

TUTELA Ŧ

DACH

State of Mobile Networks

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Annual Report

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www.tutela.com

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Introduction

Whilst countries across Europe have taken different approaches to dealing with the COVID-19 pandemic, one tool is proving vital across the entire region: connectivity. Fixed networks have seen an increase in traffic due to lockdowns and social isolation, but mobile networks have continued to be critical during this uncertain period.

At the same time, progress continues to be made on 5G, a topic that dominated conversation in the wireless industry in 2019. Switzerland has a mature 5G landscape with widespread deployments, whilst operators in Germany are on the forefront(1) of pioneering technologies like dynamic spectrum sharing, which will help 4G and 5G coexist. Wireless improvements haven't been immune to COVID-19, however. Austria's second 5G spectrum auction, which was supposed to occur in April, has been delayed(2), and infrastructure upgrades and new deployments will be hindered by restrictions on movement and work.

To evaluate how wireless networks are performing, Tutela has analyzed over 7.4 billion total records, including over 83 million speed tests and 1.02 billion latency measurements, collected from October 1st 2019 to March 31st 2020.

(1) FierceWireless, DT and Vodafone Germany use dynamic spectrum sharing for 5G <u>https://www.fiercewireless.com/5g/dt-and-vodafone-germany-use-dynamic-spectrum-sharing-for-5g</u> Retrieved 12 June 2020

(2) RTR, Telekom-Control-Kommission issues decision postponing second 5G auction from April to later date

https://www.rtr.at/en/pr/pinfo31032020TK Retrieved 12 June 2020

Key findings

- Austria has the best Excellent and Core Consistent Quality in the region, despite Switzerland taking first place for median download speed, upload speed, and latency. The difference in results is due to distribution: Although Switzerland's networks are faster on average, they are slightly less consistent, and there's a higher chance that a Swiss user will record a download throughput slower than 5 Mbps. It shows that whilst a high average speed is important, being the "fastest network" and "consistently delivering a fast-enough speed" are not the same.
- Swisscom is the best operator in Switzerland and in the region in terms of Excellent Consistent Quality, download throughput, and upload throughput. However, A1 recorded the best Core Consistent Quality of any operator in the DACH region, and also won four out of five categories in Austria.



KEY FINDINGS



- Latency performance was excellent across all three countries, with no operator recording a one-way latency higher than 20 milliseconds. The recent surge in working from home — not to mention online video gaming — has shown the necessity of a responsive network for real-time applications like video chatting, and DACH operators are well suited to respond to this demand.
- Germany's users are spending more time on 4G than in previous years, however still significantly less than users in other parts of the DACH region – and this shows in the results in almost every KPI, where Germany places in third behind Austria and Switzerland.

Results overview

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Mobile experience results

Austria, July 2020

	Et al		
Excellent Consistent Quality	★ Winner		
Core Consistent Quality		★ Winner	
Download throughput		★ Winner	
Upload throughput		★ Winner	
Latency		★ Winner	

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<u>^1</u>

Magenta®

Results from 33,817,949,270 measurements taken across Common Coverage Areas (CCAs) in Austria between October 1st 2019 & March 31st 2020.

"Three delivered the highest percentage of Excellent Consistent Quality in Tutela's tests"



Based on the highest Excellent Consistent Quality in Common Coverage Areas.

Results overview

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Mobile experience results

Germany, July 2020	Ŧ··	0	O ₂
Excellent Consistent Quality	★ Winner		
Core Consistent Quality	★ Winner		
Download throughput	★ Winner		
Upload throughput	★ Winner		
Latency			★ Winner

Results from 210,773,666,665 measurements taken across Common Coverage Areas (CCAs) in Germany between October 1st 2019 & March 31st 2020.

"Telekom delivered the highest percentage of Excellent Consistent Quality in Tutela's tests"



Based on the highest Excellent Consistent Quality in Common Coverage Areas.

Results overview

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Mobile experience results			
Switzerland, July 2020	swisscom	Salt.	Sunrise
Excellent Consistent Quality	★ Winner		
Core Consistent Quality	★ Winner		
Download throughput	★ Winner		
Upload throughput	★ Winner		
Latency			★ Winner

Results from 25,883,401,957 measurements taken across Common Coverage Areas (CCAs) in Switzerland between October 1st 2019 & March 31st 2020.

"Swisscom delivered the highest percentage of Excellent Consistent Quality in Tutela's tests"



Based on the highest Excellent Consistent Quality in Common Coverage Areas.

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Understanding this report

Tutela uses two key methodological components to best compare user experience across operators: Consistent Quality and Common Coverage Areas. Consistent Quality is a set of metrics that Tutela has developed to objectively evaluate when networks are (and are not) enabling users to do almost everything that they want to do on their smartphones.

The methodology is covered in detail at the end of this report and <u>on our website</u>, but simply put, there are two sets of thresholds, Excellent and Core. A connection that hits the Excellent threshold is sufficient for usecases like 1080p video streaming or multiplayer gaming, while a Core connection will stream standard-definition video or handle things like web browsing or uploading photos to social media. The percentages you see in this report represent the percentage of tests on a given operator that were above the Excellent or Core thresholds. These were most recently reassessed and updated September 1st, 2019.

Common Coverage Areas are parts of the country where the majority of operators offer service. In this report, we present results nationally and from Common Coverage Areas, which helps present both a full national picture, as well as highlighting network conditions wherever operators are directly in competition.





Consistent Quality

Country comparison

Austria narrowly beat Switzerland to provide the best mobile network experience in the region, as measured using Excellent Consistent Quality on a country-wide level, as well as for Core Consistent Quality – Tutela's two thresholds representing ranges of use cases that matter to users. The thresholds used for Excellent Consistent Quality cover a group of uses including 1080p video streaming, HD video calling, and real-time mobile gaming, while those for Core Consistent Quality represent lessintensive uses such as social media sharing, VoIP calling and SD video streaming.

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Consistent Quality Percentage in Common Coverage Areas



Austria

3 narrowly moved into first place for Excellent Consistent Quality in Common Coverage Areas across Austria, with A1 in second and Magenta a close third. However, for Core Consistent Quality, A1 provided the highest result, while 3 slipped into third place. 3's narrow advantage for Excellent Consistent Quality comes despite A1 recording the best median download speed, upload speed, and latency, largely due to slight differences in the distribution of those download and upload speeds within the test results. 3's network was slightly more consistent in providing download speeds above 5 Mbps as well as upload speeds above 1.5 Mbps, leading to its marginal overall win for Excellent Consistent Quality. You can learn more about this in Tutela's blog post '<u>why averages don't tell the whole</u> <u>story</u>'.



Germany

Telekom was the clear winner in Germany – both for Excellent and Core Consistent quality. This means that Telekom users likely experience a network capable of uses like 1080p video streaming and HD video calling, as well as VoIP calls and social media sharing, more than users for any other operator.

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Consistent Quality Percentage in Common Coverage Areas



Switzerland

Swisscom was the outright winner for Switzerland, with its users experiencing a network that meets the Excellent Consistent Quality thresholds greater than one in 20 times more often then users on the nextbest operator, Salt. Sunrise meanwhile was just behind Salt on Excellent Consistent Quality, however notably more behind on the easier set of thresholds – Core Consistent Quality. Just under one in 20 times, a user's connection would not be suitable for uses like social media, VoIP Calling and SD video streaming.

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Consistent Quality Percentage in Common Coverage Areas



Download throughput

Country comparison

While Austria had the edge for mobile network experience, Switzerland was notably faster when it came to median download speeds. It beat second-place Austria by a full 5 Mbps, and more than doubled the median download speed from Germany.

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DOWNLOAD THROUGHPUT

Austria

While 3 took the top spot for the best mobile experience, A1 was notably faster on median download speed - taking the lead by 3.6 Mbps at 28.5 Mbps. There was also a similar-sized step down to third-place Magenta at 21.4 Mbps.

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DOWNLOAD THROUGHPUT

Germany

Telekom again led for median download speed in Germany, with O2 overtaking Vodafone for second place. All three operators provided median download speeds below those in either Austria or Switzerland, however each operator provided competitive speeds well over the 5 Mbps threshold Tutela uses as part of its Excellent Consistent Quality metric.

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DOWNLOAD THROUGHPUT

Switzerland

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Again Swisscom had a distinct lead over the competition, with more than 14 Mbps separating it and second-place Salt. Sunrise was then a close third. Swisscom's 38.0 Mbps is among the highest median download speeds observed in any of Tutela's recent reports.



Upload throughput

Country comparison

On median upload speed, again Switzerland outperformed the other countries in the DACH market, beating Austria by 1.5 Mbps Germany was again a step behind in third place at 6.8 Mbps.

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UPLOAD THROUGHPUT

Austria

In Austria, A1 was again the fastest network for median upload speed at 11.8 Mbps, with

3 in second place at 10.4. Magenta was in third at 9.1 Mbps.

TUTELA 7 Median Upload Speed in Common Coverage Areas



UPLOAD THROUGHPUT

Germany

Telekom took the lead for Median Upload Speed in Common Coverage Areas of Germany by 0.9 Mbps, with Vodafone in second place. O2 was close behind Vodafone, with just 0.3 Mbps separating the two.

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UPLOAD THROUGHPUT

Switzlerand

Swisscom demonstrated a compelling lead over Sunrise and Salt in upload speed at 14.1 Mbps. Sunrise was second at 10.9, with Salt in third at 9.8 Mbps. It's notable that Salt, the worst-performing operator for upload speed in Switzerland, still had a faster median upload speed than any of the operators in Germany.

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Latency

Country comparison

As for download and upload speed, Switzerland was also the fastest of the three countries in the report for latency, as measured using the median one-way latency over UDP, a protocol commonly used for latency-sensitive applications like voice and video calling. A more responsive network will result in a connection that feels 'faster' for a user, especially for applications like online gaming and real time communications. Although Swiss users experienced an average latency significantly better than users in Germany or Austria, the latency for all three countries is extremely low, and several times better than what is required even for the most latency-sensitive applications.



LATENCY

Austria

Within Austria, A1 once again came out on top, with a median latency of 15.2 milliseconds. Magenta was in second place, one millisecond behind, while 3 lagged on a median latency of 18.0 ms.



Germany

O2 had the best latency in Germany by 1.5 milliseconds, beating Vodafone and Telekom for first place. The results were close, however, with all three operators

recording a median latency lower than 17 milliseconds, and just two milliseconds separating first and last place.

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Median Latency in Common Coverage Areas



Switzerland

Across all three Swiss operators, networks were consistently responsive. Switzerland overall had the best latency of any country in the test, and the per-operator results

show why: just 1.1 milliseconds separate first-place Sunrise from last-place Salt, and all three operators were comfortably under 15 milliseconds.

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Median Latency in Common Coverage Areas





Technology usage

Country comparison

4G availability is a persistent issue for German mobile subscribers; although we've noted an improvement in the last year, comparisons to Austria and Switzerland make it clear that German operators still have a ways to go in order to achieve parity with surrounding countries.

3G networks may be satisfactory for some use-cases, but the inferior network performance — particularly when it comes to latency — limits the functionality of the network. That's particularly evident in Germany's Consistent Quality results: the country is close to Austria and Switzerland for Core Consistent Quality, which only requires a 100ms connection, but falls far behind for Excellent Consistent Quality, where the 50ms latency threshold becomes a problem.



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TECHNOLOGY USAGE

Austria

Within Austria, we can see that users on all three networks spend a similar proportion of time connected to a 4G network. 3 is on top, at 84.0%, but A1 is just three percentage points behind. The spectrum used for those 4G networks varies quite significantly, however. A1 uses the lowband 800 MHz spectrum for nearly half of all data traffic over LTE, whereas 3 and Magenta rely on the mid-band 1800 MHz spectrum much more heavily.



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Mobile Data Volume by LTE Band Nationwide



TECHNOLOGY USAGE

Germany

Spectrum usage is relatively consistent across German operators, with few differences in the bands used by subscribers for data connections. Vodafone appears to rely more heavily on 800 MHz low-band spectrum, while Telekom users send the highest proportion of their data of the 1800 MHz band. More of a difference is seen in

the technology used, however. O2 subscribers spent a significantly higher proportion of their time connected to 4G, indicating that where O2 users have a signal, it's more likely to be 4G. Vodafone and Telekom were relatively close, with 65% and 60% of time on 4G respectively.

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Percent of Time by Mobile Connection Type Nationwide



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Mobile Data Volume by LTE Band Nationwide



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TECHNOLOGY USAGE

Switzerland

1800 MHz dominates for Salt and Sunrise in Switzerland, with Salt and Sunrise subscribers using the mid-band frequency for the majority of their data traffic. Although 1800 MHz is the most heavilyused individual band for Swisscom, the network also relies on its 2100 MHz and 2600 MHz high-band holdings for a significant amount of data traffic. Despite its utilization of high-band spectrum, which could be expected to suffer in coverage compared to low-band and mid-band holdings, Swisscom led the other operators for time spent on 4G. In fact, it was the only operator in this report to see its users spend more than 90% of their time connected to 4G.

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Mobile Data Volume by LTE Band Nationwide



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Methodology

Tutela is an independent crowdsourced data company with a global panel of over 300 million smartphone users. We gather information on mobile infrastructure and test wireless experience, helping organisations in the mobile industry to understand and improve the world's networks.

Tutela collects data and runs network tests via software embedded in a diverse range of over 3000 consumer applications, which enable the measurement of real-world quality of experience for mobile users, 24/7. For this report, Tutela has collected over 7.4 billion total records including over 83 million speed tests and 1.02 billion latency measurements, between October 1st 2019 & March 31st 2020.

Tutela measures network quality based on the real-world performance of actual network subscribers, inclusive of occasions when a network or tariff may be throttled or congested, and of users on the flanker subbrands of operators. Results in this report are based on a testing configuration designed to represent the typical (rather than maximum) performance that users experience. We use a 2 MB file to perform our download testing and a 1 MB file to perform our upload testing. Latency performance in this report reflects one-way UDP latency. Tests are conducted against the same content delivery networks that power many of the world's most popular consumer applications, and as such reflect the end-to-end performance of the network.

Consistent Quality

Download speed is most often used as a proxy for network quality, but while download throughput is important, it's just one of several crucial requirements for a "good" connection.

As operators have upgraded 3G networks to LTE-Advanced technology, theoretical (and even real-world) peak throughput speeds have increased to where they vastly outstrip the maximum needed for any current usecase. Real-world speeds above 100 Mbps are now common in parts of the world, and with a 4K video stream — which itself is rarely something smartphone users need — using a fifth of that, average download speed has lost some of its relevance as the dominant statistic used to measure the quality of wireless networks.

At its most basic, a good connection is one that doesn't get in the way of users doing what they want to do. In the real world, smartphone users aren't running speed tests all day — they're browsing the web, using apps, voice calling their friends, streaming Netflix and YouTube, or making video calls.



To more objectively evaluate when networks are (and are not) enabling users to do those things, Tutela has developed a standard called consistent quality. Simply put, it's two sets of thresholds, called Excellent and Core. If a connection hits the Excellent standard, it's sufficient for the most demanding mobile use-cases, like HD group video calling or 1080p video streaming. A Core connection is good enough for SD video streaming, web browsing, emails, and VOIP calling, but users are more likely to experience delays or buffering when trying to use more demanding apps. Tutela bases the threshold values on the minimum performance requirements published by popular apps. We most recently updated our Consistent Quality thresholds on <u>September 1st, 2019</u>.

Tutela's consistent quality metric, as used in our reports, simply measures the percentage of time that users can hit the thresholds. The higher the number, the more often users have a Core or Excellent quality connection.

Excellent Quality

KPI	Download throughput	Upload throughput	Latency	Jitter	Packet loss
Minimum acceptable value	5 Mbps	1.5 Mbps	50 ms	30 ms	1%

Core Quality

KPI	Download throughput	Upload throughput	Latency	Jitter	Packet loss
Minimum acceptable value	1.5 Mbps	500 Kbps	100 ms	50 ms	5%

Discover Tutela Explorer

Tutela Explorer is a powerful cloud-based solution for real-time analysis of crowdsourced data. Using the platform, mobile operators can:

- Create coverage and quality maps
- Benchmark network quality and coverage across all operators
- Drill down to any KPI at city, street or even building level
- Analyse spectrum utilisation, performance and more

Visit www.tutela.com/explorer to learn more

Learn more



Appendix

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Total Results Overview Nationwide

		Download Throughput	Upload Throughput	Latency	Excellent CQ	Core CQ
Austria	3	24.9 Mbps ± 0.11 Mbps	10.4 Mbps ± 0.04 Mbps	18.0 ms ± 0.002 ms	88.98% ± 0.12%	98.64% ± 0.04%
	A1	28.3 Mbps ± 0.14 Mbps	11.7 Mbps ± 0.04 Mbps	15.2 ms ± 0.002 ms	87.60% ± 0.13%	98.98% ± 0.04%
	Magenta	21.3 Mbps ± 0.10 Mbps	9.1 Mbps ± 0.03 Mbps	16.2 ms ± 0.003 ms	87.27% ± 0.13%	98.70% ± 0.04%
Germany	02	14.6 Mbps ± 0.02 Mbps	6.6 Mbps ± 0.01 Mbps	14.8 ms ± 0.001 ms	76.31% ± 0.05%	92.05% ± 0.03%
	Telekom	17.1 Mbps ± 0.05 Mbps	7.8 Mbps ± 0.03 Mbps	16.8 ms ± 0.003 ms	83.49% ± 0.08%	98.36% ± 0.03%
	Vodafone	13.3 Mbps <u>+</u> 0.03 Mbps	6.9 Mbps <u>+</u> 0.02 Mbps	16.3 ms ± 0.001 ms	80.04% ± 0.07%	96.99% ± 0.03%
Switzerland	Salt	23.9 Mbps ± 0.17 Mbps	9.8 Mbps ± 0.05 Mbps	13.8 ms ± 0.004 ms	84.94% ± 0.17%	98.02% ± 0.07%
	Sunrise	23.2 Mbps ± 0.12 Mbps	10.8 Mbps ± 0.05 Mbps	12.7 ms ± 0.003 ms	83.90% ± 0.17%	95.52% ± 0.10%
	Swisscom	37.9 Mbps ± 0.11 Mbps	14.1 Mbps ± 0.05 Mbps	13.8 ms ± 0.003 ms	91.11% ± 0.10%	98.67% ± 0.04%

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Total Results Overview in Common Coverage Areas

		Download Throughput	Upload Throughput	Latency	Excellent CQ	Core CQ
Austria	3	24.9 Mbps ± 0.11 Mbps	10.4 Mbps ± 0.04 Mbps	18.0 ms ± 0.002 ms	88.99% ± 0.12%	98.64% ± 0.05%
	A1	28.5 Mbps ± 0.14 Mbps	11.8 Mbps ± 0.05 Mbps	15.2 ms ± 0.002 ms	87.78% ± 0.13%	99.01% ± 0.04%
	Magenta	21.4 Mbps ± 0.10 Mbps	9.1 Mbps ± 0.03 Mbps	16.2 ms ± 0.003 ms	87.33% ± 0.13%	98.71% ± 0.04%
Germany	02	14.6 Mbps ± 0.02 Mbps	6.6 Mbps ± 0.01 Mbps	14.8 ms ± 0.001 ms	76.32% ± 0.05%	92.04% ± 0.03%
	Telekom	17.2 Mbps ± 0.06 Mbps	7.8 Mbps ± 0.03 Mbps	16.8 ms ± 0.003 ms	83.57% ± 0.08%	98.38% ± 0.03%
	Vodafone	13.3 Mbps <u>+</u> 0.03 Mbps	6.9 Mbps <u>+</u> 0.02 Mbps	16.3 ms ± 0.001 ms	80.08% ± 0.07%	96.99% ± 0.03%
Switzerland	Salt	23.9 Mbps ± 0.16 Mbps	9.8 Mbps <u>+</u> 0.05 Mbps	13.8 ms ± 0.004 ms	84.97% ± 0.17%	98.03% ± 0.07%
	Sunrise	23.3 Mbps ± 0.13 Mbps	10.9 Mbps <u>+</u> 0.05 Mbps	12.7 ms ± 0.003 ms	83.93% ± 0.17%	95.53% ± 0.10%
	Swisscom	38.0 Mbps ± 0.11 Mbps	14.1 Mbps ± 0.06 Mbps	13.8 ms ± 0.003 ms	91.20% ± 0.10%	98.69% ± 0.04%

About Tutela

Tutela Technologies, Ltd., is an independent crowdsourced data company with a global panel of over 300 million smartphone users. It gathers information on mobile infrastructure and tests wireless experience, helping organizations in the mobile industry to understand and improve the world's networks. Data and insights provided by Tutela are trusted by the engineering teams at mobile network operators and network equipment manufacturers around the world and used to compare operators as well as inform decisions in network and infrastructure planning and optimisation. The organization is headquartered in Victoria, British Columbia.

Tutela does not collect any sensitive personal data and is compliant with international privacy regulations including CCPA and GDPR.

For further information about the methodology, data and tools used to create this report, please contact analysis@tutela.com or visit www.tutela.com.

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