**3GPP TSG-RAN WG2 #130 R2-250xxxx**

**St.Julians, Malta, May 19th – 23rd, 2025**

Agenda Item: 8.9.3

Source: Ericsson (Rapporteur)

Title: Report of [AT130][306][R19 IoT NTN] CB-RNTI (Ericsson)

Document for: Discussion

# 1 Introduction

This is to summarize the input on the following offline:

* [AT130][306][R19 IoT NTN] CB-RNTI (Ericsson)

Scope: discuss the solution for CB-RNTI

Intended outcome: summary of the offline discussion

Offline time: Thursday 2025-05-22 (time/location FFS)

Deadline for offline discussion summary (in R2-2504777): Friday 2025-05-23 08:00

RAN2 had made the following agreements regarding the CB-RNTI.

RAN2 Agreements on CB-RNTI

• The RNTI used at least to schedule Msg4 transmission is derived based on the resource associated to the PUSCH occasion used for contention based Msg3 EDT transmission (FFS on the details. FFS how this is impacted by DSA)

• For DSA case, FFS if we only have one or multiple PDCCH monitoring window(s) (i.e. one window per each replica) for response reception. FFS when the window(s) is/are started (or restarted) and stopped. FFS on the window length. FFS if the UE needs to monitor only one RNTI or multiple RNTIs)

• For CB-msg3-EDT we adopt a Single Msg4 monitoring window and Single RNTI (the RNTI is derived on the transmit resource for the transmission window).

• Introduce a new RNTI (i.e. CB-RNTI) for CB-Msg4 monitoring and CB-Msg3 scrambling. We include this agreement in the LS to RAN1

## 1.1 Submitted tdocs

|  |  |
| --- | --- |
| Company | Proposal |
| [R2-2503355](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503355.zip) vivo | **Proposal 12: RAN2 to definite the CB-RNTI value range to be entirely independent of the RA-RNTI.**  **Proposal 13: CB-RNTI calculation considers the following parameters,**   * **the subframe timing index of the last valid CB-msg3 occasion within the corresponding CB-msg3-EDT transmission window;** * **the frequency resource index associated with that last valid CB-msg3 occasion (e.g. PRB index or carrier ID);** * **the maximum length of CB-msg4 monitoring window.** |
| [R2-2503461](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503461.zip) CATT | **Proposal 1: (MAC-2): RAN2 discusses whether to support one specified CB-RNTI value in the specification.** |
| [R2-2503500](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503500.zip) ZTE | **Proposal 9: The CB-RNTI calculation can be as below:**  **CB-RNTI = 1 + floor(SFN\_id/A) + [C\*(H-SFN mod B)]**  **Where, SFN\_id is the index of the radio frame of the first time-domain transmission occasion within the selected CB-msg3 transmission window and H-SFN is the index of the hyper frame of the first time-domain transmission occasion within the selected CB-msg3 transmission window.**  **A is determined by the minimum periodicity of the CB-msg3 transmission window in units of radio frame (e.g., 10ms). B is determined by the maximum length of CB-msg4 monitoring window in units of H-SFN duration. C is determined by the maximum value of floor(SFN\_id/A)+1.** |
| [R2-2503529](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503529.zip) OPPO | **Proposal 1:** The CB-RNTI is preconfigured or predefined. |
| [R2-2503662](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503662.zip) Nokia | **Proposal 10: The RNTI for CB-Msg4 reception can be reused by different Msg3 transmission windows if the Msg4 monitoring windows corresponding to the different Msg3 transmission windows are not overlapping.**  **Proposal 11: RAN2 to discuss below formula for deriving RNTI for Msg4 monitoring.**  **RNTI=X + Msg3\_W\_index mod (ceil (Msg4\_WS/Msg3\_WP)) + ceil (Msg4\_WS/Msg3\_WP)\*carrier\_id**,  *wherein:*   * *X is the starting RNTI for Msg4 reception, which can be defined by RAN2 e.g. X=1 or any other value,* * *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.* * *Msg4\_WS is the window size of Msg4,* * *Msg3\_WP: is the transmission window periodicity of Msg3.* |
| [R2-2503880](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503880.zip) NEC | **Proposal 14: The RNTI calculation should, at least, consider the carrier ID if non-anchor carrier transmission is supported and H-SFN related to the transmission window.** |
| [R2-2503959](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2503959.zip) Spreadtrum | **Proposal 7:** Only time domain information (e.g., subframe index, SFN) is taken into account for CB-RNTI calculation.  **Proposal 8:** The CB-Msg4 can comprise RRC message. |
| [R2-2504065](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504065.zip) Huawei, Turkcell | **Proposal 3:** (MAC-2) The calculation of CB-RNTI is based on the first PUSCH occasion within the Msg3 transmission window and can reuse the RA-RNTI calculation formula. |
| [R2-2504091](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504091.zip) Samsung | **Proposal 2:** Same RNTI is used for CB-Msg3 and Msg4 and it is derived based on the transmission window. |
| [R2-2504175](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504175.zip) Apple | **Proposal 2:** For CB-RNTI derivation, time domain information (SFN) of the starting point of Msg3 transmission window is used. FFS on frequency domain info (depending on the decision of Msg3 transmission window). **Proposal 3:** Specifically for NB-IoT, carrier\_id should be also considered for CB-RNTI derivation. |
| [R2-2504318](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504318.zip) Qualcomm | **Proposal 6:** For eMTC, the CB-RNTI is derived as SFN\_id mod (Cmax/10)+offset, where SFN\_id is the index of the first radio frame of the specified CB-Msg3 window, Cmax is the maximum possible CB-Msg4 Contention resolution window size in subframes and Offset is defined as the largest value that RA-RNTI can take. **Proposal 7:** For NB-IoT, the CB-RNTI is derived as 1 + floor(SFN\_id/M) + (1024/M)\*carrier\_id + offset where SFN\_id is the index of the first radio frame of the specified CB-Msg3 window and carrier\_id is the index of the UL carrier associated with the specified CB-Msg3, M is the periodicity in radio frames allowed for CB-Msg3 window and Offset is defined as the largest value that RA-RNTI can take. |
| [R2-2504393](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504393.zip) CMCC | **Proposal 2: It is proposed to calculate the CB-RNTI based on the start of the time domain (N)PUSCH resource.** |
| [R2-2504528](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504528.zip) MediaTek | **Proposal 1a: (MAC-2) For eMTC, CB-RNTI = 2401+ floor(SFN\_id / Wmin) where the SFN\_id is the start SFN of the transmission window and the Wmin is the minimum value of transmission window length.**  **Proposal 1b: (MAC-2) For NB-IoT, CB-RNTI = 4097+ floor(SFN\_id / Wmin) + N\*carrier\_id where the SFN\_id is the start SFN of the transmission window, the Wmin is the minimum value of transmission window length, the carrier\_id is the index of UL carrier and the N can be the maximum value of floor(SFN\_id / Wmin). The carrier\_id of the anchor carrier is 0.** |
| [R2-2504645](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_130/Docs/R2-2504645.zip) Ericsson | **Proposal 5 One single CB-RNTI, configured in SIB, is used by all UEs for scrambling Msg3 and for monitoring for Msg4.** |

Rapporteur summary of input proposals

**Calculate CB-RNTI based on time and/or subcarrier and/or window length:** vivo, ZTE, Nokia, NEC, Spreadtrum, Huawei, Turkcell, Samsung, Apple, Qualcomm, CMCC,

**Use a single configured CB-RNTI:** CATT, OPPO, Ericsson,

## 1.2 Online discussion Wednesday

**From chair notes R2-130 NR-NTN-IoT-NTN (Sergio)\_ 2025-05-21\_1800**

Proposal 5 One single CB-RNTI, configured in SIB, is used by all UEs for scrambling Msg3 and for monitoring for Msg4.

Some alternative options from other contributions:

|  |
| --- |
| From [R2-2503500](file:///C:\Data\3GPP\Extracts\R2-2503500%20Remaining%20issues%20for%20CB-msg3-EDT%20in%20IoT%20NTN.docx):  CB-RNTI = 1 + floor(SFN\_id/A) + [C\*(H-SFN mod B)]  SFN\_id is the index of the radio frame of the first time-domain transmission occasion within the transmission window  H-SFN is the index of the hyper frame of the first time-domain transmission occasion within the selected transmission window. A is determined by the minimum periodicity of the CB-msg3 transmission window in units of radio frame (e.g., 10ms).  B is determined by the maximum length of CB-msg4 monitoring window in units of H-SFN duration.  C is determined by the maximum value of floor(SFN\_id/A)+1  From [R2-2503662](file:///C:\Data\3GPP\Extracts\R2-2503662%20Further%20discussion%20on%20UL%20capacity%20enhancement%20for%20IoT%20NTN.docx): |
| RNTI=X + Msg3\_W\_index mod (ceil (Msg4\_WS/Msg3\_WP)) + ceil (Msg4\_WS/Msg3\_WP)\*carrier\_id,  wherein: X is the starting RNTI for Msg4 reception, which can be defined by RAN2 e.g. X=1 or any other value, 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. Msg4\_WS is the window size of Msg4, Msg3\_WP: is the transmission window periodicity of Msg3.  From [R2-2504318](file:///C:\Data\3GPP\Extracts\R2-2504318%20EDT%20enh.docx): |
| eMTC: CB-RNTI = 1+ SFN\_id mod (Cmax/10)+offset  where SFN\_id is the index of the first radio frame of the specified CB-Msg3 window, and Cmax is the maximum possible CB-Msg4 Contention resolution window size in subframes for BL UEs or UEs in enhanced coverage. Offset is defined as the largest value that RA-RNTI can take i.e. 1+9+10\*5+60\*39 NB-IoT : CB-RNTI = 1 + floor(SFN\_id/M) + (1024/M)\*carrier\_id + offset  where SFN\_id is the index of the first radio frame of the specified CB-Msg3 window and carrier\_id is the index of the UL carrier associated with the specified CB-Msg3. The carrier\_id of the anchor carrier is 0.  M can be set to the minimum periodicity in radio frames allowed for CB-Msg3 window. Offset is defined as the largest value that RA-RNTI can take i.e. 1+255+256\*MaxNumberOfCarriers.  From [R2-2504528](file:///C:\Data\3GPP\Extracts\R2-2504528%20Discussion%20on%20CB-Msg3-EDT.docx): |
| For eMTC, CB-RNTI = 2401+ floor(SFN\_id / Wmin) where the SFN\_id is the start SFN of the transmission window and the Wmin is the minimum value of transmission window length  For NB-IoT, CB-RNTI = 4097+ floor(SFN\_id / Wmin) + N\*carrier\_id where the SFN\_id is the start SFN of the transmission window, the Wmin is the minimum value of transmission window length, the carrier\_id is the index of UL carrier and the N can be the maximum value of floor(SFN\_id / Wmin). The carrier\_id of the anchor carrier is 0 |
| From [R2-2504175](file:///C:\Data\3GPP\Extracts\R2-2504175_Contention%20based%20MSG3.doc): |
| Proposal 2: For CB-RNTI derivation, time domain information (SFN) of the starting point of Msg3 transmission window is used. FFS on frequency domain info (depending on the decision of Msg3 transmission window). Proposal 3: Specifically for NB-IoT, carrier\_id should be also considered for CB-RNTI derivation.  From [R2-2503355](file:///C:\Data\3GPP\Extracts\R2-2503355%20Discussion%20on%20CB-Msg3%20Mechanism.docx): |
| CB-RNTI: the subframe timing index of the last valid CB-msg3 occasion within the transmission window; the frequency resource index associated with that last valid CB-msg3 occasion; the maximum length of msg4 window  From [R2-2503461](file:///C:\Data\3GPP\Extracts\R2-2503461%20Discussion%20on%20open%20issues%20for%20CB-Msg3%20EDT.docx) / [R2-2503529](file:///C:\Data\3GPP\Extracts\R2-2503529-%20Discussion%20on%20CB-msg3%20EDT%20and%20msg4%20enhancement.docx): |
| The CB-RNTI is preconfigured or predefined |

- Oppo thinks that if the monitoring window is short enough we can avoid ths risk of overlapping windows

- Nokia thinks the NW should have the flexibility to have longer windows and then the windows could overlap

- HW thinks we can reuse existing formulas for the calculation

- QC thinks we need to ensure that CB-RNTI and RA-RNTI do not collide

* We continue the discussion on a solution for CB-RNTI in offline 306, ensuring that there is no collision between CB-RNTI and RA-RNTI.

## 1.3 Formulas for RA-RNTI, MAC section 5.1.4

For BL UEs and UEs in enhanced coverage, RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI=1+t\_id + 10\*f\_id + 60\*(SFN\_id mod (Wmax/10))

where t\_id is the index of the first subframe of the specified PRACH (0≤ t\_id <10), f\_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f\_id< 6), SFN\_id is the index of the first radio frame of the specified PRACH, and Wmax is 400, maximum possible RAR window size in subframes for BL UEs or UEs in enhanced coverage. If the PRACH resource is on a TDD carrier, the f\_id is set to , where  is defined in clause 5.7.1 of TS 36.211 [7].

For NB-IoT UEs, the RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI=1 + floor(SFN\_id/4) + 256\*carrier\_id

where SFN\_id is the index of the first radio frame of the specified PRACH and carrier\_id is the index of the UL carrier associated with the specified PRACH. The carrier\_id of the anchor carrier is 0.

For NB-IoT UEs operating in TDD mode, the RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI = 1 + floor(SFN\_id/4) + 256\*(H-SFN mod 2)

where SFN\_id is the index of the first radio frame of the specified PRACH and H-SFN is the index of the first hyper frame of the specified PRACH. The PDCCH transmission and the PRACH resource are on the same carrier.

## 1.4 RNTI values, MAC section 7.1

RNTI values are presented in Table 7.1-1 and their usage and associated Transport Channels and Logical Channels are presented in Table 7.1-2.

Table 7.1-1: RNTI values.

|  |  |
| --- | --- |
| Value (hexa-decimal) | RNTI |
| 0000 | N/A |
| 0001-0960  0001-1000 (Note 3) | RA-RNTI, C-RNTI, Semi-Persistent Scheduling C-RNTI, Temporary C-RNTI, eIMTA-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, SL-RNTI (see note), G-RNTI, SL-V-RNTI, UL Semi-Persistent Scheduling V-RNTI, SL Semi-Persistent Scheduling V-RNTI, SRS-TPC-RNTI, AUL C-RNTI, and PUR-RNTI |
| 0961-FFF3  1001-FFF3 (Note 3) | C-RNTI, Semi-Persistent Scheduling C-RNTI, eIMTA-RNTI, Temporary C-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, SL-RNTI, G-RNTI, SL-V-RNTI, UL Semi-Persistent Scheduling V-RNTI, SL Semi-Persistent Scheduling V-RNTI, SRS-TPC-RNTI, AUL C-RNTI, and PUR-RNTI |
| FFF4-FFF8 | Reserved for future use |
| FFF9 | SI-RNTI |
| FFFA | SC-N-RNTI |
| FFFB | SC-RNTI |
| FFFC | CC-RNTI |
| FFFD | M-RNTI |
| FFFE | P-RNTI |
| FFFF | SI-RNTI |

NOTE 1: A MAC entity uses the same C-RNTI on all Serving Cells.

NOTE 2: SI-RNTI value FFFF may be used for MBMS-dedicated carrier. SI-RNTI value FFF9 is only used for MBMS-dedicated carrier.

NOTE 3: Range applicable for NB-IoT.

## 1.5 Summary of RA-RNTI values

For eMTC we have the values

1 + 0..9 + 10\*(0..5) + 60\*(0..39) = 1..(1 + 9 + 10\*5 + 60\*39) = 1..(60\*40) = 1..2400

The 2400 is 0960 in hexadecimal notation.

For NB-IoT in FDD we have the values

1 + 0..255 + 256\*(0..15) = 1..(1 + 255 + 256\*15) = 1..(256\*16) = 1..4096

The 4096 is 1000 in hexadecimal notation.

The RNTIs are 16 bits, thus the RNTI space is 0..65535.

# 2 Discussion

In line with majority companies preferences, we propose to base the CB-RNTI on time and/or subcarrier and/or window length. As a simplification, we use the start of msg3 window as the time reference.

We note that RAN2 agreed to support multiple carriers meaning that the carrier\_id may need to be part of the CB-RNTI in case load on each carrier is high, however, if the load on the carriers is low, it is an advantage if the CB-RNTI is not dependent on the carrier\_id to allow multiplexing of multiple replies in one msg4.

Further, we note that the maximum RAR window may be shorter than the msg3 window, and thus reusing the RA-RNTI formulas (using start/end of msg3 window as reference) can lead to msg3 windows having the same CB-RNTI and if the msg4 windows overlap, the UEs may need to decode messages that are intended for UEs that transmitted in a different msg3 window.

Further, we note that Nokia proposal uses very few RNTIs, and only as many as are required to make RNTIs unique for each msg4 window.

**Proposal 11: RAN2 to discuss below formula for deriving RNTI for Msg4 monitoring.**

**RNTI=X + Msg3\_W\_index mod (ceil (Msg4\_WS/Msg3\_WP)) + ceil (Msg4\_WS/Msg3\_WP)\*carrier\_id**,

*wherein:*

* *X is the starting RNTI for Msg4 reception, which can be defined by RAN2 e.g. X=1 or any other value,*
* *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.*
* *Msg4\_WS is the window size of Msg4,*
* *Msg3\_WP: is the transmission window periodicity of Msg3.*

To make the CB-RNTI not overlap with RA-RNTIs, we can just set X above range of RA-RNTIs. Further, we can make it configurable whether the carrier\_id shall be included or not to allow NW to maximize multiplexing of UEs in msg4 for low load, and separate load on different CB-RNTIs in case load on each carrier is high enough.

**Proposal 1: RAN2 to discuss below formula for deriving RNTI for Msg4 monitoring.**

**RNTI=X + Msg3\_W\_index \* mod (Y) + UseCarrierId \* Y\*carrier\_id**,

*wherein:*

* *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,*
* *Y is ceil (Msg4\_WS/Msg3\_WP)*
* *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.*
* *Msg4\_WS is the window size of Msg4,*
* *Msg3\_WP: is the transmission window periodicity of Msg3.*
* *UseCarrierId is configured by the NW, e.g., 1 for inclusion of carrier\_id and 0 for not including carrier\_id*

Q1: Do companies agree the P1?

# 3 Conclusion

# 4 Reference