

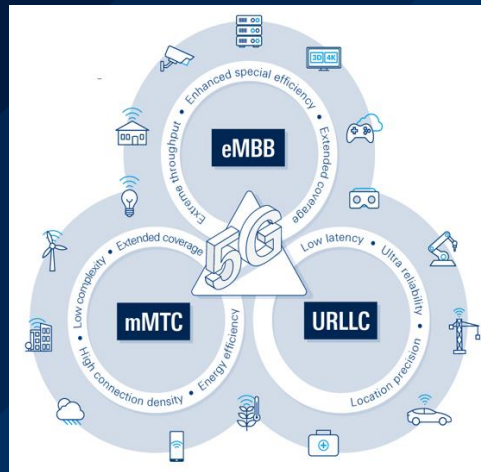
5G TODAY AND INTO THE FUTURE

A SHORT OVERVIEW OF IOT-NTN AND REDCAP

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Technology Manager Wireless

ROHDE & SCHWARZ

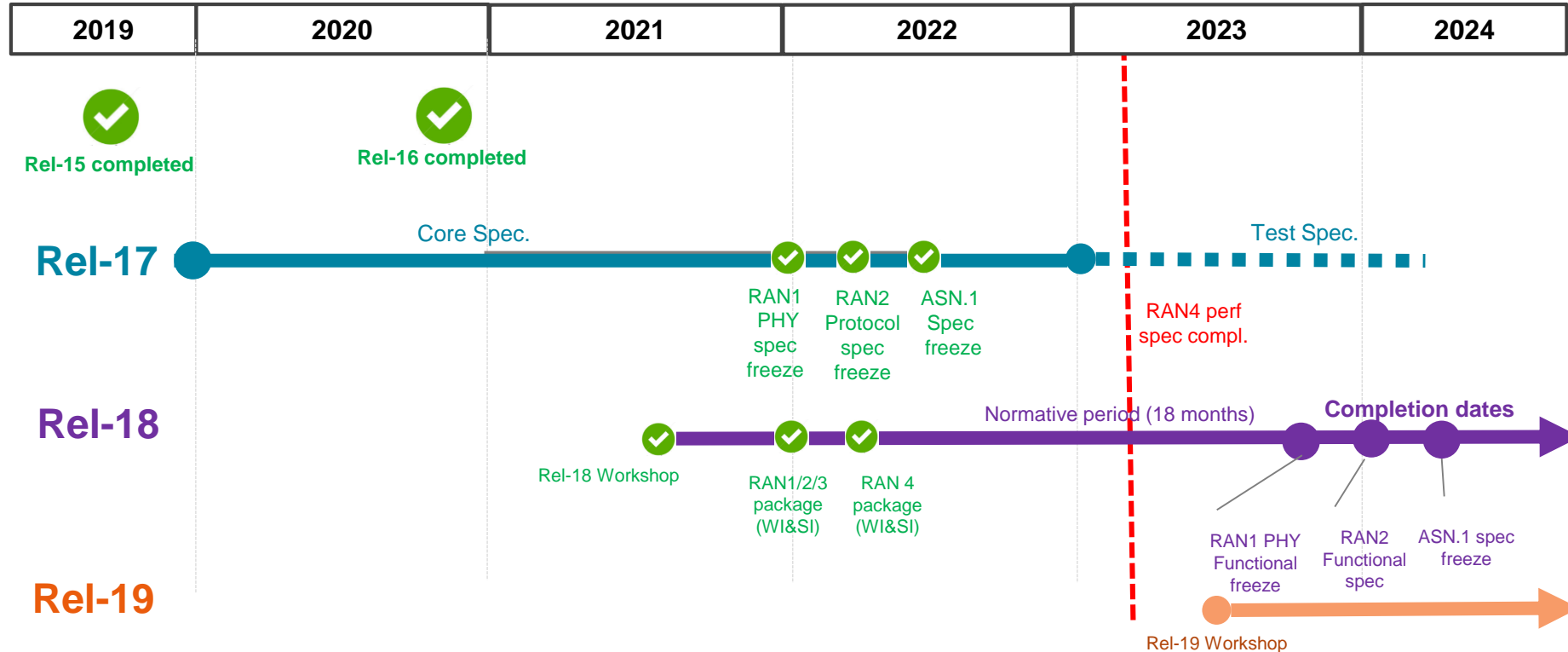
Make ideas real



3GPP RELEASE SCHEDULE

DECEMBER 2022

- Release 18 Plan unchanged
- Anticipated Spec. functional freeze
- Rel-19 Workshop planned

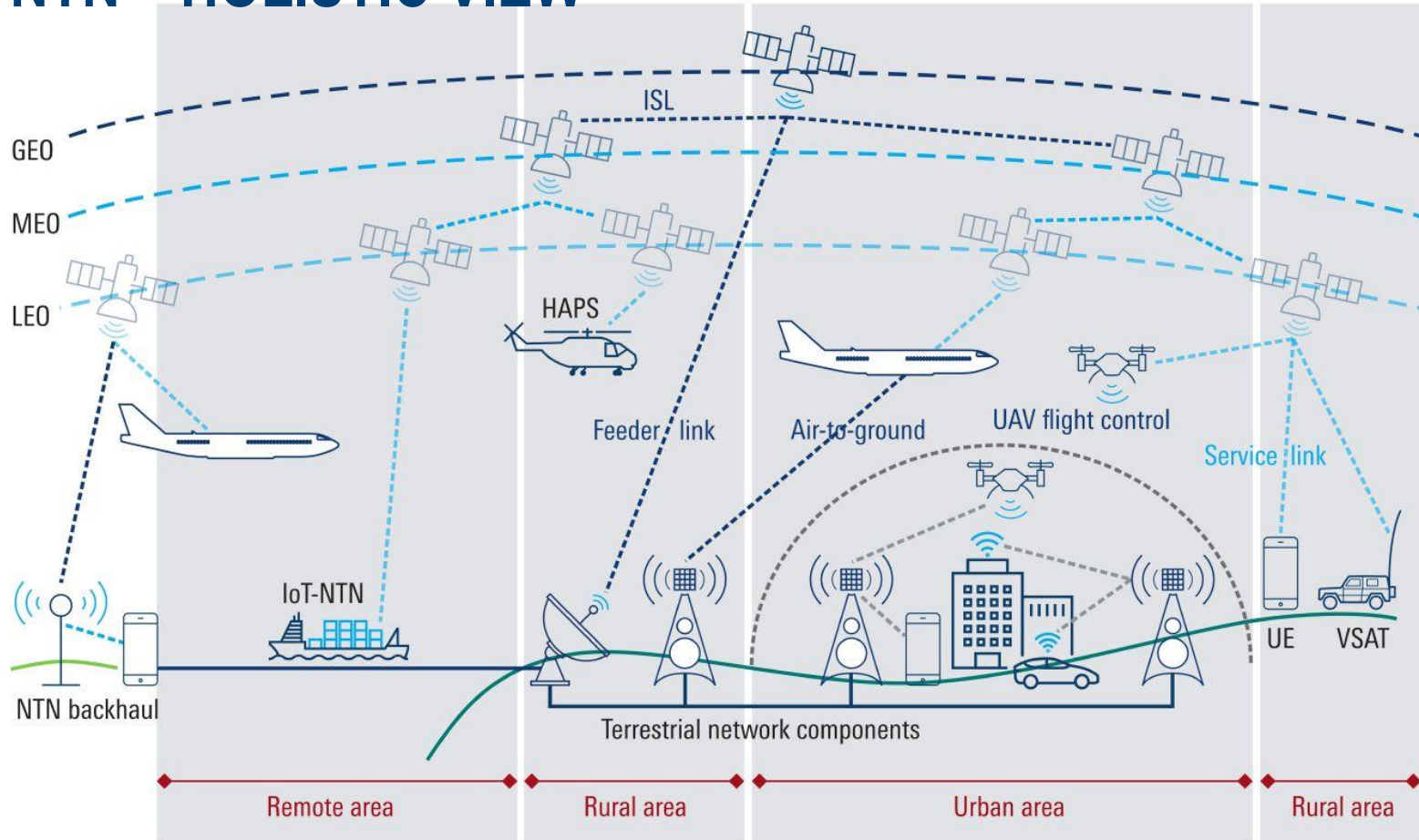




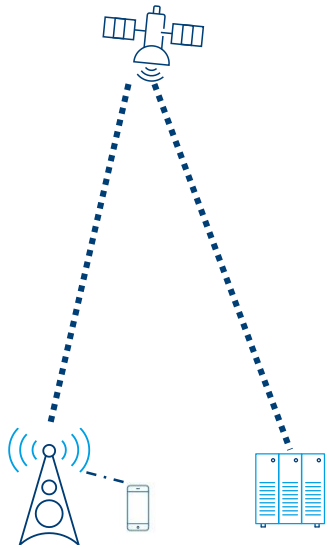
The ongoing evolution of 5G

NON-TERRESTRIAL NETWORKS

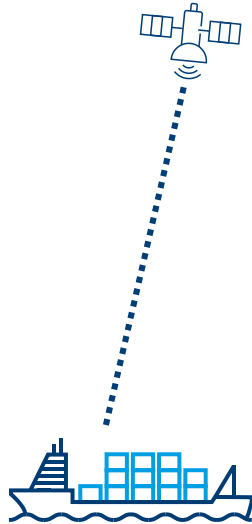
5G NTN – HOLISTIC VIEW



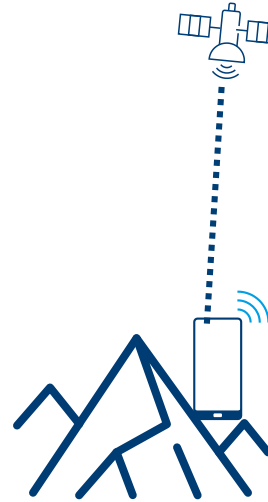
5G-NTN FOUR FACETS (PERSPECTIVE USE CASE)



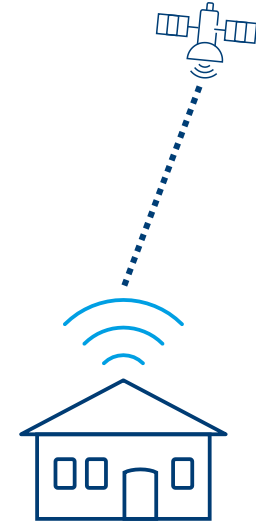
5G NTN backhaul



IoT-NTN



**NR-NTN
(handheld,
<6GHz)**



**NR-NTN
(VSAT,
>10GHz)**

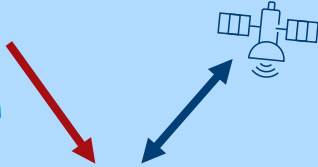


Non-terrestrial networks (NTN)

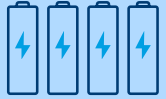
NB-IoT NTN & LTE-M NTN

IoT-NTN VS NR-NTN – CONCISE OVERVIEW

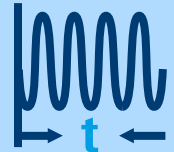
GNSS



- LTE-M and NB-IoT based
- Best effort QoS
- Low & sporadic throughput
- Worldwide coverage
- No or idle mode mobility only (NB-IoT)
- Connected mode mobility for LTE-M

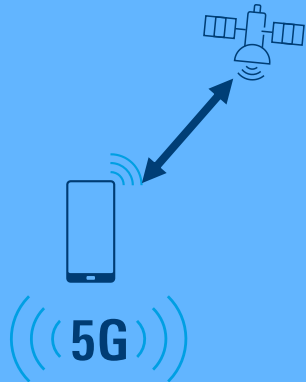


Energy constraint

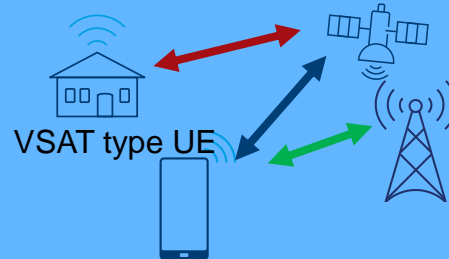


Frequency sub 6GHz

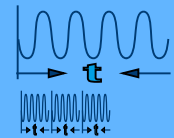
R17: UE support GNSS mandatory
R18: NTN without positioning



- 5G (&6G) based
- Long term evolution from interworking to unification
- Higher throughput envisaged
- Mobility scenarios
- Frequency extension FR2 + FR3?



Multiple mobility & dual connectivity scenarios



Frequency both FR1 + FR2

NB-IOT/EMTC SUPPORT FOR NTN - MOTIVATION

Motivation: Making the Internet of Things ubiquitous and global

Justification

- Industries where IoT operation is critical in remote areas:
 - Transportation, logistics, solar & oil industries, gas harvesting, farming; environmental monitoring, mining, etc.

UE types for IoT-NTN:

- Bandwidth limited, low complexity (BL UE) = LTE-M
- UE in coverage enhanced mode
- NB-IoT UEs

- NB-IoT and eMTC fit these use cases but suffer from low/no cellular connectivity.
 - Satellite connectivity it's required to provide global coverage beyond terrestrial deployments.

- Best effort QoS
- Delay tolerant
- Low throughput



Challenges:

- Link budget (UE = PC3 (23dBm))
- FR1 spectrum + Omnidirectional antenna (~1RX)
- Satellite accessibility vs. Battery consumption
- Doppler shift and timing advance

IoT-NTN: TRANSPARENT PAYLOAD ARCHITECTURE

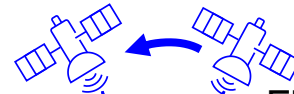
GEO and LEO orbit scenarios

GNSS

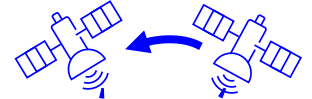


GEO = continental / regional service

LEO = regional service, e.g. polar regions as well (non-permanent accessibility)



Fixed or steerable beams possible



Serving link

Feeder link

Transparent repetition

Satellite can be served by multiple eNB
eNB can serve multiple satellites

Possible, but lower prio

Transparent repeat

FDD
<6GHz

UE

NTN gateway

eNB (NG-eNB)

EPC

Data network

NARROWBAND-IoT OVER NTN – PHYSICAL LAYER ASPECTS

The uplink and downlink total transmission bandwidth is 180 kHz (200kHz channel BW)

Downlink: OFDM with 15 kHz subcarrier spacing (1PRB)

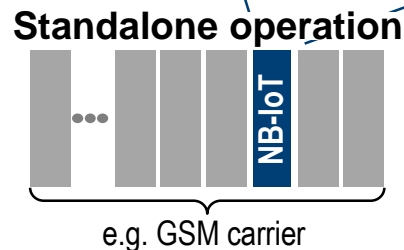
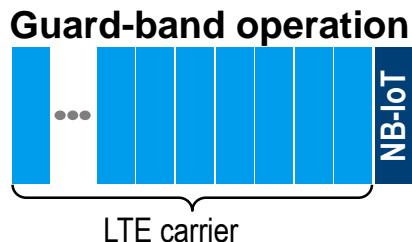
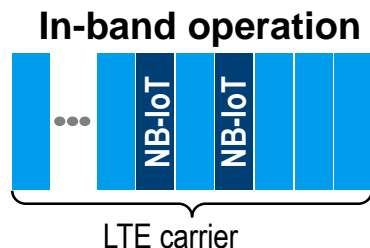
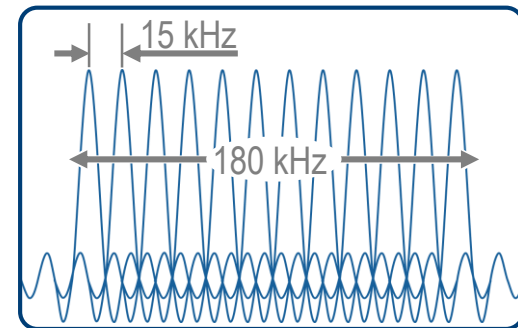
Uplink: SC-FDMA with 3.75 kHz and 15 kHz for single-tone transmissions and optional multi-tone transmissions with 15 kHz subcarrier spacing

Only FDD in **half-duplex mode** (analog to UE Cat. 0 half-duplex Type B)

Reduced downlink **transmission schemes (MIMO)**:

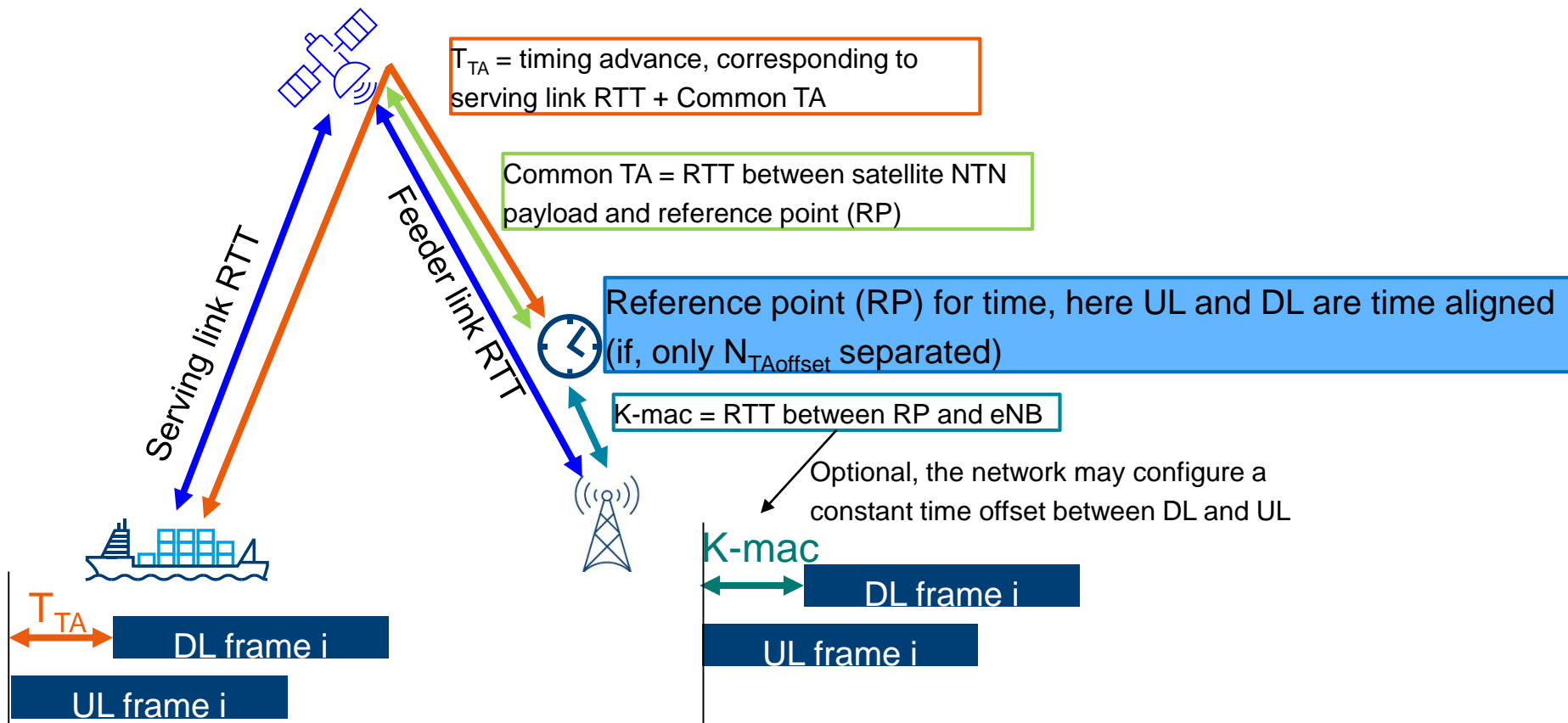
TM1: single antenna port, TM2: two antenna ports, using transmit diversity

Only **mobility** in IDLE mode is supported

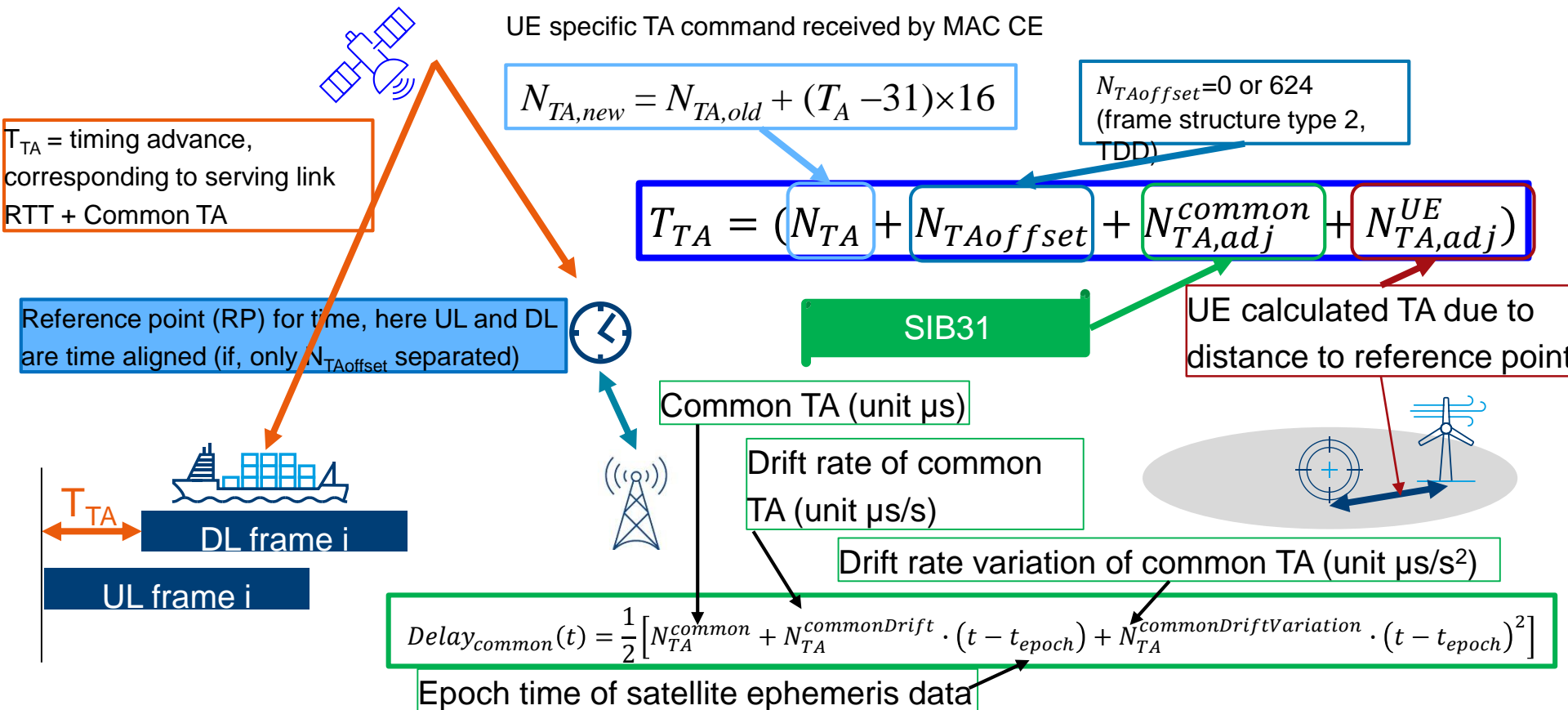


IoT-NTN potentially focus on standalone operation or guard-band operation (e.g. using NewSpace proprietary channels guard bands or in combination with NR-NTN)

NB-IoT-NTN – PHYSICAL LAYER ASPECTS, TIMING



NB-IoT-NTN – PHYSICAL LAYER ASPECTS, TIMING ADVANCE



IoT-NTN DISCONTINUOUS COVERAGE

UE faces discontinuous coverage.

UE predicts coverage & out of coverage periods

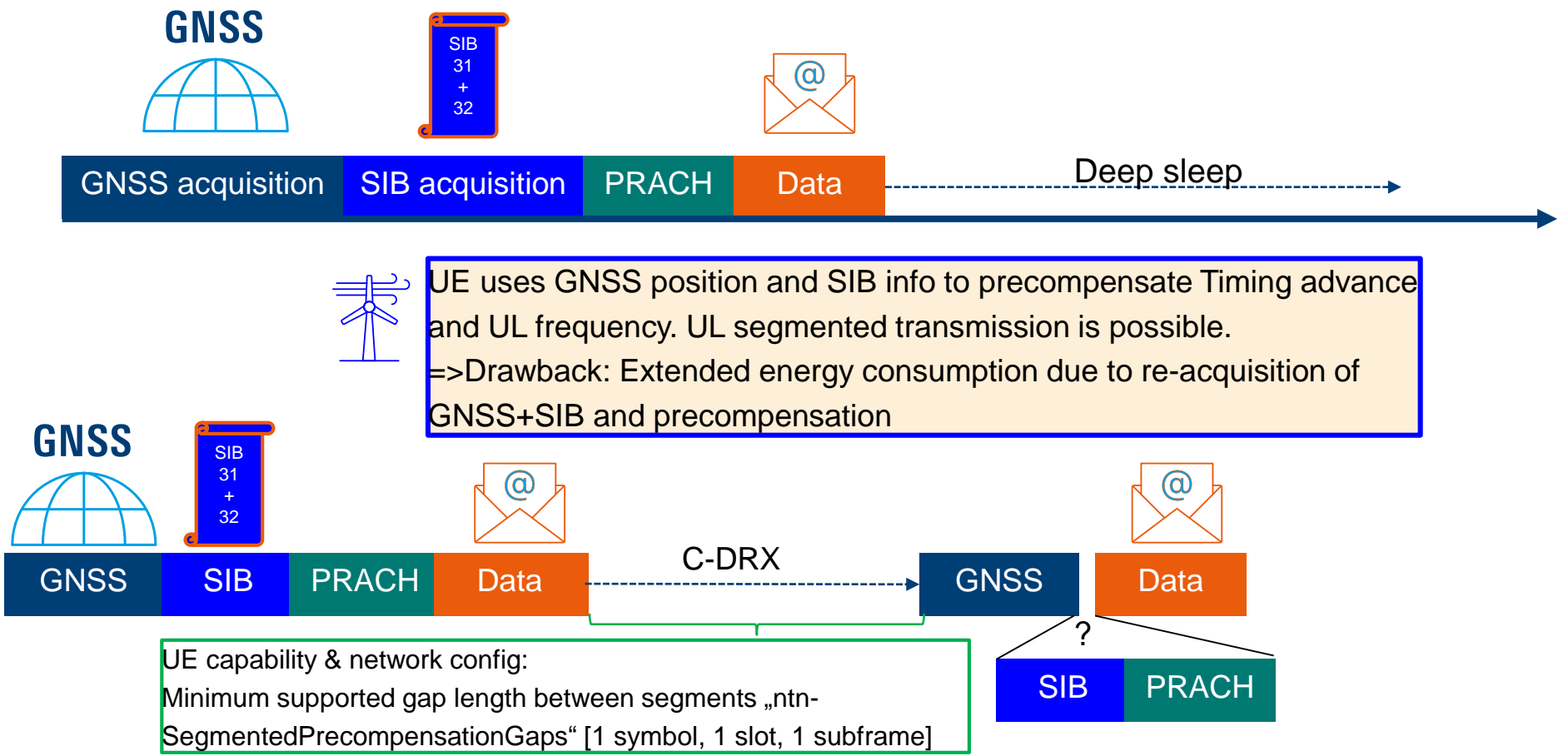
Sparse satellite constellations.
No permanent coverage

UE may stop cell retrieval steps when in „discontinuous coverage“ situations, to save battery

Ephemeris information in SIB32

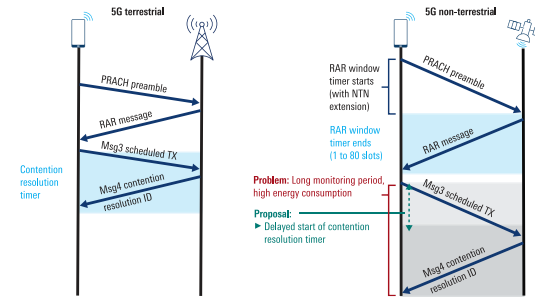
To enable UE DRX and power saving periods, the network supports with start-time of upcoming coverage info

IoT-NTN SHORT AND LONG CONNECTIONS, SEGMENTATION



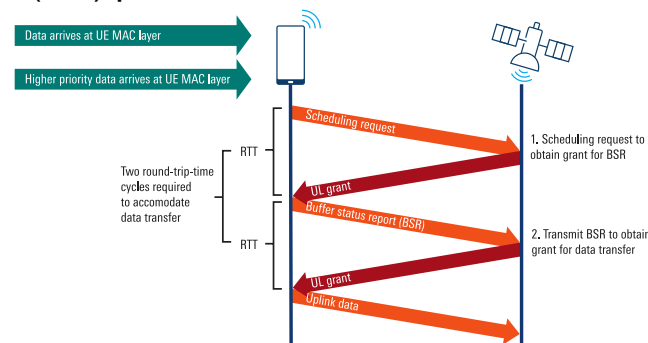
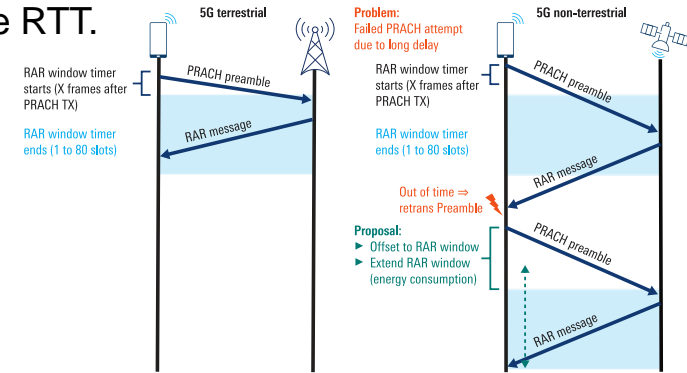
IoT-NTN MAC LAYER ENHANCEMENTS

MAC layer, timer extensions. Similar between NR-NTN and IoT-NTN



MAC layer enhancements

- Delay the start of the random access response (RAR) window by the RTT.
- Delay the start of the contention resolution timer by the RTT.
- Delay the start of the PUR response window by the RTT.
- Extend C-DRX DL/UL HARQ RTT Timer to include the RTT.
- Extend the Scheduling Request (SR) prohibit timer.



SYSTEM INFORMATION BLOCK TYPE 31

```
ServingSatelliteInfo-r17 ::= SEQUENCE {  
    ephemerisInfo-r17          CHOICE {  
        stateVectors            EphemerisStateVectors-r17,  
        orbitalParameters      EphemerisOrbitalParameters-r17    },  
    nta-CommonParameters-17    SEQUENCE {  
        nta-Common-r17          INTEGER (0..8316827)              OPTIONAL,  
        nta-CommonDrift-r17     INTEGER (-261935..261935)         OPTIONAL,  
        nta-CommonDriftVariation-r17 INTEGER (0..29479)           OPTIONAL },  
    ul-SyncValidityDuration-r17 ENUMERATED {s5, s10, s15, s20, s25, s30, s35,  
                                             s40, s45, s50, s55, s60, s120, s180, s240, s900},  
    epochTime-r17              SEQUENCE {  
        startSFN-r17            INTEGER (0..1023),  
        startSubFrame-r17       INTEGER (0..9)  
    } OPTIONAL,  
    k-Offset-r17               INTEGER (0..1023),  
    k-Mac-r17                  INTEGER (1..512)                  OPTIONAL,  
    ... }
```

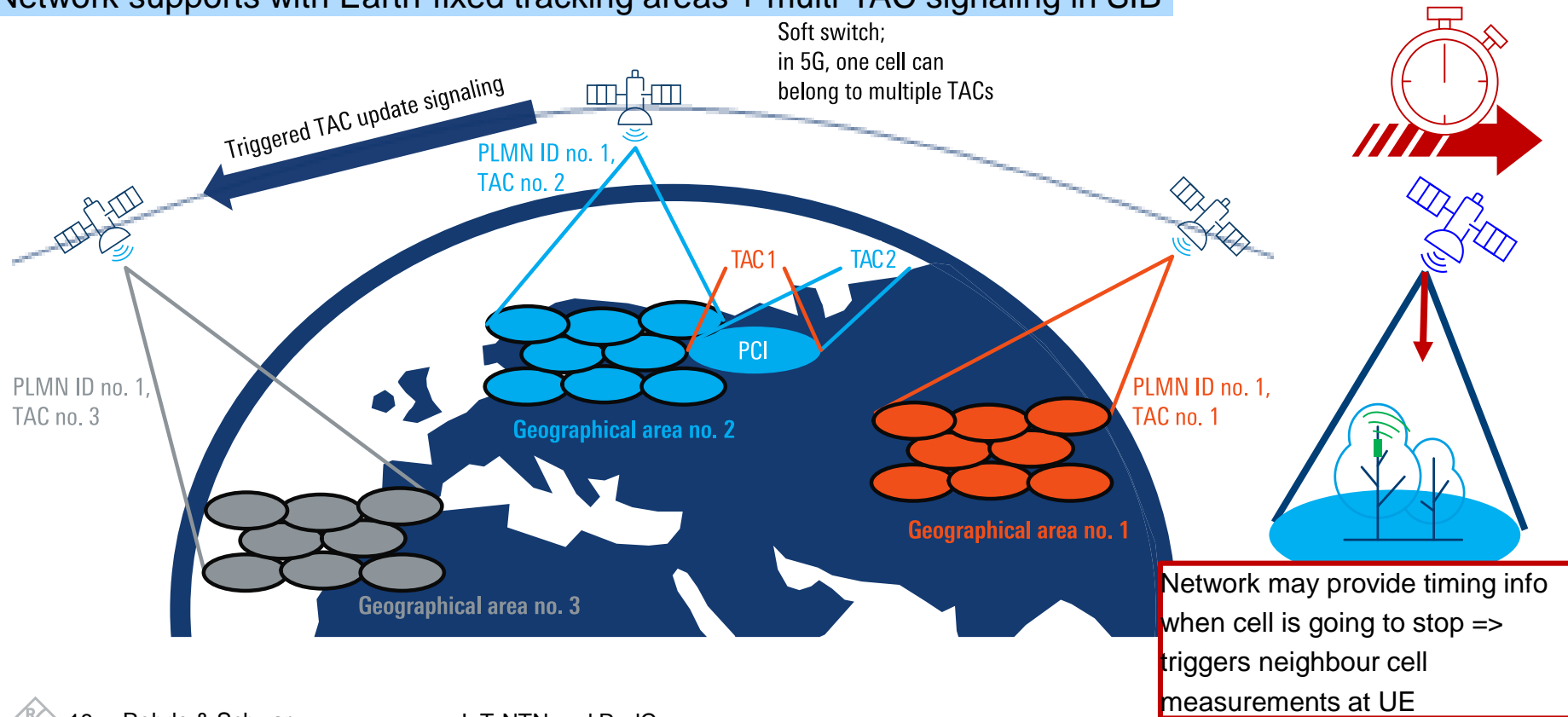
SYSTEM INFORMATION BLOCK TYPE 32

SatelliteInfoList-r17 ::= SEQUENCE (SIZE (1..maxSat-r17)) OF SatelliteInfo-r17

```
SatelliteInfo-r17 ::=          SEQUENCE {
    satelliteId-r17              INTEGER (0..255),
    serviceInfo-r17              SEQUENCE {
        tle-EphemerisParameters-r17 TLE-EphemerisParameters-r17    OPTIONAL,
        t-ServiceStart-r17          TimeOffsetUTC-r17                OPTIONAL
    },
    footprintInfo-r17           SEQUENCE {
        referencePoint-r17      SEQUENCE {
            longitude-r17         INTEGER (-131072..131071),
            latitude-r17          INTEGER (-131072..131071)
        } OPTIONAL, -- Need OR
        elevationAngles-r17    SEQUENCE {
            elevationAngleRight-r17 INTEGER (-14..14),
            elevationAngleLeft-r17  INTEGER (-14..14)                OPTIONAL
        } OPTIONAL,
        radius-r17              INTEGER (1..256)                    OPTIONAL -- Need OR
    }
}
```

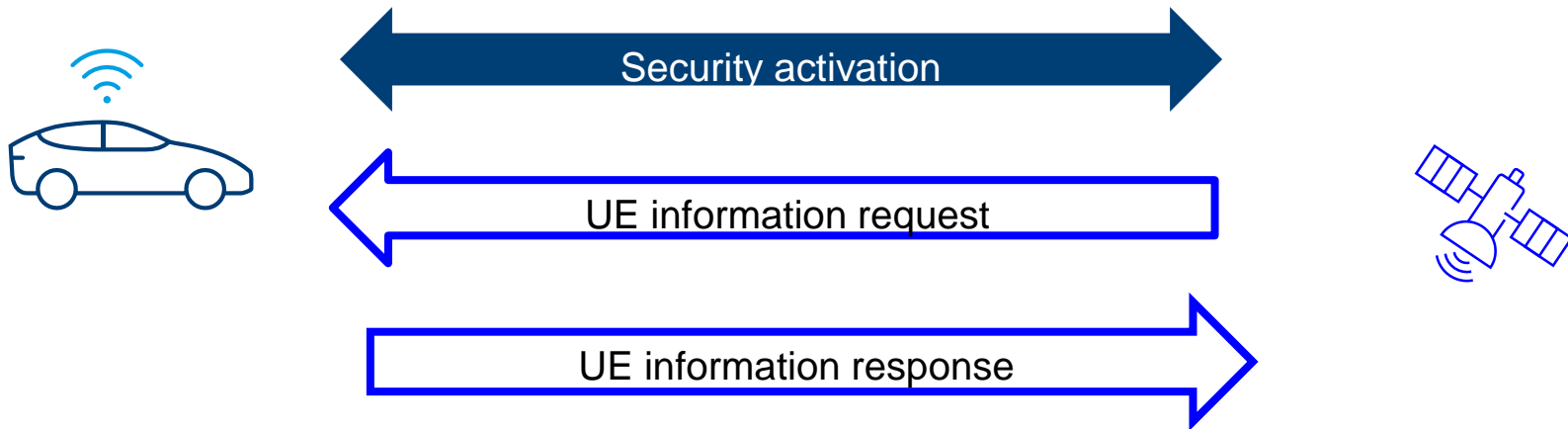
IoT-NTN NON-ACCESS STRATUM (NAS), TAC SIGNALING

Network supports with Earth-fixed tracking areas + multi-TAC signaling in SIB



IoT-NTN UE INFORMATION REQUEST & REPORTING

Network may retrieve information from the UE



May include:




- RACH info: #preambles and contention resolution result
- Coverage enhancement level or initial NRSRP level
- Radio link failure (RLF) report
- Logged measurement results
- Coarse location info (accuracy $\pm 2\text{km}$)

5G NTN RELEASE 17: NR-NTN VERSUS IOT-NTN

Scenarios and general

	NR-NTN	NB-IoT-NTN	eMTC-NTN
Support for GEO, MEO, LEO, HAPS	✓	✓	✓
Payload type	Transparent	Transparent	Transparent
Cell-ID/CGI corresponds to fixed geographical areas	✓	✓	✓
Support for sporadic short-data transmission	✗	Main use case	Main use case
Support for soft and hard feeder link switchover	✓	✓	✓
GNSS support for TA estimation and frequency pre-compensation	✓	✓	✓
Support for indication of DL/UL polarization information	✓	✗	✗
TDD/FDD	No TDD bands	FDD only	FDD only
Support of discontinuous coverage	✗	SIB32-NB ✓	SIB32 ✓
Broadcast of satellite assistance information for the serving cell (state vectors or orbital parameters format)	SIB19 ✓	SIB31-NB ✓	SIB31 ✓

5G NTN RELEASE 17: NR-NTN VERSUS IOT-NTN

Mobility			
	NR-NTN	NB-IoT-NTN	eMTC-NTN
Connected mode mobility	Enhancements to conditional handover (CHO) Time-based triggered Location-based triggered	Rel. 16 radio link failure and connection re-establishment procedures	Rel. 16 conditional handover scenarios
Broadcast information on when a cell is going to stop serving the area for cell re-selection and cell measurements in quasi-earth fixed cell scenarios	T-Service in SIB19	T-Service in SIB3-NB	T-Service in SIB3
Terrestrial <-> non-terrestrial handover		 Not explicitly disallowed – may work.	 Not explicitly disallowed – may work.

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.

▪ Performance and power consumption enhancements:

- Disabling HARQ feedback.
- Improved GNSS operations during long connection times.
- Reduced GNSS power consumption.

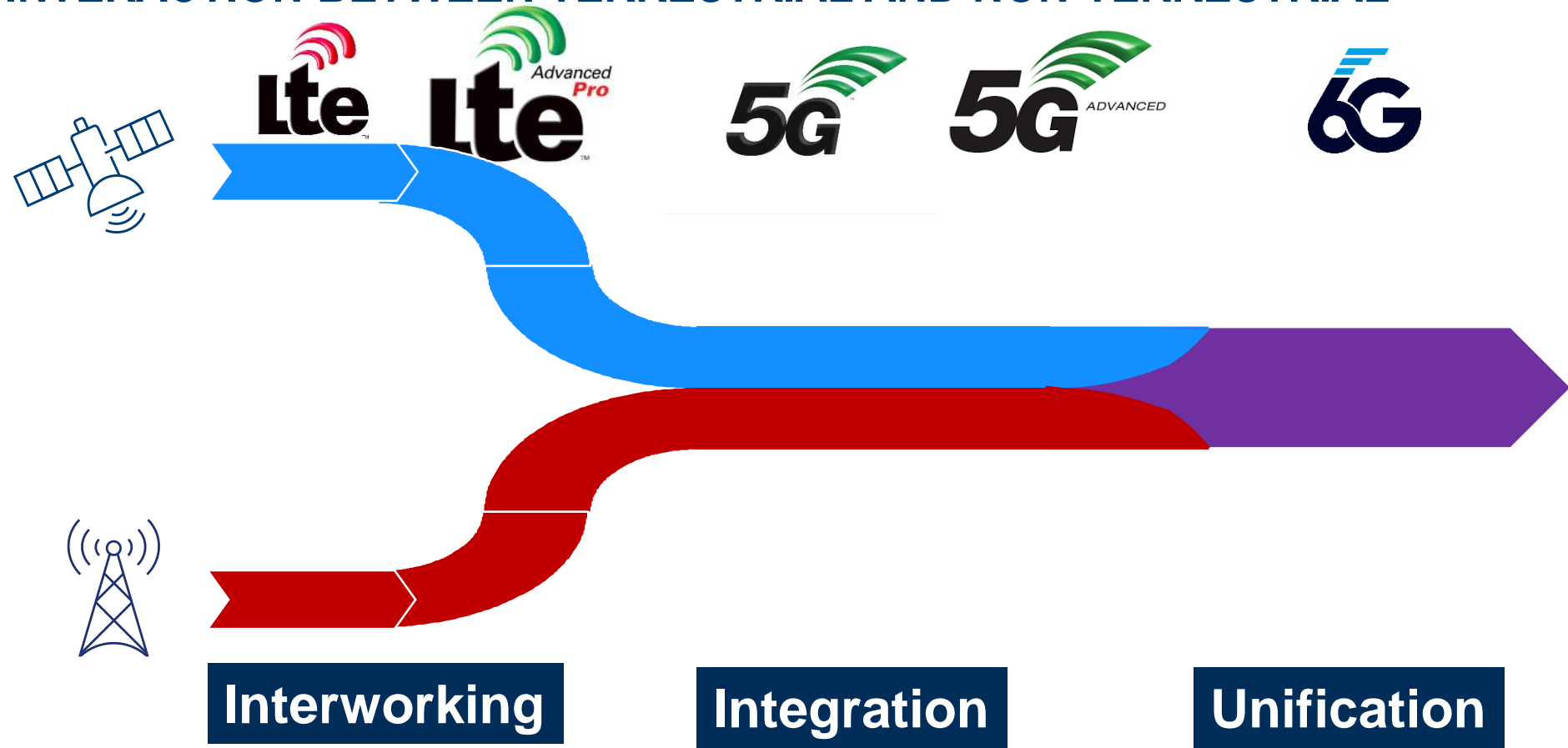
▪ Discontinuous coverage enhancements:

- Power saving mechanism for sparse constellations.
- Enhancements to RRC reestablishment for discontinuous coverage.

▪ Mobility Enhancements:

- Enhancements on RLF/RRC reestablishment (e.g. conditional RRC reestablishment).
- Adoption of mobility solutions introduced in Rel-17 NR-NTN for eMTC (e.g. location/timing-based CHO)
- Adoption of Rel-17 NB-IoT RLF and carrier selection enhancements.

INTERACTION BETWEEN TERRESTRIAL AND NON-TERRESTRIAL

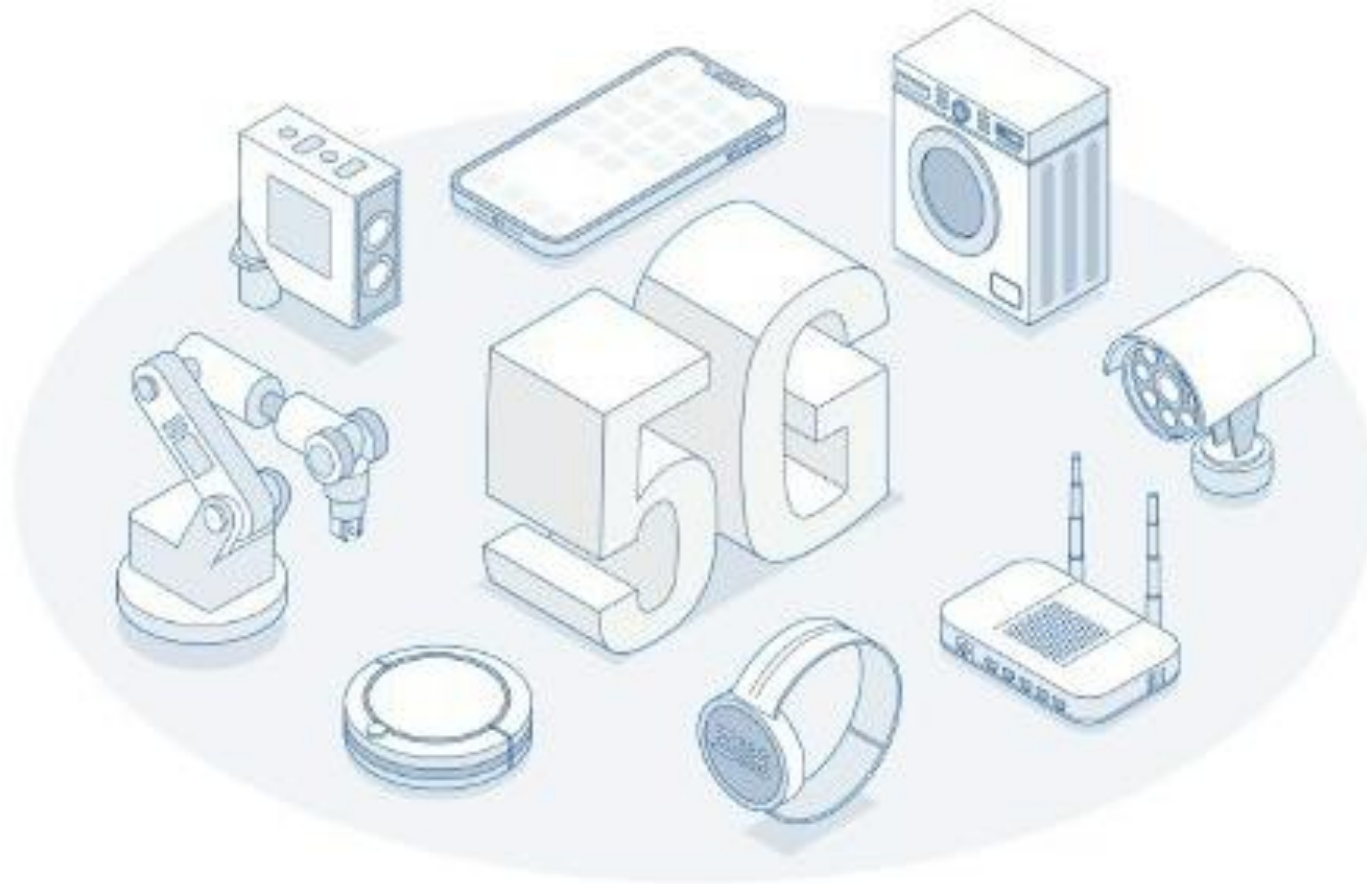




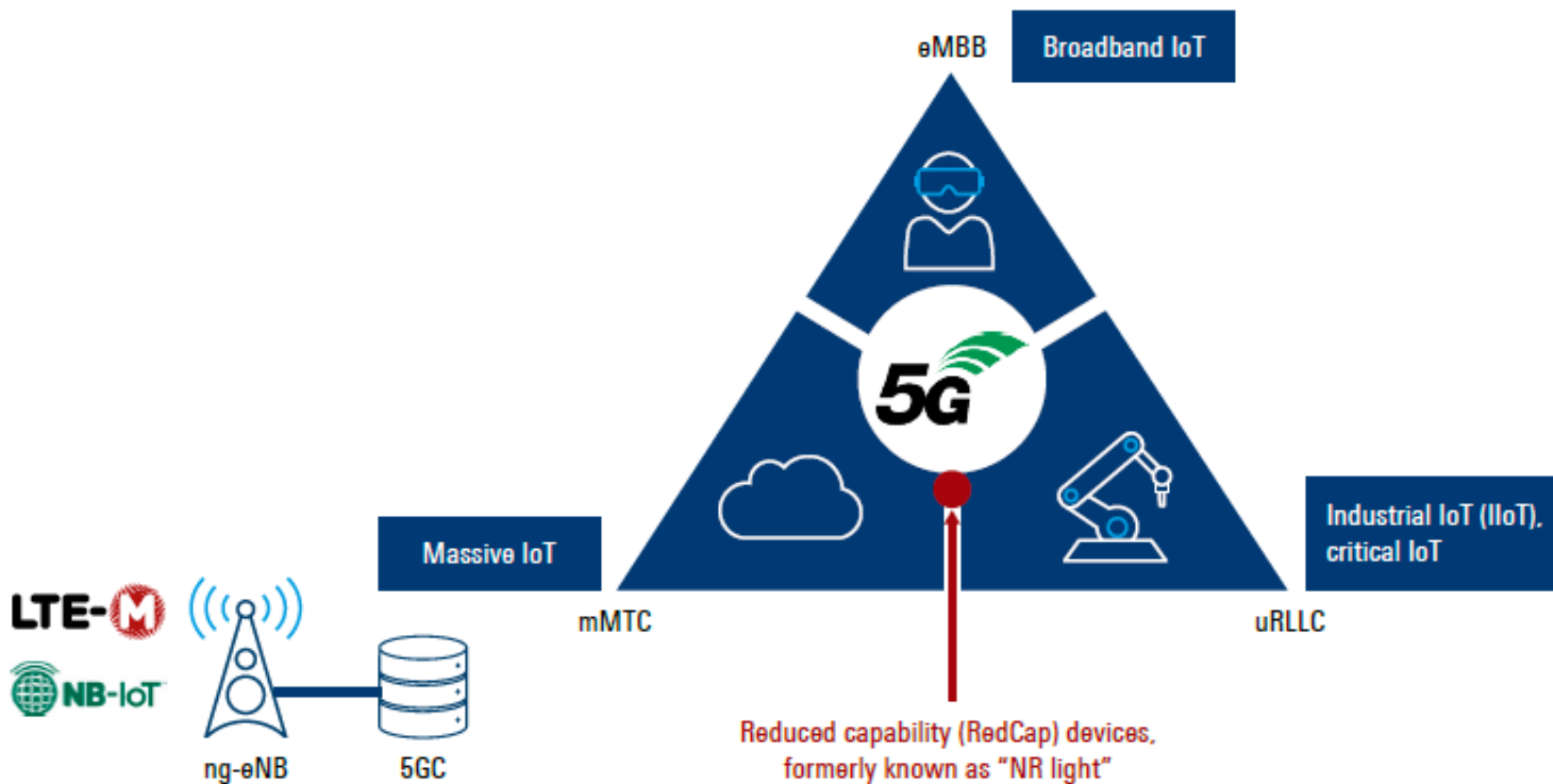
The ongoing evolution of 5G

REDUCED CAPABILITY (RedCap)

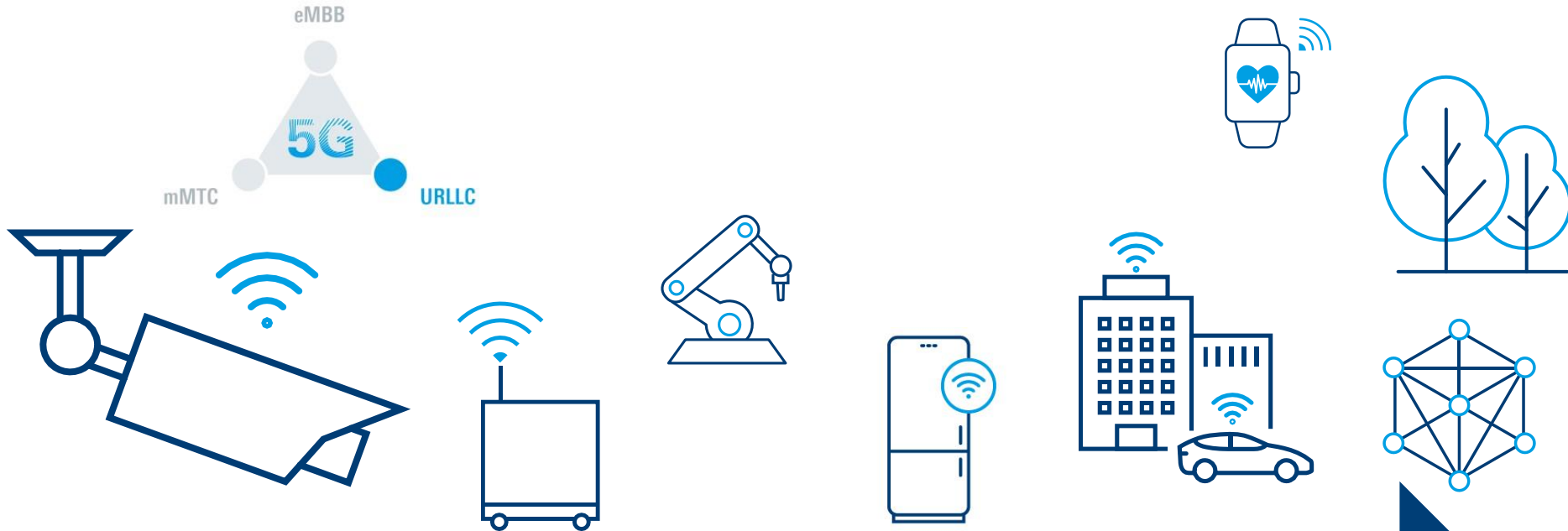
5G NR: Reduced capability (RedCap)



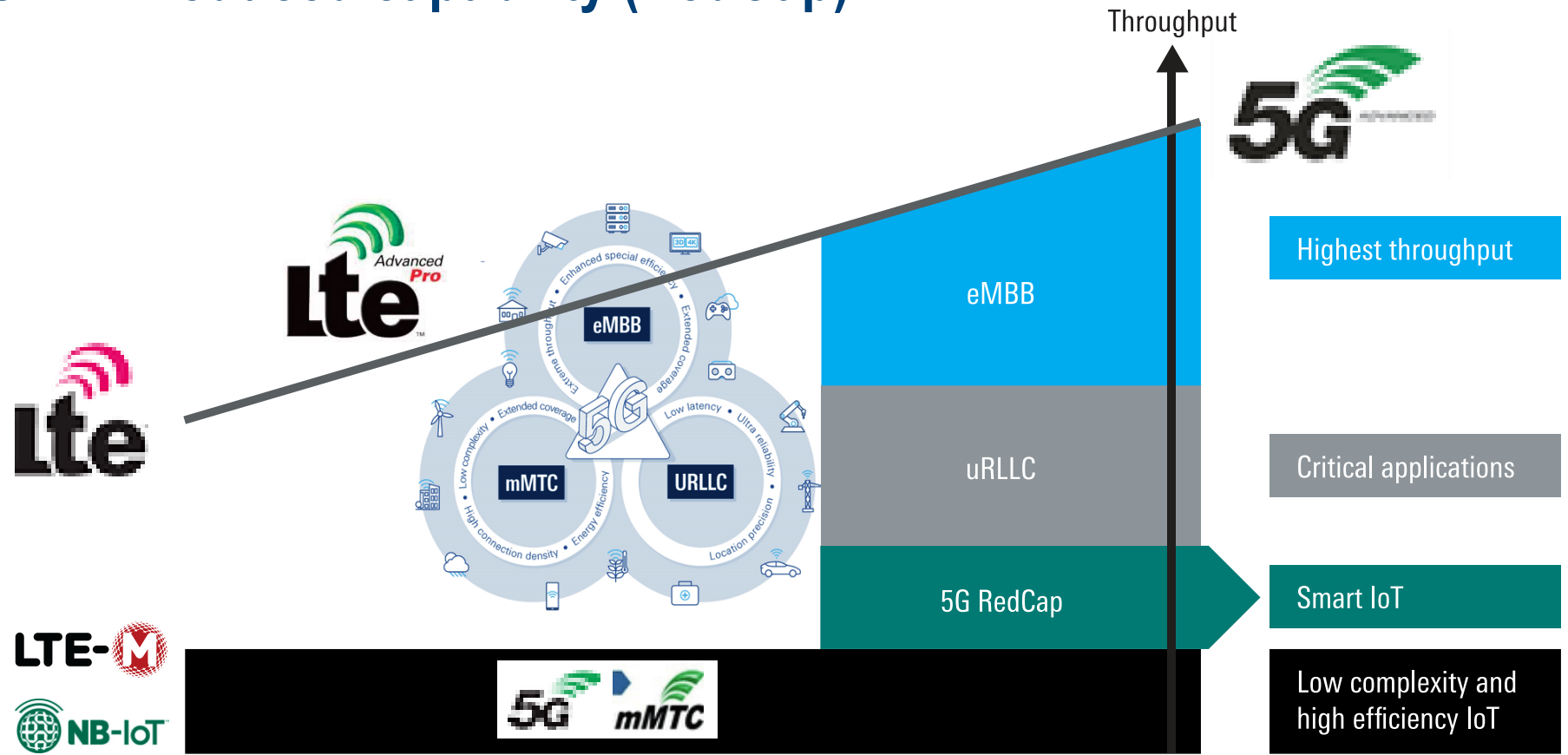
5G NR: Reduced capability (RedCap)



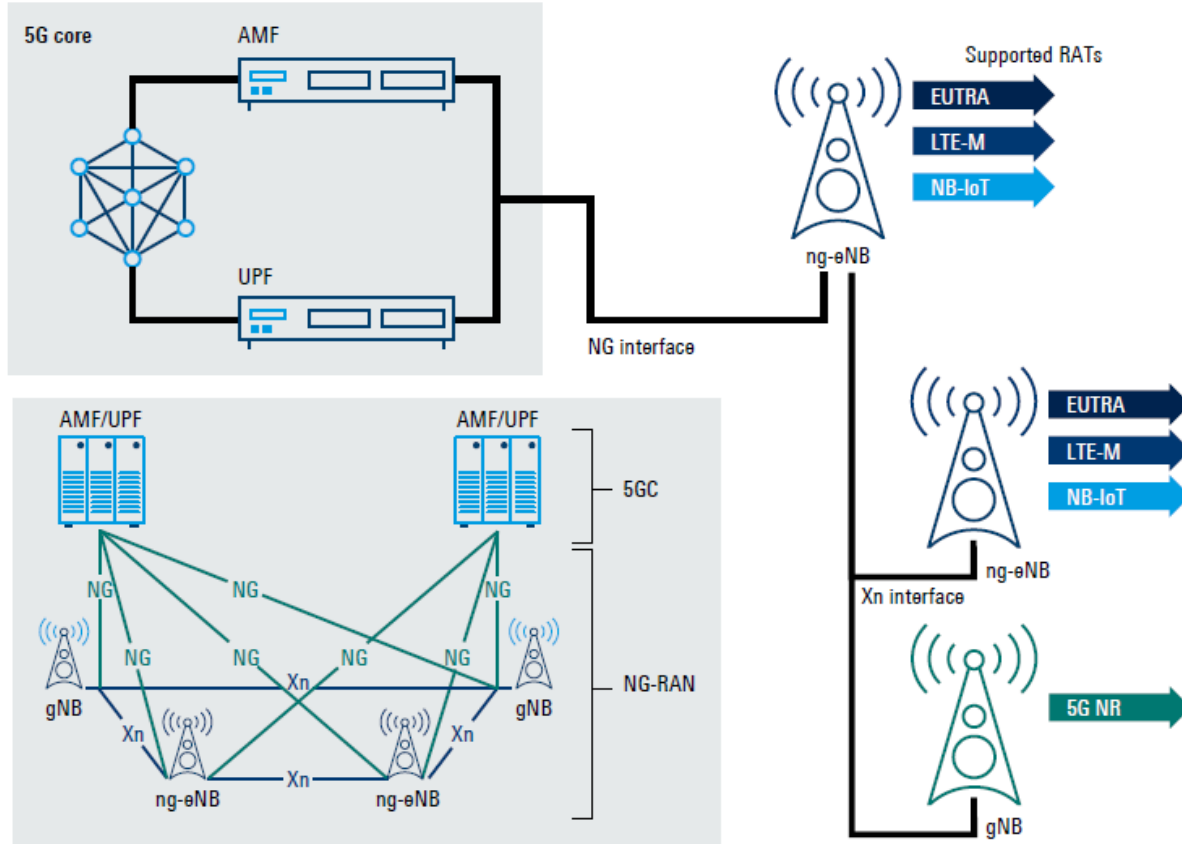
5G NR REDUCED CAPABILITY MOTIVATION & JUSTIFICATION



5G NR: Reduced capability (RedCap)



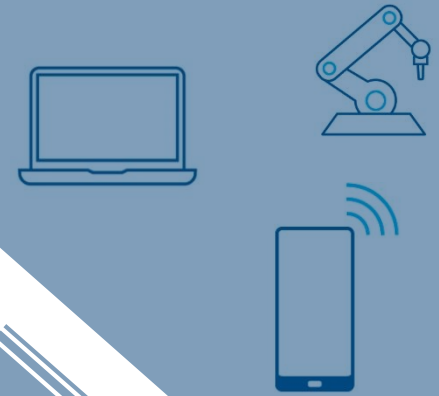
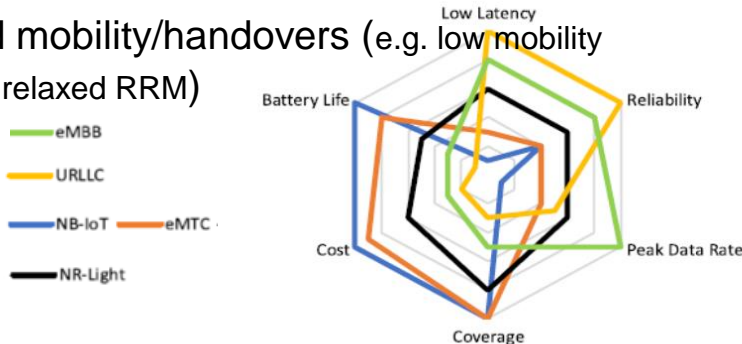
5G NR NEXT GENERATION eNodeB



DEVICE OPTIMIZATION TOPICS

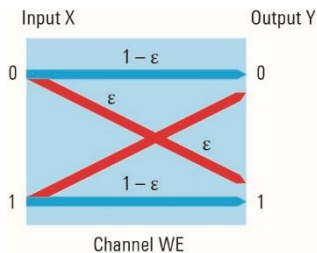
► Reduced capability (RedCap)

- 20 MHz (FR1), 100MHz (FR2)
- 1 or 2 Rx (more complex in reality: MIMO, FR1/2 etc.)
- 1 TX antenna
- 256QAM optional (FR1)
- Half duplex FDD (but full-duplex is optional)
- Lower transmit power (e.g. power class 7 for some bands in FR2)
- Limited mobility/handovers (e.g. low mobility devices, relaxed RRM)

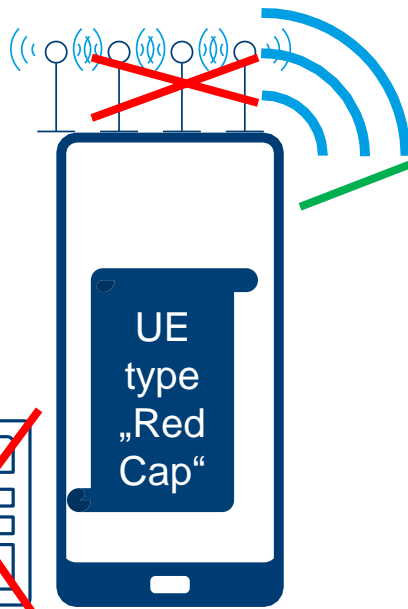


5G NR REDUCED CAPABILITY - OBJECTIVES

Reduce #layers in MIMO



Reduce #antennas



SIB info to allow RedCap UE to camp on cell

Early RedCap UE identification



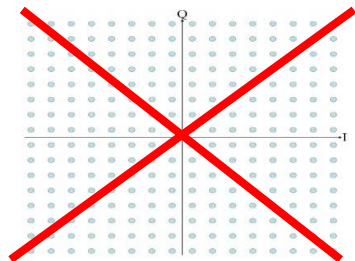
Reduced bandwidth



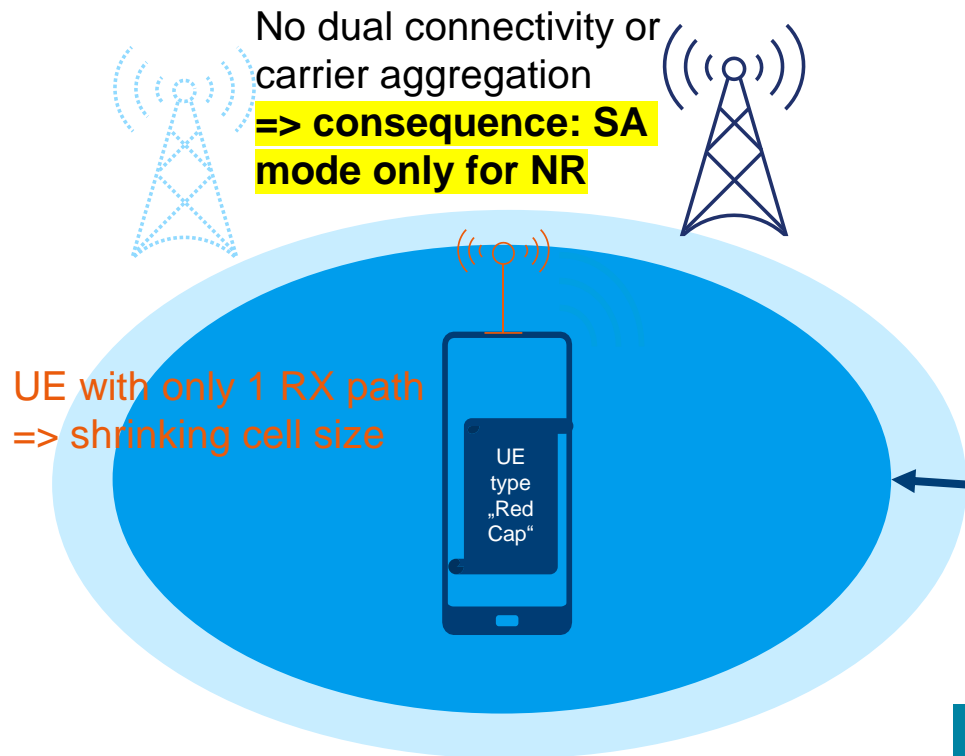
Half duplex operation



Relaxed UE RRM measurements



5G NR REDUCED CAPABILITY - OBJECTIVES



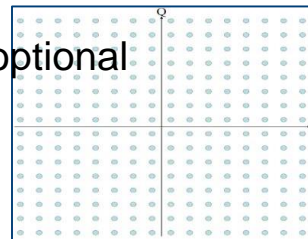
Reduced bandwidth

20 MHz

100 MHz

FR1 max 20 MHz and FR2 max 100 MHz
=> Longer SSB acquisition

256QAM optional

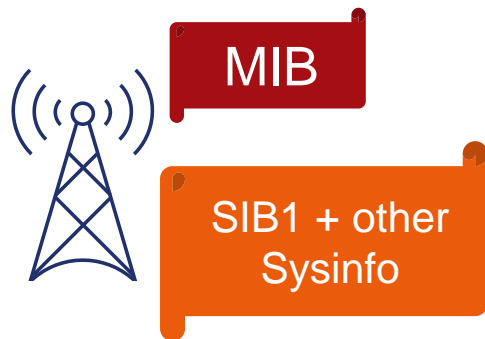


Half duplex operation



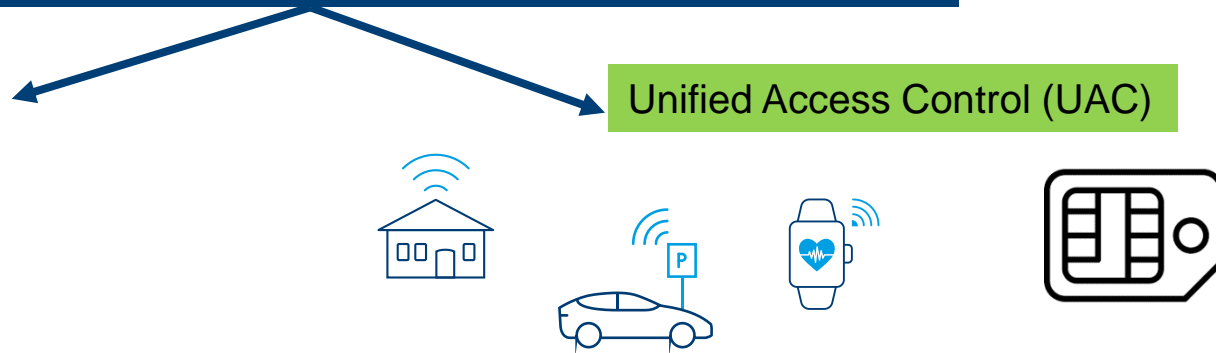
5G NR CELL CELL RESERVATIONS AND ACCESS RESTRICTIONS

Reminder: 5G NR defines two mechanisms to impose cell reservations and access restrictions



e.g. cellBarred

System info broadcast to indicate cell status + special reservations for the control of cell selection & reselection [TS 38.304]



e.g. UAC-BarringInfoSetList

Access barring check associated with given Access Category and Access Identities [TS 38.331]

5G NR REDCAP: SYSTEM INFORMATION ASPECTS

intraFreqReselectionRedCap

cellBarredRedCap1Rx

SIB1

cellBarredRedCap2Rx

halfDuplexRedCap-Allowed

featurePriorities

- *redCapPriority-r17*
- *slicingPriority-r17*
- *ce-Priority-r17*
- *sdt-Priority-r17*

SIB2

relaxedMeasurement

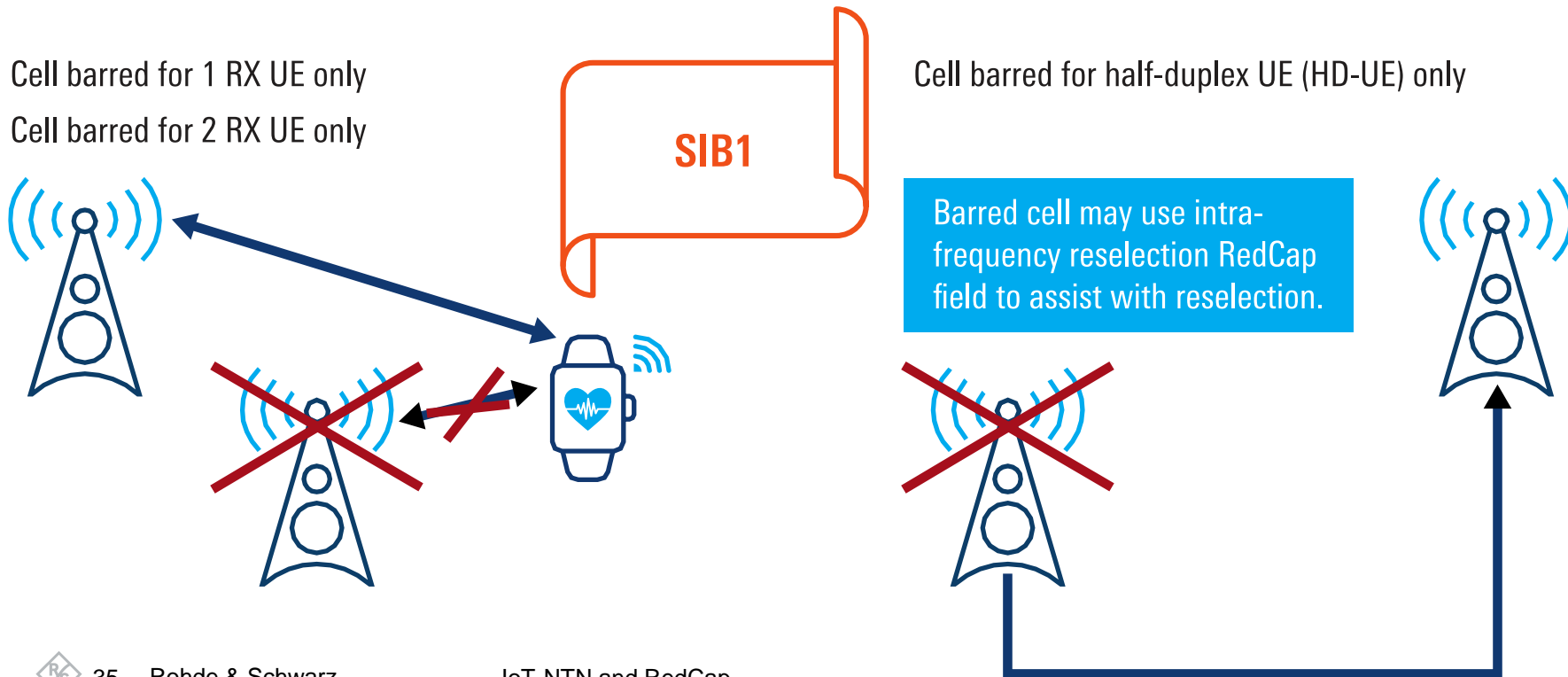
SIB4

InterFreqCarrierFreqInfo

redcapAccessAllowed

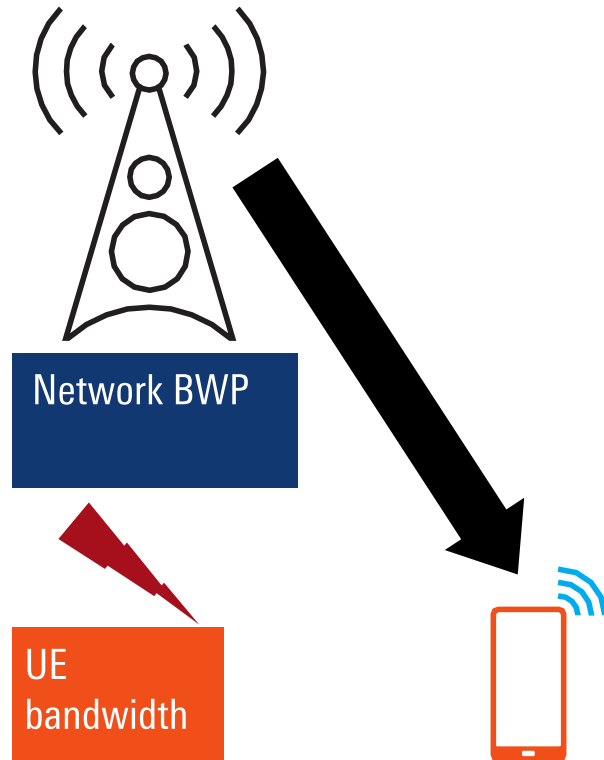
5G NR REDCAP: CELL BARRING ASPECTS

Network can restrict access on cell level! Specific for RedCap features! But: There is no "RedCap-only" cell!



5G NR REDCAP – BANDWIDTH PART (BWP) ASPECTS

Reminder: The BWP is configured via SIB, e.g. “*BWP-DownlinkCommon*”.



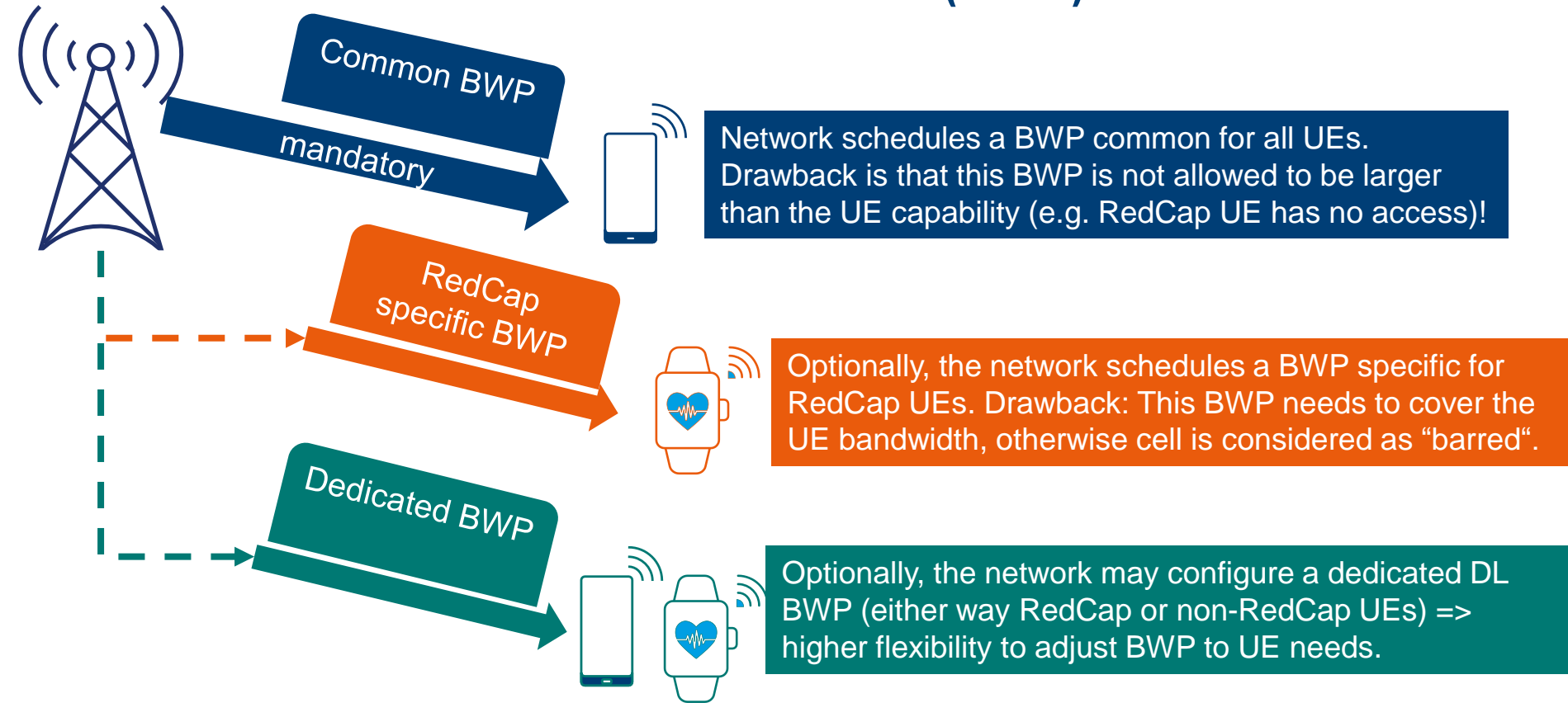
TS38.213 about RedCap UE:

“A UE expects the initial DL BWP and the active DL BWP after the UE (re)establishes dedicated RRC connection to be **smaller than or equal to the maximum DL bandwidth** that the UE supports”.

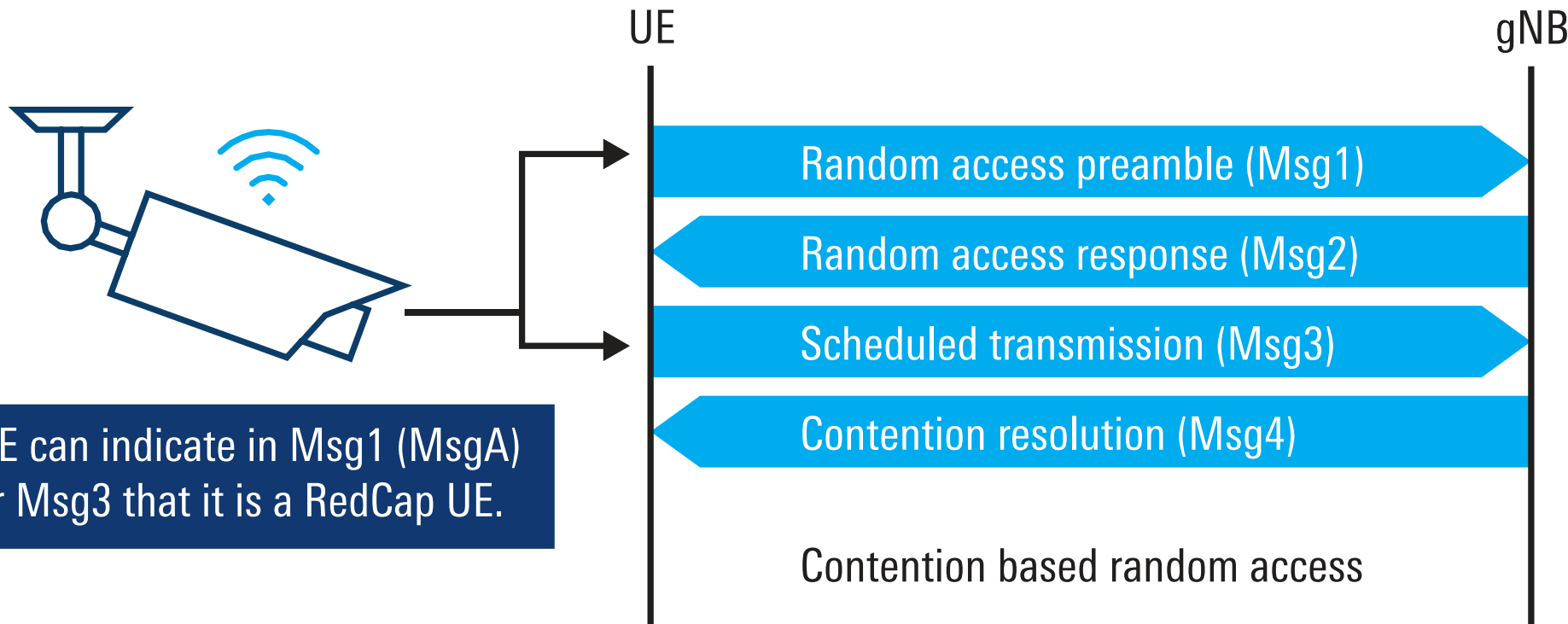
Possible conflict!

- ▶ If the network schedules a BWP wider than the RedCap UE bandwidth capability
- ▶ 3GPP introduced the possibility of a RedCap-specific BWP (in fact, two possibilities: RedCap_common or UE_dedicated)

5G NR REDCAP – BANDWIDTH PART (BWP) OVERVIEW

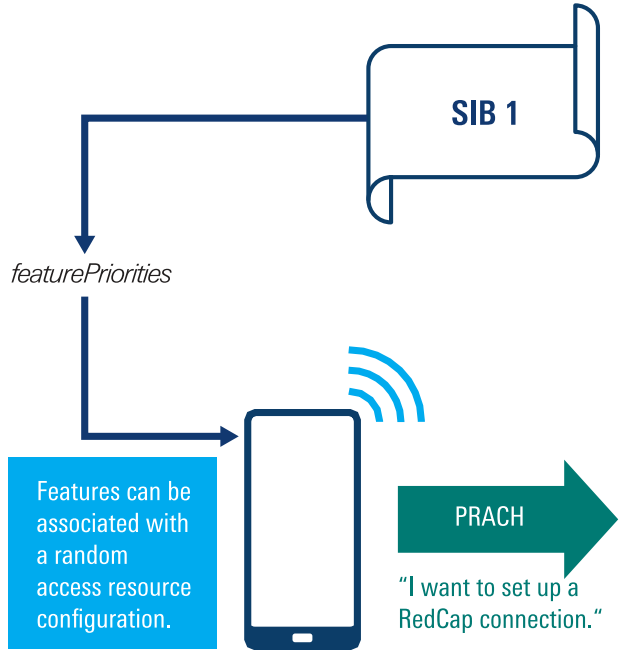


5G NR REDCAP – EARLY UE IDENTIFICATION



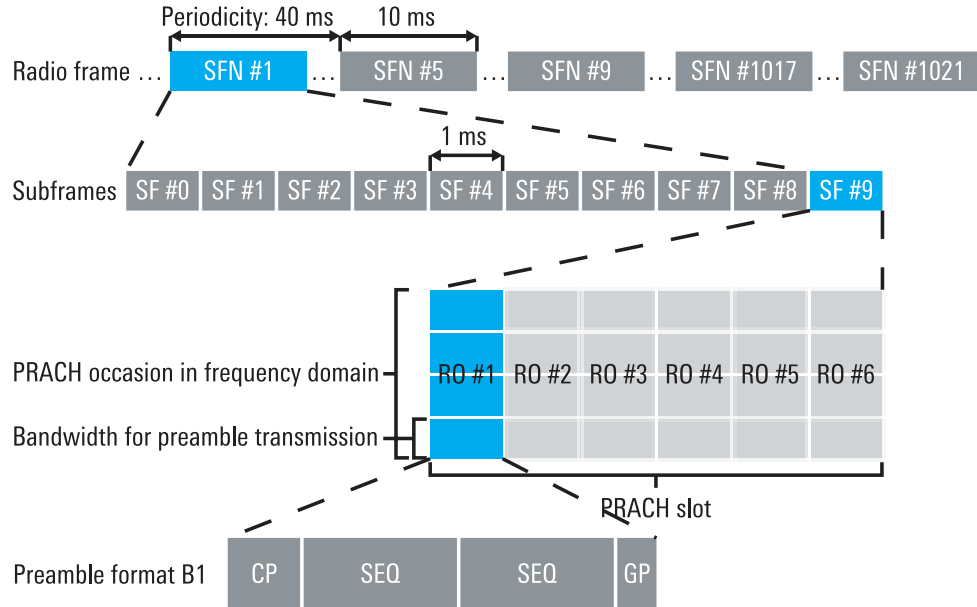
5G NR REDCAP: RANDOM ACCESS ASPECTS

Reduced capability UE may be permitted to indicate RedCap in Msg1 transmission already.



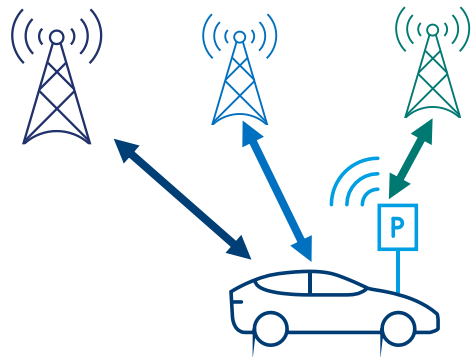
The network may configure a PRACH resource for RedCap indication
⇒ UE selects RACH preamble associated with those features.

PRACH configuration index:

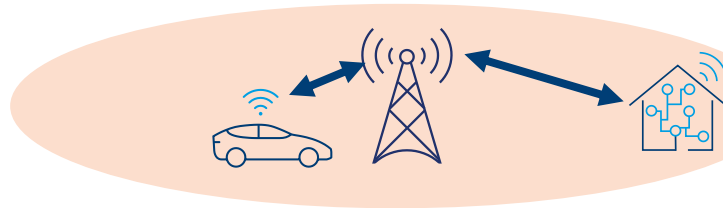


5G NR REDCAP: RELAXED MEASUREMENT ASPECTS

To reduce complexity and energy consumption, the network can configure the RedCap UE for relaxed measurements [TS 38.304]



Relaxed measurement rules for intra-frequency, inter-frequency and inter-RAT measurements



Motivation:

- Stationary devices
- Devices not at the cell edge

Relaxed measurement criterion for stationary RedCap UE (RRC connected):

When „relaxed measurement“ condition is true, the UE performs less measurements (larger DRX cycles)

$$(S_{rxlev}_{RefStationary} - S_{rxlev}) < S_{SearchDeltaP-Stationary}$$

Time period over which the S_{rxlev} variation is evaluated for stationary criterion for relaxed measurement.

$$T_{SearchDeltaP-Stationary}$$

REDUCED CAPABILITIES IN REL. 18

RedCap evolution	5G eMBB	Rel. 17	Rel. 18
Bandwidth	100 MHz	20 MHz	5 MHz
Peak rate	2 Gbps	100 Mbps	10 Mbps
Cost assessment	100%	-60%	-71%



Future railway mobile communications system (FRMCS)

- 2*5.6 MHz FDD (874.4 – 880 MHz / 919.4 – 925 MHz)
- Parallel operation: GSM-R and NR
- ~3.6 MHz available for NR



Public protection and disaster relief (PPDR)

- 2*3 MHz FDD in band n28

UE POWER SAVING + COMPLEXITY REDUCATION TRIANGLE

Hardware restrictions and reduced capabilities:

- Lower power class
- Single antenna
- Half-duplex operation
- Bandwidth restrictions
- Etc.

Enhanced mechanisms & innovations:

- Wake-up signals
- Relaxed measurements
- Adaptive bandwidth
- Etc.



Operational enhancements:

- Discontinuous reception (DRX)
- Sleep mode
- Power save mode (PSM)
- Signaling reduction, i.e. TAU
- Cross-slot scheduling
- Etc.



5G NR POWER SAVING ASPECTS – OVERVIEW

Bandwidth part (BWP= switching)

Max of DL MIMO layers configurable per active BWP

Wake up signal introduction, scheduled by PDCCH

Cross-slot scheduling

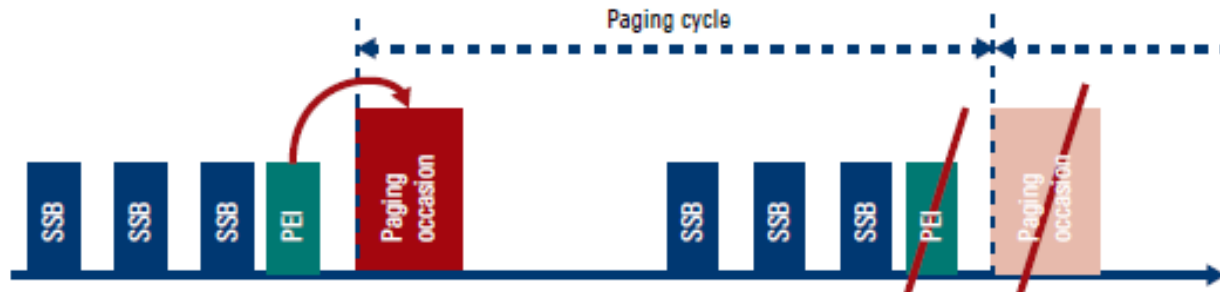
UE assisted power saving methods

RRM measurement relaxation

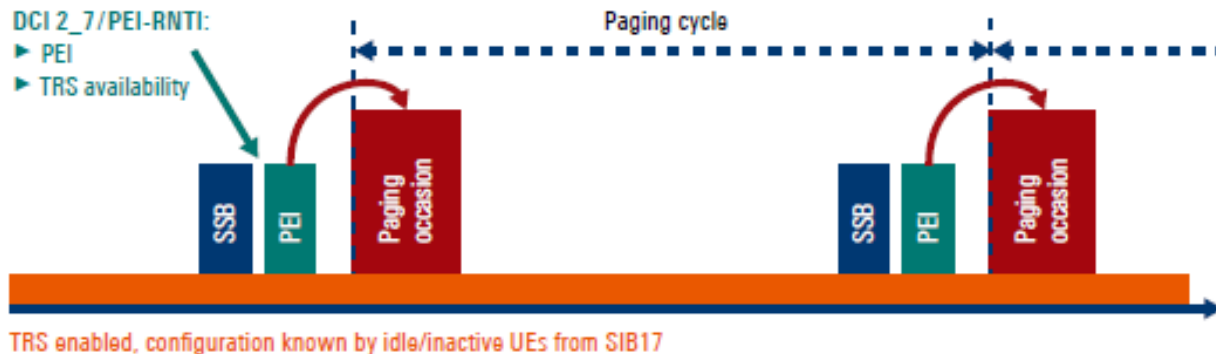
Rel. 16 ++ features: Several methodologies with respect to power saving are introduced

5G NR POWER SAVING ASPECTS – REL 17 TOPICS

Paging early indication (PEI) for idle/inactive UEs



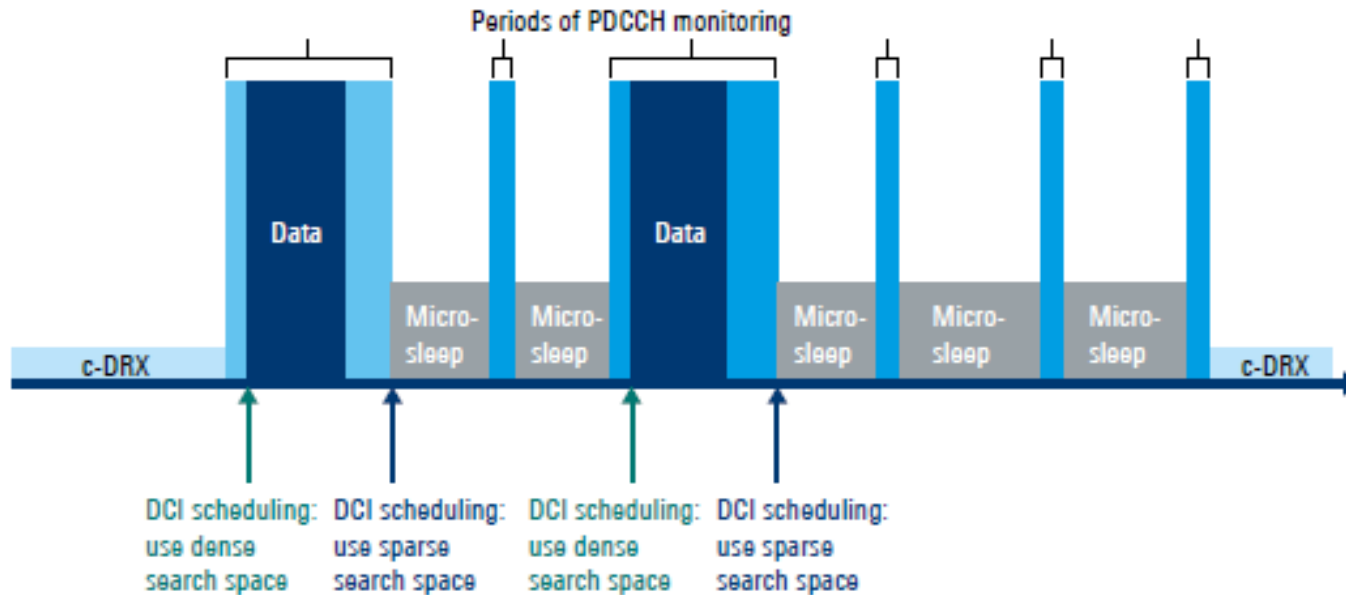
Paging early indication plus tracking reference signal (TRS)



5G NR POWER SAVING ASPECTS – REL 17 TOPICS

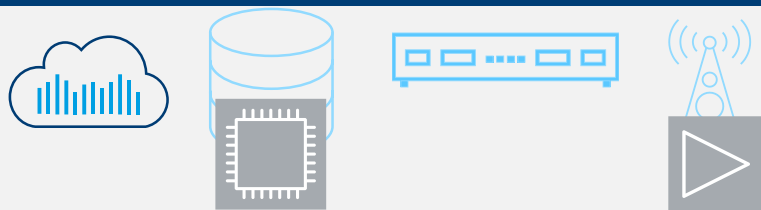
Search space switching – connected mode power saving feature

Definition of search space switching groups (SSSG) to schedule via DCI which search space is to be used in connected mode



NETWORK ENERGY EFFICIENCY

Holistic approach: From cloud to component, energy saving methods in the entire 5G system



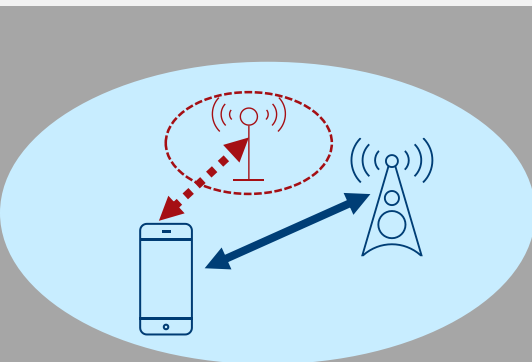
ETSI & 3GPP definition: Energy efficiency

$$EE_{MN,DV} = \frac{DV_{MN}}{EC_{MN}}$$

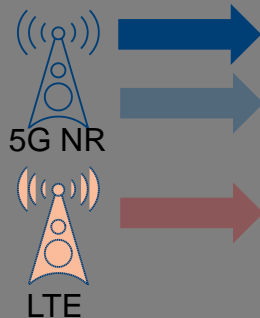
Data volume /
energy consumption

$$EE_{MN,CoA} = \frac{CoA_{des.MN}}{EC_{MN}}$$

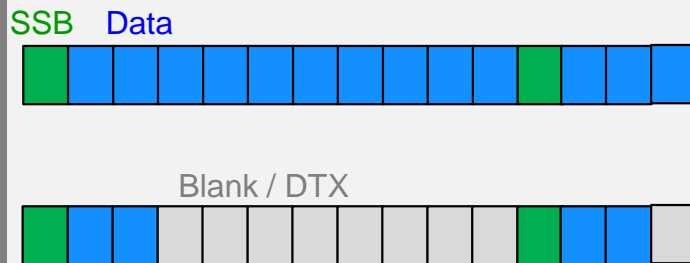
Designated coverage area /
energy consumption



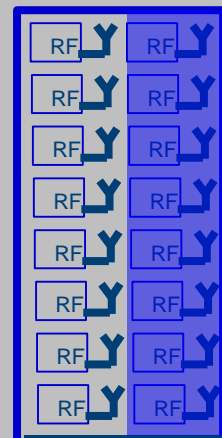
Turn on/off cells



Activate / de-
activate
carriers / RAT



Advanced sleep
mode (ASM)



Turn
on/off RF

CMX500 ONE BOX TESTER - LITE

- ▶ Supports FR1/LTE 4x4 MIMO RF Callbox Testing
 - ▶ 3GPP preconf CMseq.
 - ▶ Data Application Testing
 - ▶ Signaling EMC testing
 - ▶ Service and Repair market
 - ▶ 3GPP Rel-17 RedCap
-
- ▶ 4 GHz RF DL iBW
 - ▶ Sub8: 400 MHz - 8 GHz



REDCAP IN CMSQUARES GUI

The screenshot displays the REDCAP in CMSQUARES GUI interface, titled "R&S® CMSquares - Test Environment - CMX500 (CSW 7.20.1.11)". The interface is divided into several main sections:

- Left Panel:** Contains a "Pool" section with "Network" and "Meas & Gen" tabs. The "Network" tab shows "User Defined Network" and "Predefined Network" options. The "Predefined Network" section lists various configurations like "EPS Tracking Area" and "5G Tracking Area" with LTE and NR cell types.
- Top Panel:** Includes a "Test Environment" tab and a "Workspace" tab. The "Test Environment" tab shows a "Network square" with a "Live Mode" button and a "Minimum Footprint" button. The "Workspace" tab shows a "Cabling and DUT square" with a "DUT State" button and a "Show Labels" button.
- Center Panel:** Displays a "Network square" with a "Live Mode" button and a "Minimum Footprint" button. It shows a "PLMN 0" configuration with a "5G TrackingArea 0" and a "MCG PCell (MCG) PCell" configuration. The "MCG PCell" configuration includes parameters like "Band: FR 1 (TDD) N 78", "DL Ch: 630942", "UL Ch: 630942", and "BW: 20 MHz 20 MHz".
- Right Panel:** Contains a "DUT Configuration" section with tabs for "General", "Control", and "DUT Control". The "DUT Control" tab shows a "Filter parameters" section with "Mobile Originated Operations" and "Audio Call" sections. The "Mobile Originated Operations" section includes buttons for "Power Cycle", "Switch on Airplane Mode", "Switch off Airplane Mode", "Release Call", and "Send SMS". The "Audio Call" section includes buttons for "Establish Audio Call", "Accept Audio Call", and "Reject Audio Call".
- Bottom Panel:** Contains a "Measurement and Generator square" section with a "GPRF Meas 1" button and a "LTE TX Meas 1" button. The "GPRF Meas 1" button is set to "Off" and shows a "Frequency: 1250.00 MHz" and "Span: 250.00 MHz". The "LTE TX Meas 1" button is set to "Off" and shows a "Frequency: 1950.00 MHz".

The interface also features a "DUT" (Device Under Test) section in the center, showing a "Connected" status and a "LTE" network. Below this, there is a "Global Services" section with buttons for "Data Unit", "DNS", "IMS", "FTP", "HTTP", and "QoS", each with a "State" indicator. At the bottom, there is a "Services square" section with buttons for "IPerf" and "Ping", each with a "State" indicator.

REDCAP IN CMSQUARES GUI

The screenshot displays the CMSQUARES GUI interface. The top section shows a 'Message Table' with columns for Service, Pri..., sfn, s, slot, cell..., phys..., prach..., PDU, and dlBwp. Below this is a 'Message Tree' with a search bar and a list of messages. The right side of the interface features a 'UE Capabilities' panel with a tree view of capabilities. The '5G NR' section is expanded, showing 'Additional Parameters' (1 item), 'Bands' (3 items), and 'Measurement and Mobility Parameters' (8 items). The 'Bands' section is further expanded, showing 'bandNR = (78)', 'bandNR = (77)', and 'bandNR = (41)'. The 'Measurement and Mobility Parameters' section is also expanded, showing various supported parameters like 'ssb_RLM = supported (0)', 'eventB_MeasAndReport = supported (0)', 'handoverFDD_TDD = supported (0)', 'condHandoverFDD_TDD_r16 = supported (0)', 'handoverInterF = supported (0)', 'ss_SINR_Meas = supported (0)', and 'handoverInterF = supported (0)'. A blue box highlights the 'redCapParameters_r17' section, which includes 'supportOfRedCap_r17 = supported (0)'.

Message Table

Service Pri... sfn s slot cell... phys... prach... PDU dlBwp

Message Tree

Compare Verdict

Search: ID=2907 TS=2023-01-23 10:50:51.920 RFN=0 MDDB=NR_CRRRC 12.0

Line Details

477 ims_ParametersCommon

478 Extension_Addition_Group_2

479 voiceFallbackIndicationEPS_r16 = supported (0)

480 nonCriticalExtension

481 nonCriticalExtension

482 nonCriticalExtension

483 nonCriticalExtension

484 powSav_Parameters_r16

485 powSav_ParametersCommon_r16

486 maxCC_Preference_r16 = supported (0)

487 releasePreference_r16 = supported (0)

488 powSav_ParametersFRX_Diff_r16

489 maxMIMO_LayerPreference_r16 = supported (0)

490 highSpeedParameters_r16

491 measurementEnhancement_r16 = supported (0)

492 nonCriticalExtension

493 nonCriticalExtension

494 nonCriticalExtension

495 nonCriticalExtension

496 measurementParameters_r17

497 redCapParameters_r17

498 supportOfRedCap_r17 = supported (0)

499 mbs_Parameters_r17

UE Capabilities

Group by Category Collection

Capability

5G NR (44 items)

Additional Parameters (1 item)

accessStratumRelease = rel17 (2)

Bands (3 items)

bandNR = (78)

bandNR = (77)

bandNR = (41)

Measurement and Mobility Parameters (8 items)

ssb_RLM = supported (0)

eventB_MeasAndReport = supported (0)

handoverFDD_TDD = supported (0)

condHandoverFDD_TDD_r16 = supported (0)

handoverInterF = supported (0)

ss_SINR_Meas = supported (0)

handoverInterF = supported (0)

T&M EXAMPLE – POWER SAVING MEASUREMENTS

BLT_Shuffler_01 LTE-nCC-NR-nCC WUS with Power co...

Signaling Reset

Read CSV Data

loop over each item in list

Signaling Reset

DUT Power off

Setup Cells

DUT Power on

Check DUT Event

Start Throughput Capture

Start Power Consumption Monitor

Add User Marker

Activate EN-DC Mode

Set LTE Cell Power

Carrier Aggregation

Set NR Scheduling

Cellular Rx BLER

Set NR Scheduling

Set NR CDRX

Wait

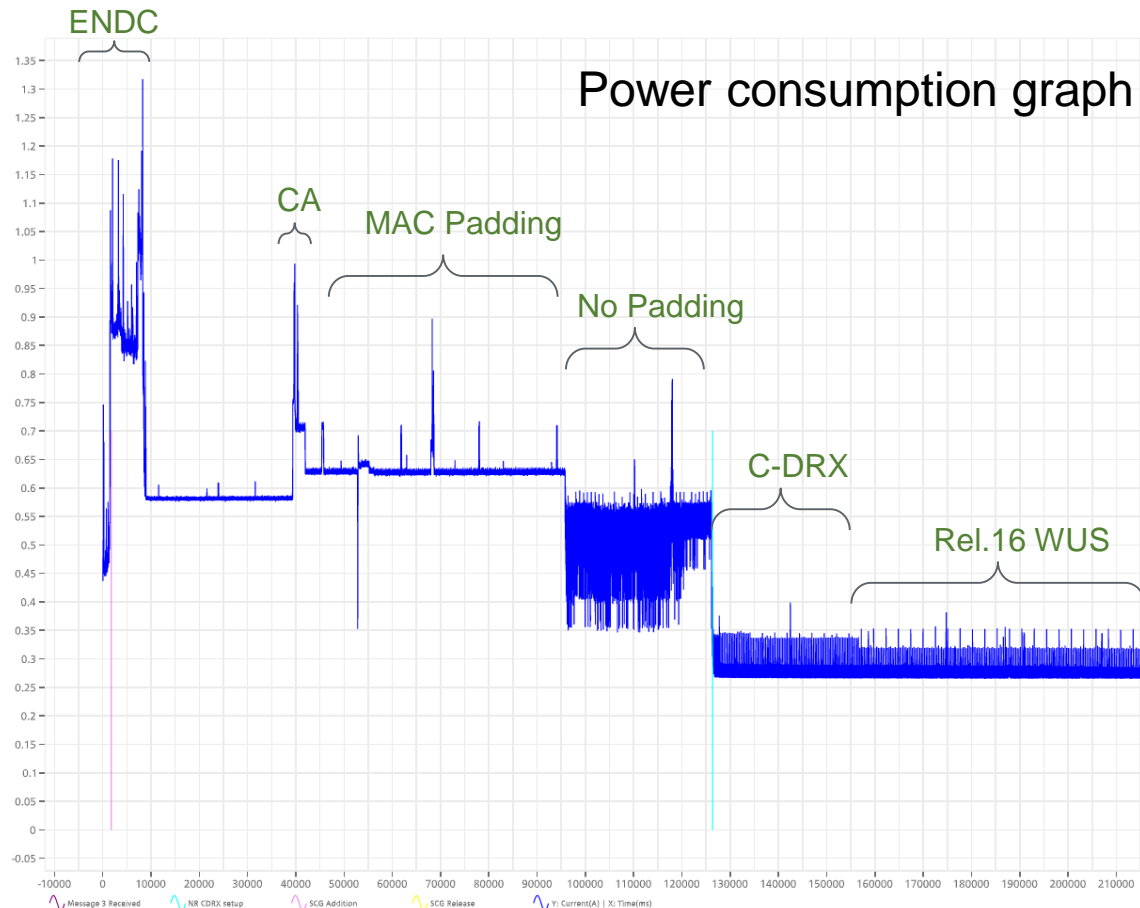
Set NR CDRX

Set NR Scheduling

Add User Marker

Stop Power Consumption Monitor

Stop/Report Throughput



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

5G technology book online version
(>1000 pages on 5G technology):

www.rohde-schwarz.com/5G



[5G Voice over New Radio \(VoNR\) | Rohde & Schwarz \(rohde-schwarz.com\)](http://www.rohde-schwarz.com/5G-VoNR)

5G VOICE OVER NEW RADIO
(VoNR)



[5G Non-terrestrial Networks | Technology Update | Rohde & Schwarz \(rohde-schwarz.com\)](http://www.rohde-schwarz.com/5G-NTN)

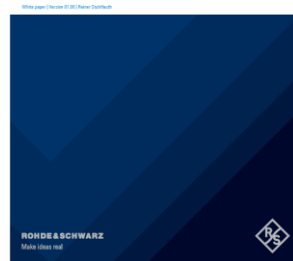
TAKING NEXT STEPS ON
NON-TERRESTRIAL NETWORKS
AND SATELLITE 5G/IoT

Non-terrestrial networks technology
from a 3GPP perspective



5G NR-V2X FOR ENHANCED
AUTOMOTIVE COMMUNICATIONS

Technology deep dive into architecture, protocols
and physical layer aspects



[5G in Automotive | Rohde & Schwarz \(rohde-schwarz.com\)](http://www.rohde-schwarz.com/5G-Automotive)

[White paper: Positioning in 5G NR | Rohde & Schwarz \(rohde-schwarz.com\)](http://www.rohde-schwarz.com/5G-Positioning)

POSITIONING IN 5G NR:
A LOOK AT THE TECHNOLOGY
AND RELATED TEST ASPECTS



REDUCED CAPABILITIES (REDCAP) –
A NEW CLASS OF 5G DEVICES



<https://www.rohde-schwarz.com/redcap>

Additional Resources

- [Worldwide Spectrum Allocation Poster \(2020\)](#)
- [Free "Demystifying 5G NR" poster | Rohde & Schwarz \(rohde-schwarz.com\)](http://www.rohde-schwarz.com/5G-Demystifying)

