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Results of Third Open Call

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Deliverable D5.5
Results of third Open Call

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Abstract

The TRIANGLE Project ran two additional Open Calls for the purposes of gathering feedback from real-world users of the Testbed and to increase the capabilities of the Testbed. The results of these open calls provided valuable feedback to the consortium on the benefits available from using the Testbed and also in identifying issues and improvements to the Testbed for future users.

Keywords

Open Call; Experiment; Feedback

Document History

V1.0	Initial release of the document
V1.1	General rewriting of the document based on the feedback received by the expert panel at the project final review. Changes are: The document has been updated to remove the names of the unsuccessful applicants to the Open Call

Executive summary

The TRIANGLE project ran two Open Calls OC5 and OC6 for the third and final wave of Open Calls. OC6 was originally not planned but added based on the request from the experts at the year 2 project review. The purpose of these Open Calls was twofold, to continue to get feedback on the Testbed from external users, in particular on the TRIANGLE Portal and also to validate if there was a demand for TRIANGLE to be used as a commercial service, by determining if there was an appetite to use the service on an unfunded basis.

The Open Call OC5 focused on attracting users willing to use the TRIANGLE Testbed without additional funding, but with the support and assistance of the TRIANGLE team and with a guarantee of a timeframe for running and supporting their experiment, something that is not available to external users that apply outside the regular Open Call process, as this is only supported when there is sufficient capacity in the Testbed.

The Open Call OC6 was a funded Open Call, targeting SMEs and had a small budget of funding available (45k euro with a cap of 15k euro per applicant) for mobile apps that would use the TRIANGLE portal as part of testing. This extra open call was not originally planned and added on request or the reviewer panel during the 2nd period review. As the TRIANGLE Portal is a significant component in the Testbed offering, and a very useful tool for abstraction of the testing process and complexity from the end user, the consortium wished to prioritise mobile applications that would run Test Campaigns that were conducted by using the TRIANGLE Portal. This follows a number of successful primarily IoT experiments from OC1 and OC3 where the consortium supported a number of IoT experiments in different configurations.

The TRIANGLE Testbed continues to show value to the Experimenters using the platform, who gained valuable insight in the operation of their respective experiments and also provided some useful insights for the consortium on their experiences using the Testbed and some improvements that can be made.

This Open Call in particular, was a clear demonstration of the ease and speed at which mobile app developers can become familiar with, and execute experiments using, the TRIANGLE Testbed Portal. The timeline from the actual start of experiment to execution of the tests, to result analysis in some cases was just a matter of a few days.

This report gives and overview of the experiment setup, results and the business benefits derived from using the TRIANGLE Testbed. Work is already underway to incorporate this feedback into the testbed for future users. This deliverable generalizes the information captured by the experimenters. The Individual experiments results are kept confidential as they are directly related to the specific experiment application or products.

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1 Introduction to TRIANGLE Open Call 5 and 6

This document outlines the results of the third, and final, set of Open Calls for the TRIANGLE Project and Testbed. The Open Call process is outlined as well as a description of the applications that were received and the applicants that were selected by the selection committee.

The main objective of this wave of Open Calls (OC5 and OC6) was on testing the TRIANGLE Testbed with Experiments that are created with companies such as application developers and device manufacturers. The experiments included application developers testing 5G scenarios such as low latency to facilitate VR, and an IoT device maker. The experiments will help developing and verifying the TRIANGLE Testbed as a whole to match the needs of experimenters. It will also verify the technical integration in the TRIANGLE Testbed by putting it at work against challenging 5G use cases. The experiments were run at Testbed locations at the University of Malaga (Spain), DEKRA (Spain) and Keysight Technologies (Denmark).

For more information about the current capabilities of the TRIANGLE Testbed and what types of experiments it can run see the testbed overview at [1] and [2].

1.1 Open Call 5

As TRIANGLE is proposing to have “testing as a service” as business model (as outlined in [3]), TRIANGLE wanted to determine if the Testbed would be attractive to SMEs (application developers and device makers) to use as a commercial service. As the Testbed is not in a fully commercial service with all of the capabilities, SLAs and other aspects that would be expected in a professional Testing Service, the consortium decided to test if there was a market for companies wishing to use the service for free, as a precursor to testing if there was a market for SMEs to pay for this type of service.

To help to validate these assumptions, Open Call OC5 was a short and small focused call on attracting users willing to use the TRIANGLE Testbed without additional funding. The user would still receive the support and assistance of the TRIANGLE team and with a guarantee of a timeframe for running and supporting their experiment. The guaranteed timeframe and support is something that is not available to external users that applied outside the regular Open Call process.

1.2 Open Call 6

The TRIANGLE Portal is a significant component in the Testbed offering, and a very useful tool for abstraction of the testing process and complexity from the end user. During the 2nd period review it became clear that only few users had been using the portal, hence a recommendation was made to create an extra open call round specifically to attract such users. For Open Call 6, the consortium wished to prioritise choosing mobile applications that would run Test Campaigns that were conducted by using the TRIANGLE Portal. In previous Open Calls, there were numerous IoT devices and researcher type experiments, but only two mobile applications that could make use of the portal ATSI and Infolysis. The TRIANGLE Portal has also evolved considerably since the OC1 application from ATSI was using it and has many new features that the consortium was eager to have feedback on.

From OC3 Infolysis re-ran their experiment using the Triangle portal during the OC5 timeline after there were improvements around device automation, allowing automated test campaigns to be managed from within the portal, instead of externally via TAP. This was a major improvement to the Portal, allowing a greater level of flexibility in the types of campaigns that

can be run, in particular, when 3rd party apps are involved where the experimenter does not control the application source.

The Open Call OC6 was a funded Open Call, explicitly targeting SMEs as this is a primary target user for the TRIANGLE and had a small budget of funding available (15 k€ per applicant) for mobile apps that would use the TRIANGLE portal as part of testing. Based on the experience of OC5, use of the platform by SMEs on an unfunded basis may be challenging, as these companies need to allocate internal resources to identifying how to automate their testing and KPIs to measure.

While the amount of effort required is quite small, and the benefit of this effort quite significant, the consortium has found that the (very small number of) companies involved in OC6 and indeed with previous funded Open Calls, had difficulties allocating staff time to work on testing with TRIANGLE. This is not surprising as for an SME with limited resources in an early product development stage where sometimes the baseline functionality is just not there yet. We also realized that for SME, 5G is still far away in some cases where concepts are not yet mature enough to be tested against a system such as TRIANGLE. These SME have due to this early stage often other competing priorities such as bug fixing, product development and customer development and support related activities. There are always challenges in making staff time available, so the funding does indeed help these companies to allocate the resources to testing which may not be the issue of the day at the time the testbed is available.

1.2.1 Open Call 6 funding

The result of putting the additional effort into the testing however, has been more than worth it based on feedback from Testbed users in these and previous Open Calls. As the Testbed users test and validate their products, discovering issues and evaluating performance under different network conditions, issues where detected early before any live deployment occurred.

The amount of funding available was limited in OC6 as, at the time of publication, there was some uncertainty about the amount of funding available from the consortium. This was due to an issue with determining if VAT was applicable to the Open Call payments as this was facilitated by UCL, a UK University with specific VAT arrangements as a registered UK charity, and not a Limited Company. This area was quite complex as it involved reverse VAT charging on inter-EU transactions and further complicated by the fact that the project was required to fund Open Calls via sub-contracting, not 3rd party support, something that was not envisioned during the proposal.

Based on the budget uncertainty at the time of the OC6 launch, the consortium decided to fund a number of applications with a maximum funding per application of 15K€, with an overall budget call set at 45K€. The proposed amount of funding available was seen as an attraction to SMEs in utilising the Testbed to support the employee time dedicated to working with it, though not significant enough to be a source of funding in itself. This lower amount of funding is something the consortium has been keen to avoid as the focus has been on working with companies that want to use the Testbed for adding real value to their products or experiments and to give good feedback to the consortium as a result. Some of the OC6 applicants did not request even close to the capped amount, a clear sign that they just needed to cover costs.

Luckily, the VAT issue has been clarified early December 2018 and after clarification from HMRC (The UK tax authority), deemed to be not applicable in these cases. However, the delay in getting a resolution meant that the amount of funding that was perceived to be available for Open Calls at the time of publication meant that only the agreed amount of funding was available

45K€. Adding additional experimenters in December would not have been possible given the end of the project schedule end of December.

1.3 Open Call process updates

After experiences on OC3 and OC4, and based on comments by the reviewers, the Open Call process was again modified for OC5 and OC6. The application questions and supporting documentation needed to be submitted by applicants has continually evolved throughout the process. The application process was largely the same for both Open Calls, but for OC5 there was no need to submit a budget as the call was unfunded.

OC5 marked a departure from the evaluation process that had been followed from previous Open Calls OC1-OC4. The consortium received some guidance from the project review team around how to evaluate Open Call applicants, where they advised that the external review panel would not be necessary for the consortium to help us in the selection process. This is quite different to how the process worked in the past where the consortium was not directly involved in the selection of applicants, but used a panel of evaluators to score the applications received in a number of categories. This original process is described in detail in D5.1.

The new approach is to simply have a vote per consortium member and, provided that the application is technically feasible, and believed to be likely to provide valuable insight to the TRIANGLE, then the application with the highest number of votes will be selected. This approach gives the consortium more control in choosing applications that are valuable for the project.

1.4 Open Call Timeline

The Open Call timeline for OC5 and OC 6 is shown below in Table 1. There was a delay with starting some of the experiments as will be outlined in the following sections that outline the experiments. Then there is a setup phase, as experimenters are getting familiar with the Testbed, access technical information and complete the legal contract review before experiments begin.

After each experiment was completed there is a period where experimental data is processed and consolidated into a report which is shared with the consortium, it is at this point that the experiment is deemed as complete.

Table 1 Open Calls Timeline

Open Call	Opened	Closed	Experiments Began	Experiments Completed
OC5	Feb 1st, 2018	March 11th, 2018	June 2018	December 2018
OC6	July 31st, 2018	Sept 14th, 2018	November 2018	December 2018

1.5 Open Call 5 & Open Call 6 Applications Summary

A summary of the Open Call 5 and 6 applications is shown in the table below

Table 2 Open Calls Applicants summary

Open Call	Official Applicants	Selected
Open Call 5	3	3
Open Call 6	5	3

1.6 Technical Review

Each selected application was evaluated based on the technical feasibility of using the TRIANGLE Testbed. The TRIANGLE Technical Review Committee can refuse applications based on the result of the technical review when proposals are deemed to be unfeasible.

Each selected applicant was requested to develop an extended proposal with more technical detail than the original proposal in order to achieve more clarity. A set of email exchanges and calls between the Technical Review Committee and each applicant was setup to discuss any potential technical issues that were identified. These interactions helped identifying any potential technical limitations with the experiment or extension.

Unlike OC3, the technical feasibility phase the committee determined that there were no feasibility problems with any of the selected applications.

1.7 Application Summary

1.7.1 OC5 – Experiment Applications

The following table outlines the selected applicants for OC5. The non-selected applicant names have been redacted for confidentiality reasons.

Table 3 OC5 Applications

ID	Name	Status
OC5_1	LucidWeb	Selected

1.7.2 OC6 – Experiment Applications

The following table outlines the selected applicants for OC6.

Table 4 OC6 Applications

ID	Name	Status
OC6_1	Soluciones Cuatroochenta SL	Selected
OC6_2	Digiotouch OÜ	Selected
OC6_3	Solbyte Team	Selected

2 Open Call Experiments Results

In total, five successful experiments have completed. The results of these experiments as documented by each of the Experimenters are outlined in the following sections, divided by Open Call.

2.1 Results of Open Call 5

2.1.1 LucidWeb

Experiment Summary

The purpose of this experiment was to test a VR experience where a user is guided through a virtual tour where he or she has options to move around and experiment in different situations. The application was at an early stage of maturity, so it was a collaborative effort to improve the UX of the application, while the TRIANGLE consortium learned about how to handle testing of a VR application.

The lack of widespread adoption of commercial VR apps that are available in public App Stores makes it difficult to source test suitable examples. The Testbed has added infrastructure to support VR applications in Release 3 of the Testbed, and this was an excellent opportunity to use these VR resources, such as the robotic arm, while having direct access to the to the application development team, which is not usually possible with public apps.

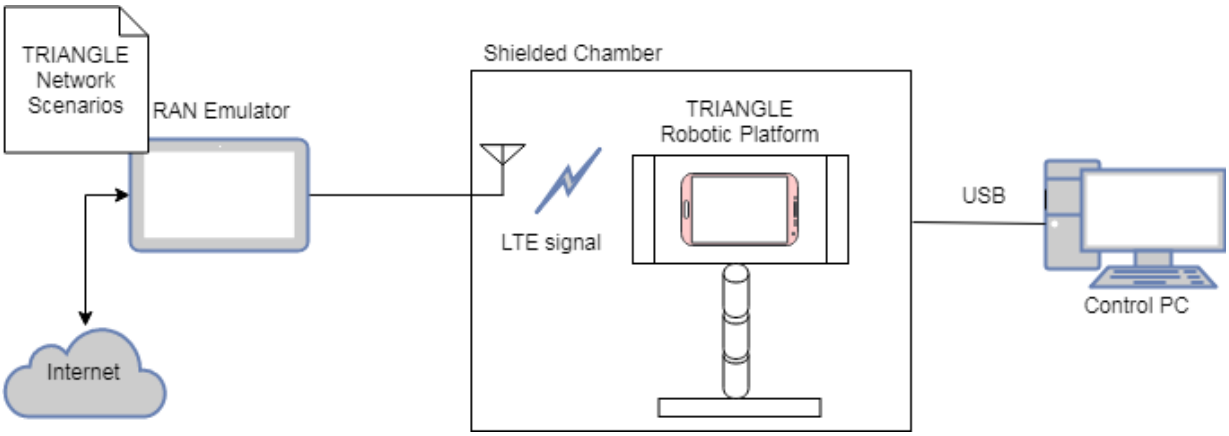

Figure 1 - Lucidweb VR Evaluation Setup

Experiment timeline

The experimentation ran from June to November 2018. Various runs were executed to test the different releases made by the developers to stabilize and correct all bugs. The report of the final test is available in D5.6 (confidential document).

Key results and Insights gained from Testing

LucidWeb has found very useful the feedback from the testing team. It has helped them to identify issues with their application.

Business benefits

TRIANGLE has helped the team make the app more stable and has improved the range of devices that are known to be supported by the application

TRIANGLE testing value identified

This experiment has been a challenging one for the team to support. The application was at an early stage of development and had numerous issues in regards to portability between devices as the application did not function in the same way on multiple devices. This was an issue trying to debug issues and lead to large periods where it was not possible to continue testing the user journey, even manually, since the application was not functioning correctly on the test devices.

This was later compounded when attempting to automate user journeys given the nature of the application and the number of possible actions to take. This has given the consortium some useful insight into the issues in testing these types of applications.

TRIANGLE benefits identified

The TRIANGLE team detected some incompatibilities between the execution of the application on a number of devices. Due to the range of devices in the market, this was useful for LucidWeb in identifying challenges to supporting their application across a number of devices.
Because of the low level of maturity of the app, TRIANGLE has used this experiment more as a verification of the testbed than a real test campaign execution. During the different runs on the different versions TRIANGLE has been improving the stability and functionality of the robotic arm and the interconnection of the different software components that build the functionality needed to test VR applications.

Planned further use of the Testbed

LucidWeb have been experimenting for a number of months. With the project drawing to a close at the end of 2018, LucidWeb will have completed the testing that they require at that point and currently the consortium has no plans to continue to support this experiment after that time. At least until Luciweb app is in final and stable format.

2.2 Pending result of Open Call 3 handled in the Open Call 5 timeframe

2.2.1 Inova DE GmbH

Experiment Summary

Inova De were originally part of the OC3 applications, however there were a number of issues preventing this experiment from completing within the OC5 timeline.

The experiment is based on a wearable with textile-based ECG sensors, that requires seamless communication with an on-line server and a platform designed for Cardiologists. This solution is the backbone of a telemedicine service to automatically analyse very long ECG signals (weeks to months) and other body-vital-signs for continuous real-time remote monitoring. The wearable measures the ECG with state-of-the-art embroidered sensors locally, and the processed ECG data is sent to the servers directly from a built in 4G LTE modem. The ECG is stored, analysed and arrhythmic events presented to the cardiologist for analysis.

The objective of the experiment is to test the whole communication chain, from the hardware to the server over the mobile network and benchmark the system under different conditions. In particular, measuring the communication speed (network latency) between the t-shirt and cloud system, particularly when in motion through a number of environments and scenarios outlined later.

The key use-case to be tested is:

- The patient made a cardiac surgery and is recovering well. It is deemed that it is safe for the patient to go home, but there is a high-enough probability of having arrhythmias on the following days after the surgery. Therefore, the patient must be remotely monitored.
- The patient uses the wearable for days or weeks and resumes his daily routine.
- If the system detects an arrhythmia, the event is recorded and signals the overseeing doctor, so it can be analysed or even trigger an emergency pick-up service. The following image shows the whole process:

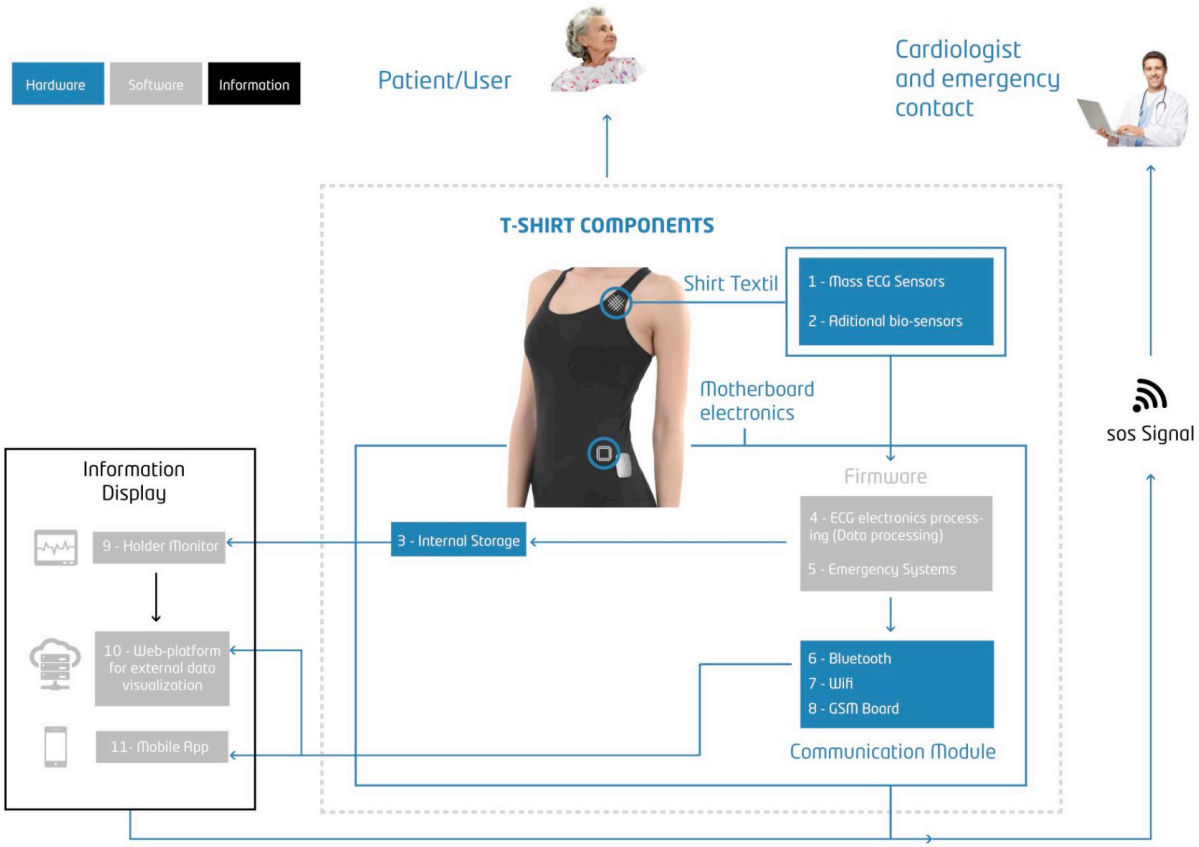

Figure 2– Inova High Level Architecture

To meet the set project objectives, the team developed a board composed by the following blocks:

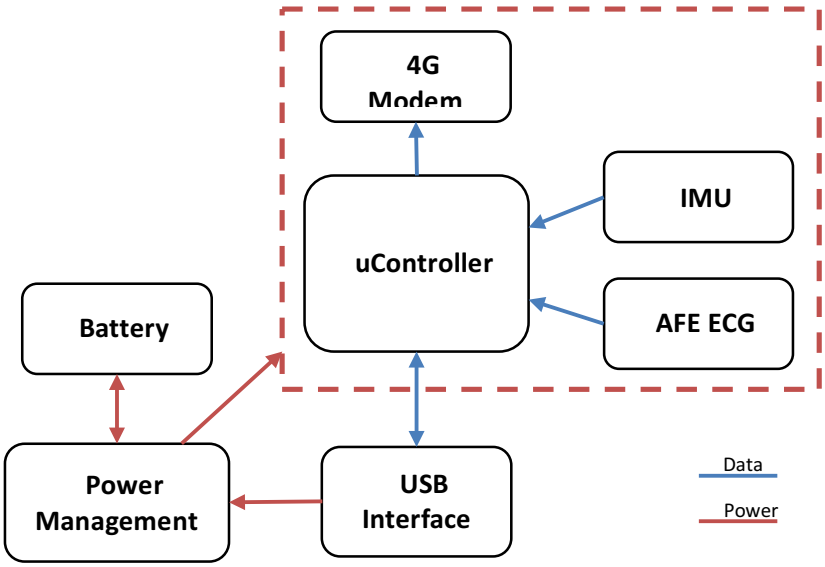

Figure 3– Inova Hardware Architecture

In this picture is also showed 2 flows: One for data flow and other about power flow. The connection between each component is also presented on the picture.

- **AFE ECG:** this block is responsible for acquiring the ECG signal through the electrodes and convert the analogic signal into digital;
- **IMU:** responsible for give us body's specific force, angular rate and magnetic field surrounding the body;
- **4G Modem:** 4G modem allows the connection of electronic system to the internet through the telephone network and to send the data to a server in the internet;
- **uController:** this component is the brain of the electronic system and manage all the threads and actions of electronics;
- **Power Management:** this block is responsible for battery charging and management, also give the power in the right level to all the electronic components;
- **USB Interface:** USB port allows the communication between the electronic system and the computer, also works as external power source to battery charging;
- **Battery:** internal device power source for stand-alone usage.

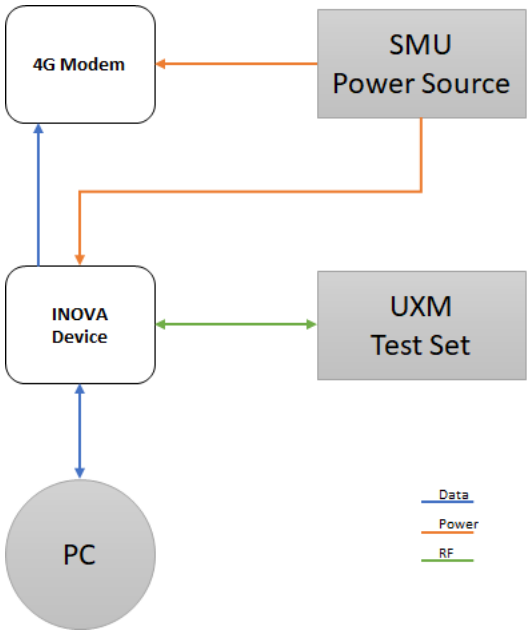

Figure 4– Inova experiment in the TRIANGLE Testbed

Key results and Insights gained from Testing

When testing began, the TRIANGLE team noticed that there were some issues with the device when attempting to connect to the UXM. Upon further investigation, it was found that there were some issues with the firmware of the 4G modem that the company were not aware of. Once this firmware issue was addressed, they also identified some hardware issue to the point that a redesign effort was launched. When the updated device was ready it was sent to the Denmark Testbed, but due to a problem during transport the test device arrived damaged and required repairs. The Inova team travelled to the Testbed in Denmark to rectify the issues with the device and resumed testing. This series of delays meant that the experiment did not begin until the start of December 2018.

The system tests were divided in 3 parts: Low data rate, High data rate and NB-IOT. For Low data rate and High data rate the system was tested in different conditions: “Ideal”, “Urban pedestrian”, “Traffic jam”, “Shopping busy hours” and “Tunnel”.

The full results of the experiment are private and outlined in D5.6 (confidential), but in summary: The data collected included:

- Device power consumption
  - LTE modem module
  - Motherboard (without LTE modem)
  - Battery life estimation
- Throughput statistics
  - average bitrate in DL & UL
  - total data used in DL & UL
- Reliability statistics (packet loss rate)

Inova gained some feedback on the impact on battery life on their device based on the different network conditions and had some insights based on the available bandwidth available in NB-IOT modems.

Business benefits

The results allowed them to correct the subsystem before they produced the final prototype, saving time in the testing tasks by having a single platform to measure bandwidth and energy consumption. The company outlined that without the testing using the Testbed, some of the issues that were found with the hardware architecture would only have been discovered after the product was launched in the market.

TRIANGLE testing value identified

The company valued that it was possible with the testbed to perform many different types of experiments without an excessive overhead for such requirement changes of development projects. Their team found that using the Testbed it was easy to modify the test scenarios and validate the development. We also learned a valuable lesson in testing prototypes early in development to match the expected performance under the final use-cases. They clearly stated that they valued having access to this type of Testing environment at their stage of product development.

The company indicated the following statement on their experience using the testbed and the value that it added:

“With TRIANGLE testbench, all the scenarios we foresee to test were covered, putting our team in clear advantage regarding competition products and developments. Which will be critical during the market penetration.”

TRIANGLE benefits identified

This experiment validated the desire for the Testbed to be easy to use and configure for Testbed users for both hardware devices and software apps. Once the issues were identified and overcome (which itself added tremendous value for the company) the testing was able to complete in just two days.

Planned further use of the Testbed

Inova do not have any further test activity planned, but they believe that in the near future they may be in touch with the consortium as they stated that they recognise the value added by TRIANGLE to this experiment. They will consider this round of additional testing for when 5G

networks are deployed, as well as with upgrades to wearable technology that they plan in the future (2-3 years-time).

2.3 Results of Open Call 6

2.3.1 Soluciones Cuatroochenta SL

Experiment Summary

Cuatroochenta, a Spanish SME and developer of mobile solutions used the TRIANGLE Testbed to analyse the performance of their mobile application called Acércate. The main feature of this app is to know the location of key people using the GPS location in different situations, set emergency contacts and share important reminders.

The main features of the application are:

- View the GPS location and position of your friends, family or contacts.
- Establish security areas and receive notifications about movements.
- Access professional telephone support services from the EULEN Group team 24 hours a day, 365 days a year.
- Have an SOS emergency button.
- Use a system of reminders and follow-up telephone calls

The app uses some synchronization web services to keep data regularly updated in order to show the most accurate information of your tracked contacts. As a result of this constant connectivity the company felt that it was important to test the performance of this data transfer for reasons such as: time of response, draining of the battery or use of device resources.

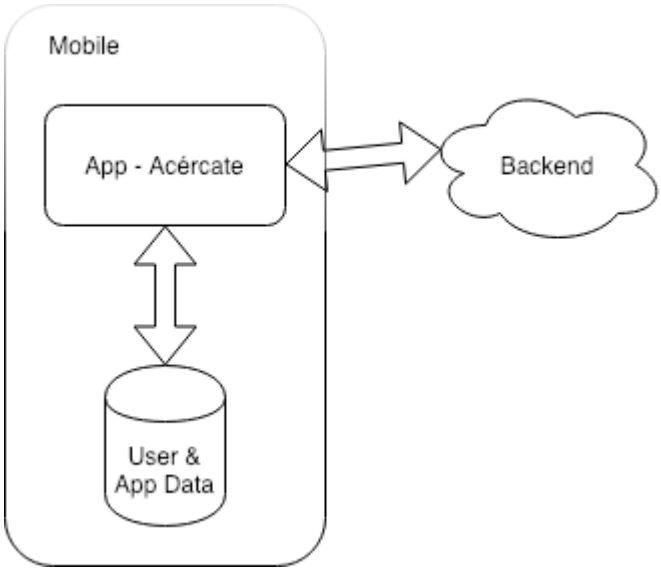

Figure 5– Cuatroochenta High Level Architecture

The primary goal of the experiment was to detect calls with latency which result on a performance slowdown on the app.

The experiment objectives were the following:

- Optimize the performance of the application in different circumstances (Wi-Fi, 2G, 3G), minimizing battery consumption and identifying elements and processes that require excessive consumption of resources.
- Testing the most common user flows on the app, to detect possible problems related with the network usage.
- Make use of an automated testing to replicate the possible flows that a user follows in the application, and be able to analyze them in different scenarios.
- Identify possible bugs in specific models and operating system versions.
- Improve app reliability on a lot of possible real world scenarios.

The scenarios that were tested were: ideal conditions, shopping mall off peak, shopping mall busy hours, pedestrian with medium data rate and office.

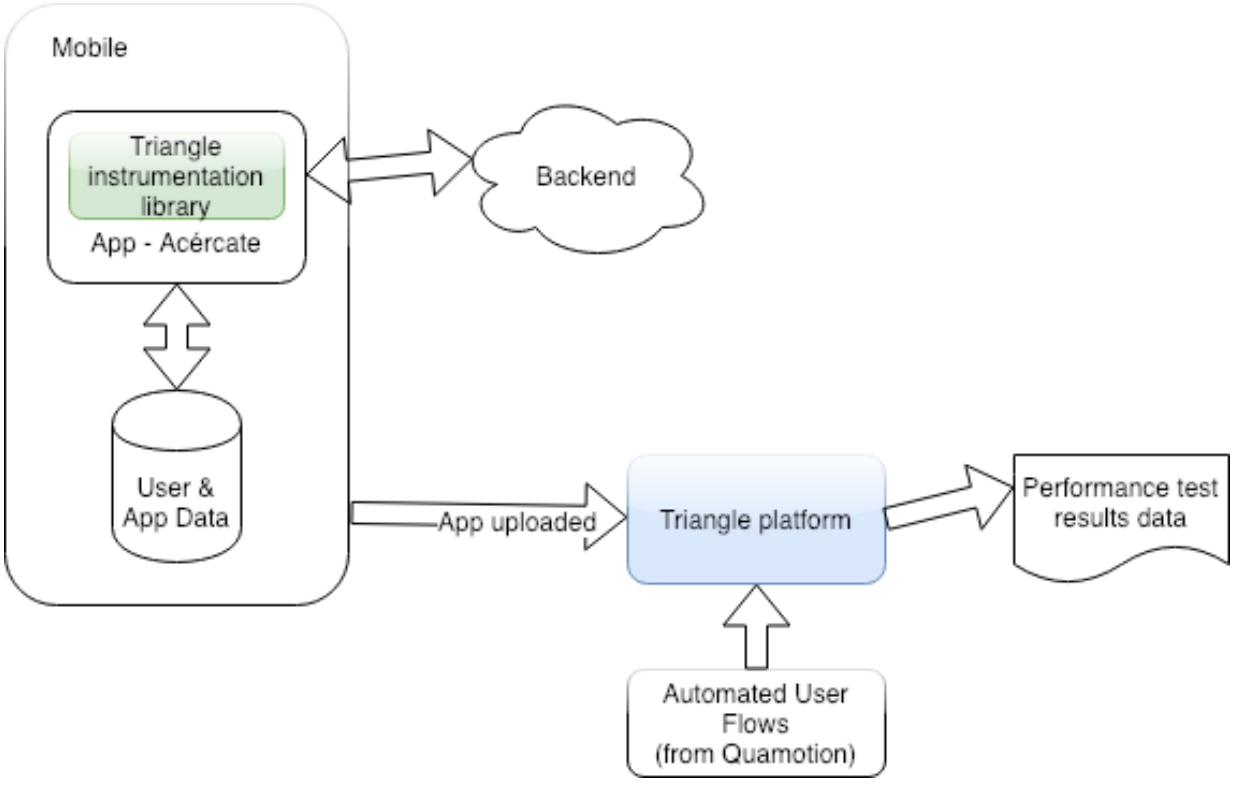

Figure 6– Cuatroochenta experiment in the TRIANGLE Testbed

Experiment timeline

The experiment had a very short timeline due to resource constraints and only began in December, with experiments lasting only a few days. Cuatroochenta, with cooperation from the University of Malaga, will rerun their experiment in January 2019 after making modifications based on the issues found with their application performance.

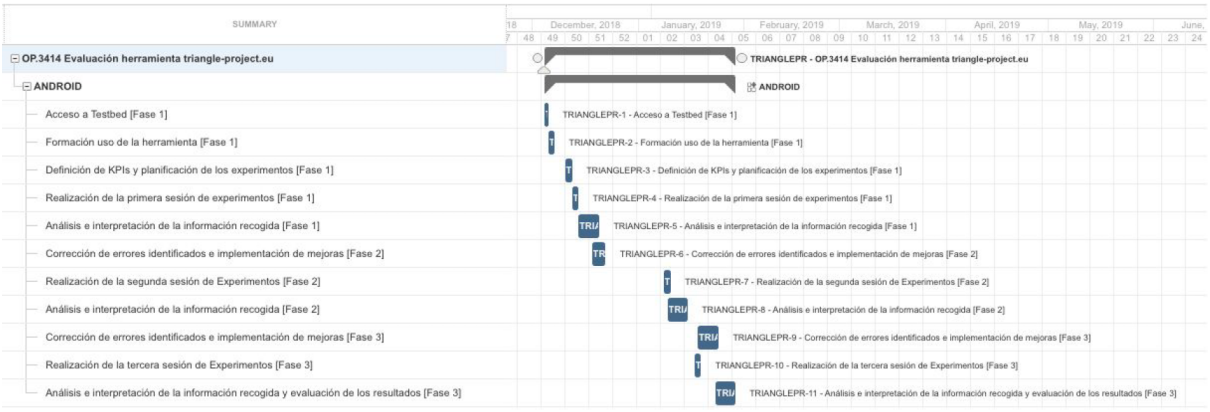

Figure 7– Cuatroochenta experiment Timeline

Key results and Insights gained from Testing

The experiment involved testing of four key features of the app: login-logout, access to a remote notification list, creation of an item and upload it to the server and a complete flow of the previous features. The QuaMotion tool was used to create the automated user flows on the app for this purpose, and then run each of them was run on the Triangle platform changing the network scenario on each execution.

The complete set of results are not available for confidentiality reasons and are available in Deliverable D5.6, however the company were able to test their application flows under the scenarios identified and noticed an impact on resource usage and UX under network congestion, for example in a busy shopping mall.

Business benefits

The results of testing using the Testbed allowed Cuatroochenta to find issues with their application and information on how to adapt the apps to different network conditions.

According to their team, improving application calls to the web services is a way to improve app response and UX. Getting fresh data as soon as possible and without interrupting user experience is a key point. They went on to indicate that they usually make apps which can be used offline, but with the tests provided by Triangle, wthey can adapt in a better way the data transfer on the web services used, which need to be online, to make the requirements lighter.

TRIANGLE testing value identified

The company valued their use of the Testbed in identifying ways to improve their application. There were a number of key quotes indicating the value that using the Testbed brought to them including:

“The platform itself is quite useful on programming automatic tests, which can be run on every new release to check if the modifications on app code iterations are impacting on the stability, usability and reliability. So, it’s a product worth paying for.”

“We believe that it is a very powerful system to evaluate issues such as performance and user experience. These variables are usually difficult to quantify.
Triangle platform offers many technical possibilities to program all kinds of tests”

"we could have run the experiment on other commercial platforms, but Triangle was more suitable to our needs in this case. Also, testing with Triangle can be a way to help on the platform development, which involves different working teams."

"The Triangle platform seems to offer all the pieces to integrate a good testing benchmark in the app development flow, and make them robust and optimized in terms of response and reliability in a wide range of situations"

"We clearly detected improvement possibilities while running the app on poor connectivity environments. Also, we gained experience on the use of the platform thanks to the support team, which will be very useful on the next round of experiments"

TRIANGLE benefits identified

This experiment validated the classic type of target user for the TRIANGLE Portal, an app developer who has a need to easily evaluate the performance of the application running under a diverse set of network conditions and the impact on QoE and resource usage.

Planned further use of the Testbed

Cuatroochenta completed their initial round of testing in December 2018, based on the testing results they have identified some improvements that can be made to their application to improve performance and the UX in response to varying network conditions. Cuatroochenta, at the time of writing, are updating their application based on the experiment results and plan a new round of testing in January 2019 to then rerun their application to measure effectiveness of the options for improvement that they have identified.

2.3.2 Solbyte

Experiment Summary

Solbyte are a Spanish SME who develop mobile solutions for business customers. The main objective of the experiment was to obtain enough information about the performance and operation of two of their mobile app products:

Novatrans Conductors. This application consists of a module of tracking and geofencing in addition to facilitating the communication of the driver and the company regarding loads, trips and incidents.

The objective with the experiment was:

- To evaluate the battery expenditure made by the application, this is important as the app makes intensive use of GPS
- Evaluation of the user experience, this should be fluid and without delays since the user should be able to interact and visualize the information of the application quickly and respond to failures.

The main network Testing Scenarios was normal driving environment, while the use cases implemented were: file upload, Login, Navigation and file download.

OcioHoteles this application is used to a list browse hotels, however the hotel images are high quality and have large file sizes.

The objective with the experiment was:

- To improve the performance and offer our users a better experience.

- To measure the load times of the images provided by the hotels and check the operation of the application in pre-5G communication environments.

This application used a model-based test approach developed by UMA to automate user testing. The scenarios used to were: Suburban - Shopping Mall - Busy Hours, Urban - Internet cafe - Off Peak, Urban - Office, Urban - Pedestrian, Suburban – Festival.

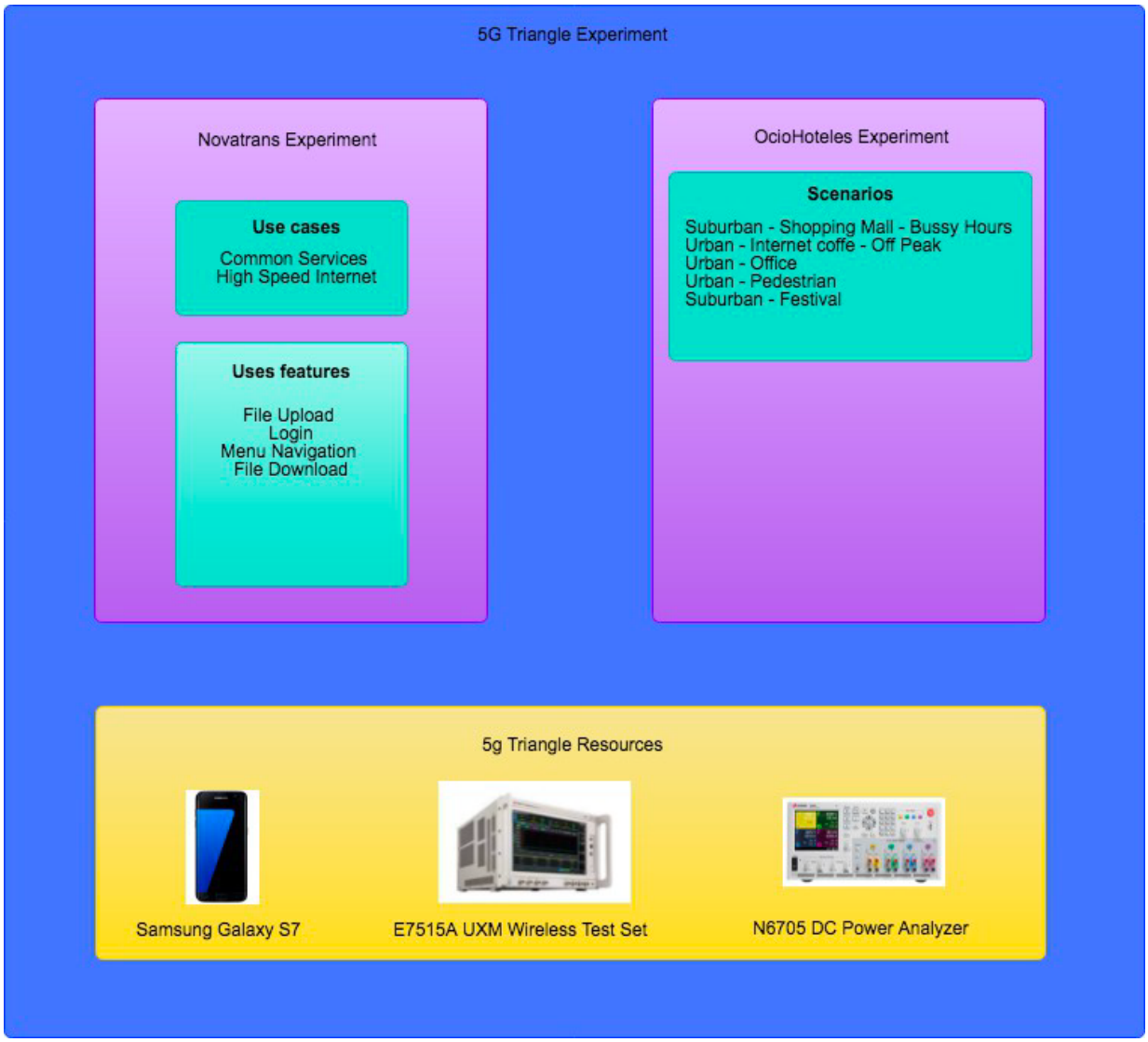

Figure 8– Solbyte experiment in the TRIANGLE Testbed

Experiment timeline

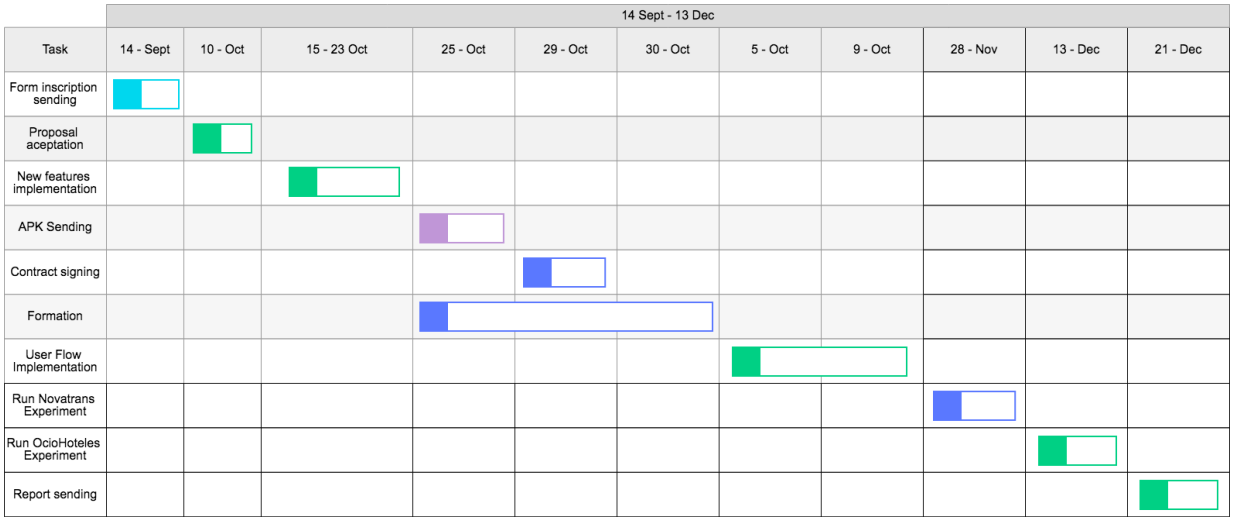

Figure 9– Solbyte experiment Timeline

Key results and Insights gained from Testing

The detailed results of the testing undertaken and the benchmarked scores obtained is confidential and available in D5.6. Overall, during the experiments it was found that both apps adapted to the various network conditions quite well. Areas for improvement were found to deal with particular network conditions and the company will continue to evolve the apps based on the insight them have gained from using the Testbed.

Business benefits

The results allowed them to evaluate their application performance and identify some issues; in particular with battery usage. There had been some customer requests to evaluate battery performance and due to the behavior identified, changes were made to improve the battery drain. These changes have now been deployed in a new application update and their customers have noticed a decrease in the battery consumption of the terminal so they can now complete a full day of work without having to charge the terminal.

The knowledge gained from this testing is also being applied in several of the other projects underway in their company as part of the development of their APIs. This will make API synchronous communications more fluid and allow a better user experience.

TRIANGLE testing value identified

The company valued that If they had not had the opportunity to perform the tests, it would have been harder to obtain the necessary measures to improve our applications and offer a better product to their customers and users.

The company indicated the following statement on their experience using the Testbed and the value that it added:

“Through the experiment, we have been able to measure battery consumption and load times of applications in scenarios that we could not have simulated by our media. We have also been able to validate the user interface, which gives us security in the behavior of the applications. Likewise, we have been able to repair errors and it will serve for the applications with which we have made tests and future projects. This allows us to develop more robust applications and offer better products to our customers.”

TRIANGLE benefits identified

This experiment showed the ease of use for companies to get started testing with minimal input required from TRIANGLE team, the company found the documentation sufficient and the TRIANGLE Portal easy to use and interpret for two different applications, with very different Use Cases. This self-service model, was what the team have been looking to create with the TRIANGLE Portal and also with the model based testing.

Planned further use of the Testbed

This experiment achieved the objectives of the company and after testing two of their main applications they indicated that have obtained enough knowledge to be able to apply them to future projects.

2.3.3 Digiotouch

Experiment Summary

Digiotouch VR is a virtual reality application developed by Digiotouch OU in Estonia for Android phones targeting Smart Museum, Smart City verticals and is currently in a pre-commercial testing phase. The app streams high quality multimedia content from a Cloud based Paradise IoT Platform to create a 3D immersive experience

The experiment objectives were the following:

- To evaluate the use of a MEC application server for the high-quality multimedia content caching and delivery. Since the server is located very close to the consumers, the Digiotouch VR app would benefit from low latency promised by 5G. The MEC server obtains the multimedia contents from the Paradise IoT Platform.
- Evaluate the benefits enabled by 5G features like low power consumption, improved Quality of Experience (QoE), and support 10x more simultaneous connections brings.
- Make the Digiotouch VR app 5G-ready. According to ABI Research and Qualcomm, 5G will break the current barriers in VR adoption, and make the later a mainstream technology. Digiotouch wanted to test our app in Triangle Testbed and obtain a certification for upcoming 5G systems

The main metrics of interest measured were reliability, energy consumption, network resource usage, and user experience. Several 5G network scenarios and three VR videos (1080p, 8K, and 360-degree) were used to test the VR app functionalities. . Each metric corresponds to a set of KPIs in the experiment including:

- For Reliability, 5GVR will evaluate stability, auto recovery, ability to manage loss of data files, and data loses. This creates a reliable user experience (UX) for consumers.
- Energy consumption will quantify that in activate state and background. Our target is to consume at least 33% less power than the current implementation to save battery. This will positively impact the consumer for app adoption.
- Network resource usage would indicate the uplink and downlink data usage in both active and background app mode. These KPIs allow us to have fine-grain control over the network resource consumption and improve the app production.
- Quality of Experience will be identified through response time, time to load and display 3D environment, and data usage. Our main target is to improve the latency to stream 1080p, 8K, and 360-degree videos for the consumer immersive experience.

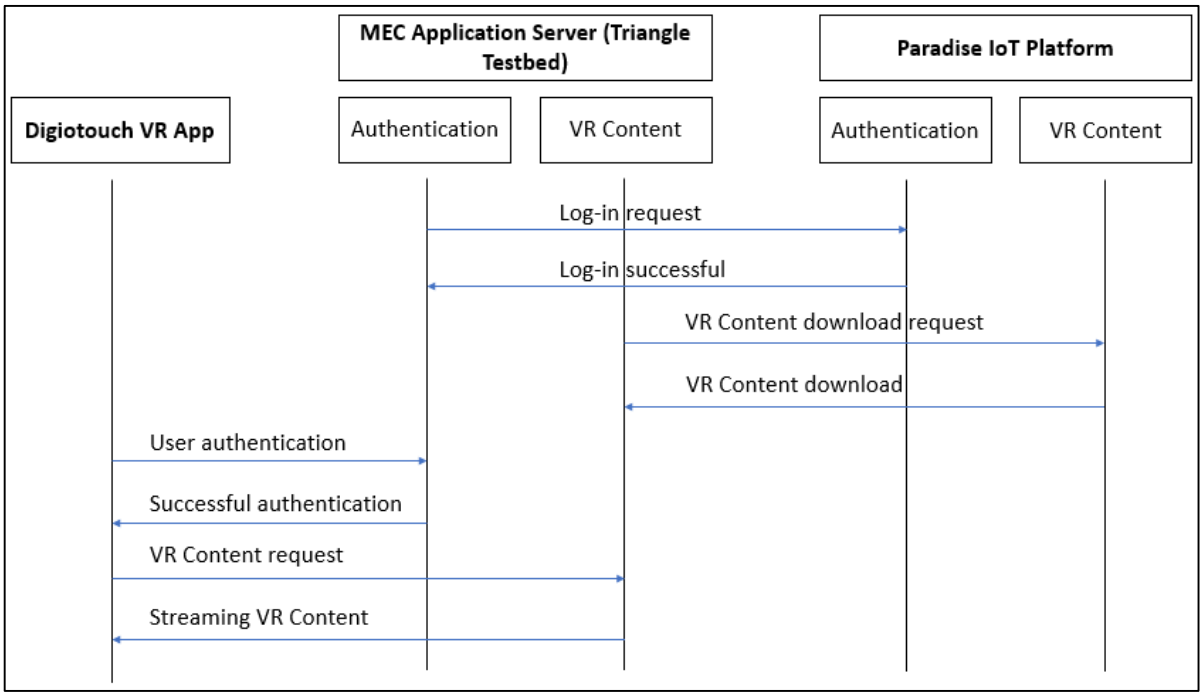

Figure 10– Digiotouch High Level Architecture

This experiment used the following TRIANGLE components:

- Performance Tool
- TestelDroid Mobile Monitoring App
- Power Consumption Analyser
- Device Action Automation Tool

The following scenarious were used:
Urban - Internet café busy hours, Internet café off peak, Office
Suburban – Festival, Stadium, Shopping mall busy hours

Milestones	Week #
M1 - MEC server developed and deployed in Triangle Testbed	W47
M2 - 5GVR testing, certification completed with final report	W51

	Week No. of 2018											
5GVR Activities	**W41**	**W42**	**W43**	**W44**	**W45**	**W46**	**W47**	**W48**	**W49**	**W50**	**W51**	**W52**
Experiment acceptance notification												
Contract signature												
Finalizing MEC Server architecture design and message exchanges with VR app, Paradise IoT Platform (Cloud)												
Development of MEC server												
MEC server provisioning with Paradise IoT Platform												
5GVR Testing in DEKRA campus (Malaga)												
5GVR test result analysis												
Upgrading Digiotouch VR app												
5GVR app certification												
5GVR final report writing and submission												
5GVR sustainability and commercialization plan												
5GVR demo preparation for final review												

Figure 11– Digiotouch experiment Timeline

Key results and Insights gained from Testing

The detailed results of the testing undertaken and the benchmarked scores obtained is confidential and available in D5.6. Overall, the company found that there were issues downloading large VR video files over realistic network conditions, leading to playback issues. There were a number of issues that lead to a poor QoE that the company are addressing.
The improvements identified include :

- An improved UX for user's when a large wait time is identified from the network conditions.
- Improved offline capability when network conditions are poor
- Resume from failure improvements during network outages
- Other network optimisations

Business benefits

The results allowed them to expand their business objective of being one of the leaders in the 5G powered VR apps in Europe. They expect that the lower power consumption, increase in bandwidth by 10x and lower latency will lead to increased VR adoption. In particular, their evaluation of MEC performance gains by using the Testbed helps to validate how important the MEC component will be in a 5G-enabled environment.

TRIANGLE testing value identified

The company indicated the following statement on their experience using the Testbed and the value that it added:

"Thanks to the TRIANGLE experiment, Digiotouch has been able to create a VR application competing with leading brands like Google Daydream and Samsung VR."

"Since 5G is touted as the technology that will bring VR technology to the masses, the Testbed experience is highly valuable for Digiotouch. 5GVR also led us to acquire new competences around 5G."

"The experimental results enabled us to understand the behaviour of the VR app under ultra-real network scenarios. We could not anticipate loading such videos could take up to 10 minutes in certain scenarios. Consequently, such results allowed us to upgrade the smartphone application providing better Quality of Experience and reliability."

"The Triangle website has a wealth of information on the project's goals, resources provided, project deliverables. This information assisted us in determining that Triangle Testbed is the perfect resource for us to carry out the experiment."

"The technical offering of Triangle Testbed was in line with the experiment expectations. The positive aspect has been the excellent usability of the Testbed resources and software tools"

"I am able to understand the behaviour of Digiotouch VR app under different 5G network scenarios and implemented a technical update which is anticipated be commercialised from early 2019."

TRIANGLE benefits identified

This experiment validated the flexibility of the Testbed in accommodating infrastructure such as Edge components into the testing scenarios. The consortium feel that the experimenter learned lots about the domain and the capabilities offered by 5G and in understanding how they use the network, in addition to strengthening the consortium's collective knowledge on VR, MEC and immersive solutions, that have been related to their experimenters and extensions.

Planned further use of the Testbed

Digiotouch intends to use the TRIANGLE facilities again in future should the Testbed access be provided by the project partners. Thus, given a chance, they claim they will utilise the TRIANGLE facilities again to test novel features in the implemented app.

2.4 Summary of Results of Open Call 5 & 6

The consortium felt that both OC 5 and 6 despite a number of challenges went well. The challenges encountered in many of the cases were a result of issues arising from the immaturity and lack of testing that had been undertaken on the applicants' applications and devices. Since TRIANGLE is targeting the SME sector, where products are not fully mature, or, in some cases, completely stable and thoroughly tested, then this type of experience is not unexpected.

This is an area where using the Testbed can be an advantage to early stage companies as they can use the Testbed to discover issues with their products that are not known to them at development or during initial testing. Due to the inability for SMEs to have the resources, or in some cases knowledge, to comprehensively test under a diverse set of network scenarios, the TRIANGLE Testbed has helped these companies to identify these issues and the source of the problem and to improve their applications as a result.

Summary of recommendations for Improvement

As in previous Open Calls, as part of the evaluation process each testbed user is required to give their feedback on their experience using the testbed and suggestions that they may have for improving the testbed. Since the testbed is maturing and some of the applicants had a diverse set of testing challenges, it was inevitable that these users encountered some issues, especially at the outset of testing that are normal when real world usage of a new platform. In general, the issues found were small in terms of the seriousness and in most cases, quickly resolved by the technical support teams at the various TRIANGLE Testbed locations.

The main improvements suggested were:

- A suggestion to have the QuaMotion application user journey recording embedded into the TRIANGLE Portal, rather than as a standalone tool
- Improved Docs and samples e.g. how to run a custom campaign for a simple feature
- An ability to expose the experimental setup for a third-party use through federation.
- An ETSI MEC-compliant Edge Server be deployed in the Testbed
- the testbed reservation tool could also be more integrated in the portal and that it does not require a double authentication to make the reservation
- The ablity to simulate some actions in the applications with the Quamotion tooling was not possible, such as sliding.
- Add improved detailed error descriptions when the campaigns fail. E.g. Why is not in compliance? What is the problem to load a user flow script? and so on. Just to make it easier than checking for it on the video.

3 TRIANGLE Experimenter Support

3.1.1 Support during the experiments

The TRIANGLE team continued to provide support for the Testbed and the Extensions that came online throughout its evolution throughout OC5 and OC6. The number of support queries was much lower than OC3 and OC4, due to less complexity being involved with supporting the testing of mobile apps and not complex devices. The maturity of the Testbed and the increase in Documentation and samples and the maturity of the instrumentation library and TRIANGLE portal was also a factor.

Requests for Support during the experiments were mainly confined to experiments belonging to OC4 and the Extensions that were used, with a light volume arising from OC5 and OC6 companies. Most of the issues were in many cases in the side of the experimenter, due to the immaturity of their applications and devices, so these were more dialog based than the traditional Support tickets from previous Open Calls. In total after reporting on OC3 in D5.4 the total number of support issues raised from 44 at the to 66 overall.

All the experimenters complemented the ease and efficiency of the support process during the experiment. Each Experiment had a corresponding project created in Redmine and individuals from each experiment team were added to the project in various roles.

Each Experiment also had a member of TRIANGLE assigned to be the main liaison on technical issues and to coordinate testbed access based on testbed availability. In the event of a technical issue, the Experimenter logged an issue on Redmine and the TRIANGLE liaison contact assigned the issue to an appropriately individual to resolve or to clarify with the reporter. In some cases, email and occasionally phone calls were scheduled to resolve issues or to clarify questions more efficiently.

3.1.2 Support for the Testbed Scheduling

One of the areas that has been improved from the previous Open Call is the ability to more efficiently and effectively manage multiple Open Callers requesting to use the TRIANGLE Testbed. In the UMA testbed, where that majority of the experiments are run, large parts of this process are now automated, with the ability to book through a calendar interface for booking time slots, with some checks to ensure testbed availability and operational state before access is granted and an experiment can start. The UMA team and the experimenters that use it find this to be a valuable feature.
With this online scheduling (compared to human interaction requests), we unfortunately saw a few times the testbed being reserved but not actually used by the experimenter due to a last-minute conflict in their agenda. This lead to some idle time and frustration for other experimenters.

4 Conclusion

Open Call 5 completed on time but unfortunately saw companies cancelling their participation due to internal priorities. Good results were achieved. We also completed the pending OC3 activities within the OC5 timeframe.

Open Call 6 was a focused call for SMEs that have applications that utilised the TRIANGLE portal as part of testing. The overall positive experience for these applicants, validated the objectives of the project to develop a platform for the rapid execution of repeated tests of mobile apps requiring little underlying network knowledge for the application developers.

The abstraction provided by the TRIANGLE Portal of the underlying Testbed infrastructure allowed SMEs, with little resources or experience in the underlying networking infrastructure of underpinning mobile communications, to rapidly learn about the Testbed and how to utilise it effectively for their particular experiment needs, instrument their application to automate key user journeys and to measure important KPIs.

The consortium is very happy with the ease at which experimenters are able to get started using the Testbed on their own. For some of the experimenters in these calls, the timeline from the actual start of experiment to execution of the tests, to result analysis in some cases was just a matter of a few days.

Using the TRIANGLE Testbed, a number of SMEs were able gain insights on the performance of their application running under different Network Scenarios and to find issues that they were not aware of and to make improvements to their apps. All of the companies found that the Testbed was a valuable asset in assisting them in improving the quality of their mobile applications, especially in the area of quality of experience for their end-users.

5 References

[1] TRIANGLE Testbed tools [online] http://triangle-project.eu/tools
[2] TRIANGLE D3.5 Implementation report on the testing framework Rel 4
[3] TRIANGLE D6.1 Business Plan for BaaS