Wireless Communications

ENSURING NB-IOT DEVICE NTN PERFORMANCE

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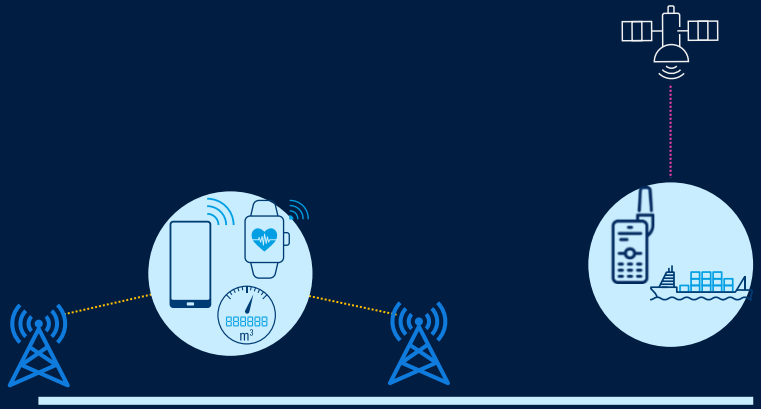
ROHDE&SCHWARZ
Make ideas real

WHAT IS NTN TRYING TO IMPROVE

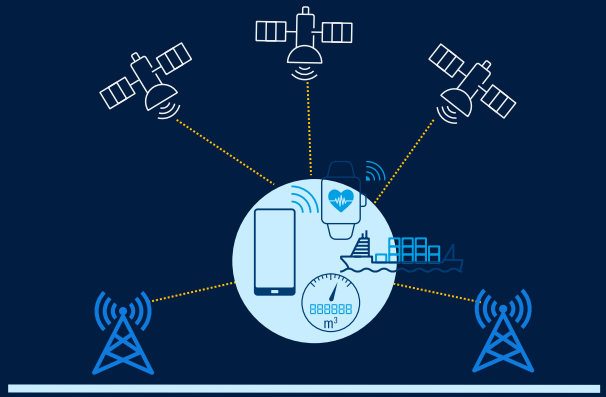
Today



Mobile Phone
IoT Device

Satellite Phone
IoT Device

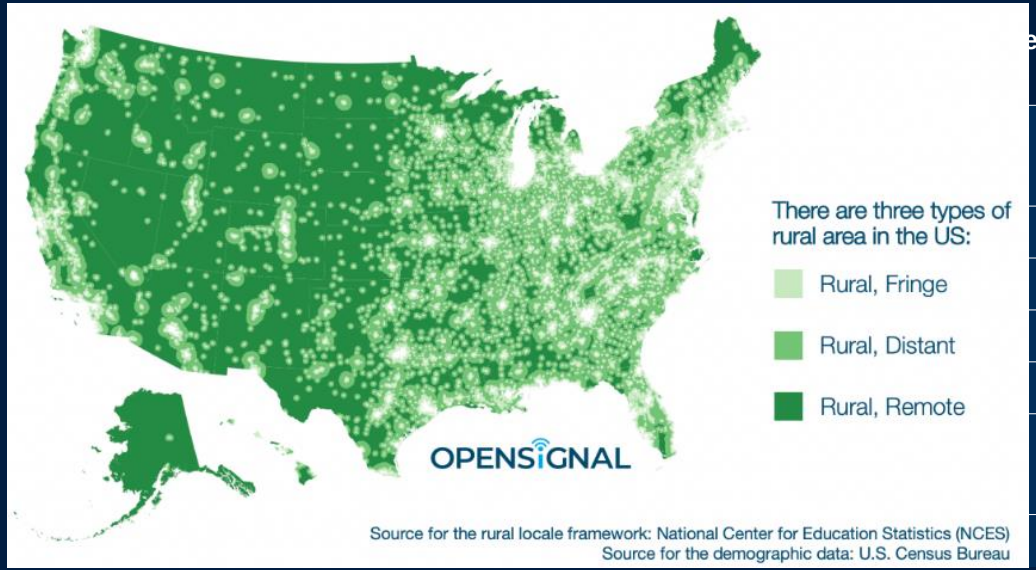
Future



Mobile Phone
IoT Device

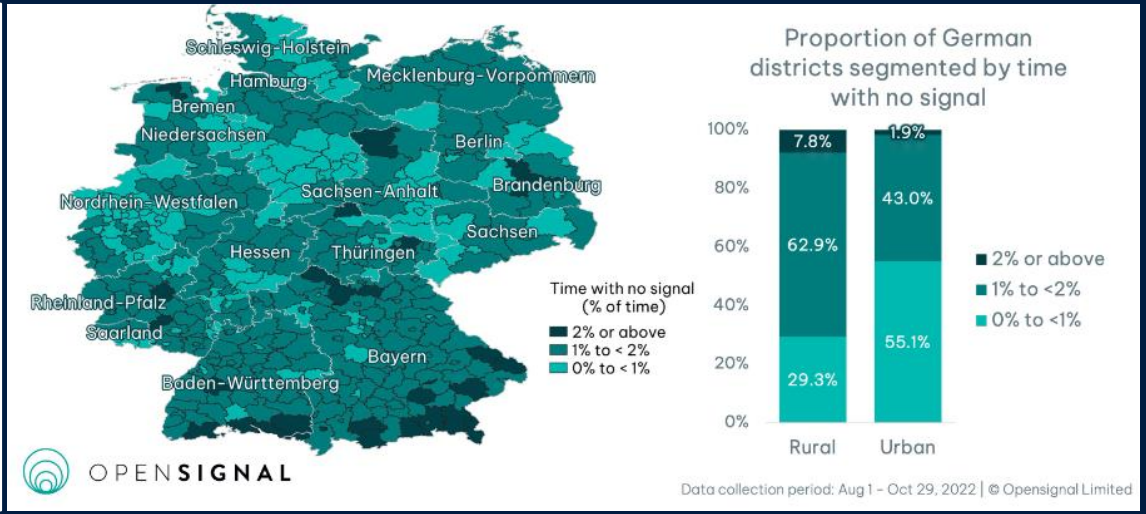
RURAL AREAS WORLDWIDE - MOST SUITED FOR NTN SERVICES AS A COMPLEMENT TO TERSTRIAL NETWORKS

15% of the time, on average, people in rural areas in the US could not gain access to mobile internet.



RURAL AREAS WORLDWIDE – GERMANY EXAMPLE

8% of the time, on average, people in rural areas in Germany could not gain access to mobile network.



USA STUDY – NUMBER OF PEOPLE AND GROUPS NOT ABLE TO COMMUNICATE AS PART OF THEIR JOB OR ACTIVITIES

57 MILLION HIKERS
11 MILLION HUNTERS
60 MILLION ANGLERS
9 MILLION ACTIVE SKIERS & SNOWBOARDERS
100 MILLION THAT GO BOATING EACH YEAR
40 MILLION AMERICANS THAT GO RV CAMPING
10 MILLION SURVIVALISTS
869.000 AGRICULTURE WORKERS
32,300 FISHING AND HUNTING WORKERS
12,600 FORESTRY AND CONSERVATION WORKERS
14, 000 NATIONAL AND STATE PARK RANGERS
45,500 LOGGING WORKERS
710.800 FREIGHT AND CARGO TRANSPORT WORKERS
66.000 WATER CARGO WORKERS
18,500 ZOOLOGISTS & BIOLOGISTS
261,300 PARAMEDICS AND EMERGENCY MEDICAL WORKERS
OVER 1 MILLION POLICE AND FIREFIGHTERS
20.000 FEMA EMERGENCY MANAGERS
18,000 DISASTER RELIEF COORDINATORS
51,500 COASTGUARD PERSONNEL AND RESERVISTS

**Bullitt Group Market Study 2022*

NTN PARTNERSHIPS AND PRESS RELEASES

MediaTek Powers World's First Satellite 5G NTN Smartphone Communication

MediaTek's collaboration with Rohde & Schwarz demonstrates the potential of 5G NTN technology to bring fast and reliable 5G connectivity everywhere via satellite

Aug 16, 2022 - 9:00 PM

HSINCHU, Taiwan – August 16, 2022 – MediaTek reached a new 5G milestone by powering a smartphone with a 5G Non-Terrestrial Network (NTN) connection in a lab environment for the first time. Through a transfer of data to ITRI's Next Generation NodeB network (gNB) test over a Low Earth Orbit (LEO) satellite channel emulated in collaboration with Rohde & Schwarz, MediaTek has demonstrated a world-first and showcased the capability of supporting satellite communications with commercial 5G smartphone hardware.

This achievement was completed in a MediaTek lab using Rohde & Schwarz test equipment, emulating a realistic LEO satellite constellation at 600km altitude where each satellite is moving extremely fast – nearly 27,000km per hour – in orbit. The smartphone was powered by MediaTek's NR NTN-enabled test chip connected to the test gNB by ITRI. The test chip was designed to meet the 3GPP Release 17 spectrum-defined functionality to simulate Doppler and timing variation effects by LEO satellite channels.

"This milestone continues MediaTek's long track record of 5G R&D innovations," said HC Hwang, General Manager of Wireless Communication System and Partnership at MediaTek. "With this test, MediaTek successfully validated the capability of connecting a 5G smartphone to satellite networks, opening up the door for 5G satellite network development to bring ubiquitous connectivity around the world."

MediaTek's demonstration showcases how 5G NTN technology can be used for satellite communications by employing the same form factor and design components as a standard smartphone. 5G NTN technology will help boost service reliability across the globe by harnessing existing terrestrial networks and economies of scale in the cellular sector, making fast and reliable 5G connectivity much more accessible in unserved and underserved areas. In addition to the consumer use cases for expanded 5G access, there are a number of business and enterprise use cases including critical communications, transportation, agriculture, fleet and heavy machine management and Internet of Things (IoT) devices.

Gerald Tietscher, Vice President Signal Generators Product Division at Rohde & Schwarz, said, "Ubiquitous connectivity is an important societal goal and Rohde & Schwarz is committed to providing test and measurement solutions that will help to bring the latest enabling technologies to the market."

Munich / 27-Feb-2023

Rohde & Schwarz verifies NTN capabilities of Bullitt's smartphone, powered by MediaTek 3GPP Rel.17 chipset

Rohde & Schwarz has partnered with Bullitt and MediaTek to fully test and verify the world's first satellite-to-mobile messaging 5G smartphone in line with 3GPP Release 17. The groundbreaking test solution from Rohde & Schwarz verifies that SOS messaging and two-way messaging work reliably in no-coverage scenarios via non-terrestrial networks (NTN) in line with 3GPP. At MWC Barcelona, a test setup is showcased at the Rohde & Schwarz booth featuring a rugged 5G smartphone from Bullitt with integrated MediaTek 3GPP NTN Rel.17 chipset as DUT.

Munich / 27-Feb-2023

Rohde & Schwarz collaborates with Qualcomm and Iridium Communications to test Snapdragon Satellite

Qualcomm Technologies Inc., Iridium Communications Inc. and Rohde & Schwarz recently collaborated on testing and validating Snapdragon® Satellite, a solution from Qualcomm Technologies for satellite-based connectivity on next-generation Android smartphones. Manufacturers who want to offer smartphones with truly global coverage can rely on test equipment from Rohde & Schwarz to confirm the full functionality of their products: The R&S CMW100 non-signaling wireless tester is supported by the Qualcomm® Development Acceleration Resource Toolkit (QDART) to verify the Iridium® waveforms in R&D and production testing.

The R&S CMW100 is supported by QDART to verify Iridium® waveforms. (Image: Rohde & Schwarz)

5G NTN

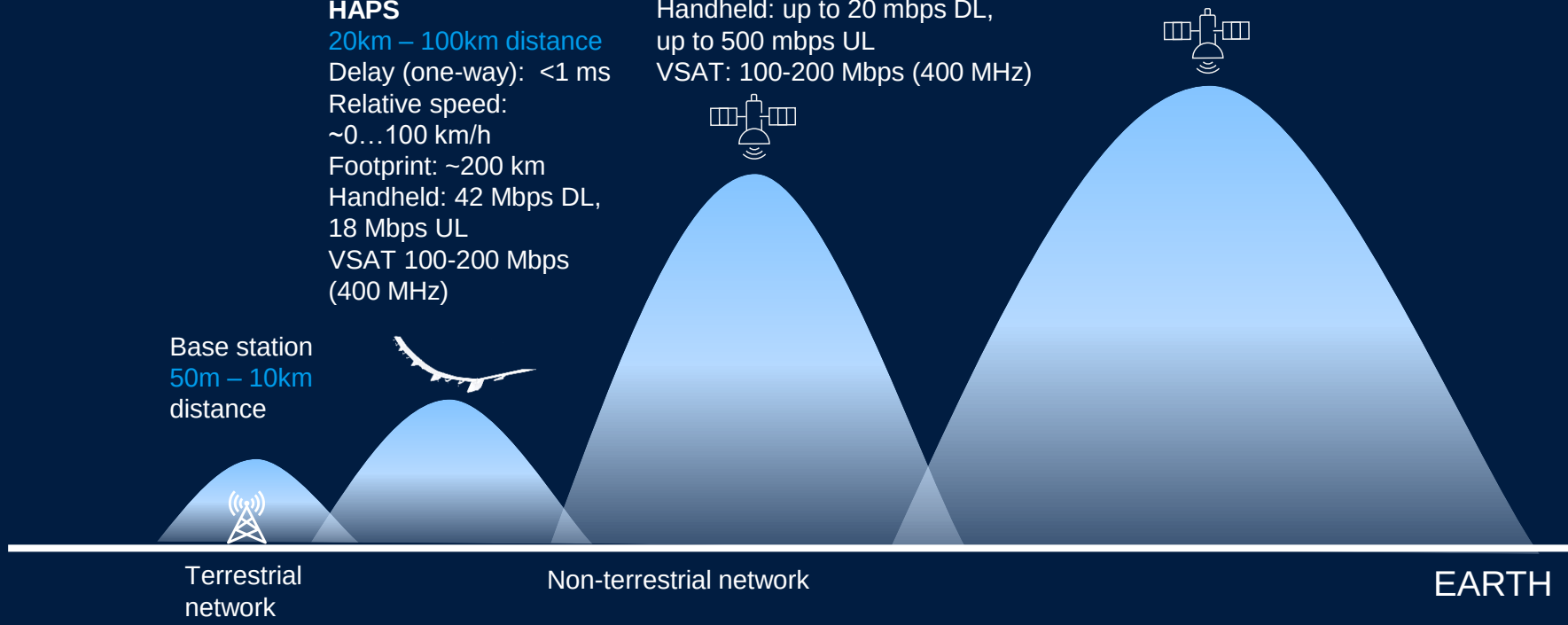
TR 38.811 (Release 17)

LEO
600km – 1900km distance
Delay (one-way): <6.4 ms
Relative speed: ~7.5 km/s
Footprint: <3000 km
S, L band in R17, Ka in R18
Up to 20 MHz bandwidth
Handheld: up to 20 mbps DL, up to 500 mbps UL
VSAT: 100-200 Mbps (400 MHz)

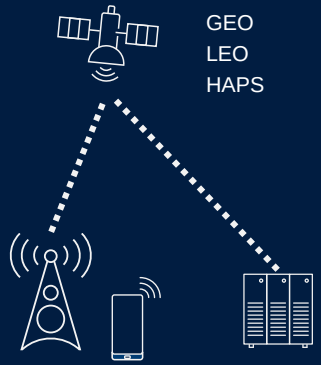
GEO
35000km – 40000km distance
Delay (one-way): 135.3 ms
Relative speed: ~0 m/s
Footprint: <10000
S, L band in R17, Ka in R18
Handheld LOW tpt IoT devices + VSAT

HAPS
20km – 100km distance
Delay (one-way): <1 ms
Relative speed: ~0…100 km/h
Footprint: ~200 km
Handheld: 42 Mbps DL, 18 Mbps UL
VSAT 100-200 Mbps (400 MHz)

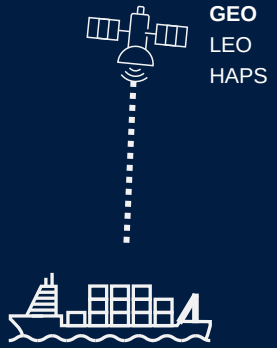
Base station
50m – 10km
distance



5G-NTN FOUR FACETS (PERSPECTIVE USE CASE)

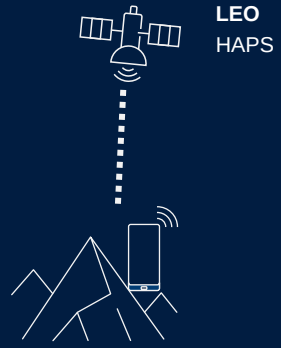


5G NTN backhaul >15 GHz



IoT-NTN S/L Bands

IoT devices 23 dBm transmit power, omni directional antenna (0dBi), use smaller bandwidth than handheld



NR-NTN (direct handheld, <6 GHz)

Mobile service is provided to handheld devices (e.g. omni directional antenna and 23 dBm transmit power)

NR-NTN (VSAT, >10 GHz)

Fixed wireless service with high gain ground antenna, terminals use VSAT/phased array

Mobile backhaul for terrestrial NWs

Global IoT network

Mobile coverage and resiliency use cases

Rural consumer and enterprise broadband services

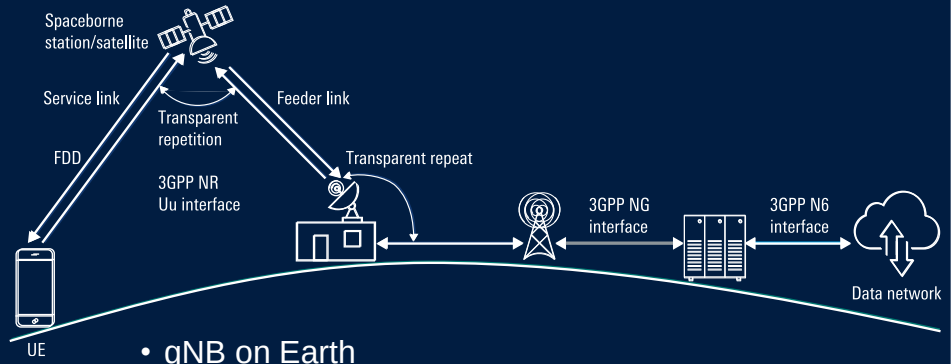
Emergency connectivity (temporary networks)

ARCHITECTURE OPTIONS IN 3GPP

TR 38.821

TRANSPARENT

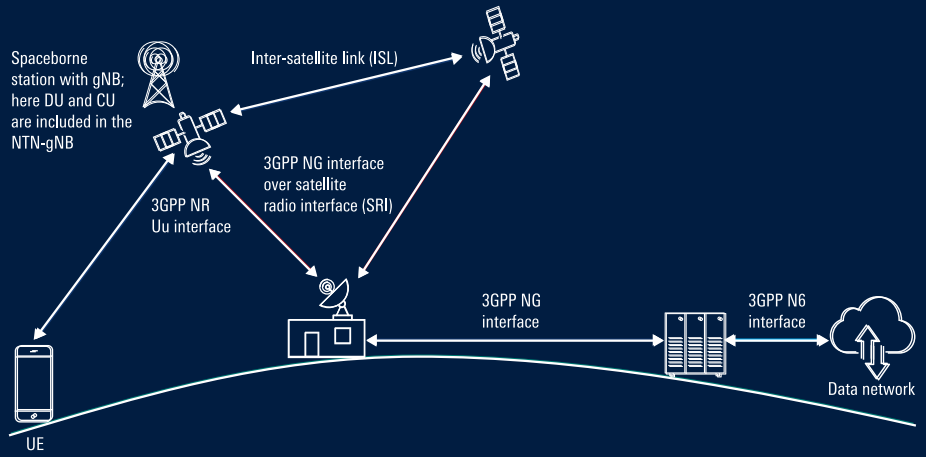
Bent-pipe payload



- gNB on Earth
- Satellite amplifies and forwards the Uu signals
- Longer L1 control plane latencies
- Uu interface = service link + feeder link
- 3GPP Rel. 17 to 18

REGENERATIVE

Full gNB on satellite



- gNB on satellite
- Shorter L1 control plane latencies
- Uu interface = service link
- NG interface = feeder link (SRI)
- 3GPP Rel. 19

NTN – SPECTRUM IN FR1

3GPP, first NTN bands for S and L-band

3GPP, bandwidth and subcarrier spacing for NTN bands + #RB

NTN band #	Uplink	Downlink	Duplex
n256	1980 – 2010 MHz	2170 – 2200 MHz	FDD
n255	1626.5 – 1660.5 MHz	1525 – 1559 MHz	FDD

NTN band #	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz
256	15	Yes	Yes	Yes	Yes
	30		Yes	Yes	Yes
	60		Yes	Yes	Yes
255	15	Yes	Yes	Yes	Yes
	30		Yes	Yes	Yes
	60	N/A	Yes	Yes	Yes
		#RB	#RB	#RB	#RB
Max. transmission bandwidth configuration	15	25	52	79	106
	30	11	24	38	51
	60	N/A	11	18	24

NTN – SPECTRUM IN FR2 – NTN

Latest 3GPP terminology for "FR3" is "FR2-0", focus is on spectrum attached to FR2-1, i.e. the region just below 24.25 GHz. This is still an ongoing discussion.

NTN will apply FDD as duplex scheme, also in the higher frequency range due to the long delay.

Maximum bandwidth = 400 MHz,
SCS = 60 or 120 kHz

NTN band #	Uplink	Downlink	Duplex
n512	27.5 - 30.0 GHz	17.3 – 20.2 GHz	FDD
n511	28.35 - 30.0 GHz	17.3 – 20.2 GHz	FDD
n510	27.5 – 28.35 GHz	17.3 – 20.2 GHz	

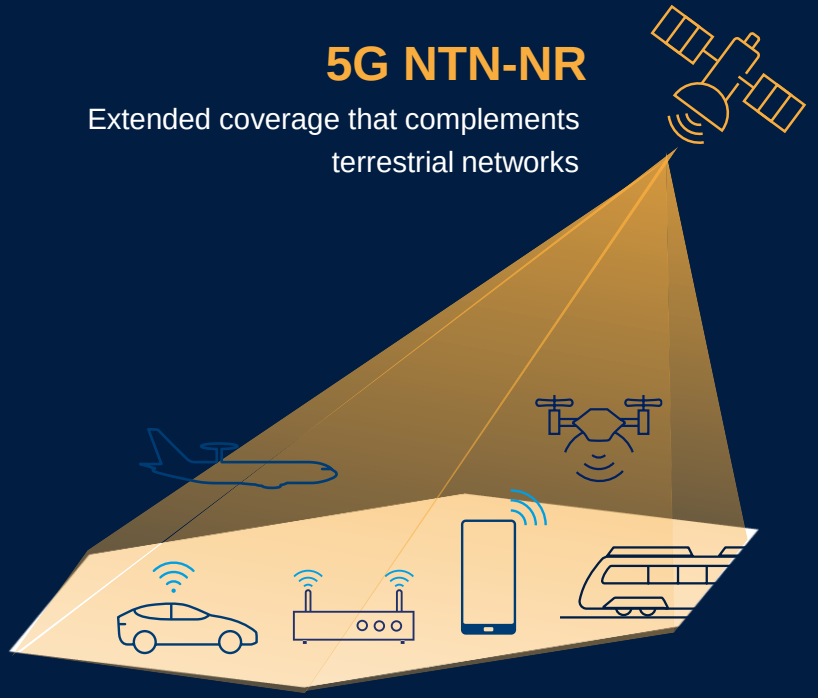
5G NTN HAS ADDRESABLE REVENUE OF $35B WORLDWIDE BY 2035*

NTN-IoT

Expand to global reach for IoT use cases across land, sea, and air

5G NTN-NR

Extended coverage that complements terrestrial networks



Today → 2026/2027 → 5G Advanced/6G

Source: GSMA Intelligence

NTN IoT USE CASES

SOS/messaging: Smartphones can implement NTN NB-IoT chipsets in order to enable SOS or two-way messaging for areas with no terrestrial access.

Agriculture and farming: IoT devices used for precision farming, livestock monitoring, or other agricultural applications may experience connectivity challenges in rural or remote locations.

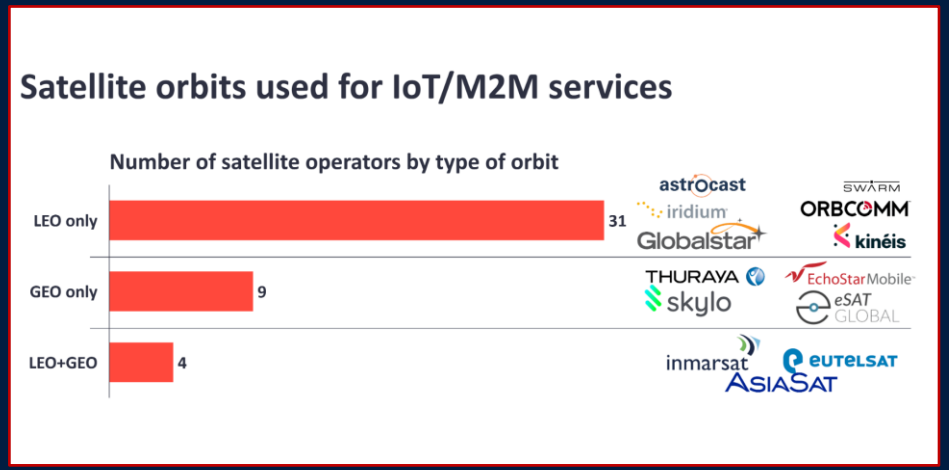
Asset tracking: Tracking the location and movement of valuable assets, such as shipping containers or vehicles, which might travel through areas with limited cellular connectivity.

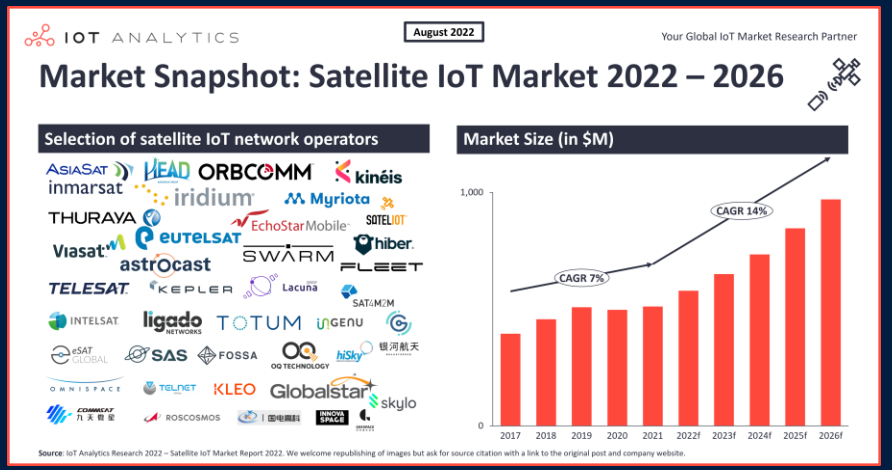
Disaster response and recovery: Cellular IoT devices used for search and rescue, damage assessment, or emergency response in areas affected by natural disasters may face limited or no connectivity due to damaged infrastructure.

Remote monitoring: Devices used to monitor equipment, environmental conditions, or other metrics in remote locations, such as oil rigs, weather stations, or wildlife tracking.

Maritime/airtime applications: IoT devices used for navigation, vessel tracking, or environmental monitoring in the open ocean or in coastal areas with limited connectivity.

Growth in Satellite IoT Market



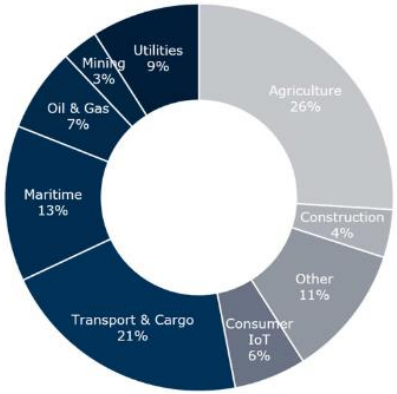


Growth in Satellite IoT Market contd.

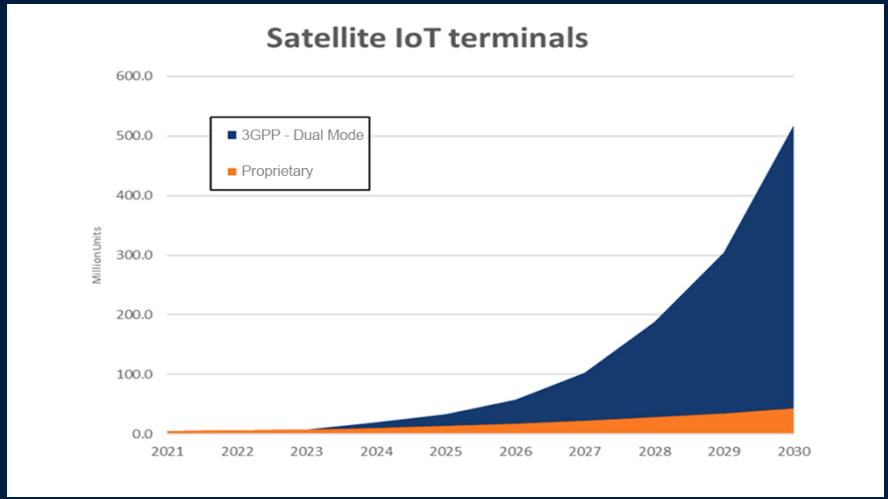
Over the next 5 to 10 years, 40 to 50 companies will provide IoT satellite-based services

Predominant use cases being agriculture, transport, and maritime.

By application



By IoT terminal shipment



Source: NSR M2M and IoT via Satellite Report

DIRECT TO SMARTPHONES/DEVICES PROJECTS

Globalstar and Apple	Future iPhones may offer free emergency texting via Globalstar satellites, with potential expansion to a global iMessage system.	Proprietary
SpaceX and T-Mobile	Next-gen Starlink satellites to enable messaging, voice, and low-speed data (2 to 4 Mbps per cell) using T-Mobile PCS spectrum.`	No modification to 3GPP phones Reuse terrestrial spectrum
Iridium and Qualcomm	New Snapdragon chipsets to feature built-in text messaging for emergency use and potentially regular texting; pricing undecided.	Proprietary
Skylo/MTK/Bullitt	Skylo implements NTN IoT Rel. 17 for their Direct-to-Device Satellite Service, a Two-Way Messaging Service. Used by Bullitt on a Motorola device using MTK chipset, T-Mobile DE. Using GEO infra.	3GPP Rel. 17
Sateliot	Mission to deploy ~40 LEO satellites. Focused on IoT use cases with NTN IoT Rel. 17. Regenerative with store and forward.	3GPP Rel. 17
AST SpaceMobile	Over 200 large LEO satellites to deliver 30 Mbps 5G to smartphones using spectrum from mobile operator partners like Vodafone and AT&T.	No modification to 3GPP phones Reuse terrestrial spectrum
Lynk	10 LEO satellites to experiment with direct-to-smartphone SMS via terrestrial mobile spectrum. Optus.	No modification to 3GPP phones Reuse terrestrial spectrum
Omnispace /Ligado	S and L band satellite filings beyond North America and Europe; aiming to develop LEO/MEO satellite systems for direct-to-smartphone communication.	No modification to 3GPP phones

NTN ON SMARTPHONE RACE STARTS WITH SOS MESSAGING USECASE, ON PROPRIETARY WAVEFORM/STACKS AND 3GPP WITH DEDICATED CONSTELLATIONS

Service	SOS Messaging over Satellite Smartphone Market/ End User				
OS	iOS	Android	Android	Android	Harmony
Constellation	Globalstar	?	Inmarsat Skylo	Iridium	Beidou
Chip Vendors	Qualcomm	SAMSUNG sLSI	MEDIATEK	Qualcomm	Qualcomm
Smartphones	iphone14	?	Bullitt	Samsung GS,Oppo, Vivo, Xiaomi	Huawei
Standard	Proprietary	NTN (NR & IoT) R17	NTN-IoT R17	Proprietary	Proprietary

NTN@BULLITT


TWO-WAY SATELLITE MESSAGING
WITH BULLITT SATELLITE MESSENGER
NO INTERNET COVERAGE
inmarsat
ECHOSTAR
DATA CONNECTION VIA SATELLITE
CELLULAR OR WIFI COVERAGE
DATA CONNECTION VIA INTERNET
SKYLO CORE NETWORK AND BULLITT SATELLITE MESSENGER MESSAGE CENTER
GEO STATIONARY SATELLITE
22,300 MILES
ABOVE THE EQUATOR
CELLULAR SERVICE
WIFI INTERNET
skylo
Bullitt
MEDIATEK
NTN CHIPSET
PROVIDER
SOS
RESPONSE CENTER
iOS
android
Bullitt


ATTACHMENT LOOP
POWER INDICATOR
LOCATION CHECK IN INDICATOR
SATELLITE CONNECTIVITY INDICATOR
SOS KEY WITH TIME DELAYED ACTIVATION
COMPATIBLE WITH:
iOS
android
motorola defy SATELLITE LINK
KEY SPECS:
DIMENSIONS
Compact form factor
70mm x 50mm x 11mm
Weight: ~70 grams
CONNECTIVITY
GPS
Bluetooth
Bullitt Satellite Connect,
Bluetooth 5.1, independent GPS
DESIGN
Vibration / Buzzer
Buttons: SOS, Check In,
Power/BT Pairing
POWER
600mAh
Li-Po battery
USB-C charger
TOUGH
IP68 dust
and waterproof
Mil Spec 810H


CAT® S75

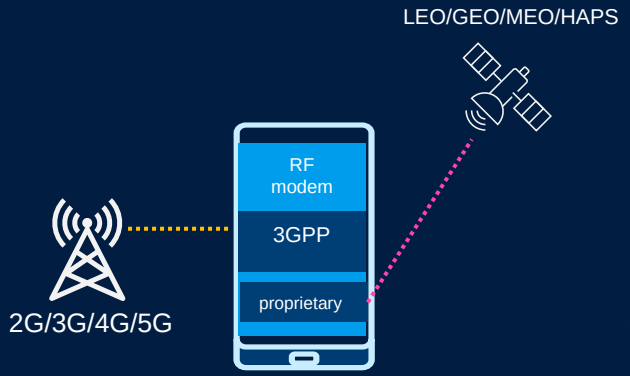
NTN@TELEKOM

- Telekom announced the partnership with Skylo
- This will enable all existing NB-IoT devices with new FW Rel. 17 upgrade to get seamless coverage globally
- Using existing Telekom SIM profiles
- The two companies established bilateral commercial and technical roaming relationship
- Target devices include:
  - Smartphones for SOS messaging
  - Wearables/watches
  - IoT sensors, trackers etc.



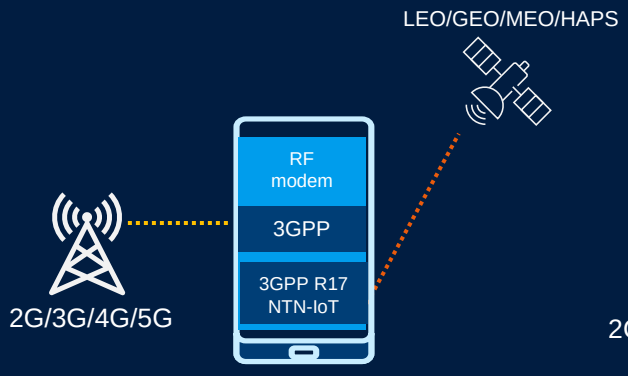

DIFFERENT IMPLEMENTATIONS OF NTN FOR SOS MESSAGING – DEVICE ASPECTS

3GPP vs. PROPRIETARY



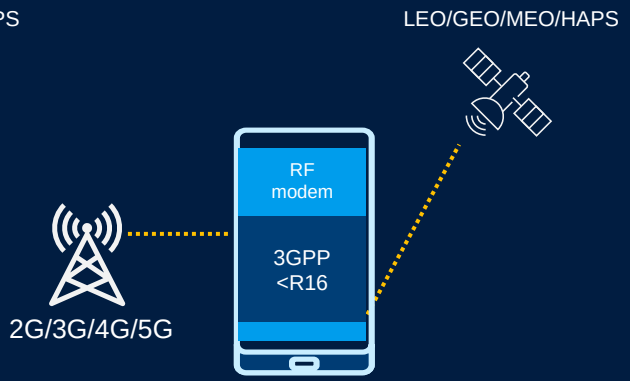
PROPRIETARY

SOS Messaging Services enablement with proprietary (waveform and stack) modem and dedicated constellation e.g. iPhone 14/Globalstar, Qualcomm/Iridium etc.



3GPP R17 NTN-IoT

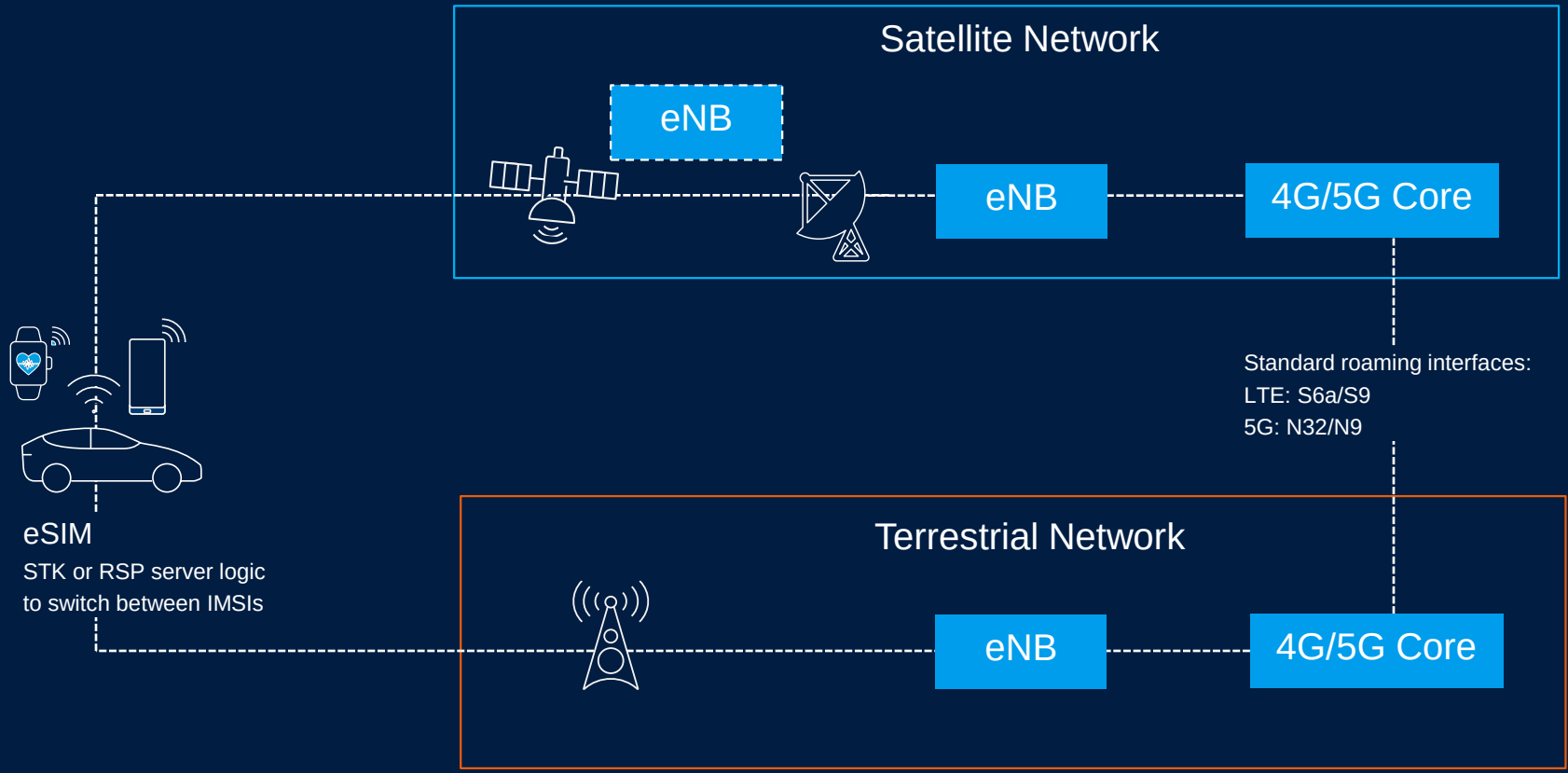
SOS Messaging Services enablement with 3GPP Rel. 17 NTN-IoT (waveform and stack) modem and dedicated constellation e.g. MTK/Bullitt/Skylo



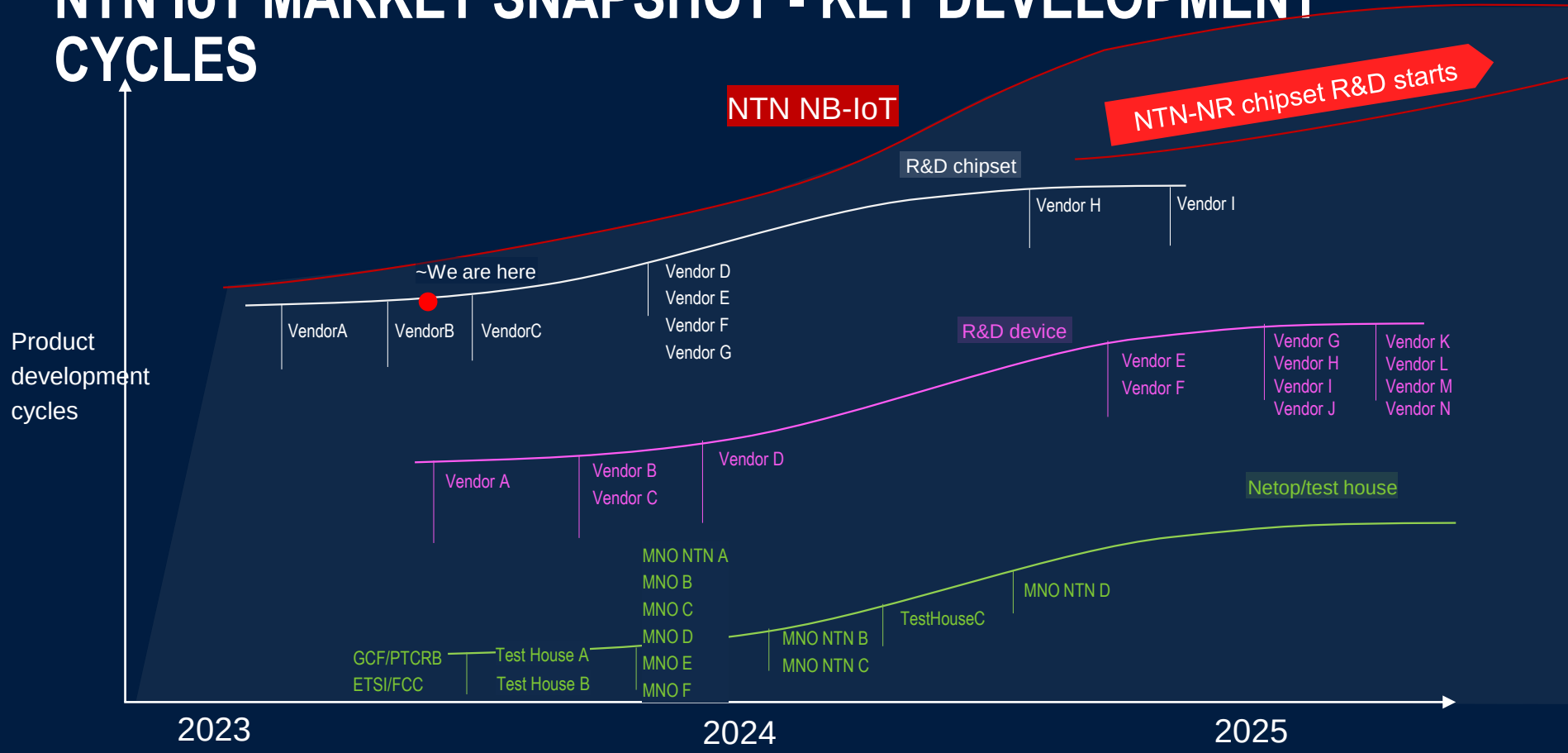
3GPP UNMODIFIED

SOS Messaging Services Enablement with no update to devices, operators reuse their own spectrum assets enabling direct to device services e.g. AT&T/AST Space Mobile, T-Mobile/Starlink, Optus/Lynk

NTN IoT SERVICE ENABLEMENT – OPERATOR PERSPECTIVE

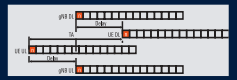
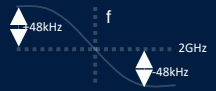
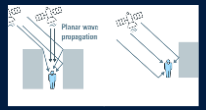
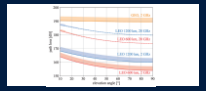


NTN IoT MARKET SNAPSHOT - KEY DEVELOPMENT CYCLES

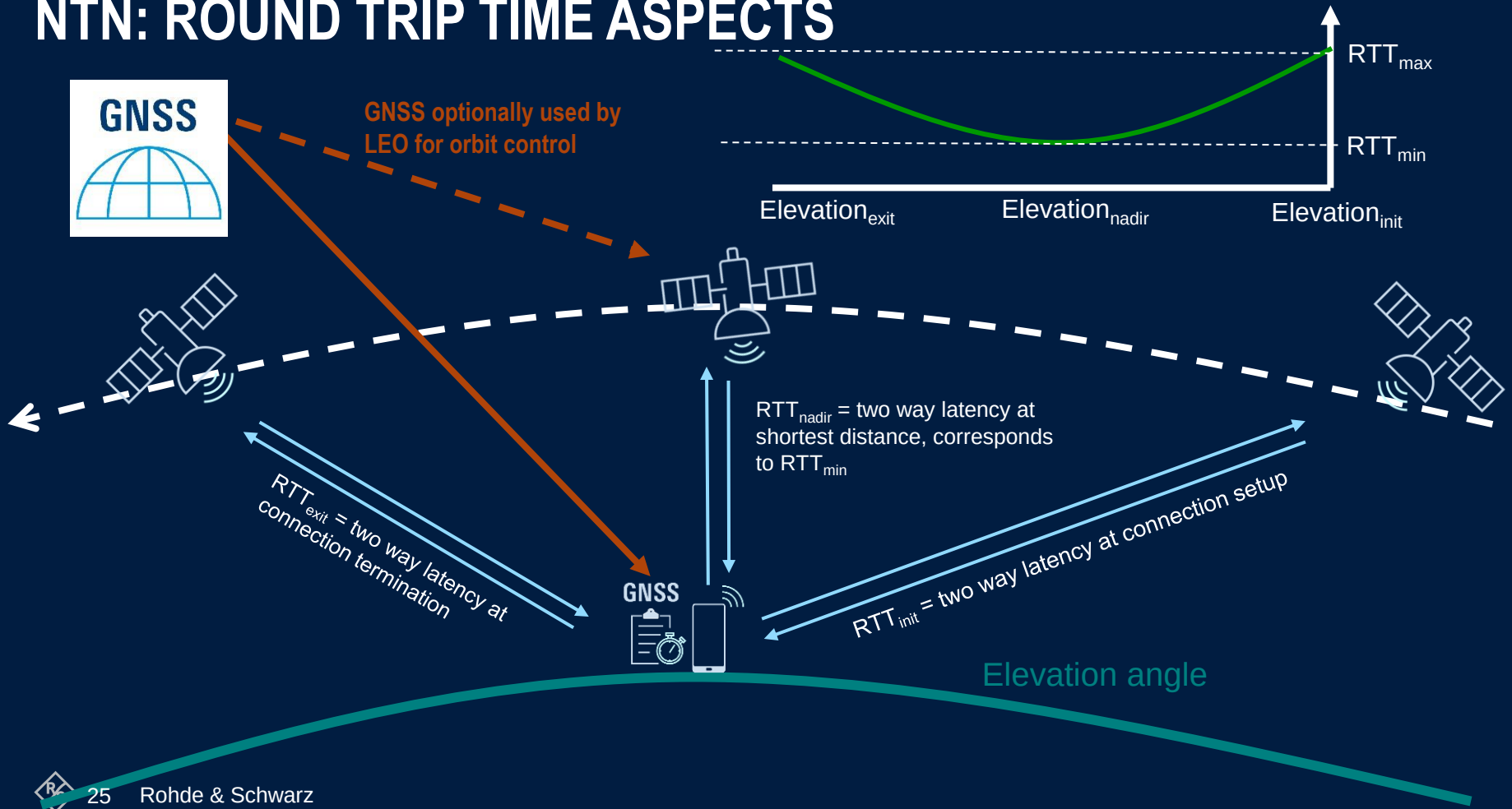


NTN technical challenges

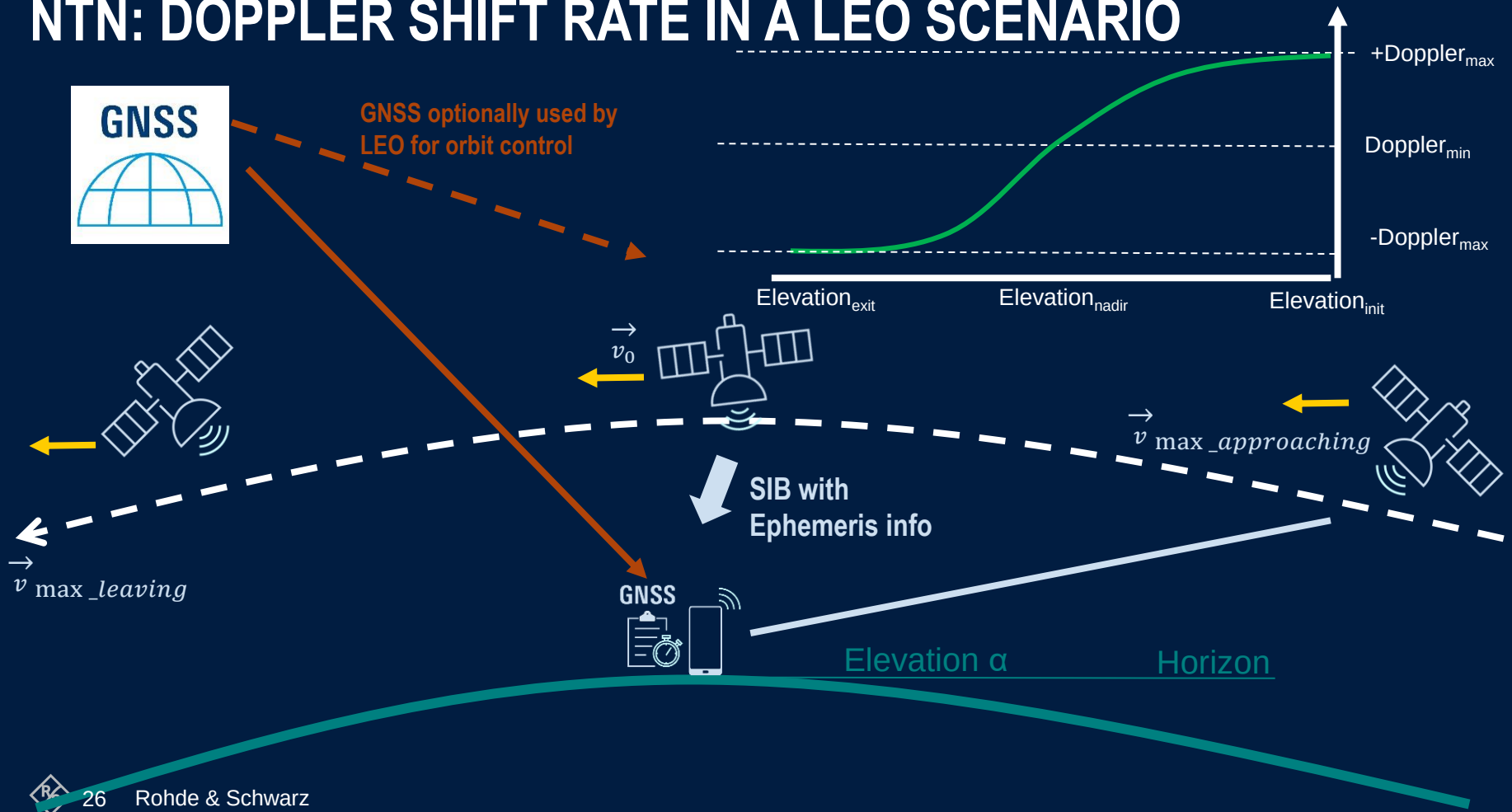
NTN NB IoT DEVICE ESSENTIAL REQUIREMENTS

Time Synchronization		Long delay and time variant delay: Distance, UE to satellite causes long absolute delay (~40 ms for LEO and 544 ms for GEO). Orbital movement of satellite will cause a time variant delay during the connection time. Variable RTT due to Elevation angle and LEO, SIB31 K_mac (RTT calc), K_offset, SIB32
Frequency Synchronization		Doppler shift: Movements of LEO satellites causes a time and elevation angle variant Doppler shift
Signal Fading		Fading profiles: Beside the legacy terrestrial fading profiles, satellite connectivity requires new fading profiles like the combination of atmospheric and terrestrial fading and also the emulation of weather specific effects (rain, cloud, sun storms causing electron flow)
Minimum SINR		High attenuation and low SNR: The large distance causes a high free space path loss ending in a low SNR at the UE side. Minimum SINR ≥ -10 dB, Minimum RSRP ≥ -137 dBm
GNSS Measurements and Satellite Ephemerals		GNSS emulation and provisioning of ephemeris information in the first approach, NTN targets at outdoor connections, UE is capable of GNSS and determines its terrestrial position. The UE is pre provisioned with the orbit information (ephemeris) via SIB broadcast
Power Saving Optimizations		Cell Acquisition, mandatory GNSS, Cell Search, eDRX/PSM (start time of upcoming coverage info, repetitions in low CQI, UE to predict discontinuous coverage based on the satellite assistance information, SIB32

NTN: ROUND TRIP TIME ASPECTS



NTN: DOPPLER SHIFT RATE IN A LEO SCENARIO

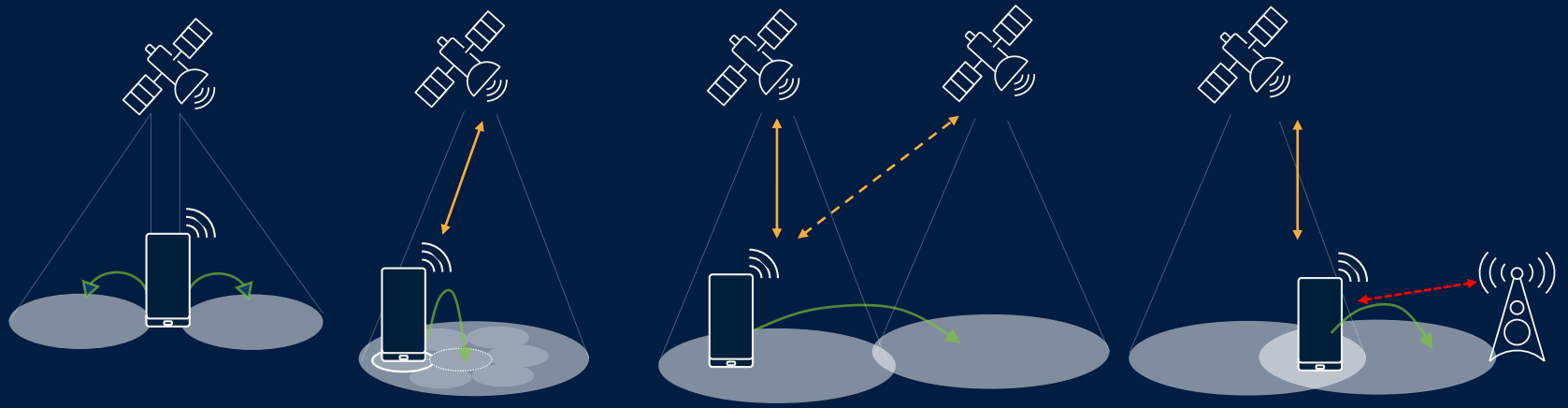


NTN IoT LONG AND SHORT CONNECTIONS

UE uses GNSS position and SIB info to precompensate timing advance and UL frequency.
UL segmented transmission is possible. =>Drawback: Extended energy consumption due to re-acquisition of GNSS+SIB and precompensation

UE capability & network config: Minimum supported gap length between segments „ntn-SegmentedPrecompensationGaps“ [1 symbol, 1 slot, 1 subframe]

NTN MOBILITY SCENARIOS



Cell selection/ cell reselection	Intra-satellite/ Inter beam handover	Inter-satellite handover/ Inter-satellite dual connectivity (DC)	NTN – terrestrial handover/DC

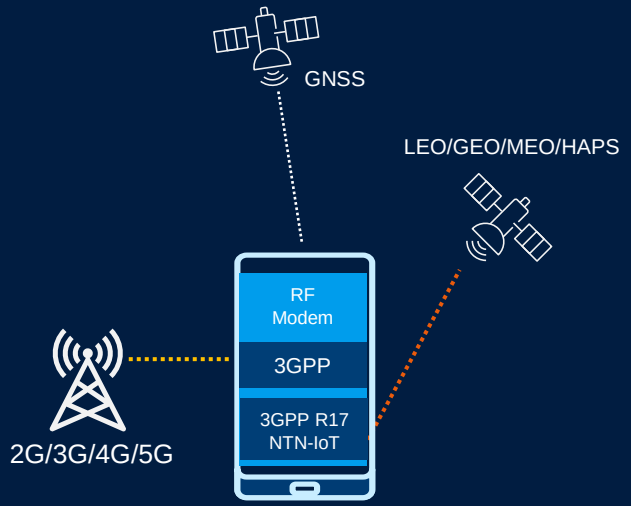
NR-NTN connection

Target or simultaneous dual connectivity NR-NTN connection

Target or simultaneous dual connectivity terrestrial connection

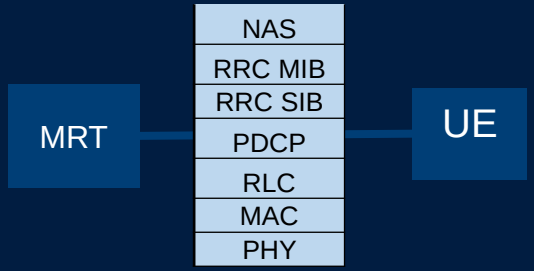
NTN IoT UE PROCEDURES

1. The UE determines its terrestrial position, e.g. via GNSS.
2. The satellite informs about its orbit information, velocity and common parameters in SIB broadcast.
3. Based on the estimated UE and satellite position, a calculation of the propagation delay is executed by the UE.
4. Finally, the UE derives the initial timing advance and frequency shift for first radio access. Depending on SIB setting, the UE reports the timing advance during the RACH procedure.



3GPP Rel. 17 NTN-IoT

NTN-NB IoT TESTING ASPECTS



R&D

Full protocol stack update and verification for all layers and IEs, NAS, RRC, MAC, PHY, E2E testing etc.

May 2023

R&S®CMW500 Signaling Tester Extension to Rel. 17 NTN

MLAPI support, support for all protocol stack extensions and IEs

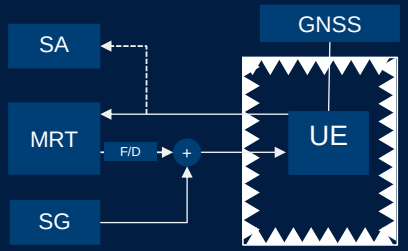
GEO/GSO/LEO/MEO emulation
(synchronous or geostationary)

Testcase scenarios include:

- Single/multi cell
- SIB31 and SIB32 support
- Fixed delay up to 540 ms
- Registration/IP/NIP/PSM/cDRX/E2E etc.

Conformance

3GPP RAN5 specs ready in 2H23
for RF/RRM/PCT
Initial GCF validations
planned in Q4/23



Regulatory

RF output power verification
Occupied bandwidth
Emission mask
Out of band emission
Additional unwanted emission
Carrier-off state emissions
Frequency stability

CMW500 MOBILE RADIO TESTER

CMW500 LTE ADVANCED / C-IOT KEY FEATURES

LTE Modem Feature	Description
Carrier Aggregation	8 DL CA / 4 UL CA, FDD+TDD CA
Higher Order MIMO	MIMO 8x2, MIMO 8x4, MIMO 4x4
Higher Order Modulation	DL 256 QAM, UL 64 QAM, UL 256 QAM*, DL 1024 QAM
Data rates	Up to 2 Gbps DL (CA + DL MIMO4x4/DL 256 QAM)
HetNet	feICIC, DL CoMP (TM10), UL CoMP
LTE + WIFI	LTE/WIFI Offloading, LTE-U (CSAT), LAA
C-IoT	UE Cat. 0/1, eMTC (Cat-M1), NB-IoT (Cat-NB1, Cat-NB2)
V2X, D2D	D2D discovery & communication, V2X Out of Coverage TM4
Other	eMBMS, ePDCCH, Dual Connectivity, Multi-SIM
Voice	VoiceWIFI, hVoLTE, EVS codec *) up to MCS 25

R&S®CMW500 market leading in IoT testing

Munich / 26.02.2018

Rohde & Schwarz and CommSolid present world's first test solution for 3GPP Release 14 location services for NB-IoT

Rohde & Schwarz and CommSolid have successfully completed the verification of 3GPP Release 14 location services (LCS), which is one of the new positioning technologies for NarrowBand-IoT (NB-IoT). The Cat-NB2 verification was performed with CommSolid's NB-IoT modem solution against the R&S CMW500 mobile communication tester. The R&S Location Based Services (LBS) solution based on R&S CMWcards GUI, a subset of TS-LBS, allows the verification of chipsets and mobile devices for mobile manufacturers, chipset manufacturers, test houses and network operators with the target to get permission to operate them in a particular network.

Munich / 14.02.2020

Rohde & Schwarz extends collaboration with Thales to minimize field testing for IoT modules

Gemalto, a Thales company, is using test equipment from T&M specialist Rohde & Schwarz to ensure that Cinterion® IoT modules operate synchronously across all networks and conditions. This reduces extensive real network drive tests in different countries for manufacturers of IoT (Cat M and NB IoT) solutions, resulting in faster time-to-market.

Munich / 19-Mar-2020

Rohde & Schwarz supports wake up signal test for improved power efficiency in NB-IoT devices

Rohde & Schwarz and Goodix (CommSolid) are first to demonstrate exhaustive test functions for the newly introduced NB-IoT wake up signal (NWUS), the latest 3GPP Release 15 feature for NB-IoT devices to further reduce power consumption. For NB-IoT long-term monitoring applications, this wake up signal can be leveraged to enable either far longer battery life without upgrading the battery, or as a way to reduce battery size while retaining the device's service life.

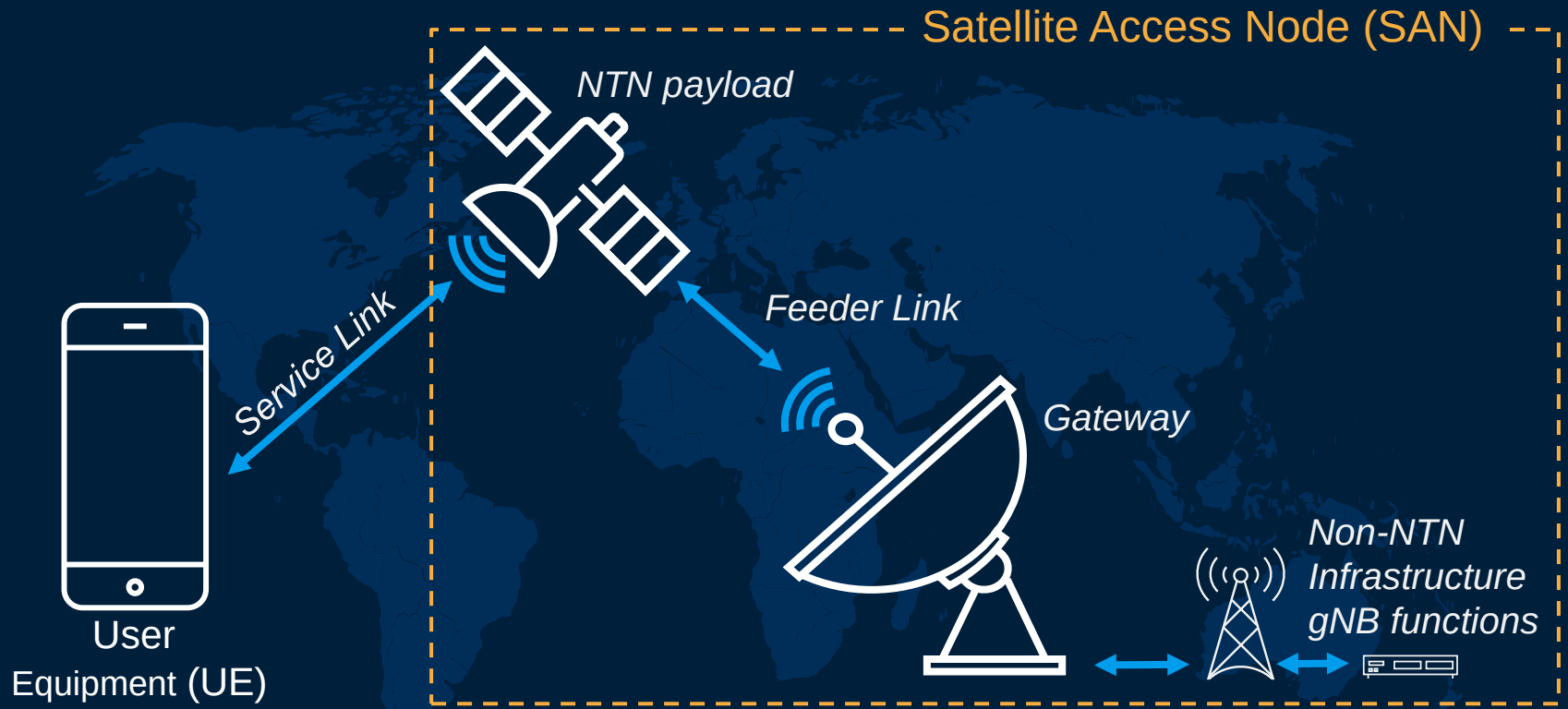
NB-NTN REL. 17 TEST SOLUTION

- Products:
  - **CMW500** Mobile Radio Tester Hardware

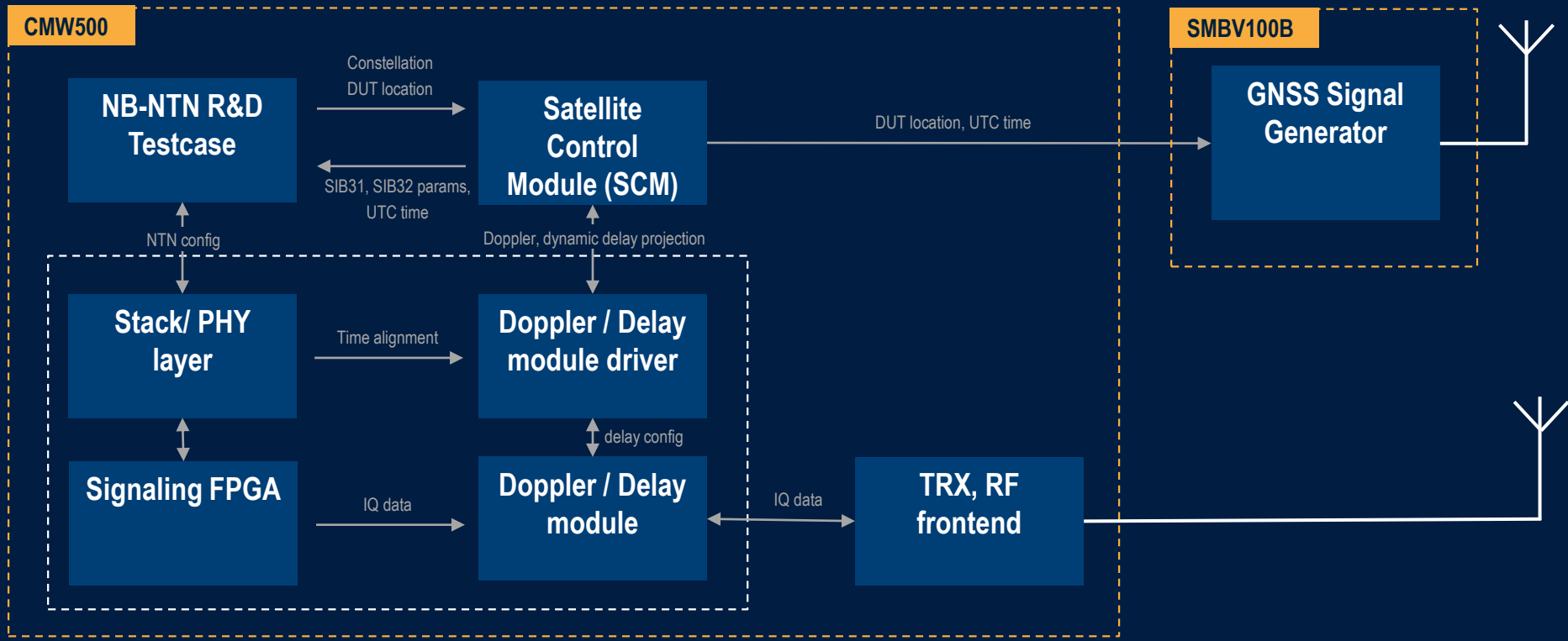
  - **CMW-KP030** NB-IoT FRAMEWORK
  - **CMW-KR317** REL.17 NB-IOT STACK EXTENSION
  - **CMW-KU317** REL.17 NB-NTN SAMPLE SCENARIOS
  - **CMW-KK307** REL.17 3GPP PCT Testcases

  - Additional **SMBV100B** required for GNSS

TOPOLOGY


Satellite Access Node (SAN)
NTN payload
Feeder Link
Service Link
Gateway
Non-NTN
Infrastructure
gNB functions
User
Equipment (UE)

R&S®CMW500 ALL IN ONE NB-NTN SIMULATION IN THE LAB



R&S®CMW500 Readymade NB-NTN Testcases

R&D example package

R&S® CMW500 MLAPI R&D Test Scenario Status List

LTE MLAPI

Scenario	Test Purpose	R&S Product
CMW-KU317	**NB-IoT NTN Scenarios**	
Initial Access		
NBIOT_R17_01_01	SIB31 reading and RACH Procedure	CMW-KU317
NBIOT_R17_01_02	RRC Connection establishment	CMW-KU317
NBIOT_R17_01_03	Timing Advance reporting procedure : ta-report enabled and offsetThresholdTA configured.	CMW-KU317
Attach procedure		
NBIOT_R17_02_01	Attached for EPS services with CP-CIoT EPS optimization, no PDN establishment.	CMW-KU317
NBIOT_R17_02_02	Attached for EPS services with CP-CIoT EPS optimization, IP data transfer.	CMW-KU317
NBIOT_R17_02_03	Attached for EPS services with UP-CIoT EPS optimization, IP data transfer.	CMW-KU317
RRC Connection procedures		
NBIOT_R17_03_01	RRC Connection Reestablishment after Radio Link Failure-SRB and DRB	CMW-KU317
NBIOT_R17_03_02	RRC Connection Resume of the Suspended DRB	CMW-KU317
MT Data		
NBIOT_R17_04_01	MT Data transfer using CP-CIoT EPS optimization	CMW-KU317
NBIOT_R17_04_02	MT Data transfer using UP-CIoT EPS optimization	CMW-KU317
MT SMS		
NBIOT_R17_05_01	MT Data SMS using CP-CIoT EPS optimization	CMW-KU317
NBIOT_R17_05_02	MT Data SMS using UP-CIoT EPS optimization	CMW-KU317
SIB-31 Update		
NBIOT_R17_06_01	UE reads modified SIB-31 after UL Sync Validity timer expiry	CMW-KU317
Cell reselection		
NBIOT_R17_07_01	Reselection between NTN cells	CMW-KU317
NBIOT_R17_07_02	Reselection from NTN cell to non-NTN cell	CMW-KU317
Battery power saving		
NBIOT_R17_08_01	Power saving mode(PSM) activation during EPS attach procedure	CMW-KU317
NBIOT_R17_08_02	Connected mode eDRX	CMW-KU317

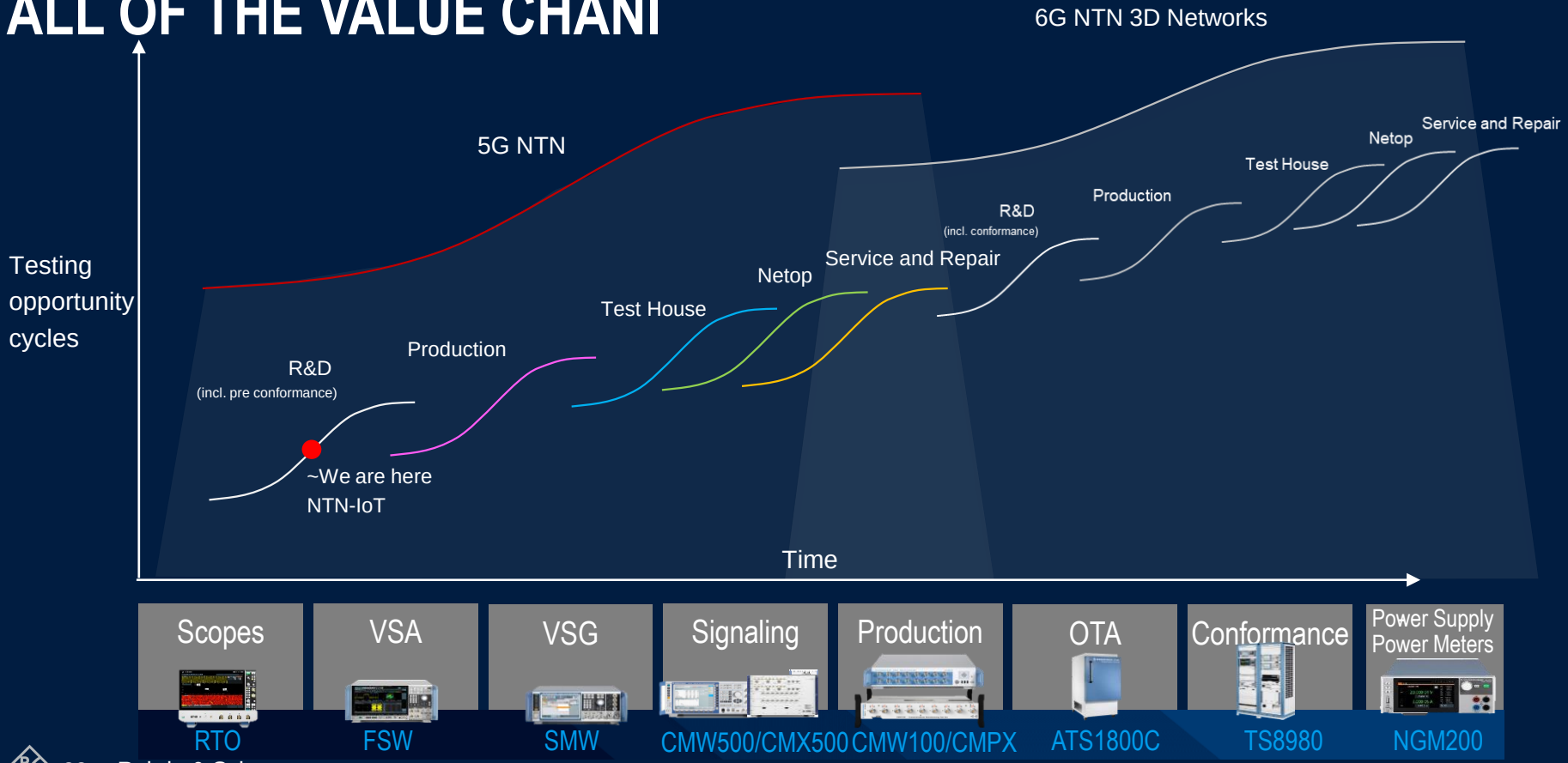
3GPP PCT testcases

Test Cases	Layer	TC Title
9.2.1.1.34	NAS	eMTC TC NB-IoT / NTN / GNSS position reporting / reject cause #78 "PLMN not allowed to operate at the present UE location"
22.1.2	IDLE	NB-IoT/ NTN / GSO
22.2.13	MAC	NB-IoT / NTN / Multi-TAC
22.3.1.5a	MAC	NB-IoT / NTN / DRX / (UL)HARQ RTT
22.3.1.13	MAC	NB-IoT / NTN / UE specific TA report / UE specific Koffset
22.3.2.7a	RLC	NB-IoT / NTN / AM RLC / Receiver status triggers / extended t-Reordering configured
22.4.30	RRC	NB-IoT / NTN / Ephemeris information update / T317 Expiry / T318 Expiry
22.5.23	NAS	NB-IoT / NTN / GNSS position reporting / reject cause #78 "PLMN not allowed to operate at the present UE location"

DEMO


ACCELERATING 5G
NTN DEVICE TESTING IN R&D, CONFORMANCE, PRODUCTION
VALIDATED TEST SOLUTION FOR SNAPDRAGON SATELLITE BASED SOS MESSAGING VERIFICATION
WORLD'S FIRST 5G SATELLITE-TO-MOBILE MESSAGING SMARTPHONE WITH MEDIATEK 3GPP NTN REL.17 CHIPSET
EXPANDING 5G TO NEW COVERAGE AREAS WITH NTN

NTN STARTS WITH 5G AND MATURES IN 6G AND AFFECTS ALL OF THE VALUE CHANI



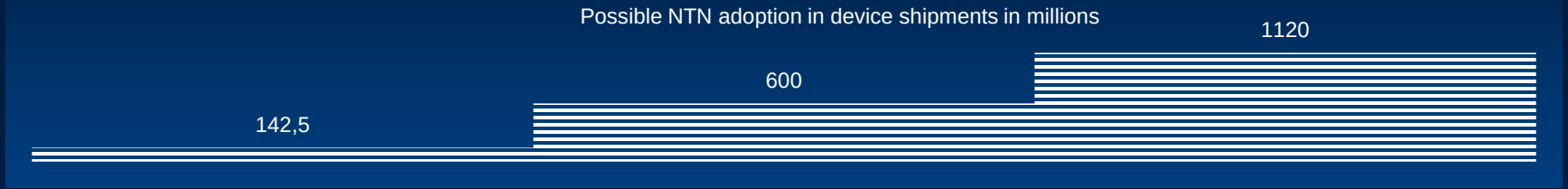
Towards 5G Hybrid Network

Augmenting connectivity for the end user, creating the network of networks

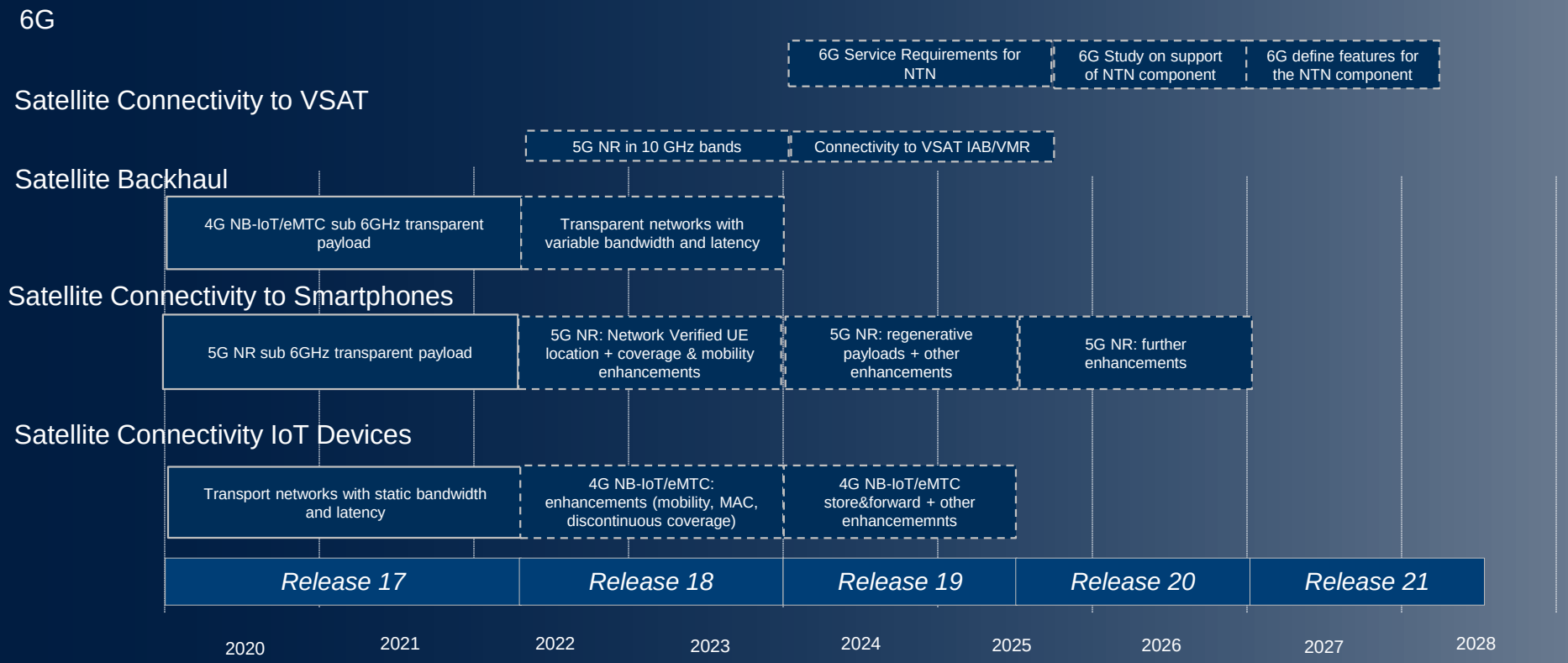
Prior 5G: Interworking → 5G and 5G Advanced: Integration → 6G: Unified

1 to 2 years Exploratory phase	2 to 5 years Adoption phase	5 to 10 years Mature phase (6G starts)
5G Extended coverage (Transparent/Regenerative) Mission Critical SOS Messaging/small data/public safety IoT (land,sea,air) Premium Smartphones	Roaming via Space Networks (Transparent/Regenerative) New roaming business model for subscribers 3G speeds Connected Car Critical Comms for 5G Enterprise IoT/drones/cars Smartphones First hybrid networks	6G 3D model with Network in Space 5G to 6G fully integrated NTN Converged terrestrial and ntn access extreme connectivity
10%-20% of devices support NTN Rel.17 and Proprietary support	20%-60% of devices support 5G NTN Rel.17/18 support	>90% of devices support 5G NTN Rel.19 onwards

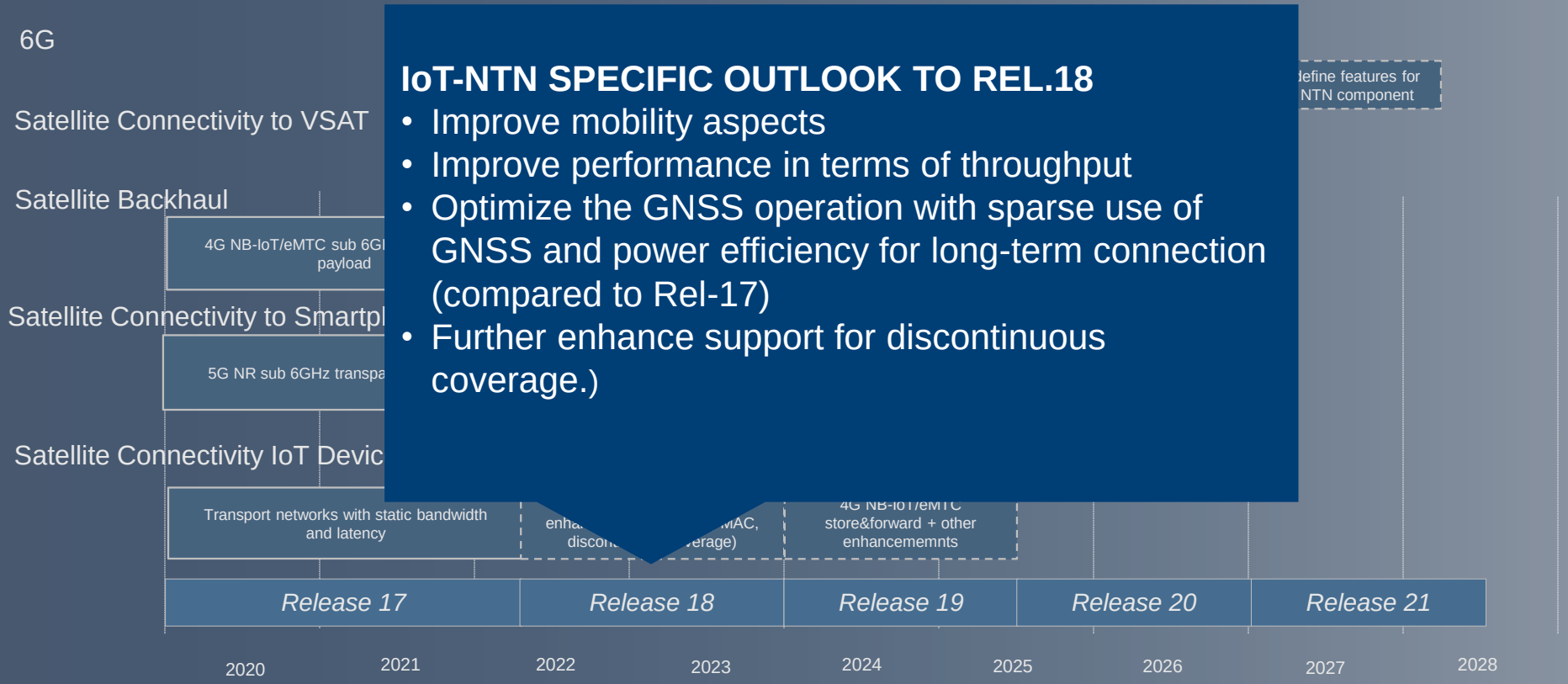
Testing needs for R&D antenna design, RF non-signaling, signaling, conformance, production, live network



NTN TENTATIVE 3GPP ROADMAP WITH PERSPECTIVE



NTN TENTATIVE 3GPP ROADMAP WITH PERSPECTIVE



IoT-NTN SPECIFIC OUTLOOK TO REL.18

- Improve mobility aspects
- Improve performance in terms of throughput
- Optimize the GNSS operation with sparse use of GNSS and power efficiency for long-term connection (compared to Rel-17)
- Further enhance support for discontinuous coverage.)

Find out more

www.rohde-schwarz.com/5G

THANK YOU

ROHDE&SCHWARZ

Make ideas real