Embedded Network services for 5G Experiences:
The "5G ESSENCE" Project Conceptual Approach

Dr. Ioannis P. Chochliouros
Ph.D., M.Sc., Telecommunications Engineer
Head of Fixed Network R&D Programs Section
Hellenic Telecommunications Organization S.A. (OTE)
5G ESSENCE Project Coordinator

20th INFOCOM World Conference – *Athens, Greece, November 21, 2018*

5G PPP PUBLIC-PRIVATE PARTNERSHIP
European Commission
Horizon 2020
European Union funding
for Research & Innovation
5G ESSENCE

Introductory Framework_(1/4)

Current challenges from the 5G deployment:

- Up to now, **several visions of 5G have been proposed** and their basic features converge to the idea that "*any person or item can connect at arbitrarily high data rates, from any place, and with extremely low latency*".
- The way "*how these traits can be realised*" **depends on several factors, including combinations of existing types of communication networks**, as well as ***new and ground-breaking implementations***.
- **5G solutions envisage consolidation of cellular, Internet of Things (IoT), and Wi-Fi networks**, potentially enriched with broadcast networks and automotive systems.

Options for further deployment:

- **Separate radio interfaces are required for the different solutions**, *such as cellular over IoT.*
- The **demand for extremely low latency *"drives"*** to **ultra-dense deployments** and **usage of higher frequencies.**

Introductory Framework_(2/4)

Some critical concerns:

- The **main problem of the actual 5G solutions** is that ***they neither have been "adequately tied" to a solid business case***, ***nor well integrated to the legacy infrastructure of network operators and the rest of actors,*** *within the communications ecosystem*.

- Therefore, ***5G needs not only to "target" to new technological solutions***, ***but should take into account current economic position of telecom operators/market actors*** *and* ***"pave the way" for producing new benefits*** *that will create new markets and services.*

- ***This has been the main challenges of the 5G-PPP phase 2 effort!***

Introductory Framework_(3/4)

The way forward:

- **The** second phase of 5G-PPP program activities suggests that **communication networks need to become sufficiently flexible, *to handle a range of applications/services originating from different domains/verticals.***

- **A transformation towards a significant reduction in cost** and the **optimal allocation of available resources** take the place of initial Key Performance Indicators (KPIs) **for driving capacity growth**, and "coping" with the numerous barriers on the infrastructure and management domains.

- On the users' side, **a high level of personalised services, along with edge mobile capabilities and innovative services are anticipated**, ***since customers require added-value to their choices*** *to accommodate specialised requirements with greater quality of both perception and experience.*

Introductory Framework_(4/4)

Essential Objectives of the 5G ESSENCE context

- **5G ESSENCE addresses** the **paradigms of Edge Cloud computing and Small Cell-as-a-Service (SCaaS)**, *by fuelling the drivers and removing barriers in the Small Cell (SC) market.*
  - *The SC market is expected to grow rapidly up to 2020 and beyond, and*
  - *also to play a "key-role" in the 5G ecosystem!.*

- **5G ESSENCE provides** a **highly flexible and scalable platform**, able to support:
  - **New business models & revenue streams**, ***by creating a neutral host market;***
  - **reduction of operational costs**, ***by providing new opportunities for ownership, deployment, operation and amortisation*.**

- **5G ESSENCE leverages and influences knowledge**, **SW modules** and **prototypes** *from various 5G-PPP Phase-1 projects*, ***"SESAME" being particularly relevant*.**

Ambitious aims are targeted,

culminating with the prototyping and demonstration of 5G ESSENCE system

in three real-life use cases, *associated to* ***vertical industries.***

Market Vision_(1/3)

From "SESAME" to the "5G ESSENCE"

- During 5G-PPP Phase-1, **the ongoing SESAME project evolves the Small Cell (SC) concept by integrating processing power** (i.e., a low-cost micro server) and **by enabling the execution of applications and network services**, *in accordance to the Mobile Edge Computing (MEC).*

- SESAME also **provides network intelligence and applications by leveraging the Network Function Virtualisation (NFV) concept**. *(The SESAME platform consists of one or more clusters of "Cloud – Enabled" Small Cells (CESCs), which are devices that include both the processing power platform and the small cell unit. CESCs can be deployed at low- and medium-scale venues and support multiple network operators (i.e.: multitenancy) and further, network services and applications at the edge of the network).*

- **SESAME has developed several SC-*related* functions as Virtualised Network Functions (VNFs).**
- **SESAME has demonstrated so far that some network related functions** (*such as content caching, firewalls and monitoring*) **perform adequately well when running as VNFs** in the developed micro-server infrastructure *(coined as "Light Data Centre" - Light DC).*

Market Vision_(2/3)

From "SESAME" to the "5G ESSENCE"

- **5G ESSENCE leverages results from the SESAME project**, as well as from other 5G-PPP Phase-1 projects (COHERENT, SPEED 5G, and SONATA mainly), **to provide an evolution of the SESAME platform and to "meet" the 5G-PPP Phase-2 requirements** *(i.e., to cover the specific network needs of the vertical sectors and their interdependencies).*

- **5G ESSENCE:**
  - **enhances the processing capabilities** for data that have immediate value beyond locality;
  - **addresses the processing-intensive small cell management functions**, *such as Radio Resource Management (RRM)/ Self Organising Network (SON);*
  - **culminates with real life demonstrations**.

- 5G ESSENCE **suggests clear breakthroughs** in the research fields of wireless access, network virtualisation, and end-to-end (E2E) service delivery.

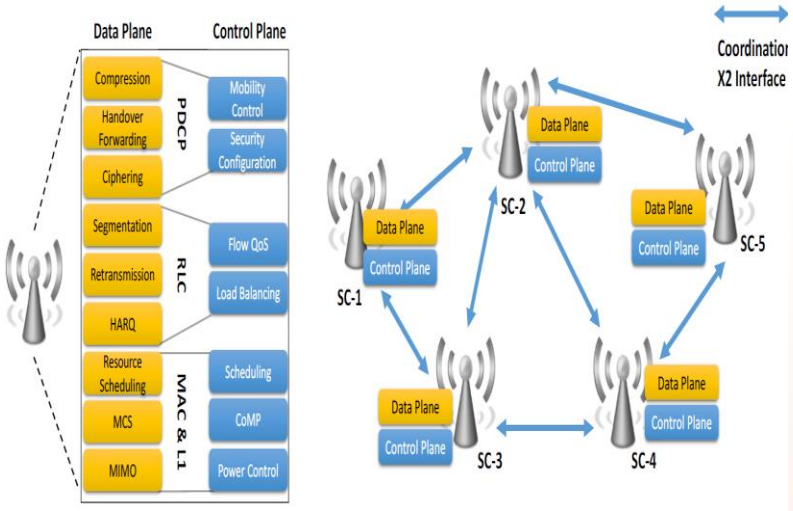
- 5G ESSENCE **builds upon the SESAME project** by developing a distributed edge cloud environment (coined as *"Edge Data Centre" (Edge DC)*), ***based on a two-tier architecture:***
  - **the first tier (i.e., Light DC) will remain distributed inside the CESCs** for providing latency-sensitive services to users directly from the network's edge;
  - **the second tier will be a more centralised, "high-scale" cloud, namely the Main Data Centre (Main DC),** which will provide high processing power for computing intensive network applications. It will also have a more centralised view so as to host efficient Quality of Service (QoS) enabled scheduling algorithms.

Market Vision_(3/3)

Challenges and Drawbacks

- **The capacity offered from small cells does not scale beyond a specific threshold,** due to interference.

- **Existing radio resource allocations remain inadequate,** due to the lack of a centralised coordination, *especially in urban areas and environments with high density of users*.



Challenges for Growth_(1/2)

- **5G ESSENCE aims to include multiple Radio Access Technologies (RAT) in its network architecture**, representing an important step towards fulfilling the vision of 5G wireless networks *(ensuring **higher performance and flexibility** and offering **more efficient spectrum utilisation**).*

- **Benefits are foreseen also in the fields of high-performance virtualisation, service delivery and resource orchestration**, *targeting the **critical issues of resource efficiency and latency reduction.***
  (*These will be achieved through the support of a converged cloud-radio environment, the orchestration of diverse types of lightweight virtual resources, and the support of live VNF migration).*

- **5G ESSENCE will provide even "tighter mapping" and closer interactions between the resource orchestration** *(i.e., deployment, placement, and scaling of VNFs)* **and service orchestration** *(i.e., building, coordinating and exposing services to upper layers).*

- On the domain of hardware technologies, **the processing power attached to small cells brings new capabilities to the network,** *as well as new challenges.*

Challenges for Growth_(2/2)

- A ***significant part of 5G ESSENCE*** is devoted to the **actual demonstration of outcomes in vertical industries.**

- *In order to showcase that 5G will be able to create a whole new ecosystem for technical and business innovation*, **5G ESSENCE unifies computing and storage resources into a programmable and unified small cell infrastructure that can be provided as-a-Service,** *to all related stakeholders.*

- **5G ESSENCE provides a clear plan for real life demonstrations** in the fields of:
  - *multimedia-entertainment;*
  - *mission critical communications at emergency events, and;*
  - *in-flight connectivity and entertainment.*

Scenarios of Use_(1/3)

Identification of 3 Main Real-Life Use Cases, *associated to Vertical Industries*

5G edge network acceleration for a stadium:

- **Demonstration of a combined 5G-*based* video production and video distribution for delivering benefits to media producers and mobile operators,** who will be able to offer enriched event experience to their subscribers.
- *The production/distribution of locally generated content through the 5G ESSENCE platform, coupled with value-added services and rich user context,* ***will enable secure, high-quality and resilient transmission****, in real-time and with minimal latency.*

Mission critical applications for public safety (PS):

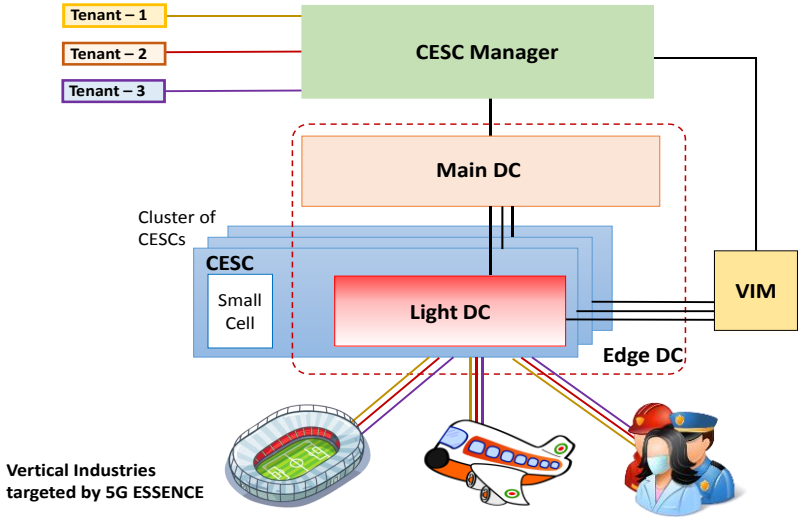
- **Involvement of one -*or more*- PS communications providers, to use the resources offered by a dedicated platform for the delivery of communication services to PS organisations in a country/region.**
- *The 5G ESSENCE platform can be owned by either a mobile (potentially virtual) network operator* or by a *venue owner*.
- *The infrastructure owner will exploit system capabilities to provide the required network/cloud slicing capabilities with dedicated SLAs to different types of tenants, by prioritising the PS communications providers.*

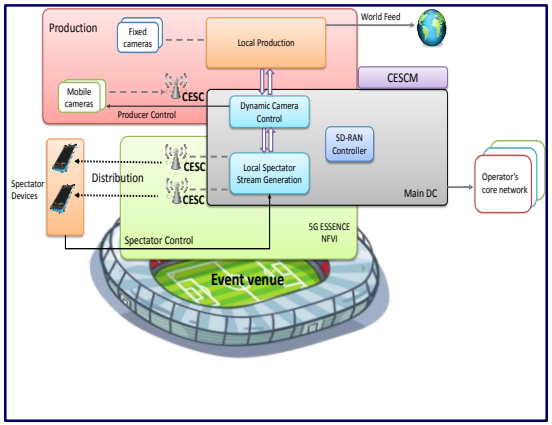
Next-Generation integrated in-flight connectivity and entertainment (IFEC) services:

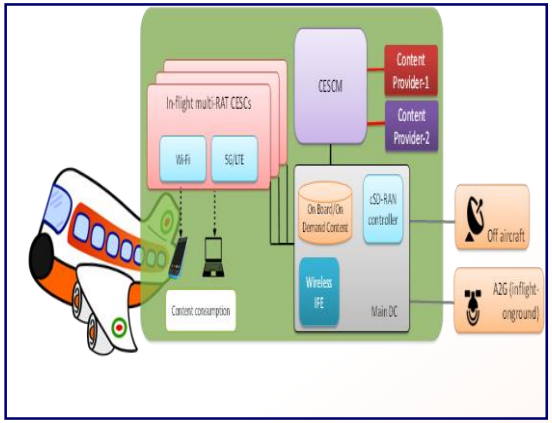
- **Testing and validation of the multi-tenancy enabled network solution for passenger connectivity and wireless broadband experience.**
- ***The multi-RAT CESCs will be implemented as a set of integrated access points to be deployed on-board.***
- Then, since IFE has to consider the explosive growth of multi-screen content consumption, the 5G ESSENCE CESCs will stream on demand multi-screen video content *(both from on-board 5G Edge DC servers and via satellite/air2ground links) to the wireless devices.*
- ***5G ESSENCE CESCs will rely on broadcast links*** *to optimise the bandwidth usage.*

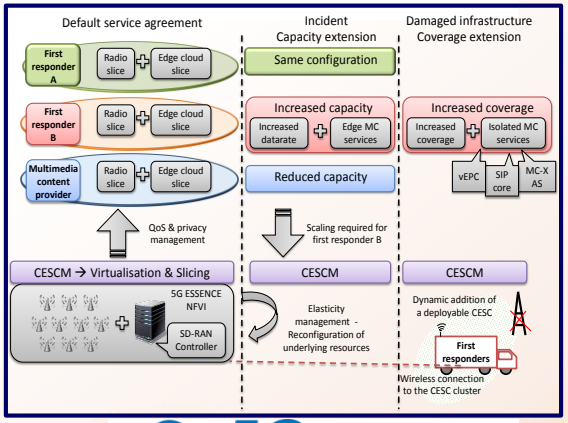
Scenarios of Use_(2/3)

Identification of 3 Main Real-Life Use Cases (cont.)









5G ESSENCE

Scenarios of Use_(3/3)

5G ESSENCE will explore the means to deliver its achievements to the market, with emphasis in the **quantification of benefits**, especially in terms of total cost of ownership, revenues and profits.

5G ESSENCE will allow the sharing of existing and new infrastructure by many operators in a multitenant environment, *thus* ***enabling new business models*** *that will help new entrant market players to develop and analyse the perspectives of potential win-win strategies based on the developed solutions.*

Key actors, revenue streams, and cost/performance drivers of the various RAN partitioning options will be identified.

The main benefits of 5G ESSENCE include

- the **maximisation of resource usage**
- the **reduction of equipment and management costs**, *and*
- the **QoS improvement**

thus encouraging ***network innovation*** *and* ***deployment of distinct network services.***

Objectives

Objective 1: *To **specify** the critical architectural enhancements from 5G-PPP Phase-1 that are needed to fully enable cloud-integrated multi-tenant small cell networking.*

Objective 2: *To **define** the baseline system architecture and interfaces for the provisioning of a cloud-integrated multi-tenant small cell network and a programmable RRM controller, both customisable on a per vertical basis.*

Objective 3: *To **develop** the centralised SD-RAN controller that will program the radio resources usage in a unified way for all CESCs.*

Objective 4: *To **exploit** high-performance and efficient virtualisation techniques for better resource utilisation, higher throughput and less delay at Network Services creation time.*

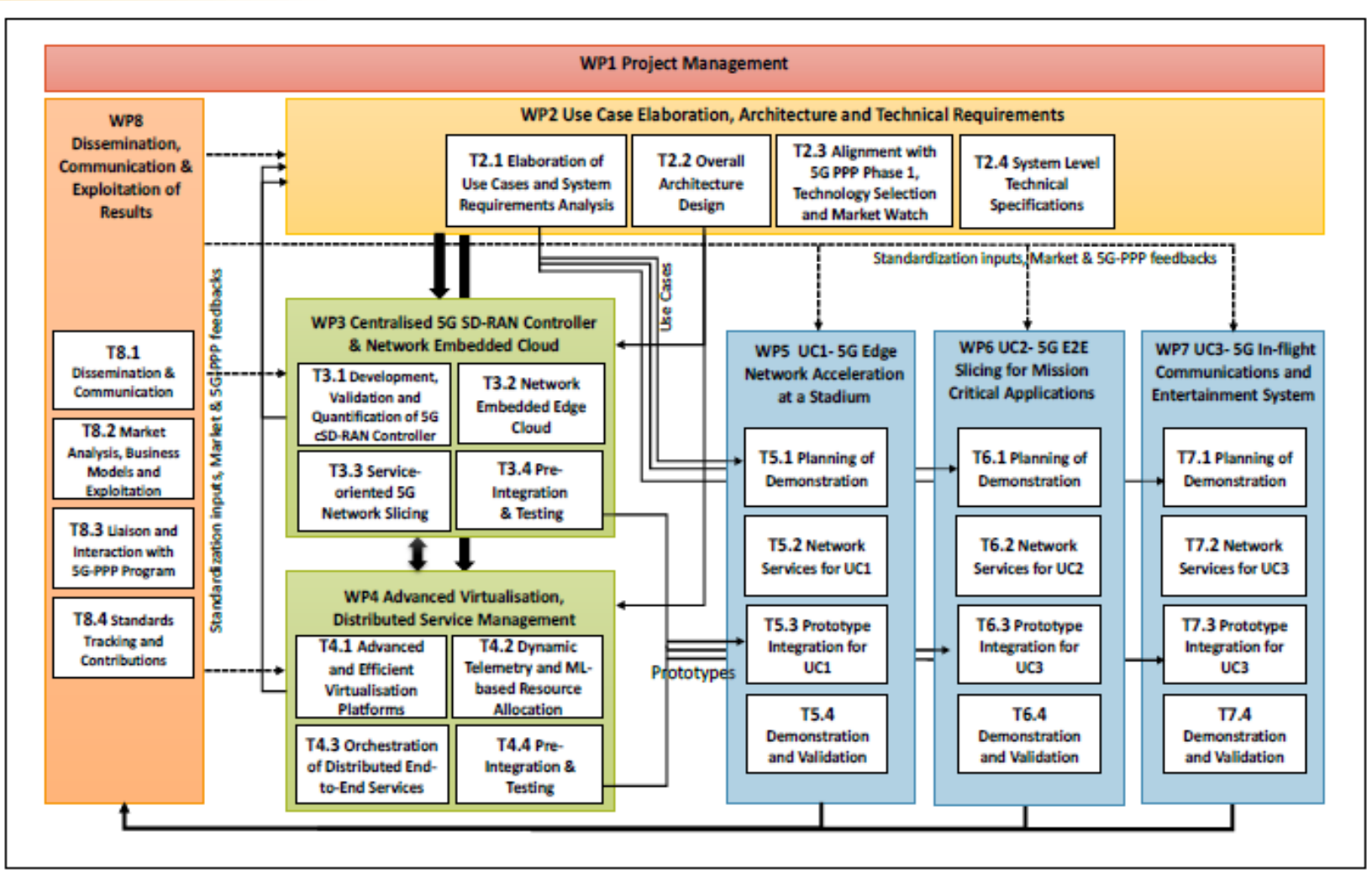
Objective 5: *To **develop** the orchestrator enhancements for distributed service management.*

Objective 6: *To **demonstrate and evaluate** the cloud-integrated multi-tenant small cell network via three real-life vertical industries.*

Objective 7: *To **conduct** a market analysis and to **establish** new business models. Detailed techno-economic analysis and roadmapping towards exploitation and commercialisation by industrial partners is also a priority.*

Objective 8: *To **ensure** maximisation of 5G ESSENCE impact to the realisation of the 5G vision by establishing close liaison and synergies with 5G-PPP projects and the Association. To **pursue** extensive dissemination and communication activities, as well to **assess** the perceived impact from the stakeholders and the wider community.*

5G ESSENCE – Structuring of WPs



Advantages

- ***Rapid deployment of new services for consumer and enterprise business segments** which can help them differentiate their service portfolio, benefitting from the CESC framework.*
- ***Adding new revenue streams from innovative services delivered closer to the user**, together with offering the user a better service-oriented QoE, leveraging the Edge DC and the CESCM entities, and furthermore, improving revenue opportunities by sharing the infrastructure for specific service providers.*
- ***Introduce new applications which are aware of the local context in which they operate** (RAN conditions, localised information, density information, etc.) **through the integration of the CESC virtual small cells functionalities,** which open up new service categories and enrich end-user offerings.*
- ***Drastic reduction of OPEX costs by offloading management related functionalities closer to the edge and by developing smarter management techniques**, and further limiting the Total Cost of Ownership (TCO)/CAPEX costs by promoting shared infrastructures enabled by the multi-tenancy and the virtualised multi-service management framework (CESCM).*
- ***Flexible development of market innovative and ground breaking services and applications** that take advantage of the contextual information provided by the CESC on the radio network conditions and other information at the edges (e.g., edge caching, critical services).*
- ***Create new market entrants by opening up the shared infrastructures** to new software and application providers, infrastructure vendors and other CSPs, thereby increasing revenues and also promoting regulatory support.*

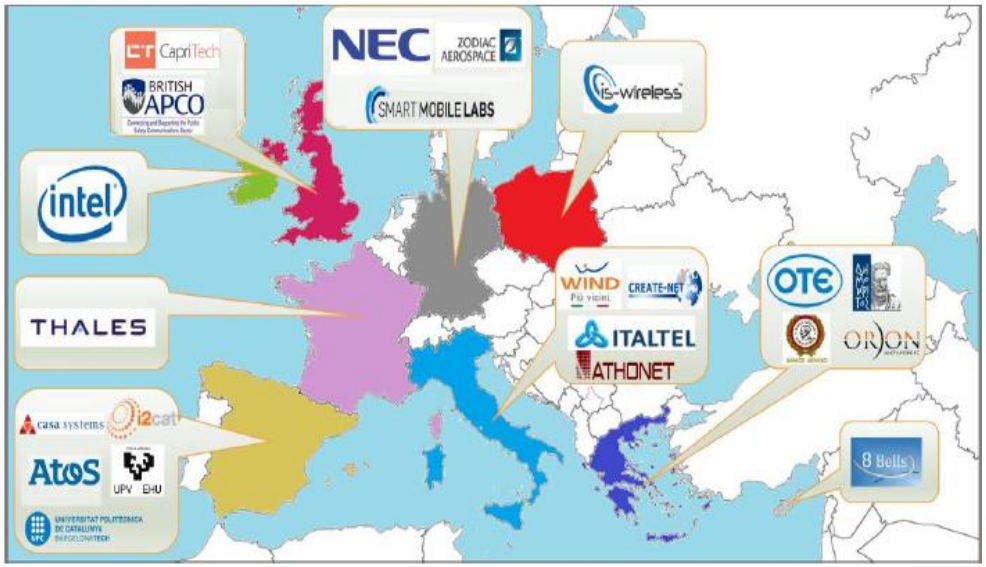
Benefits for the Society

- ***Provision of social well-being:*** ***The employment of software network technologies, greatly promotes service efficiency and agility, resulting to improved perceived quality of experience****. This is* ***critical*** *as more and more basic services from governments, banks, retailers, media companies, and other stakeholders are conducted online.*
- ***Reinforcement of the social cohesion:*** ***The infrastructure sharing and the business models on shared resources that 5G ESSENCE introduces will bring lower service fees****. Therefore, European citizens will have effective and equitable access to communication services, skills and knowledge.*
- ***Connectivity support in extraordinary events:*** *Thanks to the flexibility, agility and configurability offered by SDN/NFV technologies and the edge cloud setup,* ***it is possible to offer and configure new services on the spot with a setup time of only a few minutes****. 5G ESSENCE can offer natively the extra capacity, the lower latency, and the dramatically reduced service creation time needed in emergency cases and at sporadic/flash crowd events.*
- ***Stimulating growth in all industries that can exploit 5G technology:*** ***European economy will strongly benefit from the new services*** *and greater efficiencies suggested by the project to become more competitive,* ***to create new business models, and to offer new job opportunities****.*

5G ESSENCE Consortium – Who we are…_(1/2)

- Research & Innovation Action (RIA)
- Proposal No.: 761592
- Topic: ICT-07-2017
- Duration: 30 months
- Overall budget (requested grant) of ~7.978 Million euro
- Consortium members: 22 partners
  from 9 EU member states
- Project Coordinator: OTE (Hellenic Telecoms S.A.)
- Project Manager: Dr. Ioannis Chochliouros (OTE)
- Technical Manager: Dr. Anastasios Kourtis (NCSRD)

- More information at: https://5g-ppp.eu/5G ESSENCE/
- Contact: 5G ESSENCE-Contact@5g-ppp.eu



- **Two Network Operators: OTE** and **WI3** are nationwide network operators, with strong orientation to innovation, and significant background in innovative SDN/NFV architectures. OTE and WI3 will support actions to identify market opportunities and dissemination of 5G ESSENCE outcomes.

- **Six Large industries:** They will lead the technology development so as to enhance their products with the 5G ESSENCE innovative results.
- **NECLE, INTEL, TCS** and **ITL** are leading global players in the fields of broadband and mobile technologies and in particular of cloud computing and virtualised and SDN-enabled networks systems integration. **ATOS** is a global player in innovative IT and telco solutions.
- **ZII** is a world leader in aerospace equipment and systems for commercial, regional, and business aircrafts, helicopters, and space applications.

- **SevenSMEs:** They will exploit the momentum and the critical mass of the project to develop highly innovative products and services, thus gaining a strong competitive advantage.
- **ISW** is leading small cell developers/integrators, focused on the development of improved small cell systems and solutions.
- **SML** is a Nokia Siemens Networks spin-off that develops special solutions for the new mobile radio standard LTE.
- **ATH** is well established in the market of high performance Mobile Core Network providers.
- **ORION** and **CPT** are emerging players in the NFV arena as developers of cutting-edge virtual network devices and security services.
- **8BELLS** provides in-depth experience of telecommunication systems and techno-economic aspects and will contribute with a market analysis.
- **CASA** is an innovator providing access network solutions based on a variety of modern technologies.

- **Three research centres (NCSRD, i2CAT, FBK/CNET)** and **two universities (UPC, EHU)** with long term experience in ICT sector and networking.
- **Two organisations** with end-users/representatives of vertical sectors (**BAPCO, MoE**).

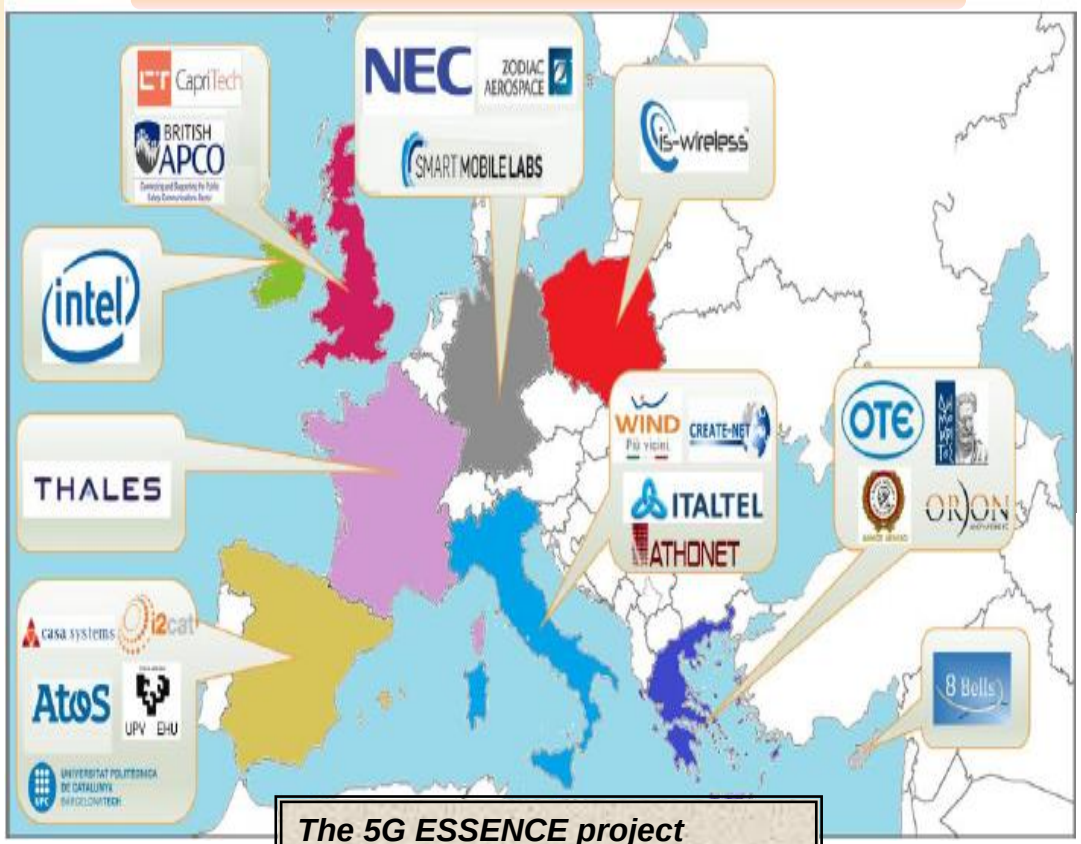
5G PPP PUBLIC-PRIVATE PARTNERSHIP

European Commission | Horizon 2020 European Union funding for Research & Innovation

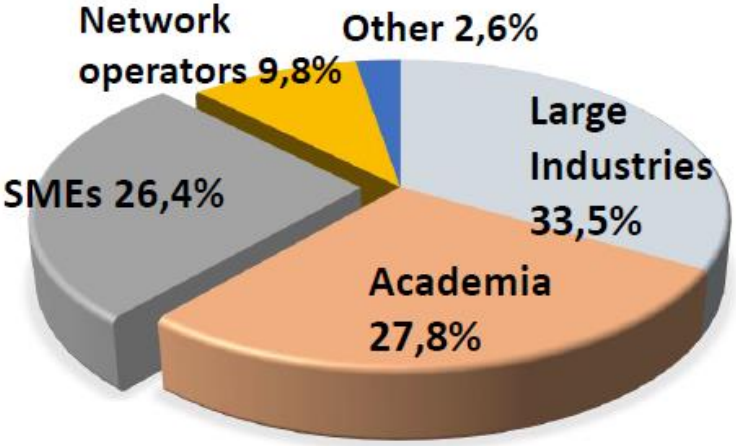
5G ESSENCE

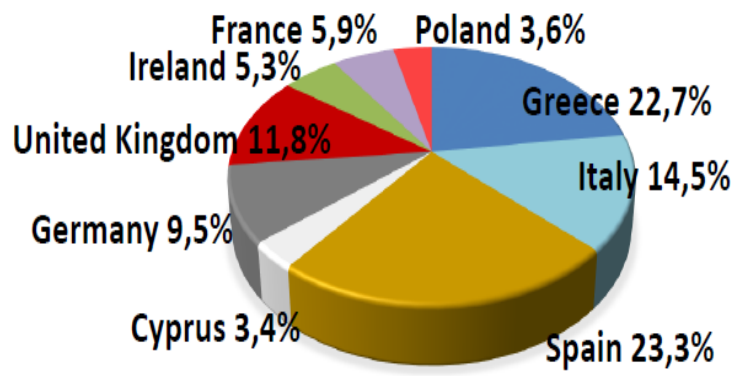
5G ESSENCE Consortium – Who we are…_(2/2)

***22 Partners from all over Europe**



*The 5G ESSENCE project consortium is **geographically balanced** and is composed of partners coming from **nine European countries***





5G PPP PUBLIC-PRIVATE PARTNERSHIP

European Commission | Horizon 2020 European Union funding for Research & Innovation

5G ESSENCE

For further communication…

Dr. Ioannis P. Chochliouros
Head of Fixed Network R&D Programs Section
5G ESSENCE Project Coordinator

Hellenic Telecommunications Organization S.A. (OTE)
Core Network DevOps & Technology Strategy Division, Fixed & Mobile
Research and Development Department, Fixed & Mobile
Fixed Network R&D Programs Section

1, Pelika & Spartis Street
15122 Maroussi-Athens
Greece

Tel.: +30-210-6114651
Fax: +30-210-6114650
E-Mail: *ichochliouros@oteresearch.gr; ic152369@ote.gr;*

http://www.5g-essence-h2020.eu