

# The great 2018 Mobile Network Test



In its 24th year, the connect mobile network test is still considered as the highest benchmark in the mobile communications industry. Together with our well-renowned benchmarking partner P3 communications, we have once again investigated which mobile operators in Germany, Austria and Switzerland are ahead – with the utmost effort and our customer-oriented testing methodology.

The procedure is reminiscent of exciting elections: After extensive preparations and intricate investigations, the candidates face their moment of truth. Going to the ballot box corresponds to the drive-tests and walktests that the network benchmarking specialist P3 communications has conducted in Germany, Austria and Switzerland. Election campaigns and demographic surveys have their equivalents within the intensive preparations and the precise gathering of measurement values over the course of several weeks here.

At the end of the process, the P3 experts thoroughly check and evaluate all measurement values, while the network operators tensely anticipate the results – much like politicians wait for the outcome of the elections. In our case as well, the candidates vigorously speculate about their performances until the analyses are complete. Only at the very end, all facts are on hand.

In the next step, not all of the participants are exactly happy about the results. But everyone has to live with the consequences. While in politics, the negotiations about forming a government start, the mobile network operators are concerned about the

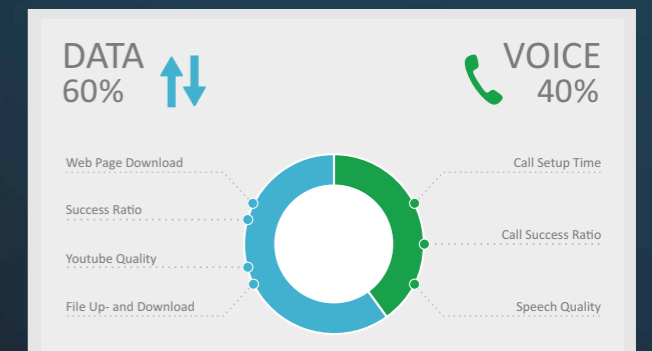
meaning of their test results for their ongoing network upgrades and not least for their marketing activities.

### Permanent Enhancements

But there are also some distinct differences between our network tests and the course of democracy: Opinion polls are completely irrelevant for our assessments, and the process leading to the final result is considerably more complicated than just ticking boxes on a list. After all, we permanently enhance our methodology and framework in order to ensure the validity of our test results.

So how do we consistently challenge the relevance of our criteria and evaluations? It begins with staying up-to-date, and representing state-of-the-art-technology. You can read the conclusions that we drew from these considerations from page 66 on. Also, you can find an outlook to our plans about even extending the scope of our quality assessments in the near future from page 64 on.

But now, let's make way for the analyses, trends and results of this year's mobile network test. One or two aspects may look familiar to frequent readers. But we can also guarantee a number of surprises on the following pages. **HANNES RÜGHEIMER**



### Practical relevance in mind

The importance of data communications is steadily growing. The evaluation of our test results respects this. The performance indicators gathered in the data discipline therefore account for 60 per cent of the total result, those of the voice discipline account for 40 per cent.

# Germany

## Voice

In order to make the mobile internet and a high voice quality coexist well on smart phones, all three German operators rely on VoLTE. The acronym stands for Voice over LTE, which means conducting phone calls via LTE-based data packets.

The drivetests and walktests conducted by P3 show that this is working effectively by now. The Samsung Galaxy S7 phones that were installed in the test cars as well as in the backpacks of the walktest teams permanently established voice calls to their defined counterparts. The calls that originated in the test cars were set up to the according smartphones in another car. The phones in the walktest backpacks called stationary receivers. In order to simulate common smart phone utilisation, the mobile phones transmitted parallel data streams in the background of the telephony tests.

This, however, does not mean that all test calls actually used

Even if many users are focussing on data communications, they still expect a high connection quality when talking on the phone. Where can it be found?

VoLTE. If one of the participating mobile phones was not registered in a LTE network, the call was connected in the "circuit-switched" mode of the older mobile communications standards.

### Close voice race between Vodafone and Telekom

The test drives in larger cities conveyed the same picture that also could be observed in the subsequent disciplines: The race between Telekom and Vodafone was neck to neck, O2 followed at considerable distance. Still, the Telefónica network achieved far better results in the big city walktests compared to the results of the drivetests. This indicates that O2 offers better coverage in inner-city locations where there is a lot of foot traffic.

Compared to last year's results, Vodafone managed to considerably improve the call set-up times in its network. In this regard, the Dusseldorf-based

provider beats its competitors in all tested scenarios with the only exception of voice calls in railways. Deutsche Telekom holds up with slightly higher success rates – again, with the exception of rail journeys.

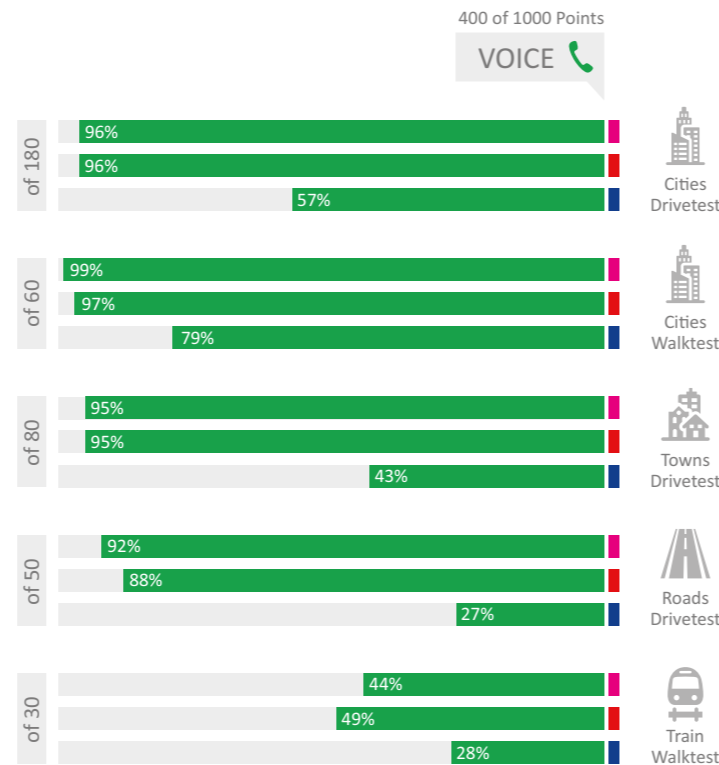
In smaller towns and on the connecting roads, both contenders offer high quality as well. Telefónica's network, that still suffers from the ongoing integration of O2's and E-Plus' formerly separate radio cells,

falls back considerably outside of the big cities. In those locations, we see a distinct drop in the level of the measured values.

When it comes to conducting phone calls in trains, the performances of neither operator are a glorious chapter – especially when bearing in mind that the results in this discipline looked far better last year. Despite Vodafone being a small step ahead, there is much room for improvement in all considered networks.



OPERATOR	Telekom	Vodafone	Telefónica
<b>VOICE (Cities; Drivetest)</b>			
Call Success Ratio (%)	99.6	99.4	94.3
Call Setup Time (s)	3.1	2.8	5.9
Speech Quality (MOS-LQO)	3.9	4.0	3.4
<b>VOICE (Cities; Walktest)</b>			
Call Success Ratio (%)	99.9	99.5	97.1
Call Setup Time (s)	1.7	1.5	3.5
Speech Quality (MOS-LQO)	4.2	4.3	3.6
<b>VOICE (Towns; Drivetest)</b>			
Call Success Ratio (%)	99.5	99.4	91.9
Call Setup Time (s)	3.4	2.9	6.2
Speech Quality (MOS-LQO)	3.9	3.9	3.3
<b>VOICE (Roads; Drivetest)</b>			
Call Success Ratio (%)	98.8	97.4	83.9
Call Setup Time (s)	3.7	3.3	6.7
Speech Quality (MOS-LQO)	3.9	3.8	3.1
<b>VOICE (Train; Walktest)</b>			
Call Success Ratio (%)	84.2	85.7	73.5
Call Setup Time (s)	2.1	2.2	4.0
Speech Quality (MOS-LQO)	3.8	3.8	3.2



## Data

The mobile internet and audio/video streaming are booming. How do the mobile networks cope with the high demand?

We are awarding 60 per cent of the achievable points in the data discipline. This pays tribute to the fact that internet communications and streaming applications nowadays have the biggest share in smartphone usage. The demanding measurements conducted by the drivetest and walktest teams are also reflecting these conditions: The smartphones regularly access the most popular web sites according to the renowned Alexa ranking. Furthermore, they invoke the static ETSI reference web page, also known as "Kepler page". We evaluate the speed and reliability of data transfers with downloads of 3 MB and uploads of 1 MB test files. Furthermore, we gauge the amount of data travelling over the network in a seven-second period.

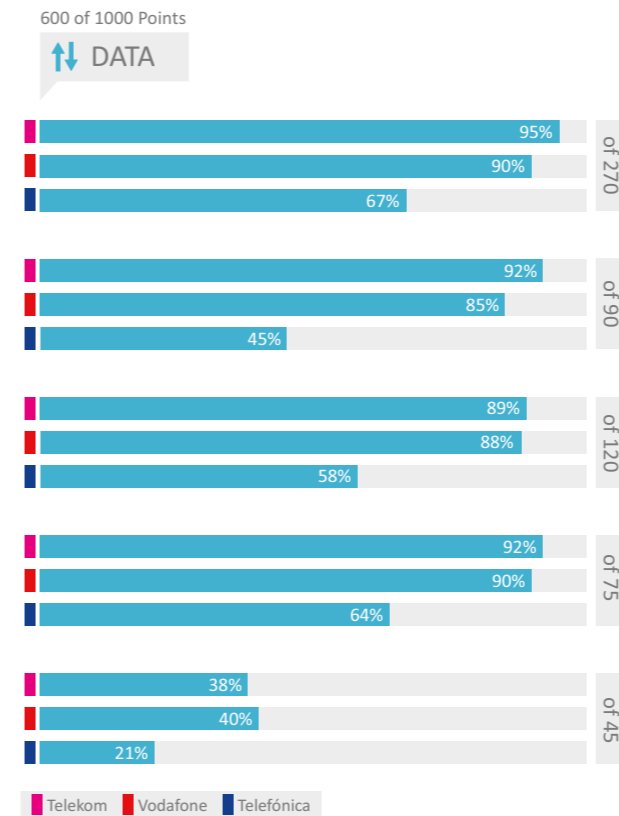
This is complemented with playing back Youtube videos. Here we examine the success ratios and how much time pas-

ses until the playback starts. Above that, we look at the percentage of videos that run through without interruptions as well as their average image resolution.

In order to account for the behaviour of various smart phones, we appointed two different phone models to the data tests. In addition to the Samsung Galaxy S7 phones that were also used for the voice tests, half of the measurements were conducted with Sony Xperia XZ.

### Clear ranking order in the data discipline

The data tests in the big cities confirm the results of the data discipline – almost regardless of the number of the cities' inhabitants. In comparison to the previous year's results, the leading duo Telekom and Vodafone succeeded in taking their performances up a notch especially in urban areas. We are particularly impressed >>



OPERATOR	Telekom	Vodafone	Telefónica
<b>DATA (Cities; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.7/99.8	99.6/99.7	97.6/97.5
Static: Avg. Session Time (s)	1.1	1.1	1.8
Live: Reaction Time (ms)	398	423	447
Live: Initial DL Speed 1st sec (kB/s)	447	421	356
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.9/1.0	99.8/2.0	99.1/5.2
90%/10% faster than (kbit/s)	18398/66852	6348/55312	2023/38302
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.9/0.8	99.8/1.0	98.4/2.1
90%/10% faster than (kbit/s)	8120/24845	5515/22161	1764/14286
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.9	99.7	98.0
∅ Throughput (kbit/s)	70408	38084	19821
90%/10% faster than (kbit/s)	22644/130349	6802/88030	2324/48126
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.7	99.7	97.6
∅ Throughput (kbit/s)	31839	20072	10309
90%/10% faster than (kbit/s)	9878/54165	5847/40227	2046/18530
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.6/2.0	99.2/2.3	90.8/2.8
Playouts without Interruptions (%)	99.9	99.5	95.6
∅ Video Resolution (p)	1076	1068	1026
<b>DATA (Cities; Walktest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.4/99.8	99.4/99.4	92.8/91.4
Static: Avg. Session Time (s)	1.1	1.2	2.1
Live: Reaction Time (ms)	405	437	553
Live: Initial DL Speed 1st sec (kB/s)	425	396	315
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.7/1.0	99.7/2.3	95.0/6.9
90%/10% faster than (kbit/s)	16880/56926	5073/58680	1160/40914
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.2/1.1	98.9/1.2	93.5/2.9
90%/10% faster than (kbit/s)	6488/24242	3886/22780	1073/17279
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.7	99.2	95.8
∅ Throughput (kbit/s)	66228	44535	25653
90%/10% faster than (kbit/s)	19722/126002	5417/108006	1220/65374
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.5	99.2	90.8
∅ Throughput (kbit/s)	25085	18830	12700
90%/10% faster than (kbit/s)	5605/41817	4145/38607	1197/35108
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.5/1.9	97.9/2.4	82.3/2.9
Playouts without Interruptions (%)	99.5	98.2	95.0
∅ Video Resolution (p)	1076	1057	1020
<b>DATA (Towns; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.2/99.6	99.4/99.8	95.2/96.2
Static: Avg. Session Time (s)	1.2	1.2	2.3
Live: Reaction Time (ms)	425	438	566
Live: Initial DL Speed 1st sec (kB/s)	433	420	317
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.5/1.3	99.8/2.1	98.5/5.7
90%/10% faster than (kbit/s)	13161/60030	6216/43636	2107/23563
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.5/1.3	100.0/1.1	96.8/3.5
90%/10% faster than (kbit/s)	4329/22409	4543/18705	939/11859
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.5	99.5	98.0
∅ Throughput (kbit/s)	49466	28260	14447
90%/10% faster than (kbit/s)	13357/92916	6512/63751	2453/29461
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	98.6	99.5	93.7
∅ Throughput (kbit/s)	25602	16591	7009
90%/10% faster than (kbit/s)	6018/46923	5659/26292	1233/16730
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	98.3/2.1	98.8/2.4	91.8/3.1
Playouts without Interruptions (%)	100.0	99.3	95.5
∅ Video Resolution (p)	1075	1067	1027



by the high success ratios of the leading duo. In big cities and smaller towns alike, this year's network test confirms the high availability and stability of LTE mobile network coverage.

However, Telekom takes a clear step ahead of Vodafone in the data discipline and builds the foundation of this year's overall win on this. The lead is most distinct regarding the upload and download data rates. Above that, the really fast transmission speeds in both networks are a good indication of the advanced stage of completion of the so-called "carrier aggregation" – increasing data rates by means of combining several LTE frequency bands.

**Performance losses at O2**

But our test results also expose the problems currently met by Telefónica and its customers. Since O2 acquired its former competitor E-Plus in October, 2014, the technicians have been

working hard in order to consolidate the formerly separate cells of both networks. The measurement values at hand clearly indicate that this task is everything but trivial. The O2 network already ranked distinctly behind Telekom and Vodafone in our previous mobile network test (2016/2017). But this year, the gap did actually increase.

O2 manages to keep up its last year's level in the drivetests conducted in larger cities. However, the operator massively loses points in the inner city walktests. This suggests that fine tuning the merged networks is especially demanding at locations with high numbers of users simultaneously accessing the mobile network. Considerably lower success ratios and data rates than those delivered by Telekom and Vodafone result in a significant loss of points for Telefónica. Customers who join O2 due to its undoubtedly attractive tariffs must, at his point in time, be somewhat

patient especially when they are using the mobile internet.

**Vodafone makes up leeway over Telekom in smaller towns**

In the drivetest conducted in smaller towns, O2 also ranks substantially lower than in the previous year. At least, the level of results rises a little in this scenario in comparison to the inner city walktests. As was to be expected, the leading duo also shows somewhat weaker results in the smaller towns than in the

metropolises. Interestingly, in this category, Vodafone catches up closely to Telekom. Especially the success ratios of the Dusseldorf-based contender are a tiny step ahead of its Bonn-based competitor. Telekom counters this with slightly better data rates as well as an excellent Youtube performance.

All in all, Telekom and Vodafone customers in cities and towns can be very pleased with their operators. For O2, this currently applies only with some restrictions.

*Communication and connectivity play an ever increasing role behind the wheel. So what can be found out about mobile network coverage on German roads?*

OPERATOR	Telekom	Vodafone	Telefónica
<b>DATA (Roads; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.6/99.6	99.0/99.1	93.5/94.0
Static: Avg. Session Time (s)	1.3	1.2	2.0
Live: Reaction Time (ms)	425	433	548
Live: Initial DL Speed 1st sec (kB/s)	420	417	336
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.9/1.9	99.6/2.4	94.5/4.9
90%/10% faster than (kbit/s)	6870/53440	5401/41739	2158/33058
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.5/1.3	99.3/1.3	92.6/2.7
90%/10% faster than (kbit/s)	3709/20429	3832/18824	1310/12937
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.7	98.8	95.1
∅ Throughput (kbit/s)	40166	26435	17997
90%/10% faster than (kbit/s)	7073/88720	5420/51000	2758/42504
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	98.3	99.1	91.3
∅ Throughput (kbit/s)	20225	16284	8728
90%/10% faster than (kbit/s)	4798/41578	5012/26525	1371/17749
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	98.0/2.3	97.9/2.4	88.6/3.0
Playouts without Interruptions (%)	99.0	99.1	96.4
∅ Video Resolution (p)	1068	1065	1033

*Leaning back and using your mobile devices while riding a train – how well does this actually work?*

# Data on Railways

"When it comes to connectivity in German railways, there remains a lot of work to be done." This was the conclusion of the corresponding section of our mobile network test one year ago. So, this year, our test teams started their tasks with eager expectations and successfully completed more than 30 hours of travelling in various ICE and IC trains. Especially in the ICE flagship trains, Deutsche Bahn has recently made extensive upgrades to their cellular and online coverage.

In the face of these efforts, the results are somewhat disappointing – particularly as all three German mobile operators were further ruffled in comparison to the mobile connectivity results obtained in the previous year. However, for the sake of fairness, we have to mention that the test connections did not make use of the WiFi hotspots that are meanwhile available in almost all ICE trains, but exclusively used the mobile networks. Still, they too should be receivable in good quality due

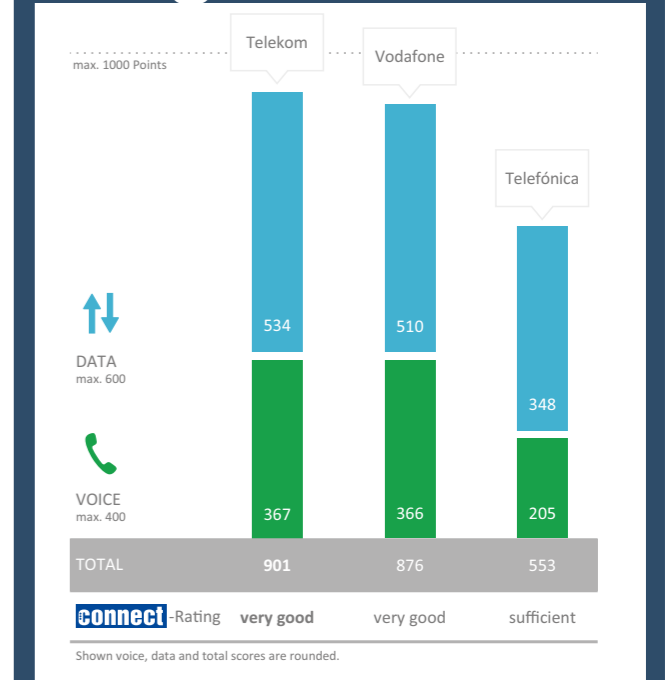
to elaborate repeater technology in the railway waggons. Unfortunately, the result is still indisputable: When looking across the borders to Austria and especially to Switzerland, German railway customers can be only jealous. Both alpine countries are ahead in this discipline at an enormous distance.

**Still need for improvement on German railways**

It is not a very high level on which Vodafone beats the overall winner Telekom in this discipline. Success ratios and data rates of web-page downloads and Youtube playbacks as well as file transfers leave a lot to be desired in all three considered networks. The weakest candidate in this category, O2, failed at a quarter of all attempts to use an online connection in trains. When accessing Youtube, this number even rose to about half of the attempts. So this year's conclusion sadly is: When it comes to using the internet in German railways, there still remains a lot of work to be done.

OPERATOR	Telekom	Vodafone	Telefónica
<b>DATA (Train; Walktest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	84.6/85.2	86.4/87.1	71.0/69.5
Static: Avg. Session Time (s)	2.2	2.5	3.1
Live: Reaction Time (ms)	565	614	718
Live: Initial DL Speed 1st sec (kB/s)	287	277	224
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	88.4/8.2	90.4/9.2	76.1/11.5
90%/10% faster than (kbit/s)	1119/26163	1007/22605	920/14815
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	84.5/2.9	87.8/3.1	76.4/4.6
90%/10% faster than (kbit/s)	1280/18002	1162/12587	720/9212
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	87.1	89.5	78.0
∅ Throughput (kbit/s)	13839	9471	7083
90%/10% faster than (kbit/s)	1125/32490	1322/21081	1035/14315
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	88.6	87.1	81.5
∅ Throughput (kbit/s)	11436	7700	4312
90%/10% faster than (kbit/s)	1055/29278	915/15799	692/10094
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	67.8/3.1	73.2/3.7	55.0/4.2
Playouts without Interruptions (%)	91.4	89.6	90.9
∅ Video Resolution (p)	1020	957	968

# Single review



Deutsche Telekom managed to grow once more on its results of the previous year. And although its Dusseldorf-based competitor also improved, the Bonn-based operator celebrates its seventh win in a row on

the occasion of our network test 2017/2018. Telekom gains the overall win particularly in the data discipline. But also for Telekom, there still remains work to be done. This especially applies to voice and data connections in German railways.



In the voice discipline, Vodafone catches up with Telekom up to a distance of just one point. The final showdown and overall win of the Bonn-based competitor was decided in the data category

– even if the Dusseldorfers also deliver a respectable performance in this discipline. So Vodafone fully deserves the overall grade "very good". In the railways, Vodafone is even a small step ahead of Telekom – but there is still room for improvement in this category as well.



Compared to last year's results, O2 falls behind severely. The supposed reason for this are the challenges of the still ongoing network merger with E-Plus. So, in our network test 2017/ 2018,

Telefónica again only achieves the overall grade "sufficient". We send our best wishes to the Munich-based operator and its customers, hoping that this difficult phase may soon be over and that next year's test results will reflect true advancements. >>

# Austria

Traditionally, the competition in Austria takes place on a high level. So it is even more remarkable that this year's winner was once again able to improve considerably.

Since 2009, our great network test has included the mobile networks in the alpine countries. From the very beginning, the Austrian operators were consistently among the best when we compare all three countries. And year after year they present a neck and neck race at the highest level.

All of this is extremely pleasant for Austrian cellular customers who can choose between three strong providers. And on top of this, the offerings of these providers are definitely more affordable than in the neighbouring Germany. Only tremendous roaming tariffs in the Non-EU neighbouring Switzerland frequently offend Austrian smartphone users.

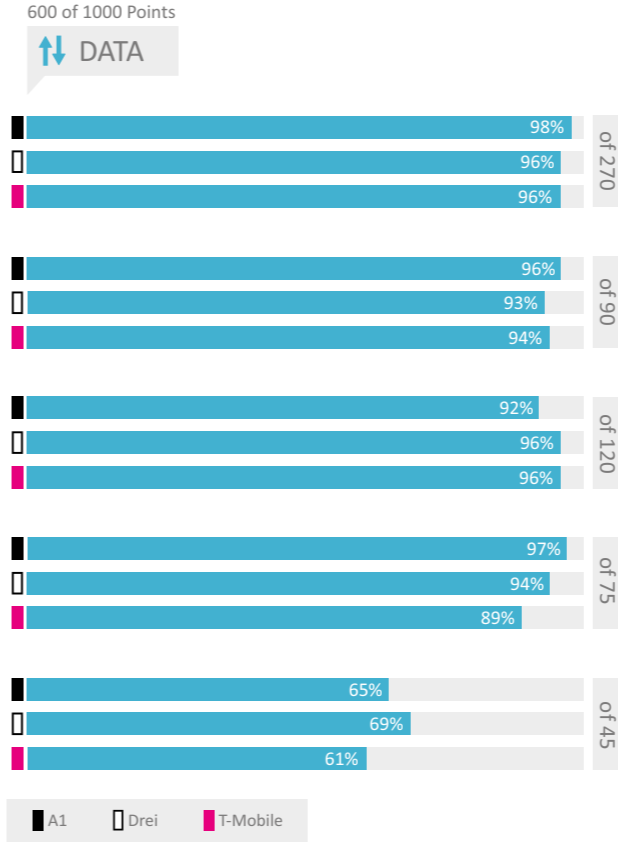
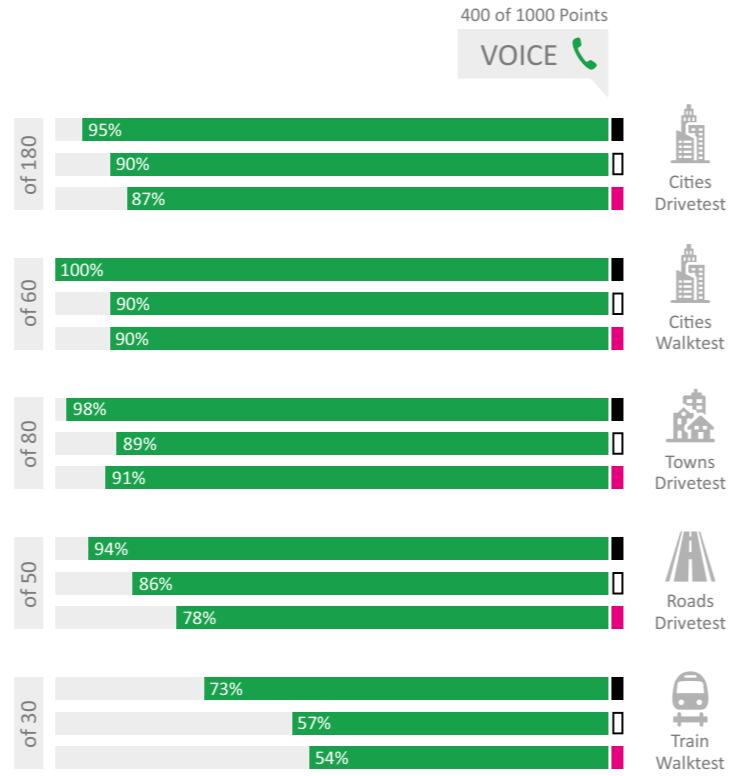
At least, the Austrian operators seem to re-invest also controversial revenues like these in upgrading and expanding their mobile service. In fall 2017, Austria's LTE networks have reached a pleasantly high stage of completion. And the fact that especially the Austrian winner

was able to once more improve on its performance compared to the previous year conveys a clear message.

We were even more excited to learn about the results of the drivetest conducted by P3 in eleven big cities and in 20 smaller towns as well as on approximately 5,000 kilometres of roads in Austria. And about the results of the walktests conducted in seven cities, supplemented by about 21 hours of traveling in various Austrian trains.

## Voice

In the assessment of voice telephony, A1 takes the lead in all tested scenarios. Having achieved top results in all of the disciplines, A1 impresses particularly with its results of the walktests conducted in big cities. Here, the operator achieved the full number of possible points.



OPERATOR	A1	Drei	T-Mobile
<b>VOICE (Cities; Drivetest)</b>			
Call Success Ratio (%)	99.5	99.7	99.2
Call Setup Time (s)	3.3	5.1	5.0
Speech Quality (MOS-LQO)	4.0	3.7	3.7
<b>VOICE (Cities; Walktest)</b>			
Call Success Ratio (%)	100.0	99.6	99.8
Call Setup Time (s)	2.1	5.0	5.4
Speech Quality (MOS-LQO)	4.3	3.7	3.7
<b>VOICE (Towns; Drivetest)</b>			
Call Success Ratio (%)	100.0	99.6	100.0
Call Setup Time (s)	3.3	5.1	5.1
Speech Quality (MOS-LQO)	4.0	3.7	3.7
<b>VOICE (Roads; Drivetest)</b>			
Call Success Ratio (%)	99.0	98.7	97.2
Call Setup Time (s)	3.5	5.2	5.9
Speech Quality (MOS-LQO)	4.0	3.7	3.5
<b>VOICE (Train; Walktest)</b>			
Call Success Ratio (%)	92.2	90.3	89.9
Call Setup Time (s)	2.3	5.1	5.7
Speech Quality (MOS-LQO)	4.1	3.7	3.6

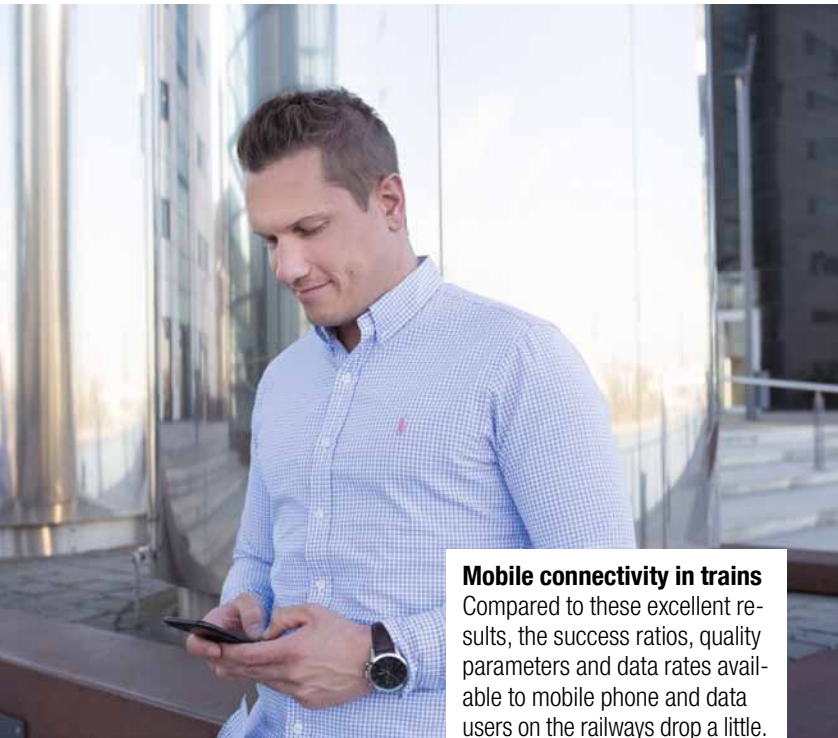
While A1 competently defends its top position, its two contenders Drei (Three) and T-Mobile fiercely fight for the second rank. They are at level in the big city walktests, while Drei takes a small step ahead in the big city drivetests and T-Mobile takes a narrow lead in the smaller towns. On the connecting roads, the ranking order is even a little more distinct: A1 gathers the highest number of points, Drei follows at a distance on the second rank, and T-Mobile ranks third, falling yet a little further behind Drei. In Austria, A1 is currently the only provider who offers the modern VoLTE to its customers. Short call set-up times and high KPIs for voice quality prove that this investment was worthwhile.

**Data**  
In the supreme discipline of data connectivity, the three Austrian operators rank even closer together. We observe some fierce fighting in all tested categories. In the big cities, A1 takes a close lead ahead of its also extremely strong competitors. Remarkably, the situation is almost vice-versa in smaller towns: Here, Drei and T-Mobile together take the leading position – but this competition takes place on an overall considerably higher level than in the neighbouring Germany. The stability and data speeds that the Austrian mobile networks provided in cities and towns have reached a standard that Germany customers can only watch with envy. >>

OPERATOR	A1	Drei	T-Mobile
<b>DATA (Roads; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%)	99.2/99.2	98.9/98.8	97.4/97.9
Static: Avg. Session Time (s)	1.0	1.2	1.2
Live: Reaction Time (ms)	358	404	359
Live: Initial DL Speed 1st sec (kB/s)	494	474	463
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.5/1.1	99.5/0.9	97.3/1.6
90%/10% faster than (kbit/s)	15975/62877	14440/79734	9277/55684
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.5/0.9	97.6/1.1	96.8/1.2
90%/10% faster than (kbit/s)	9091/26667	4049/20613	3587/21563
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.5	99.5	98.4
∅ Throughput (kbit/s)	48869	67137	41565
90%/10% faster than (kbit/s)	16087/85111	18364/121755	12000/81148
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.2	98.4	97.3
∅ Throughput (kbit/s)	28906	22780	19817
90%/10% faster than (kbit/s)	10265/42668	4460/37437	5120/30880
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.1/2.0	98.6/2.1	96.5/2.2
Playouts without Interruptions (%)	99.7	100.0	99.7
∅ Video Resolution (p)	1080	1079	1074

OPERATOR	A1	Drei	T-Mobile
<b>DATA (Cities; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%)	100.0/100.0	99.9/99.9	99.8/99.8
Static: Avg. Session Time (s)	0.9	1.0	1.0
Live: Reaction Time (ms)	331	386	334
Live: Initial DL Speed 1st sec (kB/s)	509	493	491
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.9	100.0/1.0	100.0/1.0
90%/10% faster than (kbit/s)	20426/71429	16795/75949	15707/65898
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.6	99.7/0.7	99.8/0.7
90%/10% faster than (kbit/s)	13236/27682	9279/19822	10191/26144
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.9	100.0	99.9
∅ Throughput (kbit/s)	68724	56526	53983
90%/10% faster than (kbit/s)	24281/130422	18929/105713	18811/97211
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	100.0	100.0	99.8
∅ Throughput (kbit/s)	33608	21482	29643
90%/10% faster than (kbit/s)	14962/44300	11905/30056	13144/43398
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	100.0/1.9	99.6/2.0	99.9/1.9
Playouts without Interruptions (%)	100.0	100.0	100.0
∅ Video Resolution (p)	1080	1080	1080
<b>DATA (Cities; Walktest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%)	99.6/99.8	99.2/99.4	99.8/99.6
Static: Avg. Session Time (s)	1.0	1.1	1.2
Live: Reaction Time (ms)	352	403	356
Live: Initial DL Speed 1st sec (kB/s)	496	473	448
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.8/1.0	99.5/0.9	99.8/1.1
90%/10% faster than (kbit/s)	16472/58111	14983/72551	18675/56436
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.5/0.7	99.3/0.9	99.5/1.0
90%/10% faster than (kbit/s)	13489/27397	9292/19656	7358/25397
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	100.0	100.0	100.0
∅ Throughput (kbit/s)	54802	57422	51351
90%/10% faster than (kbit/s)	19134/101427	19078/102604	17207/95144
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.3	99.5	99.1
∅ Throughput (kbit/s)	34537	21088	28276
90%/10% faster than (kbit/s)	17812/44195	11945/29483	11078/42592
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.7/1.8	99.2/1.9	99.5/1.9
Playouts without Interruptions (%)	99.7	100.0	99.5
∅ Video Resolution (p)	1078	1079	1079
<b>DATA (Towns; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%)	99.6/99.8	99.9/99.8	100.0/100.0
Static: Avg. Session Time (s)	1.1	1.1	1.1
Live: Reaction Time (ms)	378	389	331
Live: Initial DL Speed 1st sec (kB/s)	480	489	483
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.7/1.2	100.0/0.9	100.0/1.1
90%/10% faster than (kbit/s)	12650/58766	21151/76433	13097/58910
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.7/1.0	99.7/0.7	100.0/0.7
90%/10% faster than (kbit/s)	4734/25974	9329/20336	9487/21745
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.7	100.0	99.7
∅ Throughput (kbit/s)	42918	66818	43902
90%/10% faster than (kbit/s)	12544/81103	25322/123887	14628/76586
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.7	99.7	100.0
∅ Throughput (kbit/s)	27664	23981	24862
90%/10% faster than (kbit/s)	4133/42316	12676/31032	10933/31298
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.7/2.1	99.7/2.0	100.0/1.9
Playouts without Interruptions (%)	100.0	100.0	100.0
∅ Video Resolution (p)	1080	1079	1080

# Single review

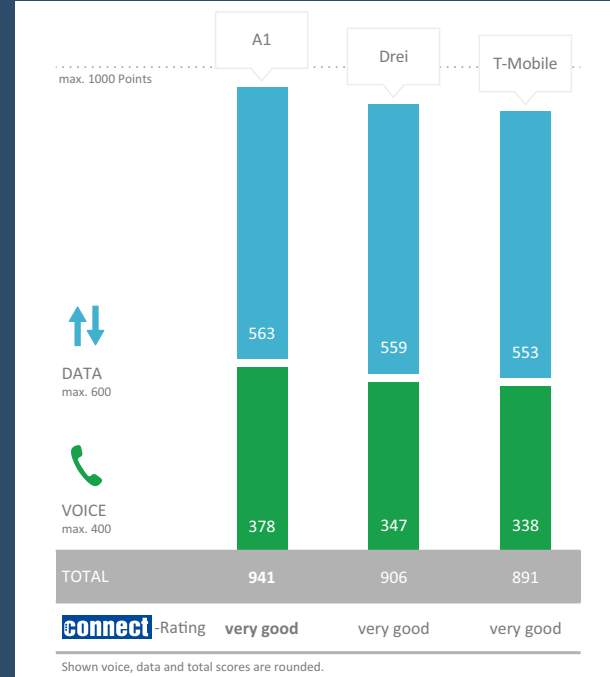


### Mobile connectivity in trains

Compared to these excellent results, the success ratios, quality parameters and data rates available to mobile phone and data users on the railways drop a little. But all in all, Austrian customers can also be happy about these results – especially especially when making the comparison with their large northern neighbour Germany.

While A1 succeeds in defending its top position in the discipline of making voice calls in trains, in the data category, the Hutchison network Drei achieved slightly better results for data connections in the trains. It is followed by A1 and after that by T-Mobile.

The competition about offering the best connectivity on Austrian rural roads happens at a comparably high level. In this case, the ranking order of A1 leading, followed by Drei and after that T-Mobile is still a little more distinct. But even the third-ranking T-Mobile offers a performance standard that in Germany can only be found in the top duo. Austria is well prepared for the demands of connected mobility.



OPERATOR	A1	Drei	T-Mobile
<b>DATA (Train; Walktest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	92.3/92.0	92.5/91.9	91.0/89.2
Static: Avg. Session Time (s)	1.4	1.5	1.4
Live: Reaction Time (ms)	424	447	450
Live: Initial DL Speed 1st sec (kB/s)	436	427	411
<b>File Download (3MB)</b>			
Success Ratio/∅ Session Time (%/s)	93.0/2.0	92.8/2.0	90.3/2.4
90%/10% faster than (kbit/s)	6908/52016	10837/62436	5563/45028
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	86.9/2.5	88.5/1.7	88.0/2.5
90%/10% faster than (kbit/s)	1109/23022	2156/16654	1430/20050
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	91.2	93.8	90.8
∅ Throughput (kbit/s)	34569	45799	28702
90%/10% faster than (kbit/s)	8883/74200	9269/92057	6025/63602
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	87.0	87.0	87.0
∅ Throughput (kbit/s)	17396	13700	14609
90%/10% faster than (kbit/s)	1413/38237	1579/26057	1901/29566
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	90.5/2.4	94.1/2.4	90.4/2.3
Playouts without Interruptions (%)	98.4	99.5	98.5
∅ Video Resolution (p)	1067	1061	1065



Last year's winner A1 is not only able to defend its first rank, but actually manages to even enhance its position. This year's result of the Austrian market leader reflects an impressive 23 point gain over the previous connect

mobile network test. A1 is one step ahead of the competition both in the voice and in the data discipline. However, its lead is even more distinct regarding voice telephony and still in the demanding railway connections. All in all, a very convincing performance!



Even if Drei loses some points in the voice discipline in comparison to the previous year, the Hutchison company keeps up well and is able to gather a few additional points in the important data tests. Like over their market

shares, Drei is fiercely competing with T-Mobile over the technical performance too. On points, this operator is behind A1 in the voice and data test alike, but still ahead of T-Mobile in both categories. So, a very good second rank is well deserved.



Compared to the previous network test, T-Mobile Austria continued to improve. This year, it catches up considerably to its constant rival Drei. We recognize distinct improvements in the data discipline, but T-Mobile loses some

points over last year's results in the voice tests. This applies particularly to the connecting roads. But all of this is complaining while enjoying an already very high standard. So, the third rank in Austria still fully deserves the grade "very good". >>

# Switzerland

Swisscom and Sunrise fought to the finish about the pole position in our test of the Swiss networks. In this year's competition, this resulted in a surprising outcome.

"Outstanding" is a grade that connect only awards rarely. Based on the 1000 point scheme of our mobile network test, it is only awarded for the impressive achievement from 950 points upwards. Among the Swiss operators, this award was achieved for the first time in our previous year's network test. Now, in the 2017/2018 season, there are even two Swiss operators who can be thrilled about this rare decoration. This tells a lot about the high level of network performance and quality in Switzerland.

The little sensation may also be a consequence of the fierce fight about the top position in the test of the Swiss networks. In the previous year, Sunrise successfully took the first rank from the hitherto top dog Swisscom. The latter would not accept the defeat and threw itself onto improving its already high performance. But Sunrise acted similarly, and so both contenders managed to gain a considerable number of additional points in comparison to last year's results.

The race of these extremely strong opponents was fascinating until the very end also for P3 and connect. Multiple careful evaluations of the results, accounted for a distinct tie of both contenders. And this happened on the highest level of points that was ever reached in a network test conducted by P3 and connect so far. Now Swiss mobile customers can be proud about even two "outstanding" operators in their country.

### Voice

Both Swisscom and Sunrise are well prepared for the battle in the voice discipline as they both support the modern voice connections according to the VoLTE standard. Only the third Swiss provider, Salt, still relies exclusively on the older circuit-switched telephony.

The overall results show that Sunrise could gain a small lead over Swisscom in the voice discipline. But this competition takes place in the highest regions of achievable points.



However, Salt follows at some distance behind the leading duo in all tested disciplines. As a matter of fact, VoLTE alone is no guarantee for excellent voice quality. But its abstinence from this technology seems to make it hard for the smallest Swiss provider to keep up with its two strong competitors in this category.

More distinct weaknesses of Salt can be observed especially for phone calls on connecting roads and on trains. It must be emphasized that part of why this lag looks so pronounced is the unusual strength of the other two contenders even in these difficult disciplines.

### Data

The overall picture in the data category is not much different than the one seen in the voice measurements. Again, there is

little to no difference between the results that Swisscom and Sunrise achieve in our drivetests covering 18 larger cities and 35 smaller towns in Switzerland as well as approximately 5,100 kilometres of roads between them. The same applies to the walktests conducted in seven Swiss cities.

In the data measurements, Salt again ranks a little behind the top duo, with the distance being somewhat less pronounced particularly in the drivetest scenarios.

As Salt attacks the two bigger competitors quite successfully with aggressive tariffs, the distinct loss of points resulting from the walktests may indicate that this provider has to cope with capacity shortages at locations with a higher number of mobile users. In this clarity, however, this only applies to the walktest scenarios.

The success ratios, reaction times and data rates observed in the data measurements conducted as part of our drivetests, on the whole are absolutely satisfactory in the Salt network.

When we compare the third-ranking operators in each of the considered countries, Salts data performance scores behind

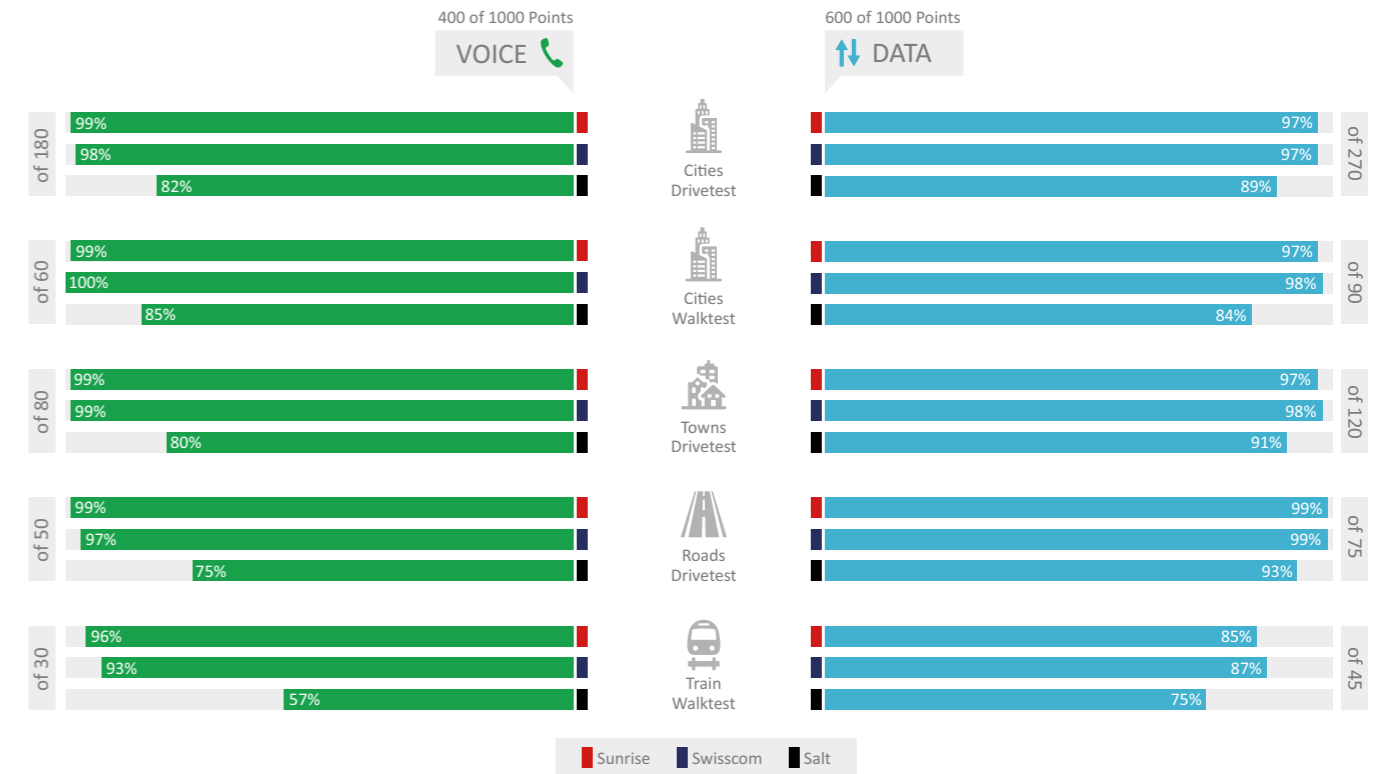
T-Mobile in Austria but is clearly ahead of O2 in Germany.

### Mobile connectivity in trains

Once we take a look at the Swiss railways, we immediately stop making comparisons between the three countries – the insights would just be too frustrating. The performance especially of the

leading duo simply plays in a league of its own. Only Salt loses some valuable points when we examine telephony on the railways. This comes somewhat as a surprise when we remember the convincing results in this discipline in last year's test. In the data tests conducted in trains, Salt also ranks a little behind the

top contenders Sunrise and Swisscom. Nevertheless – achieving 75 per cent of the possible points in this discipline is still six per cent ahead of Austria's strongest provider and a whole 35 per cent ahead of the strongest contender in Germany. Mobile network coverage in Swiss trains simply is and stays unrivalled. >>



OPERATOR	Sunrise	Swisscom	Salt
<b>VOICE (Cities; Drivetest)</b>			
Call Success Ratio (%)	99.8	99.6	98.5
Call Setup Time (s)	2.4	2.3	5.6
Speech Quality (MOS-LQO)	4.1	4.0	3.7
<b>VOICE (Cities; Walktest)</b>			
Call Success Ratio (%)	99.8	99.9	99.1
Call Setup Time (s)	1.3	1.5	5.5
Speech Quality (MOS-LQO)	4.3	4.4	3.7
<b>VOICE (Towns; Drivetest)</b>			
Call Success Ratio (%)	99.9	99.8	98.3
Call Setup Time (s)	2.3	2.2	5.7
Speech Quality (MOS-LQO)	4.1	4.1	3.6
<b>VOICE (Roads; Drivetest)</b>			
Call Success Ratio (%)	99.6	99.2	96.0
Call Setup Time (s)	2.4	2.4	5.8
Speech Quality (MOS-LQO)	4.1	4.0	3.5
<b>VOICE (Train; Walktest)</b>			
Call Success Ratio (%)	98.7	97.9	90.9
Call Setup Time (s)	1.5	1.7	5.7
Speech Quality (MOS-LQO)	4.1	4.1	3.5

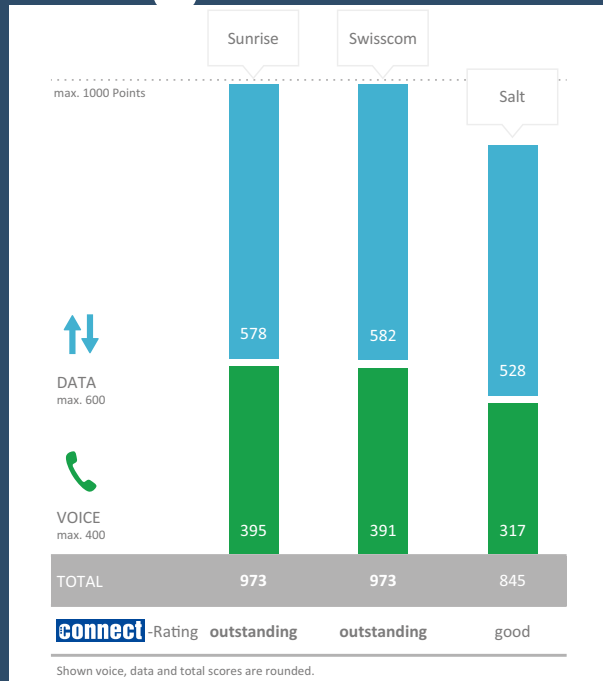
OPERATOR	Sunrise	Swisscom	Salt
<b>DATA (Roads; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.6/99.7	99.9/99.8	98.9/99.0
Static: Avg. Session Time (s)	1.0	1.2	1.5
Live: Reaction Time (ms)	377	346	482
Live: Initial DL Speed 1st sec (kB/s)	519	504	443
<b>File Download (3 MB)</b>			
Success Ratio/Ø Session Time (%/s)	100.0/1.1	100.0/1.0	99.1/1.7
90%/10% faster than (kbit/s)	12805/86643	13240/97010	9146/51282
<b>File Upload (1 MB)</b>			
Success Ratio/Ø Session Time (%/s)	99.7/0.9	100.0/0.7	99.1/1.0
90%/10% faster than (kbit/s)	5591/29091	9258/29929	6062/18648
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	100.0	99.8	99.1
Ø Throughput (kbit/s)	61166	76562	49117
90%/10% faster than (kbit/s)	15580/115416	16652/158730	10255/97413
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.8	99.8	98.5
Ø Throughput (kbit/s)	25891	30417	26501
90%/10% faster than (kbit/s)	7677/43451	12485/45711	7316/45404
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.8/2.0	99.8/1.9	98.3/2.0
Playouts without Interruptions (%)	100.0	99.5	99.8
Ø Video Resolution (p)	1078	1075	1078

OPERATOR	Sunrise	Swisscom	Salt
<b>DATA (Train; Walktest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	97.5/97.6	97.7/97.7	96.3/96.4
Static: Avg. Session Time (s)	1.4	1.5	1.8
Live: Reaction Time (ms)	458	403	589
Live: Initial DL Speed 1st sec (kB/s)	453	452	373
<b>File Download (3MB)</b>			
Success Ratio/Ø Session Time (%/s)	98.4/2.4	99.6/2.1	97.1/3.9
90%/10% faster than (kbit/s)	5696/66116	5183/66852	3022/40582
<b>File Upload (1 MB)</b>			
Success Ratio/Ø Session Time (%/s)	98.0/1.8	96.5/1.5	95.9/1.8
90%/10% faster than (kbit/s)	2226/25592	2853/27211	2161/17668
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.2	97.2	96.3
Ø Throughput (kbit/s)	41488	54174	27167
90%/10% faster than (kbit/s)	6215/90649	7484/109263	2735/67875
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	95.0	95.4	92.7
Ø Throughput (kbit/s)	20023	21504	18065
90%/10% faster than (kbit/s)	2668/39815	4141/39910	2869/36239
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	93.9/2.3	96.7/2.1	91.5/2.5
Playouts without Interruptions (%)	98.7	97.9	97.7
Ø Video Resolution (p)	1069	1069	1058

# Single review

## NETWORK TEST

OPERATOR	Sunrise	Swisscom	Salt
<b>DATA (Cities; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.8/100.0	99.8/99.8	99.2/99.5
Static: Avg. Session Time (s)	1.0	1.1	1.4
Live: Reaction Time (ms)	383	341	467
Live: Initial DL Speed 1st sec (kB/s)	521	504	441
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	99.9/0.9	99.9/0.9	99.4/2.1
90%/10% faster than (kbit/s)	17603/84418	19108/94564	7070/48368
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.6	99.9/0.5	99.6/0.9
90%/10% faster than (kbit/s)	11903/30189	12907/30189	6828/18605
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	99.9	100.0	99.3
∅ Throughput (kbit/s)	66898	75932	38276
90%/10% faster than (kbit/s)	21694/122492	21273/150630	8268/76814
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	99.8	99.8	99.4
∅ Throughput (kbit/s)	33584	34673	26144
90%/10% faster than (kbit/s)	13170/45181	15326/45604	8354/44216
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.9/2.0	99.9/1.9	98.8/2.1
Playouts without Interruptions (%)	99.9	99.9	99.5
∅ Video Resolution (p)	1078	1077	1072
<b>DATA (Cities; Walktest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.8/100.0	99.9/100.0	98.0/98.4
Static: Avg. Session Time (s)	1.0	1.1	1.4
Live: Reaction Time (ms)	379	332	456
Live: Initial DL Speed 1st sec (kB/s)	518	520	440
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.8	100.0/0.8	97.1/1.7
90%/10% faster than (kbit/s)	20598/82192	18257/90773	8227/44910
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.6	100.0/0.5	100.0/1.0
90%/10% faster than (kbit/s)	12732/30303	11747/30769	5723/18731
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	100.0	99.8	97.8
∅ Throughput (kbit/s)	71915	92352	39050
90%/10% faster than (kbit/s)	22679/138393	23087/173512	9836/76000
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	100.0	100.0	100.0
∅ Throughput (kbit/s)	33044	34024	24191
90%/10% faster than (kbit/s)	15794/44735	14756/45634	7332/43553
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.2/1.7	100.0/1.6	97.5/1.9
Playouts without Interruptions (%)	100.0	100.0	99.5
∅ Video Resolution (p)	1059	1079	1075
<b>DATA (Towns; Drivetest)</b>			
<b>Web-Page Download (Live/Static)</b>			
Success Ratio (%/%)	99.7/100.0	99.8/99.9	99.6/99.7
Static: Avg. Session Time (s)	1.0	1.1	1.4
Live: Reaction Time (ms)	371	331	450
Live: Initial DL Speed 1st sec (kB/s)	524	508	445
<b>File Download (3 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.9	100.0/0.8	100.0/1.9
90%/10% faster than (kbit/s)	18399/80537	21425/92951	7299/49762
<b>File Upload (1 MB)</b>			
Success Ratio/∅ Session Time (%/s)	100.0/0.6	100.0/0.5	99.8/0.9
90%/10% faster than (kbit/s)	9792/29740	12674/30189	7449/18561
<b>File Download (7 Seconds)</b>			
Success Ratio (%)	100.0	99.8	99.6
∅ Throughput (kbit/s)	62475	84275	49495
90%/10% faster than (kbit/s)	19671/113125	26128/172477	7902/95827
<b>File Upload (7 Seconds)</b>			
Success Ratio (%)	100.0	99.8	99.8
∅ Throughput (kbit/s)	30984	34613	28307
90%/10% faster than (kbit/s)	9946/44361	16148/45707	9055/45680
<b>Youtube Videos</b>			
Success Ratio/Start Time (%/s)	99.8/2.0	99.8/1.8	99.3/2.0
Playouts without Interruptions (%)	99.8	100.0	99.8
∅ Video Resolution (p)	1079	1080	1074



## Sunrise

The fierce fight over the best test results in Switzerland this year leads to a tie at the top position. As Sunrise is a little further up in the alphabet, we mentioned this operator first in our winners' list. When comparing

the results directly with those of Swisscom, Sunrise leads by four points in the voice discipline but has to hand them back to its bigger rival in the data discipline. But there is no doubt that this result is truly "outstanding".



Great efforts after losing the top position in the previous year's test paid off: This time, the market leader Swisscom shares the winner's podium with its strong competitor Sunrise. Both networks

deliver an impressive performance in this test. Swisscom is slightly ahead of Sunrise in the data evaluation, while the latter manages to take a small lead in the voice results. For these results, we sincerely send our congratulations to Swisscom too!

## Salt.

Salt's overall results seem weaker than they actually are due to the contrast to its two "outstanding" competitors. The smallest Swiss operator was still able to improve in comparison to last year's results in the data

discipline. However, we observed some setbacks in the voice assessment – those are so distinct that Salt loses a total of 33 points and thus a full step on the grade scale over the previous year's results. Still, Salt fully deserves its grade "good" >>



# Outlook: Crowdsourcing Operational Excellence

We constantly update the methodology of our network test in order to accommodate the technological development and to ensure that we can give a valid assessment of the quality, performance and stability of the tested networks. As an additional important step, we plan to extend our test schedule with a crowdsourced examination of operational excellence. At the moment, we have not quite arrived at this objective in Germany, Austria and Switzerland – but we can give a first outlook to where we are heading.

An additional important aspect of mobile service quality – above performance and measured values – is the actual availability of the mobile networks to their customers. Obviously, even the best performing network is only of limited benefit to its users, if it is frequently impaired by outages or disruptions. Therefore, P3 has been looking into additional methods for the quantitative determination of network availability, collecting data via crowdsourcing. This method must however not be confused with the drivetests and walktests described on the previous pages. We are convinced that crowdsourcing can significantly enhance the aspects of benchmarking in the future.

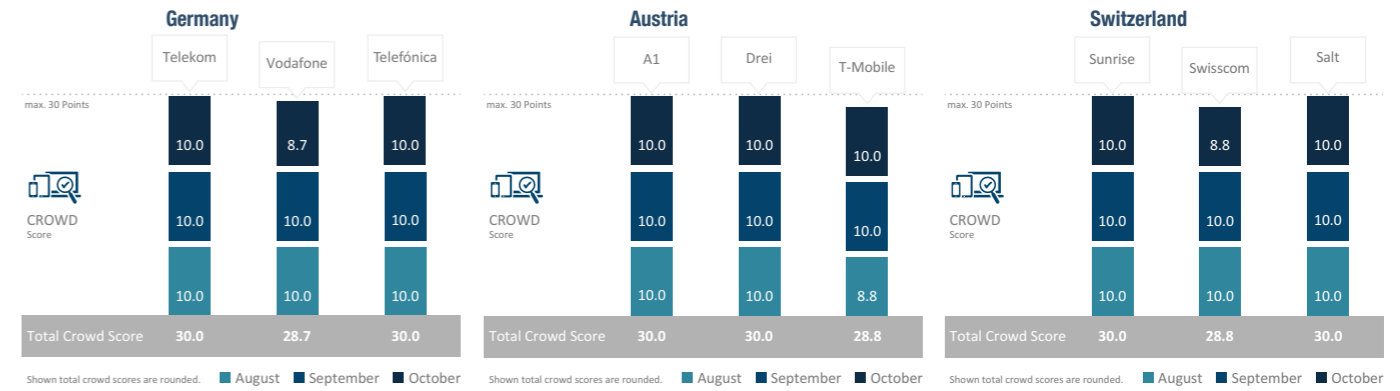
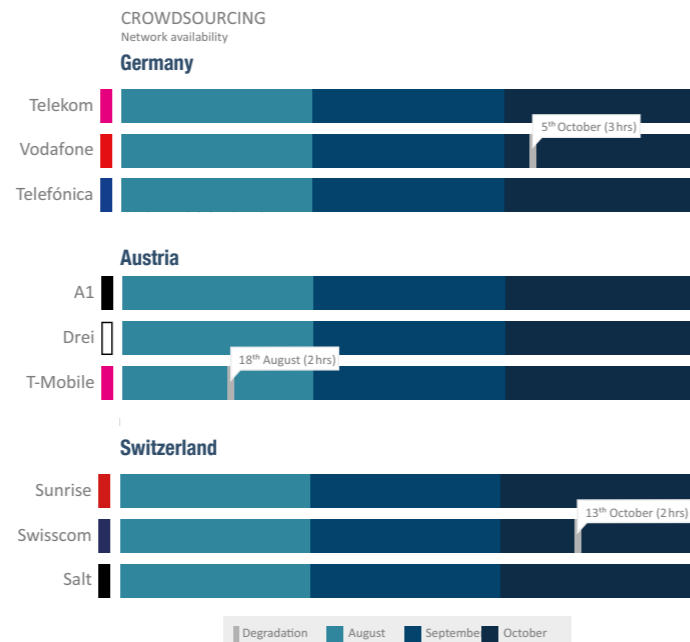
We obviously do not intend to replace our demanding drivetesting and walktesting with this approach. The well-proven gathering of measurement values has clear advantages, being conducted in a very controlled environment. Crowdsourcing accelerates this practice when looking for time periods or geography beyond the driven route.

Therefore, P3 has developed an app-based crowdsourcing mechanism in order to assess how a large number of mobile customers experience the availability of their mobile network. We call this aspect “operational excellence”. The detailed methodology is described in the box on the right-hand page.

**Not yet part of the overall score in the 2017/2018 network test**  
Our clear objective for the near future is to include this “crowd score” into the overall scoring of our network test. Operational excellence will then be an additional criteria, complementing the quality and performance of voice and data connections.

However, we follow equally high standards for the crowdsourcing results as for the other parts of our network test. This not least applies to the statistical relevance of our observations. Although we have been working on the necessary preparations for some time now, especially in Switzerland the number of participants has not yet reached the threshold that we

have appointed. In contrast, in the network tests that we have recently conducted in Spain and the UK (see [www.connect-testlab.com](http://www.connect-testlab.com) for the results), the crowd score is already a part of the overall results. On the other hand, we did not want to withhold the results of our first observation months (August, September and October 2017) in Germany, Austria and Switzerland. Therefore we have calculated the crowdsourcing results according to the evaluation scheme described on the right-hand page, but we did not include them into the results of this year’s network test at hand. We, however, expect that this will be the case starting next year.



## Steady in all three countries

As we have allotted ten achievable points per tested month, each contender could gather a total of 30 points. The overall crowd score thus represents the extent of relevant network degradations in the observed months.

In Germany, this only applied to Vodafone during the observation period. There, we identified a degradation on the morning of October 5th during a three-hour period. This led to the deduction of 1.3 points for this month. In August and September, we did not register any disruptions at Vodafone. For Telekom and O2, this applies to the whole three-month observation period.

A similar result can be seen in Austria: There,

T-Mobile was affected by a degradation lasting up to two hours on the morning of August 18th. According to our evaluation scheme, this results in deducting 1.2 points.

In Switzerland, only Swisscom was affected. Here, we observed a degradation within a two-hour period on October 13th at 6 am. This also costs 1.2 points.

As the candidates scored within a very close range, the involvement of the crowd results would not have affected the overall ranking in Germany and Austria. Given the very close race in Switzerland, however, the loss of 1.2 points could have had unpleasant consequences for Swisscom. But as mentioned before, this result does not comply with the demanded statistical relevance. >>

## Crowdsourcing Methodology

*Even if the crowdsourcing results are not yet part of the overall scoring of the connect mobile network test this year, the underlying methodology is already exactly defined and ready for use.*

For the crowdsourcing of operational excellence, P3 considers connectivity reports that are gathered by background diagnosis processes included in a number of popular smartphone apps. While the customer uses one of these apps, a diagnosis report is generated daily and is then evaluated per hour. As such reports only contain information about the current network availability, they generate just a small number of bytes per message and do not include any personal user data. Additionally, interested parties can deliberately take part in the data gathering by using the “connect app” (see box below on the left).

In order to differentiate network glitches from normal variations in network coverage, we apply a precise definition of “service degradation”: A degradation is an event where data connectivity is impacted by a number of cases that significantly exceeds the expectation level. To judge whether an hour of interest is an hour with degraded service, the algorithm looks at a sliding window of 168 hours before the hour of interest. This ensures that we only consider actual network service degradations in contrast to a simple loss of network coverage of the respective smartphone due to prolonged indoor stays or similar reasons. Incidents that occur in the night hours between 0 am and 6 am are not considered.

In order to ensure the statistical relevance of this approach, a valid assessment month must fulfil clearly designated prerequisites: A valid assessment hour consists of a pre-

defined number of samples per hour and per operator. The exact number depends on factors like the market size and the number of operators. A valid assessment month must be comprised of at least 90 percent of valid assessment hours (again per month and per operator).

### Sophisticated scoring model

The relevant KPIs are then based on the number of days when degradations occurred as well as the total count of hours affected by service degradations. In the scoring model that we plan to apply to the gathered crowdsourcing data, 60 per cent of the available points will reflect the number of days affected by service degradations – thus representing the larger-scale network availability. An additional 40 per cent of the total score is derived from the total count of hours affected by degradations, thus representing a finer-grained measurement of operational excellence.

Each considered month is then represented by a maximum of ten achievable points. The maximum of six points (60 per cent) for the number of affected days is diminished by one point for each day affected by a service degradation. One affected day will cost one point and so on until six affected days out of a month will reduce this part of a score to zero.

The remaining four points are awarded based on the total number of hours affected by degradations. Here, we deduct 0.1 points per hour affected by a network degradation. So, a period of up to two hours, costs 0.2 points, of up to three hours 0.3 points and so on.

## Participate in our crowdsourcing

The **connect app** not only allows you to take part in our crowdsourcing. Above that, you receive latest telecommunications news and you can also check the speed of your network with an informative speed test. The Android version additionally reveals interesting details like the data consumption and usage time per app.

Only if you agree, the app will also perform completely anonymous connection tests in the background. The required data volume for these tests is less than 2 MB per month.



**Connectivity at a glance:** The “history” shows when and with which technology and speed you were online.





# METHODOLOGY

For the tests in Austria and Switzerland, connect's partner for the network measurements, P3 communications, used two vehicles to test drive the chosen cities, towns and roads. In Germany, even four cars were used simultaneously. Each car carried a total of nine smartphones. For the voice tests, we used two Samsung Galaxy S7 per operator, accounting for six of the total of nine phones per vehicle. The remaining three smartphones per car were used for the data measurements which were deliberately based on a mix of devices: In one half of the cars (thus one car each in the alpine countries and two cars each in Germany) we also used Samsung Galaxy S7 for the data tests. In the other half, Sony Xperia XZ took over the job in order to reflect varying device technologies in our measurements and evaluations. This is especially applicable when it comes to data transmissions at the edge of the networks' performance such as using "3 Carrier Aggregation" (the combination of three LTE carrier frequencies).



The voice tests and a part of the data tests were performed with Samsung Galaxy S7 smartphones.

The walktest teams consistently utilized Samsung Galaxy S7 that were installed in trolleys and back packs with additional strong batteries.

The devices' firmware was each operator's current firmware version. If such software was not available, the most current firmware from the smartphone manufacturer was used.

### Voice telephony

Voice services were measured with the smartphones performing calls alternating between the measurement cars ("mobile to mobile"). The walktest teams called a stationary counterpart for all voice tests.

Background data traffic was transmitted by one of the smartphones simultaneously to each call to reflect a realistic usage scenario. Audio quality was assessed by using the HD-Voice capable POLQA (Perceptual Objective Listening Quality Assessment) wide band scoring.

All devices were configured in "LTE preferred" mode. Thus, in the three German Networks as well as with A1 in Austria plus Swisscom and Sunrise in Switzerland, the modern Voice over LTE (VoLTE) service could be used. Within networks not yet supporting VoLTE, the smartphones were forced to switch to 3G or 2G technology, the so-called circuit switched fallback (CSFB).

### Data connectivity

To assess cellular data performance a sequence of tests was executed. As a dynamic web browsing test, each country's top web sites (according to the Alexa ranking) were downloaded in the so-called live web browsing test. Additionally a static web site was tested, the industry standard ETSI (European Telecommunications Standards Institute) "Kepler" reference page. HTTP downloads and uploads were performed with



Professional and critical: Bernd Theiss, head of test and technology at connect (on the left), and Hakan Ekmen, managing director of P3 communications (on the right).

3 MB and 1 MB files, simulating small file transfers. The networks' peak performance was tested with a seven second download and upload of a single, very large file.

The Youtube measurements performed on the smartphones considered the "adaptive resolution" feature of this video platform. In order to offer a persistent video experience, Youtube adapts the video streams' resolution dynamically to the bandwidth that is currently available. Our scoring therefore considers the success ratio, the time until the playback starts, the percentage of video payouts that take place without interruptions as well as the videos' average resolution or line number count respectively.

### Indoor and train measurements

The walktests consisted of the same routines combining voice and data measurements. For this effort, the teams measured in so-called "areas of interest" with a distinctive visitor frequency like train stations, airport terminals, buildings such as coffee shops and museums, but also in public transport. Travelling from city to city allowed the assessment of cellular network quality within the long distance trains.

### Logistics

The tests were performed in Austria, Germany and Switzerland around the same period of time (Germany: October 11 – 30, 2017; Austria: October 9 – 27; Switzerland: October 7 – 27). All drivetests and walktests were done between 8 AM and 10 PM. During the drivetests, two cars were present in the same cities, but on different routes to avoid any interference of one car's measurement by the other car's.

On the connecting roads, both vehicles drove a given route, but followed each other at a small temporal and spatial distance. At each location, the test smartphones had to share the networks' bandwidth with normal customers. This represents the usual competition for the limited resource of the networks' available radio frequencies.

In Germany, the measurements included 19 larger cities and 28 smaller towns, while the walktests frequented ten cities. In Austria, the drivetests covered 11 big cities and 20 smaller towns, the walktest team visited seven cities. In Switzerland, the test route included 18 big cities and 35 smaller towns with the walktests conducted in also seven cities. Travel between the cities

mainly used highways, but smaller state and county roads were driven as well. For each connect test, P3 communications follows a well-defined process to generate four independent and representative city and route plans. The connect editors then choose randomly one of these four alternatives.

### Test efforts and results

Overall, 23,000 km were driven for the connect P3 mobile network test in 2017. In Germany, the approximately 9,600 km of driven routes alongside the cities and areas visited represent 14 million inhabitants, which equals around 17 per cent of Germany's population.

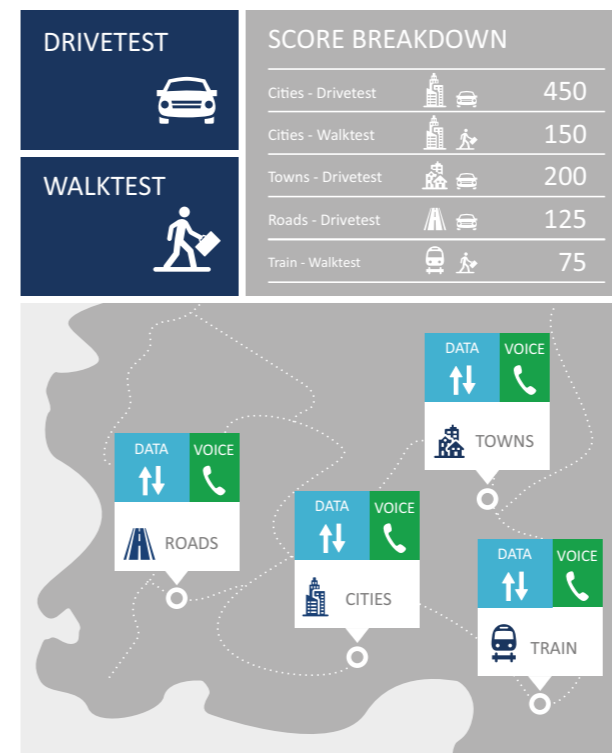
Austria was measured by driving 5,000 km covering about 3 million inhabitants (approximately 35 per cent of the Austrian population).

In Switzerland, the test teams drove approximately 8,460 km, covering 2 million people representing around 25 per cent of the Swiss population.

Certainly a huge effort but necessary to gain the required statistical relevance and confidence in the test results.

### Scoring

The results of the voice tests contribute 40 per cent of the total score, those of the data tests make up 60 per cent. For the overall result we apply a 1000 point scheme in order to represent sufficiently detailed results. Moreover, this scheme allows us to better compare the results of network tests that we have conducted in different countries (all results and additional information can be found on our website [www.connect-testlab.com](http://www.connect-testlab.com)). >>



# FAIRNESS AND TRANSPARENCY

*In the preparation of this year's network test, an anonymous writer tried to cast doubt over our neutrality and methodology in a letter with pretended insider information. The accusations turned out to be baseless.*

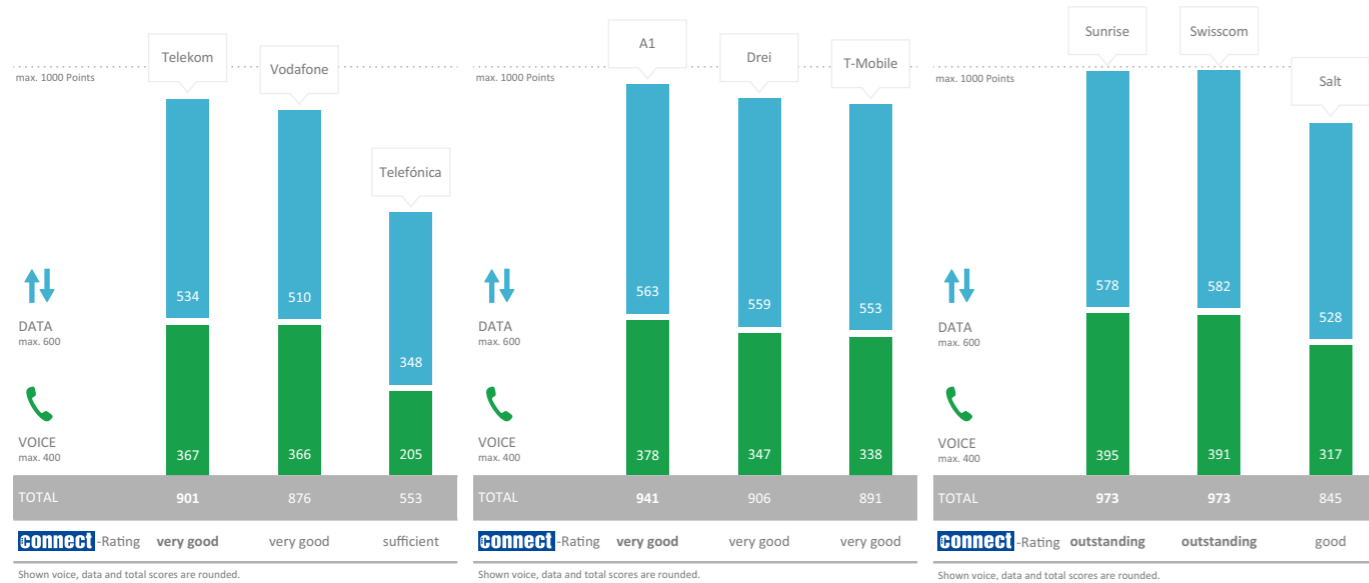
Once again, in the preparation of this year's network test, connect and P3 met in early 2017 in order to define the conditions and parameters for the test. We identified changes to our methodology and test criteria, adapting them to the current state of technology. We defined the timeframe as well as a preselection of smartphone models that we intended to use for the measurements. Then, we communicated these preliminary definitions in advance to the CTOs of the network operators. In this process, we appreciate feedback about aspects like suitable tariffs or the firmware versions of the smartphones used for the measurements.

For each suggestion, we carefully consider whether it is technically justified or whether it tries to enforce measurement conditions that would favour the contender's own network. We understand these typically intense discussions to prove the high relevance that the operators assign to our network test.

### Anonymous allegations of manipulations

Some attempts to put the neutrality and transparency of our measurement methods into question, however, originated from unknown sources. In the forefront of this year's network test, connect, P3 and several operators in one of the tested countries received

an anonymous letter, accusing the winner of last year's network test in the respective country of manipulation. The pretended insider asserted the operator in question to have illegally increased the transmitting power of its cellular base stations. This accusation may match how a non-tech-savvy person imagines a possible cheating. In fact, it soon turned out to be completely baseless as the insinuated procedure would massively interfere with the delicate interplay of neighbouring cellular base stations. Now there is a strong suspicion that a stranger tried to exploit our network test in order to impair one of the operators.



			GERMANY			AUSTRIA			SWITZERLAND		
Overall Results Voice and Data			Telekom	Vodafone	Telefónica	A1	Drei	T-Mobile	Sunrise	Swisscom	Salt
VOICE	max. 400 Points		367	366	205	378	347	338	395	391	317
Cities	Drivetest	180	96%	96%	57%	95%	90%	87%	99%	98%	82%
Cities	Walktest	60	99%	97%	79%	100%	90%	90%	99%	100%	85%
Towns	Drivetest	80	95%	95%	43%	98%	89%	91%	99%	99%	80%
Roads	Drivetest	50	92%	88%	27%	94%	86%	78%	99%	97%	75%
Train	Walktest	30	44%	49%	28%	73%	57%	54%	96%	93%	57%
DATA	max. 600 Points		534	510	348	563	559	553	578	582	528
Cities	Drivetest	270	95%	90%	67%	98%	96%	96%	97%	97%	89%
Cities	Walktest	90	92%	85%	45%	96%	93%	94%	97%	98%	84%
Towns	Drivetest	120	89%	88%	58%	92%	96%	96%	97%	98%	91%
Roads	Drivetest	75	92%	90%	64%	97%	94%	89%	99%	99%	93%
Train	Walktest	45	38%	40%	21%	65%	69%	61%	85%	87%	75%
Total	max. 1000 Points		901	876	553	941	906	891	973	973	845
<b>connect RATING</b>			very good	very good	sufficient	very good	very good	very good	outstanding	outstanding	good

All values have been rounded to integer numbers. The internal calculation of points and percentages was based on three decimal places. Intermediate results therefore can slightly deviate from the specified values.



**CONCLUSION**  
Hannes Rügheimer,  
connect author

In the context of adapting our test methods and the scaling of our points to the ongoing technical development, we deliberately and regularly increase our thresholds and requirements. If already very good candidates then succeed in still improving, we are even more happy because this demonstrates that our demanding network test in fact contributes to improving the mobile networks – to the benefit of all customers.

In Germany, the two strong contenders Telekom and Vodafone obviously worked hard in order to enhance their networks. Although Vodafone made remarkable progress and almost caught up with its Bonn-based rival especially in the voice discipline, Deutsche Telekom once more succeeds in gaining the overall victory in our test. The decisive factor for this was a stronger performance of the Bonn-based operator particularly in the data discipline.

In contrast, O2 did not really look good in this year's rating. The Telefónica network struggles under the burden of integrating the formerly separate network cells of E-Plus and O2 even more than in the previous year. Regardless of our neutrality, we cross our fingers that this situation improves soon again.

Also, we still have to assert a strong need for improvement concerning cellular coverage in

German trains – despite all efforts of Deutsche Bahn to upgrade this aspect of its service.

In Austria, last year's winner A1 managed to change for the better once again. T-Mobile and Three also improved, especially in the data category. However, both contenders lost some points in the telephony test. And although Drei falls back nine points in comparison to last year's result, the operator can hold on to the second rank. All three Austrian mobile networks have legitimately earned the grade "very good".

Fierce fighting in Switzerland resulted in a tie that was a surprise for us as well. With "outstanding" performances (according to our grading), both Swisscom and Sunrise share the first rank this time. This is good news, equally for Swiss customers as for both operators. Salt somewhat falls back compared to the previous year due to weaker results in the telephony tests – but still achieves the grade „good“.

For many years now, our network test is the de-facto industry standard thanks to its sophisticated methodology and continuous adaptations to the technological development. In the future, additional crowdsourcing will contribute to portray the networks' quality from a customer perspective even more accurately, over longer periods and over a wider geographical area.

