3GPP TSG-RAN WG2 Meeting #131  R2-2506278

Bengaluru, India, Aug 25th – 29th, 2025

**Agenda item: 8.9.3**

**Source: MediaTek Inc.**

**Title:** **Report of [AT131][302][R19 IoT NTN] UL enhancements**

**Document for: Discussion and Decision**

# Introduction

This is the report of below offline:

* [AT131][302][R19 IoT NTN] UL enhancements (Mediatek)

      Scope: continue the discussion on the CB-RNTI formula and on the details of the power ramping.

      Intended outcome: summary of the offline discussion (in R2-2506278)

      Offline time: Wednesday 12:00 – 12:30

Deadline for offline discussion summary:  Thursday 2025-08-28 08:00

# Discussion

## CB-RNTI

Current WA on CB-RMTI calculation is:

* Working Assumption confirmation on CB-RNTI formula

including

* + Whether to define Msg3\_W\_index to floor(start SFN\_id of Tx window / minimum Tx window length or periodicity].
	+ Whether to define Y = 16.
	+ Whether starting value X is optionally configurable.

(RAN2#130 Working Assumption:

The formula for RNTI for mMsg4 monitoring is:

RNTI=X + Msg3\_W\_index modulo (Y) + Y\*CE\_level + 3\*Y\*carrier\_id.

• X is the starting RNTI for Msg4 reception, which can be defined by RAN2 e.g. X=2401 for eMTC or 4097 for NB-IoT,

• Msg3\_W\_index is the index of Msg3 transmission window within a periodicity of 1024 SFNs and index 0 corresponds to the Msg3 transmission window starts at the SFN defined by IE startSFN-r19,

• Y is ceil (Msg4\_WS/Msg3\_WP),

• CE\_level is the CE level, 0 <= CE\_level < 3

• carrier\_id is the index of the UL carrier of the CB-Msg3 resources, anchor carrier has index 0,

0 <= carrier\_id < 16

Can come back to check if the NW can also simply configure RNTI = X)

During the posting meeting discussion on MAC open issue [1], the companies proposed some changes based on the working assumption:

* Whether to define Msg3\_W\_index to floor(start SFN\_id of Tx window / minimum Tx window length or periodicity].
* Whether to define Y = 16.
* Whether starting value X is optionally configurable.

Prior to the online meeting, an unofficial offline discussion on the CB-RNTI was held. Most companies seems okay to replace the Msg3\_W\_index modulo (Y) with floor(start SFN\_id of Tx window / minimum Tx window periodicity) and to define Y as a fixed constant. It was also suggested to remove the CE level from the formulation to reduce the number of used RNTIs.

As a result, the rapporteur proposed a new formula in R2-2506416. Note that the minimum number of Tx window is less than 10ms and thus we cannot divide by this value. For NB-IoT, it is suggested to use the minimum Tx window periodicity (40ms) while in eMTC it is suggested to use a relatively small value (i.e. 20ms). The proposal in R2-2506416 has a very similar formulation as in legacy RA-RNTI calculation.

During the online meeting, some companies suggested retaining the CE level but some company want to remove the UL carrier id. This result in completely different direction.

From rapporteur understanding, we can discuss below options.

**Option 1 (R2-2506416)**

The CB-RNTI is calculated as below:

* Supporter: Vivo, Nokia, ZTE
* For eMTC
	+ floor (start SFN\_id of Tx window/2) + 2401
* For NB-IoT
	+ floor (start SFN\_id of Tx window/4) + 256\*carrier\_id + 4097
* Note: To ensure 20ms (for eMTC) and 40ms (for NB-IoT) is the minimum value in configuration.

**Option 2 (Add CE-level)**

The CB-RNTI is calculated as below:

* For eMTC
	+ 2401 + floor (start SFN\_id of Tx window/2) + 512\*CE\_level
* For NB-IoT
	+ 4097 + floor (start SFN\_id of Tx window/4) + 256\*CE\_level + 768\*carrier\_id

**Option 3 (remove carrier id)**

* For eMTC
	+ 2401 + floor (start SFN\_id of Tx window/2)
* For NB-IoT
	+ 4097 + floor (start SFN\_id of Tx window/4)

**Option 4 (remove carrier id add CE-level)**

* For eMTC
	+ 2401 + floor (start SFN\_id of Tx window/2) + 512\*CE\_level
* For NB-IoT
	+ 4097 + floor (start SFN\_id of Tx window/4) + 256\*CE\_level

**Option 5 (fix Y = 32 in the WA)**

* For eMTC
	+ 2401 + floor (start SFN\_id of Tx window/configured Tx window periodicity) modulo (32) + 32\*CE\_level
* For NB-IoT
	+ 4097 + floor (start SFN\_id of Tx window/configured Tx window periodicity) modulo (32) + 32\*CE\_level + 96\*carrier\_id

**Option 6 (R2-2506184)**

* For both eMTC and NB-IoT
	+ CB-RNTI = *startCB-RNTI* + (M modulo (*nrofCB-RNTI*))
	+ Both *startCB-RNTI* and *nrofCB-RNTI* are configured by NW
	+ M is the index of MSG3 window
* Proposals from R2-2506184
	+ A first CB-Msg3 window (M = 0), starting in startH-SFN and startSFN, is associated with a CB-RNTI equal to *startCB-RNTI*.
	+ For the Mth CB Msg3 window before or after the first CB-Msg3 window, the associated CB-RNTI is equal to: CB-RNTI = *startCB-RNTI* + (M modulo (*nrofCB-RNTI*))

**Option 7**

The CB-RNTI is calculated as below:

* For eMTC
	+ 2401 + (control-1) \* floor (start SFN\_id of Tx window/2) + (control-2) \* 512\*CE\_level
* For NB-IoT
	+ 4097 + (control-1) \* floor (start SFN\_id of Tx window/4) + (control-2) \* 256\*CE\_level + (control-3) \* 768 \* carrier\_id
* control-x is 0 or 1 and is configured by NW.

For eMTC, the CE\_level is the selected enhanced coverage level (0 <= CE\_level < 2).

For NB-IoT, CE\_level is the selected enhanced coverage level (0 <= CE\_level < 3). carrier\_id is the index of the UL carrier associated with the selected UL grants (0 <= carrier\_id < 16). The carrier\_id of the anchor carrier is 0.

The value ranges of each option are list as the following table:

|  |  |  |
| --- | --- | --- |
|  | **Value range, eMTC** | **Value range, NB-IoT** |
| **Option 1** | 2401 ~ 2401+512 | 4097 ~ 4097+4096 |
| **Option 2** | 2401 ~ 2401+1024 | 4097 ~ 4097+12288 |
| **Option 3** | 2401 ~ 2401+512 | 4097 ~ 4097+256 |
| **Option 4** | 2401 ~ 2401+1024 | 4097 ~ 4097+768 |
| **Option 5** | 2401 ~ 2401+64 | 4097 ~ 4097+1536 |
| **Option 6** | Depends on configuration | Depends on configuration |
| **Option 7** | Same as option 2 | Same as option 2 |

According to rapporteur’s understanding, in this formulation the selected CE level is used to partition UEs, thereby reducing the false alarm rate in CB-Msg4 detection. The same applies to the carrier id. Both parameters can be useful, provided that their associated value ranges are not set too broadly.

Discussion

Supporter for option 1 – ZTE, Nokia, Vivo

Supporter for option 5 – QC, Samsung, Nokia, Ericsson

No much support for other options.

Summary

Rapporteur suggests to go with either option 1 or option 5.

**Proposal 1: RAN2 to select one of below options to calculate CB-RNTI**

* **Option 1**
	+ **For eMTC**
		- **floor (start SFN\_id of Tx window/2) + 2401**
	+ **For NB-IoT**
		- **floor (start SFN\_id of Tx window/4) + 256\*carrier\_id + 4097**
		- **carrier\_id is the index of the UL carrier associated with the selected UL grants (0 <= carrier\_id < 16). The carrier\_id of the anchor carrier is 0.**
	+ **Note: To ensure 20ms (for eMTC) and 40ms (for NB-IoT) is the minimum value in transmission window periodicity configuration.**
* **Option 5**
	+ **For eMTC**
		- **floor (start SFN\_id of Tx window/WP) modulo (32) + 32\*CE\_level + 2401**
		- **the CE\_level is the selected enhanced coverage level (0 <= CE\_level < 2)**
	+ **For NB-IoT**
		- **floor (start SFN\_id of Tx window/WP) modulo (32) + 32\*CE\_level + 96\*carrier\_id + 4097**
		- **the CE\_level is the selected enhanced coverage level (0 <= CE\_level < 3)**
		- **the carrier\_id is the index of the UL carrier associated with the selected UL grants (0 <= carrier\_id < 16). The carrier\_id of the anchor carrier is 0.**
	+ **WP is the configured CB-MSG3 transmission window periodicity in unit of 10ms.**

## Power Ramping

Note that this part is mainly copied from Nokia contribution.

Below has been discussed online in RAN2-131 meeting.

|  |
| --- |
| * Power ramping

[R2-2505632](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2505632%20Remaining%20issues%20on%20UL%20capacity%20enhancement%20for%20IoT%20NTN.docx) Remaining issues on UL capacity enhancement for IoT NTN Nokia, Nokia Shanghai Bell discussion Rel-19 IoT\_NTN\_Ph3-CoreObservation 2: The CB-Msg3 UL transmission power calculation is not clearly defined in TS36.213 (i.e., which j should be followed for CB-Msg3 UL transmission power calculation).Observation 3: In legacy Msg3 transmission, UE can not only perform Msg3 power ramping but also increase its CE level to improve the Msg3 transmission successful rate.Observation 4: The UE has no means to improve its CB-Msg3 transmission reliablity if both the CB-Msg3 power ramping and the CE level increase are not supported.Observation 5: There is no clear conclusion in RAN1 whether the CB-Msg3 power ramping should be supported because they have no time for performance evaluation. RAN2 can make the final decision considering the CB-Msg3 CE level increase is forbidden.Proposal 3: Power ramping between CB-Msg3 windows is supported.Proposal 4: The same principle as for legacy Msg3 power ramping (j=2) should be followed to limit the specification impact.- vivo thinks that without RAN1 work we cannot decide on power ramping- ESA thinks that if we can use existing procedures for power ramping we should do it- Samsung thinks we have agreed to avoid increasing the CE level assuming that there would be power ramping.- IDC is not sure we should introduce power ramping without RAN1- HW thinks power ramping is not essential- ZTE is ok to discuss a possible simple power ramping scheme* We try to define a simple power ramping scheme reusing existing mechanisms and then we inform RAN1 inviting them to respond if they find a problem
* Continue in offline 302
 |

Msg3 power ramping is supported by the UE through adjustments to the Msg3 received target power, as defined in the MAC specification. The received target power is increased with the number of preamble failures. If the Random Access Response reception is not successful within the RAR window, the UE increments the *PREAMBLE\_TRANSMISSION\_COUNTER* by 1. Additionally, the network provides two RRC parameters as input for power ramping calculation, i.e., *preambleInitialReceivedTargetPower* and *powerRampingStep*.

|  |
| --- |
| TS36.321 Section 5.1.3 for legacy Msg3 power ramping:- the MSG3\_RECEIVED\_TARGET\_POWER is set to *preambleInitialReceivedTargetPower* + (*PREAMBLE\_TRANSMISSION\_COUNTER\_CE* – 1) \* *powerRampingStep*; |

To reuse the existing mechanism, we propose that the same formula be applied for CB-Msg3 received target power calculation, with the following adaptations.

Firstly, RAN2 needs to define power ramping RRC parameters dedicated to CB-Msg3 by reusing the same type of parameters as those defined for legacy Msg3 power ramping. Since the network may also support legacy UEs using the existing power ramping parameters, it is preferable to define a separate set of parameters dedicated to CB-Msg3 power ramping in *CB-Msg3-ConfigSIB-NB*.

**Legacy parameters:**

PowerRampingParameters ::= SEQUENCE {

 powerRampingStep ENUMERATED {dB0, dB2,dB4, dB6},

 preambleInitialReceivedTargetPower ENUMERATED {

 dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,

 dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,

 dBm-100, dBm-98, dBm-96, dBm-94,

 dBm-92, dBm-90}

}

**Proposed parameters for CB-Msg3:**

cb-Msg3-powerRampingParameters-r19 ::= SEQUENCE {

 powerRampingStep ENUMERATED {dB0, dB2,dB4, dB6},

 cb-Msg3-InitialReceivedTargetPower ENUMERATED {

 dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,

 dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,

 dBm-100, dBm-98, dBm-96, dBm-94,

 dBm-92, dBm-90}

}

Proposal 2: RAN2 define two new RRC parameters for CB-Msg3 power ramping (i.e., *powerRampingStep* and *cb-Msg3-InitialReceivedTargetPower*), with the same value ranges as those defined for legacy Msg3 power ramping.

Discussion

No concern from companies.

Summary

It is suggested to agree P2.

**Proposal 2: RAN2 to define two new RRC parameters for CB-Msg3 power ramping (i.e., *powerRampingStep* and *cb-Msg3-InitialReceivedTargetPower*), with the same value ranges as those defined for legacy Msg3 power ramping.**

Secondly, similar to the counter increment used for legacy Msg3 power ramping, a CB-Msg3 failure counter should also be defined. In fact, the counter (*CB\_MSG3\_TRANSMISSION\_COUNTER\_CE*) has already been specified in the MAC running CR. This counter is initialized to one during the CB-Msg3-EDT initialization procedure and is incremented by one each time the *CB-Msg3ResponseTimer* expires

|  |
| --- |
| 5.1x.1 CB-Msg3-EDT initializationThe CB-Msg3-EDT procedure shall be performed as follows:- flush the Msg3 buffer;**- set the CB\_MSG3\_TRANSMISSION\_COUNTER\_CE to 1;**…5.1x.3 CB-Msg4 reception- if the *CB-Msg3ResponseTimer* expires:- flush the HARQ buffer used for transmission of the MAC PDU in the Msg3 buffer;**- increment CB\_MSG3\_TRANSMISSION\_COUNTER\_CE by 1;**- if CB\_MSG3\_TRANSMISSION\_COUNTER\_CE = *maxNumCBMsg3AttemptCE* for the corresponding enhanced coverage level + 1:- discard the CB-RNTI;- consider the CB-Msg3 transmission unsuccessfully completed;- indicate an unsuccessful completion of the CB-Msg3 transmission to the upper layers.- else:- based on the CB-Msg3-EDT backoff parameter, select a random backoff time according to a uniform distribution between 0 and the CB-Msg3-EDT backoff Parameter value;- delay the subsequent CB-Msg3 transmission by the backoff time;- proceed to the CB-Msg3 transmission (see clause 5.1x.2).  |

We think the counter can be reused for Msg3 received target power calculation for power ramping.

Proposal 3: The UE applies power ramping when the *CB-Msg3ResponseTimer* has expired and the UE proceeds to the next CB-msg3 transmission, by reusing the *CB\_MSG3\_TRANSMISSION\_COUNTER\_CE* as defined in the MAC running CR*.*

Discussion

No concern from companies.

Summary

It is suggested to agree P3.

**Proposal 3: The UE applies power ramping when the *CB-Msg3ResponseTimer* has expired and the UE proceeds to the next CB-msg3 transmission, by reusing the *CB\_MSG3\_TRANSMISSION\_COUNTER\_CE* as defined in the MAC running CR*.***

With proposals above, the CB-Msg3 received target power can be calculated as below:

Proposal 4: The CB-Msg3 received target power can be calculated as below:

the CB-MSG3\_RECEIVED\_TARGET\_POWER is set to *cb-Msg3-InitialReceivedTargetPower* + (CB\_MSG3\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStep*;

Discussion

No concern from companies.

Summary

It is suggested to agree P4.

**Proposal 4: The CB-Msg3 received target power can be calculated as below:**

* **the CB-MSG3\_RECEIVED\_TARGET\_POWER is set to *cb-Msg3-InitialReceivedTargetPower* + (CB\_MSG3\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStep*;**

A TP has been provided in Annex2. We will use it as a strat point for further discussion.

# Conclusion

CB-RNTI

**Proposal 1: RAN2 to select one of below options to calculate CB-RNTI**

* **Option 1**
	+ **For eMTC**
		- **floor (start SFN\_id of Tx window/2) + 2401**
	+ **For NB-IoT**
		- **floor (start SFN\_id of Tx window/4) + 256\*carrier\_id + 4097**
		- **carrier\_id is the index of the UL carrier associated with the selected UL grants (0 <= carrier\_id < 16). The carrier\_id of the anchor carrier is 0.**
	+ **Note: To ensure 20ms (for eMTC) and 40ms (for NB-IoT) is the minimum value in transmission window periodicity configuration.**
* **Option 5**
	+ **For eMTC**
		- **floor (start SFN\_id of Tx window/WP) modulo (32) + 32\*CE\_level + 2401**
		- **the CE\_level is the selected enhanced coverage level (0 <= CE\_level < 2)**
	+ **For NB-IoT**
		- **floor (start SFN\_id of Tx window/WP) modulo (32) + 32\*CE\_level + 96\*carrier\_id + 4097**
		- **the CE\_level is the selected enhanced coverage level (0 <= CE\_level < 3)**
		- **the carrier\_id is the index of the UL carrier associated with the selected UL grants (0 <= carrier\_id < 16). The carrier\_id of the anchor carrier is 0.**
	+ **WP is the configured CB-MSG3 transmission window periodicity in unit of 10ms.**

Power Ramping

**Proposal 2: RAN2 to define two new RRC parameters for CB-Msg3 power ramping (i.e., *powerRampingStep* and *cb-Msg3-InitialReceivedTargetPower*), with the same value ranges as those defined for legacy Msg3 power ramping.**

**Proposal 3: The UE applies power ramping when the *CB-Msg3ResponseTimer* has expired and the UE proceeds to the next CB-msg3 transmission, by reusing the CB\_MSG3\_TRANSMISSION\_COUNTER\_CEas defined in the MAC running CR*.***

**Proposal 4: The CB-Msg3 received target power can be calculated as below:**

* **the CB-MSG3\_RECEIVED\_TARGET\_POWER is set to *cb-Msg3-InitialReceivedTargetPower* + (CB\_MSG3\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStep*;**

# References

[1] R2-2505555 Remaining MAC open issues in IoT NTN MediaTek Inc. discussion Rel-19 IoT\_NTN\_Ph3-Core

[2] R2-2506416 Discussion on CB-RNTI Mediatek discussion Rel-19 IoT\_NTN\_Ph3-Core

# Annex 1: Msg3 power ramping defined in legacy NB-IoT

TS 36.213:

16.2.1 Uplink power control

Uplink power control controls the transmit power of the different uplink physical channels.

16.2.1.1 Narrowband physical uplink shared channel

16.2.1.1.1 UE behaviour

The setting of the UE Transmit power for a Narrowband Physical Uplink Shared Channel (NPUSCH) transmission is defined as follows. For FDD, if the UE is capable of enhanced random access power control [12], and it is configured by higher layers, and for TDD, enhanced random access power control shall be applied for a UE which started the random access procedure in the first or second configured NPRACH repetition level.

The UE transmit power  for NPUSCH transmission in NB-IoT UL slot *i* for the serving cell is given by:

For NPUSCH (re)transmissions corresponding to the random access response grant if enhanced random access power control is not applied, and for all other NPUSCH transmissions except for NPUSCH (re)transmission corresponding to preconfigured uplink resource, when the number of repetitions of the allocated NPUSCH RUs is greater than 2:

[dBm]

otherwise

 [dBm]

where,

- is the configured UE transmit power defined in [6] in NB-IoT UL slot *i* for serving cell .

- is the NPUSCH transmission resource bandwidth normalized by 15 kHz, where {1/4} is used for 3.75 kHz subcarrier spacing and {1, 3, 6, 12} are used for 15kHz subcarrier spacing

- is a parameter composed of the sum of a component  provided from higher layers and a component  provided by higher layers for *j=1*, *3* andfor serving cell where . For NPUSCH (re)transmissions corresponding to a dynamic scheduled grant or a semi-persistent grant then *j=1*, for NPUSCH (re)transmissions corresponding to the random access response grant then *j=2* and for NPUSCH transmission using preconfigured uplink resource then *j=3*. . If enhanced random access power control is not applied, , where the parameter *preambleInitialReceivedTargetPower* [8] () and are signalled from higher layers for serving cell . If enhanced random access power control is applied,

- For *j*=*1*, for NPUSCH format 2, =1; for NPUSCH format 1, is provided by higher layers for serving cell. For *j*=2,  For *j*=*3*,  is the parameter *alpha* in *PUR-Config-NB* provided by higher layers for serving cell.

-  is the downlink path loss estimate calculated in the UE for serving cell  in dB and  = *nrs-Power* + *nrs-PowerOffsetNonAnchor* – NRSRP, where *nrs-Power* is provided by higher layers and Clause 16.2.2, and *nrs-PowerOffsetNonAnchor* is set to zero if it is not provided by higher layers and NRSRP is defined in [5] for serving cell .

- If a NB-IoT UE is configured with *npusch-16QAM-Config* or *pur-UL-16QAM-Config*, then for NPUSCH (re)transmissions with QPSK and 16QAM,

- for and for where  is given by the parameter *deltaMCS-Enabled* provided by higher layers for serving cell , and

- where is the code block size and is the number of resource elements determined as where , , are defined in [3], and is defined in section 16.5.1.1

- otherwise .

TS 36.321:

### 5.1.3 Random Access Preamble transmission

The random-access procedure shall be performed as follows:

- set PREAMBLE\_RECEIVED\_TARGET\_POWER to *preambleInitialReceivedTargetPower* + DELTA\_PREAMBLE + (PREAMBLE\_TRANSMISSION\_COUNTER – 1) \* *powerRampingStep*;

- if the UE is a BL UE or a UE in enhanced coverage:

- the PREAMBLE\_RECEIVED\_TARGET\_POWER is set to:
PREAMBLE\_RECEIVED\_TARGET\_POWER - 10 \* log10(*numRepetitionPerPreambleAttempt*);

- if the UE is an NB-IoT UE:

- for enhanced coverage level 0, the PREAMBLE\_RECEIVED\_TARGET\_POWER is set to:
 PREAMBLE\_RECEIVED\_TARGET\_POWER - 10 \* log10(*numRepetitionPerPreambleAttempt*)

- for FDD if the UE supports enhanced random access power control and *PowerRampingParameters-NB-v1450* is configured by upper layers, or for TDD:

- the MSG3\_RECEIVED\_TARGET\_POWER is set to *preambleInitialReceivedTargetPower* + (PREAMBLE\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStep*;

- for other enhanced coverage levels:

- for FDD if the UE supports enhanced random access power control and *PowerRampingParameters-NB-v1450* is configured by upper layers, or for TDD; and

- if the starting enhanced coverage level was enhanced coverage level 0 or enhanced coverage level 1:

- if the MAC entity considers itself to be in enhanced coverage level 1 and if *powerRampingStepCE1* and *preambleInitialReceivedTargetPowerCE1* have been configured by upper layers:

- the PREAMBLE\_RECEIVED\_TARGET\_POWER is set to *preambleInitialReceivedTargetPowerCE1* + DELTA\_PREAMBLE + (PREAMBLE\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStepCE1* - 10 \* log10(*numRepetitionPerPreambleAttempt*);

- the MSG3\_RECEIVED\_TARGET\_POWER is set to *preambleInitialReceivedTargetPowerCE1* + (PREAMBLE\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStepCE1*;

- else:

- the PREAMBLE\_RECEIVED\_TARGET\_POWER is set to *preambleInitialReceivedTargetPower* + DELTA\_PREAMBLE + (PREAMBLE\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStep* - 10 \* log10(*numRepetitionPerPreambleAttempt*);

- the MSG3\_RECEIVED\_TARGET\_POWER is set to *preambleInitialReceivedTargetPower* + (PREAMBLE\_TRANSMISSION\_COUNTER\_CE – 1) \* *powerRampingStep*;

- else:

- the PREAMBLE\_RECEIVED\_TARGET\_POWER is set corresponding to the max UE output power;

- if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:

- instruct the physical layer to transmit a preamble with the number of repetitions required for preamble transmission corresponding to the selected preamble group (i.e., *numRepetitionPerPreambleAttempt*) using the selected PRACH corresponding to the selected enhanced coverage level, corresponding RA-RNTI, preamble index or for NB-IoT subcarrier index, and PREAMBLE\_RECEIVED\_TARGET\_POWER.

- else:

- instruct the physical layer to transmit a preamble using the selected PRACH, corresponding RA-RNTI, preamble index and PREAMBLE\_RECEIVED\_TARGET\_POWER.

TS 36.331:

– *RACH-ConfigCommon-NB*

The IE *RACH-ConfigCommon-NB* is used to specify the generic random access parameters.

***RACH-ConfigCommon-NB* information element**

-- ASN1START

RACH-ConfigCommon-NB-r13 ::= SEQUENCE {

 preambleTransMax-CE-r13 PreambleTransMax,

 powerRampingParameters-r13 PowerRampingParameters,

 rach-InfoList-r13 RACH-InfoList-NB-r13,

 connEstFailOffset-r13 INTEGER (0..15) OPTIONAL, -- Need OP

 ...,

 [[ powerRampingParameters-v1450 PowerRampingParameters-NB-v1450 OPTIONAL -- Need OR

 ]],

 [[ rach-InfoList-v1530 RACH-InfoList-NB-v1530 OPTIONAL -- Cond EDT

 ]]

}

RACH-InfoList-NB-r13 ::= SEQUENCE (SIZE (1.. maxNPRACH-Resources-NB-r13)) OF RACH-Info-NB-r13

RACH-InfoList-NB-v1530 ::= SEQUENCE (SIZE (1.. maxNPRACH-Resources-NB-r13)) OF RACH-Info-NB-v1530

RACH-Info-NB-r13 ::= SEQUENCE {

 ra-ResponseWindowSize-r13 ENUMERATED {

 pp2, pp3, pp4, pp5, pp6, pp7, pp8, pp10},

 mac-ContentionResolutionTimer-r13 ENUMERATED {

 pp1, pp2, pp3, pp4, pp8, pp16, pp32, pp64}

}

RACH-Info-NB-v1530 ::= SEQUENCE {

 mac-ContentionResolutionTimer-r15 ENUMERATED {

 pp1, pp2, pp3, pp4, pp8, pp16, pp32, pp64}

}

PowerRampingParameters-NB-v1450 ::= SEQUENCE {

 preambleInitialReceivedTargetPower-v1450 ENUMERATED {

 dBm-130, dBm-128, dBm-126, dBm-124, dBm-122,

 dBm-88, dBm-86, dBm-84,dBm-82, dBm-80}

 OPTIONAL, -- Need OR

 powerRampingParametersCE1-r14 SEQUENCE {

 powerRampingStepCE1-r14 ENUMERATED {dB0, dB2, dB4, dB6},

 preambleInitialReceivedTargetPowerCE1-r14 ENUMERATED {

 dBm-130, dBm-128, dBm-126, dBm-124, dBm-122,

 dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,

 dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,

 dBm-100, dBm-98, dBm-96, dBm-94, dBm-92,

 dBm-90, dBm-88, dBm-86, dBm-84, dBm-82, dBm-80}

 } OPTIONAL -- Need OR

}

-- ASN1STOP

| ***RACH-ConfigCommon-NB* field descriptions** |
| --- |
| ***connEstFailOffset***Parameter "Qoffsettemp" in TS 36.304 [4]. If the field is not present the value of infinity shall be used for "Qoffsettemp". |
| ***mac-ContentionResolutionTimer***Timer for contention resolution in TS 36.321 [6]. Value in PDCCH periods. Value pp1 corresponds to 1 PDCCH period, pp2 corresponds to 2 PDCCH periods and so on. *mac-ContentionResolutionTimer-r15* is only applicable for EDT. UE performing EDT shall use *mac-ContentionResolutionTimer-r15*, if present.For FDD: The value considered by the UE is: *mac-ContentionResolutionTimer* = Min (signaled value x PDCCH period, 10.24s).For TDD: The value considered by the UE is: *mac-ContentionResolutionTimer* = Min (signaled value x PDCCH period, 20.48s). |
| ***powerRampingParameters, powerRampingParametersCE1***Power ramping step and preamble initial received target power – same as TS 36.213 [23] and TS 36.321 [6].For FDD, if the UE does not support enhanced random access power control and more than one repetition level is configured in the cell, then the UE transmits NPRACH with max power except for the lowest repetition level. Otherwise, the UE uses NPRACH power ramping.For FDD, if the UE supports enhanced random access power control and *powerRampingParameters-v1450* is signalled, or for TDD, the UE uses NPRACH power ramping across repetition levels as specified in TS 36.321 [6]. If *preambleInitialReceivedTargetPower-v1450* is present, the UE shall use *preambleInitialReceivedTargetPower-v1450* instead of *preambleInitialReceivedTargetPower* (i.e. without suffix). If *powerRampingParametersCE1* is present, the UE shall use *powerRampingParametersCE1* instead of *powerRampingParameters* for NPRACH power ramping in the second repetition level. |
| ***preambleTransMax-CE***Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. |
| ***ra-ResponseWindowSize***Duration of the RA response window in TS 36.321 [6]. Value in PDCCH periods. Value pp2 corresponds to 2 PDDCH periods, pp3 corresponds to 3 PDCCH periods and so on.For FDD: The value considered by the UE is: *ra-ResponseWindowSize* = Min (signaled value x PDCCH period, 10.24s).For TDD: The value considered by the UE is: *ra-ResponseWindowSize* = Min (signaled value x PDCCH period, 20.48s). |

| **Conditional presence** | **Explanation** |
| --- | --- |
| *EDT* | The field is optionally present, Need OR, if *edt-Parameters* is present; otherwise the field is not present and the UE shall delete any existing value for this field. |

**PowerRampingParameters ::= SEQUENCE {**

 powerRampingStep ENUMERATED {dB0, dB2,dB4, dB6},

 preambleInitialReceivedTargetPower ENUMERATED {

 dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,

 dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,

 dBm-100, dBm-98, dBm-96, dBm-94,

 dBm-92, dBm-90}

}

|  |
| --- |
| ***powerRampingStep***Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on. |
| ***preambleInitialReceivedTargetPower***Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on. |

# Annex 2: TP for CB-Msg3 power ramping for NB-IoT

Changes marked in yellow.

TS 36.331:

#### *–* *CB-Msg3-ConfigSIB-NB*

The IE *CB-Msg3-ConfigSIB-NB* is used to specify the CB-Msg3-EDT configuration.

*CB-Msg3-ConfigSIB-NB* information element

-- ASN1START

CB-Msg3-ConfigSIB-NB-r19 ::= SEQUENCE {

 cb-Msg3-MinRSRP-Threshold-NB-r19 NRSRP-Range-NB-r14 OPTIONAL, --Need OR

 cb-Msg3-RSRP-CE-Levels-NB-r19 CB-Msg3-RSRP-CE-Levels-NB-r19 OPTIONAL, --Need OR

 cb-Msg3-ConfigList-NB-r19 CB-Msg3-ConfigList-NB-r19

 cb-Msg3-powerRampingParameters-r19 cb-Msg3-powerRampingParameters-r19 OPTIONAL, --Need OR

}

CB-Msg3-ConfigList-NB-r19 ::= SEQUENCE (SIZE (1.. maxCE-Level-NB-r19)) OF

 CB-Msg3-Config-NB-r19

CB-Msg3-Config-NB-r19 ::= SEQUENCE {

 cb-Msg3-TBS-NB-r19 ENUMERATED {b328, b408, b504, b584, b680, b808, b936,

 b1000},

 cb-Msg3-NumOfReplicas-NB-r19 INTEGER (1..4),

 cb-Msg3-TimeResource-NB-r19 SEQUENCE {

 npusch-Periodicity-r19 ENUMERATED {ms40, ms80, ms160, ms240,

 ms320, ms640, ms1280, ms2560},

 npusch-StartSFN-r19 INTEGER (0..1023),

 npusch-StartSubframe-r19 INTEGER (0..9)

 },

 cb-Msg3-PhysicalConfig-r19 ::= SEQUENCE {

 npusch-NumRUsIndex-r19 INTEGER (0..7),

 npusch-NumRepetitionsIndex-r19 INTEGER (0..7),

 npusch-SubCarrierSetList-r19 SEQUENCE (SIZE(1..48)) OF NPUSCH-SubCarrierSet-r19,

 npusch-MCS-r19 CHOICE {

 singleTone INTEGER (0..10),

 multiTone INTEGER (0..13)

 },

 ack-NumRepetitions-NB-r19 ACK-NACK-NumRepetitions-NB-r13 OPTIONAL, --Need OP

 p0-UE-NPUSCH-r19 INTEGER (-8..7),

 alpha-NB-r19 ENUMERATED {al0, al04, al05, al06,

 al07, al08, al09, al1},

 npdcch-CarrierIndex-r19 INTEGER (1..maxNonAnchorCarriers-NB-r14)

 OPTIONAL, -- Need OP

 npdcch-NumRepetitions-r19 ENUMERATED {r1, r2, r4, r8, r16, r32, r64, r128,

 r256, r512, r1024, r2048,

 spare4, spare3, spare2, spare1},

 npdcch-StartSF-CSS-r19 ENUMERATED {v1dot5, v2, v4, v8, v16, v32, v48, v64},

 npdcch-Offset-CSS-r19 ENUMERATED {zero, oneEighth, oneFourth, threeEighth}

 },

 cb-Msg3-TxWindow-NB-r19 SEQUENCE {

 windowSize-NB-r19 ENUMERATED {4, 8, 12, 16, 24, 32, 48, 64},

 windowPeriodicity-NB-r19 ENUMERATED {4, 8, 12, 16, 24, 32, 48, 64}

 } OPTIONAL, --Need OP

 cb-Msg3-ResponseWindow-NB-r19 ENUMERATED {pp1, pp2, pp3, pp4, pp8, pp16, pp32,

 pp64},

 cb-Msg3-MaxAttemptNum-NB-r19 ENUMERATED {n2, n3, n4, n5, n6, n7, n8, n10} OPTIONAL, --Need OP

 ...

}

CB-Msg3-RSRP-CE-Levels-NB-r19 ::= SEQUENCE (SIZE(1..2)) OF RSRP-Range

NPUSCH-SubCarrierSet-r19 CHOICE {

 khz15 INTEGER (0..18),

 khz3dot75 INTEGER (0..47)

cb-Msg3-powerRampingParameters-r19 ::= SEQUENCE {

 powerRampingStep ENUMERATED {dB0, dB2,dB4, dB6},

 cb-Msg3-InitialReceivedTargetPower ENUMERATED {

 dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,

 dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,

 dBm-100, dBm-98, dBm-96, dBm-94,

 dBm-92, dBm-90}

}

}

-- ASN1STOP

TS 36.321:

### 5.1x CB-Msg3-EDT Procedure

#### 5.1x.1 CB-Msg3-EDT initialization

The CB-Msg3-EDT procedure described in this clause is initiated by the RRC sublayer and can only be performed in a non-terrestrial network. If the UE is an NB-IoT UE, the CB-Msg3-EDT procedure is performed on the anchor carrier or one of the non-anchor carriers for which CB-Msg3-EDT resource has been configured in system information.

The following information is assumed to be available before the procedure can be initiated for NB-IoT UEs, BL UEs or UEs in CE mode A, as specified in TS 36.331 [8]:

- if the UE is a BL UE or a UE in CE mode A:

- the available set of PUSCH resources associated with each enhanced coverage level for the transmission of the CB-Msg3, [FFS *cb-Msg3-EDT-PUSCH-Config*].

- if the UE is an NB-IoT UE:

- the available sets of PUSCH resources on the anchor carrier, [FFS *cb-Msg3-EDT-StartTimeParameters*] and on the non-anchor carriers, in [FFS *ul-ConfigList*].

- the mapping of the PUSCH resources into enhanced coverage levels is determined according to the following:

- the number of enhanced coverage levels is equal to one plus the number of RSRP thresholds present in [FFS *cb-Msg3-EDT-RSRP-ThresholdList*].

- each enhanced coverage level has zero or one anchor carrier PUSCH resource present in [FFS *cb-Msg3-EDT-StartTimeParameters*] and zero or one PUSCH resource for each non-anchor carrier signalled in [FFS *ul-ConfigList*].

- enhanced coverage levels are numbered from 0 and the mapping of PUSCH resources to enhanced coverage levels are done in increasing [FFS *npusch-NumRepetitionsIndex*] order.

- when multiple carriers provide PUSCH resources for the same enhanced coverage level, the UE will randomly select one of them using the following selection probabilities:

- the selection probability of the anchor carrier PUSCH resource for the given enhanced coverage level, [FFS *nusch-ProbabilityAnchor*], is given by the corresponding entry in [FFS *npusch-ProbabilityAnchorList*].

- the selection probability is equal for all non-anchor carrier PUSCH resources and the probability of selecting one PUSCH resource on a given non-anchor carrier is (1-[FFS *npusch-ProbabilityAnchor*])/(number of non-anchor PUSCH resources).

- the criteria to select PUSCH resources based on RSRP measurement per enhanced coverage level, [FFS *cb-Msg3-EDT-RSRP-ThresholdList*].

- the number of replicas for CB-Msg3 transmission corresponding to the selected enhanced coverage level, [FFS *cb-Msg3-EDT-NumReplicas*].

- CB-Msg3 transmission window configuration corresponding to the selected enhanced coverage level, [FFS *cb-Msg3-EDT-TransmissionWindow*].

- *CB-Msg3ResponseTimer* corresponding to the selected enhanced coverage level, [FFS *cb-Msg3-EDT-ResponseWindowTimerLength*].

- the maximum number of transmission attempts per enhanced coverage level, [FFS *maxNumCBMsg3AttemptCE*].

- Power ramping factor for CB-Msg3 transmission, [FFS *powerRampingStep*].

- Initial CB-Msg3 transmission power, [FFS *cb-Msg3-InitialReceivedTargetPower*].

- [FFS other parameters]

~~Editor’s note: FFS the power ramping parameters.~~

The CB-Msg3-EDT procedure shall be performed as follows:

- flush the Msg3 buffer;

**- set the CB\_MSG3\_TRANSMISSION\_COUNTER\_CE to 1;**

- if the UE is an NB-IoT UE and if the RSRP threshold of enhanced coverage level 2 configured by upper layers in [FFS *cb-Msg3-EDT-RSRP-ThresholdList*]and the measured RSRP is less than the RSRP threshold of enhanced coverage level 2:

- the MAC entity considers to be in enhanced coverage level 2;

- else if the measured RSRP is less than the RSRP threshold of enhanced coverage level 1 as configured by upper layers in [FFS cb*-Msg3-EDT-RSRP-ThresholdList*] then:

- the MAC entity considers to be in enhanced coverage level 1;

- else:

- the MAC entity considers to be in enhanced coverage level 0;

- set the CB-Msg3-EDT backoff parameter value to 0 ms;

- set current NTA to 0;

- proceed to the transmission of the CB-Msg3 (see clause 5.1x.2).

#### 5.1x.2 CB-Msg3 transmission

Before the CB-Msg3 Transmission, the MAC entity shall select [FFS *cb-Msg3-EDT-NumReplicas*] UL grants for CB-Msg3 transmission as follows:

- select the next upcoming CB-Msg3 transmission window provided by the [FFS *cb-Msg3-EDT-TransmissionWindow*] associated with the selected enhanced coverage level;

- randomly select [FFS *cb-Msg3-EDT-NumReplicas*] PUSCH resources in the time domain within the selected CB-Msg3 transmission window from the CB-Msg3 resources provided by [FFS *cb-Msg3-EDT-PUSCH-Config*] associated with the selected enhanced coverage level;

- randomly select a frequency domain PUSCH resource for each selected time domain resource provided by [FFS *cb-Msg3-EDT-PUSCH-Config*] associated with the selected enhanced coverage level.

The CB-Msg3 Transmission shall be performed as follows:

~~Editor’s note: FFS the power ramping parameters and how the power ramping is done.~~

- the CB-MSG3\_RECEIVED\_TARGET\_POWER is set to cb-Msg3-InitialReceivedTargetPower + (CB\_MSG3\_TRANSMISSION\_COUNTER\_CE – 1) \* powerRampingStep;

- if this is the first attempt of CB-Msg3 transmission within the selected CB-Msg3 transmission window:

- obtain the MAC PDU to transmit from the "Multiplexing and assembly" entity and store it in the Msg3 buffer.

5.1x.3 CB-Msg4 reception

Once all the CB-Msg3s of a CB-Msg3 transmission window are transmitted, the MAC entity shall monitor the PDCCH of the SpCell, while *CB-Msg3ResponseTimer* is running, for CB-Msg4(s) identified by the CB-RNTI defined below.

For BL UEs and UEs in CE mode A, the CB-RNTI associated with the CB-Msg3 transmission window in which the CB-Msg3(s) are transmitted, is computed as:

CB-RNTI = 2401 + (Msg3\_W\_id mod [FFS *X*]) + [FFS *X*]\*CE\_level

Where:

- Msg3\_W\_id is floor((SFN\_id - startSFN) / windowPeriodicity), where the SFN\_id is the first SFN of the selected CB-Msg3 transmission window, startSFN is the CB-Msg3 transmission window start SFN defined by IE [FFS], the windowPeriodicity is the CB-Msg3 transmission window periodicity defined by IE [FFS].

- [FFS *X*] is ceil(Msg4\_WS/Msg3\_WP), where the Msg4\_WS is [FFS], the maximum CB-Msg3 response timer length, the Msg3\_WP is [FFS], the minimum CB-Msg3 transmission window periodicity.

- CE\_level is the selected enhanced coverage level (0 <= CE\_level < 2).

For NB-IoT UEs, the CB-RNTI associated with the CB-Msg3 transmission window in which the CB-Msg3(s) are transmitted, is computed as:

CB-RNTI = 4097 + (Msg3\_W\_id mod [FFS *X*]) + [FFS *X*]\*CE\_level + 3\*[FFS *X*]\*carrier\_id

Where:

- Msg3\_W\_id is floor((SFN\_id - startSFN) / windowPeriodicity), where the SFN\_id is the first SFN of the selected CB-Msg3 transmission window, startSFN is the CB-Msg3 transmission window start SFN defined by IE [FFS], the windowPeriodicity is the CB-Msg3 transmission window periodicity defined by IE [FFS].

- [FFS X] is ceil(Msg4\_WS/Msg3\_WP), where the Msg4\_WS is [FFS], the maximum CB-Msg3 response timer length, the Msg3\_WP is [FFS], the minimum CB-Msg3 transmission window periodicity.

- CE\_level is the selected enhanced coverage level (0 <= CE\_level < 3).

- carrier\_id is the index of the UL carrier associated with the selected UL grants (0 <= carrier\_id < 16). The carrier\_id of the anchor carrier is 0.

Editor’s note: FFS whether to confirm the working assumption of CB-RNTI calculation.

After the CB-Msg3 transmission, the MAC entity shall:

- start the *CB-Msg3ResponseTimer* at the subframe that contains the end of selected the CB-Msg3 transmission window plus UE-eNB RTT.

Editor’s note: FFS whether the timer or window is used.

Editor’s note: FFS processing time is needed.

- monitor the PDCCH while *CB-Msg3ResponseTimer* is running.

- if notification of a reception of a PDCCH transmission is received from lower layers; and

- if the CB-Msg4 is successfully decoded:

- if the CB-Msg4 contains a CB Backoff Indicator subheader:

- set the CB-Msg3-EDT backoff parameter value as indicated by the BI field of the CB Backoff Indicator subheader and Table 7.2-1, except for NB-IoT where the value from Table 7.2-2 is used.

- else:

- set the CB-Msg3-EDT backoff parameter value to 0 ms.

- if the CB-Msg4 contains one or more MAC CMRs; and

- if there is a UE Contention Resolution Identity in a MAC CMR that matches the 48 first bits of the CCCH SDU transmitted in CB-Msg3(s):

- consider CMR reception successful and finish the disassembly and demultiplexing of the MAC PDU;

- discard the CB-RNTI;

- stop *CB-Msg3ResponseTimer*;

- flush the HARQ buffer used for transmission of the MAC PDU in the Msg3 buffer;

- if the corresponding CMR contains a Timing Advance Command field:

- process the received Timing Advance Command (see clause 5.2).

- if the corresponding CMR contains a C-RNTI field:

- set the C-RNTI to the value of the C-RNTI field.- consider CB-Msg3 transmission successfully completed;

- indicate the successful completion of the CB-Msg3 transmission to the upper layers.

- if the *CB-Msg3ResponseTimer* expires:

- flush the HARQ buffer used for transmission of the MAC PDU in the Msg3 buffer;

**- increment CB\_MSG3\_TRANSMISSION\_COUNTER\_CE by 1;**

- if CB\_MSG3\_TRANSMISSION\_COUNTER\_CE = *maxNumCBMsg3**AttemptCE* for the corresponding enhanced coverage level + 1:

- discard the CB-RNTI;

- consider the CB-Msg3 transmission unsuccessfully completed;- indicate an unsuccessful completion of the CB-Msg3 transmission to the upper layers.

- else:

- based on the CB-Msg3-EDT backoff parameter, select a random backoff time according to a uniform distribution between 0 and the CB-Msg3-EDT backoff Parameter value;

- delay the subsequent CB-Msg3 transmission by the backoff time;

- proceed to the CB-Msg3 transmission (see clause 5.1x.2).

<skip>