

# 5G-SOLUTIONS

## Analysis of Living Labs and KPIs definition methodology

Ioannis Markopoulos

Director, Innovation & Project Management Department  
Forthnet S.A.  
Athens, Greece  
jmarkopo@forthnet.gr

Andrea Di Giglio

Researcher  
Telecom Italia  
Turin, Italy  
andrea.digiglio@telecomitalia.it

Matteo Grandi

Project and Innovation Manager  
IRIS Technology Solutions S.L.  
Barcelona, Spain  
mgrandi@iris.cat

Silvia Canale

Researcher  
Applied Research to Technologies  
Rome, Italy  
silvia.canale@ares2t.com

Sofiane Zemouri

Research Scientist  
IBM  
Dublin, Ireland  
Sofiane.Zemouri1@ibm.com

Baruch Altman

AVP, CTO office  
LiveU  
Israel  
Baruch@liveu.tv

Håkon Lønsethagen

Senior Research Scientist  
Telenor Research  
Oslo, Norway  
hakon.lonsethagen@telenor.com

Angelos Antonopoulos, Christos Verikoukis

Centre Tecnològic de Telecomunicacions de Catalunya  
(CTTC/CERCA)  
Barcelona, Spain  
{aantonopoulos, cveri}@cttc.es

**Abstract**— The scope of this paper is to provide an analysis of the 5G-SOLUTIONS Living Labs (LLs), the associated use cases, as well as the requirements and the target Key Performance Indicators (KPIs) definition methodology that will set the benchmarking for the actual measurements.

**Keywords**—Living Lab (LL); Use Case (UC); Key Performance Indicator (KPI); Enhanced Mobile Broadband (eMBB), Low Latency Communications (URLLC), Massive Machine Type Communications (mMTC)

### I. INTRODUCTION

5G-SOLUTIONS is a 5G-PPP project supporting the EC's 5G policy by implementing the last phase of the 5G-PPP roadmap. It aims to prove and validate that 5G provides prominent industry verticals with ubiquitous access to a wide range of forward-looking services with orders of magnitude of improvement over 4G, thus bringing the 5G vision closer to deployment. This will be achieved through conducting advanced field-trials of innovative use cases, directly involving end-users across five significant industry vertical domains (LLs): Factories of the Future, Smart Energy, Smart Cities, Smart Ports, Media & Entertainment. 5G-SOLUTIONS LL analysis is dependent on usability needs. The project aims at capturing the requirements from the end-user stakeholders, as well as the relevant target technological and business KPIs,

which will be validated in the LLs. This outcome will feed other critical tasks and point out the technological enablers for facilitating the execution of the field trials. To this end, the use cases will be validated towards their conformance to target 5G KPIs, service types i.e. eMBB, URLLC and mMTC as well as their business potential, ethical and social acceptance. This paper defines the initial version of the LL analysis, in order to prove and validate that the 5G technology can provide prominent industry verticals with ubiquitous access to a wide range of forward-looking services with orders of magnitude of improvement over 4G. In the forthcoming section the 5G-SOLUTIONS living labs are analyzed as well as the methodology to define the respective technical and business KPIs [1].

### II. LIVING LAB 1: FACTORIES OF THE FUTURE (FOF)

To enable the execution of representative FoF use cases, the approach will involve both horizontal and vertical slicing. Horizontal slicing involves computational offloading, e.g., Multi-access Edge Computing (MEC). It addresses the diverse network capacity and latency requirements due to the huge numbers of sensors, other networked devices and time-critical applications. It requires over-the-air resource sharing across network nodes and, as such, the 5G air interface will be an appropriate enabler. For vertical slicing, which entails separate

virtual networks within the 5G network, technologies at the air interface, RAN will be setup and configured. The use cases identified in the context of the FoF LL are: Time-critical process optimization inside digital factories; Non-time-critical communication inside factories; Remotely controlling digital factories; Connected goods; Rapid deployment, auto/re-configuration and testing of new robots.

### III. LIVING LAB 2: SMART ENERGY

The Smart Energy LL targets three use cases referring to the broad area of Demand Side Management (DSM). DSM refers to the changes in electricity use by consumers from their normal consumption patterns in response to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. In a broader sense, DSM also embeds the topic of overload avoidance and optimal self-consumption, in those scenarios where the peak power affects the energy bill, and local Renewable Energy Sources (RES) have an impact on the net power withdrawn from the grid. The Smart Energy LL use cases are: Industrial Demand Side Management; Electrical Vehicle Smart Charging; Electricity Network Frequency Stability.

### IV. LIVING LAB 3: SMART CITY AND PORTS

The use cases to be validated in this Smart City and Ports LL include the following: Intelligent street lighting; Smart parking; Smart city co-creation; Smart buildings – smart campus; Autonomous assets & logistics for smart port; Port safety: monitor & detect irregular sounds. Through the use of digital and telecommunication technologies, traditional networks and services become more efficient for the inhabitants, business' and ports benefit. It is estimated that 50 billion devices will be connected to mobile networks by 2020, while a large proportion of communications will occur between machines and not humans. In this respect, 5G supporting mMTC, eMBB, URLLC, virtualization and slicing will be able to respond to the smart cities and ports needs of the future.

### V. LIVING LAB 4: MEDIA & ENTERTAINMENT

The uses cases identified in the Media & Entertainment LL are: Ultra High-Fidelity Media; Multi CDN selection; On-site Live Event Experience; User & Machine Generated Content; Immersive and Integrated Media and Gaming; Cooperative Media Production. Taking into account that media is the main, volume-wise, traffic type being delivered by cellular networks, the new 5G networks will play a major role in media contribution and distribution. Media uplink and downlink delivery must be transparent in different levels in order to enable universally adopted media delivery protocols and workflows and to maximize networks efficiency, avoiding overheads and excessive messaging. Target devices include regular smartphones, VR/AR glasses, TV sets, public displays, as well as in-car entertainment systems (which are expected to gain an increasing role in the advent of autonomous driving).

### VI. LIVING LAB 5: MULTI LIVING LAB

An additional LL, aims at testing vertical concurrent usage of eMM, mMTC & URLLC. It leverages, combines and

executes in a combined and concurrent manner a subset of use cases previously described, whose target KPI requirements (i.e., high throughput, low latency, high density of devices) fall under such classes of service.

### VII. METHODOLOGICAL FRAMEWORK

In 5G-SOLUTIONS, we provide a framework to map collected requirements and KPIs from use cases arising in five LLs into consolidated 5G-PPP service types. Beyond the previously defined KPIs, new KPIs are defined and tested within 5G-SOLUTIONS according to different business needs and UC flows. 5G-SOLUTIONS methodology enhances KPIs definition considering additional resources that further analyze specific-vertical KPIs as such resources have become available over time. KPI definition methodology carefully considers context information to ensure proper comparison across experimentation and testing campaigns, taking into consideration devices, applications, traffic load, and where relevant multi-slice concurrency. This will ensure reproducibility and benchmarking comparison across testing facilities. In addition, the project focuses also on defining and analyzing business KPIs for the verticals associated with the technical ones.

### VIII. CONCLUSIONS

5G-SOLUTIONS analyses all LLs, within the project's scope, which are expected to shape the future of 5G networks and applications. This analysis resulted in identifying the stakeholders and the roles of those in each UC, the objective of each UC, the requirements from the stakeholders, the technical and business KPIs and the required targets of those KPIs and the measurements that have to be taken. The use case analysis has taken into account the most recent recommendations on the 5G use cases and KPIs from the 5G-PPP perspective. The classification of the use cases based on the 5G-PPP recommendations has also shaped the recommended methodology for identifying the use case requirements and relevant KPIs.

The identification of the use case requirements as well as the technical and business KPIs is a stepping stone for the project, since it feeds other critical tasks, and points out the technological enablers for facilitating the execution of the field trials. To this end, the use cases will be validated towards their conformance to target 5G KPIs, as well as their business potential, ethical and social acceptance.

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### REFERENCES

- [1] D1.1A - Definition and analysis of use cases/scenarios and corresponding KPIs based on LLs (v1.0)