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DEPLOYMENT OF NB-IOT NTN CORE NETWORK FUNCTIONS ON SOFTWARE DEFINED RADIO (SDR) NANOSATELLITES: APPROACH AND PERFORMANCE ASSESSMENT

Abstract

According to forecasts, around 30 billion connected devices in the world will exchange data over the Internet by 2025. These objects will mainly be embedded devices, controlled by intelligent software and operated in the cloud, integrating the Internet of Things (IoT) ecosystem. The significant increase in connections threatens to congest terrestrial networks and classic operator solutions do not meet IoT requirements: remote access areas, multiple network domains crossing and adaptable latency and bandwidth.

The 3GPP standard in rel-17 defines the concept of Non-Terrestrial-Networks (NTN) as an extension for terrestrial networks to provide global and ubiquitous coverage. The term includes, among others, non-terrestrial nodes such as GEO, MEO and LEO satellites. Lately, LEO satellites have contributed to consolidate the New Space industry opening new business opportunities by providing services using low-cost Cubesats. Despite offering important benefits compared to GEO (e.g. lower latency and propagation loss), LEO still has challenges to face related to communication discontinuity (occasional direct view to specific regions). Global coverage is achieved through satellite constellations; however, the main concern is the non-guarantee of direct contact from User Equipment (UE) to the Ground Station Network (GSN) via the satellite. While 3GPP rel-17 specs have centered on the specification of satellites using transparent payload, the use of regenerative payloads is not precluded and has a central role in the technology roadmap. Regenerative payloads envision to embark part of the Network Functions (NF) within the satellite, giving multiple enhancements (e.g. lower latencies, store-and-forward operation, in-satellite local loop communications and edge computing). Onboard functions may include radio access functions, such as eNB/gNB, as well as core NF, which enables direct satellite response to UE.

In this context, this work provides a performance analysis of a deployment of core NF in a regenerative payload consisting of a Software Defined Radio (SDR) based on FPGA technology for nanosatellites. Measures are obtained and contrasted against a Raspberry Pi4 board by running an Evolved Packet Core (EPC) with NB-IoT NTN support based on the open-source Magma framework. Distinct EPC configurations are applied: (1) native Operating System (OS), (2) containerized and (3) emulated over QEMU-AMD64 architecture. To complete the study, for each configuration, different scenarios are con-

sidered: non-deployed EPC services, deployed and deployed with traffic. Main work contributions are: (1) ARMv8-64bits architecture validation for the regenerative payload case, (2) provision of performance metrics, (3) evaluation of virtualization techniques impact and (4) Magma framework validation on embedded context.