTS, IMPORTANCE OF NETWORK KEY
PERFORMANCE INDICATORS ON PURCHASE DECISIONS

			Last purchase importance	Next purchase importance	+/-
Consumers	Download and upload speeds	Overall	65%	70%	+5%
		UK	59%	65%	+6%
		US	71%	75%	+4%
	Availability of 5G service	Overall	40%	49%	+9%
		UK	30%	39%	+9%
		US	49%	59%	+10%
Enterprise users	Download and upload speeds	Overall	73%	77%	+4%
		UK	68%	70%	+2%
		US	80%	83%	+3%
	Availability of 5G service	Overall	58%	65%	+7%
		UK	50%	56%	+6%
		US	65%	74%	+9%

Source: RootMetrics commissioned survey - User perceptions of carriers: Survey analysis of consumer and enterprise users in the UK and US

5G offers a bright future, but 5G today is first and foremost beginning to address enhanced broadband use cases (eMBB). These enhanced mobile broadband 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.
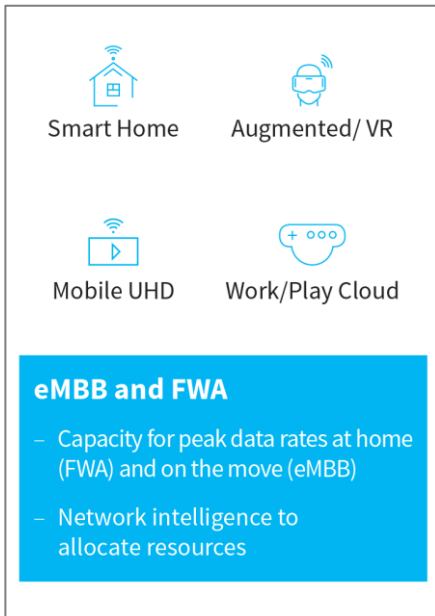
Source: RootMetrics "The promise and potential of 5G: Evolution or revolution?"[2]

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.

Step one: 5G availability as a primary threshold for comparison

The RootMetrics framework begins with an evaluation of 5G availability. This is in many ways the most important criteria for network evaluation as 5G rollouts begin and expand. Indeed, 5G availability is the gateway for consumers to access enhanced mobile network experience promised by this new technology. The reason for 5G availability being classified as a first, critical consideration are therefore twofold: 1) while 5G speeds and latency are impressive, if a 5G network is not available, consumers will never experience those game-changing performances; 2) sample size must be considered, with a low sample count potentially painting a skewed view of the performance a consumer could expect under real-world circumstances.

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[2] https://rootmetrics.com/en-US/content/the-promise-and-potential-of-5g-evolution-or-revolution

A low sample count also makes accurate comparisons between networks difficult. Over the past year we have seen an increased 5G presence from each of the four operators tested by RootMetrics in the UK, but the disparity in availability is still large. Operators with only a small number of tests on 5G can benefit from inflated performance metrics this is particularly notable when measuring download speed where a 5th percentile value may only represent a single test when there is not a sufficient sample size.

In short, a handful of 5G tests recorded at a very high (or very low) speed does not provide an accurate assessment of the most likely consumer experience for an individual network nor does it allow for meaningful cross-carrier comparisons. *Having a sufficiently high sample count and percentage of 5G availability was thus deemed a primary gating factor for the RootMetrics evaluation of 5G networks: to ensure both statistically and practically meaningful performance conclusions, a carrier must offer at least 10% of tests on its 5G network to be considered for this star rating framework.*

A threshold set at 10% ensures sufficient sample sizes across all geographies that the 5G rating methodology could be applied to – both individual Metros and a National level aggregation. RootMetrics' smallest Metro markets in the UK included about 750 download tests in 2H 2020, the 10% threshold will guarantee that comparisons are not made with less than 75 tests.

In practice, this threshold will be applied anytime 5G performance comparisons are being made using the 5G rating methodology. Only operators that meet or exceed 10% of data tests on 5G in the geography being considered will be given a rating for performance related metrics.

Selection of metrics

Availability is the first but not the only important metric RootMetrics considers when evaluating 5G network performance. Consumers also expect improved performance, and metrics pointing toward those benefits have also been built into the RootMetrics framework.

Beyond availability, 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 thinking about 5G.

While speed and availability may be some of the first things 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 near-perfect reliability and low latencies.

To capture these consumer expectations and use case needs the following metrics are considered in the 5G rating for the UK:

- Percent of tests on 5G (Availability)
- Download Throughput 5th Percentile (Speed)
- Download Throughput Median (Speed)

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

- Lite Data Secure Access Speed (Latency)

- Lite Data Secure Access Success (Reliability)

- Lite Data Secure Task Success (Reliability)

Performance Thresholds

While there is no outside standard for 5G availability, the expectation is that the technology will move towards ubiquity over the next couple of years. The thresholds for availability reflect the expectations for increased 5G footprints at both the Metro and National level as well as capture the importance to consumers that they are able to access the 5G network. The RootMetrics availability thresholds therefore begin at the minimum 10% requirement and increase in even increments up to 85%, a figure which reflects the long-term goal of near ubiquity.

For the other metrics included in the 5G rating, key considerations from IMT-2020 include:

- 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, this 100 Mbps threshold is used as a minimum to achieve stars for median download throughput in the rating system with a lower threshold for the 5th percentile. 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[4]. This threshold also maps to what RootMetrics has publicised[5], including information that shows consumers how these 5G speeds will impact typical mobile behaviour.

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[4] https://www.ofcom.org.uk/__data/assets/pdf_file/0011/211115/report-emerging-technologies.pdf
[5] https://www.rootmetrics.com/en-US/content/speeds-in-the-real-world-infographic
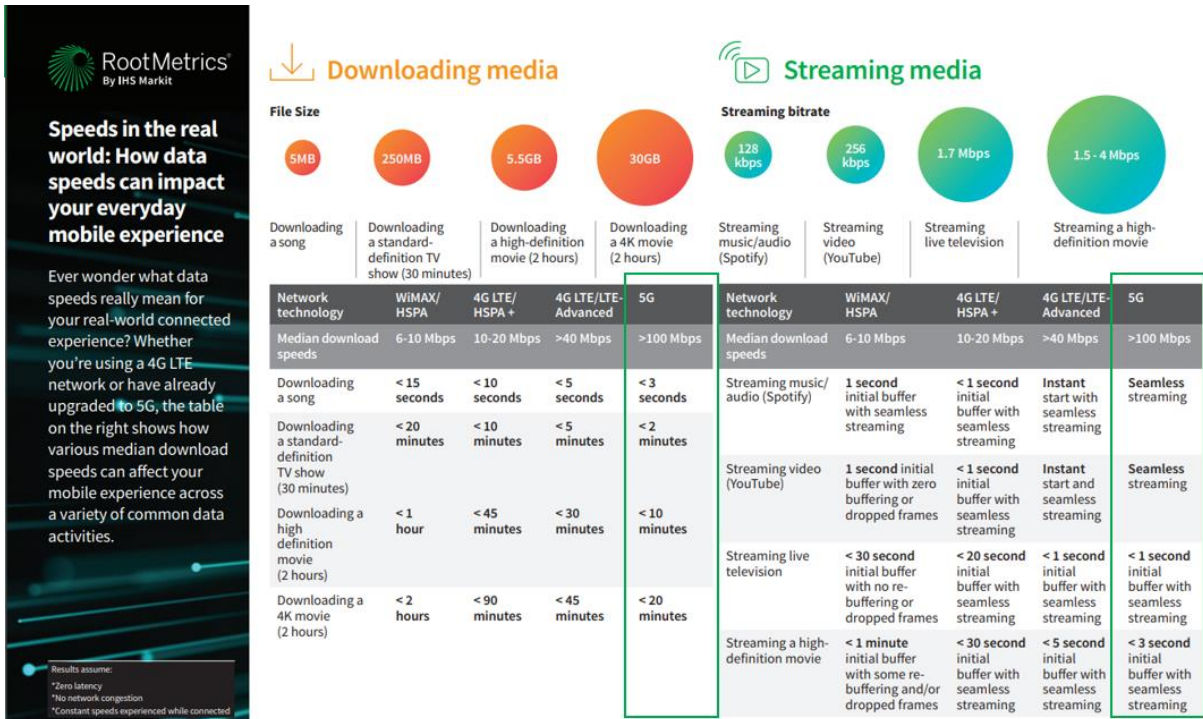
Source: RootMetrics "Speeds in the real world: what data speeds mean for your daily connected experience"[6]

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[7], Google Stadia[8], 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

[6] https://www.rootmetrics.com/en-US/content/speeds-in-the-real-world-infographic
[7] https://support.xbox.com/en-US/help/games-apps/cloud-gaming/about-cloud-gaming#about-cellular-gameplay
[8] https://support.google.com/stadia/answer/9607891?hl=en

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.

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.

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 FRAMEWORK

Metric Name	Performance Element	Maximum Achievable Stars	Units	Measure	Star threshold					
					0.25★	0.5★	0.75★	1.0★	1.25★	1.5★
Percent of tests on 5G	**Availability** (ability to access)	1.5★	%	≥	10	25	40	55	70	85
Download Throughput 5th Percentile	**Speed** (ubiquitously available throughput)	0.5★	Mbps	≥	10	30				
Download Throughput Median	**Speed**	1.0★	Mbps	≥	100	150	200	250		
LDRS Access Speed Median	**Accessibility** (latency)	1.0★	ms	≤	80	60	40	20		
LDRS Access Success	**Reliability**	0.5★	%	≥	-	99.5				
LDRS Task Success	**Reliability**	0.5★	%	≥	-	99.5				
		5.0★								

Ratings only applied to operators with at least 10% of tests on 5G

2H 2020 UK 5G star ratings

Operator	Availability	Download Throughput 5th Percentile	Download Throughput Median	LDRS Access Speed Median	LDRS Access Success	LDRS Task Success	Rating
EE	36.79% (0.5)	24.51 (0.25)	129.48 (0.25)	37.50 (0.75)	99.63% (0.5)	99.57% (0.5)	2.75★
Three	13.25% (0.25)	19.89 (0.25)	100.62 (0.25)	22.00 (0.75)	99.80% (0.5)	99.80% (0.5)	2.5★

EE has the highest star rating for 5G at the UK aggregate level and therefore are the best or "no.1" 5G network in the UK.