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5G-STARDUST

5G-STARDUST's ambition is to deliver a fully integrated 5G-NTN autonomous system with novel self-adapting end-to-end connectivity models for enabling ubiquitous radio access.

OVERVIEW

The 5G-STARDUST project has been originated from the Stream A call 01-02 from the first SNS call in year 2022 and dealing with ubiquitous radio connectivity, whereby the main objective is to achieve seamless integration between terrestrial and non-terrestrial networks in a variety of scenarios by aligning to the existing 3GPP specifications from Rel 17 and Rel. 18. In particular, the main objective is to demonstrate the potentials of fully-regenerative non-terrestrial networks (mostly NGSO satellite systems) in a converged network ecosystem, whose unification is achieved by means of an affective self-organised network paradigm building on data-driven performance optimisation. To this end, a proof-of concept (PoC) targeting TRL4-5 is under design, which will integrate the main components of terrestrial and non-terrestrial network with the main goal to show end-to-end connectivity for exemplary scenarios and the consequent candidate services, which are further outlined in the next sections.

The 5G-STARDUST project is mostly aligning to the 5G-advanced wave of 3GPP standardisation path (i.e. Rel. 17-19), but supposed also to provide inputs to the following 6G standardisation phase starting with Rel. 20. As such, specific synergies have been already established with the other ongoing projects dealing with NTN, i.e. 6G-NTN and ETHER, with which joint dissemination events have been already organised (i.e. NTN workshop at EuCNC'23) and future ones are under preparation as well.

CONCEPT/ ARCHITECTURE

The underlying architecture builds on the concept of fully-softwarised self-organised network concept, hence allowing the integrated system to dynamically adapt to changing conditions of traffic and network topology, the latter being possibly resulting from satellite mobility. Then, the main innovation addressed in the project is the use of a fully-regenerative satellite architecture, which implements unprecedented onboard processing capabilities that go beyond what available nowadays in terms of local signal processing. In more detail, the objective is really to implement a full gNB in space and possibly also additional network functions (e.g. UPF) from the core network part in order to enable new services (e.g., edge computing in space) and in general to achieve a more flexible in-space network design.

In light of this, a special attention is devoted to the design of the space segment towards the allocation of the necessary network functions for the implementation of gNB onboard satellite. Under the assumption of a fully interconnected satellite network (i.e. neighbour satellites interconnected by means of inter-satellite links), the main concept exploited in the 5G-STARDUST project is that all space nodes may embed a fully 5G/6G enabled payload, whose functionalities are however not always active and can stay idle for a certain time interval time. The reason for that relies on the fact that NGSO satellite illuminates for a large time of their daily orbit areas where there are no users, so that the corresponding 5G/6G functionalities can be switched off. On the other hand, as soon as the satellite is again offering service to the users in

the coverage area, the relevant network functions can be activated accordingly. Moreover, considering this architecture, it is also possible to think of a 5G functional splitting achieved in space across neighbour satellite implementing different "parts" of a distributed gNB architecture.

USE CASES/ SCENARIOS

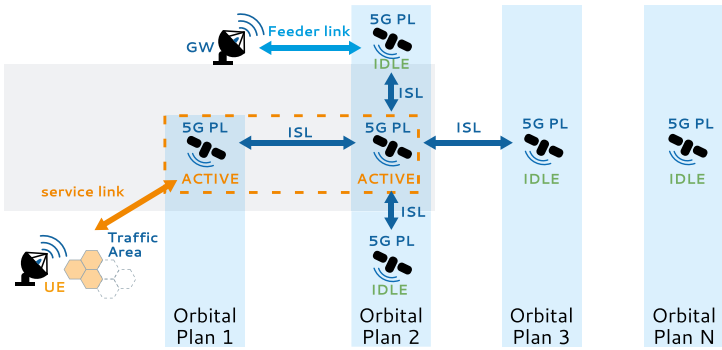
Based on the objective of providing ubiquitous wide-area wireless access, the 5G-STARDUST project has defined and selected five scenarios and use cases representing both unserved zones and vertical industry. Scenarios with seamless and transparent experience for end users have been prioritised among others, identifying key social challenges (KVIs) and analysing new market opportunities. The selected use cases are shortly outlined in the following points:

- Airway scenario: Aimed at providing 5G services to the passengers thanks to multi-orbital solutions using GEO and NGSO satellites, working on FR2 bands, offering ubiquitous coverage across numerous geographies.
- Residential broadband scenario: Aimed at providing 5G connectivity to residential users in underserved areas using dual GEO/LEO satellites operating in FR2.
- Vehicle connected scenario: Aimed at providing 5G connectivity to vehicles to give him services such as Software over the air (SOTA), HD maps and NG eCall service.
- PPDR Scenario: Aimed at providing backup connectivity access via satellite and temporary coverage for first responders and extended coverage in case of uncovered areas for first responder agencies.
- Global private networks scenario: Aimed at providing coordinated global connectivity with NGSO satellites so as to achieve distributed 5G systems for private networks.

FIRST RESULTS

The project has just entered the design & development phase of the elements composing the end-to-end connectivity chain, so that the first research and integration results will be available in the second half of year 2024. The general vision is in any case to come up with a TRL4/5 PoC able to show the advantages stemming from the integration of regenerative satellite systems the counterpart terrestrial networks to boost the performance of 5G-based services in scenarios where the terrestrial connectivity alone will not suffice. In that respect, the evolution to 6G with more demanding service requirements will make this evolutionary path building on the integration of 6G and NTN an absolute need for fulfilling demands of society and industry verticals. Such a vision will be then substantiated by dedicated demonstration of the so-procured PoC and in terms of dissemination as well as standardisation actions within Rel. 19 of 3GPP.

5G-STARDUST Architecture



Satellite And Terrestrial Access For Distributed, Ubiquitous And Smart Telecommunications

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