

Summer 2019

EURESCOM message

The magazine for telecom insiders

CELTIC News 1/2019



5G Trials and Experimentation

The Kennedy perspective
No man is an island

Events
5G trials workshop at ICC

A bit beyond
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Dear readers,

The year 2019 is crucial for the development of 5G worldwide. That is particularly true for Europe, where network operators are bidding for 5G spectrum licenses and preparing for the rollout of 5G networks. At the same time vertical industry players are working on 5G-based applications and services in areas like smart cities, factories of the future, and automotive. With billions of devices joining the network, 5G will reach unprecedented levels of complexity. And that is the reason why 5G trials and experimentation are of high importance for the success of 5G.

In Europe, the 5G PPP programme is reaching a decisive phase, as a number of vertical trial projects have started in June 2019. The editorial team decided that this the perfect time for a cover them on 5G trials and experimentation.

In this issue of Eurescom message, we will shed light on 5G trials and experimentation and present insights from leading European researchers in this area.

The cover theme features articles on 5G trials and experimentation with a focus on Europe. The first article explains how 5G infrastructure project 5G EVE is meeting the requirements of verticals. In an article from Telenor, the coordinator of 5G-VINNI, another 5G infrastructure project, presents the work of his project. The next article presents 5GENESIS, yet another 5G infrastructure project. In an exclusive interview, Didier Bourse from Nokia explains why Europe is strong in 5G research, development and trials. In the next article, we present another 5G infrastructure project, 5GINFIRE. Finally, you will learn about 5G-related satellite research in the article about ESA project SATIS5.

This edition of Eurescom message also includes a variety of further articles on different, ICT-related topics. See, for example, the new opinion article by Eurescom director David Kennedy on the good sides and bad sides of being a

data-sharing digital citizen in his column "The Kennedy Perspective". See also our "Events" section, which covers two 5G-related workshops. Finally, in the latest "A bit beyond" article you can learn about the unhealthy side effects of a social media phenomenon.

My editorial colleagues and I hope you will find value in this edition of Eurescom message, and we would appreciate your comments on the current issue as well as suggestions for future issues.

Milon Gupta
Editor-in-chief





EVENTS CALENDAR

17 – 18 June 2019

7th Global 5G Event

Valencia, Spain

<https://www.7thglobal5gevent.eu>

18 – 21 June 2019

EuCNC 2019

Valencia, Spain

<https://www.eucnc.eu>

24 – 28 June 2019

NetSoft 2019 – IEEE International Conference on Network Softwarization

Paris, France

<http://netsoft2019.ieee-netsoft.org>

2 – 5 July 2019

SPAWC 2019 – IEEE International Workshop on Signal Processing Advances in Wireless Communications

Cannes, France

<http://www.spawc2019.org>

19 – 24 August 2019

ACM SIGCOMM 2019

Beijing, China

<http://conferences.sigcomm.org/sigcomm/2019/>

5 September 2019

EUREKA Stakeholder Conference – Creating Ecosystems for Innovation

Amsterdam, Netherlands

<https://english.rvo.nl/news/events/eureka-stakeholder-conference-creating-ecosystems-innovation>

30 September – 2 October 2019

IEEE 5G World Forum

Dresden, Germany

<http://sites.ieee.org/wf-5g>

9 – 13 December 2019

IEEE GLOBECOM

Waikoloa, USA

<http://globecom2019.ieee-globecom.org>

SN@PSHOT





Robot anchor

In April 2019, Russian state news channel Rossiya 24 introduced a robot presenter to anchor some of its newscast. At this time, 'Alex' could only move his facial features and neck. However, the final robot is supposed to have fully mobile limbs as well.

Production of the robot began in 2017 and should be completed by the end of 2019, according to its Russian development firm Promobot. The robot's silicon head is modelled on the face of Promobot's co-founder Alexei Yuzhakov. Reception by the TV audience was ambiguous, with some viewers mocking the uncanny appearance of 'Alex'.



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No man is an island

But he might have to be a digital island



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When John Donne lay in his bed quite ill, he heard the church bells ringing for funerals and wondered who had died. But as the days went by he realised that he should “never send to know for whom the bell tolls: it tolls for thee” in that we will all eventually die. In considering this, he realised that in life, we have many impacts on others, some small and seemingly trivial, some major and lasting and we at the end have actually no real idea of how much we have influenced the people around us.

Today the digital world has opened up a tremendous communications sphere, where the things we say and do can have a disproportionately large effect, if they “go viral” as it is currently described. However, as we progress into the era of big data and large-scale analytics, it may just be that our unseen and unnoticed contributions to the data pool will quietly contribute to making the world a better place for all.

A good digital citizen

Today I saw a sticker on the back of a car saying: “Don’t take your organs to heaven as they are needed here”. In some ways this is the digital philosophy that we need to capture. The world was very quick to jump on the data protection crusade, and that is not totally wrong. But what if our data can help someone else? Do we have the right to prevent use of our data when it is of clear benefit to the community?

For example, after the Tsunami in Japan, data from navigation systems was put in the public domain, and very quickly a map emerged of the roads that were passable and where travel was not possible. This could not have been done without accessing many individuals’ private location information. But when done in a correct way, the greater good of accessing that information was clearly a massive benefit to the community.

Similarly, if I have received a medical treatment that has worked wonderfully and allowed me to fully recover, this information should be added to the community knowledge base to



complement the information from the drug suppliers about their trials. It may be that deeper analysis from real world use data will identify better the limitations and the variations that occur in the application of the treatment.

Given these types of community benefits, we should all be open to sharing the relevant parts of our data without sharing the intimate parts. But can we trust the system?

The abuse of a good digital citizen

It is well known that we, as a collective species, are easily influenced. For years the supermarkets caused many family wars by stacking the checkouts of the supermarkets with sweets that we were forced to look at for minutes on end as we waited for our turn to pay for our food. No self-respecting under-seven-year-old could resist asking for the sweets, and most three-year-olds were happy to scream for them. Starbucks stack the cookies beside the till for the same reasons to tease you into an additional purchase. But today the influences are more subtle. Have you noticed that a store smells nice? Did you notice it before or after you bought the coffee?

Digitally we can be influenced as well. Voting for Trump and voting for Brexit were just two examples of scenarios that were affected by targeted propaganda. Propaganda is nothing new. Actually propaganda started out as discussions in ancient Athens that were supported by theatre presentations that promoted one or other political views. It continued through the middle ages as “propagating” the good message of the church(es). But by the time of the European wars, propaganda was officially a weapon being used to subversively influence actions and reactions.

Unfortunately the digital world has become a hotbed of false information – some spread maliciously, but a lot spread by people who just want to believe ill of others. There is a wonderful example of the anti-Europeans referring to the Lisbon agreement as a charter of evil against the European people doing the rounds. It is total rubbish, but it is very hard to counter it, as the people

who share it will only believe what they were told and will not read it for themselves.

This brings us to the major challenge of the digital world – how to meet the people whose views differ from yours. I think Brexit is the greatest act of self-harm that a few have managed to inflict on the many since Eve ate the apple. However, as I only meet the cosmopolitan people from the UK who work in European initiatives, I don’t actually meet any of the Brexit ultras, so my view of them is formed by what they publish – and that is not good.

Back to the digital island

So now I know what I want, I want a communications sphere where the extremists of all shapes and sizes are correctly identified and labelled as such. Maybe future AI systems can provide the correct identification of these – not by how people characterise themselves, but by how their actions and words present them. The truth filter might be the most important and useful AI application for the next 100 years.

The AI system should also be a filter of anti-social material so that the origins of bad material – from hate speech to bomb making – are identified and excluded. We’ve got to stop the modern “equality” idea that uneducated and stupid views are entitled to be given the same airtime and platform to challenge scientifically proven facts. I may lose some “flat earth” or “anti-vax” acquaintances for denying them the right to spread untruths, but they were fed such false information in the first place, so we have to break the circle somewhere.

It will be a sad reflection on society, if the main impact of the advent of the communications age is to stimulate the return of the plagues and diseases of the middle ages. Not on my digital island please.

The 5G EVE platform

Site facilities designed for validating vertical demands on 5G



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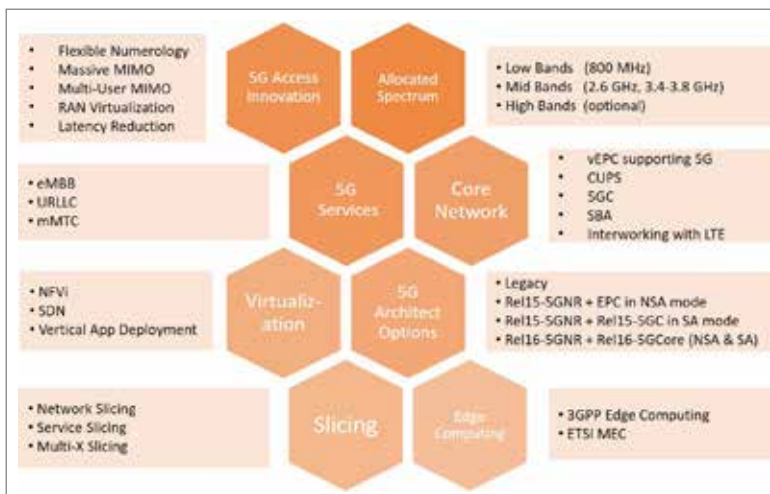


Figure 2: 5G EVE Platform 5G Capabilities

The market of 5G services will be built around the needs and demands of key vertical industries operating in very different and heterogeneous areas, from Industry 4.0 to public utilities, smart cities and smart transportation. The imminent market launch of 5G services calls for a solid and extensive basis of prior trials, validation tests and measurements at site facilities which deliver an end-to-end 5G service chain and enable the reproduction of different live network operation conditions. 5G EVE is a 5G PPP project under Horizon 2020 (ICT-17), which does exactly that. 5G EVE has taken on the challenge of implementing a multi-site 5G validation platform for that type of purpose. The platform will enable timely and advanced 5G validation services for innovative use cases of different vertical industry sectors.

Motivation

We are currently at a turning point, where the usability of 5G is being demonstrated and its success or failure determined. The worlds of vertical industries embracing digital transformation and the ICT industry ecosystem launching 5G need to be bridged on both technical and business levels to foster competitiveness of all industries in Europe.

In this context 5G EVE aims to implement a platform with open, easy-to-use, trustworthy and smart tools, which enables innovative European verticals and SMEs to validate their 5G-ready applications and systems. The project will do so by offering to all 5G experimenters a 5G end-to-end facility, which enables them to validate the performance of their 5G-ready solutions, based on standard KPIs, prior to the commercial roll-out 5G networks.

cluding verticals involved in new 5G PPP projects (ICT-19), which are planning to join the 5G EVE innovation ecosystem.

Approach

In the 5G EVE framework (figure 1), 5G EVE's integrated portal for 5G experimentation and validation, which includes interworking capabilities among trial sites, acts as the major technical interface between verticals and the 5G world. The portal delivers the following two essential benefits for the 5G validation plans of verticals:

- Beyond enabling the access to the necessary 5G technologies and systems in continuous evolution, 5G EVE will support verticals with a **comprehensive, open and easy-to-use toolbox for simplifying their whole process of validation** of their 5G-ready applications, from needs/intent to results/exploitation readiness.
- Besides offering the possibility to perform those validations activities with one trial site of choice (Italy, France, Spain, Greece), 5G EVE will support verticals with advanced interworking features **allowing verticals to flexibly carry out validation activities in a homogeneous way at any 5G EVE site, or even involving several 5G EVE sites within the same test case, whenever required.**

5G EVE platform capabilities

The 5G EVE project evolves and interconnects four existing European sites located in Italy, France, Spain and Greece, where the key 5G capabilities (see figure 2) are coherently deployed

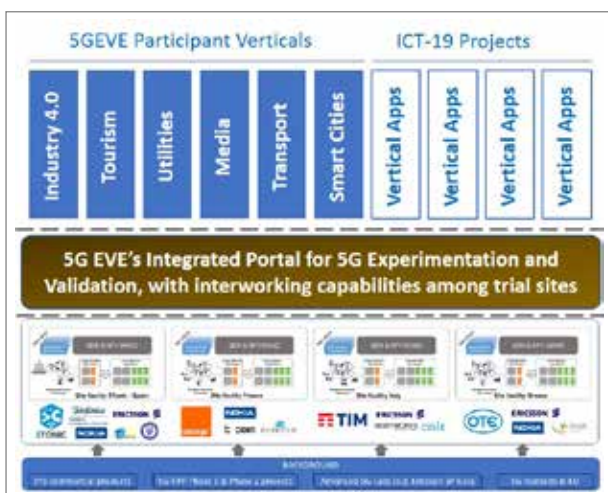


Figure 1: 5G EVE framework

From the project start, important representatives of European vertical industries have been directly involved as consortium members of 5G EVE, in order to assess and influence the design of 5G EVE's end-to-end platform and its services. 5G EVE will support the requirements of the verticals in the project consortium. Furthermore, 5G EVE's ambition is to create the common foundation for supporting a large variety of innovative verticals ready to carry out structured experimentation and validation tests, in-

and upgraded every sixth months at each 5G EVE site, according to a well-defined overall road-map.

The support of 5G new radio (NR), 5G Core, Virtualization, Slicing and Edge Computing provided at the 5G EVE sites translates into the best guarantee for verticals not only for executing their test cases over a real, yet controlled full-chain 5G environment, but also for extracting reliable conclusions related to 5G performance, which can anticipate that of the standard 5G environments and configurations where those vertical applications will be launched commercially.

The 5G EVE roadmap outlines an implementation of Release 16-compatible technologies in the four sites, starting from the evolution of current Release 15, and also leveraging and combining with legacy and evolved 4G technologies deployed in each site.

Verticals in the driving seat of 5G EVE platform

The 5G EVE project takes a step forward with a decisive focus on designing, implementing and offering key value-added features for Verticals performing E2E validations tests, including:

- intent-based APIs, which enable specifying experiments in high-level terms, in order to abstract the complexity of the underlying infrastructure.
- an advanced framework for KPI collection, monitoring and analysis, to simplify the evaluation of network KPIs and their influence on vertical service behaviour under different conditions.
- site interworking and multi-domain and multi-technology (multi-x) slicing/orchestration mechanisms.

Basically all that vertical experimenters planning to use the 5G EVE platform are asked to provide is a set of standard 5G network KPIs, and the minimum expected performance level for each of them, which influence the behaviour of their applications and devices according to their business needs. Figure 3 illustrates an example of the KPI levels in regard to expected network performance by the application. KPI levels are charted on a radar map that also shows the standard maximum levels of support of both 4G and 5G for each KPI. 5G EVE offers verticals the means to formalise their network performance requirements and provides full support for the following KPIs, as defined by ITU for 5G networks: user data rate, peak data rate, capacity, E2E latency, mobility, reliability, availability.

By processing those performance requirements, and thanks to the flexibility of the deployments at 5G EVE sites, a number of test cases

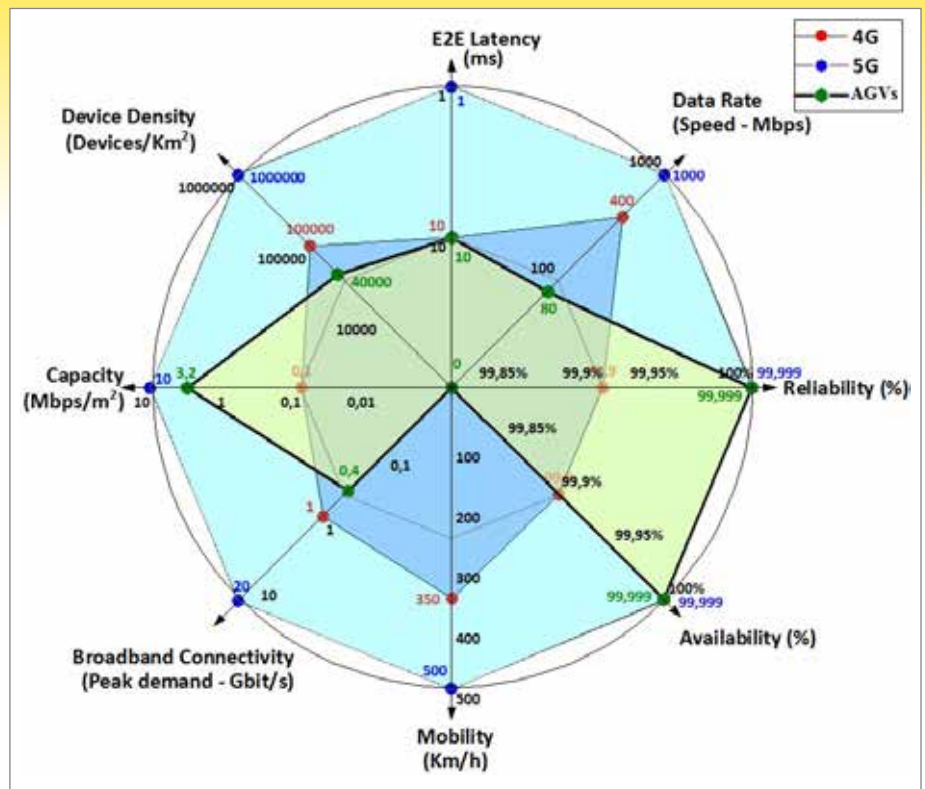


Figure 3: 5G EVE KPI radar example

relevant to each managed vertical use case are synthesized, and the environments are prepared for their execution. Then the use case is launched with the vertical according to the agreed plan, and finally all the data generated are gathered, analysed, and summarised for the vertical users.

At the end of the process the vertical shall have executed, functionally tested and fully characterised the performance of its early 5G-ready applications and devices under several conditions. This will enable the vertical to make a well-informed business decision on whether, when, where and how they can successfully launch their services over commercial 5G networks.

The 5G EVE project is still consolidating the suite of tools and innovations required to simplify and automate the above-mentioned process. From January 2020 on, larger-scale validations tests can be performed, and a broader scope and number of vertical can benefit from the platform. Meanwhile the process is already available and run in semi-automated fashion with our six verticals in the 5G EVE consortium. This gives them access to early inputs and allows for improving the development of the 5G EVE framework based on early feedback by its users.

In order to complete the picture of 5G EVE's value-added services, it is worth mentioning the possibility to compose, deploy and execute use cases and test cases in a homogeneous way at any 5G EVE site, and also at several 5G EVE sites in a coordinated way. This feature of the 5G EVE

framework is a key objective of the project and a differentiating factor for our validation platform, which enables a wider range of applications and test scenarios.

Conclusions

In summary, 5G EVE implements a platform equipped with the latest advancements on 5G technologies. The project offers a framework of value-added features for extensive validation tests to be performed by verticals in a simple and effective way. Thus, 5G EVE will enable verticals to achieve results of maximum reliability for supporting business decisions.

The 5G EVE project benefits in this mission from the inputs and feedback of six industry verticals, who are already accessing the sites for carrying out early validation tests. In the near future 5G EVE will consolidate the automation of its framework by completing the deployment of 5G capabilities and opening new collaborations with vertical use-case projects from phase 3 of the 5G PPP ICT 19, which are scheduled to start in June 2019.

➤ **Further information** is available on the 5G EVE website at <http://www.5g-eve.eu>

5G-VINNI

Design of 5G end-to-end facility for performance evaluation and use case trialling



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A focus area of phase 3 of 5G PPP is the design and deployment of a 5G end-to-end facility, which can demonstrate that the key 5G network KPIs can be met, and which can be accessed and used by vertical industries. In this article I present key guidelines to implement 5G-VINNI, a 5G end-to-end facility.

5G aims to significantly improve the capabilities of network infrastructure in terms of the supported key performance indicators (KPI). The telecommunications industry has aligned itself to a number of KPIs, including "1000 times higher mobile data volume per geographical area", "10 to 100 times more connected devices", "10 times lower energy consumption" and "end-to-end latency of less than 1ms" [1]. The 5G network will be a key asset to support societal transformation, societal cohesion and sustainable

development by empowering the vertical industries. In a number of white papers and publications the 5G PPP has described use cases and requirements of several vertical industry sectors, such as automotive, e-Health, energy, entertainment, manufacturing and others [2]. Achieving the above ambitions will be demonstrated based on an end-to-end (E2E) experimental 5G network, which is being designed and deployed taking advantage of the latest network research and innovation technologies and concepts.

Herein, I present key guidelines to implement a 5G E2E facility that is composed of several interworking 5G sites. I use the term *5G end-to-end (E2E) facility* to denote a unified set of network, compute and storage resources providing E2E services modelled according to 5G architecture [3]. I present the conceptual architecture of the 5G E2E facility, identify the main technological areas of consideration for building it and introduce the testing framework to validate KPIs and enable verticals to trial use cases.

Conceptual architecture for E2E facility

Figure 1 depicts the conceptual E2E facility architecture and highlights the key elements. The various building blocks are organized in three levels;

the *Service Level*, *Network Level* and *Resources and Functional Level* as described in [3].

The *Resources and Functional Level* of the E2E facility are comprised of the Radio Access Network (RAN), Backhaul, Mobile Core and Cloud Computing facilities. They provide the physical resources to host the *Service Level* and *Network Level* elements such as the Virtual Network Functions (VNFs). These are interconnected to build dedicated logical networks, customized to support enhanced Mobile Broadband (eMBB), Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communication (mMTC) services.

The requirements derived from the diversity of the use cases and possible configurations introduce a whole new set of intra- and inter-domain interworking issues. Their resolution is currently being addressed in various Standards Developing Organisation (SDOs) and there is a pressing need for harmonization and validation under realistic conditions. The *Service Level E2E Facility* shall be the reference environment in which this validation can take place, using agreed test plans. The *Service Level E2E Facility* is an implementation of the Network and Service Management and Orchestration Plane defined in the 5G Architecture [3].

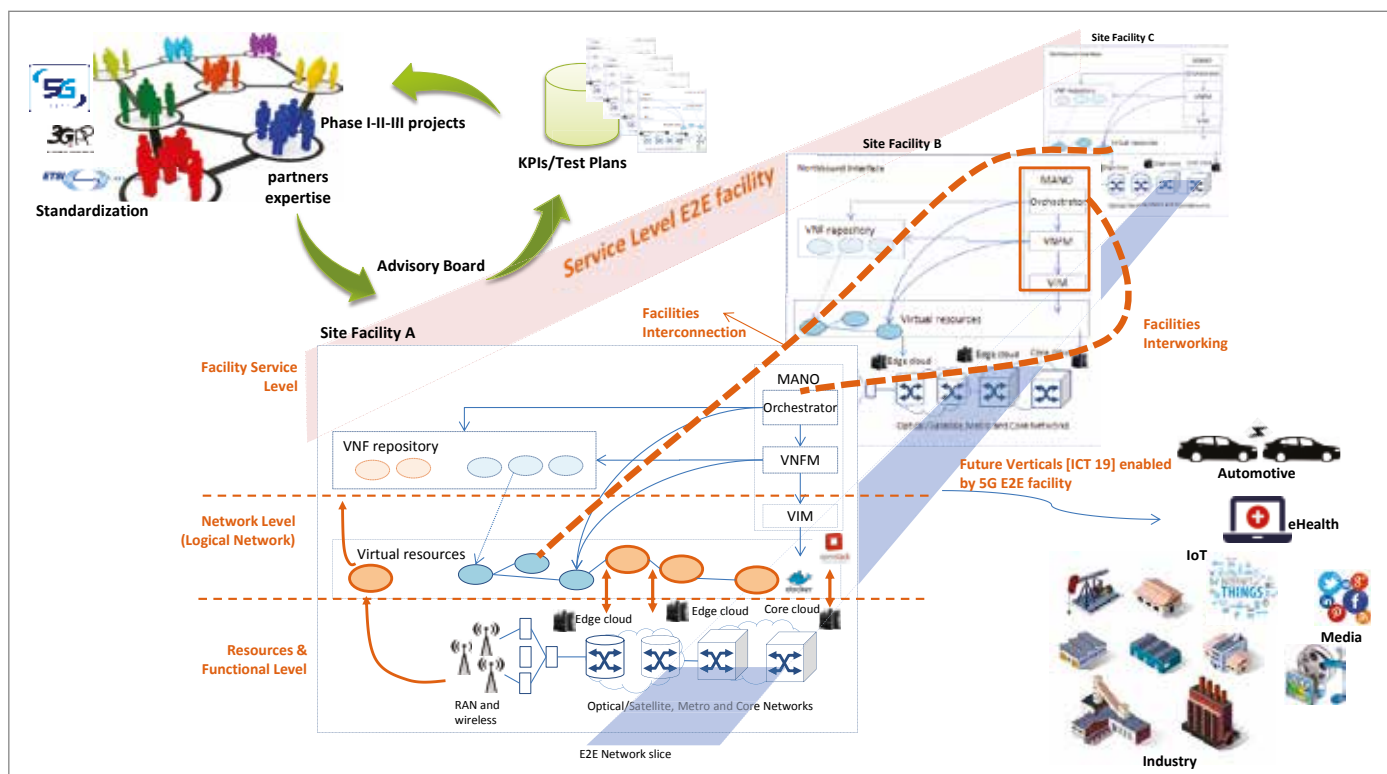


Figure 1: Conceptual Architecture for 5G-VINNI

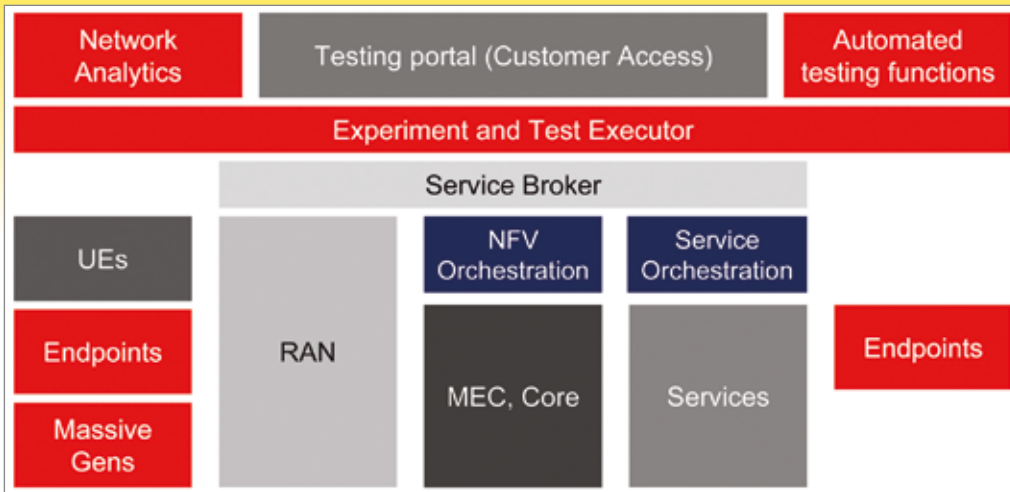


Figure 2: 5G-VINNI Testing Framework

Technological areas

The main technological areas of consideration for building the 5G E2E facility are listed herein. Each of these areas presents its own technological challenges.

- 5G radio access
- Reliability enhancements for urban Vehicle-to-Everything (V2X) communication
- Internet of Things (IoT) data fabric functions embedded into network slices
- E2E network service orchestration
- Edge computing support and IoT Edge slicing capabilities
- Satellite integration with 5G
- 5G network KPIs measurements and evaluations
- E2E slicing implementation and management
- Emergence of new business models – ecosystem

Testing capabilities of the E2E facility

An advanced and radical step in networking an envisioned for 5G requires similarly advanced testing capabilities. Figure 2 illustrates the testing framework and its functional blocks. These are overarching across the entire facility and are based on the presence of an *Experiment and Test Executor* layer for connecting to the appropriate infrastructure components via open APIs.

The execution of internal validation campaigns, as well as the vertical customer experiments, should be run through a user-friendly Testing Portal, which will be the point where tests are configured, test campaigns are executed, and campaigns results are visualized and analysed.

The combination of a comprehensive test framework, the multiple inter-working 5G RAN and 5G core infrastructures, and zero-touch E2E service orchestration provide a unique platform for performance testing and for trialling industry use cases. The platform facilitates the rapid on-

boarding of verticals by exposing network slice life-cycle management functions through open APIs. By using the APIs, the verticals will be able to create, manage and de-commission network slices. This will offer a high level of agility in the management of connectivity services and will allow verticals to shorten their innovation cycles, quickly establish network connectivity for E2E communication services and apply different test scenarios to the connectivity using the testing portal in order to evaluate the impact upon their E2E communication services.

The testing capabilities of a facility in the scope of the new 5G infrastructure must address the following areas:

- 5G-specific test methodology encompassing test cases from component integration to E2E performance tests, including benchmarking,
- test cases that can be recognized as industry reference for 5G network validation and testing,
- detailed test plans for validation of 5G network KPIs via execution of test campaigns,
- develop, deploy, and maintain an industry reference testing framework and infrastructure,
- validate customers' use cases by customizing and executing suitable test campaigns.

Conclusion

The role of a next generation operator is evolving and the current industry trend has bound this role with the capabilities and performance of the new 5G network infrastructure. Hence, all main operators world-wide are establishing private and public trial infrastructures to better understand the impact of this paradigm shift in providing network services to customers.

It is this rationale that inspires the 5G E2E facility to take a number of emerging 5G technologies and introduce them into infrastructure instances to prove that the practical implementation of 5G networks is possible while meeting the 5G

PPP network KPIs. It endeavours to demonstrate that the cumulative capabilities of the 5G innovations, such as Network Slice as a Service, Network Function Virtualization, new Radio Access Networks and Zero Touch Management will make the complex 5G infrastructure reliable, usable and deliver the expected performance. 5G will be unique in that new customer and service provider roles are emerging. These new roles require that all management information and open interfaces are designed and implemented with performance, reliability, security, and flexibility in mind to meet all service requirements. Showcasing the capabilities of the facility will help to unleash and accelerate the industrial advancement and uptake of 5G by demonstrating that 5G works and is fit for the services.

Acknowledgement

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“Europe is strong in 5G research, development and trials”

Interview with Didier Bourse from Nokia on 5G trials

Currently there are plenty of 5G trial activities going on in Europe. They include end-to-end platforms for 5G trials and a new set of 5G trial projects involving verticals. Eurescom message editor-in-chief Milon Gupta asked someone who should know about the progress and expected benefits of these activities – Didier Bourse. He is Senior Director for European R&I Programs at Nokia and chairman of the trials and experimentation working group within the 5G Infrastructure Association.

What types of 5G trial activities are currently performed in Europe?

There are many 5G trials and pilots activities in the EU. Some are already completed, some are currently on-going and some are due to start in the near future. One great public reference for these trials and pilots is the EU 5G Observatory launched by EC in June 2018. The trials and pilots are clustered in categories related to the scale and dimension, 5G features and verticals use-cases. These trials leverage and utilize European research and the early 5G solution portfolio of leading vendors and manufacturers in the context of various use-cases and associated potential for economic growth. The 5G-IA Trials WG has also developed the 5G Pan-EU Trials Roadmap Version 4.0 released in November 2018. This document defined a clustering of the trials based on 4 categories from technological trial to pre-deployment cities. The category selection was based on the number of sites for the trials and the inclusion or non-inclusion of customers. Both the Observatory and the Trials Roadmap jointly analyzed in depth the EU 5G trials and pilots, including the number of 5G trials in the different EU countries. The Roadmap also summarized the key EU cities engaged at the forefront of 5G activities.

Which major results have been so far achieved in European 5G trials?

The core part of the 5G trials and pilots is and will remain private trials. Such private commercial and pre-commercial trials are performed between network operators and manufacturers/vendors and they increasingly involve vertical stakeholders. Such trials are an integral part of the European open ecosystem activities in both technology and business development dimensions. The European network operators have been working



Didier Bourse from Nokia

since 2016 with equipment manufacturers/vendors and vertical players on various tests and trials in order to validate 5G capabilities. They are now progressing towards the deployment phase and are performing tests under increasingly realistic conditions. By mid-November 2018, EU operators were heavily involved in 5G testing with already more than 105 trials and pilots reported in EU countries. The latest figures in the Observatory highlight more than 150 trials and pilots, with verticals use-cases and applications mainly addressing media and entertainment, transportation, automotive, industry, smart cities and health.

How well synchronised are the currently ongoing activities?

In addition to the pre-commercial and commercial trials, there are also many activities at EC level and national level to boost EU 5G trials and pilots. These activities are supported through specific programmes and projects, with a clear focus on verticals sectors and use-cases. In the context of the EC H2020 5G Infrastructure PPP, the Phase 2 projects are engaged in 63 experiments, trials and pilots in 38 cities, as reported in the Roadmap Version 4.0. The PPP Phase 3 ICT-17 E2E Platforms projects started in July 2018, the ICT-18 Corridors projects started in November 2018 and the ICT-19 Verticals Pilots projects starting in June 2019 are clearly boosting these trials and pilots. The new areas considered are extended 5G features and many different verticals use-cases. Activities are synchronized between EC and Member States in the context of

the EC 5G Action Plan (5GAP) and also clearly benefit from the catalyser role of the 5G Infrastructure Association (5G-IA), which is developing specific MoUs with key verticals associations like 5GAA for Automotive and 5G-ACIA for Industry 4.0. Expanding the point highlighted by the EATA Manifesto in the Automotive domain, Europe needs a stronger systemic approach on 5G and the different verticals sectors, combining telecommunications and vertical needs and innovation. Increasing focus, linking innovation and policy frameworks as well as accelerating cooperation and leveraging international experience are essential for achieving global market leadership.

To what extent are vertical industries involved in 5G trials?

Verticals stakeholders are more and more engaged in the different 5G trials and pilots, both in the pre-commercial and commercial domains and in the EC and national programmes. This is well in line with the increased level of engagement by verticals in 3GPP standardization activities on requirements and system architecture level. The clear target is to validate the benefits of 5G to vertical sectors, proving feasibility of specific use-cases and also de-risking potential specific issues in order to create a path to successful and timely 5G deployment in Europe, passing the break-even points to ensure full adoption of the 5G technology. The EU 5G strategy is clearly targeting large scale adoption of 5G by vertical sectors, as already stressed during Mobile World Congress 2016. Concerning the EC 5G Infrastructure PPP programme, the Verticals Cartography webpage summarizes the key up-to-date information on these trials and pilots. This cartography will be further developed in the third quarter of 2019 with the latest up-dates related to the ICT-19 Verticals Pilots projects.

What are currently the most challenging trials involving verticals?

Trials and pilots address many different verticals use-cases and demonstrate specific features and capabilities. To highlight one (among many others) there is a very challenging and far ranging 5G trial led by the Hamburg Port Authority, combining many aspects of future smart cities. This work is associated with the 5G Infrastructure PPP project 5G-MoNArch and won the GSMA MWC

2019 “5G Industry Partnership Award” for “first large scale industrial commercial 5G trial”. Several EC and national projects also address 5G test corridors and Connected and Automated Driving (CAD). Automotive and Industry 4.0 are clearly considered as 5G flagships use-cases in the EU. The 5G test corridors are expected to pave the way for the future 5G deployment corridors to be possibly boosted in the context of the EC Connecting Europe Facility (CEF2) programme (2021-2027).

How well do emerging technologies meet the 5G KPIs according to the available trial results?

5G technologies clearly deliver on promises to reach the targeted specifications on 5G performance KPIs like data rate, latency, density, coverage, reliability and, as importantly, the benefits that come from flexibility and automation. Most of the initial trials and pilots targeted the demonstration of high data rates and low latency communications performance, focusing on enabling technologies related to the radio interface like high throughput, millimetre-waves and other new wide spectrum bands, antenna technologies..., the network architecture including virtualization, cloudification, network slicing, edge computing...

and the introduction of new technologies dedicated to specific use-cases like technologies for IoT and for the automotive sector. The trials and pilots are building on this initial work to more and more address verticals use-cases and related performance requirements.

How and when will the multi-million euro investment in 5G trials pay off?

Europe is strong in 5G research, development and trials. The initial targets specified in the EC 5G Action Plan are clearly on the right tracks. These targets include first the early 5G launch in selected areas in 2018, second the commercial launch of 5G services in at least one major city in all MSs in 2020 and third the uninterrupted coverage in all urban areas and along main transport paths in 2025. The trials and pilots play a key role on the path from research and innovation to pre-commercial and commercial deployment. This is also clearly worked out in tight connection with the overall standardization and regulatory 5G specification work. The latest updates on EU 5G readiness have been addressed during the EC Workshop “European 5G Observatory – Is Europe ready for 5G?” organized in May 2019 in Brussels.

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The 5GINFIRE Platform

A facility for end-to-end 5G experimentation



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5G is the next generation networking infrastructure with a strong focus on requirements of various vertical domains, bringing improvements on networking performance but also introducing new services and appli-

cations deployed in an end-to-end manner from the edge to the cloud. 5GINFIRE is an EU Horizon 2020 project that builds and operates an Open 5G NFV based ecosystem for experimentation tailored for vertical industries and 5G networking.

The 5G system has the ambition of responding to the widest range of services and applications in the history of mobile and wireless communications [1]. Addressing the question of how a platform can host and integrate verticals and concurrently deal with reconciling their competing and opposing requirements, requires operational 5G infrastructures that can host various vertical industries’ applications. A key issue is the lifecycle management of the verticals’ services by means of Virtualized Network Functions (VNF) deployment and programmability techniques. The technical objective of 5GINFIRE is to build and operate an Open, and Extensible 5G NFV-based reference ecosystem of experimental facilities that lays down the foundations of a standards-

based network substrate for instantiating fully softwareized architectures for vertical industries purposes.

Platform architecture

Figure 1 illustrates the 5GINFIRE conceptual architecture derived from the ETSI NFV reference architecture [2] and upstream open source projects. It depicts the major architectural areas and shows in a workflow manner the various interactions. Although not exhaustive, the conceptual architecture highlights the functionality that is required to integrate existing open source components and physical resources, following an automotive use case implementation as an example.

In Figure 1 an application is composed of services that are configured to offer this application. These services are further decomposed into virtual networking and vertical functions (VxFs) that are deployed at the corresponding points of presence in the infrastructure. The 5GINFIRE middleware communicates with the endpoints of the

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Dear readers,

As planned, the CELTIC-NEXT Cluster started its operations in January 2019. CELTIC-Next will issue two calls for proposals per year, one in spring and one in autumn. All information related to our calls and projects can be found on the CELTIC-NEXT Web site.

The start of CELTIC-NEXT was synchronous with the take up of the new function of Valérie Blavette, the new Chairperson giving CELTIC a new face. It is seen as a strong point that Valérie comes from a big European operator, Orange in France. Together with the two Vice-Chairpersons, Jari Lehmusvuori from Nokia and Riza Durucasugil from Netas and the entire CELTIC Core Group the European industries are very well represented. In her article on the view of the CELTIC Chair, Valérie explains how CELTIC-NEXT is evolving to support Europe's competitiveness. In March Valérie has also been elected by the EUREKA Clusters as the new inter-Cluster-spokesperson. She will take this additional function for one year, starting in July.

After the decision of Innovate UK in late 2018 to fund CELTIC projects we organised for the first time a CELTIC Proposers Day in the United Kingdom. It took place on 5th February in the prestigious building of Institute of Contemporary Arts in London. The clear goal of the day was to stimulate the UK community to participate in CELTIC projects. Very important for this is that the UK ICT community builds up a close relationship with the existing CELTIC communities from other EU countries. The Proposers Day gave some new insights on recent technological developments, provided information on funding opportunities and showed 12 new project Ideas. You can find more information about this event in the article "CELTIC Proposers Day in London".

Another highlight was the SENDATE Closing Event that took place on 27th March 2019 in Sweden. After three years the CELTIC flagship project SENDATE that targeted "secure networking of data centres in Europe" held its closing event. The 73 million euro project generated numerous new security technologies that resulted in new and improved products and it realised four world records. More than 100 high-level representatives from industry and public funding organisations participated at the event, which was held at Ericsson headquarters in the high tech city of Kista close to

Stockholm.

In this issue, you can also read about EGIS, the EUREKA Global Innovation Summit, which took place in Manchester on 14-16 May. CELTIC and the other six EUREKA Clusters jointly contributed with a large numbers of speakers to the success of this event. A highlight was the handover ceremony of the EUREKA Global Project of the Year Award 2019. Two CELTIC projects were among the 5 finalists for this prestigious price: the CELTIC flagship project SASER and one of the very first projects on SDN (Software Defined Networks), SIGMONA. Finally the EUREKA Global Project of the Year Award 2019 went to CELTIC project SIGMONA - read more about it under Events in the article about EGIS.

Another interesting event is coming soon: The CELTIC Event 2019 will take place in Valencia on 19-20 June, collocated with EuCNC. The programme includes keynote speeches, a panel on successful CELTIC projects, and an exhibition of CELTIC projects.

A brand new information is that the CELTIC Core Group will have two new members. The German companies ADVA and Bosch will strengthen the CELTIC Core Group and will contribute to generating new CELTIC projects.

In this edition of CELTIC News our start up story is a Spanish SME: Raul Herrero, CEO of Smart Health TV Solution, explains how his company achieved better access to telemedicine for the elderly. The company uses the innovative multimedia platform that was developed in CELTIC project E3 to eliminate the digital divide in telemedicine. Please have a look at his article.

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How CELTIC is changing to support Europe's competitiveness



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The first half of 2019 has seen significant changes at CELTIC, which reflect and support changes in the European ICT industry. First, the name of our EUREKA Cluster changed from Celtic-Plus to CELTIC-NEXT. Second, I took over the function of CELTIC-NEXT chairperson from Jacques Magen, who had done a great job for CELTIC since the Cluster was launched. And third, the scope of CELTIC has expanded.

The composition of the CELTIC-NEXT Core Group and management team shows how important our Cluster is for the European ICT industry. I am coming from a big European network operator, Orange, and the two vice-chairpersons are representing major equipment manufacturers – Jari Lehmusvuori is from Nokia and Risa Durucasugil is from Netaş.

Besides the personnel changes, the domain covered by CELTIC is undergoing dramatic changes, as the ICT domain moves towards a new era of very powerful infrastructures and immersive services that will change the way we live. Therefore many ICT companies and vertical industries are currently considering how they can adapt and accelerate the innovation process to stay competitive. This is where CELTIC-NEXT comes into the picture – the pressure to innovate means that there is an increased need for R&D activities in Europe, which transcends the bounds of the ICT sector.

Accordingly, CELTIC-NEXT will involve actors from the vertical sectors in the CELTIC Core Group who complement the ICT sector representatives. This will result in closer cooperation between telecom players and verticals in areas like smart industry, mobility, and health.

In addition to our Cluster, also EUREKA as a whole is changing. This is most visible from the way Clusters interact with EUREKA and how Clusters work together..

In the inter-Cluster meeting in March, CELTIC-NEXT has been elected to represent the Clusters during the Dutch EUREKA Chairmanship for one year from July 2019. I will assume the role of inter-Cluster chairperson with pleasure in these exciting times. The strengths of the Clusters with their huge industry communities are getting more and more attention in the whole EUREKA network and beyond. I am convinced that EUREKA will make an even stronger contribution to the European research landscape and the competitiveness of European industry in the near future.

New countries participating in CELTIC

Not only the topical scope, but also the regional scope of CELTIC is expanding. While everyone is talking about Brexit, the UK has decided to participate in our activities and fund CELTIC projects. I am optimistic that the first Proposers Day 2019, which took place in London on 5th February, will be the start of a long-lasting cooperation between Innovate UK and CELTIC. In our Spring call, we already got the first project proposals with UK participation. We are also working with the Canadian public authority and Canadian companies to extend cooperation within CELTIC-NEXT projects. A possible collaboration with Japan will be explored soon.

Faster time to market

The time from new ideas to market readiness is getting shorter and shorter. Therefore timeliness is a key factor for a competitive European industry.

In the next year it will be one of the most important duties of CELTIC and the Inter-Cluster group to convince stakeholders to come to more pragmatic and shorter decision processes.

CELTIC is already on a good way when it comes to funding decisions. In countries like Sweden, Luxembourg, Israel, and Spain CELTIC projects get the decision in about three months. We should build on those examples. CELTIC will discuss with its Public Authorities how to enable a quick start of projects across all countries participating in our Cluster.

SENDATE and the success of CELTIC flagships

From the start of CELTIC, its flagship projects have made a strong contribution to innovation in European ICT. Our recent flagship project SENDATE for secure networking of data centres in Europe showed it again in a brilliant way. At its closing event at the Ericsson headquarters in Kista, Sweden on 27th March, the high-level representatives from industry and public funding organisations learned about the impressive impact of the project.

Thanks to SENDATE results, cybercrime, which causes very high costs for enterprises and the whole society, will be reduced. Among many great achievements the project has developed new datacentre technology which has the potential to make European suppliers globally more competitive. SENDATE is also a good example of impactful collaboration between large and small enterprises.

We are already defining our next flagship project. We encourage flagships on topics that are important for a number of countries like AI, green ICT, digital sovereignty, and more.

Please join us, if you would like to take part in those initiatives!

Next CELTIC Event

The CELTIC Event 2019 will be collocated with the European Conference on Networks and Communications (EuCNC) in Valencia on 19–20 June. Please come to Valencia to enjoy an interesting programme of keynote speeches, panel discussions, and proposers sessions. There will be also an exhibition of our most successful projects and the awards of the best CELTIC projects.

Conclusion

As you can see, exciting developments are going on at CELTIC-NEXT, which involve new players from vertical sectors and also new countries.

We look forward to fruitful collaborations on bottom-up subjects as well as on the countries' strategic priorities using our flagship instrument. In all cases we will foster collaboration among the different stakeholders by organising a number of Proposers Days and ad-hoc networking events. I look forward to meeting you there!

CELTIC Proposers Day in London

On 5th February 2019, CELTIC, Innovate UK and KTN jointly organised a Proposers Day in the prestigious building of Institute of Contemporary Arts in London.

After the decision of Innovate UK in late 2018 to fund CELTIC projects, the very clear goal of the day was to stimulate the UK community to participate in CELTIC projects. Very important for this is that the UK ICT community builds up relationships with the existing CELTIC communities in many other EU countries. The Proposers Day gave some new insights on recent technological developments, provided information on funding opportunities and showed 12 new project ideas.

The Proposers Day was opened by Mr Jon Kingsbury from KTN and by Ms Valérie Blavette, CELTIC Chair Person from Orange in France. They welcomed the 70 participants and explained why this decision of Innovate UK to fund CELTIC project was exciting news that is so important for the UK and Europe.

Beyond 5G

Paul Crane, Converged Networks Research Director at BT said that virtualization is a radical change to the way networks are build and he showed his vision on how future developments will change and boost the businesses of his company and the world of communication.

CELTIC-NEXT project framework in UK, Germany and Spain

Jean-Francois Fava Verde from Innovate UK presented the first Call for EUREKA CELTIC projects in the UK: The CELTIC Call for the international proposals was open until 8th of April. It was closely followed by an Innovate UK Call for the national application. The priorities for this Innovate UK Call are on "Innovative 5G infrastructure technologies" and on "Applications and services that leverage 5G networks, as well as 5G features in satellite networks or 5G applications and services integrating satellites". On the 2nd of April Innovate UK organised an additional briefing event to get CELTIC projects funded by Innovate UK.

Matthias Kuom from DLR explained the main focus of funding in Germany and how important it is to actively shape the digital revolution to maximise the benefits for our



Welcome of Mr Jon Kingsbury, KTN from UK and Mrs Valérie Blavette, Celtic Chair Person from Orange in France



Audience of the Proposers Day in the Meeting room in the Institute of Contemporary Arts in London

society. Today, the main researched topics in Germany are production systems (Industry 4.0), energy systems for the future and social systems able to cope with demographic changes.

Juana Sanchez from CDTI presented the Spanish involvement in CELTIC projects. Spanish companies are among the most active in CELTIC. There is no other country that had more participation in CELTIC projects than Spain. She also explained how the application for public funding to the open CDTI Call works in Spain.

Panel on business impacts of CELTIC projects

Richard Foggie from KTN opened and guided through the panel session.

The first panellist, Ian Cooper from BT presented the results of the CELTIC projects 4GBB, HFCC/G.fast and GOLD all developing the G.fast technology that allows G-bit bandwidths over copper. The technology is currently rolled out by BT. Ian highlighted the commercial and technological advantages of this technology that avoids opening roads and gardens (Digging becomes even more expensive when coming closer to the homes).

Valérie Blavette from Orange reported on the high impact of CELTIC projects and she reported two examples: ODSI and SOOREEN. The first, "On Demand Secure Isolation" of a Network segment resulted in 12 new or improved products and allowed to win tenders in Paris, Hong Kong and with the company Bayer. The second SOGREEN attacks the en-



Jean-Francois Fava Verde explains the new funding scheme of CELTIC projects from Innovate UK



Paul Crane from BT presenting the Keynote "Beyond 5G"



Matthias Kuom explains funding of CELTIC projects at DLR



Richard Foggie from KTN opened the panel on business impacts of CELTIC projects



Juana Sanchez explains funding of CELTIC projects at CDTI



Christiane Reinsch from the CELTIC-Office introduces 13 pitch presentations



Peter Herrmann from the CELTIC-Office explained how to submit a CELTIC proposal

ergy consumption of communication networks helping to keep power consumption at an acceptable level, while the traffic doubles every two years.

Steve Clements from the UK start-up company aXenic reported how the 80 million euro CELTIC flagship project SASER that resulted in 55 new or improved products and 3 start-ups, generated a new business outside the initial scope of the project. After quite some struggle the project partners were able to develop a new type of modulators (electronic device that modulates the information on the light beam of the optical fiber) with higher bandwidth and with only half of the volume. It is therefore much lighter and ideal for satellite applications; aXenic took up this challenge successfully and sells today this new type of modulators for space applications.

Steny Solitude from the French start-up Perfect Memory explained how the CELTIC Project MediaMap+ initiated a new paradigm in Digital Asset Management (DAM). This allows translating factual knowledge, using semantic technics into formal knowledge that can be injected in datamining and machine learning systems. Today the technology is used in audio visual productions. Partners are ATOS, Cap Gemini and BPI serving clients in the audio-visual domain such

as RTL-TVI Belgium, Radio France and RTBF. In ten years of existence Perfect Memory has established the technology and has grown to 15 employees.

Marco Mattavelli from EPFL (the Federal University of Lausanne) presented how the CELTIC 4KREPROSIS project integrated technologies for 4K TV content production. The system integrates 4K UHD Wireless Camera Heads and Recording Units for Remote pro-

duction. It further integrates an advertisement insertion system and it is able to selectively protect contents. The full system was used for audio-visual production at the FIFA World Cup 2018 in Moscow where the system successfully covered the whole event. Today there are 10 new products based on 4KREPROSIS technology that are commercialised.



Panellists (from left): Steny Solitude from Perfect Memory (France), Steve Clements from aXenic (UK), Marco Mattavelli from EPFL (Switzerland), Valérie Blavette from Orange (France) and Ian Cooper from BT (UK).

Project proposal pitches

Another core element of the Proposers Day was the pitching of project ideas. 13 proposers presented their ideas on a wide range of ICT topics. They included future 5G vertical aspects, Industry 4.0, Agritechnologies, Autonomous intelligent systems, verification and proof of 5G enabling IoT topics and other cutting edge 5G-related technologies such as Artificial Intelligence and edge computing. The

presentations led to productive discussions with the audience and CELTIC consortium building webinars for the different pitches had been announced to the audience.

> Further information

All presentations and project pitches are available at <https://www.celticplus.eu/event/proposers-day-in-madrid-26-september-2018/>

After the pitch presentations the participants had enough time to discuss the project ideas

that had been presented. This possibility has been largely used and appointments were made for follow up telcos that were scheduled in the following week.

Making the Internet more secure – Closing event of CELTIC flagship project SENDATE

On 27th March 2019, SENDATE, the CELTIC flagship project for secure networking of data centres in Europe, held its closing event. More than 100 high-level representatives from industry and public funding organisations participated at the event, which was held at Ericsson HQ, in the high tech city of Kista close to Stockholm.

The participants discussed SENDATE's achievements. The project created a secure, distributed data centre environment, which meets the requirements of industrial communication, autonomous driving, and more. SENDATE helps to limit cybercrime that causes very high costs for enterprises and the whole society. The project has initiated a new datacentre technology which has the potential to make European suppliers globally more competitive.



Mr Magnus Frodigh, Head of Ericsson Research



Ms Valérie Blavette, CELTIC Chairperson from Orange



All the speakers who made the SENDATE Closing Event a success.

The event started with presentations by representatives of ministries and funding agencies from the countries financing SENDATE. After that industry leaders from the consortium presented the achievements of the five SENDATE subprojects. These presentations were complemented by demonstrations of technical results. The event concluded with a panel discussion on SENDATE outcomes and business impacts.

High-level opening speakers

The Event was opened by Mr Magnus Frodigh, Head of Ericsson Research, and Ms Valérie Blavette, CELTIC Chairperson from Orange.



Ms Darja Isaksson

Ms Darja Isaksson, General Director at Vinnova, was the first speaker from the funding agencies. She stated that digital infrastructures may very well be one of the most important areas for human collaboration, as digital infrastructure is now a geopolitical matter and the threat of cyberwarfare is real. She said: "It is fantastic to see even competitors co-creating pre-commercial solutions together and to prove the value of interoperability. SENDATE is an example of not only top class research but also on collaboration that build trust between big and small industry and academia." This has been shown in a common field trial in Stockholm as a joint activity between the two SENDATE subprojects FICUS and SECURE-DCI.

Mr Ole Hitzemann from BMBF stated that SENDATE made the internet more European and contributed to creating a digital world with its own requirements and standards for privacy and data protection. He said: "We can only achieve this goal of digital sovereignty if we do this together." According to Mr Hitzemann, it gives Europe the chance to become a pioneer in privacy and data protection. Furthermore, it offers the opportunity for European ICT providers to create innovations that are data protection friendly and generates a competitive advantage compared to the American and Asian providers. Europe can never be digitally sovereign



Left: Mr Ole Hitzemann, Officer at BMBF being introduced by, Mr Tor Björn Minde Ericsson, the moderator of the day.

without its infrastructure. SENDATE has developed ideas and solutions for the Internet and makes Europe more independent from the rest of the world. Innovations in privacy and data protection will strengthen Europe's competitiveness and create new markets.



Ms Outi Keski-Äijö

Ms Outi Keski-Äijö, Head of AI Business at Business Finland, looked into the future, where 5G, IoT and AI will form a new digital critical infrastructure that is essential for the operations of a modern society and businesses. In this world, security will be the biggest challenge. She proposed that AI should be part of the solution that will make digital networks more secure. This will be achieved by recognizing anomalies in digital networks to better protect privacy.

SENDATE success stories

The event continued with presentations by high-level representatives of the SENDATE project partners, including Nokia, Ericsson, Coriant, ADVA, and Thales. These presentations focused on the five subprojects and the four transversal focus themes.

Ms Julie Byrne, Head of External Programs at Nokia Bell Labs, showed that SENDATE PLANETS achieved the first security architecture that supports different data centres. The project realized 26 demonstrators, 12 new products and an open ecosys-



Ms Julie Byrne

tem based on standardized APIs and open source software. She also explained that SENDATE TANDEM has made data centres more secure with a new integrity monitoring for data centre network elements. It also has realized a new dynamic network interconnection for future data centre network elements.



Mr Tor Björn Minde

Mr Tor Björn Minde from Ericsson showed the latest developments in bringing another level of intelligence into the network which enables to predict its failure before it actually happens. In the future this data-driven modelling in dynamic environments technology will help to avoid failures that are very costly for network operators and the whole society. He said that the project was the ignition of a new data-centre technology

that brings European suppliers back into the competitive data centre business.



Mr Bernd Sommerkorn-Krombholz

Bernd Sommerkorn-Krombholz from Coriant explained how SENDATE FICUS strived for innovative solutions at the technological edge and how the industry-first multi-vendor SDN field trial was carried out with equipment from ADVA, Coriant, Highstreets Technologies and VPIphotonics. These were integrated in the Telia network in Sweden and the field trial allowed testing the new autonomous intelligent functionality of the optical network elements.



Mr Jörg-Peter Elbers

Mr Jörg-Peter Elbers, Vice-President Advanced Technology from ADVA explained the recent developments in a new type of secure data centre interconnect. Among other ground-breaking developments he mentioned the pioneering field trial where ADVA achieved the world-first quantum-safe transport over a 2,800 km fibre network. In another trial Fraunhofer realized a 400 Gb/s super-channel for the connection of data centres with a single diode.

Mr Emmanuel Dotaro (Technical Director, Thales) explained how the work between the subprojects was carried out and explained the main results that were achieved. In a white paper the partners agreed on a high-level security architecture that was shared and agreed among the project partners. This was introduced into the 5G Security Working Group of the 5G Infrastructure As-



Mr Emmanuel Dotaro

sociation. He also mentioned the sustainability of the research work and the impact performed through CELTIC.

Demos

During the break different demos were shown that generated a high level of interest and lively discussions.



Mr Andreas Aurelius

Panel discussion

Andreas Aurelius, ICT Manager at Vinnova at Sweden's innovation agency VINNOVA moderated the panel on the "Outcome and Business Impact of SENDATE". The panel discussed the

project impact on business, the strategy forward and for SMEs the value of collaboration in a large project:

- › Telia has a big scope in the optical business and SENDATE has helped to establish confidence in new technologies that were still far away only one year ago.
- › VTT is very active in cybersecurity and could establish new cooperation's with European SMEs that were quite unknown before the SENDATE project.
- › Airbus implemented the security in critical radio communication systems allowing now fully networked airport services. An aircraft can be considered as a data platform transmitting the relevant data to the different service providers. This allows to increase efficiency.
- › Orange has used machine learning to allow fibre intrusion detection before fibre actually breaks – example: digging incident during civil works. It is very important for the customers that the traffic can be redirected before the failure actually happens. Orange also worked on automatic reconfiguration of the optical connectivity for the interconnection of data centres.
- › SENDATE has enabled the consulting firm ArctosLabs, an SME, to offer network optimisation solutions on how to distribute micro services in the cloud by modelling data-centre cost versus transportations costs.
- › New data centres are installed in the northern part of Sweden. ABB has realised modelling of the cooling of data centres, where an efficiency increase of 10% was achieved.
- › Thanks to SENDATE the people working in the field of data centres in her company RISE have been increased from 3 to 23 Persons.



Panelists at the SENDATE event (from left): Mr Mauro Costa, Head of planning, strategy & architecture at Telia, Sweden; Mr Pertti Raatikainen, Research Manager - Connectivity at VTT, Finland; Mr Hugues Favin Lévêque, Airbus Connectivity Roadmap Owner at Airbus France; Ms Valérie Blavette, Open Innovation Manager at Orange France; Mr Alf Isaksson, Group Research Manager - Control from ABB Sweden; Mr Mats Eriksson, CEO at ArctosLabs Sweden and Ms Jeanette Nilsson, Industry Relations Manager from RISE, Sweden.

EUREKA Global Innovation Summit in Manchester

CELTIC project SIGMONA wins EUREKA Award

This year's EUREKA Global Innovation Summit was hosted by Innovate UK in Manchester under the UK EUREKA Chairmanship on 14 – 16 May 2019. A record number of around 2,000 participants had registered for the event, which took place at the Victoria Warehouse close to the Old Trafford stadium, the home of Manchester United, one of Europe's top football clubs. CELTIC was strongly represented at the event.

CELTIC speakers in inspiring sessions

The motto of the event was 'Innovating across borders for business growth', and the numerous sessions proved that the EUREKA network lives up to this ambitious claim. In a number of these sessions, speakers from CELTIC projects and the CELTIC Core Group shared their insights.

On the first day, CELTIC chairperson Valérie Blavette from Orange was on stage at the EUREKA Academy session, where companies had the opportunity to learn from a panel of EUREKA experts how to apply to different funding opportunities across the EUREKA instruments. Valérie Blavette also participated in a thought-provoking session with the title 'If Industry Designed the Global Innovation Ecosystem'. The panellists discussed how the innovation ecosystem would look different, if it was designed by industry alone.

Also on day one, an interesting session on 'Collaborating with Africa' took place, which provided first-hand information on how companies can collaborate with partners in Africa and how to best access the African market. Jose Costa-Requena from Finnish start-up Cumucore, which participated in CELTIC project SIGMONA and which provides a solution that integrates Network Function Virtualization (NFV) and Software Defined Networking (SDN), shared his business experiences in South Africa.

On day 3, CELTIC Core Group member Riza Durucasugil from Netaş participated in an interesting session on the main stage about 'Benefits of SME and Large Industry Collaboration', in which the panellists offered their advice on where the next opportunities for SME collaboration will come from and the best ways to approach corporate collaboration.

Also on day 3, Milon Gupta, CELTIC Office communication manager at Eurescom, chaired a session on the 'Business Impact of



CELTIC Core Group member Riza Durucasugil from Netaş (second from left) in the session on 'Benefits of SME and Large Industry Collaboration'



SIGMONA project participants and officials at the EUREKA Award ceremony in Manchester (from left): Philippe Vanrie (Head of the EUREKA Secretariat), Juana Sanchez (CDTI), Tim Bestwick (UK EUREKA Chairperson), Jose Costa Requena (Cumucore), Marco Hoffmann (Nokia), Reijo Savola (VTT), Tarik Sahin (Tubitak) and Valérie Blavette (Celtic Chairperson and Orange).

EUREKA Clusters'. Speakers from different Cluster projects presented the impacts they generated and explained how their companies benefitted from these projects. Among the speakers was Stephen Clements, CEO of British SME aXenic, which participated in CELTIC flagship project SASER.

EUREKA Award goes to SIGMONA

On the final day of the EUREKA Summit, CELTIC project SIGMONA received the EUREKA Global Project of the Year 2019 Award. The project had developed an innovative software-defined network (SDN) concept in generalized mobile network architectures, which

has contributed to the development of 5G networks. SIGMONA won the award together with EUROSTARS project Kids4LIFE. Among the five finalists of the award was also CELTIC flagship project SASER, which has made an important contribution to the development of safe and secure European routing.

> Further information

- › EUREKA Global Innovation Summit – <http://egis2019.org>
- › CELTIC project SIGMONA – <https://www.celticnext.eu/project-sigmona/>
- › CELTIC flagship project SASER – <https://www.celticnext.eu/project-saser/>

Innovate UK funding scheme for CELTIC projects

Innovate UK



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This article explains how Innovate UK is funding collaborative R&D projects in the context of the CELTIC-NEXT programme.

Innovate UK, the UK's innovation agency

Innovate UK, part of UK Research & Innovation (UKRI), is the UK's innovation agency. Our aim is to drive productivity and economic growth by funding business and research collaborations to accelerate innovation and drive business investment into R&D. Innovate UK helps companies of all sizes in all sectors, from spin-outs and start-ups to companies with the ambition to scale and grow through global markets, access the research, partners, investors and markets they need to innovate and grow. Innovate UK has invested £2.7 billion through 11,000 projects since 2007.

Innovate UK and EUREKA's CELTIC-NEXT Cluster

Innovate UK has allocated £2 million to fund CELTIC-NEXT's collaborative R&D projects in 2019 in order to stimulate the development of 5G and encourage international collaborative environment by helping UK organisations take part in the CELTIC-NEXT programme. To this end, Innovate UK is organising two competitions aligned with CELTIC's spring and autumn calls. These competitions follow a two-stage process: applicants must first submit a CELTIC proposal, before applying to Innovate UK's competition.

How to apply for funding?

All the Innovate UK competitions are published on the gov.uk website (see link at the end of the article). Applying to the Innovate UK's competition is an online application process via our digital Innovation Funding Service (IFS). Ten questions must be answered, and the CELTIC proposal must be appended. The first question, for example, is about the need or the challenge, the second question asks about the approach and the innovation, etc. UK applications are assessed independently from the CELTIC evaluation process. There is at least one briefing event for each competition and attendance is highly recommended. A recorded webcast of these events is also made available.

A consortium within a consortium

We expect collaboration at both UK and EUREKA levels. In other words, there must be a UK consortium, which must be business-led, within a EUREKA consortium. The partner(s) in the UK consortium may be any UK organisation, including businesses, research organisations, public sector organisations or charities. There must also be at least one UK-based micro, small or medium-sized enterprise (SME) in the UK consortium.

Type of projects

The proposed collaborative R&D projects may last up to 24 months and be classified as either industrial research or experimental development, that is, nearer to market. Businesses within the UK consortium may, depending upon the type of project and size of the company, receive a grant of up to 70% of their eligible project costs. Research organisations in the consortium can share up to 30% of the total eligible project costs, funded

at 80% of full economic costs. All project work from the UK consortium must be carried out in the UK and the results exploited from or in the UK. The competitions are designed to provide state aid funding under article 25, 'Aid for research and development projects', of the General Block Exemption Regulation (GBER). It is the responsibility of the partners to make sure that the organisations are eligible to receive state aid.

Scope of the competition

To be eligible for funding, projects need to align with the scope of the published competition. It should be noted that the scope may vary from competition to competition. For the spring competition, for instance, we are looking for proposals to develop innovative 5G infrastructure technologies that make use of artificial intelligence (AI) in network operation or multi-access edge computing (MEC), and applications and services that use 5G networks to offer new or improved user experiences. We are also looking for 5G applications and services, which can be about the Internet of Things (IoT), the tactile internet, mission critical applications, infotainment mobile services or immersive technologies. The scope is deliberately broad to ensure industry-wide interest and we are looking to fund a portfolio of projects, across a variety of technologies, markets, technological maturities and research categories.

Any question? Email the author or support@innovateuk.ukri.org

> Further information

Innovate UK competitions – <https://apply-for-innovation-funding.service.gov.uk/competition/search> (enter the keyword 'CELTIC' to find CELTIC-NEXT-related competitions)

Better access to telemedicine for the elderly

E3-project-based start-up Smart Health TV Solution provides innovative multimedia platform



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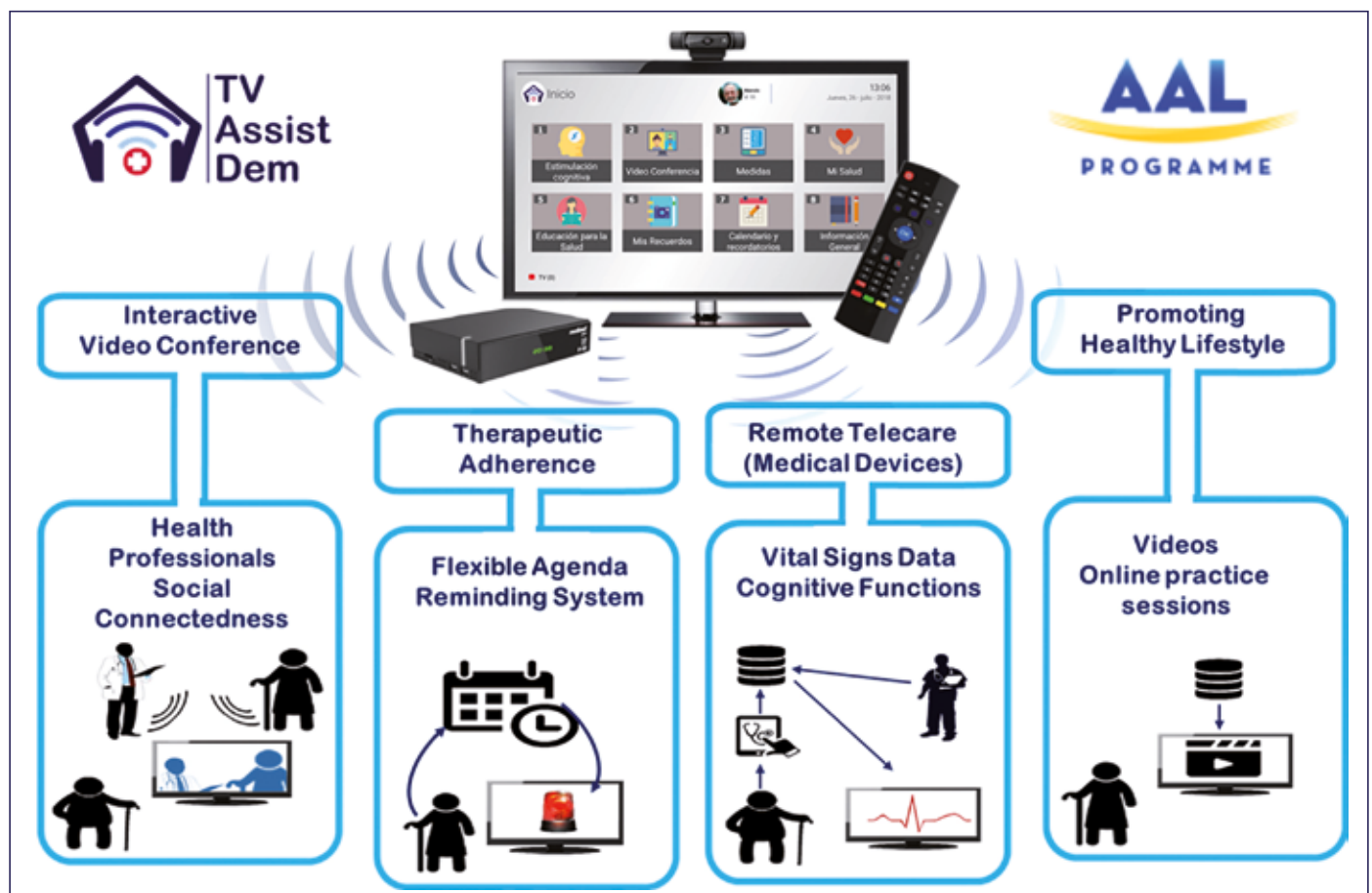
Smart Health TV Solution s.l. is a start-up based in Málaga, Spain which was fostered by Celtic-Plus project E3, 'E-health services Everywhere and for Everybody'. The mission of Smart Health TV is to enable elderly people access telemedicine and telecare services at home using their TV set.

The E3 project ran from 2014 to 2019. It designed and implemented an end-to-end plat-

form which aimed to enable anybody to access e-health services anywhere. As part of the SME-focused cross-domain, international collaboration promoted by the Celtic-Plus project, Smart Health TV designed and developed a solution to eliminate the barriers that keep older people and people with physical, cognitive or intellectual disabilities from accessing modern telecare and telemedicine applications and services. Removing these barriers and giving this segment of the population access to telemedicine and telecare allows social and healthcare institutions or services to improve the quality of life of these people and at the same time that generate significant cost savings for the healthcare sys-

tem. Our platform supports the sustainability of social and healthcare services to the elderly, one of the most important challenges our society is facing in the next decade.

How we do it? We use the home's TV set, a device very familiar and easy to use for our potential users through a simple remote control. The Smart Health TV device, once installed at the end-user's home, transforms the home TV into a Smart TV system designed specifically for telemedicine and telecare services. The Smart Health device is easy to install in the end-user patient home. It is based on Android O.S. and is compatible with different digital TV formats, such as terrestrial, cable, IP, or satellite.





The platform is mainly based on the following applications:

- › Interactive Video Conference: a video communication system between patients and health professionals to foster their communication
- › Therapeutic Adherence Reminders: reminders and alerts to help patients to adhere to their treatment and their medical appointments
- › Remote Telecare: remote transmission of vital signs data (e.g. blood pressure) and stimulation of cognitive functions (e.g. cognitive exercises)
- › Promoting Healthy Lifestyle: video promoting a healthy lifestyle, best practices and health tip videos. Furthermore, the platform promotes a healthy lifestyle of people living with dementia at home through counselling, video-based training, and online practice sessions.

Smart Health TV is working currently in the TV Assistdem project under the Active Assisted Living (AAL) programme. The consortium includes SMEs and institutions from the public healthcare and elderly care sector in Italy, Romania, Spain, and Switzerland.

The aim of the TV-AssistDem project is twofold: to build a TV-based home-care solution for supporting patients with mild cog-

nitive impairment and their carers; and to carry on a clinical trial for validating both the effectiveness of the solution on the quality of life of patients and their carers and the ability of the system to increase adherence to the treatment. The project is based on three key assumptions:

- › Accessibility: the system can be adapted in such a way that patients with MCI can use it confidently and comfortably. The key to this adaptation is user-centred design, where the patients, their carers and healthcare professionals drive the looks and functionality of the MCI-compatible application.
- › Efficacy: the system improves the quality of life of both patients and their carers. Patients will benefit from improved adherence to their treatment, which will slow down their physical or mental deterioration. Carers will benefit from the system's support in coping with the caregiving burden.
- › Cost effectiveness: the system reduces the costs to the healthcare system associated with care for MCI patients. The main cost savings will be based on reduced complications in mental or physical health (both for patients and carers), which reduces the need for hospitalization, emergency doctors' appointments or short-term formal care (to cover for

exhausted informal carers).

Aim of TV-AssistDem is to develop a Digital TV-based platform to facilitate remote support to patients affected by mild cognitive impairment by means of a set of TV-based services.

Conclusion

The project will finish the clinical trial in 2020 and will allow Smart Health TV to complete the Minimal Viable Product developed in E3. Smart Health TV is currently funding its expansion from Spain to both the European and Latin American markets in Q1/2020. Our participation in the E3 project helped us to focus our R&D efforts on the real market and to validate our results with the E3 project partners.

› Further information

- › E3 project www.celticnext.eu/project-e3/
- › Smart Health TV Solution <http://www.shtvsolution.com/>
- › TV Assistdem project <http://www.tvassistdem-aal.eu>
- › AAL programme project <http://www.aa-europe.eu>



About CELTIC-NEXT

CELTIC-NEXT is an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications & services focusing on next-generation telecommunications for the digital society. CELTIC-NEXT is a EUREKA ICT cluster and belongs to the inter-governmental EUREKA network. CELTIC-NEXT is open to any type of company covering the CELTIC-NEXT research areas, large industry as well as small companies or universities and research organisations. Even companies outside the EUREKA countries may get some possibilities to join a CELTIC-NEXT project under certain conditions.

www.celticnext.eu



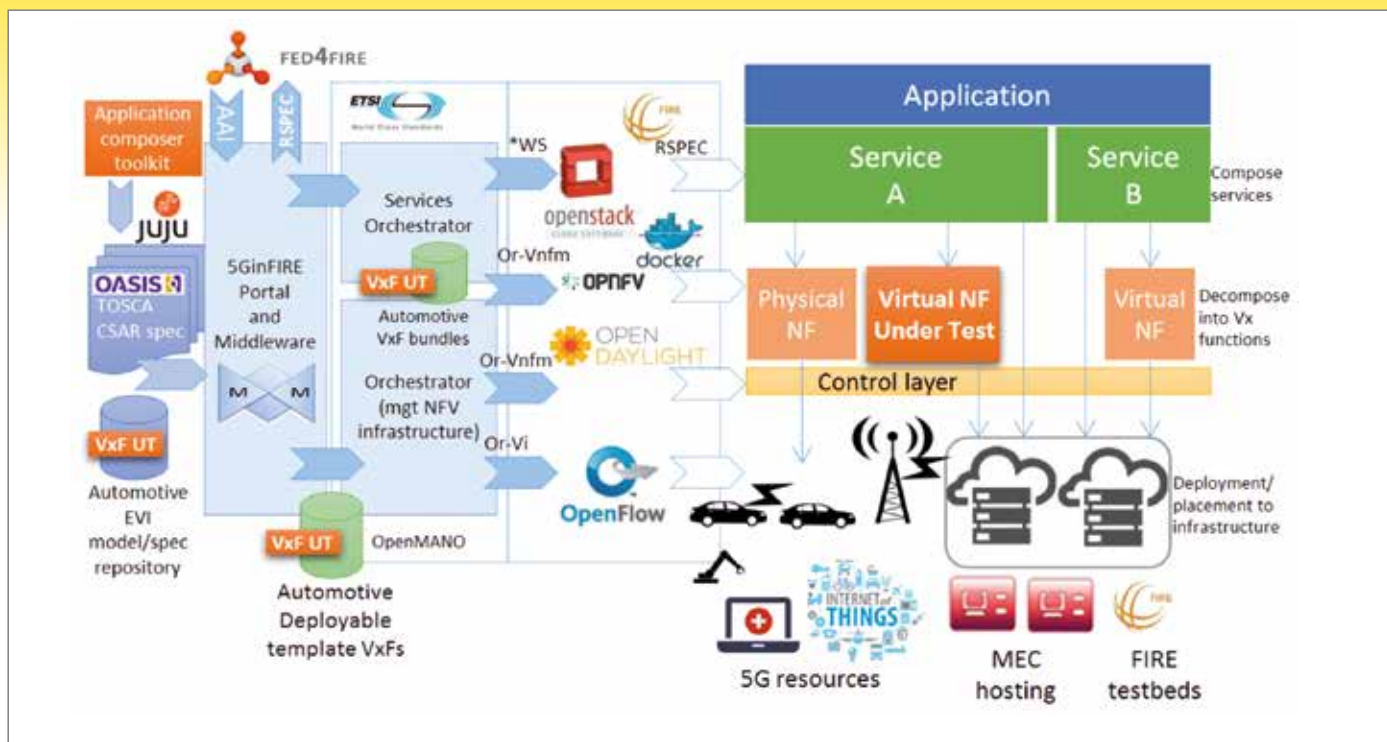


Figure 1: 5GINFIRE conceptual architecture for experimentation

orchestration services by using the Open Source MANO [3] implementation that is based on the corresponding ETSI specification. With it, the 5GINFIRE provides a platform that allows experimenters to easily deploy their VxFs under test. To do so, the user needs to submit to the repository the VxV specification, its metadata, and deployment template so that the platform can deploy it on top of the infrastructure and configure it to be used by existing services.

5GINFIRE testbeds

The 5GINFIRE project established its framework at an early stage, to enable a variety of external experiments. The initial 5GINFIRE experimental infrastructure included an automotive and a smart city testbed as well as the 5TONIC facility. The infrastructure has been extended through competitive open calls to eight 5GINFIRE testbeds enabling remote implementation of experiments, by using the 5GINFIRE experimenter portal, and addressing various vertical sectors and 5G oriented networking experimentation. In addition, 5GINFIRE has links with testbeds in Brazil through a connection with the Federal University of Uberlândia.

- **5TONIC** laboratory hosts the 5GINFIRE orchestration service and the NFV infrastructure as well as it serves to evaluate and demonstrate the capabilities and interoperation of pre-commercial 5G equipment and devices, services, and applications. This multipurpose environment of multiple racks can be flexibly interconnected according to any experimentation requirements. In particular, secure external access may be provided, allowing remote

solutions to support management, control, and data operations.

- **IT-Aveiro Automotive Environment** consists of On-Board Units (OBUs) in the vehicles and roadside units connected to the Internet, where each OBU has multiple wireless interfaces, enabling communications with other vehicles and the entire testbed infrastructure. A datacenter is directly connected to the multi-site orchestration managed by Open Source MANO, deployed in 5TONIC. The OBUs have access to the vehicular information such as velocity, position, and trajectory as well as information about the surroundings.
- **University of Bristol 5G testbed** is a multi-site network connected through a 10km fibre with several active switching nodes, including the core network and an extra edge computing node. Access points using various technologies are located in the city center. The available radio access technologies deliver high-bandwidth, high-bitrate, and high-reliability connections, where availability of LTE-Advanced and future installations of 5G access points are of particular importance.
- **eHealth experimental infrastructure** located in Poznan Supercomputing and Networking Center consists of cutting-edge equipment enabling implementation and testing of eHealth cloud applications, products or services. The infrastructure makes accessible to experimenters eHealth devices from three functional groups: the operating room, the physiological parameter sensors, and the patient wellbeing sensors.
- **5G Media testbed** enables execution of media use cases beyond current state of the art, looking at two target areas; 6-degrees-of-free-

dom (6DoF) VR streaming and professional video production (uplink streaming) for live TV. The testbed provides hardware components, such as data plane acceleration modules, encoding/decoding modules, GPUs, etc., to meet necessary requirements, in terms of bandwidth and latency, to the target classes of future media applications.

- **PPDR ONE** is a 5G enabled telco-grade development, testing, and verification facility for outdoor and indoor experimentation on network architectures and services for Public Protection and Disaster Relief. PPDR ONE is an all-in-one facility which includes SDR-based radio and core mobile system, cloud backend infrastructure, etc. A portable compact PPDR ONE node is ready to be shipped and deployed anywhere in the EU, covering both indoor scenarios and field operation.
- **NITOS testbed** is one of the largest single-site open experimental facilities in Europe, allowing users to take advantage of highly programmable equipment supporting a variety of wireless technologies, such as IEEE 802.11 compatible equipment, LTE, WIMAX, and SDR 5G, which are all interconnected via OpenFlow switches and with a cloud computing testbed. The equipment is distributed across three different testbed locations in the city of Volos and can be combined with each other.
- **WINS-5G testbed** provides a radio slicing and virtualization tool called Hypervisor for Software Defined Radios (HyDRA), developed to support experimentation monitoring in wireless, packet, and optical networks. HyDRA as a VNF is available in other 5GINFIRE testbeds equipped with Universal Software Radio Peripherals (USRPs) N210s, offering an op-

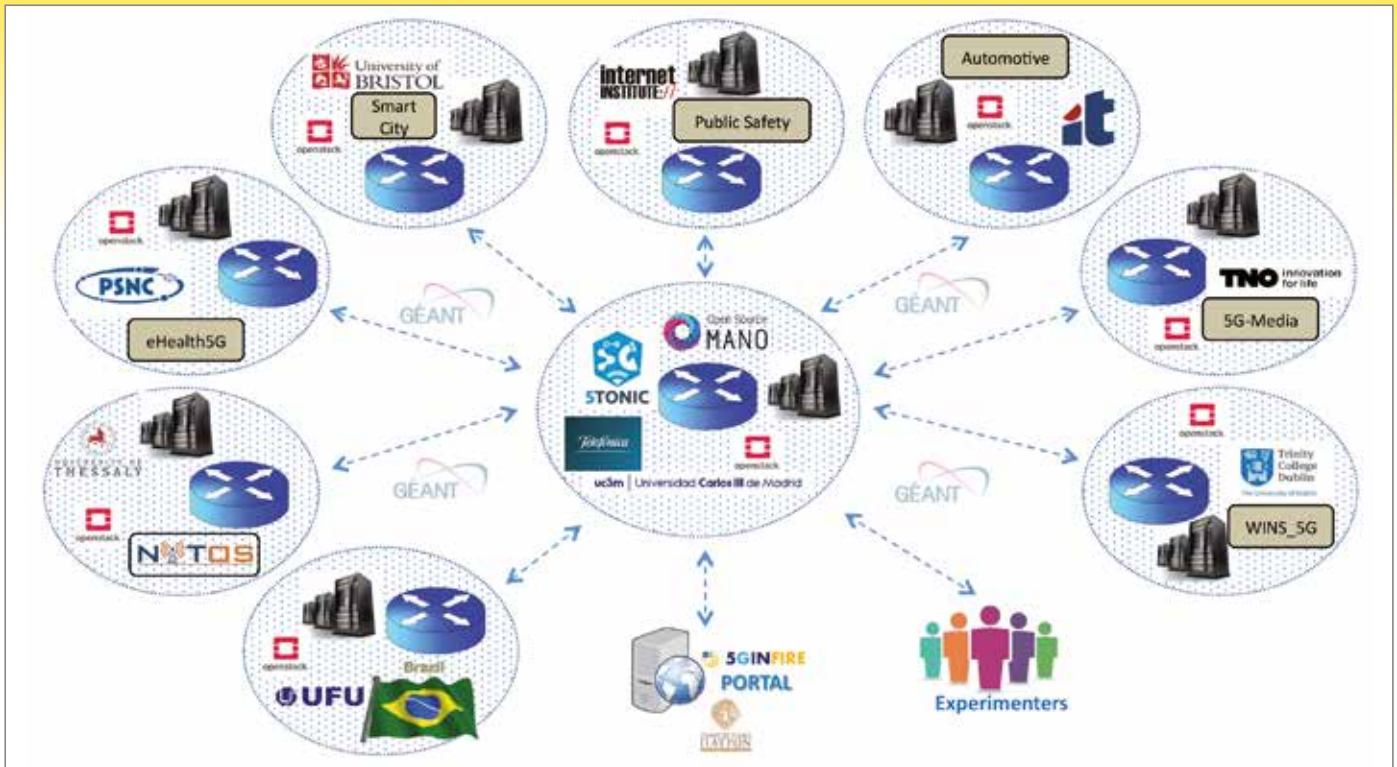


Figure 2 – 5GINFIRE experimental facilities

portunity to test and evaluate advanced 5G use case scenarios with massive communications needs and ultra-low latency requirements.

Even though the planned 5GINFIRE open calls for new testbeds are completed now, new testbeds are welcome to join.

The experiments

Within its four rounds of the open calls, 5GINFIRE attracted more than 100 researchers and developers to propose various 5G and NFV related experiments, being able at the end to accommodate and fund all together 22 experiments. For the time being, five experiments have been concluded and are summarized below, showing the capabilities of the 5GINFIRE environment through concrete experimentation examples.

- **Context-Aware Video Controller for autonomous transport and security monitoring** experiment demonstrated how several techniques can be merged to provide a new class of services on the basis of partial results. Video QoE and network QoS has been measured to adjust video encoder in order to save transmission bandwidth or improve image fidelity depending on the transmission environment and user’s expectations.
- **5G Smart City Robotic Surveillance Platform** experiment tested correlations between QoS and QoE, as well as defined encoding and transmission profiles for various surveillance scenarios. Having the media routing on an edge node allows disabling the sending of the other

videos to the monitoring application, and only to the storage, which can be placed at a different location. Finally, a new VNF for providing real-time QoE measurement for video streams has been developed and tested.

- **Service Function Chaining orchestration application for low latency guarantees** experiment focused on the evaluation of a tenant-side Service Function Chaining management solution. Concerning the impact on resource consumption the implemented approach appeared sustainable. Also, the deviation between the estimated latency computed on the abstract topology and the measured end-to-end latency along the established chain resulted in a reasonable average of 3.8%.
- **Hybrid Communications to Foster 5G Vehicular Services** experiment presents advantages in the area of high-performance data processing from OBUs. The results show that an improvement of several orders of magnitude (from 80 to 2 msec) can be achieved if it is not necessary to receive data from a physical OBU for data which can be provided by a virtual OBU. Further improvements could be achieved, if higher processing loads would be moved from the physical OBU to its virtual counterpart.
- **Vulnerable Road Users Safety using a hybrid Cloud RAN and Edge Computing model** - this experiment showcased the performance of a MEC-based and a cloud/VNF-based system. The cloud-based outperforms the RSU(Road-Side Unity)-based deployment in the majority of the scenarios, but both systems exhibit end-to-end delays, satisfying re-

quirements of V2X applications. With respect to the system scalability, the results show that the VNF-based deployment performs in a more stable manner.

Outlook

Further experiments will be conducted until the project end in December 2019. The 5GINFIRE framework and its experimental facilities will remain available for experimenters after the life time of the project

More up-to-date information about 5GINFIRE, its facilities, and implemented experiments can be found on the project website at www.5ginfire.eu.

Acknowledgement

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The article includes valuable contributions from Christos Tranoris (University of Patras) and Anastasius Gavras (Eurescom).

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5GENESIS

5th generation end-to-end network experimentation, system integration, and showcasing



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This article presents 5G PPP infrastructure project 5GENESIS. It is developing a facility for 5th generation end-to-end network experimentation, system integration, and showcasing.

Motivation and scope of 5GENESIS

The fifth generation of mobile technology (5G) is positioned to address the demands and business contexts of IMT 2020 and beyond. Standards Development Organizations (SDOs), industry fora and research projects have identified as common ground the need to i) enhance the network architecture, in view of emerging technologies and features, and ii) push the envelope of performance, from network and user perspective, towards capabilities far beyond 4G, in support of a wide range of innovative use cases for various types of vertical industries. In this context, 5G PPP Phase I and Phase II projects have mapped the 5G requirements to specific Key Performance Indicators (KPIs) and have defined the overall 5G architecture that can achieve these KPIs.

At this point, the “Genesis of 5G” has entered the crucial phase of experimentation. A key challenge is to integrate the highly diverse results and technologies from all activities at EU level. In this context, 5GENESIS is validating 5G KPIs for vari-

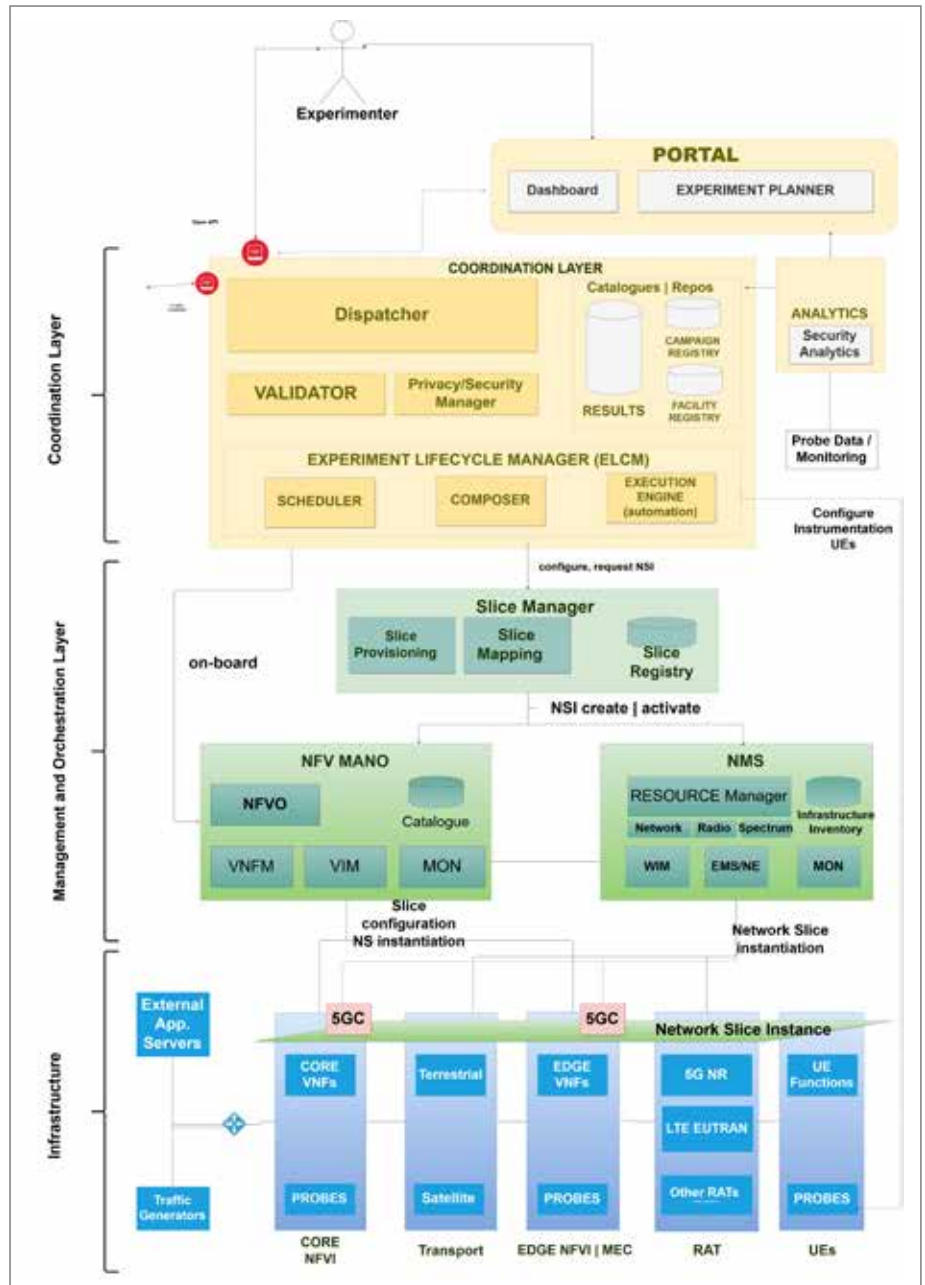


Figure 1: Detailed 5GENESIS Experimentation Blueprint

ous 5G use cases, in both controlled set-ups and large-scale events, while supporting further experimentation from vertical markets. More precisely, the 5GENESIS Facility implements and is capable of verifying all evolutions of the 5G standard via an iterative integration and testing procedure. It offers the resulting end-to-end 5G facility to developers of services for vertical markets with a fully automated experimentation framework and unified interface for remote uploading, deployment and monitoring of the services under test.

The 5GENESIS facility implementation

5GENESIS has already defined a 5G experimentation blueprint that will serve as common architectural reference for the implementation of the Facility. This blueprint also includes the openness framework, with APIs for exposing the facility to verticals for experimentation. By instantiating this blueprint, 5GENESIS is building the Facility on five diverse – yet fully interoperable – experimentation platforms distributed across

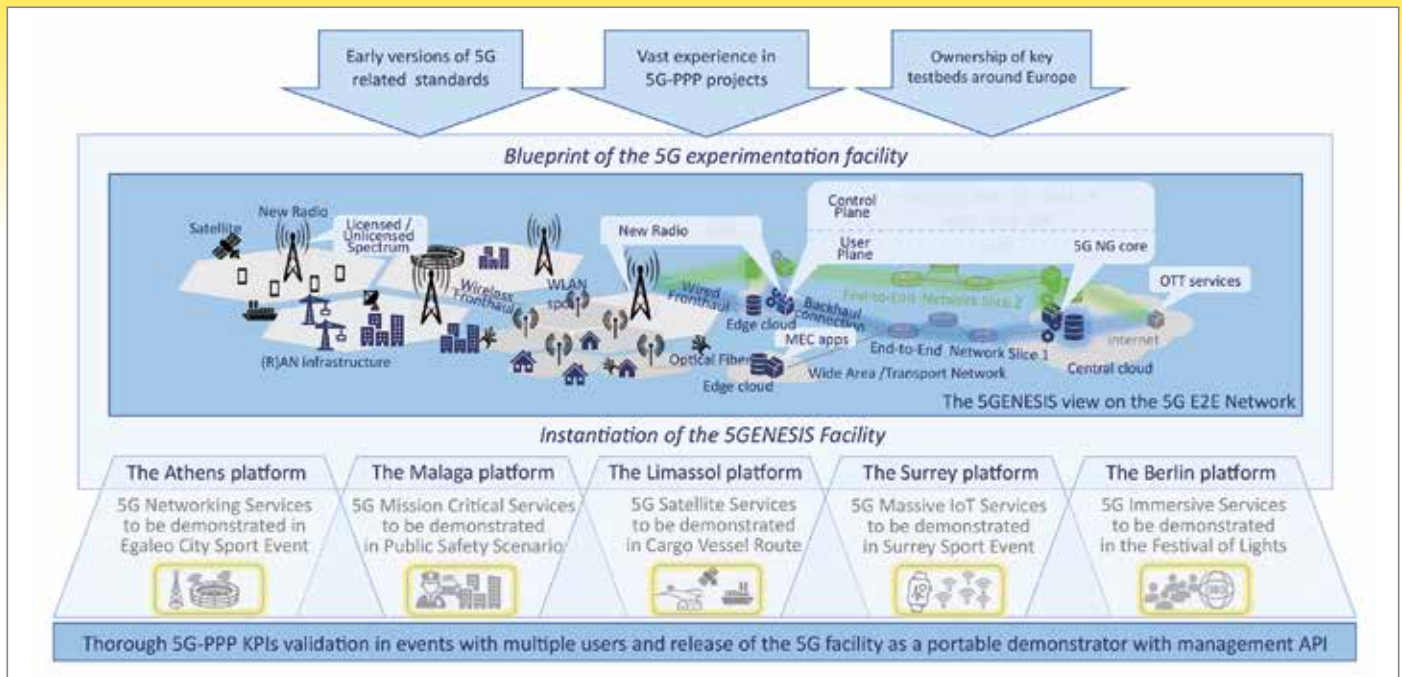


Figure 2: The 5GENESIS End-to-End Facility

Europe. Based on this approach, the guiding principles that shape the 5GENESIS Facility are:

- The 5GENESIS Facility is distributed and is comprised of various geographically dispersed Platforms,
- The Platforms are partially complementary in terms of features, nevertheless aligned to the proposed common reference architecture,
- The Platforms are administratively independent, exposing open interfaces for verticals experimentation and light inter-platform coordination,
- The Platforms accommodate multiple experiments, that can be executed concurrently, coming from various verticals with diverse requirements,
- The Platforms are fully interoperable and can be interconnected in order to form a truly End-to-End Facility.

The 5GENESIS experimentation blueprint

For harmonizing the different platforms and experimentation infrastructures, elements of the common reference architecture need to be replicated across the five platforms. A detailed view of the 5GENESIS Experimentation Blueprint is depicted in Figure 1. It shows the three interlinked layers, namely the coordination layer, the management and orchestration layer and the infrastructure layer, as defined in 5GENESIS Deliverable D2.2.

A functional requirement analysis per layer (published in 5GENESIS Deliverable D2.1) has revealed the following aspects, covered by the components in Figure 1:

- For the **Coordination layer**, 18 essential requirements have been identified, that cluster around below functional domains:

- *Experimenter Interface*: Related to Open APIs towards experimenters, Facility and Platform Inventory, Experiment Definition, Vertical Experimenter Dashboard and Profiling Experimentation Configurations,
- *Execution of the Experiments*: Related to Experiment Pre-evaluation, Experiment execution, Experiment life cycle, Inter-experiment Coordination, Southbound Control APIs for Experiment Execution, Experiment Data Storage and Maintenance, Adaptation for Communication with Management,
- *Measurements and KPIs reporting*: Related to KPIs Validation and Evaluation, Experiment Monitoring, Transparency in Experiments Measurements,
- *Security*: Requirements related to Experiment Data Isolation and Security Analytics,
- For the **Management and Orchestration layer**, 17 essential requirements have been identified, that cluster around below functional domains:
 - *Slice Management*: including service automation: Referring to Slice Management, Slice Isolation, Slice Stitching and Inter-Platform Slice Coordination, Coexistence of Multiple Network Slices and/or Services, Network Slice Support for User Equipment (UE) and Quality of Service Mapping,
 - *Management and Organisation (MANO)*: Referring to Resource Catalogue per Service, Adaptation of Service Scale Up and Down, Flexible and Fast Allocation of Network Resources, Distributed NFVI on User or Service Demand, Network Service Composition and NFV Management and Organisation,
 - *Mobile Edge Computing Management*: Extending MANO requirements for MEC management, referring to Resource Cata-

- logue, Adaptation of Services, Flexible Allocation of Resources,
- For the Infrastructure layer, 22 essential requirements have been identified. Most of them can be clustered in the following functional domains:
 - *5G NG Core network*: referring to QoS Management Interface, network function virtualisation infrastructure, SDN Support,
 - *Backhaul network*: addressing High Backhaul Bandwidth, Link Aggregation,
 - *5G New Radio*: Referring to the use of Regulated Spectrum, 5G Deployments, Support Small Cells and D-RAN as well as Multi-RAT interoperability and/or aggregation,
 - *5G End-User equipment*: (Flexible Configuration of User Equipment),
 - *Multi-access Edge Platform*: Referring to the Experimentation on the Edge Node, Edge Isolation Support and MEC Infrastructure Deployment and Integration,
 - *Virtualised Computing & Management*: Referring to the Infrastructure support via virtual machines or containers, as well as, to the availability of the proper management APIs that are used by the MANO layer components.
- **Cross-layer** requirements, referring to more generic functionalities across the layers, include: KPI Validation (to measure, collect, process, validate and present), Automation, Integration of Satellite Communication, Mobility Support and Management.

The 5GENESIS experimentation platforms

The five platforms of the 5GENESIS Facility, their location and main features, are listed below and are shown in Figure 2.

- **The Athens Platform.** An edge-computing-enabled shared radio infrastructure (gNBs and small cells), with different ranges and overlapping coverage that are supported by an SDN/NFV enabled core, to showcase secure content delivery and low latency applications in large public-events.
- **The Málaga Platform.** Automated orchestration and management of different network slices over multiple domains, on top of the 5G NR and fully virtualised core network to showcase mission critical services in the lab and in outdoor deployments.
- **The Limassol Platform.** Radio interfaces of different characteristics and capabilities, combining terrestrial and satellite communications, integrated to showcase service

continuity and ubiquitous access in under-served areas.

- **The Surrey Platform.** Multiple radio access technologies that can support massive Machine Type Communications (mMTC), including 5G NR and NB-IoT, combined under a flexible Radio Resource Management (RRM) and spectrum sharing platform to showcase massive IoT services.
- **The Berlin platform:** Ultra dense areas covered by various network deployments, ranging from indoor nodes to nomadic outdoor clusters, coordinated via advanced backhauling technologies to showcase immersive service provisioning.

How to get involved

The main objective of 5GENESIS is to support verticals in early validation of their services with the first 5G experimental platforms. The primary way to access and experiment on the 5GENESIS platforms is through collaboration in the context of 5G PPP projects. However the platforms are also open for experimentation with other Horizon 2020 and national initiatives.

You can find more information on how to get involved for experimentation at <https://5genesis.eu>, but also via our social media channels, the 5GENESIS Handbook available online and the upcoming YouTube video tutorials.

Convergent 5G satellite-terrestrial system and beyond – ESA testbed SATis5



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Within 5G, satellite communications has become an integral part of the global carrier grade systems, supporting a large number of 5G use cases. This article presents the European Space Agency’s SATis5 testbed and the critical technology elements which have to be addressed for satellite-terrestrial convergence.

With its specific capabilities of wide area coverage, availability with minimal infrastructure, broadcasting and security, satellite communications is natively addressing most of the new 5G use cases. Such use cases include multimedia distribution – both live and on demand – and the means for dynamic content and context acquisition. Similarly, satellite networks offer an alternative in dense urban areas for the deployment of dedicated connectivity islands for sensors and other devices requiring communication either static, nomadic or mobile, see figure 1.

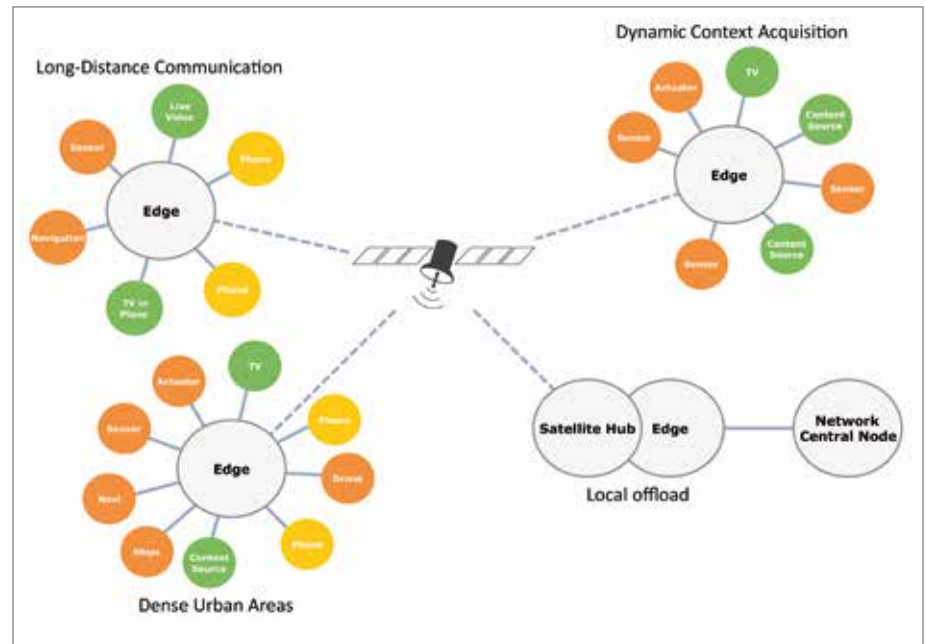


Figure 1: Convergent Satellite-Terrestrial Use Cases

By its specific nature, satellite is currently the best alternative for long distance use cases appropriately addressing the global communication. Additionally, with the new generations of low orbit / high capacity satellites, satellite communications offers characteristics close to terrestrial networks, e.g. regarding latency, while maintaining its specific advantages.

For the above reasons, there is a push in the 5G community towards the standardization of a convergent system, using the same architecture and mechanisms for both the terrestrial and the satellite networks. In order to support this standardization activity and for enabling a practical hands-on approach, the European Space Agency (ESA) has set up a testbed titled SATis5 which

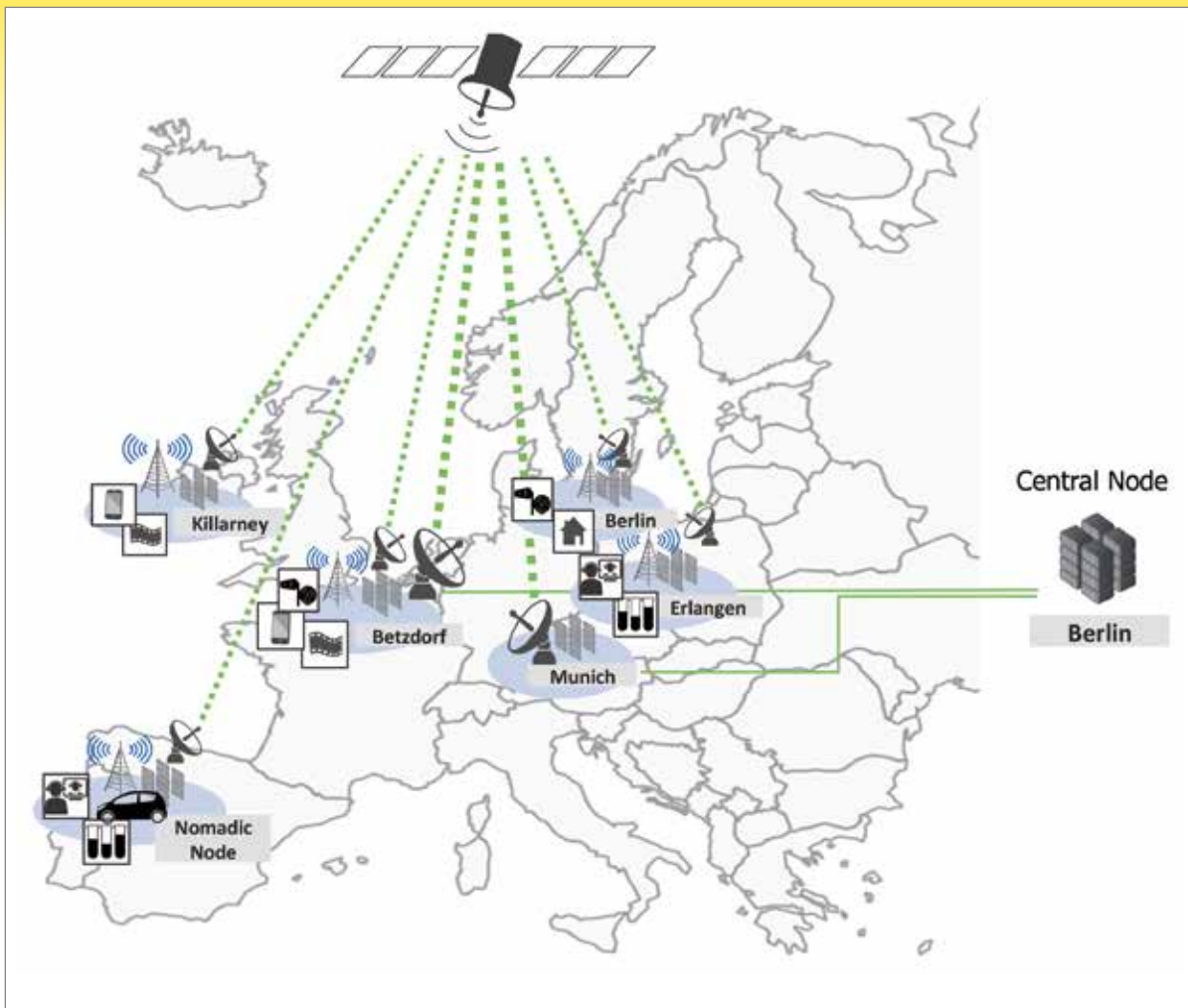


Figure 2: SATis5 Testbed

provides the means to test and evaluate the different use cases and scenarios. Below, details of the **SATis5** testbed and the critical technology elements which have to be addressed for the satellite-terrestrial convergence are described.

The ESA SATis5 testbed

The ESA SATis5 testbed represents a practical implementation of a convergent satellite-terrestrial system within the 5G environment. It includes a set of remote nodes in Killarney (Ireland), Betzdorf (Luxembourg) and Berlin and Erlangen (Germany) as well as a nomadic node enabling demonstrations at practically any location in Europe. The nodes are connected via two satellite networks and over best-effort mobile or fixed internet to two satellite hubs in Betzdorf, Luxembourg and Munich, Germany and further to a central node in Berlin, see figure 2.

These nodes address different local 5G testbed network deployments and different use cases including multimedia chain, remote internet access and IoT networks in order to showcase the capabilities of the satellite networks towards the different vertical markets. In order to be able to properly support these use case, SATis5 is based on a distributed slice architecture in which

the different network slices are deployed at the edge, aggregating the local communication and optimizing the remote communication as well as within a central location, through this further minimizing the impact of the long distance network within the system.

For this to be possible, the Fraunhofer FOKUS Open5GCore was optimized with different edge-central functional split models enabling local offload, partial local control and management appropriate to the specific use case needs. The testbed includes additionally an end-to-end slice orchestrator and a new solution for dynamically handling backhaul conditions for efficiently deploying and running end-to-end customized slices. Furthermore, SATis5 includes a first implementation of satellite 5G direct communication, in which the edge node acts as a 5G terminal and the hub as a 5G base station, enabling the satellite system to act as yet another 5G access network and thus, enabling easier integration into a carrier-grade telecom system.

Further research required

The initial over-the-air evaluation of the SATis5 testbed has shown that for a fully convergent 5G system, integrating satellite and terrestrial com-

ponents, there is still considerable research required. This includes mainly the convergence of the most appealing use cases for the satellite networks: broadcasting and communication island coverage. Most notably, new mechanisms are needed in 5G systems for the handling of simultaneous communication to a large number of devices in an optimised way, as opposed to the current individual bearer type environment.

Furthermore, for the island coverage scenarios, there is the need for an integrated control of the local access and of the long distance network. Considering the momentary network conditions, the system has to be able to allocate end-to-end resources for the communication both locally and to the central location, to handle backhaul interruptions or packet loss as well as to efficiently deploy and manage applications at the edge.

➤ **Further information** is available at <https://satis5.eurescom.eu/>.

The next phases of 5G

Insights from a 5G-VINNI workshop in Leganés



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On 20-21 February 2019, the 5G-VINNI project organised an open workshop in Leganes, Spain hosted by University Carlos III de Madrid (UC3M). The workshop aimed to explore the expected and desired next phases of 5G. The workshop brought together representatives from world-class telecom operators and vendors, representatives from the automotive, energy and security sectors, as well as academia. The discussion highlighted three essential directions which will contribute to shaping the future of telecommunication systems.

Expectations of verticals

One essential aspect clearly emerging from the workshop is: Verticals confirmed the expectation of applying 5G Systems (5GS) to mission critical services and applications, characterised by challenging performance and reliability requirements. This aspect requires the technology to evolve in the direction of improving performance and, more importantly, their predictability. Notable examples relate to: high precision relative lateral and longitudinal positioning for vehicular communications (with accuracy of 0.1m and 0.5m

respectively); Vehicular to Vehicular (V2V) and Vehicular to Infrastructure (V2I) Quality of Service (QoS) prediction; ultra-low latency communications for rail safety critical data (<10ms) and wide-area smart grid metering and sensing (<1ms) with four nines or 99.99% availability, or for Medium-Voltage/High-Voltage self-healing Smart Grid solution (<5ms) with six nines or 99.9999% availability. These are obviously just a few examples, but indeed sufficient to identify an important evolutionary direction: the integration of verticals' applications in 5GS will require further enhancements of QoS and Service Level Agreement (SLA) frameworks.

Mobile network operators approaches

Different Mobile Network Operators (MNOs) interestingly showed different perspectives, as end-customer behaviours, business opportunities and market regulations exhibit national differences. A common trait was nevertheless identified: MNOs seem inclined towards a "phased" approach towards 5G deployment, characterised by an incremental introduction of advanced features, starting from enhanced mobile broadband and then moving towards ultra-reliable low latency communication and massive machine-type communication, while focusing on further development of enablers which may allow entering new markets, e.g. in vertical domains. On the one hand, the conservative intention of providing 5G services starting from early deployments exploiting 4G EPC in Non-Stand-Alone configurations was evident. On the other hand there is a high interest in the evolution of technologies fa-

cilitating deployment of 5GS on third parties' infrastructures, integrating third parties functionalities on the MNOs' owned infrastructures, and even enabling integration of public and non-public networks.

The relevance of trials and early deployments

The innovation-driven attitude which motivates the effort (especially) of vendors, always aiming at system enhancements, requires concrete use cases and business justification. The workshop highlighted the uncertainty on the speed of 5G adoption by verticals market, and which could slow down the pace of 5GS evolution. Moreover, the first phase of 5G (corresponding to 3GPP Release 15/16) already includes a massive set of new features and enhancements compared to 4G, which necessity is still unclear, and which will take time to be consolidated and deployed. In this scenario, several MNOs would rather consider as source of innovation and inspiration for the next 5G phases, the insights gained from early trials, tests and large scale deployments, which might highlight concrete limitations or necessary improvements. For example, the radical innovation featured by 5G core network, which includes service based interfaces and a brand new protocol suite, must still answer the question about its scalability at carrier grade. The bottom line is: early trials and deployments are expected to provide essential insights for 5GS evolution.

Conclusions

The 5G-VINNI workshop collected clear indications on the next phases of 5G research and standardisation from a number of verticals, MNOs and vendors. The immediate evolution of 5GS will have to consider QoS and SLA framework enhancements satisfying the most challenging vertical use cases, and will have to develop enablers allowing a more flexible integration of MNOs' and verticals' infrastructures and functionalities. This seems to be an agreed vision from the representative sample of 5G actors that the workshop brought together and who consider the insights gained from early trials and deployments of paramount importance.



Participants of the 5G-VINNI workshop

From 5G experiments to business validation

5G trials workshop at IEEE ICC 2019 in Shanghai



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The 5G PPP project 5G-DRIVE and China Mobile Research Centre jointly organised the first workshop on '5G-Trials – From 5G Experiments to Business Validation' in Shanghai on 20 May 2019. It was part of the IEEE International Conference on Communications (ICC) at the Oriental Riverside Hotel in China's largest city.



A large number of 5G trials are currently being organised around the globe. In the current phase of 5G evolution, where the design phase has been successfully completed and the first set of standards has been released, the focus is now on trialling. The goal of the workshop was to take a snapshot and get feedback from some of the ongoing 5G trialling activities, and also to discuss potential market opportunities for 5G.

The organisers of the workshop, 5G PPP project 5G-DRIVE and China Mobile Research Centre, are running a joint project on 5G trialling between the EU and China. As they are well connected in the 5G community, they were successful in distributing the call for papers for this workshop. With 30 paper submissions received, this workshop was ranked number 2 among all 29 workshops. In line with IEEE rules that require a 50% rejection rate, 15 papers were retained. The paper presentations together with three invited keynote speeches and two panel discussions filled a long and interesting day for the about 40 workshop attendees.

In the welcome talk the author of this article gave an overview of 5G trial activities in Europe and showed some statistics on trials per country,



Panelists of the first panel session on the potential of 5G for verticals (from left): Matti Kutila, VTT; Maurizio Cecchi, Associazione PIIU; Latif Ladid, IPv6 Forum, University of Luxembourg; Chih-Lin I, China Mobile Research Institute; and Uwe Herzog, Eurescom

spectrum usage, the participation by vertical sectors in 5G trialling activities and the size of larger trials and first 5G roll-outs around the globe.

In the first keynote speech, Chih-Lin I from China Mobile Research Institute gave her view on "The Twists and Turns of the 5G Journey", which gave a glimpse on the 5G activities of China Mobile and a comprehensive tapping into various aspects of 5G down to more recent topics as e.g. O-RAN which aims at open interoperable interfaces and RAN virtualisation.

In the second keynote, Matti Kutila from VTT shared his insights on activities "Towards Connected and Highly Automated Driving", which are being addressed in 5G-DRIVE and national projects in Finland.

In the first session, five papers on "Recent 5G Trial Activities and Trial Results" were presented. This included a paper about '5G Trial Cooperation between EU and China', an overview of the 5G EVE end-to-end 5G facility for extensive trials, presented by Maurizio Cecchi, and presentations on recent trials of G.metro-based passive WDM fronthaul and database supported flexible spectrum access.

The second session addressed aspects related to the 5G architecture and enabling technologies. Results from a number of interesting areas were presented, including the deployment of a 5G architecture for crowd events, an indoor positioning platform to support 5G location based services, and the application and experiments of 5G technology-powered industrial Internet. The third paper session, finally, addressed aspects related to the performance analysis of 5G technologies.

Two interesting panel discussions were organised: one on the potential of 5G for verticals, and the other on challenges in 5G trials. In the panel 'Potential of 5G for Verticals', which was moderated by Wei Deng from China Mobile Research Institute, an interesting debate took place about what revenue operators can assume to actually generate from providing 5G services for vertical sector companies.

There was no doubt among the panelists that there seems to be large potential for operators in this area. At the same time the increasing interest from vertical sectors to get individual frequency spectrum allocated, which would allow verticals to build their own 5G network, seems to contradict this. It indicates a certain doubt, at least among some of the verticals, whether they are happy to let operators provide the network for them. A study from a consulting firm was quoted which estimates that about 80-90 % of 5G revenue will come from eMBB type services, which would leave only 10-20 % for other services – including those for verticals. The panel concluded that keeping the view open into all directions for future 5G revenue is probably a good approach in this early phase of 5G commercialisation.

✦ **Further information:** Workshop website – <https://icc2019.ieee-icc.org/workshop/w03-5g-trials-5g-experiments-business-validation/program>

News in brief

Blacklist of most breached passwords published by NCSC

Millions of people worldwide are using easy-to-guess passwords on sensitive accounts. The most widely-used password on breached accounts is '123456'. This is the result of an analysis performed by the UK's National Cyber Security Centre (NCSC) in collaboration with US security expert Troy Hunt, who runs the 'Have I Been Pwned' website. The analysis is based on a blacklist of the 100,000 most breached passwords, which was published on the NCSC website in April 2019.

The password '123456' has been breached 23 million times. The second-most popular string, '123456789', was not much harder to crack. Others in the top five included 'qwerty', 'password' and '1111111'. The most common name to be used in passwords was 'Ashley', followed by 'Michael', 'Daniel', 'Jessica' and 'Charlie'. The NCSC experts warn users that even a more complex password is not secure, as the example of 'oreocookie' shows, which has been cracked over 3,000 times.



The published blacklist is meant to help users, developers and system administrators avoid passwords that can be easily breached. The NCSC recommends that users should string three random but memorable words together to create a strong password.

✦ Further information at <https://www.ncsc.gov.uk/blog-post/passwords-passwords-everywhere>

EC recommends common EU approach to 5G security

On 26 March 2019, the European Commission published recommendations for ensuring a high level of 5G network security across the EU. They include a set of actions to assess cybersecurity risks of 5G networks and to strengthen preventive measures. The recommendations are a combination of legislative and policy instruments meant to protect economies, societies and democratic systems in the EU. In a press release the Commission pointed out that 5G is a key asset for Europe to compete in the global market, and its cybersecurity is crucial for ensuring the strategic autonomy of the Union. Any vulnerability in 5G networks or a cyber-attack targeting the future networks in one Member State would affect the Union as a whole, according to the Commission.

Next steps include that Member States complete their national risk assessments by 30 June 2019 and update necessary security measures. In parallel, ENISA will complete a 5G threat landscape that will support Member States in the delivery of an EU-wide risk assessment by 1 October 2019. Once the Cybersecurity Act – which at the time of writing is pending approval by the European Council – enters into force, the Com-



mission and ENISA will set up an EU-wide certification framework. Member States are encouraged to cooperate with the Commission and ENISA to prioritise a certification scheme covering 5G networks and equipment.

✦ Further information at http://europa.eu/rapid/press-release_IP-19-1832_en.htm

Open Call of 5G METEORS



On 24th May 2019, the first open call of 5G METEORS was launched. 5G METEORS is an activity for satellite communication in 5G funded by the European Space Agency (ESA). It implements and operates a framework supporting dynamic prototyping in the 5G satellite convergence domain.

✦ Further information at <https://5gmeteurs.eurescom.eu/open-calls>

Deadly selfies

The unhealthy side effects of a social media phenomenon



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In July 2018, 19-year-old Gavin Zimmerman from Utah stood on a cliff in Sydney's Royal National Park at a whale watching event and took a selfie. Then he slipped, fell off the cliff and died. The young American is not the only one who had to pay dearly for a spectacular selfie. And the number of selfie-related accidents seems to be still growing.

Between 2011 and 2017, the quest for extreme selfies killed 259 people, an average of 37 per year, according to a global study published by the US National Library of Medicine in 2018. For comparison: the average number of fatal shark attacks in the period 2011–2015 was 8. This means selfies kill almost five times more people than sharks.

Causes of selfie deaths

What is driving some individuals to take extreme risks for an impressive photo of themselves? In order to get closer to answering this question, we should consider who the victims of selfie-related deaths are. Almost three quarters of them (72.5%) are male. The average age is 23 years. Most selfie deaths and selfie-related incidents have been reported in India followed by Russia, the United States, and Pakistan. The main reasons of selfie deaths were drowning, transport accidents, and falling from considerable heights.

Not surprisingly, the study found out that risky behaviour caused more selfie-related deaths and incidents than non-risky behaviour. Selfie deaths in males are about three times more likely to be caused by risky behaviour than non-risky behaviour. In contrast, deaths in females are less due to risky behaviour than non-risky behaviour. According to another study from 2017, the most frequently reported accident type was falling from a sizable height to the ground.

Thus, a typical victim would be a 23 year old Indian male falling from a cliff while taking a selfie. Research confirms, what you would have guessed anyway. At all times, young males brimming with testosterone have tried to prove to their



Smile – It could be our last selfie! (Photo: Julia Orige, Pixabay)

peers and themselves how brave they are. What is new is the ubiquitous temptation by social media. While narcissism is as old as humankind, social media and smartphones have provided the means for amplifying anyone's posing in front of millions of people. If you are a male in your early twenties who sees Facebook photos of his friends posing on cliffs and mountaintops, the social pressure is high to post a cool selfie of yourself standing at a cliff as well.

While it was possible in the early days of selfies, to impress your peers with a selfie of yourself and a celebrity that is no longer enough to impress anyone who hasn't lived under a rock for the last decade. Social media have accelerated an upward spiral towards more spectacular photos and videos, in order to catch the attention of an audience overloaded with billions of images. Selfie deaths are the tip of the iceberg within the self-accelerating dynamics of social media usage.

Measures against selfie accidents

What can be done to reduce the number of selfie-related fatalities? The authors of the 2018 US study recommend that 'No selfie zones' should be declared across tourist areas, especially at places such as water bodies, mountain peaks, and tall buildings to decrease the incidence of selfie-related deaths. This recommendation is not new.

In India, authorities had already taken action along these lines in 2016. The Indian Ministry of Tourism had asked federal states to identify and

barricade 'selfie danger' areas. Mumbai Police identified at least 16 danger zones, after a man drowned attempting to save a selfie-taker. No-selfie zones were also established in certain areas of the Kumbh Mela, a mass Hindu pilgrimage of faith, because organizers feared that bottlenecks caused by selfie-takers could cause stampedes. In summer 2018, the Indian state of Goa declared 24 "no-selfie zones" along its coastline after a spate of deaths and injuries.

To my knowledge there is so far no evidence on the effectiveness of such warning signs. In some cases, it could help make selfie junkies aware of the risks they would otherwise neglect. However, it remains doubtful, if signs will stop hardcore selfie junkies in their quest for an impressive photo of themselves against a spectacular backdrop.

Conclusion

As long as the root causes of selfie deaths – social-media-enhanced narcissism and limited risk awareness – are not addressed by counter measures beyond warning signs, there will be more unfortunate and avoidable fatalities. While society has a certain responsibility to help young selfie junkies stay unharmed, it is ultimately up to the individual to take care of his own safety. No amount of education, fences and warning signs will stop some reckless youngsters do stupid things. We can only hope that cliff selfies fade in popularity.



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