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5G-LEO

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5G-NTN support in OpenAirInterface™ with a focus on Low Earth Orbit satellites

CONTEXT AND BACKGROUND

Standardisation of 5G at 3GPP is progressing rapidly. Release 17 features supporting Non-Terrestrial Networks (i.e. satellites) were frozen in March 2022 as planned. Early demonstrations and validation are essential to support further standardisation. Inevitably, any such activity relies on the availability of a 5G NTN protocol stack implementation. One implementation that is available for research purposes, i.e. open and accessible for the necessary NTN adaptations, is the one by the Open-Air Interface software alliance (<https://openairinterface.org/>).

Recognising the importance of a protocol stack implementation suitable for validating NTN aspects the European Space Agency contracted the 5G-LEO consortium to develop the necessary extensions to the OAI protocol stack implementation with a specific focus on Low Earth Orbit (LEO) satellites and their constellations.

5G-LEO OBJECTIVES

The 5G-LEO project will extend the OAI open-source code to support satellite systems in non-geostationary orbits. This extension will implement a full 5G protocol stack (Release 17) for both the UE and the gNB. The main outcome of this activity will be a publicly available updated version of the open source OAI software library with new features to simulate and to test 5G satellite communication links.

The 5G-LEO project prioritizes “Scenario C1” of 3GPP TR38.821 (LEO based steerable beams and transparent payload) as the reference scenario for the OAI extension in order to minimize the frequency of hand-overs and knowing that the beam-steering technology is mature enough for such a scenario.

The choice of the transparent payload is motivated by the low complexity involved and the fact that this is a more mature technology compared to the regenerative payload. Furthermore, most of the challenges imposed by LEO satellites are more pronounced when a transparent payload is considered, thus addressing them considering a transparent payload represents a worst-case scenario, and if successfully addressed for a transparent payload, then a regenerative satellite should not pose a problem.

OAI EXTENSIONS PLANNED BY 5G-LEO TO SUPPORT NTN FEATURES

5G-LEO is committed to provide the following OAI extensions necessary for NTN experimentation and validation considering low earth orbit (LEO) satellites, and as such it is based on and complements the improvements provided by the ESA ARTES 5G-GOA activity (<https://artes.esa.int/projects/5ggoa>).

Specifically, 5G-LEO will provide:

Features broader than NTN, but necessary for NTN experimentation

- PHY and MAC Layer:
 - Continuous frequency offset compensation
 - SNR measurement and Channel State Information (CSI) Reporting
 - Uplink Power Control (Open loop & Closed loop)
 - Adaptive Modulation and Coding (AMC)
- Other
 - Extensions to the OAI gNB and UE KPI GUI

NTN specific feature extensions

- PHY and MAC Layer
 - Adapted continuous timing drift compensation
 - Support for up to 32 HARQ Processes (following 3GPP Release 17)
- RLC Layer
 - Increased t-ReassemblyTimer when HARQ is enabled
- PDCP Layer
 - Increased discardTimer at the transmit entity
 - Increased t-ReorderingTimer at the receive entity
 - Increased SDU buffer at the transmit entity
- RRC Layer
 - Increasing UE-timers and constants used by the UE when in RRC_CONNECTED, RRC_INACTIVE and RRC_IDLE state
 - Extending sr-Prohibit Timer
 - Adaptation of the basic 5G NR Handover procedure and paging protocols

All the above NTN OAI extensions concerning UE and gNB will be compatible and interoperable with the OAI Stand-Alone Core Network.

AVAILABILITY OF THE IMPROVED OAI PROTOCOL STACK

5G-LEO will merge the developed extensions and improvements into the main development branch of OAI and release it as part of the OAI protocol stack available at <https://openairinterface.org/oai-5g-ran-project/> and <https://openairinterface.org/oai-5g-core-network-project/>.

OAI PROTOCOL STACK EXTENSION TIMELINE

Considering that Release 17 specifications were frozen in March 2022 and that 5G-LEO intends to release code that is not only standard compliant, but is thoroughly tested and verified, 5G-LEO plans to release this extended code for 5G-NTN in March 2023.