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Verifying licence obligations with crowdsourced data

A guide for regulators, authored by Professor William Webb

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

The current situation

Over time, telecoms regulators have increasingly added obligations to spectrum licenses. The aim of the obligations is to allow customers to access services such as voice calls and increasingly broadband data across most of the country. However, regulators find it difficult to measure data rates and so tend to specify a coverage obligation in terms of a signal strength that should enable the data rates required. Coverage obligations take many forms including percentage of population, percentage of landmass, number of base stations, indoor coverage thresholds, and coverage along roads and railways. Some form of obligation applies to many of the recent auctions including France, Germany, Japan, Ireland and in the forthcoming UK 700MHz auctions.

With any obligation comes the need for verification (and subsequent enforcement). This has been a significant issue in the past, with many approaches either proving to be inadequate or facing complex challenges and adjustments. The problem is that in order to determine whether, for example, a coverage obligation of 98% of the population has been met, then measurements need to be made in at least 98% of the places where people live. This would be a huge undertaking, impossible to do in a reasonable timescale.

Instead, regulators have predominantly resorted to modelling. Often the licence will set out the model to be used (for example a particular ITU published propagation model) then the licence holder informs the regulator as to their base station locations and the regulator uses a propagation planning tool to predict the coverage. This has the advantage of being relatively simple, low-cost and repeatable, such that the regulator and licence holder can independently perform the same prediction and arrive at the same result.

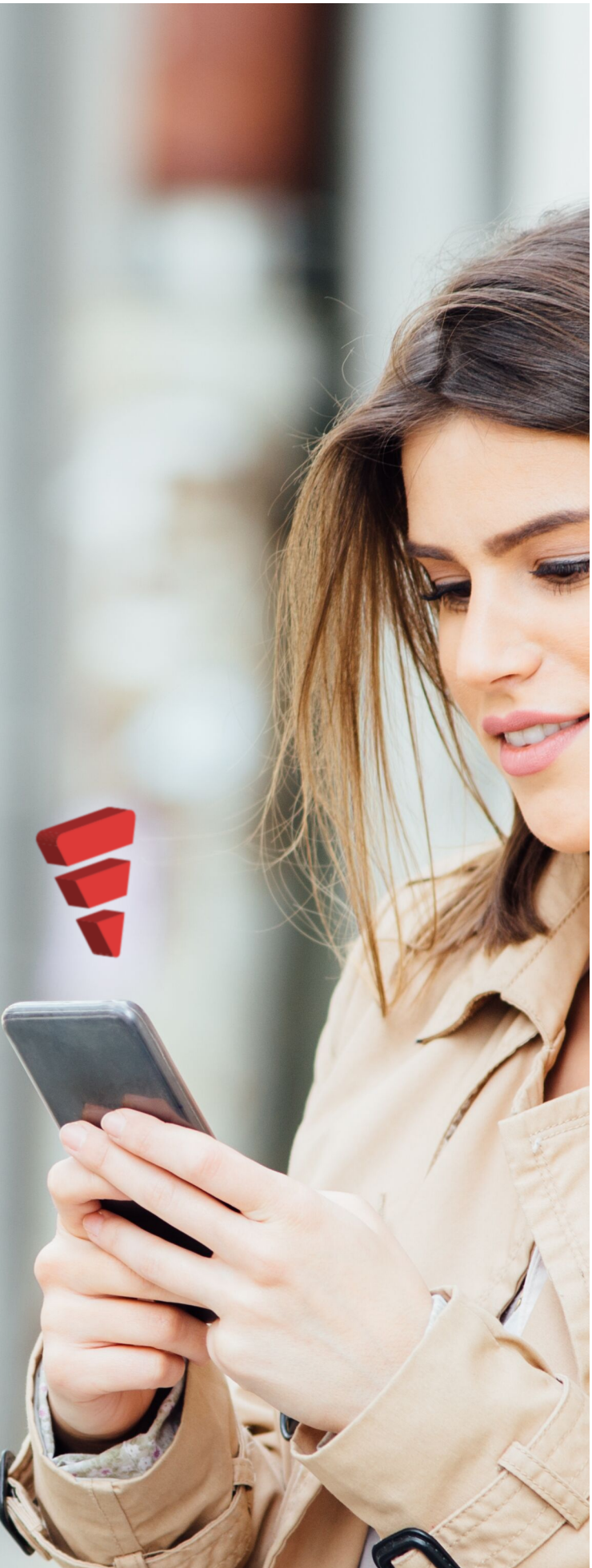
However, prediction has its problems. The primary one is that it is approximate. This has led to the situation where regulators and operators claim 98% coverage and yet the experience of users is vastly worse. Models that do not align with those used by the operators for their actual deployment can result in issues, such as pointless additional base stations being needed to fill coverage holes predicted by the regulatory model that do not exist in reality.

"With any obligation comes the need for verification"

Obligations are often open to gaming. Coverage obligations related to landmass can result in operators deploying sites in areas where there are very few people but where it is easy to cover a large geographical area from one mast. Obligations related to number of sites, meanwhile, can result in sites being all in the same area. This makes deployment easier, but does not ensure that new masts are set up in the areas that need them the most.

These obligations are just a proxy for the services required. Of course, it would be better to measure actual data rates rather than predicted signal levels. The overarching target for regulators is normally expressed as a base level of service, be that a throughput speed or duration of call that can be placed without interruption. Predictive models are used for practical simplicity; no regulator has ever set out to hit a milestone in a theoretical planning tool, but the design of the regulatory framework ensures that theoretical targets are being chased and enforced, rather than practical results.

Fundamentally, the reason for obligations is societal – to create a better mobile network than the markets alone would deliver. But the translation of the spirit of this intent into practice, especially into verification, is far from perfect.



An alternative approach

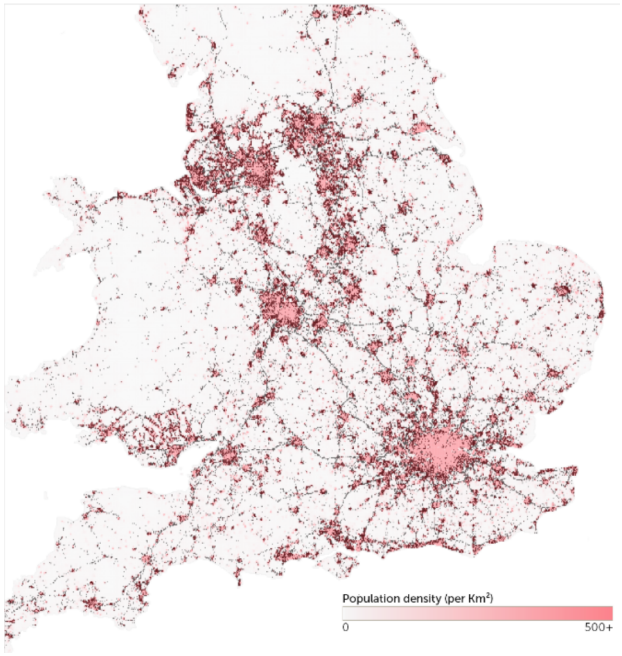
There is a different way – one that perfectly reflects reality, is updated in real time, and ensures that the spirit of the obligation is fully met in network deployment. This is the use of crowdsourced data. Crowdsourced data comes from many thousands of phones which take measurements of signal levels, data rates and other parameters as part of their normal operation and report these back to a central database where they can be aggregated and turned into overall network metrics. Many companies now provide this information and it is extensively used by network operators to enhance their networks, by consultants to understand key trends such as deployment rates, and by regulators to assess a wide range of factors.

Crowdsourcing is inherently better than theoretical models in that the measurements it delivers are naturally aligned with the regulatory intent. Crowdsourced data provides the data rates actually experienced, negating the need to use signal strength as a proxy for system performance. It would not be possible to "game" a landmass coverage obligation by covering areas where people did not go, as this would not be reflected in the crowd-sourced measurements since no measurements would be delivered from these areas. Instead, the operator would need to cover, say, 98% of the places where people actually go.

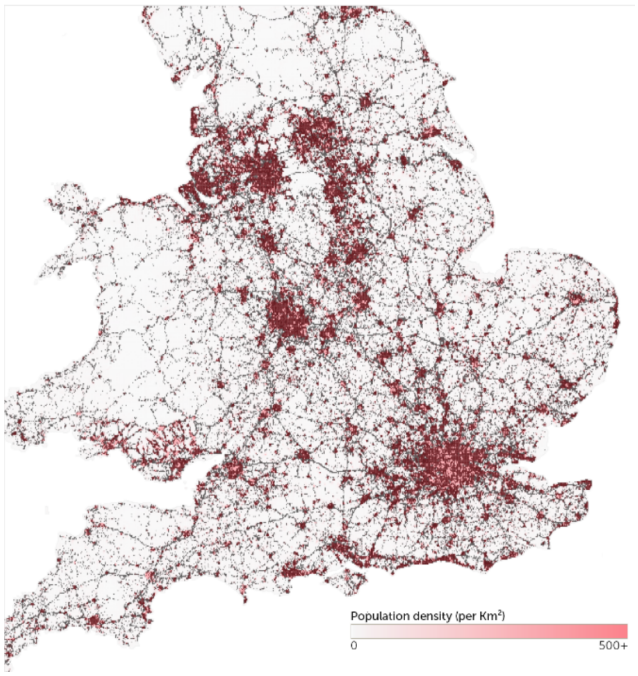
Also, it would not be possible to provide minimal coverage, with insufficient capacity, as this would lead to the handset reporting low data rates. This is clearly a much better outcome. Because measurements reflect reality, and because a handset will report exactly what its user experiences, then there will be no mis-alignment between reported coverage and typical user experience. All of this comes at an even lower cost than the current approach and in a way that does not require complex agreements over propagation tools and the exchange of base station locations which a regulator has to take on trust.

The power of crowdsourcing and the problems with the current approach are starkly illustrated in the figures on the right and the following page produced from Tutela data. Here, grey squares are those that deliver more than 2 Mbits/s over a 4G connection, but a sparse population. Dark red squares are those with a dense population and better than 2Mbits/s. Lighter pink squares show where there is a relatively dense population, but data rates fall below 2 Mbits/s. Ofcom aims for a 2 Mbits/s data rate but as the figures show this is often not achieved in rural areas due to lack of coverage but also often not in urban areas (almost certainly due to congestion).

3— Areas where 95% of tests are faster than 2 Mpbs



EE— Areas where 95% of tests are faster than 2 Mpbs

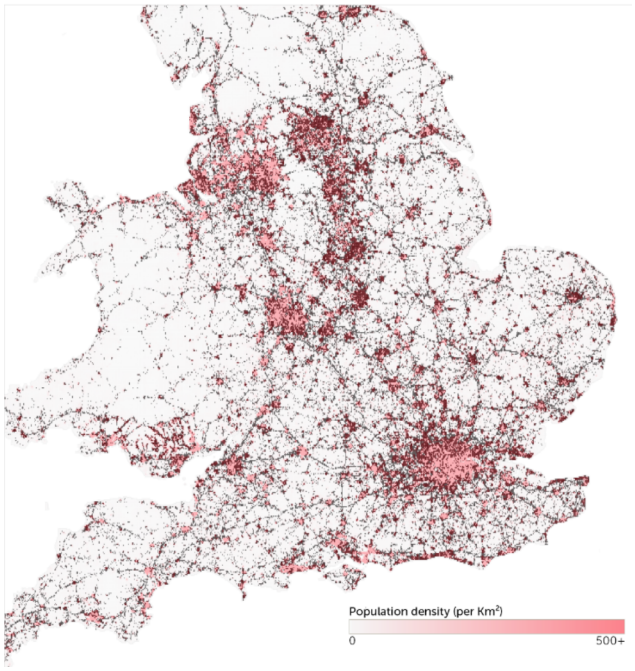


A practical example of how assumptions using predictive models can be misleading is found in Ofcom's 2018 consultation for the award of 700 MHz and 3.6 – 3.8 GHz spectrum. In the consultation, Ofcom says that "our new measure of good mobile coverage (i.e. at least -105 dBm for outdoor coverage) is an appropriate benchmark that ensures a high probability (i.e. 95%) of a successful voice call and access to 2 Mbits/s data service."

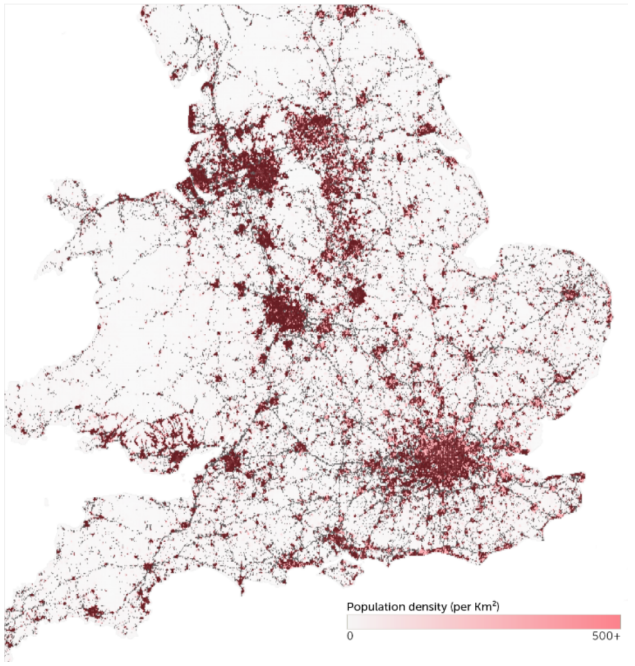
This assumption may work for a network under ideal conditions, but Tutela's data suggests that particularly in urban areas, the correlation between signal strength and data rates is limited, at best. Some of this may be due to handsets predominantly being used indoors - but if that is where consumers wish to use them then that is where regulators should aim to encourage reliable and fast service.

"Tutela's data suggests the correlation between signal strength and data rates is limited"

O2 — Areas where 95% of tests are faster than 2 Mpbs

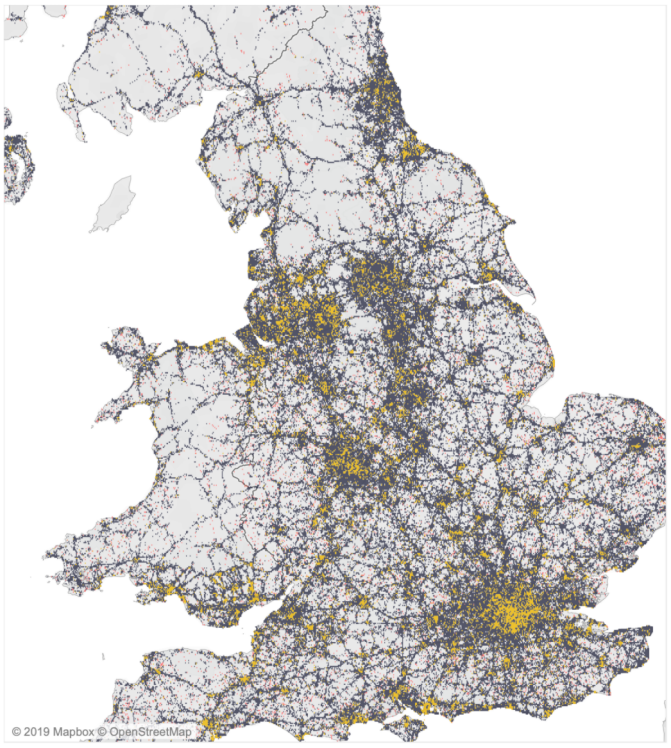


Vodafone — Areas where 95% of tests are faster than 2 Mpbs



Of the 46.8 million people in the UK living in a dense urban area (1,000 people per square kilometre or greater), Tutela's data suggests that 15.8 million – just over a third – live in areas where the average signal strength exceeds Ofcom's -105 dBm threshold, but less than 95% of data connections exceed the 2 Mbps threshold[1].

Thresholds comparison map: average of -105 RSRP (4G signal strength) and 95% of download tests above 2 Mbps



[1]Note that handsets often do not report the same signal level as a calibrated measurement receiver with optimal external antenna. Handsets might report signal levels typically between 5-7dB below that of a calibrated receiver, reflecting the more compromised antennas they use. We re-ran our results for a reported handset measurement level of -111dBm, corresponding to -105dBm for a calibrated receiver. This made very little difference to the results, with the maps visually looking near-identical. Therefore, we believe that the accuracy of handset measurements is not a critical component of this analysis.

Operators	% population with an average 4G signal strength greater than -105 dBm	% population in areas where more than 80% of 4G tests exceed 2 Mbps	% population in areas where more than 95% of 4G tests exceed 2 Mbps
EE	98.2%	92.1%	80.7%
Three.co.uk	93.7%	78.2%	47.2%
O2	98.6%	86.6%	58.6%
vodafone	96.8%	88.0%	78.3%

Crowdsourcing is not new – so why has it not been extensively used for licence obligation? Partly this may be due to risk-aversion from regulators. Partly it may be due to discouragement from mobile operators, who perceive that this approach will prevent them finding ways to meet the letter of the obligation rather than the spirit. Partly it may be due to a concern that such an approach is not exactly repeatable and fully under the control of both the regulator and the operator.

But this last concern is over-stated. Once there are many thousands of users generating measurements the daily variation is very small and the probability of erroneous results vanishingly tiny. An approach can be agreed with the crowdsourcing company as to how the data will be processed and averaged to remove short-term variation and ensure consistency over the lifetime of the licence. It is different from the current approach, but the current approach is clearly not an accurate representation of real-world user experience on mobile networks.

There are many upsides of crowdsourcing beyond just licence verification. Regulators can look at speed of deployment of new frequencies, at levels of congestion, at the relative performance of different networks, at the off-load to Wi-Fi and much more. These insights can provide important evidence for future regulatory change. For example, a recent report showed that the best way to deliver ultra-high capacity networks was less to do with spectrum allocation and more to do with a greater base station density, suggesting more of a regulatory focus on "barrier busting" the legislation that makes deployment more difficult.

Conclusions

Licence obligations are becoming ever more important, and yet the approach to verifying whether they are being met is inappropriate, allowing for the spirit of the obligation to be subverted by gaming the inadequacies of the verification method. Crowdsourcing overcomes all of these issues, delivering an approach that aligns perfectly with the intent of the regulation and with user experience. It is immediately available, real-time, low-cost and provides a wealth of insight. Most of all, it provides data that speaks directly to the mission of regulators: ensuring the provision of consistent mobile services to end-users wherever they may be, through the most direct measurement possible.

Methodology

Tutela measures network quality based on the real-world experience of millions of users. We employ software installed in more than 3,000 partner apps to actively test network performance, conducting download, upload, and server response tests against Tutela-configured servers. The tests are conducted randomly and in the background to avoid sampling bias, with a testing configuration designed to emulate and measure real-world user activity, not maximum network throughput.

At the heart of Tutela's throughput testing is our use of small, lightweight files (2MB for download and 1MB for upload), which are designed to mimic the way that people actually use their devices. The most common smartphone uses include things like web browsing, using weather apps, written communication with friends and colleagues, playing games, or reading the news -- all of which involve sending and receiving small data packets. How a network performs depends on the size and type of data packets being sent and received, which is why Tutela uses a small, fixed file size to test how the network handles typical traffic -- rather than huge files of several hundred megabytes, which are representative of downloading huge apps, entire movies to watch offline, and little else.

Unlike traditional methods of benchmarking mobile network performance, the crowdsourcing techniques employed by Tutela don't inherently offer a head-to-head comparison of operators in exactly the same location. Crowdsourcing is complementary to drive-test techniques and measures network performance wherever users are actually using the network -- which, if you're seeking to examine the real-world experience of subscribers using their own devices on the network, is exactly what you'd be after.

In addition to working in the background (to eliminate user-initiation bias) and testing using representative packet sizes, Tutela also employs the largest crowdsourced population in the world for mobile network testing. Our software is present on over 300 million Android and iPhone devices globally, and our network collects over 10 billion mobile data measurements every day. Our data scientists analyze results for countries on a monthly basis and tabulate the results into reports. Our custom analytics solution, Tutela Explorer, updates with new measurements on a daily basis, and enables operators to chart, map, and filter over 80 key performance indicators into customized dashboards to help them better understand network performance, enhance customer Quality of Experience, and benchmark their network against competitors.

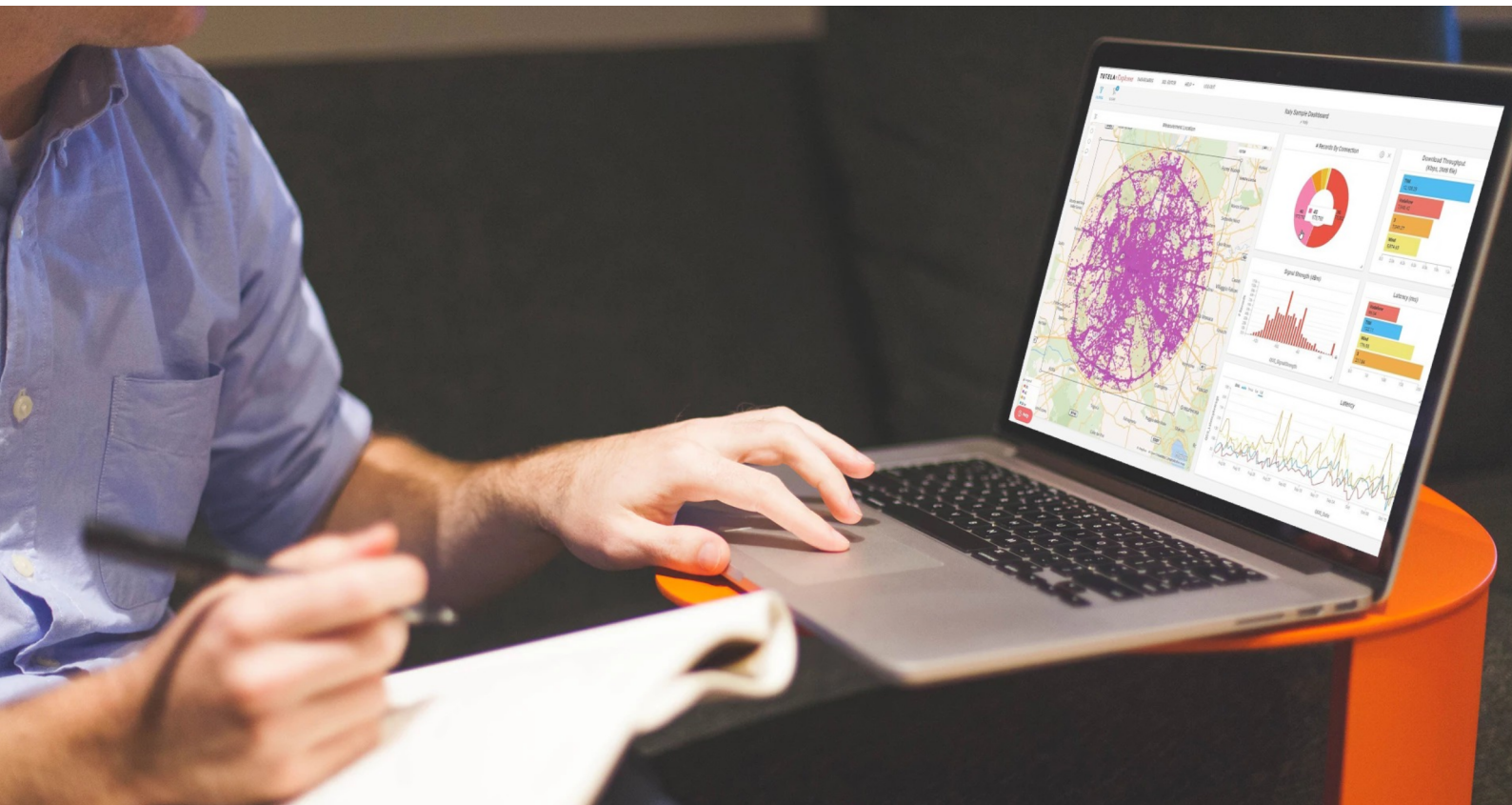
Complimentary Solutions for Regulators

Tutela enables regulators to verify licence obligations with crowdsourced data, ensuring mobile operators provide an adequate communication service and a reasonable quality of experience across the country. With Tutela's complimentary data solutions, regulators can access aggregated data and detailed interactive analytics to:

- Create coverage and quality maps
- Benchmark network quality and coverage across all operators
- Analyse spectrum utilisation, performance and more
- Integrate Tutela's data directly into your existing analysis and mapping tools

To find out more and to gain access, please contact Tom Luke on tom@tutela.com, or complete our contact us form.

Contact us



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 personal data and is compliant with international privacy regulations including GDPR.

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