




# LONDON'S BEST MOBILE NETWORK

BENCHMARK MEASUREMENT OF MOBILE  
NETWORKS IN THE GREATER LONDON AREA  
APRIL / MAY 2023

**NET CHECK**



**03** | ABOUT  
NET CHECK

**04** | BENCHMARKING  
METHODOLOGY

**05** | MEASUREMENT  
SPECIFICATIONS

**06** | MEASUREMENT  
EQUIPMENT

**07** | TESTING  
OF SERVICES

**08** | OVERALL  
RESULTS

**09** | VOICE  
RESULTS

**11** | DATA  
RESULTS

**13** | KPI  
DESCRIPTION

**14** | OUR  
CONCLUSION

# NET CHECK

# Quality assurance for modern communication networks

## ABOUT NET CHECK

**NET CHECK was founded in 1999 to improve the quality of communication networks. Since then, NET CHECK has become one of the leading partners of network operators and infrastructure providers in the operation and optimisation of mobile and fixed communication networks of all technologies.**

NET CHECK's core competencies include international network benchmarking (comparative measurements), network planning and fault analyses, covering drive test services, optimisation, site audit, network planning, rollouts, upgrades, swaps, root cause analysis, and advanced custom reporting.

NET CHECK is part of the NC Group, headquartered in Berlin (Germany), and independent of any industry stakeholders. It is a trusted partner of scientific and government institutions due to its high level of expertise, data quality and security.

To ensure the sustainability and reproducibility of reliable results in repeating campaigns, NET CHECK has implemented an ISO-certified management system, and approved its testing and post-processing procedures according to telecommunication industry standards.

The criteria according to which the network operators are assessed and the benchmarking created are determined exclusively by NET CHECK's experts. They follow the NET CHECK benchmarking methodology and are the same for all countries and test areas. The network operators have no influence on the routing of the tests within the test area. They also have no influence on the timing of the tests within the test period.

## #1 provider of quality assurance

The NET CHECK testing methodology strives to provide an accurate, unbiased, and balanced assessment of network performance. It is based on ETSI (European Telecommunications Standards Institute) and has been successfully implemented in various countries and by different network operators.

To ensure that sample collection provides a representative view of the network performance across different-sized communities the following approach is used:

- The **walk tests** cover important areas of interest like malls, airports, and main train stations connected by public transport. The measurement engineers carry special backpacks containing the measurement equipment.
- The **drive tests** cover big, medium and small cities, motorways, main roads and rural roads. The measuring equipment is placed in the roof boxes and collects data on the performance of voice and data services.

Drive and walk tests are performed separately by different teams and can't be performed in parallel.

Measuring various KPIs (Key Performance Indicators) for voice and data services, NET CHECK's goal is to present real customer experience, as users perceive it when using a mobile communications network. Operators can earn a maximum of **1000 points**, with **350 points** for voice services and **650 points** for data services.

The network operator receives ranking points based on the measured KPI value. Each KPI can contribute a predefined number of ranking points.

**350 pts**

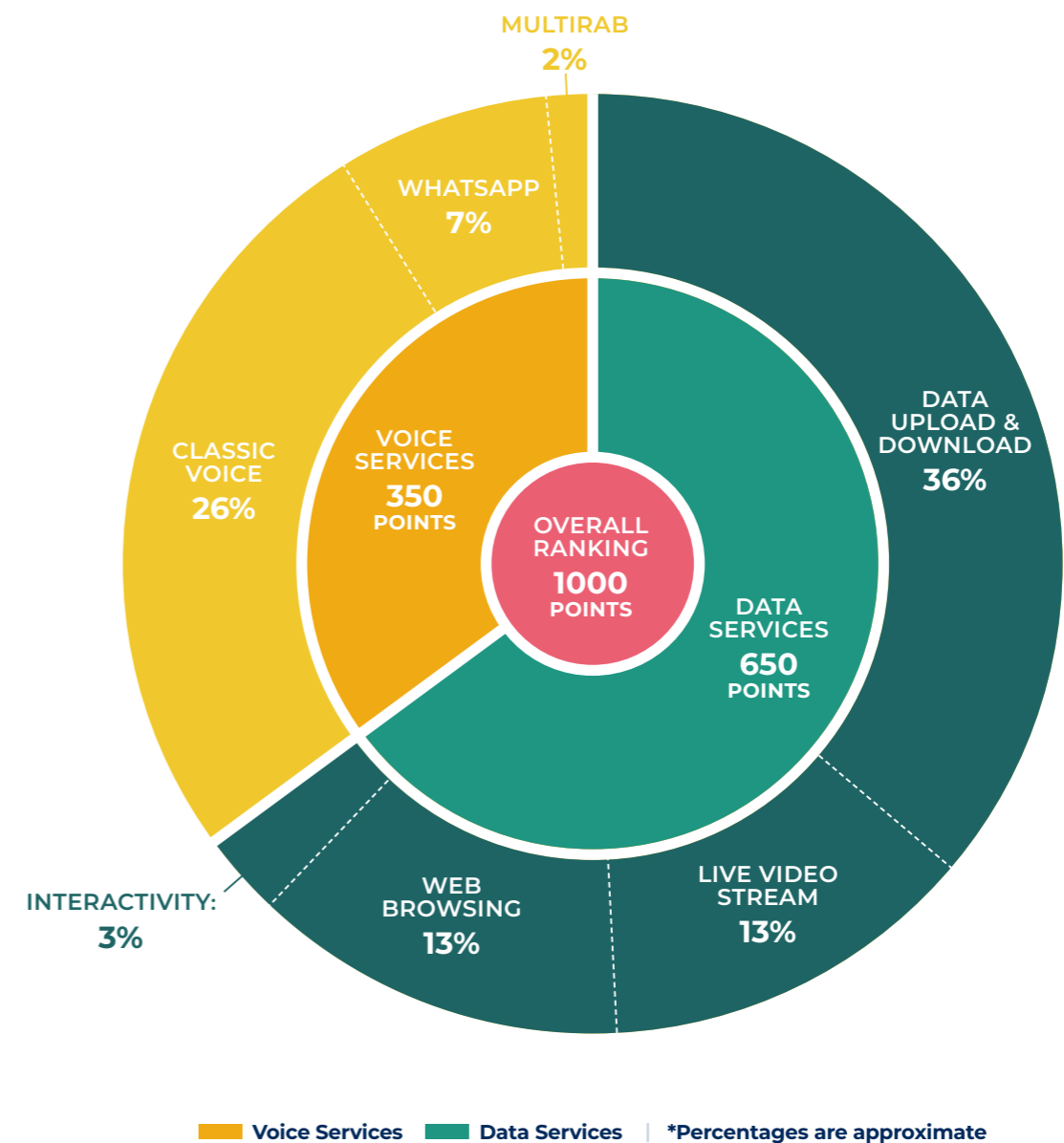
VOICE SERVICE

**650 pts**

DATA SERVICE

**1000 pts**

OVERALL RANKING POINTS



## MEASUREMENT BOUNDARIES

The measurement area conforms to the Greater London Area as defined in the administrative area of the Greater London Authority in 1965.

NET CHECK carried out tests in all **33 local government districts**, with driving and walking routes passing through all the **32 London boroughs** and the City of London. The routes and areas of interest were determined independently.

## MEASUREMENT PERIOD

The measurements were conducted between 20th of April 2023 and 2nd of May 2023.

## DISTANCE COVERED

The measurement technicians drove **20 routes** in the measurement vehicles and covered a measurement distance of **894 kilometres**.

The walk testers carried out tests at **13 different locations**, travelling for 1-3 hours around each area of interest and using public transport between the locations. They covered a distance of **120 kilometres**.



NET CHECK drive testing

**33 districts**  
**32 boroughs**

DRIVING & WALKING

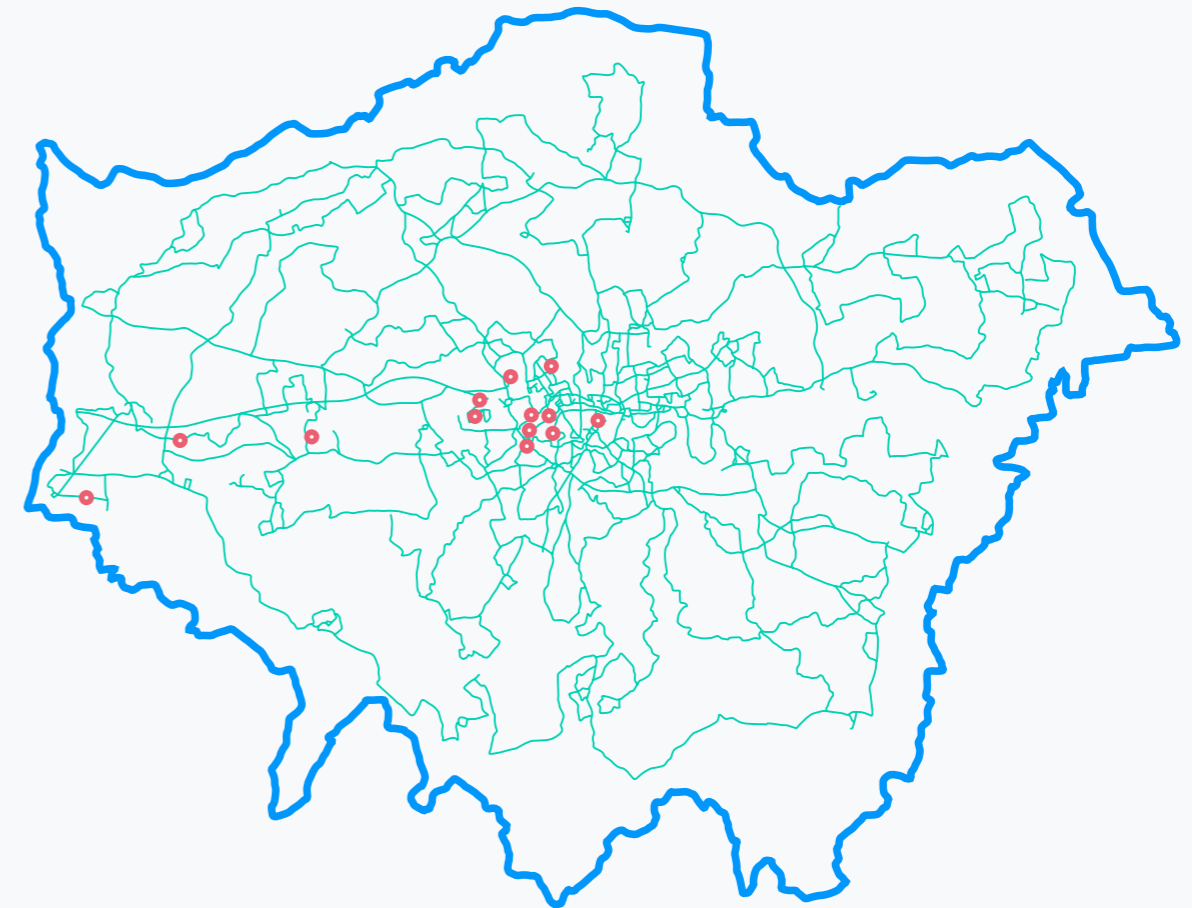
**20 routes**  
**894 kilometres**

DRIVE TESTING

**13 locations**  
**120 kilometres**

WALK TESTING

## TESTING AREA



### KEY:

- Boundary of Greater London Area
- Testing Routes
- Areas of Interest

**NET CHECK**  
attaches great  
importance  
to using high  
quality and  
state-of-the-art  
measurement  
technology  
for all tests

## MEASUREMENT EQUIPMENT

NET CHECK



### DRIVE TESTING

**Measurement equipment for drive testing:**  
*SwissQual Benchmarker II (Rohde & Schwarz)*

The measuring equipment was placed in the roof boxes of two passenger cars collecting data on the performance of voice and data services during the tests. They are cooled down to avoid overheating due to sun and extensive use.

This approach allows performance measurement for all the operators simultaneously and on the same locations.



### WALK TESTING

**Measurement equipment for walk testing:**  
*SwissQual Freerider IV (Rohde & Schwarz)*

For testing network performance in pedestrian zones and tourist areas, a Rohde & Schwarz backpack solution was used, filled with smartphones and external batteries, carried along the walking routes by a measurement engineer.

For both walk and drive testing, current models of Android mobile phones of Samsung were used.



For data services, a total of around **30,000** data samples per operator were collected. For voice services, around **2,400** test calls were made and 10 speech samples were collected in each test call, resulting in a total of around **24,000** speech samples.

## VOICE SERVICES

Voice services are tested through sequences consisting of a series of six mobile-to-mobile voice calls:

- 2 standard calls
- 3 calls during which a data download session is executed simulating internet usage during a call
- 1 WhatsApp call.

Then the sequence repeats.

## DATA SERVICES

Data services are tested through sequences consisting of:

- Web browsing on frequently visited web-pages
- Playing a YouTube video
- Network capacity tests: downloading and uploading files of given sizes or during a given time
- Interactivity tests: Simulating online gaming and online meetings.

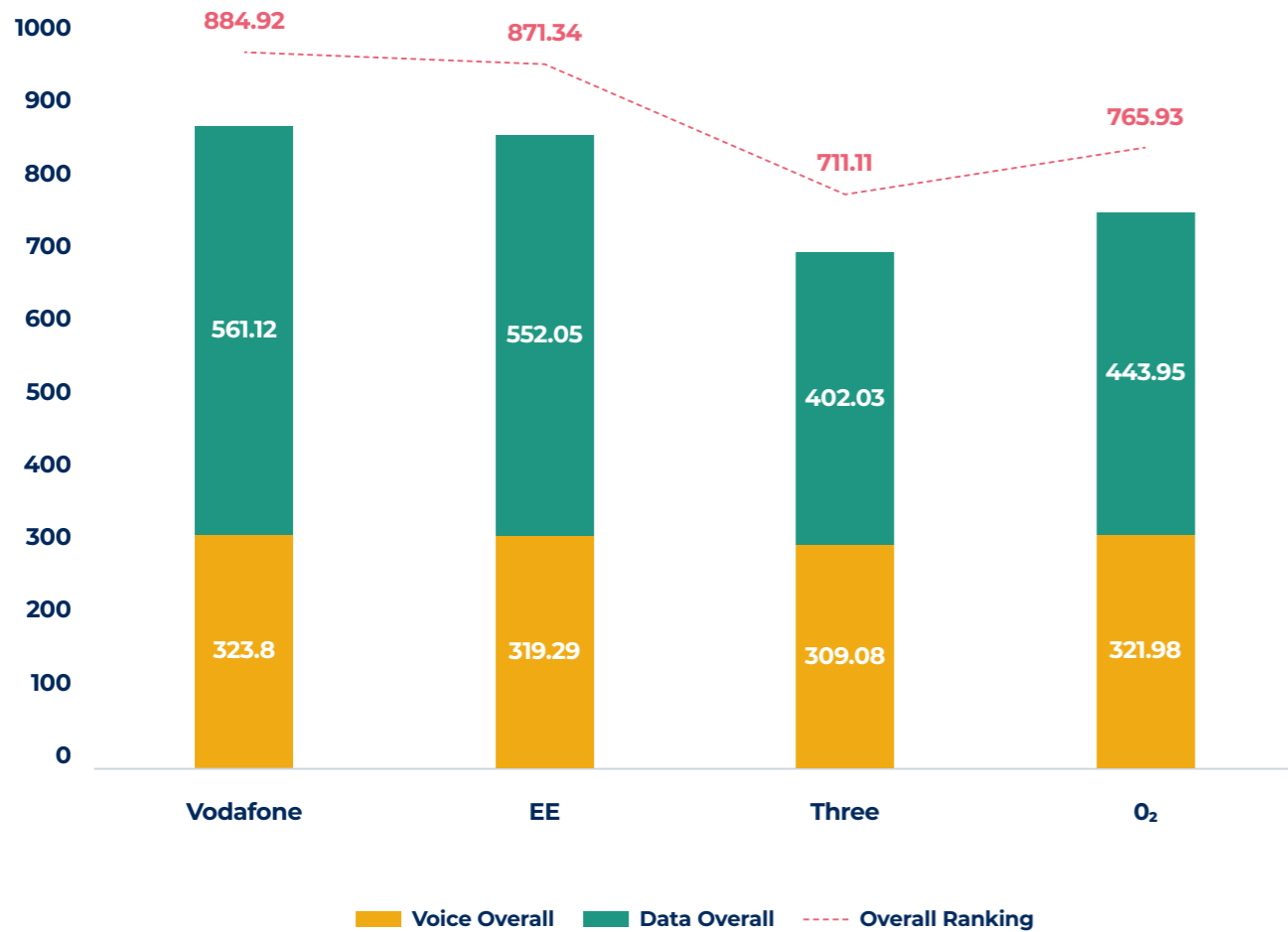
The sequence repeats during the entire measurement.

	VOICE SERVICES	DATA SERVICES
MEASUREMENT DEVICE	Samsung S21+	Samsung S22+
MEASUREMENT OBJECTIVE	Greater London Area	Greater London Area
MEASUREMENT SAMPLE	2,400 calls per operator	30,000 tests per operator
TEST CASE SCENARIO	<p>Max Call Setup Time: 30 (s)                      Call duration: 120 (s)                      Call window: 160 (s)                      Call mode: VoLTE preferred                      Speech quality: POLQA WB                      Reference File: English                      Scenario: 2 x VoLTE preferred                      + 3 x MultiRAB                      + 1 x WhatsApp call</p>	<p>YouTube 4K (livestream)                      Web Browsing, static and dynamic (Kepler as static, and dynamic based on Alexa ranking)                      Download and Upload tests:                      • HTTP time based: FDTT DL 10 (s)/ UL UDP FDTT 10 (s)                      • HTTP file based: FDFS DL/ UL (10MB/5MB)                      Online gaming and online meeting simulations</p>
	<p>-----  <b>2,400</b>                      -----                      test calls</p>	<p>-----  <b>30,000</b>                      -----                      data samples</p>

# OVERALL RESULTS

Vodafone achieved the best overall ranking result. Out of a possible 1000 points, Vodafone scored with 884.92, close behind is EE with 13.58 points less. With a difference of more than 100 points, O<sub>2</sub> and Three are in third and fourth place.

In both the voice and data categories, Vodafone achieved the highest score of all four network operators tested. In voice, Vodafone scored nearly 2 points more than the second ranked O<sub>2</sub>, and 4 points more than the third ranked EE. In the data category, Vodafone scored 9 points more than EE, which came second. The next places follow with a much larger gap, with O<sub>2</sub> in third place, 117 points behind.



OVERALL RESULTS

884.92 pts

#1: Vodafone

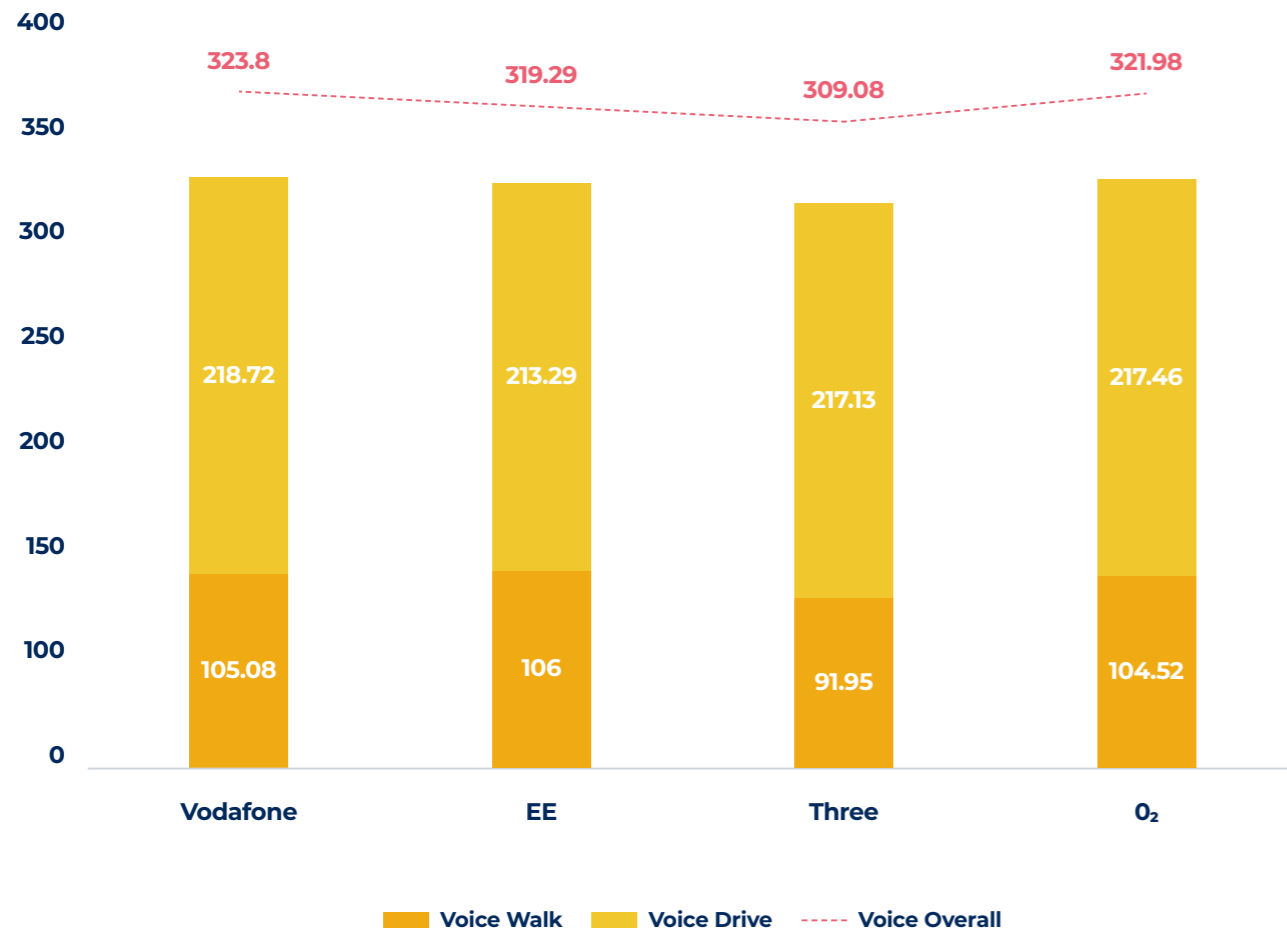


# VOICE RESULTS

In the voice services tests, Vodafone scores **323.8** points out of 350 possible ranking points for voice services, followed by O<sub>2</sub> with 321.98 and EE with 319.29 points. Three comes in fourth place with a gap of around 10 points.

If we look at the voice service results differentiated in drive and walk test, the ranking order from the drive test results resemble the overall voice results ranking.

In the walk tests, the ranking order differs slightly: EE ranks first with 0.92 points ahead of Vodafone.







VOICE RESULTS





323.8 pts

#1: Vodafone

## Voice Walk

Ranking Identifiers	 vodafone	 EE	 3	 O <sub>2</sub>
<b>CLASSIC CALLS</b>				
Call Setup Success Ratio (%)	99.00	98.99	97.57	98.79
Dropped Call Ratio (%)	0.61	0.81	1.45	0.61
Avg CST (s)	4.37	3.78	3.35	4.08
Bad CST Ratio (>= 15 s) (%)	0.20	0.00	0.41	0.20
MOS <= 1.6 RATIO (%)	0.39	0.21	1.60	0.45
POLQA AVG (MOS)	4.63	4.60	4.32	4.56
Disturbed and Impaired Call Ratio (%)	0.20	0.00	0.84	0.00
<b>WHATSAPP CALLS</b>				
Call Setup Success Ratio (%)	98.17	96.33	97.20	99.08
Dropped Call Ratio (%)	0.00	0.00	0.00	0.00
MOS <= 1.6 RATIO (%)	0.84	0.57	3.06	1.79
POLQA AVG (MOS)	4.48	4.49	4.33	4.48
Disturbed and Impaired Call Ratio (%)	0.00	0.00	5.77	0.93
<b>MULTIRAB DATA</b>				
MultiRAB Data Success Ratio (%)	100.00	99.64	98.56	100.00

## Voice Drive

Ranking Identifiers	 vodafone	 EE	 3	 O <sub>2</sub>
<b>CLASSIC CALLS</b>				
Call Setup Success Ratio (%)	99.39	99.06	99.53	99.05
Dropped Call Ratio (%)	0.07	0.68	0.27	0.14
Avg CST (s)	4.22	3.80	3.45	4.20
Bad CST Ratio (>= 15 s) (%)	0.07	0.07	0.07	0.20
MOS <= 1.6 RATIO (%)	0.33	0.56	0.43	0.38
POLQA AVG (MOS)	4.63	4.59	4.41	4.57
Disturbed and Impaired Call Ratio (%)	0.14	0.07	0.00	0.00
<b>WHATSAPP CALLS</b>				
Call Setup Success Ratio (%)	100.00	100.00	99.38	100.00
Dropped Call Ratio (%)	0.31	0.00	0.00	0.00
MOS <= 1.6 RATIO (%)	0.87	0.52	1.39	1.80
POLQA AVG (MOS)	4.50	4.53	4.40	4.46
Disturbed and Impaired Call Ratio (%)	0.31	0.00	0.31	0.00
<b>MULTIRAB DATA</b>				
MultiRAB Data Success Ratio (%)	99.41	99.53	99.07	99.88

# DATA RESULTS

In the data services tests, Vodafone scores **561.12 points out of 650 possible ranking points for data services, followed by EE with 552.05. O<sub>2</sub> with 443.95 and Three with 402.03 points follow at a greater distance.**

If we look at the data service results differentiated in drive and walk test, distribution across walk and drive test results resembles that of the voice results, only a bit accentuated: Vodafone takes the lead in the drive tests, while in walk EE comes first.

Three achieves a safe third place in the drive tests with 348.21 points but falls back to fourth place with only 53.82 points in the walk tests, while O<sub>2</sub> performs better in the walk tests with 133.84 points and a fourth place in the drive tests.



DATA RESULTS

561.12 pts

#1: Vodafone

## Data Walk

Ranking Identifiers	 vodafone	 EE	 3	 O <sub>2</sub>
<b>DOWNLOAD (File Size 10MB)</b>				
FDFS DL Success Ratio (%)	97.92	98.43	73.37	97.31
<b>UPLOAD (File Size 5MB)</b>				
FDFS UL Success Ratio (%)	97.15	98.64	84.79	92.92
<b>DOWNLOAD (Test Duration 10 seconds)</b>				
FDTT DL 10 PCTL Data Rate (Mbit/s)	14.693	14.750	0.530	5.707
FDTT DL Average Data Rate (Mbit/s)	114.170	114.125	64.079	51.321
FDTT DL 90 PCTL Data Rate (Mbit/s)	252.199	258.835	180.049	128.000
<b>UPLOAD (Test Duration 10 seconds)</b>				
FDTT UL 10 PCTL Data Rate (Mbit/s)	3.718	5.563	1.585	1.801
FDTT UL Average Data Rate (Mbit/s)	26.003	23.860	13.873	11.536
FDTT UL 90 PCTL Data Rate (Mbit/s)	56.704	49.106	29.406	25.456
<b>BROWSING (Web Browsing)</b>				
HTTP Browsing 1MB Reached Time Average (ms)	1594.8	1747.9	2789.8	1851.9
HTTP Browsing Success Ratio (%)	98.38	99.19	88.61	97.36
<b>VIDEO STREAM (YouTube live stream 4k)</b>				
Video Stream Success Ratio (%)	97.75	97.62	81.17	97.56
TTFP >= 10 s Ratio (%)	0.19	0.20	1.51	1.04
Video Stream Irritating Experience Ratio (%)	0.96	1.22	5.42	1.88
<b>INTERACTIVITY KPIS</b>				
Interactivity Packet Error Ratio (%)	5.54	5.10	16.21	9.89
Interactivity Median RTT (ms)	41	35	42	43

## Data Drive

Ranking Identifiers	 vodafone	 EE	 3	 O <sub>2</sub>
<b>DOWNLOAD (File Size 10MB)</b>				
FDFS DL Success Ratio (%)	99.61	98.90	97.08	97.20
<b>UPLOAD (File Size 5MB)</b>				
FDFS UL Success Ratio (%)	98.95	98.44	97.25	95.24
<b>DOWNLOAD (Test Duration 10 seconds)</b>				
FDTT DL 10 PCTL Data Rate (Mbit/s)	27.361	21.504	10.314	7.730
FDTT DL Average Data Rate (Mbit/s)	167.916	211.634	225.958	83.982
FDTT DL 90 PCTL Data Rate (Mbit/s)	347.575	449.646	560.224	205.665
<b>UPLOAD (Test Duration 10 seconds)</b>				
FDTT UL 10 PCTL Data Rate (Mbit/s)	7.945	7.289	3.858	3.818
FDTT UL Average Data Rate (Mbit/s)	37.847	32.843	33.527	20.050
FDTT UL 90 PCTL Data Rate (Mbit/s)	73.975	64.244	82.786	38.556
<b>BROWSING (Web Browsing)</b>				
HTTP Browsing 1MB Reached Time Average (ms)	1387.3	1794.2	1671.6	1728.4
HTTP Browsing Success Ratio (%)	99.33	99.08	98.33	97.90
<b>VIDEO STREAM (YouTube Live Stream 4k)</b>				
Video Stream Success Ratio (%)	99.50	98.91	97.28	97.58
TTFP >= 10 s Ratio (%)	0.00	0.17	0.54	0.42
Video Stream Irritating Experience Ratio (%)	0.28	0.99	1.49	1.57
<b>INTERACTIVITY KPIS</b>				
Interactivity Packet Error Ratio (%)	3.54	5.06	7.79	7.35
Interactivity Median RTT (ms)	37	33	32	40

# KPI DESCRIPTION

What we measured:

Ranking Identifiers	
<b>CLASSIC CALLS</b>	
Call Setup Success Ratio	Percentage of successfully established calls
Dropped Call Ratio	Percentage of dropped calls
Avg Call Setup Time	Average time to establish a call
Call Setup Time >= 15 s Ratio	Percentage of successfully established calls, where call establishment takes more than 15 seconds
POLQA <= 1.6 RATIO	Percentage of speech samples where the voice signal quality (MOS) is lower than 1.6
POLQA AVG (MOS)	The average value of the voice signal quality (MOS)
Disturbed Call Ratio	Call flow where for three or more consecutive samples (out of a total of ten) for speech quality measurement, the quality is less than 1.6
Impaired Call Ratio	Call flow where for five samples (out of a total of ten) for measuring speech quality, the quality is less than 1.6
<b>WHATSAPP CALLS</b>	
Call Setup Success Ratio	Percentage of successfully established calls
Dropped Call Ratio	Percentage of dropped calls
POLQA <= 1.6 Ratio	Percentage of speech samples where the voice signal quality (MOS) is lower than 1.6
POLQA AVG (MOS)	The average value of the voice signal quality (MOS)
Disturbed Call Ratio	Call flow where for three or more consecutive samples (out of a total of ten) for speech quality measurement, the quality is less than 1.6
Impaired Call Ratio	Call flow where for five samples (out of a total of ten) for measuring speech quality, the quality is less than 1.6
<b>MULTIRAB DATA</b>	
MultiRAB Data Success Ratio	The percentage of successfully completed data transfers during the duration of the voice service

Ranking Identifiers	
<b>DOWNLOAD (File Size 10MB)</b>	
HTTP Transfer FDFS DL Success Ratio	Percentage of successfully completed data download transfer tests
<b>UPLOAD (File Size 5MB)</b>	
HTTP Transfer FDFS UL Success Ratio	Percentage of successfully completed data upload transfer tests
<b>DOWNLOAD (Test Duration 10 seconds)</b>	
HTTP Transfer FDTT DL MDR P10	10% of total measured tests slower than (MB)
HTTP Transfer FDTT DL MDR AVG	Average file download speed (MB)
HTTP Transfer FDTT DL MDR P90	90% of total measured tests slower than (MB)
<b>UPLOAD (Test Duration 10 seconds)</b>	
UDP FDTT UL MDR P10	10% of total measured tests slower than (MB)
UDP FDTT UL FDTT DL MDR AVG	Average file upload speed (MB)
UDP FDTT UL FDTT DL MDR P90	90% of total measured tests slower than (MB)
<b>BROWSING (Web Browsing)</b>	
HTTP Browsing Time To 1MB	The time required to open a 1MB page
HTTP Browsing Success Ratio	Percentage of successfully completed web browsing tests
<b>VIDEO STREAM (YouTube Live Stream 4k)</b>	
Video Stream Success Ratio	Percentage of successfully completed video streaming tests
Video Stream TTFP >= 10 s Ratio	Percentage of tests where the video started after ten seconds or more
Video Stream Irritating Experience Ratio	Percentage of tests with significantly reduced quality of video transmission

## OUR CONCLUSION

Measurements of voice and data services of the UK mobile operators have shown that the overall performance is good and at level with the other European network operators.

In the measurements across the administrative area of Greater London, Vodafone UK achieved the best overall ranking result with notably better results in the drive tests.

In the walk tests, EE obtained most points but only enough to make the gap to the overall winner smaller.

**The people  
of Greater  
London  
can count  
on mobile  
networks  
with very  
good overall  
performances**

# LONDON'S BEST MOBILE NETWORK

## NET CHECK

### **NET CHECK GmbH**

Ella-Barowsky-Straße 45-47  
10829 Berlin  
Germany

**T** +49 (0) 30 303080-600

**F** +49 (0) 30 303080-668

**E** [info@netcheck.de](mailto:info@netcheck.de)

[nc-group.net/en/net-check](https://nc-group.net/en/net-check)