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6G NTN Use-Cases

EUCNC 2024

“European vision on 6G use-cases” Session
Wednesday, 5th of June 2024, 11:00-13:00

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THALES SIX FRANCE

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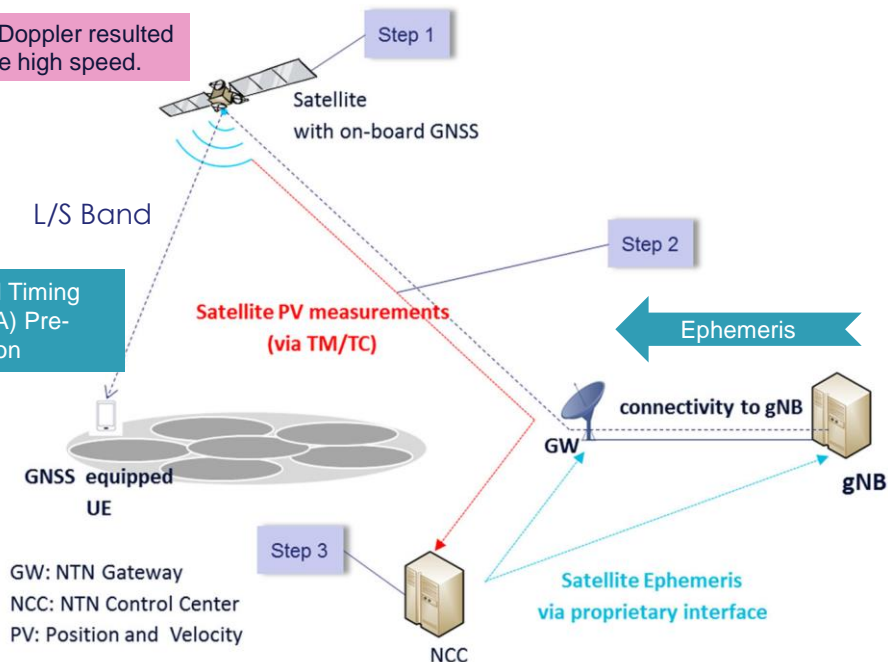
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A large, circular aerial view of a city and beach, presented as a 'little planet' or 'nubia' projection. The city features a mix of green spaces, buildings, and a prominent beach with blue water. The entire scene is set against a dark, starry space background with a bright light source on the right. A teal curved line separates this image from the white text area on the left.

5G NR NTN in Release-17 (5G NR Direct Smartphone Access)

Key Issue: Doppler resulted from Satellite high speed.

Doppler and Timing Advance (TA) Pre-compensation



General Hypothesis:

- UE (User Equipment) with GNSS;
- Ephemeris data send through satellite to UE (broadcast SIB19);

UE is using GNSS and Ephemeris data to pre-compensate Doppler and Timing Advance;

Transparent satellite configuration with:

- Earth Fixed or Earth Moving Cells;

Considered constellation types:

- LEO@600km (worst case, higher Doppler);
- LEO@1200km;
- GEO.

Intermediate constellations are also possible.

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5G NR Satellite NTN integration with 5G NR TN – Short View

Rel-17: Ended (March 2023 from RAN4 point of view)

- **Transparent Satellite;**
- NTN UE is a **Smartphone** in **L/S Bands**.

Rel-18: Ended (RAN4 work finished in May 2024)

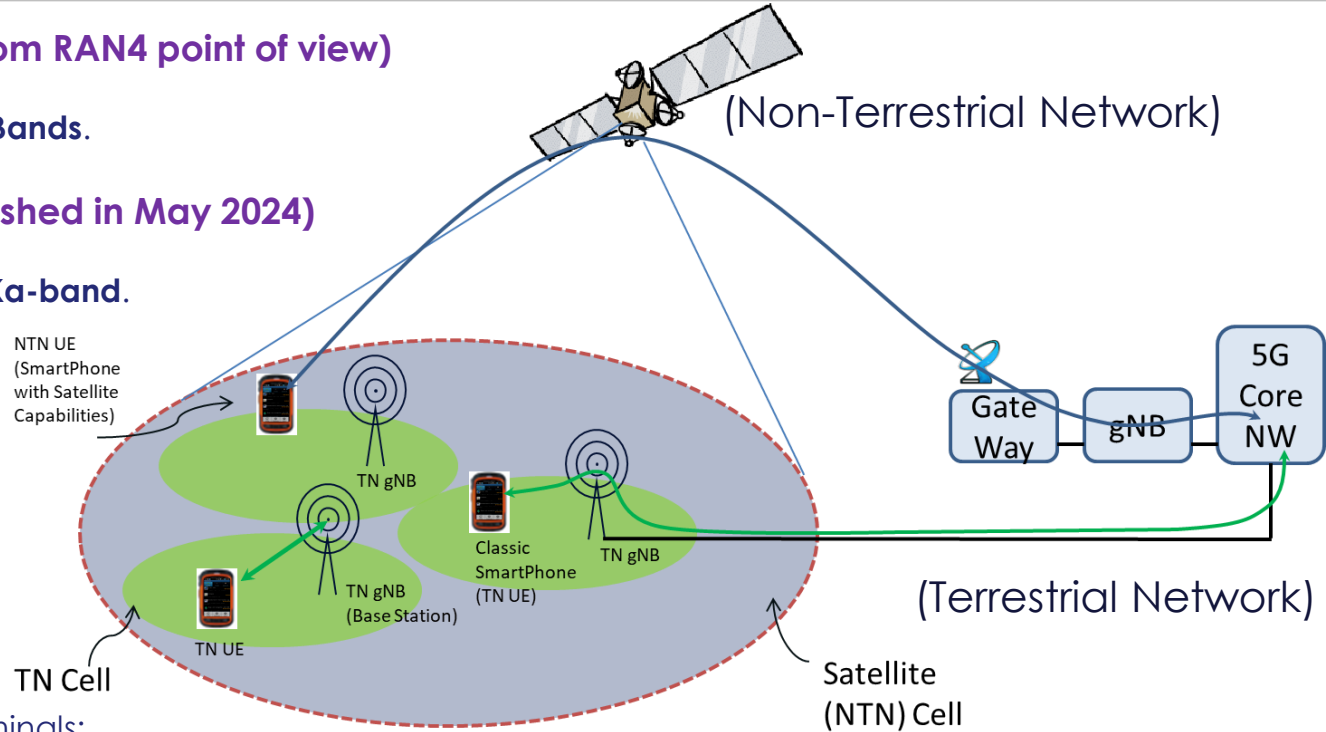
- **Transparent Satellite;**
- NTN UE is a **VSAT** operating in **Ka-band**.

Rel-19: TBC end-2025?

- **Regenerative Satellite;**
- **DL coverage enhancements;**
- Other bands: **Ku-band;**
- Other **FR1-NTN UE types: HPUE.**

Rel-20/Rel-21:

- **GNSS-free operation;**
- Other bands: **Q/V band;**
- **Lower form factor** for VSAT terminals;
- **Enhanced (broadband) services.**



5G NR NTN 3GPP bands in Rel-17 and Rel-18 (as for now)

“Exotic” Satellite frequency ranges compared with TN.

NTN operating bands in FR1 for satellite networks (FR1-NTN⁴)

NTN satellite operating band	UpLink (UL) operating band SAN receive / UE transmit $F_{UL,low} - F_{UL,high}$	DownLink (DL) operating band SAN transmit / UE receive $F_{DL,low} - F_{DL,high}$	Duplex mode
n256	1980 MHz – 2010 MHz	2170 MHz – 2200 MHz	FDD
n255	1626.5 MHz – 1660.5 MHz	1525 MHz – 1559 MHz	FDD

NOTE: NTN satellite bands are numbered in descending order from n256.

Rel-17

NTN operating bands in above 10 GHz for satellite networks (FR2-NTN⁵)

n512 ¹	27.5 - 30.0 GHz	17.3 - 20.2 GHz	FDD
n511 ²	28.35 - 30.0 GHz	17.3 - 20.2 GHz	FDD
n510 ³	27.5 - 28.35 GHz	17.3 - 20.2 GHz	FDD

NOTE 1: This band is applicable in the countries subject to CEPT ECC Decision(05)01 and ECC Decision (13)01.
NOTE 2: This band is applicable in the USA subject to FCC 47 CFR part 25.
NOTE 3: This band is applicable for Earth Station operations in the USA subject to FCC 47 CFR part 25. FCC rules currently do not include ESIM operations in this band (47 CFR 25.202).

Rel-18

Technical, regulatory & sometimes political challenges to introduce new bands.

Other release-independent Work Items will follow for other NTN band introductions..

n254	1610 – 1626.5 MHz	2483.5 – 2500 MHz	FDD
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NOTE: NTN satellite bands are numbered in descending order from n256.

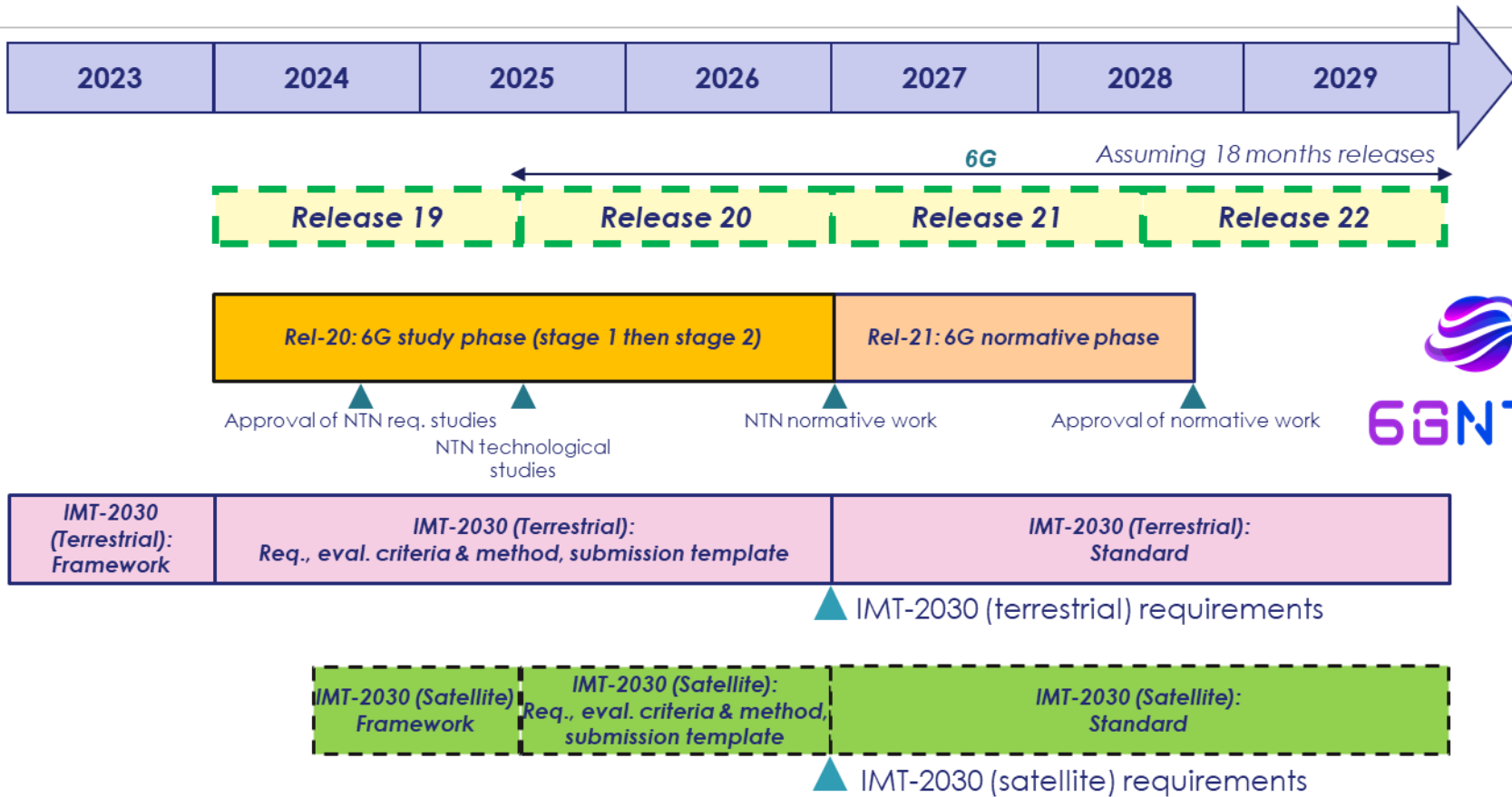
Rel-Independent

Difficult Satellite radio channel propagation, with relatively low Spectral Efficiency per end user.

FR1-NTN⁴: 410 MHz – 7125 MHz

FR2-NTN⁵: 17300 MHz – 30000 MHz

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



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3GPP

ITU-R
WP5D

ITU-R
WP4B



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, governmental users;
- Specific requirements: e.g. autonomy, security;
- Several millions of users are expected to require satellite connectivity.

Proposed Topics from 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. 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, ..).

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.



6GNTN

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Target features for research

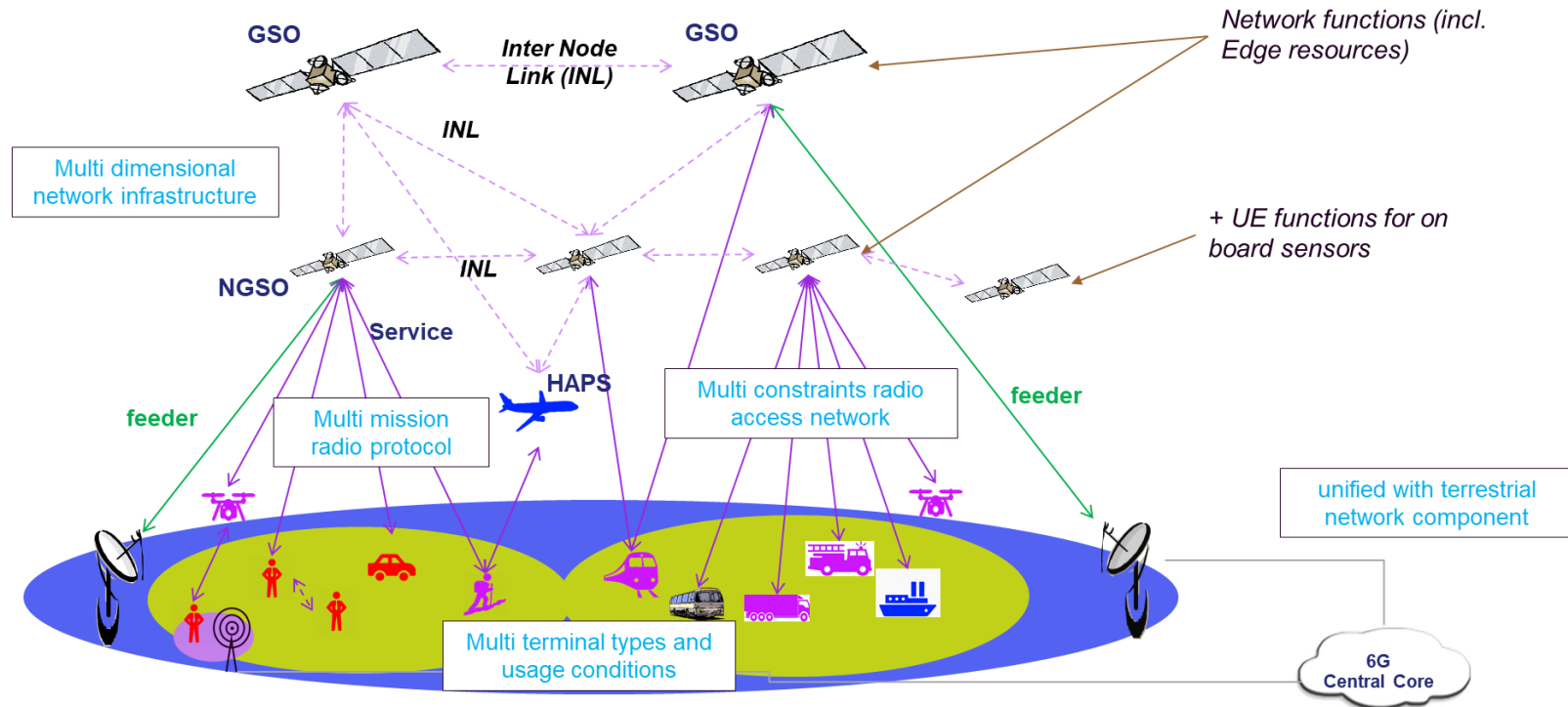
- Compatibility with terrestrial network
- Possibility for spectrum sharing
- Robustness to co-channel interference
- Possibility for seamless connectivity
- Ability to provide additional link margin in C-band and Q/V-band
- Support of accurate network-based positioning
- Support to UE without GNSS
- Backward compatibility with 5G
- Support of FDD and TDD
- Low computational complexity

Research outcomes / not for standardization purposes

6G-NTN SNS Project: Key Design Principles

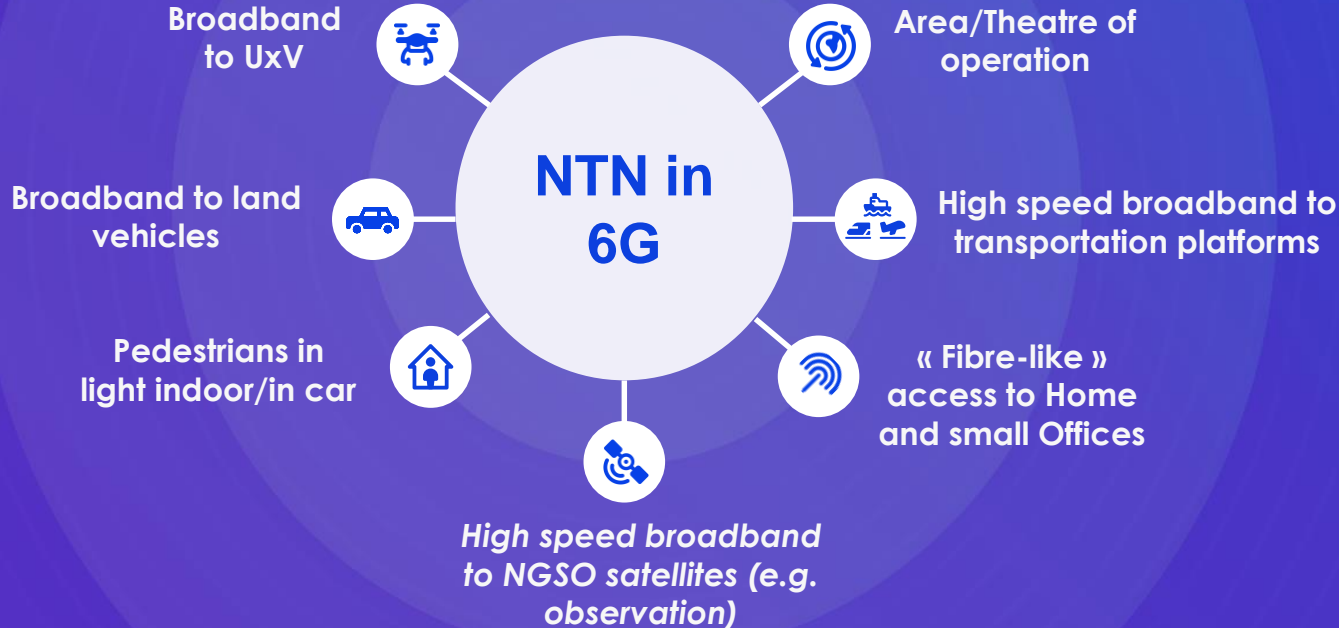


6GNTN



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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 (NTN-UE) & Mesh (UE-NTN-UE) connectivity

Sustainability



Compact and self-tracking FPA for vehicle/UxV mounted devices



GNSS free operation



Seamless NTN/TN service continuity



Reliable, high accuracy and low latency determination of UE location



UE-NTN-UE or Local access-NTN-Local access (without feeder)

Enabling FEATURES For NTN in 6G



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

Big Ambitions Make the World Go Round

Any Questions?



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

