3GPP MRP mini workshop
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NTN requirements in Rel-18

Mainly focusing on RAN aspects

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Disclaimer: Some views expressed in this presentation may not represent views of all Satellite stakeholders

Satellite integration in 3GPP eco-system: Expected benefits
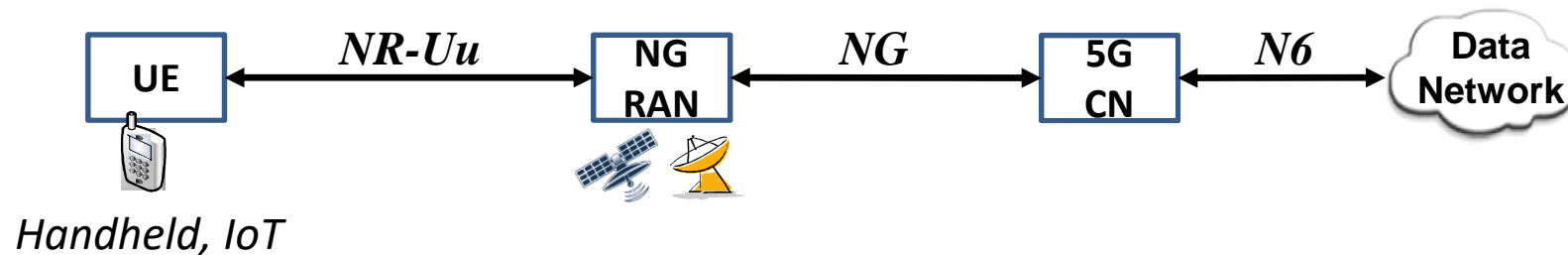
- For mobile stakeholders
  - Extend 5G in un/under served areas for true ATAWAD
  - Reinforce 5G network resilency
- For satellite stakeholders
  - New business opportunities through seamless combination of mobile and satellite access
  - Multi vendor systems: network infrastructure and terminals
  - Cost reduction by leveraging the 3GPP economy of scale market
  - Native support of all 5G features (e.g. Slicing, energy saving, mobility, 3rd party network management)
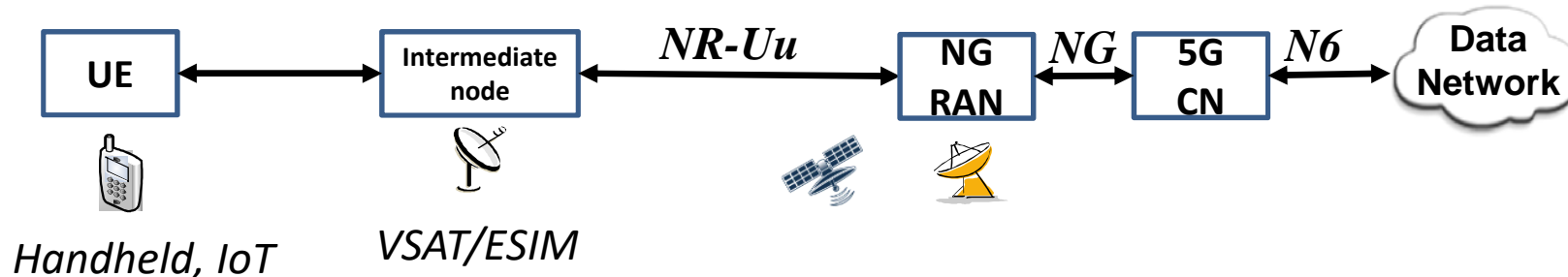
Satellite in 3GPP rel-17

- SA/CT level
  - 5G architecture enhancements to support satellite access and backhaul: Normative phase to be completed in Sept 2021

- RAN level
  - Enhancements to the 5G New Radio protocol to support Non-Terrestrial Network:
    - Normative phase to be completed in March 2022 including S band
    - Study phase for above 10 GHz bands to start in April 2022
  - Enhancements to the 4G NB-IoT/eMTC Radio protocol to support Non-Terrestrial Network:
    - study phase completed, Normative phase approved (RAN4 activity postponed post March 2022)

5G satellite access network scenarios: Architecture

NGSO/GSO based **direct connectivity** to UE (e.g. handheld and IoT devices)

| UE | $\xleftrightarrow{NR\text{-}Uu}$ | NG RAN | $\xleftrightarrow{NG}$ | 5G CN | $\xleftrightarrow{N6}$ | Data Network |

Handheld, IoT

NGSO/GSO based **indirect connectivity** to UE (e.g. VSAT/ESIM))

| UE | $\longleftrightarrow$ | Intermediate node | $\xleftrightarrow{NR\text{-}Uu}$ | NG RAN | $\xleftrightarrow{NG}$ | 5G CN | $\xleftrightarrow{N6}$ | Data Network |

Handheld, IoT   *VSAT/ESIM*

Note: Satellite transport network to support backhaul is out of 3GPP RAN scope

5G satellite access network scenarios: Characteristics

	IOT-NTN direct connectivity	NR-NTN direct connectivity	NR-NTN indirect connectivity
Frequency band	below 7.125 GHz	below 7.125 GHz	above 7.125 GHz
Max service rate targeted	hundreds of kbps (narrowband)	several Mbps (Wideband)	hundred Mbps (Broadband)
Orbit	GEO and NGSO	NGSO and possibly GEO	GEO and NGSO
Smallest terminals targeted	IoT devices	handset (smart phones)	VSAT and/or ESIM
Minimum viable antenna at terminal	Omni directional	Omni directional	Directional
Targeted 3GPP Radio interfaces	4G NB-IoT/eMTC	5G NR	5G NR
Max beam size and Recommended beam types	Wide beams (hundreds of km) Earth fixed (GEO), Earth moving (NGSO)	Narrow beams (tens of km) quasi Earth fixed (NGSO) and Earth fixed (GEO) *(Earth moving - TBD)*	Narrow beams (tens of km) Earth fixed (GEO) and quasi Earth fixed (NGSO)
Example of applications	Verticals : utilities, agriculture, AIS	Consumer market Verticals : Transport, public safety, utilities, agriculture, smart grids	Backhaul, IP connectivity, Satellite News Gathering, aeronautical/maritime broadband/IoT, government & defense, Oil field

3GPP technology applicable for all satellite networks: any band, any orbit, any device, any service
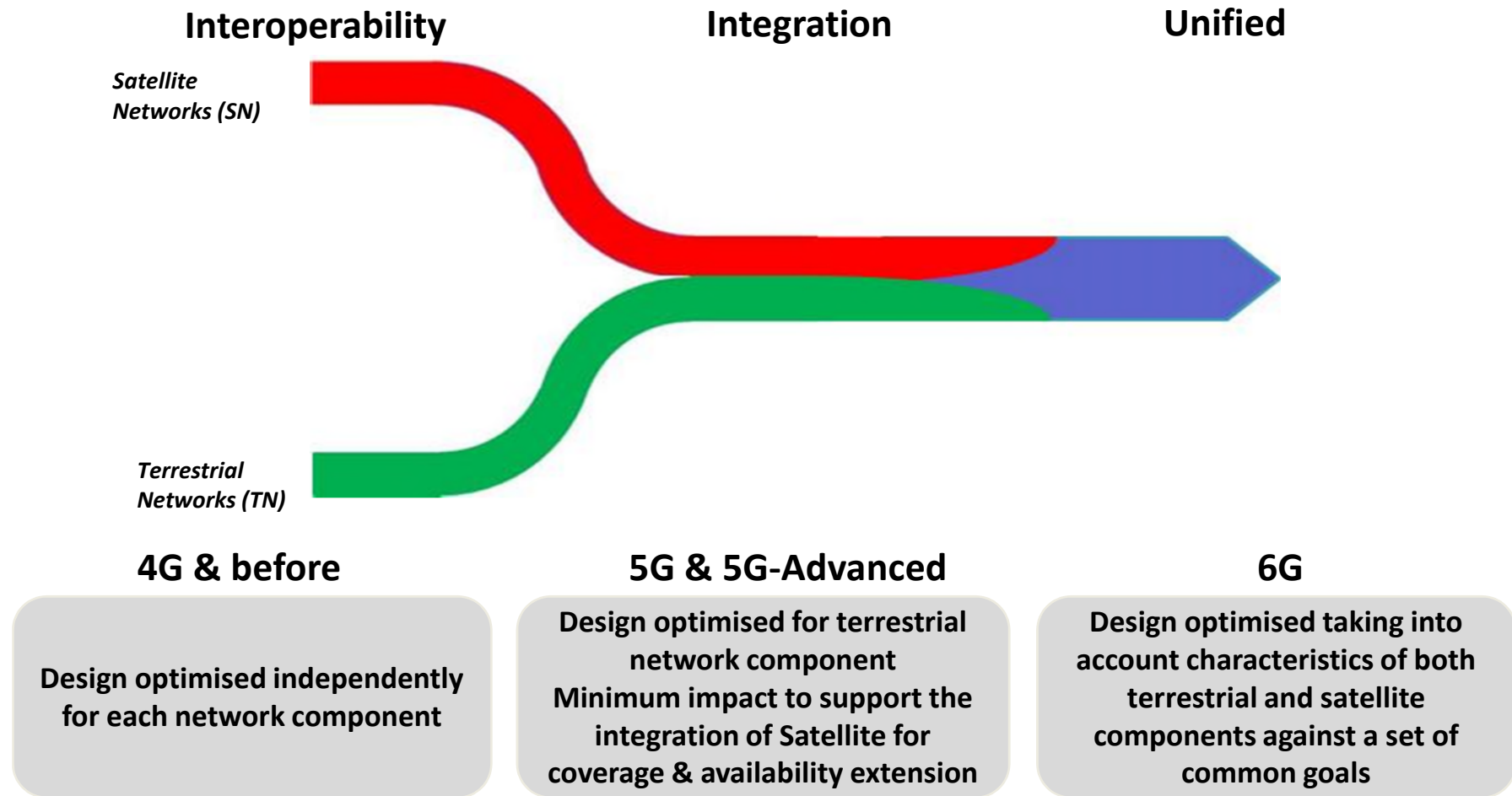
5G satellite access network scenarios: design challenges

- IOT-NTN direct connectivity
  - Smallest targeted UE: low cost devices with omnidirectional antenna
  - Space segment: Low cost satellite network infrastructure below 7.125 GHz
    - Already in orbit GEO satellites with large deployable antenna; Sparse LEO constellation of small satellites or hosted payload
  - Max Service rate: hundreds of kbps
- NR-NTN indirect connectivity
  - Smallest targeted UE: VSAT (Very Small Aperture Terminal) & ESIM (Earth Station In Motion)
  - Space segment: VHTS like GEO or NGSO operating above 7.125 GHz
  - Max Service rate: hundred of Mbps per User Equipment
- NR-NTN direct connectivity
  - Smallest targeted UE: Smart phones & REDCAP devices
  - Space segment: Novel NGSO (possibly GEO) constellation operating below 7.125 GHz
  - Max Service rate: Several Mbps per user equipment

5G Satellite network solutions development

- 5G satellite backhaul solution using legacy SatCom system
  - February 2021: 5G Backhaul via legacy SatCom (Thales & KT SAT): https://www.fkcci.com/actualites/n/news/thales-alenia-space-partners-with-kt-sat-for-the-5g-satellite-backhauling-demonstration.html
- Direct connectivity to 4G IoT devices with GEO satellite access based on NB-IoT
  - August 2020: https://www.satellitetoday.com/iiot/2020/08/19/mediatek-inmarsat-demonstrate-5g-satellite-iot-data-connection/
- Indirect connectivity with 5G NR based Very High Throughput GEO system
  - March 2021: 3GPP NR-NTN via GEO (Fraunhofer IIS) https://www.iis.fraunhofer.de/en/pr/2021/20210312_5G_new_radio.html
- Direct connectivity to 5G smart phones with NGSO Satellite access based on NR-NTN
  - Several on going ambitious industrial initiatives for a service opening in 2024-25

Roadmap to support a vision for satellite in 3GPP

Interoperability **Integration** **Unified**

Satellite Networks (SN)

Terrestrial Networks (TN)

4G & before

Design optimised independently for each network component

5G & 5G-Advanced

Design optimised for terrestrial network component
Minimum impact to support the integration of Satellite for coverage & availability extension

6G

Design optimised taking into account characteristics of both terrestrial and satellite components against a set of common goals

Satellite roadmap in 3GPP RAN

	Releases	Approach for 5G satellite	Satellite related standardisation activities	End of release	Initial deployment
5G	Rel-15	Introduction of the subject	5G service requirements for 5G via satellite Satellite propagation model definition & Issues for 5G support NTN	June 2018	2020
	Rel-16	Assessment of the issues	Study satellite features for 5G system and RAN	March 2019	2022
	Rel-17	Definition of **Market enabling features**	Define satellite features for 5G system and RAN	March 2022	2023-24
5G-Advanced	Rel-18	Definition of **enhancements optimizing performance and enabling new capabilities**	Define enhanced satellite features for 5G system and RAN	Sept 2023	2025
	Rel 19	Definition of 2nd set of **enhancements optimizing performance and enabling new capabilities**	Define 2nd enhanced satellite features for 5G system and RAN	*2025*	*2027*
6G	*Rel-20*	*Contribution to initial 6G work*	*6G Use cases & preliminary requirements (service, radio, access) and early enabling features*	*2027*	*2029*

Rel-18 NR-NTN WI: Proposed enhancements (Thales)

- Rel-17 left overs (e.g. beam management, BWP association)
- Enhancements to optimize performance
  - 1. **Asynchronous multi connectivity & Carrier Aggregation** (e.g. between two satellites and possibly between NTN/TN)
  - 2. **Further coverage enhancements** to support mass market smart phones (including study phase on NTN-specific coverage issues)
  - 3. **UE characteristics enhancement** for verticals (e.g. PC 2)
- Enhancements to provide new capabilities
  - 1. **Network based UE location service** (LCS) for emergency calls (including Study phase)
  - 2. **Support of UE without GNSS** for energy saving and availability issues (including further study leveraging Rel-16 NR-NTN study item)
  - 3. **Support of discontinuous coverage** due to sparse constellation for non real time applications

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Rel-18: Other non specific NR-NTN enhancements (Thales)

- RedCAP: 5 MHz min channel bandwidth
- NR Protocol simplification (e.g. Overhead reduction for voice over NR - VoNR)
- Complementary TDD (unidirectional TDD on UL and DL)
- IAB (moving or nomadic cell) for indirect connectivity
- NR MBS evolution

All NR-NTN enhancements proposed

NR-NTN enhancements	Categories	members
UE without GNSS	New capability	14
Regenerative payload	New capability	11
NTN-TN or NTN-NTN Mobility (further optimisation)	Rel-17 left overs	9
Dual Connectivity/Carrier Aggregation (NGSO &NGSO, NGSO & GEO, NTN & TN)	Performance improvement	8
Network based UE location	New capability	7
Beam management and BWP association	Rel-17 left overs	7
Coverage enhancement	Performance improvement	6
DL PAPR reduction	Performance improvement	4
NTN-TN spectrum sharing	New capability	3
Discontinuous coverage (non-real time service with sparse constellation)	New capability	3
High performance UE (Higher Tx power, lower NF, higher antenna gain)	Performance improvement	4
VoNR	Performance improvement	3
MBS	New capability	2
NR-NTN above 10 GHz	New capability	2
Relay-based architecture for NTN	New capability	2
UL/DL capacity performance (CSI aging mitigation, DM-RS config)	Performance improvement	1
RedCAP support NTN	New capability	1
Coordinated transmission	Performance improvement	1
Half Duplex FDD	New capability	1
Pre paging alert	Performance improvement	1
RedCAP channel BW reduced	Performance improvement	2
Protocal simplification	Performance improvement	
On-board edge computing	Performance improvement	

Rel-18 IoT-NTN WI: proposed enhancements (Thales)

- Proposed scope will depend on the Rel-17 IoT-NTN WI scope
- Possible Enhancements
  - Energy saving
  - Mirror some enhanced NR-NTN features where relevant

Way forward for RAN on NTN in Rel-18

- Prioritise performance optimisation enhancements
    - Throughput per UE, network capacity, UE power saving

- Address in priority new capabilities to
    - meet requirements associated to regulated services: e.g. Reliable UE location
    - exploit space segment including during its deployment phase

Questions ?

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