1MW1 – Technology Management

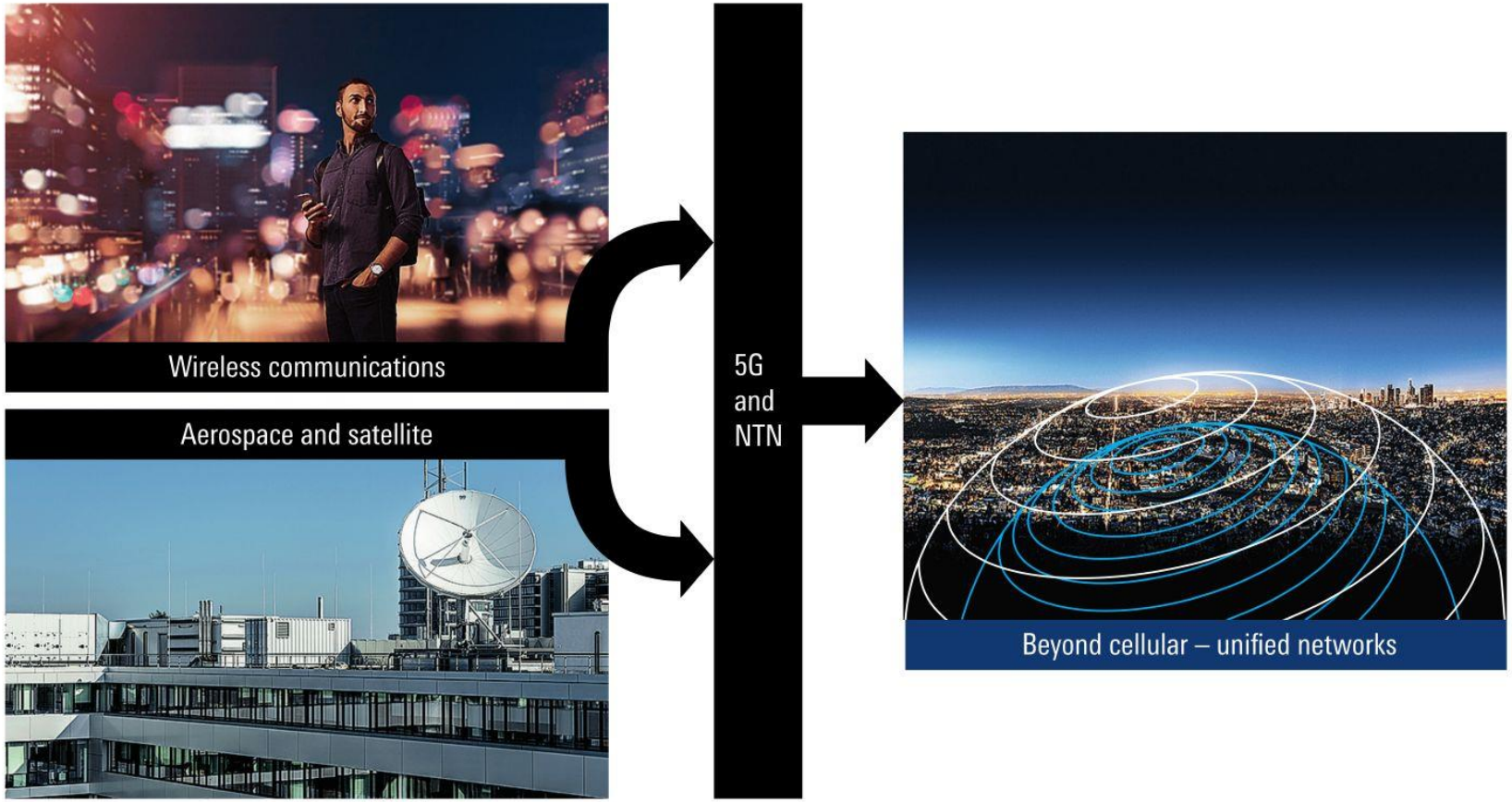
5G NTN TAKES FLIGHT: 5G NON-TERRESTRIAL NETWORKS EVOLVING TOWARDS 6G

Reiner Stuhlfauth, Technology Manager Wireless

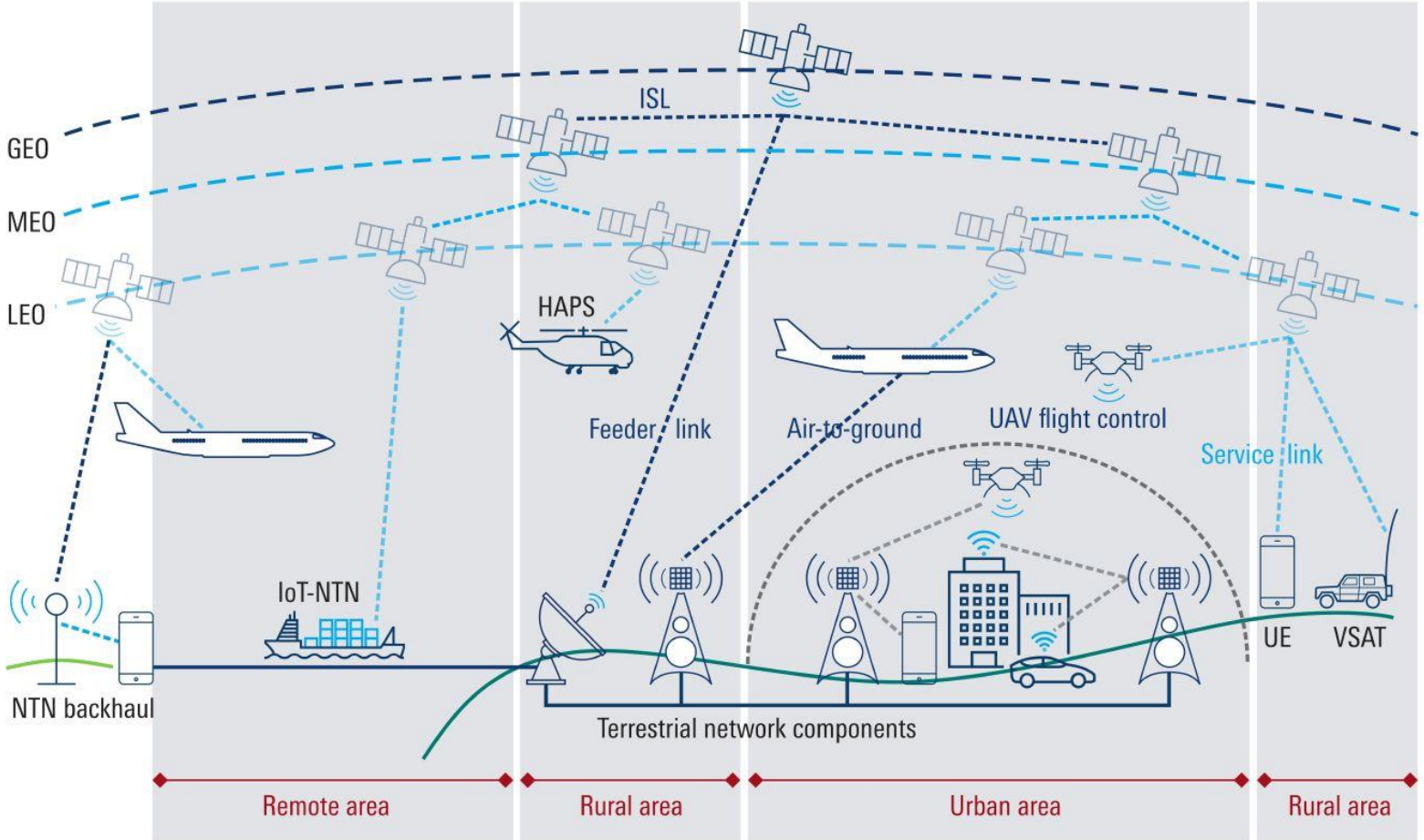
ROHDE&SCHWARZ

Make ideas real

CONVERGENCE BETWEEN AEROSPACE AND WIRELESS ECOSYSTEMS



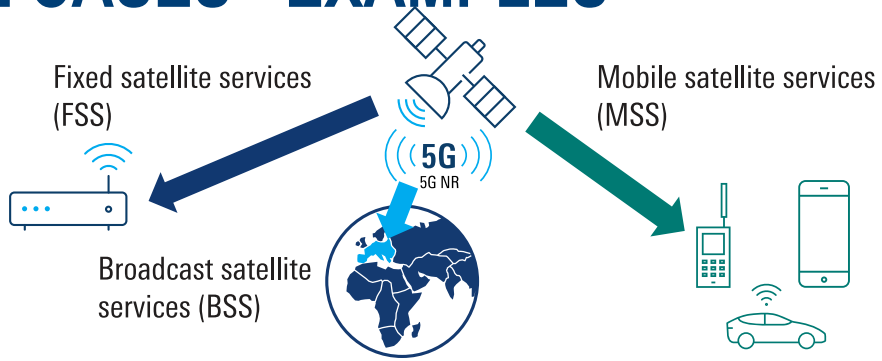
5G NTN – HOLISTIC VIEW



Non-terrestrial networks (NTN)

5G NTN USE CASES AND SOME CHALLENGES

5G NTN USE CASES - EXAMPLES

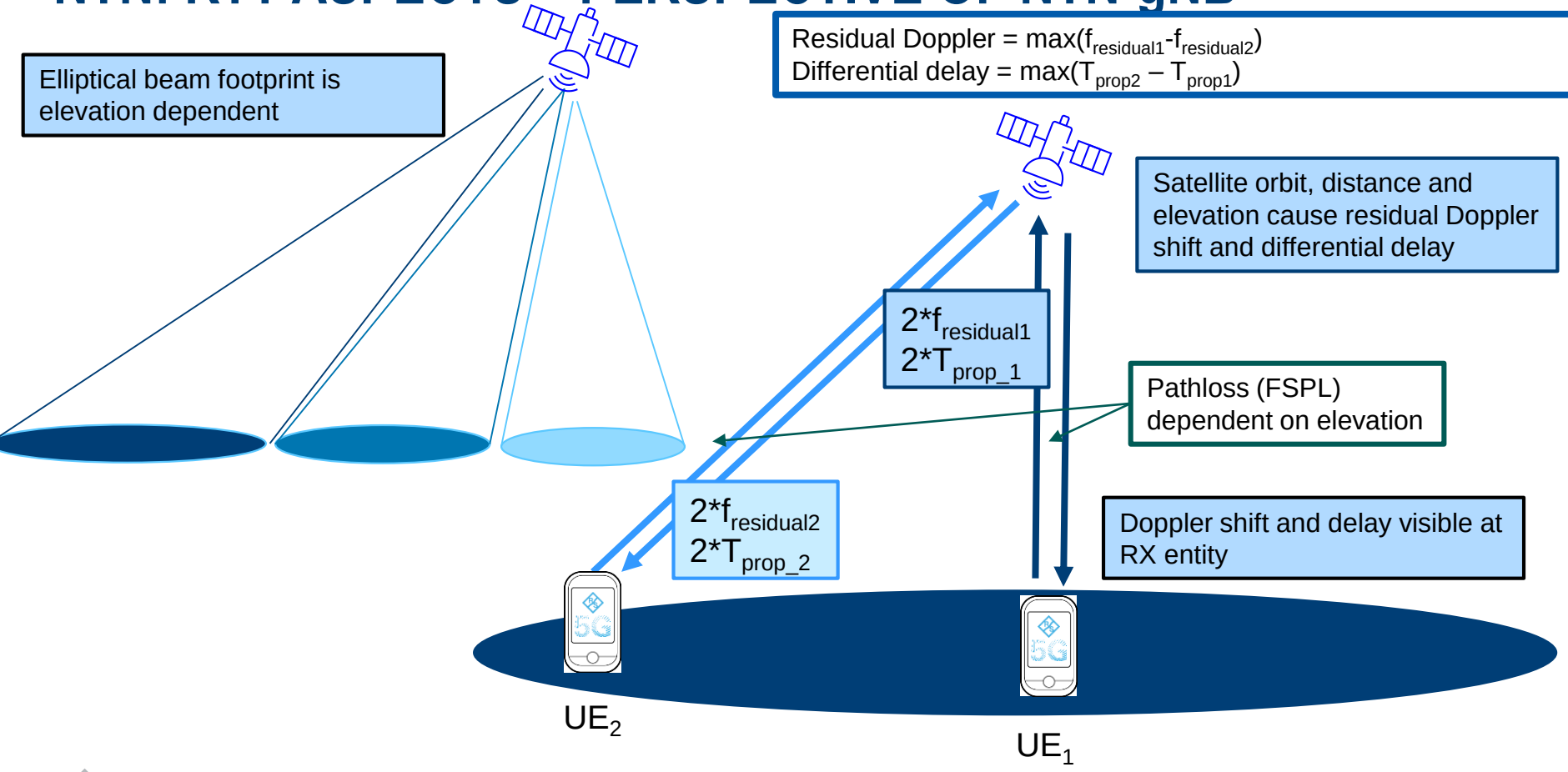


3GPP use case categories:

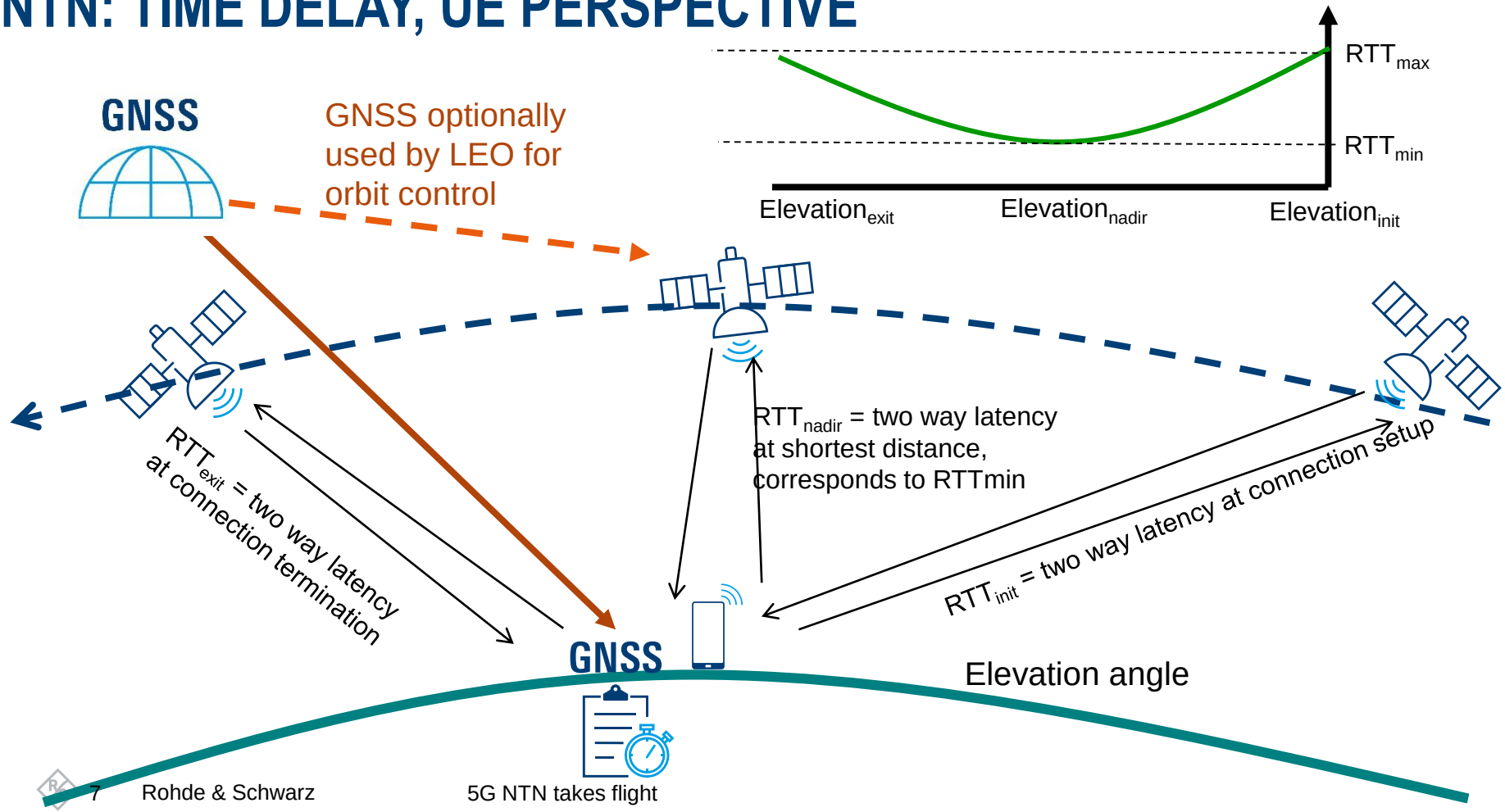
- Service continuity
- Service ubiquity
- Service scalability

Urban	Rural	Remote	Isolated
Overlay and traffic offload, hotspot on demand, network resilience and emergency, fixed wireless access	Network resilience and emergency, fixed wireless access, wide area connectivity, public protection and desaster relief (PPDR)	Network resilience, backhaul, PPDR and emergency, wide area connectivity	Aeronautical, maritime, remote hotspots, PPDR and emergency

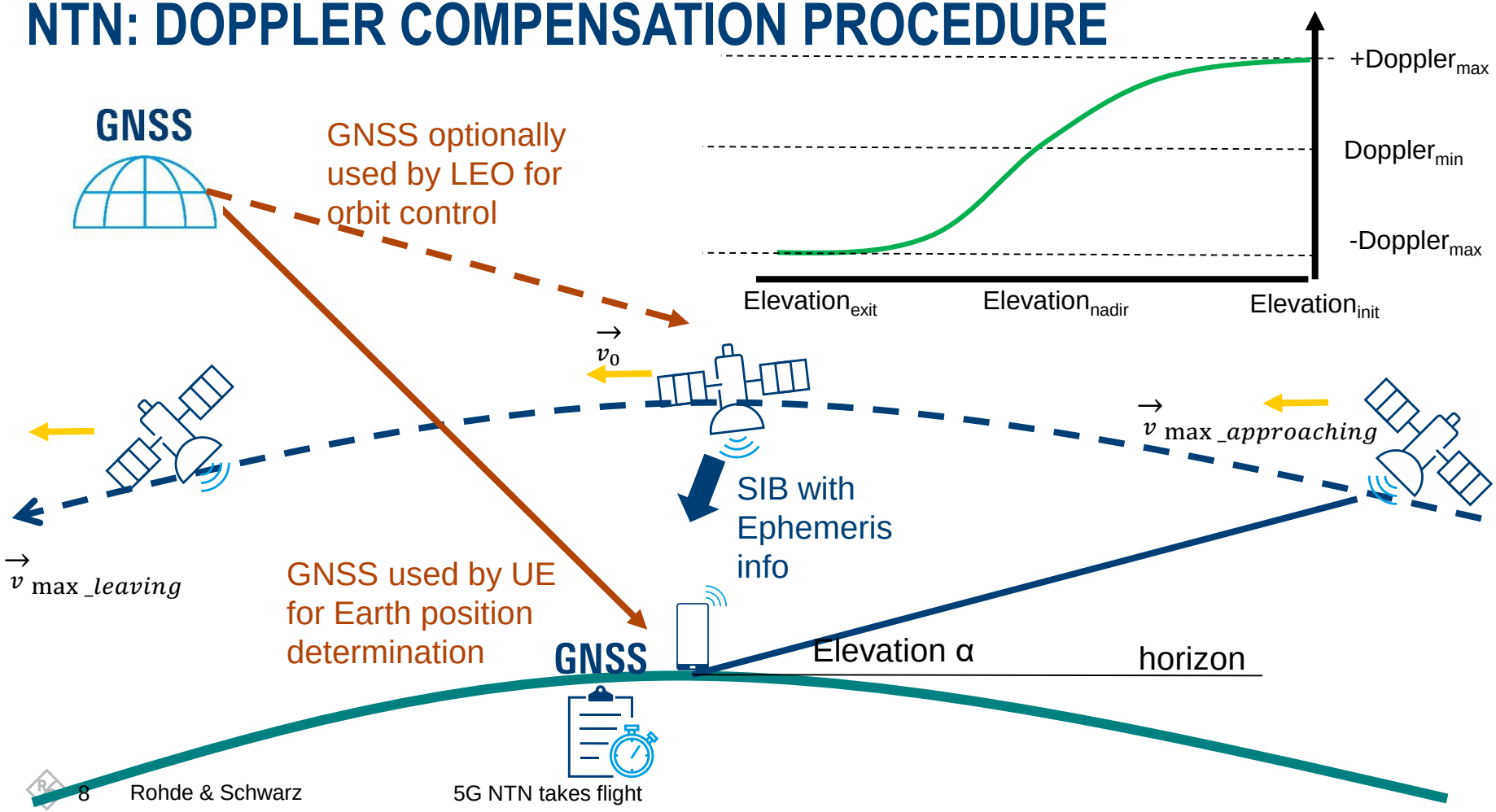
NTN: RTT ASPECTS – PERSPECTIVE OF NTN-gNB



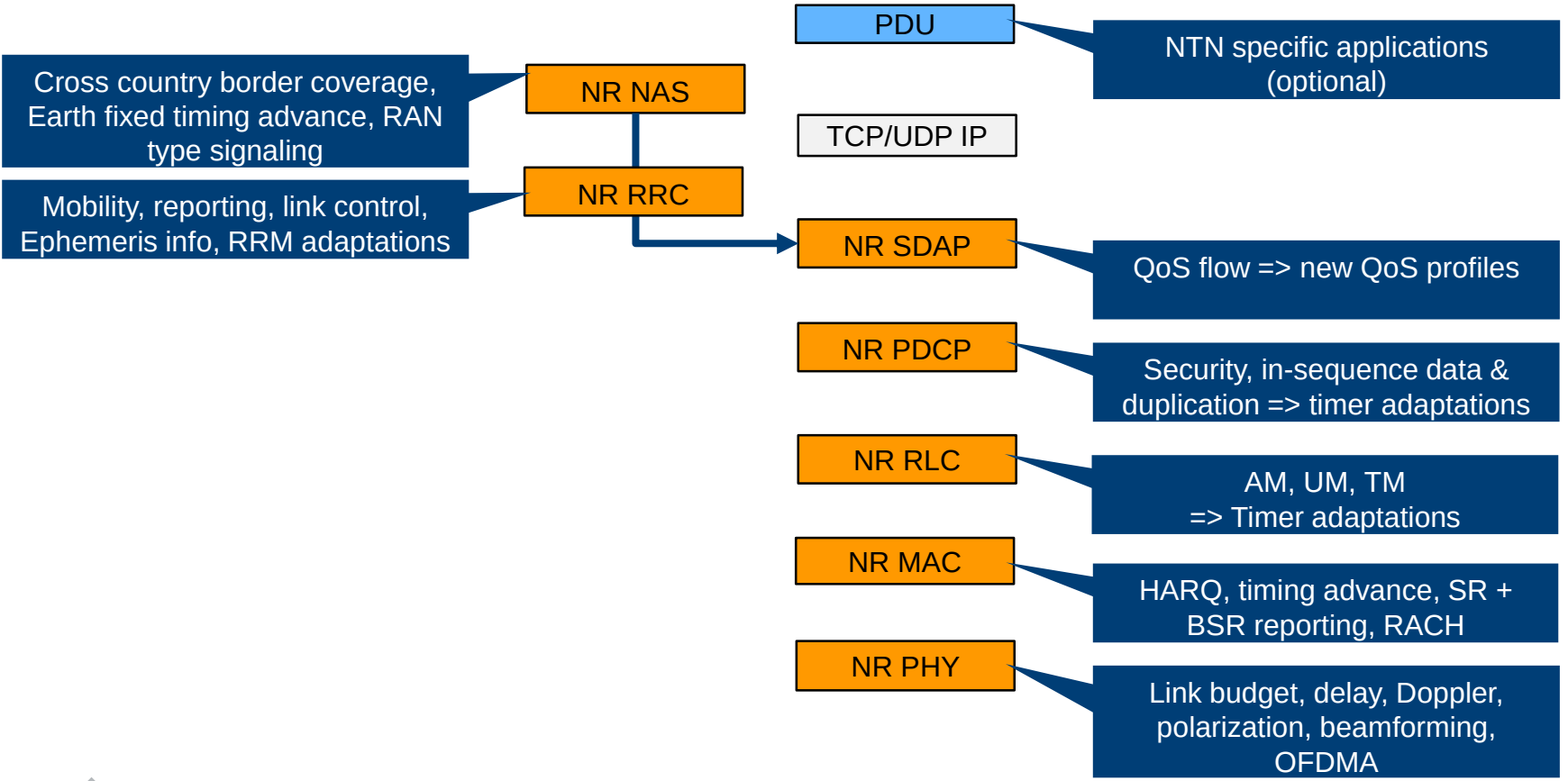
NTN: TIME DELAY, UE PERSPECTIVE



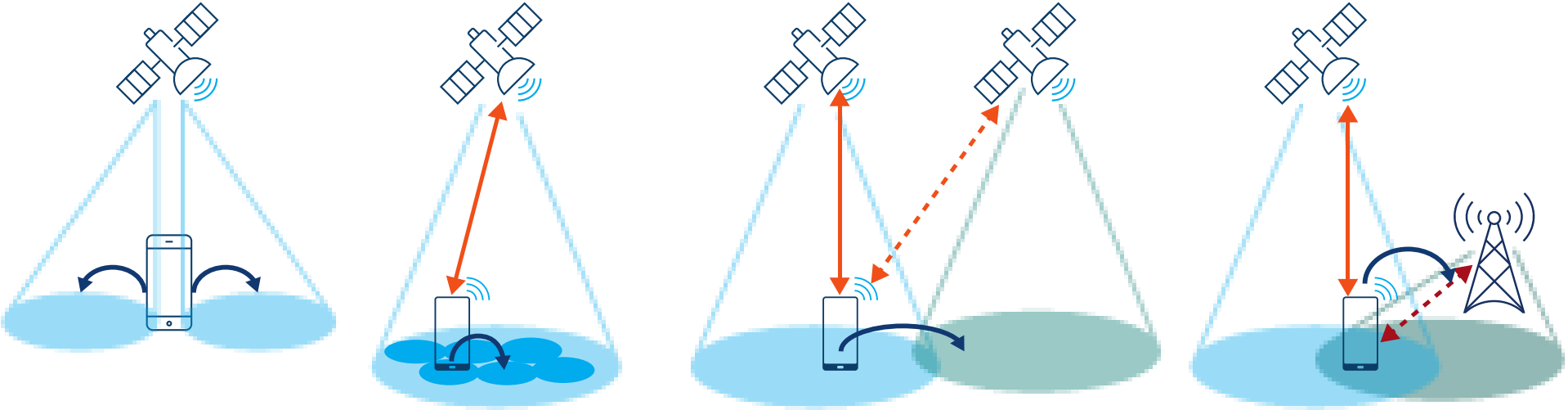
NTN: DOPPLER COMPENSATION PROCEDURE



5G-NTN: PROTOCOL STACK



5G NTN USE CASES - EXAMPLES



Cell selection/
cell reselection

Intra-satellite/
inter-beam handover

Inter-satellite handover/
inter-satellite dual connectivity (DC)

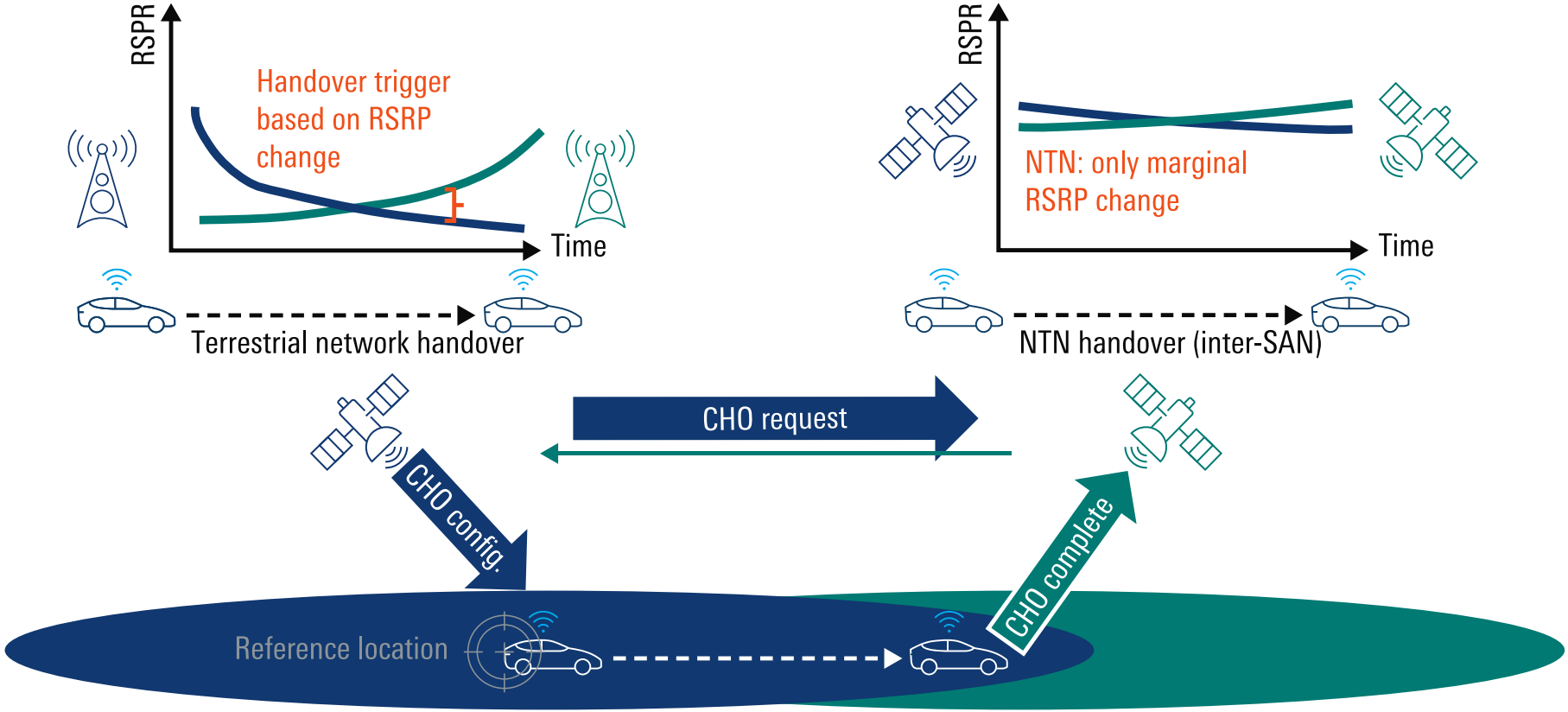
NTN – terrestrial
handover/DC

NR-NTN connection

Target or simultaneous dual connectivity NR-NTN connection

Target or simultaneous dual connectivity terrestrial connection

5G NTN USE CASES - EXAMPLES

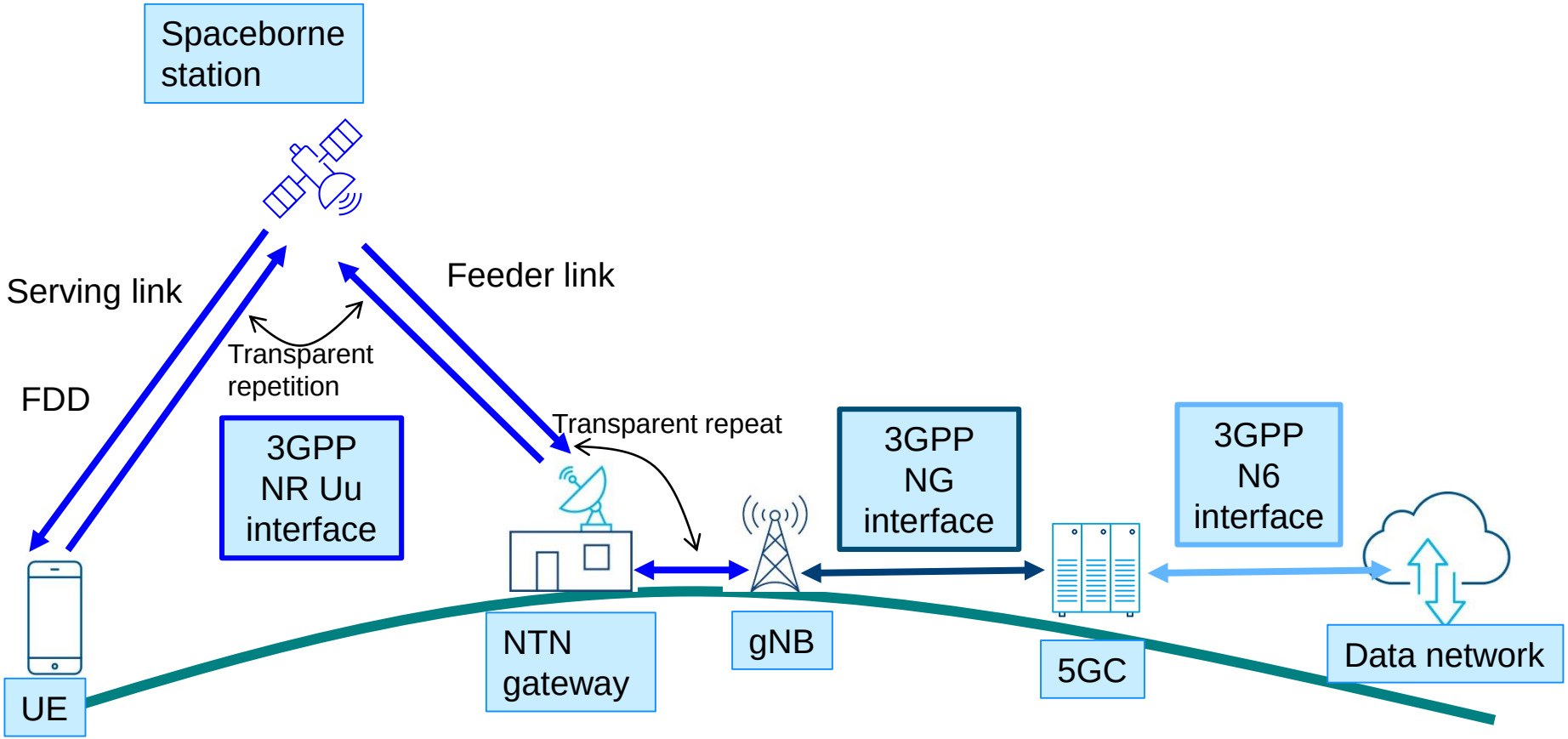


Conditional handover (CHO): network configures UE with triggering condition; e.g. distance between UE and reference location

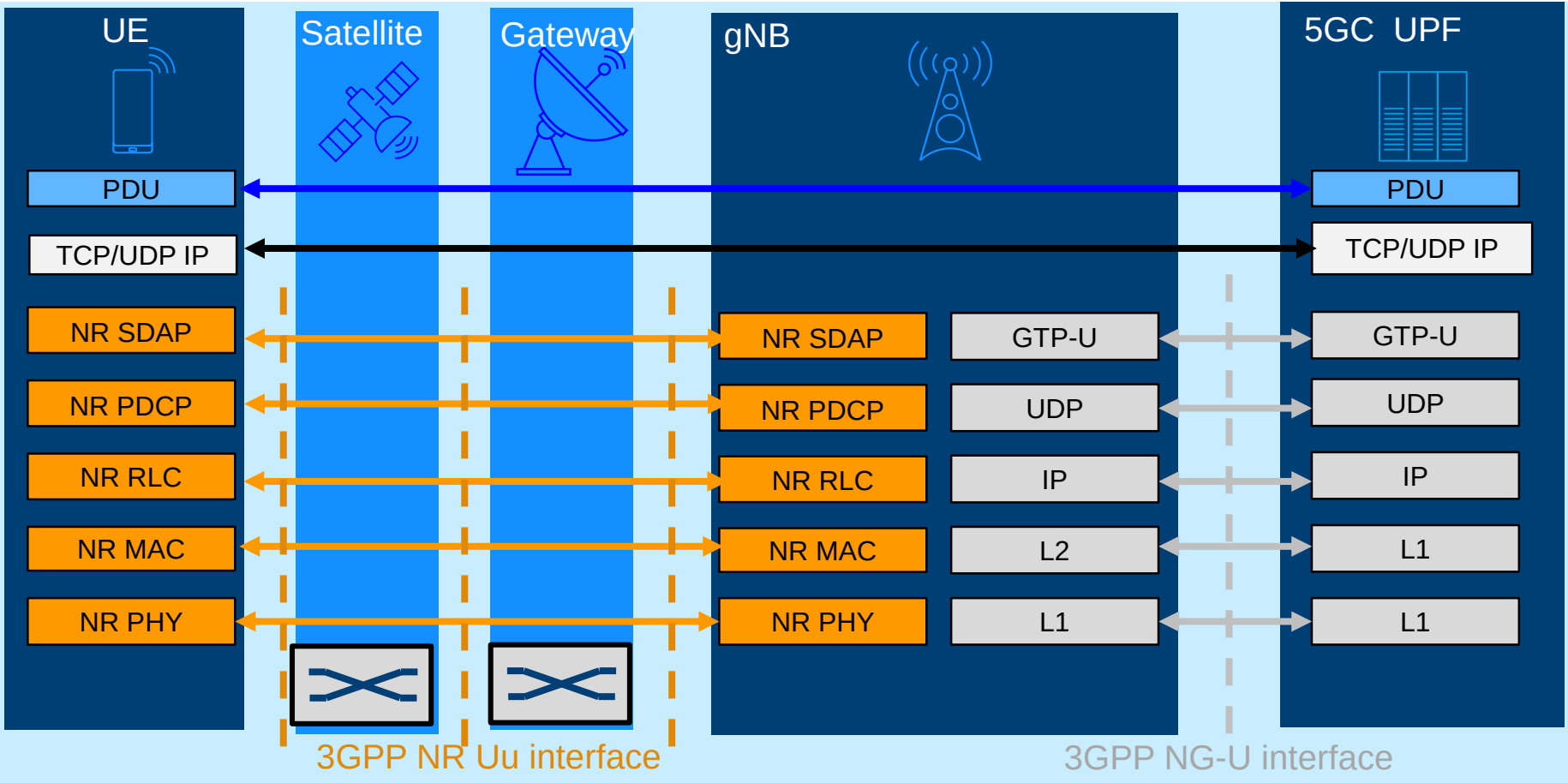
Non-terrestrial networks (NTN)

ARCHITECTURE

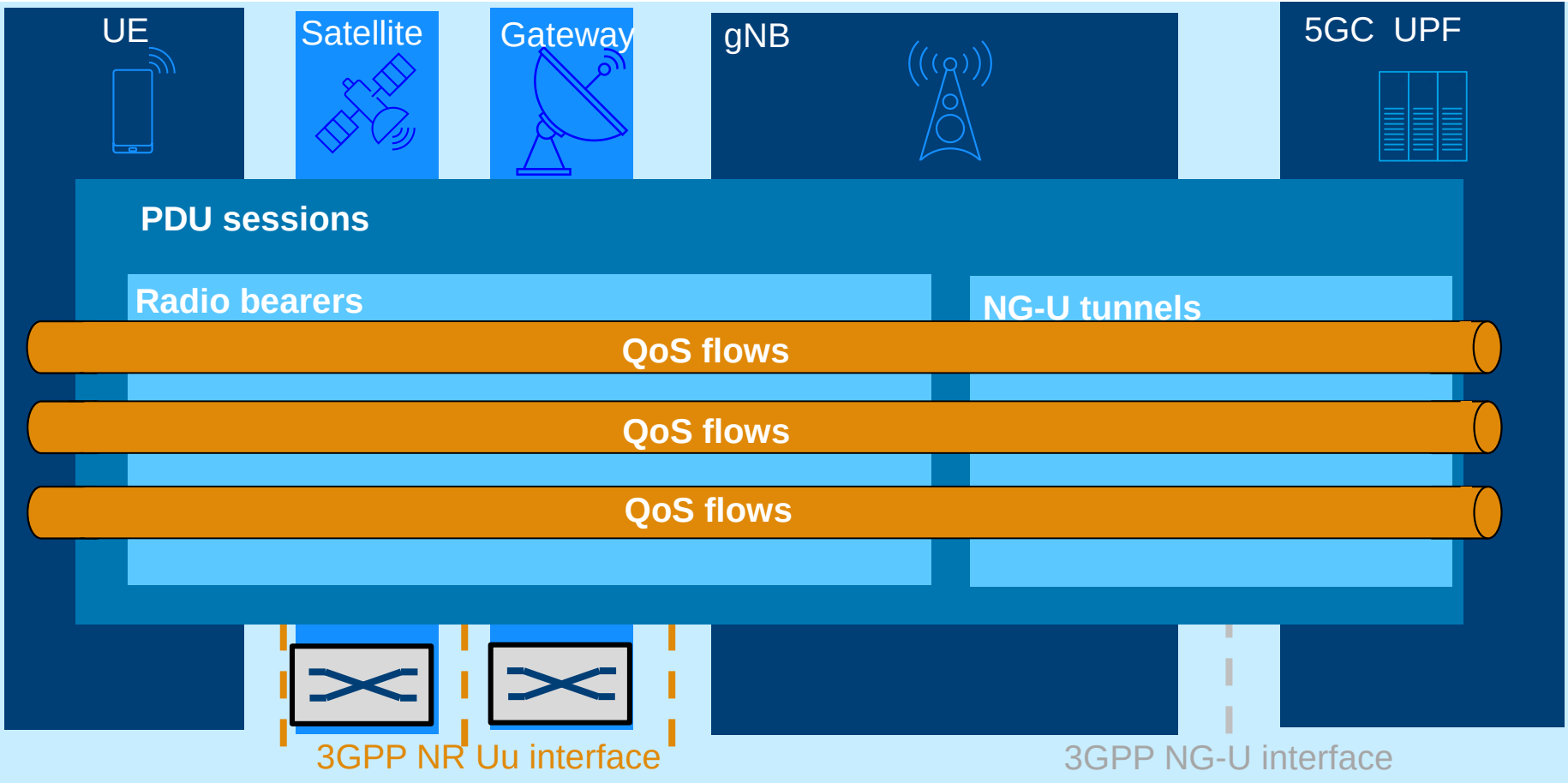
NTN: TRANSPARENT PAYLOAD ARCHITECTURE



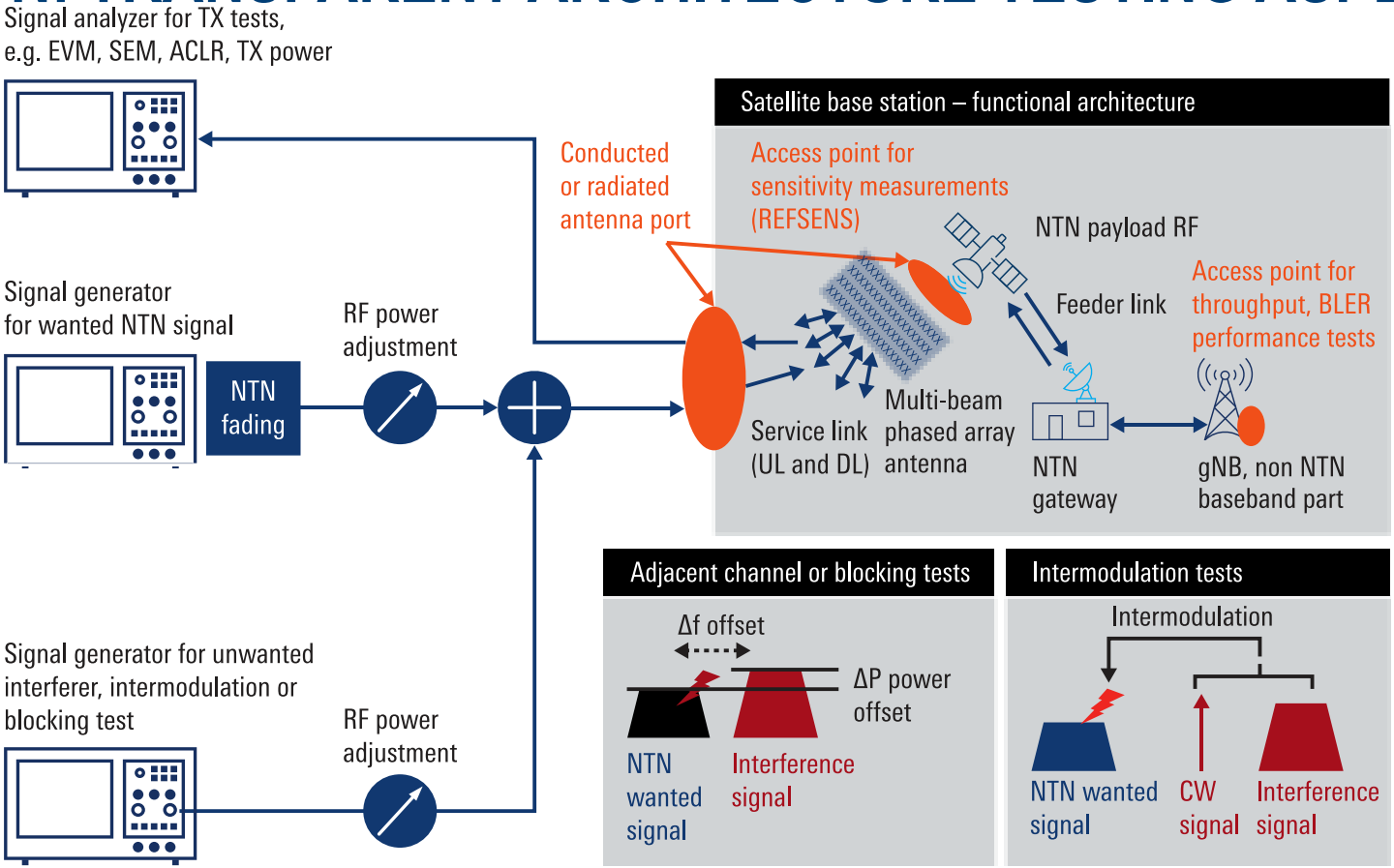
NTN: TRANSPARENT PAYLOAD - PROTOCOL STACK, U-PLANE



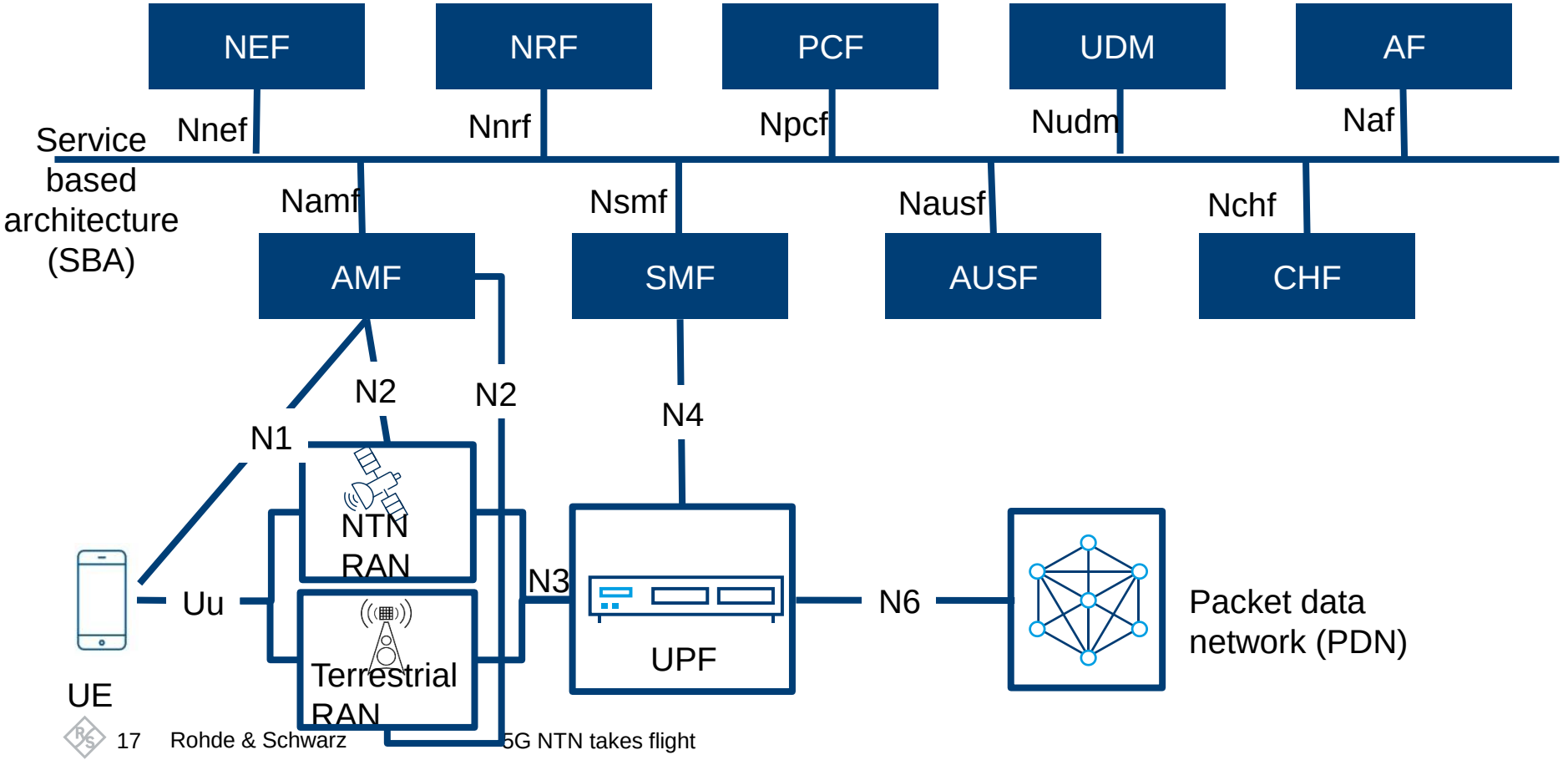
NTN: TRANSPARENT PAYLOAD - BEARER & QoS FLOWS



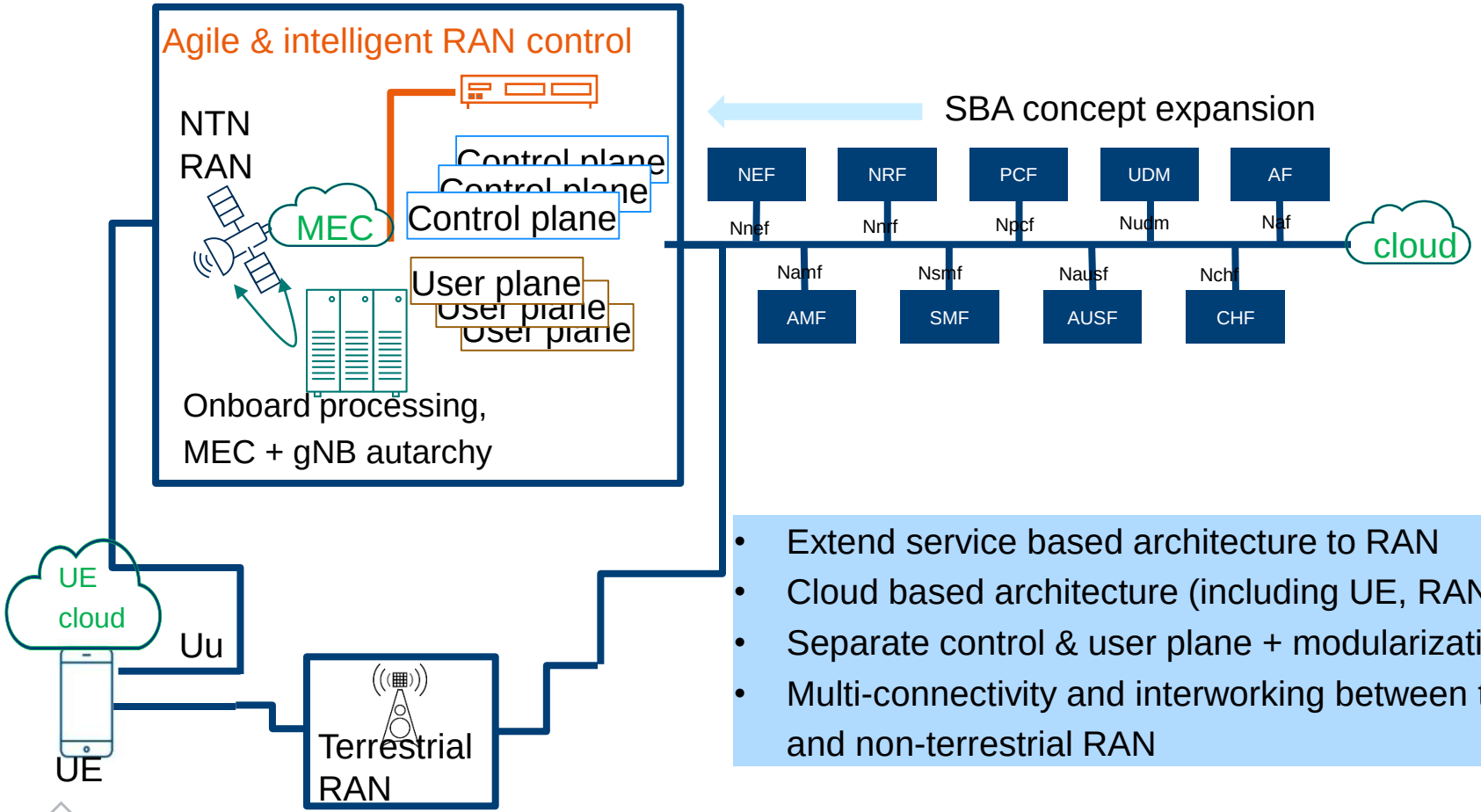
NTN: TRANSPARENT ARCHITECTURE TESTING ASPECTS



5G SYSTEM ARCHITECTURE SUPPORTING NTN

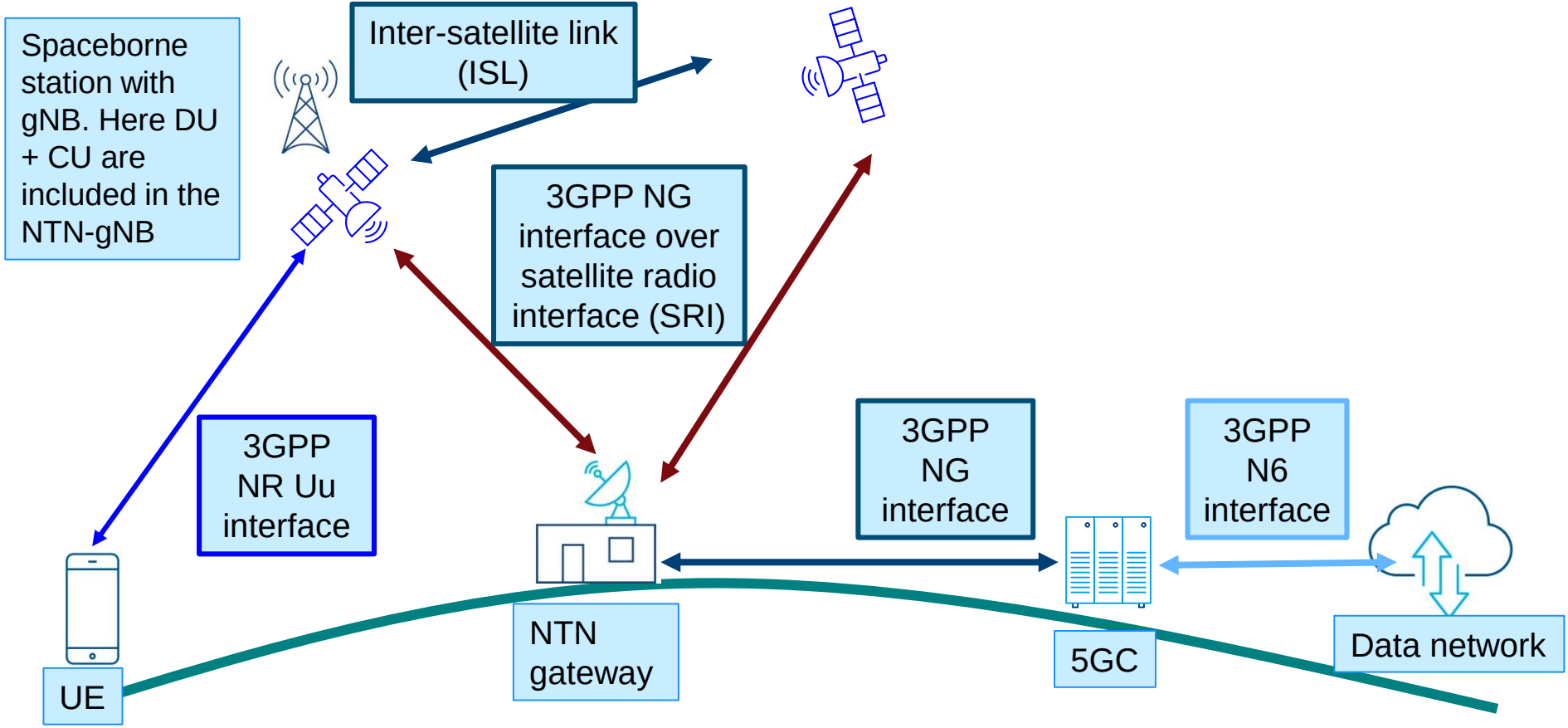


5G NTN ARCHITECTURE TOWARDS 6G

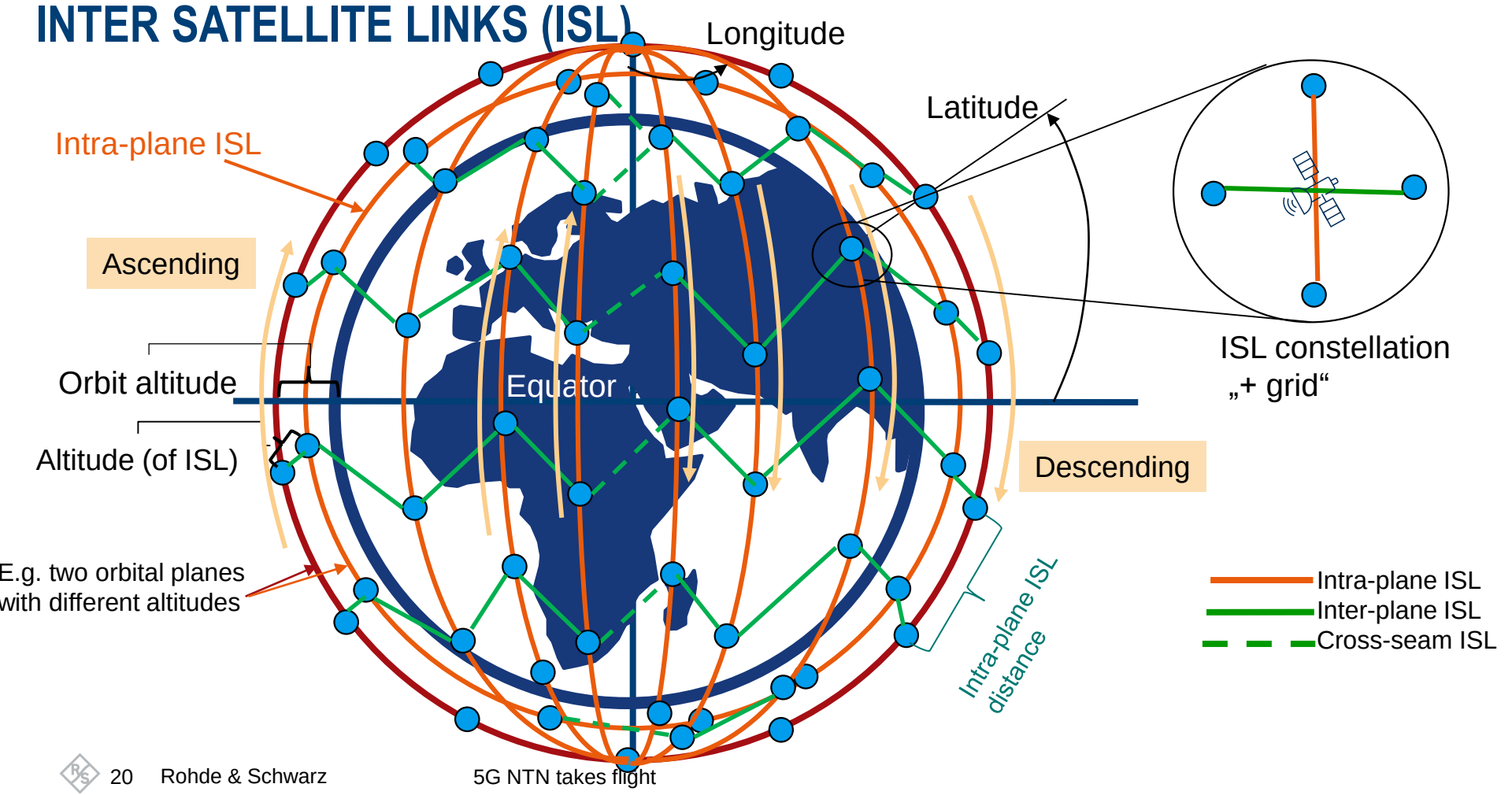


- Extend service based architecture to RAN
- Cloud based architecture (including UE, RAN, core, …)
- Separate control & user plane + modularization
- Multi-connectivity and interworking between terrestrial and non-terrestrial RAN

NTN: REGENERATIVE PAYLOAD ARCHITECTURE



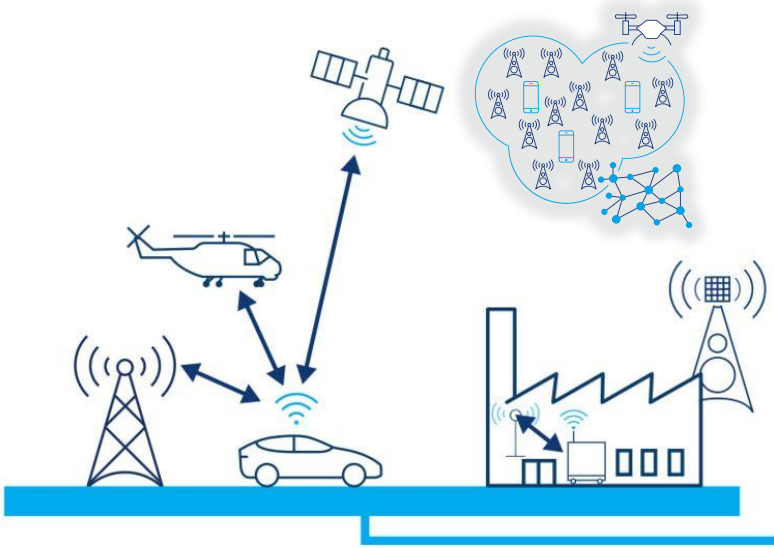
INTER SATELLITE LINKS (ISL)



Non-terrestrial networks (NTN)

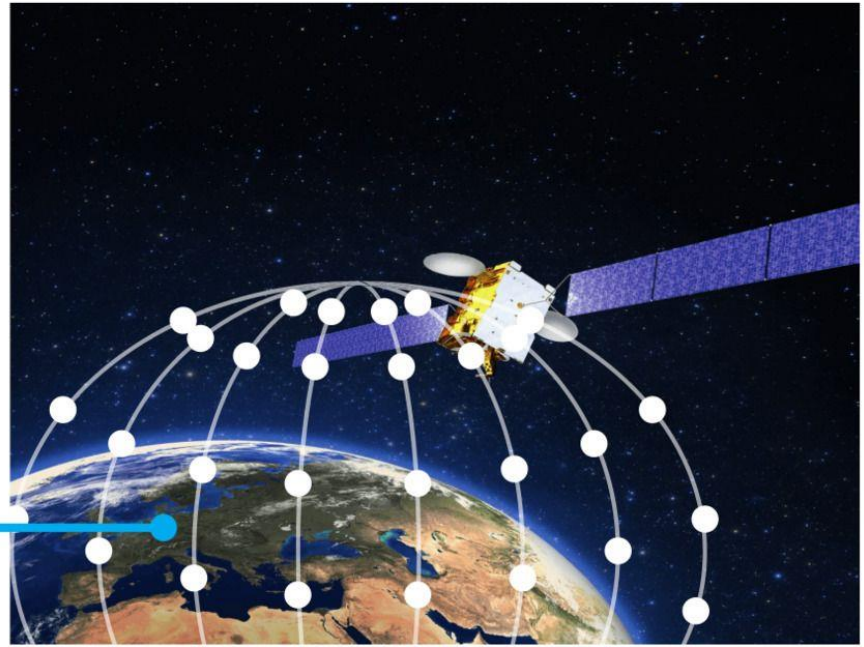
OUTLOOK

5G NTN – ON THE PATH TO 6G



Beyond cellular – 3D unified networks

- Dynamic, self-configuring
- Resilient and intelligent
- Autonomous and infrastructure agnostic

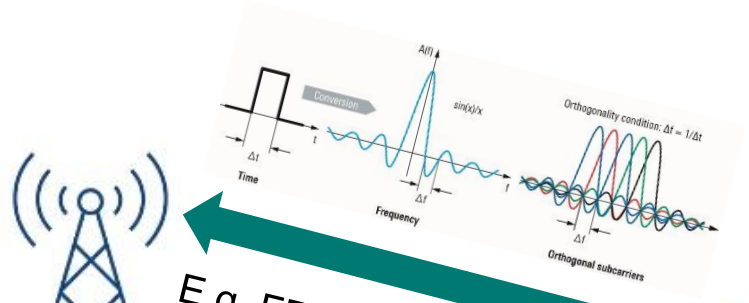


5G NTN – OUTLOOK: 6G

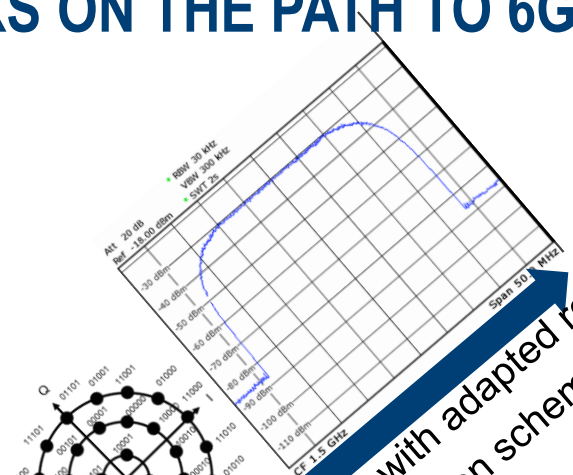
- Beyond cellular: network nodes are dynamic: birth-death scenarios, moving relative to each other
- Autarchic network architecture, resilient networks: node can provide services without core NW
- Unified networks, “network of the networks“ => multiple RATs offered, best QoS RAT selected
- AI for multiple scenarios: flight control, traffic steering, inter-cell coordination, autonomous decisions
- Joint communications and multi-link support, e.g. macro diversity and enhanced MIMO
- NOMA waveforms and interference cancellation methods
- Holographic radio control
- Free space optical (FSO) links, non-RF communication

NON-TERRESTRIAL NETWORKS ON THE PATH TO 6G

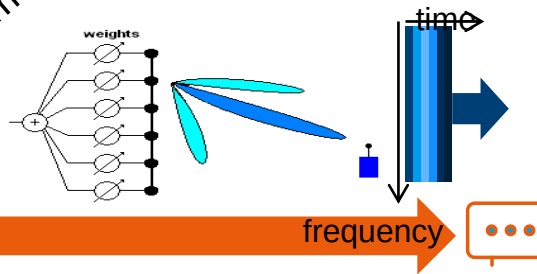
Multi-RAT and spectrum sharing „network of networks“



E.g. FR1 for terrestrial propagation, applying OFDMA



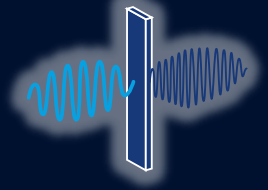
E.g. DVB-S2 with adapted roll-off and modulation scheme



E.g. mmWave using single carrier, wide bandwidth and beamforming

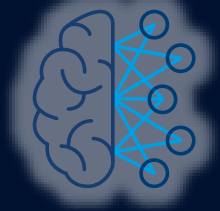
6G RESEARCH AREAS

THz communication

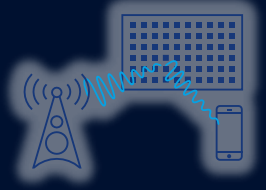


Joint communication & sensing

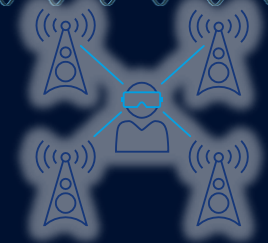
Artificial Intelligence and Machine Learning



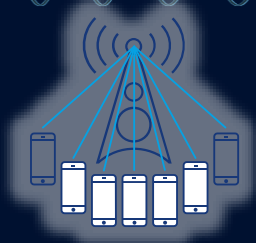
Reconfigurable Intelligent Surfaces



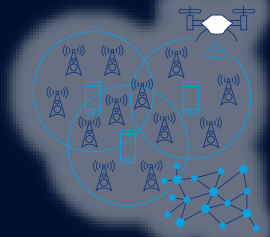
Photonics, Visible Light Communication



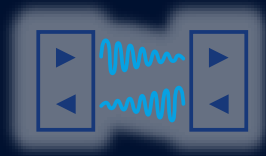
Multiple access, new waveforms, channel coding



Ultra-massive MIMO



New network topologies, distributed computing



Full-duplex communication

Security & Trustworthiness

A high-level overview on all these research areas is provided in one of our #THINKSIX video. Don't miss it!

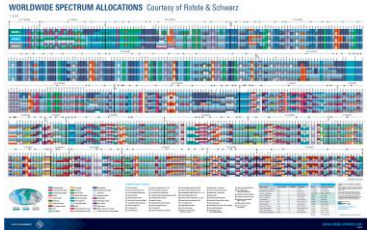

“If you want to go fast, go alone.
If you want to go far, go together!”
African proverb

ADDITIONAL RESOURCES AND WHITEPAPER RELATED TO THE CONTENT OF TODAY'S PRESENTATIONS:

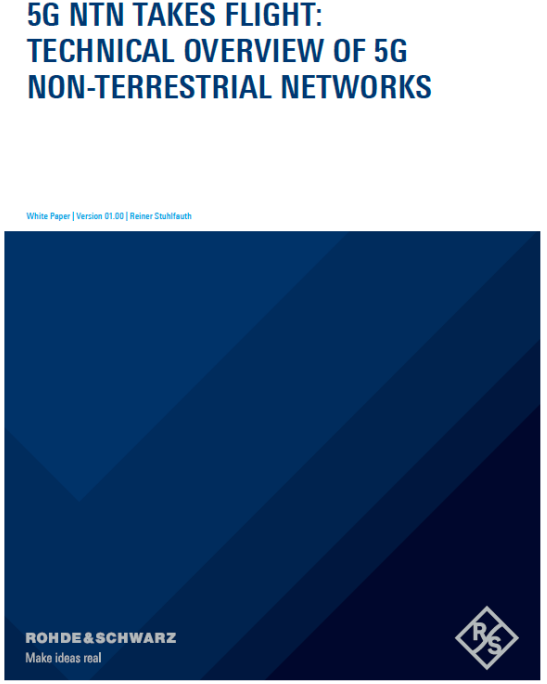
5G technology book oline version (>1000 pages on 5G technology): www.rohde-schwarz.com/5G

Whitepaper (short version)

5G Non-terrestrial Networks | Technology Update | Rohde & Schwarz (rohde-schwarz.com)



- Worldwide Spectrum Allocation Poster (2020)
- Free "Demystifying 5G NR" poster | Rohde & Schwarz (rohde-schwarz.com)



Whitepaper (extended version): https://www.rohde-schwarz.com/solutions/test-and-measurement/aerospace-defense/satellite-test/white-paper-5g-ntn-takes-flight-technical-overview-of-5g-non-terrestrial-networks_255919.html