CERTIFICATE

Systemics-PAB Sp. z o.o.
Wolodyjowskiego 46B, 02-724 Warsaw, Poland

hereby certifies that

Orange Slovensko a.s.
Metodova 8, 821 08 Bratislava, Slovakia

Received the title for

THE BEST SLOVAKIAN MOBILE NETWORK IN THE TEST

This certificate is based on the results of the measurement campaign, which was carried out by Systemics-PAB in July 2020. The measurement campaign assessed the quality of experience of mobile services in Slovakia. We also tested Carrier Aggregation coverage for all operators in Slovakia: Orange Slovensko a.s. (Orange), SWAN a.s. (SWAN), Slovak Telekom a.s. (Telekom) and O2 Slovakia s.r.o. (O2). Systemics-PAB performed the benchmarking measurements throughout Slovakia covering 23 largest cities as measured by population, and national roads across the country. The measurements were carried out using SwissQual Smart Benchmarker system equipped with Samsung Galaxy S10 terminals for voice test and Samsung Galaxy S9 terminals for data tests. For the coverage assessment Rohde and Schwarz radio scanners were used. Voice tests were done in mobile to mobile mode. The assessment of quality of services was done using international standards and Systemics-PAB expert knowledge.

The results of the measurements showed Orange as operator achieving the highest overall results for the quality of experience of mobile services in Slovakia.

Orange Slovensko a.s. can therefore be certified as the operator with the highest overall quality of mobile services in the test.

Certificate Date: 18.08.2020

Jan Kondej
Chief Technical Officer

Test Route

The periodical drive tests of mobile networks play vital role in maintaining the highest standards of the telecommunication services quality and customer experience when using the network. It allows to assess the situation on the market and is one of the tools for stimulating the competitiveness.
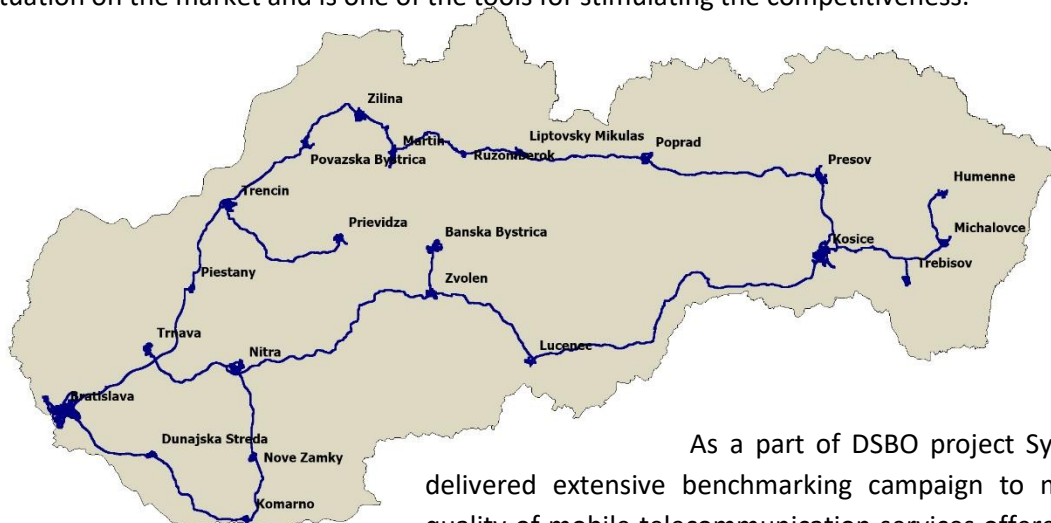
As a part of DSBO project Systemics-PAB delivered extensive benchmarking campaign to measure the quality of mobile telecommunication services offered by mobile networks operators in Slovakia across the country.

The benchmarking measurements took place between July 1st and July 16th of 2020 and covered representative areas of Slovakia including 23 cities and Slovakian roads. The total distance covered by each of 2 drive test cars used was ~3300 km. Measurements took close to 90 hours delivering ~2600 voice service tests and ~1500 for each of data services tests. All the tests were conducted using SwissQual (Rohde&Schwarz Group) benchmarking solution installed in the roof boxes on measurement cars.

Measurement Setup

	Voice/VOLTE testing	Data testing
Device	Samsung Galaxy S10 cat. 20 (SM-G973FDS) LTE / HSPA+ DC / HSUPA 5.76 signal attenuation* - 7dB	Samsung Galaxy S9 cat. 18 (H8216) LTE / HSPA+ DC / HSUPA 5.76 signal attenuation* - 7dB
Test Cases	**Mobile-to-Mobile** **Best available Voice technology**: 115 sec call window 85 sec call duration 15 sec call setup time out MultiRAB - 100kB http traffic injection	**Data 4G preferred:** **APN with default IPv4/IPv6 settings** HTTP UL and DL stress test 7s HTTP 1MB UL and 3MB DL file transfer Live Web Browsing 4 pages (http & https) YouTube Streaming
Tests and Route Types	100% Drivetest Big Cities, Small Cities and Connecting Roads	

* attenuation inserted to simulate usage conditions

Scoring Methodology

The quality assessment and the comparison between operators was prepared using the ETSI Technical Report 103559 Annex B approach.

The Report was developed and published in August 2019. It fulfils market needs for open and "standardized" countrywide mobile network benchmarking and scoring. These when published in the press enjoy great public interest and are of high importance for the operators of mobile networks. TR103599 allows to get results which are transparent about how the actual scoring has been achieved including methods and underlying assumptions.

Document discusses the construction and methods of such a countrywide measurement campaign, with respect to the area and population to be covered, the collection and aggregation of the test results and the weighting of the various aspects tested.

Experienced quality of service varies over time so that the individual score of a particular throughput cannot be fixed once and for all.

The basic philosophy of the scoring is driven by customer's experience with the network and service quality. In assessing the overall performance and overall score of each mobile network, 2 main categories of services (with subcategories) have been evaluated:

- Voice services, affecting 40% of the overall score

- Data services, affecting 60% of the overall score and consisting of following tests:
  - Fixed Size File DL
  - Fixed Size File UL
  - Fixed Duration File DL
  - Fixed Duration File UL
  - Web Browsing
 - YouTube streaming

Additional assumptions

Test area was designed to cover cities and connecting roads (with villages along roads) that constitute 50% of the Slovakian population.

In order to keep the fairness of testing methodology all the operators in the benchmark were tested using the same measurement terminal type supporting functionalities offered by networks to achieve the best performance. The selection of measurement terminals models for data and voice tests took also into account the stability of the terminal itself as well as availability of the appropriate firmware version to support VoLTE and high data throughputs. The quality of services was not limited by SIM cards used in the project. Commercial tariffs were used.

Selection of web pages to be tested was done based on Alexa rank of most popular web destinations in Slovakia which are accessible for drive testing (automated test by robots).

Scoring Results

With applied scoring methodology the highest number of points in overall scoring was achieved by Orange and was equal to 941.7 out of 1000 of maximum achievable. The other operators scored 885.8, 841.0 and 711.1. Orange got the best score in both voice and data tests.
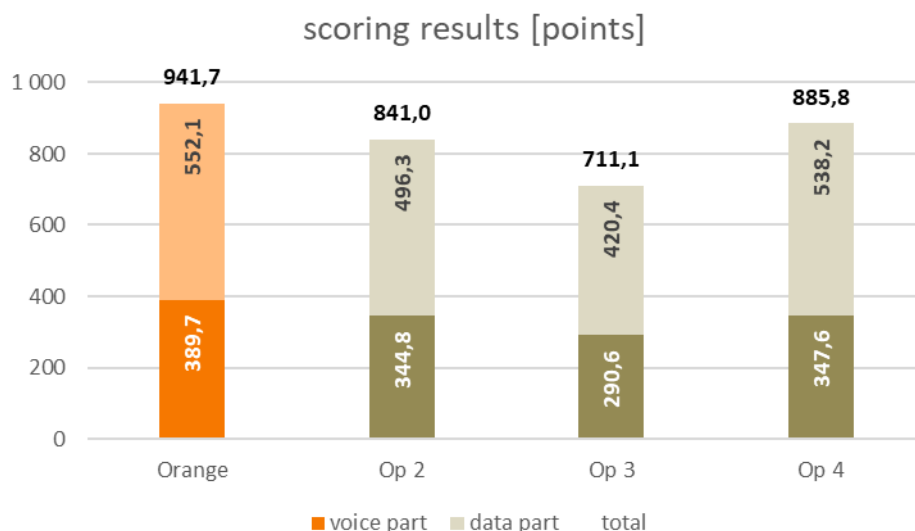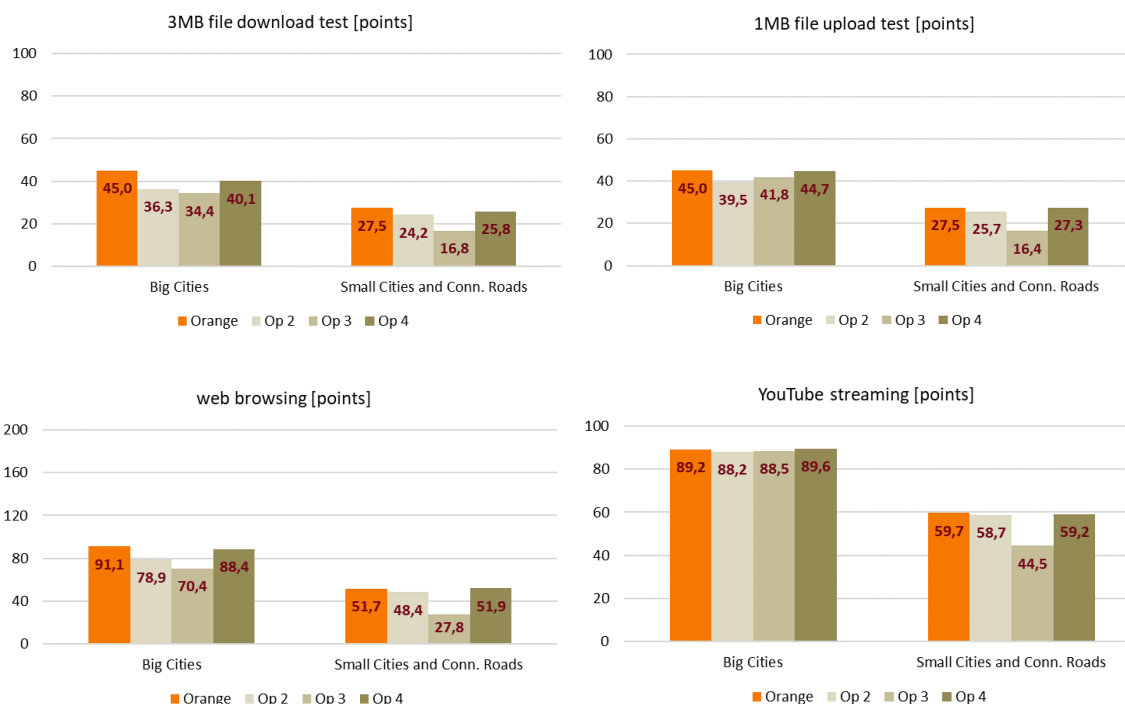

Orange achieved the highest overall score due to the best quality of services in all measured aggregations, in Large Cities, Small Cities and on Roads.
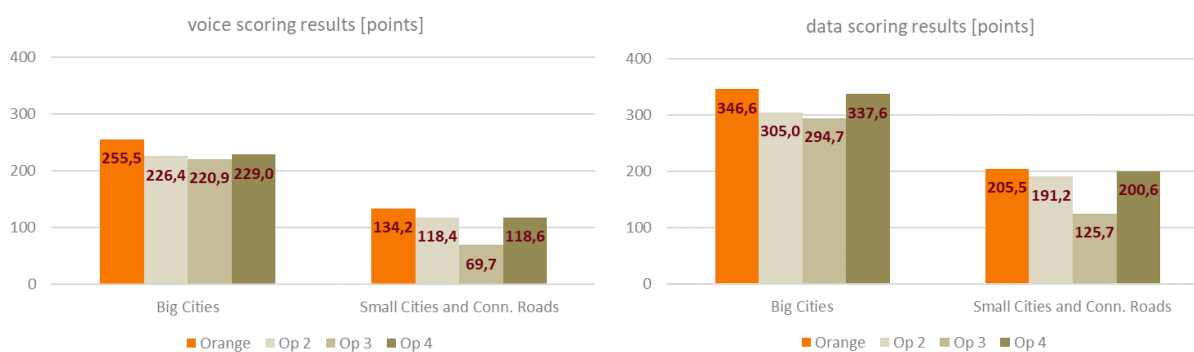
In Small Cities and on the Connecting Roads, the results of Orange and Op4 are not far from each other, but with Orange being ahead especially for voice services. The scoring difference varies in specific tests types and geographical locations. There is a noticeable difference in scoring results between these two mobile operators and two others.

The comparison of the scoring results for selected tests for big cities and other areas is presented on charts below.

3MB file download test [points]

Big Cities: Orange 45,0 — Op 2 36,3 — Op 3 34,4 — Op 4 40,1
Small Cities and Conn. Roads: Orange 27,5 — Op 2 24,2 — Op 3 16,8 — Op 4 25,8

1MB file upload test [points]

Big Cities: Orange 45,0 — Op 2 39,5 — Op 3 41,8 — Op 4 44,7
Small Cities and Conn. Roads: Orange 27,5 — Op 2 25,7 — Op 3 16,4 — Op 4 27,3

web browsing [points]

Big Cities: Orange 91,1 — Op 2 78,9 — Op 3 70,4 — Op 4 88,4
Small Cities and Conn. Roads: Orange 51,7 — Op 2 48,4 — Op 3 27,8 — Op 4 51,9

YouTube streaming [points]

Big Cities: Orange 89,2 — Op 2 88,2 — Op 3 88,5 — Op 4 89,6
Small Cities and Conn. Roads: Orange 59,7 — Op 2 58,7 — Op 3 44,5 — Op 4 59,2
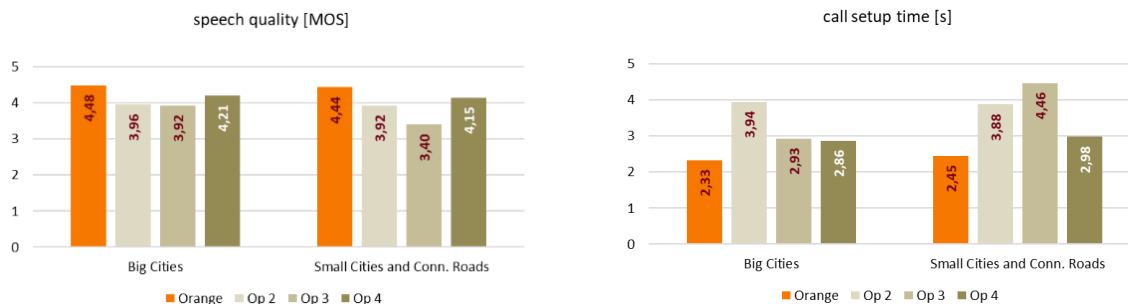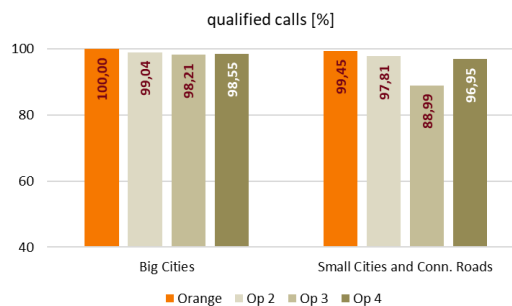
Tests Results in Details

All operators achieved good results in Voice Call test but there is significant difference between leading two operators (Orange and Op4) and two others. All operators provide VoLTE connections. Orange demonstrates the best VoLTE qualifier (Successful calls with sufficient speech quality and low call setup time). Orange, Op2 & Op4 reported ~99% of voice test with VoLTE.

Orange has best speech quality MOS, marginally ahead of Op4.

qualified calls [%]

Big Cities: Orange 100,00 — Op 2 99,04 — Op 3 98,21 — Op 4 98,55
Small Cities and Conn. Roads: Orange 99,45 — Op 2 97,81 — Op 3 88,99 — Op 4 96,95

Both leading operators utilize EVS codec, which is VoLTE codec offering superior speech quality compared to legacy (2G/3G) codecs. Op2 and Op3 utilize AMR WB codecs, which provide lower speech quality score.

speech quality [MOS]

Big Cities: Orange 4,48 — Op 2 3,96 — Op 3 3,92 — Op 4 4,21
Small Cities and Conn. Roads: Orange 4,44 — Op 2 3,92 — Op 3 3,40 — Op 4 4,15

call setup time [s]

Big Cities: Orange 2,33 — Op 2 3,94 — Op 3 2,93 — Op 4 2,86
Small Cities and Conn. Roads: Orange 2,45 — Op 2 3,88 — Op 3 4,46 — Op 4 2,98

Orange has the fastest call setup time thanks to extensive use and very good performance of VoLTE-VoLTE calls. Other operators present longer call setup time even in case of pure VoLTE Calls.

average data rate DL 7s test [kbps]
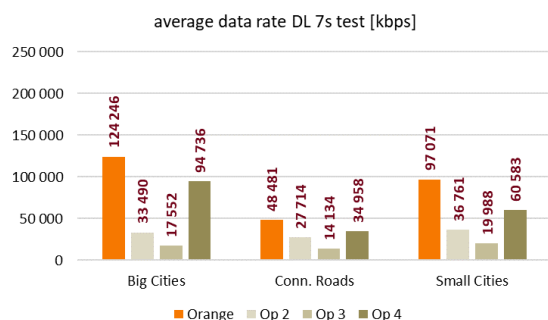
Orange DL throughput performance is significantly ahead of competition. Compared with 2019 benchmark, vast increase in Orange throughput is observed, due to extension of 4G capacity by massive LTE 4CA deployment with 2100 band usage. Op4 scored as 2nd best operator, leading confidently over Op3 and Op2. Op4 downlink throughput results are stagnant compared with 2019 benchmark campaign, as Downlink CA deployment has not been increased visibly. Op2 and Op3 results are much lower due to lower LTE CA usage and lower bandwidth of LTE channels.

average data rate UL 7s test [kbps]
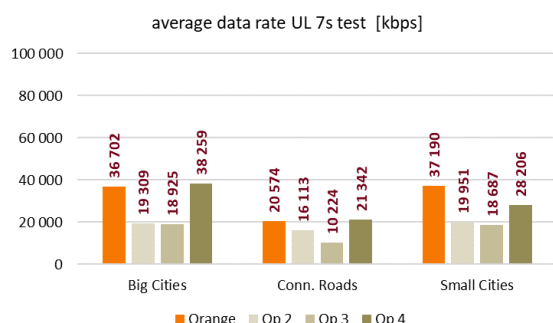
In case of Uplink throughput, Orange and Op4 are broadly on pair in Big Cities and Connecting Roads. In Small cities, Orange scores higher throughput than Op4. Compared with 2019 benchmark, an increase in uplink throughput can be noted for Orange reflecting improvement in LTE deployment, while results for Op4 remained on the same level. Similarly as in Downlink, Uplink results of Op2 and Op3 are limited due to level of LTE deployment and bandwidth of the channels. Uplink Carrier Aggregation was not measured during 2020 benchmark.

average session time 3MB DL [s]
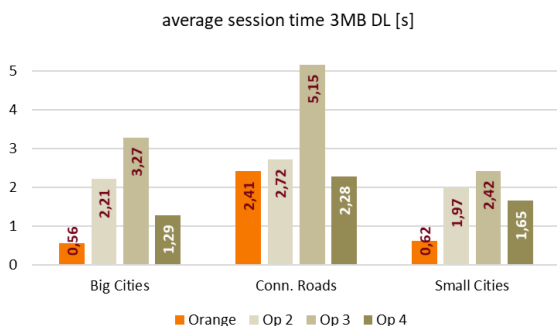
Orange achieved shortest average session time among all operators for 3MB file download in Big and Small cities. For connecting roads, Op4 showed the shortest session time. Op2 and Op3 are behind competitors, with Op3 results being severely impacted due to poorer service reliability on Connecting Roads.

average session time 1MB UL [s]
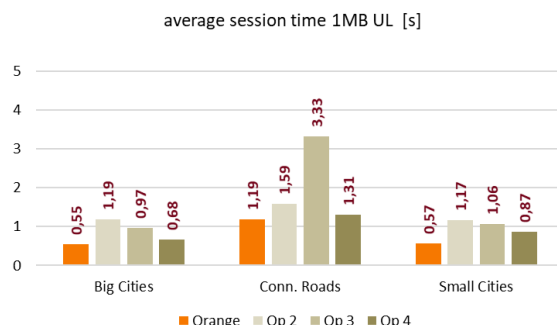
Orange achieves also the shortest session times among all operators for the 1MB file upload. Almost all operators demonstrate very similar UL reliability except Op3 with low UL reliability especially on connection roads. Op4 stays very close to Orange. Orange presents a significant improvement in comparison to 2019. Op4 has slightly improved in big cities but small deterioration is noticeable in small cities and connecting roads.
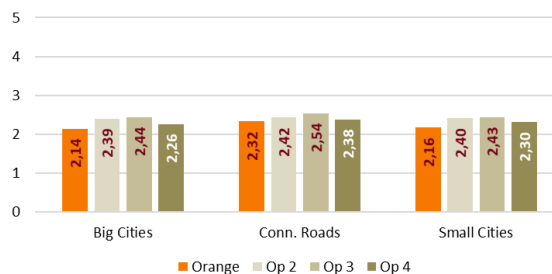
For Live Browsing, Orange with the shortest access to live web content (time to 1st paint) and the best service reliability in all aggregations, Op4 stays very close (~100ms behind) with good service reliability. Op3 well behind competition in term of service reliability.

Orange and Op4 show the fastest YouTube playout start time and the best YouTube reliability. Almost all operators achieve similar VMOS scoring well above 4 points but Orange and Op4 take a lead in term of avg. picture resolution. Live video initial resolution is 720p; for the majority of cases, video is upgraded to 1080p based on YouTube algorithms and current network performance.
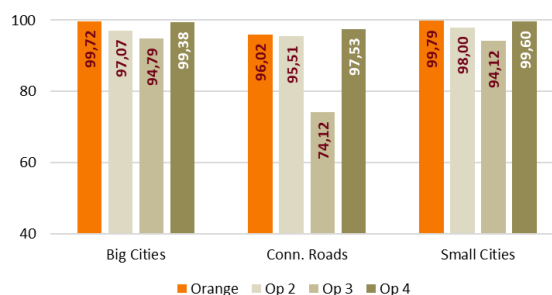
Orange, Op4 and Op3 download video content mainly from servers residing in their own network, hence, deploying Google Global Cache. Op2 uses Google LLC servers.

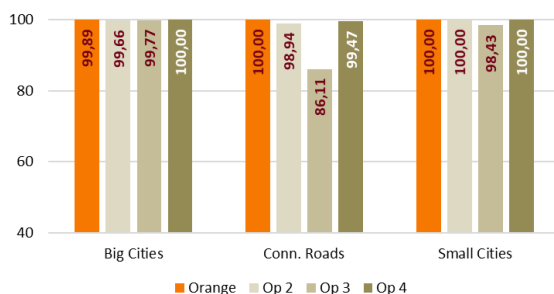All tests for Orange, Op2 & Op4 are carried out in LTE.
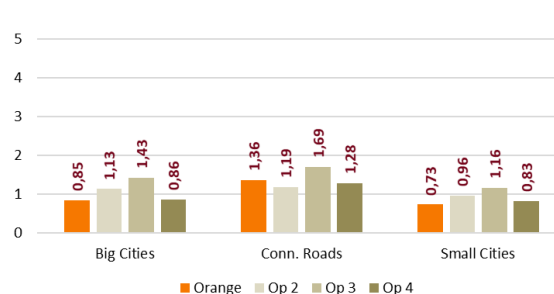
web browsing time to first paint [s]

	Orange	Op 2	Op 3	Op 4
Big Cities	2,14	2,39	2,44	2,26
Conn. Roads	2,32	2,42	2,54	2,38
Small Cities	2,16	2,40	2,43	2,30

web browsing qualified sessions [%]

	Orange	Op 2	Op 3	Op 4
Big Cities	99,72	97,07	94,79	99,38
Conn. Roads	96,02	95,51	74,12	97,53
Small Cities	99,79	98,00	94,12	99,60

YouTube qualified playouts [%]

	Orange	Op 2	Op 3	Op 4
Big Cities	99,89	99,66	99,77	100,00
Conn. Roads	100,00	98,94	86,11	99,47
Small Cities	100,00	100,00	98,43	100,00

YouTube playout start time [s]

	Orange	Op 2	Op 3	Op 4
Big Cities	0,85	1,13	1,43	0,86
Conn. Roads	1,36	1,19	1,69	1,28
Small Cities	0,73	0,96	1,16	0,83

It is also worth to mention that testing included WhatsApp performance even it was not a part of the scoring. WhatsApp Application was up-to-date 2020 version. All MNOs demonstrate very similar WhatsApp performance in terms of Call Setup Time in vicinity of 2s. Op2 takes a lead in term of WhatsApp reliability with the result 99,3% while Orange and Op4 ~98,5%.

WhatsApp speech quality is similar in all networks and lays between 4,24 and 4,31. The speech quality of WhatsApp is better than speech quality offered by Legacy Voice technologies (3G/2G/4G CSFB) but VoLTE outperforms it in all measurement locations in Orange network. In other networks WhatsApp speech quality is better than VoLTE. Orange, Op2 and Op4 have almost all calls initiated in LTE, overall as well as in connecting roads.

Systemics-PAB is well known European company providing comprehensive surveys and measurements of the quality of network services and the end-user experience. Systemics-PAB conducts complex projects in multiple countries worldwide for telecom operators, regulators, network equipment providers, lab testing organizations and enterprises. Systemics-PAB offers the expert know-how developed over more than 15 years in this business.