



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

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Tommaso de Cola

German Aerospace Center (DLR)



Co-funded by
the European Union

6G SNS

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*

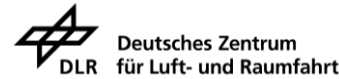
Technical Manager: *Mathieu Arnaud, Thales Alenia Space (F)*

 **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.

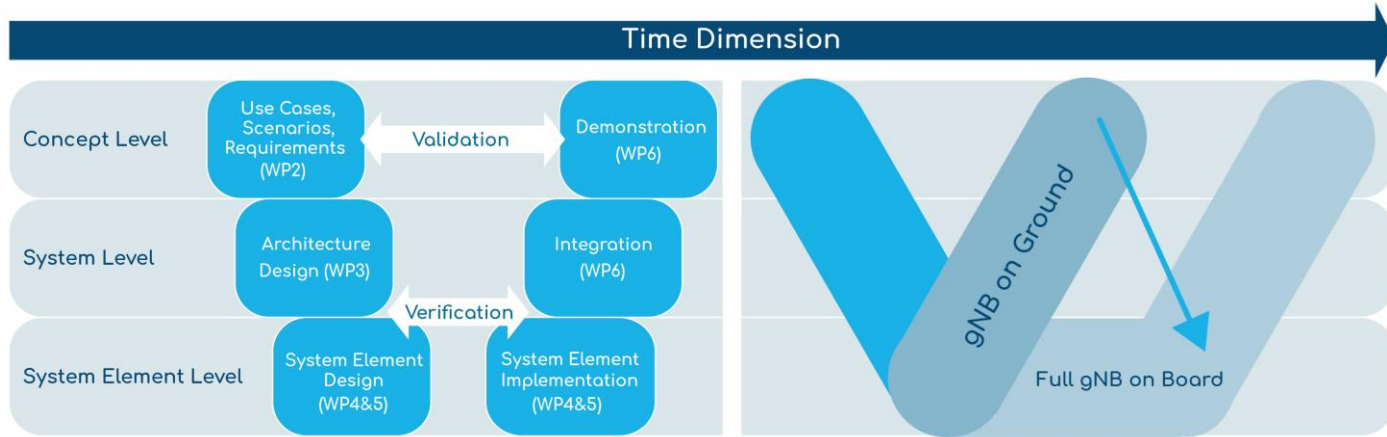
Project Objectives



- 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.

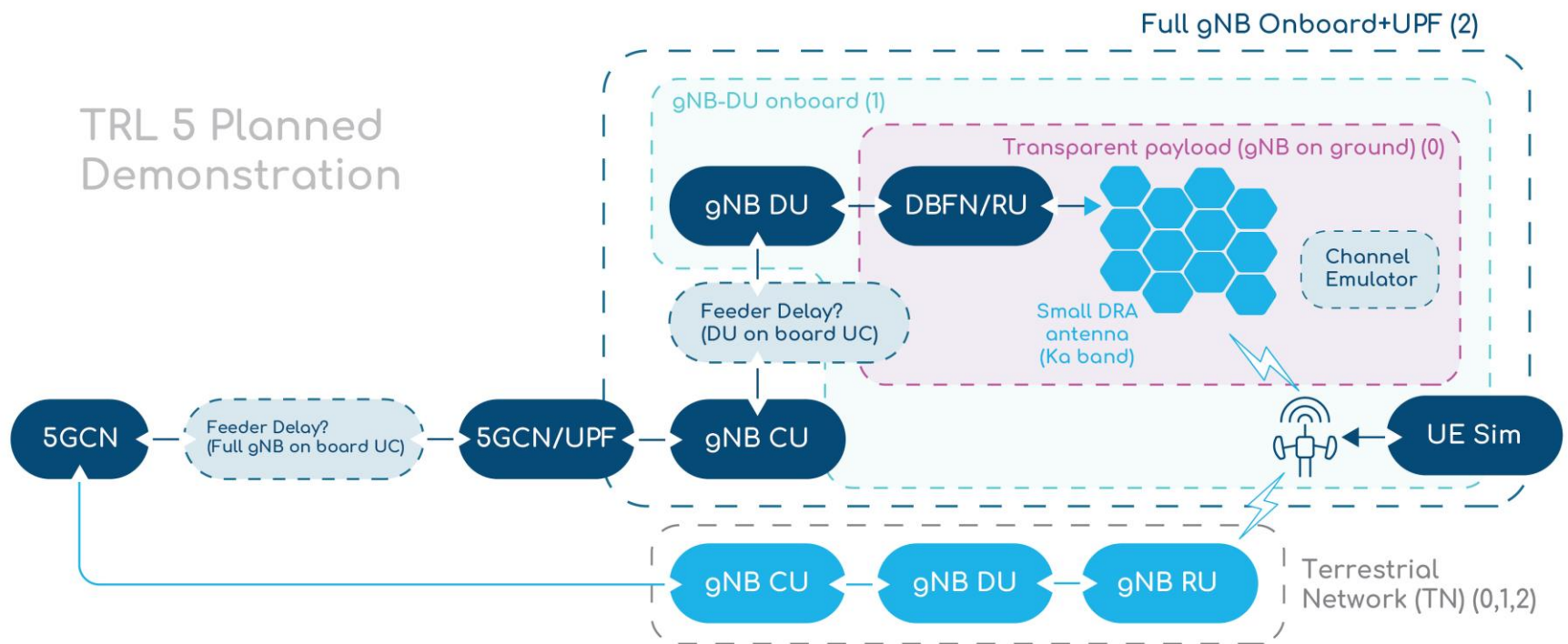
Project Methodology

- 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

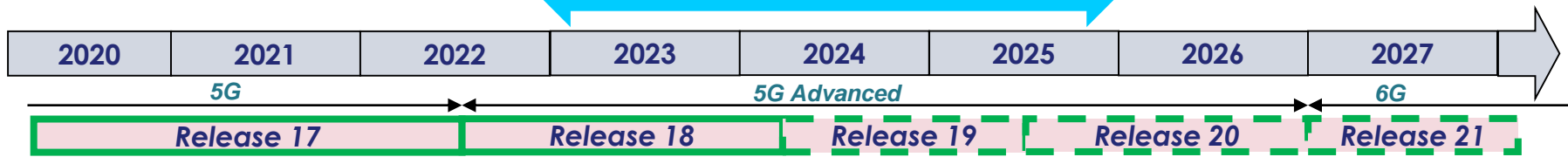


TRL 5 Planned Demonstration

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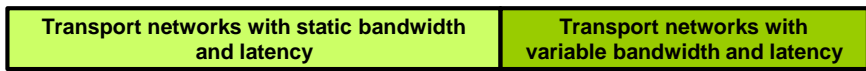


Timeline

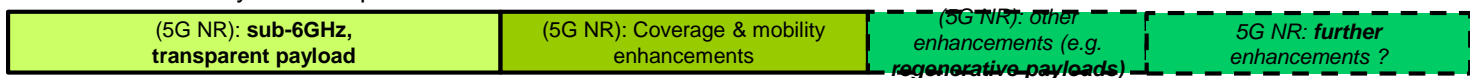


Satellite backhaul

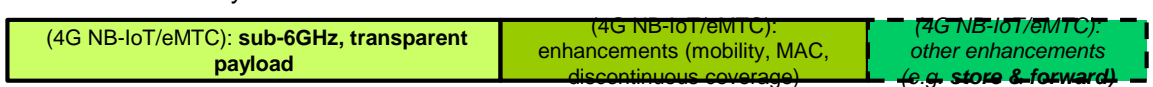
Assuming 18 months releases



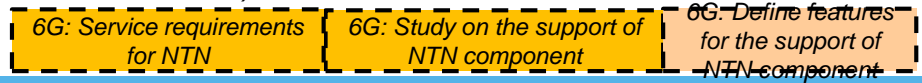
Satellite connectivity to smart phones



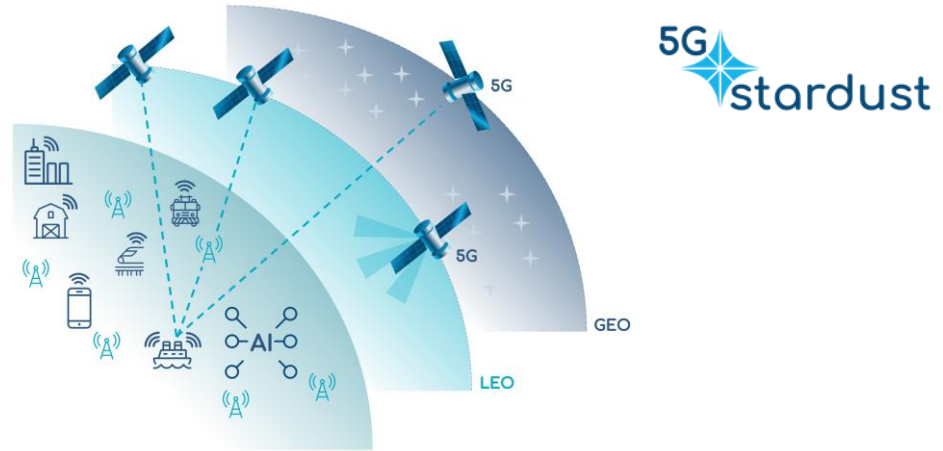
Satellite connectivity to IoT devices



Satellite connectivity to "VSAT"



KEY TECHNOLOGIES



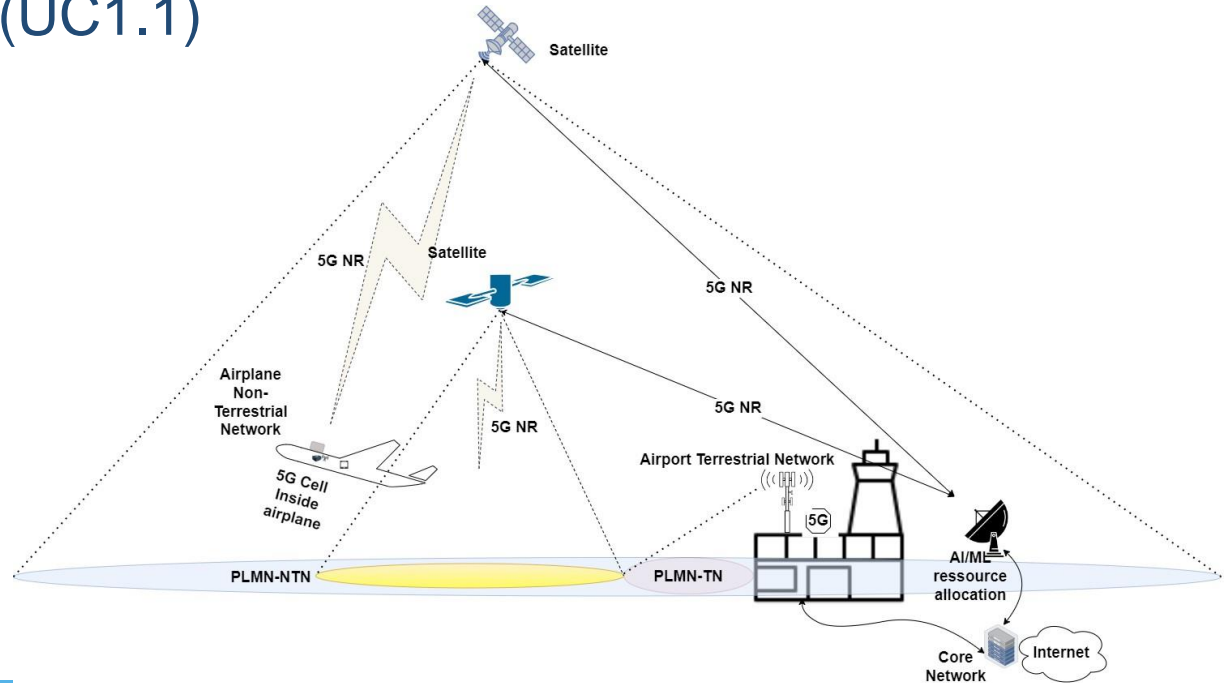
- *Regenerative payloads for GEO and NGSO systems*
- *Unified radio interface for cost-effective converged TN/NTN multi-tenant networks*
- *Softwarised self-organised network architecture*
- *E2E AI-Driven Network Design*

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.

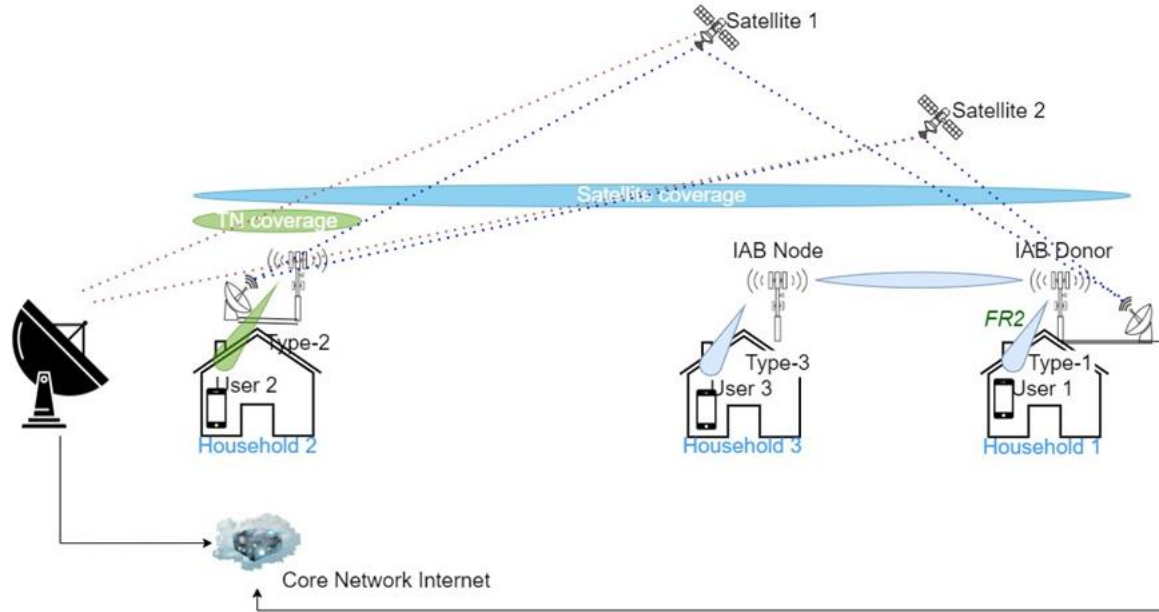
Dual Connectivity Scenarios

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



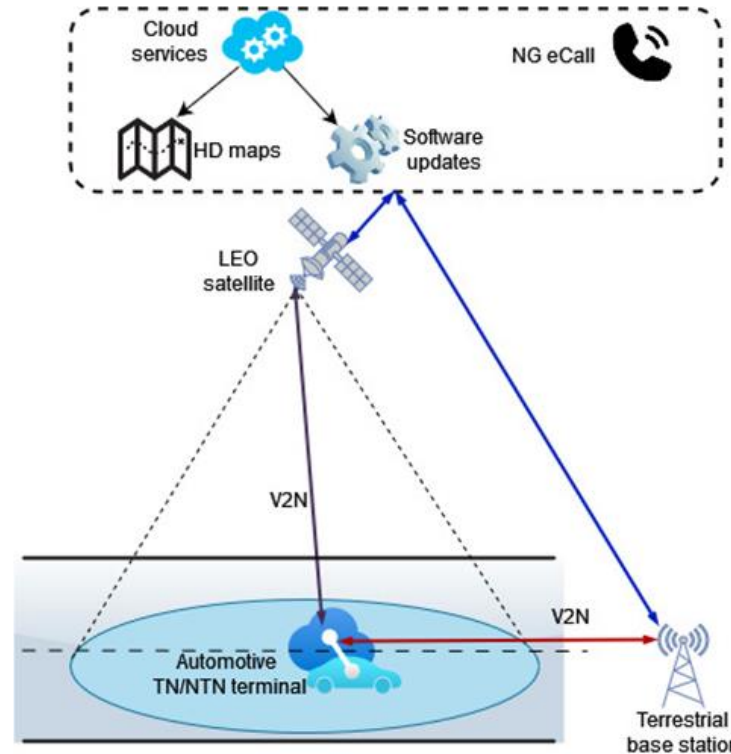
Dual Connectivity Scenarios

- Residential Broadband (UC1.2)



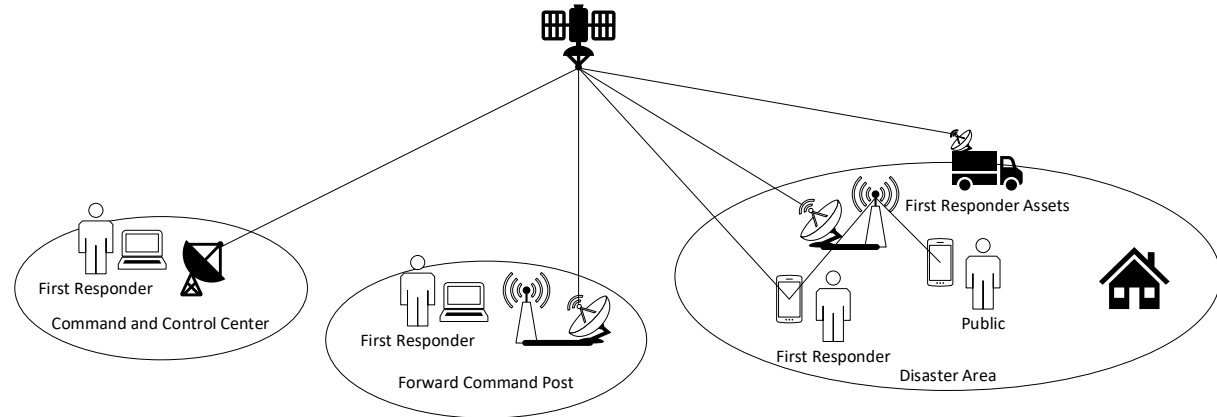
Architecture and Service Distribution Scenarios

- Vehicle connected (UC2.1)



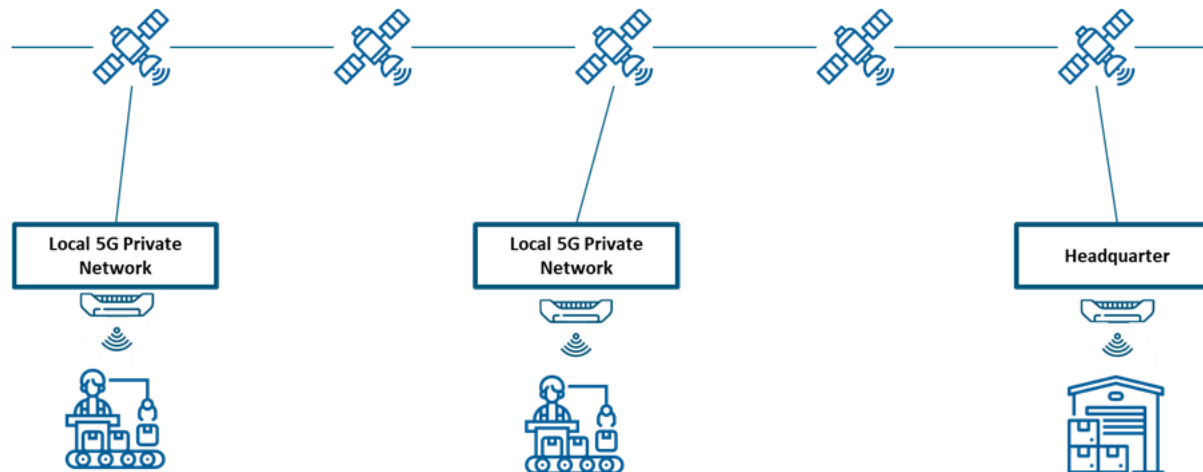
Architecture and Service Distribution Scenarios

- 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	Green	Yellow	Red	Green	Red	Rel. 19
	1b	gNB-DU	D	UE	Y	Yellow	Yellow	Red	Green	Yellow	Rel. 19
IAB	2a	T	I	IAB-node	N	Red	Red	Green	Green	Green	Rel. 19-20
	2b	T	I	IAB-Donor	N	Red	Red	Green	Green	Green	Rel. 19-20
	2c	IAB-Donor	I	IAB-node	Y	Green	Yellow	Green	Green	Yellow	Rel. 19-20
	2d	IAB-Donor DU	I	IAB-node	Y	Yellow	Yellow	Green	Green	Yellow	Rel. 19-20
MC	3a (NTN-TN)	gNB	D	UE	Y	Green	Green	Red	Yellow	Red	Rel. 19
	3b (NTN-NTN)	gNB	D	UE	Y	Green	Green	Red	Yellow	Red	Rel. 19
	3c (NTN-NT)	gNB-DU	D	UE	Y	Yellow	Green	Red	Yellow	Yellow	Rel. 19
	3d (NTN-NTN)	gNB-DU	D	UE	Y	Yellow	Green	Red	Yellow	Yellow	Rel. 19
	3e (NTN-TN)	T	D	UE	N	Red	Green	Red	Yellow	Green	Rel. 18
	3f (NTN-NTN)	T	D	UE	N	Red	Green	Red	Yellow	Green	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	Yellow	Green	Red	Green	Green	Green	Green
	1b	gNB-DU	D	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Yellow
IAB	2a	T	I	Red	Red	Red	Red	Red	Red	Red
	2b	T	I	Red	Red	Red	Red	Red	Red	Red
	2c	IAB-Donor	I	Green	Green	Green	Green	Red	Green	Green
	2d	IAB-Donor DU	I	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow
MC	3a (NTN-TN)	gNB	D	Red	Red	Red	Yellow	Red	Red	Yellow
	3b (NTN-NTN)	gNB	D	Green	Green	Yellow	Green	Yellow	Green	Green
	3c (NTN-NT)	gNB-DU	D	Red	Red	Red	Yellow	Red	Red	Yellow
	3d (NTN-NTN)	gNB-DU	D	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Yellow
	3e (NTN-TN)	T	D	Red	Red	Red	Red	Red	Red	Red
	3f (NTN-NTN)	T	D	Red	Red	Red	Red	Red	Red	Red



**THANKS
FOR YOUR
ATTENTION**

GET IN TOUCH



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the European Union



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