3GPP NTN standard and next steps

One6G summit 2022

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ThalesAlenia Space
a Thales / Leonardo company

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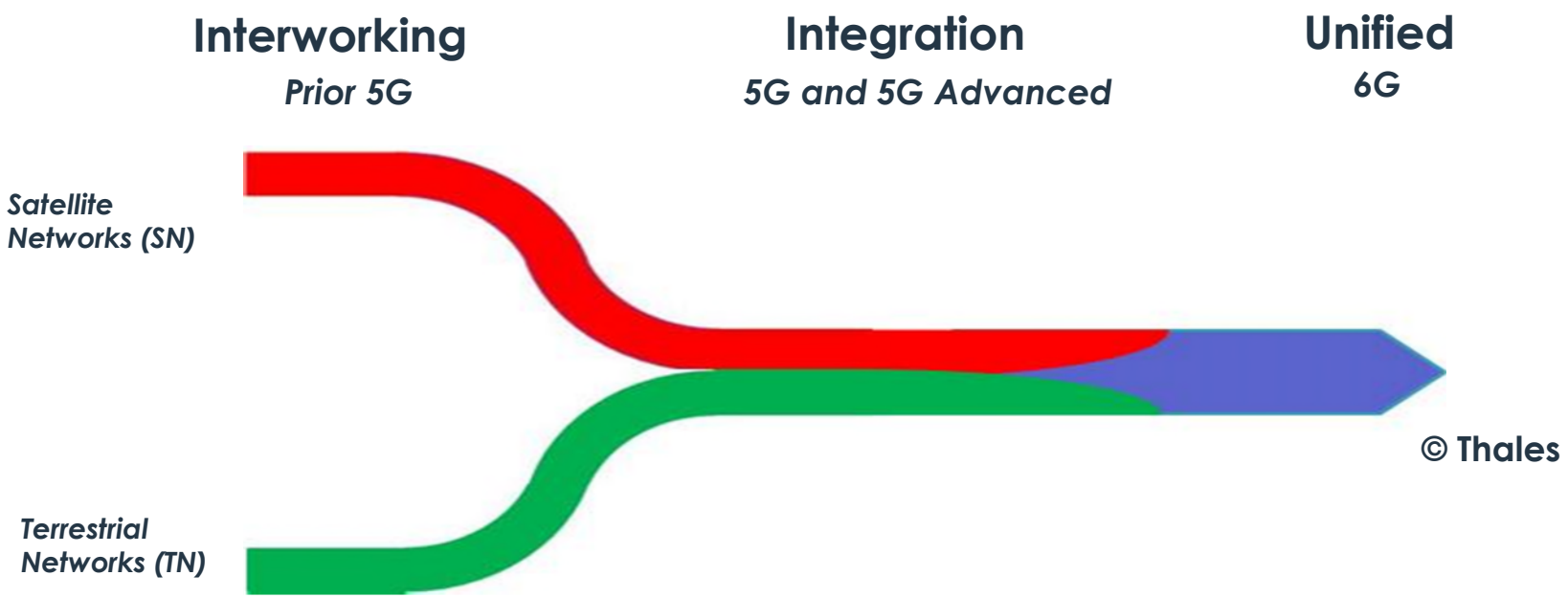
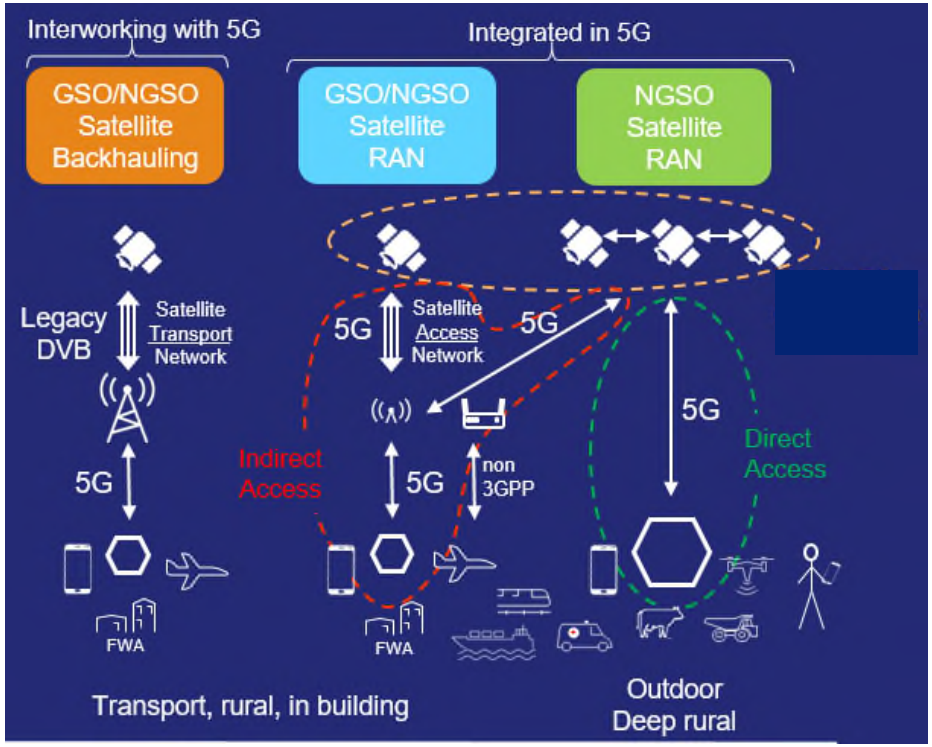
Satellite integration in 3GPP eco-system: Vision



Interworking between Independently designed network components	Adding a satellite component to the 5G system	Native support of both terrestrial and satellite network components to address a set of common goals

NTN: a standard for the integration of satellite with mobile systems



- Satellite access complementing mobile access
- Combination for service continuity and reinforced reliability/availability

3GPP technology framework to best manage (Perf., QoS, Security, Slicing) across the access technologies

5G Satellite networks: Reference scenarios

GSO = Geo Synchronous Orbit
NGSO = Non GSO
VSAT = Very Small Aperture Terminal
ESIM = Earth Station In Motion

	Release 17		Release 18
	Direct connectivity (< 7 GHz)		**Indirect connectivity (above 10 GHz)**
Targeted terminals	**IoT devices**	**handset (smart phones) and car/drone mounted devices**	**VSAT and/or ESIM**
Service	**Narrowband** **hundreds of kbps**	**Wideband** **few Mbps**	**Broadband** **hundred Mbps**
Orbit	GSO and NGSO	NGSO	GSO and NGSO
3GPP Radio interfaces	**4G NB-IoT/eMTC**	**5G New Radio**	**5G New Radio**
Example of applications	*Professional : utilities (smart grids, water distribution, oil & gas), agriculture*	*Consumer market* *Professional markets : Automotive, public safety, utilities, agriculture, Defense*	*Professional markets: Telco (e.g. Backhaul), IPTV service providers, Satellite News Gathering, Transport (aeronautical, maritime, railway), public safety, defense*

3GPP technology applicable for all satellite networks: any band, any orbit, any device, any service

GNSS = Global Navigation Satellite System
FDD = Frequency Division Duplexing

3GPP NTN standard: Release 17 & 18

- **(Non) Geostationnary** Earth orbiting satellites
- T**ransparent payload architecture**

- Addressing identified issues
  - **Extended & variable propagation delays & Doppler**
  - **Wide and/or moving radio cells** in NTN.
  - **Service continuity** between Terrestrial Network and NTN.
  - **Spectrum below 6GHz and above 10 GHz**
  - **Reliable UE location to support regulatory services**

Implicit compatibility to support HAPS (High Altitude Platform Station) and ATG (Air To Ground) scenarios

UEs with GNSS capabilities

FDD

Earth fixed Tracking area

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3GPP Rel-17 NTN standard: Impact on NR/NG-RAN specifications

RAN1: Physical layer

- Timing relationship
- UL time and frequency synchronization
- Enhancements on HARQ
- Polarization signalling for VSAT/ESIM

RAN3: Access network architecture

- Network Identity handling
- Registration Update and Paging Handling
- Cell Relation Handling
- Feeder Link Switch-Over (NGSO)
- Aspects Related to Country-Specific Routing

SA2: System level

- Mobility management with huge cell size
- UE location and support of regulated service
- QoS class for GEO satellite links
- Impact of satellite backhauling

RAN2: Access layer

- User Plane: RACH aspects, Other MAC aspects (e.g. HARQ), UP: RLC, PDCP
- System information broadcast
- Control Plane: Tracking Area Management, Idle/connected mode mobility, UE Location Service

RAN4: RF & RRM performance

- New bands
  - TN/NTN coexistence
  - Satellite Access Node, UE
- RRM: e.g. timing compensation (idle, connected mode), GNSS accuracy

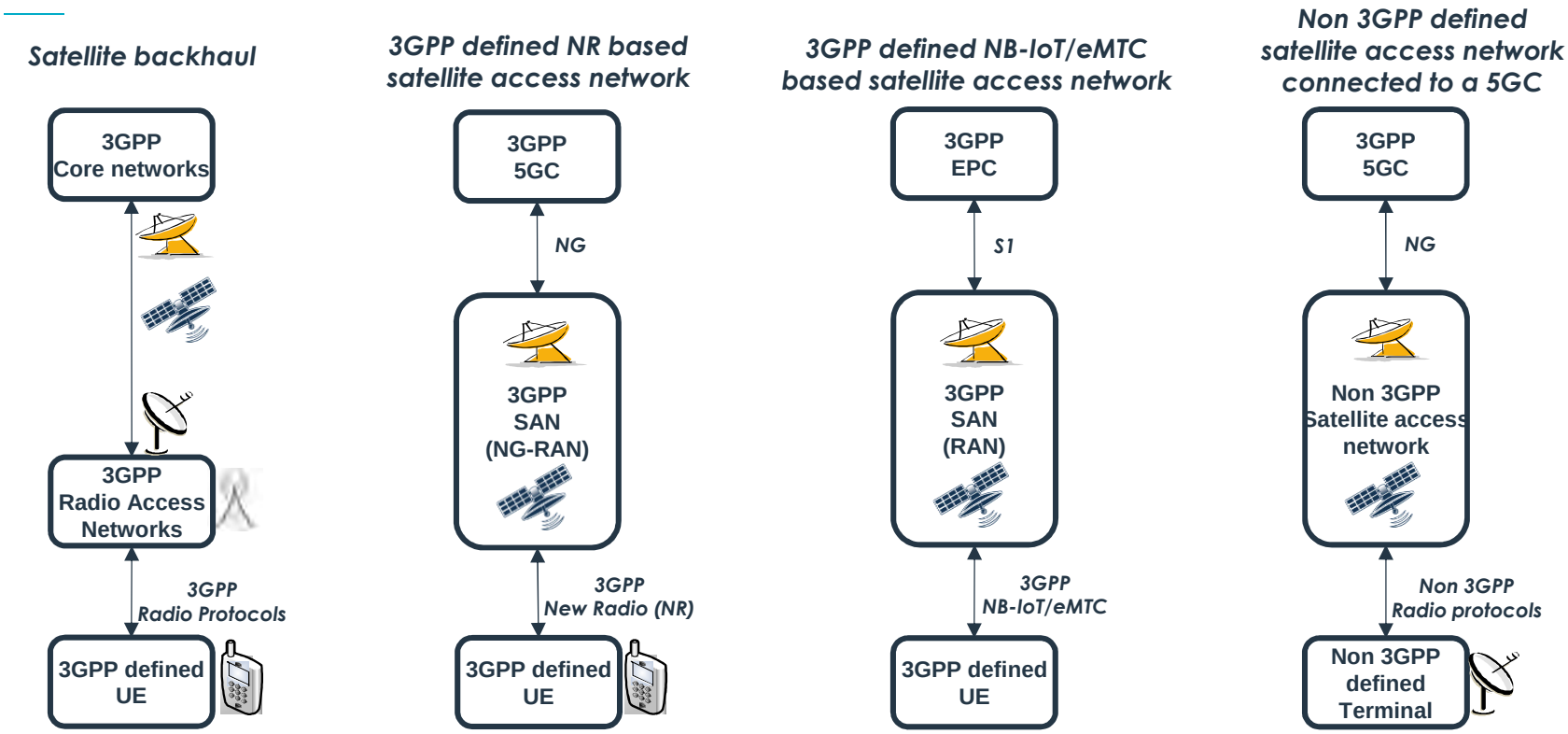
CT1: Network protocols

- PLMN (re)selection
- NAS timers

Key benefits of the 3GPP « NTN » standard

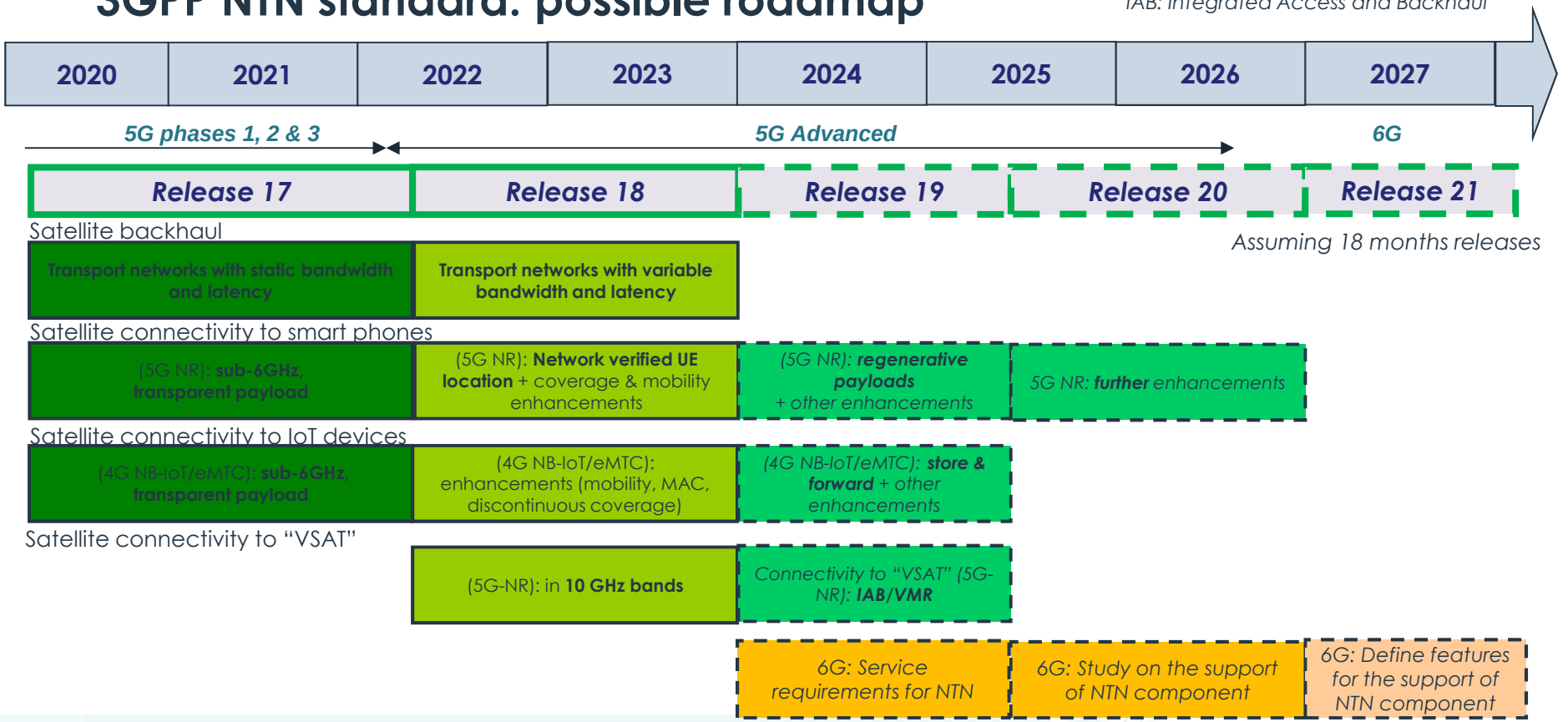
- The 5G's New Radio protocol (NR) enhanced with NTN functions will enable to develop a new generation of Satellite networks able to support
  - **multi-vendor interoperability** => addressing the current vendor lock that all satcom users (Public safety, transport, …) want to escape from
  - **integration of satellite in the global 3GPP eco system** => enabling access to a wider set of vendors as chipset, terminal and network level and allowing the economy of scale to drive down the cost
  - **combination with terrestrial mobile network** => to offer service continuity (mobility) or increased reliability (multi connectivity)
  - **combination of NGSO and GSO access for enhanced Quality of Experience** => to mitigate the latency of GSO and the relative reduced throughput of NGSO)
  - **natively advanced 5G features** such as slicing, QoS, Security, energy saving thanks to a common technology framework with mobile systems
- In addition, the standardization activity on NTN paves the way for future enhancements of these 3GPP defined satellite networks in the context of beyond 5G and 6G.

Definitions of satellite network solutions for 5G

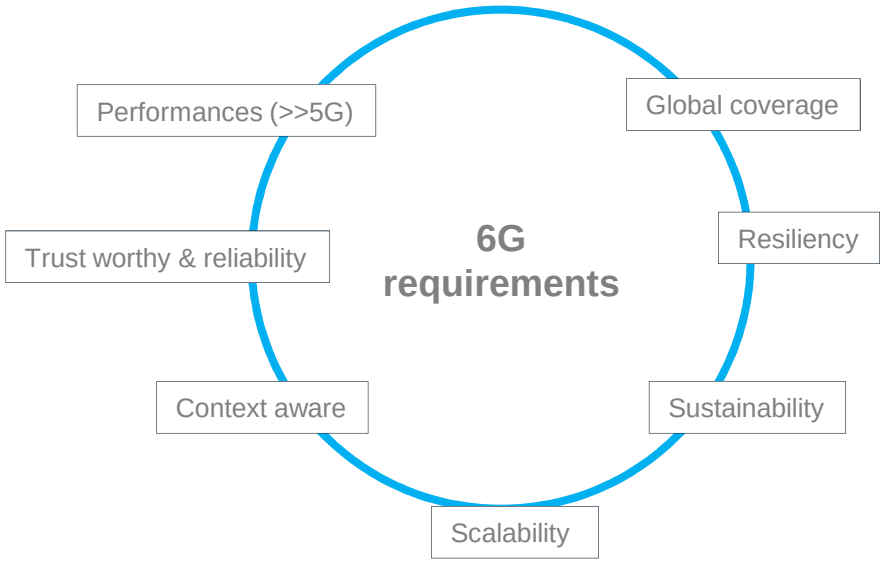


3GPP NTN standard: possible roadmap

TN = Terrestrial Network
NTN = Non Terrestrial Networks (Satellite, HAPS)
VMR: Vehicle Mounted Relay
IAB: Integrated Access and Backhaul



6G overview



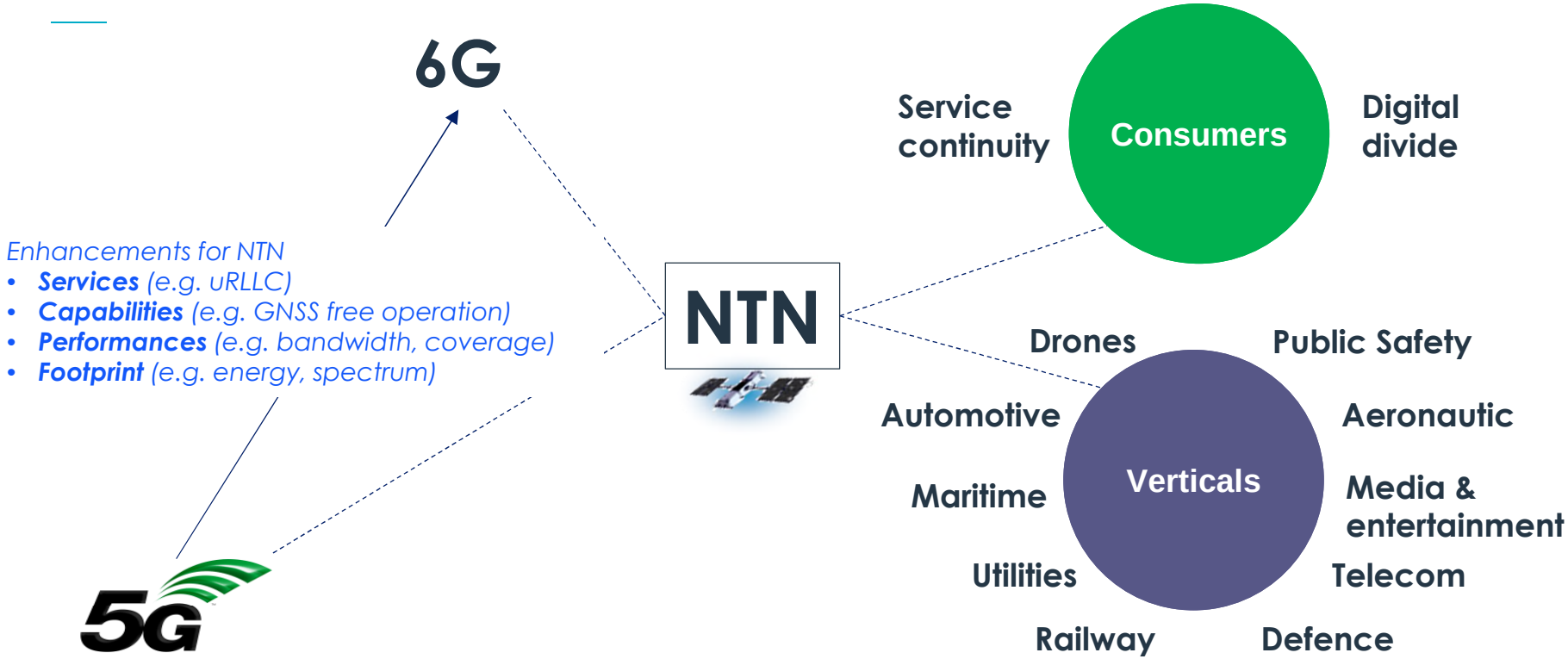
Vision of IMT beyond 2030- Preliminary list of requirements

IMT Future Technology Trends Towards 2030 and Beyond

Key Performance requirements trends envisioned for 6G:

- Throughput/data rate up to 1 Tbit s−1
- user-experienced data rate of 1 Gbits−1(ten timesthe one targeted by 5G)
- End-to-end latency less than 1 ms
- over-the-air latency of 10−100μs with mobilityup to 1000 km h−1
- very broad bandwidth with frequencies reaching1−3THz
- "always-ON" terrestrial-aerial-satellite network
- Frame error rate (reliability) equal to $1 - 10^{-9}$
- Very high energy efβiciency also supporting "battery-free IoT devices" (10-100 times the one of 5G)and especially equal to 1pJ bit^{-1}
- Spectrum efficiency greater than three times the one of 5G
- receiver sensitivity less than−130dBm
- a connectivity density ten times the one provided by 5G, with an area traffic capacity of up to1Gbit $s^{-1}m^{-2}$
- Density of connected devices greater than 106km−2
- Localisation precision equal to 1 cm in three dimensions

NTN: 6G versus 5G



Thank you

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Acronyms

- VSAT: Very Small Aperture Terminal
- HH: Handheld
- xMBB: extreme Mobile Broad Band
- xMTC: extreme Machine Type Communications
- uRLCC: Ultra Reliable and Low Latency Communications
- RAN: Radio Access Network
- CN: Core Network
- xCAST: unicast, multicast, broadcast
- DVB: Digital Video Broadcasting (see www.dvb.org)

3GPP NTN standard: Study and work items in Rel-15 to 17

Release	Item ref	Lead WG	Title	3GPP doc	Completion	Rapporteurs
15	SI "FS_NR_nonterr_nw on NR"	RAN	Study on New Radio (NR) to support Non Terrestrial Networks (Release 15)	TR 38.811	June 2018	N. Chuberre - Thales
	SI "FS_5GSAT"	SA1	Study on using Satellite Access in 5G; Stage 1 (Release 16)	TR 22.822	June 2018	C. Michel – Thales
16	SI "FS_NR_NTN_solutions"	RAN3	Solutions for NR to support non-terrestrial networks (NTN) (Release 16)	TR 38.821	Dec 2019	N. Chuberre - Thales
	WI "5GSAT"	SA1	Service requirements for the 5G system; Stage 1 (Release 16)	CR to TS 22.261	Dec 2018	C. Michel – Thales
	SI "FS_5GSAT_ARCH"	SA2	Study on architecture aspects for using satellite access in 5G (Release 16)	TR 23.737	June 2020	C. Michel - Thales
	SI "FS_5G_SAT_MO"	SA5	Study on management and orchestration aspects of integrated satellite components in a 5G network	TR 28.808	March 2021	C. Michel – Thales
17	**WI " NR_NTN_solutions"**	**RAN2**	**Solutions for NR to support non-terrestrial networks (NTN)**	**CR to TS 38.XXX TS 38.108 TS 38.101-5 TR 38.863**	**Dec 2022**	**N. Chuberre - Thales**
	WI "5GSAT_ARCH"	SA2	Integration of satellite systems in the 5G architecture	CR to TS 23.XXX	Dec 2021	J.Y. Fine - Thales
	SI « 5GSAT_ARCH-CT »	CT1	Study on PLMN selection for satellite access	TR 24.821	Sept 2021	A. Catovic – Qualcomm
	WI « 5GSAT_ARCH-CT »	CT1	PLMN selection for satellite access	CR	March 2022	A. Catovic – Qualcomm
	SI " FS_LTE_NBIOT_eMTC_NTN"	RAN1	Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN)	TR 36.763	June 2021	G. Charbit – MediaTek, Rene Faurie – Eutelsat
	WI "LTE_NBIOT_eMTC_NTN"	RAN1	Solutions for NB-IoT & eMTC to support non-terrestrial networks (NTN)	CR to TS 36.XXX	June 2022	G. Charbit – MediaTek, Rene Faurie – Eutelsat

3GPP NTN standard: Study and work items in Rel-18

Release	Item ref	Lead WG	Title	3GPP doc	Completion	Rapporteurs
18	SI « FS_5GET - Extra territoriality »	SA1	Guidelines for extra-territorial 5G Systems (5GS)	TR 22.926	Dec 2021	N. Chuberre - Thales
	SI « FS_NR_NTN_netw_verif_UE_loc »	RAN	New SID: Study on requirements and use cases for network verified UE location for Non-Terrestrial-Networks (NTN) in NR	TR 38.882	June 2022	N. Chuberre - Thales
	WI " NR_NTN-enh"	**RAN2**	**Enhancements to Solutions for NR to support non-terrestrial networks (NTN)**	**CR to TS 38.XXX**	**Dec 2023**	**N. Chuberre - Thales**
	WI " IoT_NTN-enh"	**RAN2**	**Enhancements to Solutions for NB-IoT & eMTC to support non-terrestrial networks (NTN)**	**CR to TS 36.XXX**	**Dec 2023**	**R. Abhishek – MediaTek**
	WI « NR_NTN_solutions_plus_CT-UEConTest »	**RAN5**	**UE Conformance – Solutions for NR to support non-terrestrial networks (NTN) plus CT aspects**	**CR to TS 38.XXX**	**Dec 2023**	**V. Balasubramanian/Qualcomm**
	SI " FS_ 5GSAT_ARCH_Ph2"	**SA2**	**5GC enhancement for satellite access Phase 2**	**TR 23.700-28**	**Jun 2023**	**J.Y. Fine - Thales**
	SI «FS_5GSATB »	**SA2**	**Study on satellite backhauling**	**TR 23.700-27**	**Jun 2023**	**Hucheng Wang/CATT**
	SI « FS_eLCS_ph3 »	**SA2**	**Enhanced location services**	**TR 23.700-71**	**Jun 2023**	**Ming AI/CATT**
	SI « FS_5GSAT_SEC »	**SA3**	**Study on security aspects of satellite access (Release 18)**	**TR 33.700-28**	**Jun 2023**	**Xiaomi**
	SI « FS_IOT_NTN »	**SA5**	**Study on Management Aspects of IoT NTN Enhancements**	**TR 28.841**	**Jun 2023**	**M. Sun/China Unicom**

3GPP NTN standard: Study and work items in Rel-19

Release	Item ref	Lead WG	Title	3GPP doc	Completion	Rapporteurs
19	SI « FS_5GSAT_Ph3 »	SA1	Study on satellite access - Phase 3	TR 22.865	Jun 2023	T. Bérisot/Novamint
	SI « FS_DualSteer »	SA1	New SID: Study on Upper layer traffic steering, switching and split over dual 3GPP access	TR 22.841	Jun 2023	Francesco Pica/Qualcomm

Definitions of satellite network solutions for 5G (2)

3GPP defined NR based satellite access network:

- a NG-RAN based on satellite access nodes, connected to a 5GC, and providing connectivity to 3GPP defined user equipment. It may also provide connectivity to IAB nodes.
- It supports the 3GPP defined New Radio (NR) access technology enhanced with NTN capabilities specified by 3GPP.

3GPP defined NB-IoT/eMTC based satellite access network:

- E-UTRA Radio Access network based on satellite access nodes, connected to an EPC, and providing connectivity to 3GPP defined user equipment.
- It supports the NB-IoT and eMTC access technologies enhanced with NTN capabilities specified by 3GPP

Non 3GPP defined satellite access network connected to a 5GC:

- Satellite access network, connected to a 5GC via an interworking function, which provides broadband services to non 3GPP defined terminals
- Such access network supports a non 3GPP defined radio protocol. It may support some 3GPP features

Satellite backhaul:

- A transport network over satellite that provides connectivity between 5GC and gNB. This transport network may be based on 3GPP or non 3GPP defined radio protocols
- It may support/maintain the 5G slices