



TUTELA 

USA

State of Mobile Experience

Analysts

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SEPTEMBER 2020

Annual Report

www.tutela.com

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Introduction

Although 5G deployments and adoption have been the focus for wireless operators over the last 12 months, 4G networks still dominate real-world subscriber experience in 2020. As of the time of writing, there's still no 5G-compatible iPhone, and true standalone 5G networks are still in their infancy.

Luckily for wireless subscribers, innovation and improvement in 4G networks has continued apace. AT&T's nationwide rollout of the new 700 MHz LTE spectrum band (as part of the FirstNet agreement) is mostly complete according to the operator(1), Verizon continues to add capacity with deployments such as mid-band CBRS, and of course, the T-Mobile/Sprint merger has already led to widescale network changes to prepare for the New T-Mobile.

With the nationwide carrier landscape shifted much more towards three operators relatively equal in scale, the importance of customers' Quality of Experience as a differentiating factor between operators will only increase. To measure how subscribers' mobile experience compares between operators, Tutela has analyzed over 54 billion total records taken from real-world smartphone users, including more than 185 million speed and latency tests, taken between March 1st and August 31st 2020.

In this report, T-Mobile and Sprint are considered as separate subscriber bases for performance metrics, as over the time period of data collection, significant differences remained in customers' access to different networks, and subsequently in their mobile experience. However, coverage information for the combined network is included for reference, and any benefits to the individual user bases — for example, Sprint users now able to roam onto the T-Mobile network — are incorporated in the mobile experience results.

5G, of course, is the hottest topic in the US wireless industry at present; however, given the limited availability of 5G coverage, and overall scarcity of 5G devices among the installed base, it's not yet driving significant change in average mobile experience. Results from hundreds of thousands of 5G users are included in this report as part of the calculation of mobile experience, but since the effect of 5G hasn't yet shown up as a driver of average subscriber experience, it's not broken out separately within this report.

(1) Urgent Communications, AT&T to finish 80% of FirstNet buildout in coming months, exec says
<https://urgentcomm.com/2020/01/31/att-to-finish-80-of-firstnet-buildout-in-coming-months-exec-says/>



Key findings

- Verizon remains the operator to beat in the US, thanks to a substantial lead in coverage, a clear first-place result for download throughput, and a first-place tie with T-Mobile for Excellent Consistent Quality. However, T-Mobile and AT&T are both making up ground in other categories, and the race at the top is tighter than ever.
- T-Mobile tied with Verizon for Excellent Consistent Quality, and took home undisputed first-place results for upload throughput and latency. As T-Mobile continues to integrate the Sprint network, and take advantage of Sprint's vast spectrum holdings for widespread 5G deployment, there is a realistic possibility that it will be able to challenge Verizon's speed crown. Additionally, the improvement in coverage from the New T-Mobile network (as well as 600 MHz deployment) shows that T-Mobile has addressed a significant historical weakness when it comes to coverage.
- AT&T provides the best Core Consistent Quality at a nationwide level, and is dominant as the provider of a core mobile experience, winning the vast majority of states. Although Verizon still has the upper hand for coverage, the additional push to deploy more low-band coverage nationwide, including the FirstNet spectrum, could provide an avenue to challenge Verizon's dominance in that arena, especially in the 5G era.

Results overview

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Mobile experience results

USA, September 2020

verizon 



Sprint 

Excellent Consistent Quality	★ Draw	★ Draw		
Core Consistent Quality			★ Winner	
Download throughput	★ Winner			
Upload throughput		★ Winner		
Latency		★ Draw	★ Draw	
Coverage	★ Winner			

Results from over 54 billion total records taken from real-world smartphone users, including more than 185 million speed and latency tests, between March 1st and August 31st 2020.

"Verizon & T-Mobile delivered the highest percentage of Excellent Consistent Quality in Tutela's tests"



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

Understanding this report

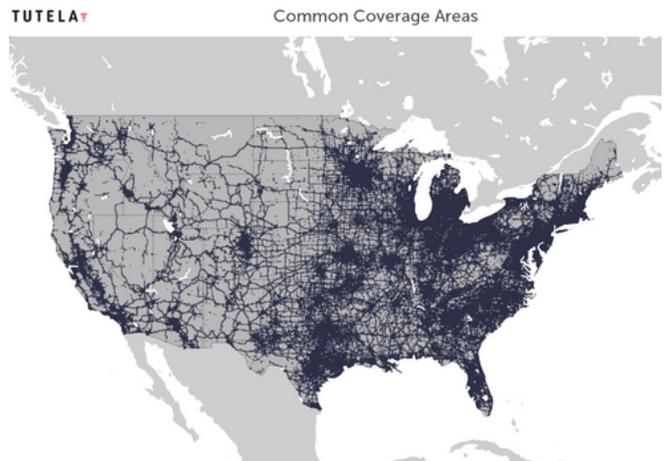
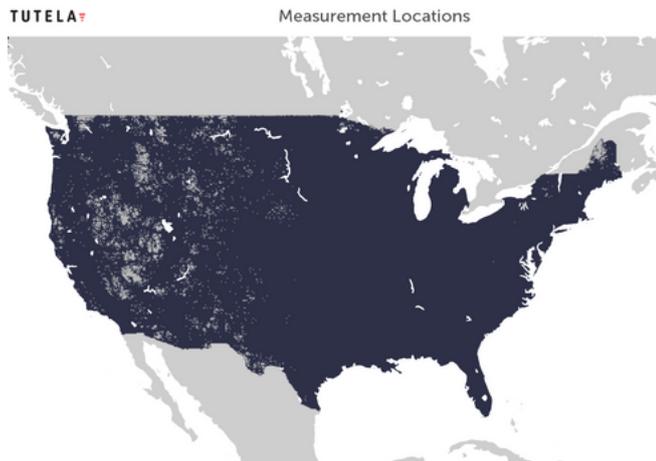
Tutela uses two key methodological components to best compare user experience across operators: Consistent Quality and Common Coverage Areas. Consistent Quality is a set of metrics that Tutela has developed to objectively evaluate when connections networks are (and are not) enabling users to do almost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

To best serve Tutela's goal to accurately measure and represent the real-world, end-to-end experience of actual users, our methodology is subject to ongoing improvements, which allow us to update the methodology in line with changes in network technology, measurement capabilities, and the realities of how people use their smartphones. As of this report, the methodology includes an updated version of Consistent Quality that better accounts for reliability, an area-based Coverage Score, a more granular Common Coverage Areas definition, and the separation out of users on MVNO or flanker brands. As a result, changes in the numeric values in this report compared to 2019 are not necessarily representative of year-on-year changes in the end-to-end user experience.



The methodology is covered in detail at the end of this report and [on our website](#), but simply put, there are two sets of thresholds, Excellent and Core. A connection that hits the Excellent threshold is sufficient for use-cases 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.

Common Coverage Areas are parts of the country where all national operators offer service, either on their own network or through a domestic roaming agreement. Comparing performance within common coverage areas ensures that user experience is being compared in places where networks are competing head-to-head, and ensures that operators with more diverse coverage are not being penalized. In this report, all performance metrics are taken from tests conducted in Common Coverage Areas only.



Consistent Quality

Verizon and T-Mobile tied for first place in Excellent Consistent Quality at 83.4%, Tutela's measure for a network connection good enough for demanding use-cases, such as group HD video calling, mobile gaming, or high-quality video streaming. AT&T was only marginally behind, with an Excellent Consistent Quality of 82.0%. Sprint users had a substantially worse mobile experience for demanding applications, with just 71.6% of tests meeting the requirements. For Core Consistent Quality, both the rankings and the differences between providers is substantially different. Core Consistent Quality represents a network

connection good enough for everyday use-cases, such as web browsing, voice calling over popular applications, or streaming SD video. AT&T took first place for Core Consistent Quality, with T-Mobile beating Verizon to second place by just 0.2%. Sprint was once again in fourth place, but the gap between operators was much smaller: less than 5% separated first-place AT&T from last-placed Sprint, suggesting that where a signal is available, operators are relatively similar in their ability to provide a network connection good enough for everyday applications.

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Consistent Quality Percentage in Common Coverage Areas



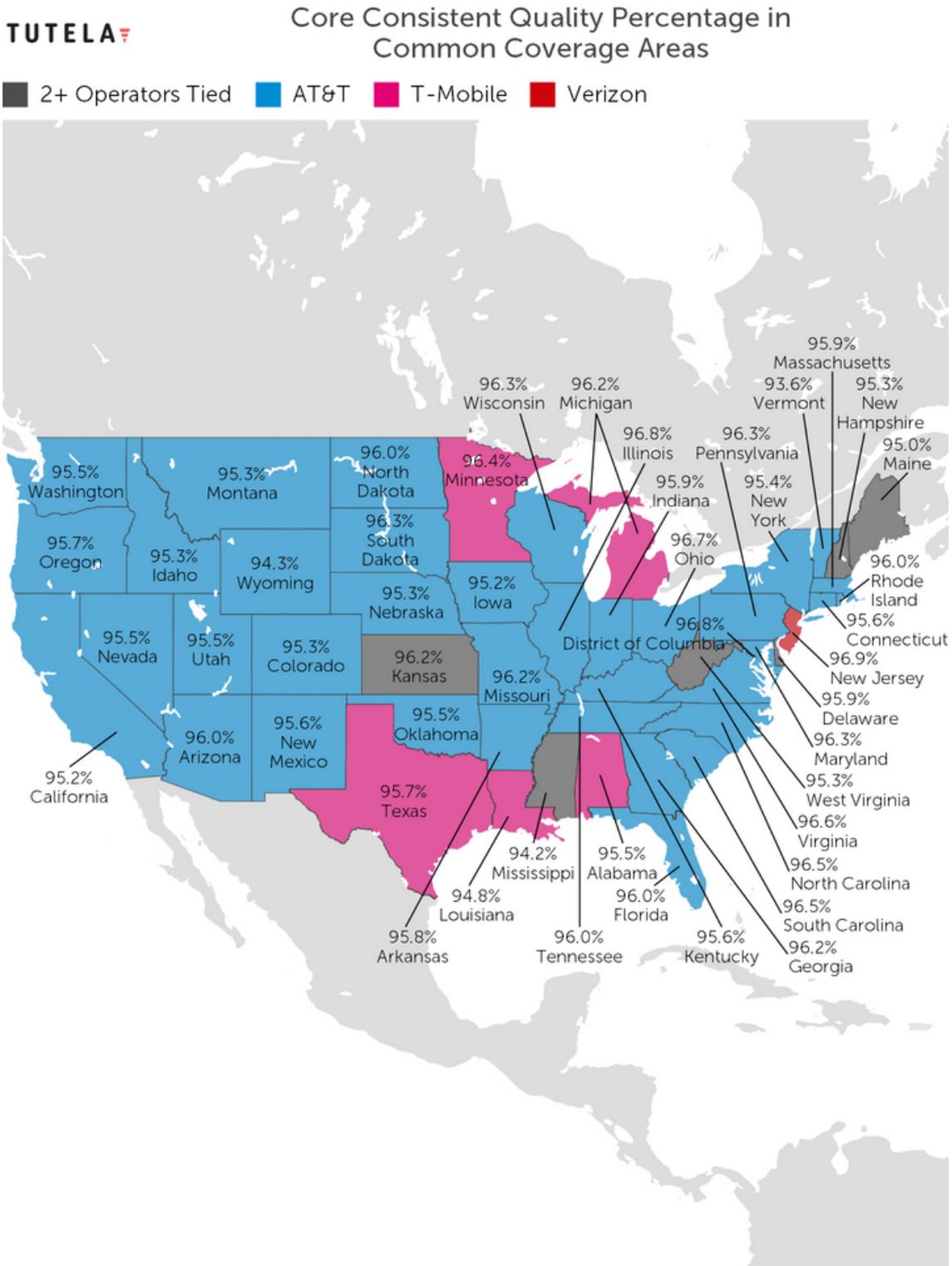
At a regional level, the picture for Excellent Consistent Quality is a little more diverse than when looking at all Common Coverage Areas nationwide. AT&T, T-Mobile, and Verizon all have some states in which they win, and some regional strengths are

apparent. Notably, Verizon’s Excellent Consistent Quality result in its home state of New Jersey, 88.6%, is the best Excellent Consistent Quality result of any operator in any state.



For Core Consistent Quality, the result is much more reflective of the picture we saw at the top level: AT&T dominates, winning all but 12 of the lower 48 states. T-Mobile

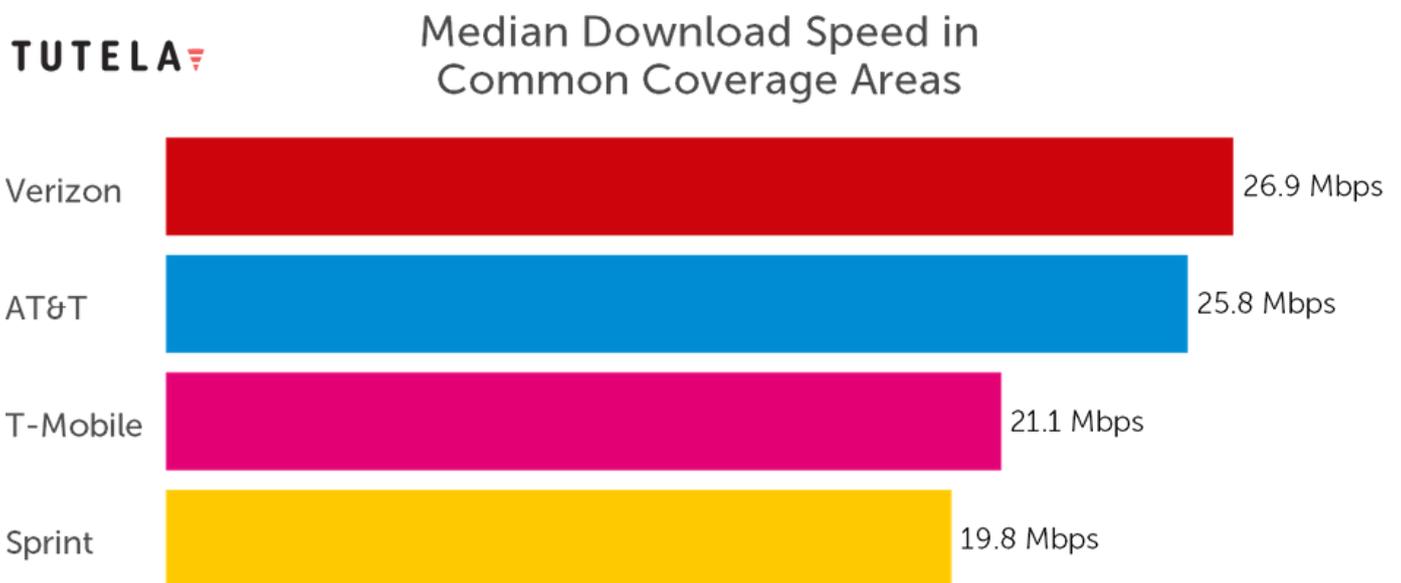
picked up wins in some states in the South and along the Great Lakes, whilst Verizon's sole state-level win was in its home state of New Jersey.



Download throughput

Verizon eked out a small but significant advantage over AT&T to take the crown of the fastest network, at 26.9 Mbps. AT&T was 1.1 Mbps behind, whilst there was a gap of over 5 Mbps back to T-Mobile in third. The difference in download throughput is

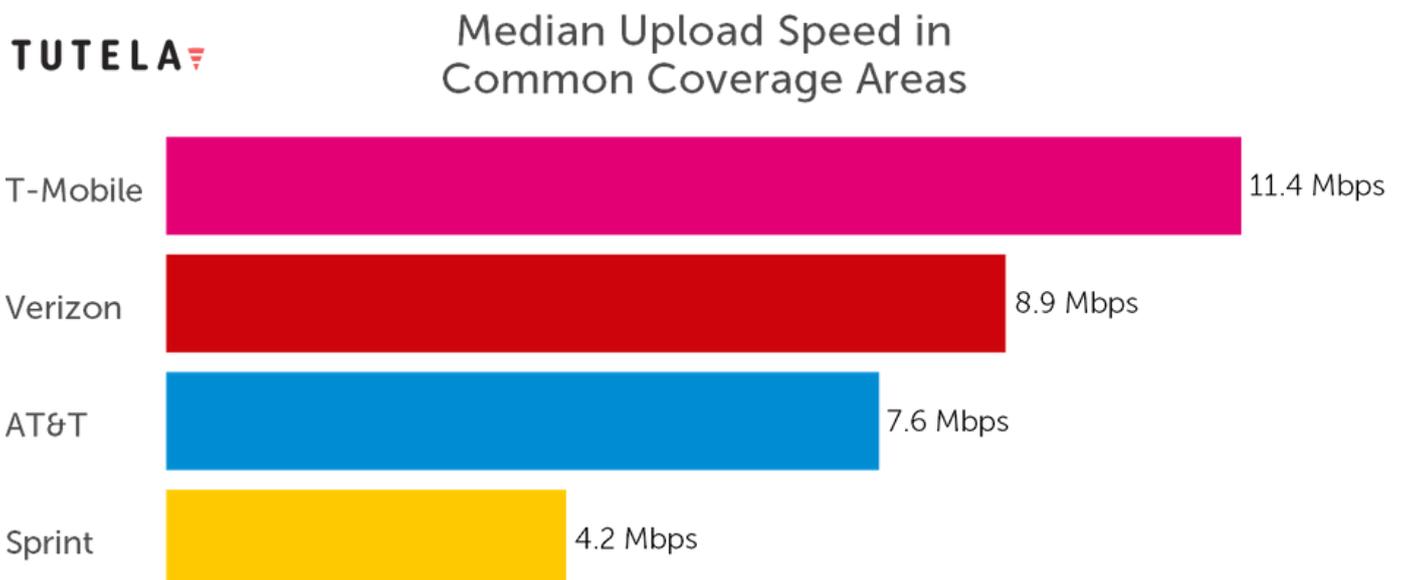
particularly interesting given that Verizon and T-Mobile are tied for first place for Excellent Consistent Quality – it goes to show that average throughput, while important, isn't always in alignment with other measures of a good network experience.



Upload throughput

For upload throughput, the picture is quite different: T-Mobile is in first place, Verizon second, and AT&T in third, with gaps of more than one megabit separating all four operators. Sprint's particularly slow upload throughput — nearly a third of first-placed

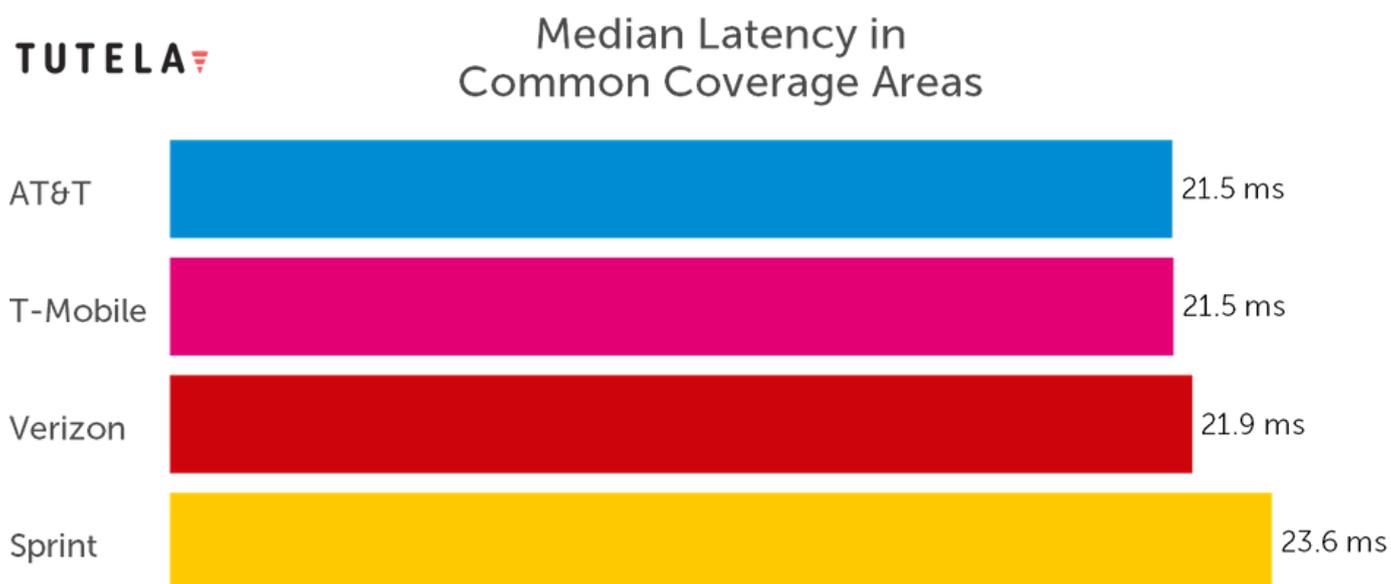
T-Mobile — can partially be attributed to the configuration of Sprint's network. Sprint's TDD 2500 MHz band allocates more resources to download than upload, unlike the FDD system used in other bands.



Latency

Latency, which manifests itself to users as the responsiveness of their connection, is increasingly critical for subscribers, as the use of cellular connections for applications like real-time video calling or online gaming

is on the rise. There is minimal difference between the latency for subscribers of all four operators: just 2.1 milliseconds separates first-place AT&T and T-Mobile from last-place Sprint.



Coverage

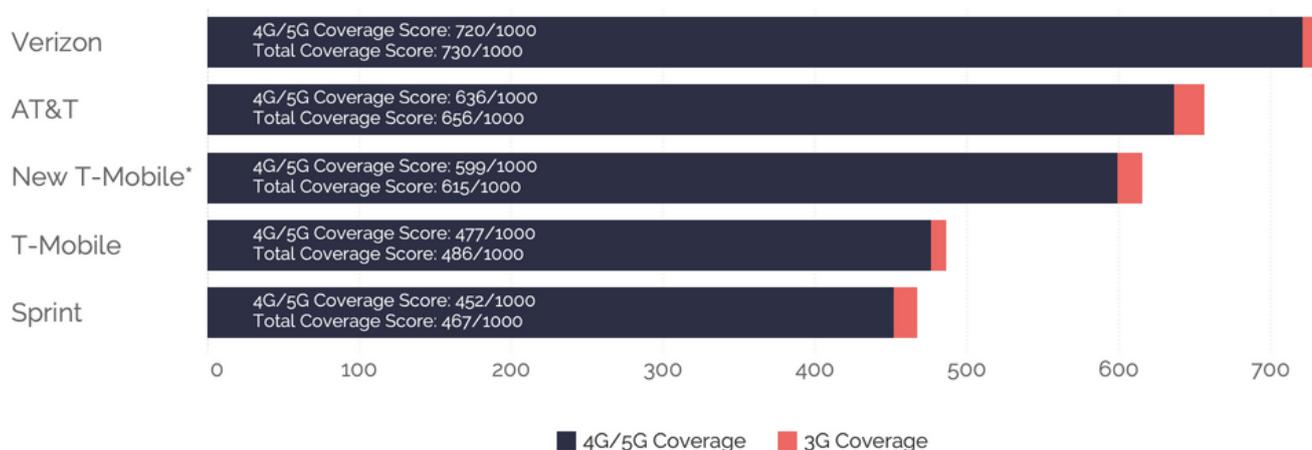
Verizon has a substantial advantage over its competitors when it comes to the area covered, a coverage score of 730 – over 10% better than its next-closest competitor. AT&T is in second place for both the 4G coverage score and total coverage score, although it is notable that a slightly higher proportion of AT&T’s coverage uses the older 3G technology rather than 4G. Verizon’s advantage over T-Mobile is more stark: a gap of 250 points in terms of 4G

coverage, which in real terms represents notable parts of the country where Verizon has signal and T-Mobile does not.

However, combining the networks of T-Mobile and Sprint – the “New T-Mobile” shows how much of a coverage improvement the combined network may be able to offer. New T-Mobile’s 4G and 5G network has a coverage score of 599, just 37 points (around 5%) behind AT&T.

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United States Relative Area Coverage Score



*Coverage score for 'New T-Mobile' is a hypothetical 'best case' construct from combining the existing T-Mobile and Sprint coverage footprints, and may not necessarily reflect the eventual coverage of the combined network

Tutela measures relative coverage between providers in a country by looking at the geographic area that an operator’s subscribers have seen coverage, compared to the total area of the country where the subscribers of any operator can get a mobile connection. The geographic area covered by each operator, relative to the total covered area of the country, is presented as a score out of 1,000.

Tutela measures this coverage from the perspective of end users – that is to say, inclusive of times when coverage is provided as part of a domestic roaming agreement or shared infrastructure program. An equal number of representative samples are considered from each operator in a country to determine coverage. Coverage is assessed over the preceding 12 months to ensure any effects of seasonality are appropriately included.

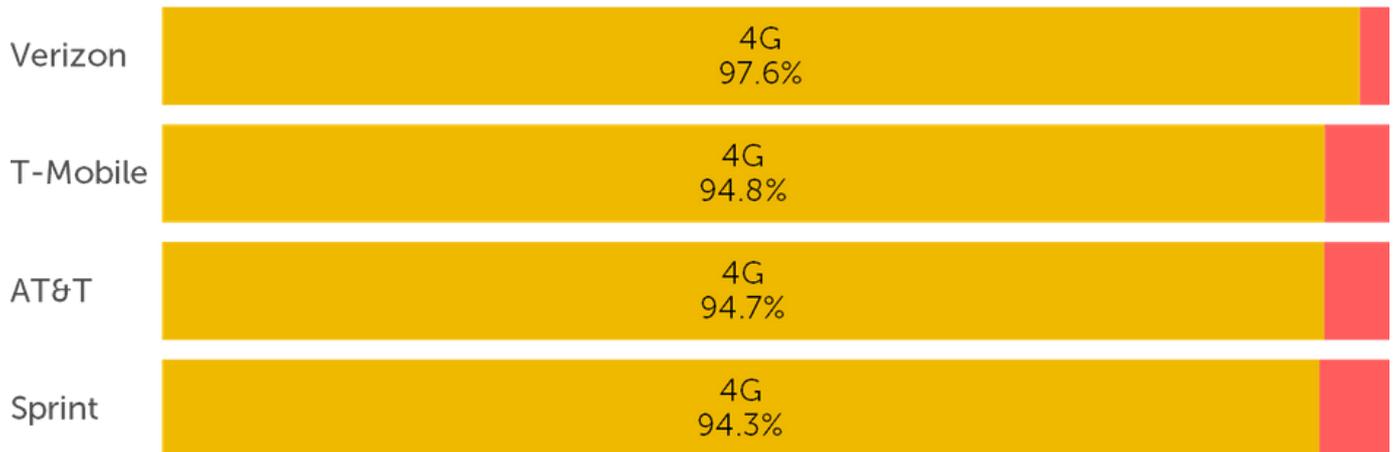
Technology usage

When it comes to the proportion of time that users spend connected to a particular technology, it is a very different picture. Verizon users spend the smallest proportion of time connected to 3G, with the older technology making up just 2.4% of connections by time. T-Mobile, AT&T, and Sprint are all within 0.5% of each other, and all four operators are well over 90% of time spent connected to 4G, showing that the older, legacy technologies no longer make

up a particularly significant proportion of US networks. Although 5G devices and coverage are now more widely available to US consumers, the vast majority of 5G deployments in the report time period are non-standalone (NSA) — that is, the 5G connection is reliant on a 4G anchor connection. As a result, measures of ‘time spent on 5G’ are inconsistent when comparing 5G NSA to 4G or 3G connections.

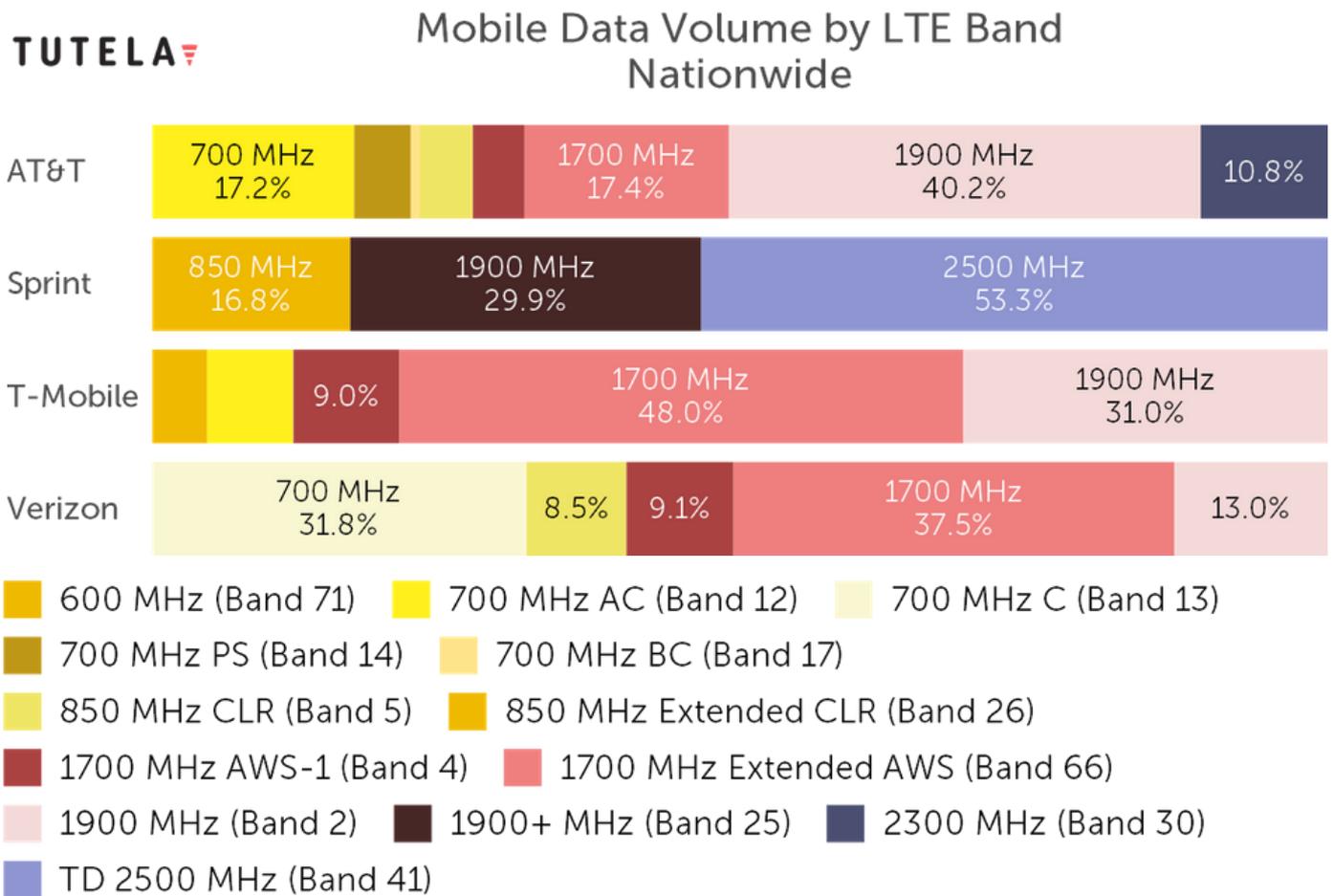


Percent of Time by Mobile Connection Type Nationwide



The biggest story in spectrum deployment over the last year has been T-Mobile’s rapid rollout of 600 MHz, and as expected, the low-band frequency is accounting for an ever-increasing proportion of T-Mobile users’ data usage. Although T-Mobile still leans heavily on 1700 and 1900 MHz for the majority of its data usage, the proportion accounted for by 600 MHz has more than doubled year-on-year, which shows the impact that a widespread rollout can have.

For other operators, little has changed. With the focus currently on the deployment of brand-new spectrum with 5G technology, the 4G picture has remained largely static from a spectrum capacity perspective in the last year. However, recent and upcoming spectrum auctions in the mid-band space – not to mention New T-Mobile’s ambitious spectrum reorganization – herald major changes to come in the next 12 months.





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 organizations in the mobile industry to understand and improve the world's networks. Tutela is a member of the Comlinkdata family.

Tutela collects data and runs network tests via software embedded in a diverse range of consumer applications, which enable the measurement of real-world quality of experience for mobile users, 24/7. For this report, Tutela has collected over 54 billion total records, taken between March 1st and August 31st 2020.

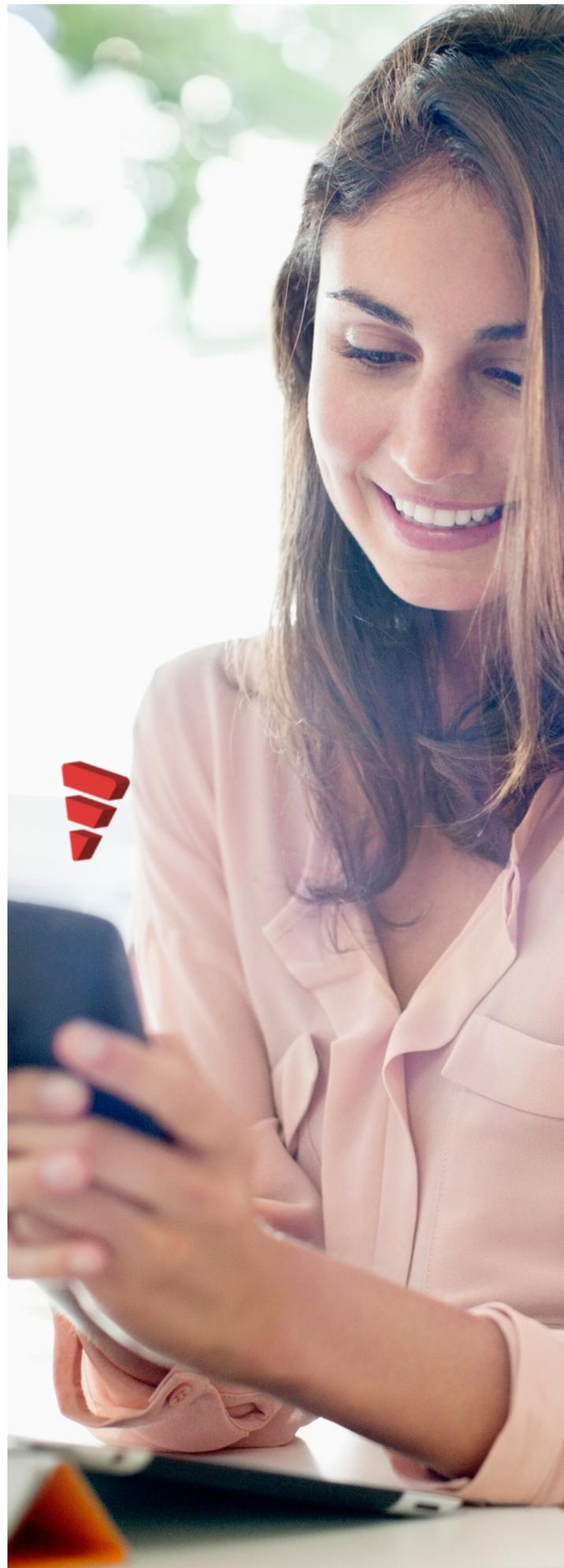
Tutela measures mobile experience based on the real-world performance of actual network subscribers for a given brand, inclusive of occasions when a network or tariff may be throttled or congested. Results in this report are based on a testing configuration designed to represent the typical (rather than 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 websites, 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 through to the latest 5G 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 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 connections 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 also considers times when a Consistent Quality style test was attempted, but subsequently failed for distinguishable connectivity issues

on the download or server response component, towards the total percentage of "failed" tests against both sets of thresholds. Tutela bases the threshold values on the minimum performance requirements published by popular apps. We most recently updated our Consistent Quality thresholds on September 1st, 2020. 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	Time to first byte
Minimum acceptable value	5 Mbps	1.5 Mbps	50 ms	30 ms	1%	3.2 s

Core Quality

KPI	Download throughput	Upload throughput	Latency	Jitter	Packet loss	Time to first byte
Minimum acceptable value	1.5 Mbps	500 Kbps	100 ms	50 ms	5%	10.67 s

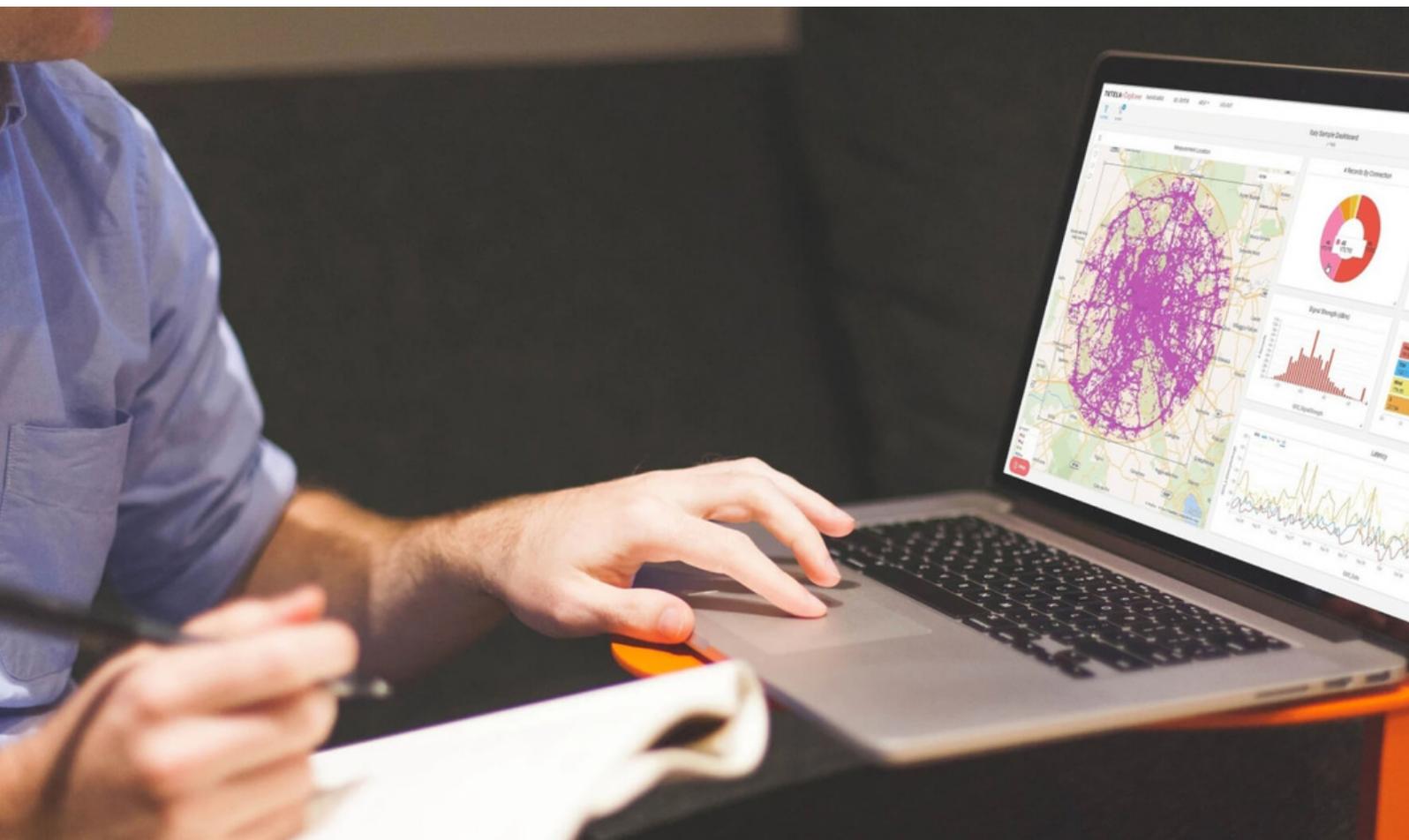
Discover Tutela Explorer

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

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Appendix

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Results Overview in Common Coverage Areas

	Download Throughput	Upload Throughput	Latency	Excellent CQ	Core CQ
AT&T	25.8 Mbps \pm 0.01 Mbps	7.6 Mbps \pm 0.01 Mbps	21.5 ms \pm 0.007 ms	81.99% \pm 0.02%	95.80% \pm 0.01%
Sprint	19.8 Mbps \pm 0.02 Mbps	4.2 Mbps \pm 0.00 Mbps	23.6 ms \pm 0.008 ms	71.64% \pm 0.04%	90.93% \pm 0.02%
T-Mobile	21.1 Mbps \pm 0.01 Mbps	11.4 Mbps \pm 0.01 Mbps	21.5 ms \pm 0.007 ms	83.37% \pm 0.02%	94.89% \pm 0.01%
Verizon	26.9 Mbps \pm 0.01 Mbps	8.9 Mbps \pm 0.00 Mbps	21.9 ms \pm 0.003 ms	83.40% \pm 0.01%	94.70% \pm 0.01%

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Results Overview Nationwide

	Download Throughput	Upload Throughput	Latency	Excellent CQ	Core CQ
AT&T	24.8 Mbps \pm 0.01 Mbps	6.8 Mbps \pm 0.00 Mbps	22.4 ms \pm 0.004 ms	79.41% \pm 0.02%	95.10% \pm 0.01%
Sprint	19.1 Mbps \pm 0.02 Mbps	4.1 Mbps \pm 0.00 Mbps	23.9 ms \pm 0.008 ms	69.81% \pm 0.03%	89.86% \pm 0.02%
T-Mobile	20.9 Mbps \pm 0.01 Mbps	10.9 Mbps \pm 0.01 Mbps	22.0 ms \pm 0.007 ms	82.67% \pm 0.02%	94.71% \pm 0.01%
Verizon	25.2 Mbps \pm 0.01 Mbps	7.8 Mbps \pm 0.00 Mbps	22.7 ms \pm 0.002 ms	80.42% \pm 0.01%	93.56% \pm 0.01%

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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