

An open source 5G experimentation testbed

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Abstract— The development of the 5GENESIS portable demonstrator targets a compact 5G physical layout to guarantee portability. Multiple building blocks have been integrated in a modular way to enhance the variety of test cases and experiments that the 5GENESIS portable demonstrator can support. Performance 5G-NSA results are presented in this demo paper.

Keywords— 5G, NSA, Portable, Demonstrator, OAI.

I. INTRODUCTION

The Portable Demonstrator of the 5GENESIS project [1] provides a mobile end-to-end platform for demonstration purposes in exhibitions and various events, as well as a fully functional tool that enables on-site testing and experimentation for vertical industries. The main principle of the development process for the 5GENESIS Portable Demonstrator refers to a compact and mobile platform that integrates all the necessary components for experimentation over a 5G mobile network.

To facilitate its portability and the feature of “on-site testing”, the 5GENESIS Portable Demonstrator is realized with small form factor PC cases and laptops, while all the software and tools are onboarded in order to be self-contained and autonomous. However, the potential of connecting the infrastructure part of the 5GENESIS Portable Demonstrator with other facilities is under study. This potential could enable new demonstration scenarios not foreseen so far.

Figure 1 depicts the physical components of the Portable 5G Demonstrator. It is noted that the diagram in Figure 1 includes the full set of physical components that are currently active for the development process, meaning that it shows commercial nodes, auxiliary PCs/monitors, as well as the nodes where open source or project specific software is installed (e.g., OAI, WAN emulator etc).

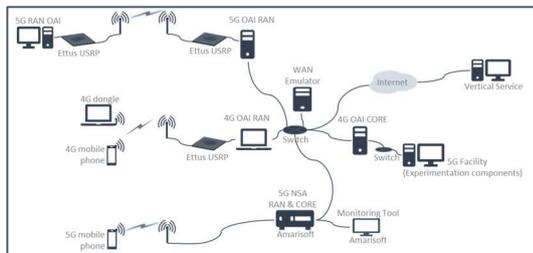


Fig. 1. The 5GENESIS Portable Demonstrator.

In terms of the functional components as Open5GENESIS Suite [2], [3] the features of the Portable Demonstrator are:

- 5G NR radio front-end (eNB/gNB) and user equipment (UE), based on open source SDR and software components by ECM, as well as Commercial Off-The-Self (COTS) solutions (especially for commercial 5G mobile phones);
- 4G and 5G NG core functions, including open source implementation by ECM (OAI);
- Coordinator layer components on top of NFV/SDN MANO stack.

II. MOBILE NETWORK TECHNOLOGY

The 5G RAN and Core are based on open source solutions (OpenAir Interface - OAI software) [4] have been integrated in the Portable 5G Demonstrator. The inclusion of an open-source solution in the Portable Demonstrator serves mainly for showcasing its significant efficiency in RAN and Core design from both innovation and cost perspectives to appropriate target audiences, given that there is a trend towards open interfaces. It is also an approach that allows for the full integration of Open5GENESIS Suite, i.e., the layers that enable the run of automated and controlled tests for different vertical industries and use-cases [5].

A. 5G NR setup

The 5GENESIS Portable Demonstrator has integrated the 5G RAN open source solution provided by ECM. The setup has been implemented bearing high processing power and portability in mind, satisfying the Portable Demonstrator’s requirements. ECM’s OAI application implements the NR features at the gNB and UE side (the so-called nrUE component in OAI) in compliance to the Rel.15 Standards. It also provides utilities for debugging, monitoring and demonstration purposes. In this context, the 5GENESIS Portable Demonstrator shall continue integrating the OAI software extensions that will be made gradually available throughout the different phases of the 5GENESIS project.

The OAI gNB and OAI nrUE software runs on top of two laptops with overclocked i9-processors, in order to support the high processing requirements of the OAI software. The software implements the whole chain of signal processing functions of the 5G-NR protocol stack, ranging from the physical to the higher layers of the RAN protocol stack.

The ETTUS USRPs N300 convert the RF signal to and from baseband using analog filtering, digital up and down conversion circuits. They feed the signal through 10GbE SFPs, which are required to support the sampling rates of 5G-NR (61.44Ms/s and 122.88Ms/s, depending on the 5G configuration). The laptops are connected to the USRPs with

10GbE-Thunderbolt3 adapters, capable of supporting the required rates.



Fig. 2. 5G NR Setup of the 5GENESIS Portable Demonstrator

The connection between the two USRPs takes place either over-the-air or wire with proper attenuators to protect the radio frequency units. The supported bandwidths are 40, 80 and 100 MHz (106, 217 and 273 PRBs respectively) and the frequency band of operation is 3.5GHz. When transmitting over-the-air in areas with assigned license, the USRPs shall utilize a set of omnidirectional antennas, while the proper transmission and reception gains of the SDRs will be configured through the OAI application.

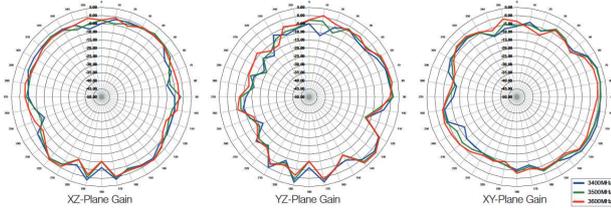


Fig. 3. Antennas gain plots on 3.5GHz

The ETTUS USRPs are synchronized with the Octoclock-G Clock Distribution Module, providing 8 pulse per second and 10MHz reference signals for time and frequency synchronization. The reference signals of the Octoclock-G are generated either by an internal GPS-disciplined, oven-controlled crystal oscillator or an external source. The OAI gNB and OAI nrUE laptop hosts have been configured with Ubuntu 18.04 LTS and 5.0.0.25-low-latency kernel version. 5G RAN monitoring takes place using the T-Tracer and XForms utilities.

B. Mobile Core Network

The Mobile Core Network of the Portable Demonstrator is integrated by the open-source Eurecom's OAI Core Network solution. The code is implementing all basic functions of the LTE core components (MME, HSS, SPGW). OAI Core Network solution is divided in two projects:

- openair-cn, implementing HSS and MME functions
- openair-cn-cups, implementing the separation of user and control plane functions of SPGW (SPGWU, SPGWC).

OAI implements the core network components and respective interfaces. In the Portable Demonstrator, in order to follow the principles of Network Slicing concept, every core component is thought as a separate VNF. As a result, all core components are deployed on different virtual machines.

III. PERFORMANCE EVALUATION OF NSA 5G PORTABLE DEMONSTRATOR

The OAI end-to-end NSA setup is composed from the eNB and gNB components, the OAI CN and a 5G NSA supporting COTS UE, which in this case is the Google Pixel 5. The different performance evaluation measurements are based on testing with different MCS schemes, which have a direct impact on the Downlink throughput performance. The current release of the portable demonstrator reaches up to 75 Mbps for MCS 24 for DL (TABLE I). This performance ranges around the theoretical expected values, considering the configurations made. The UL throughput is currently up to 7.15 Mbps regardless of the MCS scheme. Same for RTT latency measurements with ping which was measured on average 14-14.5 ms.

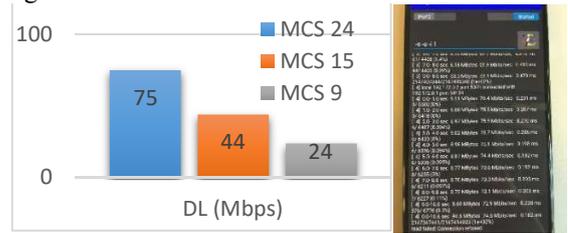


Fig. 4. DL (Mbps) assessment at MCS 24/15/9

Regarding the setup, this is on Frequency Range 1 (FR1, band 78) for the gNB based on TDD, 30kHz subcarrier spacing, 106PRB (40MHz), SISO.

TABLE I. PERFORMANCE ASSESSMENT CONFIGURATION

CS	Qm (Modulation Order)	Modulation Scheme	Downlink Throughput
9	2	QPSK	24 Mbps
15	4	16-QAM	44 Mbps
24	6	64-QAM	75 Mbps

IV. CONCLUSIONS

This paper presents the 5G portable demonstrator, based on open source 5G implementation that is used in the H2020/5G-PPP 5GENESIS project for participating in exhibitions/demo events and, also, to provide vertical sectors with a full 5G reference testbed for on-site testing.

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