The "5G ESSENCE" Approach for the Provision of Enhanced 5G Network Services and Facilities

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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**.

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.

❖ Thus, **additional 5G actors** -*such as multimedia content providers and vendors*- **should be able to "enter the market and increase their profits"**.

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.

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.

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).

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 **will build on 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.

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.* **As a remedy**, **the Cloud-Radio Access Network (C-RAN) approach has introduced centralised BaseBand Units (BBUs)** for processing both the control and user planes, *to support flexible scaling and sophisticated interference coordination techniques.*

➢ **However, the significant capacity gains proposed by C-RAN come with a high cost for the fronthaul network** *since the fronthaul requirements for C-RAN are in the order of 6 Gbps bandwidth for small cell sites and of latency less than 0.5ms Round Trip Time (RTT).*

➢ **Small cells can be connected to fronthaul through a variety of technologies** (*cable, public fibre, and microwave*) and there are scenarios in which they are deployed without a central planning.

➢ **SESAME applies some advantageous distributed RRM/SON techniques for managing interference and increasing capacity**. The coarse coordination achieved through X2 interface targets to reduce interference but it is less efficient for allocating resources in a unified fashion among multiple cells, in comparison with the C-RAN approach.
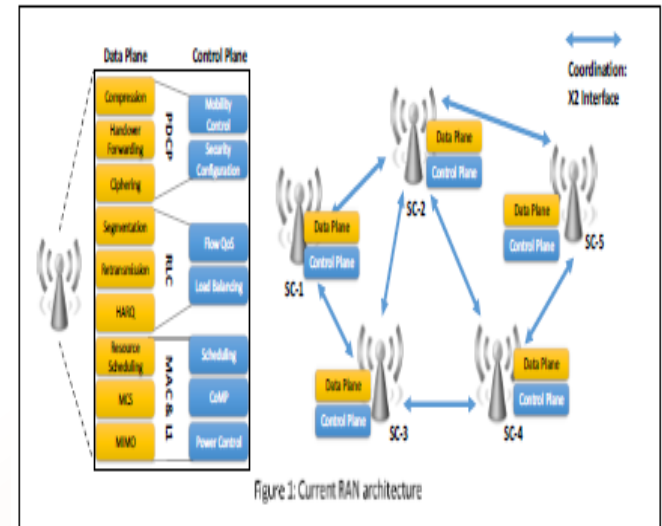

Fig. 1. Current RAN architecture

➡ **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.*

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.*

PUBLIC-PRIVATE PARTNERSHIP

Horizon 2020
European Union funding
for Research & Innovation

🔴 **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.*
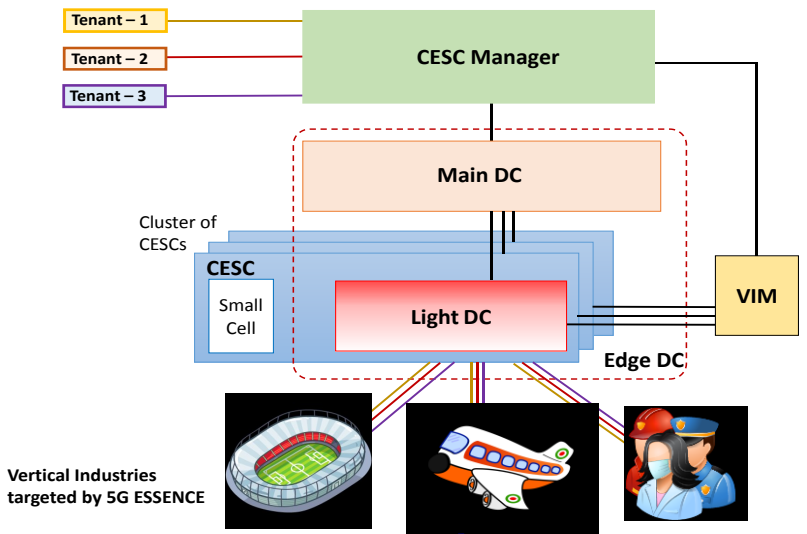
➡️ *Mission critical applications for public safety (PS):*

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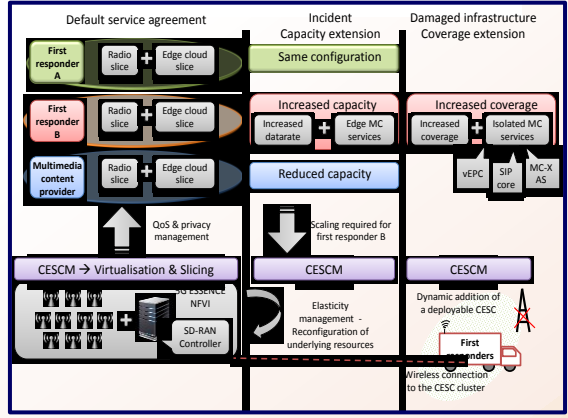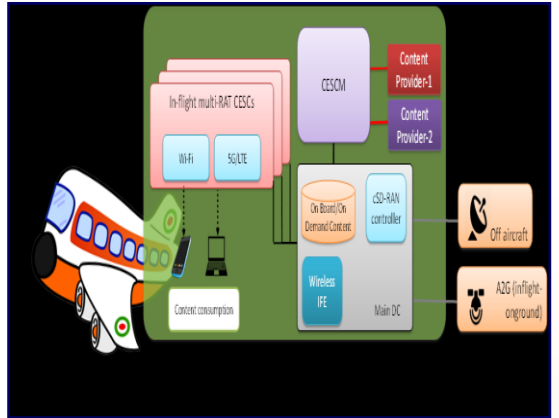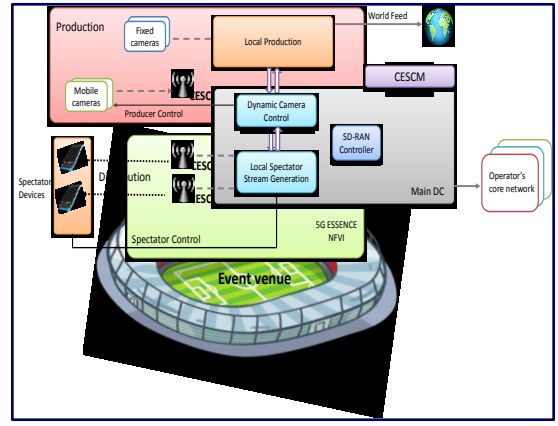
➡️ *Next-Generation integrated in-flight connectivity and entertainment (IFEC) services:*

- **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.*

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

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- **At the network's edge, each CESC is able to host one or more service VNFs,** directly applying to the users of a specific operator.
- **VNFs can be instantiated inside the Main DC *and be parts of a Service Function Chaining (SFC) procedure*.**
- **The Light DC can be used to "implement different functional splits of the Small Cells *as well as to support the mobile edge applications of the end-users.***

5G ESSENCE proposes the development of small cell management functions as VNFs, which run in the Main DC and coordinate a fixed "pool" of shared radio resources, *instead of considering that each small cell station has its own set* of resources.

Vertical Industries targeted by 5G ESSENCE
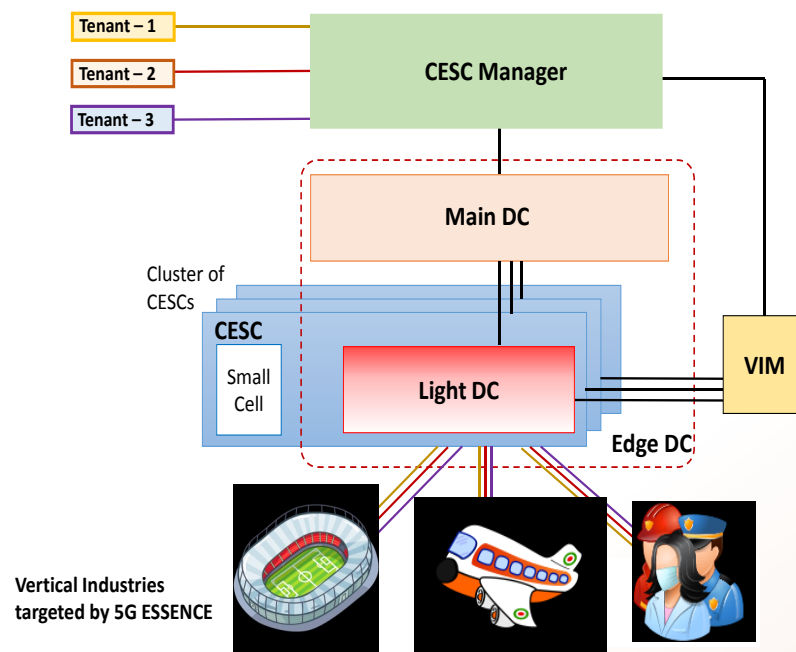
- ❑ *The CESC Manager (CESCM) is responsible for coordinating and supervising the use, the performance, and the delivery of both radio resources and services*. It controls the interactions between the infrastructure (CESCs, Edge DC) and the network operators.

- ❑ The *CESCM handles Service Level Agreements (SLAs)*, while on an architectural basis it encompasses telemetry and analytics as fundamental tools for efficiently managing the overall network.

- ❑ *The Virtualised Infrastructure Manager (VIM) is responsible for controlling the NFV Infrastructure (NFVI)*, which includes the computing, storage and network resources of the Edge DC.

5G ESSENCE – Some Advice for Success…
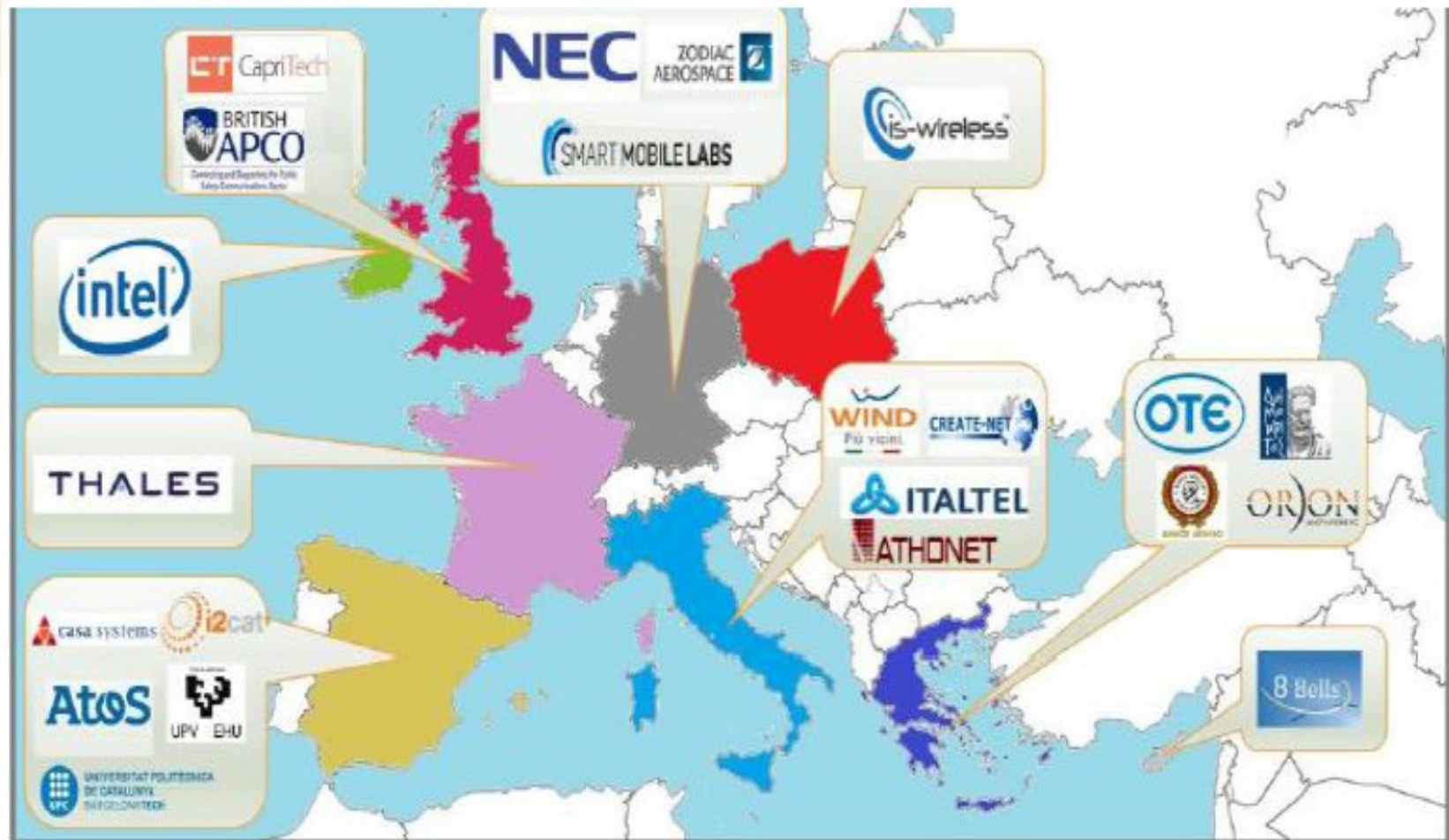
- **Full appliance of Project Management procedures during the preparation of the project**, in particular according to the PMI approach.
- **Proper selection of the consortium members** with **complementarity and diversity**, as of partners' competencies and expertise, *per case*.
- **"Good balance" between the (various) market actors**.
- **Clear roles and duties allocated between the partners**, by focusing of related explicit know-how and expertise, per partner.

- **Fulfilling the corresponding requirements of the Call**, with detailed, exact *-but also simple and easy-to understand-* argumentation.
- **Relevance to the specific objectives of the Call** and coverage of all necessary requirements by providing dedicated text for this purpose, especially to explain relevance to the Community Work Program.
- **Detailed description of the current state-of-the-art as of existing technology** *– Making clear how the project is to contribute to growth and via which specific methodology, per case.*

5G ESSENCE – Some Advice for Success...

➡ **Defining clear and explicit objectives as well as detailed motivation.**

➡ **Promoting a reliable methodology and a detailed concept,** *by focusing on technology, market requirements, business aspects, regulation, social issues, etc.*

➡ *Credibility of the proposed methodology*

➡ **Emphasizing on expected impact(s) with measurable KPIs.**

➡ **Identifying benefits per potential thematic area,** explicitly and implicitly relevant to the project scope.

➡ **Demonstrate innovation potential.**

➡ **Good exploitation policy,** by all involved actors in order to: assure innovation capacity, create new market opportunities, strengthen competitiveness and growth of companies, bring benefits for the market and the end-users.

➡ **Reliable dissemination and communication plans,** *by all involved actors and targeting a variety of potential recipients.*

➡ **Emphasis on IPRs management (knowledge management and protection),** *where relevant.*

5G ESSENCE – Some Advice for Success...

➡ **Exact Work Plan, with appropriate WPs complementing one each other –** *Quality and Effectiveness*.

➡ **Detailed and homogeneous analysis of each WP,** *with appropriate deliverables and milestones.*

➡ **Good timing** *for all expected actions*.

➡ **Balanced justification of all requested costs and/or resources.**

➡ **Suitable risk and innovation management**

➡ **Professional Project Management framework.**

➡ **Process and methodology for appropriate internal governing of the project consortium,** *to assure achievements of all expected aims in due-time and according to the Grant Agreement.*

➡ **Clear roles for the involved partners/actors.**

➡ **Assurance for continuous and dynamic management and overview of all actions.**

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