5G stardust

Non-Terrestrial Networks: A Connectivity Paradigm Shift Towards 6G

FUSECO FORUM 2023

Berlin, 14-15.09.2023

FUSECO Forum 2023
FUTURE SEAMLESS COMMUNICATION

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German Aerospace Center (DLR)

Co-funded by the European Union

6GSNS

Project Overview

Full name: *Satellite and Terrestrial Access for Distributed, Ubiquitous and Smart Telecommunications*

Stream: *A-01-02 Ubiquitous Radio Access*

Project Coordinator: *Tomaso De Cola, DLR*

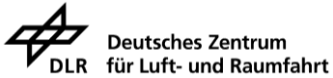
Technical Manager: *Mathieu Arnaud, Thales Alenia Space (F)*

11 *partners*

7 *countries*

36 *months*

The Consortium



PROJECT AMBITION

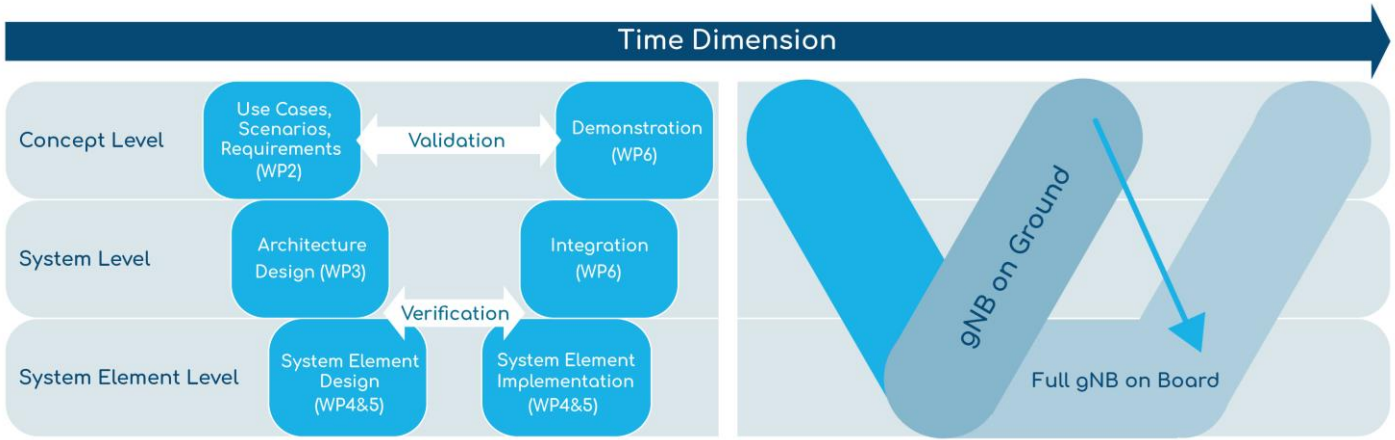
Design, develop and demonstrate a deeper integration of TN and NTN:
Deliver a fully integrated 5G-NTN autonomous system with novel self-adapting end-to-end connectivity models for enabling ubiquitous radio access.

Project Objectives

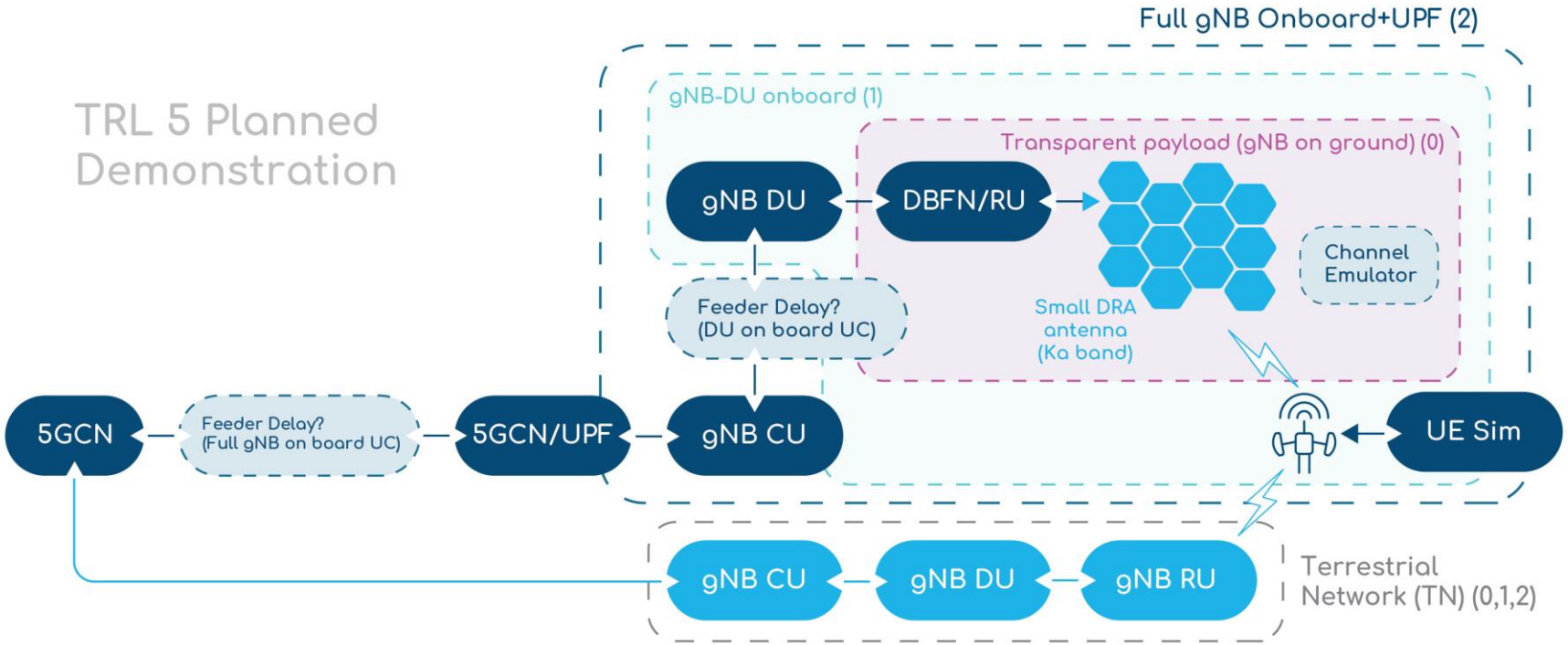
- Study, design, a **5G-based satellite network**, implementing onboard processing and storage capabilities towards effective networking and mobile computing in the sky.
- Define, design **data-driven management system components**, building on AI/ML based solutions for resource allocation and service provision in highly dynamic integrated hybrid networks.
- Design, implement, and demonstrate **E2E services over a fully integrated TN-NTN** advanced network architecture with regenerative space nodes.
- Contribute to the development of a **European Research and Technology roadmap** to ensure strategic positioning and global competitiveness of Europe in integrated TN-NTN communications.

Project Methodology

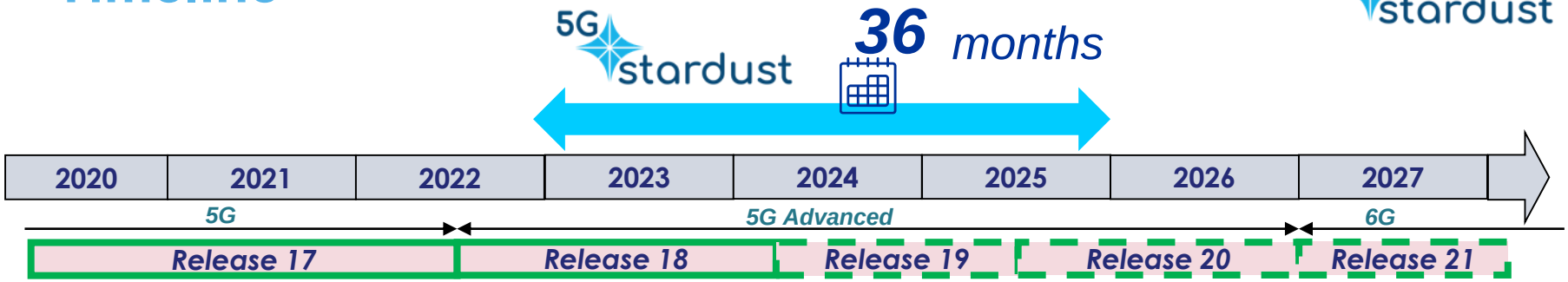
- System engineering approach based on the Vee-model with multiple increments:
  - From gNB on ground towards full gNB onboard NTN nodes
  - Concept, System, and System Element Level



TRL 5 Planned Demonstration



Timeline



Assuming 18 months releases

Satellite backhaul

Transport networks with static bandwidth and latency	**Transport networks with variable bandwidth and latency**

Satellite connectivity to smart phones

(5G NR): **sub-6GHz, transparent payload**	(5G NR): Coverage & mobility enhancements	*(5G NR): other enhancements (e.g. **regenerative payloads**)*	*5G NR: **further** enhancements ?*

Satellite connectivity to IoT devices

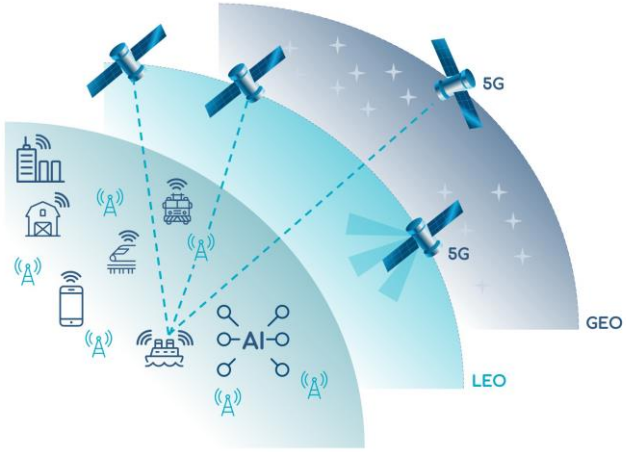
(4G NB-IoT/eMTC): **sub-6GHz, transparent payload**	(4G NB-IoT/eMTC): enhancements (mobility, MAC, discontinuous coverage)	*(4G NB-IoT/eMTC): other enhancements (e.g. **store & forward**)*

Satellite connectivity to “VSAT”

(5G-NR): in **10 GHz bands**	*(5G-NR): other enhancements (e.g. **IAB/VMR**)*

6G: Service requirements for NTN	*6G: Study on the support of NTN component*	*6G: Define features for the support of NTN component*

KEY TECHNOLOGIES



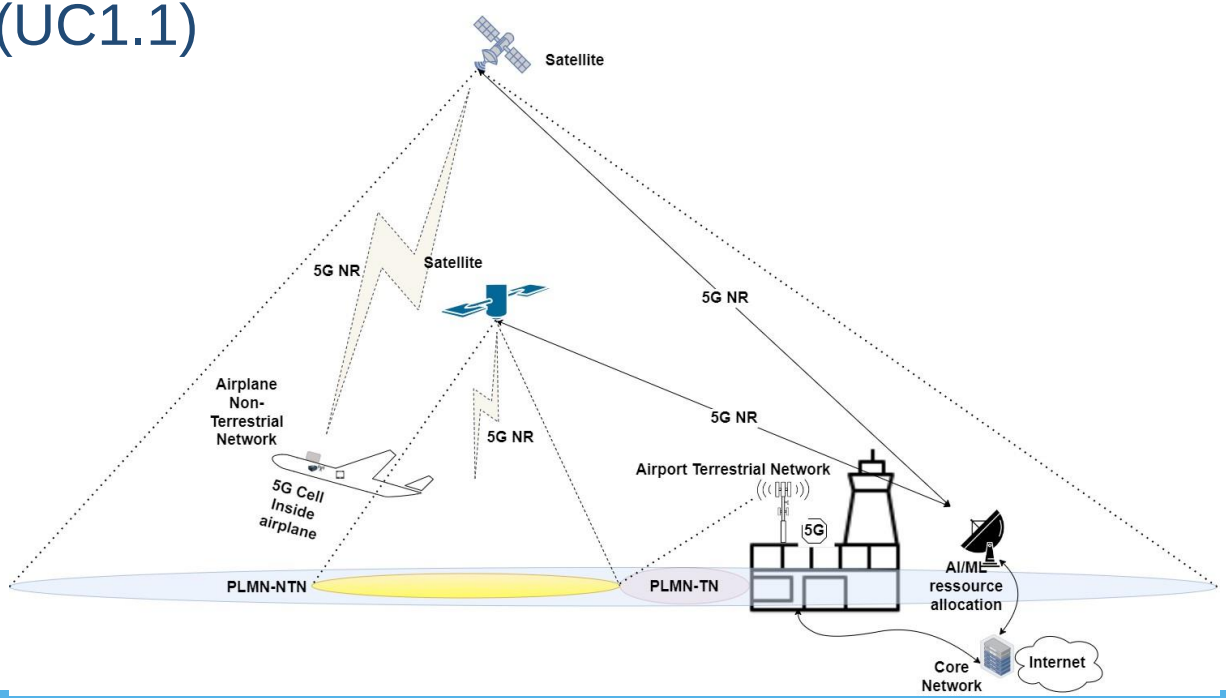
- *Regenerative payloads for GEO and NGSO systems*
- *Unified radio interface for cost-effective converged TN/NTN multi-tenant networks*
- *Softwarised self-organised network architecture*
- *E2E AI-Driven Network Design*

Reference Scenarios

Topics	Scenario	Description
DUAL CONNECTIVITY	Scenario 1.1	Airway GEO and NGSO complementing terrestrial coverage when airplane leave the airport. 5G broadband services for passengers with terrestrial and satellite, providing a homogeneous and transparent experience for users.
	Scenario 1.2	Direct Access/LEO (IAB), helping to fast deploy networks to accelerate terrestrial 5G rural deployments or temporal gap filler. FWA from LEO/GEO with dual connectivity and common O&M with terrestrial and satellite, providing a homogeneous and transparent experience for users and a common management for the MNOs.
Architecture and Service Distribution	Scenario 2.1	V2N communications to enhance 3 different services like Software over the air updates, HD maps updates and NG eCall service to provide rapid assist in serious accident; using TN and LEO satellites to extent V2N coverage for underserved areas.
	Scenario 2.2	PPDR communication in case TN infrastructure is damaged during a disaster event. NTN will provide temporarily coverage for first responders. Also, extended coverage in case of uncovered areas for first responder agencies is considered. Direct and backhauled access of LEO satellites.
	Scenario 2.3	Distributed 5G Systems for private networks. LEO onboarded with UPF, ensuring shorter global data paths, data retention and potentially with ultra-secure and ultra-reliable signalling centralized in satellite environment.

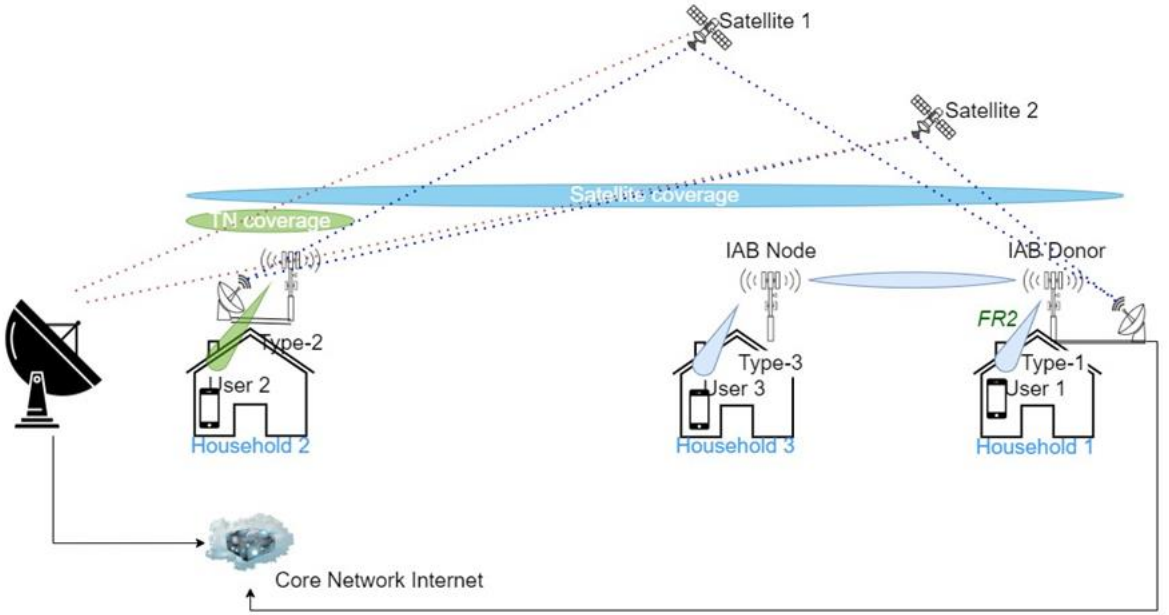
Dual Connectivity Scenarios

- Maritime, railway, airway neutral host-cell (UC1.1)



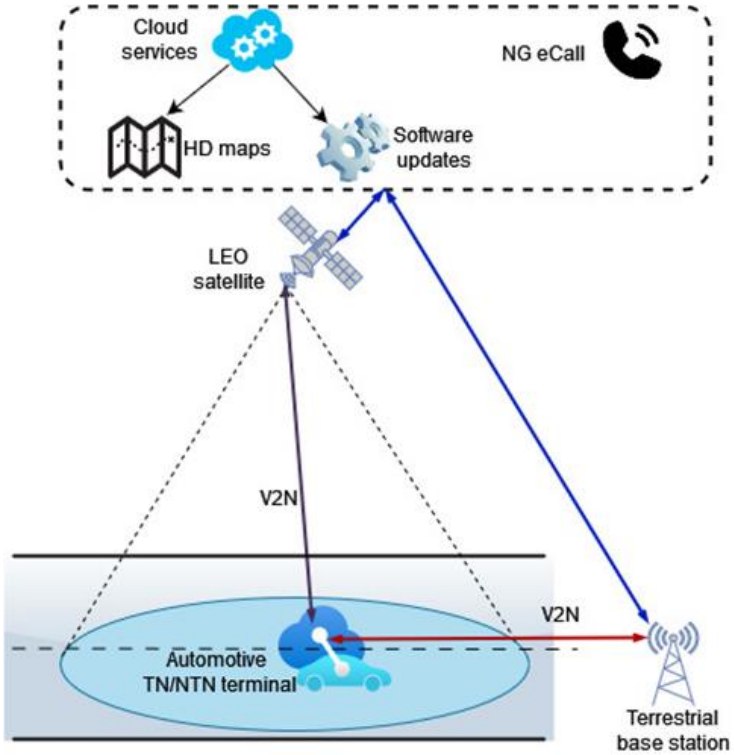
Dual Connectivity Scenarios

- Residential Broadband (UC1.2)



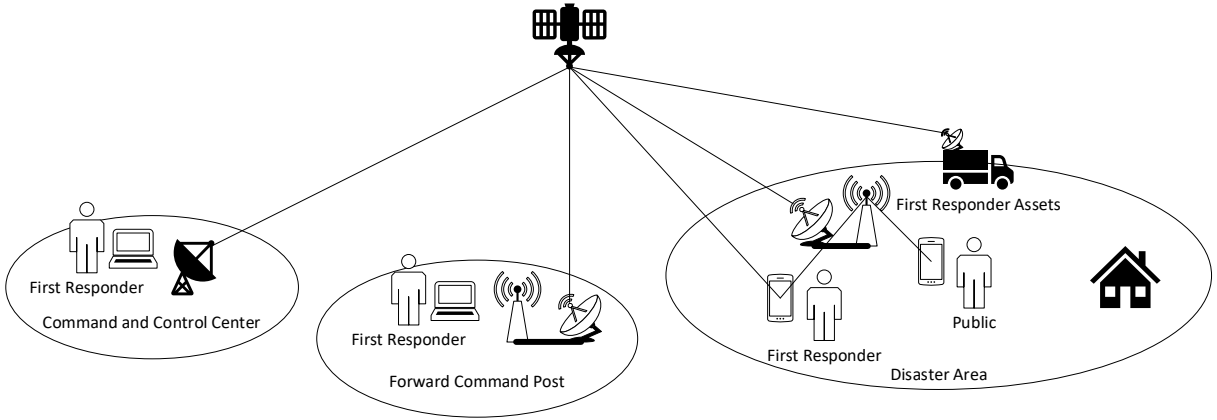
Architecture and Service Distribution Scenarios

- Vehicle connected (UC2.1)



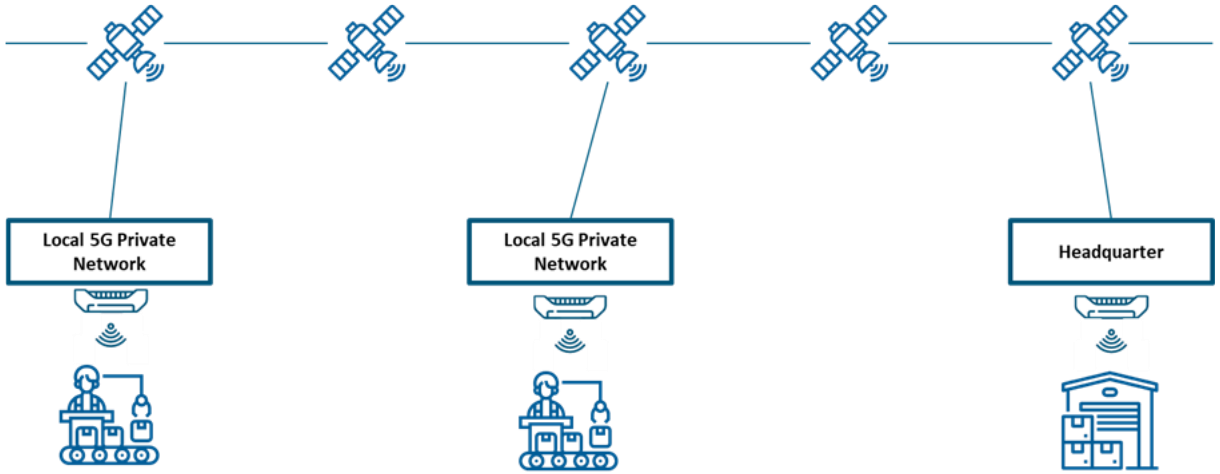
Architecture and Service Distribution Scenarios

- Broadband for Public Protection and Disaster Relief (PPDR) (UC2.2)



Architecture and Service Distribution Scenarios

- Global Private Networks (UC2.3)



NTN Architecture Option Analysis

Category	#	Payload	Connectivity *(D: direct; I: indirect)*	Served entity	ISL	Latency	Capacity	Adaptations to handset	Adaptations to VSATs	Payload complexity	Expected Release
Regenerative	1a	gNB	D	UE	Y						Rel. 19
	1b	gNB-DU	D	UE	Y						Rel. 19
IAB	2a	T	I	IAB-node	N						Rel. 19-20
	2b	T	I	IAB-Donor	N						Rel. 19-20
	2c	IAB-Donor	I	IAB-node	Y						Rel. 19-20
	2d	IAB-Donor DU	I	IAB-node	Y						Rel. 19-20
MC	3a (NTN-TN)	gNB	D	UE	Y						Rel. 19
	3b (NTN-NTN)	gNB	D	UE	Y						Rel. 19
	3c (NTN-NT)	gNB-DU	D	UE	Y						Rel. 19
	3d (NTN-NTN)	gNB-DU	D	UE	Y						Rel. 19
	3e (NTN-TN)	T	D	UE	N						Rel. 18
	3f (NTN-NTN)	**T**	**D**	**UE**	**N**						**Rel. 18**

NTN Architectures vs Use-Cases

Category	#	Payload	Connectivity	UC1.1c	UC1.2a	UC1.2b	UC1.2c	UC2.1	UC2.2	UC2.3
Regenerative	1a	gNB	D							
	1b	gNB-DU	D							
IAB	2a	T	I							
	2b	T	I							
	2c	IAB-Donor	I							
	2d	IAB-Donor DU	I							
MC	3a (NTN-TN)	gNB	D							
	3b (NTN-NTN)	gNB	D							
	3c (NTN-NT)	gNB-DU	D							
	3d (NTN-NTN)	gNB-DU	D							
	3e (NTN-TN)	T	D							
	3f (NTN-NTN)	**T**	**D**							

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THANKS FOR YOUR ATTENTION

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Co-funded by the European Union

6G SNS

5G-STARDUST project has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101096573.