TUTELA

Italy

State of Mobile Networks

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Annual Report

DECEMBER 2019

www.tutela.com

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Introduction

2019 has been a year of major change for the Italian wireless world. In the last 12 months, we've seen the launch of commercial 5G networks from TIM(1) and Vodafone(2), the rapid growth of a challenger network(3), and aggressive promotional activities(4) that are driving more mobile data consumption than ever before.

At a time when established operators are transitioning between network technologies, and new wireless networks are being built out at a rapid pace, the quality of user experience becomes more important than ever. In this State of Mobile Networks report, global independent mobile data company Tutela uses tens of millions of speed tests and billions of mobile measurements to better understand how mobile networks are functioning for real-world paying subscribers. Tutela has conducted over 20 million speed tests, 311 million latency tests, and 1.9 billion total mobile records from over 1.4 million mobile subscribers in Italy, with records gathered from May 1st to October 31st, 2019.

(1) Telegeography, TIM launches limited 5G service
https://www.telegeography.com/products/commsupdate/articles/2019/06/25/tim-launches-limited-5g-service/
Retrieved 27 November 2019

(2) RCR Wireless, Vodafone launches commercial 5G services in five Italian cities
https://www.rcrwireless.com/20190606/5g/vodafone-launches-commeercial-5g-services-five-italian-cities
Retrieved 27 November 2019

(3) Telecompaper, Iliad Italia customers top 4.5m in September as 9-month revenues reach EUR286m
https://www.telecompaper.com/news/iliad-italia-customers-top-45-mln-in-september-as-9-month-revenues-reach-eur-286-mln--1315754
Retrieved 27 November 2019

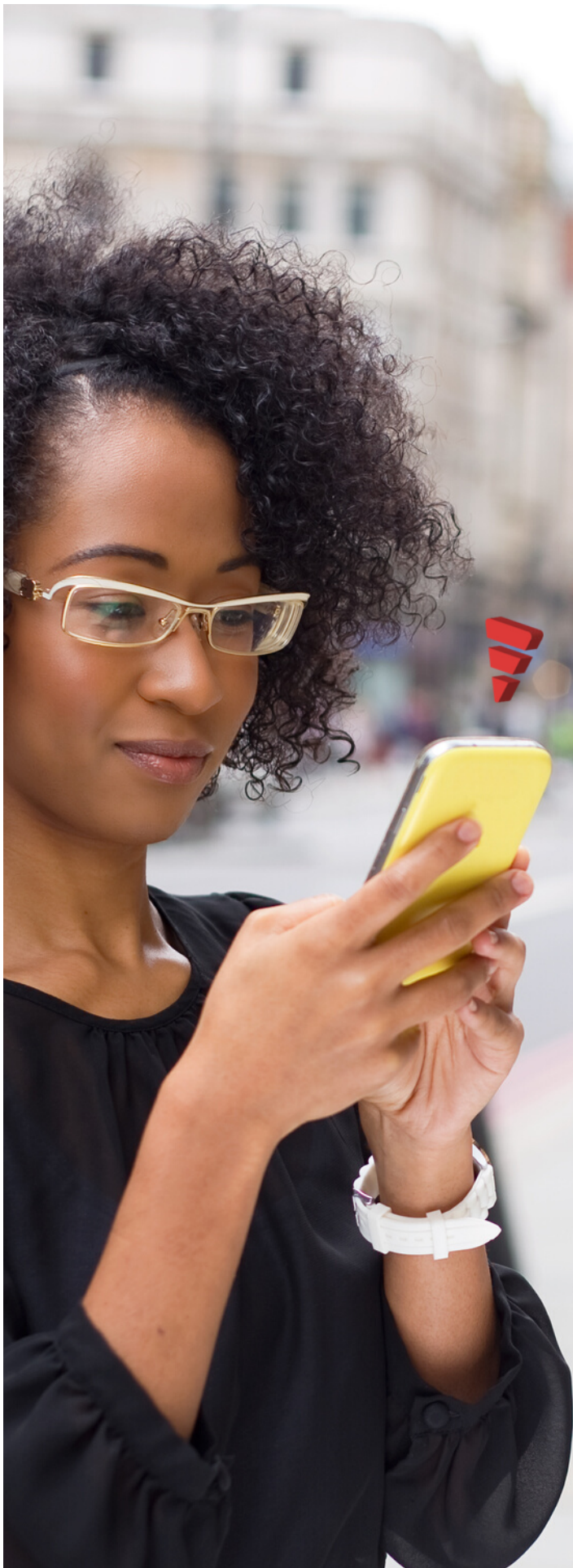
(4) Telecompaper, Italy's Wind offers all clients 24 hours of free data on 10 November
https://www.telecompaper.com/news/italys-wind-offers-all-clients-24-hours-of-free-data-on-10-november--1315499
Retrieved 27 November 2019

Key findings

- TIM and Vodafone tied for first place in Excellent Consistent Quality, Tutela's most comprehensive metric for measuring user experience. Vodafone and TIM also occupied the top two places for download speed and latency, showing that the two operators compete fiercely to be the best overall network.

- The Wind network finished as the runner-up to Vodafone and TIM in almost all categories, and finished a close second place overall for upload speed. As Wind Tre moves towards the completion of its brand and network merger, we expect to see improvements to user experience for both Wind and 3 customers.

- Despite its relatively new entrance to the Italian market, Iliad is delivering a mobile experience that is competitive with the incumbent operators. With new 5G spectrum holdings and future commitments to continue building out its own network, we anticipate seeing Iliad's mobile network performance continuing to improve.



Results overview

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Mobile experience results

Italy, December 2019

	vodafone	TIM	iliad	3	WIND
Excellent Consistent Quality	★ Draw	★ Draw			
Core Consistent Quality	★ Draw	★ Draw			
Download throughput	★ Winner				
Upload throughput		★ Winner			
Latency	★ Winner				

Results from 132,703,751,746 measurements taken in Common Coverage Areas between May 1st to October 31st 2019.

"Vodafone and TIM delivered the highest percentage of Excellent Consistent Quality in Tutela's tests"

TUTELA
Best Mobile Network Experience
DECEMBER 2019

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 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 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. These were most recently re-assessed 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.

When evaluating network performance, Tutela focuses on the mobile experience of real-world end users; as such, our data reflects the experience and network utilization that subscribers pay for, inclusive of any network sharing or roaming agreements in place. We have also chosen to include Wind and 3 as separate operators in this report; although the operations are increasingly being integrated, the two brands are still differentiated to consumers.

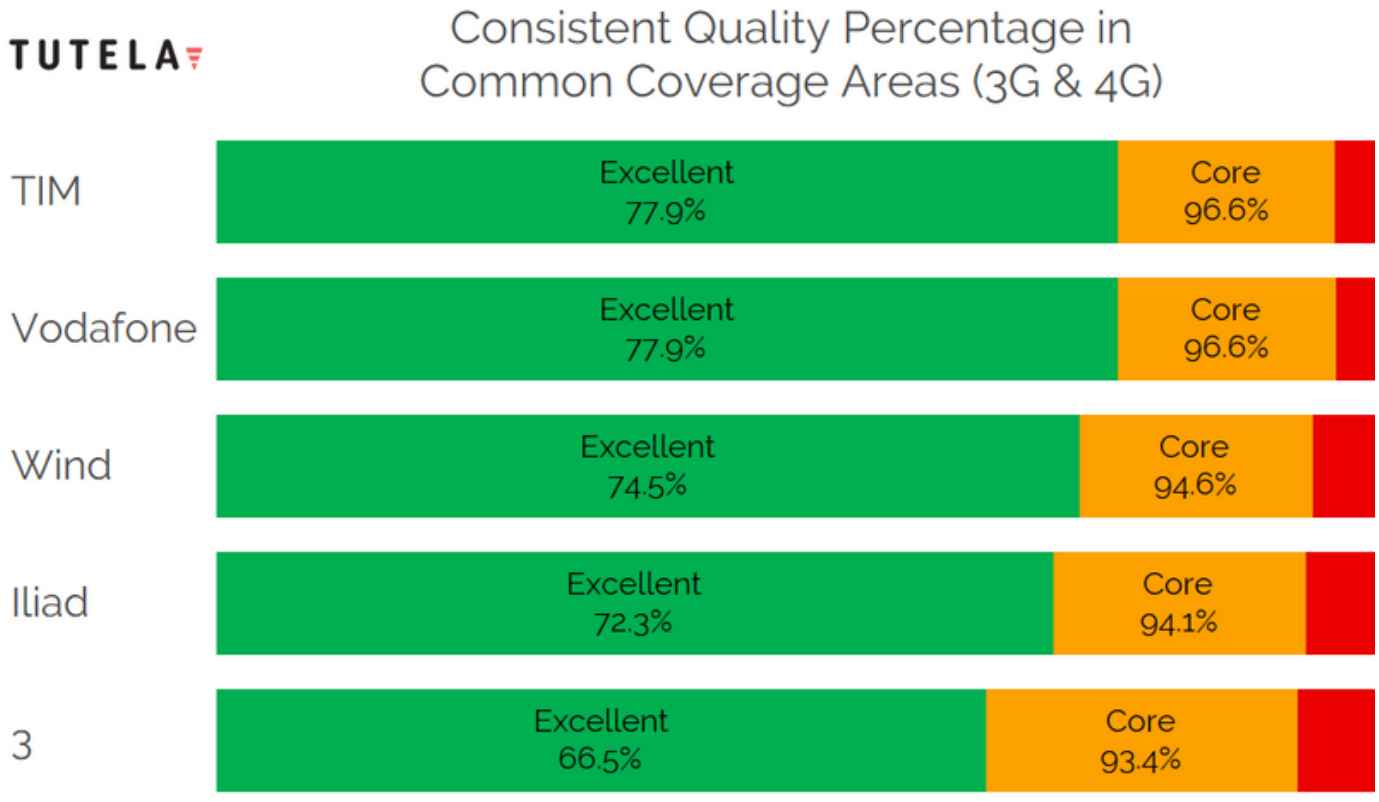
TUTELA Common Coverage Areas (3G & 4G)

Consistent Quality

A network connection that passes the Excellent Consistent Quality thresholds is deemed to be sufficient for highly demanding smartphone applications, such as 1080p video streaming, group HD video calling, or mobile multiplayer gaming — and 77.9% of the time, when a TIM or Vodafone user had signal, their network quality hit those thresholds, putting both networks comfortably in first place.

However, neither Wind nor Iliad were far behind. Wind users saw their tests pass the Excellent Consistent Quality thresholds 74.5% of the time, while Iliad was close behind on 72.3%. 3 was the only operator to have less than 70% of its test pass the thresholds.

For Core Consistent Quality, the metric that represents a network's suitability for everyday applications like streaming SD video, web browsing, or making VOIP calls, all five networks were much closer. TIM and Vodafone still tied for first place, both on 96.6%, but the gap between first and fifth place was much smaller. Wind was behind the two leaders on 94.6% — a drop of just two percentage points — while Iliad and Three saw 94.1% and 93.4% of their tests pass the thresholds respectively.

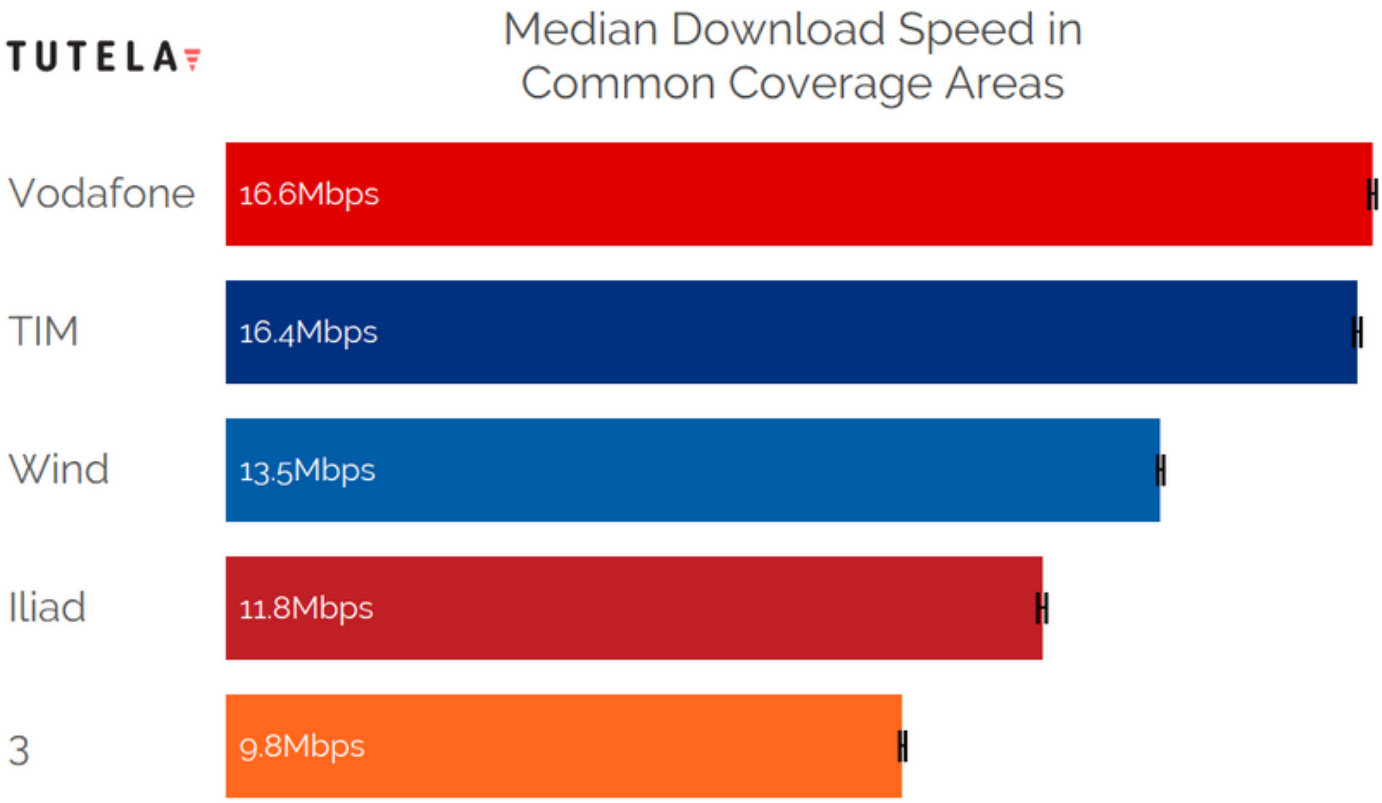


Overall, it's notable that all operators were comfortably over 90% for Core Consistent Quality, showing that the vast majority of the time, when a user has a signal, their connection is good enough for most applications. To close the gap between Core and Excellent Consistent Quality, operators will need to continue deploying LTE-Advanced technologies, push 5G adoption, and add additional spectrum capacity.

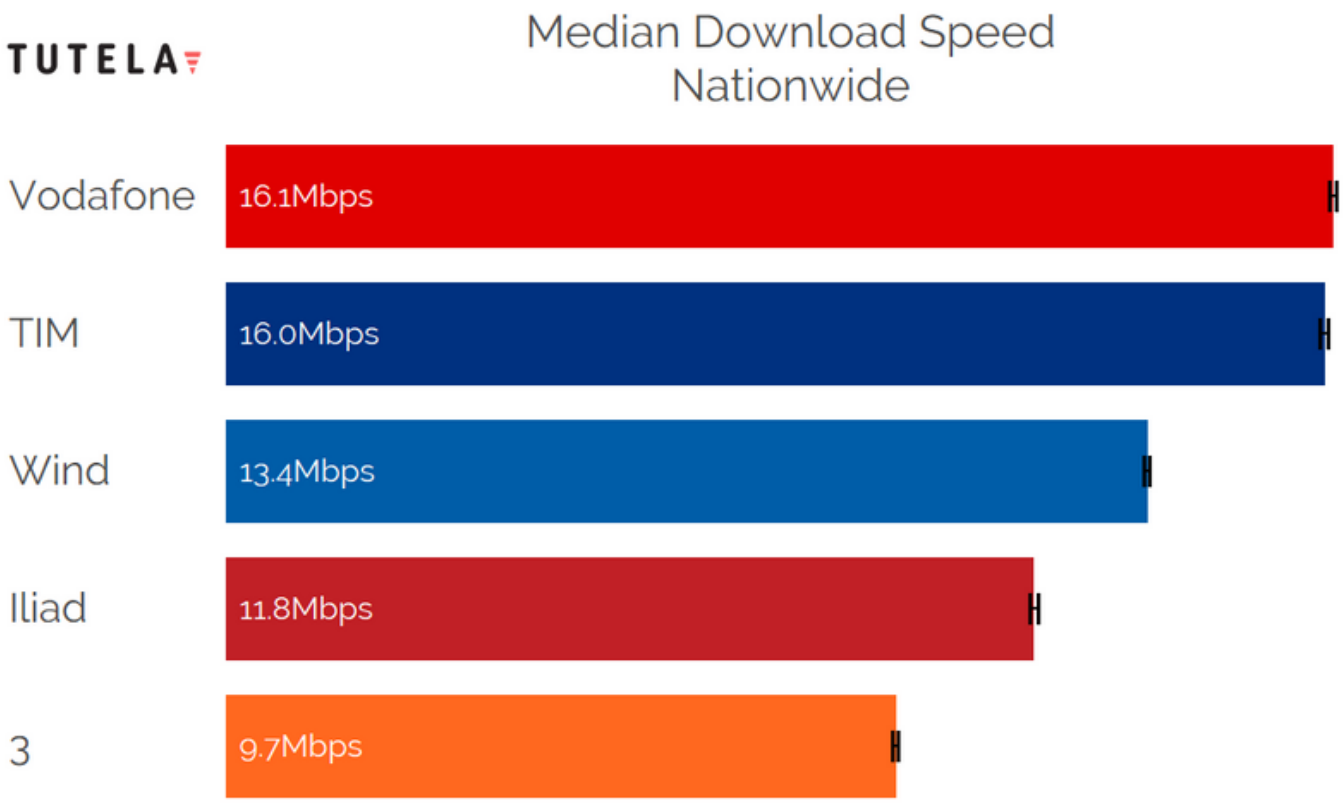
There was minimal difference in Consistent Quality between Common Coverage Areas and nationwide results, with leaders TIM and Vodafone seeing drops of just 0.5% and 0.1% to their Excellent and Core Consistent Quality percentages respectively.

Download throughput

Vodafone squeezed past TIM to take first place for median download throughput, although the gap was extremely small: just 0.2 Mbps separated Vodafone's first-place 16.6 Mbps result from TIM's 16.4 Mbps second-place result. The gap to other operators was more substantial: Wind's median download throughput was 13.5 Mbps, while Iliad was a further 1.7 Mbps behind, on 11.8 Mbps. When comparing Common Coverage Areas — which are predominantly more developed and populated parts of the country — to the nationwide results, a few changes stand out. Vodafone sees the greatest decrease in its median download performance, from 16.6 Mbps to 16.1 Mbps, while TIM goes from 16.4 to 16.0 Mbps.

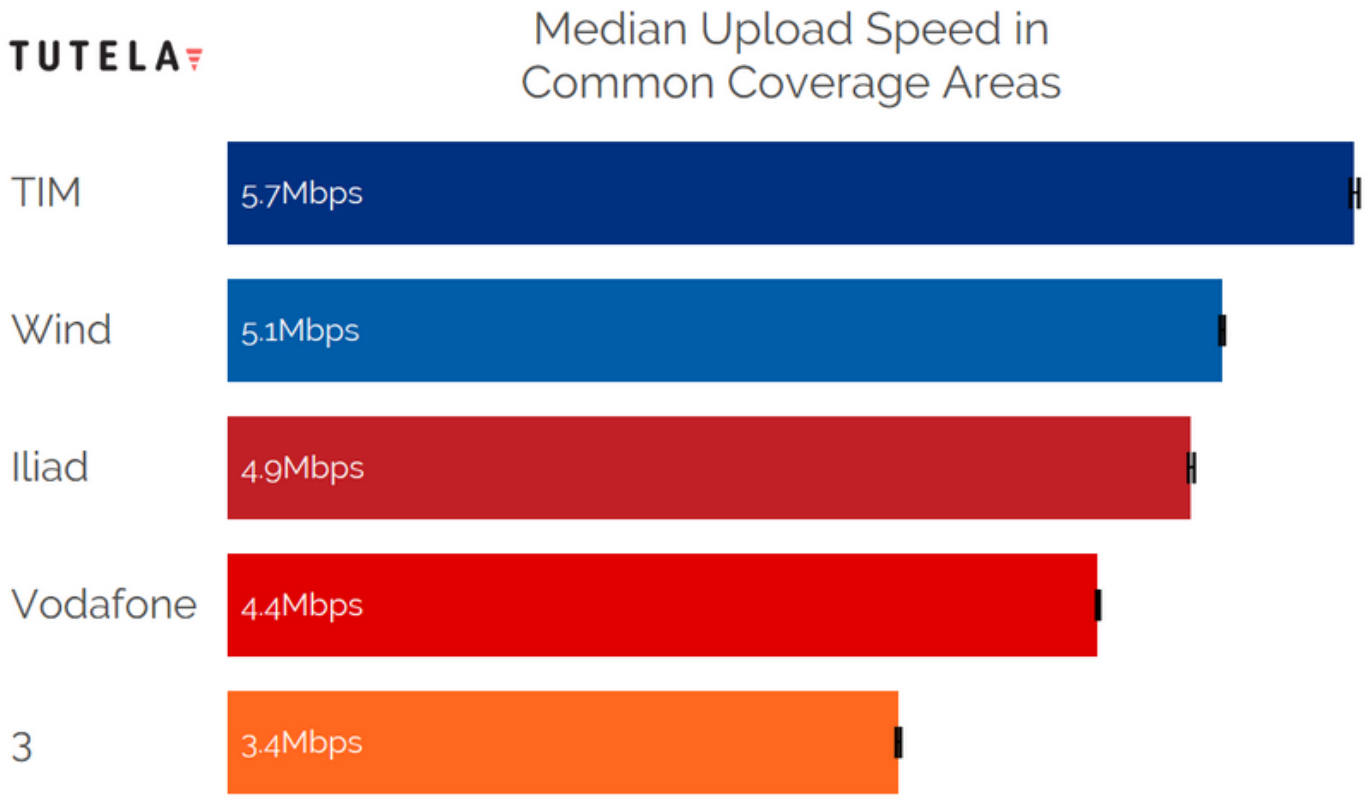


In order to achieve a fast median download above 16 Mbps, both networks have employed LTE-Advanced (and more recently 5G) deployments, which are able to provide peak download throughputs of hundreds of megabits. Those network technologies are slower to roll out nationwide, which explains the decrease in performance from Common Coverage Areas to nationwide records.



Upload throughput

TIM placed first for upload throughput, with a median speed of 5.7 Mbps. Wind beat Iliad, Vodafone and 3 to place second, and upload was the only category in which Vodafone did not place in the top two operators. Although the spread amongst operators was relatively significant — TIM's first-place 5.7 Mbps was nearly double 3's last-place 3.4 Mbps — it is notable that all five operators still saw median upload throughput well in excess of the 1.5 Mbps required for a test to pass Tutela's Excellent Consistent Quality thresholds. There was virtually no difference between upload speeds in common coverage areas and nationwide, showing that upload performance is more consistent across the country than other performance metrics, such as download speed.

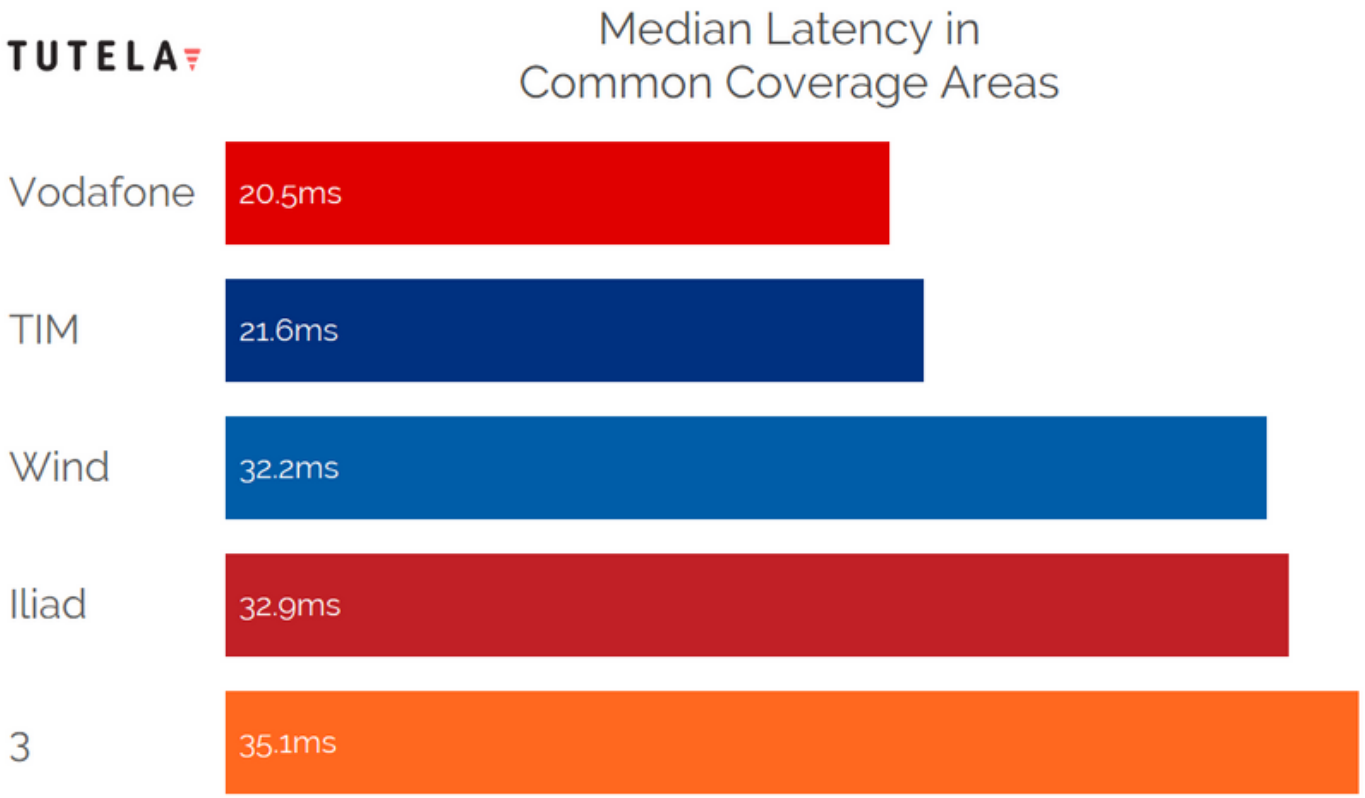


Latency

Vodafone users recorded the fastest one-way latency in the country, with a median of just 20.5 milliseconds. TIM was barely in second place, on 21.6 milliseconds. There was more of a gap back to third-place Wind, on 32.2 milliseconds, with Iliad and 3 close behind.

Latency is a measure of how long a packet takes to travel from a consumer device, such as a smartphone, back to the server that hosts content or provides a given service. A "fast" network connection is often taken to be one with a high download throughput, but for many consumer applications that require frequent interaction, such as web browsing or multiplayer gaming, a connection with a low latency will feel "faster" than a connection with a higher download throughput but longer latency.

In Italy, all five networks do an admirable job of providing connections which, on average, are well below the threshold where consumers would notice any observable lag.



Technology usage

On a day-to-day basis, one of the greatest differentiators for a consumer is whether they connect to a 3G or 4G network. 4G connections provide a consistently faster throughput and lower latency than 3G connections; for a consumer, in general, the more time they spend on 4G, the better the network performance is likely to be. As a result, it's unsurprising to see Vodafone and TIM — the networks that lead for mobile experience — on top for 4G utilization. Vodafone does take the lead over TIM, with users spending 84.0% of their time on 4G networks, compared to 79.3% for TIM.

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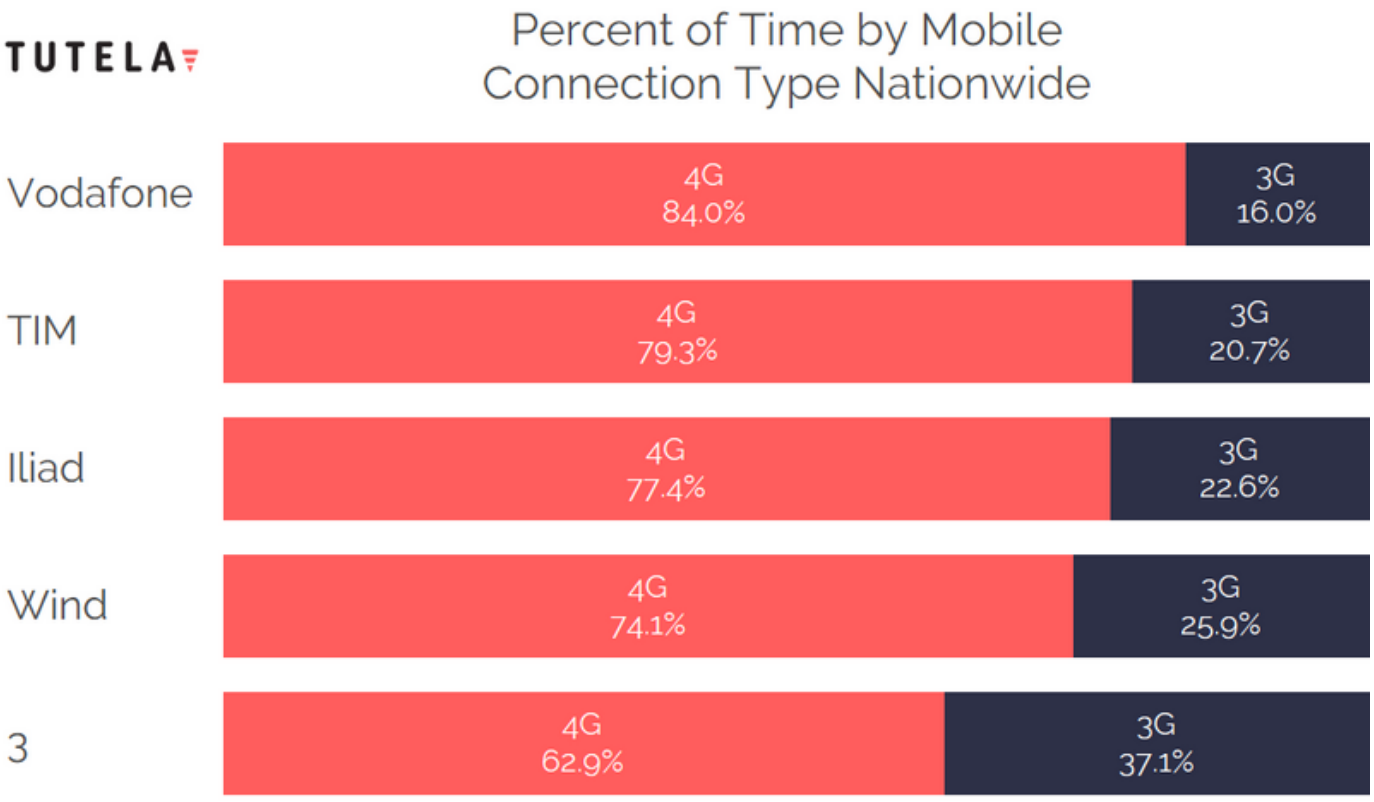
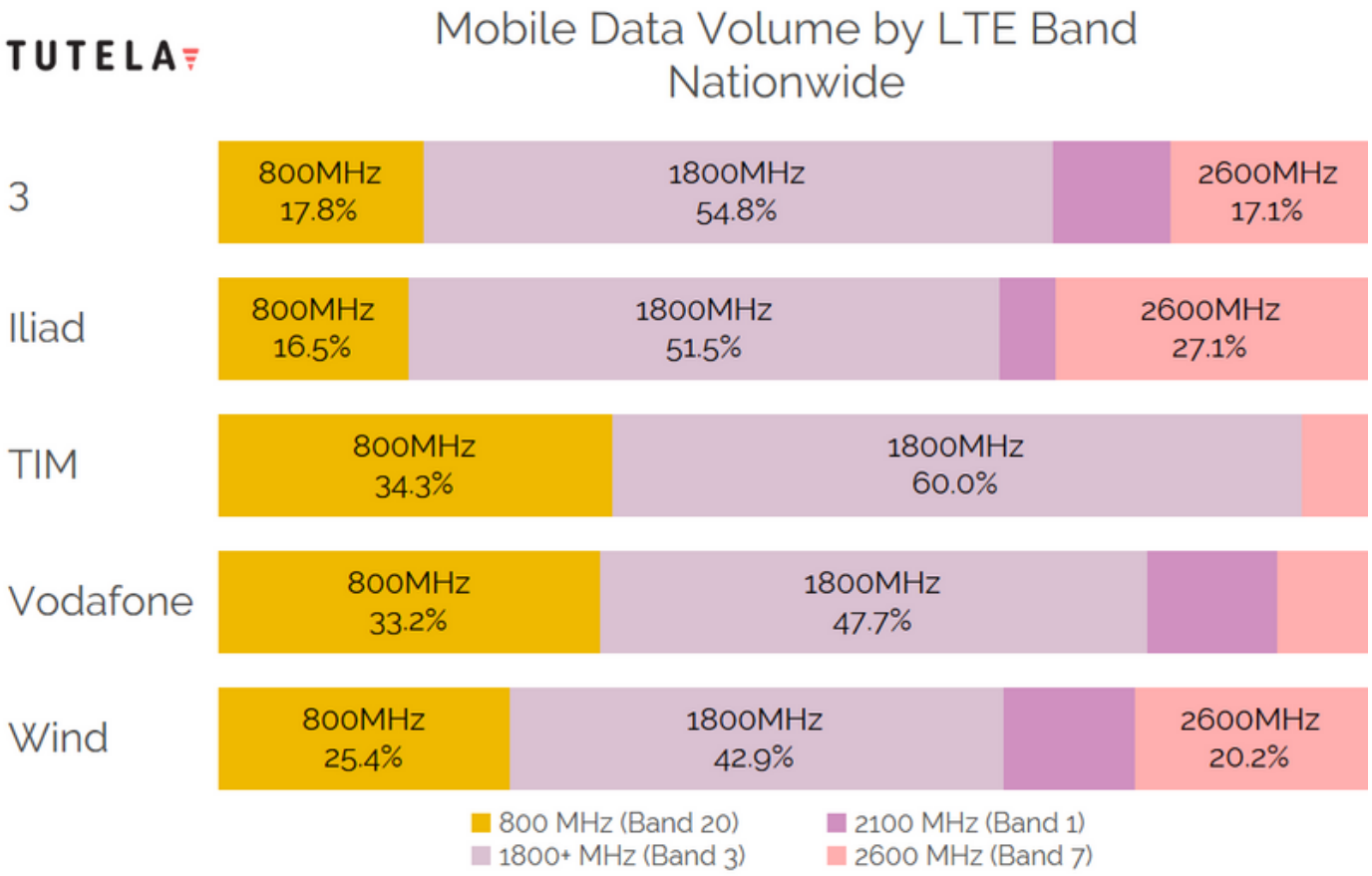


However, not all 4G signals are equal: operators typically use a mix of low, mid, and high-band spectrum to provide both coverage and capacity for their network. Low-band radio waves (like 800 MHz) travel further and penetrate obstacles better than mid-band or high-band spectrum, which helps with coverage, especially in rural areas or inside buildings. Typically, operators use a mix of low-band spectrum for coverage and mid-band and high-band for capacity, to prevent the low-band spectrum from being congested. TIM and Vodafone both use 800 MHz more heavily than other operators (whose users, in some cases, are roaming onto other networks' infrastructure). TIM's usage also stands out for its heavy utilization of 1800 MHz spectrum -- a mid-band frequency that typically provides a good mixture of coverage and capacity.



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 conducted over 20 million speed tests, 311 million latency tests, and 1.9 billion total mobile records from over 1.4 million mobile subscribers in Italy, with records gathered from May 1st to October 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. 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

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

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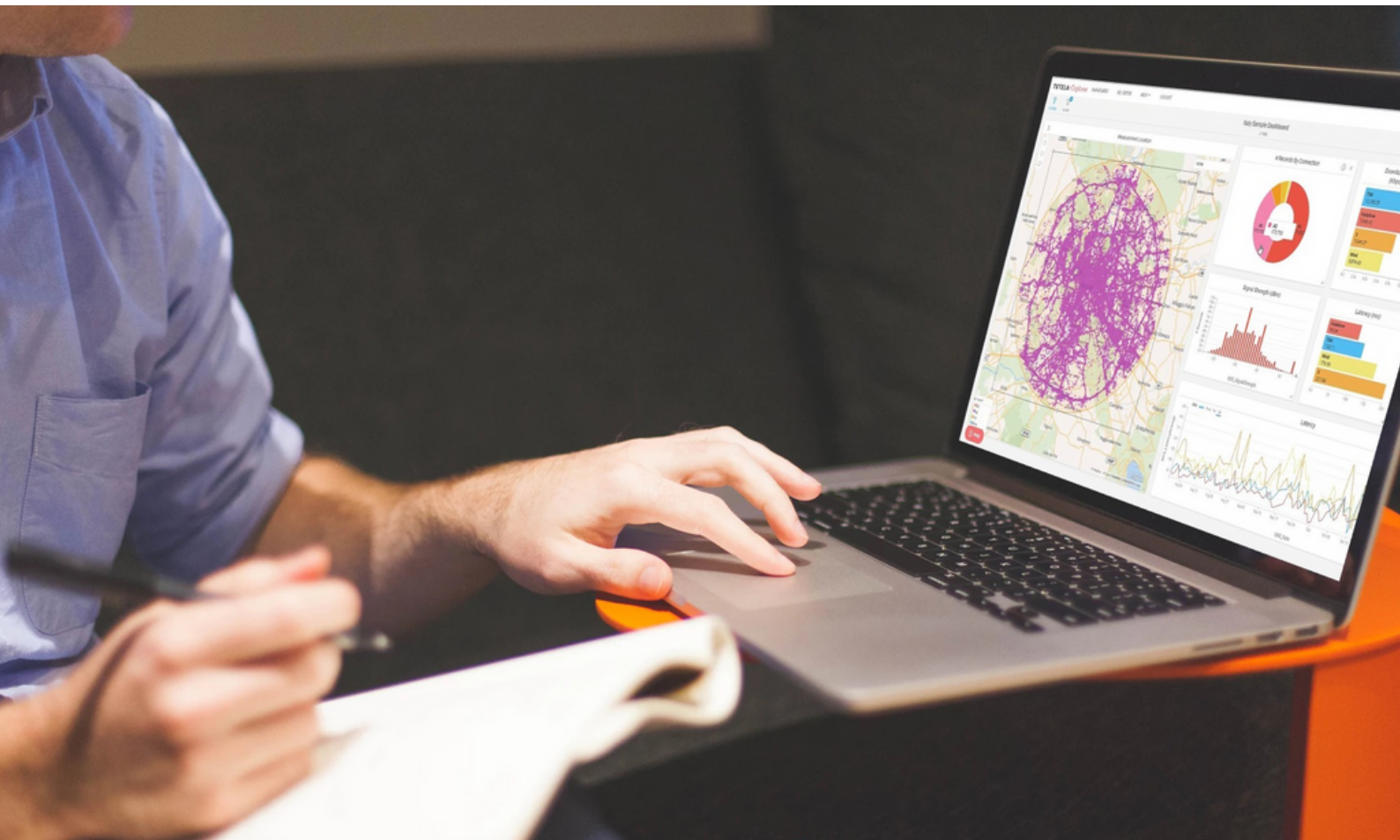

Appendix

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Error Margins

		Download Median	Upload Median	Latency Median	Excellent CQ	Core CQ
Common Coverage Areas	3	±0.04Mbps	±0.01Mbps	±0.00ms	±0.2%	±0.1%
	Iliad	±0.06Mbps	±0.02Mbps	±0.00ms	±0.2%	±0.1%
	TIM	±0.06Mbps	±0.02Mbps	±0.00ms	±0.1%	±0.0%
	Vodafone	±0.05Mbps	±0.01Mbps	±0.00ms	±0.1%	±0.0%
	Wind	±0.04Mbps	±0.01Mbps	±0.00ms	±0.1%	±0.1%
National	3	±0.04Mbps	±0.01Mbps	±0.00ms	±0.2%	±0.1%
	Iliad	±0.06Mbps	±0.02Mbps	±0.00ms	±0.2%	±0.1%
	TIM	±0.06Mbps	±0.02Mbps	±0.00ms	±0.1%	±0.0%
	Vodafone	±0.06Mbps	±0.01Mbps	±0.00ms	±0.1%	±0.0%
	Wind	±0.04Mbps	±0.01Mbps	±0.00ms	±0.1%	±0.1%

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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