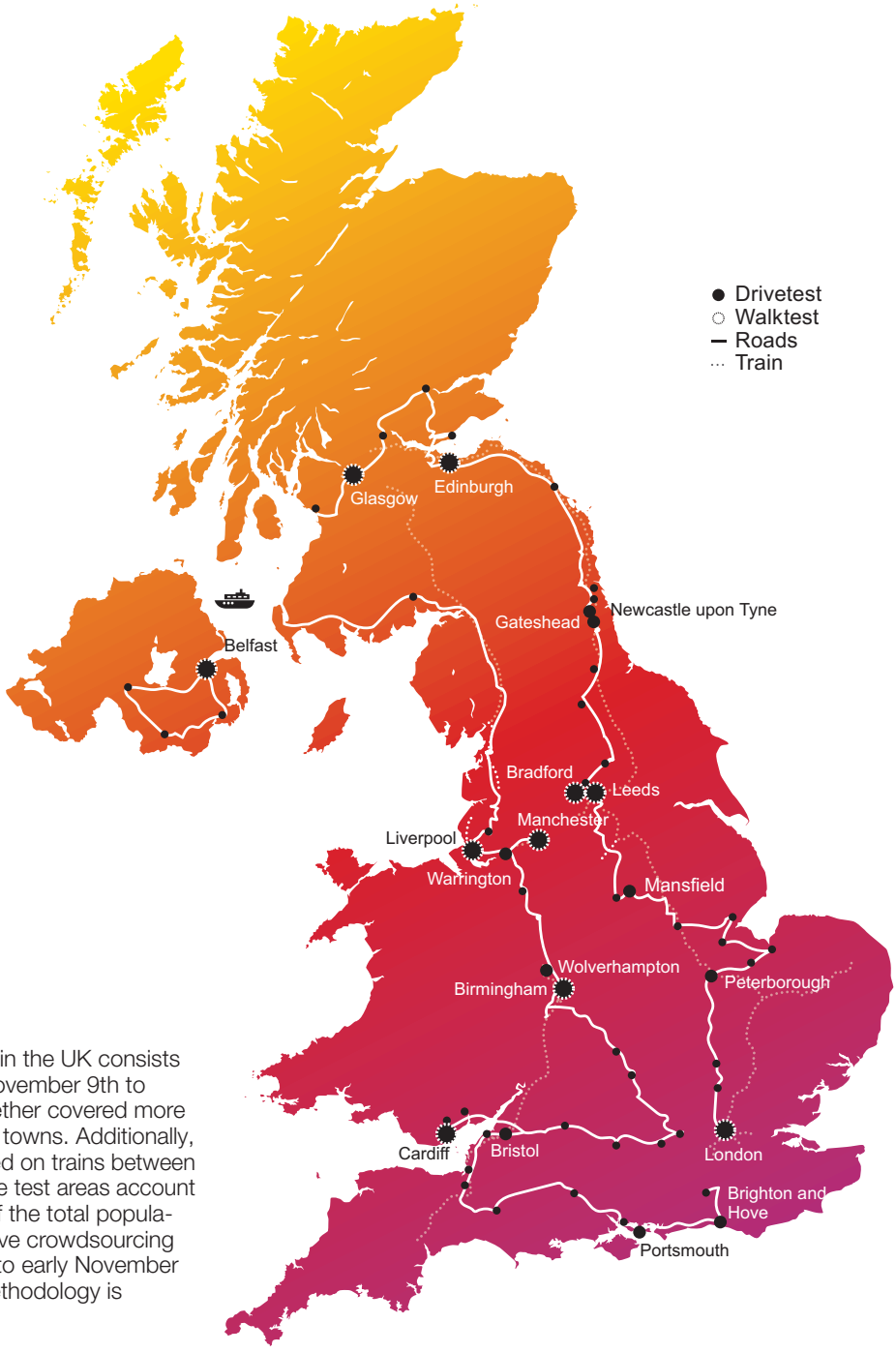
connect business

The 2023 Mobile Network Test in the United Kingdom

umlaut Part of Accenture

For the eighth time, we – umlaut, part of Accenture, and connect – have conducted our comprehensive benchmark of the UK's mobile networks. Its results show a clear winner, two contenders ranking in the good mid-field, and one runner-up with the grade satisfactory.

The carefully designed methodology of our 2023 benchmark in the United Kingdom represents a holistic approach to network benchmarking. It combines drive tests and walk tests for executing detailed voice and data measurements under controlled circumstances combined with a sophisticated crowdsourcing methodology. The drive tests and walk tests allow for the maximum capabilities of the networks to be evaluated. Crowdsourcing provides profound insights into the overall coverage of voice, data and 5G services as well as realworld User Download Speeds and Latencies.
We have thoroughly weighed these components in order to give a realistic and conclusive assessment of the rated networks' true potential and performance.



Scope

The 2023 umlaut connect Mobile Network Test in the UK consists of drive tests and walk tests conducted from November 9th to November 26th, 2022. Four drive test cars together covered more than 10,000 kilometres, visiting 19 cities and 40 towns. Additionally, two walk test teams visited ten cities and travelled on trains between them as well as to more remote destinations. The test areas account for 17.4 million people, or approx. 26 percent of the total population of the UK. In addition, the results of extensive crowdsourcing analyses, considering 24 weeks from mid-May to early November 2022 are included in the score. Our detailed methodology is described on pages 11/12.

DRIVE TEST AND WALK TEST FACTS

17.37 million people covered	**10,380** km drive test	**204,767** data samples	**30,758** voice samples

CROWDSOURCING FACTS

2626 million samples	**24** weeks (mid-May to early November 2022)	**99.3%** of built-up area covered	**99.8%** of population covered

The UK Mobile Operators

With almost 32 million mobile subscribers, O2 is the largest mobile network operator. Formerly a subsidiary of British Telecom, O2 plc was purchased by the Spanish telecommunications company Telefónica in 2006. In 2021, O2 entered a 50:50 joint venture with Liberty Global, combining Liberty's brand Virgin Media and O2. The joint company also owns half of the mobile virtual network operator Tesco Mobile which operates on the O2 network in the UK. The operators claim to cover approx. 99 percent of the UK population with 4G. Like the other UK operators, O2 is supporting Voice over LTE (VoLTE) in most of its 4G network. O2 is also continuously rolling out 5G, using its 3500 and 700 MHz spectrum for 5GNR. In late 2022, the company claimed to be live with 5G in around 750 towns and cities, targeting to cover 50 percent of the UK's population with 5G in 2023.

With approximately 26 million customers, EE (formerly Everything Everywhere) is the second largest mobile network operator in the UK. Since 2016, EE has been part of the British Telecom Group. EE started offering its 4G service in 2012. Regarding 4G/LTE coverage, EE reports geographic coverage instead of population coverage. They quote Ofcom reporting an 85 per cent 4G geographic coverage which equates to more than 99 percent of the population. EE operates a growing number of "4G+" cells that support up to 5CA (five carrier frequencies) with up to 1 Gbps under the name "4GEE". Voice over LTE (VoLTE) is available in most of its 4G network.
BT with its brand EE claims to offer 5G in more cities and towns than any other operator in the UK. They announced to cover half of the UK population by early 2023 and the "entire" UK by 2028.

Vodafone UK is part of the international Vodafone Group which is also headquartered in the UK. The Vodafone Group owns and operates networks in 22 countries, with partner networks in 48 further ones. Vodafone UK launched 4G/LTE in 2013. With around 17 million mobile subscribers, Vodafone is the third largest mobile network in the UK.
In June 2012, Vodafone and O2 signed a deal to "pool" their network technologies, creating a single national grid of 18,500 transmitter sites. Both operators however announced they would continue to use their own independent spectrum. Vodafone claims to cover more than 99 percent of the UK population with 4G/LTE offering up to 1 Gbps – as well as Voice over LTE (VoLTE). At the end of 2022, Vodafone UK reports 5G coveage in 124 UK cities and towns and announced a further speed up of its 5G rollout during 2023.

Three UK is a subsidiary of CK Hutchison and launched its mobile service in the UK in 2003. As a relatively young operator Three started as a 3G-only network supplemented by 2G via national roaming. In December 2013, Three began to roll out its 4G/LTE service and expanded it rapidly all over the UK. With about 10.3 million customers, Three is the smallest mobile network operator in the UK. The company claims to cover more than 99 percent of the UK's population with 3G or 4G. Voice over LTE (VoLTE) is available in most of its network. According to the company, "Three's customers use 3.5x more data than the average Brit" – competitive pricing and the availability of unlimited data tariffs will certainly play a part in this.
The operator claims to offer more spectrum for its 5G service than any other UK network operator. From 66 towns and cities in February 2020, Three has continuously extended its 5G network coverage.

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Results at a Glance

As in the previous years, the BT brand is the winner, this time scoring more than 100 points ahead of the second-ranking Vodafone and achieving the grade "very good" as the only candidate in this comparison. EE's lead is manifested in all three test categories, Voice, Data and Crowdsourcing. Also, compared to our previous Mobile Network Test in the UK in 2021, EE managed to improve its score by 14 points.

Vodafone reaches a good second place, scoring particularly strong in the voice tests. This operator showed the best voice performance in the walktest scenarios, as well as achieving the best reliability and the best voice results in London. Nationwide in the voice tests, Vodafone scored on a par with EE. For an even better score, Vodafone should particulary concentrate on the data download scenarios.

Three achieves a good third rank, not too far behind the second-placed Vodafone. Particularly in the Data and Crowdsourcing results, these contenders score very closely together. In comparison to our previous Mobile Network Test in the UK in 2021, Three achieved the biggest score improvement with an advance of 17 score points. In our single city assessments, Three is the local champion in Liverpool.

The UK's largest provider ranks fourth with the overall grade "satisfactory". It scores on a comparable level in the Crowdsourcing discipline, but loses valuable points both in the voice as well as the data tests. In general, O2 shows a good voice reliability as well as a high level of MultiRAB connectivity in the drive tests performed in the cities, towns and on the roads.

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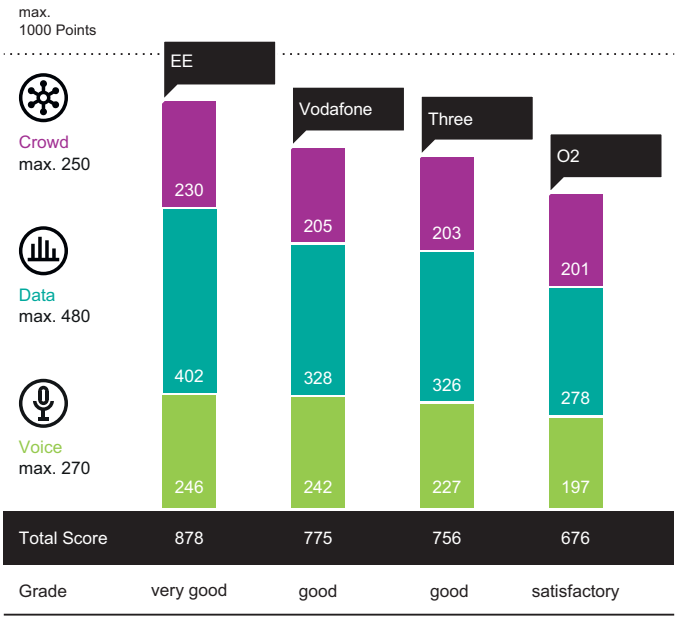
BEST IN TEST
EE
12/2022
MOBILE NETWORK TEST UNITED KINGDOM
www.connect-testlab.com

"Congratulations to British Telecom for its brand EE winning our Mobile Network Test in the UK with convincing results in all test disciplines. Vodafone shows good results particularly in the Voice reliability across the country, and Three manages to achieve the highest score improvement compared to our previous test. O2 shows its best results in the crowdsourcing."
Hakan Ekmen, CEO Telecommunication at umlaut, part of Accenture

Overall Results		EE	Vodafone	Three	O2
Voice	max. 270.00 P.	246	242	227	197
Cities (Drivetest)	121.50	94%	91%	88%	76%
Cities (Walktest)	40.50	94%	97%	95%	73%
Towns (Drivetest)	54.00	94%	91%	83%	81%
Roads (Drivetest)	33.75	91%	86%	83%	74%
Railways (Walktest)	20.25	64%	68%	42%	34%
Data	max. 480.00 P.	402	328	326	278
Cities (Drivetest)	216.00	86%	74%	73%	62%
Cities (Walktest)	72.00	85%	74%	71%	61%
Towns (Drivetest)	96.00	82%	63%	62%	52%
Roads (Drivetest)	60.00	89%	66%	69%	60%
Railways (Walktest)	36.00	63%	41%	45%	40%
Crowd	max. 250.00 P.	230	205	203	201
Crowd	250.00	92%	82%	81%	80%
Connect Rating	max. 1000 P.	878	775	756	676

Percentages and points rounded to integer numbers.
For the calculation of points and totals, the accurate, unrounded values were used.



Shown voice, data, crowd and total scores are rounded.

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Voice

EE LEADS IN BIG CITIES VOICE DRIVETESTS

In the voice tests, conducted by umlaut's test cars while driving in the UK's big cities, EE takes the overall lead. Vodafone follows at close distance and is ahead in this category in some cities such as London, Manchester, Liverpool or Leed (see page 10). Three achieves the shortest call setup times in the cities. In terms of speech quality, EE and Vodafone are ahead of Three and O2.

CITIES DRIVETEST

EE

VODAFONE AHEAD IN VOICE IN BIG CITIES WALKTESTS

In the walktests, conducted in Belfast, Birmingham, Bradford, Cardiff, Edinburgh, Glasgow, Leeds, Liverpool, London and Manchester, in the overall assessment Vodafone achieves the highest score. Three follows on second place and EE on third, both ranking very close together. Three shows the highest call reliability in the cities walk test. In this category, O2 scores behind by a more distinct margin.

CITIES WALKTEST

VODAFONE

EE ALSO AHEAD IN SMALLER TOWN VOICE DRIVETESTS

In the voice tests conducted by umlaut's test cars while visiting 40 smaller towns of the UK (see route map on page 1), EE takes the lead and – as in the cities – shows the highest call reliability. Also, in the towns, EE provides the shortest call setup times. Three and O2 follow at some distance, but close together. O2 scores better in this scenario than in the other voice scenarios.

TOWNS DRIVETEST

EE

EE SCORING BEST IN VOICE TESTS ON ROADS

On the voice tests performed while driving on British roads, EE scores best, with Vodafone and Three showing stable mid-field results. In this scenario, O2 shows the best MultiRAB connectivity behind EE, albeit at a narrow margin ahead of Vodafone and Three. Users benefit from this because apps then still have access to a data connection during phone calls.

ROADS DRIVETEST

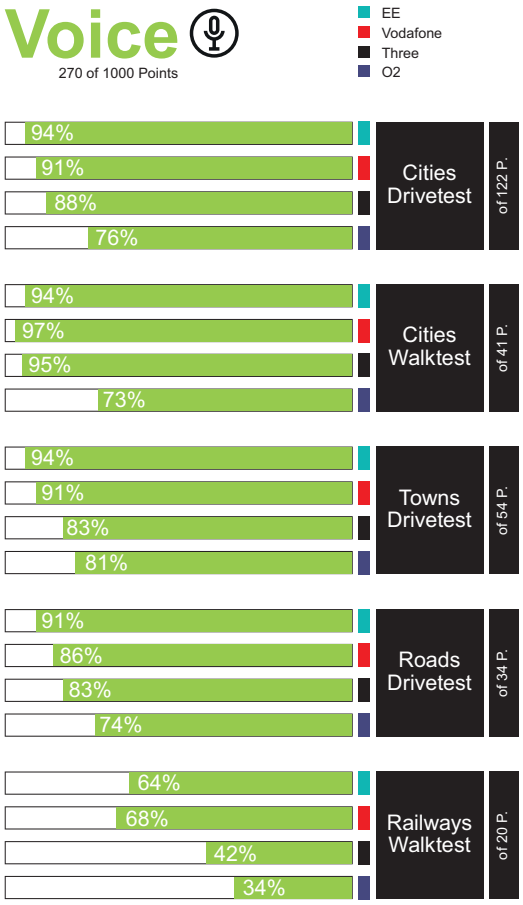
EE

VODAFONE SCORES AHEAD OF EE IN VOICE TESTS PERFORMED ON RAILWAYS

In the voice tests performed by the test teams while travelling in trains through the UK, all operators fall clearly behind their scores in the other scenarios. Here, Vodafone takes the lead, ahead of EE. The distance of Three and O2 in terms of scoring is pronouncedly more distinct in the railway scenario compared to the other ones.

RAILWAYS WALKTEST

VODAFONE



Operator	EE	Vodafone	Three	O2
Cities (Drivetest)				
Sucess Ratio (%)	99.4	99.1	98.6	98.6
Call Setup Time P90 (s)	2.0	2.1	1.9	4.4
Speech Quality P10 (MOS-LQO)	4.2	4.1	3.9	3.6
Multirab Connectivity (%)	99.6	98.9	99.2	99.3
Towns (Drivetest)				
Sucess Ratio (%)	99.4	99.2	97.9	99.0
Call Setup Time P90 (s)	2.0	2.2	2.1	3.7
Speech Quality P10 (MOS-LQO)	4.2	3.9	3.7	3.5
Multirab Connectivity (%)	99.9	99.5	99.7	98.9
Roads (Drivetest)				
Sucess Ratio (%)	98.2	98.3	96.6	97.6
Call Setup Time P90 (s)	2.1	2.7	2.3	4.4
Speech Quality P10 (MOS-LQO)	4.0	3.5	3.5	3.3
Multirab Connectivity (%)	99.5	98.5	98.5	98.6
Cities (Walktest)				
Sucess Ratio (%)	99.4	99.7	99.9	98.5
Call Setup Time P90 (s)	1.8	1.9	1.5	4.5
Speech Quality P10 (MOS-LQO)	4.2	4.3	4.0	3.6
Multirab Connectivity (%)	98.5	99.9	98.3	97.5
Railways (Walktest)				
Sucess Ratio (%)	90.4	94.0	84.4	87.5
Call Setup Time P90 (s)	2.4	3.1	2.5	5.1
Speech Quality P10 (MOS-LQO)	3.6	3.3	3.3	2.9
Multirab Connectivity (%)	97.9	95.0	96.3	94.0

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Data

EE AHEAD IN BIG CITIES DATA DRIVETESTS

In the data drivetests conducted in big UK cities, EE clearly takes the lead. Vodafone and Three follow at a distinct gap in mid-field, ranking closely together. O2 follows at a wider gap. In a more detailed analysis, EE benefits from using 5CA (carrier aggregation), which this operator utilizes above 35 percent in the cities. This can be seen for example in the results of live web-browsing or the playback of Youtube videos.

CITIES DRIVETEST

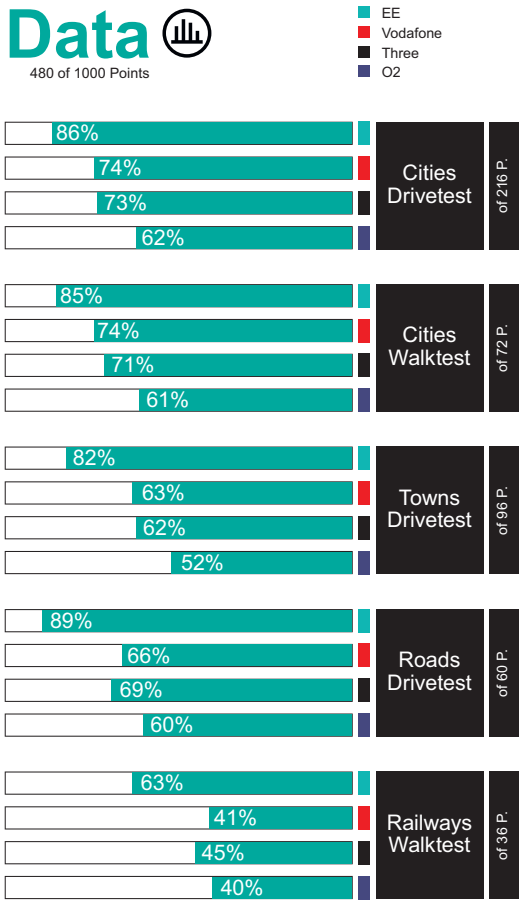
EE

EE ALSO LEADS IN BIG CITIES DATA WALKTESTS

The results of the data drive tests are confirmed by the data walktests conducted in the UK's bigger cities. EE again leads the field, Vodafone ranks second – in this category at a minimally wider gap to Three. O2 again takes last place. The latter shows particular room for improvement in the YouTube tests, but ranks second in gaming interactivity behind EE.

CITIES WALKTEST

EE



Data Cities (Drivetest)	EE	Vodafone	Three	O2
Web-Page Download				
Success Ratio/Avg. Session Time (%/s)	99.3/1.6	98.6/2.2	98.3/2.0	97.0/2.0
File Download (10 MB)				
Success Ratio/Avg. Session Time (%/s)	99.8/2.3	97.8/8.0	99.7/4.9	99.0/5.8
90%/10% faster than (Mbps)	21.9/155.9	3.4/118.6	7.0/200.4	5.9/130.1
File Upload (5 MB)				
Success Ratio/Avg. Session Time (%/s)	99.4/4.6	99.1/5.2	99.4/6.4	98.4/8.3
90%/10% faster than (Mbps)	4.2/41.5	3.7/38.1	2.9/54.3	2.1/29.0
File Download (7 Seconds)				
Sucess Ratio (%)	99.1	99.3	98.8	98.6
10% faster than (Mbps)	388.9	211.7	530.8	203.3
Speed > 20Mbps / 100Mbps (%)	93.7/65.5	81.9/32.5	82.7/50.9	76.8/33.8
File Upload (7 Seconds)				
Sucess Ratio (%)	98.3	98.7	97.5	95.4
10% faster than (Mbps)	58.4	56.2	73.3	33.3
Speed > 2Mbps / 5Mbps (%)	96.5/88.8	96.6/87.6	93.8/80.6	88.9/73.7
Youtube				
Success Ratio/Start Time (%/s)	98.2/2.2	97.5/2.6	93.8/2.5	90.4/3.3
Time to Full Resolution (s)	9.3	9.9	9.5	9.2
Youtube live				
Success Ratio/Start Time (%/s)	96.3/3.8	96.4/4.2	93.3/3.9	88.9/3.9
Time to Full Resolution (s)	7.8	8.2	8.0	7.9
Youtube 4K Smartphone				
Success Ratio/Start Time (%/s)	96.0/2.6	92.2/2.7	87.5/2.8	84.4/3.5
Time to Full Resolution (s)	8.7	10.6	9.2	9.1
Conversational-App				
Sucess Ratio (%)	99.9	99.7	99.8	99.4
Speech Quality P10 (MOS-LQO)	3.5	2.8	2.8	2.9
Interactivity e-Gaming				
Interactivity e-Gaming (%)	70.0	40.7	54.9	57.3

Data Cities (Walktest)	EE	Vodafone	Three	O2
Web-Page Download				
Success Ratio/Avg. Session Time (%/s)	98.4/1.5	99.4/2.2	97.8/2.1	97.3/2.1
File Download (10 MB)				
Success Ratio/Avg. Session Time (%/s)	99.7/2.6	96.6/7.0	99.5/6.4	99.1/6.9
90%/10% faster than (Mbps)	18.3/153.8	4.1/119.9	4.5/208.0	5.3/124.1
File Upload (5 MB)				
Success Ratio/Avg. Session Time (%/s)	99.5/4.9	98.2/5.1	99.5/6.3	98.4/7.8
90%/10% faster than (Mbps)	4.1/42.1	4.1/42.9	3.1/51.9	2.1/26.9
File Download (7 Seconds)				
Sucess Ratio (%)	99.7	99.3	99.0	97.6
10% faster than (Mbps)	396.7	259.3	466.5	208.8
Speed > 20Mbps / 100Mbps (%)	91.2/62.2	80.9/39.8	77.3/47.1	76.6/35.9
File Upload (7 Seconds)				
Sucess Ratio (%)	98.0	99.0	97.4	94.7
10% faster than (Mbps)	60.1	64.7	75.1	32.7
Speed > 2Mbps / 5Mbps (%)	97.8/90.7	96.1/89.2	94.3/80.5	89.6/72.7
Youtube				
Success Ratio/Start Time (%/s)	98.2/2.2	95.7/2.6	93.2/2.5	90.9/3.4
Time to Full Resolution (s)	9.2	9.9	9.5	9.5
Youtube live				
Success Ratio/Start Time (%/s)	96.5/3.8	97.4/4.0	92.9/3.9	90.2/4.0
Time to Full Resolution (s)	7.8	8.0	7.8	8.0
Youtube 4K Smartphone				
Success Ratio/Start Time (%/s)	94.1/2.6	90.1/2.8	87.7/2.5	83.2/3.3
Time to Full Resolution (s)	8.3	10.5	9.5	9.5
Conversational-App				
Sucess Ratio (%)	99.9	100.0	100.0	100.0
Speech Quality P10 (MOS-LQO)	3.7	3.1	3.6	3.6
Interactivity e-Gaming				
Interactivity e-Gaming (%)	69.4	38.4	55.4	57.0

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Data

EE ALSO LEADS IN DATA DRIVETESTS IN TOWNS

The lead of EE in the data drivetests becomes even more pronounced when it comes to the visited smaller towns. Here, the gap to the rest of the field is wider than in the bigger cities. Vodafone and Three score very close together in this assessment, while O2 falls behind even more distinctly. This ranking can be seen particularly clearly in the upload categories.

TOWNS DRIVETEST

EE

EE AHEAD IN DATA DRIVETESTS ON THE UK'S ROADS

The data tests performed by our test cars on the UK's roads are of particular interest for motorists. In this category, EE once again leads the field, but Three advances to second place. Vodafone and O2 follow at a smaller gap compared to the smaller towns, which is good news to car drivers subscribed to their services.

ROADS DRIVETEST

EE

Photo: JeniFoto, shutterstock

Data Towns (Drivetest)	EE	Vodafone	Three	O2
Web-Page Download				
Success Ratio/Avg. Session Time (%/s)	99.0/1.7	98.1/2.3	97.0/2.3	95.4/2.3
File Download (10 MB)				
Success Ratio/Avg. Session Time (%/s)	99.5/3.2	98.2/10.3	99.3/6.7	97.4/12.1
90%/10% faster than (Mbps)	14.0/105.7	2.9/66.4	5.3/146.7	2.7/54.4
File Upload (5 MB)				
Success Ratio/Avg. Session Time (%/s)	99.4/5.0	98.9/7.0	98.6/9.0	98.5/8.6
90%/10% faster than (Mbps)	3.6/38.7	2.8/26.3	1.8/31.6	2.1/23.4
File Download (7 Seconds)				
Sucess Ratio (%)	99.2	99.3	97.5	96.3
10% faster than (Mbps)	200.4	90.2	351.7	62.5
Speed > 20Mbps / 100Mbps (%)	85.4/36.7	55.8/8.4	69.5/23.7	43.2/3.5
File Upload (7 Seconds)				
Sucess Ratio (%)	98.2	98.3	96.5	95.8
10% faster than (Mbps)	54.9	35.2	38.0	25.9
Speed > 2Mbps / 5Mbps (%)	95.6/85.3	93.5/79.3	87.2/66.1	87.8/69.1
Youtube				
Success Ratio/Start Time (%/s)	97.1/2.3	91.8/2.6	91.8/2.5	86.4/3.2
Time to Full Resolution (s)	9.4	9.9	9.6	9.7
Youtube live				
Success Ratio/Start Time (%/s)	98.1/4.0	92.9/4.2	94.7/4.0	82.9/4.0
Time to Full Resolution (s)	7.8	8.3	8.0	7.8
Youtube 4K Smartphone				
Success Ratio/Start Time (%/s)	95.6/2.5	84.2/2.6	81.9/2.7	70.4/3.0
Time to Full Resolution (s)	9.6	11.0	9.8	10.0
Conversational-App				
Sucess Ratio (%)	100.0	100.0	100.0	99.7
Speech Quality P10 (MOS-LQO)	3.4	3.2	2.7	3.1
Interactivity e-Gaming				
Interactivity e-Gaming (%)	66.7	37.5	51.1	56.5

Data Roads (Drivetest)	EE	Vodafone	Three	O2
Web-Page Download				
Success Ratio/Avg. Session Time (%/s)	99.3/1.6	96.3/2.5	96.4/2.4	93.4/2.4
File Download (10 MB)				
Success Ratio/Avg. Session Time (%/s)	99.6/3.2	96.3/12.9	99.0/7.6	99.5/12.2
90%/10% faster than (Mbps)	13.6/99.9	2.4/51.5	5.1/74.1	2.9/44.9
File Upload (5 MB)				
Success Ratio/Avg. Session Time (%/s)	99.5/4.7	98.6/8.7	98.2/9.1	97.9/9.2
90%/10% faster than (Mbps)	4.0/38.9	2.4/22.9	1.8/30.7	1.9/23.0
File Download (7 Seconds)				
Sucess Ratio (%)	98.4	96.6	98.4	96.7
10% faster than (Mbps)	144.3	69.0	115.9	42.1
Speed > 20Mbps / 100Mbps (%)	86.7/25.3	44.7/5.8	62.0/12.8	30.1/1.2
File Upload (7 Seconds)				
Sucess Ratio (%)	98.6	96.2	92.2	94.4
10% faster than (Mbps)	58.0	28.7	35.8	23.3
Speed > 2Mbps / 5Mbps (%)	95.7/86.1	91.1/74.9	86.8/66.2	84.8/64.8
Youtube				
Success Ratio/Start Time (%/s)	97.8/2.3	86.8/2.6	91.8/2.6	79.6/3.4
Time to Full Resolution (s)	9.4	9.7	9.5	9.4
Youtube live				
Success Ratio/Start Time (%/s)	96.1/3.8	91.2/4.2	90.2/4.1	84.3/4.1
Time to Full Resolution (s)	7.9	8.1	8.1	8.2
Youtube 4K Smartphone				
Success Ratio/Start Time (%/s)	96.1/2.3	74.9/2.6	81.6/3.0	59.1/3.0
Time to Full Resolution (s)	9.8	11.2	10.0	10.3
Conversational-App				
Sucess Ratio (%)	100.0	100.0	99.0	99.7
Speech Quality P10 (MOS-LQO)	3.2	2.8	2.6	3.1
Interactivity e-Gaming				
Interactivity e-Gaming (%)	66.0	37.7	49.1	54.7

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Data

EE AHEAD IN RAILWAYS DATA TESTS ON OVERALL LOW LEVEL, THREE ON SECOND RANK

In the walktests that were specifically conducted on British trains, all operators show some room for improvements – in particular when it comes to data uploads. At an overall low level, EE is ahead in this assessment as well, and Three scores on second place. In terms of data performance on railways, Vodafone and O2 rank close together.

RAILWAYS WALKTEST

EE

Data Railways (Walktest)	EE	Vodafone	Three	O2
Web-Page Download				
Success Ratio/Avg. Session Time (%/s)	92.8/2.3	86.2/2.8	84.8/3.0	81.6/3.1
File Download (10 MB)				
Success Ratio/Avg. Session Time (%/s)	96.2/6.8	86.0/11.4	95.8/12.3	89.8/15.8
90%/10% faster than (Mbps)	4.9/134.2	2.6/77.3	2.8/109.2	1.8/79.7
File Upload (5 MB)				
Success Ratio/Avg. Session Time (%/s)	94.3/10.9	81.3/11.0	86.4/14.3	87.4/16.2
90%/10% faster than (Mbps)	1.3/27.4	1.2/23.5	1.3/26.0	1.1/18.6
File Download (7 Seconds)				
Sucess Ratio (%)	94.7	85.0	90.8	88.7
10% faster than (Mbps)	285.2	128.6	215.7	131.2
Speed > 20Mbps / 100Mbps (%)	72.1/36.3	47.2/13.4	61.7/23.4	36.1/13.5
File Upload (7 Seconds)				
Sucess Ratio (%)	88.5	80.0	76.6	78.2
10% faster than (Mbps)	52.5	29.4	27.6	17.2
Speed > 2Mbps / 5Mbps (%)	83.9/67.1	86.3/61.3	67.6/45.7	71.2/45.9
Youtube				
Success Ratio/Start Time (%/s)	80.0/2.6	69.6/2.7	65.6/2.7	70.0/3.4
Time to Full Resolution (s)	10.2	10.9	9.6	10.0
Youtube live				
Success Ratio/Start Time (%/s)	89.9/4.0	66.7/4.2	81.1/4.0	65.0/4.3
Time to Full Resolution (s)	8.5	8.1	8.5	8.5
Youtube 4K Smartphone				
Success Ratio/Start Time (%/s)	76.8/2.7	60.3/2.7	64.8/2.7	66.7/3.3
Time to Full Resolution (s)	10.0	10.7	9.9	10.8
Conversational-App				
Sucess Ratio (%)	100.0	99.5	100.0	99.0
Speech Quality P10 (MOS-LQO)	3.3	2.8	2.6	3.1
Interactivity e-Gaming				
Interactivity e-Gaming (%)	46.3	26.0	31.4	33.5

THREE SHOWS PARTICULARLY HIGH 5G DATA RATES

5G is assumed to be the standard in our measurements. But to shed light on the progress of the 5G rollout, we look at the results of the KPI "Data rates of the 7 second Download tests". This gives a good indication of the data rates which are supported thanks to the 5G technology. But as this assessment does not limit the overall results to the 5G-related aspects or factors such as 5G coverage or the measured latencies of 5G-only connections, we do not identify a separate 5G category winner.

That said, in this assessment, Three shows particularly high 5G data rates, both average and maximum, in all scenarios. All operators show a strong 5G penetration in the cities. EE, Vodafone and O2 to some extent use Dynamic Spectrum Sharing (DSS), but the share of samples is not very significant. For Three, the tests did not register this type of connections.

5G

Photo: Lilly Trott, shutterstock

Data rates 7s Download	EE			Vodafone			Three			O2		
Samples with 5G	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)
Cities – Drivetest	79,2%	204,9	417,6	65,1%	113,6	245,2	78,5%	240,2	588,9	70,6%	111,0	225,8
Cities – Walktest	80,5%	190,4	406,5	73,4%	126,4	280,0	68,9%	240,3	542,8	69,6%	114,7	234,6
Towns – Drivetest	37,3%	118,1	255,6	7,4%	138,8	259,9	33,4%	275,0	713,0	27,4%	51,4	110,7
Roads – Drivetest	26,7%	101,4	185,6	6,0%	123,4	265,3	23,3%	179,8	538,4	15,6%	40,7	81,6
Trains – Walktest	39,7%	166,4	353,9	38,7%	81,4	165,0	46,9%	155,0	394,8	41,4%	76,4	185,0
Samples with 5G-DSS	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)
Cities – Drivetest	2,0%	104,7	231,5	4,0%	48,4	105,8	–	–	–	1,9%	32,1	62,0
Cities – Walktest	2,7%	87,3	181,4	2,9%	36,0	68,5	–	–	–	0,7%	60,7	104,2
Towns – Drivetest	5,1%	76,0	134,6	2,3%	52,8	114,2	–	–	–	2,3%	36,5	63,4
Roads – Drivetest	1,4%	84,8	168,4	0,8%	21,8	30,6	–	–	–	2,0%	23,3	38,7
Trains – Walktest	0,6%	8,7	8,7	5,6%	35,5	79,7	–	–	–	1,5%	16,1	16,7

Crowd

EE LEADS IN TERMS OF BROADBAND COVERAGE, O2 SLIGHTLY AHEAD IN COVERAGE REACH CONSIDERATION

From the coverage perspective, although EE and O2 are on a similar level in Coverage Reach, EE offers the best coverage quality to their subscribers as well as the best result in the Time on Broadband (4G and 5G) assessment. Vodafone takes second place in the coverage category overall.

BROADBAND COVERAGE

EE

EE LEADS IN PASSIVE DOWNLOAD ANALYSIS

In the passively observed download data rates, EE leads the field, with the highest fulfilment rates in all three designated speed classes. In the Basic Internet class (minimum of 2 Mbps) and HD Video class (at least 5 Mbps), the ranking corresponds to the overall result. In the demanding UHD Video class (at least 20 Mbps), Three is ahead of O2 and Vodafone.

DOWNLOADS PASSIVE

EE

EE ALSO AHEAD IN ACTIVE DOWNLOAD ANALYSIS

The actively performed download tests are conducted to better approximate the maximum performance of an internet connection. In this metric, EE again takes the lead, with Three following due to higher average and P90 (10 percent faster than) results in comparison to Vodafone. As in almost all of the speed metrics, O2 shows some room for improvement.

DOWNLOADS ACTIVE

EE

Operators	EE	Vodafone	Three	O2
Broadband Coverage				
Coverage Quality (%)	97.1	91.4	88.1	88.8
Coverage Reach (%)	96.0	94.2	92.1	96.2
Time on Broadband (%)	98.1	94.7	94.2	92.4
Download Speed				
Basic Internet Class(%)	95.2	94.1	93.7	92.7
HD Video Class / UHD Video Class (%)	85.4/29.8	80.1/23.0	79.9/24.6	76.2/23.2
Latency				
Gaming Class / OTT Voice Class (%)	85.5/96.1	58.1/92.7	56.1/94.0	64.3/94.6
Voice				
HD Voice (%)	98.4	88.8	93.8	89.0
Download Speed (Active)				
Avg. Throughput (Mbit/s)	57.6	29.5	35.3	24.6
90% / 10% faster than (Mbit/s)	4.5/143.0	2.5/72.4	2.3/79.5	2.3/59.2
Upload Speed (Active)				
Avg. Throughput (Mbit/s)	14.3	11.6	11.3	8.6
90% / 10% faster than (Mbit/s)	1.5/36.1	1.6/26.5	1.5/24.9	1.3/19.6
Stability				
Transaction Success (%)	92.6	89.1	87.3	86.5

EE AHEAD IN ACTIVE UPLOAD TESTS

The results of the active Download category are also confirmed by the accompanying upload tests. Thus, EE also achieves the highest sub-score in this category. In the P10 KPI (90 percent of the measured values faster than), Vodafone ist slightly ahead of Three and EE. O2 ranks fourth also in this category.

UPLOADS ACTIVE

EE

EE LEADS IN HD VOICE AVAILABILITY, THREE RANKS SECOND BEST IN THIS CATEGORY

In the analysis of the availability of HD voice connections (i.e Voice over LTE with the current state of mobile network implementations in the UK), EE takes the first place. In this assessment, Three ranks second best, ahead of O2 and then Vodafone.

VOICE

EE

EE PROVIDES THE SHORTEST LATENCIES, O2 SHOWS BETTER LATENCY RESULTS THAN VODAFONE AND THREE

EE shows the best resuts in the latency category, both for the more relaxed OTT Voice class (roundtrip times up to 100 milliseconds) as well as in the more demanding Gaming class (up to 50 ms). However, in both latency KPIs, O2 achieves higher scores than Vodafone and Three.

LATENCY

EE

EE AHEAD IN CROWDSOURCED ASSESSMENT OF TRANSACTION STABILITY

In the Stability category, which looks at the success rates of regular transaction tests, the overall ranking is once more confirmed: EE takes the lead, while Vodafone, Three and O2 follow in this order, with comparatively smaller gaps between their results.

STABILITY

EE

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The 2023 Mobile Network Test in the United Kingdom

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Part of Accenture

Reliability

Reliability is not an additional category of our tests, but rather a diffent angle of looking at the results: For each KPI, our scoring distinguishes between "Qualifiers" (the expected basic performance) and "Differentiators" (the additional performance that exceeds the expected basics). The view at Reliability limits itself to most of the Qualifiers and the basic KPIs of the crowdsourcing – thus conveying an impression of the standards, a user can reasonably expect from a mobile network. The reference values in this representation are therefore only the subset of score points which we assigned to the Qualifiers. The resulting scores state the reliabilty with which an operator offers its network services. This approach concentrates on the compulsory basics instead of the highest peaks of a network's performance.

Operator		EE	Vodafone	Three	O2
Voice	max. 149 points	134	134	119	123
Drivetest	115	93%	91%	83%	87%
Walktest	33	78%	87%	70%	67%
Data	max. 222 points	191	170	159	131
Drivetest	172	89%	80%	74%	61%
Walktest	50	78%	66%	62%	52%
Crowd	max. 123 points	114	108	108	106
Crowd	123	93%	88%	88%	87%
Total	max. 493 points	439	412	386	360

VOICE

VODAFONE & EE

VODAFONE AND EE ON A PAR IN VOICE RELIABILITY

In the overall assessment of the Reliability of voice connections, EE and Vodafone score on a par, with O2 ranking third and Three on fourth place. This is exactly the ranking based on the Qualifier scores achieved in the drivetests. However, in the walktests investigating voice performance, Vodafone is ahead of the field, with EE scoring on second place, Three on third and O2 scoring at the tail end.

DATA

EE

EE LEADS IN DATA RELIABILITY

Looking at Reliability in the Data tests, EE leads – based both on the results of the walktests as well as on the results of the drivetests. The gap to the runner-ups is distinct. In both aggregations (drivetets and walktests), Vodafone follows on a strong second rank, Three on the third rank, and O2 on the fourth.

CROWD

EE

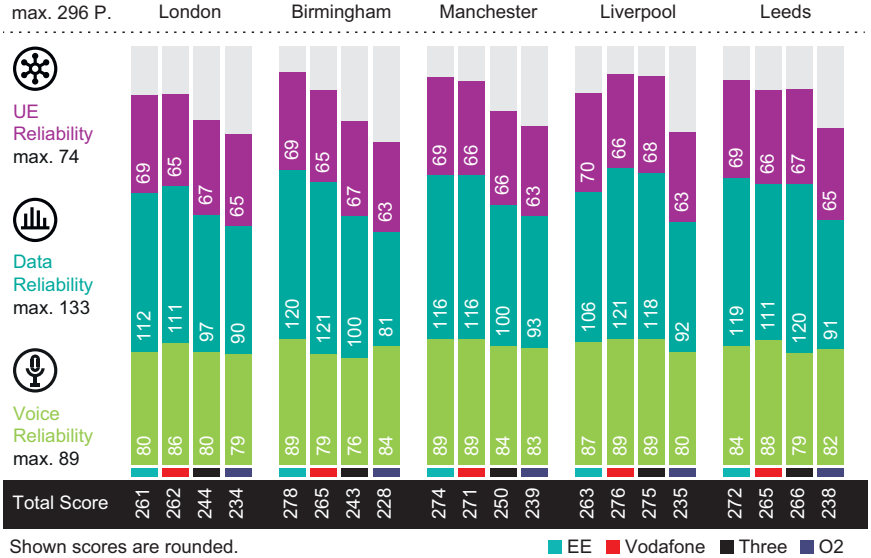
EE ALSO AHEAD IN CROWDSOURCING, VODAFONE AND THREE ON A PAR, O2 FOLLOWS AT CLOSE GAP

In the crowdsourced KPIs, EE once more takes the lead at a distinct gap over the other contenders. The rest of the field ranks close together. Vodafone and Three score on a par in crowdsourcing, and O2 follows at a small gap of only two score points in this assessment.

RELIABILITY IN CITY SCORES

EE ALSO AHEAD IN RELIABILITY CITY SCORES IN BIRMINGHAM, MANCHESTER AND LEEDS. VODAFONE LEADS IN LONDON AND LIVERPOOL

In the the Reliability Assessment of the UK's largest cities (see next page), EE is ahead in Birmingham, Manchester and Leeds. Vodafone leads by margin of one score point ahead of EE in London, and by the same margin ahead of Three in Liverpool. In Leeds, Three ranks on the second place behind EE, with Vodafone ranking third at a one-point score gap behind Three.



Shown scores are rounded.

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The 2023 Mobile Network Test in the United Kingdom

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City Scores

Traditionally, umlaut and connect take a closer look at the UK's capital to see how the operators cover this lively centre of business, politics and culture. Furthermore, for the inhabitants of the other large cities in the UK, it is interesting to see how the different operators perform in their areas. Therefore, we performed additional analysis also for Birmingham, Manchester, Liverpool and Leeds. They reveal very good results for EE in all cities. Vodafone achieves the grade "very good" in Liverpool and Leeds, and "good" in the others. Three is "very good" in Liverpool, and "good" in the other cities. O2 receives the grade "good" in London and Leeds, and "satisfactory" in the other cities highlighted here.

EE AHEAD IN LONDON, VODAFONE ACHIEVES BEST VOICE RESULT AND BEST RELIABILITY

Greater London is by far the most densely populated area in the UK. This also makes the nation's capital an especially demanding terrain for deploying and maintaining a mobile network. Although the gaps between the candidates are smaller here, we still see that EE is clearly ahead. Vodafone achieves the best voice result in London, followed by Three.

LONDON

EE

EE ALSO LEADS IN MANCHESTER

In the northwestern industrial city, EE leads overall, ahead of Vodafone, Three and O2, which all have distinct gaps between their scores. In the voice category, Vodafone is one score point ahead of EE. In the crowdsourcing, Three is ahead of Vodafone by a narrow margin of one score point. O2 ranks fourth, but with a stronger result than for example in Liverpool.

MANCHESTER

EE

THREE IS LOCAL CHAMPION IN LIVERPOOL, CLOSE AHEAD OF EE AND, AT A MORE DISTINCT GAP, VODAFONE

In Liverpool, Three manages to outperform EE in the overall assessment, due to the strongest data results in this city. This makes Liverpool the only city in this comparison where EE is not leading. Generally, here the gaps between the strongest three providers are smaller than elsewhere. Vodafone is closely ahead in the voice results as well as in the Reliability city score, and EE leads in the crowdsourced assessment.

LIVERPOOL

THREE

EE DISTINCTLY AHEAD IN BIRMINGHAM

In the West Midlands city, the lead of EE is quite pronounced – the BT brand achieves the highest score in all three sub-categories. Vodafone and Three rank relatively close togehther in the mid-field, with Three achieving a higher score than Vodafone in the crowdsourcing. The gaps between Vodafone, Three and O2 become particularly clear in the data category.

BIRMINGHAM

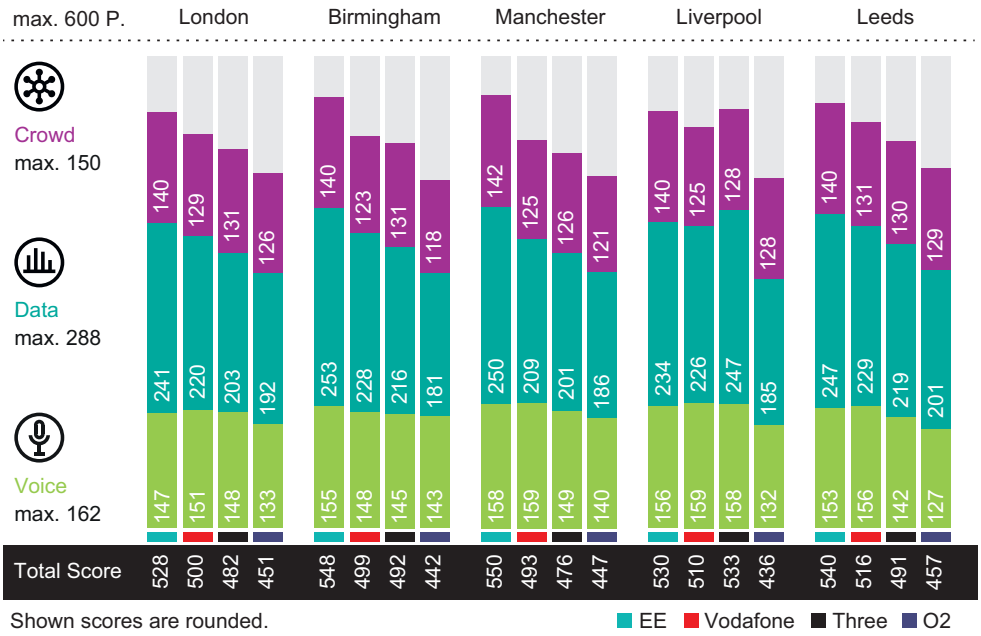
EE

EE AHEAD IN LEEDS, VODAFONE STONGER IN VOICE HERE

In the Yorkshire city, EE leads the field with the best scores in the data and crowdsourcing categories. Vodafone is ahead in the voice category, while the data results show the same ranking as the nationwide result. In the crowdsourcing category, the runner-ups Vodafone, Three and O2 score closely together with only one-point gaps between them.

LEEDS

EE



Shown scores are rounded.

Photo: Paul Daniels, shutterstock

connect business

The 2023 Mobile Network Test in the United Kingdom

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Methodology

The umlaut connect Mobile Network Test is the result of extensive drivetests and walktests, combined with a sophisticated crowdsourcing analysis.

Logistics

connect's network test partner umlaut, Part of Accenture, sent four measurement vehicles through the country, each equipped with twelve smartphones. For each network operator, a Samsung Galaxy S21+ took the voice measurements, and another S21+ established the connections for the new test case "conversational app" (see section "Data connections" below). In the actual data test, we used a Samsung Galaxy S22+. For all measurements, the smartphones were set to "5G preferred" – so wherever supported by the network, the data tests took place via 5G.

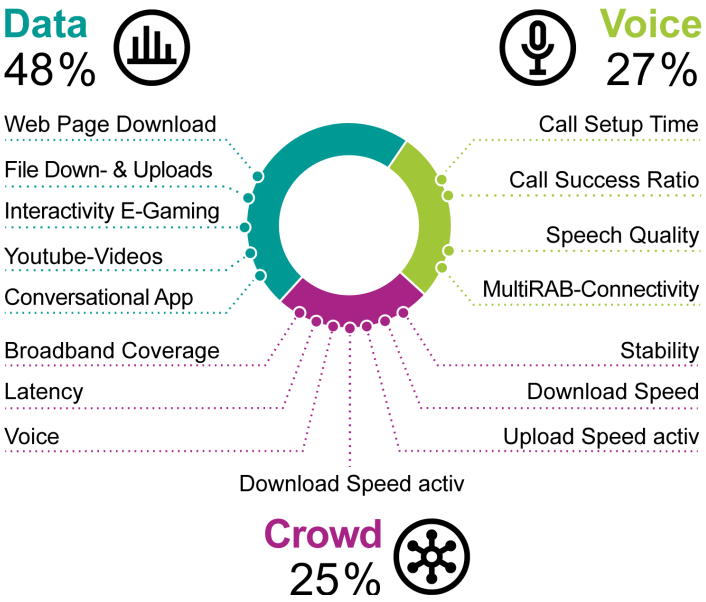
In addition to the drive tests, two walk test teams carried out measurements on foot in each country, in zones with heavy public traffic such as railway station concourses, airport terminals, cafés, public transport and museums. The walk test programme also included journeys on long-distance railway lines. For the walk tests, the same three smartphone types were used per network operator for the same measurements as in the drive tests. The walk test teams transported the smartphones in backpacks or trolleys equipped with powerful batteries. The firmware of the test smartphones corresponded to the original network operator version in each case.

The drive and walk tests took place between 8 am and 10 pm. For the drive tests, two vehicles were in the same city, but not in the same place, so that one car would not falsify the measurements of the other. On the connecting roads, two vehicles each drove the same routes, but one after the other with some time and distance between them. For the selection of the test routes, umlaut created four different suggestions for each country, from which connect blindly selected a route.

Voice connections

Voice connections account for 27 percent of the overall result. For this purpose, mobile telephone calls were established from vehicle to vehicle („mobile-to-mobile") and their success rates, call set-up time and voice quality were measured. The smartphones of the walk test teams made calls to a stationary (smartphone) remote station for the voice tests.

To ensure realistic conditions, data traffic was handled simultaneously in the background. We also recorded MultiRAB connectivity: the use of several "radio access bearers" provides data connections in the background of the voice calls. The transmission quality was evaluated with the POLQA wideband method suitable for HD voice. "VoLTE preferred" was configured on all phones – from 5G, the phones thus fall back to telephony via LTE.



Data connections

The data measurements account for 48 percent of the total result. Several popular live pages (dynamic) and the ETSI reference page known as the Kepler page (static) were retrieved to assess internet page calls. In addition, 10 MB and 5 MB files were downloaded and uploaded, respectively, in order to determine the performance for smaller data transfers. We also determined the data rate within a 7-second period when uploading and downloading large files. Since Youtube dynamically adjusts the played-out resolution to the available bandwidth, the rating takes into account the average image resolution or line count of the videos, the time to reach full resolution as well as the success rate and time to playback start.

To challenge network performance, the smartphones additionally retrieved videos in 4K (2160p). A typical over-the-top voice connection (OTT) is represented by the test case "conversational app". For this, we set up a voice channel via the SIP and STUN protocols using the OPUS codec and determined the success rate and voice quality. In addition, our measurements simulated a highly interactive UDP multiplayer session to determine the latency times of the connection and any possible packet losses. This was done in our newly added test point "Interactivity of eGaming". >>

Methodology

Crowdsourcing
Crowdsourcing results accounted for 25 per cent of the overall rating. They show which network performance actually arrives at the user – however, the end devices and tariffs used also have an effect in this.

To obtain the data basis for these analyses, thousands of popular apps recorded the parameters described below in the background – provided the user agreed to the completely anonymous data collection. The measured values were recorded in 15-minute intervals and transmitted to the umlaut servers once a day. The reports contain only a few bytes, so they hardly burden the user's data volume.

Broadband Coverage
In order to determine the broadband *coverage reach*, umlaut laid a grid of 2 x 2 km tiles ("Evaluation Areas", in short EAs) over the test area. A minimum number of users and measured values had to be available for each EA. For the evaluation, umlaut awarded one point per EA if the network under consideration offered 3G coverage. Three points were awarded if 4G or 5G was available in the EA. The score achieved in this way was divided by the achievable number of points (three points per EA in the "common footprint" – the area of the respective country covered by all tested providers).

We also looked at the *coverage quality*. This KPI relates the percentage of EAs where a user had 4G or 5G reception to all EAs in the common footprint.

The *time on broadband* in turn tells us how often a user had 4G or 5G reception in the period under consideration – regardless of the EAs in which the samples were recorded. For this purpose, umlaut sets the samples that show 4G/5G coverage in relation to the total number of all samples. Important: The percentage values determined for all three parameters reflect the respective degree of fulfilment – and not a percentage of 4G/5G mobile coverage in relation to area or population.

Data rates and Latencies
The *passive* determination of *download data rates* and *latencies* was carried out independently of the EAs and focused on the experience of each user. Samples that were captured via Wi-fi or when flight mode was activated, for example, were filtered out by umlaut before the analysis.

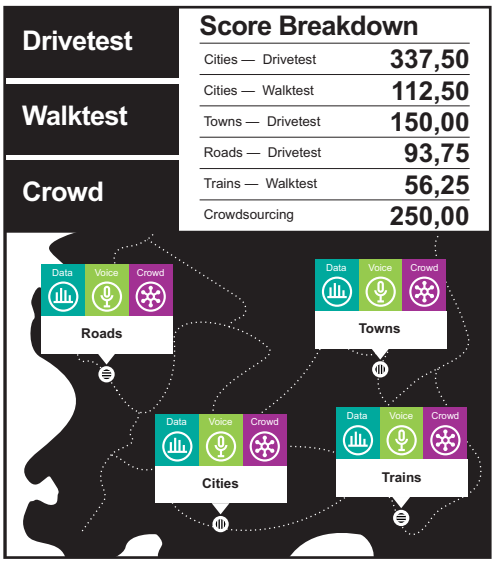
To take into account that many mobile phone tariffs throttle the data rate, umlaut defined three application-related speed classes: *Basic internet* requires a minimum of 2 Mbit/s, *HD video* requires 5 Mbit/s and *UHD video* requires 20 Mbit/s. For a sample to be valid, a minimum amount of data must have flowed in a 15-minute period.

Similarly, the latency of the data packets is assigned to an application-related class: Roundtrip times up to 100 ms are sufficient for *OTT voice services*, less than 50 ms qualify a sample for *gaming*.

In this way, the evaluation also does justice to the fact that the passively observed data rates depend on the applications used in each case. In order to better assess the maximum possible throughput, umlaut also conducted active measurements of upload and download data rates once a month. They determine the amount of data transferred in 3.5 seconds.

In addition to the passive measurements, umlaut also conducts *active* measurements of *upload* and *download* data rates once a month. They determine the amount of data that could be transferred in 3.5 seconds. For the determined values, we consider the average data rate, the P10 value (90% of the values higher than the specified threshold, a good approximation of the typical minimum speed) and the P90 (10% above this threshold), a view at the peak values.

Stability
Based on the determined data rates and additional browsing and connection tests, umlaut also examined when a broadband connection could be used at all. The averaged and weighted results define the percentage of *transaction success*.

HD Voice
The parameter *HD voice* shows the proportion of the user's voice connections that were established in HD quality – and thus via VoLTE (Voice over LTE). A prerequisite was that the smartphone supports this standard.

Reliability
umlaut divided all measured values into basic requirements ("Qualifier KPIs") and values related to peak performance ("Differentiator KPIs"). The presentation of *reliability* takes into account only the "Qualifier KPIs" from the voice and data category and the basic KPIs from crowdsourcing.