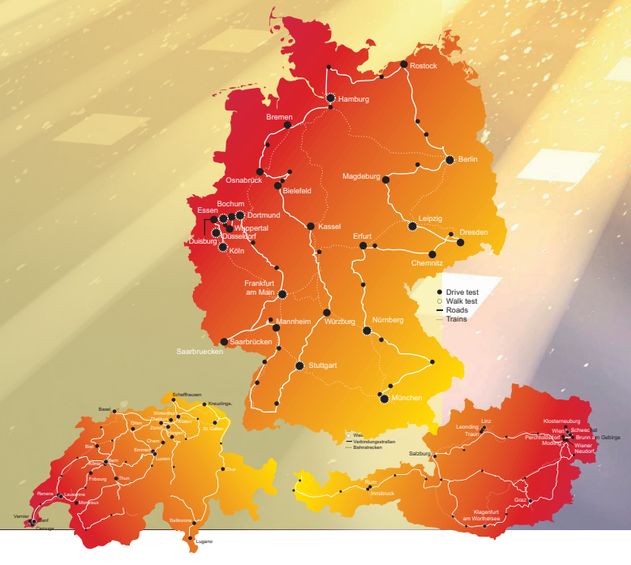
The Great Mobile Network Test 2025

umlaut Part of Accenture + connect

SINCE THE BENCHMARK 1993

Our Mobile Network Test has been carried out for 31 years now. As usual, we have continued to develop and refine our measurement methodology this year again in close cooperation with our test partner umlaut. How will the mobile networks in Germany, Austria and Switzerland perform in 2025?



Our Mobile Network Test celebrated its 30th anniversary last year. If there has been one constant since its beginnings in 1993, it is this: The scope of the analysis and the measurement methodology have continuously evolved. This has been all the more true since 2004: since that year, connect has been working with the Aachen-based benchmarking specialist, which at the time still traded as 'P3' and has been called umlaut since 2019. Together, we have repeatedly expanded the number of countries analysed. Switzerland was added to our home country of Germany in 2011, Austria in 2012 and the United Kingdom in 2014. In 2015, we continued with the Netherlands and Spain, and since then more and more countries have followed.

Leading the industry

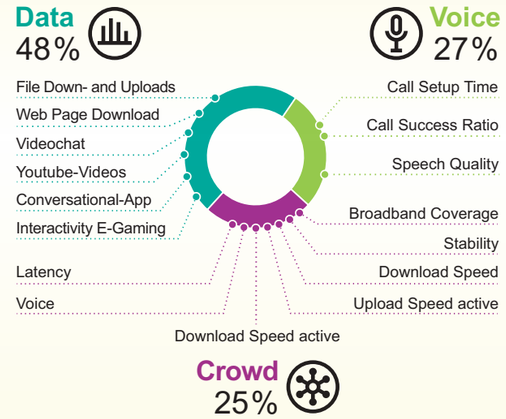
Although some imitators have come along, the connect mobile network test has been the most important and most recognised benchmark in the industry for many years. CTOs base their planning on its results, and many customers make their decision in favour of a provider on the basis of our test results. In order to maintain this quality advantage, umlaut and connect regularly work on adapting the test criteria to the latest developments in mobile networks. From this year on, for example, our test programme will include the increasingly important video chats, and we have also adapted some other threshold values and weightings to current requirements.

Measuring energy efficiency

In addition to performance and quality aspects, the mobile communications industry is also concerned with another important topic: the energy efficiency of the networks. How can high availability and performance be reconciled with the lowest possible energy consumption? However, this aspect is not part of our assessment. Nevertheless, it can be quantified within the framework of the existing measurement methodology. You can find an initial analysis of this question on page 78 of this test. And as already announced in previous issues, we will continue to keep an eye on it in the future.

In oal current test, the aim remains to explore the maximum performance of the networks, but to also keep an eye on everyday performance. Read here how the providers in Germany, Austria and Switzerland fared in our demanding comparative test.

Hannes Rügheimer



Practice-orientated **Evaluation**

The most relevant smartphone applications today are text, voice and video messaging, app usage and mobile web applications. They are all based on data connections, which is why they account for 48% of our overall ranking. However, voice telephony is still important and should work well when you need it. It therefore accounts for 27% of the overall result. Crowdsourcing contributes 25%. These tests supplement the performance-oriented measurements with analyses of the 'user experience' as perceived by a large number of network users.

DRIVETESTS AND WALKTESTS

22,0	23 010	415 005	57 753
million inhabitants	km drive test	Daten-Samples	voice samples

CROWDSOURCING

101,1	3,83	17,8	98,5 %
million inhabitants covered	million participants in the crowd-sourcing	billion samples	average coverage of bulit-up area

Picture: © ra2 studio - Shutterstock.de

The combined values for Germany, Austria and Switzerland are shown here. For individual values per country, see Methodology on page 76.

Germany
Data

In terms of 5G coverage and in our measurements, Telekom is ahead overall – more so in rural areas than in cities and towns. But Telefónica is catching up.

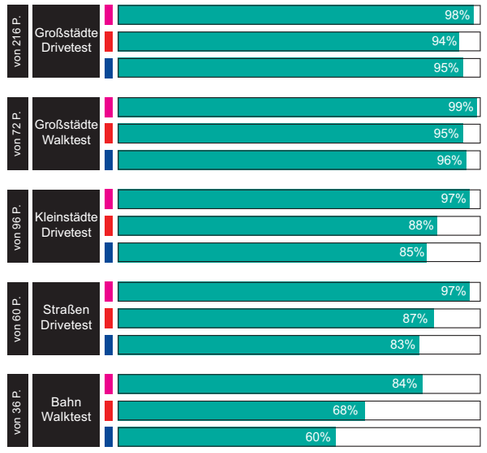
Looking at the overall points achieved in the important data discipline, Telekom was able to maintain exactly the same result as last year, Telefónica improved by two points, while Vodafone lost three points.

The drive and walk tests, which were carried out with the powerful Samsung S23 which supports all network configurations, also clearly show the progress made in 5G expansion: In the sum of the measured values collected in these tests on 5G, Telekom is ahead overall – in large cities with more than 99% (Telefónica/O2: almost 96%, Vodafone: around 89%). Outside of the cities, however, Vodafone has a larger 5G share than Telefónica: In smaller towns, Telekom has over 97%, Vodafone around 80% and Telefónica around 74%. Telekom is also in the lead on connecting roads with a 5G share of around 93%, while Vodafone achieves around 76% and Telefónica around 71%.

The 5G lead of the Bonn-based company becomes even clearer in the trains: even there, our measurements in the Telekom network still show a 5G share of over 95%, while Vodafone only achieves just under 65% and Telefónica just under 58%. The 'Radio standards' column on the right shows how much of this 5G coverage actually reaches customers.

Cities: Telekom leads, Telefónica ahead of Vodafone

In the data measurements carried out as part of the drive and walk tests in major cities, Telekom is in the lead. In both cases, Telefónica/O2 follows at a distance, but one percentage point ahead of Vodafone in each case. The Munich-based company's network expansion in cities is having an effect here. In the data rates recorded in urban drive tests, the P90 value (the fastest 10%) in the Telekom network is an impressive 915 Mbit/s, while Telefónica/O2 with 598 Mbit/s and Vodafone with 564 Mbit/s follow closely behind. The walktests show a slight advantage for Vodafone.



Competition: Telekom is ahead in all scenarios. In the major cities, however, O2/Telefónica overtakes Vodafone.

Operator	Telekom	Vodafone	Telefónica
Data (Cities; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.8	99.8/1.0	99.7/1.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.9/0.7	99.8/1.4	99.9/1.2
90%/10% faster than (Mbit/s)	99.3/321.3	35.2/281.7	41.6/277.6
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.3	99.8/2.4	100.0/2.1
90%/10% faster than (Mbit/s)	18.7/97.2	9.0/77.4	10.3/76.6
File Download (7 Seconds)			
Sucess Ratio (%)	99.9	99.7	99.8
10% faster than (Mbit/s)	915.5	564.3	597.8
Speed > 20Mbit/s / 100Mbit/s (%)	99.4/94.5	97.4/79.2	96.6/82.4
File Upload (7 Seconds)			
Sucess Ratio (%)	99.9	99.8	99.9
10% faster than (Mbit/s)	138.5	119.4	110.1
Speed > 2Mbit/s / 5Mbit/s (%)	99.9/99.3	99.1/95.1	99.4/97.6
Youtube Video			
Success Ratio/Start Time (%/s)	99.8/1.3	99.4/1.6	99.6/1.5
Average Video Resolution (p)	1080	1080	1080
Youtube Live			
Success Ratio/Start Time (%/s)	99.8/2.2	99.5/2.5	99.3/2.4
Average Video Resolution (p)	1080	1079	1079
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.9/4.3	99.9/3.9	99.8/3.9
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	99.3/88.4	97.5/79.4	97.7/79.3
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	98.6/94.3	95.8/89.9	97.3/90.4
Data (Cities; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	100.0/0.8	99.7/1.0	99.8/0.9
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.6	99.8/1.1	100.0/1.2
90%/10% faster than (Mbit/s)	111.8/326.9	43.6/282.3	51.4/273.0
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.3	100.0/1.9	99.4/1.8
90%/10% faster than (Mbit/s)	24.7/97.8	17.2/81.0	14.2/74.8
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	99.6	100.0
10% faster than (Mbit/s)	870.7	589.5	483.7
Speed > 20Mbit/s / 100Mbit/s (%)	99.6/95.9	98.1/77.8	98.3/84.3
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	99.6	99.6
10% faster than (Mbit/s)	139.0	119.3	106.0
Speed > 2Mbit/s / 5Mbit/s (%)	99.4/99.4	99.4/98.1	99.6/97.9
Youtube Video			
Success Ratio/Start Time (%/s)	99.8/1.3	99.6/1.6	99.4/1.5
Average Video Resolution (p)	1080	1080	1080
Youtube Live			
Success Ratio/Start Time (%/s)	99.8/2.1	99.4/2.5	99.4/2.4
Average Video Resolution (p)	1080	1079	1080
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/4.4	99.9/4.3	99.8/4.4
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	99.4/90.7	97.9/81.4	98.1/83.4
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	99.2/95.4	95.8/90.9	98.1/91.6
Data (Towns; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.9	99.6/1.2	99.4/1.3
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.9	99.7/2.1	99.7/3.0
90%/10% faster than (Mbit/s)	65.8/254.0	22.8/215.5	14.7/204.1
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.9/1.6	99.6/3.6	99.7/3.6
90%/10% faster than (Mbit/s)	13.7/91.1	5.2/65.0	5.7/59.5
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	99.3	99.3
10% faster than (Mbit/s)	535.0	397.2	354.2
Speed > 20Mbit/s / 100Mbit/s (%)	98.5/81.8	91.8/56.0	89.3/50.1
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	99.7	98.7
10% faster than (Mbit/s)	129.1	97.2	79.3
Speed > 2Mbit/s / 5Mbit/s (%)	99.6/98.4	97.1/92.3	97.7/94.0
Youtube Video			
Success Ratio/Start Time (%/s)	99.9/1.4	98.9/1.8	97.3/2.0
Average Video Resolution (p)	1080	1079	1080
Youtube Live			
Success Ratio/Start Time (%/s)	99.7/2.4	98.0/2.7	98.4/2.9
Average Video Resolution (p)	1080	1078	1077
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.9/4.1	99.9/3.7	99.6/3.9
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	98.8/84.8	94.5/74.8	92.7/69.8
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	98.2/92.4	94.1/87.9	94.3/83.6

Telekom ahead in rural areas

In smaller towns and on the connecting roads, Telekom's lead is growing, with Vodafone and Telefónica/O2 following some way behind. At the level of the tested services, Telefónica/O2 shows potential for improvement especially in the YouTube tests. However, it is a positive observation that the success rates of most of the applications tested are quite high, despite varying performance.

Slight improvements in German trains

All three providers made small improvements compared to the previous year when it comes to the perennial problem of the railways. However, the gap to the other test scenarios is still clear. Telekom also achieved the relatively best results here, with Vodafone following at a distinct distance and Telefónica/O2 again behind. But perhaps we are seeing the first successes of the expansion efforts that have been launched by all operators

Tour of Germany: This year's test tour led through 23 major cities (11 of them with walk tests) and 25 smaller towns.

Operator	Telekom	Vodafone	Telefónica
Data (Roads; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.6/1.0	98.4/1.3	98.7/1.4
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.8/1.4	99.5/3.7	100.0/4.2
90%/10% faster than (Mbit/s)	37.1/212.2	10.7/172.1	7.6/144.6
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/2.3	100.0/4.5	99.6/5.2
90%/10% faster than (Mbit/s)	9.5/84.7	3.9/57.6	3.7/52.8
File Download (7 Seconds)			
Sucess Ratio (%)	99.5	99.3	98.4
10% faster than (Mbit/s)	370.3	242.7	219.3
Speed > 20Mbit/s / 100Mbit/s (%)	97.5/78.8	83.4/42.6	81.2/29.1
File Upload (7 Seconds)			
Sucess Ratio (%)	99.8	99.3	98.9
10% faster than (Mbit/s)	124.1	94.9	74.9
Speed > 2Mbit/s / 5Mbit/s (%)	98.9/96.6	96.9/89.4	96.2/88.0
Youtube Video			
Success Ratio/Start Time (%/s)	99.6/1.5	97.4/1.9	93.9/2.1
Average Video Resolution (p)	1080	1078	1078
Youtube Live			
Success Ratio/Start Time (%/s)	99.5/2.4	95.9/2.9	95.5/3.1
Average Video Resolution (p)	1079	1076	1073
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.9	99.1/3.6	99.5/3.6
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	97.5/83.1	90.5/72.8	89.8/69.8
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	94.2/90.5	87.9/88.1	90.9/86.0

Operator	Telekom	Vodafone	Telefónica
Data (Trains; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	98.1/1.5	94.1/1.8	90.3/2.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.5/4.5	97.9/6.7	96.6/10.6
90%/10% faster than (Mbit/s)	7.0/240.0	5.1/167.5	2.3/200.2
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.7/4.1	98.7/6.9	97.6/7.3
90%/10% faster than (Mbit/s)	4.4/60.8	2.6/46.0	2.5/40.8
File Download (7 Seconds)			
Sucess Ratio (%)	97.7	97.1	91.9
10% faster than (Mbit/s)	483.6	288.2	322.8
Speed > 20Mbit/s / 100Mbit/s (%)	81.9/44.4	69.4/30.6	63.0/35.6
File Upload (7 Seconds)			
Sucess Ratio (%)	98.7	97.4	95.5
10% faster than (Mbit/s)	84.4	49.7	48.5
Speed > 2Mbit/s / 5Mbit/s (%)	97.9/92.0	95.2/85.8	94.2/82.9
Youtube Video			
Success Ratio/Start Time (%/s)	95.5/2.2	86.4/2.6	84.2/2.6
Average Video Resolution (p)	1076	1077	1073
Youtube Live			
Success Ratio/Start Time (%/s)	92.9/3.0	79.7/3.5	78.5/3.6
Average Video Resolution (p)	1075	1068	1064
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.7/3.5	97.8/3.3	99.0/3.4
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	84.3/71.4	77.7/64.5	70.5/63.7
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	78.9/84.3	71.4/77.7	73.5/77.1

Radio standards

What developments can be seen in the networks in the expansion from 5G NSA to 5G SA? This question can be answered by crowdsourcing.

How the expansion of mobile networks is progressing is no longer only reflected in the answer to the question 'Is 5G available?'. The next step in 5G roll-outs is the development from 5G non-standalone (NSA, shared core network with 4G) to 5G standalone (SA, own 5G core network).

In Germany, Telefónica/O2 and Vodafone already offer '5G SA' – O2 since autumn 2023, Vodafone since spring 2024. In both cases, customers need suitable end devices and must register for '5G plus'. Deutsche Telekom is still holding back regarding this topic.

As we have deliberately not yet included 5G SA in our drive tests and walk tests, the development can best be read from the crowdsourcing data collected by umlaut. The table below shows what proportion of the samples were received via which radio standard. We show the percentage values at the beginning and the end of this year's observation period – but for the entire data pool, without the filtering carried out in the crowd discipline.

The increase in 5G overall and in 5G SA can be clearly seen. The fact that the 5G shares are smaller than in the drive tests and walk tests is due to the end devices and tariffs used.

Crowdsourcing samples	Telekom		Vodafone		Telefónica	
Month	May 24	November 24	May 24	November 24	May 24	November 24
2G/3G	2,5%	2,1%	4,4%	3,5%	3,8%	2,8%
4G	84,4%	81,4%	78,9%	76,2%	84,3%	79,9%
5G Non-Standalone	13,1%	16,4%	16,3%	19,3%	11,8%	17,1%
5G Standalone	0,0%	0,0%	0,4%	0,9%	0,1%	0,1%

All values rounded to one decimal place. The internal calculation of points and percentages was carried out with three decimal places.

Voice

Vodafone ranks close to Telekom when it comes to making calls in cities, with Telefónica/O2 following at a slight distance. The differences are greater in rural areas.

The fact that the scores achieved in the telephony discipline are high overall and that this also applies to success rates in particular is good news. After all, quality deficiencies are particularly noticeable when speaking on the phone if the connection is not established at all or if the voice quality is extremely poor.

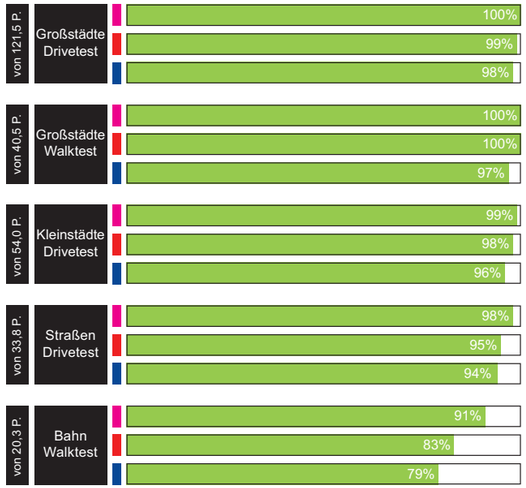
Telekom slightly ahead of Vodafone in major cities

Although there are differences in the major cities, they are very small. The further you move into the countryside, the greater becomes the gap between Telekom, that is also the leader here, and second-placed Vodafone as well as third-placed Telefónica.

Despite gaps Telekom ahead on connecting roads and on the railways

However, the gaps are still negligible, even in the smaller towns. The distane between Vodafone and Telefónica becomes more pronounced on connecting roads. This is particularly noticeable for car drivers who want to make calls while driving in these areas.

When making calls on the train, the air is getting thinner for all three providers, but Telekom still achieves the best results. However, both the Bonn-based provider and Vodafone fall behind the scores they achieved last year in this discipline. A small ray of hope is that Telefónica/O2 manages to narrow the gap to Vodafone in this most difficult test scenario and is the only provider in the test field to improve in the railway scenario.



Raised: Telekom is ahead everywhere, but in smaller towns, on connecting roads and especially on the railway, the gaps to Vodafone and Telefónica/O2 are clearer than in the big cities.

Operator	Telekom	Vodafone	Telefónica
Voice Cities (Drivetest)			
Sucess Ratio (%)	100.0	99.9	99.8
Call Setup Time P90 (s)	1.0	1.0	1.1
Speech Quality P10 (MOS-LQO)	4.7	4.6	4.5
Voice Cities (Walktest)			
Sucess Ratio (%)	100.0	99.9	99.6
Call Setup Time P90 (s)	1.0	1.0	1.0
Speech Quality P10 (MOS-LQO)	4.7	4.7	4.7
Voice Towns (Drivetest)			
Sucess Ratio (%)	99.9	99.8	99.5
Call Setup Time P90 (s)	1.0	1.0	1.1
Speech Quality P10 (MOS-LQO)	4.6	4.6	4.5
Voice Roads (Drivetest)			
Sucess Ratio (%)	99.6	98.8	98.8
Call Setup Time P90 (s)	1.1	1.1	1.3
Speech Quality P10 (MOS-LQO)	4.6	4.4	4.4
Voice Trains (Walktest)			
Sucess Ratio (%)	97.4	95.0	93.8
Call Setup Time P90 (s)	1.1	1.2	1.4
Speech Quality P10 (MOS-LQO)	4.3	4.1	4.1

Single reviews

Telekom

The 14th test victory in a row is clear proof of the high performance of the Telekom network and the technicians responsible for it. The fact that the Bonn-based company was able to improve its result this year by a further three points compared to the previous year, even in the high spheres of the rare top grade of 'outstanding', also speaks for a very consistent network expansion.

Vodafone

Vodafone essentially maintained its previous year's result, which should not be underestimated in view of strong competitors and increasing customer demands. The Düsseldorf-based company's second place is confirmed across the board in all test categories. Its lead over third-placed Telefónica/O2 in the 5G roll-out outside major cities is also clear.

O2

Telefónica/O2 achieved the most significant increase among German network operators this time: The Munich-based company improved its previous year's result by a whopping 14 points. Although it remains in third place, O2 overtakes its competitor Vodafone in some categories such as data performance in major cities and some crowdsourcing KPIs, while the gap shrinks in others.

Crowd

Crowdsourcing based on the user experience of a large number of customers shows the increasingly tough battle between the leading Telekom and the runner-up Vodafone.

Long-time connect readers already know that while the drive tests and walk tests concentrate on the maximum performance provided by the networks, crowdsourcing focuses on the broader range: analysing over 16.5 billion samples contributed by almost 3.6 million users allows conclusions to be drawn about the 'user experience' – how well is the performance of the networks received by all of their users?

The evaluation of broadband quality shows that 5G or at least 4G is received by almost all customers who are logged into the mobile network at all. Telekom is ahead in all sub-results for broadband coverage, but Telefónica just manages to overtake its competitor Vodafone. The exact definition of quality, reach and time share of broadband coverage is shown on page 77.

In terms of the data rates achieved by customers, Telekom leads in almost all values, with Vodafone only ahead in the P10 value (90% of samples faster than...) for active download data rates. In the active upload measurements, Telefónica is in second place ahead of Vodafone, who follows in third place.

Telekom also achieved the largest shares in the analyses of the latency categories. In the basic categories (OTT voice class and gaming), Vodafone and Telefónica follow in this order and keep up quite well with the Bonn-based company overall. In the most demanding latency category 'high-end gaming', Telekom is extending its lead, but Telefónica/O2 has a higher share than Vodafone. The ranking for HD telephony and stability also remains in the order Telekom — Telefónica – Vodafone.

Operator	Telekom	Vodafone	Telefónica
Broadband Coverage			
Coverage Quality (%)	98.7	96.6	97.1
Coverage Reach (%)	97.5	97.0	97.7
Time on Broadband (%)	99.0	97.1	97.3
Download Speed			
Basic Internet Class (%)	97.0	96.7	96.5
HD Video Class / UHD Video Class (%)	90.0/41.2	89.2/35.9	87.6/31.4
Latency			
Gaming Class / OTT Voice Class (%)	93.6/97.7	88.6/96.1	84.5/95.5
High End Gaming (%)	31.2	8.8	10.0
Voice			
HD Voice (%)	98.8	93.3	96.6
Download Speed (Active)			
Avg. Throughput (Mbit/s)	99.5	80.9	56.5
90%/10% faster than (Mbit/s)	7.4/236.8	7.7/188.7	4.7/134.5
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	24.3	20.0	18.2
90%/10% faster than (Mbit/s)	2.9/54.4	2.2/47.1	2.3/41.9
Stability			
Transaction Success (%)	96.5	94.6	94.8

Reliability

In our separate look at the basic requirements, Telekom is also ahead and Vodafone follows slightly behind. All three networks deliver stable performance.

The 'Reliability' section is not a separate test discipline, but rather a different look at the results of the previous categories. The analysis here concentrates on the basic requirements and ignores the KPIs that focus more on top performance. The result shows how well the operators provide their customers with the services relevant for everyday use.

The described reliabilty evaluation shows no significant differences compared to the overall picture. The ranking and the gaps between the three candidates remain roughly the same in all analyses. Telefónica has to accept a more pronounced points deficit, particularly in the walk tests in the data and voice disciplines – the coverage weaknesses identified in the railway may in particular have an impact here. However, this also applies to a lesser extent to Vodafone and Telekom.

Vodafone also achieved a solid second place in the reliability ranking in all categories behind frontrunner Telekom. In crowdsourcing category as well as overall, however, Telefónica was able to reduce its gap to the second placed Vodafone.

Operator		Telekom	Vodafone	Telefónica
Voice	max. 162 points	159	156	152
Drivetest	126	99%	97%	96%
Walktest	36	96%	91%	87%
Data	max. 288 points	282	266	261
Drivetest	223	99%	94%	93%
Walktest	65	95%	86%	83%
Crowd	max. 150 points	141	135	132
Crowd	150	94%	90%	88%
Total	600	582	557	545

All values rounded to whole numbers. The internal calculation of points and percentages was carried out with three decimal places. The maximum achievable 600 points are an extract from the overall result totalling 1000 points (see p. 76/77 for details).

Austria
Data

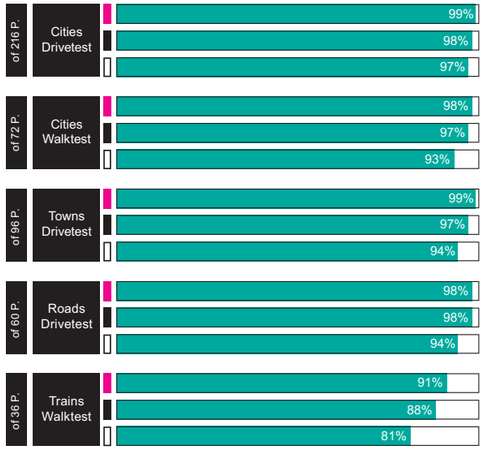
Magenta leads the data ranking closely ahead of A1. Drei is catching up with its competitors' high performance.

Magenta and A1 largely maintain their levels from the previous year in the data category (Magenta: -2 points, A1: -1 point). Drei caught up significantly and scored 10 points more in the data category.

This is probably partly due to the progress made in the 5G roll-out of Austria's smallest provider. However, an analysis of the measured values collected in the drive tests and walk tests shows that 5G radio cells are widespread among all three operators – especially in urban areas. The crowdsourcing results shown on the right, on the other hand, reflect the actual 5G usage by Austrian mobile customers. They also depend on end user devices and tariffs booked. In the 15 major cities tested, the drive tests for Magenta and A1 show a 5G share of over 99%, for Drei over 98%. In the walk tests, the values are slightly lower: around 94% for Magenta, around 91% for A1, around 89% for Drei. In smaller cities, Magenta and A1 are at around 99%, while the 5G share for Drei is around 93%. On connecting roads, A1 leads with a 5G share of around 99%, while Magenta achieves around 69% and Drei only around 37%. The situation is similar on railways, where A1 achieves a 5G share of around 88%, Magenta around 82% and Drei around 61%.

Major cities: Magenta minimally ahead of A1 and Drei

The race in the drive tests in major Austrian cities is close. Magenta, A1 and Drei crossed the line in a photo finish with the wafer-thin margin of one percentage point each. The metropolitan walk tests show very similar results for Magenta and A1, with Drei falling slightly behind. A closer look at the measurement data also shows that A1 and Magenta have already come a long way with the combined use of more than onr frequenciy – the so-called 'carrier aggregation'. In the cities, we see high proportions of 5G on two frequencies plus LTE on three frequencies (5GNR 2CA plus LTE 3CA). Magenta uses one 5G and four LTE frequencies (5GNR + LTE4CA).



Narrow race: Magenta and A1 are close to each other in all scenarios, but Drei is also keeping up well.

Operator	Magenta	A1	Drei
Data (Cities; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.6/0.8	100.0/0.9	99.8/1.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.5	100.0/0.7	100.0/0.8
90%/10% faster than (Mbit/s)	152.3/379.1	125.3/251.9	98.5/296.3
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.9	100.0/1.1	100.0/1.6
90%/10% faster than (Mbit/s)	32.0/100.9	27.7/93.5	17.2/82.6
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.8
10% faster than (Mbit/s)	1031.7	1102.3	773.6
Speed > 20Mbit/s / 100Mbit/s (%)	99.9/99.0	99.7/97.6	99.6/96.5
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.9
10% faster than (Mbit/s)	169.2	146.5	122.5
Speed > 2Mbit/s / 5Mbit/s (%)	99.9/99.9	99.9/99.8	99.2/98.2
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.3	100.0/1.9	99.9/1.6
Average Video Resolution (p)	1080	1077	1080
Youtube Live			
Success Ratio/Start Time (%/s)	100.0/1.9	99.9/2.6	99.8/2.3
Average Video Resolution (p)	1080	1080	1079
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.6/4.4	100.0/4.1	99.7/3.8
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	99.2/86.3	99.6/78.0	97.7/76.4
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	95.8/93.5	99.2/89.4	96.6/87.6
Data (Cities; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	100.0/0.8	100.0/1.0	99.6/1.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.6	100.0/0.8	100.0/1.0
90%/10% faster than (Mbit/s)	131.1/361.0	113.3/231.5	82.1/279.7
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.4	99.8/1.2	99.6/2.6
90%/10% faster than (Mbit/s)	24.9/98.5	26.3/86.2	10.1/77.8
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	99.8	99.6
10% faster than (Mbit/s)	1049.4	1001.5	726.9
Speed > 20Mbit/s / 100Mbit/s (%)	99.6/97.6	100.0/97.4	98.9/89.7
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.3
10% faster than (Mbit/s)	165.2	132.5	122.5
Speed > 2Mbit/s / 5Mbit/s (%)	99.8/98.3	99.3/98.7	98.5/96.2
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.4	100.0/2.0	99.8/1.7
Average Video Resolution (p)	1080	1078	1078
Youtube Live			
Success Ratio/Start Time (%/s)	99.8/2.0	99.8/2.7	98.2/2.3
Average Video Resolution (p)	1080	1079	1080
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.3/4.5	99.9/4.3	99.7/4.1
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	99.2/84.4	99.6/77.2	96.0/75.5
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	91.7/95.8	99.6/93.1	94.9/91.5
Data (Towns; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.8	99.9/1.0	99.7/1.1
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.6	100.0/0.8	99.7/1.0
90%/10% faster than (Mbit/s)	125.5/337.8	111.4/244.6	68.3/273.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.0	100.0/1.4	99.7/1.8
90%/10% faster than (Mbit/s)	31.3/92.4	19.7/88.2	13.5/72.5
File Download (7 Seconds)			
Sucess Ratio (%)	99.7	100.0	99.7
10% faster than (Mbit/s)	936.0	1106.7	841.8
Speed > 20Mbit/s / 100Mbit/s (%)	99.7/96.7	99.7/96.4	99.0/91.4
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	100.0
10% faster than (Mbit/s)	150.7	138.5	111.8
Speed > 2Mbit/s / 5Mbit/s (%)	100.0/100.0	100.0/99.5	99.7/99.2
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.4	100.0/2.0	99.2/1.7
Average Video Resolution (p)	1080	1076	1079
Youtube Live			
Success Ratio/Start Time (%/s)	100.0/2.0	100.0/2.7	99.5/2.4
Average Video Resolution (p)	1080	1079	1079
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.5/4.4	99.8/4.2	100.0/3.8
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	99.7/81.6	98.7/74.0	95.6/70.9
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	98.6/90.0	99.2/84.9	94.8/81.6

Operator	Magenta	A1	Drei
Data (Roads; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/0.9	99.8/1.0	99.7/1.2
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.3	100.0/1.0	100.0/1.5
90%/10% faster than (Mbit/s)	34.3/292.8	64.1/238.6	38.3/190.7
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/2.0	100.0/1.9	100.0/2.3
90%/10% faster than (Mbit/s)	11.3/73.9	13.4/81.4	9.2/56.3
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.2
10% faster than (Mbit/s)	654.4	782.8	417.2
Speed > 20Mbit/s / 100Mbit/s (%)	94.9/70.1	99.7/83.1	99.2/57.7
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.5
10% faster than (Mbit/s)	111.3	124.2	76.6
Speed > 2Mbit/s / 5Mbit/s (%)	98.9/98.4	99.2/98.6	99.2/97.5
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.5	100.0/2.0	98.6/1.9
Average Video Resolution (p)	1079	1077	1078
Youtube Live			
Success Ratio/Start Time (%/s)	99.7/2.2	99.5/2.7	98.9/2.6
Average Video Resolution (p)	1080	1079	1078
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.6/4.3	99.9/4.1	99.4/3.6
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	98.0/79.8	99.4/74.8	95.7/66.3
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	94.4/89.4	98.3/86.7	93.1/78.1

Magenta closely ahead in small towns, on par with A1 on roads

The performance level in the 15 smaller towns visited as part of the test and on connecting roads is similar: In the small towns, Magenta leads by a narrow margin of A1, while on the connecting roads the two are on a par. Three follows at a relatively close distance. A pleasant result for drivers in Austria.

On the railways too: Magenta just ahead of A1

In the most difficult scenario, in the tests conducted in Austrian trains, the achieved scores fall and the gaps in the ranking become again more pronounced: Magenta is ahead here, closely followed by A1 and at a slightly greater distance by Drei. Compared to Germany, the performance is high – but it is a pity that it has fallen slightly compared to the previous year.

Operator	Magenta	A1	Drei
Data (Trains; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	98.4/1.0	97.3/1.2	96.4/1.3
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	97.9/1.4	97.9/2.5	98.6/2.5
90%/10% faster than (Mbit/s)	36.4/339.0	33.2/218.0	15.6/252.9
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	98.2/3.2	96.8/2.9	95.3/4.8
90%/10% faster than (Mbit/s)	6.2/82.7	7.3/69.9	4.5/51.3
File Download (7 Seconds)			
Sucess Ratio (%)	98.6	98.6	96.1
10% faster than (Mbit/s)	720.6	795.2	595.7
Speed > 20Mbit/s / 100Mbit/s (%)	96.1/77.5	96.4/77.3	91.2/57.7
File Upload (7 Seconds)			
Sucess Ratio (%)	96.9	96.5	97.1
10% faster than (Mbit/s)	111.6	104.1	69.5
Speed > 2Mbit/s / 5Mbit/s (%)	97.9/94.3	98.2/94.9	94.1/86.7
Youtube Video			
Success Ratio/Start Time (%/s)	98.3/1.6	94.8/2.2	95.4/2.0
Average Video Resolution (p)	1076	1077	1078
Youtube Live			
Success Ratio/Start Time (%/s)	98.9/2.2	96.7/3.0	93.9/2.7
Average Video Resolution (p)	1075	1079	1077
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	98.0/4.4	97.6/3.8	97.6/3.6
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	90.6/74.6	93.6/68.3	86.6/61.7
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	78.9/87.9	91.8/86.6	77.9/80.2

Alpine tour: The drive tests led through 15 large and 15 small towns, plus walk tests in six cities.

Crowdsourcing samples	Magenta		A1		Drei	
Month	May 24	November 24	May 24	November 24	May 24	November 24
2G/3G	3,5%	2,7%	10,0%	8,5%	5,4%	4,4%
4G	86,8%	88,9%	77,6%	77,2%	79,6%	79,1%
5G Non-Standalone	9,7%	8,3%	12,3%	14,3%	13,3%	10,5%
5G Standalone	0,0%	0,0%	0,0%	0,0%	1,7%	6,0%

All values rounded to one decimal place. The internal calculation of points and percentages was carried out with three decimal places.

Radio standards

The crowdsourcing carried out by umlaut also provides insights into which mobile communications technologies Austrian customers use.

The crowdsourcing-based analysis of the use of the various mobile communications standards in the networks examined reveals two special aspects in Austria: Firstly, although 3G/UMTS is gradually being switched off, it was still in operation at the time of the assessment shown below. The proportions in the 2G/3G category are correspondingly high, particularly in the A1 network.

On the other hand, Austria's smallest network operator, Drei, decided to early switch to the more advanced '5G Standalone' (5G SA) technology for its 5G roll-out. Shares with this type of radio connection, which we have not yet made use of in this year's drive tests and walk tests for compatibility and performance reasons, have grown rapidly at Drei during the period under review. Drei benefits from the fact that the provider has realised a '5G common core' in its network: a core network that supports both 5G non-stand-alone (i.e. in cooperation with LTE) as well as5G SA.

However, the number of customers using 5G will also grow at Magenta and A1 in the long term. This is also in the interest of the network operators because it frees up their 4G frequencies and provides new capacities with 5G.

Voice

Magenta defends the top position in mobile telephony, with A1 and Drei following at a slight distance. With an otherwise high level, only telephoning on the train could improve somewhat.

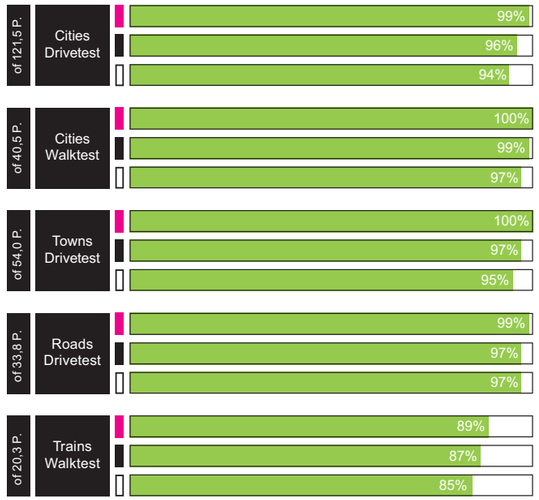
In the voice discipline, Magenta and A1 each gained one point compared to the previous year. Three achieved a somewhat more significant increase of 5 points.

Magenta narrowly ahead in cities and in the countryside

Although there is a difference of a few percentage points in each case, the results of the voice measurements in the larger cities and the smaller towns as well as on the connecting roads are at a high level. Magenta is close ahead in each case, but its two competitors follow at a narrow distance. A1 and Drei even share second place on connecting roads. The high voice quality in all the scenarios mentioned is pleasing. Magenta benefits the most from VoLTE ('Voice over LTE'), which has now been introduced in all networks. Magenta and A1 also offer fast call set-up times - with Drei, on the other hand, they are somewhat longer.

Slight restrictions on trains, Magenta closely ahead of A1 and Drei

As could already beseen in the data measurements, the performance determined by the test teams in Austrian trains drops visibly compared to the other scenarios. However, it is noticeable here that all three operators are still close together. Compared to the previous year, A1 and Drei were able to narrow the gap to Magenta, which is narrowly ahead. Overall, telephoning on ÖBB trains works comparatively well.



High performance: Whether in large cities, small towns or on Austrian roads: Magenta leads by a narrow margin, with A1 and Drei following close behind. This also applies to the railways, albeit at a slightly lower level.

Operator	Magenta	A1	Drei
Voice Cities (Drivetest)			
Sucess Ratio (%)	99.8	99.5	99.4
Call Setup Time P90 (s)	0.9	1.3	1.9
Speech Quality P10 (MOS-LQO)	4.7	4.6	4.5
Voice Cities (Walktest)			
Sucess Ratio (%)	100.0	99.9	99.7
Call Setup Time P90 (s)	0.9	1.3	1.8
Speech Quality P10 (MOS-LQO)	4.7	4.6	4.6
Voice Towns (Drivetest)			
Sucess Ratio (%)	100.0	99.7	99.5
Call Setup Time P90 (s)	0.9	1.3	1.9
Speech Quality P10 (MOS-LQO)	4.7	4.6	4.5
Voice Roads (Drivetest)			
Sucess Ratio (%)	99.7	99.3	99.6
Call Setup Time P90 (s)	0.9	1.4	1.9
Speech Quality P10 (MOS-LQO)	4.6	4.6	4.5
Voice Trains (Walktest)			
Sucess Ratio (%)	96.5	95.7	95.5
Call Setup Time P90 (s)	0.9	1.4	1.9
Speech Quality P10 (MOS-LQO)	4.6	4.5	4.5

Single reviews

Magenta With this year's test victory, Magenta took first place in our mobile network test for the seventh time in a row – once again with the rare score of 'outstanding'. The provider leads in all individual disciplines and improved by three points compared to the previous year. In the drive tests, Magenta achieved a 5G share of over 99% in both small towns and larger cities - together with A1.

A1 A1 maintains its very high performance level from the previous year and therefore also rightly receives the rare grade 'outstanding'. In most test disciplines, A1 is almost on a par with Magenta. Regarding the 5G roll-out, the provider leads on Austrian connecting roads and in trains, and in the urban as well as suburban drive tests we see 5G shares of over 99% together with Magenta.

Drei With an increase of 24 points, the Hutchison brand achieved the most significant improvement compared to the previous year. This applies to both the data and voice disciplines and is confirmed by the crowdsourcing. In many test disciplines, Drei comes close to A1 or even overtakes its competitor. Its increased efforts in terms of 5G roll-out is also paying off.

Crowd

In the crowdsourcing analyses, which reflect the actual customer experience, Magenta leads ahead of Drei, with A1 closely coming in third.

In the crowdsourcing analyses conducted by umlaut, Magenta gained 4 points compared to the previous year, while A1 fell slightly behind by 2 points. Drei manages to improve the most – by a total of 9 points, moving up to second place in the crowd discipline. Crowdsourcing thus confirms the significant improvements we have seen this time for Austria's smallest network operator.

In the analyses of broadband coverage, Magenta takes the lead in the KPIs coverage quality and time on broadbanc. A1 is ahead in terms of broadband reach (definitions and explanations on page 77).

In the passively observed data rates, A1 was able to carve out a small lead in the demanding 'UHD video' speed class (at least 20 Mbps), with Drei coming in second place and relegating Magenta to third place. In the lower data rate classes, the competitors rank again very close together. In the actively determined upload and download speeds, the order is Magenta - A1 - Drei.

In the latency measurements, Magenta and Drei are ahead in the gaming category (less than 50 ms), while the gaps become quite narrow in the 'OTT voice services' (less than 100 ms).

However, the differentiation becomes clear in the 'high-end gaming class' (less than 20 ms), which was added this year: Here, A1 falls well behind Magenta and Drei. A similar situation can also be observed to a lesser extent in the proportion of voice connections in HD quality as well as in the stability rating.

Operator	Magenta	A1	Drei
Broadband Coverage			
Coverage Quality (%)	99.3	96.9	97.8
Coverage Reach (%)	92.1	93.2	89.1
Time on Broadband (%)	99.3	95.4	97.8
Download Speed			
Basic Internet Class (%)	97.3	97.3	97.1
HD Video Class / UHD Video Class (%)	91.9/37.9	91.1/39.9	90.7/39.2
Latency			
Gaming Class / OTT Voice Class (%)	95.8/98.6	90.6/98.2	95.0/97.7
High End Gaming (%)	49.4	5.0	36.2
Voice			
HD Voice (%)	98.6	93.2	97.6
Download Speed (Active)			
Avg. Throughput (Mbit/s)	95.6	78.1	62.8
90%/10% faster than (Mbit/s)	14.7/186.8	10.6/161.1	8.2/134.7
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	25.4	21.5	19.3
90%/10% faster than (Mbit/s)	3.9/54.1	3.5/46.9	2.6/39.6
Stability			
Transaction Success (%)	97.9	94.7	95.8

Reliability

The familiar ranking of Magenta - A1 - Three is also evident in the reliability ranking, which focuses on basic performance.

Our special reliability rating only takes into account the KPIs that are relevant for good basic services, while we exclude the scoring related to top performance. This is why this discipline is not a separate evaluation category, but rather an additional look at the overall results.

Accordingly, the ranking in this category is the same as the overall ranking in Austria. In the voice category, Magenta is slightly ahead of A1 and Drei, which rank quite close together here.

In the data category, on the other hand, A1 has a wafer-thin lead of one point. Drei was able to narrow the gap to its two competitors here, but is still 8 points behind Magenta.

Magenta leads in crowdsourcing. But with the improvements already observed in the other sub-chapters, Drei achieved second place here, 2 points ahead of A1. Overall, however, the reliability rating confirm in any case that the three Austrian network operators provide their customers with stable connections.

Operator		Magenta	A1	Drei
Voice	max. 162 points	158	153	151
Drivetest	126	98%	95%	94%
Walktest	36	94%	92%	90%
Data	max. 288 points	282	283	274
Drivetest	223	99%	100%	97%
Walktest	65	95%	95%	89%
Crowd	max. 150 points	144	138	140
Crowd	150	96%	92%	93%
Total	600	584	574	565

All values rounded to whole numbers. The internal calculation of points and percentages was carried out with three decimal places.
The maximum 600 points achievable here are an extract from the overall result totalling 1000 points (see p. 76/77).

Switzerland
Data

In terms of data connectivity, Swisscom and Sunrise are tied, with Salt following close behind.

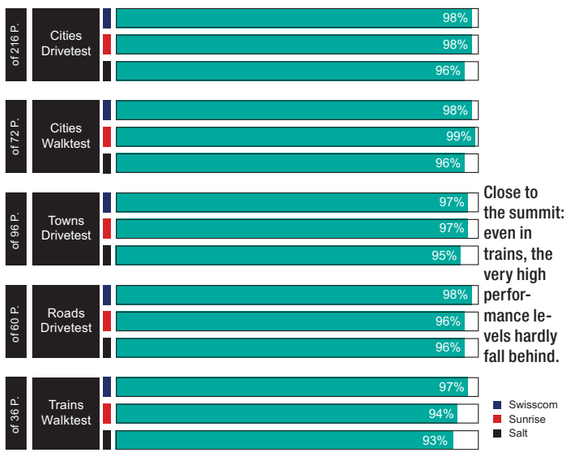
Traditionally, the battle for the first place in the network test in Switzerland takes place at the highest level. This should be borne in mind when you observe that Swisscom scored 4 points less in the data discipline than in the previous year and Salt dropped one point, while Sunrise gained 2 points.

The analysis of how many measured values were collected in the drive and walk tests via 5G shows high 5G shares: In the drive tests in 24 major Swiss cities, Swisscom comes in at just under 99%, Sunrise at more than 97% and Salt at over 95%. In the walk tests in the major cities, part of which was carried out indoors, Swisscom scored around 93%, Sunrise around 91% and Salt around 85%. The 5G shares are also high in the smaller towns visited by the drivetest teams: for Swisscom around 98%, for Sunrise around 95% and for Salt around 92%.

The differences become greater on Swiss connecting roads: Here, Swisscom has a 5G share of around 94%, Sunrise around 76% and Salt around 65%. Finally, on Swiss trains, we count around 91% 5G for Swisscom, 82% for Sunrise and around 68% for Salt. It should be noted that where there is no 5G, the Swiss operators very probably offer 4G/LTE.

Swisscom and Sunrise on a par in urban drive tests, Sunrise closely ahead in walk tests

In the drive tests conducted in major cities, Swisscom and Sunrise are on a par, with Salt following close behind. In the walk tests done in eight Swiss cities, Sunrise is narrowly ahead, followed by Swisscom and then Salt, each at a small gap and all three with excellent success rates. In the download tests, Swisscom delivers over 1 Gbps in urban scenarios, thanks to the 'carrier aggregation' of four or even five LTE frequencies with 5G. In the 17 small towns visited, Swisscom and Sunrise are on a par, with Salt following behind at very close distance. Overall, performance outside the centres drops only very slightly.



Close to the summit: even in trains, the very high performance levels hardly fall behind.

Operator	Swisscom	Sunrise	Salt
Data (Cities; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.8	99.9/0.8	99.9/0.9
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.6	100.0/0.8	100.0/1.1
90%/10% faster than (Mbit/s)	109.3/459.8	71.8/347.8	52.4/305.3
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.0	100.0/1.2	99.7/1.3
90%/10% faster than (Mbit/s)	26.4/120.5	19.7/100.5	23.1/87.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.6	100.0	99.9
10% faster than (Mbit/s)	1029.8	938.8	719.6
Speed > 20Mbit/s / 100Mbit/s (%)	99.7/94.1	98.3/88.0	97.8/86.9
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.7
10% faster than (Mbit/s)	173.5	159.0	132.2
Speed > 2Mbit/s / 5Mbit/s (%)	99.8/99.8	99.8/99.2	99.1/97.9
Youtube Video			
Success Ratio/Start Time (%/s)	99.8/1.3	99.8/1.3	99.4/1.4
Average Video Resolution (p)	1080	1080	1080
Youtube Live			
Success Ratio/Start Time (%/s)	99.9/2.2	99.8/2.2	99.3/2.4
Average Video Resolution (p)	1080	1080	1080
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.9/3.9	100.0/4.4	99.9/4.4
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	97.9/87.0	99.1/88.6	99.2/88.4
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	95.7/92.4	98.7/94.4	98.5/92.2
Data (Cities; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.7	100.0/0.8	99.8/0.9
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.5	100.0/0.7	99.8/1.1
90%/10% faster than (Mbit/s)	146.1/459.8	73.0/360.7	42.2/305.3
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.7	100.0/1.1	99.8/1.3
90%/10% faster than (Mbit/s)	44.6/119.9	23.9/99.3	21.3/85.3
File Download (7 Seconds)			
Sucess Ratio (%)	98.9	100.0	99.6
10% faster than (Mbit/s)	1000.0	962.1	662.0
Speed > 20Mbit/s / 100Mbit/s (%)	100.0/96.6	99.8/89.6	98.4/77.3
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	100.0
10% faster than (Mbit/s)	173.5	152.7	121.3
Speed > 2Mbit/s / 5Mbit/s (%)	100.0/100.0	100.0/98.9	98.4/97.5
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.3	100.0/1.3	99.6/1.6
Average Video Resolution (p)	1080	1080	1079
Youtube Live			
Success Ratio/Start Time (%/s)	100.0/2.1	100.0/2.2	99.3/2.4
Average Video Resolution (p)	1080	1080	1079
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/4.3	100.0/4.4	99.9/4.4
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	99.1/89.8	99.8/88.9	99.3/87.2
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	98.4/95.2	99.6/94.4	98.7/92.4
Data (Towns; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.8	99.9/0.9	99.8/0.9
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.5	100.0/0.9	100.0/1.1
90%/10% faster than (Mbit/s)	117.3/416.7	58.6/330.6	51.4/278.9
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.0	100.0/1.8	99.8/1.7
90%/10% faster than (Mbit/s)	25.0/112.9	12.1/89.2	17.1/80.7
File Download (7 Seconds)			
Sucess Ratio (%)	99.0	100.0	99.6
10% faster than (Mbit/s)	1039.5	795.0	680.5
Speed > 20Mbit/s / 100Mbit/s (%)	99.4/94.9	97.2/83.9	98.4/82.3
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.4
10% faster than (Mbit/s)	158.3	130.3	123.7
Speed > 2Mbit/s / 5Mbit/s (%)	100.0/100.0	99.8/98.4	99.6/98.8
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.3	100.0/1.4	99.6/1.5
Average Video Resolution (p)	1079	1080	1080
Youtube Live			
Success Ratio/Start Time (%/s)	99.6/2.2	99.8/2.3	99.0/2.4
Average Video Resolution (p)	1080	1080	1079
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.9	100.0/4.4	99.9/4.3
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	97.0/85.5	98.8/86.7	98.2/87.1
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	95.3/91.2	97.0/92.3	98.0/91.7

Swisscom narrowly ahead on roads and railways, top performance from all operators

On the connecting roads, the point levels of the three providers are almost equalised, with Swisscom narrowly leading here as well. And here, too, the performance hardly falls behind that in large cities and smaller towns. Drivers in Switzerland who use data services while driving will be pleased.

It is noteworthy that this even applies to the difficult railways scenario, with only very minor compromises. There, too, the performance data is hardly worse than on the roads and in small towns. Swisscom is once again slightly ahead, closely followed by Sunrise and Salt. Once again in this year's three-country comparison, the SBB trains turn out to be the benchmark for mobile communications coverage on the railways.

Almost the whole of Switzerland: the test route took the umlaut teams through 24 Swiss cities and 17 towns.

Operator	Swisscom	Sunrise	Salt
Data (Roads; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/0.8	100.0/1.0	99.6/1.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.6/0.8	100.0/1.7	99.6/1.2
90%/10% faster than (Mbit/s)	78.3/407.1	26.3/322.3	51.0/243.9
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.7	100.0/2.7	100.0/2.4
90%/10% faster than (Mbit/s)	13.1/101.5	6.4/77.2	9.4/75.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.6	99.6	100.0
10% faster than (Mbit/s)	847.0	609.8	597.4
Speed > 20Mbit/s / 100Mbit/s (%)	98.2/90.2	91.9/64.1	97.0/79.5
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.6
10% faster than (Mbit/s)	146.1	110.1	109.3
Speed > 2Mbit/s / 5Mbit/s (%)	99.2/98.1	98.9/93.5	98.1/90.5
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.4	99.3/1.6	98.9/1.6
Average Video Resolution (p)	1080	1080	1080
Youtube Live			
Success Ratio/Start Time (%/s)	100.0/2.2	99.6/2.4	98.9/2.4
Average Video Resolution (p)	1080	1080	1080
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.7	99.8/4.1	99.1/4.0
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	95.2/84.3	94.9/82.8	98.2/84.9
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	90.7/89.5	94.7/89.8	93.6/89.5

Operator	Swisscom	Sunrise	Salt
Data (Trains; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/0.9	99.4/1.1	98.6/1.2
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.1	99.6/1.8	99.3/1.9
90%/10% faster than (Mbit/s)	47.6/368.7	28.1/278.6	26.9/239.5
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.9	100.0/3.1	99.3/2.8
90%/10% faster than (Mbit/s)	13.7/88.0	5.8/70.1	8.1/65.2
File Download (7 Seconds)			
Sucess Ratio (%)	99.3	99.0	98.2
10% faster than (Mbit/s)	713.0	520.1	423.3
Speed > 20Mbit/s / 100Mbit/s (%)	97.5/81.1	93.6/60.8	92.1/60.3
File Upload (7 Seconds)			
Sucess Ratio (%)	99.7	99.6	100.0
10% faster than (Mbit/s)	121.2	99.2	85.0
Speed > 2Mbit/s / 5Mbit/s (%)	99.7/97.9	96.8/93.3	95.7/89.3
Youtube Video			
Success Ratio/Start Time (%/s)	99.3/1.5	99.0/1.7	96.5/1.7
Average Video Resolution (p)	1080	1078	1079
Youtube Live			
Success Ratio/Start Time (%/s)	100.0/2.4	98.2/2.6	97.5/2.8
Average Video Resolution (p)	1077	1077	1078
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.9/3.8	99.8/4.2	99.8/4.1
Interactivity e-Gaming			
Success Ratio/Interactivity e-Gaming (%)	95.1/79.0	95.0/77.4	95.7/82.5
Interactivity Videochat			
Success Ratio/Interactivity Videochat (%)	87.5/87.4	89.9/86.8	90.5/87.3

Radio standards

In Switzerland, we also used umlaut's crowdsourcing methodology to analyse which mobile network technologies are used in everyday life.

In Switzerland, the situation regarding the use of so-called legacy technologies is somewhat different than in the neighbouring countries: In recent years, the Swiss operators have successively switched off the oldest standard 2G/GSM and in return have allowed 3G/UMTS to stay around for a little while longer – although a 3G switch-off in Switzerland is also already being discussed for the end of 2025.

The analysis of the crowdsourcing samples below by the mobile technology used clearly shows that only very few customers of all three Swiss providers are still using this remaining 3G network. The majority turns to 4G, with the Swiss operators achieving much higher shares of 5G usage than their counterparts in Germany and Austria. Whether this can be explained by the roll-out strategy or in part by the higher wage and price levels in the country remains an open question.

In any case, it is remarkable that there is already almost a parity between 4G and 5G users, especially in the Sunrise network. However, the 5G SA standard observed with some operators in Germany and Austria apparently does not yet play a role in Switzerland.

Crowdsourcing samples	Swisscom		Sunrise		Salt	
Month	May 24	November 24	May 24	November 24	May 24	November 24
2G/3G	3,3%	2,7%	3,2%	2,7%	3,4%	2,7%
4G	62,3%	65,1%	48,0%	48,5%	56,1%	55,9%
5G Non-Standalone	34,4%	32,2%	48,8%	48,8%	40,5%	41,4%
5G Standalone	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%

All values rounded to one decimal place. The internal calculation of points and percentages was carried out with three decimal places.

Voice

In the category ranking for mobile telephony, Sunrise is one point ahead of the equally strong Swisscom, with Salt following at close distance.

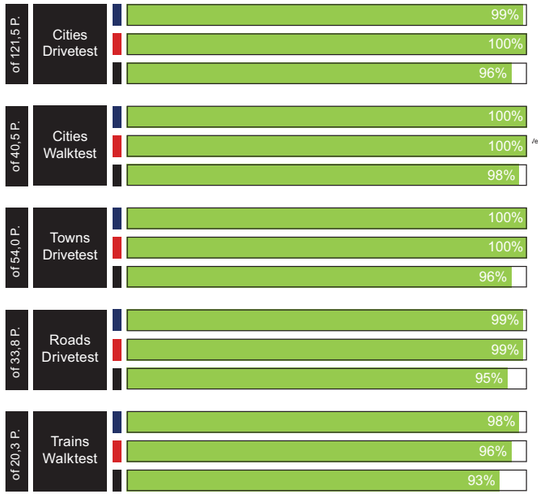
The level of performance is also very high when making calls on the Swiss mobile networks. Swisscom maintained its score from the previous year, Sunrise increased by 2 points and Salt by one. The consistent roll-out of VoLTE ('Voice over LTE') in all networks also leads to pleasantly short call setup times and high MOS values for voice quality.

Large cities: Sunrise ahead in the drive test, on a par with Swisscom in the walk test

In the metropolitan drive tests, Sunrise is slightly ahead in the voice evaluation, while in the walk test Swisscom and Sunrise score on a par – with the full amount of possible points. The same applies in small towns. The smallest provider, Salt, follows slightly behind in cities.

On roads Swisscom and Sunrise on a par, on the railways Swisscom slightly ahead; top level for all

Performance also barely drops on the connecting roads. Here, Swisscom and Sunrise are on a par, Salt scores only slightly behind. Even in the demanding train scenario, the performance also remains high. Swisscom is able to carve out a small lead here. However, although there is a small score gap to Sunrise and Salt, success rates, call setup times and voice quality remain at a very high level. 'Call back later, I'm travelling on the train' is unlikely to be heard on Swiss railways.



Highest level: The gaps between the candidates in larger cities and smaller towns and even on the roads and trains are narrow. Only on the trains do the scores fall slightly.

Operator	Swisscom	Sunrise	Salt
Voice Cities (Drivetest)			
Sucess Ratio (%)	99.9	100.0	99.4
Call Setup Time P90 (s)	1.0	0.8	1.0
Speech Quality P10 (MOS-LQO)	4.6	4.7	4.7
Voice Cities (Walktest)			
Sucess Ratio (%)	100.0	99.9	99.8
Call Setup Time P90 (s)	1.0	0.8	1.6
Speech Quality P10 (MOS-LQO)	4.7	4.7	4.7
Voice Towns (Drivetest)			
Sucess Ratio (%)	100.0	100.0	99.5
Call Setup Time P90 (s)	1.0	0.9	1.0
Speech Quality P10 (MOS-LQO)	4.6	4.7	4.7
Voice Roads (Drivetest)			
Sucess Ratio (%)	99.7	99.8	98.8
Call Setup Time P90 (s)	1.0	0.9	1.1
Speech Quality P10 (MOS-LQO)	4.5	4.7	4.6
Voice Trains (Walktest)			
Sucess Ratio (%)	99.5	98.7	97.9
Call Setup Time P90 (s)	1.0	0.9	1.7
Speech Quality P10 (MOS-LQO)	4.6	4.6	4.6

Single reviews

swisscom Swisscom wins in Switzerland for the seventh time in a row. The market leader confidently maintains the rarely awarded grade of 'outstanding', even if it loses 4 points compared to the previous year. Nevertheless, Swisscom is still ahead in Switzerland. When it comes to 5G roll-out, Swisscom is not only strong in the cities, but also outside of them in particular.

Sunrise Sunrise once again performs outstandingly, increasing its score by 5 points compared to the previous year –which really means something at this level of performance. Sunrise is narrowly in the lead in the voice discipline, while the provider sores on a par with Swisscom in the data ranking. Second place is decided in crowdsourcing, which is perhaps also due to the somewhat lower 5G penetration outside the centres.

Salt. The smallest provider in Switzerland also receives the grade 'outstanding'. In crowdsourcing, it comes close to the second-placed Sunrise, while the gap is slightly larger in voice and data – despite top performance. Outside the cites, the provider's 5G expansion is still underway, but here at least there is strong LTE from Salt.

Crowd

The analysis of the user experience of a large number of mobile phone customers underlines the close duel: Swisscom is in the lead, Sunrise and Salt are separated by just one point.

While the drive tests and walktests analyse peak network performance, crowdsourcing focuses on the extent to which everyday performance is received by a large number of customers. The bottom line is that these analyses show Swisscom as the overall winner – but Sunrise and Salt are hot on the heels of the market leader here too. The two runners-up are only one point apart of each other.

In the crowd-based surveys on broadband coverage, Swisscom leads in terms of coverage reach and time on broadband, while Sunrise is slightly ahead in terms of the coverage quality, and regarding this KPI, Salt is on a par with Swisscom (for definitions, see page 77).

Swisscom also wins all speed classes in the passively determined download data rates. Salt is slightly better than Sunrise in 'Basic Internet' (at least 2 Mbps), while in the higher classes 'HD video' (at least 5 Mbps) and 'UHD video' (at least 20 Mbps), Sunrise remains ahead of Salt.

In terms of latency, Swisscom beats its competitors in the categories 'OTT voice services' (less than 100 ms) and 'Gaming' (less than 50 ms). Salt follows in second place for OTT voice and Sunrise for gaming. There is a little surprise in the most demanding latency class 'high-end gaming': Sunrise leads, followed by Salt, with Swisscom in third place. The familiar ranking of Swisscom - Sunrise - Salt applies again to the proportion of HD calls. Stability is once more led by Swisscom, ahead of Salt and Sunrise.

Operator	Swisscom	Sunrise	Salt
Broadband Coverage			
Coverage Quality (%)	98.4	98.6	98.4
Coverage Reach (%)	97.4	96.1	91.0
Time on Broadband (%)	98.8	98.6	98.5
Download Speed			
Basic Internet Class (%)	96.4	95.2	95.6
HD Video Class / UHD Video Class (%)	90.9/41.4	88.8/35.4	88.6/34.9
Latency			
Gaming Class / OTT Voice Class (%)	96.4/98.6	93.8/97.5	92.3/97.7
High End Gaming (%)	26.4	48.7	38.6
Voice			
HD Voice (%)	97.1	97.0	96.4
Download Speed (Active)			
Avg. Throughput (Mbit/s)	118.6	89.7	85.6
90%/10% faster than (Mbit/s)	12.6/260.1	8.2/197.6	7.0/196.8
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	30.1	27.1	25.0
90%/10% faster than (Mbit/s)	4.4/58.9	3.0/62.5	4.0/53.2
Stability			
Transaction Success (%)	97.1	96.3	96.6

Reliability

This category is not a separate test discipline, but a different view of the results. Swisscom and Sunrise are ahead here – and on a par.

The reliability score, which is reported separately, excludes KPIs that are aimed at absolute peak performance. This leaves those test results that allow conclusions to be drawn about the quality of the basic services relevant to everyday life. From this perspective, Swisscom and Sunrise share first place, with Salt following 17 points behind.

In the voice ranking, Swisscom and Sunrise are tied, with Salt ranking slightly behind, mainly due to the drive test results. In the data ranking, Sunrise takes the lead with very strong results in both the drive tests and the walk tests. This puts Sunrise 3 points ahead of Swisscom, while Salt remains in third place. In the crowdsourcing section of the reliability ranking, Sunrise and Salt are again tied for second place, with Swisscom finishing 3 points ahead of them. Ultimately, these results also demonstrate the high level of performance among the Swiss operators. Although Salt scores slightly further behind here, in line with the overall result, all three Swiss networks are also characterised by their high reliability.

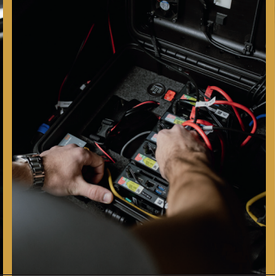
Operator		Swisscom	Sunrise	Salt
Voice	max. 162 points	161	161	152
Drivetest	126	99%	100%	93%
Walktest	36	99%	97%	95%
Data	max. 288 points	282	285	277
Drivetest	223	98%	99%	97%
Walktest	65	98%	99%	96%
Crowd	max. 150 points	143	140	140
Crowd	150	95%	93%	93%
Total	600	586	586	569

All values rounded to whole numbers. The internal calculation of points and percentages was carried out with three decimal places. The maximum 600 points achievable here are an extract from the overall result totalling 1000 points (see p. 76/77).

Methodology

The sophisticated methodology of our network test takes into account both the top performance of the networks and the everyday requirements of users.

Each drive test vehicle carried nine smartphones for the voice and data tests.



A special control system monitors the test smartphones and logs the measured values they record.

The walk test teams used trolleys or backpacks with powerful batteries to power the test smartphones.

As every year, we have taken extensive measures to ensure that our mobile network test is fair and transparent. A detailed description of these measures can be found online behind the URL or the QR code shown below.

Logistics and test routes

The measurements in Germany took place from 14 to 25 October 2024, in Austria from 3 to 12 October 2024 and in Switzerland from 15 to 26 October 2024.

connect's network test partner umlaut sent four test vehicles to each country, each equipped with nine smartphones. One Samsung Galaxy S23 per network operator carried out the voice measurements, another S23 was used for data tests and a third established the connections for the 'conversational app' test case (see 'Data connectivity').

'5G preferred' was set in the phones for all measurements – where supported by the network, they were carried out via 5G.

In addition to the drive tests, two walk test teams carried out measurements on foot in each country – in areas with public traffic such as railway station concourses, airport terminals, cafés, public transport and museums. The walk test programme also included journeys on long-distance and local railway lines. The same smartphone types were used for the walk tests as for the drive tests for each network operator. 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 versions.

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 did not falsify the measurements of the other. Two vehicles travelled the same routes on the connecting roads, but at different times and with some distance between them.

In Germany, drive tests were carried out in 23 large cities and 25 smaller towns, and walk tests in eleven cities. This covered around 16.4 million inhabitants, approximately 19.7% of the German population. The drive tests covered around 11,030 km

In Austria, the testers drove around 5750 km through 15 large cities and 15 smaller towns. There were also walk tests conducted in six cities. This covered around 3.4 million inhabitants (around 37.5 % of the population). The drive tests in Switzerland took place in 24 large cities and 17 smaller towns, while the walk tests took place in eight cities. The test route in Switzerland was around 6230 km long, and the measurement campaign covered around 2.3 million inhabitants (around 25.7% of the Swiss population).

To select the test routes, umlaut made four different suggestions for each country, from which connect blindly selected one route each.

You can find detailed information on our measures for fairness and transparency at www.connect.de/netztest (in German)

Voice connections

Voice connections account for 27% of the overall result. For this purpose, phone calls were established from one test vehicle to the other ('mobile-to-mobile') and their success rates, call setup times 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 took place simultaneously in the background. The transmission quality was assessed using the POLQA wideband method suitable for HD voice. '5G non-standalone preferred' was configured on all phones, with voice telephony being handled via VoLTE.

Data connectivity

The data measurements account for 48% of the results. Several popular live pages (dynamic) and the ETSI reference page known as the Kepler page (static) were retrieved to assess website visits. In addition, umlaut developed a preliminary stage of a designated successor to the Kepler page (working title: 'Newton'), which ETSI is currently considering.

In addition, 10 and 5 MB files were downloaded and uploaded respectively to determine the performance for smaller data transfers. We also determined the data rate in a 7-second period when uploading and downloading large files. As YouTube dynamically adjusts the resolution played out to the available bandwidth, our evaluation takes into account the average video resolution of the video clips as well as the success rate and the time until playback starts.

An over-the-top (OTT) voice connection is modelled by the conversational app test case. To do this, we set up a voice channel using the SIP and STUN protocols with the OPUS codec and determined the success rate and voice quality.

Our measurements also simulated a highly interactive UDP multiplayer session in order to determine the latency times of the connection and any packet losses for the eGaming interactivity test point. A video chat is also part of the test scope, which follows the ITU-T G.1051 recommendation. It measures latencies, packet delays and data rates in both directions.

Crowdsourcing

The results of crowdsourcing accounted for 25% of the overall rating. They show which network performance is received by users – although the end devices and tariffs used also have an impact.

The samples collected in all three countries from the beginning of May to mid-October 2024 (calendar weeks 19 to 42) were analysed for this purpose.

Around 16.5 billion individual samples were analysed from Germany, statistically covering 100% of the population. For Austria, umlaut analysed around 453 million samples (99.9% of the population). In Switzerland, around 722 million samples correspond statistically to 100% of the population. In order to obtain the database for the analyses, a large number of popular apps record the parameters described below in the background – provided the users have agreed to the completely anonymous data collection. In slightly simplified terms, measured values are recorded in 15-minute intervals and transmitted to the umlaut servers once a day. The reports only contain a few bytes, so they hardly burden the user's data volume.

Broadband quality

To determine the *coverage reach*, umlaut laid a grid of 2 x 2 km tiles ('evaluation areas', EAs) across the test area. A minimum number of users and measured values had to be available for each EA. For the evaluation, umlaut awarded three points per EA if the network in question offered 4G or 5G coverage. The score achieved was divided by the maximum number of points achievable (three points per EA in the 'union footprint' – the area of the respective country measured by all test participants with their smartphones).

We also looked at the *coverage quality*. For each operator, this value indicates the average percentage of 4G or 5G coverage on an EA, averaged over all EAs in the 'common footprint' - this describes the area in which samples are available from all operators.

In addition, the *time on broadband* indicates how often a user had 4G or 5G reception in the period under review – regardless of the EAs in which the samples were recorded. To do this, umlaut sets the samples with 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 – not the percentage of 4G/5G coverage in terms of area or population.

Data rates and latencies

The passive determination of *download data rates* and *latencies* was carried out independently of the EAs and focussed on the individual experience of each user. Samples that were recorded via Wi-Fi or when flight mode was activated, for example, were filtered out by umlaut before being analysed.

In order to take into account the fact that many mobile phone tariffs throttle the data rate, umlaut defined three different application-related speed classes: *Basic Internet* requires a minimum of 2 Mbps, *HD video* requires 5 Mbps and *UHD video* requires 20 Mbps. 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 of up to 100 ms are sufficient for *OTT voice* services, less than 50 ms qualify a sample for *gaming* and less than 20 ms for *high-end gaming*.

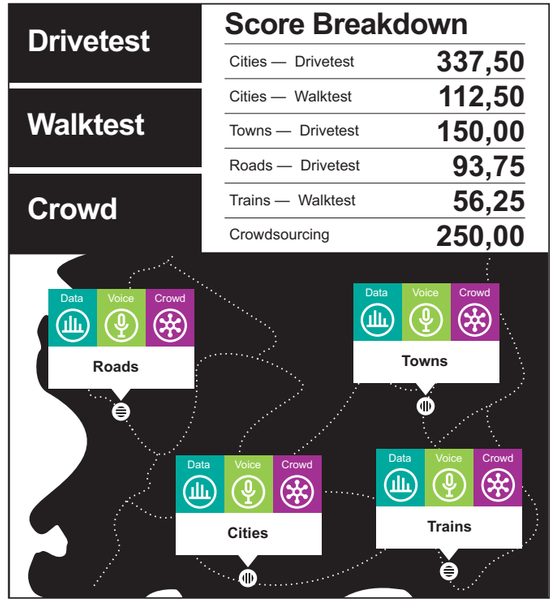
In order to approximate the maximum possible throughput, umlaut also carried out *active measurements of upload and download data rates* once a month. They determine the amount of data transferred within 3.5 seconds.

Telephony

The *HD telephony* parameter shows the proportion of the user's voice connections that were set up in Voice over LTE (VoLTE) or Voice over WiFi (VoWiFi) and therefore support HD quality.

Stability

Based on the success rates of the download, upload and browsing tests as well as additional connection tests, umlaut also calculates the *transaction success* rates.



Reliability

The reliability assessment is not a separate category, but an additional consideration of the results of the previous categories. For this purpose, umlaut sorts all measured values into basic or everyday requirements ('Qualifier KPIs') and values related to maximum performance ('Differentiator KPIs').

The presentation of reliability only takes into account the 'Qualifier KPIs' from the voice and data categories as well as the basic results from crowdsourcing. This makes it possible to determine how well a mobile network fulfils everyday requirements.

INTERVIEW

Hakan Ekmen, Global Networks Lead, Comms Industry and CEO umlaut

'The efficiency measures are taking effect in the networks and customers can rely on their operators.'

Network operators are increasingly shifting their focus from 'faster, higher, farther' to greater efficiency. What does this mean for benchmarks such as the connect mobile network test?
Hakan Ekmen: For us, this development is also very relevant, and KPIs such as reliability or the user experience determined by crowdsourcing have been taking this development into account for some time.
Are the providers' efficiency efforts also reflected in this year's test results?
Hakan Ekmen: Network operators are already taking many measures to improve their efficiency. The increases in our scores compared to the previous year show that they are doing the right thing.
Does this mean that efficiency will take precedence over performance in the networks in future?
Hakan Ekmen: We see that many providers manage to fulfil both dimensions. This will be an important success factor in the future.

How to measure **energy efficiency?**

The energy efficiency of mobile networks is becoming increasingly important. How can operator successes be measured?

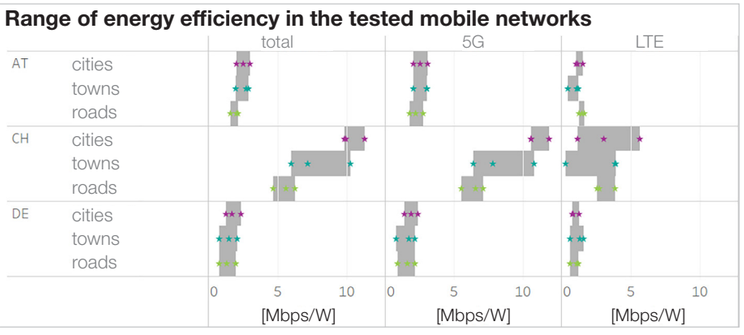
Mobile network operators must reduce the operating costs of their networks and become climate-neutral in the long term. The Radio Access Network (RAN) is the most energy-hungry component of a mobile network. Saving just a few per cent of its energy consumption can amount to millions of kilowatt hours and euros per year.

umlaut has analysed how the data collected in drive and walk tests can be used to determine how the networks use a not insignificant proportion of the energy consumed in the RAN: the energy used for active transmission to users. The results also allow conclusions to be drawn about the operator's overarching efficiency strategy.

The approach presented here relates the speed at which the networks transmit data to the smartphone to the transmission power required for this. The result is a value with the unit Mbps per Watt. To test this, umlaut carried out this analysis for the 7-second file download – one of the test items that pushes the performance of a network to the limit. The value determined in this way is influenced by a variety of factors – for example, the spatial arrangement of the base stations, the operator's network coverage strategy via macro, micro and pico cells as well as the number of frequency bands used and the mobile radio technologies deployed on them.

We have deliberately decided not to reveal the results by operator in order to not suggest any kind of evaluation. However, the ranges shown below illustrate that there are significant differences depending on the country and scenario under consideration.

Range of energy efficiency in the tested mobile networks



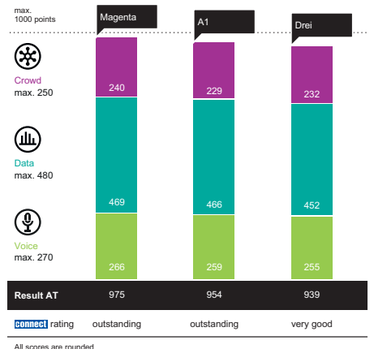
Savings potential: The chart shows the average efficiency of downlink transmission power in various scenarios (total = 5G and 4G/LTE combined), sorted by country. The range between the network operator with the lowest and the one with the highest is shown. (Higher values = higher efficiency.)

Overall Results

Voice, Data & Crowd		
Voice	max. 270.00 points	
Cities	Drivetest	121.50
Cities	Walktest	40.50
Towns	Drivetest	54.00
Roads	Drivetest	33.75
Trains	Walktest	20.25
Data	max. 480.00 points	
Cities	Drivetest	216.00
Cities	Walktest	72.00
Towns	Drivetest	96.00
Roads	Drivetest	60.00
Trains	Walktest	36.00
Crowd	max. 250.00 points	
Crowd		250.00
Total	max. 1000.00 points	
connect -rating		

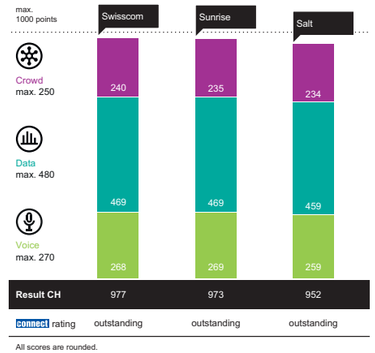
Germany

Telekom	Vodafone	Telefónica
267	262	258
100%	99%	98%
100%	100%	97%
99%	98%	96%
98%	95%	94%
91%	83%	79%
465	434	427
98%	94%	95%
99%	95%	96%
97%	88%	85%
97%	87%	83%
84%	68%	60%
238	228	224
95%	91%	90%
970	924	909
outstanding	very good	very good



Austria

Magenta	A1	Drei
266	259	255
99%	96%	94%
100%	99%	97%
100%	97%	95%
99%	97%	97%
89%	87%	85%
469	466	452
99%	98%	97%
98%	97%	93%
98%	97%	94%
98%	98%	94%
91%	88%	81%
240	229	232
96%	92%	93%
975	954	939
outstanding	outstanding	very good



Switzerland

Swisscom	Sunrise	Salt
268	269	259
99%	100%	96%
100%	100%	98%
100%	100%	96%
99%	99%	95%
98%	96%	93%
469	469	459
98%	98%	96%
98%	99%	96%
97%	97%	95%
98%	96%	96%
97%	94%	92%
240	235	234
96%	94%	93%
977	973	952
outstanding	outstanding	outstanding

All values rounded to whole numbers. The internal calculation of points and percentages was carried out to three decimal places. Intermediate results may therefore deviate slightly from the stated values.

Hannes Rügheimer, connect author

COCLUSION

First of all, we would like to congratulate all the network operators tested – because every one of them has either improved or at least essentially maintained their previous year's result. In view of growing data traffic and rising energy costs, this should by no means be taken for granted.

In Germany, Telekom defended its test victory for the 14th time in a row, once again achieving the grade 'outstanding' and increasing its score by three points compared to the previous year.

Vodafone essentially maintained its previous year's result. However, the increase for Telefónica/O2 is particularly significant. The operator gained a whopping 14 points and once again managed to narrow the gap to Vodafone. Both providers received the grade 'very good'. In Deutsche Bahn, Vodafone and Telefónica/O2 in particular still have room for improvement, but the test results show a first silver lining on the horizon.

In Austria, Magenta, which is part of the Telekom Group, once again came out on top – for the seventh time in a row in the Alpine republic – with the grade 'outstanding' and a three-point improvement on the previous year's result. A1 maintained its high performance level from last year's test and also achieved the grade'outstanding'. And in the Alpine republic too, it is once more the smallest provider that achieves the most significant improvement: Compared to the previous year, Drei improved by a whopping 24 points – its strategy of quickly adopting the modern '5G standalone' technology could have payed off here.

In Switzerland, where competition traditionally takes place at the highest level, all three operators now achieve the top grade 'outstanding'. Swisscom won the test for the seventh time in a row – even though the operator lost four points compared to the previous year. Sunrise, on the other hand, improved by five points and would only need to increase its 5G coverage outside the centres. Salt remains in third place in Switzerland, gaining two points compared to the previous year.