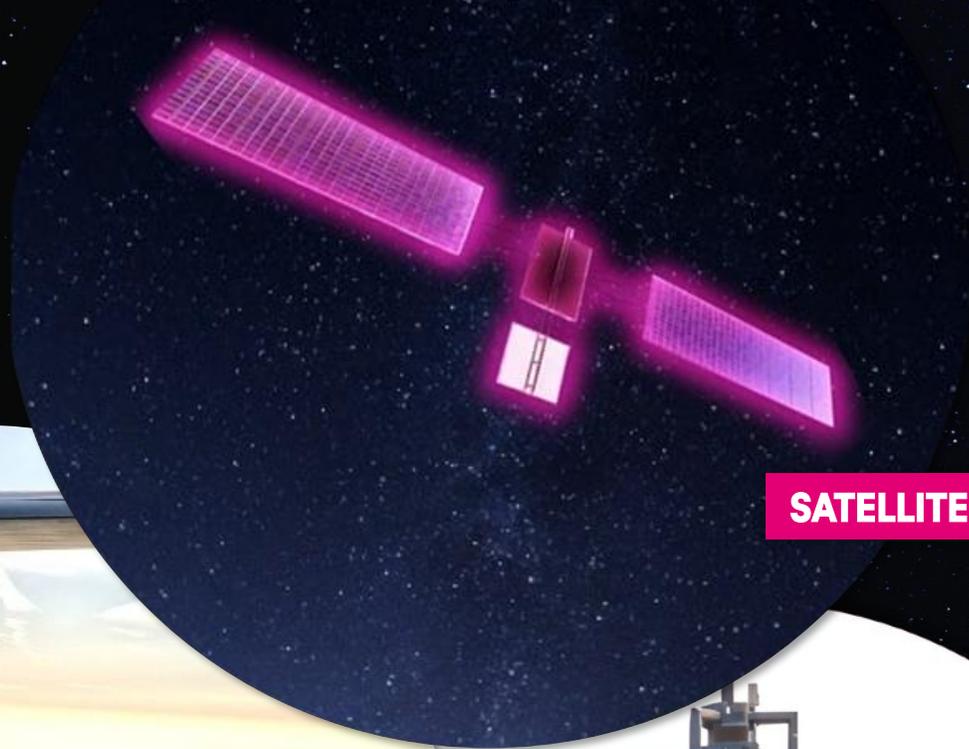# On the Mobility of NTN Basestations

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Deutsche Telekom · Group Technology

O-RAN F2F Meeting
Rome, 2026/02/05

Mobile D2H connectivity anywhere & anytime requires an integrated layered approach

SATELLITE

FLYING BASE STATION

TERRESTRIAL

3D Network research activities in Deutsche Telekom

6G-TakeOff

Holistic 3D Communication Networks for 6G

Combination of ground-based and non-terrestrial execution platforms in a holistic manner as infrastructure for network elements

Project duration: 07/2022 to 12/2025

Further details: https://www.6g-takeoff.de

With funding from the:
Federal Ministry of Research, Technology and Space

6G SmartSat

Beyond 5G/6G Networking Architectures for Multi-Layered Non-Terrestrial Networks and Smart Satellites

Routing solutions for Multi-Level Non-Terrestrial Networks (ML-NTNs) having rapidly changing topologies and limited computational capacities to process information

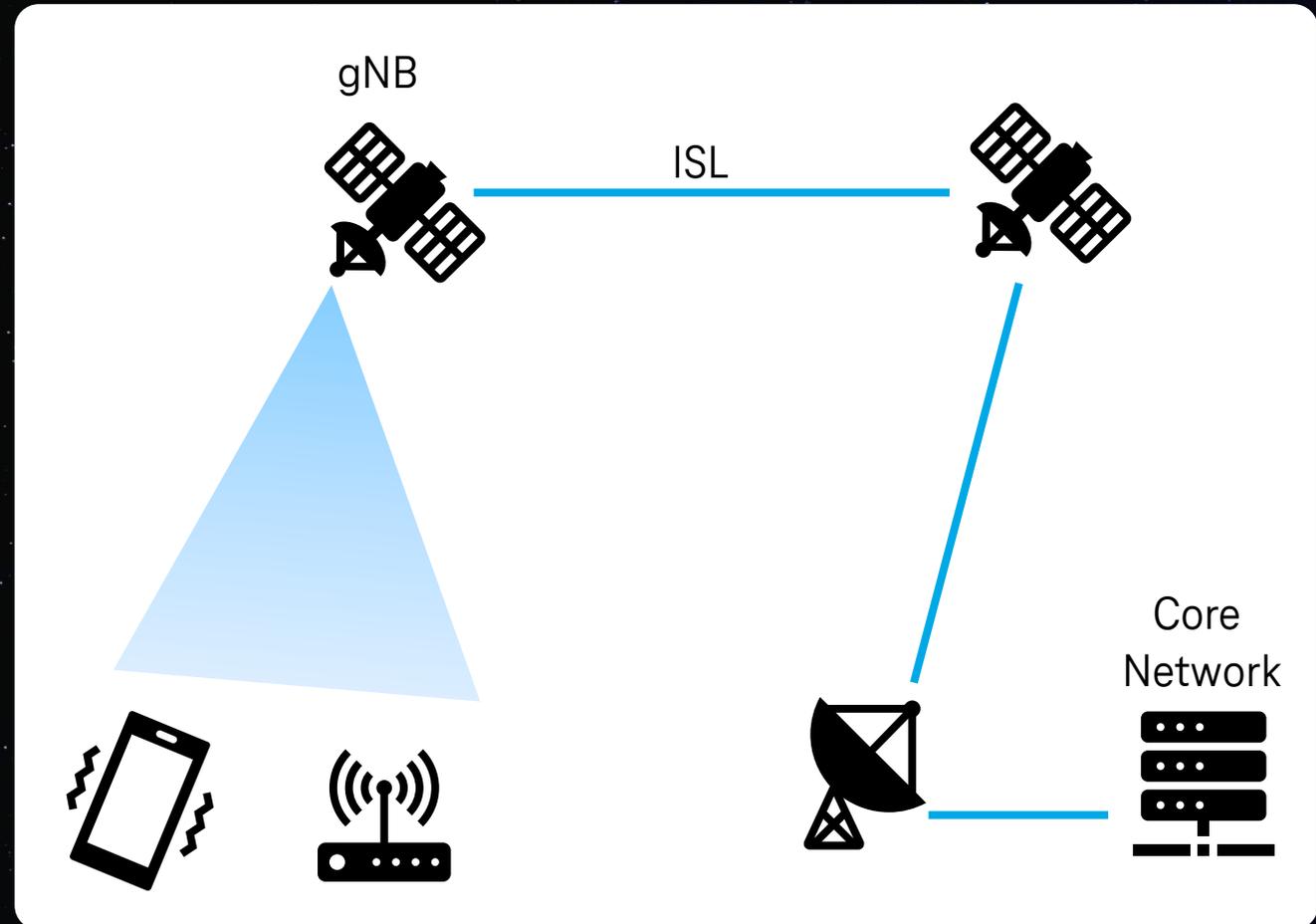Project start: 01/2024

Further details: https://connectivity.esa.int/archives/projects/6g-smartsat

eesa
→ THE EUROPEAN SPACE AGENCY

NTN systems characteristics considered in the sequel

➢ **3GPP-based network technology**

➢ **Direct-to-Handset or Satellite-BroadBand operation**

➢ **Regenerative payload**

➢ **Availability of intersatellite links (ISL)**

➢ **Non-GSO orbit**

Moving infrastructure: A paradigm shift?

## Initial working assumption in 6G-TakeOff:

6G-TakeOff

Infrastructure network nodes will be moving relatively to each other

- LEO satellites crossing Germany in less than 5 mins
- Frequent handovers of terminals
- Rapidly changing connectivity within network infrastructure (sat-2-sat and sat-2-ground)

Required properties:

- Nodes can join / leave network dynamically
- Security mechanisms / authentication of joining nodes
- Connectivity management for air interface / service link and backhaul / feeder link
- Dynamic reallocation of network functions

Earth-Moving vs. Earth-Fixed Beams for D2H Services
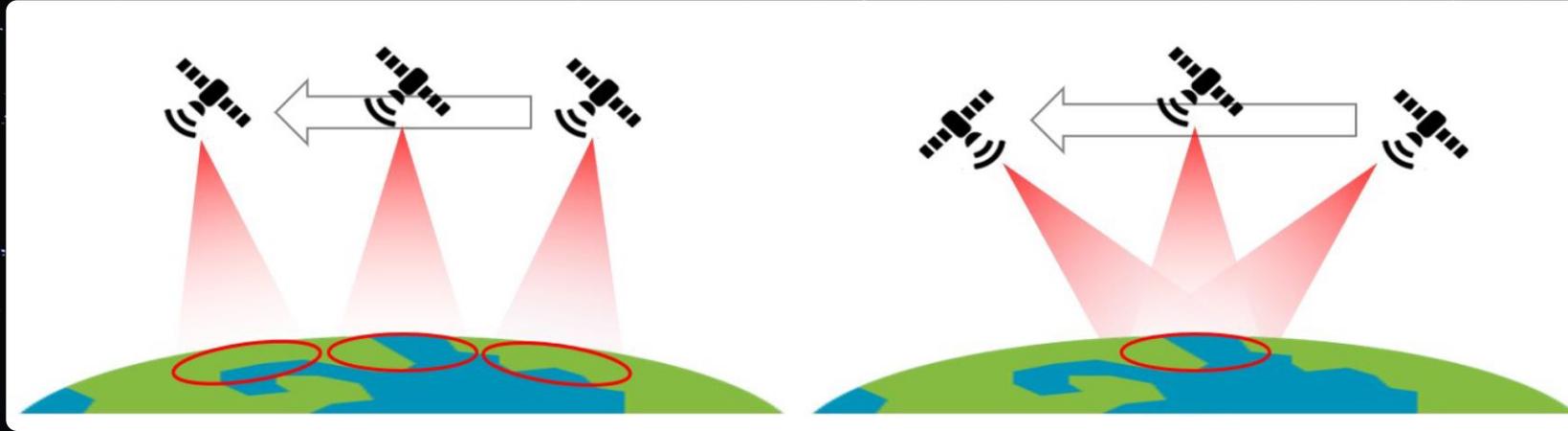
Earth-moving cells

Handover of UEs in connected-mode when source cell is moving away and target cell is approaching

→ **High signalling load**

- High processing load in base station and UE
- Reduction of traffic capacity on service link
- Battery drain of UEs

→ **Not advisable for D2H**

Earth-fixed cells / quasi-earth-fixed cells

**Base station functionality is quasi geo-stationary,
No change of radio cell from UE perspective**

→ **No change of radio cell from UE perspective**
  (→ "Satellite switch with-resync", no L3 handover)

→ **Sync of satellites to minimize service link interruption**

→ **Preferable for D2H**

Picture: https://www.mdpi.com/electronics/electronics-13-01349/article_deploy/html/images/electronics-13-01349-g001.png

Base Station Functionality for earth-fixed beams

Satellite **platform** is moving fast.

But: Base station **functionality** has to stay in the vicinity of the radio cell on the ground → Quasi geo-stationary
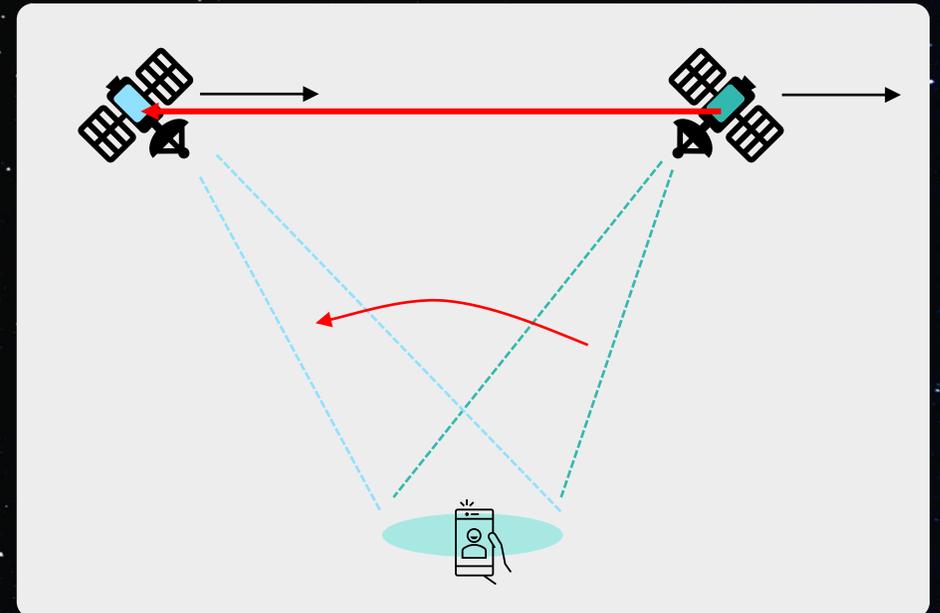
→ **Virtualisation**
to separate network functionality from satellite HW as underlying execution platform ("NFV"-like)

→ **Transfer of base station functionality between satellites**
- user contexts and cell config parameters
- or RAM image (like server migration in cloud)

→ **Backhaul link has to be maintained on the transport network**

Transport Network Routing

Design assumptions:

- **Each beam corresponds to an individual virtual base station**
  → Beams can be switched individually to subsequent satellite; no need to switch all beams simultaneously

- **Each virtual base station is assigned an individual IP address**

If IP addresses are bound to the base station function (instead to the satellite platform),

then IP endpoint addresses of the backhaul (N2 / N3) remain unchanged when switching to subsequent satellite

→ Minimum impact to 3GPP RAN and core network functionality

→ Impact of satellite mobility to be handled in transport network

Source: 6G-SmartSat
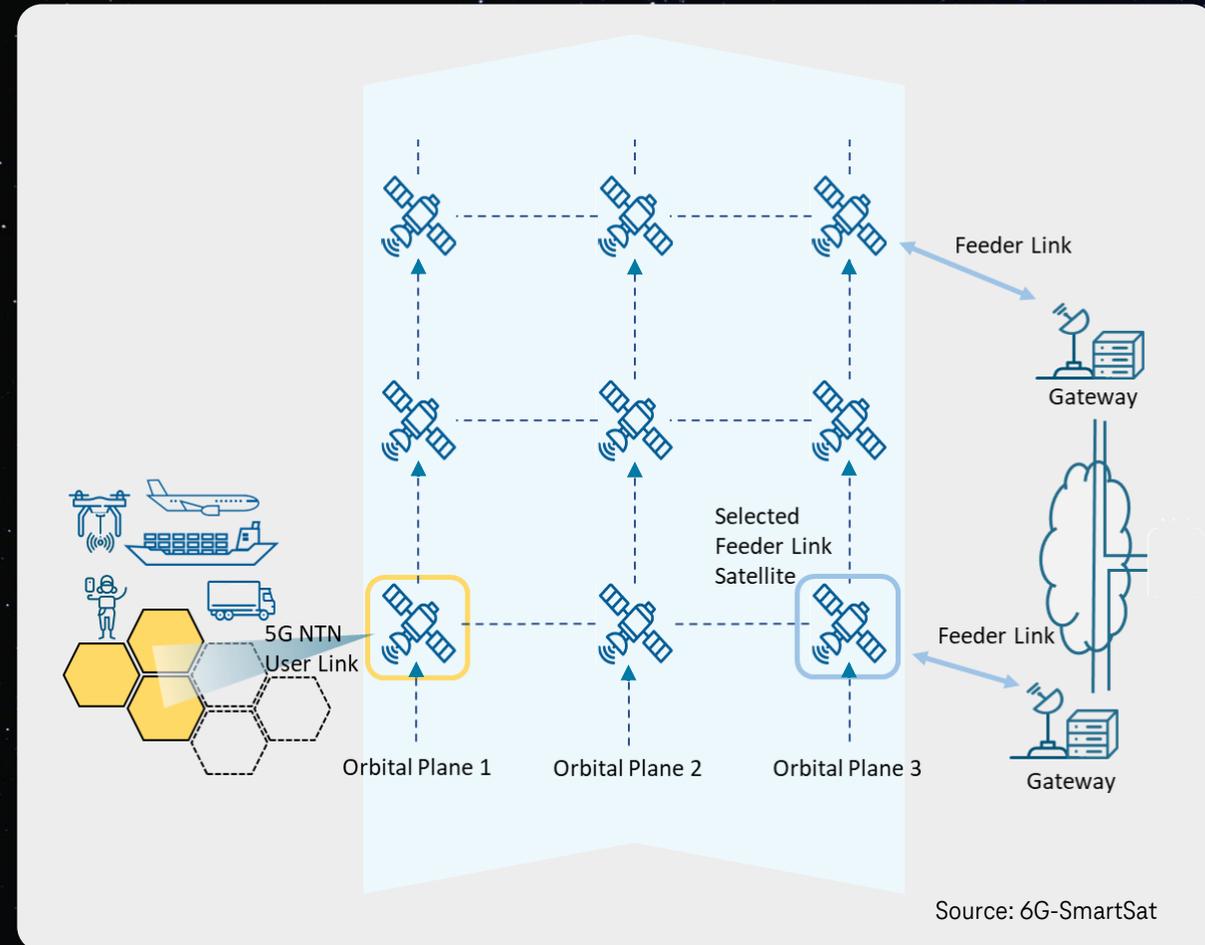
Opportunities of quasi-stationary NTN base stations

Earth-fixed NTN cells can be planned like conventional TN cells

Static neighbourcell relationships between TN and NTN cells

Management of quasi-earth-fixed NTN base stations similar to conventional TN base stations

➔ **Possibility for deep integration of NTN network elements with terrestrial networks**

Enables transfer of existing UE HO mechanisms to TN – NTN scenario

➔ **Enabler for Seamless Service Continuity**

Quasi-stationarity of NTN base stations is the key

- for using NTN to cover typical European terrestrial small-size whitespots and

- for providing ubiquitous coverage with seamless service continuity

Seamless integration
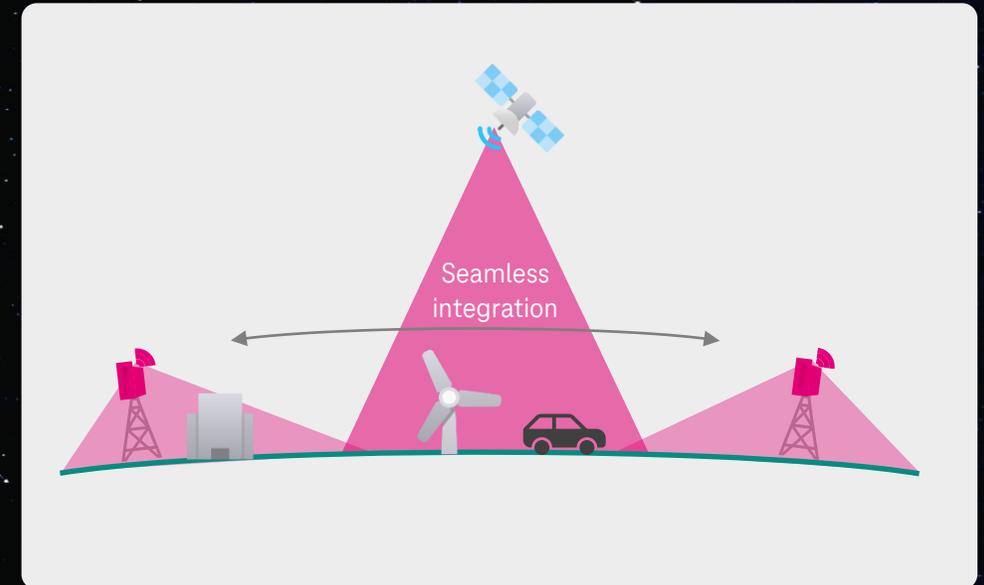
Conclusions for D2H and SatBB services

➢ Initial assumption that "in NTN infrastructure network nodes will be moving" is too simple

    ➢ Earth-fixed beams are clearly preferable over Earth-moving beams

➢ Base station functions are quasi geo-stationary – only their execution platforms are moving

    ➢ Transport network / routing algorithms has to handle the main burden of topology dynamics

➢ Stable neighbourhood relationships between TN and NTN base stations enable seamless UE handover between TN and NTN

Thank you for your Attention!