



TUTELA 

United States of America

Special Report: State of MVNOs

Analysts

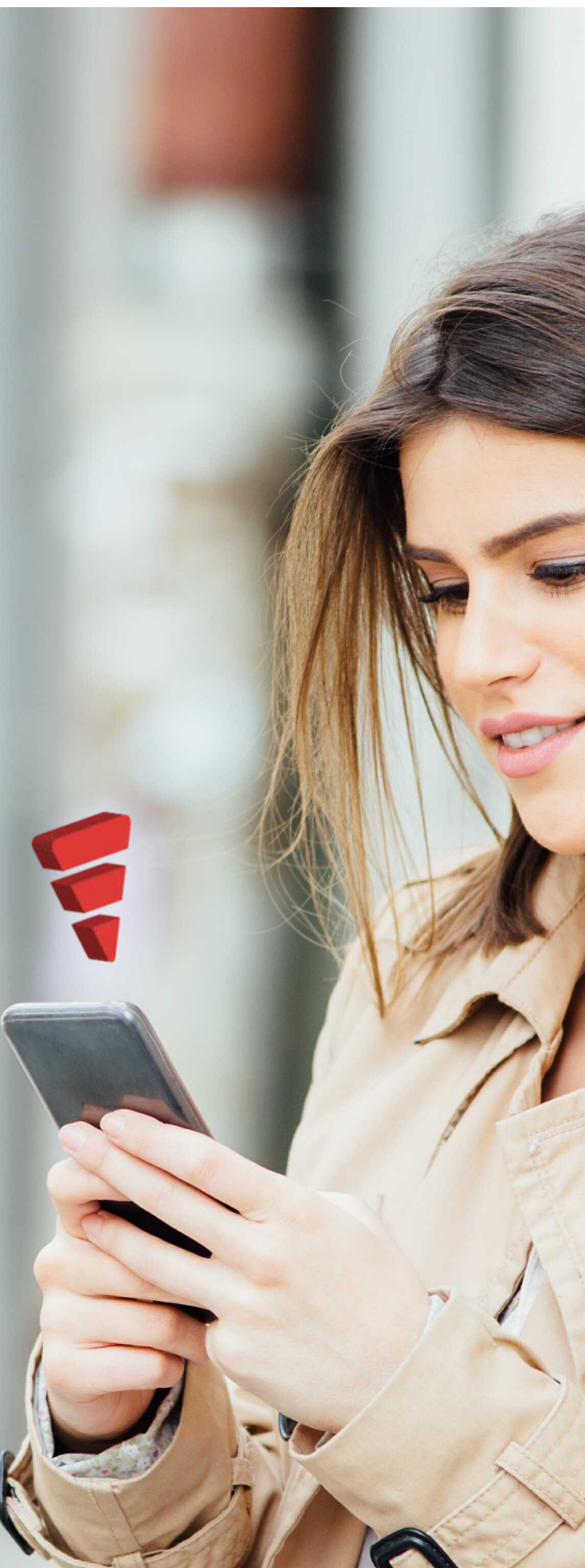
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OCTOBER 2019

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Mobile virtual network operators (MVNOs) have traditionally been regarded as a complement to traditional operators. By offering bundles and services aimed at highly specific segments of the market, MVNOs and MNO flanker brands in the US carved out a niche largely serving the needs of lower-income customers or those with particular data needs(1).

But in 2019, the landscape is rapidly shifting. Technological advancements have made the barrier for operating some kind of network much lower; the entrance of cable companies into the market have pushed MVNO service into the more lucrative postpaid segment; and multi-network MVNOs are innovating on the network side of the equation, rather than solely differentiating on price or customer service.

Tutela, an independent crowdsourced mobile data company with over four million daily active users in the US, is in a unique position to provide insights into how MVNOs are transforming the competitive landscape of cellular service in the US. By combining crowdsourced network Quality of Experience data with network utilization information, this report will answer the question of how, where, and to what degree MVNOs are disrupting the wireless telephony industry.

(1) FCC, Twentieth Mobile Wireless Competition Report

<https://docs.fcc.gov/public/attachments/DO C-346595A1.pdf>

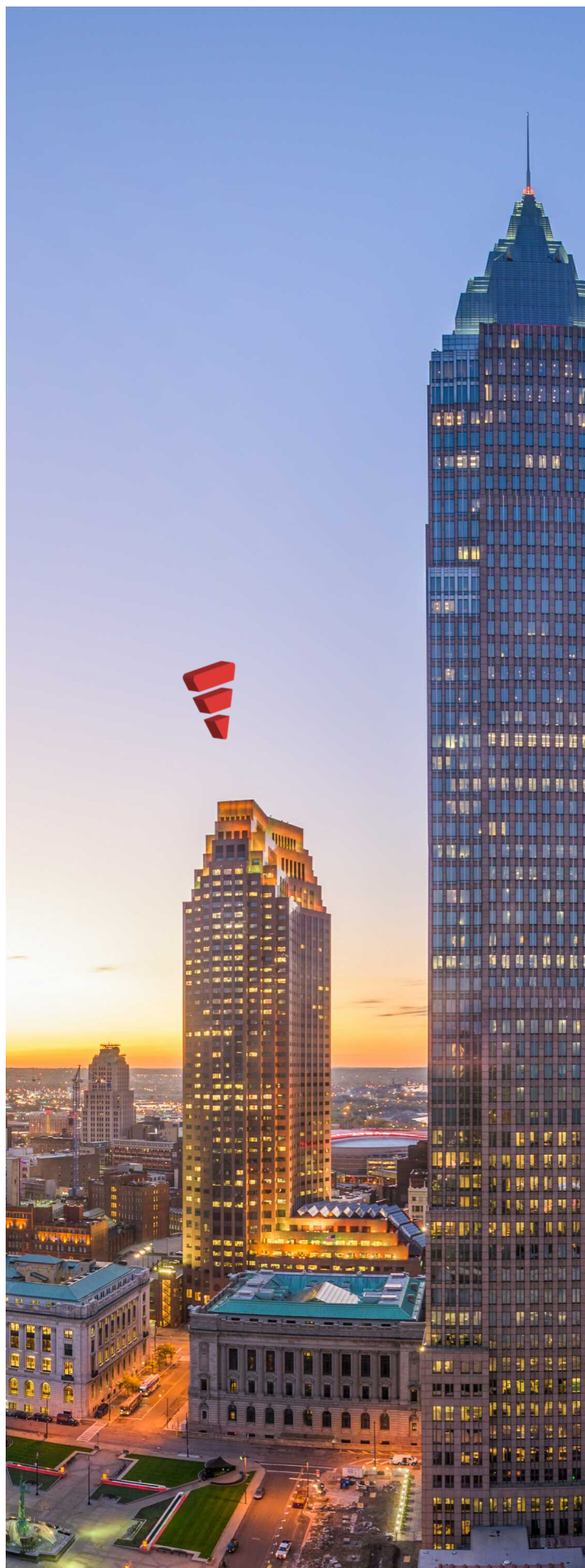
Retrieved 4 October 2019

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Key findings

- Comcast and Charter's wireless plays have seen MVNOs disrupt the lucrative postpaid market for the first time. Xfinity Mobile and Spectrum Mobile captured nearly 50% of the postpaid subscriber growth in Q2 2019, and combined added nearly as many postpaid subscribers as host network Verizon. Tutela data suggests that Xfinity Mobile has already succeeded in offloading over 6% of smartphone data traffic onto its Wi-Fi network - far more than any other network - and the emergence of new technology (such as shared CBRS spectrum) shows a path to profitability for a hybrid MVNO.
- Multi-operator MVNOs can compete on user Quality of Experience, as well as factors such as price and customer service. Google Fi's service, running on T-Mobile, Sprint, and US Cellular, outperformed T-Mobile and Sprint's respective prepaid brands by a significant margin, when measured using Tutela's Excellent Consistent Quality methodology.
- Altice's just-launched MVNO service has several of the key features that Tutela has identified in other successful MVNO plays including a widespread and fast Wi-Fi network, a multi-operator MVNO agreement, and highly competitive pricing. Although it's too early to evaluate the quality of its offering, Altice is poised to make waves in the market.



MVNO performance

Tutela uses two key methodological components to best compare user experience across MVNOs: 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 or 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, taken when a user has signal. These were most recently re-assessed and updated [September 1st, 2019](#).

Common Coverage Areas are parts of the country where the majority of nationwide operators (AT&T, Sprint, T-Mobile, and Verizon) offer service. It is important to realize that this comparison is of real-world Quality of Experience, as recorded from handsets of actual MVNO customers. Among MVNOs, the use of metered or speed-limited tariffs is particularly common, given MVNOs' historic focus on lower-income demographics. As such, the measured network performance reflects what a user has paid for -- not what the network may hypothetically be capable of.



Consistent Quality

Xfinity Mobile and Spectrum run their service over Verizon's network, which explains why they both finish in the top three for Excellent and Core Consistent Quality. Google Fi, which runs across T-Mobile, Sprint and US Cellular, comes in second place for Excellent Consistent Quality and third place for Core Consistent Quality. In both instances, Fi performs better than Metro or Boost, the prepaid

brands of T-Mobile and Sprint respectively. This is likely due to Google Fi's approach to dynamic network switching, with the company stating that on phones designed for the Fi network, Google moves users onto the network which offers the best experience in a user's current location(2). For the majority of MVNOs, the measured Quality of Experience closely mimics what we saw in Tutela's [recent report on MNOs](#).

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Consistent Quality Percentage in Common Coverage Areas



(2) Google Fi, Frequently asked questions
<https://fi.google.com/about/faq/#coverage-3>
 Retrieved 4 October 2019

The best Excellent Consistent Quality was just shy of 80% -- close to Verizon's MNO-leading Excellent Consistent Quality of 80.6%. With the exception of Cricket, the lowest Excellent Consistent Quality was 61.4%, just shy of fourth-place AT&T at 62.4%.

This indicates that in many cases and looking on average across the United States, even on the cheaper pre-paid plans that some MVNOs specialise in, users tend to get a broadly equivalent experience to users on the "main" networks.

Cricket's 24.6% Excellent Consistent Quality can be explained by looking at the speed limitations on the majority of its plans. "Cricket caps download speeds on all its rate plans at 8Mbps (LTE)/4Mbps (4G) except for

the Cricket Core Plan which is capped at 3 Mbps (LTE/4G) and the Cricket More Plan and data only plans," according to Cricket's terms of service(3). Since Tutela's Excellent Consistent Quality threshold requires a download throughput of 5 Mbps --in line with what Netflix recommends for HD video streaming(4) among other core use cases -- the majority of tests from Cricket subscribers fail the Excellent Consistent Quality test.

Nonetheless, Cricket's Core Consistent Quality -- that is, its tested performance against metrics designed to represent SD video streaming, social media usage and VOIP calls -- is very much in line with other MVNOs, and indicates that for simpler use cases, most users can do the things they want to do with their phone the vast majority of the time when they have a signal.

(3) Cricket Wireless, Mobile Broadband Information

<https://www.cricketwireless.com/legal-info/mobile-broadband-information.html>

Retrieved 4 October 2019

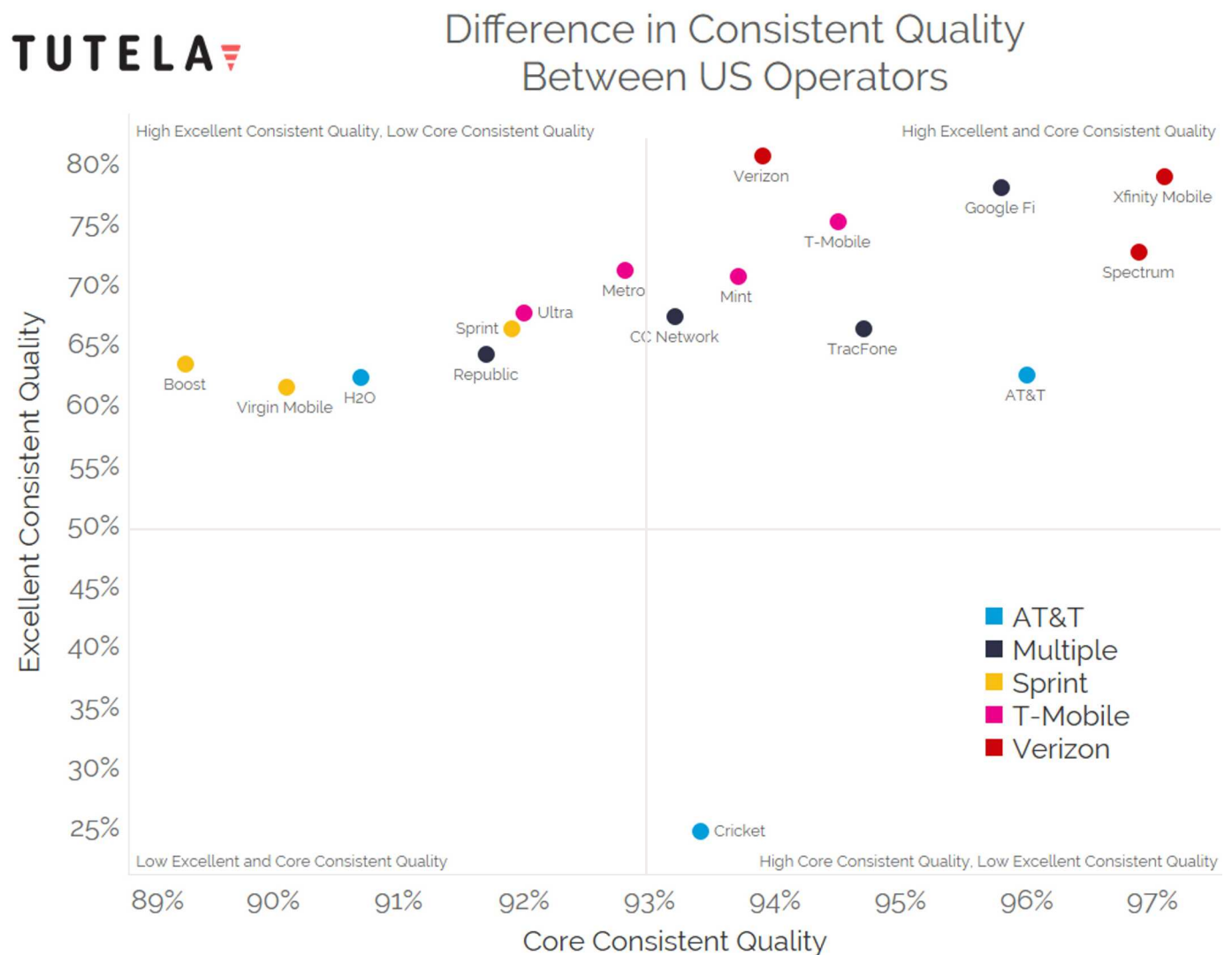
(4) Netflix, Internet Connection Speed Recommendations

<https://help.netflix.com/en/node/306>

Retrieved 4 October 2019

When looking across the entire United States at Common Coverage Areas, Verizon-powered networks (including Verizon's own services but also MVNOs Xfinity and Spectrum that run on Verizon infrastructure) tend to perform extremely well for both Core and Excellent Consistent Quality; all three appear in the upper-right quadrant of

the below chart. Verizon subscribers on the Verizon network had the overall best Excellent Consistent Quality in Common Coverage Areas in the US across all MNO and MVNOs, while Xfinity had the highest Core Consistent Quality, and placed second overall for Excellent Consistent Quality.

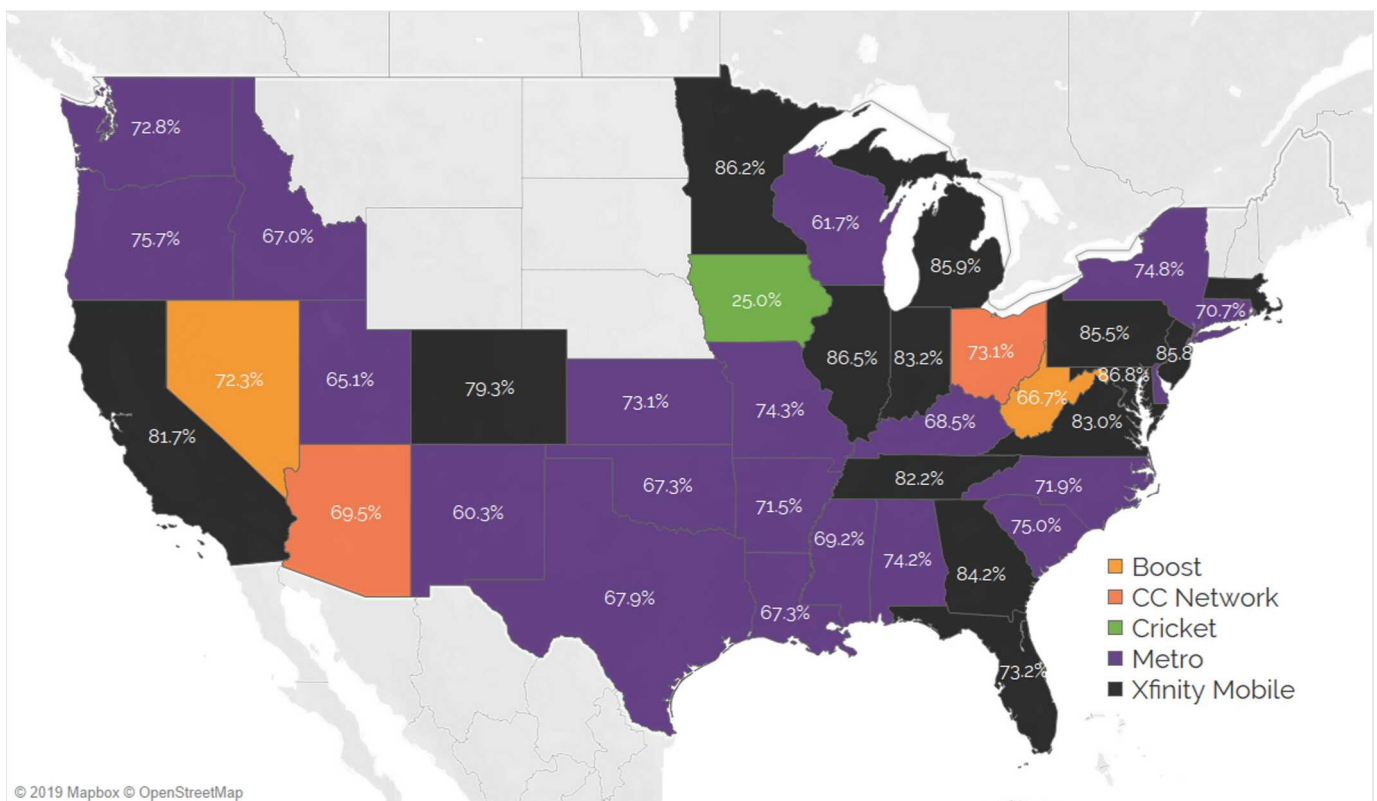


All four MNOs outperform the MVNOs that operate solely on their networks when it comes to Excellent Consistent Quality, while Sprint, AT&T and T-Mobile all also outperform their resident MVNOs on Core Consistent Quality as well. Some of the differences in Core Consistent Quality results -- such as Xfinity Mobile and

Spectrum Mobile outperforming Verizon for Core Consistent Quality -- are attributable to the different approaches networks take to traffic management, as well as the mix of prepaid and postpaid subscribers and geographical differences in where customers are located.



Best Provider for Excellent Consistent Quality Percentage in Common Coverage Areas



State-by-state results for Consistent Quality. MVNOs have only been included in a state-level comparison if Tutela has a statistically significant number of records (with an error margin of less than one percent) in a given state.

Cricket is a notable outlier -- the reasons for its lower Excellent Consistent Quality have already been established but it is interesting to note that its Core Consistent Quality is relatively high, placing in the bottom right quadrant.

Its Core Consistent Quality was higher overall than that of Sprint, as well as several of the Sprint and T-Mobile based MVNO networks.

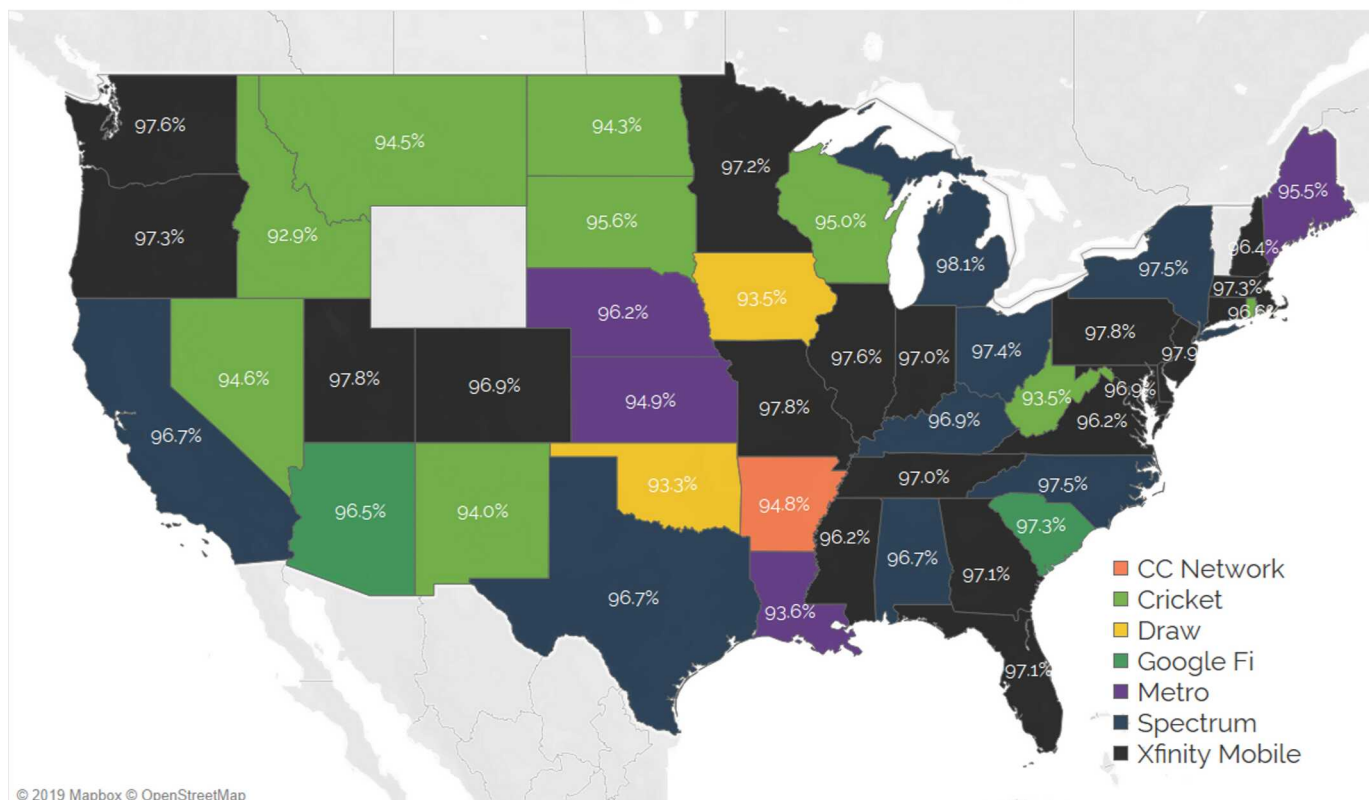
In many ways, this is a testament to the strength of AT&T's base network for Core Consistent Quality -- in Tutela's recent State

of Mobile Networks report for the US, AT&T was the best provider for Core Consistent Quality in 35 of the lower 48 states. It is important to note that the combination of different plans and devices on different host networks will have a tangible impact on the perceived and reported mobile experience.

For example, networks that operate stringent throttling procedures will appear in Tutela's tests as having a worse result due to the capped speed, while users may of course be happy to accept these in exchange for lower-cost plans.

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Best Provider for Core Consistent Quality Percentage in Common Coverage Areas



Download throughput

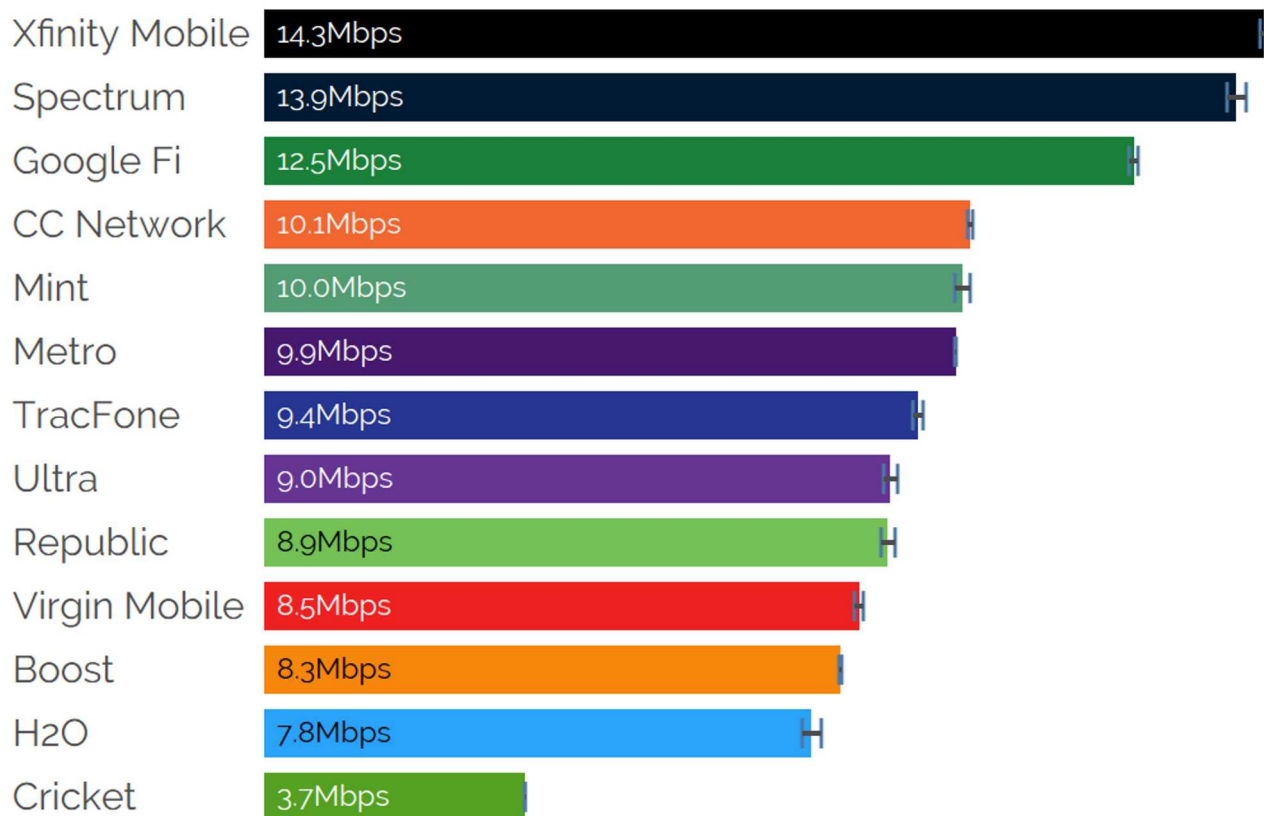
The difference in speeds between MVNOs running on the Verizon network and those running on those of Sprint, T-Mobile and AT&T was not as striking as in [Tutela's State of Mobile Networks Report](#) on the USA.

There, Verizon had a comfortable 7.1 Mbps

lead over T-Mobile for median download throughput, but just 1.4 Mbps separates Spectrum, running on Verizon's network, from Google Fi on Sprint and T-Mobile (and, to a certain extent, US Cellular).

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Median Download Speed in Common Coverage Areas



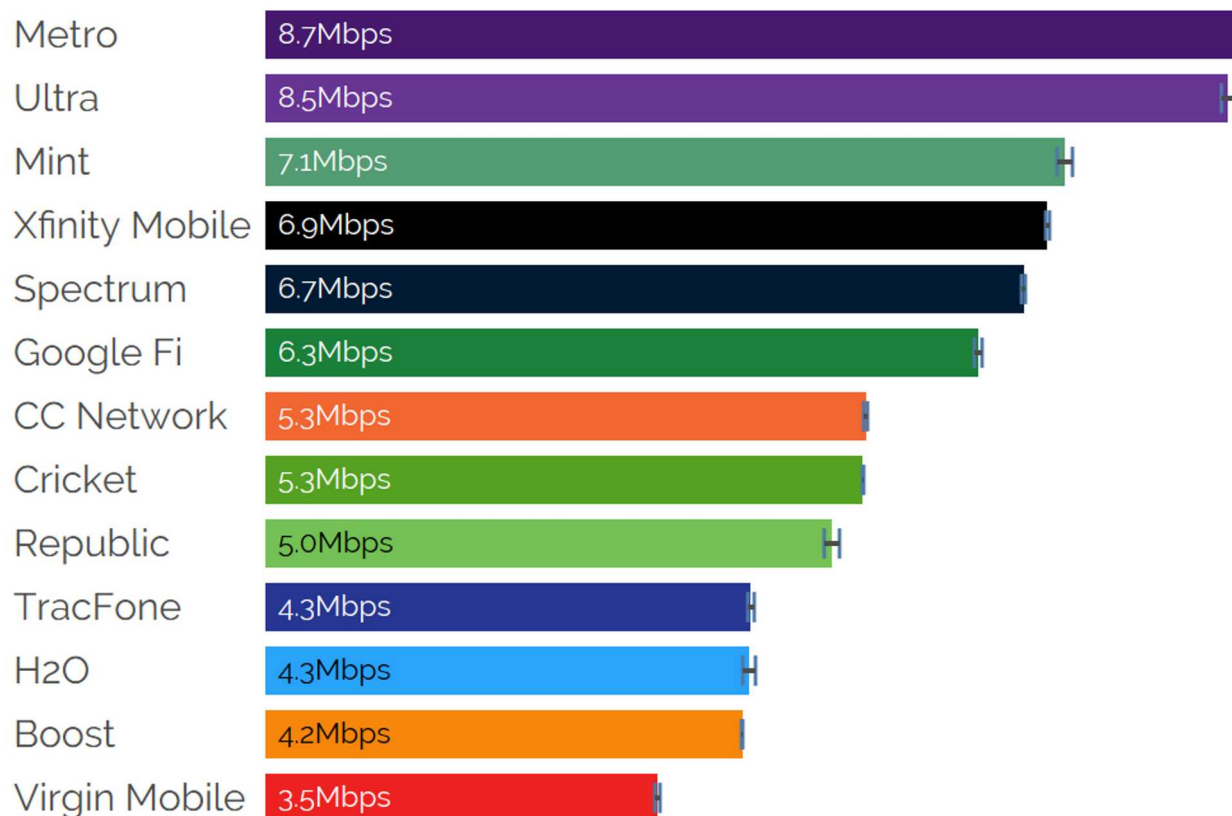
Upload throughput

Metro, Ultra and Mint, all T-Mobile MVNOs topped the table for median upload speed, again echoing the findings of the earlier national MNO report which saw T-Mobile demonstrate a clear lead of 0.9 Mbps over Verizon in this metric. Metro's 8.7 Mbps

upload speed was actually slightly faster than that of host-network T-Mobile (8.5 Mbps), likely a result of Metro's focus on urban areas only where networks tend to be slightly faster.

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Median Upload Speed in Common Coverage Areas



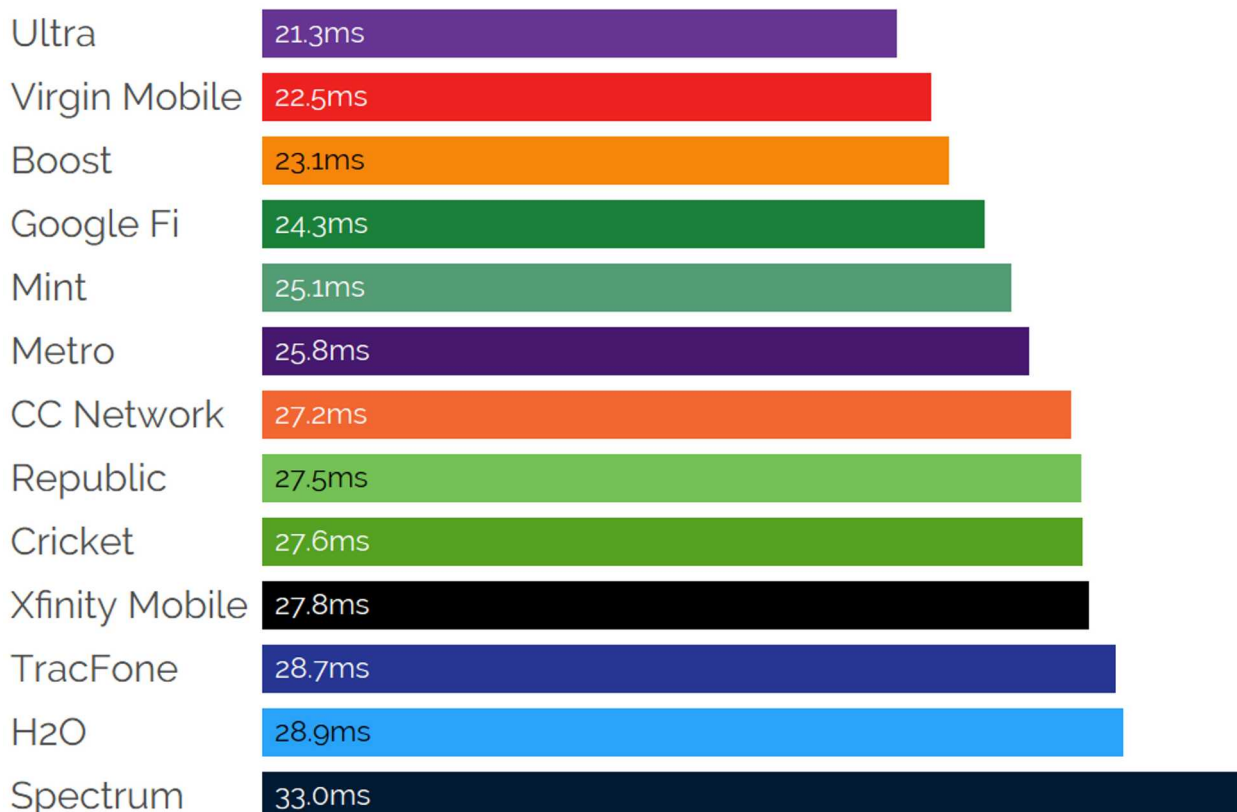
Latency

In terms of latency, Ultra's 21.3 ms performance on the T-Mobile network is particularly impressive. T-Mobile ranked third for latency in the State of Mobile Networks report, yet one of its MVNOs beat out Virgin Mobile and Boost (both on Sprint's network, which had the best latency in the US across Common Coverage Areas)

in the MVNO ranking. Meanwhile, Spectrum finished last for latency among MVNOs at 33.0 ms, significantly behind host network Verizon's national median in Common Coverage Areas of 23.1 ms. This could be indicative of the impact of different packet switching approaches between the host network and CDNs.



Median Latency in Common Coverage Areas



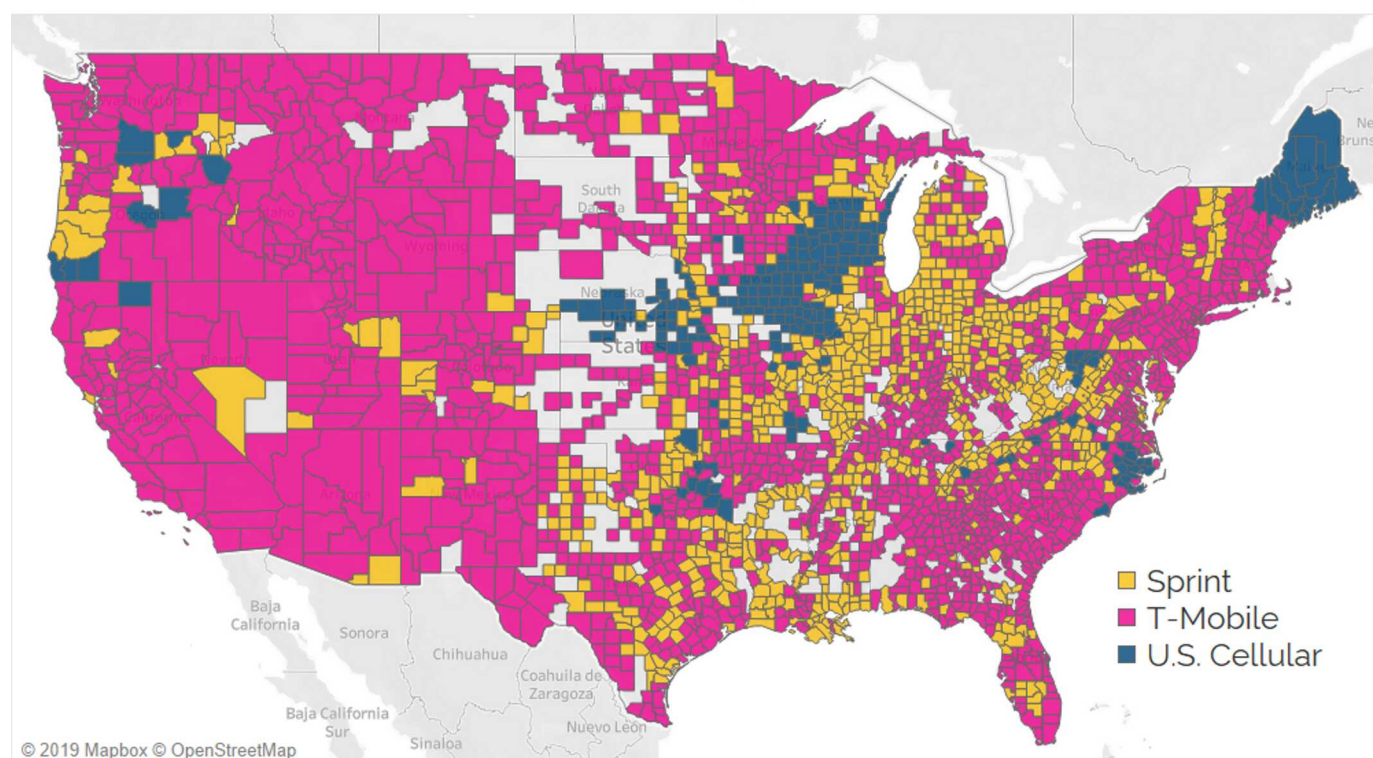
The performance advantage of multi-network MVNOs

Google Fi outperformed almost all other MVNOs, in particular Metro and Boost, the prepaid brands of T-Mobile and Sprint respectively. The difference is substantial: Google Fi comes in second place for Excellent Consistent Quality and third place for Core Consistent Quality, with an Excellent Consistent Quality some 14.7% better than Boost and 6.9% better than Metro. There are two factors that largely explain Google Fi's superior performance (compared to every MVNO other than Xfinity

Mobile and Spectrum). Firstly, it primarily uses both T-Mobile and Sprint's network (with additional coverage from US Cellular), with certain Android handsets designed to use whichever network is best in any particular location. Dynamically switching between LTE networks based on performance means Google Fi customers have access to dramatically more cell sites, and are less affected by network congestion.

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Most Common Connection Provider
for Google Fi Customers

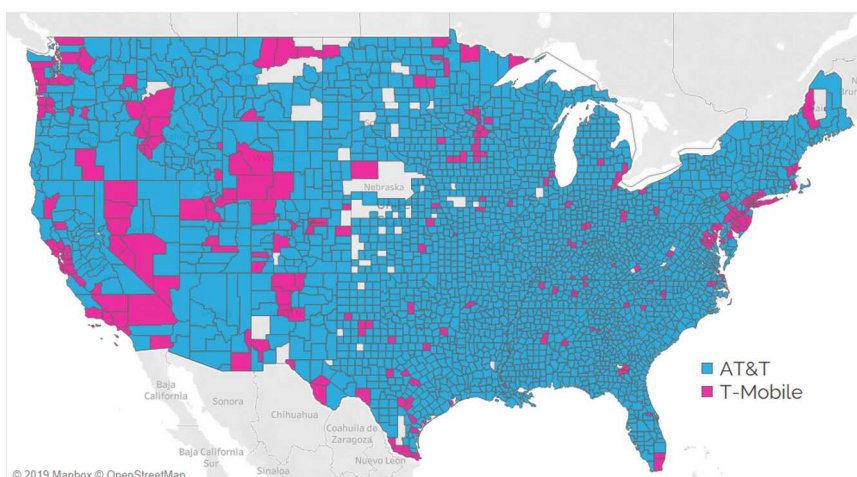


The second factor explaining Google Fi's performance compared to Metro or Boost is the device breakdown. Although a broad range of Android and iOS devices work with Google Fi's service, the network is targeted most heavily at owners of Google's own Pixel devices, as well as selected LG and Motorola handsets.

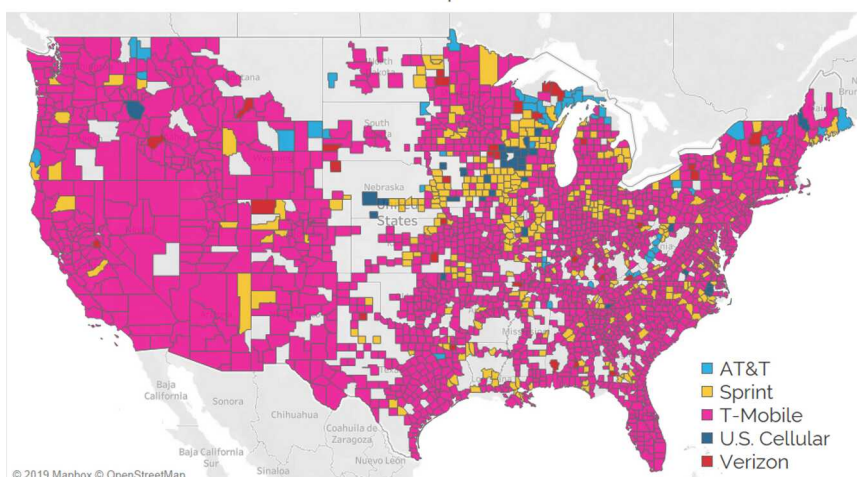
Tutela data suggests that the Pixel 3 and Pixel 2 family are the most popular devices on Google Fi's network -- a sharp contrast to other US operators, where Samsung models dominate. The Pixel devices use top-of-the-line cellular modems, which intrinsically provide a better cellular experience than older or mid-range devices.

Although three other MVNOS employ a multi-operator model, none have been as successful as Google Fi in using the multi-operator model to improve performance. There are some possible explanations: Google Fi is the only MVNO to send a significant portion of its traffic over US Cellular; its device mix is also more strongly preferenced towards (better-performing) flagship devices.

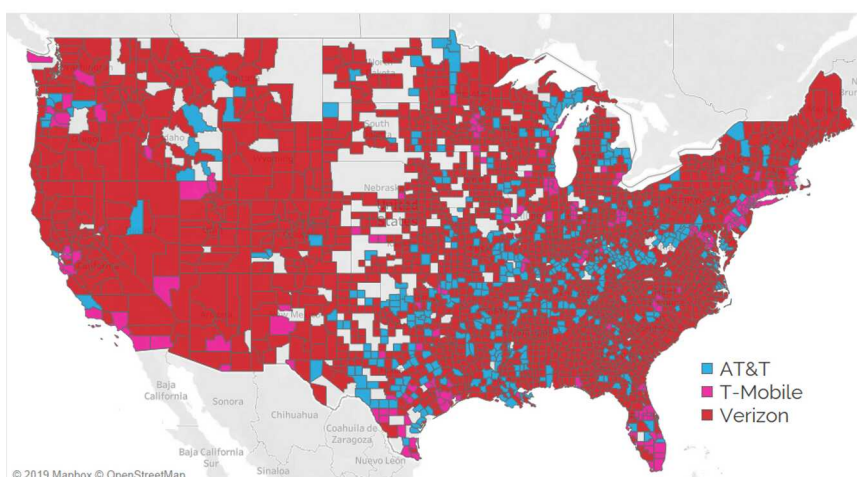
TUTELA Most Common Connection Provider for Consumer Cellular Customers



TUTELA Most Common Connection Provider for Republic Customers



TUTELA Most Common Connection Provider for TracFone Customers



The rise of the cable companies

Arguably the greatest shift in the MVNO market in the last decade was the 2012 deal⁽⁵⁾ that saw Comcast and Charter sell valuable AWS spectrum to Verizon for \$3.6 billion -- and a future agreement to use Verizon's network to resell wireless services.

In the years since the deal was struck, Verizon has built out a formidable LTE network, thanks in no small part to the mid-band capacity acquired from the cable companies. Starting in 2017 -- the year they were eligible to begin MVNO operators -- the cable companies have begun building out a very different kind of MVNO. Xfinity Mobile and Spectrum Mobile, the MVNO brands of

Comcast and Charter that began service in 2017 and 2018 respectively, are differentiated from traditional MVNO brands on virtually every front. Most significant has been the growth: in just two years, Xfinity Mobile has hit 1.58 million subscribers⁽⁶⁾; Spectrum Mobile, currently around 500,000 subscribers, is on a similar trajectory.

Both companies are now significant players in the lucrative postpaid market, where MVNOs had before failed to make an inroad. Xfinity Mobile and Spectrum Mobile captured nearly 50% of the postpaid subscriber growth in Q2 2019, and combined added nearly as many postpaid subscribers as host network Verizon.

(5) Multichannel, DOJ Approves SpectrumCo Deal

<https://www.multichannel.com/news/doj-approves-spectrumco-deal-263616>

Retrieved 4 October 2019

(6) Comcast, 2nd quarter 2019 results

<https://www.cmcsa.com/static-files/f5deca1f-ba30-4ad5-a891-30811f3e677b>

Retrieved 4 October 2019

The value of the customers that Xfinity and Spectrum are attracting is evident, both from financial statements but also the devices on offer. Spectrum's average wireless revenue per subscriber is \$90 higher than Verizon's -- likely due to the premium device mix on offer, as well as the fact that BYOD is only a recent introduction.

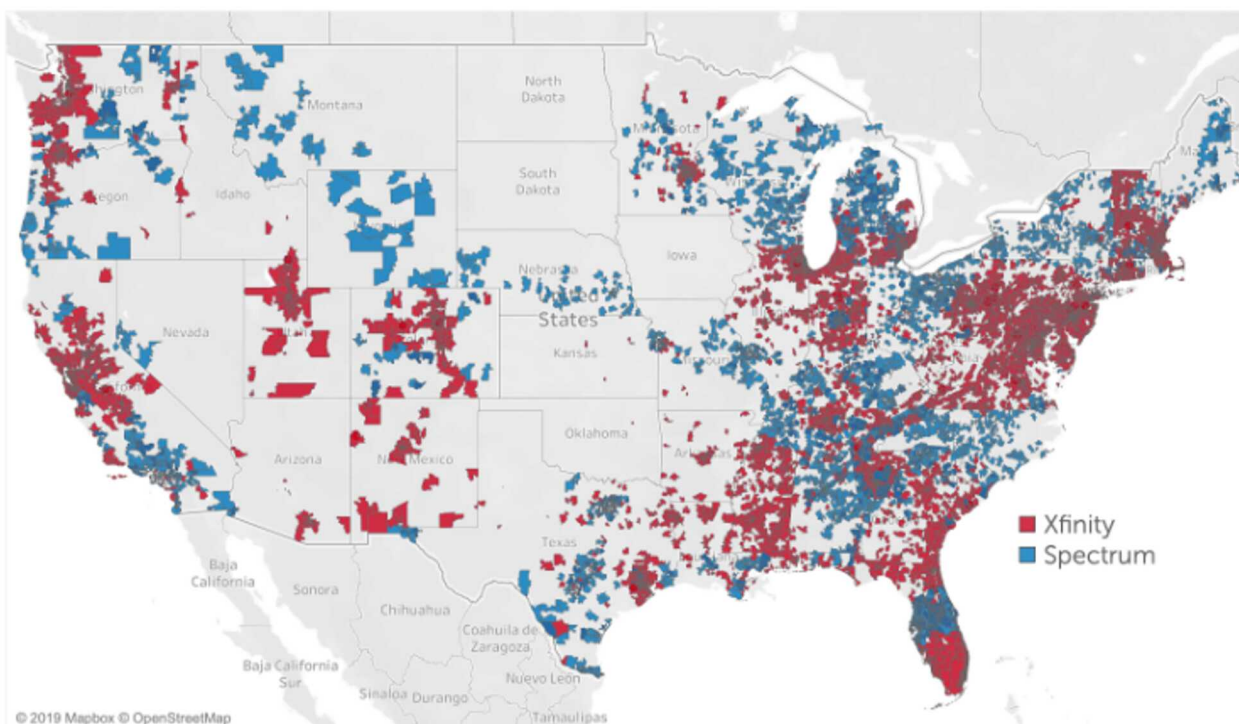
In addition to the targeting of high-value postpaid subscribers, there are other major operating differences between the cable MVNOs and traditional independent MVNOs. For one, the economics of a triple-play or quad-play model have made low prices and loss-leading user acquisition the focus, rather than profitability. Xfinity Mobile and Spectrum Mobile are only offered to customers who purchase one of the cable

companies' traditional wired products, pushing consumers towards bundling. The revenue from other telecoms products allows Comcast and Charter to offer their wireless services for some of the lowest prices in the industry -- \$45 for unlimited service, or \$12-14 per-GB for metered plans.

"Revenue from other telecoms products allows Comcast and Charter to offer their wireless services for some of the lowest prices in the industry"

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Market footprint comparison – Spectrum Mobile and Xfinity

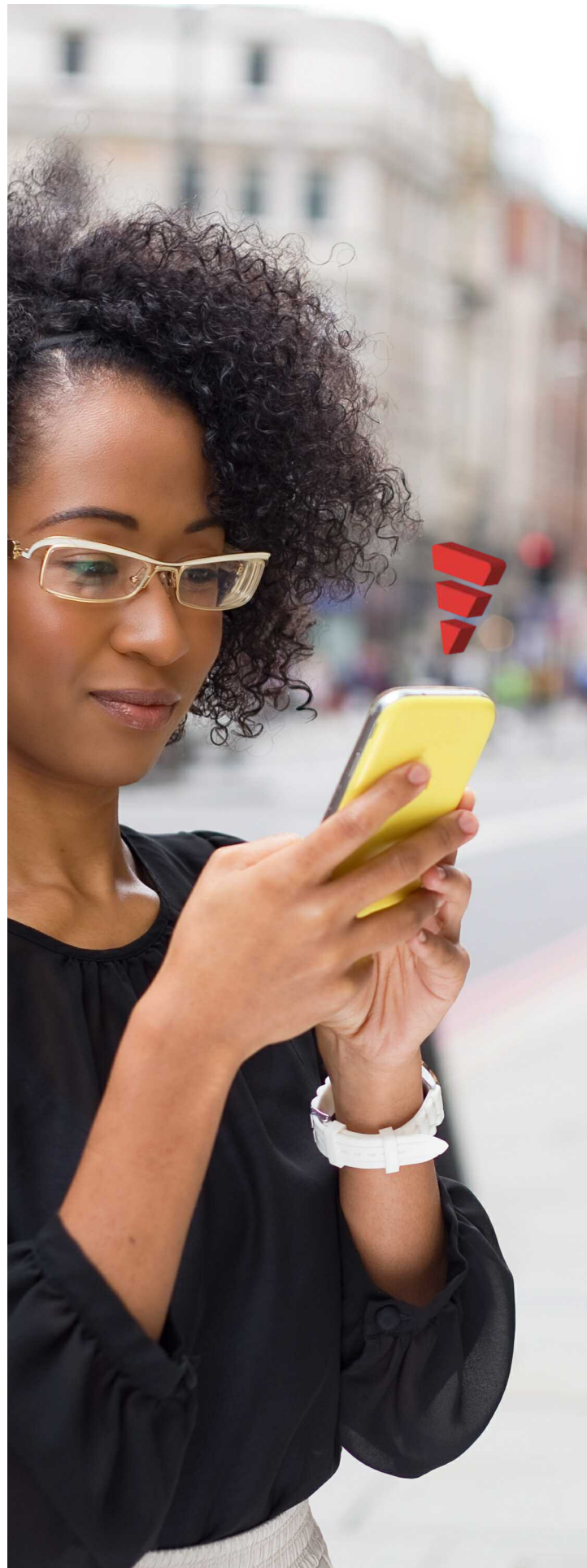


Verizon's cheapest Unlimited plan runs \$70 for a single line, and since Xfinity Mobile and Spectrum Mobile users get service on par with Verizon postpaid subscribers, the cable MVNOs' offerings are much more affordable -- especially for families that may want to mix-and-match unlimited and metered lines on the same account. A 2018 survey(7) of Xfinity Mobile customers indicated that the greatest share of them came from Verizon.

Of course, the highly competitive pricing has come at a significant cost to the cable companies. Xfinity Mobile lost an estimated \$1.2 billion in its first two years of operation -- approximately \$1,000 per subscriber line added over that period.

The majority of that loss is in payments for wireless service to Verizon, and as such, the cable MVNOs' path to profitability relies on reducing those payments, primarily by offloading data traffic from Verizon's network.

(7) Fiercewireless, Editor's Corner—Here's exactly who Xfinity Mobile is stealing customers from ... and why
<https://www.fiercewireless.com/wireless/editor-s-corner-here-s-exactly-who-xfinity-mobile-stealing-customers-from-and-why>
Retrieved 4 October 2019



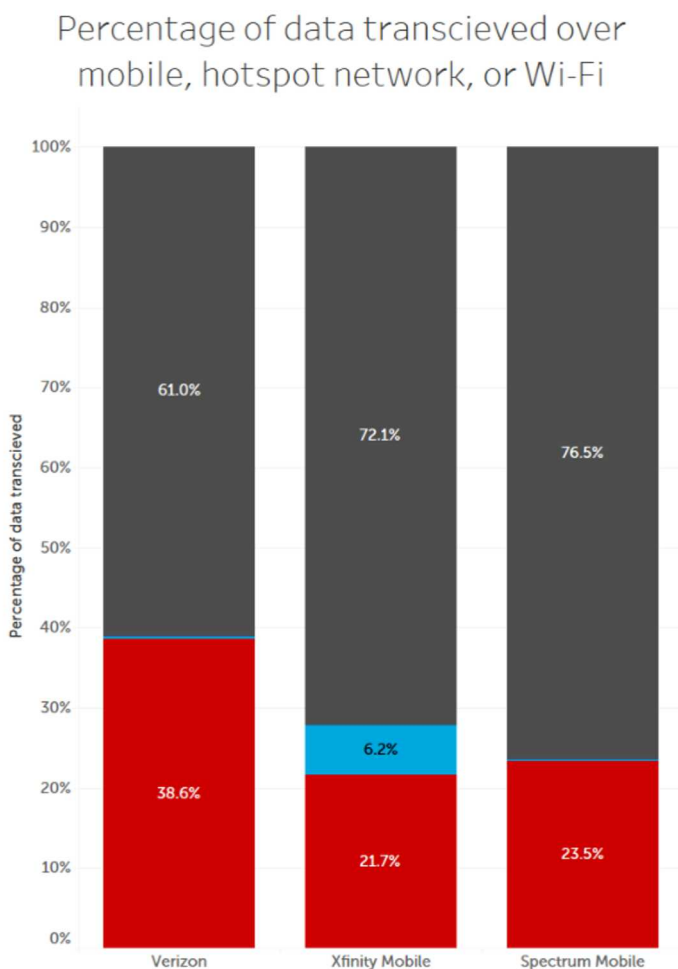
Wireless offloading: Comcast's hotspots pay off

The most immediate solution for wireless traffic offload are the networks of public or semi-public hotspots operated by the cable companies. Comcast has a clear advantage here: the company claims to operate a network of 18 million "xfinitywifi" hotspots nationwide, far more than the 2 million Optimum hotspots claimed by Altice, or the 500,000 that Spectrum claims to operate. Comcast's numbers line up with Tutela data: "xfinitywifi" is the most

commonly-seen Wi-Fi network nationwide. Comcast's advantage in the number of hotspots appears to directly translate to a reduction in cellular data usage.

As a proportion, Xfinity Mobile customers send the lowest amount of data traffic over a mobile network -- 21.7%, according to Tutela data from Xfinity Mobile users nationwide over the last six months.

"Comcast's advantage in the number of hotspots directly translates to a reduction in cellular data usage."





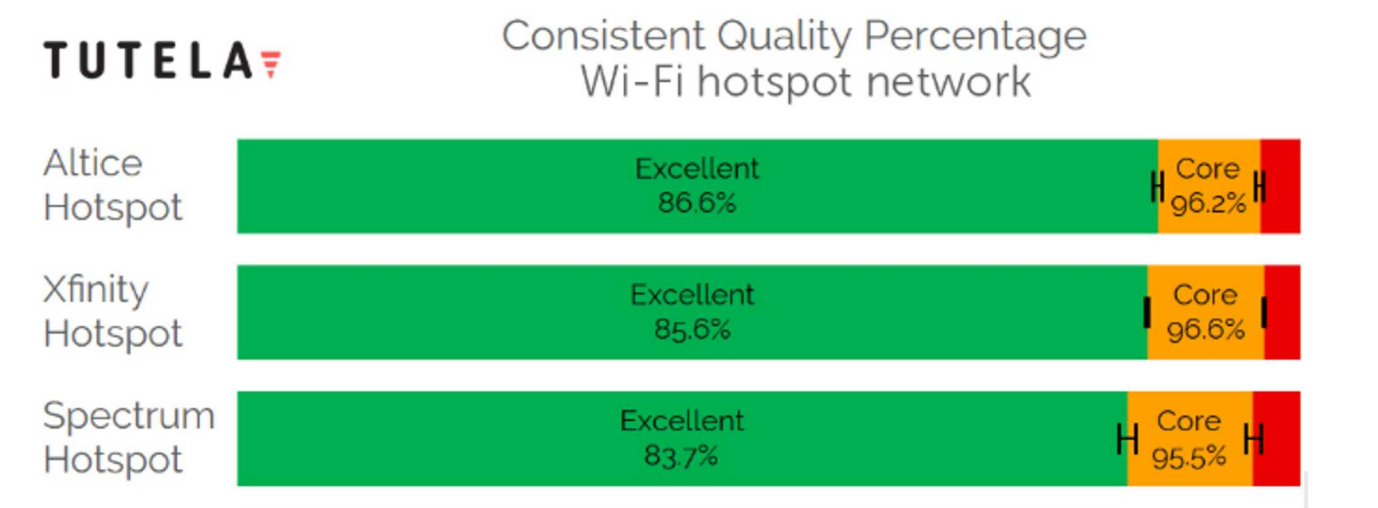
6.2% of smartphone data traffic went over the Xfinity hotspot network for Xfinity Mobile customers, while Spectrum's Wi-Fi network -- reportedly 1/36th of the size of the Xfinity Wi-Fi network -- accounted for essentially none of Spectrum Mobile users' data traffic.

Wi-Fi traffic offloading, which uses network setting profiles on consumer devices to actively push devices onto the public hotspot network, has largely been seen as a way for cable companies to reduce their mobile network bill from Verizon.

However, Tutela's data also shows that it can provide a benefit to consumers in terms of Quality of Experience. Tests over the Wi-Fi network of Altice, Comcast, and Charter all recorded Excellent and Core Consistent Quality percentages well in excess of the average for Verizon's network -- the best in the United States.

Looking further into the future, the hybrid MVNO model -- splitting data traffic between a limited facilities-based network while relying on an MNO partner for widespread traffic -- shows significant promise. The geographic distribution of mobile data traffic is not even, and is heavily skewed towards urban centers. As such, a cable company could build out a 4G or 5G

network that only covers a fraction of its geographical footprint, but successfully offload the majority of its mobile data traffic. Moreover, the increasing availability of unlicensed spectrum, such as CBRS GAA licenses, can provide significant (if less reliable capacity) without needing expensive capital investment in spectrum licenses(8).



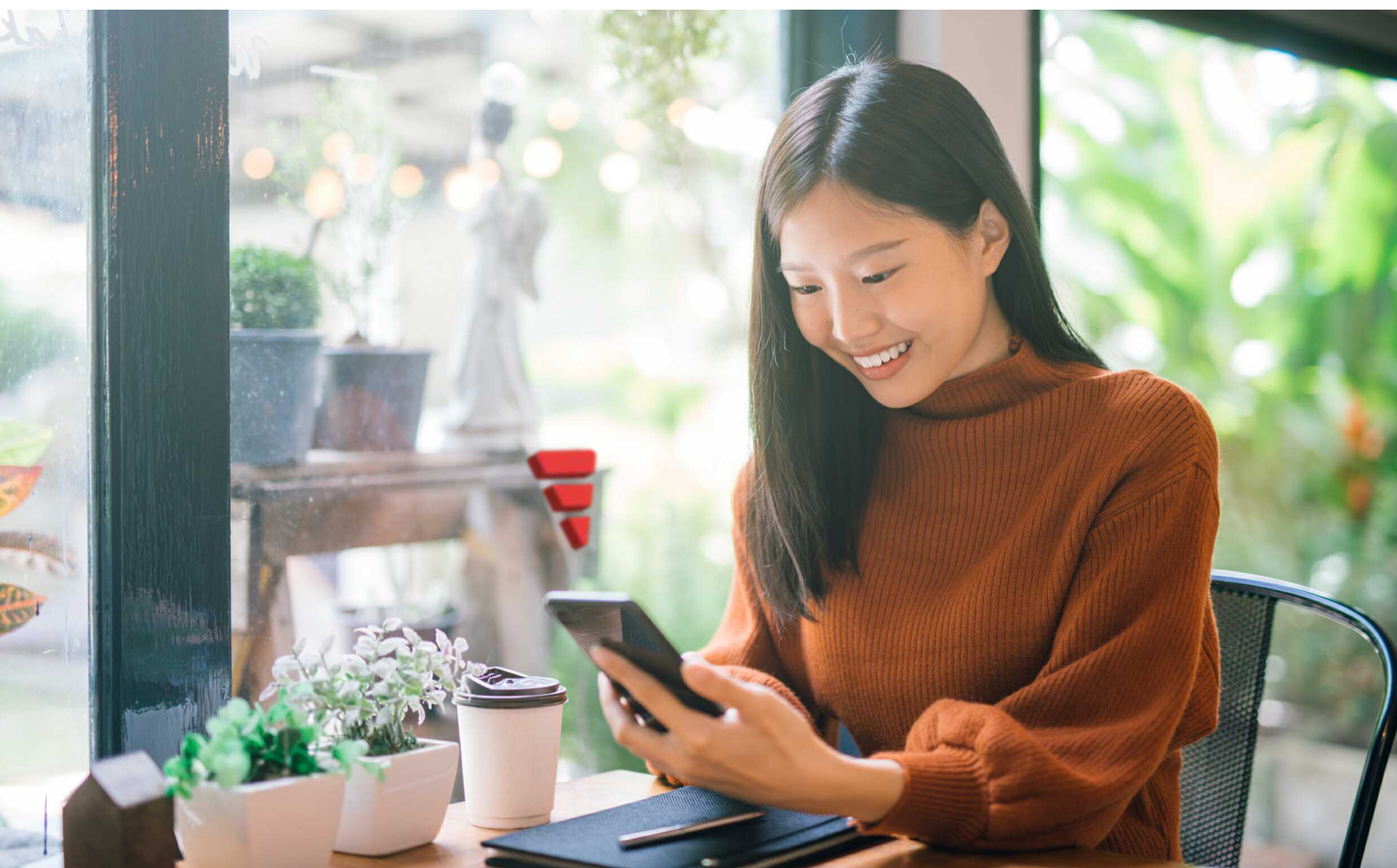
(8) Fiercewireless, WirelessComcast eyes 3.5 GHz CBRS for both fixed and mobile applications, including commercial handsets
<https://www.fiercewireless.com/wireless/comcast-eyes-3-5-ghz-cbrs-for-both-fixed-and-mobile-applications-including-commercial>
Retrieved 4 October 2019

Ones to watch: Altice Wireless

In the past weeks, Altice launched its own MVNO, Altice Mobile. It differs from the Comcast and Charter offerings in some significant ways that could make it an interesting player. The price is the lowest on the market, at just \$20 a month for unlimited data for existing Optimum or Suddenlink customers; it's available for \$30 a month for non-Altice customers; and it uses both AT&T and Sprint's network, which could confer some performance advantages in the mold of Google Fi. Combine that with Altice's Wi-Fi network, which is both fast

and more densely populated than Spectrum's, and it has the potential to disrupt the market even further. Altice Mobile is also well positioned to exploit future technology improvements and spectrum deployments to embrace the "hybrid MVNO" model. Altice operates the core network, device SIMs, and in some cases has infrastructure agreements in place with Sprint for small cells.

Not only does that minimize the cost to Altice of providing wireless service, but it makes the company closer to an infrastructure-sharing MNO than traditional MVNO.





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, we gathered 281,559,204,519 measurements, including over 40 million speed tests and 649 million latency measurements, from over 3.8 million devices (iOS and Android smartphones) between February 1st and July 31st 2019.

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, or when a subscriber is roaming onto another operator's network. 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 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.



Consistent Quality

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 [September 1st, 2019](#).

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%

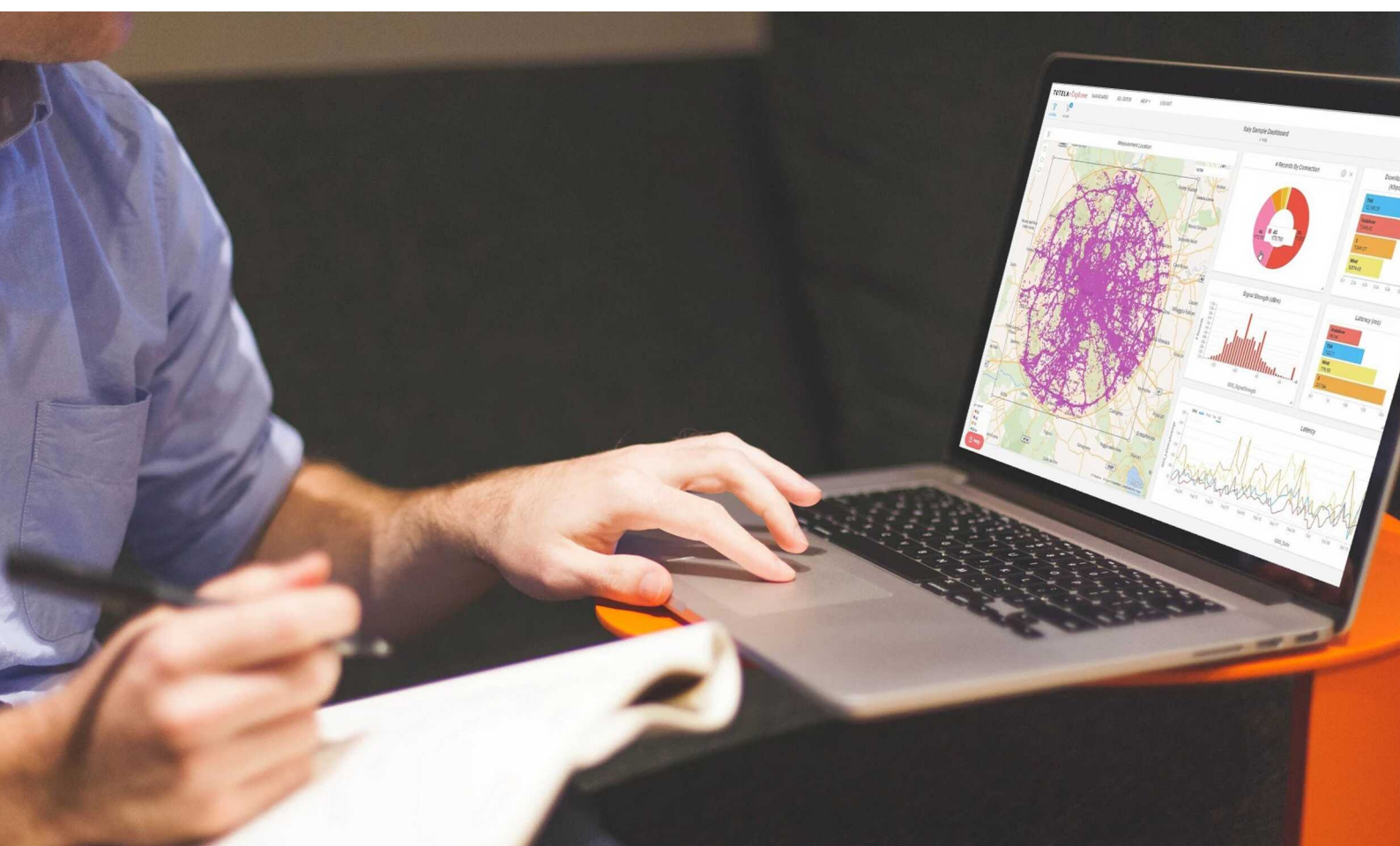
Discover Tutela Explorer

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- Benchmark network quality and coverage across all operators
- Drill down to any KPI at city, street or even building level
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Learn more



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 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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