THE GREAT 2022 MOBILE NETWORK TEST

In its 28th year, our mobile network test once again stands for maximum objectivity and at the same time the closest possible customer orientation. Once again, connect and its long-standing partner umlaut have closely examined the mobile networks in Germany, Austria and Switzerland.

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As in other areas of life, almost two years of the pandemic have led to a certain degree of routine in dealing with it: The network analyses carried out throughout the year by our test partner umlaut prove that the mobile networks in Germany, Austria and Switzerland are not only running stably, but have also adapted optimally to the changed usage patterns. So there was no question that we would be able to carry out our network test as usual. In doing so, we protected the teams conducting our drive and walktests with carefully adjusted logistics.

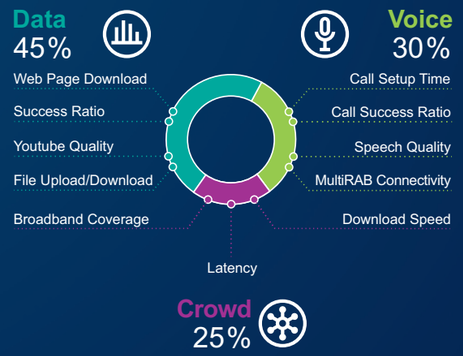
The new normal also includes 5G

The network operators have also become accustomed to the new normality – which can be observed not least in the fact that their 5G rollouts are proceeding at an undiminished pace. Since last year, the latest mobile technology has been integrated into our test methodology as a natural part. This year, we have dispensed with configuring some of the test smartphones for 4G preference, which we still did last time to be on the safe side. Nevertheless, in each tested country we take a separate look at how well the providers have progressed with the expansion of their 5G networks.

In detail, we, umlaut and connect, have nevertheless further developed the methodology of our great mobile network test in many places. We have once again increased the considerable effort behind the determination of the results at decisive points – the key figures shown below give an impression of this. This way, we ensure that the results reflect both the performance of the networks and the real experience of their users in the best possible way. At the same time, this ensures that the mobile industry still considers our network test to be by far the most relevant assessment of their performance.

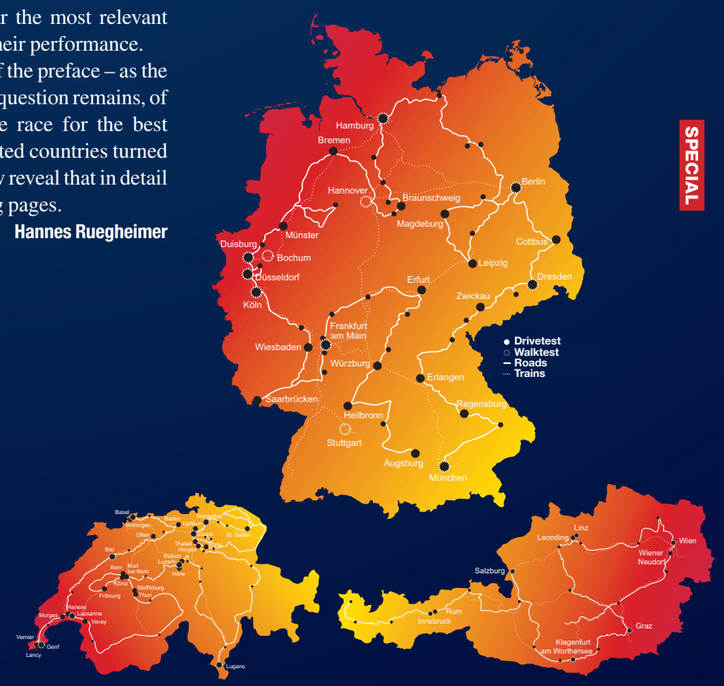
But enough of the preface – as the most important question remains, of course, how the race for the best places in the tested countries turned out. We will now reveal that in detail on the following pages.

Hannes Ruegheimer



A 360 degree view at network quality

In the light of almost 60 per cent more users and almost 80 per cent more samples in the crowdsourcing compared to the previous year, we have increased the share of our crowd analyses in the overall result from previously 20 per cent to now 25 per cent. The scores for voice and data evaluation remain in the same proportion as before, reflecting the importance of these two applications for users. We describe the methodology of our network test in detail on pages 88/89.



DRIVETESTS AND WALKTESTS

20,2 million inhabitants	25 176 km drivetest	268 763 data samplöes	92 753 voice samples

CROWDSOURCING

100,6 million inhabitants covered	725 174 participants in the crowdsourcing	5252 million samples	97,4% average coverage of bulit-up area

Indicated are the combined values for Germany, Austria and Switzerland. See the separate values per country under "Methodology" on page 88.

Germany

Voice

It is still true: Mobile telephony must function reliably when needed and in the best voice quality. That is why voice measurements account for 30 per cent of our overall rating.

▶ With the current network implementations, even if a smartphone has a connection to 5G, it switches back to VoLTE ("Voice over LTE") and thus to 4G when making phone calls. So it is a good thing that all German mobile network operators –and incidentally also their counterparts in Austria and Switzerland – now fully support this LTE-based telephony in high quality.

Our candidates thus achieve convincingly short call set-up times. In the Telekom and Vodafone networks, these set-tip times are quite close to one second, and in the Telefónica network, they are under two seconds in all test scenarios except for the railways.

In the inner-city walktests, the O2 network even catches up closely with the other contenders – here, all three network operators reach a very high level.

The success rates for establishing voice connections are also overall very good. Only when trying to make calls on connecting roads could they be somewhat higher for all three candidates.

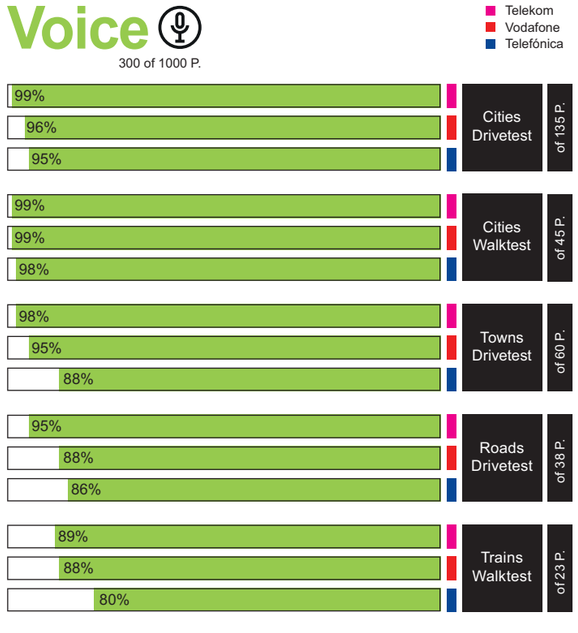
Still, Deutsche Telekom succeeds in setting itself apart somewhat more clearly from its two competitors in this scenario, which is particularly important for car drivers. With this, as well as the highest voice quality observed in both the urban and rural test situations, Deutsche Telekom then takes the category win in the voice discipline. Vodafone follows only slightly behind Telekom in the driving tests in large and small cities.

Telefónica shows a certain gradient from large cities to rural areas – in small towns and on connecting roads, this provider still has some potential for optimisation.

Little movement on the trains

When it comes to telephoning on trains, the picture is familiar: Telekom and Vodafone perform slightly better than O2, but there is room for improvement with all three providers. Telefónica/O2, however, was able to improve significantly compared to the previous year - as the only German provider.

Operator	Telekom	Vodafone	Telefónica
Voice Cities (Drivetest)			
Sucess Ratio (%)	99.9	99.6	99.7
Call Setup Time P90 (s)	1.3	1.3	1.8
Speech Quality P10 (MOS-LQO)	4.4	4.2	4.1
Multirab Connectivity (%)	99.8	99.0	99.1
Voice Cities (Walktest)			
Sucess Ratio (%)	99.9	99.9	99.9
Call Setup Time P90 (s)	1.3	1.2	1.4
Speech Quality P10 (MOS-LQO)	4.5	4.4	4.3
Multirab Connectivity (%)	99.7	99.9	99.5
Voice Towns (Drivetest)			
Sucess Ratio (%)	100.0	99.5	98.6
Call Setup Time P90 (s)	1.3	1.3	1.8
Speech Quality P10 (MOS-LQO)	4.3	4.1	4.0
Multirab Connectivity (%)	99.1	99.5	98.6
Voice Roads (Drivetest)			
Sucess Ratio (%)	98.8	97.9	97.7
Call Setup Time P90 (s)	1.3	1.5	1.9
Speech Quality P10 (MOS-LQO)	4.2	3.8	3.7
Multirab Connectivity (%)	99.3	95.7	95.3
Voice Trains (Walktest)			
Sucess Ratio (%)	97.7	97.3	96.1
Call Setup Time P90 (s)	1.7	1.6	2.0
Speech Quality P10 (MOS-LQO)	3.8	3.8	3.4
Multirab Connectivity (%)	98.7	98.7	96.8



Data

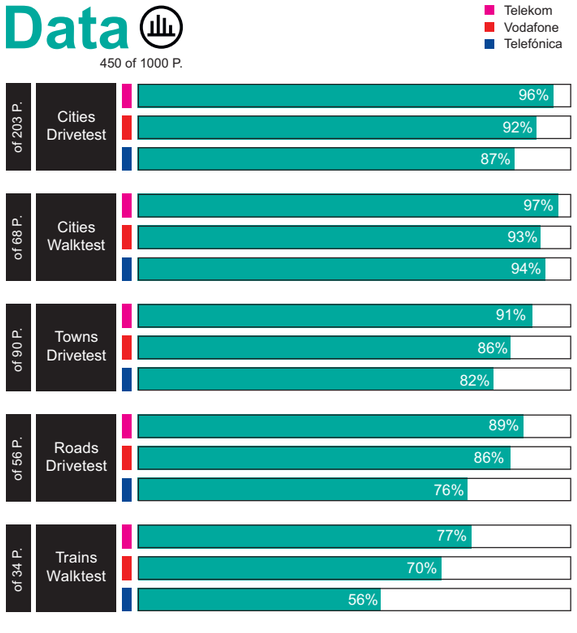
We take into account the high importance of web surfing, app use, messaging and streaming by assigning the data discipline 45 percent of the overall score.

▶ If you look at the shares of the frequency spectrum that are now available to the three German providers, Deutsche Telekom has the biggest piece of the pie – and knows how to use it. This is clearly shown by the average data rates in our various test scenarios. Number two in terms of available spectrum is Telefónica/O2, which can be observed above all in the results in large cities – of course, good results here do not result solely from the available frequencies; the Munich-based company has also made great progress in its network and especially 5G expansion in the large cities. Vodafone, on the other hand, manages to get a lot out of this scarce resource despite a certain handicap in terms of frequency share: In large and small cities as well as on the connecting roads, the provider follows only a small distance behind the stronger competitor from Bonn in each case.

It is also worth noting that the extensive decommissioning of the 3G networks, which is now almost completed, was conducted relatively quietly and did not have any negative impact on mobile coverage – on the contrary, thanks to the associated reallocation of frequencies.

Walktests in large cities: O2 in second place after Telekom

In the walktests in larger cities, Vodafone is beaten by Telefónica/O2 by a razor-thin margin. In the upload performance, the advantage of the Bonn-based company is clearer: here, Telekom is



Operator	Telekom	Vodafone	Telefónica
Data (Cities; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.8	99.6	99.0
Avg. Session Time (s)	1.2	1.2	1.4
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.2	99.7/2.0	99.6/3.0
90%/10% faster than (Mbps)	46.9/256.4	27.5/155.9	15.4/194.6
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.8	99.7/2.9	99.7/3.5
90%/10% faster than (Mbps)	13.2/65.7	7.2/55.4	6.5/51.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.7	99.9	99.2
10% faster than (Mbit/s)	594.6	238.9	367.4
Speed > 5Mbit/s / 20Mbit/s (%)	99.9/98.7	99.4/95.1	98.5/89.1
File Upload (7 Seconds)			
Sucess Ratio (%)	99.8	99.7	98.1
10% faster than (Mbit/s)	109.9	75.8	65.4
Speed > 5Mbit/s / 20Mbit/s (%)	99.5/97.6	97.5/93.4	98.3/93.7
Youtube			
Success Ratio/Start Time (%/s)	99.3/1.4	99.3/1.4	97.8/1.4
Ø Video Resolution (p)	1078	1076	1069
Youtube Live			
Success Ratio/Start Time (%/s)	98.1/1.3	98.9/1.5	97.6/1.6
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.7/1.5	98.7/1.5	96.9/1.4
Ø Video Resolution (p)	2128	2095	2066
Data (Cities; Walktest)			
Web Page Download			
Sucess Ratio (%)	99.9	99.6	99.6
Avg. Session Time (s)	1.1	1.1	1.2
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.0	99.9/1.9	100.0/1.7
90%/10% faster than (Mbps)	61.3/281.7	28.7/149.5	27.8/230.5
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.7	99.7/2.4	99.9/2.2
90%/10% faster than (Mbps)	16.7/62.2	10.6/68.7	11.5/62.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.7	99.6	99.6
10% faster than (Mbit/s)	820.3	241.7	435.8
Speed > 5Mbit/s / 20Mbit/s (%)	100.0/99.0	99.7/95.4	99.5/95.1
File Upload (7 Seconds)			
Sucess Ratio (%)	99.7	99.3	99.6
10% faster than (Mbit/s)	103.4	107.3	90.2
Speed > 5Mbit/s / 20Mbit/s (%)	99.7/99.2	98.6/96.1	99.4/98.3
Youtube			
Success Ratio/Start Time (%/s)	99.7/1.4	100.0/1.5	99.1/1.4
Ø Video Resolution (p)	1079	1077	1078
Youtube Live			
Success Ratio/Start Time (%/s)	97.4/1.2	96.8/1.4	97.4/1.3
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.4/1.5	99.1/1.5	98.0/1.5
Ø Video Resolution (p)	2139	2090	2112
Data (Towns; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.7	99.4	98.8
Avg. Session Time (s)	1.3	1.3	1.5
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	99.7/2.1	99.9/3.1	99.9/4.2
90%/10% faster than (Mbps)	29.9/146.9	17.8/128.5	9.5/112.4
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	99.9/2.6	99.9/4.1	99.5/4.4
90%/10% faster than (Mbps)	8.5/62.7	4.8/47.8	4.9/42.7
File Download (7 Seconds)			
Sucess Ratio (%)	99.4	99.4	98.9
10% faster than (Mbit/s)	237.1	188.6	136.9
Speed > 5Mbit/s / 20Mbit/s (%)	98.9/95.6	98.7/90.7	96.4/80.3
File Upload (7 Seconds)			
Sucess Ratio (%)	99.2	98.7	98.3
10% faster than (Mbit/s)	101.8	59.5	51.5
Speed > 5Mbit/s / 20Mbit/s (%)	98.4/94.8	96.3/91.0	96.7/89.6
Youtube			
Success Ratio/Start Time (%/s)	98.2/1.5	97.9/1.5	98.2/1.5
Ø Video Resolution (p)	1075	1071	1067
Youtube Live			
Success Ratio/Start Time (%/s)	97.9/1.5	96.4/1.6	95.4/1.7
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	98.5/1.6	97.1/1.5	95.5/1.4
Ø Video Resolution (p)	2085	2051	2003

Operator	Telekom	Vodafone	Telefónica
Data (Roads; Drivetest)			
Web Page Download			
Sucess Ratio (%)	98.8	98.5	97.3
Avg. Session Time (s)	1.5	1.5	1.9
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	99.6/4.1	99.6/4.8	99.0/9.0
90%/10% faster than (Mbps)	9.1/128.7	7.4/116.5	3.7/89.9
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	99.3/4.4	99.4/6.0	99.4/7.2
90%/10% faster than (Mbps)	4.3/47.7	2.8/39.9	2.6/28.0
File Download (7 Seconds)			
Sucess Ratio (%)	99.4	99.1	98.1
10% faster than (Mbit/s)	200.9	152.4	104.3
Speed > 5Mbit/s / 20Mbit/s (%)	96.2/85.0	95.4/79.7	88.0/53.6
File Upload (7 Seconds)			
Sucess Ratio (%)	98.9	97.4	95.7
10% faster than (Mbit/s)	79.6	49.7	33.2
Speed > 5Mbit/s / 20Mbit/s (%)	95.0/85.7	93.0/75.3	90.3/74.7
Youtube			
Success Ratio/Start Time (%/s)	97.5/1.5	96.5/1.5	92.5/1.5
Ø Video Resolution (p)	1069	1054	1037
Youtube Live			
Success Ratio/Start Time (%/s)	94.5/1.6	95.4/1.8	92.7/2.1
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	94.5/1.5	93.1/1.5	89.1/1.4
Ø Video Resolution (p)	1989	1948	1752

Operator	Telekom	Vodafone	Telefónica
Data (Train; Walktest)			
Web Page Download			
Sucess Ratio (%)	94.3	94.7	87.7
Avg. Session Time (s)	2.2	2.1	2.4
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	97.6/7.2	97.5/8.8	92.4/15.4
90%/10% faster than (Mbps)	4.9/133.5	3.8/86.0	1.9/98.9
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	99.5/5.1	98.6/5.4	99.1/9.0
90%/10% faster than (Mbps)	3.5/43.2	3.3/38.1	1.9/30.8
File Download (7 Seconds)			
Sucess Ratio (%)	98.1	96.4	93.1
10% faster than (Mbit/s)	196.4	115.4	167.7
Speed > 5Mbit/s / 20Mbit/s (%)	91.9/62.8	84.3/55.8	73.1/42.6
File Upload (7 Seconds)			
Sucess Ratio (%)	97.6	95.6	92.7
10% faster than (Mbit/s)	60.7	36.9	40.5
Speed > 5Mbit/s / 20Mbit/s (%)	96.4/85.7	93.7/82.4	88.3/73.1
Youtube			
Success Ratio/Start Time (%/s)	89.7/1.6	81.9/1.5	77.0/1.4
Ø Video Resolution (p)	1054	1017	997
Youtube Live			
Success Ratio/Start Time (%/s)	91.3/2.4	86.8/2.1	75.5/2.3
Ø Video Resolution (p)	1080	1079	1073
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	87.7/1.5	85.2/1.5	77.8/1.4
Ø Video Resolution (p)	1870	1752	1594

ahead, Vodafone and O2 are about equally strong – but follow behind the Bonn-based operator.

Telekom and Vodafone strong on the roads

In the drivetests on the connecting roads, Telekom and, by a small margin, Vodafone set themselves apart more clearly from Telefónica/O2. Those who want to use connected services while driving are certainly to feel the differences.

While Telefónica has already achieved a lot in the big cities, this provider still has some work to do in the more rural areas. But Telekom and Vodafone also still have a lot of work ahead of them in these areas.

Mixed picture on the railways

We do not want to neglect the more difficult general conditions that affected all three networks: Due to numerous track renovations, German trains this year often had to travel far away from their regular routes, which were better supplied with mobile communications. Nevertheless, Telekom and Vodafone were each able to gain a few percentage points in this most difficult scenario. In contrast, Telefónica performed slightly weaker in this year's rail ranking than last year. Ultimately, however, all three German network operators remain challenged to further improve their performance in German trains. A look at Switzerland in particular may inspire them to do so.

5G

Even though 5G is a regular part of our network test, it is worth taking a closer look at the 5G results from our drivetests and walktests. Not least, it provides information on how the providers have progressed in upgrading their networks to the latest mobile communications standard.

■ Since last year, all three German providers have made great progress in expanding their 5G networks. Telekom and Vodafone still often rely on DSS (Dynamic Spectrum Sharing – the demand-based distribution of bandwidth between 4G and 5G). Coverage figures are therefore to be understood as the sum of the values for pure 5G cells and cells with 5G DSS. However, it is also clear that the highest data rates can only be achieved on the high 5GNR frequency bands around 3.5 GHz. All in all, Telekom continues to lead the way in 5G expansion – in large cities, around 90 percent of data samples have already been captured with 5G. Vodafone is in the good midfield – the pronounced DSS can also be explained by the frequency bands available to the Duesseldorf-based company. Telefónica, which only started its 5G expansion last year, already has impressive 5G shares in the larger cities, which are already ahead of the two competitors without taking into account the DSS that is hardly used by this provider.

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	28.9%	523.6	840.4	5.2%	397.4	616.2	53.7%	215.2	423.5
Cities – Walktest	64.1%	551.7	893.4	2.2%	268.9	352.2	72.1%	253.1	450.1
Towns – Drivetest	1.8%	528.0	786.4	2.3%	294.6	465.8	3.0%	128.2	288.1
Roads – Drivetest	0.1%	232.6	232.6	1.7%	423.3	590.5	0.5%	105.9	244.6
Trains – Walktest	7.8%	413.6	695.5	1.7%	286.6	552.4	25.3%	155.8	360.8
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	62.8%	159.2	281.2	31.8%	125.2	219.3	–	–	–
Cities – Walktest	25.8%	175.1	284.8	34.1%	146.3	266.1	–	–	–
Towns – Drivetest	81.7%	135.1	237.8	25.7%	123.1	229.7	–	–	–
Roads – Drivetest	68.0%	103.2	207.7	19.2%	84.3	155.4	–	–	–
Trains – Walktest	63.9%	50.9	120.4	31.3%	56.3	166.8	–	–	–

Crowd

While the drivetests and walktests focus on the maximum possible performance in the networks, the crowd analyses show to what extent this performance is received by the users.

▶ The crowdsourcing discipline also presents the same ranking as in the voice and data categories – proving that the results of our drive and walk tests correlate with the level of performance that actually reaches the individual users.

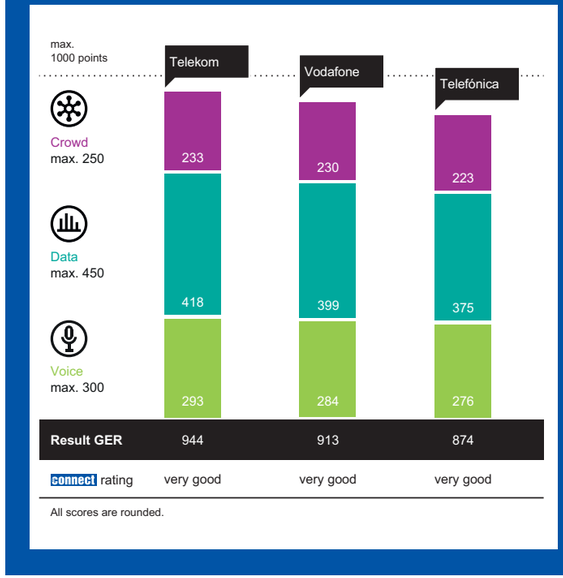
When it comes to broadband coverage – i.e. the question of where 4G or 5G is available in the first place – the three German network operators are close to each other. Telefónica leads here by a thin margin, ahead of Telekom and Vodafone. The quality of broadband coverage, which indicates the ratio of "evaluation areas" ("EAs") with 4G/5G reception compared to all EAs covered by a provider, is again highest for Telekom – ahead of Vodafone and Telefónica. The same ranking is also evident when looking at the "time on broadband" – the proportion of time in which the customers of the three providers had 4G/5G reception.

In terms of data rates, Telekom takes the lead in all subcategories, followed by Vodafone and finally O2. This hierarchy can be observed in all three speed categories – the gaps between Telekom and Vodafone are narrower in each case than those between Vodafone and Telefónica/O2. So, the gap becomes most obvious in the most demanding speed category "UHD Video".

The observed latencies are equal for Telekom and Vodafone in the basic OTT voice services class, closely followed by Telefónica/O2. The more demanding gaming class again brings the previous ranking to light.

Operator	Telekom	Vodafone	Telefónica
Broadband Coverage			
Coverage Quality (%)	97.1	96.4	95.6
Coverage Reach (%)	94.2	93.9	94.3
Time on Broadband (%)	97.2	95.9	94.9
Download Speed			
Basic Internet Class (%)	95.5	94.6	90.5
HD Video Class (%)	84.4	81.5	75.6
UHD Video Class (%)	36.6	31.9	25.3
Latency			
Gaming Class (%)	85.4	82.8	79.9
OTT Voice Class (%)	96.0	96.0	95.6

Single Review



For the eleventh time in a row, Deutsche Telekom achieved the overall victory in Germany – with a clear lead over the pursuing field. Compared to the previous year, the Bonn-based company has improved in the data and crowd categories, while maintaining its high level in the voice discipline. They are now only six points away from the grade "outstanding". Telekom is also ahead in 5G roll-out.

Vodafone has also improved significantly since last year – among the German providers, the Duesseldorf-based company achieved the largest increase in points compared to the previous year and its strongest result to date.They achieved this in the data and crowd categories – in the voice discipline, Vodafone maintained the previous year's level. The provider has also made considerable progress in the roll-out of 5G.

Once again, Telefónica makes a big leap forward compared to the previous year, comes closer to its competitors and achieves its best result to date. O2 succeeded in making gains in the voice and crowd disciplines, while in the data tests the picture is mixed: significant increases in the cities, but a need to catch up in the countryside. This also applies to the 5G roll-out, which is already exemplary in the big cities.

Austria

In the Alpine Republic we find largely familiar circumstances this year – this applies to the general conditions as well as to the ranking of the providers.

Foto: Kanuman/shutterstock.com

▶ Traditionally, the Austrian providers still achieve slightly higher scores in our mobile network test than their counterparts in Germany, but fall somewhat behind the operators from Switzerland, which is particularly strong. This is also valid this year – although the gaps are no longer quite as pronounced and also changes in our methodology somewhat relativise comparisons with previous year's results.

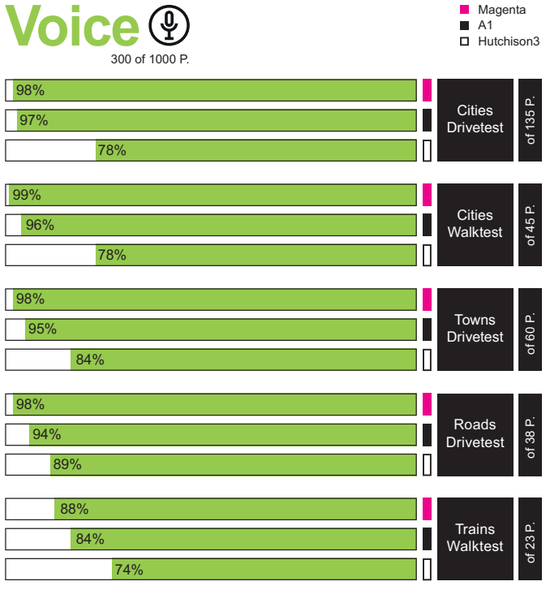
The roll-out of 5G in the Alpine Republic has made good progress in recent months (see box on page 82). And despite high upgrade costs, the level of mobile tariffs in Austria remains lower than in Germany. But Austrian customers still have to pay close attention to how their providers deal with the non-EU neighbouring country of Switzerland when it comes to billing. In the roaming conditions of most providers, it is equated with countries such as the USA – whereas post-Brexit Great Britain is usually still treated as a member of the EU zone.

Voice connections

A generally familiar picture also can be seen in the results of our voice measurements. The connection quality tested in all three networks via VoLTE (Voice over LTE) is at a high level. In the larger cities, Magenta and A1 have a neck-and-neck race. In this scenario, however, provider Three falls significantly behind the competitors in both the drivetests and the walktests – and, interestingly, also behind its results from the previous year. Lower success rates and longer call set-up times are to blame for this. In the smaller towns, too, there is a clear gap between Magenta and A1 at the top and chaser Three.

Magenta's call set-up times of less than one second in 90 per cent of cases are particularly striking – the provider even keeps up this impressive level in the difficult railway scenario. The success rates of our test calls via Magenta and A1 are also convincing: In larger and smaller cities as well as on connecting roads, they range over 99 per cent for these two providers, in trains still over 96 per cent. Here, Three shows potential for improvement, as in the other scenarios. When it comes to conducting phone calls on trains, the three Austrian providers are more or less at the previous year's level – improvements, as we could observe with some providers in the neighbouring countries, cannot be seen in the Alpine Republic in this scenario.

Operator	Magenta	A1	Hutchison3
Voice Cities (Drivetest)			
Sucess Ratio (%)	99.7	99.9	96.6
Call Setup Time P90 (s)	0.7	1.7	2.2
Speech Quality P10 (MOS-LQO)	4.4	4.0	4.2
Multirab Connectivity (%)	99.9	99.8	100.0
Voice Cities (Walktest)			
Sucess Ratio (%)	99.9	99.8	96.6
Call Setup Time P90 (s)	0.8	2.0	2.3
Speech Quality P10 (MOS-LQO)	4.5	4.2	4.4
Multirab Connectivity (%)	99.8	99.8	99.4
Voice Towns (Drivetest)			
Sucess Ratio (%)	99.6	99.6	97.9
Call Setup Time P90 (s)	0.7	1.8	2.3
Speech Quality P10 (MOS-LQO)	4.4	4.1	4.2
Multirab Connectivity (%)	100.0	99.8	98.6
Voice Roads (Drivetest)			
Sucess Ratio (%)	99.7	99.4	98.0
Call Setup Time P90 (s)	0.8	1.9	2.5
Speech Quality P10 (MOS-LQO)	4.3	3.9	3.9
Multirab Connectivity (%)	100.0	99.4	99.7
Voice Trains (Walktest)			
Sucess Ratio (%)	96.8	96.4	94.0
Call Setup Time P90 (s)	1.0	1.9	2.6
Speech Quality P10 (MOS-LQO)	4.1	3.8	3.6
Multirab Connectivity (%)	99.0	96.4	96.8

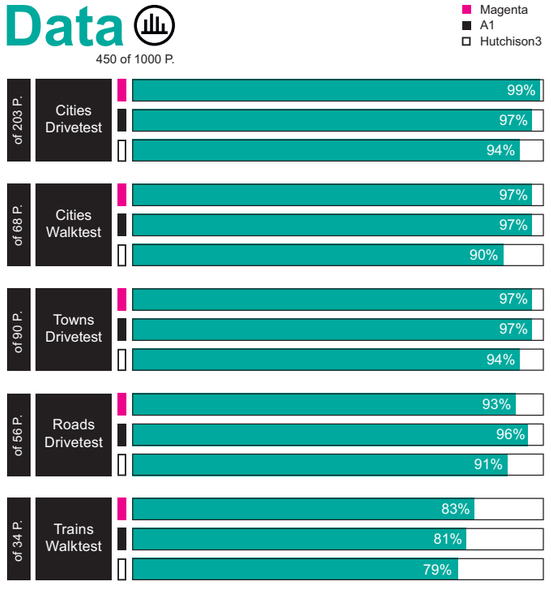


Data connections

In the data measurements, Magenta and A1 are also tough competitors. In some disciplines, such as the walktests conducted in large cities or the drive tests in small towns, the two competitors score equally in the category ratings. On the connecting roads, A1 is somewhat ahead.

Three follows at a slight distance in all scenarios, whereby the Hutchison brand was able to catch up further with the other two providers, especially in the large cities. It should also be noted that the third-placed Austrian provider achieved results in the data tests in small towns, on connecting roads and also on trains that would have easily been enough for the category win in the northern neighbouring country of Germany. At this point, the disparity in the three-country comparison becomes particularly clear.

Magenta and A1 owe their good performance in the urban scenarios to the further rollout of 4CA (4 Carrier Aggregation: the combination of up to four frequency bands) in their LTE networks and not least to their progress in 5G expansion (see box on page 82).



Operator	Magenta	A1	Hutchison3
Data (Cities; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.8	99.9	99.8
Avg. Session Time (s)	0.9	1.2	1.3
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/0.8	100.0/1.1	99.4/1.5
90%/10% faster than (Mbps)	75.1/362.0	58.7/273.8	30.3/318.5
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.3	99.9/1.6	99.8/2.8
90%/10% faster than (Mbps)	22.0/102.8	15.4/79.8	8.8/71.4
File Download (7 Seconds)			
Sucess Ratio (%)	99.9	99.8	99.8
10% faster than (Mbit/s)	775.9	682.2	537.4
Speed > 5Mbit/s / 20Mbit/s (%)	100.0/99.6	99.9/99.4	99.6/95.8
File Upload (7 Seconds)			
Sucess Ratio (%)	99.9	99.5	99.4
10% faster than (Mbit/s)	145.3	97.2	103.0
Speed > 5Mbit/s / 20Mbit/s (%)	99.8/99.2	99.1/97.7	98.4/94.4
Youtube			
Success Ratio/Start Time (%/s)	99.7/1.3	99.2/1.5	99.8/1.5
Ø Video Resolution (p)	1075	1071	1072
Youtube Live			
Success Ratio/Start Time (%/s)	100.0/1.2	99.7/1.5	99.4/1.5
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.8/1.4	99.4/1.6	98.9/1.6
Ø Video Resolution (p)	2122	2111	2073
Data (Cities; Walktest)			
Web Page Download			
Sucess Ratio (%)	99.8	99.9	99.6
Avg. Session Time (s)	0.9	1.1	1.3
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	99.8/1.0	100.0/1.0	99.8/1.4
90%/10% faster than (Mbps)	73.3/340.7	67.7/274.5	37.4/298.5
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	99.8/1.6	99.6/1.9	97.8/4.2
90%/10% faster than (Mbps)	17.8/93.2	14.3/77.1	4.8/64.7
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.8
10% faster than (Mbit/s)	757.3	757.3	535.7
Speed > 5Mbit/s / 20Mbit/s (%)	99.2/98.7	100.0/99.4	99.6/96.8
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	99.4	97.0
10% faster than (Mbit/s)	131.3	101.4	93.6
Speed > 5Mbit/s / 20Mbit/s (%)	98.1/97.5	99.6/98.3	97.7/92.8
Youtube			
Success Ratio/Start Time (%/s)	100.0/1.3	99.6/1.5	99.2/1.4
Ø Video Resolution (p)	1073	1067	1075
Youtube Live			
Success Ratio/Start Time (%/s)	99.6/1.2	100.0/1.5	98.8/1.5
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.6/1.4	98.8/1.5	98.8/1.5
Ø Video Resolution (p)	2102	2107	2093
Data (Towns; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.7	99.7	99.7
Avg. Session Time (s)	1.0	1.2	1.3
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.0	99.8/1.1	100.0/1.6
90%/10% faster than (Mbps)	56.5/323.4	66.8/255.8	33.2/269.7
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.7	100.0/2.0	100.0/3.2
90%/10% faster than (Mbps)	12.6/95.0	13.2/76.7	6.4/58.0
File Download (7 Seconds)			
Sucess Ratio (%)	99.8	100.0	99.8
10% faster than (Mbit/s)	678.0	615.5	502.9
Speed > 5Mbit/s / 20Mbit/s (%)	99.4/98.3	100.0/98.2	99.8/96.5
File Upload (7 Seconds)			
Sucess Ratio (%)	99.6	99.6	99.5
10% faster than (Mbit/s)	125.6	97.5	84.0
Speed > 5Mbit/s / 20Mbit/s (%)	99.8/97.0	100.0/98.2	98.4/95.6
Youtube			
Success Ratio/Start Time (%/s)	99.1/1.4	100.0/1.5	99.0/1.5
Ø Video Resolution (p)	1066	1072	1079
Youtube Live			
Success Ratio/Start Time (%/s)	99.5/1.4	100.0/1.6	99.6/1.6
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.5/1.5	99.5/1.6	100.0/1.6
Ø Video Resolution (p)	2125	2127	2101

Operator	Magenta	A1	Hutchison3
Data (Roads; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.7	99.9	99.2
Avg. Session Time (s)	1.2	1.3	1.4
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/3.1	99.8/1.8	99.5/2.6
90%/10% faster than (Mbps)	9.2/227.5	27.8/204.5	20.9/130.1
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/3.4	99.7/3.2	98.9/5.6
90%/10% faster than (Mbps)	6.3/50.2	6.9/62.9	2.5/34.3
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	99.5	99.2
10% faster than (Mbit/s)	308.4	370.0	187.0
Speed > 5Mbit/s / 20Mbit/s (%)	96.4/83.0	100.0/95.6	98.2/90.6
File Upload (7 Seconds)			
Sucess Ratio (%)	99.7	99.2	98.5
10% faster than (Mbit/s)	65.7	82.2	39.3
Speed > 5Mbit/s / 20Mbit/s (%)	97.0/88.3	97.4/94.1	94.8/86.8
Youtube			
Success Ratio/Start Time (%/s)	98.4/1.4	98.9/1.5	99.5/1.5
Ø Video Resolution (p)	1066	1059	1069
Youtube Live			
Success Ratio/Start Time (%/s)	98.0/1.4	99.5/1.7	98.3/1.7
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	96.8/1.5	99.0/1.6	97.9/1.6
Ø Video Resolution (p)	2013	2125	2046

Operator	Magenta	A1	Hutchison3
Data (Train; Walktest)			
Web Page Download			
Sucess Ratio (%)	96.7	96.1	95.4
Avg. Session Time (s)	1.3	1.6	1.6
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	98.2/4.5	98.1/3.4	98.1/3.7
90%/10% faster than (Mbps)	7.1/258.8	11.8/190.0	11.2/194.3
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	96.3/6.4	96.2/6.5	96.5/7.7
90%/10% faster than (Mbps)	2.6/50.6	2.4/52.8	2.2/29.5
File Download (7 Seconds)			
Sucess Ratio (%)	98.2	97.2	97.2
10% faster than (Mbit/s)	500.6	304.8	351.6
Speed > 5Mbit/s / 20Mbit/s (%)	95.6/83.4	96.9/85.2	97.7/85.1
File Upload (7 Seconds)			
Sucess Ratio (%)	93.3	91.7	92.1
10% faster than (Mbit/s)	58.1	62.5	33.1
Speed > 5Mbit/s / 20Mbit/s (%)	93.8/82.0	92.6/79.9	90.1/76.4
Youtube			
Success Ratio/Start Time (%/s)	98.1/1.3	94.2/1.5	95.5/1.6
Ø Video Resolution (p)	1066	1065	1063
Youtube Live			
Success Ratio/Start Time (%/s)	93.1/1.5	94.2/2.1	93.7/1.8
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	90.4/1.4	90.3/1.6	91.2/1.6
Ø Video Resolution (p)	2009	2020	2043

Overall, Magenta comes out on top in the data discipline with the highest data rates observed in all examined scenarios – in absolute terms, the values are best in the large cities. The small gap of Three in comparison to the other two candidates is again explained by the potential for improvement, for example, in the uplink data rates, which the umlaut testers found in the course of their walktests.

On the connecting roads, A1 scores with slightly higher average upload data rates than the two competitors. For the experienced quality of service while driving, the success rates are also particularly important – here, all three providers are on a high level, with Magenta and A1 being even slightly better in most test cases and taking turns regarding the lead.

The results of the Youtube tests are pleasing overall, although in this sub-discipline, Three sometimes also manages to come out ahead among the three.

Data connectivity on trains

When it comes to mobile internet use on trains, the Austrian providers rank ahead of their German colleagues again this year – but the potential for improvement compared to the other test scenarios is clear for both voice and data. Even compared to last year, not much has really changed here.

5G

The new mobile communications standard is a regular part of our data assessment. Nevertheless, it is worth taking a look at how the network operators perform in this promising sub-discipline. That's why we look at the samples from the drivetests and walktests that already have 5G coverage.

As an example, we look at the results of the seven-second download tests from the data discipline.

The high proportion seen here in the larger cities proves that all three Austrian providers have made significant progress in 5G roll-out in the more densely populated locations.

A1, however, ranges much higher than its competitors here, but also in the small towns as well as on the connecting roads. Even in the trains, more than 50 per cent of the samples recorded by this provider already have 5G coverage. On connecting roads, the figure is already 40 per cent. On the other hand, Magenta performs best in terms of data rates: Where this provider offers "pure 5G", downloads are usually much faster. The testers only registered samples with 5G DSS in relevant quantities in the Magenta network – but the data rates achieved with this type of coverage are lower. Where Drei can already offer 5G, the data rates offered are absolutely competitive.

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	83.0%	472.6	801.4	87.8%	351.2	699.4	75.6%	366.6	547.3
Cities – Walktest	66.2%	507.0	800.6	74.6%	432.8	823.7	63.1%	399.2	557.2
Towns – Drivetest	69.8%	409.5	711.4	89.8%	324.3	634.2	45.1%	331.5	549.0
Roads – Drivetest	26.6%	304.2	640.9	43.4%	262.5	553.8	9.1%	238.3	535.5
Trains – Walktest	38.1%	328.9	644.6	52.2%	193.6	419.2	24.7%	256.7	521.9
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	1.3%	160.8	260.8	–	–	–	–	–	–
Cities – Walktest	3.4%	178.6	277.4	–	–	–	–	–	–
Towns – Drivetest	8.6%	112.2	218.7	–	–	–	–	–	–
Roads – Drivetest	8.1%	138.5	201.8	–	–	–	–	–	–
Trains – Walktest	6.6%	66.2	127.2	–	–	–	–	–	–

Crowd

The crowdsourcing results allow a check whether the results from the other categories match the actual customer experience.

Compared to the results from the drivetests and walktests, the results of the crowdsourcing analyses carried out by umlaut only differ to a minor extent.

While Magenta is also ahead in this analysis, in the crowdsourcing discipline Three follows in second place with a five-point gap to the category winner and A1 in third place with a three-point gap to Three. In this context, however, it should be kept in mind that customers' choice of tariff and device also influence the crowd results.

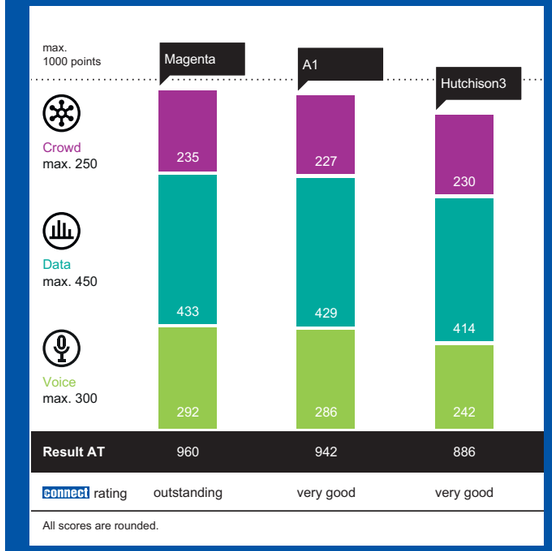
Three owes its ranking primarily to small leads in the Coverage quality and the Time on Broadband over A1 – the proportion of time with broadband coverage. But the gaps here are narrow. In terms of Coverage Reach, A1 is again ahead of the two competitors.

In the crowd-based evaluation of data rates, the three Austrian providers are roughly on a tie in the basic internet category, with Three also taking a razor-thin lead here. In the HD video category, Three's lead over the second-placed provider A1 is even more pronounced, and in the most demanding category UHD video, A1 is again ahead of Three and Magenta.

Magenta leads the latency evaluations in the basic OTT voice services class, followed by Three and then A1, while the Hutchison brand is able to take the lead in the more demanding gaming category, closely followed by Magenta and finally A1.

Operator	Magenta	A1	Hutchison3
Broadband Coverage			
Coverage Quality (%)	97.4	93.7	94.4
Coverage Reach (%)	90.2	92.0	85.2
Time on Broadband (%)	97.0	92.2	94.8
Download Speed			
Basic Internet Class (%)	95.5	95.8	95.9
HD Video Class (%)	81.2	83.7	84.7
UHD Video Class (%)	24.5	30.5	28.0
Latency			
Gaming Class (%)	95.6	92.6	95.8
OTT Voice Class (%)	98.3	97.5	98.0

Single Review



Magenta®

For the fourth time in a row, Magenta achieves the overall victory in Austria and is thus a member in the international top group. Compared to its competitors in the Alpine republic, the provider is ahead in all three test disciplines. The respective gaps to the runner-up A1 add up to a clear lead in terms of points. As in the previous year, Magenta achieved the grade "outstanding". This provider also cuts a fine figure in its 5G roll-out.

A1

As in the previous year, A1 Telekom also achieves the grade "very good" and second place in Austria with a very strong performance. Its achievements are convincing in all test disciplines – the provider is only a few points behind the Austrian test winner Magenta in each case. The lead over the third-placed provider Three, on the other hand, is clear. In terms of 5G roll-out in the Alpine Republic, A1 currently has a clear lead despite its strong competitors.

Compared to last year, the Hutchison brand was able to essentially maintain its performance level – which also means a very good third place this time. In crowdsourcing, Three performs just ahead of A1, which shows also very good results. In the test disciplines of voice and data, Three ranks just behind its two competitors, but still delivers a very convincing performance. This provider has also made good progress in its 5G roll-out in Austria over the last 12 months.

Switzerland

Traditionally, the Swiss Confederates are in the lead in the three-country comparison. This year is no different. The only question now is who is ahead within Switzerland.

▶ This is no longer a surprise for long-time connect readers: Swiss network operators regularly show their counterparts from Germany and Austria where the top is. The test rating "outstanding", which connect actually only rarely awards, has been found again and again in Switzerland for several years. Without giving too much away: This year, two out of three Swiss mobile providers made it once again to the top step of our winners' podium.

The associated neck-and-neck race, especially between the two large providers Swisscom and Sunrise, is being fought out in all fields – even in the important 5G roll-out, the rivals gave each other no quarter. And even the smallest Swiss provider, Salt, has been able to make substantial gains in terms of 5G. How the roll-out of latest mobile communications standard to the Swiss networks has progressed compared to the previous year can be read in the box on page 86 – 5G is an integral part of our data tests anyway.

Voice connections

But also in voice telephony via VoLTE (Voice over LTE), the competition in the land of the Confederates is playing out at the highest level. While Salt maintains the performance already observed in the previous year in this discipline, Swisscom and Sunrise were able to make further gains here. 99 or 100 percent of the achievable points and not least the success rates in the test calls in the large and small cities visited are a word. It is also remarkable that these reliability figures only drop slightly even on the connecting roads as well as in the walktests in Swiss trains.

On the roads, Swisscom and Sunrise are close together, with Salt following at some distance. On the railways, the performance level is also very high – here, however, Swisscom comes out ahead of its competitors by some distance. Also remarkable are the very short call set-up times for all providers – again, not only in large and small cities, but also on roads and in trains.

Once a voice connection has been established, the Swiss networks also offer top voice quality. Swisscom is just ahead in the quality ranking, which also leads to the highest overall score in the voice discipline.

Data connections

The Swiss network operators rank also together close in the data discipline. Particularly in larger cities, the measurement values recorded in the drive tests and walktests in the networks of Swisscom and Sunrise show a high proportion with 5G-NR (New Radio) or with LTE 4CA – i.e. the combination of four LTE frequency bands known as "4 Carrier Aggregation".

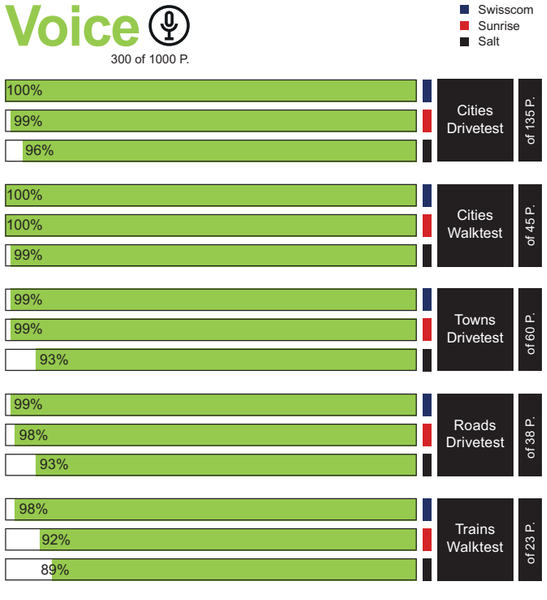
As a consequence, users benefit from high data rates: For example, the fastest ten percent ("P90 value") of the download data rates recorded in the walktests in larger cities are 820.1 Mbps in the Sunrise network, 689.6 Mbps in the Swisscom network and 270.2 Mbps in the Salt network. In terms of upload data rates, Swisscom is again ahead in all the scenarios tested.

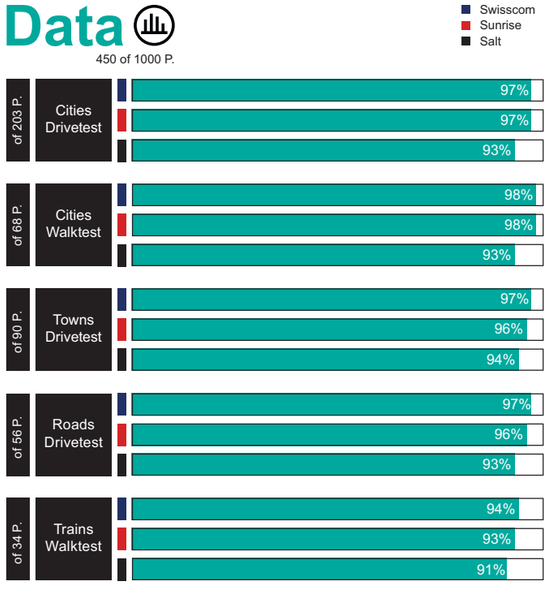
In the data tests conducted in larger cities, Swisscom and Sunrise are on equal footing, but in the small towns and on the connecting roads, Swisscom is able to carve out a razor-thin lead over Sunrise.

The smallest provider, Salt, is in third place in all scenarios – but by a very small gap. And at a score level that would still have been enough to win the respective category in Germany outside the major cities.

Foto: emperorcosar/shutterstock.com

Operator	Swisscom	Sunrise	Salt
Voice Cities (Drivetest)			
Sucess Ratio (%)	100.0	99.9	99.4
Call Setup Time P90 (s)	1.1	0.9	1.1
Speech Quality P10 (MOS-LQO)	4.5	4.3	4.2
Multirab Connectivity (%)	100.0	100.0	99.8
Voice Cities (Walktest)			
Sucess Ratio (%)	100.0	100.0	99.9
Call Setup Time P90 (s)	1.0	0.9	0.9
Speech Quality P10 (MOS-LQO)	4.7	4.5	4.4
Multirab Connectivity (%)	100.0	100.0	99.8
Voice Towns (Drivetest)			
Sucess Ratio (%)	99.9	100.0	99.0
Call Setup Time P90 (s)	1.1	0.9	1.1
Speech Quality P10 (MOS-LQO)	4.5	4.3	4.2
Multirab Connectivity (%)	100.0	100.0	99.9
Voice Roads (Drivetest)			
Sucess Ratio (%)	99.7	99.5	98.2
Call Setup Time P90 (s)	1.1	0.9	1.3
Speech Quality P10 (MOS-LQO)	4.4	4.3	4.1
Multirab Connectivity (%)	100.0	100.0	100.0
Voice Trains (Walktest)			
Sucess Ratio (%)	99.6	97.7	97.0
Call Setup Time P90 (s)	1.1	1.0	1.2
Speech Quality P10 (MOS-LQO)	4.4	4.2	4.0
Multirab Connectivity (%)	100.0	100.0	100.0





Operator	Swisscom	Sunrise	Salt
Data (Cities; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.9	99.7	99.6
Avg. Session Time (s)	0.9	1.0	1.1
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/0.9	100.0/1.0	99.7/1.8
90%/10% faster than (Mbps)	54.6/337.6	50.3/389.5	27.2/169.5
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.5	99.9/1.5	99.7/1.9
90%/10% faster than (Mbps)	17.5/102.0	15.7/95.7	13.6/51.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.9	100.0	99.6
10% faster than (Mbit/s)	667.8	806.3	248.4
Speed > 5Mbit/s / 20Mbit/s (%)	99.9/98.5	99.8/98.4	99.1/95.4
File Upload (7 Seconds)			
Sucess Ratio (%)	99.9	99.6	99.6
10% faster than (Mbit/s)	152.6	140.6	61.6
Speed > 5Mbit/s / 20Mbit/s (%)	99.4/98.4	99.2/97.0	99.4/97.9
Youtube			
Success Ratio/Start Time (%/s)	99.9/1.4	99.7/1.6	98.6/1.4
Ø Video Resolution (p)	1078	1079	1078
Youtube Live			
Success Ratio/Start Time (%/s)	97.5/1.1	97.6/1.1	97.2/1.3
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	99.3/1.6	99.4/1.8	98.7/1.7
Ø Video Resolution (p)	2145	2142	2130
Data (Cities; Walktest)			
Web Page Download			
Sucess Ratio (%)	99.9	99.8	99.6
Avg. Session Time (s)	1.0	0.9	1.1
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/0.8	100.0/0.8	99.6/1.7
90%/10% faster than (Mbps)	66.7/328.0	52.1/388.3	25.3/173.3
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.2	100.0/1.2	100.0/2.2
90%/10% faster than (Mbps)	28.7/102.0	24.6/105.5	10.8/52.6
File Download (7 Seconds)			
Sucess Ratio (%)	99.4	99.8	99.6
10% faster than (Mbit/s)	689.6	820.1	270.2
Speed > 5Mbit/s / 20Mbit/s (%)	100.0/99.4	100.0/98.9	99.6/95.3
File Upload (7 Seconds)			
Sucess Ratio (%)	99.8	100.0	100.0
10% faster than (Mbit/s)	153.7	142.5	62.5
Speed > 5Mbit/s / 20Mbit/s (%)	100.0/99.4	99.1/98.7	98.7/95.7
Youtube			
Success Ratio/Start Time (%/s)	100.0/1.4	100.0/1.6	100.0/1.5
Ø Video Resolution (p)	1079	1079	1077
Youtube Live			
Success Ratio/Start Time (%/s)	98.2/1.1	99.1/1.1	97.7/1.4
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/1.6	100.0/1.8	99.6/1.8
Ø Video Resolution (p)	2153	2154	2129
Data (Towns; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.8	99.7	99.7
Avg. Session Time (s)	1.0	1.0	1.1
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/0.9	100.0/1.2	99.9/1.7
90%/10% faster than (Mbps)	54.3/315.3	31.9/353.0	27.7/174.0
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	99.9/1.6	100.0/2.1	99.9/2.1
90%/10% faster than (Mbps)	14.0/92.6	10.1/85.9	12.1/52.8
File Download (7 Seconds)			
Sucess Ratio (%)	99.7	99.8	99.8
10% faster than (Mbit/s)	647.0	727.3	255.7
Speed > 5Mbit/s / 20Mbit/s (%)	99.7/98.3	99.7/95.0	99.5/95.9
File Upload (7 Seconds)			
Sucess Ratio (%)	100.0	99.9	99.4
10% faster than (Mbit/s)	140.5	119.2	61.6
Speed > 5Mbit/s / 20Mbit/s (%)	99.6/97.8	98.7/95.0	99.6/97.7
Youtube			
Success Ratio/Start Time (%/s)	99.7/1.4	100.0/1.6	99.4/1.5
Ø Video Resolution (p)	1078	1077	1077
Youtube Live			
Success Ratio/Start Time (%/s)	98.3/1.1	97.9/1.1	99.1/1.3
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/1.6	100.0/1.9	99.7/1.7
Ø Video Resolution (p)	2144	2136	2133

Operator	Swisscom	Sunrise	Salt
Data (Roads; Drivetest)			
Web Page Download			
Sucess Ratio (%)	99.7	99.8	99.1
Avg. Session Time (s)	1.0	1.1	1.2
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.4	100.0/1.9	100.0/2.5
90%/10% faster than (Mbps)	35.6/230.3	22.8/302.5	22.8/148.7
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	99.7/3.0	99.7/2.9	99.5/3.4
90%/10% faster than (Mbps)	7.7/74.9	6.8/63.0	6.4/45.8
File Download (7 Seconds)			
Sucess Ratio (%)	100.0	100.0	99.5
10% faster than (Mbit/s)	530.9	478.6	196.2
Speed > 5Mbit/s / 20Mbit/s (%)	99.7/97.6	99.7/92.4	98.9/92.1
File Upload (7 Seconds)			
Sucess Ratio (%)	99.7	100.0	98.4
10% faster than (Mbit/s)	113.8	77.4	49.6
Speed > 5Mbit/s / 20Mbit/s (%)	97.3/94.9	97.8/91.2	97.8/92.8
Youtube			
Success Ratio/Start Time (%/s)	99.5/1.4	99.4/1.6	97.8/1.5
Ø Video Resolution (p)	1076	1073	1070
Youtube Live			
Success Ratio/Start Time (%/s)	97.7/1.3	97.8/1.3	95.2/1.5
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	100.0/1.6	99.4/1.8	95.6/1.7
Ø Video Resolution (p)	2141	2113	2139

Operator	Swisscom	Sunrise	Salt
Data (Trains; Walktest)			
Web Page Download			
Sucess Ratio (%)	99.2	99.2	98.9
Avg. Session Time (s)	1.2	1.3	1.3
File Download (10MB)			
Success Ratio/Ø Session Time (%/s)	100.0/1.6	100.0/2.8	100.0/3.3
90%/10% faster than (Mbps)	27.5/254.5	13.6/290.5	12.7/132.2
File Upload (5MB)			
Success Ratio/Ø Session Time (%/s)	100.0/2.9	99.3/3.4	99.7/3.5
90%/10% faster than (Mbps)	6.3/68.8	6.3/61.1	5.5/42.3
File Download (7 Seconds)			
Sucess Ratio (%)	99.3	99.7	99.0
10% faster than (Mbit/s)	387.3	493.3	170.9
Speed > 5Mbit/s / 20Mbit/s (%)	99.0/94.3	99.0/88.6	97.9/86.0
File Upload (7 Seconds)			
Sucess Ratio (%)	98.3	100.0	97.9
10% faster than (Mbit/s)	89.2	74.0	52.7
Speed > 5Mbit/s / 20Mbit/s (%)	98.3/96.2	97.2/93.6	97.5/94.0
Youtube			
Success Ratio/Start Time (%/s)	99.3/1.4	97.2/1.7	96.6/1.5
Ø Video Resolution (p)	1077	1077	1072
Youtube Live			
Success Ratio/Start Time (%/s)	95.1/1.3	94.3/1.4	95.1/1.6
Ø Video Resolution (p)	1080	1080	1080
Youtube 4K Smartphone			
Success Ratio/Start Time (%/s)	95.3/1.7	97.1/1.9	95.1/1.7
Ø Video Resolution (p)	2124	2100	2081

The performance on the Swiss connecting roads is also pleasing and guarantees drivers in Switzerland excellent connections even while travelling in their cars – which is important not least for the increasingly widespread connected services of modern vehicles. In addition to the race for the fastest data rates, high reliability rates are also particularly important for this. And in this respect, the Swiss providers, including the smallest competitor Salt, are also showing quite respectable results. Even those who want to watch Youtube videos on the road do best in Switzerland in a three-country comparison.

Data connectivity on trains

And once again this year, the Swiss mobile networks show what mobile coverage while travelling on railways can – and should – look like.

In a competition at the highest level, Swisscom again takes a narrow lead in this discipline, closely followed by Sunrise and Salt, who are both also showing very strong results.

Apart from the convenience for Swiss rail passengers, it is not least very timely that the success rates and data rates in Swiss trains are hardly worse than in cars – this is also something one would wish for in other countries.

5G

The Swiss providers are also at the highest level in the analysis of 5G results. Swisscom and Sunrise offer the latest generation of mobile telephony not only in the larger cities, but also to a high degree in the more rural areas – and Salt has also made strong gains with 5G.

■ To document the progress of the strong Swiss providers in terms of their 5G roll-outs, we look at the results of the seven-second download tests from the data discipline, as we already did last year. The high proportions of samples with 5G at Sunrise and Swisscom are particularly striking. Sunrise is the only provider in Switzerland and in the entire DACH region to exceed the 90% mark for 5G downloads in larger cities. Swisscom relies on the combination of radio cells with pure 5G and those with the capacity distribution technology DSS. All in all, this also results in high 5G coverage for this provider – albeit with somewhat lower data rates, especially via DSS.

The high 5G coverage of the two large providers is also impressive in small towns, on roads and in trains. In terms of data rates, Sunrise is slightly ahead. But Salt was also able to significantly increase its 5G coverage compared to last 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	70.2%	442.0	719.3	91.1%	398.7	826.8	7.2%	185.7	453.5
Cities – Walktest	58.9%	451.8	751.5	90.0%	455.2	836.3	15.7%	238.1	524.7
Towns – Drivetest	59.6%	452.5	730.3	79.1%	362.5	763.9	15.6%	242.3	541.2
Roads – Drivetest	29.4%	433.3	774.8	43.7%	319.7	711.2	6.6%	276.8	686.5
Trains – Walktest	39.8%	284.7	503.4	62.6%	248.6	597.0	8.0%	116.2	237.3
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	16.2%	136.4	240.7	–	–	–	–	–	–
Cities – Walktest	20.3%	118.2	198.4	–	–	–	–	–	–
Towns – Drivetest	30.1%	154.4	278.3	–	–	–	–	–	–
Roads – Drivetest	44.0%	160.5	290.5	–	–	–	–	–	–
Trains – Walktest	29.4%	103.9	217.2	–	–	–	–	–	–

Crowd

The crowdsourcing analyses show the same ranking in Switzerland as the overall ranking – thus confirming the results of our drivetests and walktests.

▶ The ranking of the three Swiss providers in the crowdsourcing discipline does not differ from the previous categories of voice and data: Swisscom takes the lead by a few points, closely followed by Sunrise and finally by Salt at a slightly larger gap. Even the point differences are similar to last year, which once again underlines the high and long-term stable quality of the Swiss mobile networks.

The respective strengths are already evident in the broadband coverage category: in the Coverage Quality, Swisscom and Sunrise are on a tie, followed by Salt at a small gap.

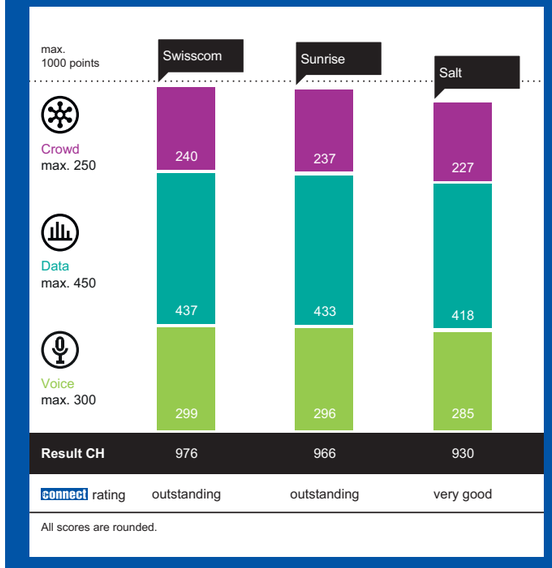
The Broadband Reach reveals a clearer ranking: here Swisscom leads, Sunrise is in second place and Salt in third. Sunrise, in turn, can gain a small lead over Swisscom in the Time on Broadband – the share of time in which a user has broadband coverage. Here, again, the two big rivals are ahead of the smaller provider Salt at some distance.

In the data rates considered in crowdsourcing, Swisscom takes the lead in all three categories, the gaps to Sunrise in second and Salt in third place becoming increasingly apparent as the demands increase.

Swisscom also leads in both categories when latencies are examined. In the basic OTT voice services class, Sunrise and Salt are on a par, while in the more demanding gaming category, the familiar ranking becomes evident again.

Operator	Swisscom	Sunrise	Salt
Broadband Coverage			
Coverage Quality (%)	97.8	97.8	94.8
Coverage Reach (%)	97.7	95.3	88.6
Time on Broadband (%)	97.9	98.0	93.8
Download Speed			
Basic Internet Class (%)	96.2	95.1	94.2
HD Video Class (%)	88.1	83.5	80.9
UHD Video Class (%)	32.4	26.2	23.8
Latency			
Gaming Class (%)	97.2	94.6	88.8
OTT Voice Class (%)	99.0	97.8	97.8

Single Review



swisscom In the fiercely competitive Swiss mobile telephony market, Swisscom fights its way to the top for the fourth time in a row and achieves an "outstanding" rating with the highest score of this year's test season. Against its strong competitor Sunrise, Swisscom succeeds this time in achieving a narrow lead in all three assessment categories. Swisscom is also a top player in the 5G roll-out.

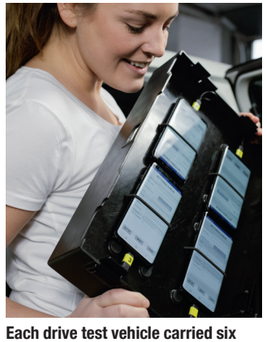
Sunrise Sunrise delivers excellent performance in all test disciplines and thus deservedly achieves the grade "outstanding" as in the previous year. In all three test disciplines the gap to the test winner Swisscom is only a few points – only in the total addition is there a slightly clearer gap. Sunrise is top regarding the combination of 5G coverage and 5G data rates.

Salt. With essentially comparable performance to last year, the smallest Swiss provider, Salt, once again achieved the grade "very good". In all three test disciplines, Salt is behind the two larger competitors, but this takes place at a high level in each case. In the 5G roll-out, there is clear progress compared to the previous year – and where 5G is already available from Salt, it offers also high performance.

umlaut Part of Accenture

Methodology

■ The measurements in Germany took place from 22.10. to 4.11.2021, in Austria from 9.10. to 18.10.2021 and in Switzerland from 21.10. to 30.10.2021.
connect's network test partner umlaut sent four measurement vehicles per country, each one equipped with six smartphones. Two Samsung Galaxy S21+ were used for each network operator: one took the voice measurements, another the data measurements. For the voice and data measurements, the smartphones were set to "5G preferred" – so wherever supported by the network, data tests took place via 5G.
In addition to the drivetests, two walktest teams carried out measurements on foot in each country – in zones with heavy public traffic such as railway stations, airport terminals, cafés, museums and public transport. The walktest programme also included journeys on long-distance railway lines. Also for the walktests, two Samsung Galaxy S21+ were used per network operator – one for voice and one for data tests in "5G preferred" mode. The walktest teams transported the smartphones in backpacks or trolleys equipped with powerful batteries. The firmware of the test smartphones corresponded to the respective original network operator versions. If there was no such version, we used the respective regional "open market" firmware.



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

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

Logistics

The drivetests and walktests were conducted between 8 am and 10 pm. During 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 a small temporal and spatial distance.
In Germany, the drivetests took place in 22 large cities and 25 small towns, the walk tests in 11 cities. Thus, about 14.8 million inhabitants were covered, which corresponds to about 17.8% of the German population. The drive tests covered about 13 196 km.
In Austria, the testers drove through 9 large and 15 small cities and covered about 5580 km. In addition, there were walktests in six cities. Thus, a total of about 3.2 million inhabitants (approx. 35.8% of the population) were covered.

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

The drive tests in Switzerland led through 29 large and 21 small cities, the walktests took place in eight cities. The test route in Switzerland was about 6400 km long, the measurement campaign covered about 2.3 million inhabitants (26.3% of the population).
For the selection of the test routes, umlaut created four different proposals for each country, from which connect blindly selected a route.

Voice connections

The telephony measurements took place from vehicle to vehicle ("mobile-to-mobile"). The smartphones of the walktest teams made calls for the speech tests with a stationary (smartphone) counterpart. To ensure realistic conditions, data traffic was handled simultaneously in the background. In the process, we also recorded MultiRAB connectivity: the use of several "**r**adio **a**ccess **b**earers" provides data connections in the background of the voice calls. The transmission quality of the transmitted voice samples was evaluated using the POLQA wideband method suitable for HD voice. "VoLTE preferred" was configured on all phones – from 5G, the phones thus fell back to telephony via LTE.

Data connectivity

During the data measurements, several popular live pages according to the Alexa ranking were downloaded (dynamically). In addition, the ETSI (**E**uropean **T**elecommunications **S**tandards **I**nstitute) reference page known as the Kepler page was used (statically). In addition, 10 and 5 MB files were downloaded and uploaded, respectively, to determine the performance for smaller data transfers. In addition, we determined the data rate within a 7-second period when uploading and downloading large files. The Youtube measurements take into account the "adaptive resolution" of the video platform: Youtube dynamically adjusts the played resolution to the available bandwidth. The rating therefore takes into account the average image resolution or number of lines of the videos. In addition, the video rating is based on the success rate, the time until playback starts and the proportion of video playbacks that went through without interruption.

Crowdsourcing

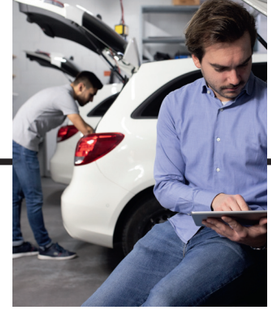
In addition, the results of the crowdsourcing analyses carried out by umlaut constitute 25% of the overall rating. This not only checks which portion of the networks' maximum performance actually reaches each user – the end devices and tariffs selected by the users also have an effect. For this purpose, the samples collected in all three countries from mid-May to the end of October 2021 were evaluated. Around 1.7 billion individual readings were analysed for Germany. This covers 99.8% of the population. For Austria, umlaut evaluated around 262 million samples, which also corresponds to 99.8% of the population. The figures for Switzerland: around 260 million samples correspond to a coverage of 99.9% of the Swiss population.
To obtain the data basis for these analyses, thousands of popular apps record in the background whether there is contact with the network, which network technologies are available and at what data rate and latency the transmission takes place – always provided that the user has consented to the completely anonymous data collection.
These measured values are recorded in 15-minute intervals and transmitted to umlaut's servers once a day. Such reports contain only a few bytes, so they hardly burden the user's data volume.

Broadband Coverage

In order to assess the *Coverage Reach*, the test area is covered by a grid of 2 x 2 km tiles ("Evaluation Areas" or EAs for short).
A minimum number of users and measured values must be available for each EA.
For the evaluation, umlaut awards one point per EA if the network under consideration offers 3G coverage. Three points are awarded if 4G or 5G is available in the EA. The number of points achieved in this way is then divided by the total number of points that can be achieved (three points per EA in the "common footprint" – i.e. the area of the respective country covered by all tested providers).
In addition, we look at the *Coverage Quality*. It relates the percentage of EAs in which a user had 4G or 5G coverage to all EAs in the common footprint.
A third KPI for broadband quality is *Time on Broadband* . It tells us how often an individual 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 – they do not correspond to the percentage of 4G/5G mobile coverage in an area or in relation to the overall population.

Data rates and Latencies

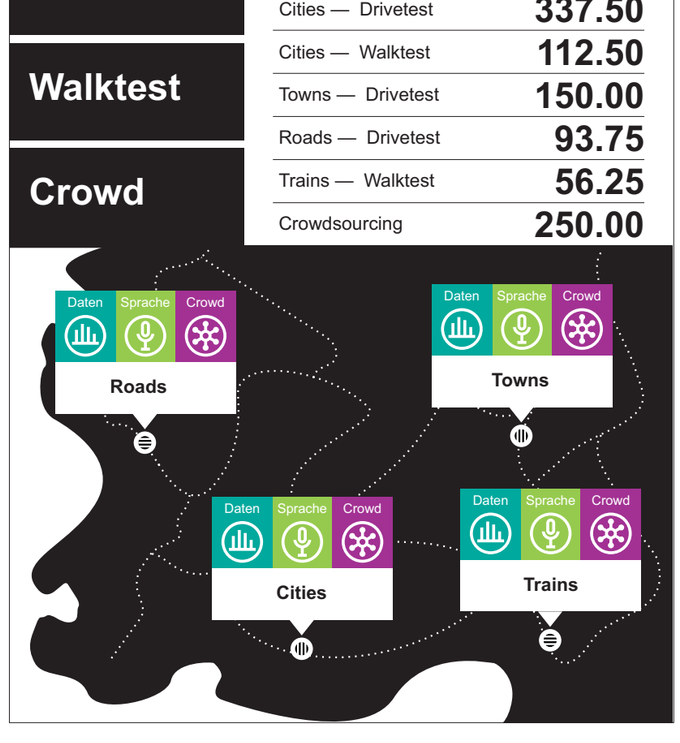
The *data rates* determined are included in the crowd score at 30%, the *latencies* at 20%.
The investigation of these parameters is also carried out independently of the EAs and thus concentrates on the experience of each individual user. Samples that were recorded via WiFi or when flight mode was activated, for example, are filtered out by umlaut before further analysis. In order to take into account the fact that many mobile phone tariffs throttle the usable data throughput, umlaut has defined three 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 also have flowed in a 15-minute period. Similarly, the latency of the data packets is also 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*.



Before the tests were carried out, the drivetest vehicles were carefully prepared for their measurement runs.

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

In the evaluation, umlaut assigns the speeds and latencies determined in the sample to one of these classes. *Basic internet* then accounts for 55% of the data rate rating, *HD video* for 33.8% and *UHD video* for 11.3%.
OTT voice services account for 55% of the latency rating and *gaming* for 45%.
You can find even more detailed descriptions of our test methodology online at **www.connect-testlab.com**.



Fairness and transparency

This year, umlaut and connect have once again ensured that all processes surrounding our mobile network test are 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 2021 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.

Interview

"In 5G, every provider has made great steps forward."

Hakan Ekmen,
CEO Telekommunikation bei umlaut

■ **Mr Ekmen, at first glance, this year's network test results are not all that different from last year. So business as usual?**
Hakan Ekmen: Not at all! Despite stricter requirements, we see clear sets ahead for some providers – especially in Germany, but also in the traditionally already very strong countries of Switzerland and Austria. The network operators who were able to improve so significantly deserve our congratulations just as much as the test winners – who again convince with their absolute performance.

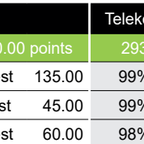
How do you assess the progress of the 5G roll-out?
Hakan Ekmen: The improvements are particularly evident in this important discipline. It is good for the providers, but especially for their customers, that in this respect really erach one of the providers tested has made big steps forward compared to the previous year.

How do you win the mobile network test conducted by connect and umlaut? Rather with selective top performances or with a stable offer across the board?
Hakan Ekmen: Both aspects are necessary. Our drivetests and walktests check out the technical capabilities of the networks. And the crowdsourcing assesses what arrives at each user. A test victory is not possible without demonstrating top performance in both areas.

Overall Results			Germany			Austria			Switzerland		
Voice, Data & Crowd			Telekom	Vodafone	Telefónica	Magenta	A1	Hutchison3	Swisscom	Sunrise	Salt
Voice	max. 300.00 points		293	284	276	292	286	242	299	296	285
Cities	Drivetest	135.00	99%	96%	95%	98%	97%	78%	100%	99%	96%
Cities	Walktest	45.00	99%	99%	98%	99%	96%	78%	100%	100%	99%
Towns	Drivetest	60.00	98%	95%	88%	98%	95%	84%	99%	99%	93%
Roads	Drivetest	37.50	95%	88%	86%	98%	94%	89%	99%	98%	93%
Trains	Walktest	22.50	89%	88%	80%	88%	84%	74%	98%	92%	89%
Data	max. 450.00 points		418	399	375	433	429	414	437	433	418
Cities	Drivetest	202.50	96%	92%	87%	99%	97%	94%	97%	97%	93%
Cities	Walktest	67.50	97%	93%	94%	97%	97%	90%	98%	98%	93%
Towns	Drivetest	90.00	91%	86%	82%	97%	97%	94%	97%	96%	94%
Roads	Drivetest	56.25	89%	86%	76%	93%	96%	91%	97%	96%	93%
Trains	Walktest	33.75	77%	70%	56%	83%	81%	79%	94%	93%	91%
Crowd	max.250.00 points		233	230	223	235	227	230	240	237	227
Crowd		250.00	93%	92%	89%	94%	91%	92%	96%	95%	91%
Total	max. 1000.00 points		944	913	874	960	942	886	976	966	930
connect -rating			very good	very good	very good	outstanding	very good	very good	outstanding	outstanding	very good

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

Conclusion



Hannes Rügheimer,
connect author

Despite stormy times, the ranking in the three countries which we tested here remains stable again – for the fourth year in a row. However, this primarily proves that all providers are making an equally strong effort to improve further. Without constant work on the network infrastructure, even merely maintaining the performance level from the previous year would not be possible. Even the wide-scale phase-out of the previous 3G networks last year did not cause any major negative impact on mobile coverage.

In Germany, we congratulate Deutsche Telekom on its eleventh consecutive test victory. The Bonn-based company also shows top performance in their 5G roll-out.

However, Vodafone was also able to clearly improve since the previous year, achieving the largest increase in points in the comparison of competitors and its best result to date in our mobile network test. In addition, the Duesseldorf-based company has significantly increased its 5G coverage. Keep it up!

Telefónica also recorded a significant increase in points compared to the previous year, also achieved its best result to date and has now clearly arrived in the top league. If now what this provider is already showing in terms of performance in the big cities – especially in terms of 5G roll-out – also continues in the rural areas, this upward trend should also continue in the future.

Since Austria and Switzerland already ranked at top levels in previous years, increases are even more difficult to realise there. Accordingly, they happen only in single digits in Austria, and the Hutchison brand Three even loses a few points.

In the Alpine republic, Magenta is the shining winner for the fourth time in a row – in all three test categories, the provider keeps its pursuers at distance and also shows respectable performance in terms of 5G. But A1 also achieves a very good result and is particularly convincing in the 5G roll-out. Three also performs very well and essentially maintains its performance level from the previous year.

In Switzerland, a very strong Swisscom takes the top spot – again for the fourth time in a row. The provider once again showed a significant increase compared to last year and is also stepping on the gas with 5G. But Sunrise also offers outstanding services and is also making particularly great progress in the roll-out

of 5G. The smallest Swiss operator, Salt, maintains its previous year's level. And where there is already 5G available in the Salt network, it is also already delivering high performance.