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Views on the NTN component of 6G

6G Forum
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THALES, Dorin Panaitopol

View point on 6G & specifically NTN

6G shall be an evolution of 5G:

- **Backward compatibility** across 5G/6G to the maximum extent;
- Main contribution of NTN (connectivity and positioning): **ubiquitous coverage**;
- **Security**, **trustworthiness**, **sustainability**, **resiliency** aspects shall be **reinforced**.

NTN shall be a “native” component of 6G:

- **NTN-friendly radio interface** from day 1 (3GPP Release-21);
- **NTN-TN unified radio interface:**
  - Leveraging New Radio(NR)/OFDM with enhancing features;
  - Flexibility to support NTN-related deployment scenarios;
- Enabling “**joint-operation**” between **TN & NTN**.

NTN targeted market segments (see S1-241041)

Consumer market:

- Includes connectivity to smartphones or wearable devices & cars;
- Need for guaranteed coverage;
- By 2030, at least:
  - 7.5% of the total number of mobile subscribers (5.2Bn) expected to be NTN;
  - 5% of the new cars (~75 million per year) are expected to be NTN capable.

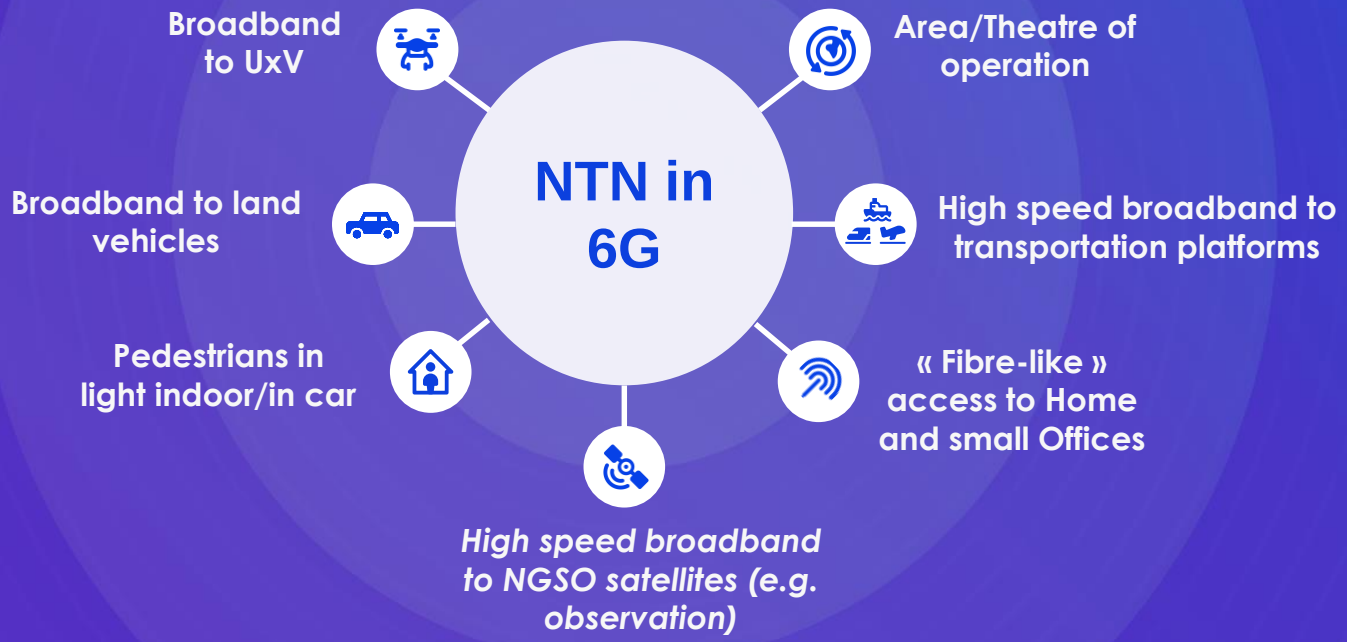
Enterprise market:

- Need for services in rural areas or less developed areas and moving platforms;
- Unique UE for both NTN/TN;
- Similar use cases to today (e.g. office, media & entertainment);
- As the technology becomes cheaper and compact and easier to access, the adoption is expected to rise.

Vertical markets:

- Utilities, agriculture (e.g. sensors), governmental users (e.g. broadband communication);
- Specific requirements: e.g. sensor data collection over a wide area, autonomy, security, resilience and mobility;
- Several millions of users are expected to require satellite connectivity.

NTN in 6G: an evolution of NTN in 5G enabling new roles / capabilities / connectivity scenarios

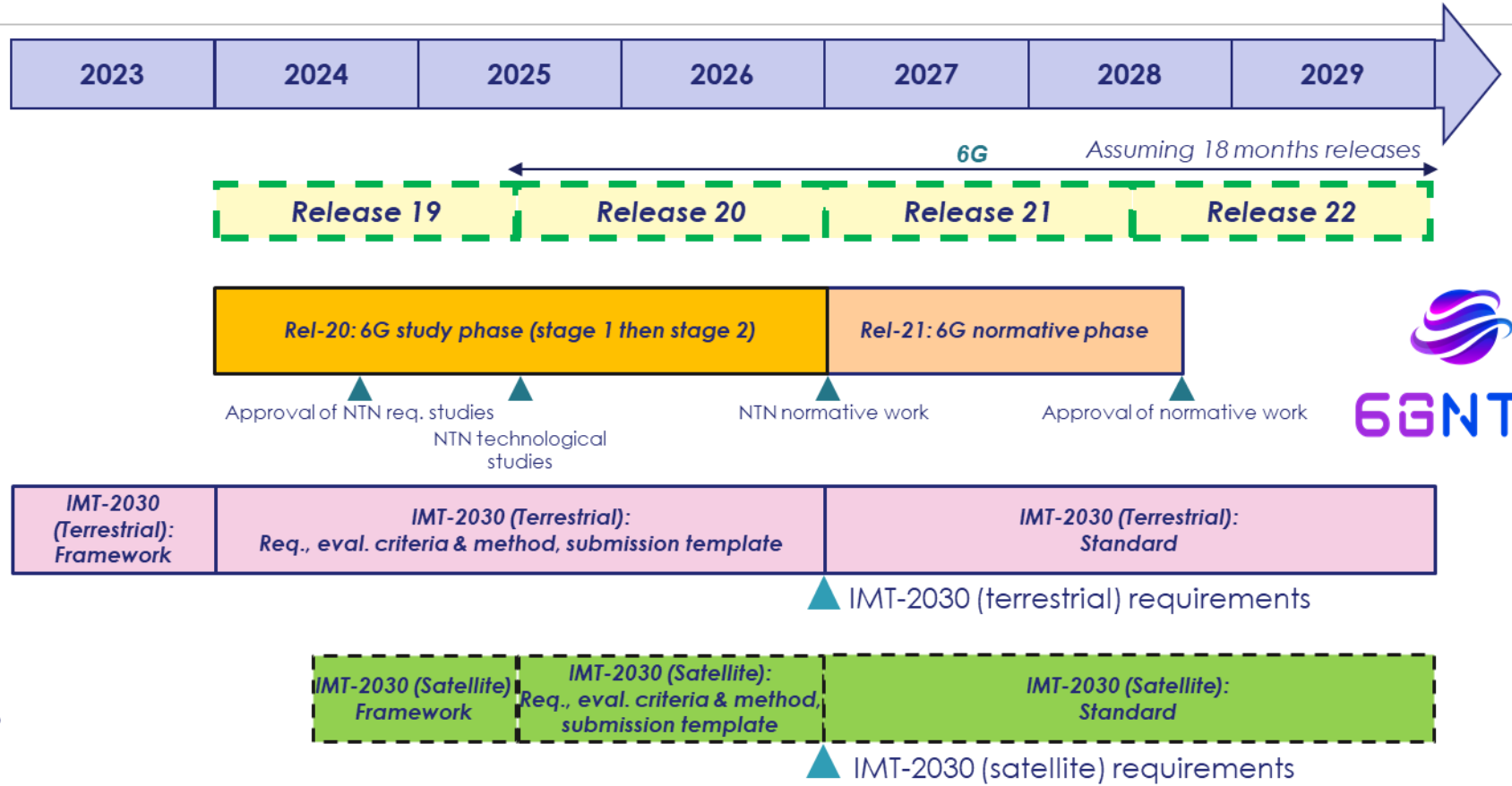


- NTN contribution to 6G: ubiquitous and resilient service
- From service to user centric design approach
- Star & Mesh NTN topologies (with/without feeder)
- Sustainability

Enabling FEATURES for NTN in 6G

- Compact and self-tracking FPA for vehicle/UxV mounted devices
- GNSS free operation
- Seamless NTN/TN service continuity
- Reliable determination of UE location
- UE-NTN-UE (without feeder) for local access
- Autonomous private network (NTN+TN) operation over a specific area
- Smart NTN/TN combination for sustainability and resilience
- Multi-tenant non-terrestrial network infrastructure
- NTN/TN spectrum coexistence optimization
- Integrated sensing

6G-NTN standardization timeline: 3GPP and ITU-R



Proposed Topics *for* Rel-20 SA1 6G SID (see S1-241041)

- **Ubiquitous and resilient connectivity, including:**
  - Enhanced NTN:
    - e.g. GNSS-free operation;
    - 3D NTN;
    - Use of AI/ML for NTN;
  - Unified TN+NTN:
    - e.g. NTN-friendly radio interface from the day 1 (unified radio interface)
    - Enhanced TN/NTN selection..

- **Focusing in priority on NTN related mass market use cases (consumer & enterprise):**
  - Enhanced direct connectivity to smartphones/wearable devices;
  - Enhanced Broadband connectivity to:
    - Land vehicles;
    - Drones (or UxV);
    - Homes/small offices;
    - Public transportation platforms (Aircraft, Railway, Maritime, ..);
  - Public Safety/Mission Critical applications with fast connectivity setup.

Trends: Standardization, Implementation and Research (takeaways)

IRIS² (approach under construction):

Support implementation of **5G NTN standards** defined in 3GPP domain
- to the maximum extent possible and
- through a gradual implementation approach

Future roadmap, in order to support 5G/6G NTN-TN convergence:

- Satellite with **regenerative** payload: starting from **Rel-19**;
- Evolution towards **6G New Radio:**
  - **Increasing Non-Terrestrial Network (NTN) capacity**:
    - Introducing **more Satellite** frequency **bands for increased capacity;**
    - **Integration of TN and NTN 5G/6G towards 3D (mesh) communications.**
  - **Simulation and testing capabilities:**
    - **6G WaveForm (WF)** abstraction **toolbox;**
    - **Channel Model** for satellite communication;
    - Evaluate **PAPR**, **resilience to Doppler & timing errors** of various WaveForms.

Some on-going work in 6G-NTN SNS R&D project.

6G-NTN SNS Architecture: Design Drivers

- Resilient 3D multi-layered architecture with Inter-Node Links (both RF and Optical) for ubiquitous coverage & affordable end-user connectivity;
- Interference mitigation through AI/ML driven RRM, possibility for spectrum sharing;
- System affordability (e.g. in terms of computational complexity, cost) and sustainability constraints;
- Reduced carbon footprint and overall energy consumption;
- Dynamic orchestration of VNF, smart routing and edge-based service provisioning in a dynamic network topology;
- Support of accurate network-based positioning;
- Software defined payloads embarking RAN & CN functionalities, edge computing resources;
- Cyber and physical layer security.

Target features for research

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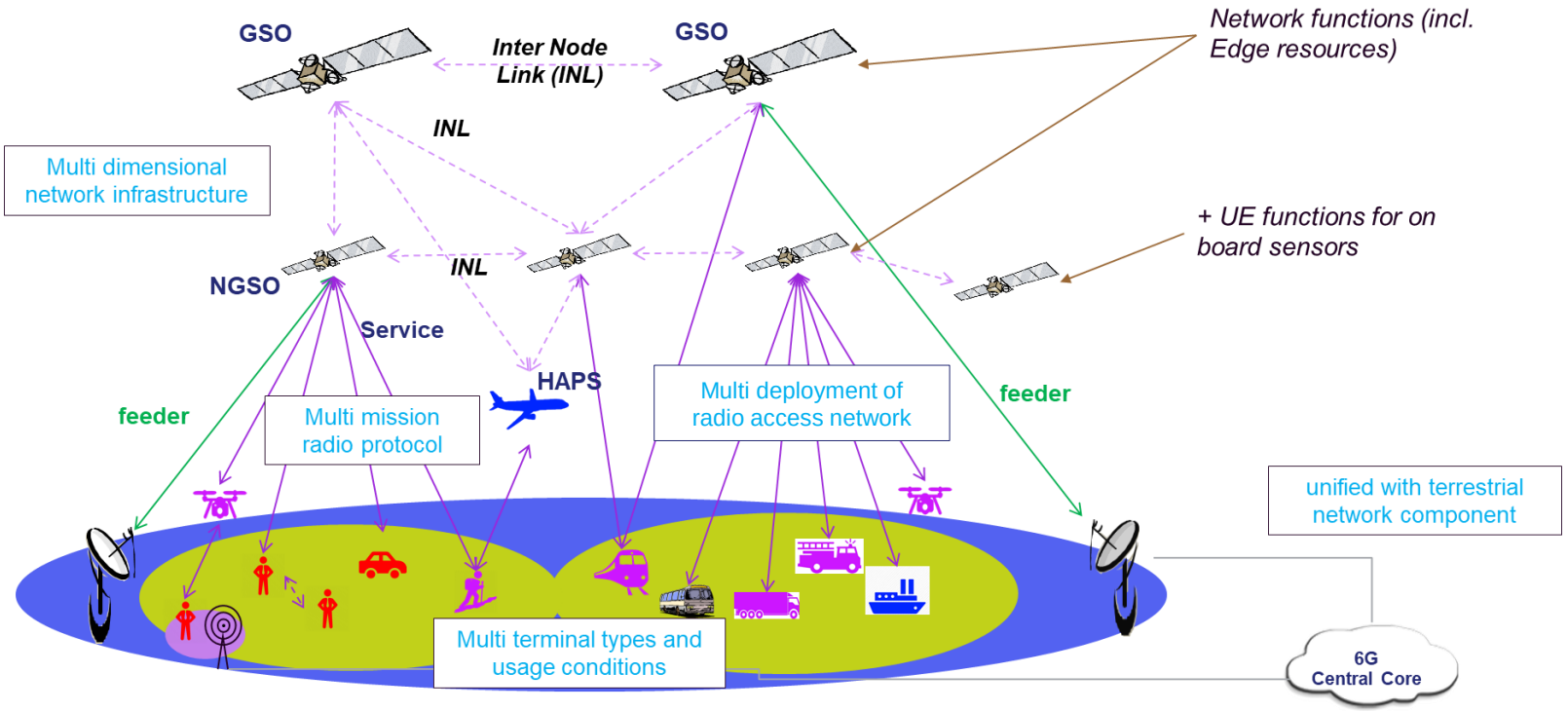
6G-NTN SNS Radio Interface: Design Drivers

Enabling features for a spectrum efficient and flexible radio interface optimized for both TN and NTN components

- Compatibility with terrestrial networks;
- Multicarrier waveform enhancements (GNSS-free, PAPR reduction);
- Advanced modulation, coding and multiple access schemes;
- Design of flexible UL/DL frame structure;
- Robust reference signals for enhanced positioning;
- Support of broadcast and multicast;
- Backward compatibility with 5G NR;
- Enablers for AI/ML-driven radio resource control and AI-enhanced waveforms;
- Enablers for optimized Spectrum coexistence between TN and NTN;
- Support of FDD and TDD;
- Integrated communication and sensing for NTN;
- New spectrum (e.g. Q/V-band, C-band).

Target features for research

6G-NTN SNS Project: Key Design Principles



6G drivers proposed by associations/organizations (both TN and NTN): Table based on 6G Workshop (Rotterdam, May 2024) – see S1-241041

Big Ambitions Make the World Go Round

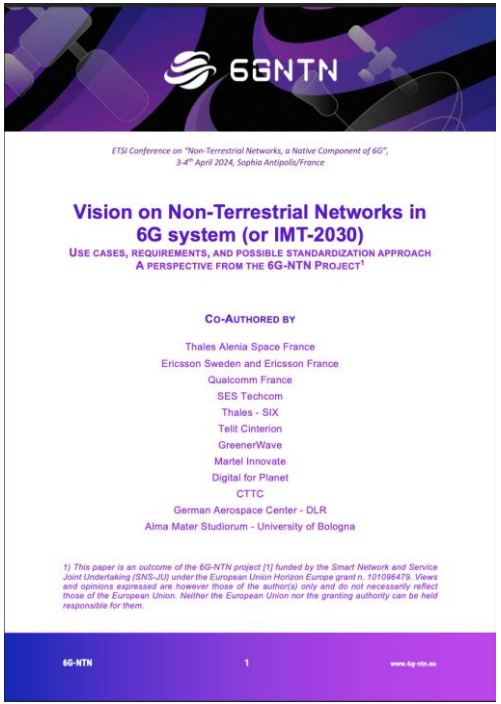
6G-NTN White Paper (2nd of April, 2024)

On 2nd of April 2024, the 6G-NTN SNS project released a white paper entitled:

"Vision on Non-Terrestrial Networks in 6G system (or IMT-2030): Use cases, requirements, and possible standardization approach – A perspective from the 6G-NTN project"

The white paper presents:

- The use cases for NTN connectivity by 2030 and beyond
- 6G and drivers for native integration of satellite components
- The 6G NTN standardization approach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ETSI Conference on "Non-Terrestrial Networks, a Native Component of 6G", 3-4th April 2024, Sophia Antipolis/France

Vision on Non-Terrestrial Networks in 6G system (or IMT-2030)

USE CASES, REQUIREMENTS, AND POSSIBLE STANDARDIZATION APPROACH A PERSPECTIVE FROM THE 6G-NTN PROJECT[1]

CO-AUTHORED BY

Thales Alenia Space France
Ericsson Sweden and Ericsson France
Qualcomm France
SES Techcom
Thales - SIX
Telit Cinterion
GreenerWave
Martel Innovate
Digital for Planet
CTTC
German Aerospace Center - DLR
Alma Mater Studiorum - University of Bologna

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Frequency Spectrum

Frequency bands that may be considered for respectively 5G and 6G NTN:

Services	NTN in 5G (currently)	NTN in 6G
Narrow/Wideband connectivity to smartphones, vehicle/drone mounted & low-cost IoT devices	**Lower frequency range (410 MHz – 7125 MHz, "FR1-NTN"):** FSS and MSS allocations in L & S-bands.	**Lower frequency range:** Same as 5G-NTN + additional satellite service allocations in FR1-NTN (see WRC 2027 outcomes).
Broadband connectivity to vehicle/drone mounted devices and to large aeronautic, maritime platforms	**Above 10 GHz (currently only 17300 MHz – 30000 MHz, "FR2-NTN"):** FSS and MSS allocations in Ka-band (finished) and Ku-band (ongoing activity).	**Above 10 GHz:** Same as 5G-NTN + additional satellite service allocated frequency bands (e.g. Q/V-bands).