5G-EPICENTRE

5G ExPerimentation Infrastructure hosting Cloud-nativE Netapps for public proTection and disaster RElief

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Quality of Service Control Mechanisms to Support PPDR *Network Applications* in 5G and Beyond

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***Abstract*—This work focuses on *Network Applications*, a development paradigm for vertical services proposed by 5G-PPP. We will describe the results on Public Protection and Disaster Relief (PPDR) *Network Applications* obtained within the *5G-EPICENTRE* project, especially on 5G Quality of Service (QoS) management as an enabler for advanced service operations, usability of the 5G capabilities, and adjustment of networks for PPDR needs. This work covers conceptually what a *Network Application* is, the different ways of reaching QoS management in the 5G core network, the internals of the *Network Applications* developed by the authors, and the platforms supporting them, highlighting the technological constraints that have shaped these achievements.**

I. Introduction

Over the past years, the 5G Infrastructure Public Private Partnership (5G-PPP) has worked towards the adoption of *Network Applications* as vertical services enabled by 5G. Many 5G-PPP initiatives consider the sector of first responders and Public Protection and Disaster Relief (PPDR) as a fundamental use case, highlighting the importance of the technological transition of its related services to mobile broadband networks. In this framework, the authors of this proposal are contributing to the 5G-EPICENTRE project [1], which offers a 5G experimentation platform exclusively focused on the PPDR sector. 5G-EPICENTRE offers a definition of *Network Applications* in line with other research projects [2], [3]: network functions can be chained together to form more complex elements such as network services; the chaining of a non-limited number of resources of both can form more complex entities called *Network Applications*, which can be vertical agnostic or vertical specific. Within 5G-EPICENTRE, these concepts have been refined towards PPDR solutions, exploring industry-specific needs to make 5G technology a home for such services, and pushing their deployment to compliance with cloud-native topologies.

The proposed poster will: i) formalize the concept of *Network Application* in 5G-EPICENTRE's perspective, and describe two *Network Applications* concretely developed within this project; ii) elaborate on the role of 5G mechanisms for Quality of Service (QoS) management in enabling *Network Application* operations; iii) report on one of 5G-EPICENTRE's physical testbed, dedicated to *Network Application* testing, and on the results achieved so far.

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II. QoS Management in 5G and Network Applications

Our work covers the interaction of the abovementioned PPDR-oriented *Network Applications* with the 5G network within the framework of Mission Critical Communications (MCX) and the associated QoS. Thanks to the direct interaction between MCX *Network Applications* and the 5G Core Network (5GC), it is possible to guarantee the QoS conditions required for this type of solutions both for default traffic and specific traffic, via direct and dynamic requests to the 5GC's Policy Control Function (PCF) or Network Exposure Function (NEF). The 5G network, by handling the required QoS for MCX, demonstrates its capability to be a key enabler for future communication solutions in the PPDR ecosystem.

A. Service exposure and QoS managament mechanisms in 5G

5G has been conceived to allow third parties and elements external to the network to interact more naturally and tightly with the network's control plane. According to the procedures and possibilities envisaged by 3GPP standards [4], [5], *Network Applications* can act on the control plane of the 5GC as (or via) Application Functions (AFs). As such, via the corresponding 3GPP interfaces, they can exploit a number of network features, like the services exposed by the NEF [5]. The latter include a broad event monitoring capability and the possibility of provisioning configuration or control information concerning the UEs and the Radio Access Network (RAN). Furthermore, via the NEF, *Network Applications* can i) influence traffic policies and routing decisions; ii) remotely trigger specific UEs' actions; iii) request the execution of services provided by the Location Managament Function (LMF); or iv) gather from, and share with the network any kind of data and analytics via the Network Data Analytics Function (NWDAF).

Additionally, PPDR *Network Applications* acting as trusted AFs can exploit the N5 interface exposed by the PCF [4] to exercise QoS management power over the network and guarantee privileged QoS to those vertical services. This can be exploited to avoid possible QoS degradation in case of overloaded network resources, where traffic prioritization for the targeted application and QoS control happen via specific configurations of the User Plane Function (UPF) at the Protocol Data Unit (PDU) session management level. Such configurations are implemented within the UPF as packet filters and are identified by a series of parameters that differentiate the so called “QoS flows” within PDU sessions. For each UE, these parameters are provided to the UPF by the Session Management Function (SMF), which in turn, receives updates on traffic policies by the PCF, solicited by the *Network Application* via the exposed PCF’s APIs.

B. A Network Application for MCX: Voice, video, and data

The first MCX solution that we will present provides a communications *Network Application* to serve first responders in 5G environments. This customisable MCX *Network Application* can be built by chaining services and network elements. In this case, the *Network Application* offers a 3GPP standards-aligned MCX server solution consisting of an MCX application server Cloud Native Network Function (CNF/KNF) and several management server CNFs for configuration, group, key, and identity management servers. Additional services can be added to the chain to support the MCX *Network Application*, such as a SIP/IMS-Core, databases, traffic proxies like HTTP or SIP, monitoring module or analysis engine. We were capable of making the *Network Application* interact with the 5GC’s PCF as a unique AF, exploiting the possibilities of the N5 interface summarized in Section II-A to provide traffic prioritisation to MCX dynamically, ensuring the targeted QoS even under difficult network conditions.

C. *The* Mobitrust *platform*

The Mobitrust platform is a situational awareness platform that enhances operations of field-deployed teams by bringing critical information to control rooms. This MCX *Network Application* is prepared for core-edge paradigms, with an automated scaling process of their internal components, which include databases, message brokers, media servers, monitoring services, API gateways and interfaces, AI intelligence nodes, and others. The platform includes a wearable field device called BodyKit that supports 5G communications and aggregates sensor data from multiple origins, namely, directly connected, Bluetooth, zigbee, RFID, and WiFi sensors. The situational awareness application enables operations with an information-rich interface that includes geolocation, field teams biosensors data, real-time video and much more. Through the usage of the services exposed by the NEF or directly through the PCF, the platform is able to adaptively manage the QoS requirements from each BodyKit to ensure that operational priorities are reflected in the 5G network allowing a proper traffic prioritisation.

III. University of Malaga’s Testbed

The deployment of the MCX *Network Applications* and the integration of QoS management into the MCX solution has been carried out at the Malaga experimentation platform, which provides a 5G private network located at the University of Malaga (Spain). The network includes four pairs of 4G + 5G Remote Radio Units (RRUs) connected to a Nokia baseband unit (BBU). The radio display supports both non-standalone (NSA) and standalone (SA) operating modes. For our experimentation, the 5GC, provided by Athonet, is configured in 5G SA mode. The 5G RRUs operate in the 3.5 GHz Time Division Duplex (TDD) band (band n28). The spectrum owned by Telefónica is being used, thanks to an agreement reached with the operator. The 5G private network has been updated recently with 2 picocells 5G SA for indoor coverage in band n78.

In addition, the main data center available for the deployment of the *Network Applications* includes a native Kubernetes (K8s) multi-master deployment. Such multi-master approach guarantees high availability through a proxy acting as the K8s API, balancing queries from the *Network Applications* among the control-plane nodes. Furthermore, to avoid collateral issues from *Network Applications* spreading across the whole installation, isolated deployments are ensured by using one namespace per *Network Application*.

IV. Conclusion and Future Opportunities

In summary, we will present tangible advanced *Network Application* development and experimentation results in the context of MCX and PPDR networks. Such results, jointly obtained by two MCX-solution vendors, a 5GC vendor, and an academic testbed owner, constitute in our view an important step towards securing mission-critical network conditions in 5G, and foster the transition of PPDR communication solutions to new use cases and business models in commercial mobile broadband networks. Understanding the importance of the achievement and aligned with the creation of cross-platform experimentation control loop by 5G-EPICENTRE, the project plans to organize a hackathon where different use-case services could be used or exploited by third-party organizations.

References

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