FUDGE-5G: Fully Disintegrated Private Networks for 5G Verticals

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***Abstract*—The use of 5G for private networks has seen an increased interest in industry and standardisation alike with an expected increase of that market in the coming years. FUDGE-5G is the first 5G-PPP project that focuses solely on Non-private Network with an innovation space in the core network domain. Beyond utilising the advancements brought by 5G and the true adoption of cloud native principles in the telco world, Non-private Networks will bring the additional potential of fine tuned, use case and Quality of Service centric 5G Core realisations fostering multi-vendor deployments due to the narrower scope in their applicability. Five use cases have been identified in FUDGE-5G focusing on the benefit of Non-private Networks underpinning the high innovation and business impact for the private 5G network market.**

***Keywords*—5G, Non-Public Networks, Service-based Architecture, Cloud Native**

I. Introduction

The activities within the 3GPP lead the standardisation activities with respect to 5G in cellular telecommunications technologies, which positions the study of Non-private Networks (NPNs) in the second phase of 5G networks, i.e. 3GPP Rel-16 and beyond. The NPN concept allows for designing, deploying, and interconnecting capabilities for the specific needs of the use cases motivating the NPN deployment in the first place. 3GPP studies two types of NPNs under the categories of Standalone Non-Public Networks (S-NPNs) and Public Network Integrated NPNs (PNI-NPNs), where the choice between both depends on the requirements of the use case and its scope of isolation from other 5G networks. This document presents the FUDGE-5G [1] high-level architecture and the use cases that aim to put a Service-based Architecture (SBA) driven platform with 5G Core (5GC) innovations at test in real-world scenarios.

II. Platform Architecture

The high-level FUDGE-5G architecture, illustrated in Fig. 1, depicts three layers: infrastructure, platform and service layer. FUDGE-5G assumes a unified access domain across all Access Network (AN) technologies (5G NR, WiFi, Ethernet), i.e. 802.3 as the shared communication denominator. Furthermore, utilising Software-defined Networking (SDN) on both control and user plane is fully supported by the platform. Lastly, the FUDGE-5G platform assumes an Network Function Virtualisation (NFV)-enabled infrastructure.

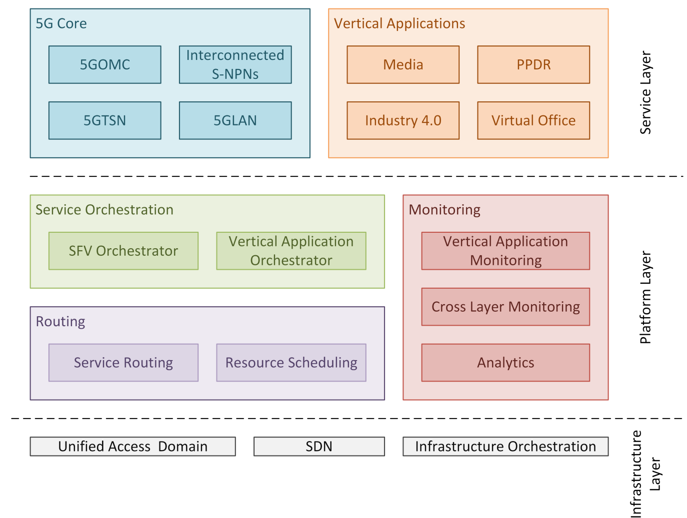

Fig. 1. High-level System Overview of FUDGE-5G.

The FUDGE-5G platform offers unified service routing, orchestration and monitoring capabilities for both control and user plane 5G services, i.e. 5GC and vertical applications, respectively. While service routing on the control plane is based on Name-based Routing (NbR), one of the three official deployment options of a Service Communication Proxy (SCP) [2], the user plane offers the integration of NbR [3], which is complemented by a novel resource scheduling [4]. The cloud native orchestration of the FUDGE-5G platform is described as an evolution of NFV for Cloud Native Network Function (NF)s (CNFs) targeted for the telco world with the addition of extended location-aware Lifecycle Management (LCM) states. The LCM states are triggered pro grammatically through monitoring alerts based on analytical cross-layer monitoring.

The service layer is divided into two areas: 5GC and vertical applications. While 5GC lists innovations around Opportunistic Multicast (OMC), 5G Time Sensitive Networking (TSN), 5G Local Area Network (5GLAN) and interconnected NPNs, the vertical applications cover four of the five use cases realised by FUDGE-5G to demonstrate the innovations.

III. Use Cases

The FUDGE-5G project has carefully selected five NPN use cases, shown in Fig. 2, which will be designed, developed,

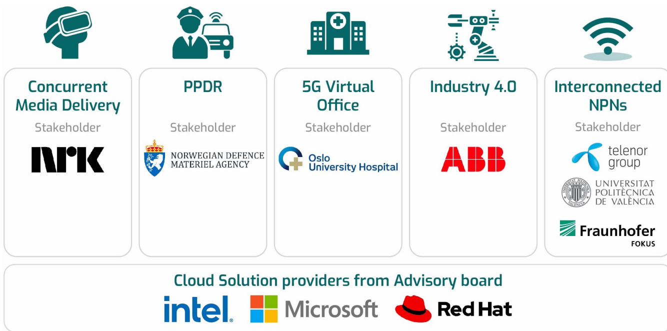

Fig. 2. FUDGE-5G Use Cases, Stakeholders and Advisory Board.

and validated in FUDGE-5G, covering both types of NPNs.

A. Concurrent Media Delivery

FUDGE-5G will introduce NPN solutions for remote production and media delivery. This Use Case (UC) will showcase the viability of FUDGE-5G technologies, innovations and components to serve remote production, using PNI-NPNs, and media showroom services over a single platform with two separated 5GCs in a NPN deployment. The advantages of using NPNs for professional remote production are customised Quality of Service (QoS) traffic flow support, and a tight integration of User Equipments (UEs) (4k cameras remotely semi-controlled) with the Radio Access Network (RAN) and the 5GC. The media showroom will showcase and validate the ability of the FUDGE-5G platform to deliver immersive media services featuring the re-introduction of multicast for HTTP-based responses through an innovative service routing on the user plane.

B. Public Protection and Disaster Relief

The main objective in this UC is to provision transparent mission-critical services to the end-user independently of the underlying telecommunication infrastructure. This ensures that first responders are able to access critical information and communicate with each other during crises, even when public 5G network networks are down or congested. NPNs are suitable for Public Protection and Public Relief (PPDR) since they guarantee consistently high levels of availability, support for deployable base stations, dynamic prioritization of traffic, congestion management, and enhanced security. In this UC, three scenarios will be showcased: (1) FUDGE-5G will enable rapid deployment of tactical bubbles (i.e. autonomous network) using S-NPNs; (2) these tactical bubbles will be able to make opportunistic use of intermittent backhaul links to access a remote cloud; and (3) the tactical bubbles will be able to coexist with public networks and use their resources, i.e. usage of PNI-NPNs.

C. 5G Virtual Office

The process of office digitalisation is expected to generate operational efficiencies and productivity improvements without disregarding security and privacy. In this UC, innovations will allow hospital staff to be able to work more effectively and for medical knowledge and expertise to be distributed over a much wider area. This is achieved by remote procedures and remote diagnosis with the latest technologies and innovations in terms of network connectivity and IT security. With these capabilities, remote consultation, monitoring and evaluation will be possible. This UC comprises scenarios such as remote patient monitoring, intra-hospital patient transport monitoring (using its own S-NPN), and ambulance emergency response supported by PNI-NPNs due to broad geographical coverage.

D. Industry 4.0

This UC aims at demonstrating the applicability of S-NPNs and their integration with 5GLAN and TSN, replacing fixed and wired alternatives for industrial communications with 5G. An S-NPN-based factory floor will provide the following advantages: high security (isolation); low latency (edge computing); high efficiency, QoS, adaptability and scalability (owner control over NPN); better coverage (cell location); and greater flexibility (wireless communications). To demonstrate the advantages of NPNs in industrial environments, FUDGE-5G will implement and validate a UC in which a controller interacts with sensors and actuator devices using 5G connectivity.

E. Interconnected Standalone Non-Public Networks

The main motivation of this UC is deployment of 5GLAN in case of federated 5G S-NPN and depicting the capability of NPN with 5G architecture. This UC will concentrate on the authentication and authorization of subscribers across multiple domains (home and visited domains) and the establishment of proper control and data plane, as well as the management of the connectivity across best-effort backhauls. This UC will demonstrate the capabilities of the FUDGE-5G platform to support seamless connectivity of devices across three administrative domains as well as security and isolation capabilities to the home network. Alternatively, multiple locations in the same university campus might be connected as separated 5GLANs.

IV. Conclusion

In the poster we will present the use cases and their architecture with more detail as well as the detailed FUDGE-5G platform architecture.

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