THE GREAT 2023 MOBILE NETWORK TEST
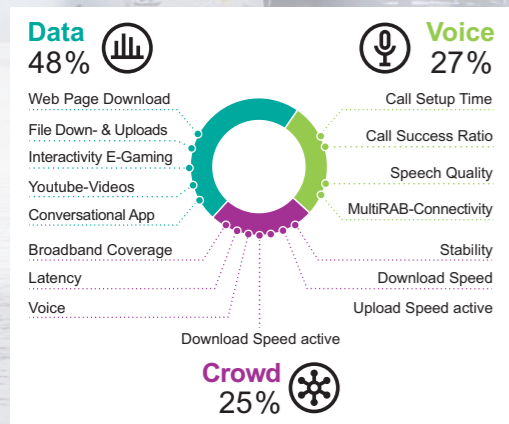
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Part of Accenture
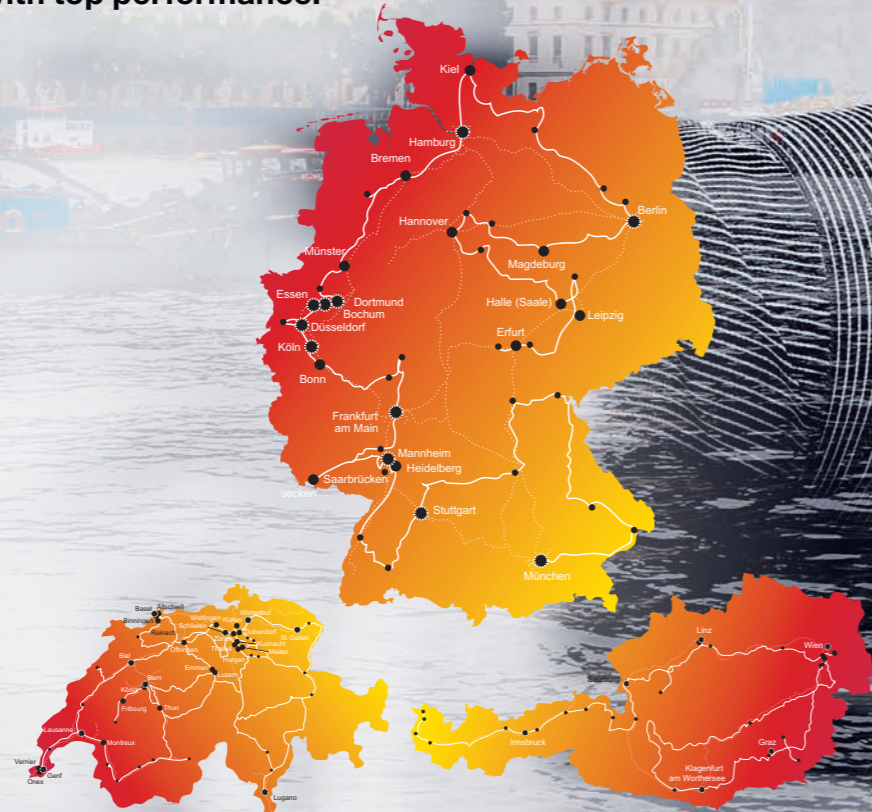
connect

SINCE 1993
THE BENCHMARK

We are conducting our major mobile network test for the 29th year. As in previous years, it combines maximum objectivity with the greatest customer proximity. This year, our critical test shows clear improvements in performance, especially in Germany, but also in Austria. And the Swiss operators once again inspire with top performance.

The number of crises and global challenges has not decreased in the past year. In contrast, one could easily get the impression that everything is actually business as usual in mobile communications. However, behind the fact that the networks are working reliably and the 5G expansion is continuing with great strides, there is much more to it than just a "new normal".

After all, mobile network operators are also affected by the drastic rise in energy prices, global supply bottlenecks, increasing cyber attacks and the like. The fact that customers in Germany, Austria and Switzerland can rely on the usual quality in their mobile networks is therefore a huge achievement on the part of their providers.

Enhanced methodology with additional usage patterns

Independently of this, umlaut, now part of Accenture, and connect have once again consistently developed their test procedures and criteria in the 29th year of their renowned mobile network test. For example, we now also take OTT voice transmissions and e-gaming into account in our drive and walk tests. And we have expanded the crowdsourcing analyses to include active speed tests, a look at HD voice connections and a stability assessment. In addition, we separately analyse the reliability of the networks. Although 5G is becoming increasingly commonplace in the networks, we still take a separate look at it in order to be able to quantify the progress of the rollout. The great effort behind our test is demonstrated by the key figures below.

All of this is aimed at better reflecting the usage, but also the performance of the networks in our results. Our success proves us right: although more and more market competitors are trying their hand at mobile tests, our test is considered by far the most relevant and meaningful in the industry. So let's take a detailed look at the results this time.

Hannes Ruegheimer

Data 48%

Web Page Download
File Down- & Uploads
Interactivity E-Gaming
Youtube-Videos
Conversational App
Broadband Coverage
Latency
Voice

Voice 27%

Call Setup Time
Call Success Ratio
Speech Quality
MultiRAB-Connectivity
Stability
Download Speed
Upload Speed active

Download Speed active

Crowd 25%

A 360 degree view at network quality

Compared to the previous year, we have added and expanded various aspects in our evaluation scheme. For crowdsourcing in particular, a number of additional "KPIs" are included in the evaluation. In addition, we have given data communication a slightly higher weighting in relation to voice telephony in order to take into account the growing importance of this type of communication. A detailed description of the methodology of our network test can be found on page 78/79.

DRIVE TESTS AND WALK TESTS

21.6 million inhabitants	24 926 km drive test	423 731 data samples	63 301 voice samples

CROWDSOURCING

101.8 million inhabitants covered	923 044 participants in the crowd-sourcing	2851 million samples	97.8 % average coverage of bulit-up area

The combined values for Germany, Austria and Switzerland are given here. For individual values per country see Methodology on page 78.

Germany

Voice

Although data applications are continuously gaining in importance, mobile phone calls are still a core application of mobile communications. They therefore account for 27 percent of our rating.

▶ The 5G equivalent to VoLTE („Voice over LTE") with the designation VoNR („Voice over New Radio") is not yet supported by any of the German mobile networks. As a result, smartphones have to switch back to 4G to make calls, even if a 5G connection is available. They then benefit from the fact that the German networks support the now proven VoLTE technology in high quality.

This is also reflected in the quite short call set-up times that all three candidates achieve not only in large cities, but also in smaller towns, on connecting roads and even on trains. Success rates and voice quality of the connections are also at a high level in bigger

and smaller cities and on connecting roads. In all scenarios tested, Telekom comes out on top. In large cities and on connecting roads, however, O2/Telefónica achieves slightly better results than Vodafone – a somewhat higher success rate on connecting roads reveals Telefónica to be an interesting Telekom alternative for frequent travellers. In the small towns, however, the picture turns and Vodafone can get ahead of O2.
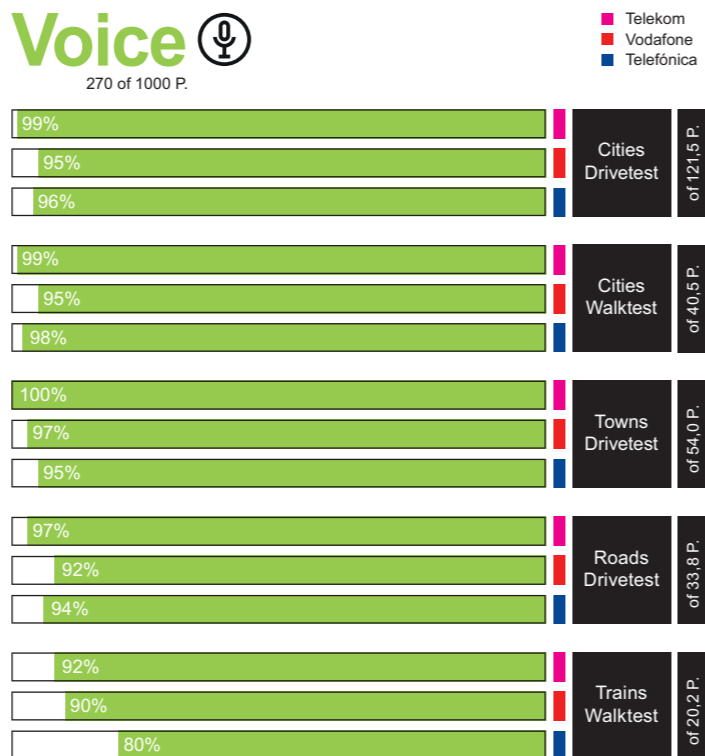
Telekom also leads in all scenarios when it comes to MultiRAB connectivity – the test of whether data connections remain possible in the background even during ongoing voice calls. With the exception of the tests in

German trains, O2/Telefónica again achieves slightly higher percentages here than Vodafone. In the overall ranking for the voice discipline, however, the Düsseldorf-based company defends second place with a narrow margin of one point ahead of O2.

Improvements on trains

When it comes to phoning on trains, Telekom and Vodafone perform slightly better than last year. Telefónica/O2 remains at the previous year's level. Nevertheless, especially in comparison with the performance of the Swiss operators, there is still room for improvement for all three German providers.

Map legend
- Kiel
- Hamburg
- Bremen
- Hannover
- Berlin
- Münster
- Magdeburg
- Essen
- Dortmund
- Bochum
- Düsseldorf
- Halle (Saale)
- Leipzig
- Köln
- Erfurt
- Bonn
- Frankfurt am Main
- Mannheim
- Heidelberg
- Saarbrücken
- Stuttgart
- München

- ● Drivetest
- ○ Walktest
- — Roads
- --- Train

Voice (270 of 1000 P.)

Operator	Telekom	Vodafone	Telefónica
Voice Cities (Drivetest)			
Success Ratio (%)	99.9	99.5	99.5
Call Setup Time P90 (s)	1.2	1.5	1.3
Speech Quality P10 (MOS-LQO)	4.6	4.4	4.3
Multirab Connectivity (%)	99.9	99.1	99.4
Voice Cities (Walktest)			
Success Ratio (%)	99.8	99.6	99.6
Call Setup Time P90 (s)	1.2	1.5	1.2
Speech Quality P10 (MOS-LQO)	4.7	4.5	4.5
Multirab Connectivity (%)	99.9	97.8	99.6
Voice Towns (Drivetest)			
Success Ratio (%)	100.0	99.8	99.3
Call Setup Time P90 (s)	1.2	1.6	1.4
Speech Quality P10 (MOS-LQO)	4.6	4.4	4.3
Multirab Connectivity (%)	99.8	99.0	99.4
Voice Roads (Drivetest)			
Success Ratio (%)	99.3	98.6	99.0
Call Setup Time P90 (s)	1.3	1.6	1.6
Speech Quality P10 (MOS-LQO)	4.4	4.0	4.0
Multirab Connectivity (%)	99.1	96.8	98.6
Voice Trains (Walktest)			
Success Ratio (%)	98.0	97.8	94.9
Call Setup Time P90 (s)	1.6	1.7	1.5
Speech Quality P10 (MOS-LQO)	4.2	4.1	3.8
Multirab Connectivity (%)	98.6	98.2	97.3

Legend: ■ Telekom ■ Vodafone ■ Telefónica

Cities Drivetest (of 121.5 P.): 99% / 95% / 96%
Cities Walktest (of 40.5 P.): 99% / 95% / 98%
Towns Drivetest (of 54.0 P.): 100% / 97% / 95%
Roads Drivetest (of 33.8 P.): 97% / 92% / 94%
Trains Walktest (of 20.2 P.): 92% / 90% / 80%

Data

Apps, messaging, streaming and web surfing are the focus for smartphone users. The share of the data discipline was thus increased to 48 percent of the overall score.

▶ In addition to the network architecture, the frequency spectrum available to the mobile operators is the most important factor when it comes to data rates and capacities. Deutsche Telekom still has the biggest piece of the pie and knows how to use it. This can be seen in all tested scenarios, for example, in the fact that the Bonn-based company is clearly ahead in terms of basic data rates (P10 value – i.e. 90 percent faster than) as well as peak values (P90 – 10 percent faster than). Number two in the available spectrum is Telefónica/O2, which can be seen above all in the results in large cities.

However, Vodafone also gets the best out of its resources and scores 16 points ahead of the competition from

Munich in the data ranking. All three German network operators continue to make good progress with their 5G rollouts in 2022. Still, the ranking resulting from the entirety of all test scenarios and test points in the data discipline is once again confirmed by a detailed look at 5G (see box on the next page).

O2 and Vodafone almost on a par in cities

As in the voice discipline before, the Bonn-based company also comes out on top in the data tests in all individual scenarios.

However, the gap between second-placed Vodafone and O2/Telefónica becomes razor-thin in the drive tests and walk tests conducted in the bigger cities.

Data (480 of 1000 P.)
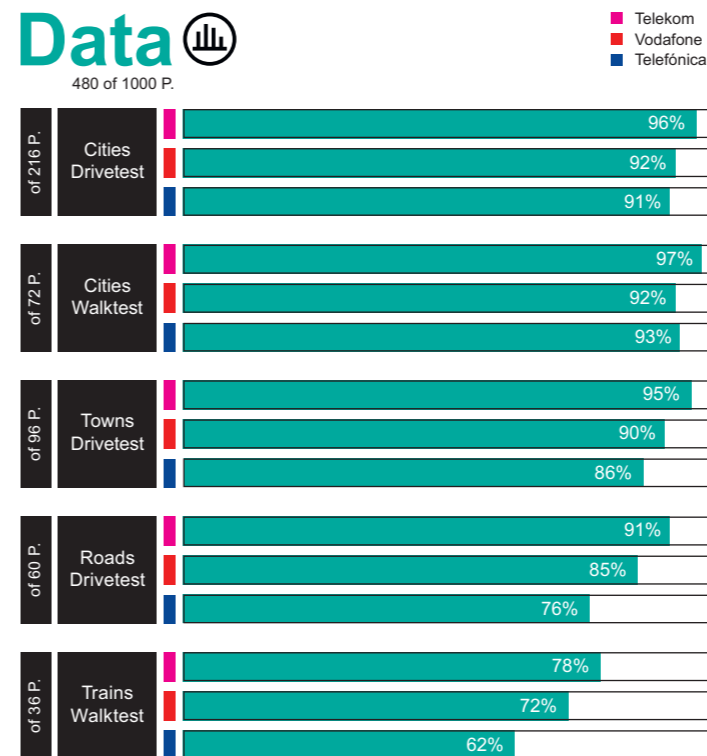
Operator	Telekom	Vodafone	Telefónica
Data (Cities; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/1.3	99.7/1.4	99.5/1.5
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.9/0.9	99.8/1.7	99.8/2.5
90%/10% faster than (Mbit/s)	78.6/277.8	25.9/203.0	18.5/219.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.8/1.4	99.9/2.8	99.9/3.1
90%/10% faster than (Mbit/s)	19.5/74.5	8.5/69.2	7.2/58.2
File Download (7 Seconds)			
Success Ratio (%)	99.9	99.8	99.6
10% faster than (Mbit/s)	788.3	379.8	459.7
Speed > 20Mbit/s / 100Mbit/s (%)	99.4/90.6	96.3/64.3	93.4/69.1
File Upload (7 Seconds)			
Success Ratio (%)	99.5	99.3	99.4
10% faster than (Mbit/s)	121.8	102.6	84.5
Speed > 2Mbit/s / 5Mbit/s (%)	99.8/98.8	97.1/93.1	98.4/93.7
Youtube Video			
Success Ratio/Start Time (%/s)	99.9/2.0	99.7/1.9	99.2/2.0
Time to Full Resolution (s)	10.2	10.2	9.4
Youtube Live			
Success Ratio/Start Time (%/s)	99.4/4.0	98.7/4.0	98.4/3.9
Time to Full Resolution (s)	8.3	8.3	7.9
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.5/2.4	98.8/2.2	98.4/2.3
Time to Full Resolution (s)	10.6	10.6	9.2
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.9/3.6	100.0/3.5	99.7/3.1
Interactivity e-Gaming			
Interactivity e-Gaming (%)	83.6	76.9	68.5
Data (Cities; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/1.2	99.6/1.3	99.6/1.3
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.9	99.8/1.9	100.0/1.8
90%/10% faster than (Mbit/s)	85.9/281.5	25.5/209.9	31.5/212.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.4	99.5/2.7	99.9/2.3
90%/10% faster than (Mbit/s)	22.5/75.1	8.5/69.4	10.8/63.4
File Download (7 Seconds)			
Success Ratio (%)	100.0	99.6	100.0
10% faster than (Mbit/s)	846.9	428.1	463.4
Speed > 20Mbit/s / 100Mbit/s (%)	99.3/91.5	94.5/62.6	95.9/73.4
File Upload (7 Seconds)			
Success Ratio (%)	99.9	99.0	99.3
10% faster than (Mbit/s)	124.6	99.6	98.5
Speed > 2Mbit/s / 5Mbit/s (%)	99.5/98.7	97.8/93.7	98.5/96.1
Youtube Video			
Success Ratio/Start Time (%/s)	99.8/2.0	99.5/2.1	98.8/1.9
Time to Full Resolution (s)	10.0	10.0	9.1
Youtube Live			
Success Ratio/Start Time (%/s)	99.8/4.0	99.5/4.1	98.5/3.7
Time to Full Resolution (s)	8.1	8.1	7.8
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.8/2.3	97.1/2.3	99.0/2.4
Time to Full Resolution (s)	10.5	10.6	8.4
Conversational-App			
Success Ratio/Speech Quality P10(%MOS-LQO)	99.9/4.1	99.9/3.9	100.0/3.1
Interactivity e-Gaming			
Interactivity e-Gaming (%)	85.5	79.7	74.7
Data (Towns; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/1.4	99.6/1.4	99.6/1.6
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.4	99.9/1.9	99.9/3.6
90%/10% faster than (Mbit/s)	42.2/209.0	27.5/152.4	11.5/132.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/2.1	99.6/3.0	99.7/3.2
90%/10% faster than (Mbit/s)	13.1/71.7	7.7/61.9	7.7/52.4
File Download (7 Seconds)			
Success Ratio (%)	99.9	99.6	99.6
10% faster than (Mbit/s)	509.6	251.4	194.7
Speed > 20Mbit/s / 100Mbit/s (%)	98.0/77.8	95.2/53.2	84.6/32.3
File Upload (7 Seconds)			
Success Ratio (%)	99.9	98.7	98.3
10% faster than (Mbit/s)	129.8	101.0	83.9
Speed > 2Mbit/s / 5Mbit/s (%)	99.2/97.9	97.9/93.0	97.8/94.4
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/2.0	99.2/1.9	98.7/2.0
Time to Full Resolution (s)	10.2	10.2	9.8
Youtube Live			
Success Ratio/Start Time (%/s)	99.2/4.1	98.7/4.0	97.1/4.1
Time to Full Resolution (s)	8.2	8.3	8.1
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.5/2.4	98.5/2.2	95.6/2.2
Time to Full Resolution (s)	10.6	10.8	10.2
Conversational-App			
Success Ratio/Speech Quality P10(%MOS-LQO)	100.0/3.5	100.0/3.5	100.0/3.5
Interactivity e-Gaming			
Interactivity e-Gaming (%)	76.9	70.9	62.3

Legend: ■ Telekom ■ Vodafone ■ Telefónica

Cities Drivetest (of 216 P.): 96% / 92% / 91%
Cities Walktest (of 72 P.): 97% / 92% / 93%
Towns Drivetest (of 96 P.): 95% / 90% / 86%
Roads Drivetest (of 60 P.): 91% / 85% / 76%
Trains Walktest (of 36 P.): 78% / 72% / 62%

Operator	Telekom	Vodafone	Telefónica
Data (Roads; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	98.8/1.6	98.6/1.7	97.1/2.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.8/2.6	99.8/4.5	99.5/6.9
90%/10% faster than (Mbit/s)	16.3/150.4	8.1/130.9	4.7/104.9
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.1/3.7	99.2/6.2	99.1/7.2
90%/10% faster than (Mbit/s)	5.5/58.9	2.7/56.1	2.4/42.0
File Download (7 Seconds)			
Success Ratio (%)	99.5	99.2	98.8
10% faster than (Mbit/s)	231.8	183.0	127.1
Speed > 20Mbit/s / 100Mbit/s (%)	92.5/54.3	82.2/32.1	69.2/15.9
File Upload (7 Seconds)			
Success Ratio (%)	98.0	96.3	96.1
10% faster than (Mbit/s)	97.6	74.5	56.0
Speed > 2Mbit/s / 5Mbit/s (%)	96.7/92.3	92.4/79.6	89.2/75.2
Youtube Video			
Success Ratio/Start Time (%/s)	98.1/2.1	97.6/2.2	88.5/2.2
Time to Full Resolution (s)	10.4	10.4	10.1
Youtube Live			
Success Ratio/Start Time (%/s)	97.4/4.2	94.9/4.1	93.0/4.1
Time to Full Resolution (s)	8.3	8.5	8.0
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	98.1/2.4	92.6/2.3	84.3/2.4
Time to Full Resolution (s)	10.8	10.7	10.1
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.2	100.0/3.1	99.6/3.3
Interactivity e-Gaming			
Interactivity e-Gaming (%)	67.7	58.6	53.5

Operator	Telekom	Vodafone	Telefónica
Data (Trains; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	95.4/2.1	94.8/2.2	90.0/2.4
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	98.2/6.8	98.6/8.7	97.3/12.0
90%/10% faster than (Mbit/s)	3.7/205.8	3.4/149.7	2.3/165.9
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.2/4.3	99.4/6.1	98.2/7.5
90%/10% faster than (Mbit/s)	4.8/55.8	2.7/44.7	2.2/41.0
File Download (7 Seconds)			
Success Ratio (%)	95.7	97.3	91.2
10% faster than (Mbit/s)	479.2	244.8	321.4
Speed > 20Mbit/s / 100Mbit/s (%)	74.5/45.2	59.8/28.0	60.3/35.2
File Upload (7 Seconds)			
Success Ratio (%)	97.8	95.8	92.9
10% faster than (Mbit/s)	74.9	51.8	55.9
Speed > 2Mbit/s / 5Mbit/s (%)	97.4/89.8	91.2/81.0	90.0/75.2
Youtube Video			
Success Ratio/Start Time (%/s)	90.3/2.6	84.7/2.6	77.0/2.4
Time to Full Resolution (s)	10.5	10.5	9.8
Youtube Live			
Success Ratio/Start Time (%/s)	90.5/4.2	87.3/4.4	80.6/4.0
Time to Full Resolution (s)	8.3	8.3	8.0
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	82.1/2.5	81.9/2.4	68.7/2.5
Time to Full Resolution (s)	10.9	10.7	10.0
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.8/2.9	99.6/3.0	99.6/2.8
Interactivity e-Gaming			
Interactivity e-Gaming (%)	54.6	52.6	46.2

Small towns and streets: Telekom - Vodafone - O2

However, the gap between the Düsseldorfers becomes more pronounced in small towns and – somewhat in contrast to the voice discipline – also on the connecting roads. Here, success rates and data rates again speak in favour of Telekom, and at a smaller margin also for Vodafone.

In the small towns, all three providers improved in comparison to the previous year; on the roads, only Telekom succeeded in doing so, while Vodafone and Telefónica/O2 essentially stagnated in this scenario. The further our test vehicles moved away from the big cities, the clearer the ranking emerged: Telekom – Vodafone – Telefónica/O2.

Mixed picture on railways

While we saw slight progress in the voice connections in long-distance trains, this unfortunately turned out to be considerably less true in the data discipline. However, we should not conceal the fact that this year, too, numerous track renovations often led the trains away from their main lines, which are better supplied with mobile radio. However, the three network operators were at least able to improve slightly compared to the previous year – so the direction is right, hopefully this train will continue to pick up speed. Because at present, the gap between data communication in German railways and the two neighbouring countries in the Alps remains strikingly clear.

5G

5G is being included in our data evaluation at an increasing rate. Nevertheless, we want to take a look again this year at the results achieved via 5G alone from our drive and walk tests. Because it shows how the providers have progressed with their 5G rollouts.

■ For the exemplary analysis, we again use the results from the category "File download (7 seconds)" achieved via 5G alone. The shares of samples with 5G or 5G-DSS (Dynamic Spectrum Sharing – the demand-dependent distribution of bandwidth between 4G and 5G) shown for this part of our test are in the same order of magnitude also for the other data tests.

Compared to the previous year, it is clear that all three providers have once again made great progress in upgrading their networks to 5G. Not only in large cities have 5G rates increased significantly, but also in the smaller towns, on roads and even on trains. Data rates remain essentially at the previous year's level, but this is no surprise. After Telekom and Vodafone, which have been using DSS for a long time, especially in the rural areas, Telefónica is now also making use of this sharing technology for the first time. Overall, however, the O2 network has the largest share of pure 5G.

Data rates 7s Download	Telekom			Vodafone			Telefónica		
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	61.0%	540.9	885.3	37.1%	287.4	551.7	85.2%	247.6	482.4
Cities – Walktest	69.6%	560.6	902.6	41.8%	302.3	612.5	85.5%	270.1	493.0
Towns – Drivetest	20.0%	510.7	803.6	10.2%	353.5	626.4	26.1%	149.4	415.1
Roads – Drivetest	6.9%	207.5	435.0	1.7%	312.1	532.7	28.3%	83.7	177.8
Trains – Walktest	27.9%	430.3	717.4	22.1%	231.8	458.4	51.5%	191.7	426.9
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	35.8%	177.8	289.5	31.0%	146.8	250.7	0.1%	204.2	204.2
Cities – Walktest	26.4%	170.9	277.9	20.4%	159.3	305.4	–	–	–
Towns – Drivetest	75.4%	157.9	261.0	48.1%	121.8	221.3	2.0%	108.2	158.8
Roads – Drivetest	79.1%	126.4	229.5	49.9%	92.0	183.8	0.9%	76.0	121.8
Trains – Walktest	60.9%	72.9	185.0	35.4%	51.1	144.2	0.4%	3.0	4.3

Crowd

While the drive and walk tests focus on the maximum possible performance in the networks, the crowd analyses show what is actually received by users.

▶ The crowdsourcing discipline also shows the same ranking that is already known from the other categories – at a distance of four or five points respectively between the three providers.

In detail, however, there are some surprises: For example, although Telekom is ahead in all three aspects of broadband quality, Telefónica overtakes its competitor Vodafone in terms of coverage reach. In terms of coverage quality, these two competitors are on a par, while in terms of time on broadband, Vodafone is just ahead of Telefónica.

Regarding the availability of HD voice, the upload data rates determined with active measurements as well as in the stability assessment, Telefónica is just ahead of Vodafone. However, Telekom is the undisputed leader in these categories again – clearly visible even in the active download measurements. In the passively determined data rates, Telekom and Vodafone again take the lead together. The champion in the demanding gaming latencies is Vodafone by a narrow margin.

Operator	Telekom	Vodafone	Telefónica
Broadband Coverage			
Coverage Quality (%)	98.2	97.4	97.4
Coverage Reach (%)	94.5	94.0	94.9
Time on Broadband (%)	98.5	97.4	97.2
Download Speed			
Basic Internet Class (%)	95.6	95.6	95.0
HD Video Class / UHD Video Class (%)	86.8/42.6	86.7/40.9	85.4/35.5
Latency			
Gaming Class / OTT Voice Class (%)	85.2/96.6	85.3/96.2	78.3/95.1
Voice			
HD Voice (%)	96.5	93.9	95.4
Download Speed (Active)			
Avg. Throughput (Mbit/s)	74.1	57.4	44.5
90%/10% faster than (Mbit/s)	5.2/176.6	5.3/137.5	3.6/105.6
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	20.6	15.6	16.3
90%/10% faster than (Mbit/s)	2.4/47.6	1.8/38.2	1.9/37.1
Stability			
Transaction Success (%)	94.0	92.9	93.0

Single review

T·· For the twelfth time in a row, Telekom wins our mobile network test in Germany and now, for the first time, has cracked the mark of „outstanding", which has not yet been achieved in this country. Despite increased test requirements, the Bonn-based company improved its voice and data performance once again.

vodafone Vodafone keeps its very good result – the slight increase in points compared to the previous year even means an improvement in performance given the stricter criteria. The Düsseldorf-based company has improved in particular in the important data category – in Crowd and Voice it has maintained its previous year's result.

O2 The most significant increase in points among the German providers this year is achieved by O2/Telefónica – which underlines its progress in network expansion. In the voice rating, the Munich-based company is almost on a par with Vodafone, and they have improved most significantly in the important data discipline.

Reliability

Although we separate the compulsory programme from the "freestyle" programme in this consideration of our test results, the familiar order of operators is evident in Germany.

▶ The chapter "reliability" is new this year. However, it is not based on additional test points, but is more a different look at the results of the preceding chapters. The analysis is based on the fact that umlaut differentiates between "Qualifier KPIs" (mandatory, so to speak) and "Differentiator KPIs" (equivalent to freestyle) for all KPIs – see also the methodology description on page 79. The providers who score well in the mandatory programme deliver reliable services, irrespective of any top performance they may or may not achieve in the freestyle.

Nevertheless, Telekom is ahead in this analysis as well. Its lead is evident in all individual disciplines – more pronounced in the drive and walk tests, more narrowly in crowdsourcing. The fact that all providers achieve very good or even outstanding scores here underlines the increased reliability of the German mobile networks.

Operator		Telekom	Vodafone	Telefónica
Voice	max. 149 points	145	140	138
Drivetest	115	98%	95%	95%
Walktest	33	95%	93%	88%
Data	max. 222 points	213	207	200
Drivetest	172	97%	95%	92%
Walktest	50	93%	88%	84%
Crowd	max. 123 points	116	114	113
Crowd	123	94%	93%	92%
Total		493	474	461	451

All values rounded to whole numbers. The internal calculation of points and percentages was done with three decimal points.
The 493 maximum points achieved here are an extract from the total of 1000 points (see also p. 78/79).

Austria

This year, the level of performance in the Alpine Republic has risen significantly – in particular, the second and third-placed teams are managing to get closer to the front-runner.

▶ The ranking in the Alpine Republic looks familiar this time again – but a closer look at the performance of the three network operators in Austria reveals some pleasant surprises. In any case, the score level in this country has been somewhat higher than in Germany for years – although still a little behind the results of the strong Swiss providers.

In addition to test winner Magenta, which has already achieved the exclusive grade of "outstanding" for the fourth time in a row, second-placed A1 Telekom can also be happy about their grade again this year – after it had already achieved it in 2020. This time, the triumph is even greater because, as in every year, we have tightened our evaluation criteria considerably compared to the previous year. What is also all the more remarkable is the significant increase of the third-placed provider Drei compared to its previous year's result.

Voice connections

Let's look at the circumstances in detail, starting with the voice category. In all tested scenarios, there is an intense duel here between Magenta and A1. In the metropolitan walk tests, A1 not only improved significantly over its results from the previous year, but also outperformed its competitor Magenta. In addition, the competitors also clearly improved on their results from the previous year in small towns – where Magenta in particular stands out with top performance – as well as on connecting roads.

The fact that the compliance rates here are only slightly behind the larger and smaller cities is good news for drivers on Austrian roads.

However, improvements are also evident in the results of Drei – especially in the large cities and smaller towns, the Hutchison brand was able to narrow the distance to the performance of Magenta and A1.
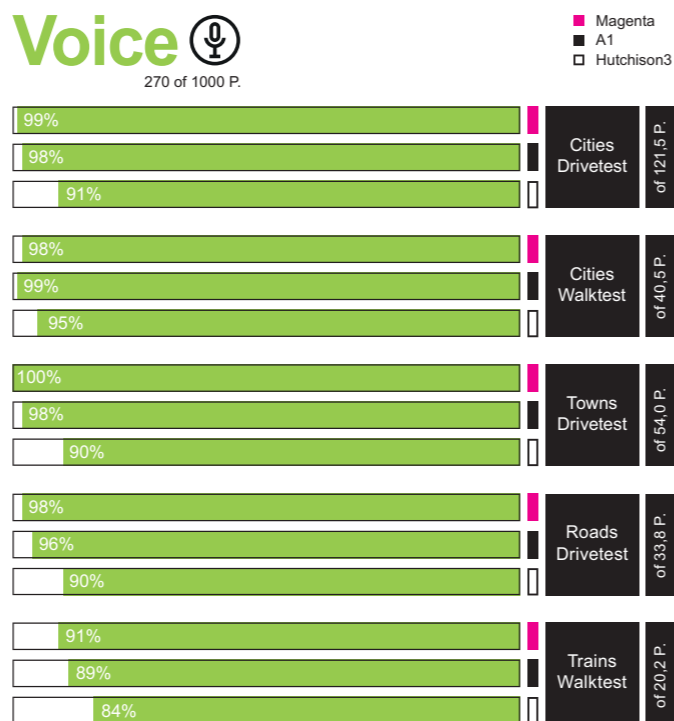
Magenta took the category victory with particularly short call set-up times and in the drive tests also with higher voice quality. The MultiRAB connectivity is also pleasingly high, proving that data communication remains possible in the background even during ongoing phone calls.

Our test results in Austria give rail passengers another reason to be happy: In the trains, all three providers have improved significantly compared to the previous year - even if they still do not quite reach the dream results from Switzerland.

Data connections

The data measurements also show a similar picture: Magenta and A1 are engaged in a duel at a high level. In the large city and small town drive tests, Magenta is ahead by a narrow gap, on the connecting roads A1 performs slightly better, and in the walk tests in larger cities, both are on a par. Hutchison Three essentially maintains its previous year's level in the data discipline.
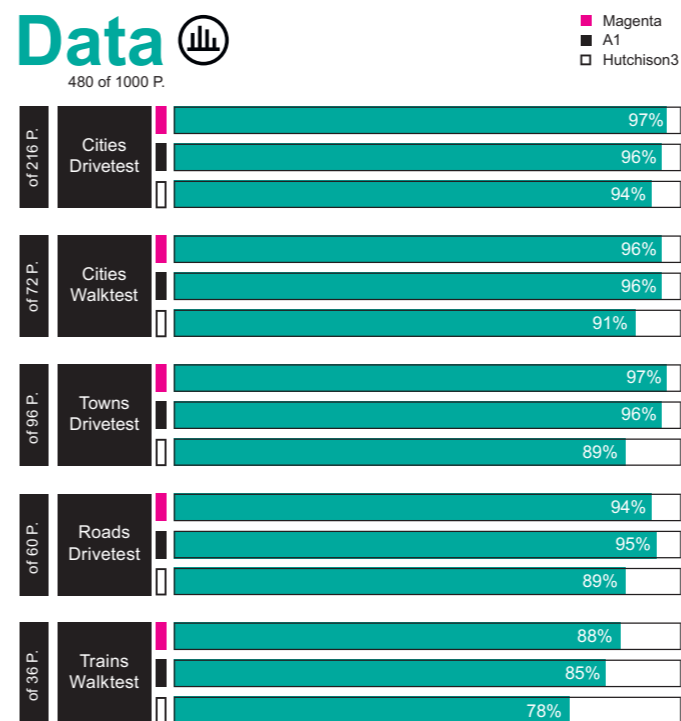
The good results reflect the high success rates in the various data tests, which are well above 99 percent in the large and small cities as well as on the connecting roads.

The data rates then reveal a certain divide between urban and rural regions, which is particularly pronounced for Hutchison Drei.

In the YouTube tests, again, all three candidates perform well in large cities, small towns as well as on the connecting roads.

In our new eGaming test case, which primarily rewards short latency times, Magenta and A1 perform well, while Drei falls a little behind here.

Overall, the results in the also newly added category "Conversational App", which maps IP-based voice transmissions as used in Whatsapp

Voice

270 of 1000 P.

Operator	Magenta	A1	Hutchison3
Voice Cities (Drivetest)			
Success Ratio (%)	99.8	99.8	98.9
Call Setup Time P90 (s)	0.8	1.2	2.1
Speech Quality P10 (MOS-LQO)	4.5	4.2	4.2
Multirab Connectivity (%)	100.0	99.8	99.5
Voice Cities (Walktest)			
Success Ratio (%)	99.8	99.9	99.5
Call Setup Time P90 (s)	0.8	1.2	1.9
Speech Quality P10 (MOS-LQO)	4.4	4.4	4.4
Multirab Connectivity (%)	99.8	99.5	99.8
Voice Towns (Drivetest)			
Success Ratio (%)	100.0	99.9	98.7
Call Setup Time P90 (s)	0.9	1.3	2.3
Speech Quality P10 (MOS-LQO)	4.5	4.2	4.2
Multirab Connectivity (%)	100.0	99.7	100.0
Voice Roads (Drivetest)			
Success Ratio (%)	99.5	99.3	98.2
Call Setup Time P90 (s)	0.8	1.3	2.5
Speech Quality P10 (MOS-LQO)	4.4	4.2	4.0
Multirab Connectivity (%)	99.9	99.1	99.5
Voice Trains (Walktest)			
Success Ratio (%)	97.7	97.1	96.7
Call Setup Time P90 (s)	1.1	1.3	2.2
Speech Quality P10 (MOS-LQO)	4.1	4.0	3.7
Multirab Connectivity (%)	99.2	98.8	98.9

Magenta ■ A1 □ Hutchison3

Cities Drivetest (of 121,5 P.): 99% / 98% / 91%
Cities Walktest (of 40,5 P.): 98% / 99% / 95%
Towns Drivetest (of 54,0 P.): 100% / 98% / 90%
Roads Drivetest (of 33,8 P.): 98% / 96% / 90%
Trains Walktest (of 20,2 P.): 91% / 89% / 84%

Data

480 of 1000 P.

Magenta ■ A1 □ Hutchison3

Cities Drivetest (of 216 P.): 97% / 96% / 94%
Cities Walktest (of 72 P.): 96% / 96% / 91%
Towns Drivetest (of 96 P.): 97% / 96% / 89%
Roads Drivetest (of 60 P.): 94% / 95% / 89%
Trains Walktest (of 36 P.): 88% / 85% / 78%

Operator	Magenta	A1	Hutchison3
Data (Cities; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/1.2	99.8/1.2	99.6/1.5
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.8/0.8	100.0/1.0	100.0/1.4
90%/10% faster than (Mbit/s)	101.2/305.3	73.1/272.3	50.1/267.6
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.9/1.4	99.7/1.9	99.8/2.1
90%/10% faster than (Mbit/s)	22.0/81.5	13.1/80.5	13.1/70.8
File Download (7 Seconds)			
Success Ratio (%)	99.8	99.9	99.5
10% faster than (Mbit/s)	767.7	736.1	734.3
Speed > 20Mbit/s / 100Mbit/s (%)	99.5/93.8	99.1/90.5	99.2/88.5
File Upload (7 Seconds)			
Success Ratio (%)	99.8	99.6	99.6
10% faster than (Mbit/s)	128.0	115.9	99.9
Speed > 2Mbit/s / 5Mbit/s (%)	99.8/99.5	99.4/97.6	99.3/97.2
Youtube Video			
Success Ratio/Start Time (%/s)	99.7/1.8	100.0/1.8	99.3/2.0
Time to Full Resolution (s)	8.9	8.8	8.8
Youtube Live			
Success Ratio/Start Time (%/s)	99.0/3.6	99.2/3.6	98.6/3.6
Time to Full Resolution (s)	8.0	7.8	7.9
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.8/2.2	99.4/2.1	98.5/2.2
Time to Full Resolution (s)	8.6	8.6	9.0
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.6	99.9/3.5	99.9/3.1
Interactivity e-Gaming			
Interactivity e-Gaming (%)	80.3	77.9	63.9
Data (Cities; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.7/1.2	99.8/1.2	99.3/1.6
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.8	100.0/1.0	99.8/1.5
90%/10% faster than (Mbit/s)	89.5/300.6	73.4/261.4	35.7/254.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.8	99.8/1.6	99.7/3.4
90%/10% faster than (Mbit/s)	20.0/76.0	15.6/82.0	6.5/69.0
File Download (7 Seconds)			
Success Ratio (%)	100.0	99.9	99.7
10% faster than (Mbit/s)	818.6	721.9	777.3
Speed > 20Mbit/s / 100Mbit/s (%)	98.6/90.7	99.9/91.4	97.6/78.1
File Upload (7 Seconds)			
Success Ratio (%)	99.4	99.3	98.7
10% faster than (Mbit/s)	120.3	117.5	95.9
Speed > 2Mbit/s / 5Mbit/s (%)	99.5/97.6	98.5/96.8	98.0/94.7
Youtube Video			
Success Ratio/Start Time (%/s)	99.7/1.7	100.0/1.9	98.8/2.1
Time to Full Resolution (s)	9.1	8.9	8.9
Youtube Live			
Success Ratio/Start Time (%/s)	98.4/3.6	98.7/3.7	98.4/3.7
Time to Full Resolution (s)	8.0	8.0	8.0
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.4/2.1	99.7/2.3	99.1/2.2
Time to Full Resolution (s)	9.1	8.4	9.5
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.7/3.9	99.9/4.1	99.6/3.1
Interactivity e-Gaming			
Interactivity e-Gaming (%)	80.5	79.5	61.4
Data (Towns; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/1.2	99.9/1.2	99.2/1.6
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.8	100.0/1.1	99.5/1.8
90%/10% faster than (Mbit/s)	93.2/290.9	62.8/246.2	25.8/231.9
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.5	100.0/1.9	99.7/2.8
90%/10% faster than (Mbit/s)	16.2/72.2	14.1/78.5	8.7/59.0
File Download (7 Seconds)			
Success Ratio (%)	100.0	100.0	99.6
10% faster than (Mbit/s)	663.5	608.4	620.8
Speed > 20Mbit/s / 100Mbit/s (%)	99.3/91.9	99.1/87.1	95.6/64.8
File Upload (7 Seconds)			
Success Ratio (%)	99.8	99.7	99.8
10% faster than (Mbit/s)	113.2	110.8	79.9
Speed > 2Mbit/s / 5Mbit/s (%)	100.0/99.5	99.7/97.6	98.8/95.6
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.7	99.7/1.8	97.6/2.1
Time to Full Resolution (s)	9.0	9.0	9.1
Youtube Live			
Success Ratio/Start Time (%/s)	99.7/3.6	98.6/3.6	96.3/3.6
Time to Full Resolution (s)	7.9	8.0	7.6
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/2.2	99.7/2.2	97.8/2.2
Time to Full Resolution (s)	8.7	8.8	9.4
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.7	99.8/3.6	100.0/2.9
Interactivity e-Gaming			
Interactivity e-Gaming (%)	76.2	75.0	58.9

Operator	Magenta	A1	Hutchison3
Data (Roads; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.6/1.3	99.5/1.3	99.2/1.5
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/2.0	100.0/1.6	99.3/2.8
90%/10% faster than (Mbit/s)	19.2/236.0	32.3/210.8	17.3/135.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/2.7	100.0/2.9	99.7/4.3
90%/10% faster than (Mbit/s)	7.6/60.4	7.1/75.6	4.4/33.2
File Download (7 Seconds)			
Success Ratio (%)	99.3	100.0	98.1
10% faster than (Mbit/s)	435.2	380.3	230.3
Speed > 20Mbit/s / 100Mbit/s (%)	91.1/56.9	98.4/66.9	90.8/38.9
File Upload (7 Seconds)			
Success Ratio (%)	99.8	98.6	97.2
10% faster than (Mbit/s)	75.7	104.0	39.3
Speed > 2Mbit/s / 5Mbit/s (%)	98.6/93.6	98.1/93.0	95.0/86.1
Youtube Video			
Success Ratio/Start Time (%/s)	99.5/1.9	100.0/2.0	99.5/2.0
Time to Full Resolution (s)	9.4	9.1	9.1
Youtube Live			
Success Ratio/Start Time (%/s)	96.7/3.7	97.5/3.6	97.9/3.7
Time to Full Resolution (s)	8.3	8.0	7.8
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.5/2.2	98.1/2.3	95.6/2.1
Time to Full Resolution (s)	9.8	8.8	9.8
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.6/3.5	99.8/3.6	99.3/2.9
Interactivity e-Gaming			
Interactivity e-Gaming (%)	72.7	74.2	56.7

Operator	Magenta	A1	Hutchison3
Data (Trains; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	98.0/1.6	97.6/1.8	96.0/2.0
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	98.1/2.7	98.9/2.6	97.7/4.9
90%/10% faster than (Mbit/s)	14.5/256.1	11.8/220.1	6.7/188.0
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	98.8/3.8	98.8/4.5	96.8/5.9
90%/10% faster than (Mbit/s)	6.0/50.3	4.9/63.0	3.2/40.8
File Download (7 Seconds)			
Success Ratio (%)	97.7	97.4	97.0
10% faster than (Mbit/s)	562.3	420.9	437.5
Speed > 20Mbit/s / 100Mbit/s (%)	86.8/48.2	90.5/56.8	76.5/37.3
File Upload (7 Seconds)			
Success Ratio (%)	96.9	95.0	94.2
10% faster than (Mbit/s)	68.7	66.8	44.2
Speed > 2Mbit/s / 5Mbit/s (%)	98.0/90.3	95.1/89.4	93.0/80.3
Youtube Video			
Success Ratio/Start Time (%/s)	95.0/2.1	91.5/2.1	94.3/2.1
Time to Full Resolution (s)	10.0	9.9	9.1
Youtube Live			
Success Ratio/Start Time (%/s)	93.9/4.0	95.0/4.0	90.7/3.6
Time to Full Resolution (s)	8.2	8.1	7.8
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	96.1/2.4	94.7/2.4	92.0/2.2
Time to Full Resolution (s)	10.2	9.8	10.6
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.4/3.2	99.4/3.4	99.5/2.7
Interactivity e-Gaming			
Interactivity e-Gaming (%)	65.8	61.0	47.4

and the like, are also decent. Here, Magenta delivers the best results in the drive tests in large cities and small towns, while A1 is ahead in the big-city walk tests and on connecting roads. Although Drei does not come out on the very top in this discipline, this provider's results hold up well.

This year, too, Magenta and A1 owe their good performance in the data discipline to the consistent expansion of 4CA (4 Carrier Aggregation – the combination of up to four frequency bands) in their LTE networks, and this increasingly in conjunction with 5G ("5G NR + 4CA", see also box below).

Data connectivity on railways

In the test results for mobile internet use in Austrian trains, the trend points slightly upwards compared to the previous year, at least for Magenta and A1. Drei remains at its performance level of the previous year in this scenario as well. The Austrian providers can thus maintain their lead over their German counterparts - who have also improved slightly in the train category this year. Nevertheless, there is still room for improvement in this category. Still, the comparison with Switzerland, which is traditionally still much stronger in this area, does hold surprises this year – see page 78.

5G

In Austria, we also look separately at how the three tested providers perform in terms of 5G – although the new mobile communications standard is already a regular part of our data assessment, and the samples with 5G or 5G-DSS examined here are therefore included there as well.

■ The results of the seven-second download tests from the data discipline presented here are an exemplary case – however, the coverage shares with 5G and 5G-DSS that can be read here in particular are in comparable orders of magnitude in the other data tests too. They prove that all three Austrian network operators have continued to make good progress in their ongoing 5G rollouts. However, the percentages in cities are still significantly higher than on connecting roads. In railways, A1 achieves a significantly higher 5G share than its two competitors.

As in the previous year, we only see a notable share of the spectrum-sharing technology 5G-DSS in the network of Magenta. However, the results also highlight that the dynamic sharing of frequency bandwidths between 4G and 5G happens at the expense of data rates. Where 5G has already been rolled out in the Alpine Republic, however, it delivers very respectable data throughputs overall.

Data rates 7s Download	Magenta			A1			Hutchison Drei		
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	95.5%	467.4	771.6	95.4%	383.2	740.9	94.0%	430.5	740.2
Cities – Walktest	75.0%	557.4	869.2	92.7%	383.0	732.7	83.9%	419.4	824.5
Towns – Drivetest	95.5%	370.5	666.2	90.7%	345.2	617.4	65.3%	379.7	697.6
Roads – Drivetest	49.4%	286.5	585.2	65.0%	242.6	415.2	19.4%	248.2	502.5
Trains – Walktest	56.4%	325.4	646.6	81.4%	208.9	480.3	45.1%	297.5	640.2
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	1.5%	181.8	264.3	–	–	–	–	–	–
Cities – Walktest	2.7%	138.1	202.7	–	–	–	–	–	–
Towns – Drivetest	1.4%	135.6	210.4	–	–	–	–	–	–
Roads – Drivetest	4.3%	99.0	184.8	–	–	–	–	–	–
Trains – Walktest	5.4%	49.2	92.0	–	–	–	–	–	–

Crowd

The crowdsourcing results reflect the actual customer experience. Despite known rankings, there are interesting successes in individual categories here.

▶ The crowdsourcing analyses show the ranking already known from the drive and walk tests: Magenta is once again at the top, followed by A1 in second place at a gap of four points and then Drei in third place with a three-point gap to A1. Magenta is clearly ahead in the coverage quality and time on broadband (the proportion of time with broadband coverage). In these ratings, Drei also ranks ahead of A1. In terms of coverage reach, A1 is again in the lead.

The passively determined data rates of all three providers in the basic internet category are close together. A1 shines in the more demanding categories HD video and UHD video as well as in the active throughput measurements. In the passive measurements, Drei follows in second place, and in gaming latencies the Hutchison brand takes the lead ahead of A1 and Magenta. The analysis of HD voice connections again shows the familiar ranking. In transaction success and thus stability, Magenta is clearly ahead of A1 and Drei.

Operator	Magenta	A1	Hutchison3
Broadband Coverage			
Coverage Quality (%)	97.1	92.0	94.5
Coverage Reach (%)	89.8	90.9	85.2
Time on Broadband (%)	98.1	95.3	96.1
Download Speed			
Basic Internet Class (%)	96.8	96.6	96.4
HD Video Class / UHD Video Class (%)	87.8/35.1	88.9/41.0	88.7/37.1
Latency			
Gaming Class / OTT Voice Class (%)	94.4/98.2	94.6/98.5	95.5/98.1
Voice			
HD Voice (%)	96.4	94.7	92.3
Download Speed (Active)			
Avg. Throughput (Mbit/s)	48.7	67.0	47.5
90%/10% faster than (Mbit/s)	4.7/118.0	9.0/144.3	5.8/103.2
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	17.5	20.2	15.2
90%/10% faster than (Mbit/s)	3.0/40.6	2.7/45.0	2.1/30.5
Stability			
Transaction Success (%)	93.9	91.3	91.0

Single review

Magenta® For the fifth time in a row, Magenta achieves the overall victory in Austria. Despite some intense duels with A1, which includes the 5G rollout, Magenta comes out on top in all three test disciplines. As in the previous year, this strong performance earned the grade "outstanding" for this provider.

A1 A1 Telekom was able to improve on its performance shown in the previous year and now also receives the grade "outstanding". The performance is convincing in all test disciplines and is only just behind that of the test winner Magenta. A1 is the clear leader in 5G coverage on roads and in trains.

3 Compared to the previous year, the Hutchison brand clearly improved. The increase was achieved primarily in the voice discipline, while Drei was able to essentially maintain its performance level in the data and crowd categories. The 5G rollout also shows visible progress. So this results in a very good third place.

Reliability

Overall, Austrian customers can be pleased with the high reliability of their networks - but the familiar ranking is also evident in this assessment.

▶ In our new reliability assessment, in Austria the picture from the previous disciplines is confirmed: Magenta is in the lead overall, followed relatively closely by A1 and at a slightly larger distance by Drei.

In both the voice telephony and the data tests, Magenta is in the lead with a wafer-thin margin of one point over A1. The neck-and-neck race in the reliability ranking is equally evident in the drive tests and the walk tests. Three follows here at a more distinct gap in each case and thus shows a somewhat more pronounced potential for improvement.

The test field moves closer together again in the compulsory part of the evaluation in the crowd discipline. Magenta is once more at the top of the podium, but here Drei succeeds in moving ahead of the market leader A1 by one point.

Operator		Magenta	A1	Hutchison3
Voice	max. 148 points	145	144	132
Drivetest	115	98%	98%	88%
Walktest	33	94%	94%	90%
Data	max. 222 points	215	214	205
Drivetest	172	98%	97%	94%
Walktest	50	93%	92%	88%
Crowd	max. 123 points	117	114	115
Crowd	123	96%	93%	94%
Total		493	477	472	452

All values rounded to whole numbers. The internal calculation of points and percentages was also done with three decimal points.
The 493 maximum points achieved here are an extract from the total of 1000 points (see also p. 78/79).

Switzerland

This year, two Swiss network operators once again make it to the top step of the winners' podium, where they shine with the rarely awarded grade of "outstanding".

▶ Traditionally, Switzerland is at the top in the three-country comparison – for years, the Swiss mobile operators have been showing their counterparts from Germany and Austria where the top is. This is the case again this time. The high level of performance of the Swiss mobile networks is further emphasised by the fact that the usual neck-and-neck race between Swisscom and Sunrise is now being joined in more and more individual categories by the smallest provider, Salt.

This also applies to the 5G rollout (see box on page 78), where Salt has moved closer to its two larger competitors in large cities, in small towns – and with some restrictions also on the roads and in the railways. The fact that Swisscom and Sunrise have each lost a few points in the overall ranking compared to the previous year can be explained, among other things, by the fact that our test requirements have increased overall.

Voice connections

Already in voice telephony via VoLTE (Voice over LTE), the competition between the three providers takes place at the highest level. Both in the big cities and in the small towns, the three competitors are more or less on a par. Only on the connecting roads do the gaps somewhat widen – although Salt is once again clearly catching up compared to the previous year. In practice, the high scores manifest themselves in success rates of 100 or almost 100 percent, short call set-up times and high voice quality.

As in the previous year, Sunrise achieves the shortest call set-up times, which are one second or even less in all test scenarios. But Swisscom and Salt also rank closely behind, and in the major cities Salt is even on a par with Sunrise.

The high success rates and speech quality scores on Swiss roads and on train journeys through Switzerland mean in practice that travellers can rely on being able to make mobile phone calls on the move almost without restriction – and in almost perfect quality. In the tests on Swiss trains, the runners-up Sunrise and Salt have once again caught up significantly compared to last year, while market leader Swisscom maintains its already impressive result from the previous year. In the overall ranking, Sunrise leads the voice discipline by one point ahead of Swisscom.

Data connections

The Swiss network operators rank also close to each other in the data discipline. This is clearly evident in the drive and walk tests carried out in large cities, where Swisscom has a razor-thin lead – but Sunrise and Salt are close on the heels of the first-placed company.
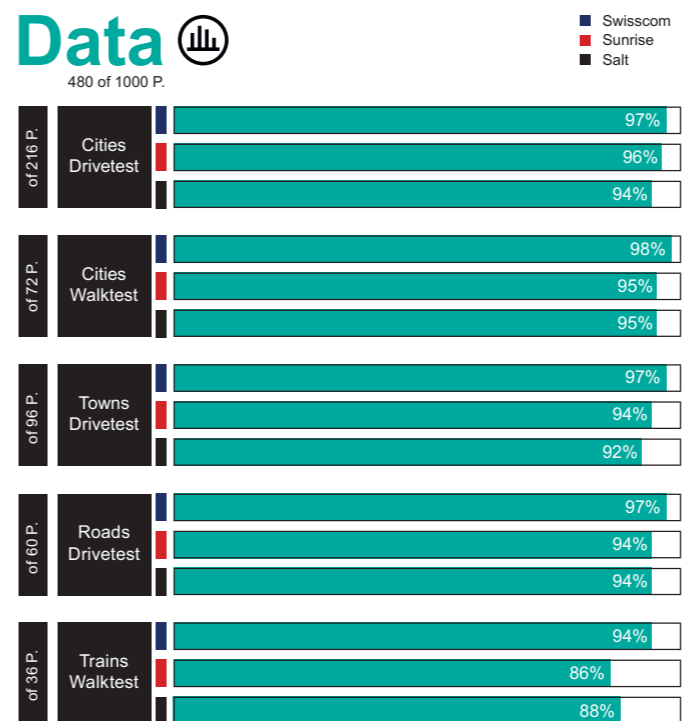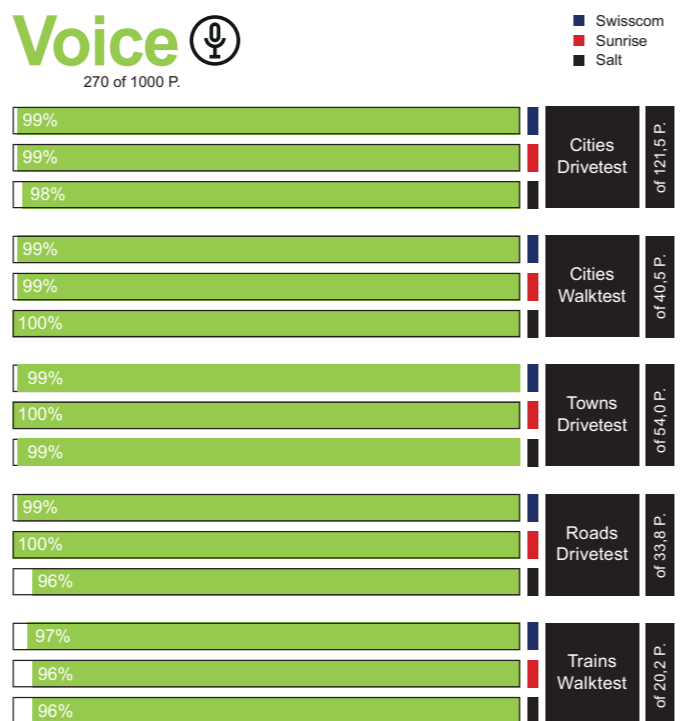
Salt manages to catch up with second-placed Sunrise more often than in the previous year. The high level of performance becomes particularly clear in the success rates of the individual data tests. Overall, Swisscom leads in this discipline, with Sunrise and Salt chasing each other for second place, depending on the respective test case.

In small towns and on connecting roads, Swisscom also defends its first place sovereignly. In these scenarios, too, it is remarkable that Salt continues to catch up – in the small towns, the gap to Sunrise is only minor, and on the roads, both providers are on a tie in the overall ranking.

All in all, the urban-rural divide in Switzerland is much less pronounced than in neighbouring countries.

Foto: kavalenkava/shutterstock.com

Operator	Swisscom	Sunrise	Salt
Voice Cities (Drivetest)			
Success Ratio (%)	99.8	99.8	99.7
Call Setup Time P90 (s)	1.2	1.0	1.0
Speech Quality P10 (MOS-LQO)	4.5	4.6	4.5
Multirab Connectivity (%)	99.9	100.0	99.9
Voice Cities (Walktest)			
Success Ratio (%)	99.9	99.8	99.9
Call Setup Time P90 (s)	1.2	0.9	0.9
Speech Quality P10 (MOS-LQO)	4.7	4.7	4.6
Multirab Connectivity (%)	100.0	100.0	100.0
Voice Towns (Drivetest)			
Success Ratio (%)	99.9	100.0	100.0
Call Setup Time P90 (s)	1.2	1.0	1.1
Speech Quality P10 (MOS-LQO)	4.4	4.6	4.4
Multirab Connectivity (%)	100.0	100.0	99.6
Voice Roads (Drivetest)			
Success Ratio (%)	99.7	99.8	99.0
Call Setup Time P90 (s)	1.3	1.0	1.3
Speech Quality P10 (MOS-LQO)	4.4	4.6	4.2
Multirab Connectivity (%)	100.0	100.0	99.5
Voice Trains (Walktest)			
Success Ratio (%)	99.4	98.9	99.1
Call Setup Time P90 (s)	1.2	1.0	1.1
Speech Quality P10 (MOS-LQO)	4.4	4.4	4.2
Multirab Connectivity (%)	100.0	99.3	99.9

Voice 🎙
270 of 1000 P.

■ Swisscom
■ Sunrise
■ Salt

99%	**Cities Drivetest**	of 121,5 P.
99%		
98%		
99%	**Cities Walktest**	of 40,5 P.
99%		
100%		
99%	**Towns Drivetest**	of 54,0 P.
100%		
99%		
99%	**Roads Drivetest**	of 33,8 P.
100%		
96%		
97%	**Trains Walktest**	of 20,2 P.
96%		
96%		

Data 📊
480 of 1000 P.

■ Swisscom
■ Sunrise
■ Salt

97%	**Cities Drivetest**	of 216 P.
96%		
94%		
98%	**Cities Walktest**	of 72 P.
95%		
95%		
97%	**Towns Drivetest**	of 96 P.
94%		
92%		
97%	**Roads Drivetest**	of 60 P.
94%		
94%		
94%	**Trains Walktest**	of 36 P.
86%		
88%		

Operator	Swisscom	Sunrise	Salt
Data (Cities; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.8/1.2	99.9/1.2	99.7/1.4
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.9/0.9	99.9/1.2	99.9/1.7
90%/10% faster than (Mbit/s)	68.8/382.8	30.2/334.7	25.2/216.8
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.4	100.0/1.4	99.8/1.5
90%/10% faster than (Mbit/s)	21.1/97.1	17.6/94.3	19.2/69.3
File Download (7 Seconds)			
Success Ratio (%)	99.8	99.9	99.7
10% faster than (Mbit/s)	822.2	816.2	425.8
Speed > 20Mbit/s / 100Mbit/s (%)	98.5/85.7	98.3/85.1	95.3/56.6
File Upload (7 Seconds)			
Success Ratio (%)	99.8	99.7	99.5
10% faster than (Mbit/s)	150.5	140.2	103.8
Speed > 2Mbit/s / 5Mbit/s (%)	99.6/98.6	99.6/98.8	99.9/99.4
Youtube Video			
Success Ratio/Start Time (%/s)	99.4/1.8	99.4/1.7	99.7/1.9
Time to Full Resolution (s)	10.0	11.1	10.1
Youtube Live			
Success Ratio/Start Time (%/s)	99.3/4.0	99.6/4.2	99.0/4.2
Time to Full Resolution (s)	8.1	8.7	8.2
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.0/2.2	99.7/2.2	98.4/2.2
Time to Full Resolution (s)	9.9	11.3	10.0
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.6	99.9/3.5	99.9/3.2
Interactivity e-Gaming			
Interactivity e-Gaming (%)	80.3	81.7	75.5
Data (Cities; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	100.0/1.1	99.6/1.1	99.8/1.3
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.8	99.7/0.9	100.0/1.6
90%/10% faster than (Mbit/s)	61.5/380.4	59.1/358.7	29.0/226.4
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/0.9	99.3/1.3	100.0/1.6
90%/10% faster than (Mbit/s)	32.3/96.4	21.3/98.8	19.2/65.9
File Download (7 Seconds)			
Success Ratio (%)	100.0	99.8	100.0
10% faster than (Mbit/s)	837.5	902.8	442.4
Speed > 20Mbit/s / 100Mbit/s (%)	99.2/81.9	97.9/88.0	95.2/58.2
File Upload (7 Seconds)			
Success Ratio (%)	100.0	99.3	99.3
10% faster than (Mbit/s)	150.1	143.7	102.5
Speed > 2Mbit/s / 5Mbit/s (%)	100.0/99.8	98.9/98.4	100.0/99.8
Youtube Video			
Success Ratio/Start Time (%/s)	100.0/1.8	99.7/1.8	100.0/1.8
Time to Full Resolution (s)	8.9	10.6	9.2
Youtube Live			
Success Ratio/Start Time (%/s)	99.2/4.2	99.2/4.3	99.6/3.9
Time to Full Resolution (s)	7.6	8.4	8.0
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/2.2	99.6/2.2	99.2/2.2
Time to Full Resolution (s)	8.0	10.6	8.7
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/4.1	100.0/4.1	100.0/3.9
Interactivity e-Gaming			
Interactivity e-Gaming (%)	86.2	85.4	77.5
Data (Towns; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/1.2	99.9/1.3	99.8/1.4
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.9/0.9	100.0/1.2	99.8/1.6
90%/10% faster than (Mbit/s)	69.2/354.0	34.2/308.9	25.6/217.6
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.3	100.0/2.1	99.8/2.0
90%/10% faster than (Mbit/s)	22.4/92.0	10.7/85.7	13.0/62.2
File Download (7 Seconds)			
Success Ratio (%)	99.8	99.8	99.5
10% faster than (Mbit/s)	789.1	776.7	385.3
Speed > 20Mbit/s / 100Mbit/s (%)	99.2/89.5	98.1/82.4	94.9/56.2
File Upload (7 Seconds)			
Success Ratio (%)	100.0	99.5	98.8
10% faster than (Mbit/s)	146.4	121.2	89.9
Speed > 2Mbit/s / 5Mbit/s (%)	99.5/99.1	99.4/97.2	99.5/98.4
Youtube Video			
Success Ratio/Start Time (%/s)	99.7/1.8	99.4/1.8	99.4/1.9
Time to Full Resolution (s)	9.8	10.9	10.0
Youtube Live			
Success Ratio/Start Time (%/s)	99.4/4.1	98.7/4.3	98.7/4.0
Time to Full Resolution (s)	8.2	8.7	8.1
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/2.1	99.0/2.2	98.7/2.2
Time to Full Resolution (s)	9.9	11.2	10.0
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.6	100.0/3.4	99.8/3.3
Interactivity e-Gaming			
Interactivity e-Gaming (%)	78.3	78.8	74.2

Operator	Swisscom	Sunrise	Salt
Data (Roads; Drivetest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.9/1.2	99.8/1.3	99.5/1.4
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/1.1	100.0/2.1	100.0/1.7
90%/10% faster than (Mbit/s)	50.6/315.1	18.8/257.6	31.8/168.1
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	100.0/2.1	100.0/3.2	99.7/2.7
90%/10% faster than (Mbit/s)	10.8/78.9	5.9/63.2	8.0/54.7
File Download (7 Seconds)			
Success Ratio (%)	100.0	99.7	100.0
10% faster than (Mbit/s)	703.4	602.5	269.4
Speed > 20Mbit/s / 100Mbit/s (%)	98.2/80.9	92.9/56.5	96.9/51.5
File Upload (7 Seconds)			
Success Ratio (%)	98.8	99.4	98.4
10% faster than (Mbit/s)	123.7	94.8	67.0
Speed > 2Mbit/s / 5Mbit/s (%)	98.8/96.7	98.1/95.3	98.1/92.7
Youtube Video			
Success Ratio/Start Time (%/s)	99.4/1.9	98.8/1.8	98.2/2.0
Time to Full Resolution (s)	9.7	10.8	9.8
Youtube Live			
Success Ratio/Start Time (%/s)	99.4/4.2	98.7/4.1	100.0/3.9
Time to Full Resolution (s)	8.0	8.6	8.1
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	98.7/2.1	100.0/2.1	98.1/2.0
Time to Full Resolution (s)	9.5	10.9	9.8
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	100.0/3.4	100.0/3.4	100.0/3.3
Interactivity e-Gaming			
Interactivity e-Gaming (%)	76.8	79.3	73.9

Operator	Swisscom	Sunrise	Salt
Data (Trains; Walktest)			
Web Page Download			
Success Ratio / Avg. Session Time (%/s)	99.1/1.4	98.1/1.6	98.2/1.7
File Download (10MB)			
Success Ratio / Avg. Session Time (%/s)	99.5/1.7	99.3/3.3	99.3/3.9
90%/10% faster than (Mbit/s)	24.0/293.3	11.9/237.0	10.0/161.7
File Upload (5MB)			
Success Ratio / Avg. Session Time (%/s)	99.5/2.2	99.0/4.2	98.5/3.0
90%/10% faster than (Mbit/s)	11.9/72.7	5.0/53.3	8.8/54.2
File Download (7 Seconds)			
Success Ratio (%)	99.1	99.3	99.8
10% faster than (Mbit/s)	562.3	423.0	230.2
Speed > 20Mbit/s / 100Mbit/s (%)	91.8/65.3	84.6/46.9	81.2/29.5
File Upload (7 Seconds)			
Success Ratio (%)	99.3	95.9	96.2
10% faster than (Mbit/s)	99.7	66.6	67.6
Speed > 2Mbit/s / 5Mbit/s (%)	97.9/96.0	95.3/87.5	97.3/91.5
Youtube Video			
Success Ratio/Start Time (%/s)	98.6/1.9	94.2/2.1	98.1/2.1
Time to Full Resolution (s)	9.2	10.5	9.9
Youtube Live			
Success Ratio/Start Time (%/s)	96.5/4.2	93.1/4.4	94.7/4.0
Time to Full Resolution (s)	7.8	8.6	7.9
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	96.1/2.3	93.5/2.2	95.5/2.2
Time to Full Resolution (s)	8.7	10.7	9.5
Conversational-App			
Success Ratio/Speech Quality P10(%/MOS-LQO)	99.8/3.3	99.9/3.2	99.8/3.3
Interactivity e-Gaming			
Interactivity e-Gaming (%)	67.7	65.8	60.7

If one wants to complain at all at such a high level, Sunrise shows slight potential for improvement in the YouTube tests, while Salt could still improve a little in the upload and download tests in large cities and small towns.

However, all three Swiss network operators again show very good results in our new "conversational app" test cases – i.e. in the examination of IP-based voice transmissions in corresponding apps – as well as the eGaming test aimed at short latency times. Swisscom owes its overall victory not least to the widespread use of the combination of 5G NR with „4 Carrier Aggregation" (4CA) in its network.

Data connectivity on railways

Yet another tradition: for years, Swiss providers have been showing what almost perfect mobile network coverage on trains looks like. The performance of Swisscom, in particular, is once again at the highest level this year. But it is noticeable that Sunrise in particular lags a little behind last year's performance in this discipline. Thus Salt also manages to overtake its competitor Sunrise in this discipline – however, also with a few points less than last year. The results here are still very good – but have lost their clear lead over the strongest operators in Austria.

5G

The rollout of 5G is also in full swing in Switzerland. Our targeted analysis of the 5G results shows increases for all three Swiss providers compared to their values from the previous year in all examined scenarios. However, Salt is catching up particularly clearly in this respect.

■ In order to shed light on the progress of the strong Swiss providers in their 5G rollouts, we are again looking at the results of the seven-second download tests from the data discipline as an example. The proportions of samples with 5G and 5G-DSS determined in these tests are also found in a similar way in the other data tests.

The first thing that stands out are the very high data rates, which are well above 800 Mbit/s in many of the scenarios examined. The proportions with 5G have also once again increased significantly for all three providers compared to the previous year. It is noticeable that in Switzerland only Swisscom relies to a significant extent on the capacity distribution technology DSS. In total, this provider also has a high 5G coverage – even on roads and in trains. Where DSS is used, however, this happens at the expense of data rates. It is also impressive how much Salt has increased in all scenarios compared to the previous year.

Data rates 7s Download	Swisscom			Sunrise			Salt		
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	77.9%	499.0	864.4	97.1%	392.2	821.2	78.7%	207.6	478.3
Cities – Walktest	69.8%	532.7	913.6	92.2%	494.5	915.8	70.7%	229.0	519.3
Towns – Drivetest	79.6%	448.0	820.5	93.6%	378.5	788.8	62.6%	224.8	515.6
Roads – Drivetest	49.4%	458.0	807.9	60.8%	319.9	686.8	25.9%	238.1	500.9
Trains – Walktest	48.5%	360.3	726.1	71.4%	197.3	460.2	47.8%	122.7	316.2
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	18.5%	129.9	240.5	–	–	–	–	–	–
Cities – Walktest	20.9%	111.8	246.8	–	–	–	–	–	–
Towns – Drivetest	17.0%	176.2	303.0	–	–	–	–	–	–
Roads – Drivetest	38.2%	168.1	290.9	–	–	–	–	–	–
Trains – Walktest	35.4%	117.8	245.0	–	–	–	–	–	–

Crowd

How much power reaches the customers? Swisscom also leads narrowly in crowdsourcing, closely followed by Sunrise and with a slightly larger gap by Salt.

▶ The crowdsourcing analyses provide the same ranking as the overall ranking in Switzerland and as in the data and voice categories. They thus confirm the results of the drive and walk tests – whereby crowdsourcing also always reflects the customers' choice of tariff and device.

Overall, Swisscom leads again with a two-point advantage over Sunrise. Salt follows in third place, five points behind Sunrise. In terms of coverage quality and time on broadband, Sunrise ranks just ahead of Swisscom. Salt is somewhat more clearly behind the leading duo here.

In terms of coverage reach, Swisscom is again in the lead. The same applies to the examination of data rates (both passive and active) and to the evaluation of latencies.

The availability of HD voice is again a neck-and-neck race between Sunrise and Swisscom, with the former narrowly winning. At a generally high level, Sunrise leads in stability just ahead of the equally strong providers Swisscom and Salt here.

Operator	Swisscom	Sunrise	Salt
Broadband Coverage			
Coverage Quality (%)	97.0	98.2	95.6
Coverage Reach (%)	97.5	95.8	89.7
Time on Broadband (%)	98.3	98.7	96.4
Download Speed			
Basic Internet Class (%)	96.4	96.0	95.4
HD Video Class / UHD Video Class (%)	90.5/43.2	89.4/40.2	88.2/37.6
Latency			
Gaming Class / OTT Voice Class (%)	96.2/98.4	94.2/97.5	92.9/97.5
Voice			
HD Voice (%)	96.7	96.9	92.0
Download Speed (Active)			
Avg. Throughput (Mbit/s)	88.2	61.0	65.2
90%/10% faster than (Mbit/s)	9.1/201.7	5.7/129.6	6.0/157.1
Upload Speed (Active)			
Avg. Throughput (Mbit/s)	27.2	21.3	22.0
90%/10% faster than (Mbit/s)	3.9/55.1	2.5/48.5	3.9/44.7
Stability			
Transaction Success (%)	94.5	94.7	94.5

Single review

swisscom Swisscom wins our test in Switzerland for the fifth time in a row. With the best results in the data and crowd categories, top performance in the 5G rollout and the highest score in the 2022/23 network test season to date, Swisscom once again achieves the grade "outstanding".

Sunrise Sunrise can be pleased about the grade "outstanding" even for the seventh time in a row – and also about being ahead in the voice discipline this year. Furthermore, its performance in the other test categories and in 5G expansion is also convincing.

Salt. The smallest provider, Salt, shows a clear improvement in performance in Switzerland this year and is moving closer to second-placed Sunrise in many test disciplines. The progress in its 5G expansion rollout is also clear. The next goal for Salt could also be the grade "outstanding".

Reliability

The high level of performance in Switzerland is also shown when looking at the basic performance – the ranking is a familiar one among the Swiss operators.

▶ This time, we added a separate look at the compulsory categories or basic performances to our results, which initially shows the familiar picture. At the same time, however, it confirms the very high level of performance overall.

While Swisscom and Sunrise were already close together in the voice and crowd ratings, they are tied regarding the achieved reliability points in these categories. Salt also follows here at only a small gap. The overall winner, Swisscom, is somewhat more distinct from the pursuing field in the data discipline, and there again especially in the walk tests carried out in large cities. In this subranking, Salt manages to draw level with Swisscom in the voice discipline and to place itself ahead of Sunrise in the data discipline. But here, too, it becomes ultimately clear that Switzerland is above the rest in terms of performance.

Operator	Swisscom	Sunrise	Salt
Voice	max. 148 points	146	146	145
Drivetest	115	98%	99%	97%
Walktest	33	98%	97%	98%
Data	max. 222 points	217	214	213
Drivetest	172	98%	98%	96%
Walktest	50	98%	92%	95%
Crowd	max. 123 points	117	117	114
Crowd	123	96%	95%	93%
Total	493	480	477	472

All values rounded to whole numbers. The internal calculation of points and percentages was done with three decimal points.
The 493 maximum points achieved here are an extract from the total of 1000 points (see also p. 78/79).

Methodoloogy

■ The measurements in Germany took place from 22.10. to 6.11.2022, in Austria from 7.10. to 27.10.2022 and in Switzerland from 20.10. to 7.11.2022. connect's network test partner umlaut sent four measurement vehicles per country, each equipped with nine 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"). 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.

Logistics

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.

In Germany, drive tests took place in 20 cities and 23 towns, and the walk tests in eleven cities. Thus, about 16 million inhabitants were covered, which corresponds to about 19.3 percent of the German population. The drive tests covered approximately 12,000 km. In Austria, the testers drove through ten large cities and 19 smaller towns and covered about 6200 km. In addition, there were walk tests in six cities. Thus, about 3.3 million inhabitants (about 37.3%

With a fleet of specially equipped test vehicles, umlaut's teams conducted the drive tests in the three countries.

of the population) were covered. The drive tests in Switzerland led to 28 cities and 19 smaller towns, the walk tests took place in nine cities. The test route in Switzerland was about 6700 km long, the measurement campaign in Switzerland covered about 2.3 million inhabitants (26.3% of the population). 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".

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

A special control system monitors the smartphones and logs the measurement values they collect.

Part of **Accenture**

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.

For this purpose, the samples collected in all three countries from mid-May to the end of October 2022 (week 19 to week 42) were evaluated. Around 2.1 billion individual samples were analysed from Germany, statistically representing 99.9 percent of the population. For Austria, umlaut evaluated around 316 million samples (representing 99.8 percent of the population). In Switzerland, the approximately 463 million samples represent about 99.9 percent of the population. To obtain the data basis for these analyses, thousands of popular apps recorded the parameters described below in the background – provided the user agreed to the completely anonymous data collection. The measured values were recorded in 15-minute intervals and transmitted to the umlaut servers once a day. The reports contain only a few bytes, so they hardly burden the user's data volume.

Broadband Coverage

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

achievable number of points (three points per EA in the "common footprint" – the area of the respective country covered by all tested providers). We also looked at the *coverage quality*. This KPI relates the percentage of EAs where a user had 4G or 5G reception to all EAs in the common footprint. The *time on broadband* in turn tells us how often a user had 4G or 5G reception in the period under consideration – regardless of the EAs in which the samples were recorded. For this purpose, umlaut sets the samples that show 4G/5G coverage in relation to the total number of all samples. Important: The percentage values determined for all three parameters reflect the respective degree of fulfilment – and not a percentage of 4G/5G mobile coverage in relation to area or population.

Data rates and Latencies

The passive determination of *download data rates* and latencies was carried out independently of the EAs and focused on the experience of each user. Samples that were captured via Wi-fi or when flight mode was activated, for example, were filtered out by umlaut before the analysis. To take into account that many mobile phone tariffs throttle the usable data rate, umlaut defined three application-related speed classes: *Basic internet* requires a minimum of 2 Mbit/s, *HD video* requires 5 Mbit/s and *UHD video* requires 20 Mbit/s. For a sample to be valid, a minimum amount of data must have flowed in a 15-minute period. Similarly, the *latency* of the data packets is assigned to an application-related class: Roundtrip times up to 100 ms are sufficient for *OTT voice services*, less than 50 ms qualify a

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

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

The walktest teams use trolleys or backpacks in which powerful batteries feed the test smartphones.

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.

Score Breakdown	
Cities — Drivetest	**337,50**
Cities — Walktest	**112,50**
Towns — Drivetest	**150,00**
Roads — Drivetest	**93,75**
Trains — Walktest	**56,25**
Crowdsourcing	**250,00**

Drivetest

Walktest

Crowd

Fairness and Transparency

With their tried and tested measures and processes, umlaut and connect have also ensured in 2022 that our mobile network test is fair and transparent – and that all tested network operators adhere to fair play.
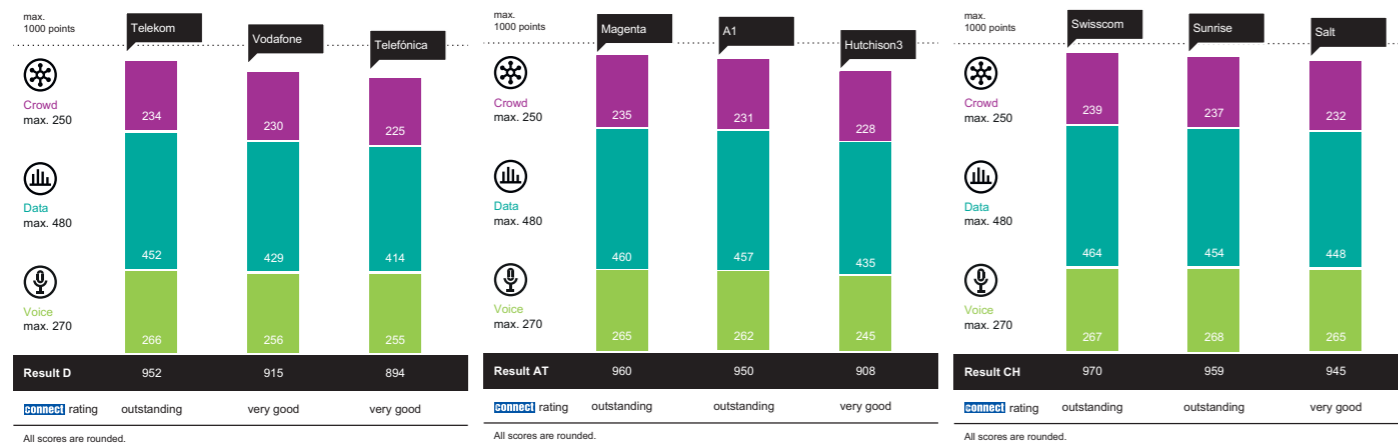
■ In order to guarantee a fair and transparent execution and evaluation of our network test, certain procedures have proven themselves in recent years.

These include that connect and umlaut inform the network operators about the basic conditions of the test at an early stage. The "framework" communicated for this purpose defines, among other things, the smartphones used for our measurements, the parameters taken into account in the measurements and evaluations, the overall evaluation scheme and the time schedule in all three countries.

connect and umlaut defined these framework data for this year's mobile network test already in early 2022 and then informed the technical directors of the network operators about it. We are open to feedback and suggestions, but do examine them critically and then have to reject some proposals. In the preparation and implementation phase of the drive and walktests, connect and umlaut are also in regular contact with the network operators. The firmware versions used on the measurement smartphones are discussed and, if necessary, updated so that they optimally support technologies such as carrier aggregation or 5G-DSS (Dynamic Spectrum Sharing).

However, communication with the network operators also includes an insistent reference to fair play rules. When carrying out and evaluating the tests, umlaut analyses the measured values intensively to see whether they show signs of possible manipulation attempts. If such an attempt were to be detected, the possible countermeasures range from the invalidation of the samples assessed as dubious to a complete disqualification of the participant in question.

In particular, the extensive data connections that have to be established during the tests make it unavoidable to use SIM cards specifically provided by the network operators for the measurement purposes. Otherwise, not only would extremely high costs be incurred, but the SIM cards would have to be constantly replaced during the tests because of tariff or fair-use limits that would be quickly reached. The SIM cards provided on loan by the providers are provisioned exactly like normal cards, but have no data limit. In order to prevent possible manipulation attempts in this area as well, umlaut compares the measurement results determined via these rental cards with random samples obtained with regularly purchased SIM cards. If a deviation were to be noticed here, this would also be cause for more in-depth analyses and corresponding countermeasures.

Overall Results

Voice, Data & Crowd		Germany			Austria			Switzerland		
		Telekom	Vodafone	Telefónica	Magenta	A1	Hutchison3	Swisscom	Sunrise	Salt
Voice	max. 270.00 points	266	256	255	265	262	245	267	268	265
Cities	Drivetest 121.50	99%	95%	96%	99%	98%	91%	99%	99%	98%
Cities	Walktest 40.50	99%	95%	98%	98%	99%	95%	99%	99%	100%
Towns	Drivetest 54.00	100%	97%	95%	100%	98%	90%	99%	100%	99%
Roads	Drivetest 33.75	97%	92%	94%	98%	96%	90%	99%	100%	96%
Trains	Walktest 20.25	92%	90%	80%	91%	89%	84%	97%	96%	96%
Data	max. 480.00 points	452	429	414	460	457	435	464	454	448
Cities	Drivetest 216.00	96%	92%	91%	97%	96%	94%	97%	96%	94%
Cities	Walktest 72.00	97%	92%	93%	96%	96%	91%	98%	95%	95%
Towns	Drivetest 96.00	95%	90%	86%	97%	96%	89%	97%	94%	92%
Roads	Drivetest 60.00	91%	85%	76%	94%	95%	89%	97%	94%	94%
Trains	Walktest 36.00	78%	72%	62%	88%	85%	78%	94%	86%	88%
Crowd	max. 250.00 points	234	230	225	235	231	228	239	237	232
Crowd	250.00	94%	92%	90%	94%	92%	91%	96%	95%	93%
Total	max. 1000.00 points	952	915	894	960	950	908	970	959	945
connect -rating		outstanding	very good	very good	outstanding	outstanding	very good	outstanding	outstanding	very good

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

connect BEST IN TEST — MOBILE NETWORK AND 5G TEST — Deutsche Telekom — Issue 1/2023 — www.connect.de

connect VERY GOOD — MOBILE NETWORK AND 5G TEST — Vodafone — Issue 1/2023 — www.connect.de

connect VERY GOOD — MOBILE NETWORK AND 5G TEST — Telefónica/O2 — Issue 1/2023 — www.connect.de

connect BEST IN TEST — MOBILE NETWORK AND 5G TEST — Magenta — Issue 1/2023 — www.connect.de

connect OUTSTANDING — MOBILE NETWORK AND 5G TEST — A1 — Issue 1/2023 — www.connect.de

connect VERY GOOD — MOBILE NETWORK AND 5G TEST — Drei — Issue 1/2023 — www.connect.de

connect BEST IN TEST — MOBILE NETWORK AND 5G TEST — Swisscom — Issue 1/2023 — www.connect.de

connect OUTSTANDING — MOBILE NETWORK AND 5G TEST — Sunrise — Issue 1/2023 — www.connect.de

connect VERY GOOD — MOBILE NETWORK AND 5G TEST — Salt — Issue 1/2023 — www.connect.de

Germany bar chart — max. 1000 points — Telekom, Vodafone, Telefónica
Crowd max. 250: 234, 230, 225
Data max. 480: 452, 429, 414
Voice max. 270: 266, 256, 255
Result D: 952, 915, 894
connect rating: outstanding, very good, very good
All scores are rounded.

Austria bar chart — max. 1000 points — Magenta, A1, Hutchison3
Crowd max. 250: 235, 231, 228
Data max. 480: 460, 457, 435
Voice max. 270: 265, 262, 245
Result AT: 960, 950, 908
connect rating: outstanding, outstanding, very good
All scores are rounded.

Switzerland bar chart — max. 1000 points — Swisscom, Sunrise, Salt
Crowd max. 250: 239, 237, 232
Data max. 480: 464, 454, 448
Voice max. 270: 267, 268, 265
Result CH: 970, 959, 945
connect rating: outstanding, outstanding, very good
All scores are rounded.

Conclusion

Hannes Rügheimer,
connect author

The stability that is missed in so many places today can also look like this: For the fifth year in a row, we see a familiar ranking in all three countries in our demanding mobile network test. As we continue to expand our test methodology and tighten the scoring year over year, this means that all network operators are making an equal effort to continue to deliver top performance. Without constant improvements to their networks, this would not be possible.

In Germany, Deutsche Telekom achieves its twelfth test victory in a row – and for the first time the grade „outstanding". Vodafone and Telefónica also improved compared to the previous year – particularly in the important data category.

Once again, it should be remembered that these increases were achieved despite stricter evaluation criteria. The 5G rollouts, which have made good progress with all three providers, have also played a clear role in this success. Good news for the customers: Not only in large cities, but also in small towns, on roads and even on trains, this progress can be clearly observed. Since Austria and Switzerland already ranked at the top level in previous years, increases are even more difficult to realise there. For the fifth time in a row, Magenta is the shiny winner in the Alpine Republic – in all three test categories, the provider can hold its own against its pursuers. But they are clearly gaining ground – A1 also achieves the top grade "outstanding" this year. In many sub-disciplines, the market leader is engaged in intense duels with the national winner Magenta. In addition, A1 is ahead in 5G coverage on roads and in trains. The Hutchison brand Drei has also clearly improved, and its 5G rollout is also showing clear progress.

In Switzerland, Swisscom again defends its top ranking – for the fifth time in a row. And for the sixth time, the Swiss market leader achieves the grade „outstanding". Swisscom earned the overall victory with the best results in the data and crowd categories. In the voice discipline, Sunrise leads and can once more be pleased with an "outstanding" second place. However, the smallest provider in Switzerland, Salt, achieved a significant improvement in performance, moving much closer to its two larger competitors. All Swiss providers have also made great strides forward in their 5G rollouts – Salt most clearly.

Interview

"The network operators are defying the challenges."

■ **Mr Ekmen, how do you see this year's results of our mobile network test?**

Hakan Ekmen: First of all, I congratulate all the operators on their great results. Special congratulations go to the winners Deutsche Telekom, Swisscom and Magenta. Despite additional challenges, for example the rollouts during the Corona epidemic, rising energy prices and rapidly growing traffic on the networks, this is a clear confirmation that the mobile industry is doing an excellent job.

What have the network operators done particularly well? Do you see any trends?

Hakan Ekmen: We see all operators improving broadband coverage as a result of their 5G rollout as well as 4G capacity additions. The reliability of the connections is also steadily increasing. An eye-catcher this year, in addition to the outstanding networks of Swisscom, Sunrise and Magenta, are the networks of Deutsche Telekom and A1. In Germany, Deutsche Telekom achieved this highest school grade as a premiere.

Can you already give us an outlook for next year?

Hakan Ekmen: We are already working intensively on our framework for the next benchmark season. We want to continue to focus on the topics of coverage, reliability and performance.

Hakan Ekmen,
CEO Telecommunication at umlaut, part of Accenture