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5G-DIVE: eDge Intelligence for Vertical Experimentation

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Abstract—**5G-DIVE targets end-to-end 5G trials aimed at proving the technical merits and business value proposition of 5G technologies in two vertical pilots, namely (i) Industry 4.0 and (ii) Autonomous Drone Scout. Its design is built around two main pillars, namely (1) end-to-end 5G connectivity including 5G New Radio, Crosshaul transport and 5G Core, and (2) distributed edge and fog computing integrating intelligence located closely to the user to achieve optimized performance, improving significantly the business value proposition of 5G in each targeted vertical application.**

I. Introduction

The 5th generation (5G) of mobile communication networks, beyond of defining several enhancements both in terms of performance and available services, aims at providing the vertical industries with a shared infrastructure capable of support multiple and disparate service requirements. Enhanced Mobile BroadBand (eMBB), Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC) are identified as the main network services to be supported by the 5G, having different requirements in terms of e.g. bandwidth, latency, reliability and scalability.

However, for certain time-sensitive and location-aware applications (e.g., patient monitoring, augmented reality, connected vehicles, remote control and robotics), which require very low end-to-end latency, it is challenging, complex and stressing for the network to deliver through a pure centralised cloud architecture [1]. To better satisfy the requirements of these applications, the distribution of computing, storage and networking capabilities closer to the connected devices (as close as one hop distance) started to be witnessed with the advent of edge computing and Multi-Access Edge Computing (MEC) [2]. Still, the virtualization substrate would mainly remain fixed and centralized in a pre-defined location (i.e., edge data center), owned by the operator.

With the increasing capabilities of nowadays end-user devices, new scenarios can be envisioned where these devices can also belong to the virtual infrastructure, the so-called fog computing [3]. This means that computing, storage and networking capabilities could be provided by any device, independently of who is its owner. However, it makes the virtualization infrastructure an highly dynamic environment, that needs to suit to a great diversity and heterogeneity of devices with disparate capabilities, to handle mobile and volatile

nodes, *etc*. A continuous monitoring along with automated and intelligent mechanisms are then required to ensure an optimal use of resources of the virtual infrastructure, as well as that the provisioning of the end-to-end services do not suffer downtime while making sure that the minimum requirements are met.

5G-DIVE aims at contributing to the verification and validation of the technical merits and business value proposition of 5G technologies, by envisioning to achieve optimized performance and thus to boost significantly the business value proposition of 5G in each targeted vertical application. Its contributions are built around two main pillar. On one hand, to provide end-to-end 5G connectivity including 5G New Radio, Crosshaul transport and 5G Core. On the other hand, to provide distributed edge and fog computing, integrating intelligence located closely to the user.

The remainder of this paper is organized as follows: Section II provides a brief overview on the 5G-DIVE platform and the vertical pilots that it aims to address. Section III presents the plans for international collaboration. Finally, the main conclusions are presented in Section IV.

II. The 5G-DIVE Platform

A. Leveraging 5G-CORAL platform

5G-DIVE platform builds on top of the two main system that compose the 5G-CORAL platform (i.e., the Edge and Fog computing System (EFS) and Orchestration and Control System (OCS)), developed under EU-TW-Phase-I 5G-CORAL project[1]. The EFS is a logical system composed by different edge and fog resources in a given domain and, therefore, comprise the virtual infrastructure where virtualized function, services and applications are hosted. The OCS is a logical system responsible for managing, controlling, orchestrating and federating one or more EFSs and its interactions with any other tiers.

B. 5G-DIVE Platform Overview

5G-DIVE platform aims at extending the EFS and OCS with automation and intelligence capabilities, effectively enhancing the 5G-CORAL infrastructure. Among others, it expects to address the following enhancements:

[1] 5G-CORAL project - http://5g-coral.eu/

- Extend the OCS to include a new Cognitive Network Management architecture, using artificial intelligence techniques and context-aware policies. In doing so, offered services can be adjusted based on changes in user needs, environmental conditions and business goals.
- Extend the EFS to consider the concepts of zero touch network and service management, enabling fully automated management and operation of the EFS.

The above enhancements are materialized in a new logical system, the 5G-DIVE Elastic Edge Platform (DEEP), as depicted in Figure 1.
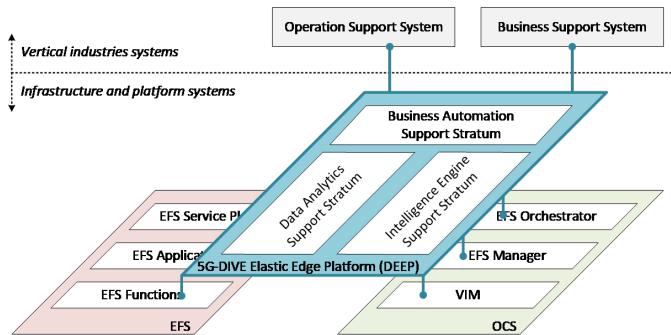

Fig. 1. 5G-DIVE Platform Overview

The DEEP enables vertical industries to support day-by-day operations, management and automation of businesses processes on-top of an edge and fog infrastructure. It is composed by three main building blocks, responsible for:

- **Data Analytics Support Stratum:** support for data analytics platform, providing the vertical industries the necessary support for gaining useful insights from the data generated from their business processes which can be enriched with a variegated set of context information.
- **Intelligence Engine Support Stratum:** support for an intelligence engine platform, allowing the vertical industries to augment their applications and operations with artificial intelligence for dynamic and mobile environments.
- **Business Automation Support Stratum:** support to the vertical industries to achieve the automation of their business processes by allowing to plug their OSS/BSS systems in the platform.

The approach followed by 5G-DIVE introduces a paradigm change where, instead of being positioned as an end-to-end Infrastructure-as-a-Service (IaaS) spanning across fog, edge, and cloud tiers (as is the case of 5G-CORAL platform), it position itself as an end-to-end Platform-as-a-Service (PaaS). In doing so, customers can develop, run and manage applications and services without the complexity of building and maintaining the infrastructure typically associated with the delivery of the application.

C. Vertical Pilots

The benefits of the 5G Edge concept provided by 5G-DIVE are proposed to be demonstrated, verified and validated, both from a technical and business points of view, by targeting end-to-end 5G trials. More specifically, it targets:

1) Industry 4.0 use cases: (i) Digital Twin App; and (ii) Real Time Video Analysis for Zero Defect Manufacturing.

2) Autonomous Drone Scouting use cases: (i) Drone Fleet Navigation; and (ii) Intelligent processing of images in the drones.

III. PLANS FOR INTERNATIONAL COLLABORATION

5G-DIVE consists in a joint project between different partners (verticals, vendors and service providers, network operators, SMEs, academia and research centers) from both the EU and Taiwan. This joint effort includes not only the collaboration on the design and implementation of the proposed solution but also the collaboration on the integration and deployment of trials on real-life testbeds in Europe and Taiwan.

We are open for new collaboration opportunities with partners from other geographical regions, namely in what respect to (i) the enhancement of the current trials and use cases with novel or alternative softwares; (ii) the integration and validation of different vertical industries; (iii) the exploitation of other testbeds to validate the trials.

IV. CONCLUSIONS

This paper presents the initial platform proposal to be developed, demonstrated and validated in the scope of 5G-DIVE project. Leveraging on the outcomes of the previous 5G-CORAL project which sets the ground for 5G-DIVE platform, it intends to enable vertical industries to support day-by-day operations, management and automation of businesses processes.

Finally, the 5G-DIVE project expects to have major impact regarding: (i) the validation of 5G technologies focusing on 5G connectivity including 5G New Radio, Crosshaul transport and Core, as well as on virtualized edge and fog computing including control, management and orchestration of 5G resources; and (ii) the design and validation of the 5G-DIVE solution in real-life testbeds using assets (hardware, software and spectrum) in Europe and Taiwan, mimicking the deployment of the targeted vertical use cases.

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