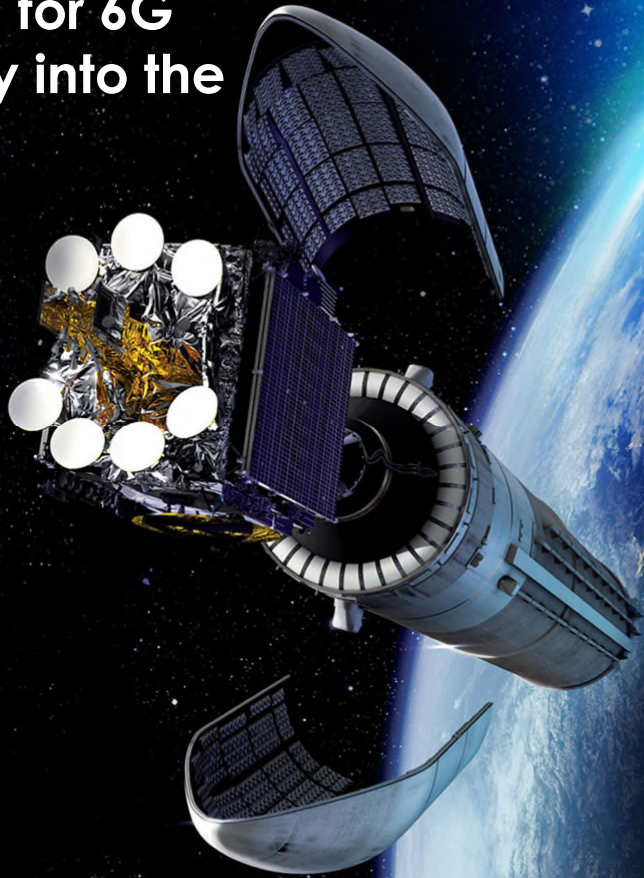# Ignition for 6G Journey into the Space

Session 3: Satellite Communication Technology

« 3GPP NTN standardization: past, current and future »

November 24th, 2021, Nicolas Chuberre

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Agenda

1. 5G Satellite networks
- Interworking versus Integration between satellite and mobile systems
- Integration for better service level
- Scenarios and capabilities

2. 3GPP NTN (NON-TERRESTRIAL NETWORK) standard
- Roadmap
- Rel-17, Rel-18
- Beyond Release 18
- Lessons' learned

3. Satellite in 6G
- Thales' vision

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1. 5G Satellite networks: Interworking versus Integration

	On line Cambridge dictionary definition	5G context
Interworking	*"the fact or process of computer equipment and software being able to **connect and exchange information**"*	Independent Cellular and satellite networks can **exchange information through standardized interface** with/without **interworking function**
Integration	*"the action or process of **combining two or more things** in an effective way"*	Mobile network and satellite networks can be **combined to achieve a common goal** (e.g. seamless global coverage)

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1. 5G Satellite networks: Integration for better service level

🪐Targeted use cases
  - 🪐Handset, IoT devices
  - 🪐Vehicle, Drone mounted devices
  - 🪐Vessel, aircraft mounted devices

NTN in 5G offers a complementing role to Terrestrial Network access

Combine the NTN & TN for service continuity and reinforced reliability/availability

RAN based on Multiple access technologies

Indirect connectivity

Intermediate node

Wi-Fi

5G

Direct connectivity

UE

5G based NTN access

5G TN access

5G Core network

Public data network
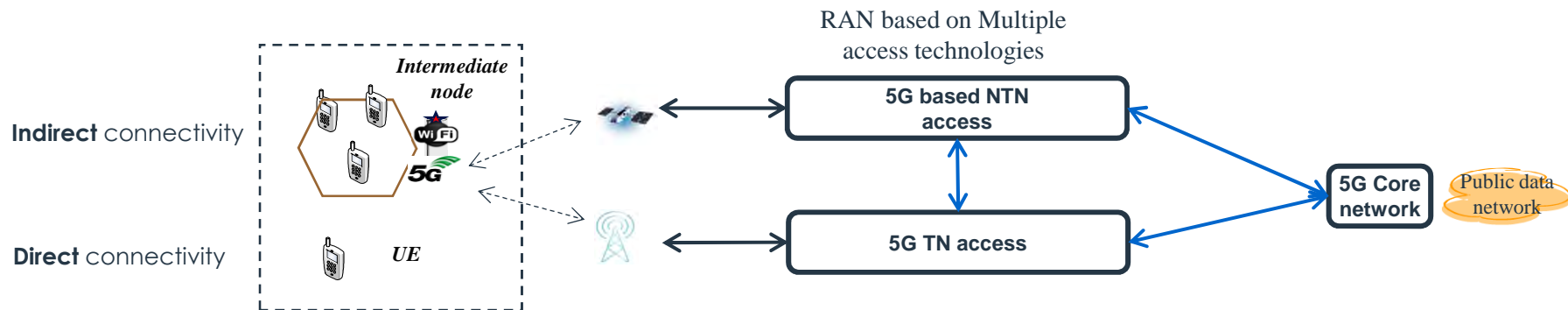
5G technology framework to best manage (Perf., QoS, Security, Slicing) across the access technologies

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1. 5G Satellite networks: Reference scenarios

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

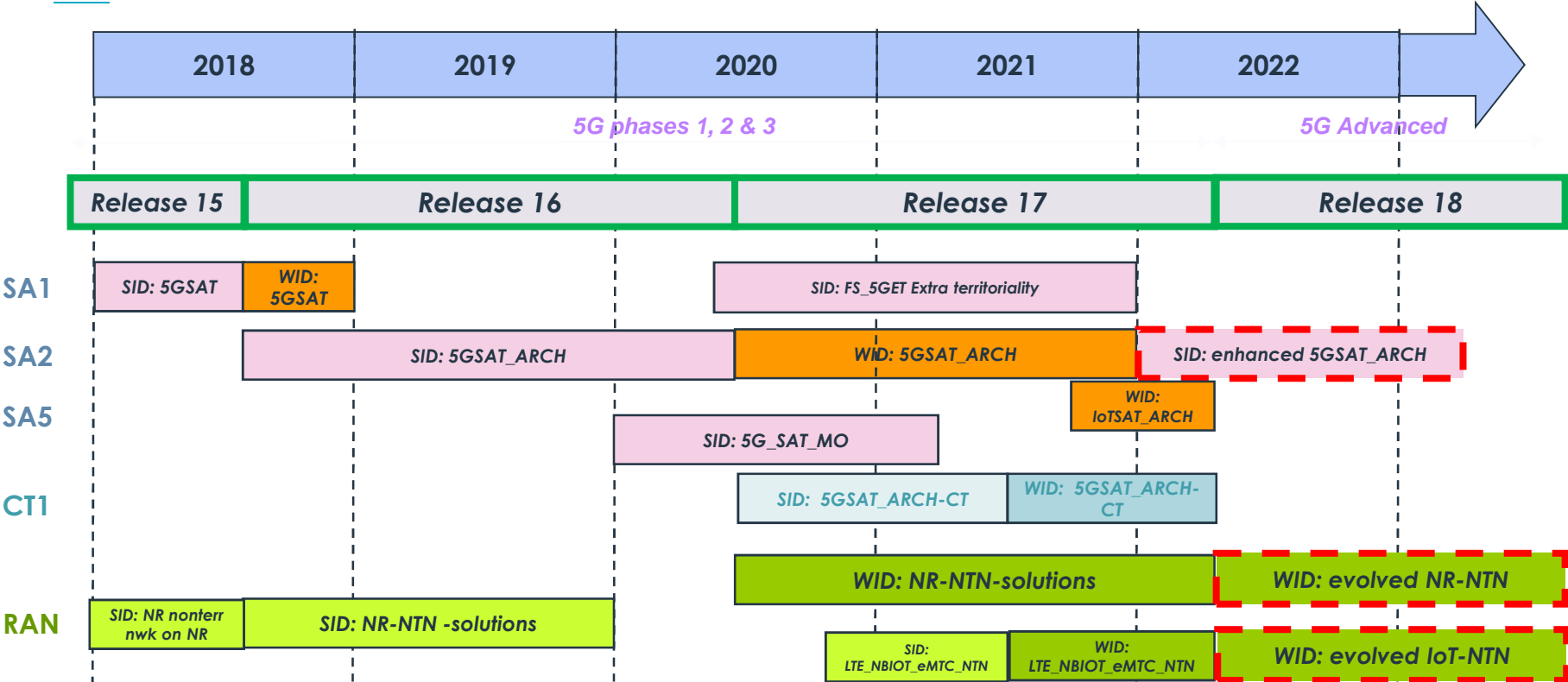|	Direct connectivity (< 7 GHz)		Indirect connectivity (above 10 GHz)
Targeted terminals	IoT devices	handset (smart phones) and car/drone mounted devices	VSAT and/or ESIM
Service	Narrowband hundreds of kbps	Wideband few Mbps	Broadband hundred Mbps
Orbit	GSO and NGSO	NGSO	GSO and NGSO
3GPP Radio interfaces	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

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2. 3GPP NTN standard: Roadmap

2018	2019	2020	2021	2022

5G phases 1, 2 & 3　　　　　　　　　　　　*5G Advanced*

Release 15	Release 16	Release 17	Release 18

SA1
- SID: 5GSAT | WID: 5GSAT
- SID: FS_5GET Extra territoriality

SA2
- SID: 5GSAT_ARCH
- WID: 5GSAT_ARCH
- SID: enhanced 5GSAT_ARCH

SA5
- WID: IoTSAT_ARCH
- SID: 5G_SAT_MO

CT1
- SID: 5GSAT_ARCH-CT
- WID: 5GSAT_ARCH-CT

RAN
- SID: NR nonterr nwk on NR
- SID: NR-NTN -solutions
- WID: NR-NTN-solutions
- WID: evolved NR-NTN
- SID: LTE_NBIOT_eMTC_NTN
- WID: LTE_NBIOT_eMTC_NTN
- WID: evolved IoT-NTN

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2. 3GPP NTN standard: Release 17

- Addressing identified issues due to **long propagation delays**, large **doppler effects**, and **moving cells** in NTN.

- NG-RAN architecture enhancements and related procedures.

- Service continuity from TN to NTN and from NTN to TN systems.

UEs with GNSS capabilities	

FDD	

Release 17:
- Focusses on **transparent architecture**
- Covers both Earth moving and Earth fixed radio cells

NR NTN based on LEO and GEO with implicit compatibility to support HAPS (High Altitude Platform Station) and ATG (Air To Ground) scenarios

Earth fixed Tracking area

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2. 3GPP NTN standard: content of Release 18

SA1

🛰VMR: Vehicle mounted relay (connected via satellite)

🛰SCVS = Satellite access to support Control and/or Video Surveillance

🛰5GET = Study on Services with Extra-territorial 5G systems

🛰5GSATB: Satellite Backhaul (bundling, variable latency/bandwidth of backhaul connections)

Tentative content
decision at RAN&SA#94-e

	eMBB (New Radio)	IoT (NB-IoT, eMTC)
SA2 WG	• Network based UE location determination • TN/NTN service continuity • Relay based architecture including satellite	• Discontinuous coverage • Store and forward (regenerative payload for C-IoT)
RAN WGs	• Coverage enhancements • NR-NTN deployment in above 10 GHz bands and support for VSAT/ESIM NTN UE • NTN-TN and NTN-NTN mobility and service continuity enhancements • Network based UE location	• IoT-NTN Enhancements in Rel-18 to address remaining issues from Rel-17 • Mobility enhancements • Further enhancement to discontinuous coverage • *Support for store-and-forward on-board NTN payload*

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2. 3GPP NTN standard: Beyond Rel-18

🪐Possible new RAN features

Performance enhancements	New capabilities
• NTN-NTN or NTN-TN asynchronous multi-Connectivity & Carrier Aggregation • PAPR optimization • Coordinated transmission	• UE without GNSS capabilities • Regenerative payload (including edge computing) • NTN-TN Spectrum coexistence

🪐Possible new SA features

🪐Support of Performance Enhancement Proxy

🪐Opportunistic connectivity between network nodes of satellite constellation
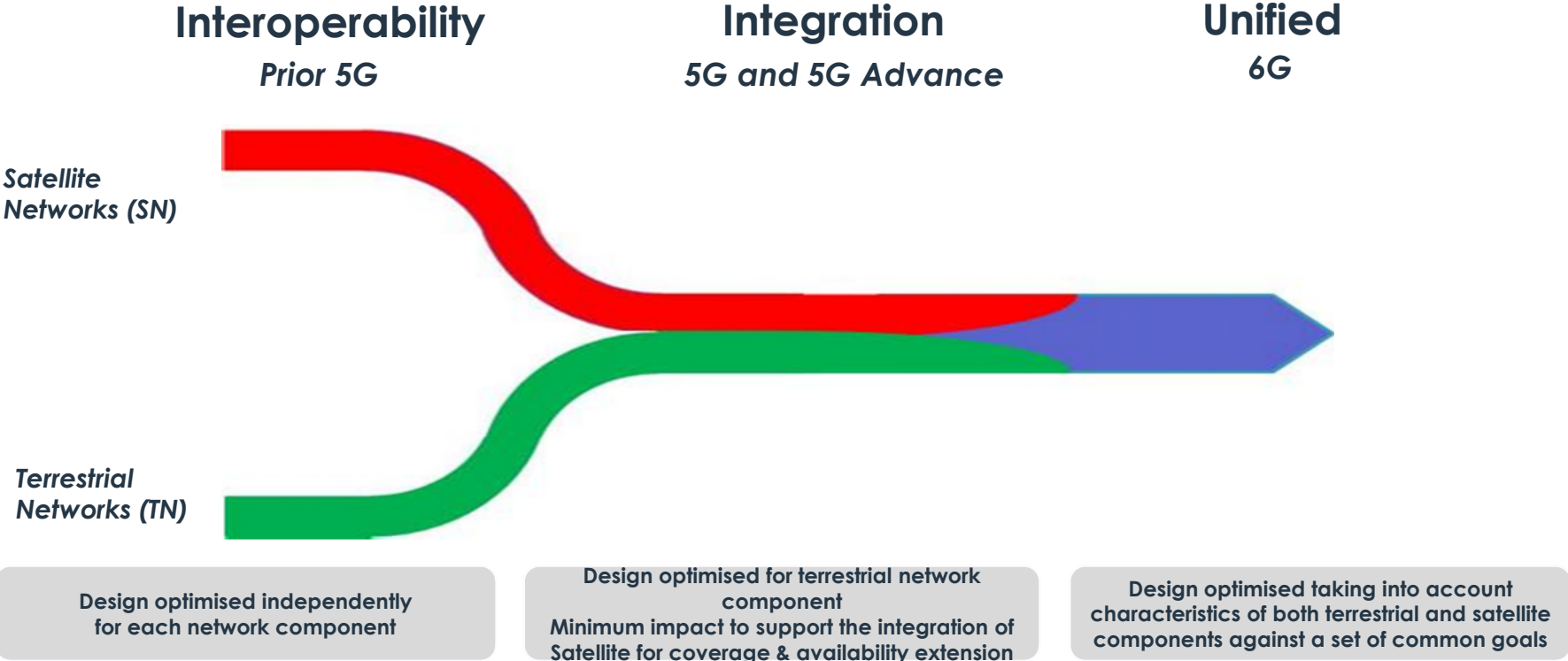
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2. 3GPP NTN standard: Lessons' learned

- **Integration** of satellite with mobile systems **is now possible** with 3GPP Release 17 NTN standard

- This standard is the result of a **joint effort** between stakeholders of both mobile and satellite industry who both find benefits
  - **Satellite helps mobile** to provide global service continuity and resiliency
  - **Mobile enables satellite** to access a unified and large eco system and drive down the cost through economy of scale

- It is also **supported by Telecommunication User groups** (Public safety, transport, automotive...) calling for
  - **seamless combination** of satellite and mobile systems (Mobility, Multi connectivity)
  - **support of all 5G features** (Slicing, energy saving, mobility, 3rd party network management, application & service platforms) across the access technologies

Paving the way to new business opportunities

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3. Satellite in 6G: Thales' vision

Interoperability
Prior 5G

Integration
5G and 5G Advance

Unified
6G

Satellite Networks (SN)

Terrestrial Networks (TN)

Design optimised independently for each network component

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

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

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Thank you

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"Support to Standardisation of Satellite 5G Component"

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