



RootMetrics®
By IHS Markit

Mobile gaming ratings for the United Kingdom 1H 2021

Substantiation of Claims

Last Review: 10.08.2021

Claim:

- **EE's unbeatable network for gaming**
- **EE's network is unbeatable for gaming**
- **Unbeatable gaming on the UK's best network**
- **Unbeatable gaming on the UK's no. 1 network**

RootMetrics Testing Methodology Facts

- RootMetrics uses well-controlled “drive” tests to arrive at geographically and temporally diverse “apples-to-apples” comparisons of the four major wireless operators’ network performance.
- RootMetrics performs tests using unmodified, off-the-shelf smartphones acquired from each operator. Testing in the first half of 2021 was done using the Samsung Galaxy Note 20 Ultra 5G for EE, O2, and Vodafone and the Samsung Galaxy S20 5G for Three.
- Testing is done simultaneously across all four operators to show a same-place, same-time view of performance differences between operators.
- RootMetrics physically drive 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 all data remains current, RootMetrics performs tests in each nation at least every six months.
- In the first half of 2021, RootMetrics personnel drove over 27,500 miles around the United Kingdom. RootMetrics obtained approximately 636,000 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 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 in the first half of 2021 was not performed at indoor locations.
- RootMetrics’ drive-based methodology successfully controls for numerous variables that fundamentally distorts data obtained through certain alternative, “crowd”-based methodologies. In doing so, 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 operators’ customers, differences in operators’ 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.
- The FCC, the Better Business Bureau, and British telecom regulators Ofcom and Clearcast have all relied upon data from RootMetrics. As an industry analyst at Wells Fargo noted: “RootMetrics is well regarded as one of the most respectable (if not THE) network monitoring services.”

- RootMetrics has intentionally decided not to consider deprioritization as part of its testing. Deprioritization being defined as an artificial limitation of network performance intentionally caused by a network operator based on a user's rate plan or data usage. We exclude this limitation because the objective of the testing is to isolate for network performance and not for restrictions artificially imposed by a rate plan. When RootMetrics purchases the flagship phones that it uses for its testing from each operator, it also purchases an unlimited data plan from each operator. In order to control for deprioritization and ensure it is not skewing the results, RootMetrics ensures that the plans it buys are not subject to throttling. Thus, the lack of deprioritization is reflected in the results for all four operators.
- The purpose of RootMetrics' testing is to assess network capabilities. Deprioritization is a feature that is implemented according to the terms of a customer's pricing plan, not as a direct product of the operator's network performance. Accordingly, RootMetrics testing more accurately reflects each network's actual technological capability, as opposed to the impact of separate, pricing-related features that can vary with a consumer's particular plan.
- RootMetrics' RootScore calculations are based on the accepted, standard set of data points described above. None of this data is omitted when RootMetrics calculates a RootScore—its algorithm is the method by which it weighs and combines the data to arrive at a bottom-line measurement that accurately reflects the overall results.
- A customer license with RootMetrics buys it a yearly subscription to the company's data (which customers use internally to analyse their network performance), as well as permission to cite RootMetrics' testing in its advertising. This payment does not provide the customer with any influence or control over RootMetrics' testing.
- In addition to Wireless Operators, RootMetrics has other international licensees, such as Tower and Infrastructure companies.
- RootMetrics solicits information from other Wireless Operators, including EE, O2, Three and Vodafone, with respect to its results and testing methods.
- RootMetrics has other performance benchmarking comparison products, such as gaming console networks.
- RootMetrics is not bound to make changes based on any licensees' input.

Rating Methodology

To determine which operator can provide the best real-world mobile gaming experience, RootMetrics developed a star rating system that offers a holistic and objective measurement of each network's ability to deliver a smooth real-world gaming experience based on the metrics that matter most to gamers. To determine an operator's star rating, RootMetrics focuses on multiple key performance indicators (KPIs) that are critical to mobile gaming performance. All KPIs are recorded across all network technologies, including 4G LTE, any sub-4G LTE technologies, and 5G, when available.

When calculating ratings, each KPI is assigned a maximum number of stars an operator can earn, with a total possible rating of 5 stars across all included KPIs. For each KPI, an operator earns stars by exceeding a defined performance threshold. The KPIs used in our mobile gaming rating are:

- **Median Download Throughput Speed:** Minimum levels of download throughput that must be maintained for gameplay
- **LDRS Access Speed (Latency):** Low latencies required for smooth, reactive gaming experience
- **UDP Packet loss:** Packet loss can lead to missing information disrupting gameplay

- **UDP Jitter:** High jitter indicates inconsistent latency and can result in choppy or laggy gameplay

The above KPIs are used to analyse two major facets of the mobile gaming experience: (1) bandwidth and (2) latency and reliability. Bandwidth is represented in our ratings by using median download throughput speed, which we use as a proxy for bandwidth. Latency refers to the reliability of a user's experience and is represented in our ratings by LDRS access speed, UDP packet loss, and UDP jitter.

The thresholds in our mobile gaming ratings for **median download throughput speed**, a proxy for bandwidth, were determined using requirements published by popular cloud gaming platforms (i.e. Google Stadia and Microsoft Xbox Game Pass), game developers, and industry publications. For lower resolution (ex. 720p) gaming, a 10 Mbps median download throughput speed threshold is referenced by Google Stadia¹, Microsoft Xbox Cloud Gaming², and Polygon³. For higher quality (ex. HD, 4k) gaming, speed thresholds ≥ 30 Mbps are defined by these organizations. Regarding bandwidth, more bandwidth (represented by faster median download throughput speeds) is an indicator of a connection's ability to potentially mitigate unforeseen network congestion that might affect a user's gameplay. A user may not need their full bandwidth all at one time, but it may offer the capacity required to recover from moments of latency spikes, packet loss, or inconsistent and/or high jitter. For Stadia, Google states "a slower network speed can cause issues while playing games on Stadia" in reference to the 10 Mbps threshold noted above. Further, Google's troubleshooting page notes that more bandwidth is better for the service in general and overall gaming experience. The ability for bandwidth to alleviate potential latency or reliability issues is the reason for the higher potential star accumulation for median download throughput speeds in our ratings, when compared to our latency and reliability KPIs (LDRS access speed, UDP packet loss, and UDP jitter).

Latency and reliability are also critical for gamers, which is why we have divided our latency measures into three categories worth a total of 3.5 stars.

LDRS access speed: this KPI is the metric that most consumers would understand simply as "latency." We have allocated 1.5 of the 3.5 stars available for latency and reliability to this KPI because it has a more noticeable impact on a user's gaming experience. High latency can disrupt (or even stop) a game in mid-stream, while low latency can provide smooth, buffer-free gaming. The latency results in this KPI are based on our secure web and app testing, which characterises use cases that require continuous data usage on a secure connection, which is the most common mobile cloud gaming experience. Microsoft Xbox Game Pass recommends latency below 60ms for optimal cloud gaming, and we've used that benchmark as a proxy for good cloud gaming on any cloud-gaming platform, both casual games in SD and online games in HD. Understanding that lower latency provides a better experience, we have determined that <30ms is the next threshold for a smoother mobile gaming experience. Looking ahead at future 5G capabilities and the reality of wired in-home internet access as a benchmark, we've also included <10ms as a final threshold for mobile gaming latency as this offers a true comparison to available gaming alternatives.

¹ <https://support.google.com/stadia/answer/9607891?hl=en>

² <https://support.xbox.com/en-US/help/games-apps/cloud-gaming/about-cloud-gaming#about-cellular-gameplay>

³ <https://www.polygon.com/2020/10/14/21499262/cloud-gaming-setup-internet-router-how-to>

UDP Packet Loss: we measure packet loss during our UDP tests. Packet loss, which is a measure of reliability relating to latency, can lead to a frustrating gaming experience since, in effect, packet loss means that pieces, or packets, of game data are lost in transit to and from the user and cloud server. Packets can also arrive out of order, which could theoretically lead to a game that's unintelligible. Based on our initial research and information published by industry advocates and press outlets, we recommend packet loss of below 3% for smooth casual gaming in SD, this metric was derived from the ICTP's recommendation⁴ of between 2.5-5.0% for acceptable quality. RootMetrics has selected a rounded metric on the lower end of this range to simplify the thresholds for easier comprehension while also keeping a reasonably high standard. Both ICTP and Cisco⁵ recommend packet loss of 1% or lower for activities such as video streaming and audio/voice communication which are critical for multiplayer online games in HD quality. In recent research, we have found several site developers who indicate anything above 1% packet loss is detrimental to the gaming experience.

UDP Jitter: we measure this KPI during our UDP tests. Jitter indicates that latency is inconsistent rather than stable. The effects of jitter are similar to those of latency: high jitter can lead to choppy or laggy gameplay and/or distorted audio and chat functionality, while low jitter can keep games running smoothly (as long as latency is also low). In short, the lower the jitter, the better. According to Cisco⁶, jitter below 30ms is ideal for streaming video and audio/voice communications. We have used this metric as a baseline for casual games in SD and, knowing that lower latency offers a better experience, jitter below 10ms for multiplayer online games in HD is required for a smooth mobile gaming experience.

⁴ <https://web.archive.org/web/20131010010244/http://sdu.ictp.it/pinger/pinger.html>

⁵ <https://www.ciscopress.com/articles/article.asp?p=471096&seqNum=6>

⁶ <https://www.ciscopress.com/articles/article.asp?p=471096&seqNum=6>

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The table below shows the KPIs with corresponding thresholds for the mobile gaming rating:

RootMetrics KPI	Performance Element	Maximum Achievable Stars	Units	Measure	0.5 Star Threshold	1.0 Star Threshold	1.5 Star Threshold
Median Download Throughput Speed	Speed	1.5★	Mbps	≥	10	20	30
LDRS Access Speed (Latency)	Accessibility	1.5★	ms	≤	60	30	10
UDP Packet Loss	Reliability	1.0★	%	≤	3	1	
UDP Jitter	Accessibility	1.0★	ms	≤	30	10	
5.0★							

To evaluate gaming performance across the UK, data from testing in 16 urban areas is combined with data from drive routes throughout each of the 4 nations. This data is weighted by the testing areas' population consistent with other National awards given by RootMetrics. These UK-wide aggregate values are then compared to the KPI thresholds to determine each operator's star rating. The operator(s) with the highest rating are able to make claims on gaming performance.

1H 2021 UK rating results

The table below shows the values of the relevant key performance indicators, stars earned for key performance indicator result, and final gaming rating for each of the four major UK operators in the first half of 2021 population-based aggregation:

Operator	Download Speed (Mbps)		Latency (ms)		Packet Loss (%)		Jitter (ms)		Rating
EE	58.79	1.5★	67.27	0.0★	3.7%	0.0★	1.00	1.0★	2.5
O2	15.57	0.5★	46.15	0.5★	4.6%	0.0★	1.13	1.0★	2.0
Three	19.10	0.5★	55.85	0.5★	6.8%	0.0★	1.00	1.0★	2.0
Vodafone	25.19	1.0★	48.69	0.5★	3.2%	0.0★	1.15	1.0★	2.5

'On the UK's Best Network' – 1H 2021 Results:

EE's claim to be the UK's No.1 network is based on RootMetrics' extensive testing which assesses calls, texts, data, speed, accessibility and reliability using the latest devices and a geographically representative methodology. The claim is based on network testing that takes account of all aspects of network performance.

As can be seen in the summary below, EE won outright or shared awards in all categories of RootMetrics 1H 2021 testing apart from Network Accessibility. With this strong performance across subcategories, EE was also announced as the winner of the Overall (Best) Network performance award.



UK Executive Summary

UK RootScore Results 1H 2021



Overall Performance

ROOTSCORE AWARD WINNER

EE



Network Reliability

EE & Vodafone



Network Accessibility

O2



Network Speed

EE



Data Performance

EE



Call Performance

EE & Vodafone



Text Performance

EE & Vodafone