6GNTN

6G NON-TERRESTRIAL NETWORKS FOR THE FULL INTEGRATION OF NTN COMPONENTS INTO THE FUTURE 6G INFRASTRUCTURE

USE CASES

The 6G-NTN Use Cases (UC) have been developed with the aim of selecting realistic, viable, and credible scenarios in which current and mid-term technologies would reach their limits in supporting the features exhibited by these deliverable UCs.

The project identified seven UCs: maritime coverage for search and rescue coast guard intervention (**UC1**), autonomous power line inspection using drones (**UC2**), urban air mobility (**UC3**), adaptation to public protection and disaster relief (**UC4**), consumer handheld connectivity and positioning in remote areas (**UC5**), continuous bidirectional data stream in high mobility (**UC6**) and direct communications over satellites (**UC7**). A preliminary analysis (described in D2.3) has been carried out, highlighting that the 3D multi-layer network infrastructure, seamless and transparent connectivity, and performance enhancement are relevant features to be provided by 6G-NTN. As the proposed scenarios use such enablers in different ways, particular attention will be paid to the further investigation of these aspects in the remainder of the project.

ARCHITECTURE

The 6G-NTN project targets a resilient 3D multi-layered architecture with inter-node links using both RF and optical technologies and flying nodes located at different altitudes, from HAP to GSO.

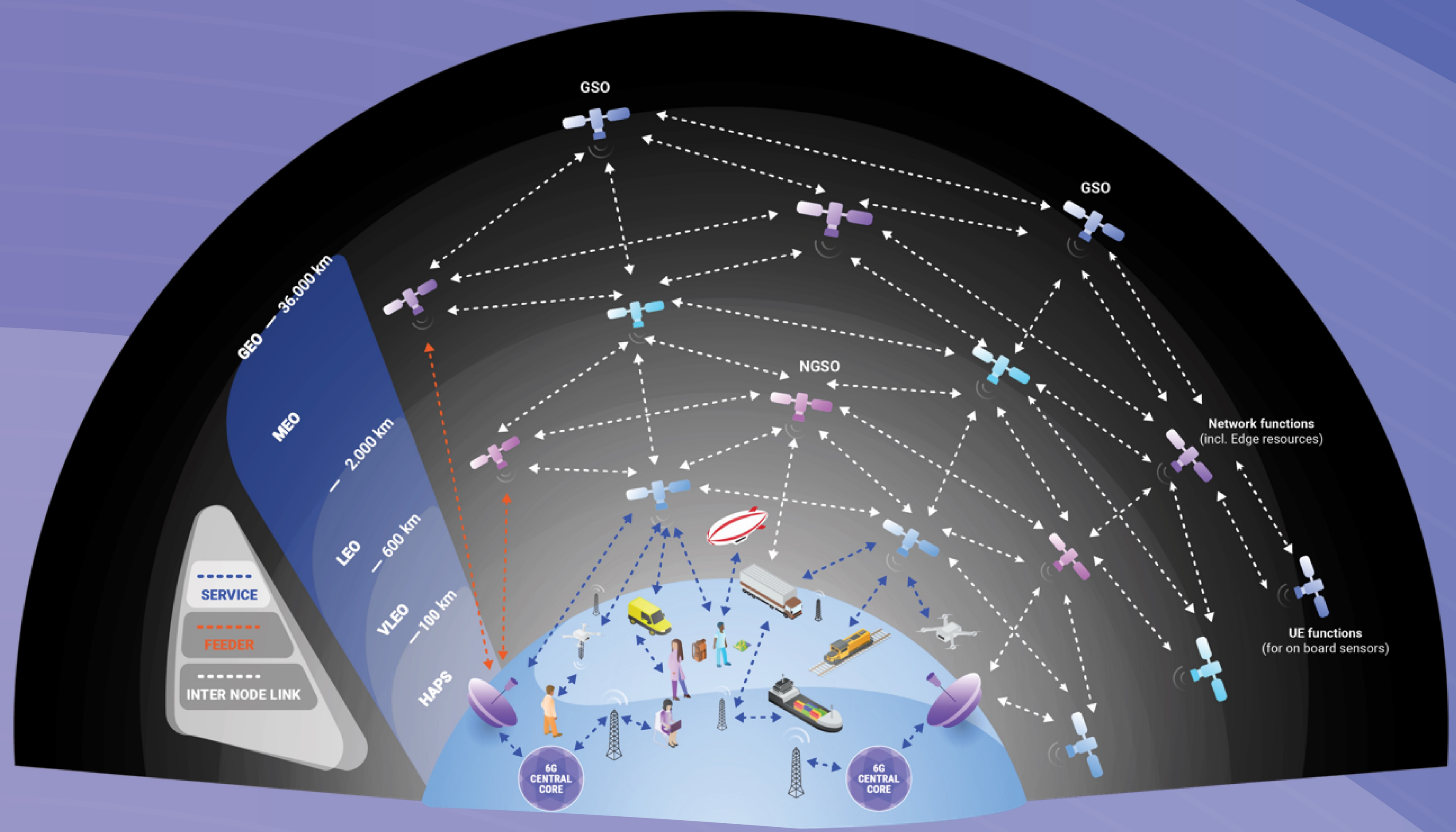
An innovative LEO constellation design with software defined payloads allows to implement in space all required RAN and CN functionalities as well as edge computing capabilities.

A distributed approach is envisaged in order to cope with realistic mass and power limitations whilst at the same time maximizing the service link throughput.

Interference mitigation through RRM driven by AI generated optimizations, smart routing capabilities and dynamic orchestration of VNF are the additional key features of the 6G-NTN architecture.

Cyber and physical layer security aspects are based on a thorough assessment of the vulnerabilities and threats introduced by the proposed architecture.

Last not least, affordability constraints are considered by defining sustainability metrics and target values for carbon foot print and overall energy consumption.



AIR INTERFACE

NTN in 6G is expected to focus on several key features. These encompass guaranteeing seamless compatibility with TN and seamless connectivity, featuring very low error rate in low SNR conditions, bolstering resilience against co-channel interference, streamlining spectrum sharing capabilities, accommodating both FDD and TDD modes, and notably diminishing computational complexities.

While leveraging the 5G waveform and access layer to the fullest extent is expected, certain enhancements will be necessary to accommodate the targeted new use cases and deliver the required capabilities, such as:

- Use of higher channel bandwidth flexibility to withstand varied terrestrials and radio link conditions.
- Enhancements of PRS and the SRS for positioning to reduce the dependency on the GNSS.
- Investigation on waveforms with lower Cyclic Prefix according to vthe propagation conditions.
- Support of AI based power/coding dynamic adaptation to maximize spectral efficiency.
- Support of interleaving techniques to enhance reliability.

REGULATORY ASPECTS

The development and operations of 6G-NTN requires careful consideration of regulatory matters, such as the allocations of frequency ranges to services, the protection of incumbent services, and the appropriate use of the bands by NTN.

Beyond the bands already defined for NTN by 3GPP, some additional FR1 bands that could be allocated to MSS (e.g. granted at WRC-2027) are candidate for NTN, with some challenges such as:

- Potential hardware limitations and/or network synchronisation for Up/Down operations.
- Regulatory challenges arising from current allocation limitations. Any possible changes to this allocation would require discussion at ITU.

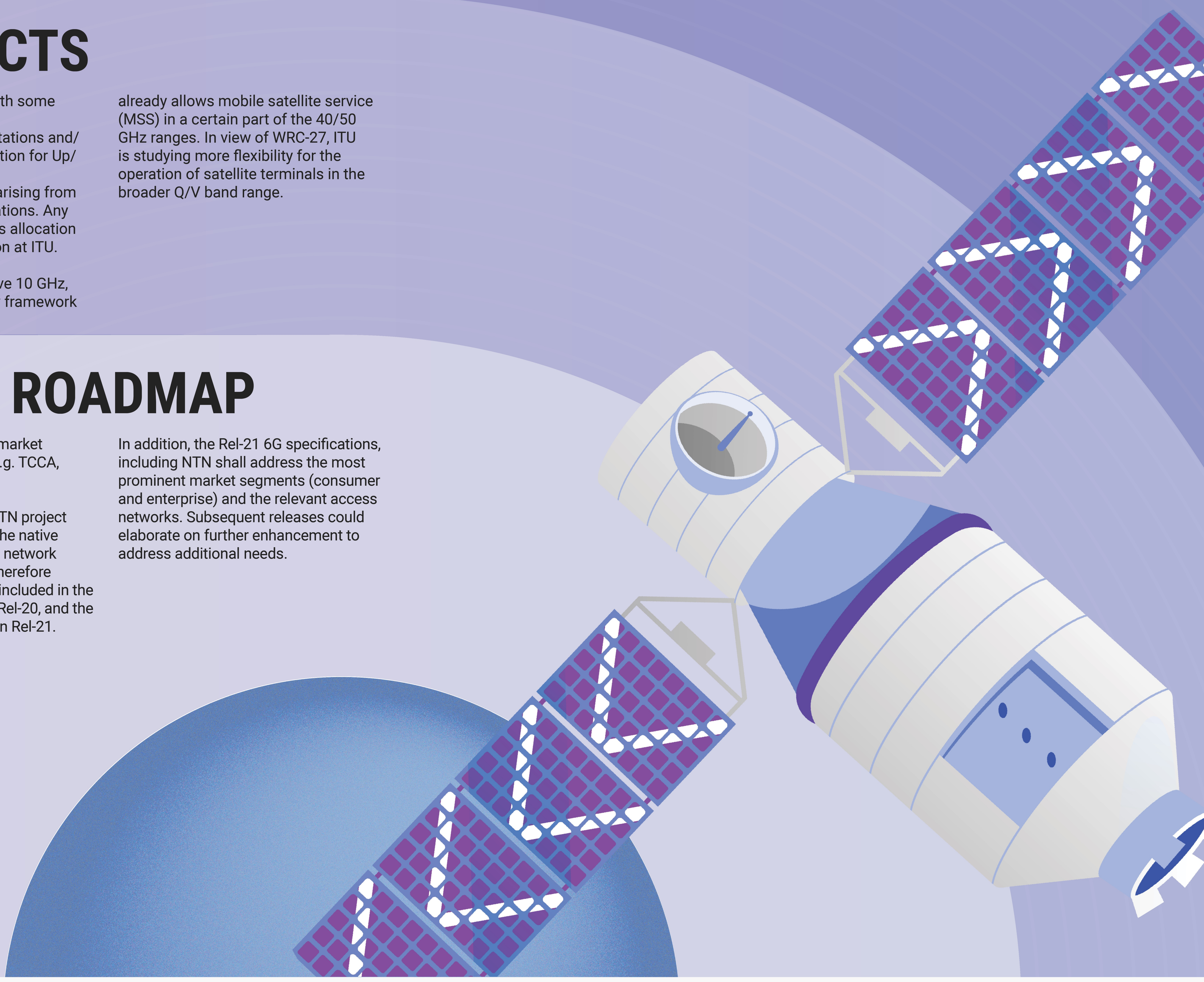
For frequency bands above 10 GHz, the current ITU regulatory framework already allows mobile satellite service (MSS) in a certain part of the 40/50 GHz ranges. In view of WRC-27, ITU is studying more flexibility for the operation of satellite terminals in the broader Q/V band range.

STANDARDISATION ROADMAP

In December 2023, 3GPP committed to the development of 6G specifications. The merits of the proactive, consensus-based process and collaborative work implemented by this organization over several technology generations - from 3G to 5G - are recognized for contributing to the development of technologies, solutions and services by a global ecosystem now including mobile and space industry stakeholders but also user groups and market representative partners (e.g. TCCA, 5GAA, SAA, EUTC, etc.).

The members of the 6G-NTN project recognize the benefits of the native inclusion of non-terrestrial network components in 6G. They therefore recommend that NTN be included in the baseline 6G study item in Rel-20, and the first normative work item in Rel-21.

In addition, the Rel-21 6G specifications, including NTN shall address the most prominent market segments (consumer and enterprise) and the relevant access networks. Subsequent releases could elaborate on further enhancement to address additional needs.



Visit the 6G-NTN website to learn more

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