

**3GPP TSG RAN #102**

**RP-233542**

**Edinburgh, Scotland, December 11-15, 2023**

**Agenda Item:**

**9.1.2.3**

**Document for:**

**Discussion**

# **Views on NR NTN for Rel-19**

**NTT DOCOMO, INC.**

## ■ Rel-17 NR NTN

- Initial spec for NR NTN
  - » E.g., NTN-specific synchronization, timing-related enhancements in lower/higher layers, HARQ-related enhancements, NTN-specific mobility support
  - » Transparent payload

## ■ Rel-18 NR NTN

- Enhancements for three aspects
  - » 1. Coverage of handheld UEs
  - » 2. UE location verification by NW side
  - » 3. Better mobility/service continuity

## ■ Rel-19 NR NTN

- At least the following two topics should be included
  - » A. **Regenerative payload support**: more flexible NW, shorter RTT, towards meshed NTN
  - » B. **Coverage enhancement**: DL coverage and UL coverage leftovers for handheld UE
  - » Note: in addition, HAPS-specific RAN4 discussion as mentioned in RP-233753 is also an important topic for R19
- Besides, R19 NTN WID should include ‘implicit compatibility to support HAPS scenario’ as in R17/18 NTN WID
- This document includes our views on other topics potentially included in R19 NR NTN scope

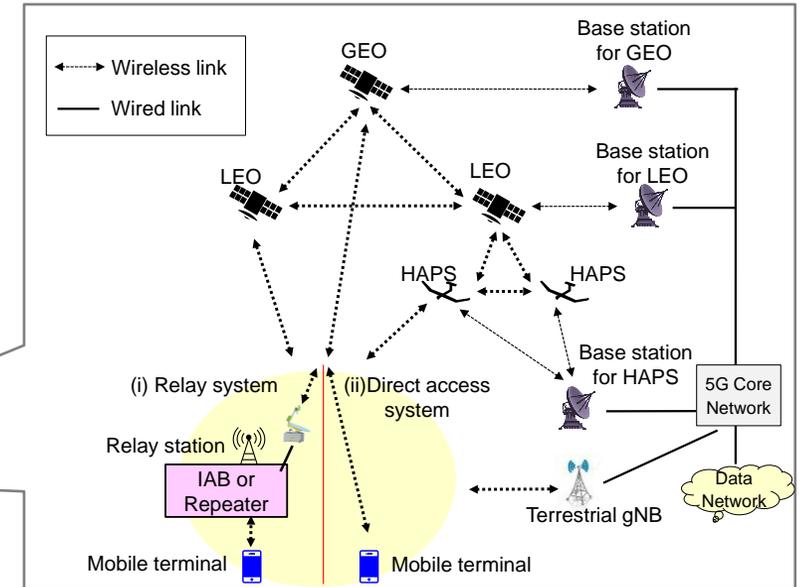
# Regenerative payload support (1/2)

High Priority

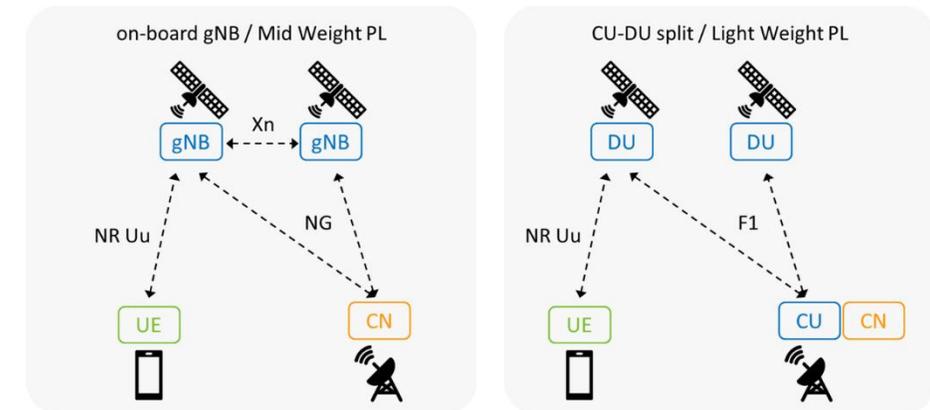


## Regenerative payload

- Background (Justification)
  - » Study on introduction of NTN was conducted in Release 16. Both transparent and regenerative payload were in scope at that time, but in later releases (Rel-17/18) only transparent payload was taken in consideration.
  - » Support of regenerative payload enables more flexible NTN as well as shorter round-trip time for L1/MAC interaction.
    - Steady step to realize meshed NTN (i.e., NTN with inter-satellite/HAPS links) in future releases.
- Observation
  - » Including LEO/GEO/HAPS scenarios, both on-board gNB on-board (with ISL) and CU-DU split (without ISL) implementations.
    - gNB on-board: No specific enhancement is needed on top of Rel-17/18 framework. Specifying support in TS 38.300 will be enough unless showstopper issue in Xn/NG interface is found.
    - CU-DU split: We see potential issues on F1 interface.



Future (later releases) realization of meshed-NTN



Scope of regenerative payload implementations in Rel-16 study

## ■ Regenerative payload

### • Proposal (Objective) – Regenerative payload

- » For objectives described in RP-232860, the following update with red color is supported in consideration of:
  - Signaling enhancements for UP packet buffering considering RTT in CU-DU split architecture.
  - Suspending F1 interface in case of feeder link switch over in CU-DU split architecture (described in clause 8.7.2.3, TR 38.821).
  - Signaling enhancements for frequent Xn setups in case of feeder link switch over in on-board gNB architecture, or in case of SRI (satellite radio interface) switch over in on-board gNB architecture with ISLs (inter satellite links) (described in clause 8.4.3.4, TR 38.821).
  - Suspending NG interface in case of feeder link switch over in on-board gNB architecture (described in clause 8.7.2.2, TR 38.821).

#### Assumptions

- Both GSO and NGSO are considered
- Both with/without Inter Satellite Links are considered. ISL is a transport link and therefore not subject to specification in this work item
- The support of UPF on board is not in the scope of this work item

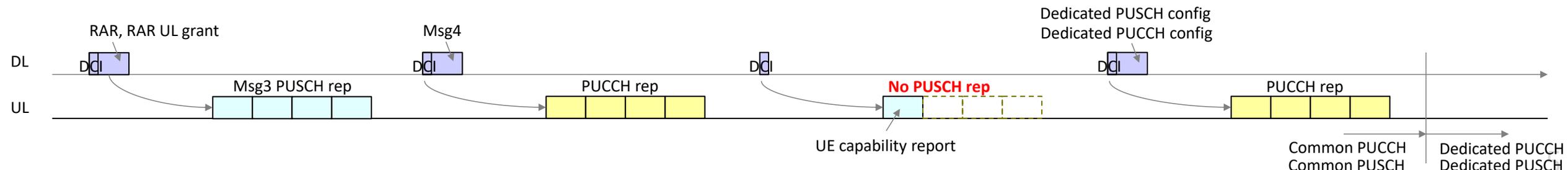
#### Objectives include

- Specify the support of gNB on board in TS 38.300 and define, if needed, any necessary enhancements related to NG protocol to address the feeder link switchover issue. [RAN3, RAN2]
- Evaluate and specify, if needed, any necessary enhancements related to the intra and inter-gNB mobility, especially for Xn interface over feeder link or over ISL. [RAN3, RAN2]
- ~~FFS Specify the support of DU on board with possible enhancements of at least F1~~
- Specify potential enhancements on F1 interface for CU-DU split architecture, if needed. (RAN3)

## ■ UL coverage enhancement

### • Background (Justification)

- » In R18 NR NTN, repetition of common PUCCH resources including Msg4 HARQ-ACK transmissions and NTN-specific DMRS bundling for PUSCH have been specified. Besides, PRACH repetition has been specified in R18 CovEnh WI
- » However, **coverage of the following UL transmission is still insufficient for handheld UE in NTN due to non-support of repetition.** The reason seems to be that simply the problem was missed in study/work in R17 CovEnh and R18
  - PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI, including “Msg5 PUSCH” (i.e., PUSCH transmission after Msg3 PUSCH but before reception of dedicated PUSCH configuration) e.g., to convey UE capability report
- » Although it was argued that legacy packet segmentation can be used instead of repetition for the coverage improvement, only packet segmentation is insufficient in NTN
  - Even for Msg3 PUSCH, where TBS = 56, repetition (e.g., 16 rep) is essential for handheld UEs in NTN. Then also for Msg5 PUSCH with packet segmentation, similar or larger TBS is applied per segment and thus still repetition is necessary. Packet segmentation with HARQ-based retransmission (e.g., up to 16 times) instead of repetition is not a realistic solution due to much larger RTT than in TN
  - Note that further coverage enhancement for TN is not to be discussed in R19 according to chair’s summary of RP-232745
- » Besides, for HP UE, UE type should be determined in early stage; in R18, the aspect was raised in later stage and the discussion became complicated



## ■ UL coverage enhancement

### • Proposal (Objective) – UL coverage enh

» For objectives described in RP-232860, the following update with red color is supported

#### Assumptions

- exemplary FR1 bands (i.e. n256, n255, n254 and upcoming Extended L-band (UL: 1668-1675 MHz, DL: 1518-1525 MHz)
- Support UE with PC2 (+26 dBm)
- Support UE with PC1.5 (+29 dBm) and PC1 (+31 dBm).
  - Note that PC1 and PC1.5 are not targeted for smartphones.
  - The targeted UE type (including beam steering mechanism) shall be clearly defined in early stage

#### Objective include

- Update, if needed, coexistence analysis based on TR 38.863 defined methodology [RAN4]
- Specify RF and RRM aspects of the targeted UE [RAN4]
- Specify transmission enhancement for NTN high power UE, e.g. duty cycle enhancement subject to Specific Absorption Rate restriction [RAN2]
- Specify repetition for PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI [RAN1] ~~FFS: Whether Msg5/PUSCH repetition or legacy packet segmentation shall be defined (if not included in NR enh as part of Rel-19).~~
- ~~FFS Whether a study is required prior to normative work~~

## ■ DL coverage enhancement

### • Background (Justification)

- » It is argued by satellite companies that in actual satellite deployment, max total transmit power is not extremely high to be shared among a lot of beams and thus there is a trade-off between the max power per satellite beam and the number N of simultaneously used satellite beam. The number N should be increased as much as possible; otherwise, communication time per satellite beam is quite small. For efficient NTN for handheld UE, DL coverage enhancement is desirable.
- » For NTN commercialization, **supporting critical message e.g., ETWS is an important aspect**. Even though UE is located in an area that NW intends, UE may fail to receive the critical message in some situations. This probability should be reduced as much as possible. From this perspective as well, DL coverage enhancement is desirable.

### • Observation

- » Current SSB performance and/or performance margin compared to required SNR are unclear in this stage. They should be clarified in study phase, rather than deciding in RAN plenary discussion.
- » Enhancement of RS such as DMRS may be feasible for DL coverage enhancement. It should not be precluded from the study phase
- » WID should not include/prioritize any technique for improvement; it should be discussed in WG. At least feasibility of solution for 'an efficient dynamic and flexible power sharing between beams or different beam pattern size...' is quite unclear from perspective of DL coverage enhancement

## ■ DL coverage enhancement

### • Proposal (Objective) – DL coverage enh

- » Identify target performance level based on SSB channel, which channels/signals need to be enhanced, and the gap from the target performance
- » No technique priority in objective section for study phase
- » System level enhancement is done only if feasible
- » For objectives described in RP-232860, the following update with red color is supported

#### Assumptions

- SSB channel enhancements is not considered in this scope.
- antenna gain of UE shall be assumed to be -5.5 dBi
- NGSO to be considered in priority : Consider LEO set-1@600 km reference satellite parameters in TR 38.821
- At least 2 Rx UE are considered in this objective.
- FFS RedCAP 1 Rx UE are considered at least for the link margin improvement
- FFS Whether RedCAP UE half duplex constraints should be considered for system level enhancements

#### The following two steps approach should be considered

- Study phase:
  - Link level :
    - Identify/prioritise which physical channels need to be enhanced
    - Identify the target link margin improvement depending on the physical channel and signals
    - Identify/prioritise which enhancements are needed at link level/physical channels and signals
  - System level :
    - Define reference Satellite payload parameters (e.g. beam illumination plan constraints, total EIRP) and energy consumption model along with necessary evaluation methodology and relevant KPIs.
    - Identify potential solutions, including the feasibility, to support an efficient dynamic and flexible power sharing between beams or different beam pattern/size (i.e., wide or narrow) across the satellite foot print ~~considering in priority existing 3GPP techniques~~.
- Normative phase:
  - Define link level enhancements wrt downlink physical data ~~and~~/ control channels and signals as appropriate
    - i.e. enhancements through repetition techniques [RAN1]
  - Define system level enhancements, if feasible, to support an efficient dynamic and flexible power sharing between beams or different beam pattern/size (i.e., wide or narrow) across the satellite foot print as appropriate.

## ■ Robust notification/alert

### • Observation

- » It was argued that new DL channel/signal for this topic should be introduced and they are copied from IoT-NTN, they are completely new channel/signal for NR and thus it is unacceptable from perspectives of spec efforts and implementation complexity
- » Although the high-level motivation is to solve paging missing e.g., in NLOS environment, it seems that service flow in the solution is not aligned among companies. Such a topic may be not RAN issue but SA issue
  - A simple message to invite UEs to move to e.g., LOS environment to receive the paging message? Include UE IDs to restrict receivers?
  - Entire paging message to UEs in poor channel conditions?

### • **Proposal (Objective) – Robust Notification/Alert**

- » For objectives described in RP-232860, the following update with **red color** is supported

#### Assumptions

- Enhancements to existing SSB signal are not considered in this scope.
- Applicable to all orbits (GSO&NGSO)
- Mitigate to the maximum extend the additional loss that can be up to 18 dB

#### Objectives include :

- Identify the notification message requirement based on liaison with SA WG [RAN1/2]
  - ~~The notification message should be addressed to a particular UE or a sub-set of UE in a cell (hence could leverage some UE identifier in legacy paging procedures)~~
- Identify and specify possible solutions for the support of a robust notification/alert message and its delivery (including paging procedure impact) over downlink physical channel(s), **after reply liaison is received from SA WG** [RAN1, RAN2, RAN3]

#### Note : Coordination with

- SA1 as needed (e.g. notification requirements/message content)
- SA2 as needed (e.g. for potential impact on the paging procedure)

## ■ Uplink capacity/throughput enhancement

### • Observation

- » Obviously UL capacity is a big issue in NTN, especially for handheld UE support with large repetition factor. PUSCH with OCC seems to be a good way. For RAN4 part, demodulation requirement may also be necessary
- » For 'sporadic access', it may intend a kind of NOMA techniques and if correct the topic is not acceptable. The same outcome as in the NR initial release is expected unfortunately
- » As well as PUSCH enhancement, PUCCH enhancement should be included in this topic. Although capacity of dedicated PUCCH in the existing spec may be sufficient, **capacity of common PUCCH is insufficient**. In R18, we introduced repetition of common PUCCH, but the capacity has not been enhanced. Only 16 resources within N slots are available per cell, where N is repetition factor such as 8. That is, the number of UEs in RRC\_CONNECTED mode may be limited due to the poor capacity

### • **Proposal (Objective) – Uplink capacity/throughput enhancement**

- » For objectives described in RP-232860, the following update with **red color** is supported

#### Assumptions

- The intent is not to replace MU-MIMO capability but to improve system capacity.
- Enhancements to PRACH not considered in this topic

#### Objectives

- Study then specify, **if beneficial**, DFT-s-OFDM PUSCH enhancements via Orthogonal Cover Codes (OCC) including initial access [RAN1], with an attempt to minimise impact on emissions:
  - Determine the potential capacity improvement (at least 2 times and not more than 12 times compared to legacy) to be targeted taking into account realistic impairments (e.g. Doppler, time variation, phase distortion) [RAN1]
  - Specify necessary signalling, if needed [RAN2]
  - Update RF/**Demod** requirements accordingly if needed [RAN4].
  - Note : The orthogonal cover codes are across OFDM symbols **and/or within an OFDM symbol**.
- ~~Study and specified if needed, sporadic access (i.e. contention based PUSCH) to a pool of shared resources [RAN1/2]~~
- **Specify PUCCH enhancements, including common PUCCH resources ~~FFS-PUCCH enhancements, if needed~~ [RAN1]**

## ■ Mobility enhancements

- View: Negative. We do not see necessity to introduce NTN-specific mobility enhancement in Rel-19. Mobility aspects should be de-prioritized in NTN and should be generally discussed in Mobility WI
- **Proposal – Mobility enhancements**
  - » De-prioritize ‘Mobility enhancements’ topic

## ■ Enhanced GNSS Operation

- Observation
  - » We are not sure whether the issue is critical in real deployment. If GNSS is unavailable, the user may move to obtain GNSS or it may be possible to use the old GNSS information and then NW can provide TAC for the UE
  - » Besides, each RRC connection does not continue during so long durations such as 14.4 min in practical cases
- **Proposal – Enhanced GNSS Operation**
  - » De-prioritize ‘Enhanced GNSS Operation’ topic

## ■ Broadcast

- View: Negative. We do not see strong motivation to include this in Rel-19. This topic should be de-prioritized in consideration of entire scope size
- **Proposal – Broadcast**
  - » De-prioritize ‘Broadcast’ topic

## ■ Support of RedCap UE

- Observation
  - » Although RedCap in NTN is a promising topic, urgency is unclear for us
  - » If RedCap UE is considered in R19 NR NTN, half-duplex FDD should be considered as in R17/18 TN RedCap
- **Proposal – Support of RedCap UE**
  - » De-prioritize ‘Support of RedCap UE’ topic

## ■ Ku band and enhanced support of above 10 GHz bands

- Observation
  - » As Ka-band in R18 NTN, Ku-band may be considerable for R19 NTN topic
  - » In R18 NTN, only RAN4 work is identified and liaison-based discussion has been triggered in other WGs. For R19 NTN, the same way should be adopted. RAN1/RAN2 are unnecessary for this topic at least in the WID

- In R17/R18 NTN WID, the following description is captured at the beginning of the objective section. Similar description should be included also in R18 NTN WID, especially implicit compatibility to support HAPS
- Proposal: R19 NTN WID includes ‘implicit compatibility to support HAPS scenario’ as in R17/18 NTN WID

The work item aims at specifying enhancements for NG-RAN based NTN (Non-Terrestrial Networks) according to the following assumptions **with implicit compatibility to support HAPS (High Altitude Platform Station)** and ATG (Air To Ground) scenarios:

- GSO (Geo Synchronous Orbit) and NGSO (Non Geo Synchronous Orbit). NGSO includes Low Earth Orbit (LEO) and Medium Earth Orbit (MEO).
- Earth fixed tracking area. Earth fixed & Earth moving cells for NGSO
- FDD mode
- UEs with GNSS (Global Navigation Satellite Systems) capabilities
- Both “VSAT” (Very Small Aperture Terminal) devices with directive antenna (including fixed and moving platform mounted devices) and commercial handset terminals (e.g. Power class 3) are supported in FR1
- Only “VSAT” devices with directive antenna (including fixed and moving platform mounted devices) are supported in above 10 GHz bands.

Note 1: In Rel-17 WID, “VSAT” device with external antenna on moving platform is equivalent to a device that operate on platforms in motion, and this is referred to as ESIM (Earth Station In Motion).

Note 2: The Rel-17 NTN architecture is assumed.

This WI is adding functionality in REL-18 to enhance features that were introduced in REL-15/16/17:

<sup>NTT</sup> docomo