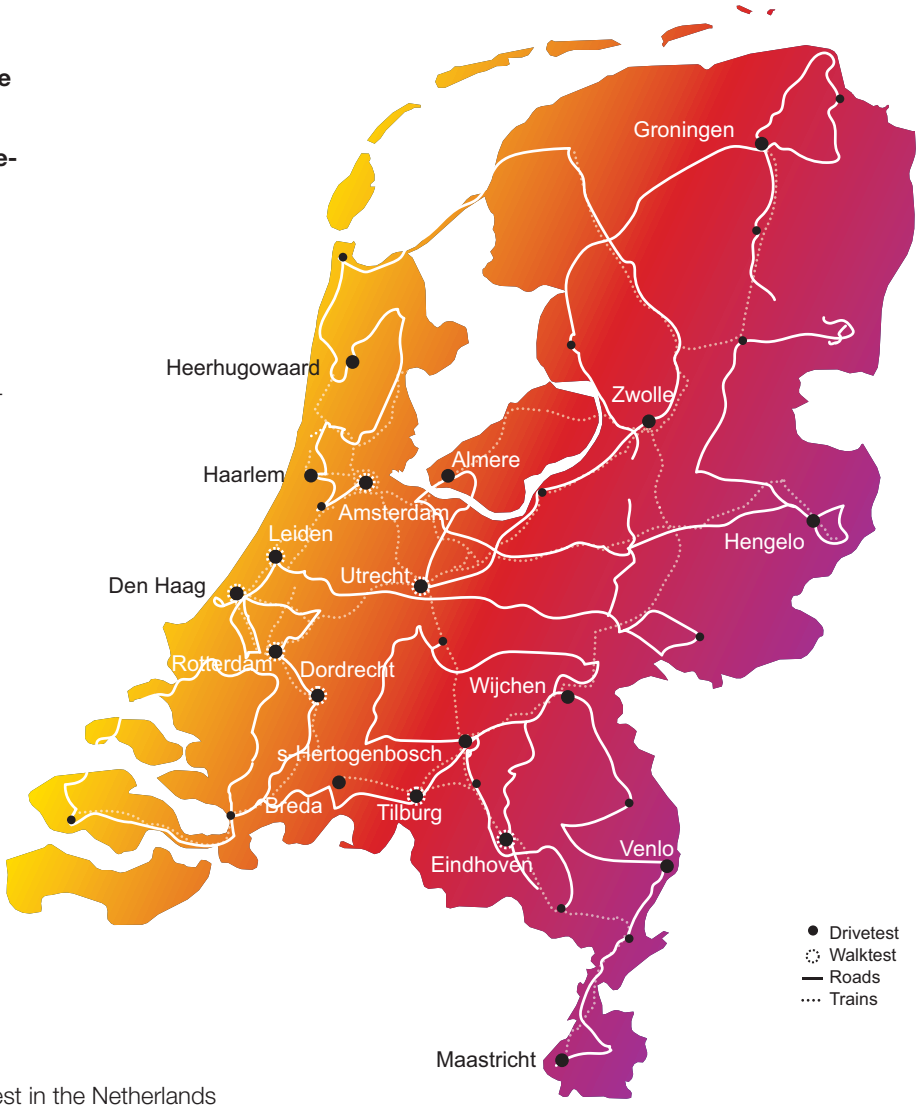
connect business

The 2023 Mobile Network Test in the Netherlands

umlaut Part of Accenture

For the eighth time, we – umlaut, part of Accenture, and connect – have conducted our comprehensive benchmark of the Dutch mobile networks. Its results show three outstanding operators, but also a clear winner with the highest score achieved in our mobile network tests so far.

The carefully designed methodology of our 2023 benchmark in the Netherlands 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 real-world User Download and Upload Speeds as well as 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 Netherlands consists of drive tests and walk tests conducted from January 18th to February 1st, 2023. Two drive test cars together covered a total of 7262 kilometres, visiting 18 cities and 14 towns. Additionally, two walk test teams visited eight cities. The test areas account for 5.86 million people, or approx. 34 percent of the total population of the Netherlands. In addition, the results of extensive crowdsourcing analyses, considering 24 weeks from mid-August 2022 to early February 2023 are included in the score. Our detailed methodology is described on pages 11/12.

DRIVE TEST AND WALK TEST FACTS

5.86 million people covered	**7262** km drive test	**309,379** data samples	**17,955** voice samples

CROWDSOURCING FACTS

461 billion samples	**24** weeks (mid-August 2022 to early February 2023)	**99.1%** of built-up area covered	**99.8%** of population covered

The Dutch Mobile Operators

In 2000, Deutsche Telekom bought a minority of the Dutch mobile network operator Ben, which was later extended to a 100 per cent acquisition. In 2003, Ben was renamed T-Mobile Netherlands, with the brand "Ben" becoming a "no-frills" offer within its portfolio. In 2007, T-Mobile NL additionally acquired Orange. At the end of 2018, the company completed its acquisition of the smallest Dutch mobile operator, Tele2. In 2020, T-Mobile NL also acquired the former virtual network operator Simpel.
In the fall of 2021, T-Mobile Netherlands was acquired by the private equity investors Apax and Warburg Pincus. In Q1 2022, the company reported figures for T-Mobile Netherlands for the last time. In these, it reported approx. 7.2 million mobile customers. which makes T-Mobile the largest Dutch mobile operator.
T-Mobile's network offers 2G, 3G and 4G/LTE. Its 4G network supports both VoLTE as well as "4G+" (carrier aggregation) up to 1 Gbps. T-Mobile launched 5G soon after the end of the spectrum auction in July 2020. It meanwhile claims that around 98 per cent of the Dutch population lives within its 5G coverage area.

The Koninklijke PTT Nederland N.V. emerged from the privatisation of the formerly state-owned PTT in 1998. The company focuses on marketing its flagship KPN brand, however with Simyo, it also has offerings in the "no-frills" segment.
For 2022, the company reported a total number of 6.6 million revenue-generating SIM cards (consumer and business).This makes KPN the second largest mobile operator in the Netherlands.
KPN offers 2G/GSM and 4G/LTE. The phaseout of 3G was completed by April 2022, which the company used to refarm its spectrum to 4G and 5G.
KPN launched 5G at the end of July 2020, reaching about half of the Dutch population at the start. Over the past three years, the company has renewed a large part of this antenna network. In early 2023, it claimed to offer the largest 5G antenna footprint of all Dutch operators and a population coverage for 5G of above 90 percent.

The Dutch subsidiary of the international Vodafone Group acquired the operator Libertel in 2003, forming Vodafone Netherlands. In 2016, it merged with the cable and fibre operator Ziggo.
Today, 50 percent of the joint company VodafoneZiggo is owned by the Vodafone Group and another 50 percent by Liberty Global. Currently, VodafoneZiggo is the smallest mobile operator in the Netherlands, reporting approx. 5 million mobile customers.
The company operates 2G and 4G/LTE, having been the first Dutch operator to phase out 3G in order to devote its spectrum to 4G and 5G. VoLTE is supported all over its 4G network, and with "4G+" the operator offers carrier aggregation up to 1 Gbps. At the end of April 2020, VodafoneZiggo was the first carrier to offer 5G in the Netherlands, starting on already available frequencies and later extending the service to spectrum acquired in the frequency auction which had ended in July 2020. Meanwhile, VodafoneZiggo claims to have reached national coverage with 5G.

Note: All claims about network coverage reported here are based on the operators' own statements, and are in no way benchmark results determined by umlaut.

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Results at a Glance

KPN wins our Mobile Network Test in the Netherlands with the highest score achieved so far in our international mobile network benchmarks. The lead is won with the best results in the Data and Crowdsourcing categories and also with the best Reliability result. In the Voice assessment, KPN scores on a par with T-Mobile, again on an outstanding level. In our separate examplary view on 5G, KPN shows particularly high data rates and a high share of samples with 5G.

T-Mobile Netherlands ranks second with the overall grade "outstanding". In the Voice category, the operator is co-leading with KPN, in the Data and Reliability assessments, T-Mobile shows the second strongest results in our assessment. In our examplary view on 5G, T-Mobile show a particularly high share of 5G samples on the Dutch roads as well as a good 5G penetration in the Drivetests performed within the big cities.

Vodafone ranks on a strong third place, also achieving the overall grade "outstanding". With a plus of 25 points over the total score of the previous year's test, Vodafone managed to improve most of all three tested Dutch providers. The operator ranks second in the Crowdsourcing discipline and is leading in the crowdsourced HD Voice availabilty. In our examplary view on 5G, Vodafone predominantly uses Dynamic Spectrum Sharing (DSS) with LTE.

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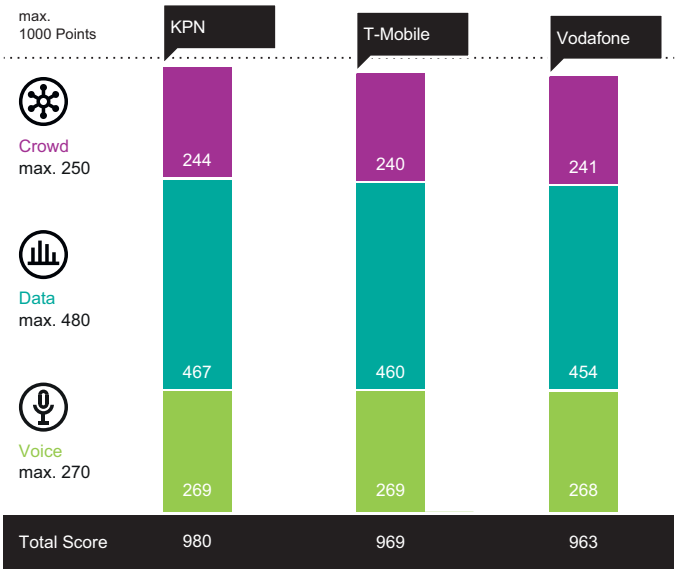
BEST IN TEST
KPN
2/2023
MOBILE NETWORK TEST IN THE NETHERLANDS
www.connect-testlab.com

"Congratulations to KPN for winning the very tight race seen in our Mobile Network Test in the Netherlands – with the highest score achieved so far in our international mobile network benchmarks. T-Mobile and Vodafone show also outstanding results. Moreover, all three competitors are also achieving the grade ‚outstanding' in the Reliability categories of our test. This high level of performance is impressive."

Hakan Ekmen, CEO Telecommunication at umlaut, part of Accenture

Overall Results		KPN	T-Mobile	Vodafone
Voice	max. 270.00 P.	269	269	268
Cities (Drivetest)	121.50	100%	100%	100%
Cities (Walktest)	40.50	100%	99%	99%
Towns (Drivetest)	54.00	100%	100%	99%
Roads (Drivetest)	33.75	100%	100%	98%
Railways (Walktest)	20.25	98%	98%	97%
Data	max. 480.00 P.	467	460	454
Cities (Drivetest)	216.00	98%	96%	96%
Cities (Walktest)	72.00	97%	96%	92%
Towns (Drivetest)	96.00	97%	96%	95%
Roads (Drivetest)	60.00	98%	96%	96%
Railways (Walktest)	36.00	95%	92%	89%
Crowd	max. 250.00 P.	244	240	241
Crowd	250.00	97%	96%	97%
Connect Rating	max. 1000 P.	980	969	963

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

ALL DUTCH OPERATORS ACHIEVE FULL AMOUNT OF SCORE POINTS IN BIG CITIES VOICE DRIVETESTS

It is seldom that all tested operators achieve the full number of possible score points in a category of our eavluation. In the voice tests, conducted by umlaut's test cars while driving in the Netherland's big cities, this is the case. High success ratios, short call setup times, high speech quality and almost perfect Multi-RAB connectivity really leave nothing to be desired.

CITIES DRIVETEST

ALL OPERATORS

KPN CLOSELY LEADING IN VOICE IN BIG CITIES WALK-TESTS, T-MOBILE AND VODAFONE FOLLOW AT VERY CLOSE DISTANCE

In the walktests, conducted in Amsterdam, Den Haag, Dordrecht, Einhoven, Leiden, Rotterdam, Tilburg and Utrecht, in the overall assessment KPN achieves the highest score. But T-Mobile and Vodafone follow – on a par and at a very close distance of only one percentage point. The performances of all Dutch operators rank definitely close together in this category.

CITIES WALKTEST

KPN

KPN AND T-MOBILE ON A PAR LEADING IN SMALLER TOWN VOICE DRIVETESTS

In the voice tests conducted by umlaut's test cars while visiting 14 smaller towns of the Netherlands (see route map on page 1), KPN and T-Mobile score on a par, taking the lead together. Vodafone follows closely behind at a distance of only one percentage point. Again, all three operators show an impressive performance in this category of our test.

TOWNS DRIVETEST

KPN & T-MOBILE

KPN AND T-MOBILE ON A PAR, SCORING BEST IN VOICE TESTS ON ROADS

As in the Drivetests performed in the smaller towns, KPN and T-Mobile are also sharing the top rank in the voice tests carried out while driving on Dutch roads. Again, Vodafone follows at very close distance. The high performance level makes conducting phone calls while driving in the Netherlands most convenient.

ROADS DRIVETEST

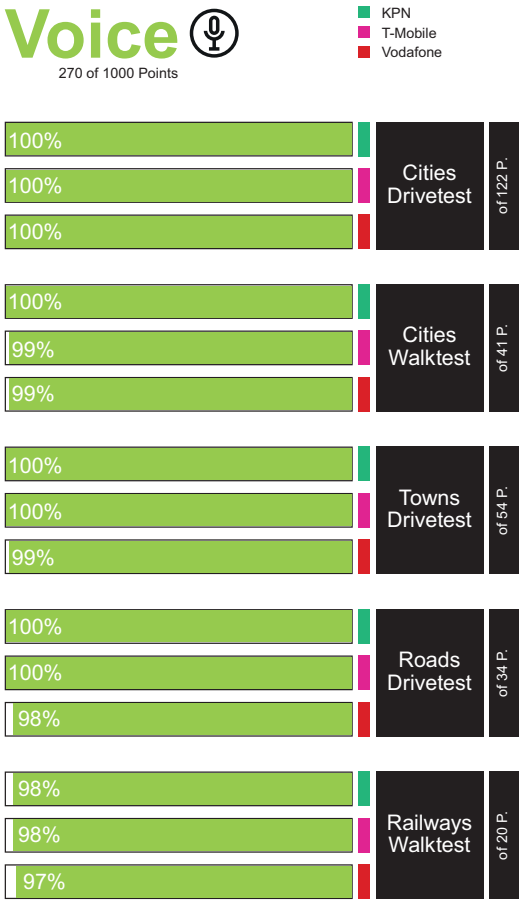
KPN & T-MOBILE

HIGH LEVEL OF PERFORMANCE IN VOICE TESTS ON DUTCH RAILWAYS. KPN AND T-MOBILE SHARE THE TOP RANK, VODAFONE FOLLOWS AT CLOSE DISTANCE

Not only on the roads, but also in Dutch trains, the performance level shown by our tests is near to perfect. As in the smaller towns and on the roads, KPN and T-Mobile share the top rank, with Vodafone following at very close distance of one percentage point. Impressive, regarding this particularly difficult environment for mobile communications.

RAILWAYS WALKTEST

KPN & T-MOBILE



Operator	KPN	T-Mobile	Vodafone
Cities (Drivetest)			
Sucess Ratio (%)	99.9	100.0	99.9
Call Setup Time P90 (s)	0.9	1.1	1.0
Speech Quality P10 (MOS-LQO)	4.6	4.6	4.5
Multirab Connectivity (%)	100.0	99.7	100.0
Towns (Drivetest)			
Sucess Ratio (%)	100.0	100.0	99.9
Call Setup Time P90 (s)	0.9	1.1	1.1
Speech Quality P10 (MOS-LQO)	4.6	4.6	4.5
Multirab Connectivity (%)	100.0	99.6	99.9
Roads (Drivetest)			
Sucess Ratio (%)	100.0	100.0	99.5
Call Setup Time P90 (s)	1.4	1.1	1.2
Speech Quality P10 (MOS-LQO)	4.5	4.5	4.3
Multirab Connectivity (%)	100.0	99.7	100.0
Cities (Walktest)			
Sucess Ratio (%)	99.9	99.8	99.9
Call Setup Time P90 (s)	0.7	1.1	1.0
Speech Quality P10 (MOS-LQO)	4.7	4.7	4.7
Multirab Connectivity (%)	100.0	99.9	99.9
Railways (Walktest)			
Sucess Ratio (%)	99.3	99.4	99.0
Call Setup Time P90 (s)	0.9	1.2	1.1
Speech Quality P10 (MOS-LQO)	4.6	4.5	4.5
Multirab Connectivity (%)	100.0	100.0	100.0

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Data

KPN AHEAD IN BIG CITIES DATA DRIVETESTS

In the data drivetests conducted in big Dutch cities, KPN takes the lead. T-Mobile and Vodafone follow at close distance and on a par. In a more detailed analysis, KPN benefits from using 5G New Radio plus LTE 4CA (four carrier aggregation), which we see in more than 85 percent of the samples gathered in the cities. In the interactivity tests, KPN leads, but Vodafone follows on the second rank ahead of T-Mobile.

CITIES DRIVETEST

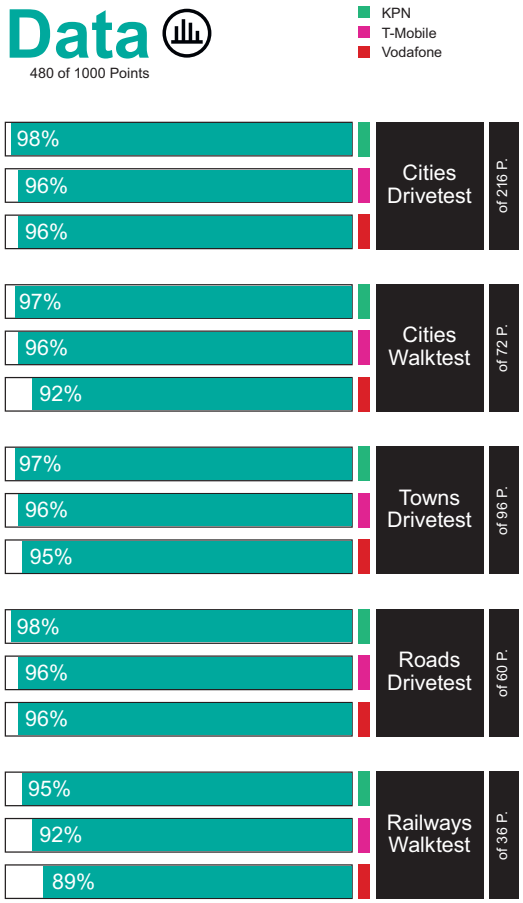
KPN

KPN ALSO LEADS IN BIG CITIES DATA WALKTESTS

The results of the data drive tests are confirmed by the data walktests conducted in the Netherlands' bigger cities. KPN again leads the field, T-Mobile ranks second, again at close distance. The results of Vodafone show a little more distinct gap in this scenario. This becomes for example visible in the Download and upload tests. Good news: All three operators achieve a 100 percent success ratio in the tests of Conversational Apps.

CITIES WALKTEST

KPN



Data Cities (Drivetest)	KPN	T-Mobile	Vodafone
Web-Page Download			
Success Ratio/Avg. Session Time (%/s)	99.9/1.0	99.9/1.1	99.9/1.1
File Download (10 MB)			
Success Ratio/Avg. Session Time (%/s)	99.9/0.9	100.0/1.1	100.0/1.4
90%/10% faster than (Mbps)	75.8/220.4	54.1/188.6	41.3/117.1
File Upload (5 MB)			
Success Ratio/Avg. Session Time (%/s)	100.0/0.9	100.0/1.1	100.0/1.4
90%/10% faster than (Mbps)	32.0/78.6	27.8/68.4	20.5/74.6
File Download (7 Seconds)			
Sucess Ratio (%)	99.9	99.8	100.0
10% faster than (Mbps)	349.1	296.5	214.8
Speed > 20Mbps / 100Mbps (%)	99.7/89.0	99.7/74.1	98.3/63.4
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.9
10% faster than (Mbps)	118.8	107.4	115.9
Speed > 2Mbps / 5Mbps (%)	100.0/100.0	99.9/99.9	99.7/98.9
Youtube			
Success Ratio/Start Time (%/s)	99.6/1.8	99.9/1.9	99.5/1.9
Time to Full Resolution (s)	9.1	9.5	9.3
Youtube live			
Success Ratio/Start Time (%/s)	99.3/3.4	99.2/3.5	99.4/3.3
Time to Full Resolution (s)	8.1	7.9	8.1
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.7/2.2	99.9/2.3	99.7/2.3
Time to Full Resolution (s)	7.9	8.5	8.4
Conversational-App			
Sucess Ratio (%)	100.0	100.0	100.0
Speech Quality P10 (MOS-LQO)	3.8	3.2	3.5
Interactivity e-Gaming			
Interactivity e-Gaming (%)	89.6	75.7	79.3

Data Cities (Walktest)	KPN	T-Mobile	Vodafone
Web-Page Download			
Success Ratio/Avg. Session Time (%/s)	99.9/1.0	99.7/1.1	99.3/1.1
File Download (10 MB)			
Success Ratio/Avg. Session Time (%/s)	100.0/1.0	100.0/1.2	99.6/1.7
90%/10% faster than (Mbps)	68.0/213.3	49.5/182.2	38.7/114.9
File Upload (5 MB)			
Success Ratio/Avg. Session Time (%/s)	100.0/1.4	99.6/1.4	99.2/2.0
90%/10% faster than (Mbps)	26.6/79.1	23.7/65.7	16.1/74.2
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	99.8	100.0
10% faster than (Mbps)	337.2	303.1	208.7
Speed > 20Mbps / 100Mbps (%)	99.1/82.0	99.2/74.2	97.7/61.0
File Upload (7 Seconds)			
Sucess Ratio (%)	99.8	100.0	98.1
10% faster than (Mbps)	119.3	109.6	114.6
Speed > 2Mbps / 5Mbps (%)	99.2/98.1	99.2/98.7	99.8/97.8
Youtube			
Success Ratio/Start Time (%/s)	99.6/1.7	100.0/1.9	98.1/1.9
Time to Full Resolution (s)	9.3	9.2	9.7
Youtube live			
Success Ratio/Start Time (%/s)	100.0/3.4	99.1/3.5	99.5/3.5
Time to Full Resolution (s)	7.8	7.6	8.2
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.6/2.3	100.0/2.3	99.6/2.3
Time to Full Resolution (s)	7.5	8.4	8.7
Conversational-App			
Sucess Ratio (%)	100.0	100.0	100.0
Speech Quality P10 (MOS-LQO)	4.0	3.8	3.7
Interactivity e-Gaming			
Interactivity e-Gaming (%)	88.6	77.5	78.9

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Data

KPN ALSO LEADS IN DATA DRIVETESTS IN TOWNS

In the data drivetests performed in the visited smaller towns, KPN is also ahead – but T-Mobile and Vodafone follow each at a close distance of just one percentage point. The performance differences can be seen for example in the data rates achieved in the file download and upload tests. But high success ratios in most of the tested scenarios prove a generally high service quality.

TOWNS DRIVETEST

KPN

KPN AHEAD IN DATA DRIVETESTS ON DUTCH ROADS

In the data tests performed by our test cars on Dutch roads, KPN once again leads the field, with T-Mobile and Vodafone following at close distance on a par. The high level of the results in this category is good news for motorists who want to use any kind of data services while driving in their cars.

ROADS DRIVETEST

KPN

Photo: Arjan de Jong, Unsplash

Data Towns (Drivetest)	KPN	T-Mobile	Vodafone
Web-Page Download			
Success Ratio/Avg. Session Time (%/s)	99.9/0.9	99.8/1.1	99.9/1.1
File Download (10 MB)			
Success Ratio/Avg. Session Time (%/s)	99.8/0.8	100.0/1.1	100.0/1.5
90%/10% faster than (Mbps)	85.6/221.0	60.8/188.6	39.0/122.5
File Upload (5 MB)			
Success Ratio/Avg. Session Time (%/s)	100.0/1.0	99.8/1.2	99.8/1.7
90%/10% faster than (Mbps)	29.7/75.5	24.2/68.3	16.0/72.9
File Download (7 Seconds)			
Sucess Ratio (%)	99.8	99.7	100.0
10% faster than (Mbps)	346.8	263.1	224.0
Speed > 20Mbps / 100Mbps (%)	99.8/91.3	99.5/79.8	98.4/59.5
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.8
10% faster than (Mbps)	112.1	102.1	111.5
Speed > 2Mbps / 5Mbps (%)	100.0/100.0	99.3/99.1	99.5/98.1
Youtube			
Success Ratio/Start Time (%/s)	99.6/1.8	99.3/1.9	100.0/1.9
Time to Full Resolution (s)	9.2	9.3	9.6
Youtube live			
Success Ratio/Start Time (%/s)	99.0/3.5	99.0/3.5	99.5/3.4
Time to Full Resolution (s)	7.9	8.0	8.0
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/2.2	99.6/2.3	100.0/2.4
Time to Full Resolution (s)	8.3	8.3	8.5
Conversational-App			
Sucess Ratio (%)	99.9	100.0	100.0
Speech Quality P10 (MOS-LQO)	3.8	3.2	3.5
Interactivity e-Gaming			
Interactivity e-Gaming (%)	87.9	74.8	79.3

Data Roads (Drivetest)	KPN	T-Mobile	Vodafone
Web-Page Download			
Success Ratio/Avg. Session Time (%/s)	99.9/1.0	99.6/1.1	99.9/1.1
File Download (10 MB)			
Success Ratio/Avg. Session Time (%/s)	100.0/0.9	99.4/1.2	100.0/1.6
90%/10% faster than (Mbps)	73.7/224.9	51.0/189.2	33.1/120.5
File Upload (5 MB)			
Success Ratio/Avg. Session Time (%/s)	99.7/1.2	99.7/1.6	100.0/2.3
90%/10% faster than (Mbps)	20.9/75.0	16.0/67.3	9.3/68.1
File Download (7 Seconds)			
Sucess Ratio (%)	99.7	100.0	100.0
10% faster than (Mbps)	374.8	260.7	224.9
Speed > 20Mbps / 100Mbps (%)	99.7/87.7	99.7/76.8	95.6/59.1
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	99.0	100.0
10% faster than (Mbps)	110.4	107.5	114.2
Speed > 2Mbps / 5Mbps (%)	99.7/99.7	99.7/98.4	98.4/95.1
Youtube			
Success Ratio/Start Time (%/s)	100.0/1.7	100.0/1.8	100.0/1.9
Time to Full Resolution (s)	9.1	9.3	9.6
Youtube live			
Success Ratio/Start Time (%/s)	98.5/3.5	97.8/3.5	97.8/3.4
Time to Full Resolution (s)	8.2	8.1	8.0
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/2.2	98.6/2.3	99.3/2.4
Time to Full Resolution (s)	8.4	8.5	8.8
Conversational-App			
Sucess Ratio (%)	100.0	100.0	100.0
Speech Quality P10 (MOS-LQO)	3.6	3.0	3.3
Interactivity e-Gaming			
Interactivity e-Gaming (%)	88.6	71.4	78.8

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Data

KPN AHEAD IN RAILWAYS DATA TESTS, HERE T-MOBILE AND VODAFONE FOLLOW AT MORE DISTINCT GAPS

In the walktests that were specifically conducted on Dutch trains, KPN holds up a high level of performance quite well. T-Mobile ranks second, and Vodafone third, each at more distinct gaps than in the other data scenarios. However, compared to the results of railway data tests in other countries, all three Dutch operators show very convincing results.

RAILWAYS WALKTEST

KPN

Data Railways (Walktest)	KPN	T-Mobile	Vodafone
Web-Page Download			
Success Ratio/Avg. Session Time (%/s)	99.5/1.1	99.2/1.3	98.9/1.3
File Download (10 MB)			
Success Ratio/Avg. Session Time (%/s)	100.0/1.5	100.0/2.0	100.0/2.4
90%/10% faster than (Mbps)	35.6/186.4	25.0/167.4	18.5/110.1
File Upload (5 MB)			
Success Ratio/Avg. Session Time (%/s)	99.4/3.4	99.1/3.9	99.1/5.0
90%/10% faster than (Mbps)	7.9/60.7	4.9/53.9	3.4/57.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.4	100.0	100.0
10% faster than (Mbps)	270.4	217.7	173.1
Speed > 20Mbps / 100Mbps (%)	97.7/68.8	96.0/54.3	93.7/39.0
File Upload (7 Seconds)			
Sucess Ratio (%)	98.6	98.5	95.3
10% faster than (Mbps)	80.0	70.5	71.1
Speed > 2Mbps / 5Mbps (%)	97.4/94.5	95.3/89.4	94.1/85.4
Youtube			
Success Ratio/Start Time (%/s)	98.3/1.7	98.8/2.0	96.8/2.1
Time to Full Resolution (s)	9.3	9.8	9.8
Youtube live			
Success Ratio/Start Time (%/s)	97.8/3.5	97.1/3.4	97.6/3.6
Time to Full Resolution (s)	7.8	7.8	8.1
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	98.2/2.2	98.8/2.4	96.6/2.5
Time to Full Resolution (s)	8.0	8.5	8.9
Conversational-App			
Sucess Ratio (%)	99.7	100.0	99.9
Speech Quality P10 (MOS-LQO)	3.8	3.1	3.2
Interactivity e-Gaming			
Interactivity e-Gaming (%)	79.5	62.7	62.5

KPN SHOWS PARTICULARLY HIGH 5G DATA RATES AND HIGHEST SHARE OF SAMPLES WITH 5G IN CITIES, TOWNS AND RAILWAYS. T-MOBILE SHOWS HIGHEST SHARE OF 5G SAMPLES ON THE ROADS

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, KPN shows particularly high 5G data rates, both average and maximum, in all scenarios, as well as the highest share of 5G data rates in the bigger cities, towns and in railways in this view. In these locations, T-Mobile shows slightly lower data rates, but a particularly high 5G penetration on the roads. Vodafone uses predominantly Dynamic Spectrum Sharing (DSS) with LTE, which explains the somewhat slower data rates in comparison to the other two contenders.

5G

Photo: Gaurav Jain, Unsplash

Data rates 7s Download	KPN			T-Mobile			Vodafone		
Samples with 5G	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)	Share	Average (Mbps)	10% faster than (Mbps)
Cities – Drivetest	97.9%	219.4	349.7	94.1%	169.1	300.4	–	–	–
Cities – Walktest	93.4%	194.1	347.9	89.1%	173.8	308.1	–	–	–
Towns – Drivetest	99.5%	224.0	347.6	89.4%	165.1	274.7	–	–	–
Roads – Drivetest	94.6%	219.3	374.6	95.7%	162.2	261.6	–	–	–
Trains – Walktest	92.4%	157.8	279.8	89.2%	124.5	221.0	–	–	–
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)
Cities – Drivetest	–	–	–	–	–	–	91.4%	130.1	216.2
Cities – Walktest	–	–	–	–	–	–	86.9%	125.5	208.4
Towns – Drivetest	–	–	–	–	–	–	89.1%	130.1	228.9
Roads – Drivetest	–	–	–	–	–	–	77.7%	129.9	233.1
Trains – Walktest	–	–	–	–	–	–	83.1%	97.1	177.1

Crowd

VODAFONE LEADS IN COVERAGE QUALITY, KPN AHEAD IN COVERAGE REACH, ALL DUTCH OPERATORS ON A PAR IN TIME ON BROADBAND

In terms of Coverage Quality (see definitions on page 12), Vodafone leads slightly ahead of KPN. In Coverage Reach, KPN takes the lead, ahead of T-Mobile and then Vodafone. In the Time on Broadband assessment, all three Dutch operators rank on a par.

BROADBAND COVERAGE

KPN

KPN AND VODAFONE AHEAD IN PASSIVE DOWNLOAD ANALYSIS

In the passively observed download data rates, KPN and Vodafone are on par in the Basic Internet class (minimum of 2 Mbps). In the HD Video class (at least 5 Mbps), all three operators are scoring very close together, with a slight lead of Vodafone. The demanding UHD Video class (at least 20 Mbps), is closely won by KPN, followed by Vodafone and at a narrow gap by T-Mobile.

DOWNLOADS PASSIVE

KPN & VODAFONE

KPN AHEAD IN ACTIVE DOWNLOAD ANALYSIS

The actively performed download tests are conducted to better approximate the maximum performance of a mobile internet connection. In this metric, KPN takes the lead with the highest data rates in all considerations. In the average and P90 (10 percent faster than) results, T-Mobile ranks second, in the P10 (90 percent faster) aggregation, Vodafone is ahead of T-Mobile.

DOWNLOADS ACTIVE

KPN

Operators	KPN	T-Mobile	Vodafone
Broadband Coverage			
Coverage Quality (%)	99.6	99.2	99.7
Coverage Reach (%)	97.8	96.8	95.5
Time on Broadband (%)	99.7	99.7	99.7
Download Speed			
Basic Internet Class(%)	95.5	95.1	95.5
HD Video Class / UHD Video Class (%)	89.7/45.0	88.7/39.5	89.9/40.1
Latency			
Gaming Class / OTT Voice Class (%)	97.0/99.2	89.1/97.7	95.4/98.4
Voice			
HD Voice (%)	98.9	99.1	99.4
Download Speed (Active)			
Avg. Throughput (Mbit/s)	113.1	95.9	81.0
90% / 10% faster than (Mbit/s)	19.5/248.7	9.4/214.8	15.0/169.1
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	30.5	27.8	20.5
90% / 10% faster than (Mbit/s)	4.4/63.4	3.4/62.0	2.4/45.9
Stability			
Transaction Success (%)	96.5	96.3	95.2

KPN AHEAD IN ACTIVE UPLOAD TESTS

A similar results as in the active Download category can also be seen in the accompanying upload tests. KPN again delivers the highest data rates and thus achieves the highest score in this category. T-Mobile follows at a close distance, and Vodafone at a little more distinct gap.

UPLOADS ACTIVE

KPN

VODAFONE LEADS IN HD VOICE AVAILABILITY, FOLLOWED BY T-MOBILE 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 Netherlands), Vodafone takes the first place. In this assessment, T-Mobile ranks second best, ahead of KPN – while all three operators show an overall high score level.

VOICE

VODAFONE

KPN PROVIDES THE SHORTEST LATENCIES, VODAFONE SCORES AHEAD OF T-MOBILE IN LATENCY ASSESSMENT

KPN also achieves the best results 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). In both latency KPIs, Vodafone achieves slightly higher scores than T-Mobile.

LATENCY

KPN

KPN 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: KPN takes the lead, with T-Mobile following at very close distance and Vodafone at a slightly more pronounced score gap.

STABILITY

KPN

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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. It shows that all three Dutch operators achieve outstanding results in Reliability – overall and in the separate categories (Voice, Data and Crowd).

Operator		KPN	T-Mobile	Vodafone
Voice	max. 149 points	148	148	146
Drivetest	115	100%	100%	99%
Walktest	33	98%	98%	97%
Data	max. 222 points	218	217	215
Drivetest	172	98%	98%	98%
Walktest	50	98%	97%	92%
Crowd	max. 123 points	119	117	118
Crowd	123	97%	96%	96%
Total	max. 493 points	485	482	479

VOICE

KPN & T-MOBILE

KPN AND T-MOBILE ON A PAR IN VOICE RELIABILITY

In the overall assessment of the Reliability of voice connections, KPN and T-Mobile score on a par, with Vodafone follow at a close distance of two score points. This ranking can be seen both in the drive-tests as well as in the walktests. In the latter, the reliabilty level of all three candidates drops slightly in comparison to the drivetest results.

DATA

KPN

KPN LEADS IN DATA RELIABILITY

In the Reliability assessment in the Data tests, KPN takes a narrow lead, one score point ahead of T-Mobile. Vodafone follows at a slightly wider score gap. In the drivetests, all three operators score on a par. The ranking is established in the walktests, where the distance of Vodafone behind the other two candidates becomes a little more distinct.

CROWD

KPN

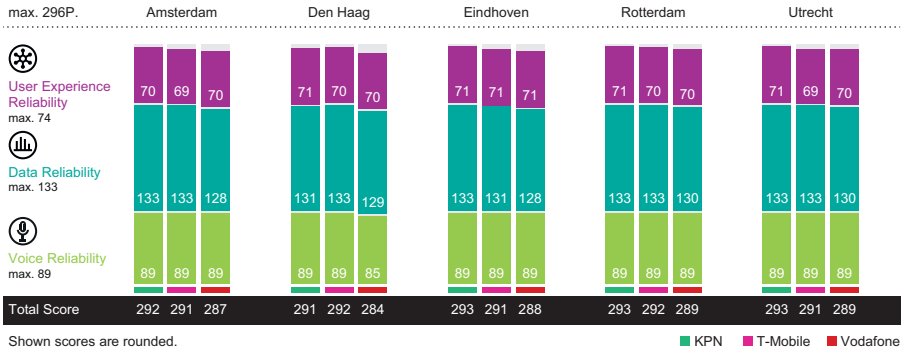
KPN ALSO AHEAD IN CROWDSOURCING, HERE VODAFONE RANKS SECOND AT CLOSE GAP

In the crowdsourced KPIs, KPN once more takes the lead. Vodafone follows at a narrow gap of one score point, and T-Mobile ranks third. Vodafone and T-Mobile achieve nominally the same percentage of fullfilment in this category, but a slight difference on the decimal places still results in a gap of one score point.

RELIABILITY IN CITY SCORES

KPN ALSO AHEAD IN RELIABILITY CITY SCORES IN EINDHOVEN, ROTTERDAM AND UTRECHT. T-MOBILE AND KPN ON A PAR IN AMSTERDAM, T-MOBILE LEADS IN DEN HAAG

In the Reliability Assessment of the Netherland's largest cities (see next page), the ranking familiar from the other categories can be seen in Amsterdam, Eindhoven, Rotterdam and Utrecht – although at partly very narrow score gaps. In Den Haag, T-Mobile takes the lead one score point ahead of KPN. The generally high level of Reliability is good news for Dutch mobile customers.



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The 2023 Mobile Network Test in the Netherlands

City Scores

In addition to the nationwide assessment, it is always interesting to have a closer look at a more regional level. Thus, we have analysed the individual results in the five largest cities of the Netherlands. These results provide valuable insights to their inhabitants, which if the three operators shows the highest performance in their regional environment. Although the overall rankings remain the same as in the nationwide assessment, there are slight variations in the distances between the results of the respective providers.

KPN AHEAD IN AMSTERDAM, VODAFONE ON A PAR WITH KPN IN VOICE AND WITH T-MOBILE IN CROWDSOURCING
The Netherland's capital has also the largest number of inhabitants among the Dutch cities. As in the nationwide results, KPN takes the overall lead with the best results in all tested categories. In the voice assessment, however, KPN scores on a par with Vodafone. And in the Crowdsourcing results, T-Mobile and Vodafone score on a par – one point behind KPN.

AMSTERDAM
KPN

KPN LEADING IN DEN HAAG, T-MOBILE AND VODAFONE ON A PAR IN THE CROWDSOURCING
In the North Sea city, KPN also leads in the overall regional assessment. In the Voice category, T-Mobile scores only one point behind KPN. In the Crowdsourcing, T-Mobile and Vodafone are on a par on the second rank, scoring two points behind KPN.

DEN HAAG
KPN

KPN LEADS IN EINDHOVEN, ALL THREE OPERATORS ON A PAR IN VOICE; VODAFONE ON A PAR WITH T-MOBILE AND ONLY ONE POINT BEHIND KPN IN THE CROWDSOURCING
In the Nordbrabant city, KPN takes the overall lead once more. As in Rotterdam and Utrecht, all three operators score on a par in the Voice assessment. In the Crowdsourcing, Vodafone and T-Mobile follow at a narrow distance of only one point behind KPN.

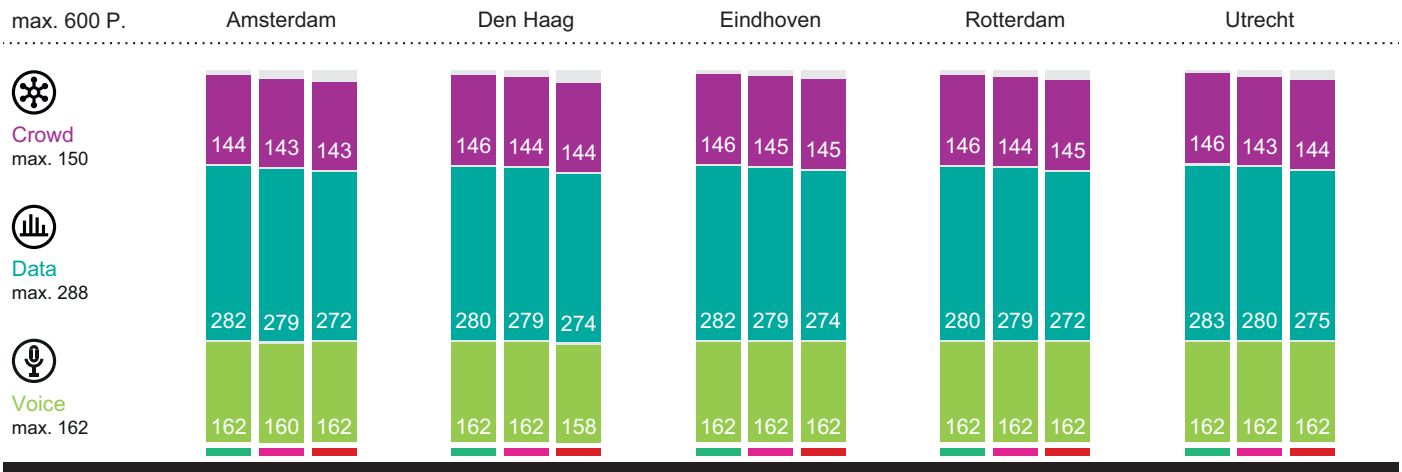
EINDHOVEN
KPN

KPN AHEAD IN ROTTERDAM, ALL THREE OPERATORS ON A PAR IN VOICE; VODAFONE CLOSELY AHEAD OF T-MOBILE IN THE CROWDSOURCING
In the famous port city, KPN is also ahead. As in Eindhoven and Utrecht, in the Voice category, all three operators score on a par. In the Data assessment, T-Mobile scores one point behind KPN, with Vodafone following at a more distinct distance. In the Crowdsourcing, KPN leads, but Vodafone follows on second rank, one point ahead of T-Mobile.

ROTTERDAM
KPN

KPN AHEAD IN UTRECHT, ALL THREE OPERATORS ON A PAR IN VOICE; VODAFONE CLOSELY AHEAD OF T-MOBILE IN THE CROWDSOURCING
In the Netherland's fourth biggest city, located in the center of the country, KPN is again ahead with leading results in all tested categories. As in Eindhoven and Rotterdam, all three operators score on a par in the Voice category. In the Crowdsourcing, Vodafone follows once more on second rank behind KPN, one point ahead of T-Mobile.

UTRECHT
KPN



Shown scores are rounded.

KPN T-Mobile Vodafone

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The 2023 Mobile Network Test in the Netherlands

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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 two 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.

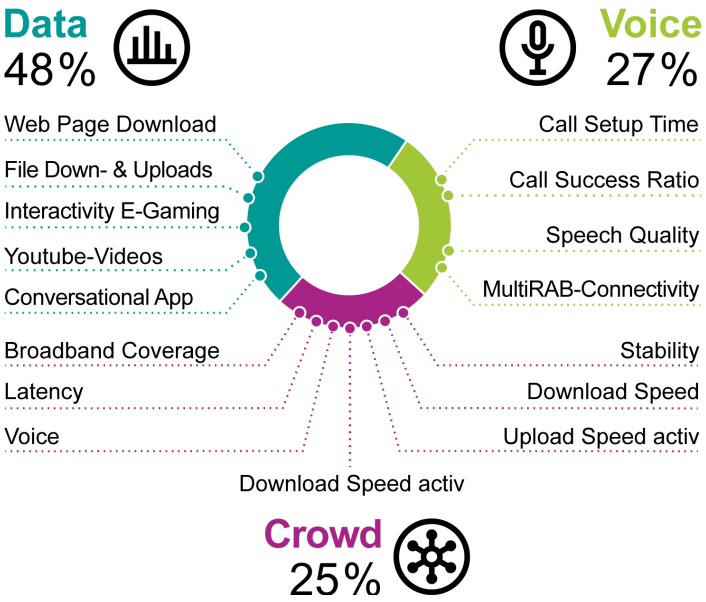
In addition to the drive tests, two walk test teams carried out measurements on foot in each country, in zones with heavy public traffic such as railway station concourses, airport terminals, cafés, public transport and museums. The walk test programme also included journeys on long-distance railway 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 number of EAs where a user had 4G or 5G reception to the total number of 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, in addition to the passive observations, umlaut also conducted *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.