Promoting Small Cells-as-a-Service in Verticals: The “5G ESSENCE “ Context
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.
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. CESC 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 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 CESC 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.**
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.
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 CESC 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 CESC 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 CESC will rely on broadcast links to optimise the bandwidth usage.
Identification of 3 Main Real-Life Use Cases (cont.)

Vertical Industries targeted by 5G ESSENCE

- First responder
- SD-RAN Controller
- Radio slice
- Edge cloud slice

5G ESSENCE NFVI

CESCM ➔ Virtualisation & Slicing

- Incident Capacity extension
- Reduced capacity
- Increased coverage

Damaged infrastructure

- Incident Capacity extension
- Reduced capacity
- Increased coverage

Default service agreement

- Same configuration
- Reduced capacity
- Increased coverage

Operator's core network

- 5G ESSENCE NFVI
- SD-RAN Controller
- SD WA controller

Operator's core network

- Mobility management - Real-time management of underlying resources
- QoS & privacy management

CESCM ➔ Virtualisation & Slicing

- Dynamic addition of a deployable CESC
- Elasticity management

Event venue

- Producer
- Spectator
- Mobile cameras
- Fixed cameras

Production

- Live Feed
- Local Production
- World Feed

Local Spectator View

- Event venue
- Operator's core network

Vertical Industries

- First responder
- Multimedia content provider
- AS
- SIP core
- vEPC

World Feed

Local Spectator Stream Generation

- Producer Control
- Spectator Control
- Devices

Producer

- SD-RAN Controller
- Radio slice
- Edge cloud slice

SD-RAN Controller

- Event venue
- Operator's core network
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.
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