

CERTIFICATE

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

hereby certifies that

Orange Poland S.A.
Aleje Jerozolimskie 160, Warsaw, Poland

received the title for

THE BEST POLISH MOBILE NETWORK IN THE TEST

This certificate is based on the results of the measurement campaign, which was carried out by Systemics-PAB between August and September 2020. The measurement campaign assessed the quality of experience of mobile services in Poland. We also tested Carrier Aggregation coverage for all operators in Poland: Orange Poland S.A. (Orange), P4 Sp. z o.o. (Play), Polkomtel Sp. z. o.o. (Plus) and T-Mobile Poland S.A. (T-Mobile). Systemics-PAB performed the benchmarking measurements throughout Poland covering 27 largest cities as measured by population, and national roads across the country. The measurements were carried out using SwissQual Smart Benchmark system equipped with Samsung Galaxy S8 terminals for voice test, Samsung Galaxy S10 terminals for VoLTE test and Sony Xperia XZ2 terminals for data tests. Voice tests were executed in best available technology (including VoLTE). 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 Poland.

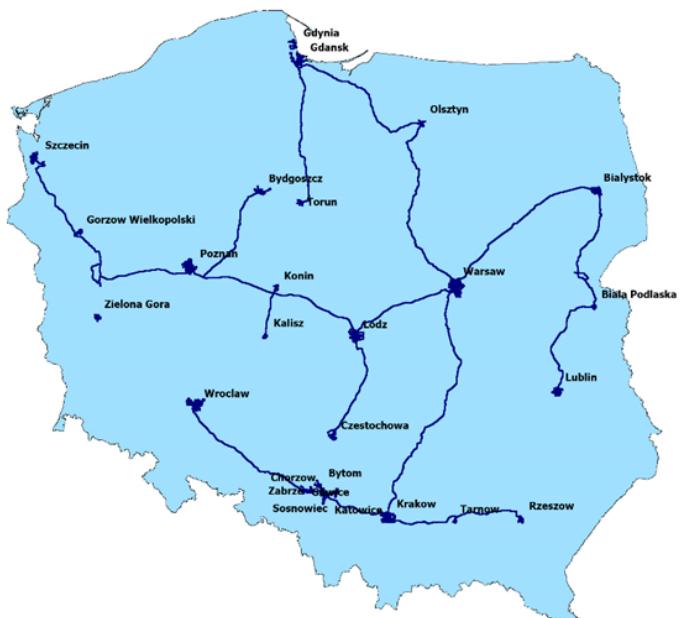
Orange Poland S.A. can therefore be certified as the operator with the highest overall quality of mobile services in the test.

Certificate Date: 04.11.2020


Jan Kondej
Chief Technical Officer

Test Route

The periodical drive tests of mobile networks play the 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 Poland across the country.

The benchmarking measurements took place between August 28th and September 29th of 2020 and covered representative areas of Poland including 27 cities and connecting roads. The total distance covered by each of 2 drive test cars used was ~6200 km. Measurements took close to 160 hours delivering ~4660 voice service tests and ~2900 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	Sony XZ2 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.

The document discusses the construction and methods of such 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.

The 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

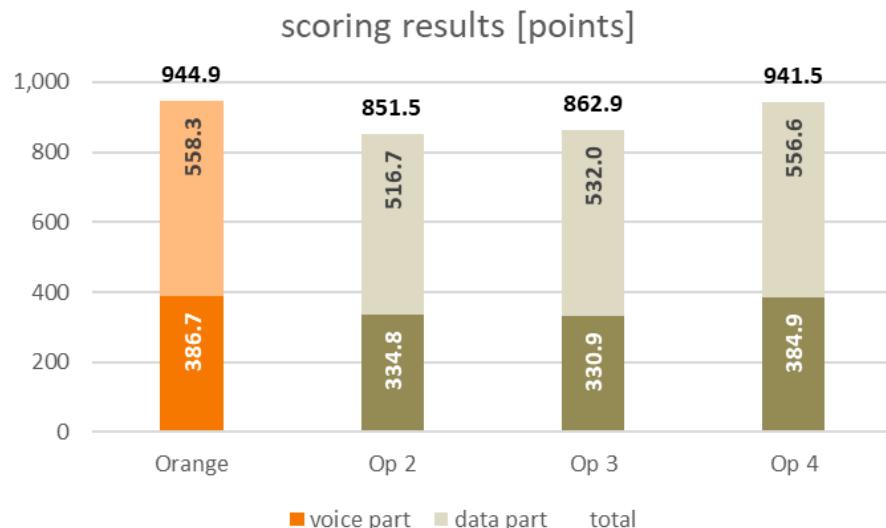
The test area was designed to cover cities and connecting roads (with villages along roads) that constitute 25% of the Polish population.

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.

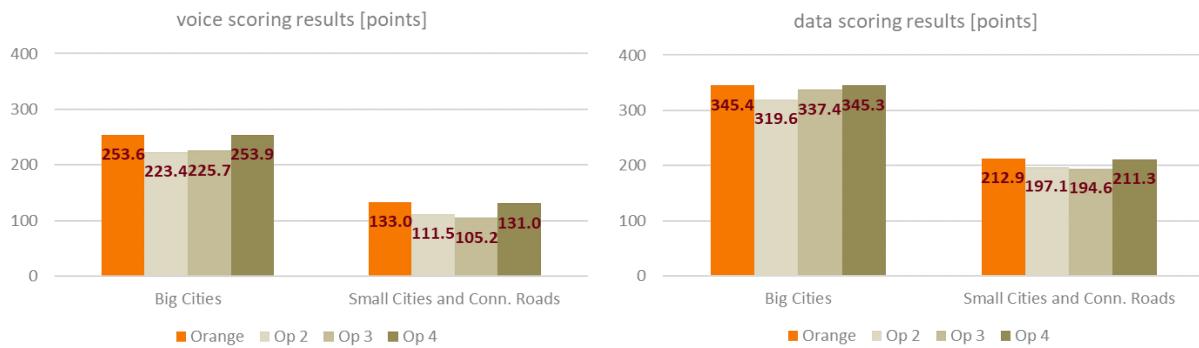
The selection of web pages to be tested was done based on Alexa rank of most popular web destinations in Poland which are accessible for drive testing (automated test by robots).

Scoring Results

With applied scoring methodology the highest number of points in overall scoring was achieved by Orange and was equal to 944.9 out of 1000 of maximum achievable. The other operators scored 941.5, 862.9 and 851.5. Orange got the best score in both voice and data tests.

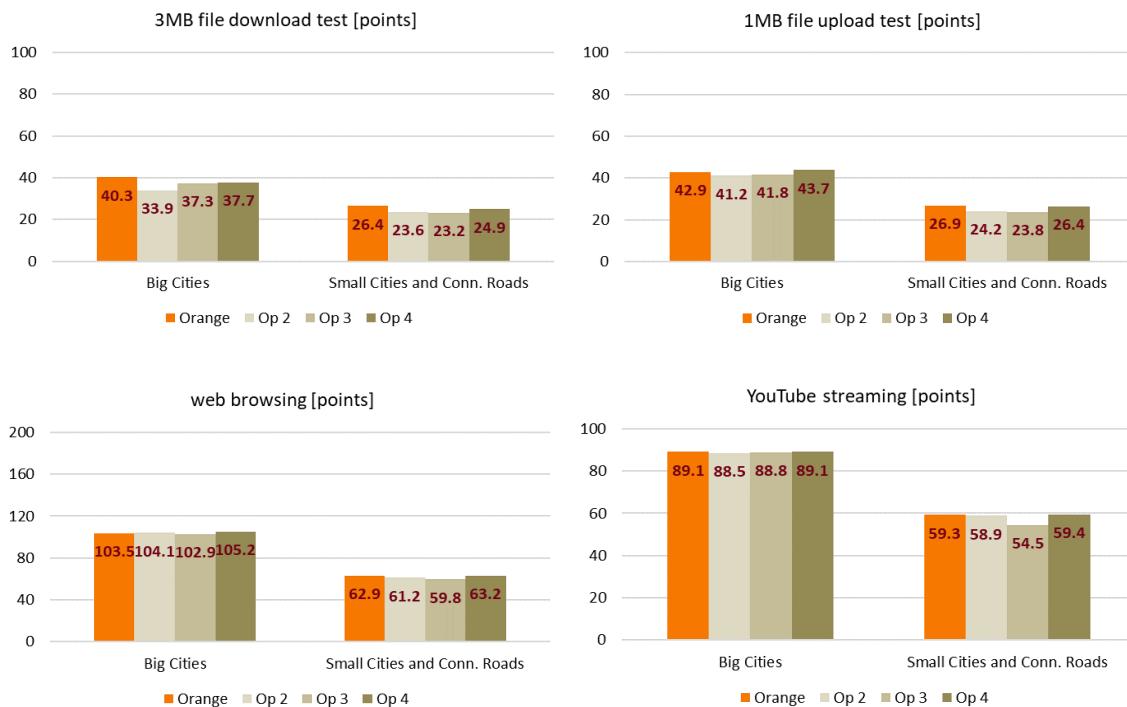


Orange achieved the highest overall score due to the best quality of services in all measured aggregations except voice tests in Big Cities where Op4 was leading by 0.3 points.



In all aggregations the results of Orange and Op4 are close to each other, with Orange being ahead especially for voice services and data services outside Big Cities. The scoring difference varies in specific tests types and geographical locations. There is noticeable distance in scoring results between Orange and Op4 who are leading operators and two others.

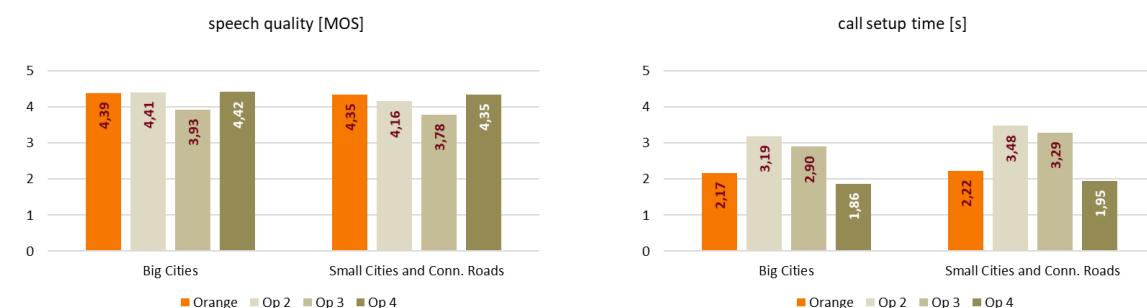
The comparison of scoring results for selected tests for big cities and other areas is presented on charts below.



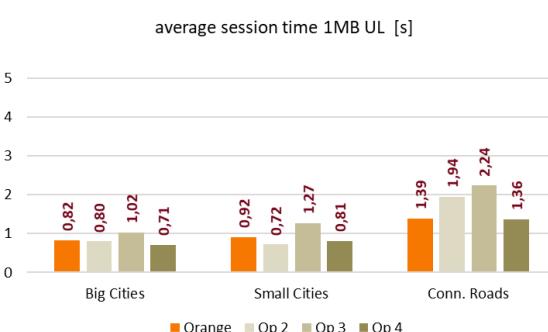
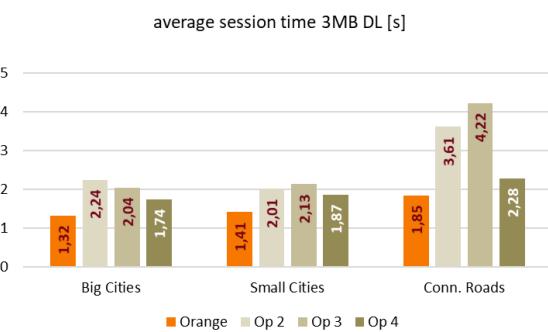
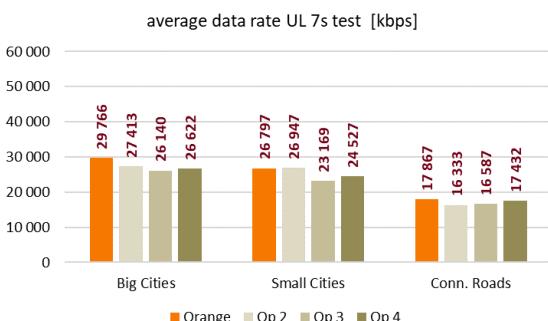
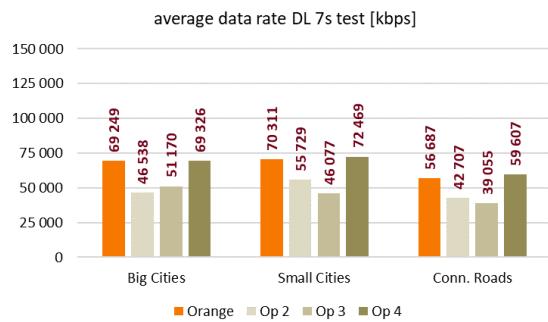
Tests Results in Details

All operators achieved good results in the 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 voice qualifier (Successful calls with sufficient speech quality and low call setup time). Orange reported 99% of voice tests with VoLTE, Op4 was on similar level with 98%. This figure was lower for Op2 and Op3 with 94% and 95% respectively.

Orange and Op4 have best speech quality MOS with Op4 marginally ahead in Big Cities. Orange, Op2 and Op4 utilize EVS codec, which is VoLTE codec offering superior speech quality compared to legacy (2G/3G) codecs. Op3 utilizes AMR WB codecs (even in VOLTE mode), which provide lower speech quality score.



Op4 is leading in call setup time with Orange being on 2nd place. Orange and Op4 achieved this 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.



Orange DL throughput performance in Capacity test is slightly behind Op4 but significantly better than Op2 and Op3. Compared to 2019 benchmarking campaign Orange and Op4 throughput results remained stable, while Op2 and Op3 improved their performance. Both leading operators attribute high throughput to advantage in LTE Carrier Aggregation deployment with Orange having 58% of tests with 4CA and Op4 having 55% of tests with 4CA. Op3 shows lowest level of LTE CA deployment with only 35% of tests with any CA combination.

In case of Uplink throughput Orange reports the best results. Orange was the only measured operator with Uplink Carrier Aggregation technology activated in the network. Uplink carrier aggregation was noted for 25% of tests and is responsible for highest throughput results scored in this test. Op2, Op3 and Op4 results reflect closely bandwidth of deployed carriers and efficiency of Uplink data transfers: in this comparison Op3 offered highest average bandwidth, while Op2 and Op4 had highest bandwidth efficiency (bits per transmitted symbol).

Orange achieved shortest average session time among all operators for 3MB file download. This significantly better result was achieved due to TCP Acceleration platform being implemented in the network. Acceleration Platforms break long TCP connection into two shorter ones, on which TCP retransmissions happen independently. This can provide additional gain in some use cases. Op2 and Op3 report more than two times longer average session time due to lower offered throughput and lack of Acceleration platform within their network.

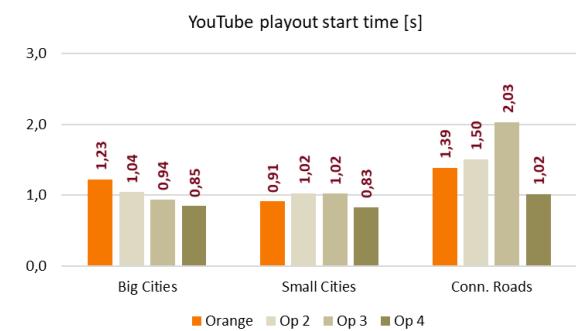
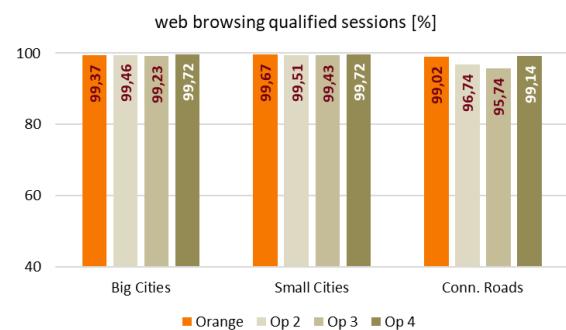
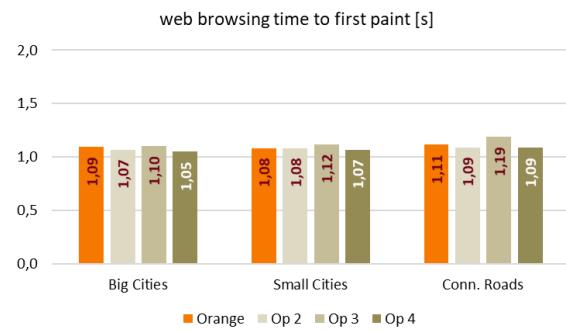
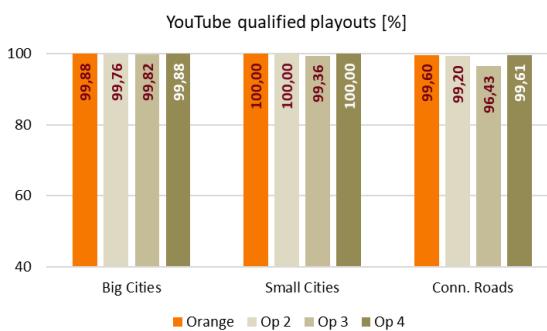
Orange and Op4 achieve the shortest session times for the 1MB file upload. Almost all operators demonstrate very similar UL reliability in Big and Small cities but Orange presents the best reliability of UL connections on Connecting Roads. Similarly to 3MB Downlink results, achieved session time for this testcase is impacted by presence or lack of TCP Acceleration. Results of this testcase are also impacted by presence of Uplink Carrier Aggregation, bandwidth of available carriers and efficiency of Uplink transfer.

All operators have similar access time to live web content as estimated by user-perceived webpage opening time (time to 1st paint). The service reliability for Orange and Op4 is similar in all aggregations. Op2 and Op3 well behind competition for service reliability on Connecting Roads.

Comparing to 2019 benchmarking campaign all operators improved their reliability, which stays on high and satisfactory level.

Orange and Op4 show best YouTube reliability. Orange has longest playout start in Big Cities and is second in other aggregations behind Op4. All operators achieved similar VMOS scoring well above 4,2 points. Orange and Op4 are leading in video resolution with 64% of samples being displayed with 1080p resolution. This figure is slightly lower for Op2 (62%) and Op3 (61%). Youtube playout starts with 720p resolution and is upgraded based on current network conditions.

Orange and Op3 download video content mainly from servers residing in their own network, hence, deploying Google Global Cache. Op2 and Op4 use predominantly Google LLC servers.



It is also worth to mention that testing included WhatsApp performance even though 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. All operators show also very similar WhatsApp reliability in Big cities in the range of 99,5% - 99,1%. Differences are visible in Small Cities and Connecting Roads where Op4 presents leading reliability of 97,7%, followed by Orange and Op2 with 96.8%.

WhatsApp speech quality is similar in all networks and lays between 4,11 and 4,3 of MOS score points. 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 for operators using EVS codec. All Operators show close to 100% of LTE initiated WhatsApp calls in Big and Small Cities. On connecting roads Orange and Op4 show 99% of WhatsApp LTE initiated calls, while Op2 and Op3 show 97% and 98% respectively.

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.