

3GPP TSG RAN Meeting #102

RP-233304

Edinburgh, Scotland, December 11-15, 2023

Agenda Item: 10.1.2.1

Views on scope for IOT NTN enhancements in Rel-19

Qualcomm Incorporated

Summary of proposals - IOT NTN

- **Improved UL capacity for NB-IoT**
 - In cases with large number of repetitions, the uplink capacity can be increased by using spreading by orthogonal cover codes (OCC) on top of single subcarrier 3.75kHz.
 - With OCC, the uplink capacity can be increased more than 2x with NPUSCH, and the NPRACH capacity can be increased 3x.
 - Downlink overhead associated with uplink transmissions (e.g. NPDCCH, EDT response) should be reduced to fully achieve improved uplink capacity.
- **Mobility enhancements**
 - For TN and NTN mobility, TAU update without UE capability update
 - Done with close coordination with SA2.
 - Adopt NR solution as baseline on satellite switch with unchanged PCI
 - Enhancement to redirection with release.
- **UE location without support of LPP**
 - NB-IoT does not support location reporting except by using LPP, which is not implemented in most products.
 - We propose to standardize a mechanism to provide this information to the network outside LPP.
 - (If not done within SA2 in Rel-18).
- **SA2 alignment**
 - System level / architectural changes (e.g. store and forward) may need the corresponding RAN2/RAN3 work

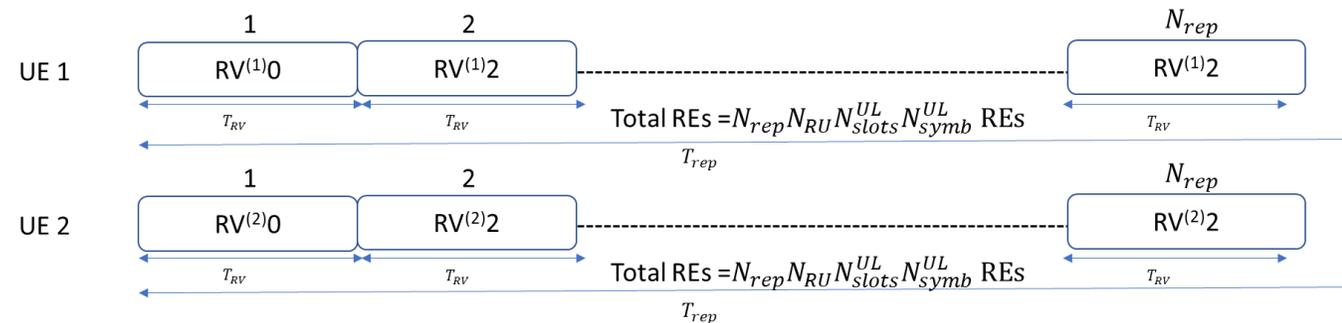
Uplink Capacity Enhancements

- **Long repetitions = poor spectral efficiency**
 - For NB-IoT single subcarrier with repetitions, a single UE will use a large amount of time-frequency resources.
 - We propose to use **orthogonal cover codes to multiplex multiple UEs** in the same time-frequency resources (increase capacity).
 - Downlink control (NPDCCH & other DL messages, including control during EDT / PUR) needs improvement to fully utilize uplink resources.

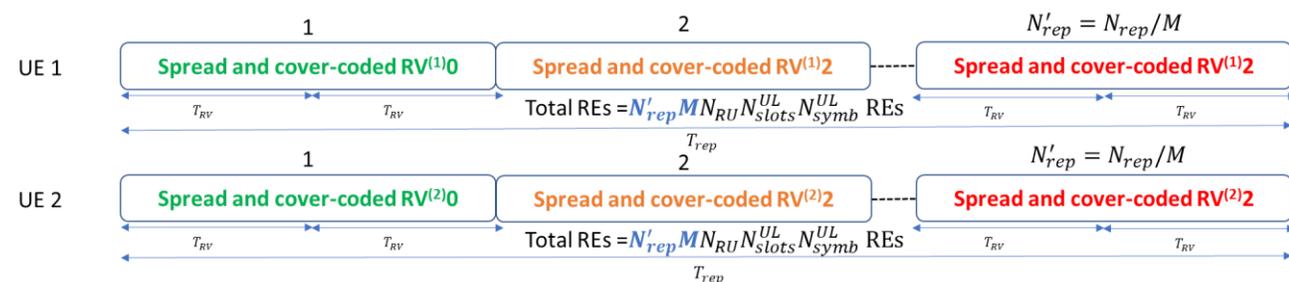
Preliminary evaluation results:

- Using RAN4 requirements on timing and frequency errors, and NTN TDL-D channel, the following capacity gains are achieved (multiplexing up to 4 UEs).

Uplink SINR (3.75kHz SCS)	Capacity gain
3dB	1x (no gain)
0dB	2x
-4dB	2.67x



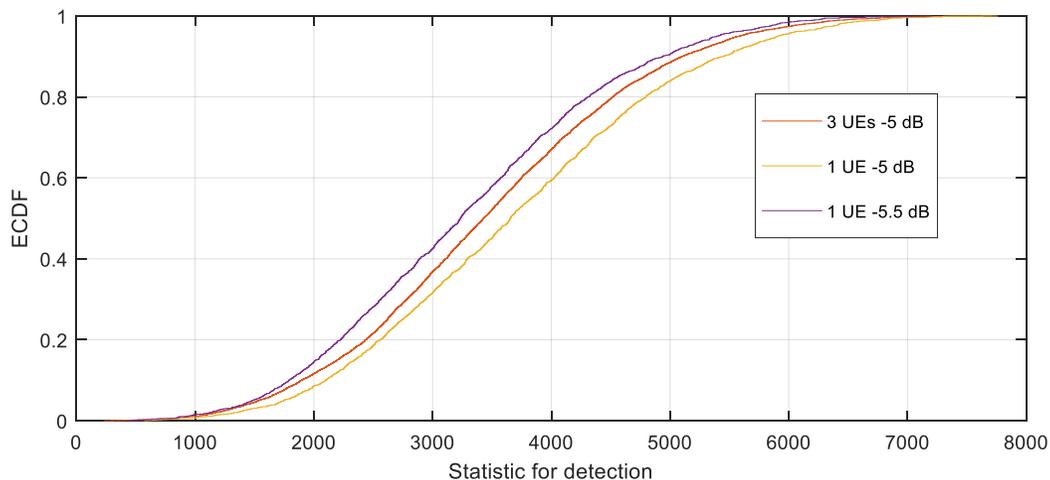
Current specs: UL transmission w/ RV-cycling: UE1, UE2 are scheduled in different time/frequency resources



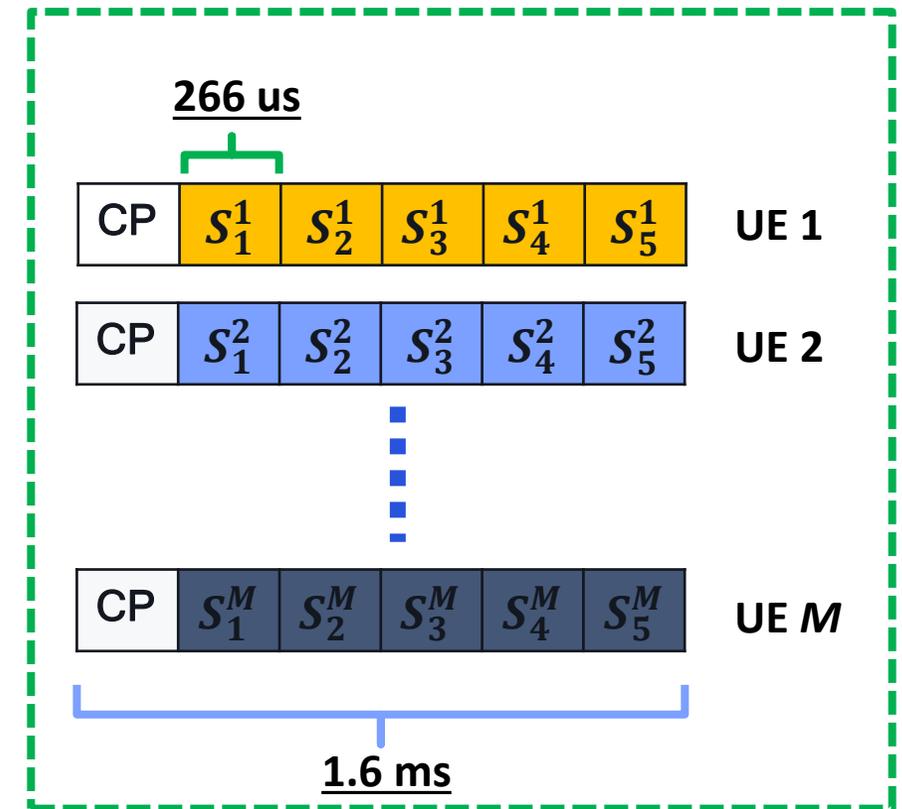
Proposed UL transmission: M ($= 2$ above) UEs are multiplexed over the same resources by using OCC (e.g. [1 1], [1, -1])

NPRACH Capacity Enhancements

- **Increasing NPRACH capacity**
 - We propose to apply **orthogonal cover code** over the NPRACH waveform to increase the capacity.
 - For instance, using a cover code of length 3 would increase the NPRACH capacity by 3x (similar to e.g. increasing by 3x the number of allocated subcarriers).
- **Preliminary evaluation results:**
 - Using RAN4 requirements on timing and frequency offset, and NTN TDL-D channel, we observe that a cover code of length 3 offers a 3x gain in NPRACH capacity with negligible performance impact (less than 0.5dB impact vs no OCC)

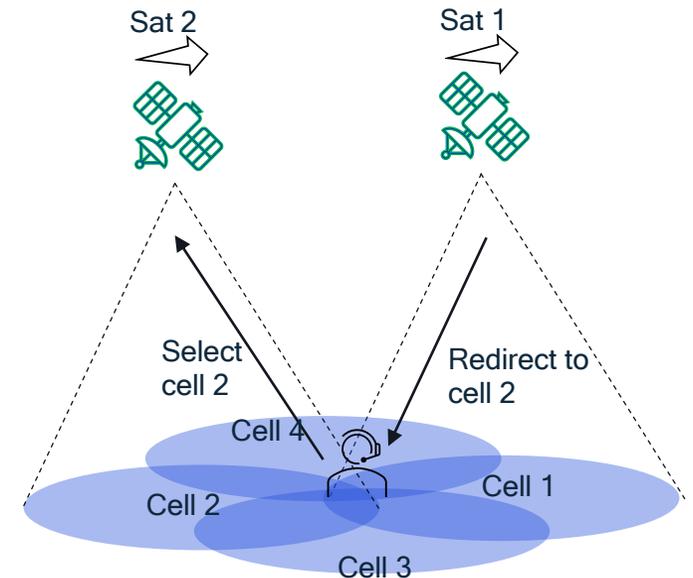


NPRACH preamble with cover codes (format 2)



Mobility enhancements

- **For TN and NTN mobility, TAU update with UE capability**
 - Core network does not differentiate whether the UE capability container belongs to TN or NTN.
 - UE triggers TAU with UE capability update every time it moves between TN and NTN.
 - Study any CN-based or RAN-based solution to update UE capability upon TN-NTN mobility.
 - Needs close coordination with SA2.
- **NR solution on satellite switch with unchanged PCI**
 - In quasi-earth fixed cell, the cell can remain same with short synchronization interruption after cell stop time.
 - For eMTC, this can avoid the handover.
 - For NB-IoT, this avoids UE going through RLF procedure or release procedure.
 - Use NR solution as base-line to define satellite switch without L3 mobility.
- **Redirection with release.**
 - Network can provide system information of one or more cells on the redirected inter-RAT carrier frequency but not on the same E-UTRA RAT frequency.
 - For NB-IoT, only carrier frequency, carrier-offset and timer information can be provided.
 - Study mechanism to redirect UE to a target cell PCI of same or different satellite.



Redirection with release

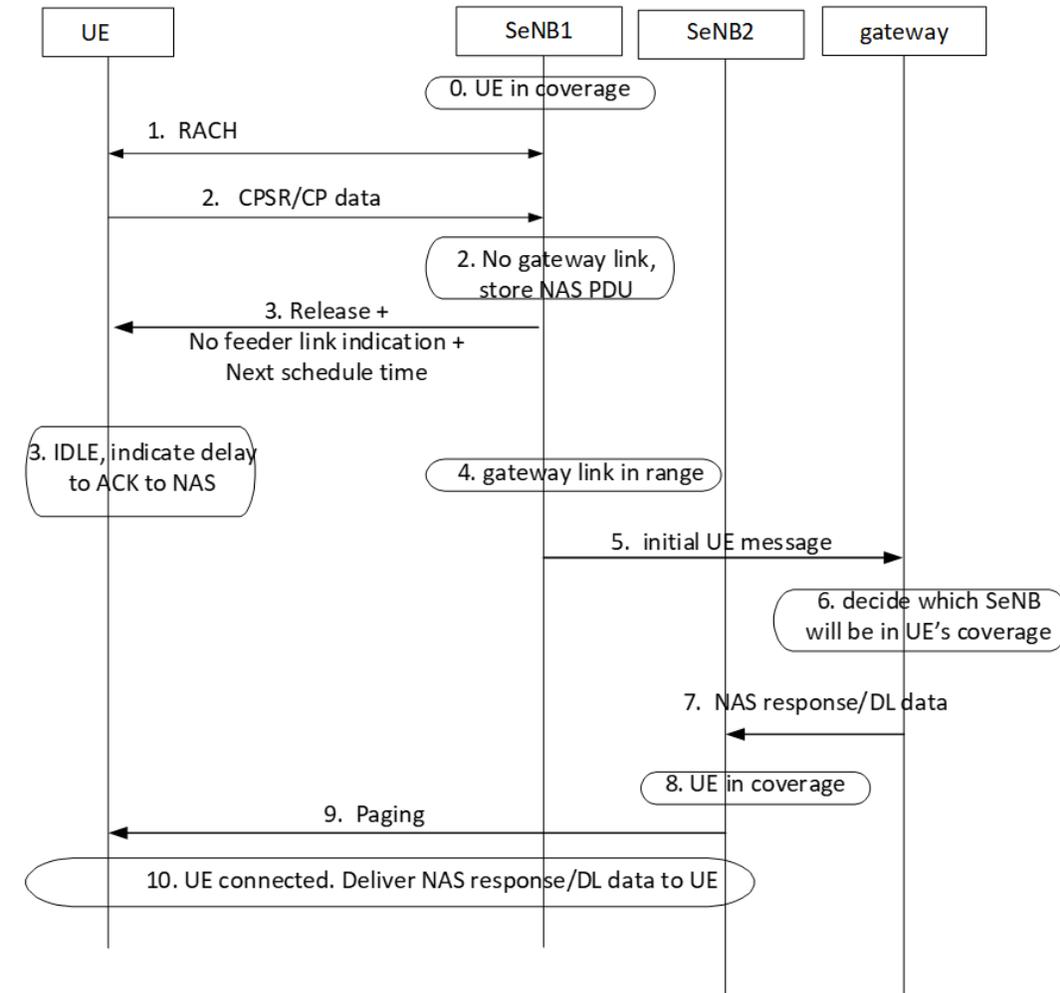
UE location without LPP support

- **LPP support in NB-IoT:**

- Although supported by specifications, most NB-IoT products do not support LPP.
- For some deployment scenarios (e.g. discontinuous coverage) it is important for the 3GPP system to know the UE location.
- UE location updating procedure may also be needed.
- We propose to introduce an alternative way of reporting UE location outside LPP.
- This is currently being discussed in SA2, can be considered for addition later in Rel-19 if no solution is agreed for previous releases.

Alignment with SA2 - store and forward

- New features potentially introduced by SA2 need the corresponding work in RAN2/RAN3 (lead WG should be SA2). Some examples include:
- **Store and forward / intermittent feeder link:**
 - On top of discontinuous coverage, there could also be intermittent feeder link (FL) connectivity with the ground station (GS) in areas where it is not feasible to deploy a ground station or where deployment of ground station is not cost effective.
 - UE needs to be informed on the availability of the feeder link.
 - UE needs to know when it expects the response from core network and when it should perform the next transmission.
 - For this, regenerative payload architecture needs to be supported. It could be full core network functionality on board or just an eNB on board.
- **Proposed enhancement**
 - Based on the regenerative architecture supported by SA2, specify the discontinuous feeder link solution.



Potential call flow for intermittent feeder link (with eNB on board)



Thank you

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