5G PPP

PUBLIC-PRIVATE PARTNERSHIP

5G PPP PROJECTS

PHASE 3

5G PPP

PUBLIC-PRIVATE PARTNERSHIP

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INTRODUCTION
FROM THE EUROPEAN COMMISSION

The third Phase of the 5G Public-Private Partnership co-financed by the European Commission under the Horizon2020 research and innovation programme fully reflects the European 5G policy based on a massive adoption of 5G network infrastructures by vertical industries.

Today, the vast majority of commercial 5G deployments are focused on the classic eMBB use case, expanding the success of mobile technologies to address broadband application initiated by 4G. However, the full promise of 5G based on the implementation of the Standalone option to serve advanced use cases from vertical industries is still to fully materialise.

The 5G PPP Phase 3 provides massive support to this objective, with comprehensive trial and pilot opportunities offered not only to the ICT industry but also to vertical user industries to test their innovative use cases with large scale 5G infrastructures. With 53 running projects representing a € 430 million public investments, more than 570 beneficiaries including about 80% of industrial actors and more than 40% of SMEs, this third Phase represents one of the largest incentive programme towards 5G adoption by industrial users in the world. It has allowed to make available a comprehensive pan European 5G trial infrastructure with more than 30 nodes allowing to validate a multiplicity of use cases. As part of the most advanced and mature use cases, Connected cars and Industry 4.0 represent flagship application domains with a flurry of successfully validated use cases such as cooperative lane merger, see-through, remote driving, seamless service provision in cross-domain scenarios, robotic applications, massive collaborative robots operations and many more. But many other domains have also been successfully addressed, notably healthcare and remote monitoring and operations, collaborative media production, logistic application in harbours, public safety life-critical intervention, connected ambulances, large scale events with PMSE applications, and many more. All these applications have allowed to validate specific 5G benefits in their specific context and demonstrated that their objective would not have been achieved with previous generations of technologies. In that context, the benefits of low latency, secure slicing and isolation, very high reliability, high density of communicating objects have been largely validated, in addition to the much larger capacity and communication speeds offered by 5G. The interesting reader will find on the 5G PPP web site the Trial and Pilot brochure n° 2 that outlines a representative sample of the results achieved.

Beyond pilots, the third Phase of the 5G PPP has also allowed to progress on specific technological issues contemplated by 3G PP for future releases. Typical cases includes very high precision positioning, industrial IoT, broadcast option, NTN scenarios including satellites or drones, blockchain-based security to name a few.

Finally, this third Phase prepares our European stakeholders to the future, with the implementation of 9 projects dedicated to early studies on what Beyond 5G or 6G could be. With multiple 6G initiatives being launched worldwide to prepare for a 6G commercial introduction around 2030, these projects provides an important platform to federate views and innovative ideas of European stakeholders. They prepare for the successful launch of our next initiative, the "Smart Networks and Services" partnership, planned to officially be launched by the end of 2021 with a sizeable budget support of € 900 million from the European Commission.

In the meantime, I invite the interested readers to visit the PPP and projects websites which include a multiplicity of interesting documents and white papers. I take this opportunity to warmly thanks the project participants for their undivided commitment to make the 5G PPP a success story and to boldly contribute to a successful "5G Europe".

Bernand Barani
Deputy Head of Unit, DG Connect, European Commission

INTRODUCTION
FROM THE 5G INDUSTRIAL ASSOCIATION

The 5G Infrastructure PPP programme and its related projects are achieving outstanding progress and impact over the three consecutive phases of the initiative: specification, development, and experimentation/pilots. This has been regularly highlighted in the PPP programme and projects websites and news.

The 5G PPP Phase 1 had 19 projects involved in the specification activities and this grew with 21 new projects in the Phase 2 development period.

Phase 3 is now fully launched and it has 53 projects not only performing experiments with new technologies and applications in user focussed pilots, but also has some project looking beyond 5G to see how we can further improve the communications infrastructure and, based on what we have learned developing 5G, start considering where further advances are possible and what could be learnt in 2030 from 6G.

This means there have been a total of 93 projects launched in the 5G PPP and we are right now at the peak of project activity with over 50 5G PPP projects running concurrently.

This brochure focussed on the 5G PPP Phase 3 activities which include an impressive number of 5G Trials and Pilots in many different Vertical Sectors, covering among others Automotive, Industry, Media & Entertainment, Public Safety, Health, Energy, Smart Cities, Transport & Logistics...

As clearly visible in this document, most of these Phase 3 Projects can have a strong social impact by validating future services that can be monetized and/or bring a unique innovation in terms of technologies and/or applications to the benefit of the users of future infrastructures and services.

We encourage you to look at all the Phase 3 projects presented here and consider that apart from providing the technological enablers for innovative services in the context of 5G, they are also providing stepping stones to the 6G Smart Networks and Services of the future.

We now invite you to join the industrial association https://5g-ia.eu/ and help in the community action to design and develop and continually improve the next generation of innovative and inclusive communications infrastructure to benefit society, industry and the environment and to make our lives better in every sense.

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Collin Willcok
Chairman, 5G IA

SMES INVOLVEMENT IN THE 5G PPP

With the advent of Phase 3 of the 5G PPP, the SME participation in 5G PPP projects has exceeded the original objective of 20% participation defined as a key performance indicator of the programme. According to the H2020 dashboard, **the participation of SMEs in the 5G PPP has reached 21.95% of EU funding,** representing a total of 156.3 M€ . SMEs have contributed to 24.43% of the total participation in 5G PPP projects. 65% of the SMEs participated in one project, and 35% in two or more projects.

167 SMEs are participating in 5G PPP Phase 3 projects, for a total EC funding in the range of 100 M€. Although the participation of SMEs in 5G PPP projects has been quite stable throughout the various phases of the programme, Phase 3, and more especially the call dedicated to "5G innovations for verticals with third party services", allowed the participation of SMEs to finally exceed the objective. The EC funding for SMEs reached 49% in this specific call, in line with the recommendation from the call text that "50% of SMEs are targeted for this action". Remarkably enough, despite this peak in participation with this call for Innovation Actions (IAs), the global level of participation of SMEs in Research and Innovation Actions (RIAs) and in IAs is similar in the 5G PPP.

Reaching the objective defined as a KPI in the 5G PPP for SME participation was supported by the activities of the NetworldEurope SME Working Group (SME WG). The SME WG has been working closely with the 5G Infrastructure Association (5G IA) and the 5G PPP. Dedicated SME-related web pages were regularly revisited and updated, to match the various topics in the 5G PPP calls . A dedicated SME brochure was periodically released . The latest version, entitled "European SME Expertise in 5G and Beyond", includes detailed information on more than 60 European SMEs, along with significant success stories, most of which are related to the participation of SMEs in 5G PPP projects.

It is worth noting that the "Find the SME you need" web page is the most consulted page on the NetworldEurope website after the home page. This clearly shows the interest among all stakeholders in the 5G ecosystem.

The interest of the SMEs in the 5G PPP, and more generally in H2020 and in the upcoming Smart Networks & Services (SNS) Partnership planned for Horizon Europe, continues to be high. Membership in the SME WG has regularly increased in the past few years, reaching 200 members, out of which 170 are SMEs. SME contribution to the SNS Partnership was illustrated with a position paper highlighting recommendations, comments and questions from SMEs . Besides, the SME contribution is being conveyed and considered by the 5G IA Board and the 5G IA Vision WG sub-group, working on the draft of the 1st SNS work programme.

The "European SME Expertise in 5G and Beyond" brochure

SMEs are looking forward to achieving significant results in the 5G PPP Phase 3 projects, and to continuing and strengthening their involvement in the 5G and 6G ecosystem via the SNS Partnership.

Jacques Magen
Chair, NetworldEurope SME Working Group

COORDINATION AND SUPPORT ACTIONS

Full5G

FULFILLING THE 5G PROMISE

Coordinated by David Kennedy (Eurescom)

September 2019 ──────────► September 2021

@5GPPP   5g-ppp.eu

MAIN OBJECTIVES & CHALLENGES

The Full5G project has a prime objective to facilitate the activities of the European 5G Initiative, as outlined in the 5G contractual Public-Private Partnership.

Moreover, Full5G has an objective to capture and promote the achievements of the 5G PPP and monitor impact these results have had on the evolution of 5G in Europe over the period of life of the 5G PPP. This work will also look to the future and consider what additional actions are necessary to maintain the European momentum

and leadership in 5G, as it moves towards Smart Networks, and facilitate the uptake of 5G by the European vertical sectors. Full5G works to progress the 5G PPP high level goal of maintaining and enhancing the competitiveness of the European ICT industry, and seeking European leadership in the 5G domain. The Full5G project also has the underlying ambition to ensure that European society, via the Vertical sectors, can enjoy the economic and societal benefits these future 5G networks will provide.

APPLICATIONS & EXPECTED IMPACT

Full-5G is mapping the path from the first 5G systems to future smart networks as a seamless, infinitely-flexible system. Assessing the outcomes of past and currently active 5G-PPP projects the Vision Working Group is working for road-mapping for the transition from Phase 3 to the Smart Network Era and the NetWorld2020 SRIA.

Full-5G is ensuring the continuity between the results of 5G PPP and Smart Network and Services programme in the Horizon Europe context, maximising cross-over of results and ideas by disseminating key 5G PPP project

results through white papers, workshops and deliverables towards Horizon Europe participants.

Full5G plays a primary role in ensuring broad visibility, impact and support to the 5G PPP Initiative. Its dissemination activity spans across editorial publications, such as the European 5G Annual Journal, dedicated verticals and working groups brochure, periodic press releases, a dynamic 5G PPP portal, aggregating projects news and results and a growing presence on social media.

CORENECT

EUROPEAN CORE TECHNOLOGIES FOR FUTURE CONNECTIVITY SYSTEMS AND COMPONENTS
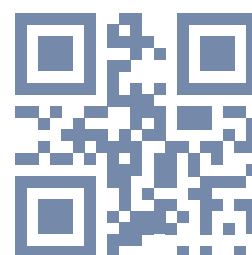
Coordinated by Gerhard Fettweis/Yaning Zou (TUD)

July 2020 ⟶ July 2022

@core_nect   corenect.eu

COREnect
European Core Technologies for future connectivity systems and components

MAIN OBJECTIVES & CHALLENGES

Core technologies are critical for European technological sovereignty. To decrease Europe's dependence on American and Asian technologies in the Smart Networks and Services domains, Europe must reinvent its strategy for developing core technologies for 5G and beyond, which requires concrete and coordinated actions from both the telecommunications and the microelectronics sectors. In COREnect, European industry and R&D leaders from both the microelectronics and the telecommunications sectors are jointly developing a high-level strategic roadmap of core technologies for future connectivity systems and components, targeting the next-generation telecommunications networks and services.

The main objectives of COREnect are a) To bring European major players in microelectronics and telecommunications together to develop a strategic roadmap of core technologies for future connectivity systems, and therefore to decrease European dependence on other continents and strengthen its technological sovereignty in 5G and beyond; b) To establish a connection and collaboration between the Smart Networks and Services (SNS) and the Key Digital Technologies (KDT) communities at Strategic Research and Innovation Agenda level; c) To promote COREnect results to stakeholders in both private and public sectors and create the condition for one or more European champion(s) in the domain of core technologies to attain technology sovereignty in future connectivity systems.

APPLICATIONS & EXPECTED IMPACT

The goal of COREnect is to establish sustainable European technology sovereignty in 5G and beyond, promote innovation and business opportunities e.g., for SMEs, pave the way for one or more future European champions in this area, and lay a solid foundation for the long-term success of both industries.

COREnect conducts a comprehensive landscape and impact analysis, encompassing the whole value chain from vertical applications and the design of future connectivity platforms at the system level to microelectronics ecosystems. Based on the identified technological gaps, COREnect will define a strategic roadmap to achieve European technological sovereignty in 5G and beyond in the next 5 to 10 years. To this

end, they will be supported by external experts from both the Smart Networks and Services (SNS) and Key Digital Technologies (KDT) communities. Experts will be divided into three groups dedicated respectively to "Computing/ Storage Core Technologies for Future Networks", "Communications/Sensing Core Technologies for Future Networks", and "Peripheral Core Technologies for Future Networks". Thanks to its extensive industry and academia network, COREnect has the potential to significantly impact the European R&I and the industry landscape of future connectivity systems.

INFRASTRUCTURE

5G EVE

5G EUROPEAN VALIDATION PLATFORM FOR EXTENSIVE TRIALS

Coordinated by Mauro Boldi (TIM)

July 2018 ⟶ July 2021

@5G_EVE   5g-eve.eu

5G EVE

MAIN OBJECTIVES & CHALLENGES

5G EVE is further developing and interconnecting existing sites in France, Greece, Italy, and Spain to form a unique 5G end-to-end facility. The four sites are interconnected to provide a seamless single platform experience for experimenters from vertical industries. The 5G EVE end-to-end facility enables experimentation and validation with full sets of 5G capabilities.

Specifically, the technical objectives include:

- Implementing 3GPP Release 16 compatible technologies on the four sites, starting from the evolutions of current Release 15. Specific pilots validate that 5G KPIs can be achieved;

- Creating intent-based interfaces to simplify access to the 5G end-to-end facility;

- Designing and implementing site interworking and multi-x slicing/orchestration mechanisms;

- Implementing a vertical-oriented open framework;

- Creating advanced 5G testing and measurement mechanisms to validate advanced 5G features and KPIs;

- Advanced data analytics on the output of monitoring processes for anticipating network operations.

APPLICATIONS & EXPECTED IMPACT

The 5G EVE results are expected to significantly contribute to the following technological and economic impacts:

- Contribution to the implementation of cross-industry 5G standards and a common architecture definition.

- Demonstration of the implementation of real vertical sector requirements.

- Accelerated development of the European innovation ecosystem for 5G with a full set of capabilities.

- Timely development and launch of compelling 5G services and applications by the European industry.

- Improved positioning of the European industry in the global 5G market.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

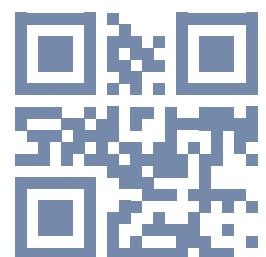Industry 4.0   Automotive   Transport & logistics   Smart cities & utilities   Energy   eHealth & wellness   Media & entertainment

5GENESIS

5TH GENERATION END-TO-END NETWORK, EXPERIMENTATION, SYSTEM INTEGRATION, AND SHOWCASING

Coordinated by Harilaos Koumaras (NCSR Demokritos)

July 2018 ⟶ December 2021

@5genesis_h2020   5genesis.eu

5Genesis

MAIN OBJECTIVES & CHALLENGES

5G provides the space to enhance the network architecture, in view of emerging technologies and features triggering the burst of performance, from network and user perspective, towards ultimate capabilities far beyond 4G. In this context, the main goal of 5GENESIS is to validate 5G KPIs for various 5G use cases, in both controlled set-ups and large-scale events, for various types of verticals. This happens by bringing together results from other EU projects as well as the partners' internal R&D activities. The main objectives of 5GENESIS are:

- Design and establish a 5G experimentation blueprint that unifies diverse 5G components to support verticals over an end-to-end virtualized and sliced network.

- Develop a 5G Facility that instantiates the identified experimentation blueprint in 5 interoperable end-to-end platforms.

- Assess and validate business, performance, and societal 5G PPP KPIs in representative 5G use cases.

- Continuously align with and contribute to the evolution of 5G standards by adopting an iterative integration and upgrade development methodology.

- Release a portable 5G Demonstrator to maximize visibility and facilitate dissemination and communication activities.

APPLICATIONS & EXPECTED IMPACT

Using the current releases of the 5G Architecture, the 5GENESIS defines a 5G experimentation blueprint that serves as a common architectural reference. This blueprint includes an openness framework, the OPEN 5GENESIS Suite with APIs for exposing the facility to verticals for experimentation. This blueprint is based on five diverse but interconnected 5GENESIS platforms in terms of capabilities across

Europe. These platforms feature the evolution of existing testbeds, already owned and operated by the 5GENESIS partners, suitable for large-scale field experimentation. Most of them are in cities already identified by the 5G-PPP as "5G Trials Cities". Thoroughly, the five 5GENESIS 5G experimentation sites are: Athens, Málaga, Limassol, Surrey and Berlin.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP
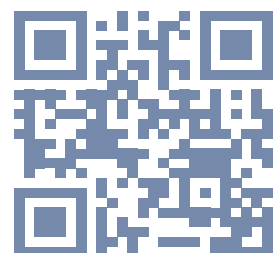
Transport & logistics

Smart cities & utilities

Public safety

Media & entertainment

5G-VINNI

5G VERTICALS INNOVATION INFRASTRUCTURE

Coordinated by Pål Grønsund (Telenor ASA)

June 2018 ⟶ June 2021

@5gVinni

5g-vinni.eu

MAIN OBJECTIVES & CHALLENGES

5G-VINNI designs and deploys an advanced and accessible 5G end-to-end facility based upon several interworking sites. The project provides user-friendly zero-touch orchestration, operations, and management systems for the 5G-VINNI facility. The facility is used to validate the 5G performance KPIs and supports the execution of end-to-end trials of vertical use cases that exploit the 5G-VINNI capabilities. Furthermore, the project develops a business and ecosystem model to support vertical application pilots using the 5G-VINNI facility during and beyond the time span of the project. Finally, it demonstrates the value of 5G solutions to the 5G community, particularly to relevant standards and open-source communities, securing widespread adoption of these solutions. The 5G-VINNI facilities exhibit the following capabilities: (i) 5G NR RAN in 26GHz, 3.5GHz, and other bands. (ii) 5G Core supporting 5G NSA in 2019 and 5G SA in 2021. (iii) Support for eMBB, URLLC, and mMTC (NB-IOT and LTE-M) slice types. (iv) End-to-end Service Orchestration. (v) Network Function Virtualization (NFV). (vi) Multi-Access Edge Computing (MEC). (vii) Satellite backhaul options. (vii)Interconnection and interworking among main facility sites.

APPLICATIONS & EXPECTED IMPACT

5G-VINNI accelerates the uptake of 5G in Europe by providing an end-to-end facility that lowers the entry barrier for vertical industries to pilot use cases and supports the pilots as the infrastructure evolves. The main 5G-VINNI facility sites located in Norway, the UK, Spain, and Greece offer services targeting projects in the context of advanced 5G validation trials across multiple vertical industries. The 5G-VINNI facility offers the following services: (i) Device Connection (eMBB, mMTC). (ii) Network Slice as a Service (eMBB, URLLC, mMTC). (iii) Customized Network Slice. (iv) Hosting of third-party VNF in Slice. (v) Distributed IoT Data Fabric Service in Slice. (vi) Integration of new non-5G-VINNI gNB. (vii) Integration of new non-5G-VINNI MEC node. (viii) Interworking with non-5G-VINNI facility sites. (ix) Testing services (KPIs). (x) Security as a Service. (xi) The 5G-VINNI facility is used by several applications in the vertical domains including Industry 4.0, Smart Cities and Utilities, Defence, Public Safety, Energy, e-Health, Wellness, Media and Entertainment, and Transportation.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

Transport & logistics

Smart cities & utilities

Public safety

Energy

eHealth & wellness

Media & entertainment

AUTOMOTIVE

5GCROCO

FIFTH GENERATION CROSS-BORDER CONTROL

Coordinated by Jesús Alonso Zárate (CTTC)

November 2018 ⟶ November 2021

@5GCroCo   5gcroco.eu

MAIN OBJECTIVES & CHALLENGES

The possibility of providing cooperative, connected, and automated mobility (CCAM) services in Europe where vehicles traverse various national borders has huge innovative business potential. However, the seamless provision of connectivity and the uninterrupted delivery of real-time services along borders poses technical challenges, which 5G technologies promise to solve.

Motivated by this, the 5GCroCo project aims to validate 5G technologies in the Metz-Merzig-Luxembourg cross-border corridor, traversing the borders between France, Germany, and Luxembourg. 5GCroCo is an Innovation Action partially funded by the European Commission where key European partners from both the telco and automotive industries joined efforts to trial and validate 5G technologies at a large scale in a cross-border setting, with the mission to reduce uncertainties before CCAM services running on top of 5G communication infrastructures are offered to the market.

APPLICATIONS & EXPECTED IMPACT

5GCroCo identified three use cases for the automated driving application domain that pose high demands to the telecommunication network side: (i) Teleoperated Driving (ToD), (ii) High Definition (HD) map generation and distribution for autonomous driving (HD Mapping), and (iii) Anticipated Cooperative Collision Avoidance (ACCA). The overall project objective is to reduce the uncertainties associated with CCAM services across borders in Europe in preparation for commercial 5G deployment and thus increase safety, efficiency, and mobility in Europe. 5GCroCo also aims to identify business opportunities and define new business models for disruptive CCAM services which are possible thanks to 5G technology, as well as ensuring the appropriate impact into relevant standardization bodies from both telco and automotive sectors.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Transport & logistics
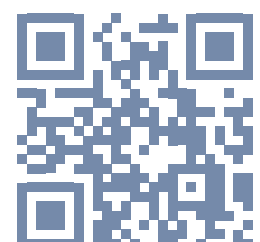
5G-CARMEN

Coordinated by Matteo Gerosa (Fondazione Bruno Kessler)

November 2018 ➝ November 2021

@5g_carmen   5gcarmen.eu

MAIN OBJECTIVES & CHALLENGES

The project supports the transformation of the automotive industry about the integration of vehicles on highways and urban environments, and how European citizens will use them in the near future.

From the very beginning, requirements for emerging V2X Communication have been collected, feeding the 5G-CARMEN system architecture design from sensors up to application software.

Native support is offered for MEC-assisted interworking between C-V2X and C-ITS platforms, distributed and multi-layer network-embedded edge clouds, end-to-end network slicing, highly accurate positioning and timing services, the predictive quality of service, and NR connectivity.

Moreover, besides the aforementioned technical aspects, a significant part of the 5G-CARMEN project is devoted to pilot real CCAM use cases over the Bologna-Munich corridor.

APPLICATIONS & EXPECTED IMPACT

Cooperative Manouvering - 5G CARMEN provides a platform through which vehicles can exchange speeds, positions, intended trajectories/ maneuvers, and other helpful data.

Situation Awareness - 5G-CARMEN promotes extended situation awareness by enabling vehicles and infrastructure to share their perception of the environment, which allows for detecting potentially dangerous situations well in advance.

Video Streaming - 5G-CARMEN investigated the synergies between LTE, 5G, C-V2X, and other technologies to satisfy not only the data rate requirements but also the needed coverage at all times.

Green Driving - 5G-CARMEN provides solutions geared towards the promotion of greener driving styles, which with time will lead to significant improvements in terms of air quality.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Transport & logistics

ADVANCED 5G VALIDATION TRIALS ACROSS MULTIPLE VERTICAL INDUSTRIES

5G-SOLUTIONS

5G SOLUTIONS FOR EUROPEAN CITIZENS
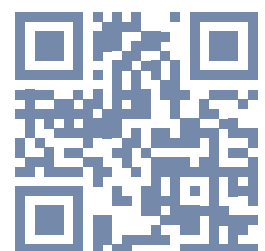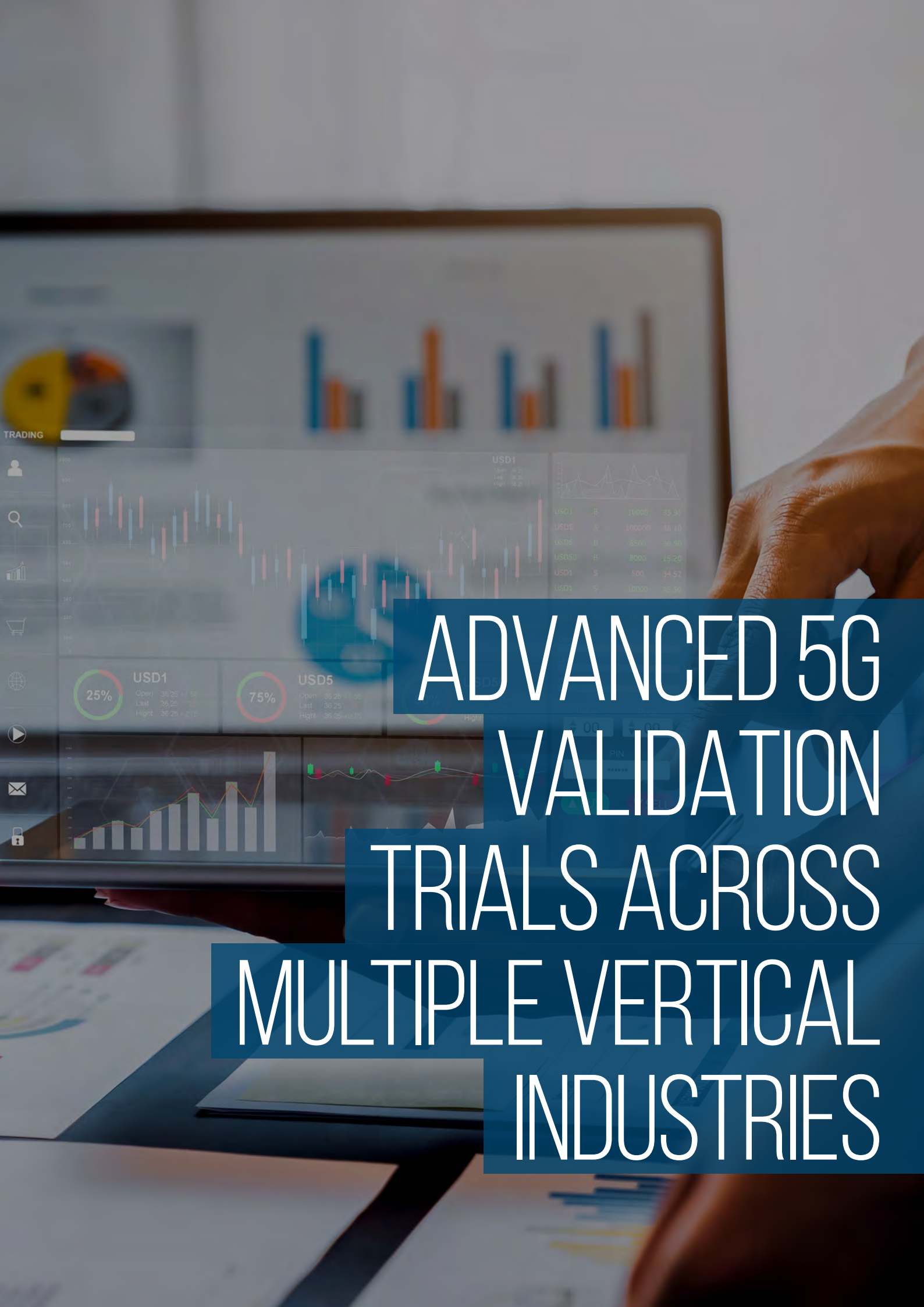
Coordinated by Andrea Di Giglio (Telecom Italia SPA)

June 2019 ⟶ June 2022

@5g_solutions   5gsolutionsproject.eu

MAIN OBJECTIVES & CHALLENGES

5G-SOLUTIONS' main objective is to conduct advanced field trials of innovative and thematically diverse digital services that require 5G capabilities and performance in a number of vertical domains, directly engaging with end-users to validate the technological performance of 5G technology in successfully serving them, as well as validate the business models and potential of these use cases prior to the commercial deployment.

5G-SOLUTIONS will interface with key ICT-17

facilities and develop the technological enablers for the validation of the use cases enabling the analysis of key challenges for performing multi and cross-domain service provisioning leveraging slicing and virtualization technologies. In addition, through the technical activities, 5G-SOLUTIONS will provide open-source APIs and interfaces to facilitate the interfacing with ICT-17 5G-EVE Turin and 5G-VINNI Norway and Patra facilities, as well as the development of new vertical applications by 3rd parties.

APPLICATIONS & EXPECTED IMPACT

5G-SOLUTIONS will validate more than 140 5G network-specific technological KPIs corresponding to 20 innovative and compelling industry use cases, covering vertical domains of Factories of the Future, Smart Energy, Smart Cities, Smart Ports, and Media and Entertainment to significantly accelerate and encourage the uptake of such services, as well as 5G in Europe.

5G-SOLUTIONS aims at maximizing the impact to the realization of the 5G Vision by conducting advanced field trials in Living Lab settings of such

key segments of the 5G market. 5G-SOLUTIONS is therefore likely to generate business and economic impact in key economic sectors, as well as accelerate 5G network deployment that would transform many aspects of the life of European citizens, e.g., the way they work, entertain themselves, etc. In addition, the project will endorse a business analysis based on the Living Labs ecosystem approach, creating a strong impact on future developers and SMEs.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP
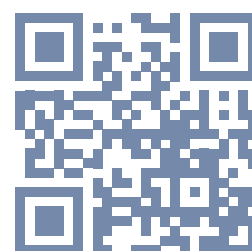
Industry 4.0   Smart cities & utilities   Smart airports/ ports   Energy   Media & entertainment

5G-TOURS

SMART MOBILITY, MEDIA AND E-HEALTH FOR TOURISTS AND CITIZENS

Coordinated by Silvia Provvedi (Ericsson)

June 2019 — June 2022

@5gtours   5gtours.eu

MAIN OBJECTIVES & CHALLENGES

The goal of 5G-TOURS is to get the European 5G Vision of "5G empowering vertical industries" [5GPPP16] closer to commercial deployment with highly innovative use cases involving cross-industry partnerships. 5G-TOURS addresses technological and business validation of 5G technology from two perspectives: (i) within the set of requirements specific from one application domain, and (ii) across all sets of heterogeneous requirements stemming from concurrent usages of network resources by different vertical domains.

Thus, the goal of the project is to demonstrate the benefits of 5G technology in the pre-commercial environment for real users, tourists, citizens, and patients by implementing 13 representative use cases in three different types of cities:

- Turin, a tourist city, focused on media and broadcast use cases,
- Athens, a mobility efficient city that brings 5G to users in motion,
- Rennes, a safe city where e-health use cases will be demonstrated.

APPLICATIONS & EXPECTED IMPACT

5G-TOURS will deploy full end-to-end trials to bring 5G to real users in a large number of representative scenarios. The trials will be executed to assess the technical capabilities of 5G against the requirements of each vertical domain. The 5G-TOURS ecosystem will be delivered in two deployments. The first one will present a restricted set of functions envisioned in the project's use cases, while the second deployment will showcase the full potential of the project. 5G-TOURS has a very high potential for technical (network products and services,

vertical solutions), economic, and social impacts, which the project will achieve by pursuing the following goals: (i) attract vertical industries to use 5G-TOURS technology; (ii) foster the widespread adoption of the technology beyond manufacturers and operators of the consortium; and (iii) protect the project findings to secure the commercial advantage of 5G-TOURS partners while fostering the adoption of the technology beyond the consortium to preserve its competetive advantage.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Transport & logistics   Smart cities & utilities   Public safety   Smart airports   eHealth & wellness   Media & entertainment

5G!DRONES

UNMANNED AERIAL VEHICLE VERTICAL APPLICATIONS' TRIALS LEVERAGING ADVANCED 5G FACILITIES

Coordinated by Jussi Haapola (University of Oulu)

June 2019 ——————————▶ November 2022

@5gdrones   5gdrones.eu

MAIN OBJECTIVES & CHALLENGES

The overall and ultimate objective of 5G!Drones is to design, implement, and run trials of UAV use cases on top of 5G infrastructures provided by two ICT-17 5G Facilities (5GENESIS and 5G EVE) and two additional sites (Oulu 5GTN and Aalto X-Networks) in Finland. The objectives related to the 5G!Drones concept and validation are:

Analysis of the performance requirements of UAV verticals' applications and business models in 5G.

- Design and implementation of the 5G!Drones software layer (or system) to execute UAV trials.

- Design of a high-level scenario descriptor language to run and analyze the results of the UAV trials.

- Design and implementation of 5G!Drones enablers for UAV trials and operations.

- Validation of 5G KPIs that demonstrate execution of UAV use cases.

- Validation of UAV KPIs using 5G.

- Advanced data analytics tools to visualize and deeply analyze the trial results, and provide feedback to the 5G and UAV ecosystem.

- Dissemination, standardization, and exploitation of 5G!Drones.

APPLICATIONS & EXPECTED IMPACT

5G!Drones drives the UAV verticals and 5G networks to a win-win position, by showing that 5G guarantees UAV vertical KPIs and demonstrating that 5G supports challenging use-cases that put pressure on network resources, such as low-latency and reliable communication, a massive number of connections, and high bandwidth requirements simultaneously. 5G!Drones builds on top of four 5G facilities while also identifying and developing the missing components to trial UAV use-cases. The four main 5G!Drones use cases are mentioned below (each one containing additional sub scenarios): UC1: UAV Traffic Management; UC2: Public safety/saving lives; UC3: Situation awareness; UC4: Connectivity during crowded events.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Transport & logistics

Public safety

Media & entertainment

5G-HEART

5G HEALTH AQUACULTURE AND TRANSPORT VALIDATION TRIALS

Coordinated by Haesik Kim (VTT)

June 2019 ——————→ November 2022

@5gheart   5gheart.org

5G HEART

MAIN OBJECTIVES & CHALLENGES

The overall objective of the 5G-HEART is to define and validate cost-efficient 5G converged network concepts, which enable an intelligent hub supported by multiple vertical industries. (i) To define and implement specific use cases of healthcare, transport, and aquaculture industries enabling testing and validation of typical 5G network KPIs like latency, throughput, capacity, connection density, mobility, and reliability. (ii) To define and develop 5G enhancements required for demonstration of Proof of Concepts (PoC), trials of multiple vertical services, such as transport, healthcare, and aquaculture industries, and demonstrate support for concurrency (simultaneous support of use cases from different vertical domains with diverse QoS requirements) in a scala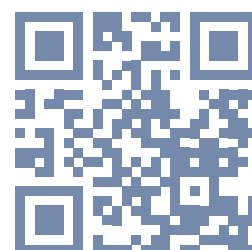ble manner. (iii) To describe and validate viable business models for the use cases tested across the multiple industry verticals. (iv) To implement and validate converged network functions on 5G end-to-end (E2E) platforms using virtualization and slicing to support multiple 5G use cases targeting the eMBB, URLLC, and mMTC scenarios. (v) To perform field trials and demonstrations of selected use cases involving multiple vertical services on the available 5G E2E platforms in order to assess how 5G can provide differentiated services across multiple verticals. (vi) To ensure extensive exploitation of project results through thoroughly planned dissemination and communication activities targeted towards carefully selected standardization bodies and industry associations.

APPLICATIONS & EXPECTED IMPACT

(i) Validated core 5G technologies and architectures in the context of specific vertical use cases and deployment scenarios, from high to low-density regions. (ii) Validated core technologies and architecture for differentiated performance requirements originating from eMBB, mMTC, and URLLC use cases, notably for end-to-end slicing and virtualization. (iii) Viable business models for innovative digital use cases tested and validated across a multiplicity of industrial sectors, including demonstration of required network resource control from the vertical industry business model perspective. (iv) Impactful contributions towards standardization bodies, involving vertical actors, for what concerns the second phase of 5G standardization. The participation of key European industrial partners with high standardization impact is desired. (v) Validation of relevant KPIs with services and outcomes linked to specific vertical sectors.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Agriculture & agri-food   Automotive   Transport & logistics   eHealth & wellness

5GROWTH

5G-ENABLED GROWTH IN VERTICAL INDUSTRIES

Coordinated by Carlos J. Bernardos (UC3M)

June 2019 ⟶ November 2021

@5growth_eu   5growth.eu

MAIN OBJECTIVES & CHALLENGES

The objective of 5Growth is the technical and business validation of 5G technologies from the verticals' points of view, following a field-trial-based approach on vertical sites (TRL 6-7). Its vision is to empower verticals industries, such as Industry 4.0, Transportation, and Energy with an AI-driven Automated and Sharable 5G End-to-End Solution that will allow these industries to simultaneously achieve their respective key performance targets.

5Growth provides a 5G platform for multi-RAT, multi-technology, multi-domain mobile networks that bridges the gaps from Phase 1 and 2 projects while leveraging the potentials of ICT-17 platforms to deliver end-to-end services. Main challenges:

- Design and implementation of a platform and algorithms to empower verticals.
- Automated multi-level, cross-domain, hierarchical service orchestration.
- Vertical-oriented trial-based assessment, including 5G PPP KPIs.
- Integration with ICT-17 testing facilities to validate 5G capabilities and measure its KPIs.

APPLICATIONS & EXPECTED IMPACT

Validation of 5G technologies in radio, transport, and core segments, combined with architectural components for control, management, orchestration, and federation of end-to-end 5G services in a multi-site environment, geographically distributed in Italy, Spain, and Portugal.

Tackling challenges characterizing eMBB, mMTC, and URLL services, including digital twin, smart factory telemetry and quality control, railway signaling, or remote substation management.

Business models for 5G value chain actors, from infrastructure providers and network operators, to high-tech SMEs and vertical industries.

Technical impact, including impact in products and services, open-source code, and standardization (3GPP, ETSI, IETF/IRTF, IEEE) as well as publications, demonstrations, and events.

Validation of 5G-PPP KPIs for 5Growth verticals.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0   Transport & logistics   Energy

5G-SMART

5G FOR SMART MANUFACTURING

Coordinated by Leefke Grosjean (Ericsson)

June 2019 ———————————➤ November 2021

@5G_smart   5gsmart.eu

MAIN OBJECTIVES & CHALLENGES

The main objective of 5G-SMART is to demonstrate, evaluate, and validate 5G systems for new manufacturing applications in 5G-enabled industry field trials. Advanced 5G-integrated manufacturing applications such as remote-controlled industrial robotics, wireless process monitoring, and mobile robotics are tested in real manufacturing setups. Additionally, the project aims to identify novel use cases, perform EMC and channel measurement for 5G in a real production facility, and develop new 5G

technology features targeting the manufacturing industry. These are, for instance, the integration of 5G with time-sensitive networking and critical cloud platforms enabling flexible software development while providing low latency and high reliability. To further accelerate the take-up of 5G in the manufacturing ecosystem, 5G-SMART explores new business models, identifying the potential for factory owners, operational technology suppliers, and mobile network operators.

APPLICATIONS & EXPECTED IMPACT

5G-SMART is creating impact by accelerating the 5G adoption in smart manufacturing, bringing together ICT & OT industries, driving future 5G to enable manufacturing solutions, and driving industry standards and scientific research. The impact is achieved, for instance, by identifying gaps between the current state of the art, the target KPIs, and the results obtained following the different activities of the project. Validating 5G for major manufacturing use cases at three trial facilities in real manufacturing environments

ensures the relevance of the results. The consortium of 5G-SMART includes ICT and 5G suppliers, network operators, providers of wireless communication technologies and components, OT suppliers, factory operators, and academics. Hence 5G-SMART will be able to approach the entire value chain in the factory and process automation ecosystem to raise awareness about what cellular technology will bring to the industry so that the vision of Industry 4.0 becomes a reality.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

5G-VICTORI

VERTICAL DEMOS OVER COMMON LARGE SCALE FIELD TRIALS FOR RAIL, ENERGY AND MEDIA INDUSTRIES

Coordinated by Jesús Gutiérrez (IHP GmbH)

June 2017 ⟶ June 2022

@5gvictori

5g-victori-project.eu

MAIN OBJECTIVES & CHALLENGES

5G-VICTORI aims at conducting large-scale trials for advanced use case verification in commercially relevant 5G environments for a number of verticals including Transportation, Energy, Media, and Factories of the Future, as well as some specific use cases involving cross-vertical interaction. 5G-VICTORI will provide a single end-to-end platform that provides the interconnection and interworking of multiple 5G facilities. The main objectives are:

- Design and prototype an open 5G infrastructure capable of instantiating and co-hosting various vertical sectors.

- Integration of commercially relevant operational environments required for the demonstration of the large variety of 5G-VICTORI vertical and cross-vertical use cases.

- Transform the current closed, purposely developed, and dedicated infrastructures into open environments where resources and functions are exposed to the telecom and the vertical industries through common repositories.

- Implement a flexible network architecture enabling function deployment and relocation of vertical-specific network functions based on their requirements in terms of capacity, latency, and reliability.

APPLICATIONS & EXPECTED IMPACT

5G-VICTORI addresses eMBB service requirements for the Media vertical where personalized broadcast services along with immersive media applications are provided targeting densely populated environments. besides, eMBB services will be provided to high-speed trains while co-existing with uRLLC-based rail signaling services, e.g., control of the ground segment, on-board segments, and rail operational voice. The second set of uRLLC-based services addresses the need for monitoring and control of "Digital Utilities". A critical service application that addresses URLLC feature requirements and popup network on-demand creation capabilities will be deployed in passenger buses. Finally, mMTC-based use cases will be validated through monitoring of the power grid used to electrify a railway system.

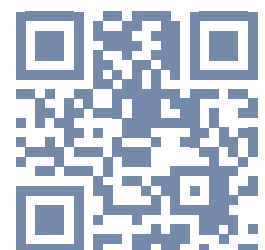## VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

Transport & logistics

Energy

Media & entertainment

LONG-TERM EVOLUTION

ARIADNE

ARTIFICIAL INTELLIGENCE AIDED D-BAND NETWORK FOR 5G LONG-TERM EVOLUTION

Coordinated by Halid Hrasnica (Eurescom)

November 2019 ⟶ October 2022

@ict-ARIADNE   ict-ariadne.eu

ARIADNE

MAIN OBJECTIVES & CHALLENGES

ARIADNE is going to enable spectral efficient, high-bandwidth, intelligent wireless communications by developing three complementary but critical new technologies for future 5G networks in an integrated and innovative way:

- New radio technologies using the above 100GHz D-Band frequency range,

- advanced connectivity based on Reconfigurable Intelligent Surfaces (RIS), and

- Machine Learning and Artificial Intelligence techniques for management of the high-frequency communications resources and RIS reconfiguration.

The following seven ARIADNE key performance indicators have been defined to follow up the project achievements along its three pillars:

- Aggregate throughput of wireless access and end-to-end throughput for any traffic load/pattern – 100 Gbit/s

- End-to-End 'zero' latency

- Coverage of the D-band link – 100m outdoors

- 'Always' available Connectivity

- Energy consumption reduction by 10x compared to 5G

- Complexity reduction – 10x compared to 5G

APPLICATIONS & EXPECTED IMPACT

ARIADNE is expected to impact the whole beyond 5G technology value chain and the future wireless network business. By realizing its vision of bringing together D-band communications and AI in order to achieve reliable, scalable, and reconfigurable connectivity, the beyond 5G network will be transformed into a highly adaptive and powerful computing and connectivity provider thus revolutionizing the way people communicate and catalyzing future applications that go far beyond communications.

To validate the project work and achieved results and be able to showcase the project achievements in an appropriate way, ARIADNE selected the following three representative scenarios:

- Backhaul/Fronthaul networks of fixed topology.

- AdHoc Backhauling.

- Advanced NLOS connectivity based on RIS.

5G-CLARITY

BEYOND 5G MULTI-TENANT PRIVATE NETWORKS INTEGRATING CELLULAR, WI-FI, AND LIFI, POWERED BY ARTIFICIAL INTELLIGENCE AND INTENT BASED POLICY
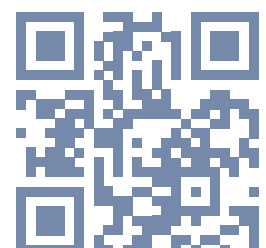
Coordinated by Jesús Gutiérrez (IHP)

November 2019 ⟶ July 2022

@5G_CLARITY   5gclarity.com

5G CLARITY

MAIN OBJECTIVES & CHALLENGES

Current and future vertical use cases are demanding 5G critical communications early on. The answer already appears to be '5G Private Networks' for enterprises, which can be provided not only by traditional Mobile Network Operators (MNOs) but also infrastructure vendors, including cloud and software vendors. To deliver on the promise of private 5G networks, several challenges need to be addressed by beyond 5G networks, namely: (i) Integration with legacy IEEE 802.11 technologies, (ii) Flexible integration with public 5G networks, (iii) Easy operation, (iv) Cm-level positioning in industry scenarios, (v) Spectrum flexibility.

5G-CLARITY addresses the previous requirements through: (i) Design and validation of a multi-tenant private wireless access network architecture, integrating 5G/Wi-Fi/LiFi, compute resources, and AI-driven and intent-based network management, (ii) Design and validation of a multi-technology coexistence framework for private 5G/Wi-Fi/LiFi networks that enables efficient spectrum sharing between private and public networks operating in the same band, (iii) Achievement of cm-level localization and ns-level synchronization capabilities, (iv) Utilization of a slice-aware spectrum broker.

APPLICATIONS & EXPECTED IMPACT

5G-CLARITY puts forward a beyond 5G architecture for private networks, which features a novel access network integrating 5G, WiFi, LiFi, compute and transport resources, and novel management components to enable AI-driven network automation. Based on this architecture, communication services have been defined to deliver measurable enhancements on the 3GPP R16 eMBB and URLLC services in terms of latency, area capacity, reliability, and accurate positioning and synchronization. 5G-CLARITY develops an AI-driven management

plan featuring SDN/NFV components to automate network management by receiving high-level intent policies from the network administrator. 5G-CLARITY targets the delivery of the project innovations to standardization bodies, such as 3GPP, O-RAN, IEEE802.11bb, and ETSI-ZSM. 5G-CLARITY technologies will be demonstrated in two relevant use cases, i.e., a human-robot interaction application in a museum in Bristol and a network slicing and AGV positioning application for Industry 4.0 services in a BOSCH factory in Spain.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

Smart cities & utilities

5G-COMPLETE

A UNIFIED NETWORK, COMPUTATIONAL AND STORAGE RESOURCE MANAGEMENT FRAMEWORK TARGETING END-TO-END PERFORMANCE OPTIMIZATION FOR SECURE 5G MULTI-TECHNOLOGY AND MULTI-TENANCY ENVIRONMENTS

Coordinated by Hercules Avramopoulos (ICCS/NTUA)

November 2019 ⟶ October 2022

@5gcomplete   5gcomplete.eu

MAIN OBJECTIVES & CHALLENGES

5G-Complete aims to merge the Mobile Edge Computing (MEC) and Cloud complementary forces under a common flexible, profitable, and energy-efficient RAN infrastructure while being able to synergistically exploit Computing, Access, and Storage services to effectively respond to the emerging mobile data deluge. More specifically, 5G-COMPLETE will:

- Develop a mmWave point-to-multipoint (PtMP) mesh node and an integrated THz transceiver to enhance functionality and capacity at the network's edge,

- Develop a delay time-sensitive and elastic optical bandwidth framework for converged network/ computational/storage architectures,

- Develop an advanced DSP platform to increase the bandwidth efficiency of edge optical transport layer,

- Develop and demonstrate a toolbox of hardware and software solutions,

- Develop joint network, computational, and storage resource allocation optimization algorithms leveraging AI/ML techniques,

- Deploy serverless computing paradigms at the edge for low latency services,

- Develop an end-to-end 5G network slicing management and orchestration framework,

- Architect a low-latency, high energy efficiency, high-capacity, and flexible 5G network,

- Validate its 5G network technologies in a series of scalable lab-scale and field-trial demonstrators.

APPLICATIONS & EXPECTED IMPACT

Being committed to fast validation that allows for immediate exploitation of its 5G technologies, 5G-COMPLETE will carry out a series of scalable demonstrators across all of its targeted prototypes and network scenarios. Targeted demonstration actions include: (i) Lab-scale evaluations and demonstrations hosted in ICCS/NTUA premises, Orange Labs, and IASA-COSMOTE targeting the integration of the developed technologies and architectures. (ii) Live demonstration in Athens 5G testbed, focusing on the integration of the deployed computing nodes for low-latency services. (iii) Live demonstration of the full 5G-COMPLETE solution in the 5G-UK testbed in Bristol. This demonstration will go beyond technology evaluation and focus on end-user services.
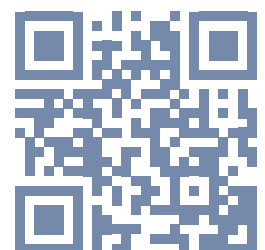
VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Smart cities & utilities

Public safety

INSPIRE-5Gplus

INTELLIGENT SECURITY AND PERVASIVE TRUST FOR 5G AND BEYOND

Coordinated by Uwe Herzog (Eurescom)

November 2019 ⟶ October 2022

@inspire_5gplus   inspire-5gplus.eu

MAIN OBJECTIVES & CHALLENGES

INSPIRE-5Gplus aims at making a radical shift in the security management of 5G and beyond networks at the platform and vertical application levels. To do this, the project focuses on establishing the architecture requirements that consider new paradigms related to Service-Based Architecture, Zero-touch Service, and network management, as well as multi-domain, multi-tenant, multi-party virtualized, and programmable network infrastructures. INSPIRE-5Gplus performs a thorough assessment of 5G security situation with a focus on key concerns and topics (e.g., the security of slices and verticals, trust, intelligence, and automation) to identify available 5G security assets, their limitations, their evolutions (to overcome those limitations) and/or replacement, as well as determine new required assets. The overall goal is to develop intelligent and autonomous end-to-end cybersecurity services to be integrated within the 5G network for predicting, detecting, and mitigating current and future threats.

APPLICATIONS & EXPECTED IMPACT

INSPIRE-5Gplus will adopt the latest advances to satisfy its overarching objectives for all the identified security and trust concerns. The project's results will be integrated into experimentation testbeds with verticals from previous and ongoing 5G PPP projects that will allow validation of specific 5G security use cases. The main results include: (i) the definition of the security architecture and core technological components, (ii) a new E2E management approach for Trustworthiness and Liability, as well as dynamic execution of countermeasures, AI/ML-driven smart cybersecurity services, (iii) the integration of hardware and software-based TEE solutions, (iv) the performance of quantitative measurements to determine the impact of the different security techniques, (v) the demonstration of the flexibility and adaptability of the security mechanisms in very dynamic and communication-intensive infrastructures, (vi) the trustworthy interoperability in multi-tenant, multi-domain environments.

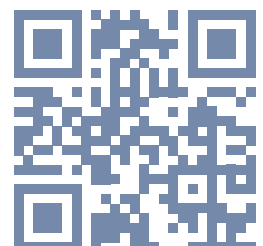## VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0   Automotive   Transport & logistics   Smart cities & utilities

LOCUS

LOCALIZATION AND ANALYTICS ON-DEMAND EMBEDDED IN THE 5G ECOSYSTEM

Coordinated by Nicola Blefari Melazzi (CNIT)

Novembre 2020 ⟶ April 2022

@H2020Locus   locus-project.eu

MAIN OBJECTIVES & CHALLENGES

LOCUS will improve the functionality of 5G infrastructures to: (i) provide accurate and ubiquitous location information as a network-native service, (ii) derive more complex features and behavioral patterns out of raw location and physical events, (iii) expose them to applications via simple interfaces.

LOCUS is targeting several scientific and technical challenges:

- System architecture with built-in security and privacy.
- Accurate 5G Localization.

- Integration with non-3GPP technologies and device-free localization.
- Analytics, Learning and Inference, and their provision "As a Service."
- Location-aware Smart Network Management.
- Localization & Analytics for New Services.

LOCUS functionality will be integrated within the 5G Service Based Architecture resulting in an enlarged cloud-integrated architecture for processing location data and analytics and thus enabling new services.

APPLICATIONS & EXPECTED IMPACT

LOCUS will develop location-based functionalities for Smart Network Management and Localization and Analytics for new vertical services. Localization and analytics functionalities will be integrated within the 5G Service Based Architecture by exploiting the combination of edge and core virtualized infrastructure, thus resulting in an enlarged cloud-integrated architecture. LOCUS will showcase its solutions in three scenarios: Smart Network Management

based on Location Information of 5G equipment, Network-assisted Self-driving Objects, People Mobility and Flow Monitoring including emergency services. Localization, together with analytics and their combined provision "as a service," will greatly increase the overall value of the 5G ecosystem, allowing network operators to better manage their networks and dramatically expand the range of offered applications and services.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0   Agriculture & agri-food   Automotive   Transport & logistics   Smart cities & utilities   Public safety   Smart airports   Energy   eHealth & wellness   Media & entertainment

MONB5G

DISTRIBUTED MANAGEMENT OF NETWORK SLICES IN BEYOND 5G

Coordinated by Christos Verikoukis (CTTC)

November 2019 ⟶ October 2022

@monb5g   monb5g.eu

MAIN OBJECTIVES & CHALLENGES

MonB5G's main aim is to develop a distributed management plan to support a massive deployment of network slices, defining novel end-to-end slice KPIs, and developing AI-based analytics engines for their accurate prediction from multi-level metrics. Moreover, MonB5G aims at devising a data-driven management system based on federated learning, targeting a multi-domain zero-touch network configuration of sliced beyond 5G (B5G) networks and defining decision engines tailored to RAN. It also aims to implement AI-driven slice security management via robust and efficient trust-based mechanisms and provide ML-assisted techniques to optimize energy efficiency throughout the network, i.e., Cloud, RAN, Core, and MEC. The developed concept will lead to practical proof-of-concepts that will serve to test various B5G use cases in live platforms. MonB5G targets the dissemination, standardization, and exploitation of the novel technologies developed with a special focus on ETSI ZSM, and ENI.

APPLICATIONS & EXPECTED IMPACT

MonB5G's applications will be evaluated through its use cases, covering:

- Zero-touch multi-domain service management evaluating data-driven management systems in multiple domains whilst assuring stringent end-to-end SLAs for practically zero downtime.

- Elastic end-to-end slice management demonstrating how its mechanisms react to performance issues and traffic changes, guaranteeing almost zero latency by predicting demand.

- Attack identification and mitigation demonstrating the detection and mitigation of malicious attacks on multiple slices, efficiency as response time, and prevention of false detections.

- Robustness of learning algorithms against advanced cyber-attacks. MonB5G will impact diverse stakeholders, including telecom providers, equipment vendors, SMEs, and end-users, offering compelling benefits, such as network scalability, secure network-virtualization environments, energy consumption reduction, and the reduction of cyber-attacks costs.
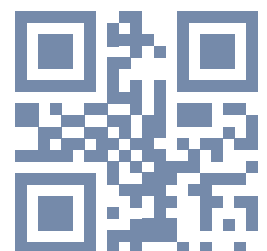
VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

4.0
Industry 4.0

Energy

TERAWAY

TERAHERTZ TECHNOLOGY FOR ULTRA-BROADBAND AND ULTRA-WIDEBAND OPERATION OF BACKHAUL AND FRONTHAUL LINKS IN SYSTEMS WITH SDN MANAGEMENT OF NETWORK AND RADIO RESOURCES

Coordinated by Hercules Avramopoulos (ICCS)

November 2019 ➔ October 2022

@TERAWAY_EU   ict-teraway.eu

MAIN OBJECTIVES & CHALLENGES

Leveraging optical concepts and photonic integration techniques, TERAWAY will develop a technology base that combines the generation, emission, and detection of wireless signals with selectable symbol rate and bandwidth within an ultra-wide range of carrier frequencies covering the W-band, D-band, and THz band.

In parallel, a new software-defined networking (SDN) controller – the TERAWAY controller - and an extended control hierarchy will be developed for the management of the network and the radio resources, providing network slices to support the different types of telecom applications.

At the end of this development, TERAWAY will make a set of ground-breaking transceiver modules with 4-channel modules operating from 92 up to 322 GHz available, offering up to 241 Gb/s total data rate with transmission reach more than 400 m in the THz band. Four independently steered wireless beams will be used to establish BH and FH connections between fixed terrestrial and moving network nodes.

APPLICATIONS & EXPECTED IMPACT

The TERAWAY system is designed to demonstrate the THz and mmWave bands as an ultra-broadband connectivity enabler for 5G and beyond. TERAWAY use cases focus on the provision of mobile connectivity through UAVs, which are deployed to provide and/or expand mobile coverage of ad-hoc events that require ultra-high bandwidth and capacity requirements.

TERAWAY application scenarios relate to high capacity, ad-hoc temporal network connectivity (BH/FH) for outdoor crowded events with ultra-broadband communication and surveillance and/or video content traffic requirements at a contained geographical area. These can be cultural, social, or sports events, as well as emergency or disaster recovery scenarios.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Public safety

Media & entertainment

5GZORRO

ZERO-TOUCH SECURITY AND TRUST FOR UBIQUITOUS COMPUTING AND CONNECTIVITY IN 5G NETWORKS

Coordinated by Shuaib Siddiqui (i2CAT)

November 2019 ———→ May 2022

@5Gzorro   5gzorro.eu

MAIN OBJECTIVES & CHALLENGES

5GZORRO envisions the evolution of 5G to achieve production-level support of diverse Vertical applications, which coexist on highly pervasive shared network infrastructure, through automated end-to-end network slicing, across multiple operators and infrastructure/resource providers, who can share heterogeneous types of resources (spectrum, virtualized radio access, virtualized edge/core).

5GZORRO uses distributed Artificial Intelligence (AI) to implement cognitive network orchestration and management with a minimal manual intervention (Zero-Touch Automation). Distributed Ledger Technologies (DLT) are adopted to implement flexible and efficient distributed security and trust across the various parties involved in a 5G end-to-end service chain.
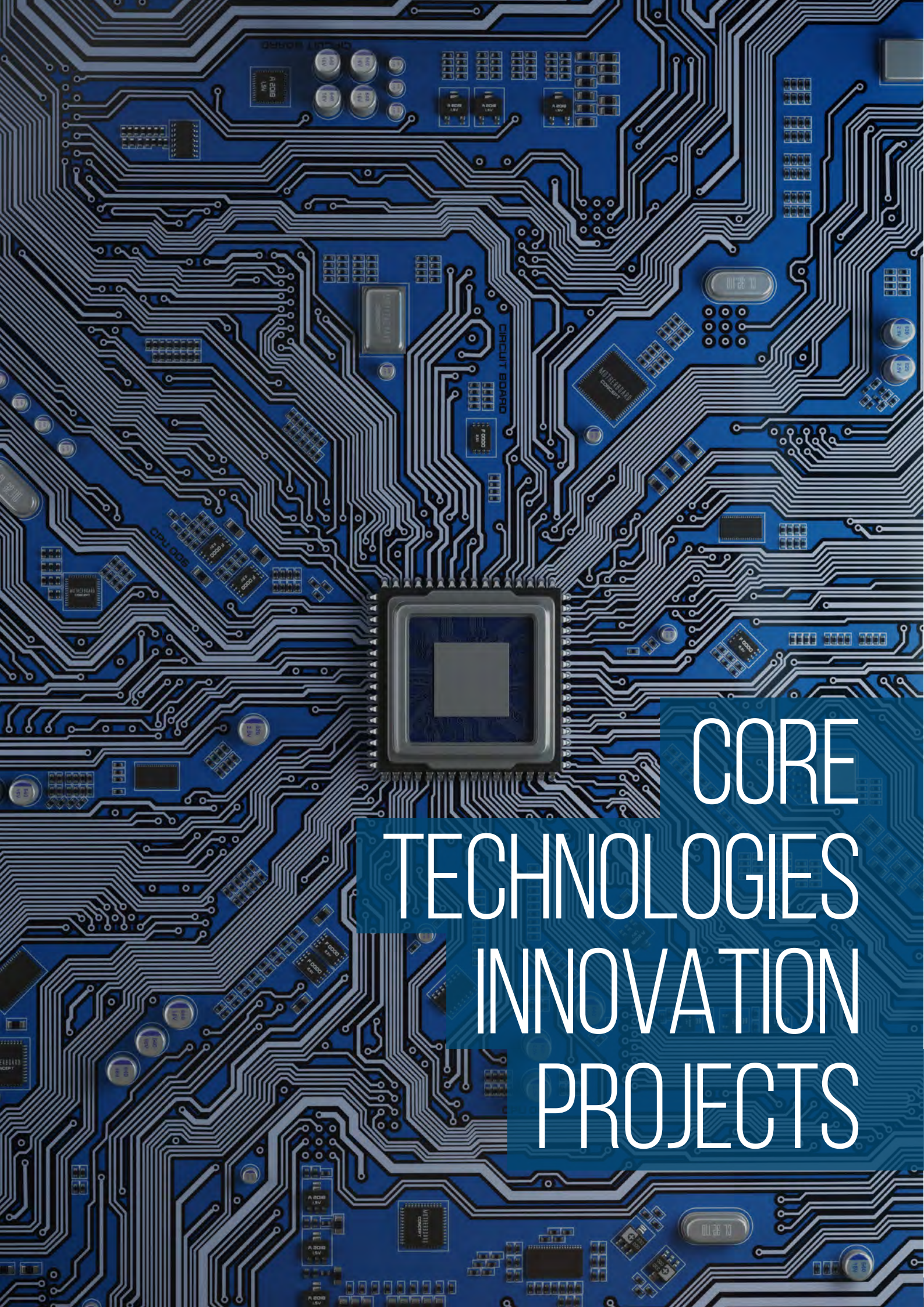
APPLICATIONS & EXPECTED IMPACT

With these solutions, it is possible to implement an evolved 5G Service Layer for Smart Contracts among multiple non-trusted parties, which allows for SLA monitoring, spectrum sharing, and intelligent and automated data-driven resource discovery and management. 5GZORRO cross-domain security and trust orchestration coupled with service lifecycle automation can enforce security policies in multi-tenant and multi-stakeholder environments. Three use cases will be validated in 5GBarcelona and 5TONIC/Madrid test facilities: Smart Contracts for Ubiquitous Computing/Connectivity, Dynamic Spectrum Allocation, and Pervasive virtual CDNs over 3rd-party edge resources. Among 5GZORRO target stakeholders are telecom operators, vertical slice owners/operators, spectrum owners, regulators, and passive/active facility owners.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0   Agriculture & agri-food   Automotive   Transport & logistics   Smart cities & utilities   Public safety   Smart airports   Energy   eHealth & wellness   Media & entertainment

CORE
TECHNOLOGIES
INNOVATION
PROJECTS

5G-LOGINNOV

5G CREATING OPPORTUNITIES FOR LOGISTICS SUPPLY CHAIN INNOVATION

Coordinated by Eusebiu Catana (Ertico-ITS)

September 2020 ⟶ September 2023

@5G_Loginnov   5g-loginnov.eu

5GLOGINNOV

MAIN OBJECTIVES & CHALLENGES

Develop and deploy Next-Generation ports and logistics hubs' operation system architecture integrated into 5G networks at three main ports in Europe: Athens (GR), Hamburg (DE), and Koper (SL), utilizing new types of 5G IoT sensors and devices.

Optimize ports and logistics hubs' operations and maintenance to reduce their operational costs with innovative concepts and use cases. Significantly reduce ports and logistics hubs operation emissions (CO_2/NOX) and regulate the resulting freight traffic on the future 5G logistics corridor in the EU including CAM truck platooning management.

Regulate the freight traffic generated by ports and logistics hubs on the future 5G logistics corridors in the EU and integrate future Connected and Automated truck platoons- as 5G-LOGINNOV GREEN TRUCK INITIATIVE according to the EU GREEN DEAL program (Dec. 2019).

Boost ports and logistics hubs operations and maintenance innovation with the involvement of new market actors including SMEs and start-ups. Support standardization of 5G enabled Next-Generation ports and logistics hubs' operation systems to ensure interoperability, platform openness, and operation harmonization around future 5G logistics x-border corridors.

Support adoption and take-up of 5G-enabled Next-Generation ports and logistics hubs' operation systems in Europe and beyond.

APPLICATIONS & EXPECTED IMPACT

- Management and Network Orchestration platform (MANO)
- Device Management Platform Ecosystem
- Optimal selection of yard trucks
- Optimal surveillance cameras and video analytics
- Automation for ports: port control, logistics, and remote automation

- 5G mission-critical communications in ports
- Predictive Maintenance
- Floating Truck & Emission Data (FTED)
- 5G GLOSA and Automated Truck Platooning (ATP)- under 5G-LOGINNOV green
- Dynamic control loop for environment-sensitive traffic management actions (DCET)

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Transport & logistics

5GMETA

MONETIZING CAR & MOBILITY DATA FOR NEW ENTRANTS, TECHNOLOGIES AND ACTORS

Coordinated by Oihana Otaegui (Vicomtech)

September 2020 ⟶ September 2023

@5GMETA   5gmeta-project.eu

MAIN OBJECTIVES & CHALLENGES

With the greater proliferation of CCAM applications, the value of data from vehicles is getting strategic not just for the automotive industry but in a wider scope that is not limited to the onboard systems and services. 5GMETA open platform aims to leverage car-captured data to facilitate and feed with innovative products and services. The result of 5GMETA will empower the automotive ecosystem, from industry players to new entrants, such as SMEs and high-tech start-ups granting access to interoperable car-captured data according to data licenses. The access to data coming from relevant regions will catalyze the generation of new business models coming from valuable services where data liability and billing will rely on an accountability dashboard of data flow subscription and volume consumption. 5GMETA expands 5G network functions to enable data monetization with a secure and private pipeline that manages data computing and dataflows according to service subscriptions and geographic queries.

APPLICATIONS & EXPECTED IMPACT

5GMETA features:

- Secure and private mass distribution of data from vehicles:
- Data ownership
- Scalable management
- Geo-based range
- Data interoperability
- Real-time data messaging
- Flexible business-driven configuration

All these aspects will have a direct impact on the value chain and the business models that will be addressed in the project: (i) Generation of new business models: New value creation models for data generators and consumers generating revenues from direct monetization of innovative services or applications. (ii) Product optimization: Automotive players would reduce costs by means of shorter and efficient iterations on design and training from data coming from real-field tests prototypes or mass-produced systems in real mobility environments. (iii) Increasing safety and security: With other users and public entities getting triggers on time to reduce the time for an intervention.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Smart cities & utilities

5G-RECORDS

5G KEY TECHNOLOGY ENABLERS FOR EMERGING MEDIA CONTENT PRODUCTION SERVICES

Coordinated by David Gomez-Barquero (UPV)

September 2020 ⟶ September 2022

@5G_Records   5g-records.eu

MAIN OBJECTIVES & CHALLENGES

5G-RECORDS aims to develop, integrate, validate, and demonstrate specific 5G components in end-to-end 5G infrastructures for professional AV media content production. The main objectives are: (i) Design and develop 5G components based on 3GPP Rel. 15, 16, and beyond. (ii) Demonstrate the potential value that 5G brings to the content production sector. (iii) Maximize the impact of the project results and influence standardization and regulation bodies. To meet the aforementioned targets, 5G-RECORDS will face several challenges that come with the integration of 5G technologies and AV production:

- Latency, reliability, bandwidth, and synchronicity of end-to-end media workflows.
- Device registration, security, and authentication.
- Integration of 5G-specific functionalities.
- Implementation of technologies that are currently not available or not cost-effective enough.
- Leverage the work from previous projects related to 5G research and development to support the emergence of new markets.

APPLICATIONS & EXPECTED IMPACT

5G-RECORDS achievements are foreseen to contribute not only to AV professional content production applications but also to play an important role in 5G R&D and deployments in general by developing, testing, and integrating existing or new technologies. 5G-RECORDS will maximize its impact by following a comprehensive and integrated set of exploitation, communication, and dissemination activities. The main expected impacts are: (i) Enable innovative business models for the 5G components used in the project, particularly for professional content production. (ii) Open new business opportunities including capacity arbitration via NPNs and SLA. (iii) Influence standardization in 3GPP and other bodies, contributing to the definition of 5G for content production. (iv) Promote the rise of virtual production environments. (v) Facilitate logistic solutions: reducing carbon footprint, reducing large teams working in the field, and allowing the production team to work remotely over more events without physical risks.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Media & entertainment

Affordable5G

HIGH-TECH AND AFFORDABLE 5G NETWORK ROLL-OUT TO EVERY CORNER
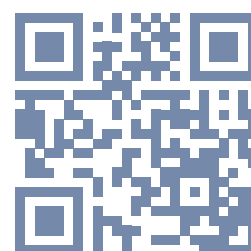
Coordinated by Josep Martrat (Atos)

September 2020 → November 2022

@affordable5g   affordable5g.eu

AFFORDABLE 5G

MAIN OBJECTIVES & CHALLENGES

Affordable5G aims at creating a 5G network that will deliver a complete and affordable solution covering the needs of private and enterprise networks through technical innovation that spans across all parts of the 5G network, leveraging cell densification, RU/DU/CU split, hardware acceleration, edge computing, and core network virtualization, seamlessly combined with the adoption of open source RAN, MEC, and MANO solutions, for cloud-native, micro-service based deployments. To achieve its innovative and ambitious goal, the consortium brings together ten European SMEs, supported by MVNOs, system integrators, and research institutes, grasping the opportunity to enhance their products, according to each company's roadmap, while fostering collaboration among them. Affordable5G will offer a first-class opportunity to European SMEs to become frontrunners in the global 5G competition supportinig them in their commercialization paths.

APPLICATIONS & EXPECTED IMPACT

Affordable5G will deliver a complete and affordable 5G offering for private and enterprise networks, evaluated and validated in three vertical use cases. The first use case is related to emergency communications. In this context, Affordable5G will demonstrate the robustness or "criticality" of the provided solution that will leverage cloud-native monitoring functions, flexible deployment and scaling, and 3GPP-compliant mission-critical services (MCS) stateful transition. The second use case is related to smart cities. Affordable5G will validate the 5G technology for efficient smart city monitoring, combining IoT data collection sensors integration and edge processing. The third pilot consists of two use cases covering different parts of the manufacturing process. The first use case deals with Process Automation. The second use case concerns the benefits arising from the introduction of the TSN concept to manage Automated Mobile Robots (AMRs) and mechanical robotic arms within a manufacturing shop floor.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

Smart cities & utilities

Public safety

DRAGON

D-BAND RADIO 5G NETWORK TECHNOLOGY

Coordinated by Vladimir Ermolov (VTT)

December 2020 → December 2023

h2020-dragon.eu

MAIN OBJECTIVES & CHALLENGES

The DRAGON project, through the exploitation of the radio spectrum in D-band (130-174.8 GHz) will overcome the constraints of current E-band wireless backhaul solutions to achieve a small-form-factor and high-capacity radio solution suitable for massive deployment that will enable bringing the speed of optical systems to backhaul systems in a cost-effective way. The DRAGON project vision and objectives rely on a power-efficient and silicon-based BiCMOS transceiver analog front end, operating in D-band and enabling the cost-efficient deployment of telecommunications networks with seamless fiber performance. A beam steering integrated antenna array using an intelligent low-cost packaging technology will be developed for the implementation of the 5G network demo trial in the field with fine beam alignment for facilitating the installation and compensating pole vibration.

APPLICATIONS & EXPECTED IMPACT

DRAGON will demonstrate and test, on a fully operating 5G network, the feasibility of a wireless front/backhaul link exploiting the mmWave 5G core technology and having the following features:

- D-Band frequency spectrum
- Large active antenna array (≥1024 elements)
- Dual carrier MODEM for fFDD with embedded XPIC or 2x2 LoS MIMO ready for 4x4 LoS MIMO
- Base band that includes the modem, the traffic management and adaptation, network interfaces, and the carrier aggregation

- Hop lengths of more than 1 km with high availability
- Reconfigurable antenna beam direction, by fine steering feature of the segmented antenna concept
- Small form factor and low visual impact (suitable for street level), allowed by the full and compact integration of the antenna array and the BiCMOS based transceiver ICs
- Installation and commissioning facilitated by beam steering capability
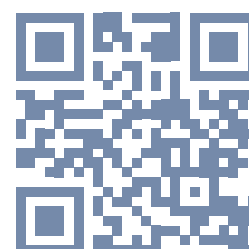- Low power consumption and low cost

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

Smart cities & utilities

FUDGE-5G

FULLY DISINTEGRATED PRIVATE NETWORKS FOR 5G VERTICALS

Coordinated by David Gomez-Barquero (UPV)

September 2020 → March 2023

@fudge5geu   fudge-5g.eu

FUDGE-5G

MAIN OBJECTIVES & CHALLENGES

FUDGE-5G project aims to devise, assess, and demonstrate a cloud-native, unified, and secured service-based 5G architecture, solutions, and systems for private networks. The project will allow for extreme interoperability and customization for industry verticals among wired and wireless access infrastructure (5GLAN with 5G-Multicast and 5G-TSN support), eSBA platform, mobile 5GC, service orchestration, and vertical applications. The unified eSBA framework poses new challenges, namely resource allocation, slice scheduling, and service routing. With 5GLAN, the main challenge is the inclusion of bearers spanning across the existing 5G vertical protocols. Another market demand is the capability to orchestrate a service on the heterogeneous RAN (4G+5G). In industry 4.0, the challenge is to deliver time synchronization to the industrial devices, while on the virtual office the challenge is to provide a common connectivity domain that would allow devices to communicate with each other seamlessly.

APPLICATIONS & EXPECTED IMPACT

The main applications of FUDGE-5G are tied to the vertical use cases and include 5G Media Services, PPDR Platform, Virtual Office for Hospitals, Industry 4.0, and a 5G Eduroam. These leverage the innovative components provided by FUDGE-5G and bring state-of-the-art technology to support their operation in a TRL 7 environment.

Expected impacts range from industry developments to standardization contributions but mainly towards market opportunities for new actors. Instead of a handful of monolithic national mobile operators, FUDGE-5G stands on the premise that this new era of connectivity requires a federation of millions of interoperating micro-5G networks that are self-deployable by everyday users. While in the early days of its adoption, it will focus on industrial applications such as those targeted in FUDGE-5G use cases. In the future, click-to-deploy 5G-ready networks will be available for every home, office, factory, warehouse, or public space to satisfy the connectivity needs.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP
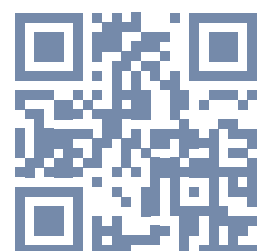
Industry 4.0   Smart cities & utilities   Public safety   eHealth & wellness   Media & entertainment

Int5Gent

INTEGRATING 5G ENABLING TECHNOLOGIES IN A HOLISTIC SERVICE TO PHYSICAL LAYER 5G SYSTEM PLATFORM

Coordinated by Prof. Hercules Avramopoulos (ICCS/NTUA)

November 2020 ⟶ October 2023

@int5gent   int5gent.eu

MAIN OBJECTIVES & CHALLENGES

Int5Gent targets the integration of innovative data plane technology building blocks under a flexible 5G network resource, slice, and application orchestration framework, providing a complete 5G system platform for the validation of advance 5G services and IoT solutions. The project builds upon a suite of innovative 5G technological solutions that have been conceptualized and developed under the latest 5GPPP initiative projects and are now taken to TRL-7 and above. More specifically, Int5Gent will:

- Develop a complete bit-interleaved SDoF interface, as well as a Baseband processor platform for Int5Gent Edge Nodes.

- Develop a NIC-enabled synchronization engine for time-sensitive edge networking.

- Develop optical multiplexing reconfigurable nodes to support d-RoF/SDoF/a-RoFrealtime transmissions.

- Develop D-band phase array antenna front-ends for 5G.

- Design and develop SDN-compatible mmWave Radio Terminal nodes with SDMoF interfaces.

- Design and implement an SDN-based control plane, fully integrated into NFV MANO framework,

- Demonstrate the potential of network solutions through lab-trails and live demonstrations of verticals.

APPLICATIONS & EXPECTED IMPACT

Aiming at a fast evaluation of Int5Gent technology blocks and enabling the immediate exploitation of its 5G technologies, two types of testing procedures will be followed: (i) Laboratory tests of individual technology blocks and network segments of the Int5Gent architecture, (ii) demonstration of these technology blocks and network segments through live demonstrations. Targeted demonstration actions include:

- NTUA, COSMOTE, CTTC, and TID will exploit

their current testbeds and define validation and testing methodologies while receiving needed testbed configuration requirements.

- After individual definition and evaluation of the applications and services supporting Int5Gent use cases, the projects' integrated solutions will be gradually deployed over the evaluation testbeds while also updating the ones referred to above, enabling the live demonstration of Int5Gent's verticals.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Transport & logistics

Smart cities & utilities

CONNECTED AND AUTOMATED MOBILITY

5G-Blueprint

NEXT GENERATION CONNECTIVITY FOR ENHANCED, SAFE & EFFICIENT TRANSPORT & LOGISTICS

Coordinated by Wim Vandenberghe (MIW Netherlands)

September 2020 ⟶ September 2023

@5G_Blueprint　　5gblueprint.eu

5G BLUEPRINT

MAIN OBJECTIVES & CHALLENGES

5G-Blueprint aims to design, test, and validate the technical architecture, business, and governance models for uninterrupted cross-border teleoperated transport based on 5G connectivity. 5G-Blueprint objectives:

TECHNOLOGICAL
- Design and implement a 5G network for CAM services with stringent requirements on latency, handover time, reliability, packet loss, and throughput,
- Tailor and implement the prototype of a teleoperated system,
- Implement and deploy enabling functions guaranteeing safety or increasing value,

- Validate the end-to-end teleoperated transport solution supported by 5G in real-life, cross-border scenarios,

BUSINESS
- 5G teleoperated transport market analysis,
- Commercial possibilities,
- Positions the possible role of teleoperated transport based on 5G in CAM
- Teleoperated transport based on 5G connectivity market adoption,

REGULATORY
- Identify regulatory issues and recommend actions.

APPLICATIONS & EXPECTED IMPACT

AUTOMATED BARGE CONTROL: Port entry efficiency will be increased by reducing crew requirements for barging. Vessel navigation during barging will be performed completely by the vessel captain in collaboration with a teleoperation captain in the Shore Control Centre.

AUTOMATED DRIVER-IN-LOOP DOCKING: Yard tractors will be equipped with standardized connectivity solutions for an optimized docking operation with respect to time and space requirements. The positioning of yard trucks will be performed via camera-based on Real-Time

Locating System. Mobile harbor cranes will be retrofitted with teleoperation functionality.

CACC BASED PLATOONING: On dedicated cross-border roads Cooperative Collision Avoidance System enabled cars and Fuel Cell Electric Vehicle self-driving containers with C-V2X capabilities will be piloted.

REMOTE TAKE-OVER OPERATIONS: Yard truck and self-driving container pilot vehicles will be equipped for remote teleoperation by human operators in the pilot areas.
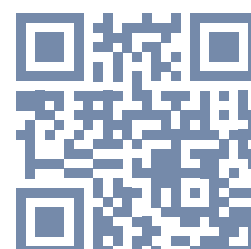
VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Transport & logistics

5GMed

SUSTAINABLE 5G DEPLOYMENT MODEL FOR FUTURE MOBILITY IN THE MEDITERRANEAN CROSS-BORDER CORRIDOR

Coordinated by Raül Gonzalez (Cellnex)

September 2020 ⟶ November 2023

@5GMED_EU   5gmed.eu

5GMED

MAIN OBJECTIVES & CHALLENGES

5GMed will demonstrate advanced Cooperative Connected and Automated Mobility (CCAM) and Future Railway Mobile Communications System services (FRMCS) along the "Figueres – Perpignan" cross-border corridor between Spain and France.

- Specify and validate a scalable, cross-border, and multi-stakeholder 5G and AI-enabled system architecture supporting CCAM and FRMCS services that can be replicated.

- Design and develop cross-operator service orchestration that enables MNOs, neutral hosts, and road/railways infrastructure operators to deliver service continuity to end-users.

- Propose and establish novel practices on how MNOs, neutral hosts, OEMs, and road operators can cooperate to deliver Remote Driving, Advanced Traffic Management, and Infotainment use cases in cross-border scenarios.

- Identify and establish MNOs and railways operators' cooperation priorities to deliver advanced FRMCS performance and business use cases across cross-border scenarios.

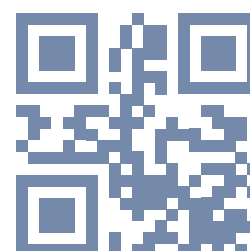## APPLICATIONS & EXPECTED IMPACT

Through 4 pilot tests on the railway and highway between Figueres and Perpignan, 5GMed will demonstrate advanced cross-border trials of 5G application scenarios in CCAM and FRMCS.

The tested services will rely on a broad range of technologies beyond 5G, including onboard sensors and Artificial Intelligence (AI), providing advanced connectivity services in a scalable and replicable manner across transportation paths.

Different Use Cases will be implemented during the project:

- Use Case 1: Remote Driving,

- Use Case 2: Road infrastructure digitalization for intelligent management of CAM,

- Use Case 3: FRMCS applications and business service continuity,

- Use Case 4: Follow-ME Infotainment.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive   Transport & logistics   Smart cities & utilities   Public safety   Energy   Media & entertainment

5G-ROUTES

5TH GENERATION CONNECTED AND AUTOMATED MOBILITY (CAM) CROSS-BORDER EU TRIALS

Coordinated by Urmas Ruuto (Ericsson EESTI AS)

September 2020 → September 2023

@5gRoutes

5g-routes.eu

MAIN OBJECTIVES & CHALLENGES

5G-ROUTES' main objective is to conduct large-scale field trials of the most representative and innovative CAM applications seamlessly functioning across a designated 5G cross-border corridor (via Baltica-North), spanning across 3 EU member states borders (Latvia-Estonia-Finland). The aim of the trials is to validate the latest 5G features and 3GPP specifications under realistic conditions to accelerate the wide deployment of 5G E2E interoperable CAM ecosystems and services in motorways, railways, and shipways.

One of the main challenges that the emerging 5G networks are facing is to support the deployment of innovative applications for CAM. EC's vision is to make the mobility of people and goods in the EU safer, cleaner, more efficient, ubiquitously connected, more accessible, and more user-friendly. 5G-ROUTES is well aligned with this vision and will help accelerate the acceptance of CAM and the seamless and uninterrupted delivery of interoperable cross-border CAM services.

APPLICATIONS & EXPECTED IMPACT

13 use cases will be conducted covering 5 CAM categories (Automated Cooperative Driving, Awareness Driving, Sensing Driving, Uninterrupted infotainment passenger services on the go, and Multimodal services), validating key technical and business-related KPIs over the latest 3GPP features. The aim is to better understand the roles, relations, and responsibilities of market players within the CAM ecosystem. Satellite 5G connectivity will be complemented and integrated with terrestrial 5G coverage to demonstrate 5G service continuity.

Accelerating the adoption of autonomous driving and providing seamless and ubiquitous access to new novel services and applications for passengers and goods, even when traversing EU borders, will improve statistics, save lives, and profoundly transform the way people and goods move across the EU. 5G-ROUTES will generate high business and economic impact in key economic sectors, and accelerate 5G network deployment that would transform the lives of European citizens.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

Transport & logistics

Media & entertainment

INNOVATIONS FOR VERTICALS WITH 3RD PARTY SERVICES

5GASP

5G APPLICATION & SERVICES EXPERIMENTATION AND CERTIFICATION PLATFORM

⚙ Coordinated by Diogo Gomes (IT - Aveiro)

📅 January 2021 ⟶ December 2023

🐦 @5gasp   🌐 5gasp.eu

MAIN OBJECTIVES & CHALLENGES

The main technical objective of 5GASP is to build and operate an Open, and Inter-Domain 5G NFV-based Reference (Open5G-NFV) ecosystem of Experimental Facilities. This ecosystem will not only integrate existing facilities already proven in previous ICT projects but will also lay down the foundations for instantiating fully softwarised architectures of vertical industries. Furthermore, it will provide facilities to test and validate NetApps taking into consideration vertical-specific requirements. 5GASP will demonstrate its Open5G-NFV ecosystem for two verticals deployed across state-of-the-art 5G infrastructures: Automotive and Public Protection and Disaster Relief (PPDR); however, it will also be as generic as possible in order to deploy, validate and certify NetApps stemming from other verticals.

- Acceleration of the development, testing and certification of NetApps, through the creation of a common platform, DevOps tools and a certification roadmap

- Provide state-of-the-art testbeds where applications for relevant verticals can be tested and validated in a cost-effective way

- Innovate technically by addressing inter-domain use-cases, security and trust aspects associated with NetApp deployment and Operation

APPLICATIONS & EXPECTED IMPACT

5GASP focus on the Automotive vertical because of its strict network requirements that require vertical specific hardware, and PPDR because it opens up interesting multi-domain use-cases that will drive innovations in the scope of the project. In the scope of the project specific use cases will be developed, resulting in different NetApps orchestrations of our partners VNF's: (i)Virtual On-Board Unit (vOBU), (ii) Virtual RoadSide Unit (vRSU), (iii) ITS station, (iv) Multi-domain Migration, (v) Vehicle-to-Cloud (V2C) Real-Time Communication, (vi) Remote Human Driving - Teleoperation for assisting vehicles in complex situations, (vii) Efficient MEC handover , (viii) Privacy Analyzer , (ix) 5G Isolated Operation for Public Safety , (x) Vehicle Route Optimizer , (xi) Fire detection and ground assistance using drones The use cases will be performed near the end of the project to show case in public events the 5GASP result: How easy is to deploy a NetApp in minutes with Zero-Touch Orchestration.
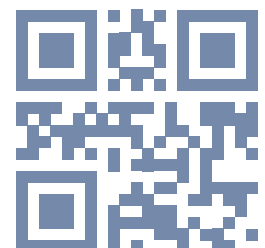
VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive   Public safety

5G-EPICENTRE

5G APPLICATION & SERVICES EXPERIMENTATION AND CERTIFICATION PLATFORM

Coordinated by Jean-Michel Duquerrois (AIRBUS DS SLC)

January 2021 ➝ January 2023

@5Epicentre

5gepicentre.eu

MAIN OBJECTIVES & CHALLENGES

5G are key technologies for mission-critical public protection and disaster relief (PPDR) services. Contributing to this, as well as lowering barriers to 5G adoption, the 5G-EPICENTRE project will develop based on a Service oriented Architecture, following the current best DevOps practices (containerization of micro-services), an open experimentation 5G platform that focuses on software solutions that serve the needs of PPDR. It aims at facilitating adoption of current services to capitalise on 5G networks advanced capabilities as well as to provide a solid ground for the proliferation of such services. The project will pave the way providing concrete experiments and libraries of VNF chains and Netapps. SMEs and developers will be able to learn about the latest 5G applications and approaches for first responders and crisis management and experiment with their solutions. 5G-EPICENTRE aims at establishing an environment that bridges development and operation worlds for PPDR services capitalising on upcoming 5G networks.

APPLICATIONS & EXPECTED IMPACT

5G-EPICENTRE applications: (i) Multimedia MC Communication and Collaboration Platform, (ii) Multi-agency and multi-deployment mission critical communications and dynamic service scaling, (iii) Ultra-reliable drone navigation and remote control, (iv) IoT for improving first responders' situational awareness and safety, (v) Wearable, mobile, point-of-view, wireless video service delivery, (vi) Fast situational awareness and near real-time disaster mapping, (vii) AR and AI wearable electronics for PPDR, (viii) AR-assisted emergency surgical care.

5G-EPICENTRE applications aim to provide significant benefit to the PPDR ecosystem. PPDR encapsulates several organizations and agencies, all with a common goal of protecting the general public and the environment. PPDR agencies engage with the various operating environments and operational domains in which scenarios are found, different requirements, equipment characteristics and communications needs are imposed.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Public safety

5G-ERA

5G ENHANCED ROBOT AUTONOMY
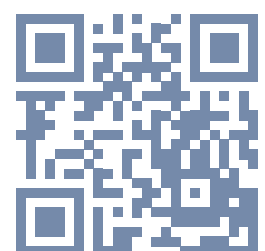
Coordinated by Rafael Lopez (Robotnik Automation SLL)

January 2021 ⟶ January 2023

@5g_era   5g-era.eu

MAIN OBJECTIVES & CHALLENGES

5G-ERA is oriented towards a user-centric paradigm of integrating vertical knowledge into the existing standardised 5G testing framework to improve Quality of Experience. The project addresses the new challenges on experimental facilities for the vertical developers and designers through the following activities: 1) integrating operational processes of essential autonomous robotic capabilities into Open Source MANO (OSM), ensuring the vertical adaptation of existing experimentation facilities, 2) realising an intent-based networking paradigm by aligning the end-to-end (E2E) resource optimisation with the autonomous operations, ensuring effective policy to be designed 3) Cloud native Network Services (NSs) on the experimental facilities will create, ensuring robotic applications exploiting NFV/SDN infrastructures efficiently 4) extending the experimentation facilities into robotic domains thorough standard APIs under Robot Operating System (ROS). Robot autonomy is essential for many 5G vertical sectors and can provide multiple benefits in automated mobility, Industry 4.0 and healthcare. Use cases from 4 vertical sectors, namely public protection and disaster relief (PPDR), transport, healthcare and manufacturing will be validated in the project by rapid prototyping of NetApp solutions and enhanced vertical experiences on autonomy.

APPLICATIONS & EXPECTED IMPACT

The project will verify and validate by 5G PPP KPI "Service creation time in minutes" through application driven network optimisation. KPIs have been sketched for all use cases. Performance optimisation will be showcased in different vertical sectors to ensure the repeatability of the project approach. Within the project period, four new NetApps which are specifically designed for PPDR (public protection and disaster relief), transport, logistical robots (in hospital), and manufacturing process will be validated and showcased in three existing testbeds (Greece, Spain and U.K.). All testbeds were built from previous 5GPP projects and national projects. These NetApp solutions will be sharing 5G-ERA progression on enhanced robot autonomy and representing their respective vertical configurations. The 5G-ERA test and validation will open a new window for further development of NetApp in related vertical sectors. In particular, this process will be accelerated in robotic community by the integration of ROS, which is the most commonly use open-source framework for robot software development.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0   Transport & logistics   Public safety   eHealth & wellness

5G-IANA

5G INTELLIGENT AUTOMOTIVE NETWORK APPLICATIONS

Coordinated by Angelos Amditis (ICCS-NTUA, GR)

June 2021 ➞ May 2024

@IANA_5G   5g-iana.eu

MAIN OBJECTIVES & CHALLENGES

5G-IANA aims at providing an open 5G experimentation platform, on top of which third party experimenters in the Automotive vertical will have the opportunity to develop, deploy and test their services. The platform is specified as a set of hardware and software resources that provides the compute and communication infrastructure as well as the management and orchestration components, coupled with a NetApp Toolkit tailored to the Automotive sector. 5G-IANA targets different virtualization technologies integrating different

MANO frameworks for enabling the deployment of the end-to-end services across different domains. 5G-IANA will develop an Automotive VNFs Repository including an extended list of ready to use Automotive-related VNFs, that will form a repository for SMEs to use and develop new applications. Finally, 5G-IANA will develop a distributed AI/ML framework, that will provide functionalities for simplified management and orchestration of collections of AI/ML service components.

APPLICATIONS & EXPECTED IMPACT

5G-IANA aims to increase the uptake of 5G starting from the key Automotive industrial segment, where 5G/B5G business practical applications carry tremendous potential. Also, significant benefits foreseen of 5G-IANA on the safety, environment and economy. By providing real-time notifications about emergency cases on the road and sharing kinematic information when overtaking, 5G-IANA will provide increased safety. 5G-IANA will improve traffic flow by providing real-time traffic data to the drivers.

This information will enable drivers to use alternative paths based on accurate data, thus increasing road utilization. 5G-IANA will lead to emissions reduction by shortening the time-to-destination (and time for parking) for each driver. An accurate and real-time traffic information system is expected to increase road utilization by 20%, leading to a similar reduction in estimated time-to-destination and a similar reduction in traffic volume.
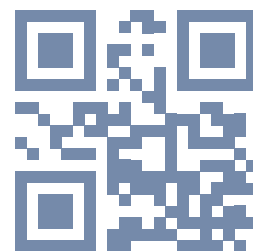
VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive   Public safety   Media & entertainment

5G-INDUCE

OPEN COOPERATIVE 5G EXPERIMENTATION PLATFORMS FOR THE INDUSTRIAL SECTOR NETAPPS

Coordinated by Franco Davoli (CNIT)

January 2021 ———————➤ January 2023

5g-induce.eu

MAIN OBJECTIVES & CHALLENGES

The success of 5G technologies depends closely on their ability to attract vertical stakeholders, seeking the move of their services from cloud to the edge, to meet unique KPIs. The 5G-INDUCE project is based on the belief that such attractiveness requires vertical stakeholders and NetApp developers to be able to smoothly deploy and manage applications in distributed 5G network environments, in a secure fashion and with strict KPI requirements. The successful implementation of this vision constitutes the main objective of 5G-INDUCE. The project focus is directed towards the Industry 4.0 service deployment environment, as a highly exploitable domain for the proposed NetApp porting and management 5G framework.

APPLICATIONS & EXPECTED IMPACT

5G-INDUCE will build application demonstrators in the area of Industry 4.0, showcasing: i) Automatic Guided Vehicle (AGV) control – Autonomous indoor fleet management; Smart operation based on human gesture recognition; VR immersion and AGV control; ii) Prdictive maintenance – ML-Supported Edge Analytics for Predictive Maintenance; iii) Drone-assisted video — Inspection and surveillance services for critical infrastructures; iv) Remote maintenance – AR-based remote maintenance, repairing and upgrade; v) Logistics – Smart logistics over supply chain linked with factory operations; vi) Monitoring – Drone assisted network performance and coverage monitoring for industrial infrastructures. The expected impact is on extensive testing, validation and interoperability of NetApps, short-time service creation, 3rd party markets for start-ups and SMEs, among other aspects.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

5GMediaHUB

5G EXPERIMENTATION ENVIRONMENT FOR 3RD PARTY MEDIA SERVICES
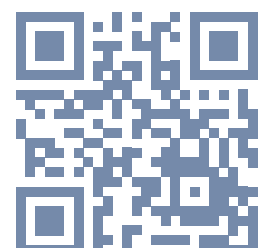
Coordinated by Christos Verikoukis (CTTC)

January 2021 ➝ January 2023

@5gmediahub   5gmediahub.eu

MAIN OBJECTIVES & CHALLENGES

5GMediaHUB aims to accelerating the testing and validation of innovative 5G-empowered media applications and NetApps from 3rd party experimenters and NetApps developers, through an open, integrated and fully featured Experimentation Facility. This will significantly reduce not only the service creation lifecycle but also the time to market barrier. 5GMediaHUB will build and operate an elastic, secure and trusted multi-tenant service execution and NetApps development environment based on an open cloud-based architecture and APIs, by developing and integrating a testing and validation system with two existing well-established 5G testbeds for enabling the fast prototyping, testing and validation of novel 5G services and

NetApps. 5GMediaHUB will offer: (i) a DevOps environment for Testing as a Service; (ii) a rich set of Experimentation Tools that offer scheduling, validation, verification, analytics and QoS/QoE monitoring mechanisms; (iii) A set of re-usable vertical-specific and vertical-agnostic NetApps with easy to use APIs that can be consumed by application developers; (iv) a re-usable open-source NetApps Repository; (v) an umbrella cross-domain service orchestrator to deliver cross-domain orchestration of NetApps; (vi) an innovative security framework offering software defined perimeter protection and isolation of NetApps; (vii) incremental validation capabilities of the Experimental Facility evidenced through 3 novel media use cases.

APPLICATIONS & EXPECTED IMPACT

5GMediaHUB will enable 3rd party experimenters in the media and entertainment sectors to: (a) have access to application testing and validation resources otherwise unavailable to them; (b) reduce entry barriers, reduce uncertainties and accelerate confidence prior to porting them to actual 5G MNO networks; (c) reduce the average service creation time cycle from hours to within minutes; (d) significantly reduce the time to market, optimise the utilisation of resources,

reduce the cost of service deployment through relevant NetApps and accelerate NetApp uptake via the DevOps environment; (e) offer performance and Service Level Agreement (SLA) guarantees for their offered services to their end-user customers through combined service oriented predictive Quality of Service and Quality of Experience indicators, resulting to a more promising and beneficial approach for service-level performance evaluation.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Media & entertainment

EVOLVED-5G

EXPERIMENTATION AND VALIDATION OPENNESS FOR LONGTERM EVOLUTION OF VERTICAL INDUSTRIES IN 5G ERA AND BEYOND

Coordinated by Javier Garcia Rodrigo (TID S.A.U)

January 2021 ➝ December 2023

@evolved5g   evolved-5g.eu

MAIN OBJECTIVES & CHALLENGES

Towards the materialization of the 5G performance gains at application and market level, key contributions are expected by the domain of design and development of Network Application (NetApp). In this context, EVOLVED-5G endorses the vision where the world of NetApps follows the paradigm of mobile applications hosted in a related market place. Moreover, the EVOLVED-5G project will contribute towards the fourth industrial revolution or Industry 4.0. Recognized as one of the major vertical industries by 5G-PPP (referring to the digital evolving of workspaces), Industry 4.0 brings innovative use cases, yet technologically challenging, and create a fertile environment for SME-driven entrepreneurship, where new use case-tailored functions (as NetApps) can be provided to compose a digitalized, secure, and automated generation of the industrial operations (mainly referring to functions for process and machine control as well as procedures for advanced product lifecycle management). The industry-oriented EVOLVED-5G NetApps will be tested, validated, and certified in a vendor-agnostic experimentation platform, and progressively define the first set of NetApps that the EVOLVED-5G marketplace will host.

APPLICATIONS & EXPECTED IMPACT

EVOLVED-5G will disrupt the market of MNOs and Industry 4.0 vendors by: (i) Creating the necessary tools and software development workspace needed by third party developers, startups and SMEs in order to start coding NetApps that exploit the 5G Network Programmability features/advances, (ii) Launching the NetApp Open Repository and Marketplace for the Industry 4.0 vertical industry, introducing new business models and value chains for MNOs., (iii) Reassuring sustainability, since we will build a community of Developers, Entrepreneurs, Spin-Offs, Startups and SMEs across Europe, who will be trained with hands-on seminars on Network Programmability.The expected impact of EVOLVED is fivefold: (i) Impact on Smart Manufacturing Vertical Industry (Factories of the Future -- FoF --), (ii) Impact on App Market: Network-driven Apps (NetApps), (iii) Impact on MNOs' Value Chain: A business model for service providers, (iv) Impact on Market and Economy: 5G conquer of ICT market, (v) Impact on Society and Economy: Boosting European Competitiveness

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

SMART5GRID

DEMONSTRATION OF 5G SOLUTIONS FOR SMART ENERGY GRIDS OF THE FUTURE

Coordinated by Daniele Porcu (Enel Srl)

January 2021 → December 2023

@smart5grid   smart5grid.eu

MAIN OBJECTIVES & CHALLENGES

Smart5Grid utilizing 5G aims to revolutionise the Energy Vertical industry through the successful establishment of four fundamental functions of modern smart grids (i) automatic power distribution grid fault detection, (ii) remote inspection of automatically delimited working areas at distribution level, (iii) millisecond level precise distribution generation control, and (iv) real-time wide area monitoring in a creative cross-border scenario, thus assisting power grid operators and other energy stakeholders such as distribution system operators, energy service providers, etc. Smart5Grid will also design, deploy, operate, and evaluate the baseline system architecture and interfaces for the provisioning of an integrated, open, cooperative, and fully featured 5G network platform, customised for smart energy distribution grids, while an open NetApp repository and high-performance NetApps will be also developed for supporting the Smart5Grid energy-oriented use cases.

APPLICATIONS & EXPECTED IMPACT

Smart5Grid introduces an open 5G experimental facility, supporting integration, testing and validation of existing and new 5G services and NetApps from third parties (i.e., SMEs, developers, engineers) since underpinning experimentation with a fully softwarised 5G platform for the energy vertical industry is one of the key targets of the project. Moreover, in order to supply start-ups and newcomers with the opportunity to accelerate their growth in the high impact industry of the energy vertical, Smart5Grid provides an open access NetApp repository, provisioning support and assistance to third parties through a clear and trustworthy experimentation roadmap, along with a Validation and Verification (V&V) experimentation framework for NetApp automatic testing, certification, and integration. Smart5Grid will ensure impact maximasation to the realisation of the 5G vision in Energy industry establishing close liaison and synergies with 5G PPP and rest 5G PPP projects.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Energy

VITAL-5G

VERTICAL INNOVATIONS IN TRANSPORT AND LOGISTICS OVER 5G EXPERIMENTATION FACILITIES
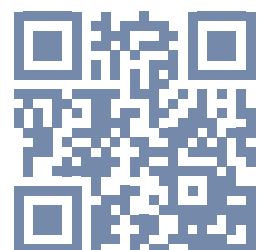
Coordinated by Kostas Trichias (WINGS ICT Solutions)

January 2021 ➔ January 2023

@5gVital   vital5g.eu

MAIN OBJECTIVES & CHALLENGES

Vital-5G enables creation of 5G-enhanced services for the Transport & Logistics (T&L) industry through an open, secure and virtualised 5G test environment, designed to validate advanced T&L-related Network Applications (NetApps). Vital-5G will engage key logistics stakeholders (sea and river port authorities, road logistics operators, warehouse/hub operators) and innovative SMEs, offering them a unique opportunity to develop T&L-related services that utilise advanced 5G testbeds and vertical-specific infrastructure, otherwise unavailable to them. NetApps represent a key enabler for the adoption of 5G solutions, as they abstract the complexity of underlying 5G infrastructure for T&L application developers, and significantly reduce service creation and deployment times, while optimising 5G resource utilisation. With this approach, VITAL-5G plans to overcome the adoption barriers of 5G-based solutions in the European T&L sector and showcase the related added-value of 5G connectivity.

APPLICATIONS & EXPECTED IMPACT

VITAL-5G aims to minimize the knowledge/ expertise gap between telecom providers, vertical industries and application developers through promotion and validation of Network Applications (NetApps). The targeted 5G-enhanced T&L applications are expected to have the following impact: (i) Faster adoption of 5G-based solutions in the T&L ecosystem based on innovative NetApps, validated through a flexible 5G virtualized environment., (ii) Enhanced service creation time and lifecycle management of 5G-enabled T&L services through mechanisms to transparently design, onboard, and manage NetApps across multiple domains and 5G networks., (iii) Wider-scale T&L vertical impact through gathering validated NetApps in an open-source repository, for leverage by 3rd party developers., (iv) Considerable commercialisation potential from novel 5G technologies and services, the implementation and validation of which can support creation of new SME-driven commercial products and service for the T&L market and beyond.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Transport & logistics
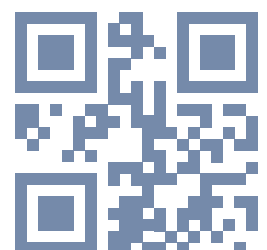
SMART CONNECTIVITY
BEYOND 5G

6G BRAINS

BRINGING REINFORCEMENT LEARNING INTO RADIO LIGHT NETWORK FOR MASSIVE CONNECTIONS

Coordinated by Anastasius Gavras (Eurescom)

January 2021 → December 2023

@6gbrains

6g-brains.eu

MAIN OBJECTIVES & CHALLENGES

6G BRAINS uses multi-agent Deep Reinforcement learning (DRL) to perform resource allocation for massive machine-type communications over new spectrum links including THz and optical wireless communications (OWC) to enhance the performance with regard to capacity, reliability and latency for future industrial networks. The cross-layer DRL driven resource allocation solution supports the massive connections over device-to-device (D2D) assisted highly dynamic cell-free networks enabled by Sub-6 GHz/mmWave/THz/OWC and high resolution 3D Simultaneous Localization and Mapping (SLAM) of up to 1 mm accuracy. The enabling technologies in 6G BRAINS focus on four major aspects: (i) disruptive new spectral links, (ii) highly dynamic D2D cell-free network modelling, (iii) intelligent end-to-end network architecture integrating the multi-agent DRL scheme and (iv) high-resolution 3D SLAM data fusion. The solution is applicable to vertical sectors such as Industry 4.0/Factory of the Future, Intelligent Transportation and Mobility, Smart Agriculture and others.

APPLICATIONS & EXPECTED IMPACT

6G BRAINS targets the "factory of the future". The first use case focuses on offloading the control logic of an industrial controller running as part of a production cell on the shop floor to a centralized computing area called ""factory edge"" in a virtualized form. This approach, where all controllers (real or virtualized) are placed in the same area will significantly increase the flexibility of the production process and reduce the cost. Connecting the production cells to the "factory edge" will enable the ease of reconfiguration of hardware and software components on demand and sets very high expectations on the guaranteed latency and deterministic communication that should support low industrial application cycle times and very precise synchronicity. The second use case focuses on wireless video cameras deployed at the factory production cells sending high quality video to an image analysing system at the "factory edge". This enables advanced production monitoring features such as anomaly detection, improved safety, process tracking and logging, remote control and predictive maintenance. The typical data rate requirements are up to 3 Gbps per camera.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0

Agriculture & agri-food

Transport & logistics

AI@EDGE

A SECURE AND REUSABLE ARTIFICIAL INTELLIGENCE PLATFORM FOR EDGE COMPUTING IN BEYOND 5G NETWORKS

Coordinated by Marco Pistore (FBK)

January 2021 ⟶ December 2023

@AIatEdgeH2020   aiatedge.eu

MAIN OBJECTIVES & CHALLENGES

AI@EDGE addresses the challenges harnessing the concept of "reusable, secure, and trustworthy AI for network automation". In AI@EDGE European industries, academics and innovative SMEs commit to achieve an EU-wide impact on industry-relevant aspects of the AI-for-networks and networks-for-AI paradigms in beyond 5G systems. Cooperative perception for vehicular networks, secure, multi-stakeholder AI for IIoT, aerial infrastructure inspections, and in-flight entertainment are the uses cases targeted by AI@EDGE. To achieve the goal, AI@EDGE targets significant breakthroughs in two fields: (i) general-purpose frameworks for closed-loop network automation capable of supporting flexible and programmable pipelines for the creation, utilization, and adaptation of the secure, reusable, and trustworthy AI/ML models; and (ii) converged connect-compute platform for creating and managing resilient, elastic, and secure end-to-end slices capable of supporting a diverse range of AI-enabled network applications.

APPLICATIONS & EXPECTED IMPACT

AI@EDGE will be validated in the context of four high-impact use cases whose requirements cannot be satisfied by current 5G systems.The validation methodology will reflect close-to-real scenarios, with conditions similar to production:

- UC1 - Virtual validation of vehicle cooperative perception

- UC2 - Secure and resilient orchestration of large (I)IoT networks

- UC3 - Edge AI assisted monitoring of linear infrastructures using drones in BVLOS operation

- UC4 - Smart content & data curation for in-flight entertainment services.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP
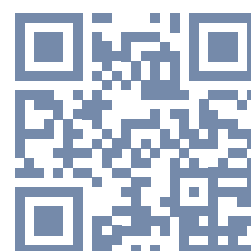
Industry 4.0   Automotive   Transport & logistics   Media & entertainment

DAEMON

NETWORK INTELLIGENCE FOR ADAPTIVE AND SELF-LEARNING MOBILE NETWORKS

Coordinated by Marco Fiore (IMDEA)

January 2021 ➝ December 2023

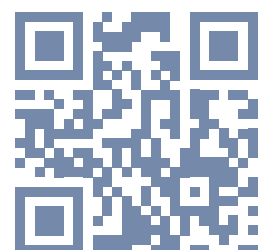@h2020daemon   h2020daemon.eu

MAIN OBJECTIVES & CHALLENGES

The success of Beyond 5G (B5G) systems will largely depend on the quality of the Network Intelligence (NI) that will fully automate network management. Artificial Intelligence (AI) models are commonly regarded as the cornerstone for NI design; indeed, AI models have proven extremely successful at solving hard problems that require inferring complex relationships from entangled and massive (e.g., traffic) data. However, AI is not the best solution for every NI task; and, when it is, the dominating trend of plugging 'vanilla' AI into network controllers and orchestrators is not a sensible choice. Departing from the current hype around AI,

DAEMON will set forth a pragmatic approach to NI design. The project will carry out a systematic analysis of which NI tasks are appropriately solved with AI models, providing a solid set of guidelines for the use of machine learning in network functions. For those problems where AI is a suitable tool, DAEMON will design tailored AI models that respond to the specific needs of network functions, taking advantage of the most recent advances in machine learning. Building on these models, DAEMON will design an end-to-end NI- native architecture for B5G that fully coordinates NI-assisted functionalities.

APPLICATIONS & EXPECTED IMPACT

The advances to NI devised by DAEMON will be applied in practical network settings to: (i) deliver extremely high performance while making an efficient use of the underlying radio and computational resources; (ii) reduce the energy footprint of mobile networks; and (iii) provide extremely high reliability beyond that of 5G systems. To achieve this, DAEMON will design practical algorithms for eight concrete

NI-assisted functionalities, carefully selected to achieve the objectives above. The performance of the DAEMON algorithms will be evaluated in real-world conditions via four experimental sites, and at scale with data-driven approaches based on two nationwide traffic measurement datasets, against nine ambitious yet feasible KPI targets.

DEDICAT 6G

DYNAMIC COVERAGE EXTENSION AND DISTRIBUTED INTELLIGENCE FOR HUMAN CENTRIC APPLICATIONS WITH ASSURED SECURITY, PRIVACY, AND TRUST: FROM 5G TO 6G

Coordinated by Vera Stavroulaki (WINGS ICT)

January 2021 ➙ January 2023

@DEDICAT6G   dedicat6g.eu

MAIN OBJECTIVES & CHALLENGES

In future 6G networks, it is imperative to support more dynamic resourcing and connectivity to improve adaptability, performance, and trustworthiness for emerging human-centric services in a hyperconnected society and industry. DEDICAT 6G aims to develop a smart connectivity platform that is green, highly adaptive, ultra-fast, and dependable for securely supporting innovative, human-centric applications. DEDICAT 6G takes the next vital step beyond 5G by addressing solutions for dynamic distribution of intelligence to improve task execution time, energy efficiency, and ultimately, reduce end-to-end latency. The project also researches enablers for dynamic coverage extensions exploiting robots, drones, and connected vehicles. The scope includes techniques for security, privacy, and trust assurance as well as enablers for novel interaction between humans and digital systems utilizing innovative interfaces and devices, like smart glasses.

APPLICATIONS & EXPECTED IMPACT

The DEDICAT 6G innovations will result in novel products and services providing substantial technological and commercial value. DEDICAT 6G mechanisms for dynamic, migratable distribution of intelligence will contribute to the reduction of energy and resource consumption and the provision of imperceptible end-to-end latency and response time in B5G/6G networks. DEDICAT 6G mechanisms for dynamic coverage extension address the vision for digital inclusion to enable access to all people, information and goods anywhere, anytime. DEDICAT 6G will reinforce security, privacy and trust in in support of advanced IoT applications. In the scope of the DEDICAT 6G use cases (Smart Warehousing, Enhanced Experiences, Public Safety and Smart Highway) the project will develop human-centric applications that will allow relevant stakeholders to improve their operational KPIs and enable the simplification, automation and consequently improved efficiency of processes in the respective domains.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive   Transport & logistics   Public safety   Media & entertainment

Hexa-X

A FLAGSHIP FOR B5G/6G VISION AND INTELLIGENT FABRIC OF TECHNOLOGY ENABLERS CONNECTING HUMAN, PHYSICAL, AND DIGITAL WORLDS

Coordinated by Mikko A. Uusitalo (Nokia Bell Labs)

January 2021 ➞ June 2023

@Hexa_X_2020

hexa-x.eu

MAIN OBJECTIVES & CHALLENGES

Address critical relevance of wireless technologies and their continuing importance for sustainable growth via developing key technology enablers targeting:

- fundamentally new radio access technologies at high frequencies and integrated localization and sensing
- connected intelligence through AI-driven air interface and network governance
- architectural enablers for network disaggregation and dynamic dependability Research challenges
- Connecting intelligence: human and artificial intelligence

- Network of networks: multiple types of resources; communication, data, AI processing optimally connected
- Sustainability: both in terms of sustainable 6G as well as 6G as an enabler for sustainability
- Global service coverage: efficient and affordable solutions for global service coverage
- Extreme experience: enabled through extreme bit rates, imperceptibly low latencies and seeming infinite capacity
- Trustworthiness: ensure security, privacy, integrity, resilience, and reliability

APPLICATIONS & EXPECTED IMPACT

Hexa-X will consider the following 6G use cases: (i) Sustainable development: leveraging on 6G to address the UN SDGs, (ii) Massive twinning: digital representations of every aspect of our societies to foster interactions and optimizations, (iii) Telepresence: Immersive communication to blur the line between the physical and digital world, (iv) From robots to cobots: robots and autonomous systems will closely collaborate with humans and each other, (v) Local trust zones: enabling extreme performance, reliability, and privacy in local parts of network of networks Expected Impact: As a 6G flagship project, Hexa-X will pave the way for the next generation of wireless networks (Hexa) by explorative research (X) and will develop a 6G vision and an intelligent fabric of technology enablers connecting human, physical, and digital worlds which will provide a platform to evolve a global harmonized 6G vision.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

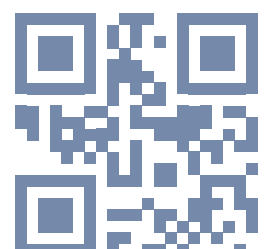Industry 4.0   Agriculture & agri-food   Automotive   Transport & logistics   Smart cities & utilities   Public safety   eHealth & wellness   Media & entertainment

MARSAL

MACHINE LEARNING-BASED, NETWORKING AND COMPUTING INFRASTRUCTURE RESOURCE MANAGEMENT OF 5G AND BEYOND INTELLIGENT NETWORKS

Coordinated by Christos Verikoukis (CTTC)

January 2021 ➝ December 2023

@MarsalProject   marsalproject.eu

MAIN OBJECTIVES & CHALLENGES

MARSAL will develop a framework for the management and orchestration of network resources in 5G and beyond. At the network design domain, MARSAL will put forth novel cell-free based solutions that allow a significant RAN scaling up in a cost-effective manner, while contributing innovative functionalities to the O-RAN project. In the fronthaul/midhaul segments, MARSAL aims to radically increase the flexibility of optical access architectures for beyond-5G cell site connectivity via different levels of fixed-mobile convergence. At the network and service management domain, MARSAL will provide a comprehensive framework for the management of communication and computational network resources by exploiting novel ML-based algorithms. Finally, at the network security domain, MARSAL will introduce mechanisms that provide privacy and security, to allow users to maintain control over their data, while AI and Blockchain will be adapted to guarantee a secured multi-tenant slicing environment.

APPLICATIONS & EXPECTED IMPACT

The innovative design, approaches, schemes, and optimization developed in MARSAL in the areas of ML-based cell-free networking and edge computing infrastructure resource management will accelerate entering markets that go beyond the wireless access network modes, integrated infrastructures, X-haul configuration, cost-efficient processing, intelligent computing protocols, and enhanced security management. The technologies developed in MARSAL will impact other markets and key vertical industries, such as automotive, energy, manufacturing, health, media/entertainment, and public safety. These sectors will be benefited from MARSAL outcomes based on its methodology to reach different QoE and QoS based targets. Accordingly, MARSAL project will create new opportunities for various stakeholders to expand their market options by enabling ML based resource optimization and providing integrated computing and storage infrastructures.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

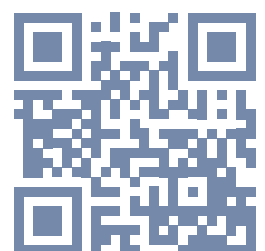Industry 4.0   Automotive   Public safety   Energy   eHealth & wellness   Media & entertainment

REINDEER

RESILIENT INTERACTIVE APPLICATIONS THROUGH HYPER DIVERSITY IN ENERGY EFFICIENT RADIOWEAVES TECHNOLOGY

Coordinated by Martina Truskaller (Technikon)

January 2021 ➞ June 2024

@H2020Reindeer   reindeer-project.eu

MAIN OBJECTIVES & CHALLENGES

The REINDEER project will develop a new smart connect-compute platform with a capacity that is scalable to quasi-infinite, and that offers perceived zero latency and interaction with an extremely high number of embedded devices. It will thereto develop "RadioWeaves" technology, a new wireless access infrastructure consisting of a fabric of distributed radio, computing, and storage resources. RadioWeaves can be deployed as panels mounted on walls and ceilings. It brings a large number of antennas and intelligence close to devices offering consistently excellent service at minimal transmit power and making very efficient usage of network bandwidth and energy. Technologically, RadioWeaves advance the ideas of large-scale intelligent surfaces and cell-free wireless access, two theoretical concepts that bear great promise to offer capabilities far beyond 5G networks. We will characterize channels based on measurements and develop distributed platform architectures to realize the great potential in actual deployments. We will develop protocols and algorithms to establish novel resilient interactive applications that require 'real-time' and 'real-space' cooperation, for future robotized industrial environments, immersive entertainment, and intuitive care, we will co-design focusing algorithms and protocols for enhanced interaction with many energy-neutral devices. REINDEER will provide experimental proof-of-concept in versatile testbeds.
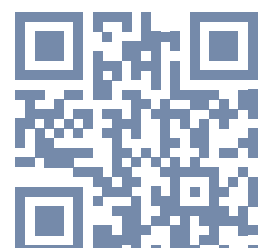
APPLICATIONS & EXPECTED IMPACT

The REINDEER project will bring essential innovation to progress both the platform architectures and the protocols and algorithms to realize the great potential in actual deployments and to establish future interactive applications in industrial, entertainment and care use cases:

- Adaptive robotized factories, warehouses, and logistics:

- Immersive entertainment for crowds of people
- Natural human-machine interaction in care environments, hospitals, and assisted living: and the esthetical integration of the electronics in the environment

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Industry 4.0   Transport & logistics   Energy   Media & entertainment

RISE-6G

RECONFIGURABLE INTELLIGENT SUSTAINABLE ENVIRONMENTS FOR 6G WIRELESS NETWORKS

Coordinated by Emilio Cavalnese Strinati (CEA-Leti)

January 2021 ⟶ January 2023

rise-6g.eu

MAIN OBJECTIVES & CHALLENGES

The RISE-6G vision capitalises on the latest advances on Reconfigurable Intelligent Surfaces (RIS) technology for radio wave propagation control, in order to substantially improve them and, to conceive and implement intelligent, sustainable and dynamically programmable wireless environments that go well beyond the 5G capabilities developed under 3G PPP release 16. RISE-6G will design, prototype, and trial radical technological advances based on Reconfigurable Intelligent Surfaces (RISs) to forge a new generation of dynamically programmable wireless propagation environments. This will support dynamic adaptation to future stringent and highly varying B5G/6G service requirements in terms of Electromagnetic Field (EMF) emissions, localisation accuracy, Energy Efficiency (EE), secrecy guarantees, as well as legislation and regulation changes, while incurring minimal connect-compute network redesign and reconfiguration costs. To this end, RISE-6G objectives are to (i) define novel network architectures and operation strategies incorporating multiple RISs; (ii) characterise its fundamental limits capitalizing on our proposed realistic and validated radio wave propagation models; (iii) design solutions to enable online trade between high-capacity connectivity, Energy Efficiency, EMF exposure, and localisation accuracy based on dynamically programmable wireless propagation environments; and (iv) prototype-benchmark proposed innovation via two complementary trials with verticals.

APPLICATIONS & EXPECTED IMPACT

RISE-6G targets to adress the following families of applications: (1) Extreme network adaptability and reconfigurability, with minimal redesign and reconfiguration cost of the connect-compute network, while offering adaptive controlled service levels; (2) Highly flexible and sustainable networks, operations and services, with a holistic energy budget, optimising not only the power consumption of the individual elements, but also their control communication with the rest of the network infrastructure; (3) Future proofing towards legislation and regulation (EMF exposure, EE, use and sharing of spectrum, data protection, and secrecy), guaranteeing wide societal acceptance of future B5G/6G networks. (4) Concentrated service provisioning in space and time in the operation of the network, its services, and the contextualisation of data, through KPI-specific boosted areas and spatially limited service delivery.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

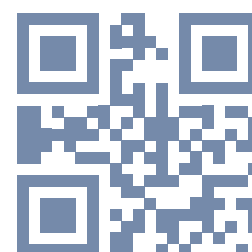Industry 4.0   Automotive   Transport & logistics   Smart cities & utilities   Public safety   Smart airports   Energy   Media & entertainment

TeraFlow

SECURED AUTONOMIC TRAFFIC MANAGEMENT FOR A TERA OF SDN FLOWS

Coordinated by Ricard Vilalta (CTTC)

January 2021 ⟶ June 2023

@TeraFlow_h2020   teraflow-h2020.eu

MAIN OBJECTIVES & CHALLENGES

TeraFlow will create a new type of secure cloud-native SDN controller that will radically advance the state-of-the-art in beyond 5G networks. This new SDN controller shall be able to integrate with the current NFV and MEC frameworks as well as to provide revolutionary features for both flow management (service layer) and optical/microwave network equipment integration (infrastructure layer), while incorporating security using Machine Learning (ML) and forensic evi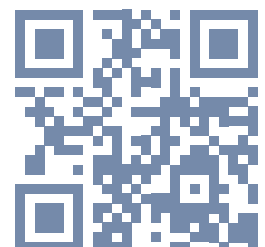dence for multi-tenancy based on Distributed Ledgers. The novel TeraFlow architecture will be validated through the implementation of the TeraFlow OS with the following innovations: a) Cloud-Native Architecture; b) Transport Network Integration; c) Unification of Network and Cloud Resource Management; d) ML-based security; and e) Distributed Ledger Technologies. The final demonstrations (TRL 5) will support three use cases: Autonomous Networks Beyond 5G, Automotive, and Cybersecurity.

APPLICATIONS & EXPECTED IMPACT

The target pool of stakeholders expands beyond the traditional telecom operators towards edge and hyperscale cloud providers. These actors will be benefited from TeraFlow by a) exploiting a new type of secure SDN controller based on cloud-native solutions while, b) achieving substantial business agility with novel and highly dynamic network services with zero-touch automation features. During the course of the TeraFlow project (30 months), experimental implementation and demonstration of prototypes will also play an important role in the project, including communication and dissemination activities and strong collaboration with Standard Defining Organizations (ETSI NFV, ZSM, ENI, PDL, IETF, ONF), and open source software community with dedicated focus on ONF ONOS and ETSI OpenSourceMANO. TeraFlow will also foster strong relationship with other 5GPPP projects through multiple collaboration activities. A concrete plan for TeraFlow results adoption will be implemented as well.

VERTICAL USE CASES ADDRESSED IN THE 5G-PPP

Automotive

5G PPP
PUBLIC-PRIVATE PARTNERSHIP

PHASE 3 PROJECTS

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5G PPP

PUBLIC-PRIVATE PARTNERSHIP

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