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5G Applications and Devices Benchmarking (TRIANGLE)

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Year 3 Periodic Report and final report, public summary

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Abstract

This deliverable contain a public summary of the project final report.

Keywords

TRIANGLE, final report, public summary.

Executive summary

Mobile applications will be a dominant element in the 5G domain. Ensuring the correct and efficient behaviour of the applications and devices on which they run becomes a critical factor to ensure the mobile communications market meets the expectations of final users. The EU project TRIANGLE, has built a framework to help app developers and device manufacturers in the evolving 5G sector to test and benchmark new mobile applications, devices, and services utilizing existing and extended FIRE testbeds. This innovative framework facilitates the evaluation of the Quality of Experience (QoE) and enables benchmarking and certification for new mobile applications and devices. The project also supports the Internet of Things (IoT) domain where major innovations in terms of system design have been witnessed, leading to a high market potential for new testing tools and services.

The project started in January 2016 and lasted for 36 months (3 years). The project delivered a functional testbed in its first year and did continuous improvement for the remaining of the project. Over the year, more functionality, more test cases & more test scenarios were added. At the same time, potential customers have been exploiting the available features and provided feedback on potential improvements and missing features. The project was divided in 3 reporting periods, the first reporting period covered from January to December 2016, the second reporting period from January 2017 to February 2018 and the 3rd period from March 2018 to December 2018.

One of the key achievements of the project was to develop a strategy around the creation of an automated measured QoE, which is crucial in the acceptance of the application by the end user. In TRIANGLE, the QoE is reported in function of the application or device performance against a set of pre-defined domains (power consumption, reliability…). These domains are then aggregated in a synthetic QoE number which is the TRIANGLE mark. To validate this approach, multiple measurement campaigns have been run including a calibration of the synthetic QoE value against a real set of users. Results are very promising and tend to show that the direction taken is a good prediction of the effective QoE.

An important part of the work in TRIANGLE, aside developing the vision and the testbed, was to attract users to validate the concept. Over the complete project duration, 42 companies and universities applied to use the testbed to run experiments and 13 applied for extensions. The test approach has been so interesting and valuable that some of the applicants not selected in the Open Call have requested access to the testbed services without funding. Open Call 5 reused this non-funded approach to ensure applicants were truly interested in the testbed and not just receiving funding. Towards the end of the project, an extra open call 6 (OC6) was launched to attract further users with low amount of funding but with a high 5G content.

One of the challenges encountered by TRIANGLE during the project was to find advanced users truly needing true 5G capabilities and test during the project. Yes, a lot of companies and universities claim 5G applications, but the reality shows that quite some of them can partially run on a 4G network. For advanced SMEs, given the fact that 5G is still 'far away', or in other words more than 2 years out, it was a challenge to find devices and true 5G applications amongst them. Here a clear signal was received that one of the first key use case for SME will be to work around IoT devices. For this reason, the consortium implemented the NB-IoT capability in the testbed and developed the associated test cases and metrics. This IoT capability did attract quite some users to the testbed.

The concept around QoE evaluated with an End-to-End testing approach also gained traction within the industry.

The project vision of E2E benchmarking and QoE automatic assessment has also gained traction from within the community. The approach was presented at the Mobile World Congress 2017 and Mobile World Congress 2018. In January 2018, NGMN published a position paper "DEFINITION OF THE TESTING FRAMEWORK FOR THE NGMN 5G PRE-COMMERCIAL NETWORKS TRIALS", which endorses the TRIANGLE approach, the TRIANGLE service definitions, and KPI for E2E QoE measurements (NGMN, 2018). The concept and approach were also presented different occasions in leading industrial bodies such as the Global Certification forum (GCF) and the International Wireless Industry Consortium (IWPC).

On the technical side, 4 testbed releases where created expanding capabilities and tests libraries. Clear feedback was received by users about the simplicity of the usability and the testing. This was one of the core values of the project to ensure low maintenance long term cost and ensure potential profitability in a commercial context. We are now at the end of the early R&D phase and prepare for commercial services in line with our planned exploitation plan. Aside the commercial aspects, some key learnings from the project will also be transferred to the other 5G EU programs (ICT17 and ICT19) around service expectations, test cases, KPI measurement and service validation.

Issued Deliverables in Period 3

Deliverable Number	Deliverable Title	WP number	Lead beneficiary	Type	Summary Description
D1.5	Year 3 Periodic Report and final report, public summary	WP1	KEYB	Report	Public summary of the P3 report
D1.8	Year 3 Periodic Report and final report	WP1	KEYB	Report	This document, full P3 management report.
D2.5	Report on 5G evolution Y3	WP2	DEKRA	Report	5G evolution and how it influences TRIANGLE
D2.6	Final test scenario & test specifications	WP2	DEKRA	Other	Final version of all test scenarios developed in TRIANGLE
D2.7	Triangle QoE approach	WP2	DEKRA	Report	Full description of the QoE framework
D3.2 V1.1	Implementation report on the testing framework Rel 2 and specification of Rel 3.	WP3	UMA	Report	Updated based on P2 review
D3.4	Implementation report on the testing framework Rel 3 and specification of Rel 4	WP3	UMA	Report	Testbed release definitions and implementation report
D3.5	Implementation report on the testing framework Rel 4	WP3	UMA	Report	Testbed final implementation report for all releases together
D3.6	Triangle testbed calibration and baseline	WP3	KEYD	Report	Covers how the TRIANGLE mark is achieved and the testbed calibration requirements
D4.3	Report on the QoS management at the application level	WP4	KEYD	Report	Explains how the QoS is controlled at the application level
D5.4	Results of Second Open Call	WP5	UCL	Report	Learning from the 2nd open call.
D5.5	Results of Third Open Call	WP5	UCL	Report	Learning from the 3rd open call.
D5.6	Final Report on Results and Insights from TRIANGLE Testbed Experimenters	WP5	UCL	Report	Reporting on all experiments (confidential an non confidential)
D5.7	TRIANGLE Experiments and Extensions	WP5	UCL	Report	1pager set to be used for the EC promotion of FIRE
D5.8	Recommended TRIANGLE marks for certification of service	WP5	UCL	Report	Certification process
D6.4	Project metrics and collection of Triangle Technical Publications	WP6	REDZ	Report	Project metrics evaluation and dissemination

Reached Milestones in Period 3

Milestone number	Milestone title	WP number	Lead beneficiary	Due date (in months)	Means of verification	Status
MS5	Final review	WP1	1 - KEYB	36	This review	Pending approval
MS21	Completion of the test framework based on experimenter feedback	WP2	6 – AT4	33	This milestone ensures the formalization of the complete set of test cases identified in the WP2 and reported in D3.5.	Achieved on time
MS12	Third version of the testing framework	WP3	3 - UMA	27	This milestone ensures that the final version of the framework has been released incorporating all the developments carried out in WP3 and WP4.	Achieved on time
MS14	QoS management at the application level ready	WP4	2 - KEYD	30	This milestone ensures that QoS configuration mechanisms have been implemented and are ready for experimentation.	Achieved on time
MS16	Results of the 2nd Open Call	WP5	5 - UCL	27	Experiments of the 2nd Open call completed. Lessons learned and results obtained will be collected and analysed.	Achieved on time
MS17	Results of the 3rd Open Call	WP5	5 - UCL	33	Experiments of the 3rd Open call completed. Lessons learned and results obtained are collected and analized in D5.4	Achieved on time
MS20	Final Collection of Technical Publications Available	WP6	4 - REDZ6	36	Collection of the technical papers and communications published to promote the results and outcomes of the project.	Achieved on time