



# ***SPEEDCHECKER***

***USER EXPERIENCE ON MOBILE NETWORKS***



## **Croatia**

June 2022

## ***ABOUT THE DATA***

<b>Total number of samples:</b>	<b>43,591</b>
<b>Total number of unique devices:</b>	<b>24,935</b>
<b>Data collection period:</b>	<b>1 June 2022 - 30 June 2022</b>

## ***ABOUT THE REPORT***

SpeedChecker aims to benchmark operators on the user experience and, therefore, the metrics in this report are designed with this in mind. Users accessing the services on the Internet are affected not only by the quality of the radio access network but also by other factors such as the mobile device performance, network backhaul capacity and interconnections to other networks.

Our [methodology](#) is designed to take into account all of those factors. Our metrics do not show the highest possible speeds or the lowest latencies that a particular operator can provide locally. The majority of the content accessed on the Internet is on CDNs and that is why SpeedChecker uses CDNs to perform the tests. Operators who have great radio access network as well as great connections to CDNs offer superior user experience and score better in our reports.



# MNO SPEED BENCHMARK

The following table shows average download and upload speeds per MNO.

The measurements were made across the whole country and across the whole spectrum of available Radio Access Technologies (3G, 4G, 5G if available).

— 95% Confidence interval

<b>A1</b>		16,875 samples
Download speed (Mb/s)	26.66	+/- 0.85
Upload speed (Mb/s)	7.46	+/- 0.24
<b>Hrvatski Telekom</b>		14,988 samples
Download speed (Mb/s)	32.01	+/- 0.86
Upload speed (Mb/s)	10.69	+/- 0.36
<b>Telemach</b>		11,403 samples
Download speed (Mb/s)	31.46	+/- 1.24
Upload speed (Mb/s)	12.45	+/- 0.45

Is your company eligible to receive the Champion Award?

See our [Champions Awards on SpeedChecker.com](#)  
Or [Contact us](#).



# MNO COVERAGE BENCHMARK

Our mobile coverage benchmark compares MNO coverage footprint (where our devices detected MNO's presence) and availability of different RAT in those locations. Operators with a large footprint and with a good 4G coverage will score higher on the Mobile Coverage benchmark.

Separately, we also report 4G Mobile Coverage which looks at 4G technology only (and does not reflect 2G or 3G coverage in the calculation).

**Data collection period:** 1 June 2021 - 30 June 2022

**A1** 17,381,213 samples

**Mobile Coverage** 790

**4G Mobile Coverage** 736

**Hrvatski Telekom** 28,358,375 samples

**Mobile Coverage** 876

**4G Mobile Coverage** 853

**Telemach** 10,078,648 samples

**Mobile Coverage** 787

**4G Mobile Coverage** 715

# MNO LATENCY BENCHMARK

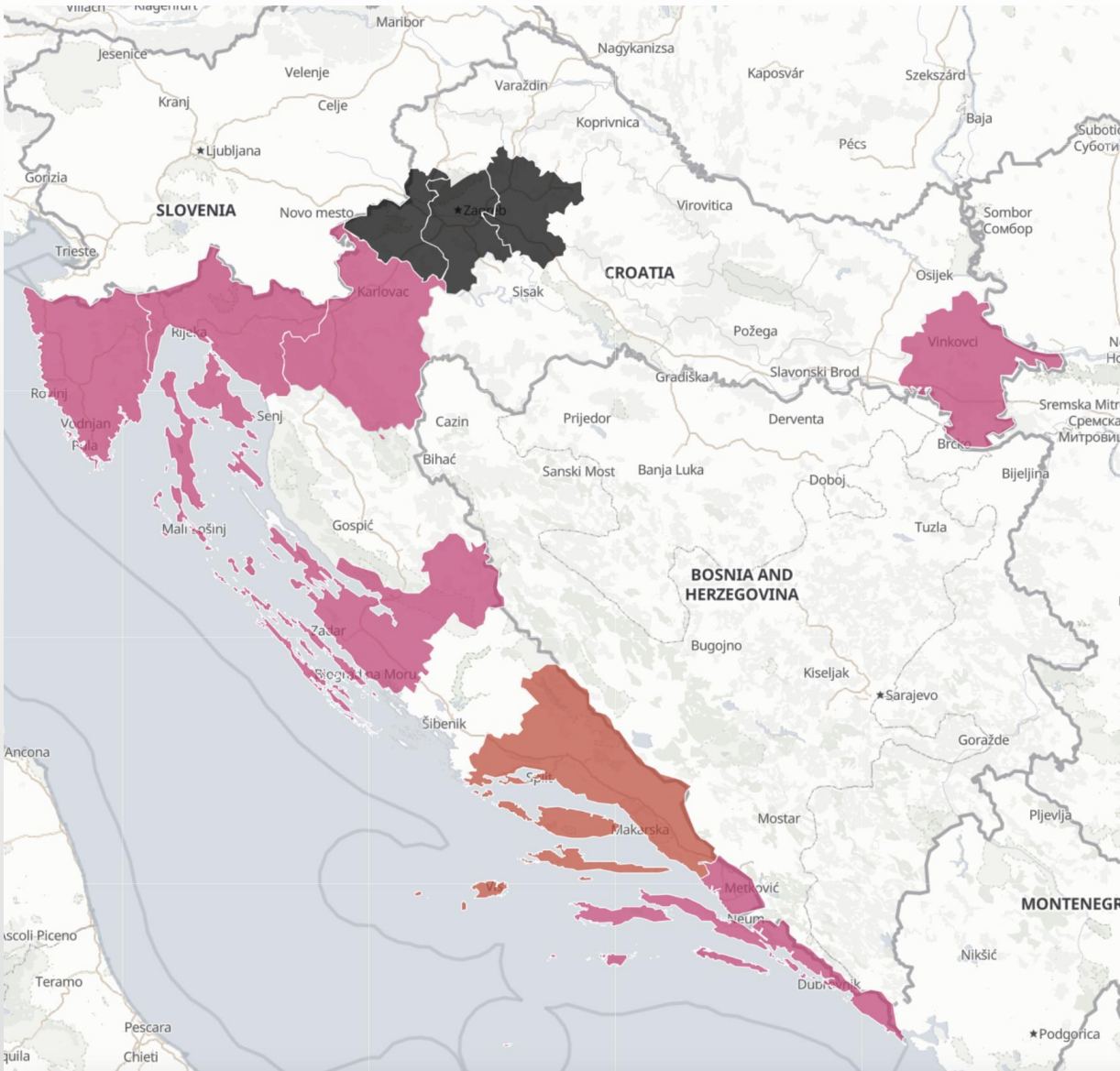
As described in our [data collection methodology](#), latency is measured to the CDN endpoints. Operators who interconnect with CDNs well tend to offer better user experience in latency-sensitive applications as well as score well in our latency comparison.




— 95% Confidence interval

<b>A1</b>		16,718 samples
Latency (ms)	<div><div>45</div><div>+/- 0.35</div></div>	
<b>Hrvatski Telekom</b>		14,847 samples
Latency (ms)	<div><div>40</div><div>+/- 0.49</div></div>	
<b>Telemach</b>		11,330 samples
Latency (ms)	<div><div>38</div><div>+/- 0.42</div></div>	

# REGIONAL SPEED WINNERS

The map shows which MNO offers the best speed in each region. We require at least 100 speed samples in each region from each operator to calculate the rank.



<b>A1</b>		1 <sup>st</sup> in 1 region
<b>Hrvatski Telekom</b>		1 <sup>st</sup> in 6 regions
<b>Telemach</b>		1 <sup>st</sup> in 2 regions

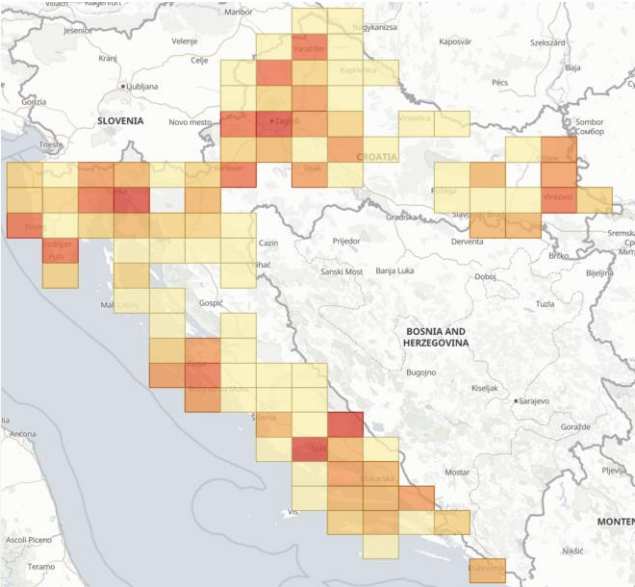
# AVERAGE DOWNLOAD SPEEDS IN DIFFERENT REGIONS OF CROATIA

The following table shows the average download speeds in different regions of Croatia. The 2<sup>nd</sup> column is an average of all MNOs in a particular region.

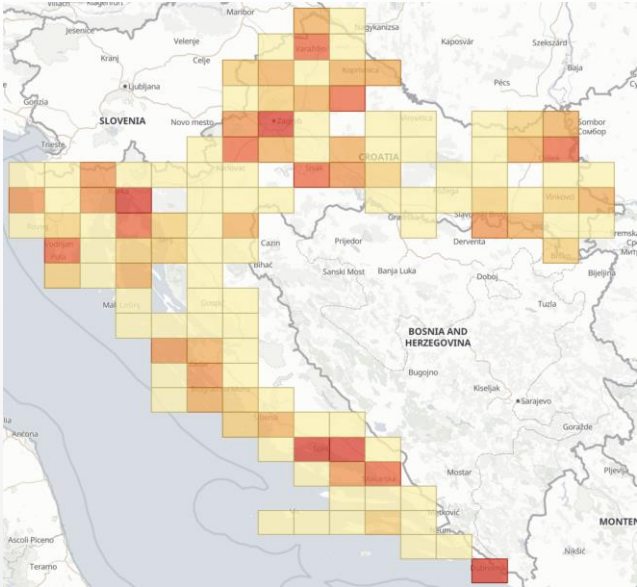
Region	All operators	A1	Hrvatski Telekom	Telemach	Test count #
Grad Zagreb	28.92	24.69	30.62	32.24	28,117
Splitsko-Dalmatinska	43.42	63.47	29.25	28.91	2,372
Primorsko-Goranska	29.99	30.06	30.93	24.65	1,333
Istarska	28.64	23.83	45.31	35.75	1,147
Zagrebačka	30.21	17.34	36.47	67.39	1,000
Vukovarsko-Srijemska	31.96	32.99	41.70	16.33	674
Osjecko-Baranjska	22.58	20.99	19.56	42.94	583
Zadarska	22.27	15.77	30.77	24.71	525
Karlovacka	27.27	19.89	36.95	28.02	524
Sisacko-Moslavacka	19.80	10.61	20.72	39.76	518
Dubrovačko-Neretvanska	27.42	8.84	41.82	18.15	451
Krapinsko-Zagorska	15.08	15.66	17.18	13.25	274
Brodsko-Posavska	20.15	17.88	67.93	12.75	257
Medimurska	22.51	23.58	16.39	44.70	253
Varaždinska	32.81	37.28	32.98	12.80	234
Šibensko-Kninska	53.66	39.98	28.75	91.34	206
Licko-Senjska	16.86	16.97	24.51	14.88	196
Bjelovarska-Bilogorska	25.28	5.89	38.47	5.73	179
Koprivničko-Križevačka	25.63	26.08	23.37	109.41	156
Požeško-Slavonska	18.67	20.34	24.93	3.80	30
Viroviticko-Podravska	35.53	57.25	16.03	58.26	26



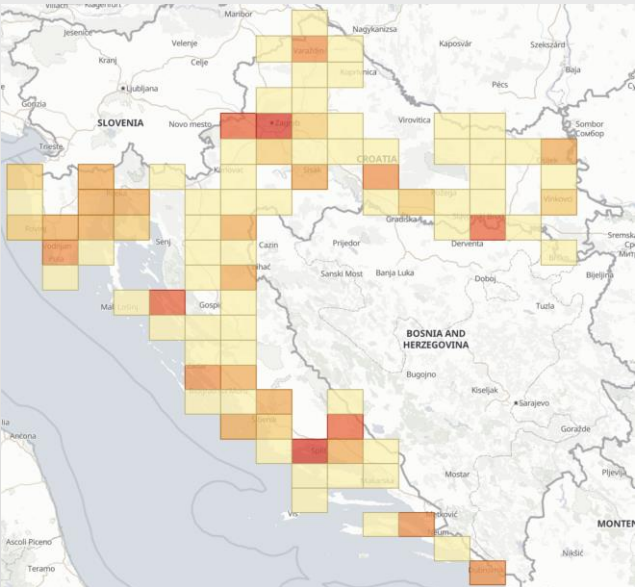
# MEASUREMENT SAMPLES DISTRIBUTION



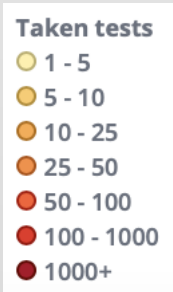
**A1**



**Hrvatski Telekom**



**Telemach**

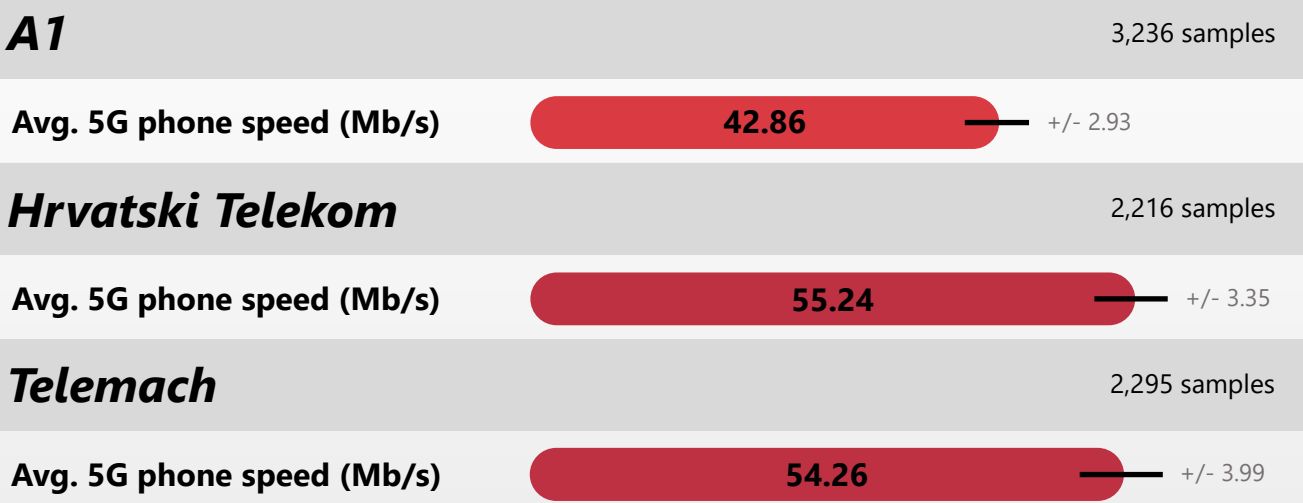




# 5G SPEEDS DON'T TELL THE WHOLE STORY

5G headline speeds may look impressive but how often a consumer with a 5G phone can enjoy them? SpeedChecker reports average speeds on 5G handsets as a primary metric for evaluating 5G experience. Operators who consistently deliver good speeds in many areas will do better than operators providing gigabit 5G with limited coverage.

95% Confidence interval



## MNO 5G PHONE UPGRADE INDEX

5G phone upgrade index shows typical increase in speeds when customers upgrades from LTE-only phone to 5G capable phone and stays on the same network.



# ***ARE YOU LOOKING FOR MORE DETAILED CROWDSOURCED DATA IN CROATIA?***

What you see in this free report is a high-level snapshot of the crowdsourced data we offer to our clients.

Our crowdsourcing system contains billions of data points collected from mobile devices worldwide.

Unlike our competitors, we can sell access to the data with different granularity: Our clients can pick data they need with significant cost savings associated with a reduced scope.

**CONTACT US FOR MORE INFORMATION**



# ***FLEXIBILITY IS IN OUR DNA***

Our customers value our flexible and modular approach in delivering our solutions. There is no one size fits all in providing crowdsourcing projects. Customers increasingly require tailored solutions which will satisfy all technical, operational and legal requirements.



With reduced scope comes reduced price. Our Basic KPI set is a more cost effective way to get speed test data. Our Advanced KPI set is more comprehensive with 100+ active and passive KPIs.



Crowdsourcing is about trade-offs. Do you want more tests or do you want tests to run longer ? Do you want to collect data passively without impacting the network and user bandwidth or run active tests which will stress and assess the capacity better?



Do you want us to host the solution for fast & easy deployment or do you require data to be within your data center for compliance purposes?

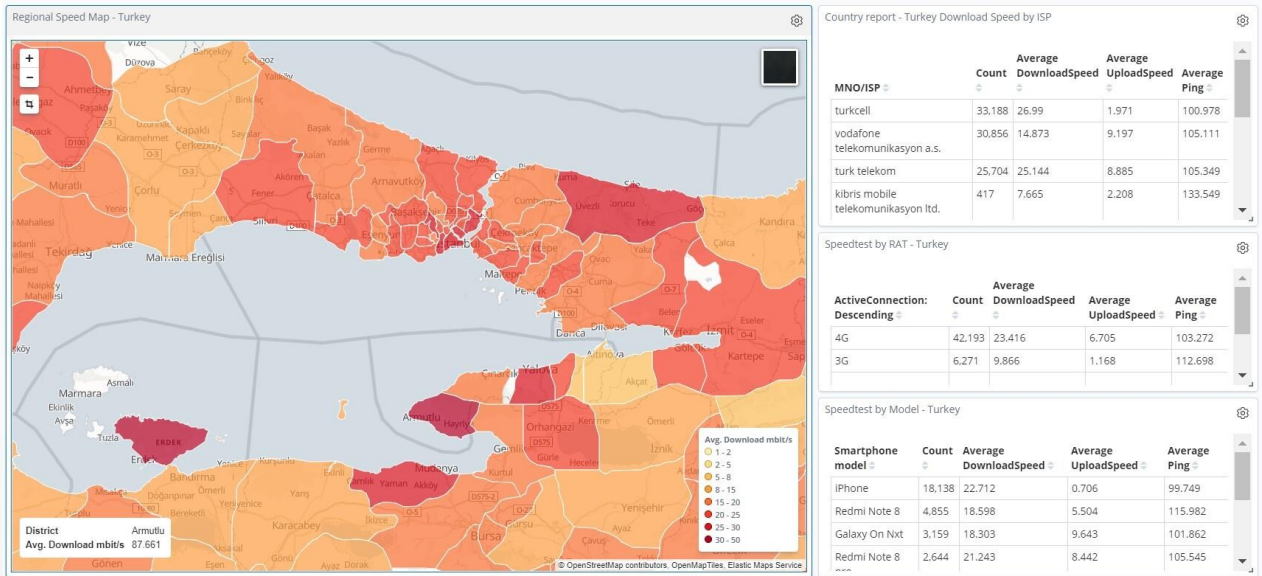


You not only want the data but you also want your own app or web-based tester? We can do it all. Our team can produce iOS, Android, HTML, Windows and MAC clients tailored to your specific needs.

 **[CONTACT US FOR MORE INFORMATION](#)**

# BASIC CROWDSOURCING SYSTEM

Our Basic Crowdsourcing System offers full analytical options like our Advanced system but with the limitation of a smaller Basic KPI set.



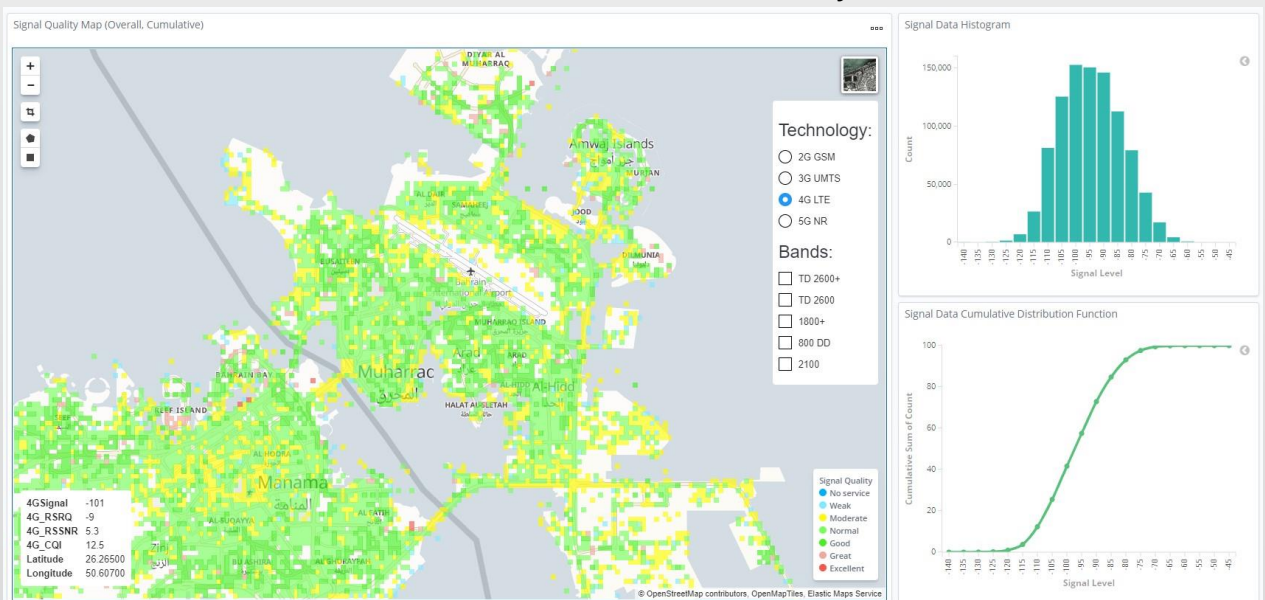
## Internet Speeds

[See Full Screen image](#)

Basic KPIs include speed test data along with device and network information but do not contain Streaming Video, detailed Radio KPI's nor passive measurements.

# ADVANCED CROWDSOURCING SYSTEM

Step up from our Basic system to our Advanced Crowdsourcing system with more than 100+ KPIs to analyse



## Coverage Analysis

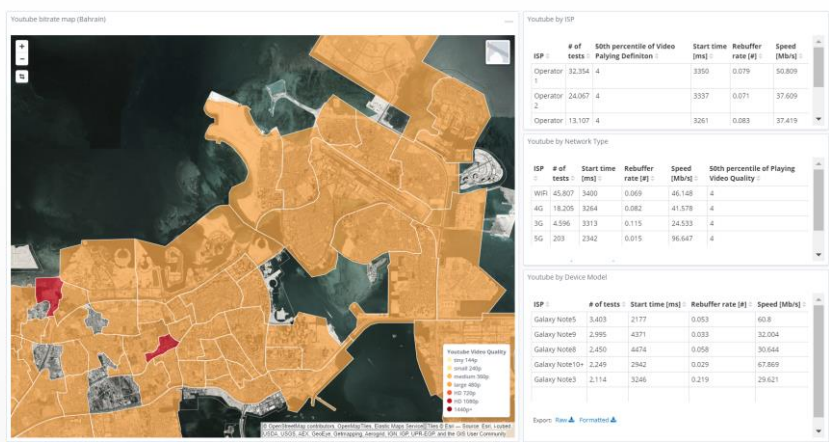
[See Full Screen image](#)

- Statistical research on the basis of millions of crowdsourced samples
- Multiple signal metrics RSRP, RSRQ, SNR, RSSI, CQI
- Split by MNO, Radio Access Type, Band (down to individual ARFCN)
- Possibility to filter by: Speed (e.g. High Speed Scenario) and Indoor



**SPEEDCHECKER**

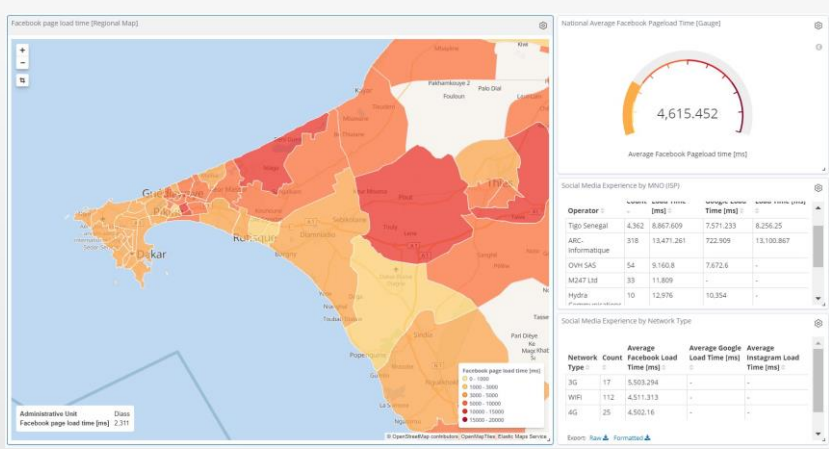
# ADVANCED CROWDSOURCING SYSTEM



## YouTube Quality

YouTube quality dashboard provides information about YouTube regional performance. It features metrics such as YouTube playing definition, buffering time, start delay.

[See Full Screen image](#)



## Social Media Experience

Social media experience dashboard shows regional performance of major social media platforms such as Facebook, Google and Twitter.

[See Full Screen image](#)



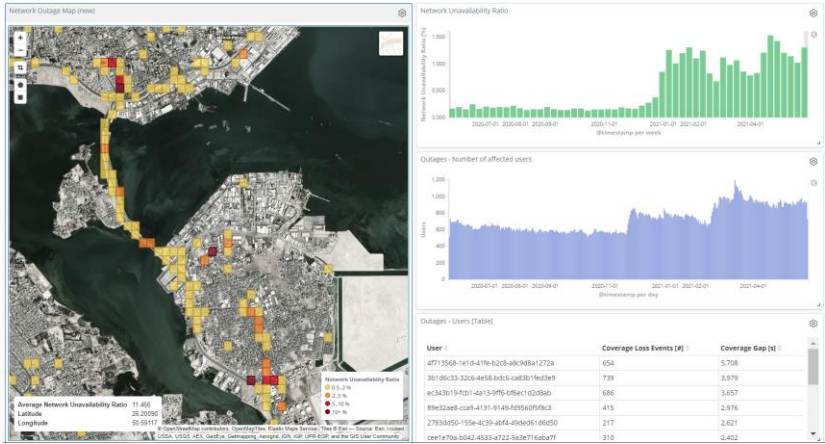
## Point of Interest Performance

Reveals Internet performance in specific important locations such as Airports, Malls, Stadiums and other places located outside of drive test routes.

[See Full Screen image](#)



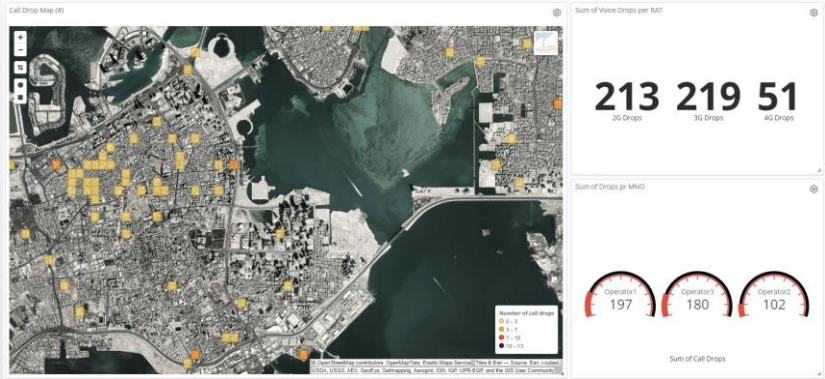
# ADVANCED CROWDSOURCING SYSTEM



## Outages

Network Availability is the number one metric for any network. While OSS data provides overall information, crowdsourcing is able to spot exact locations where subscribers are not able to attach to the network.

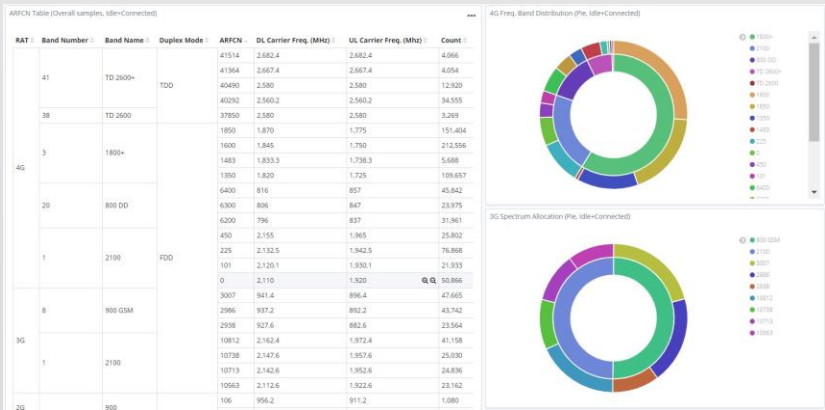
[See Full Screen image](#)



## Voice Quality

The Voice Quality dashboard shows the user issues visualized on a map to spot any areas where users are making calls and their quality is not satisfactory or where calls are being dropped.

[See Full Screen image](#)



## Spectrum Usage

Spectrum utilization dashboard allows the monitoring of how the available spectrum is used in various locations. It may reveal the load balancing situation or the fact that individual band are overloaded or unloaded.

[See Full Screen image](#)



# DATA COLLECTION METHODOLOGY

Our data is collected from end user devices running Android and iOS systems. All measurements are executed towards a CDN that has a large geographical footprint and hosts a significant part of the content that is being accessed by the users. This ensures our results are a good approximation of the user's actual quality of experience.

All measurements must contain accurate location information using GPS or wi-fi geolocation methods. Measurements are considered only from the apps that have been approved by SpeedChecker. Submitted measurements are checked to see if they are within expected ranges and additional security precautions are implemented to ensure measurement data is not being manipulated.

The data collection process aims to deliver a single measurement sample from every device in our crowdsourcing system device pool and we strive to remove all duplicates. Due to privacy settings on some users phones we cannot reliably detect unique devices therefore some devices have contributed to more than 1 measurement into this dataset.

## MEASUREMENT METHODOLOGY

The methodology is based on the concept of the [ITU-T Q.3960 \(2016\)](#) "Framework of Internet related performance measurements" and "Supplement 71 to ITU-T Q-series Recommendations".

This test methodology aims at delivering an accurate measurement of the maximum bandwidth available over a given internet connection. This is achieved by transferring multiple parallel data streams over separate TCP connections within a predefined amount of time. The transferred data consists of randomly generated data with high entropy.

#	Parameter	Unit	ITU Range	Current Setting
1	Number of parallel threads	#	$1 \leq n \leq 10$	Dynamic addition from 1 to 10
2	Duration of pre-test	s	$0 \leq T_p \leq 5$	1s
3	Duration of the downlink test	s	$5 \leq T_d \leq 15$	5s
4	Duration of the uplink subtest	s	$5 \leq T_u \leq 15$	5s
5	Number of 'pings' during delay subtest	#	$5 \leq p \leq 20$	$p = 10$

# COVERAGE SCORE METHODOLOGY

SpeedChecker has developed a robust and reliable methodology of assessing cellular coverage worldwide. Our data-driven approach is using billions of cellular measurements conducted by hundreds of millions of mobile devices.

## Process

SpeedChecker data analysis process for mobile coverage involves four primary steps: collection, filtering, spatial aggregation, and summarization. The results of that process are used to determine coverage score on a country and operator level.

## Collection

Millions of cellular measurements are received daily from Android devices around the world.

## Filtering

Filtering is applied to ensure that only relevant measurements are used:

- Erroneous out-of-range measurements are excluded from datasets
- Measurements executed by inactive devices are excluded
- Measurements with inaccurate location are excluded

## Spatial Aggregation

Filtered multi-RAT signal measurements collected for last 12 months are grouped into tiles of approximately 1 km<sup>2</sup>. All tiles where at least one operator service was detected are summed up to form a total country coverage footprint. Average signal strength is calculated per tile per RAT for each operator. Each operator is then assigned with a score per tile depending on average signal strength and particular RAT availability (higher RAT and stronger signal will contribute a higher score).

## Summarization

Finally, scores from all tiles are summed up per operator. This forms the total operator coverage score. Total operator coverage score is then divided by the total country coverage footprint to produce an overall OPERATOR COVERAGE SCORE.

\*RAT – Radio Access Type