Ubiquitous 6G Service through Non-Terrestrial Networks

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NTN in 5G and 5G Advanced
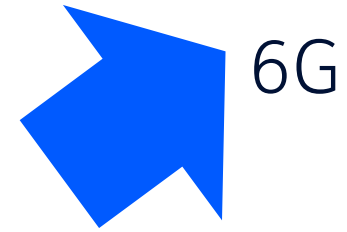
6G

3GPP Rel 8-16 Proprietary Techniques

- Existing 3GPP devices.
- Doppler compensation and delay normalization performed by proprietary techniques on the network side.
- Terrestrial spectrum.
- LTE, 5G, NB-IoT and eMTC

- Works with **existing LTE, 5G and NB-IoT terminals**
- Quick time to market

AST SpaceMobile

STARLINK

LYNK

3GPP Rel 17 NTN support

- Transparent architecture;
- Doppler and delay compensation performed by terminal
- Standardized enhancements to HARQ procedure and mobility for NR
- Discontinuous coverage for IoT
- Dedicated spectrum in S and L band
- 5G, NB-IoT and eMTC

- **Performance improvements**

3GPP Rel 18 NTN enhancements

- Additional >10 GHz frequency and support of VSAT/ESIM terminals.
- UL Coverage enhancement for smart phones
- Mobility improvements
- HARQ disabling for IoT

- **Performance improvements**
- Higher frequency support for VSAT like terminals

3GPP Rel 19 NTN enhancements

- Regenerative architecture (with ISL).
- Store and Forward for IoT
- DL coverage enhancements, incl beam hopping
- NTN support for RedCap

- **Performance improvements**
- **NR RedCap** device support

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NTN in 6G

- NTN should be part of 6G from Day 1.
- Based on principles of NTN in 5G-Advanced.
- Maximize similarity with 6G TN.

Use Cases
- Global coverage for search and rescue.
- Maritime coverage.
- Consumer handheld connectivity in remote areas.
- Service for cars, ships and planes.
- Backup for disaster relief.
- Global IoT coverage for full range of IoT devices.
- Solving the digital divide

Key components for 6G NTN

NTN support for all UE types
- From 6G LPWA to smartphone and CPE
- Extreme coverage for smartphones by falling back to 6G LPWA

Integrated Location Services
- 6G NTN to be independent from external GNSS

TN - NTN Interworking
- Seamless mobility between TN and NTN

Architecture
- Support for transparent and regenerative architectures.

Multi Orbit support
- GEO – LEO – HAPS networks

6G NTN support for full range of UE types
Examples

6G LPWA
(meters, sensors, ...)

Main KPIs/characteristics:
- **Low cost**
- **Full global and extreme coverage**
- **Long battery life**

Full capability handheld
(smartphone, tablet)

Main KPIs/characteristics:
- **Medium throughput**
- **Support for all services**
- **Full global coverage**

CPE
(connected to smartphone, car connectivity)

Main KPIs/characteristics:
- **Large throughput**
- **Support for all services**
- **Full global coverage**

Fall Back Solution when in poor coverage.

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Integrated Location Services
Use 6G NTN for positioning and initial access

- Synchronization based on 6G satellites.

- Advantages of independence from external GNSS are reduced cost, lower power consumption and potentially (light) indoor coverage.

- UE autonomous position determination based on network reference signals.

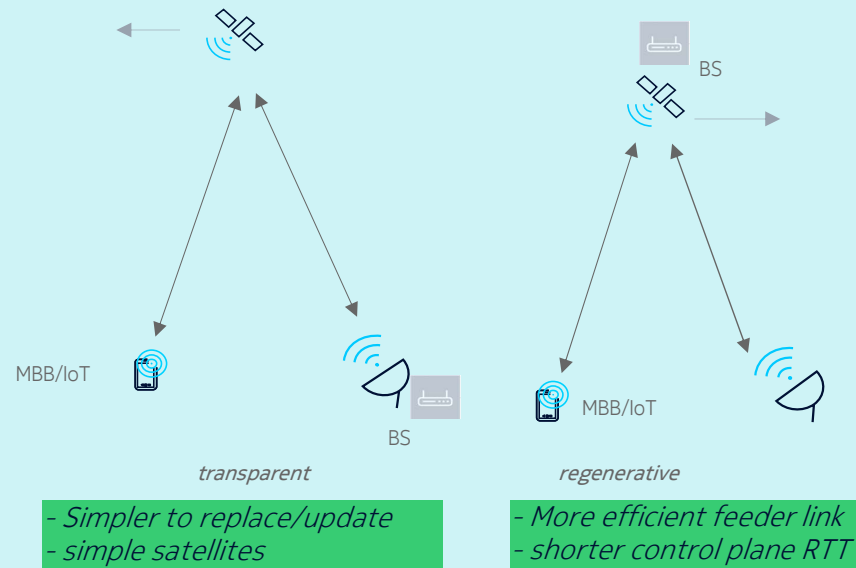- Tradeoff between accuracy and initial access efficiency.

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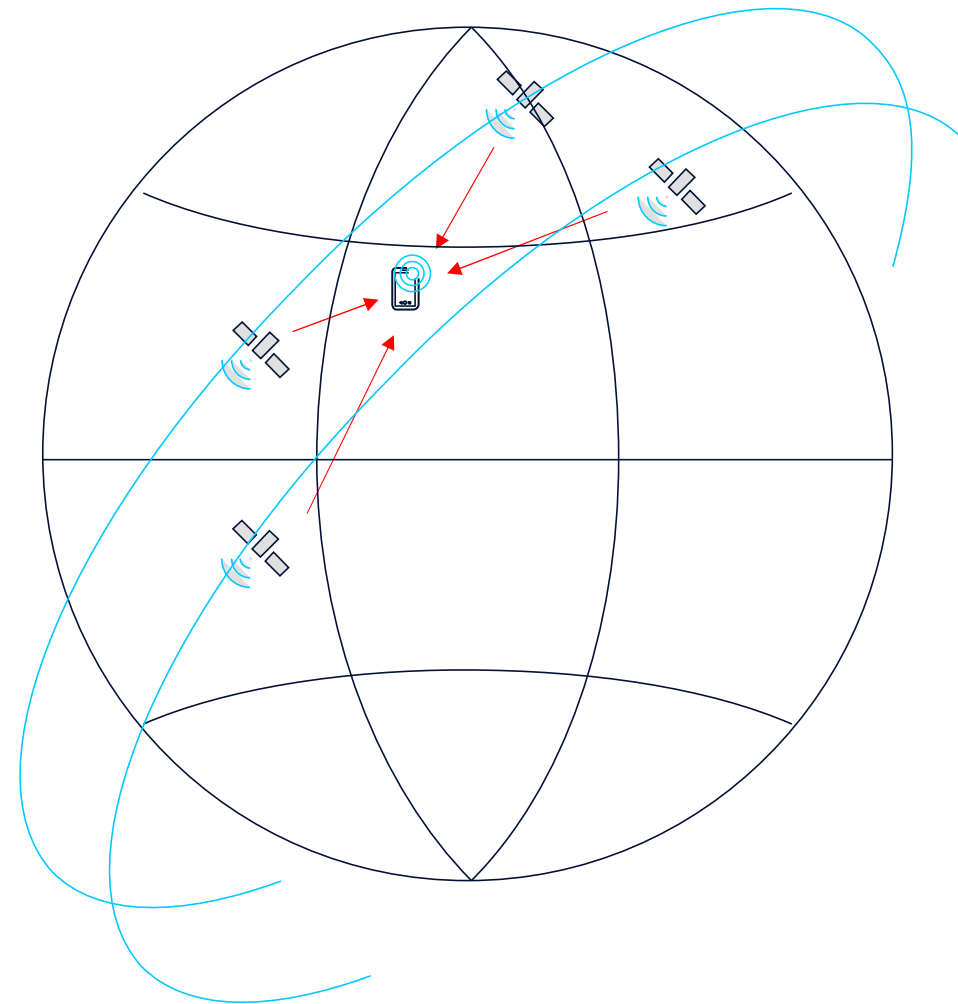
TN – NTN Interworking and Architectures

TN – NTN Interworking

Example V2X

TN cell *TN cell* *NTN cell*
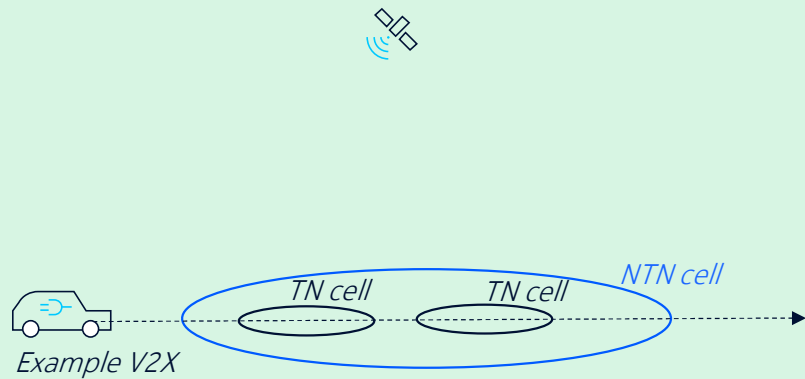
- Seamless mobility through optimization of existing solutions (including cases with different CN for TN and NTN).

Architectures

MBB/IoT

BS

transparent *regenerative*

MBB/IoT

- Simpler to replace/update
- simple satellites

- More efficient feeder link
- shorter control plane RTT

- Support for transparent and regenerative architectures.

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Multi Orbit Support

- Use advantages of different orbits and interworking between them.
  - For instance:
    - GEO: no movement relative to Earth, so fewer mobility events
    - LEO: better link budget and lower delay.
- Solutions enabling these benefits should be considered in 6G.
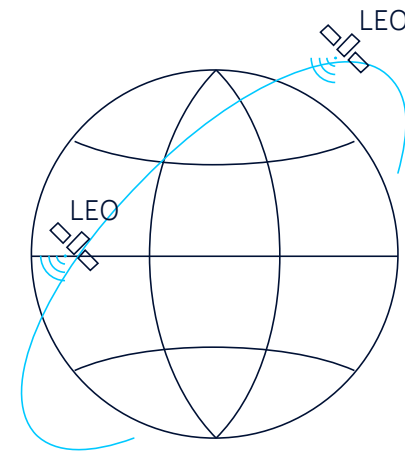
GEO

LEO

LEO

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NTN in 6G:
Natively included for all device types
without dependence on external GNSS

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