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JRC TECHNICAL REPORT

Roaming Performance Study (Smart 2018/0011) Final Report Executive Summary

An assessment of technical performance of mobile networks for Roaming in the EU

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Contents

Abstract

In the context of the review of the EU Roaming Regulation, this document presents results of a study on roaming performance assessment by field measurements on mobile broadband involving 40 mobile networks in 13 EU countries. JRC's mobile app netBravo was used to carry out the measurements and analysis of data. Download speed, upload speed and latency were measured for all roaming tests and results were analysed. The study found mixed results on the quality of service (QoS) in roaming. Customers had better as well as worse QoS than at home. However, customers of 21 mobile networks from 11 countries at least once had worse QoS in roaming compared to at home even when technical conditions were available for better quality. Such cases accounted for 25% of all roaming instances in the tests.

Executive Summary

Regulation (EU) 531/2012 of the European Parliament and the Council of 13 June 2012 on roaming on public mobile communications networks within the Union, amended in 2015 and 2017 (hereinafter the 'Roaming Regulation'), mandates the Commission to conduct a review by December 2019 of the roaming rules. One of the review requirements is to provide an assessment of the availability and quality of roaming services. The Commission's Review report[1] was adopted on 29 November 2019, and is followed by a legal proposal.

Following a request by Directorate-General for Communications Networks, Content and Technology (DG CNECT) for the above review purpose, the Joint Research Centre (JRC) undertook preliminary work, to assess the technical performance and quality of service (QoS) of EU roaming in a small sub-set of EU Member States (MSs) during the first year of the RLAH rules taking effect (i.e. between October 2017 and August 2018). This work served as a scoping exercise for a systematic approach developed later on in the present study for further tests carried out between October 2018 and October 2019.

In the present project, assessment of the performance of roaming has been based on real data from extensive field measurements on mobile networks in a subset of EU MSs. The JRC mobile app netBravo[2] was used to measure mobile network performance. The data thus collected was analysed to help answer relevant policy questions posed by DG CNECT. Results of the analysis are used to further inform the Impact Assessment for the review and prolongation of the Roaming Regulation[3].

Results from the present study by the JRC have contributed in terms of evidence-based assessment of roaming performance to the roaming review led by DG CNECT in 2020. Additional tests measuring the performance of MVNOs SIM cards when roaming were foreseen during the first half of 2020. Due to the COVID pandemic and travel restrictions those measurements had to be cancelled.

The present project complements the work carried out by the JRC.I1 unit on the economic aspects of the roaming markets under the projects SMART 2018/0010 and SMART 2019/0004.

What were the research questions?

(1) Whether roaming customers have different quality of service when roaming compared to the performance on their own home network.

(2) Whether quality of service on visited networks differs between the customers of the visited network and the roaming users visiting the network.

(3) Whether roaming customers have different quality of service on a visited network compared to other visiting roaming customers.

(4) How often did customers have worse quality of service in roaming than at home, even when the visited network was technically and practically able to provide better quality?

[1] Report on the review of the roaming market, COM(2019)616 final, and SWD(2019)416 available here.

[2] For further information and how to download netBravo, see the Annex to this Report and netbravo.jrc.ec.europa.eu.

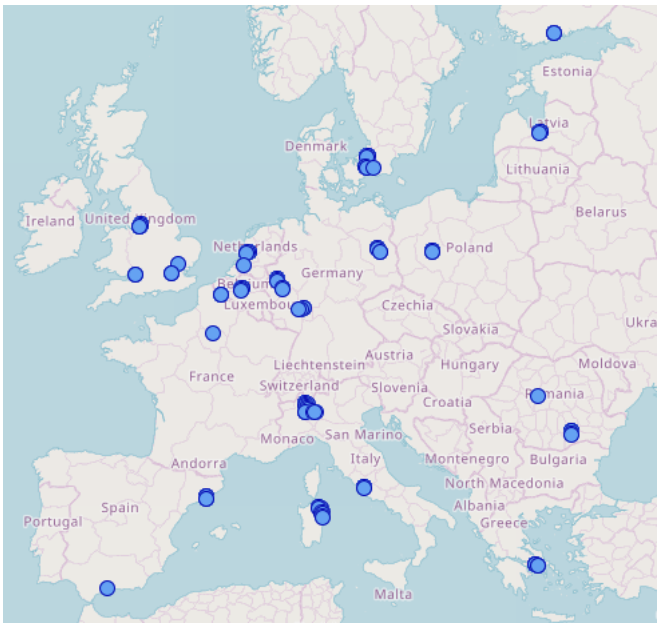
[3] This Initiative is included in the 2020 Commission Work Programme addressing the specific objective "Digital for consumers" and has to be seen in the broader political context of creating a Europe Fit for the Digital Age. The Initiative contributes to the ambition to make the most out of the digital transition to enhance opportunities to connect, communicate, solve societal issues and do business.

What was tested?

In the context of the EU Roaming Regulation, the JRC carried out a series of field measurements on 37 mobile networks in 13 EU countries[4] to assess the performance of roaming. Performance of 29 visiting SIMs from 12 EU countries was evaluated in relation to 1) their own home network, 2) in relation to the domestic SIM of the visited network, and 3) in relation to other visiting SIMs on the visited network.

Where were the tests done?

Altogether, SIMs of 40 different networks were used in field measurements. Three of these networks did not happen to be visited by any visiting SIM therefore number of visited networks was 37.



Number of visited countries:	13
Number of visited networks:	37
Number of visiting countries:	12
Number of visiting SIMs:	29

How were the tests done?

Tests were carried out in a controlled manner using the JRC's mobile app *netBravo*, which is designed to measure the coverage and quality of mobile networks and the performance of mobile broadband. All test data was stored and processed on the *netBravo* server with software adapted to the needs of the project. The app is available for free for smartphones running on Android® and Apple® iOS®.

The measurement equipment used was a set of smartphones of the same model (i.e. the same technical specifications) with netBravo app installed. The handsets used were suitable for a 4G+ network capability.

Tests were done in key city locations with high network availability. All visiting SIMs on the same visited network were tested repeatedly in a common time frame to ensure the network traffic conditions were similar.

The measurement data on download speed, upload speed and latency for various roaming SIMs in visited countries, as well as at home, was collected and analysed. Comparisons were made on the performance of visiting SIMs vs home SIMs (of the visited network) and vs other visiting SIMs on the same visited network and in the same situations. The average values of download speed and upload speed observed in several test samples were used in comparing performance.

[4] At the time of the tests, the Roaming Regulation was still applicable in the UK.

Three types of analysis were performed on the measurement data set obtained in field tests:

(a) Customer-level analysis of roaming performance
(b) Network-level analysis of roaming performance
(c) Cross-correlation analysis between the above sets.

What was found?

Q1 – Do roaming customers have different quality of service when roaming compared to the performance on their own home network?

Looking at the overall data of 177 roaming instances between 37 visited networks and 29 visiting SIMs, the download speed for customer SIMs was worse in roaming than in their respective home network on 39% occasions. The upload speed was worse in roaming than at home on 59% occasions. Latency in roaming was found worse than at home in 62% cases.

Q2 – Does the quality of service on visited networks differ between the customers of the visited network and the roaming users visiting the network?

Across the 37 networks visited by 29 visiting SIMs, results from field tests show that the download speed for visiting SIMs (roaming customers) was worse than the home SIM (home customer) of the visited network in 50% of the roaming instances. The upload speed for the visiting SIMs was worse than the home SIM in 72% of the roaming instances. Latency for visiting SIMs was found worse than the home SIM in 73% cases.

Q3 – Does the roaming customer have different quality of service on a visited network compared to other visiting roaming customers?

In relation to the roaming peers (other roaming users in the same visited network, at the same location and at the same time), there was even distribution of instances of roaming performance with *below average* and *above average* download speeds for the visited networks: 38% had better performance than the average of all roaming users[5], 40% had worse performance and 22% had about the average level of performance. The same was observed for the distribution of upload performance: 35% had better than average performance, 39% had worse than average and 26% had average level of performance. For latency the distribution was 36% above average, 32% below average and 32% average.

The figures were similar when considering only the cases where a network was visited by at least 5 visiting SIMs. It shows that the test results were overall statistically consistent.

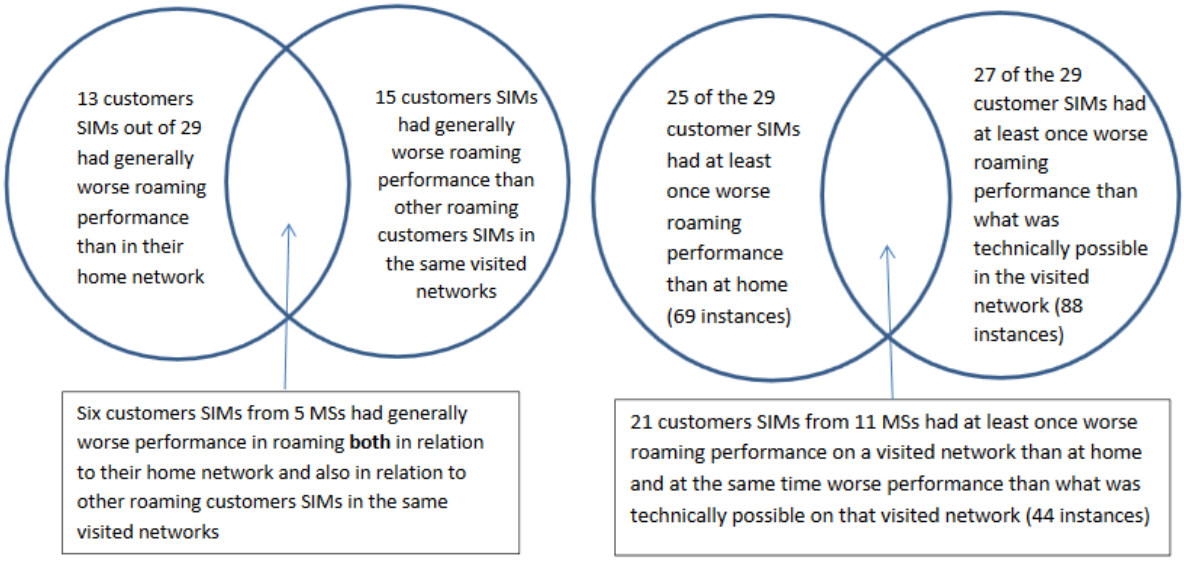
However, it was found that some visiting customer SIMs were generally more likely to have below average performance than others, pointing towards possibly QoS in roaming being offered to them at an unfavourable level.

Q4 – How often did customers have worse quality of service in roaming than at home, even when the visited network was technically and practically able to provide better quality?

On further analysing the results for Q1-Q3, it was found that 20% roaming customers (6 out of the 29 visiting SIMs) had generally worse download performance in roaming than at home and also below average download performance than the other roaming customers in the same visited network.

Detailed analysis showed that 21 customers from 11 countries had worse download speed performance than at home and also worse than what was technically possible on at least one visited network. Altogether, such cases accounted for 25% of all 177 roaming instances.

[5] For a given visited network, the average level of download speed was calculated based on the download speed for all the visiting SIMSs for that visited network.



Conclusions

Objective assessment of roaming performance is a complex exercise. There are several variables such as the QoS of the home network, QoS of the visited network, and contractual terms on the QoS both on wholesale level between the mobile operators as well as for a given customer. Moreover, there are temporal and spatial variables such as the traffic density and user density of the network that cause the network performance to fluctuate over time and across different locations. These result in the roaming performance to vary considerably for the visiting SIMs.

For a single customer, home v. roaming performance can be anecdotal or episodic. The same SIM can have better performance than at home for one visited network and worse than at home for another visited network depending on the test conditions (time, place, traffic) as well as inherent performance specifications of each network and the QoS criteria and constraints that may be applied by the network operators.

Measuring a visiting SIM's performance in relation to the performance of the home SIM of the visited network was found to be a useful yardstick to neutralize the effect of some of the above temporal and spatial variables. Doing so with a number of visiting SIMs added statistical diversity in the data set as well as a broader view of the complexity involved in analysing cross-border roaming.

Measuring the performance of a visiting SIM with respect to other visiting SIMs was yet another way to benchmark relative performance across several spatial locations.

This study is quite unique of its kind in terms of the scope, evidence-based methodology and scale of field tests. The tests had involved nearly half of the EU countries and about a third of all EU networks, taking into account the distribution between inbounder and outbounder roaming countries[6], making them representative and to show a genuine picture of the diversity in roaming performance across the EU.

[6] An outbounder operator has a customer base which consumes more mobile services abroad (i.e. on the networks of partner operators in other EU/EEA countries), than those consumed by the partner operators' customer base on its own network (i.e. when acting as a visited network). Conversely, an inbounder operator has a customer base which consumes less mobile services abroad than those consumed by the partner operators' customer base on its own network.

The relative performance of downloading data in roaming for most of the visiting SIMs was a mix of better/worse/same in relation to the benchmarks devised. However, the upload performance and latency were found overwhelming in favour of the home SIMs.

The study identified 44 instances of download performance in roaming (specific visiting SIMs on specific visited networks) that cannot be explained through variables such as temporal, spatial or technical characteristics alone. For such cases, accounting for 25% of all roaming instances, more transparent information on the QoS applied on a visiting SIM could help to explain the causes for poorer QoS in roaming than at home.

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