ETSI Conference on
Non-Terrestrial Networks,
A Native Component of 6G

Session 4 – Satellite Operator & vendor views of NTN-6G
“Integration of NTN in 6G: Requirements, Enablers and Technology Building Blocks”

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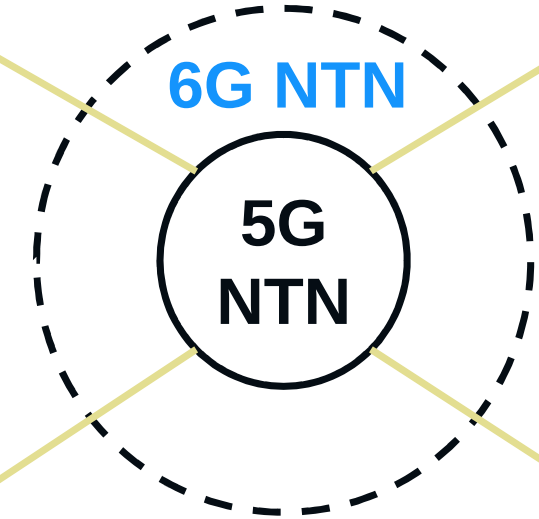
6G-NTN: design drivers



Connectivity experience

- *Increasing data rate wrt 5G*
- *Increased reliability*
- *Reduced Latency*
- *Coverage extension*

Network capabilities

- *Positioning*
  - *Increased Location accuracy/reliability*
  - *Reduced Latency*
- *Sensing capability*

Network operations

- *Capacity/connection density*
- *Resiliency*
- *Improved spectrum coexistence across NTN orbits and with TN*
- *Security*

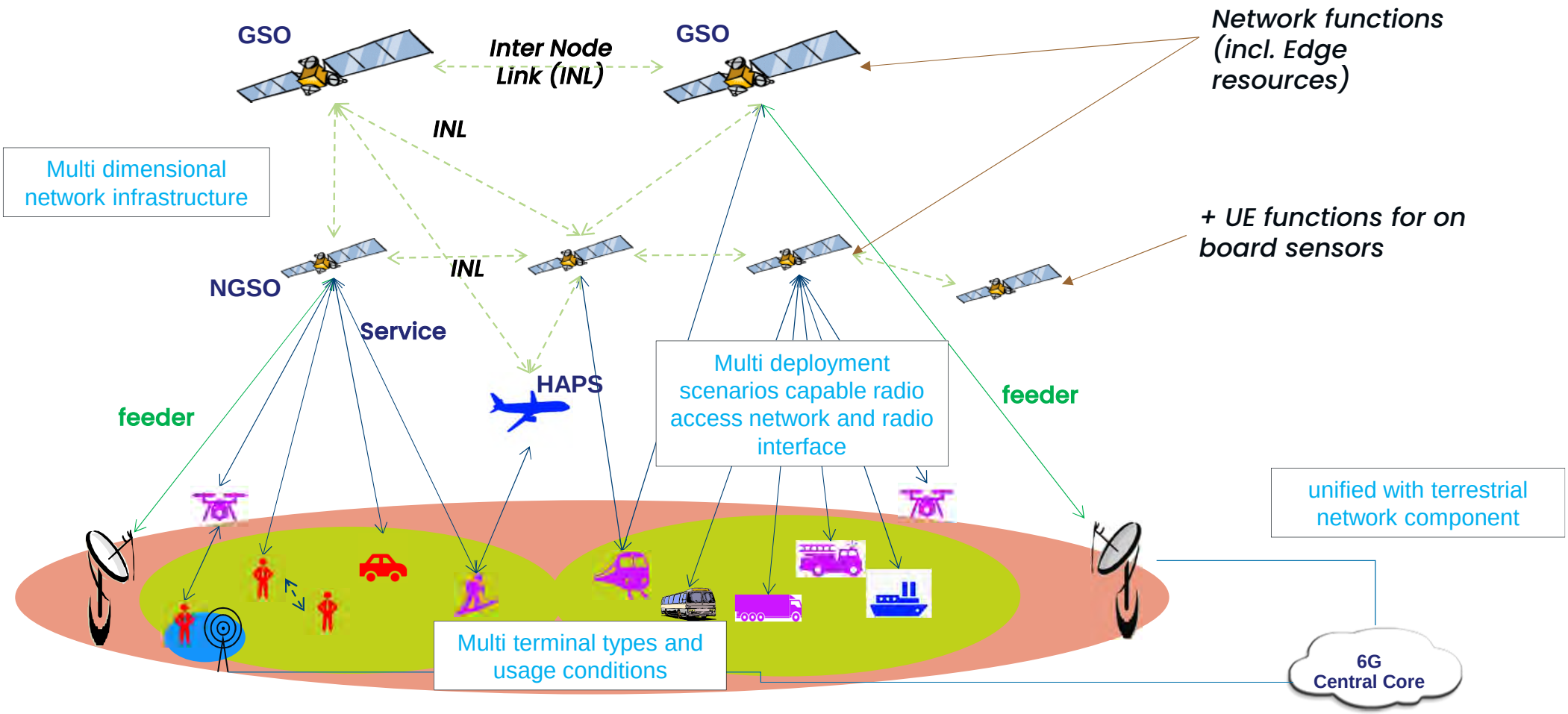
Sustainability

- *Intrinsic: Environment footprint (energy saving)*
- *Extrinsic*

6G NTN versus 5G NTN: possible performance targets (TBC)

Target service performances	NTN in 5G (As per 3GPP &/or ITU-R IMT2020 satellite requirements)	NTN in 6G
Peak data rate (DL/UL) wrt Handheld	1/0.1 Mbps (Outdoor only) @ up to 3 km/h	Outdoor conditions: Tens of Mbps @ up to 250 km/h
Peak data rate (DL/UL) wrt Vehicle or drone (flying and surface) mounted devices	[50/25] Mbps @ up to 250 km/h (with 60 cm aperture)	Hundreds of Mbps (Outdoor only) @ up to 250 km/h
Peak data rate (DL/UL) wrt Large Aeronautic, maritime platforms mounted devices	[360/180] Mbps @ up to 1000 km/h	Thousands of Mbps (Outdoor only) @ up to 1200 km/h
Location service (target accuracy and acquisition time) in outdoor conditions only	respectively 1 meter and < 100 seconds (reliability through Network verification)	Respectively 1 meter and < 1 second (95% reliability through Network based positioning method)
Coverage	Outdoor only	Light indoor/In car conditions: At least Short Message Service capability
Reliability	up to 99.9% ($1\text{-}10^{-3}$)	up to 99.999% ($1\text{-}10^{-5}$)
Over the air Latency for eMBB-s and uRLLC-s	Control plane: 40 ms User plane: 10 ms	Control plane (propagation delay excluded): same as IMT-2030 terrestrial Radio Interface User plane (propagation delay excluded): same as IMT-2030 terrestrial Radio Interface
Connection density	Up to 500 per km2	>1000 per km2

6G-NTN: key design principles



NTN Architecture: Design Drivers

- Resilient 3D multi-layered architecture with inter-node links (both RF and optical)
- Software defined payloads embarking RAN and CN functionalities, and edge computing resources
- Interference mitigation through AI driven RRM
- Dynamic orchestration of VNF, smart routing and edge-based service provisioning in a dynamic network topology
- Cyber and physical layer security
- Affordability and sustainability constraints
  - Reduced carbon foot print and overall energy consumption

NTN radio interface: design drivers

Enabling features for a spectrum efficient and flexible radio interface optimized for both terrestrial and non-terrestrial network components

- Multi carrier waveform enhancements (GNSS free, PAPR reduction)
- Advanced modulation, coding and multiple access schemes
- Design flexible UL/DL framing structure
- robust reference signals for enhanced positioning
- Support of broadcast and multicast
- Enablers for Artificial Intelligence driven radio resource control
- Enablers for optimized Spectrum coexistence between TN and NTN
- TDD support
- New spectrum
- Integrated communication and sensing for NTN

Some references

- « 3GPP Non-Terrestrial Network: A Global Standard for Satellite Communication Systems », Special Issue of the International Journal of Satellite Communications and Networking, Pages: 217-301, Edited by Mohamed El Jaafari and Nicolas Chuberre, published by Wiley, May/June 2023,
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  - https://www.amazon.co.uk/5G-Non-Terrestrial-Networks-Vanelli-Coralli/dp/1119891159