

Nordics

State of Mobile Networks
January 2019

Analysis of Tutela crowdsourced data
from over 250,000 users

TUTELA 

Executive Summary

Despite its towering landmass and relatively sparse population, the Nordic countries have always been known for providing world-leading telecommunications services to its citizens; in mobile networking, there's no exception. Nordic countries routinely set world standards for cheap access to mobile data, and with the advent of LTE-Advanced technology, easy access to high-speed internet is more ubiquitous than ever. But within the Nordics, the quality, cost, and utilization of mobile networks still varies significantly.

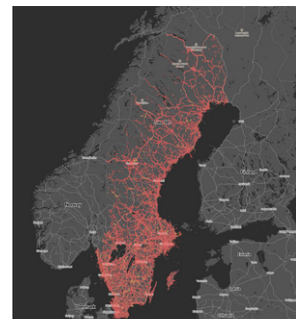
In this report, Tutela has analyzed over 14 billion measurements to provide insight into differences in coverage, spectrum utilization, data utilization, and the consistency of coverage between different operators and countries. We have focussed just on "mainland Nordics" in this report, covering Norway, Sweden, Denmark and Finland but excluding Iceland.

Key findings

- Finns love their unlimited data plans. On average, over 63% of mobile data usage in Finland is delivered via a 4G or 3G connection, with just 37% on WiFi. It is the opposite story in Norway, where only 16% of mobile data usage is over a cellular connection and 84% on WiFi, most likely due to relatively high mobile data costs.
- ICE Norway delivered the highest levels of Consistent Quality in our testing across all operators in the Nordics, delivering a high quality cellular connection capable of delivering HD video calls more than 90% of the time.
- Sweden sees more data traffic over high-band spectrum than other Nordic countries with 37.9% of data being transferred over mostly 2.6Ghz frequencies. Interestingly, Telia, despite higher data volumes on mid-band spectrum, delivered higher consistent quality scores in our tests than the other providers in Sweden.

Coverage

To see full coverage maps
for all countries please visit
<https://tute.la/nordics>



Sweden

Sweden has four national mobile network operators (MNOs): Telia, Telenor, Tele2, and Tre, although Telenor and Tele2 share networks. Despite Sweden's challenging geographic conditions and low population density, Telia, Tele2, and Telenor all claim to cover over 99 percent of the population.

The companies' claims appear to be substantiated by Tutela's coverage data. Maps of locations where Tutela has recorded tests show that Telia, Tele2, and Telenor have 4G coverage across every urban area in the country, the majority of the road network, and significant coverage in rural areas. Visually, Telia appears to have the most dense 4G coverage, with particularly strong performance in the north of the country. Telia will face increased challenges in the next two years, however, as Tele2 and Telenor have agreed to continue their network partnership into 5G, and have secured additional 700 MHz spectrum to enhance their existing 4G network.

Tre, the smallest operator in Sweden, still lags behind the competition on coverage. It has the fewest cell sites of any of the operators, and, as a result, has to rely more heavily on 800 MHz spectrum (which travels the furthest) compared to other operators. Its users also connect to 3G more often than users on competitors' networks, particularly outside of major cities.

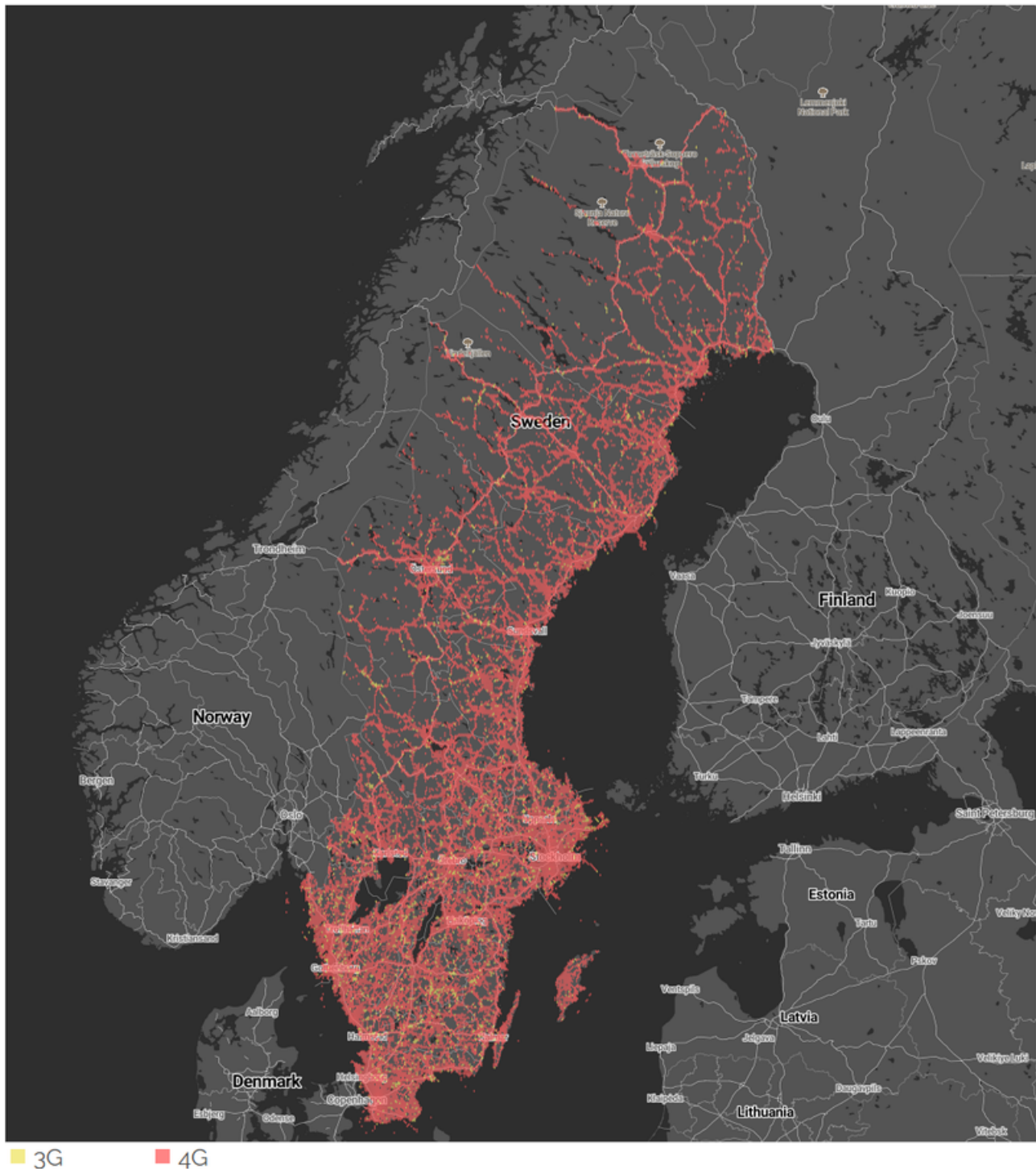
Finland

Like Norway, Finland has a sparse population served by three operators, although in Finland, there is more equity between the three operators' coverage. DNA, Elisa, and Telia all have 4G coverage across the majority of the country, including more rural areas and major road networks.

Finland's unique geography has also promoted a number of small regional wireless companies and cooperatives, which have roaming agreements with the major networks -- one prime example being the Åland islands.

Coverage

TUTELA Telia Coverage (Sweden) by Mobile Technology



Telia's 4G network coverage in Sweden is extensive. The points on the map show where Tutela users were to receive 3G or 4G signal on Telia's network.

To see coverage maps for more countries and operators, visit <https://tute.la/nordics>

Coverage

Denmark

Denmark also has four MNOs, with two of them -- in this case Telia and Telenor -- sharing networks. As Denmark is a smaller, flatter, and far more population-dense country than its Scandinavian neighbours, we would expect to see a greater proportion of landmass covered by 4G, and that is indeed the case.

TDC leads in the coverage department, with a comprehensive blanket of 4G coverage only dotted with 3G availability in some rural areas. Telenor and Telia, as network partners, exhibit a near-identical coverage map. Tre is again in fourth place; not only does it have less network coverage overall, but it appears to rely much more heavily than other operators on its 3G network, including in some semi-urban smaller towns where 4G coverage would be expected.

Norway

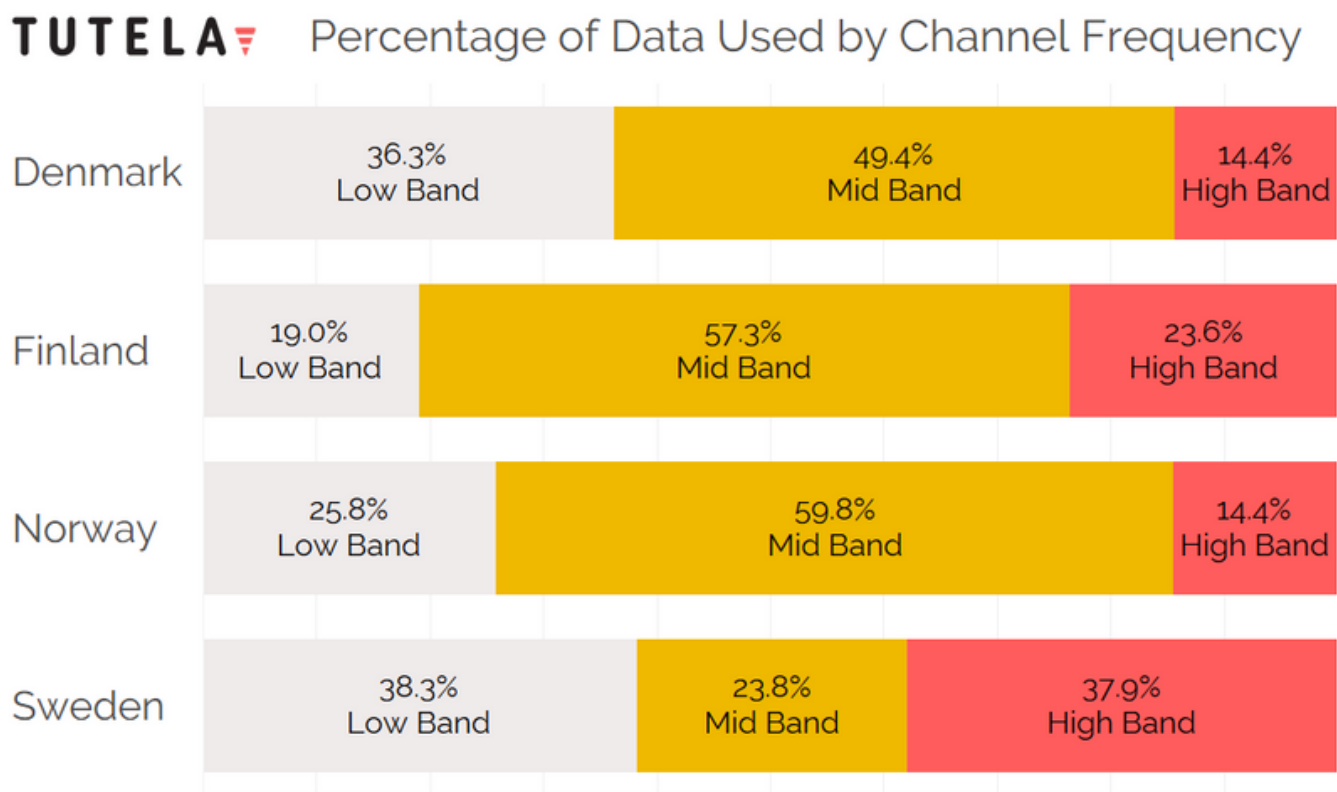
Norway has three mobile network operators, but only two with national coverage, namely Telia and Telenor. ICE is the third network, but it is much more recent entrant, having only started commercial sales in 2015. It operates its own 4G network in some regions of the country, most notably major cities such as Oslo and Bergen, and claims to cover around 80% of the population with its own infrastructure.

For users outside of ICE's own coverage, the network has a roaming agreement with Telia. According to Tutela's data, ICE subscribers are on Telia's network around 1/3rd of the time. When roaming on Telia's network, ICE users do benefit from Telia's superior coverage, although data speeds appear to be a little slower for ICE users compared to Telia users. ICE users see download speeds 17% slower than Telia users in the same areas, although the speeds are still far in excess of our consistent quality threshold.

Both Telenor and Telia have outstanding 4G availability across the rest of the country, and as a result, Norway had the highest percentage of 4G use of any of the Scandinavian countries (examined in more detail below). Norwegian operators have been particularly efficient about encouraging adoption of VoLTE, enabling subsequent refarming of 3G spectrum to 4G.

Although Telia and Telenor have a similar geographical coverage, Telenor has an edge in coverage (and consistent quality), particularly outside of urban areas. Although both operators utilize similar spectrum holdings, Telenor has significantly more cell sites, which gives it the edge.

Spectrum usage



Tutela's data collection methodology makes it possible to analyse network data usage volume by both connection type and frequency channel. The chart above shows the percentage volume of data transferred by spectrum band; given the demographic similarities between Nordic countries, it can provide insight into the differing infrastructure approaches taken by countries.

For example, we can see that Norwegian and Finnish carriers use mid-band spectrum -- specifically, the 1800 MHz band -- to handle the majority of data traffic. Sweden and Denmark use a more balanced mix of spectrum, with some Swedish operators relying particularly on the 2600 MHz spectrum.

Breaking it down further, we can see spectrum utilization on an operator-by-operator basis.

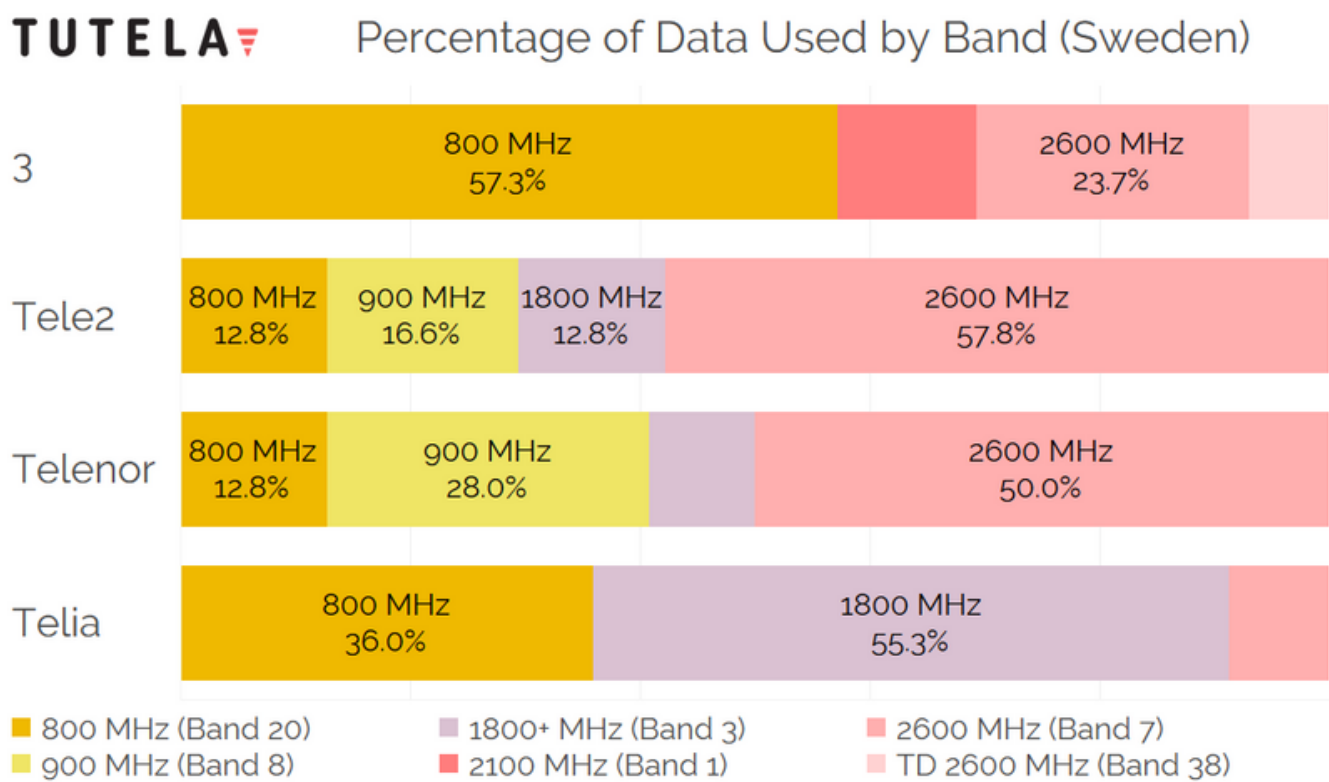
Spectrum usage

Sweden

3 uses the 800 MHz spectrum heavily, accounting for over half of its data usage. Tele2 and Telenor -- which share networks -- are both much more diverse, with a mix of 800 MHz and 900 MHz for low-band, while relying on 2600 MHz for large amounts of their total data volume.

The low volume of data transferred over 1800 MHz is surprising, given that the shared network owns 70 MHz of 1800 MHz spectrum, but it does suggest that there is underutilized capacity for future expansion. Telia, on the other hand, uses the 1800 MHz band much more than its competitors.

3 only has 20 MHz of 800 MHz spectrum, but it carries the majority of its data at present. As 3 hopes to grow its subscriber base, it has significant room in higher bands for expansion. It owns 40 MHz of 2100 MHz spectrum and 70 MHz in 2600, including a 50 MHz TDD holding. Adding capacity with higher bands requires more, smaller cell sites due to the higher bands' shorter range, but with the industry increasingly looking to high-band spectrum as the 5G future, 3's high-band spectrum holdings will only become more valuable.

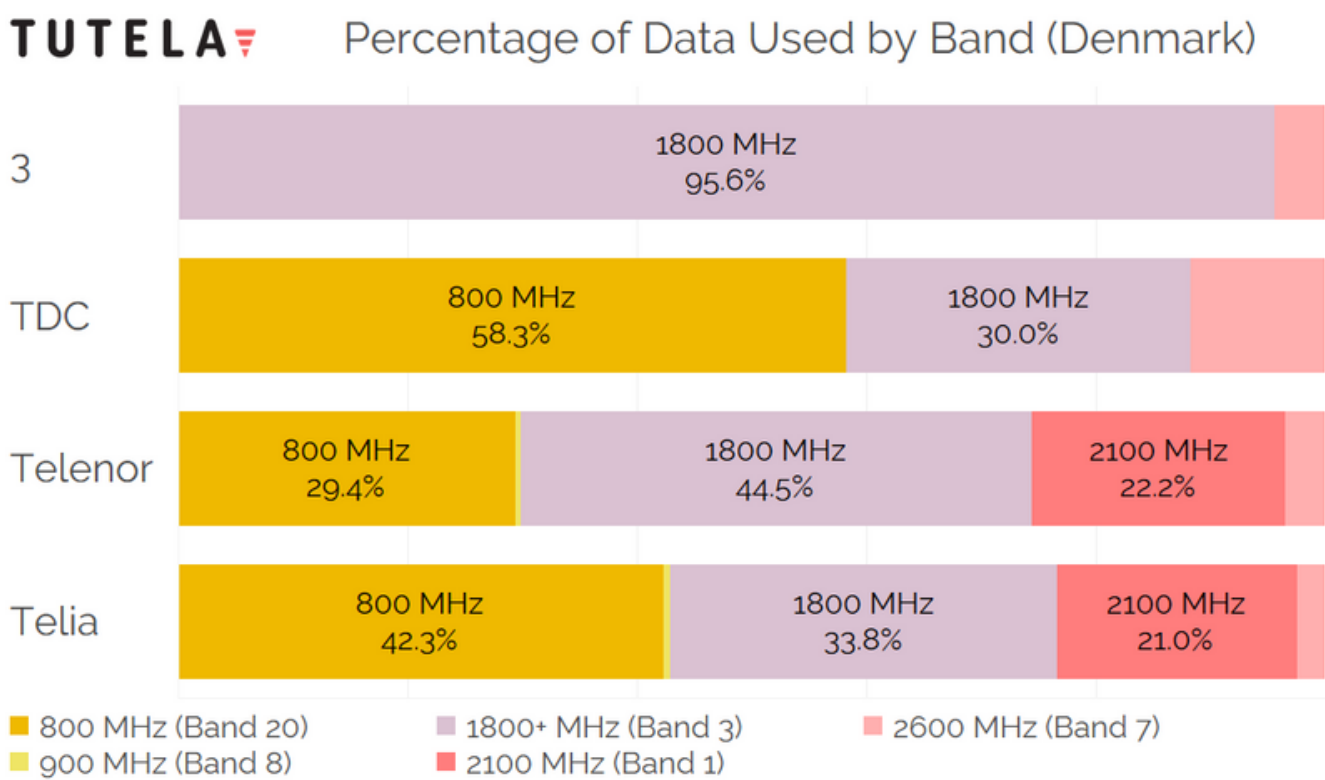


Spectrum usage

Denmark

In Denmark, the picture for 3 is very different: it holds 60 MHz of 1800 MHz spectrum, which it is using to carry the vast majority of its data traffic. Again, it has room for further capacity growth: 45 MHz of 2600 MHz spectrum and 30 MHz of 2100 MHz spectrum, which at present carries not even 5% of the network’s traffic.

However, 3 is a major outlier in Denmark. The other networks employ a more balanced spectrum approach, with a mix of 800, 1800, 2100, and 2600 MHz used.



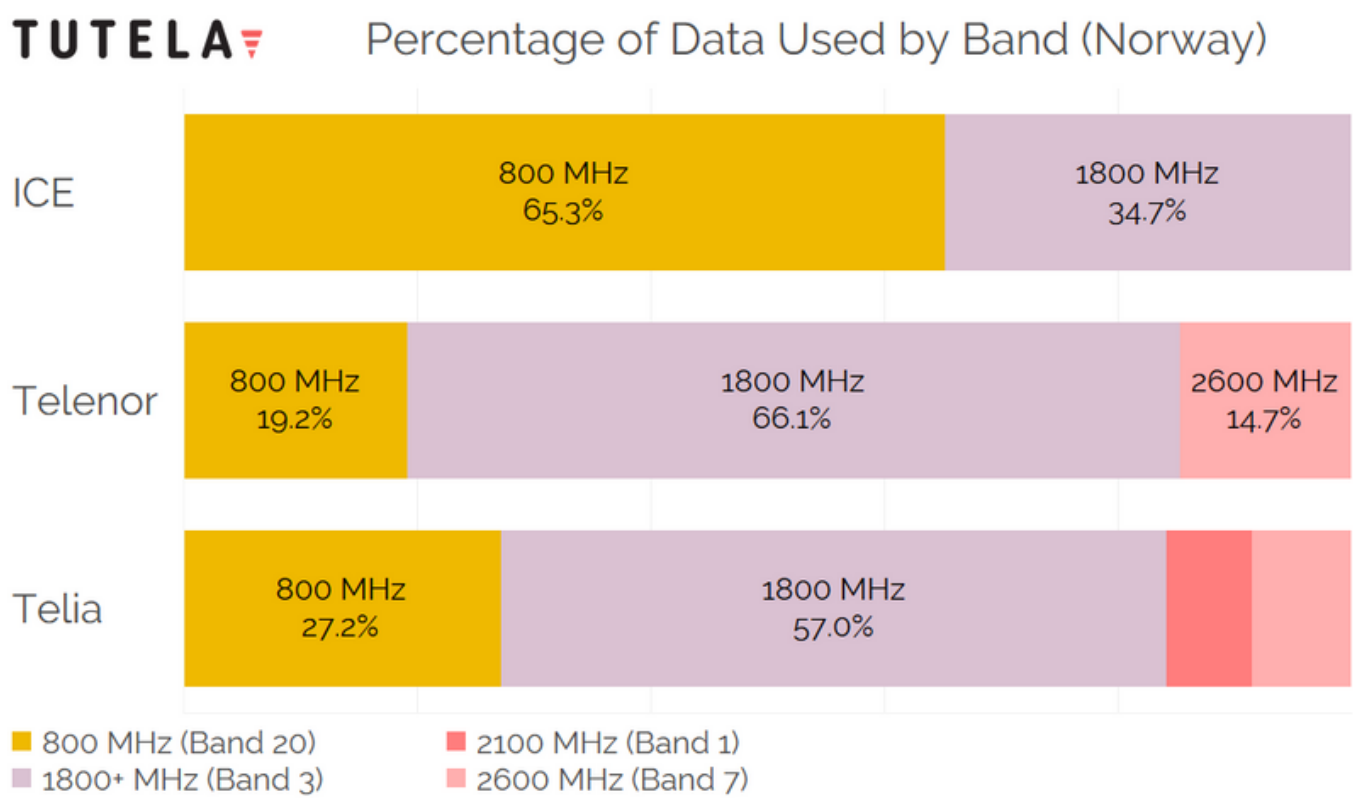
Spectrum usage

Norway

In Norway, the two major MNOs (Telia and Telenor) both use 1800 MHz most heavily, largely using 800 MHz for additional coverage and high-band spectrum for additional capacity in some urban areas. The potential for future capacity additions via high-band spectrum is there, particularly for Telenor, which owns 120 MHz of spectrum in 2100 MHz and 2600 MHz.

For ICE, however, the picture is a little less positive. The majority of its data is transferred over 800 MHz, where it owns just 20 MHz of spectrum. Future capacity expansion on 800 MHz via the addition of more cell sites will also be challenging, given that ICE's network is focused on urban areas.

There is potential in 1800 MHz expansion, however. ICE owns double the amount of spectrum in 1800 MHz that it does in 800 MHz, and as the other operators have demonstrated, 1800 MHz is an ideal LTE carrier for most situations. As Norway's regulator auctions off high-band spectrum for 5G purposes, however, ICE will need to bid against the incumbents for higher-band spectrum if it hopes to grow its subscriber base with a competitive 5G offering.

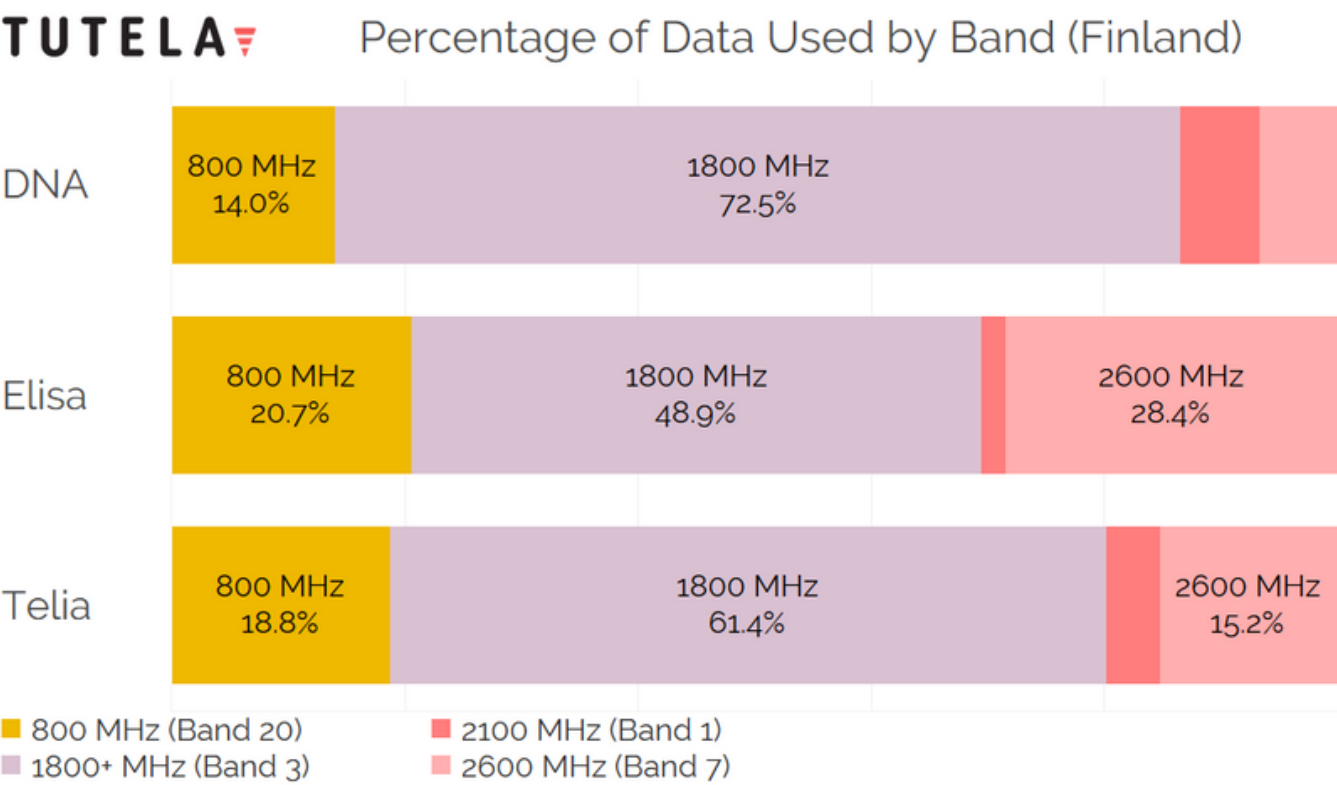


Spectrum usage

Finland

All three Finnish carriers primarily use 1800 MHz as the backbone of their networks, with some 800 MHz usage for rural coverage. Elisa uses 2600 MHz most heavily, although all four carriers have 2100 MHz and 2600 MHz spectrum deployed.

Finland has the highest rate of mobile data usage per subscriber in the world, and also has a relatively high penetration of fixed wireless access. What stands out is how Finland’s spectrum usage is similar to other countries with far less data usage: despite the heavier load on the mobile networks, more spectrum has not yet been deployed as a solution for capacity. With high-band spectrum currently playing only a limited role in the data transfer for all three networks, the spectrum resources should not be a limiting factor in expanding network capacity to keep up with future demand.



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



<https://www.tutela.com/explorer>

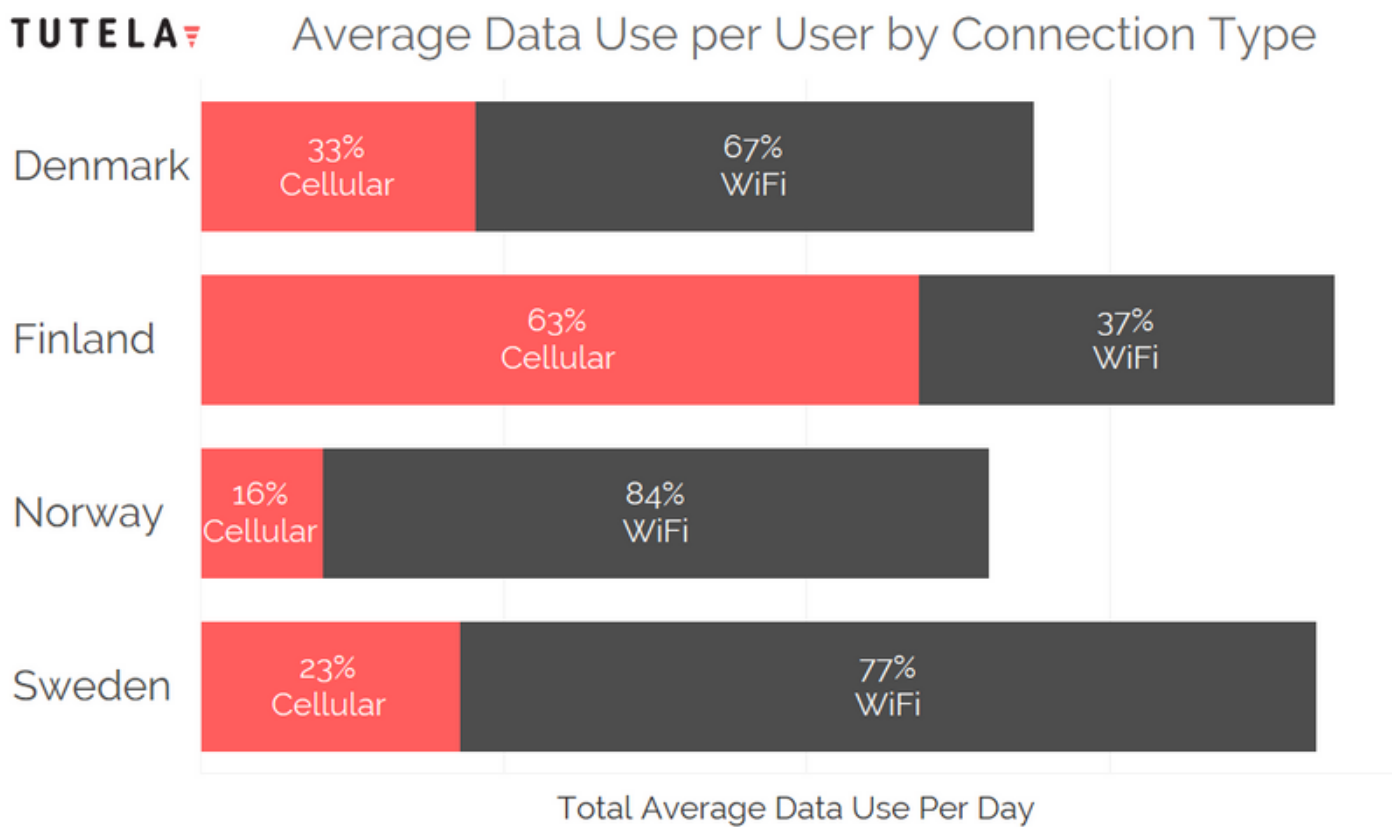
Data usage

In addition to collecting data on mobile networks, Tutela also provides insights into Wi-Fi data usage on mobile devices that allows comparisons between Wi-Fi and mobile data use. Finland has long been known as a global leader in mobile data usage, and this chart illustrates how it compares to its demographically similar neighbours.

According to research from Tefficient, Finland leads the world in data-only SIM usage, with 20% of the country's SIM base data-only. Given that some fixed wireless access -- specifically, using SIM cards in cell-to-Wi-Fi modems -- will not show up in Tutela's data, it is likely that the disparity in data usage between Finland and other Nordic countries is even higher than it appears.

But even among smartphone-only usage -- what Tutela's data primarily measures -- the correlation between cost of data and mobile data usage is clear. Finland, with the cheapest data per GB, has the most mobile data usage; Norway, with the most expensive, uses dramatically less per capita, while Sweden and Denmark are in the middle.

Tutela's data also suggests that cost of data, rather than network quality, plays the biggest role in whether or not consumers use mobile data. Norwegian subscribers use less data in total, not just less cellular data, when compared to their Finnish neighbours. That's despite the fact that Norway has the best consistent quality score of all the Nordic countries. In short: data cost, rather than data quality, appears to be the greatest determinant of how much consumers use a given network.



Consistent Quality



Our key performance indicators

Download speeds > 4Mbps
Upload speeds > 2Mbps
Latency < 50ms
Jitter < 30ms
Packet loss ~ 0%

These performance indicators might not seem especially challenging for carriers to hit. That's because most popular apps are optimized to work under less-than-ideal conditions.

With this minimum level of performance, you can stream a 1080p HD video on YouTube, download the Facebook app (71.89MB) in about two and a half minutes or upload a 5MB picture to Instagram in around 20 seconds.

The mobile excellent consistent quality score measures the percentage of time that a network connection -- whether over 3G or 4G -- meets these requirements, and therefore provides the user with a flawless connection for the majority of real world use cases.

What is Consistent Quality?

As operators have worked to upgrade 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 use-case. Real-world speeds above 100 Mbps are common in certain areas, and with a 4K video stream -- barely a realistic mobile use case -- using a fifth of that, average download speed has lost some of its relevance as the overriding statistic used to measure wireless networks.

Instead, a metric of customers' Quality of Experience provides more relevant insight into the quality of connection. With that in mind, Tutela has produced a set of five key network performance indicators that show the minimum requirements needed to flawlessly perform the most demanding mobile use-cases, including real-time HD video calling, or 1080p video streaming.

Consistent Quality

TUTELA Mobile Consistent Quality Score (Excellent) by Country



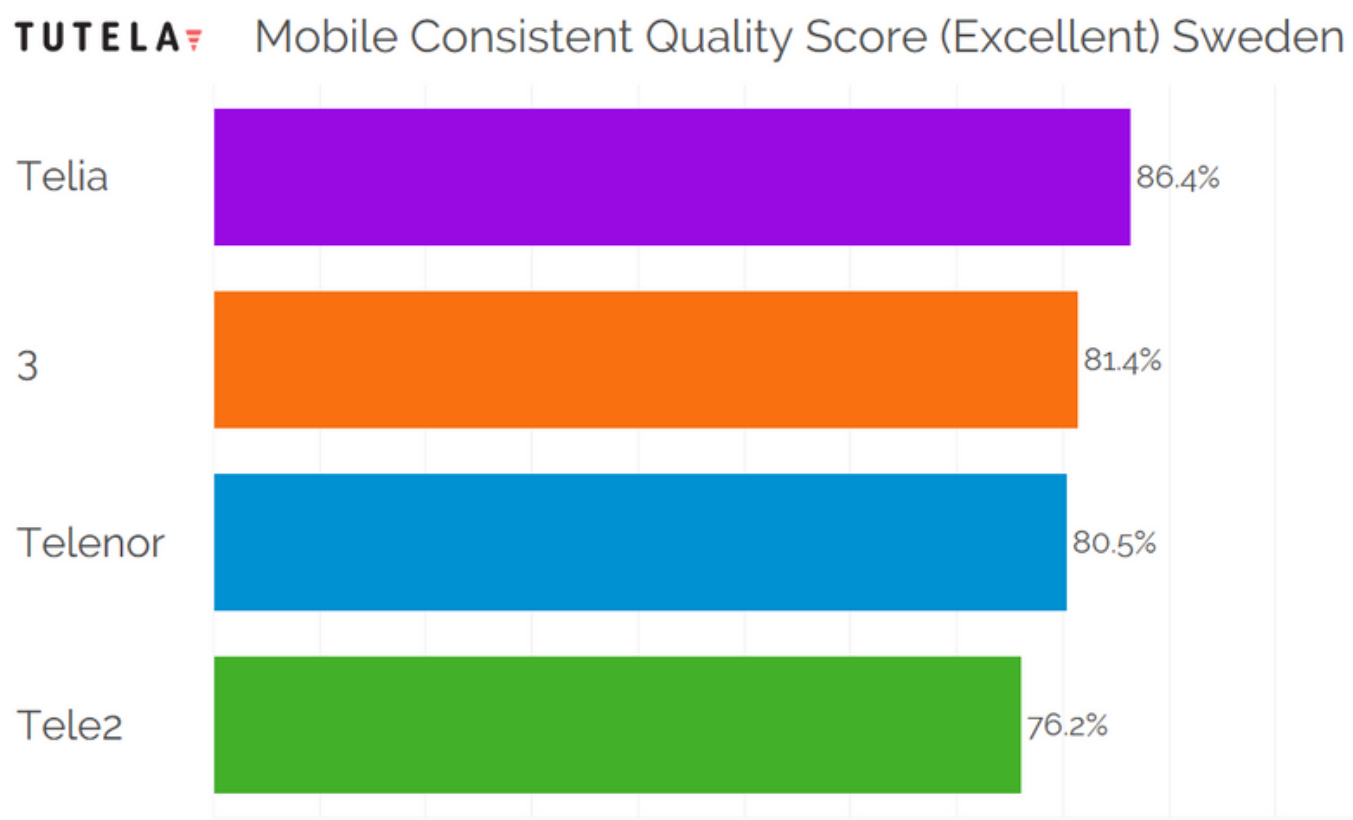
As the chart shows, all four Nordic countries perform well, with consistent quality scores over 80%. However, Norway -- which has the lowest data use per person, and the highest penetration of 4G -- has the best consistent quality of any country.

Denmark has the highest percentage of tests performed on 3G, at 16%, but has the second-best consistent quality. 85% of network connections tested in Denmark exceeded Tutela's thresholds for excellent quality. Finland, whose population uses far more data per capita than any other country, has the lowest consistent quality score.

Consistent Quality

Sweden

Telia’s reputation as the network with the best coverage is bolstered by a leading consistent quality score of 86.4%, a full five percentage points better than its closest competitor. Despite 3 having the smallest network of any Swedish MNO, it scored second-best for consistent quality. That may reflect demographic differences between 3’s subscribers and those of other networks: 3’s network coverage is more heavily biased towards urban areas, where coverage is easier than in rural areas. Although Telenor and Tele2 do share networks, there is a significant difference in consistent quality between the two providers.



Consistent Quality

Denmark

In Denmark, the network with the best coverage once again wins the crown for best consistent quality. TDC's score of 90% is the second-best of any operator in Scandinavia, and leads other operators by several percentage points. Telenor and Telia -- which share networks -- are in the middle of the ranking, while 3 is in fourth place. However, 3's fourth-place result of 82.0% means that customers still experience an excellent connection four out of five times.

TUTELA Mobile Consistent Quality Score (Excellent) Denmark



Consistent Quality

Norway

ICE, which has the least geographic coverage of any operator in Norway, scores the best for consistent quality at 90.5% -- which is also the highest score for any operator in Scandinavia. The industry-leading consistent quality may be explained by ICE mostly building out its network in urban areas; in rural areas, where consistent quality is typically lower, customers instead roam onto Telia's network.

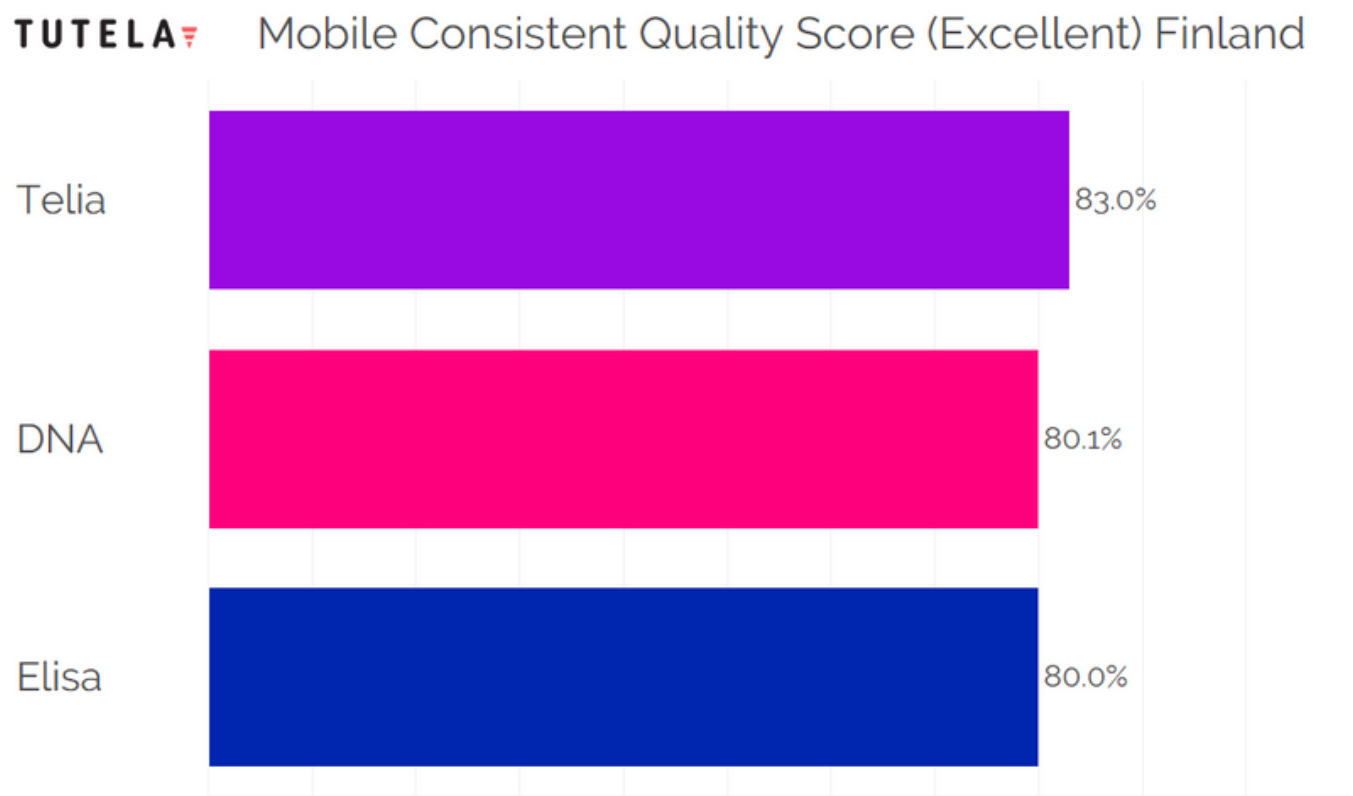
TUTELA Mobile Consistent Quality Score (Excellent) Norway



Consistent Quality

Finland

In Finland, all three operators are within three percentage points on consistent quality. Telia and DNA share a network in the north and east of the country, which may partially explain the nearly-identical results.



Methodology

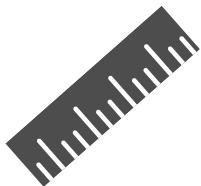
Tutela measures network quality based on the real-world performance of users in the field. Results in this report are based on a testing configuration to represent typical (not maximum) performance of users. We used a 2 MB file to perform our download testing and a 1 MB file to perform our upload testing. Tutela employs software installed on more than 3,000 partner apps to complete frequent, lightweight tests of around 2 MB.

Our results differ from other network testing companies which measure the peak performance of networks under ideal conditions (such as downloading a 500MB file).

In total, Tutela's software operates on over 250 million Android and iPhone devices globally, collecting over 10 billion mobile data measurements every day. Our data scientists analyze results for each country every month, and our analytics platform, Tutela Explorer, lets operators chart, map, and filter over 80 key performance indicators into customized dashboards to help them better understand industry performance and benchmark against competitors.

Report facts

The data in this report was taken from our crowdsourced data in 2018 between Sep 19 and Dec 17.



14.8 billion
Measurements



700 thousand
Download tests



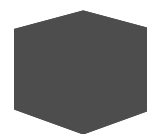
700 thousand
Upload tests



11.5 million
Latency tests



11.5 million
Jitter tests



11.5 million
Packet loss tests

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Mobile World Congress is just around the corner, and we're back for another exciting event to showcase our latest crowdsourced solutions for the mobile industry.

Schedule a meeting with us where you can:

- See a live demonstration of Tutela's data and tools for your markets
- Discover our products and roadmap and learn how Tutela's data and insights can help your business
- Start a free trial of our tools and data for your evaluation purposes
- Meet with our team

Find out more: <http://tute.la/mwc19>

Meet Tutela

Join us in Barcelona to learn more about mobile experience in Scandinavia.



MWC19™
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About Tutela

Tutela is a mobile data and analytics company serving the mobile and telecommunications industry with software is embedded in over 3000 diverse mobile applications installed on over 250 million mobile Android and iOS handsets. Tutela continuously monitors network quality of experience all across the world. We collect more than 10 billion measurements every single day, and through our interactive toolset, enable our customers to turn those numbers into actionable intelligence for their businesses.

For more information, visit www.tutela.com or contact us at info@tutela.com
