Demo: OpenAirInterface 5G NSA system with COTS phone

Florian Kaltenberger, Raymond Knopp, Cedric Roux, Panagiotis Matzakos, Francesco Mani, Sakthivel Velumani
firstname.lastname@eurecom.fr
Eurecom
Sophia-Antipolis, France

ABSTRACT

In this demo we show the current implementation status of the OpenAirInterface (OAI) 5G non-standalone (NSA) system operating with a common-of-the-shelf (COTS) phone in the sub-6 GHz band. The radio access network (RAN) comprises an OAI eNB and a gNB, both running on general purpose x86 servers and USRP N310 software defined radios. Further we use the OAI evolved packet core (EPC) comprising home subscriber server (HSS), mobility management entity (MME), serving and packet data network gateway (S-PGW), which are all deployed in Docker containers. In the demo we will show the initial connection and user registration on the 4G cell, the secondary cell addition, the initial connection on the 5G cell and some initial traffic on the 5G cell.

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1 INTRODUCTION

OpenAirInterface (OAI) is an open source initiative that today provides a 3GPP compliant reference implementations of key elements of 4G and 5G Radio Access Network (RAN) and core network that run on general purpose computing platforms (x86) together with Off-The-Shelf (COTS) Software Defined Radio (SDR) cards like the ETTUS Universal Software Radio Peripheral (USRP)[1]. It allows users to set up a compliant 4G/5G network and inter-operate with commercial equipment.

OAI distinguishes itself from other similar projects through its unique open-source license, the OAI public license v1.1, which was created by the OAI Software Alliance (OSA) [2] in 2017. This license is a modified version of Apache v2.0 License, with an additional clause that allows contributing parties to make patent licenses available to third parties under FRAND terms similar to 3GPP for commercial exploitation. The usage of OAI code is free for non-commercial/academic research purposes. The main reason for this modification is to allow companies/individuals which own significant portfolio of patents to be able to contribute to the OAI source code and still be able to keep their patent rights. Such a license allows contributions from 3GPP member companies while at the same time allowing commercial exploitation of the code, which is not at all possible with other open-source projects.

[1]http://www.ettus.com
[2]www.openairinterface.org

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2 5G

5G is also known by Release 15 of 3GPP. This release includes a brand new core network and radio interface, called 5G New Radio (5G-NR). The network has been designed from ground up to support enhanced Mobile BroadBand (eMBB), Ultra-Reliable Low-Latency Communications (URLLC), as well as Massive Machine Type Communications (mMTC) enabling new use cases for a large variety of industries. This has been achieved by a large number of new features compared to 4G LTE, such as flexible subcarrier spacing and slot lengths (also called numerology), increased bandwidth (up to 400MHz), flexible slot structure (including mini-slots and slot aggregation). 5G-NR also includes new channel codes: polar codes for control and Low Density Parity Check (LDPC) for data. A good overview of all new features is given in [1, 2].

Initial deployments of 5G-NR will use the architecture option 3 of 3GPP, also called Evolved Universal Terrestrial Radio Access (EUTRA-NR) Dual Connectivity (EN-DC). In this option the 5G cell is connected to a 4G evolved packet core network and is operating under the control of a 4G cell, which serves as an anchor to the system and carries all Control Plane (CP) traffic. User Equipment (UE)s first need to connect to the 4G network and will receive all the necessary configuration to connect to a 5G cell through Radio Resource Control (RRC) signaling on the 4G link. This setup will allow a smooth migration from 4G to 5G. This scenario is also the one that OAI is currently focusing on and which will be described in more detail in the next Section [3].

2.1 5G non-standalone mode (NSA)

The architecture of the EN-DC network is depicted in Figure 1. Here the LTE eNB takes the role of the master and the 5G gNB the role of the slave, and they are connected over the X2 interface. In this architecture, the anchors of the CP are always located in the LTE eNB, that is, the S1-MME interface is terminated by the eNB. The S1-U interface for user plane data can either be terminated at the eNB, in which case user-plane data would need to be forwarded over the Xn interface, or at the gNB, in which case the eNB would only handle control-plane traffic.

Compared to a 4G eNB, a 5G gNB can be separated into a Centralized Unit (CU) and one or more Distributed Units (DUs), which are connected over the F1 interface. The CU contains the functionality

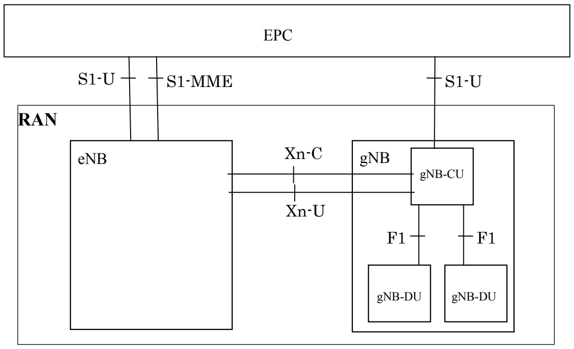

Figure 1: Architecture of the EUTRA-NR dual connectivity (EN-DC) network

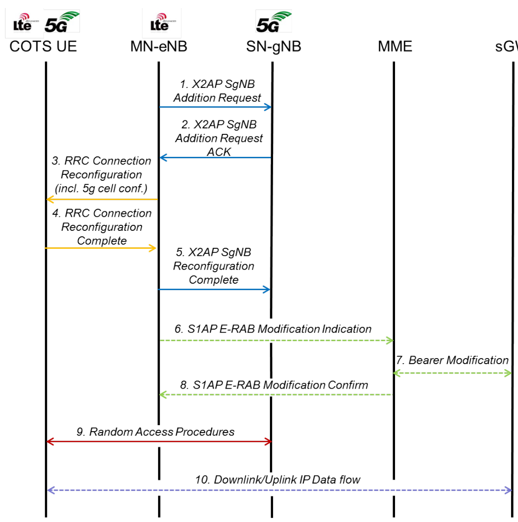

Figure 2: EN-DC connection procedure

of the Packet Data Convergence Protocol (PDCP) as well as RRC and has interfaces to the LTE eNB (Xn) and optionally also to the core network (S1-U). The DU contains the functionality of Radio Link Control (RLC), Medium Access Control (MAC), and PHYsical layer (PHY).

Further splits can be employed within the DU, but this is out of the scope of 3GPP. In OAI we have decided to use the 5G Functional Application Platform Interface (FAPI) interface between PHY and MAC specified by the Small Cell Forum (SCF) [4]. This interface provides a clean separation of the two layers. Moreover, in the future this can be extended to become a networked FAPI (nFAPI) interface, which will allow to physically separate the PHY and the MAC.

2.2 5G NSA connection procedure

The EN-DC connection procedre is depicted in Figure 2. Here, we assume that the UE is already connected to the 4G cell. The procedure starts with the secondary gNB (SgNB) addition request and acknowledge over the X2 interface. After this procedure, the eNB has all of the parameters from the gNB that need to be signalled to the UE using the RRCConnectionReconfiguration message. Upon reception of the RRCConnectionReconfigurationComplete message indicating that the 5G configuration is accepted from the UE, the path switch pcocedure is triggered from the eNB towards the MME to switch the traffic from the 4G cell to the 5G cell. In parallel, the UE can start the 5G cell aquisition and the random access procedure on the 5G cell. After the completion of random access, the UE is 5G connected and can exchange data plane traffic through the core network.

3 DEMO DESCRIPTION

In this demo we will present all of the components described above and show how to deploy the network. We will further walk you through the steps in the 5G EN-DC attachment procedure and demonstrate some user traffic on the 5G cell.

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