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TRIANGLE experiments and extensions

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Deliverable D5.7
TRIANGLE experiments and extensions

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Abstract

The TRIANGLE Project ran three waves of Open Calls for the purposes of gathering feedback from real-world users of the Testbed and to increase the capabilities of the Testbed. These results of 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. This document outlines a compact summary of the results of these Open Calls.

Keywords

Open Call; Experiment; Extension

Document History

V1.0	Initial release of the document
V1.1	recreation of the pdf embedding the fonts to avoid printing issues

Executive summary

The TRIANGLE project ran three waves of Open Calls from 2017 to 2018. This document provides a brief summary of the experiments selected in these Open Calls. The document presents the results as a set of one page summaries of each experimenter, including a brief overview of the Experimenter, the objectives and results measured and value obtained in using the testbed.

The first Open Call (OC1) was for experimenters to use the TRIANGLE Testbed infrastructure with experiments starting in April 2017 and completing in September 2017 (October 2017 for one). These experiments comprised two Mobile Apps and one Connected device. The Second Open Call (OC2) was for extensions to add additional functionality to the TRIANGLE Testbed. The selected extension began in May 2017, with a first release of the technology delivered by end of September 2017 in time for the second release of the Triangle Testbed (R2). The second part of the extension has been delivered in April 2018 and is available for use for new experimenters for OC3/4/5 and external users.

The second wave of Open Calls for experiments OC3 and extensions OC4 ran during the summer of 2018 with a number of high quality applications. The consortium chose to select the top six applicants for experiments, with a mix of IoT devices, mobile app developers and experimenters interested in running a number of different networking experiments. The consortium feels that this Open Call was a good indicator of the diverse set of experiments that can be run on the Testbed.

The third wave Open Calls was for Experiments from SMEs, OC5 was unfunded and with a small amount of funding available for OC6, the primary focus was on obtaining feedback from SMEs developing mobile apps that could take advantage of the features of the TRIANGLE portal.

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TRIANGLE Open Call overview

This document outlines a brief summary of the results of the Open Calls run by the TRIANGLE project. The Open Calls were run over the duration of the project and were divided into three waves as the TRIANGLE Testbed evolved. The primary purpose of these Open Calls was for real Testbed users, from a number of different domains and with varying types of mobile application and device types, to give their feedback and suggestions on improvements the TRIANGLE Testbed. This feedback would be then be used by the consortium to guide the evolution of, and improvements to, the TRIANGLE Testbed.

Over the duration of the project there were in total three waves of Open Calls, with some external users using the testbed on an unfunded basis when there was capacity in the Testbed schedule. There were two types of Open Call, one focussed on Experiments, and the other on Testbed Extensions.

The main objective of Open Calls OC1, OC3 and OC5 was testing the TRIANGLE testbed with **Experiments** that are co-created with companies such as application developers and device manufacturers. Example experiments could include application developers testing 5G scenarios such as low latency to facilitate VR, or an IoT device maker who wants to benchmark their devices against other low power devices. The experiments helped in guiding the development of the main Testbed location at the University of Malaga and to other TRIANGLE Testbed locations.

The Open Calls OC2 and OC4 is for testbed **Extensions**, where the main objective is adding additional capabilities to the TRIANGLE Testbed to facilitate extensions. The extensions helped improve the TRIANGLE Testbed as a whole to match other needs of experimenters.

Relationship to other Open Call documents

This document contains a brief summary of each experiment and extension as is presented in the style of a brief one page description of the results. More information on each Open Call is available from the following documents:

Table 1 – Open Call Related Documents

ID	Document Name	Purpose and Contents	Visibility
D5.1	Open Call Text and Submission Text	Outlines the Open Call process	public
D5.3	Results of known experiments and First Open Call	Overview and Results of Wave 1 (OC1 and OC2)	public
D5.4	Results of Second Open Call	Overview and Results of Wave 2 (OC3 and OC4)	public
D5.5	Results of Third Open Call	Overview and Results of Wave 3 (OC4 and OC5)	public
D5.6	Final Report on results and insights from TRIANGLE Testbed experiments	Overview of the results of all Open Call users and the feedback obtained and actions taken	private
D5.7	TRIANGLE experiments and extensions	A summary of the Open Call experiments	public

Experiment Report Summary

This section presents the results of OC1-OC6 as a set of one page summaries for each experimenter. The structure of these reporting templates is based off a structure used in existing EU projects for dissemination. It is similar to a poster used in the research community and contains the following information:

1. The title of the experiment
2. Experiment motivation
3. A brief overview of the experimenter
4. Key experiment objectives
5. A brief outline of the operation and setup of the experiment, with emphasis on how the experiment architecture involved the TRIANGLE Testbed components
6. Key results that were measured in the experiment
7. The TRIANGLE Testbed components that were used in the experiment
8. The value obtained by the experimenter in using the testbed.

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

5MARCAS: Des5G benchMarking of Augmented Reality appliCations in reAl time for touriSm

Motivation –The motivation of the experiment was to assess the performance of the Augmented Reality mobile app 5MARCAS while serving High Quality audio-visual content in real-time. The original version of the app relied on fetching stage based on a WiFi-dependent pre-download of all cloud-based assets required to serve the overlaying supplemental information to be viewed by end users. A new version of the app was generated in order to harness the full potential of 5G connectivity to fetch the required assets on-the-fly and on-demand.

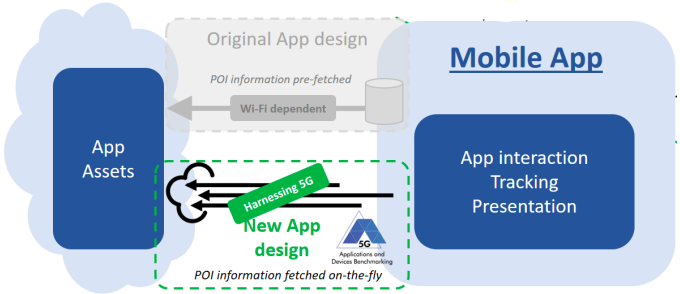
Key Objectives

The objectives for the experiment were to asses to performance of:

- user experience,
- energy and resource consumption,
- latency, bandwidth and stability

How Does It Work?

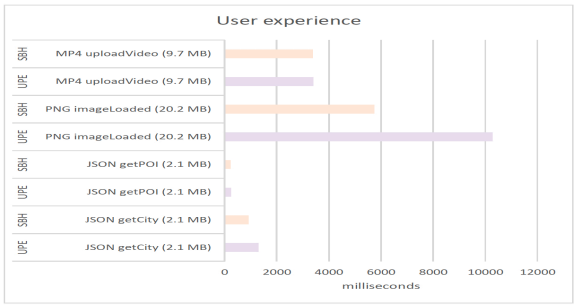
The TRIANGLE team worked with atSistemas to determine how to adapt their application to be suitable for automated end-to-end testing. This is more difficult than most mobile app scenarios as the app is designed for an Augmented reality use case.



Some challenges included the separation of the camera capture and general AR functionality from the network activity for accurate measurements and performance. To achieve accurate results the Testbed had accurate GPS emulation added to support future AR applications

Key Results

- 5MARCAS mobile app is able to perform satisfactorily when harnessing all the potential offered by future 5G Networks in terms of connectivity.



- The urban scenario was of interest which is a section of a city which typically is in the centre of the city and contains buildings considered valuable for historical or architectural reasons

Testbed Components Used

UXM RAN Emulator	TRIANGLE Web Portal
TACS4 Performance Tool	Android UEs
Quamotion WebDriver	Instrumentation Library

Facts			
Company:	atSistemas		
Coordinator:	Lorena Bourg	**Company Mission:**	Specialists in R&D activities and an Agile First Company
Duration:	01/04/2017 - 01/07/2017		

Experimenter's Impression:

"atSistemas gained priceless competitive advantage to deliver certifiable modern solutions that will soon be demanded massively within the promising future commercial environment being open by the cheaper availability of high-speed access networks such as 5G."

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

Spectating SpaceWars:

Motivation – The TRIANGLE Testbed was used to assess various visual quality levels and production conditions of an immersive game that allows players to compete in shared virtual arenas using their reconstructed realistic appearance as their in-game avatars. This assessment was also conducted after varying the network conditions in order to also extract tangible results related to its adaptation performance in sub-optimal networks.

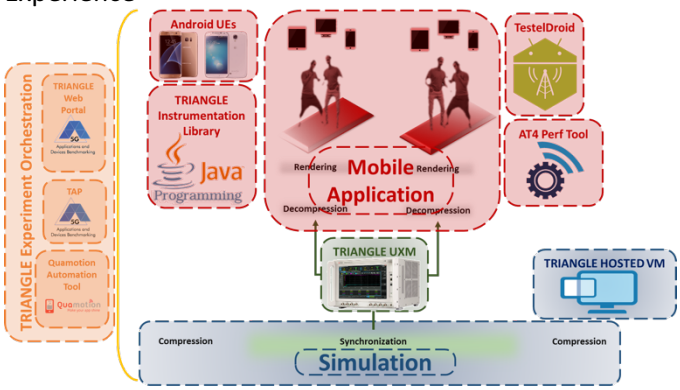
Key Objectives

The objectives for the experiment were to measure the impact of different network conditions on these KPIs:

- Replica Rate & Playback Delay
- Playback Freezing Time & Overall %
- Game Data Playback Delay

How Does It Work?

The Triangle team worked with D-Cube to establish what QoE characteristics they were looking to test and how the Testbed could best achieve their testing needs. The team worked with them on the UX of their application to modify it to achieve a better User Experience



A set of player and game simulations were developed to generate traffic flow for the spectators to spectate and to measure QoE under different network scenarious.

Key Results

Testing determined that the knowledge they acquired will greatly help in designing adaptation solutions (e.g. adaptive streaming, toggling VBR, offering spectating guidelines, etc.) for sub-optimal network conditions known channel profile for multiple scenarios.

Experiment No	Texture Decompression Time (msec)	Geometry Decompression Time (msec)
1	283	421
2	258	400
3	279	455
4	257	342
5	269	101

KPI measurements were made of the spectating mobile app under an urban environment for various parameters of the VR streaming application that affect perceived visual quality and smooth playback.

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
Quamotion WebDriver	Instrumentation Library
TACS4 Performance Tool	Android UEs

Facts		D-cube IMMERSIVE SOLUTIONS	
Company:	D-Cube		
Coordinator:	Dimitrios Katsikas	**Company Mission:**	immersive marketing event products that aim to attract and engage visitors
Duration:	01/04/2017 - 01/07/2017		

Experimenter's Impression: "We were able to better understand the limitations of our tele-immersion pipeline, find optimal parameters of the pipeline for varying network conditions and eventually be more confident about the Quality of Experience of our mobile application when deployed to end-users."

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

Health5G@- Home5G-enabled Home Healthcare Services

Motivation –The Health5G@Home experiment is aimed at validating the ability of 5G technology to effectively enable the delivery of advanced home health and care services. Thinkinside srl has developed a suite of telemonitoring and telecare services for remotely controlling fragile patients that is currently deployed with customers in nursing homes.

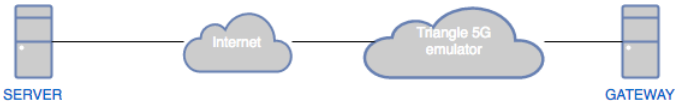
Key Objectives

Health5G@Home requires ultra-reliable communication, the following KPIs were measured:

- (end-to-end) latency
- user experienced data rate (up and down)
- network reliability

How Does It Work?

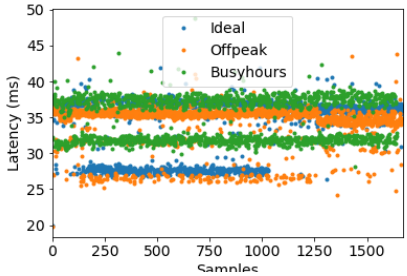
The system includes two types of sensing devices, one (based on BLE technology) for monitoring with high precision (~25cm) the position of users within the building and their movements (including fall detection), while the second ones include technology for monitoring patient's vital signs (in particular heartbeat and continuous glucose monitoring for diabetes patients). The data generated by such sensors is transmitted to a gateway which is Internet connected; data is processed in the cloud to extract relevant indicators and to trigger appropriate actions (typically notification to nurses and other staff members of a potential risk situation requiring interventions).



The server provides an HTTP endpoint to which the gateway can send the data. The gateway collects data from various sources and delivers a subset of this information to the server with some pre-processing is handled locally directly in the gateway.

Key Results

A number of experiments were run under different network scenarious with simulated traffic loads and the following data was measured:



1.Total received/sent traffic in bytes and packets
2. Bandwidth used (in bytes/s)
3. HTTP Errors
4. One way latency (OWL)
5. Round Trip Time (RTT)

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
TACS4 Performance Tool	Android UEs

Facts		thinkin	
Company:	Thinkinside srl		
Coordinator:	Iacopo Carreras	**Company Mission:**	indoor movements of people and assets are monitored in real-time, analysed
Duration:	01/04/2017 - 01/07/2017		

Experimenter's Impression: "Thanks to the experiment I conducted within Triangle, we will be able to launch to the market a new telemonitoring product for the home care market"

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

DualRoC: Dual Radio-over-Copper Remotization for Multi-RAT Centralized-RAN Architecture in 5G Deployments

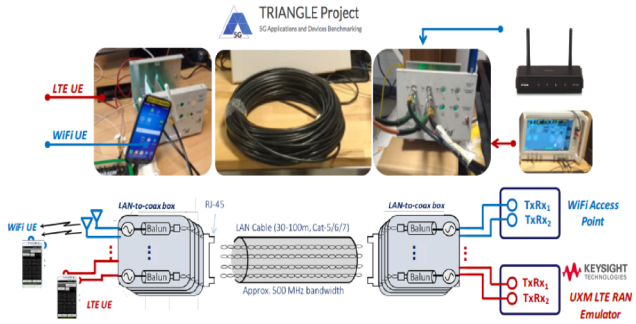
Motivation – Next generation (5G and beyond) communication networks are expected to incorporate the pre-existing LTE and WiFi connectivity of all the interconnected devices with multiple available interfaces, guaranteeing high-rate/low-latency communications. In this context, Dual-RoC is the integration of Multi Radio Access Technology (RAT) into a copper-based Centralized Radio Access Network (C-RAN) architecture.

Key Objectives

The objective of Dual-RoC Experiment is thus to experimentally observe and demonstrate the feasibility of the interplay between an all-analog C-RAN architecture based on LAN cables and Multi-RAT.

How Does It Work?

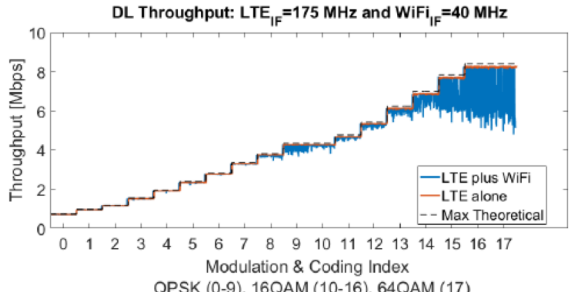
For Dual-RoC, the TRIANGLE testbed has been used in the typical device-testing configuration, with the only



difference that a 4-pairs RJ45 Cat-5e LAN cable has been inserted between the RF output ports of the UXM and the RF connections at the device to show the performance degradation introduced by the all-analog relaying over copper. The adaptation between RF connections and LAN cable is performed by the so-called LAN-to-coax boxes, which have been developed to enable Dual-RoC.

Key Results

Dual-RoC demonstrates the feasibility of carrying both MIMO LTE and WiFi signals over the same LAN cable using an all-analog relaying by a purposely selected mapping of IF frequencies onto the cable twisted pairs, iii) the performance degradation experienced for high



MCS and high IF is mainly due to the low signal power received at the user device due to the attenuation introduced by the analog relay over cable

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
Wi-Fi Access Points	TestelDroid
TACS4 Performance Tool	Android UEs

Facts				
Company:	WiSyLab – Politecnico di Milano **Error! Reference source not found.**		POLITECNICO MILANO 1863	
Coordinator:	U. Spagnolini		**Company Mission:**	Research and Education
Duration:	01/01/2018 - 01/05/2018			

Experimenter's Impression: "Thanks to the experiment I conducted within Triangle, it was possible to bring the academy closer to the industry, thus bridging the gap between theory and practice and getting unique results!

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

5G-Bot: Evaluation of 5G on QoE of Chatbot applications

Motivation – The objective of the 5G-Bot experiment was to test the behaviour of chatbot applications under different mobile reception conditions, network traffic, processing power schemes and battery utilisation plans in order to quantify and assess their impact on the QoE level as perceived by the user and to stress the reliability of the chatbot app under different network conditions.

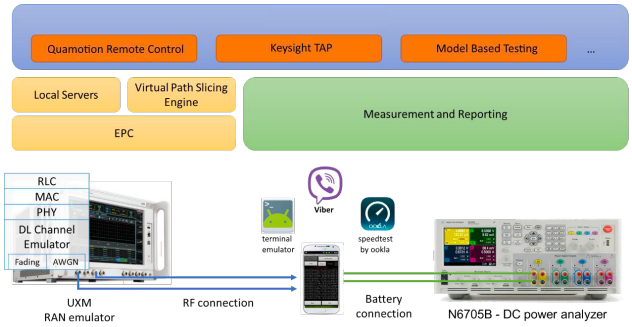
Key Objectives

The objective of experiment was to measure and benchmark chatbot app performance and QoE in different realistic network scenarios while measuring power usage

How Does It Work?

Three different types of chatbots over Viber platform have been used for the deployment of the 5G-BOT

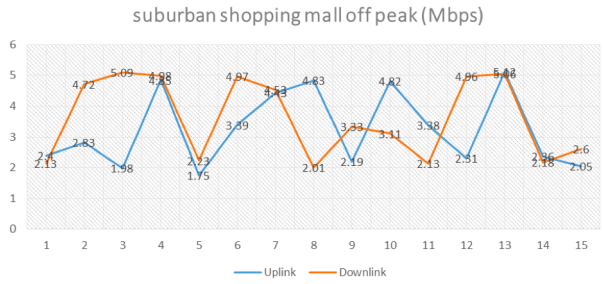
- Informative Chatbot
- Contest Participation Chatbot
- Order Placement Chatbot



These were run in a number of network scenarious:

1. Suburban: Festival, Shopping Mall Busy Hours, Shopping Mall off Peak, Stadium
2. Urban: Traffic Jam, Internet-café busy hours, Internet-café off peak, Office, Pedestrian
3. A 5G-Bot Custom made scenario

Key Results Overall, chatbot performance and functions were not remarkably affected upon changing factors/scenarios such as mobile phone models, environment conditions, reception conditions, network traffic, processing power schemes and battery use Infolysis acquired experience and documentation on which factors and parameters may affect the performance of chatbot apps and up to what degree of



severity. 5G-Bot experiment gave the opportunity to Infolysis to create a performance map under different scenarios, KPIs and metrics

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
Quamotion WebDriver	TestelDroid
DC Power Analyser	Android UEs

Facts				
Company:	Infolysis **Error! Reference source not found.**		INFOLYSiS	
Coordinator:	V. Koumaras		**Company Mission:**	Provide IT cutting edge innovative solution
Duration:	01/01/2018 - 01/05/2018			

Experimenter's Impression: "I added value to the performance credibility of chatbot applications and improved users QoE!"

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

PHYSCHED: Design space exploration and performance testing for PHY & scheduler

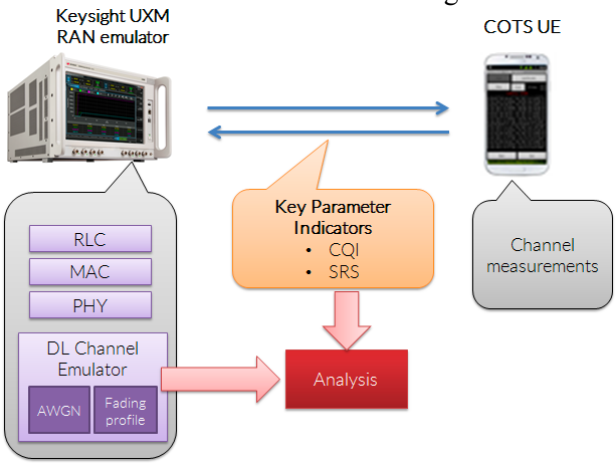
Motivation –The motivation of the experiment was to explore the design space for improvement and further implementation of a LTE eNB scheduling algorithm that is going to be a part of Software-defined RAN for 4G and 5G, developed by IS-Wireless and to perform advanced 3GPP conformance testing of link-level simulation tool, which is a key software component of ISW's 5G Toolset

Key Objectives

There were two objectives for the experiment
1) Design space exploration of standard-compliant environment for LTE eNB Scheduler optimization
2) Testing and validation of LTE PHY Lab downlink receiver processing chain.

How Does It Work?

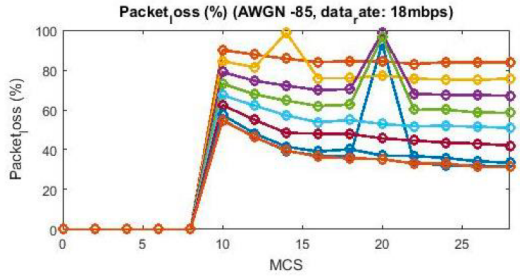
The UXM RAN Emulator was used to simulate the scheduler activity by selection of spectrum bandwidth, assignment of specific resources for the user and selection of the Modulation and Coding Scheme



DL Channel emulator was used to model the channel influence by adding the noise (AWGN) and applying fading profiles defined in 3GPP specification such as (pedestrian, vehicular or high-speed train

Key Results

For the Scheduler experiment The KPIs measured and returned by both UXM and TACS4 were analyzed dependent on the transmission configuration and known channel profile for multiple scenarios.



i) The KPI results correspond to the expectations in regards to various scheduling decisions
ii) Results confirm the assumptions for the Scheduler

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
TACS4 Performance Tool	Android UEs

Facts			
Company:	IS Wireless **Error! Reference source not found.**		
Coordinator:	L. Kwiatkowski	**Company Mission:**	IS-Wireless develops algorithms, protocols and tools for 4G and 5G mobile networks
Duration:	01/01/2018 - 01/07/2018		

Experimenter's Impression: "we had the opportunity to use the specialized equipment to explore a design space for the scheduling algorithms we have gained a solid ground for improvement and further implementation of our solutions for 4G/5G base stations"

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

CellularGrid: Cellular Networks for Real-Time Monitoring of Smart Grid

Motivation – The scope in the smart grid industry has been extended to cover also elements like distributed energy resources, electric vehicles, protection relays, and metering devices, where wired communication is not cost effective to install and maintain. 5G can have comparable performance to wired infrastructure, allowing to discretize and network individual grid elements, which can then implement intelligent sensors and switching decisions to isolate faults, reroute power and self-heal the grid. This project evaluates the connectivity requirements of smart grid applications in 5G.

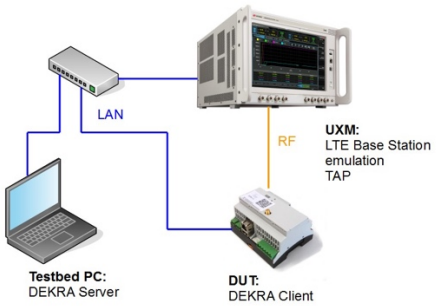
Key Objectives

The objective of the experiment will allow Comsensus **Error! Reference source not found.** to emulate their PMU/PQM devices use in different real life (LTE Cat-3, LTE Cat-M1, LTE Cat-NB1) network scenarios and thereby appropriately select the technology and/or adjust their design.

How Does It Work?

The DEKRA Performance Tool was used as a traffic generator and KPI calculator. The DEKRA server was run on a testbed PC, the client was run on DUT connected to the UXM via RF coaxial cable. The Urban-pedestrian LTE network scenario was chosen as it was the one that reassembles the DUTs target environment the closest

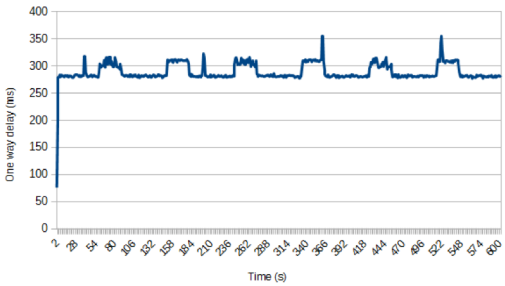
The two protocols evaluated were evaluated



i) the IEEE C37.118-2014 protocol and
ii) the IEC 61850-9-2 Sampled Values protocol both using TCP and UDP traffic.

Key Results

The Testbed was used to test the wireless link performance for different location and user density. The KPIs measured during the experiment include end-to-end delay and throughput. The results of the experiment confirmed that low throughput uplink with real-time constraints are viable using LTE Cat-3 even in the case of challenging channel conditions. In the high



throughput scenario the target throughput could not be reached in any of the predefined channel conditions.

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
TACS4 Performance Tool	

Facts			
Company:	Comsensus **Error! Reference source not found.**		COM SENSUS
Coordinator:	M. Smolnikar	**Company Mission:**	deliver in depth understanding of your business process. Increase your operational efficiency with our customized IT solutions!
Duration:	01/01/2018 - 01/05/2018		

Experimenter's Impression: "Thanks to Triangle we were able shorten the product design cycle, obtain a set of measurements in a controlled environment & experiment with technologies not yet available commercially"

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

DiMoViS: Distributed Mobile Video Surveillance in a 5G Ecosystem

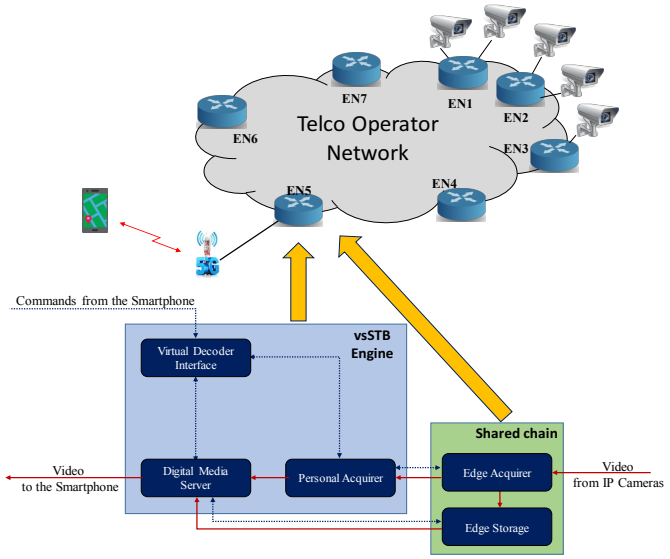
Motivation – the experiment involved a distributed mobile video surveillance system with a huge number of IP cameras operating over SDN/NFV infrastructures, a Network Orchestrator for dynamic set-up and adaptation of data delivery paths in SDN/NFV networks, and a Virtual Network Function (VNF) that is able to identify mobile terminal handovers and sending this information to the Network Orchestrator to arrange paths accordingly.

Key Objectives

There were two objectives for the experiment
1) Design space exploration of standard-compliant environment for LTE eNB Scheduler optimization
2) Testing and validation of LTE PHY Lab downlink receiver processing chain.

How Does It Work?

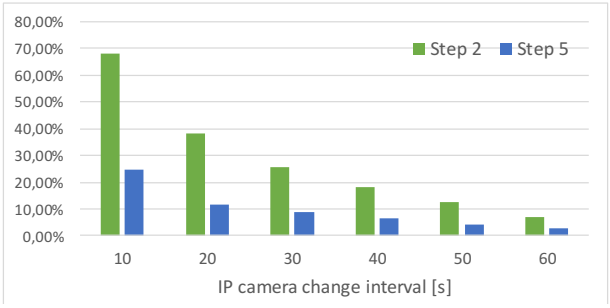
The UXM RAN Emulator was used to simulate the scheduler activity by selection of spectrum bandwidth, assignment of specific resources for the user and selection of the Modulation and Coding Scheme



DL Channel emulator was used to model the channel influence by adding the noise (AWGN) and applying fading profiles defined in 3GPP specification such as (pedestrian, vehicular or high-speed train

Key Results

Work is still ongoing on the LTE-PHY experiment, but for the Scheduler experiment The KPIs measured and returned by both UXM and TACS4 were analyzed dependent on the transmission configuration and



known channel profile for multiple scenarios.
i) The KPI results correspond to the expectations in regards to various scheduling decisions
ii) Results confirm the assumptions for the Scheduler

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
Quamotion WebDriver	TRIANGLE Portal
Virtual Machines	NFV & MEC Extensions

Facts			
Company:	CNIT		
Coordinator:	Giovanni Schembra, Barbara Martini	**Company Mission:**	37 public Italian universities to perform research, innovation and education/training in the field of the ICT
Duration:	01/07/2017 - 31/12/2018		

Experimenter's Impression: "Thanks to the experiment we conducted within TRIANGLE, we were able to strengthen and improve hand-on practice on SDN/NFV systems and software platforms"

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

SPEEDY: SPEED test for emergencY scenario of a cardiac telemedicine system

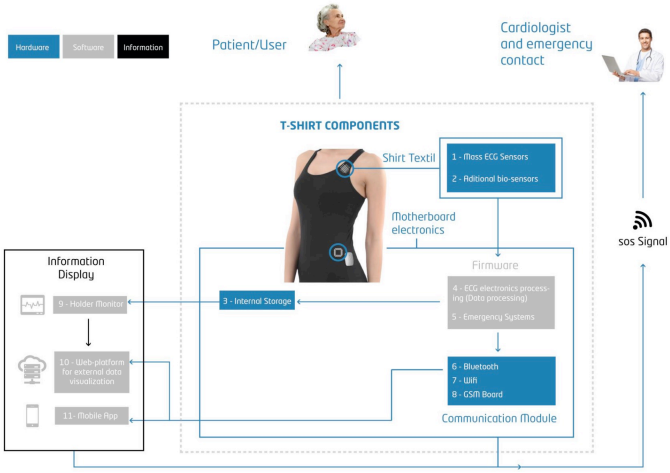
Motivation –The motivation of the experiment was to test a wearable measures the ECG with state-of-the-art embroidered sensors locally, and the processed ECG data is sent to the servers directly from a built in 4G LTE modem. The ECG is stored, analysed and arrhythmic events presented to the cardiologist. The system can detect early indications of imminent heart failure and immediately trigger notifications to doctors

Key Objectives

Testing of the whole communication chain, from the hardware to the server over the mobile network and benchmark the system under different conditions:
1)the network latency between the t-shirt and cloud.
2) communication handoff when the patient is moving
3) benchmarking and performance of communication speed and network latency maps, measure battery-life

How Does It Work?

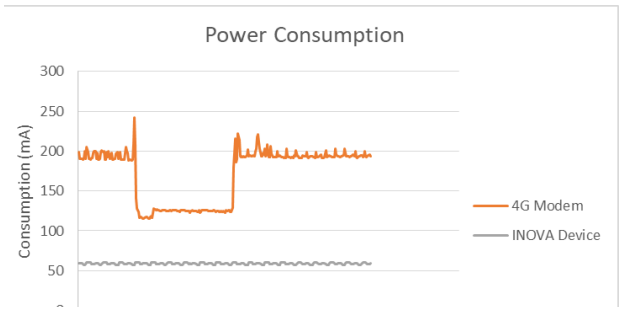
The Testbed was used to test different scenarios with different levels of noise, network and capacity and the battery life calculated in different conditions



The environments that were of interest were Outdoor/indoor urban/rural environments, at home

Key Results

The KPIs measured and analyzed and inova came to the following conclusions:
i) Due to periods of packet loss like a tunnel it is a good idea to implement a buffer within our device to avoid data loss and poor QoS
ii) Inova were able to estimate their battery time life under different network conditions
iii) with a NB-IOT modem Inova found a huge limitation



in bandwidth, even for our low data rate transfer, compression should be used

Testbed Components Used

UXM RAN Emulator	Test Automation Platform (TAP
TACS4 Performance Tool	Android UEs

Facts			
Company:	Inova DE, GmbH		
Coordinator:	Vitor Manuel Machado Vieira	**Company Mission:**	assist industry, academic and clinical partners with consultancy and medical software development
Duration:	01/07/2017 - 01/12/2018		

Experimenter's Impression:

"Thanks to the experiment I conducted within Triangle, we could to carry out tests that otherwise we couldn't do. This allowed us to mitigate future problems, and to face technical and reliability issues with more confidence."

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

5GVR: 5G Powered VR

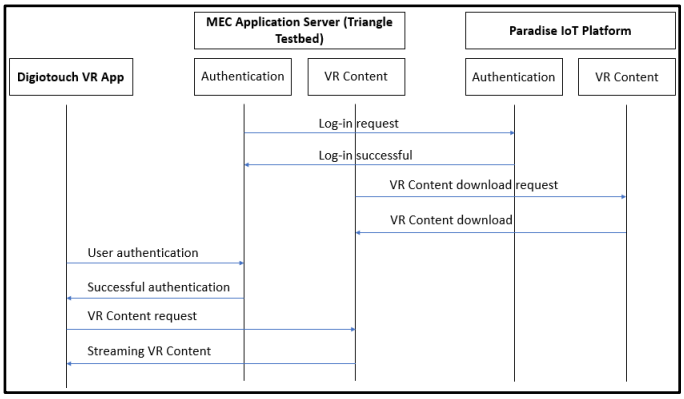
Motivation – Digiotouch VR is a virtual reality application developed by Digiotouch for Android phones targeting Smart Museum, Smart City verticals. The app streams high quality multimedia content from a Cloud based Paradise IoT Platform to create a 3D immersive experience, the experiment measured the improvements from MEC on the system.

Key Objectives

There were two objectives for the experiment:
1) To evaluate the use of a MEC server for the high-quality multimedia content caching and delivery.
2) Evaluate the benefits enabled by 5G features like low power consumption, improved Quality of Experience

How Does It Work?

The experiment was setup to measure important metrics. Each metric corresponds to a set of KPIs in the experiment including the ability to manage loss of data files, and data loses, energy consumption and network resource usage QoE as measured by response time, time to load and display the 3D environment

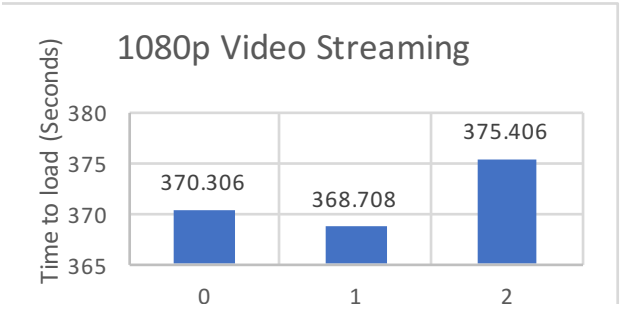


The following scenarious were tested:
Urban - Internet café busy hours & off peak, Office
Suburban – Festival, Stadium, Shopping mall busy hours

Key Results

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 tested.
App improvements identified included:

- An improved UX for user's when a large wait



time is identified from the network conditions.

- Improved offline capability
- Resume from failure improvements during network outages & other network optimisations

Testbed Components Used

UXM RAN Emulator	TRIANGLE Web Portal
Quamotion WebDriver	Instrumentation Library
TACS4 Performance Tool	Android UEs

Facts		Digiotouch OU	
Company:	Digiotouch OU		
Coordinator:	Mr. Soumya Kanti Datta	**Company Mission:**	providing sustainable digital transformation to smart city infrastructure, manufacturing, energy, and mobility industries
Duration:	01/10/2018 - 01/12/2018		

Experimenter's Impression: "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: 5G Applications and Devices Benchmarking

Experiment Overview

Eulen Acércate

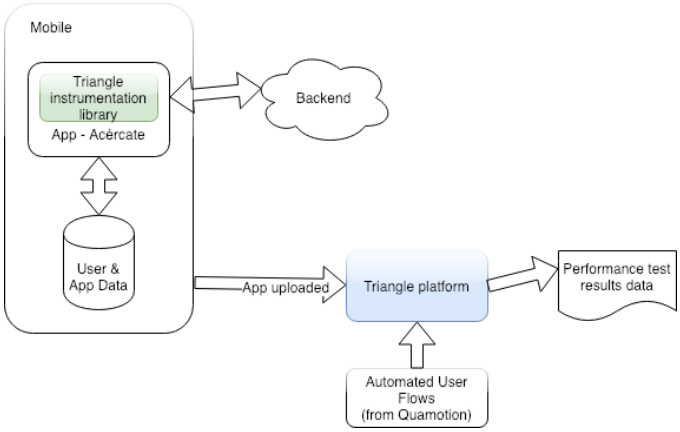
Motivation – to allow Cuatroochenta to analyse the performance of their mobile application called Acércate. The main feature of this app is to know the location of key people using the GPS location in different situations, set emergency contacts, share important reminders and establish security areas and receive notifications about movements.

Key Objectives

There were two objectives for the experiment:
1) Optimize the performance of the application in different network scenarious, minimizing battery consumption and identifying elements and processes that require excessive consumption of resources.
2) Testing the most common user flows on the app, to detect possible problems related with network usage.

How Does It Work?

The app uses some synchronization web services to keep data regularly updated in order to show the most accurate information for the tracked contacts



A subset of the web service calls made on the app were defined, and placed the measurement points of the Triangle platform to check the performance on the whole request-response flow including data transfer for reasons such as: time of response, draining of the battery or use of device resources.
Scenarious considered were - ideal conditions, shopping mall off peak, shopping mall busy hours, pedestrian with medium data rate and office

Key Results

The company were able to detect where the app suffers degradation on the performance and excessive consumption of resources

Improvements identified included:

- Detected improvement possibilities while running the app on poor connectivity environments.
- Improved offline/online capability
- Resume from failure improvements during network outages & other network optimisations

Testbed Components Used

UXM RAN Emulator	TRIANGLE Web Portal
Quamotion WebDriver	TestelDroid monitoring
TACS4 Performance Tool	Instrumentation library

Facts			
Company:	Soluciones Cuatroochenta		
Coordinator:	Mr. Víctor Meliá	**Company Mission:**	solving optimization challenges and improving performance through technological development in companies
Duration:	01/12/2018 - 31/12/2018		

Experimenter's Impression:

"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".

TRIANGLE: 5G Applications and Devices Benchmarking

Experiment Overview

Behaviour test of Solbyte applications in Pre-5G Environments

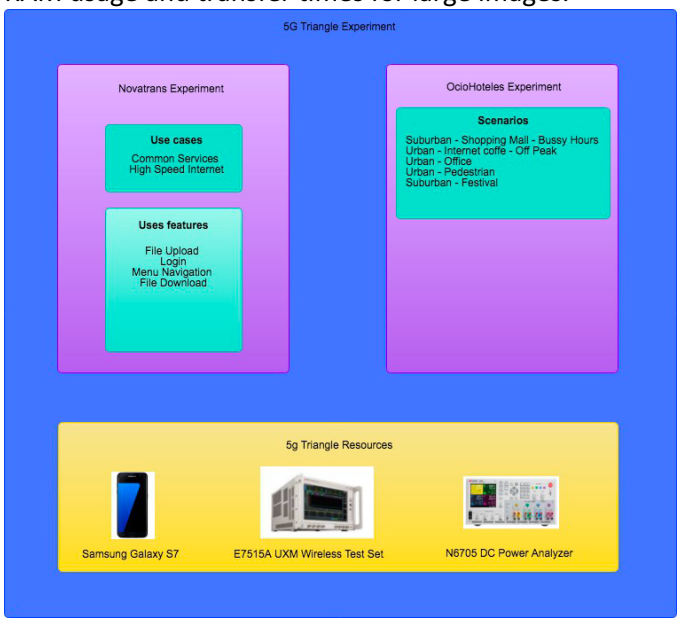
Motivation – to test the performance of two mobile applications (Novatrans Conductors and OcioHoteles) under different network conditions and to monitor the impact of network performance on User Experience and on battery life.

Key Objectives

There were two objectives for the experiment:
1) To evaluate the impact on battery life of network conditions on the Novatrans Conductors app.
2) Evaluate how higher bandwidth could improve the User Experience on the OcioHoteles app

How Does It Work?

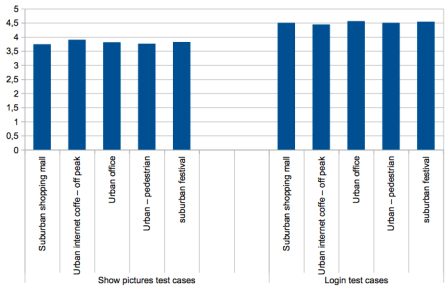
Each experiment measured important metrics corresponding to a set of KPIs in the experiment including energy consumption during GPS use, CPU and RAM usage and transfer times for large images.



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

Key Results

Both applications have obtained the expected results for common tasks and large file transfers with the apps adapting well to changes in the network.



App improvements already made as a result of testing:

- Novatrans - An improved UX and extended battery life so a full working day is possible on a single battery charge
- OcioHoteles improved UX under different connectivity scenarios

Testbed Components Used

UXM RAN Emulator	TRIANGLE Web Portal
Quamotion WebDriver	Instrumentation Library
TACS4 Performance Tool	Android UEs

Facts			
Company:	Solbyte	SOLBYTE Servicios Informáticos	
Coordinator:	Mr. José Antonio Herrada Calvo	**Company Mission:**	providing digital transformation to smart city infrastructure, manufacturing, energy, and mobility industries
Duration:	01/10/2018 - 21/12/2018		

Experimenter's Impression:

"Thanks to the experiment I conducted within Triangle I was able to know better my developments than I already knew them."