**3GPP TSG-RAN WG2 Meeting #109-e *R2-200xxxx***

**Online, 24 February–6 March 2020**

**Agenda item: 6.0.3**

**Source: Samsung**

**Title: Report of LCID extension for Rel-16**

**Document for: Discussion and Agreement**

# 1 Introduction

This is the report of the following email discussion of the main session.

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| --- |
| * [AT109e][012][R16] LCID extension (Samsung)   Scope: LCID extension, applicable to all R16 WIs that have need,  Part 1:  Intended outcome: Report, issues and resolutions.  Deadline: Mar 3 1200 CET  Part 2  Intended outcome: Agreed CR  Deadline: Mar 5 1200 CET |

For Rel-15, RAN2 reserved quite many LCID (logical channel identifier) values for the future use (i.e. 14 values for DL (33–46) and 19 values for UL (33–51)). However, as Rel-16 introduces many features, each new feature requires several MAC CEs, which consumes the remaining LCID space. Hence, RAN2 should conclude how to extend the LCID space for Rel-16 (onwards).

# 2 Discussion

## 2.1 Rel-16 status

The following Tables 1 and 2 show the list of new MAC CEs to be introduced for Rel-16 across WIs.

Table 1 List of new DL MAC CEs

|  |  |  |  |
| --- | --- | --- | --- |
| WI | No | Purpose | Remarks |
| IAB | 1 | Extended logical channel ID field | R2-1915256 |
| IAB | 2 | Timing Delta MAC CE | R2-1915256; fixed (2B) |
| IAB | 3 | (ProvidedGuardSymbols from RAN1) | variable? |
| IIoT | 4 | Duplication RLC Activation/Deactivation MAC CE | [108#12]; fixed (1B) |
| 2-step RACH | 5 | Absolute Timing Advance Command MAC CE | [108#82]; fixed (2B) |
| eMIMO | 6 | Enhanced TCI States Activation/Deactivation for UE-specific PDSCH | [108#69]; variable |
| eMIMO | 7 | Extended PUCCH spatial relation Activation/Deactivation MAC CE | [108#68]; fixed (3B) |
| eMIMO | 8 | Group-based PUCCH spatial relation Activation/Deactivation MAC CE | [108#68]; fixed (2B) |
| eMIMO | 9 | AP SRS spatial relation Indication MAC CE | [108#68]; variable |
| eMIMO | 10 | SRS Pathloss Reference RS Activation/Deactivation MAC CE | [108#68]; fixed (3B) |
| eMIMO | 11 | PUSCH Pathloss Reference RS Activation/Deactivation MAC CE | [108#68]; fixed (3B) |
| eMIMO | 12 | CC list-based TCI States Activation/Deactivation for UE-specific PDSCH MAC CE | [108#68]; variable |
| eMIMO | 13 | CC list-based TCI State Indication for UE-specific PDCCH MAC CE | [108#68]; fixed (2B) |
| eMIMO | 14 | CC list-based SRS Activation/Deactivation MAC CE | [108#68]; TBD |
| eMIMO | 15 | (maybe one more according to RAN1 input) | - |
| Others | - | (Recommended bit rate from SA4) | R2-1916516; none or one LCID |
| NR-U |  | None | [108#75] |
| V2X |  | None | [108#100] |
| RACS |  | None | - |
| NTN |  | None | Study item |
| NR Pos |  | None | - |
| NR mob |  | None | - |
| DCCAe |  | None | [108#56] |
| Power saving |  | None | [108#78] |
| SON/MDT |  | None | [108#93] |
| SRVCC |  | None | - |
| CLI |  | None | - |
| PRN |  | None | - |
| URLLC |  | None | [108#111] |

Table 2 List of new UL MAC CEs

|  |  |  |  |
| --- | --- | --- | --- |
| WI | No | Purpose | Remarks |
| IAB | 1 | Extended logical channel ID field | R2-1915256 |
| IAB | 2 | Pre-emptive BSR MAC CE | R2-1915256; variable; Long format only (TBD) |
| IAB | 3 | (DesiredGuardSymbols from RAN1) | variable? |
| NR-U | 4 | LBT failure MAC CE | [108#75]; fixed (4B); no 1B format |
| V2X | 5 | Sidelink Configured Grant Confirmation | [108#100]; fixed (1B) |
| V2X | 6 | Truncated Sidelink BSR MAC CE | [108#100]; variable |
| V2X | 7 | Sidelink BSR MAC CE | [108#100]; variable |
| IIoT | 8 | Multiple Entry Configured Grant Confirmation | [108#12]; fixed (4B); no 1B format (TBD) |
| eMIMO | 9 | SCell BFR MAC CE (four octets Ci) | [108#70]; variable |
| eMIMO | 10 | SCell BFR MAC CE (one octet Ci) | [108#70]; variable |
| Others | - | (PHR enhancement from RAN4) | TBD; to include PMPRc; none or three |
| Others | - | (Recommended bit rate from SA4) | TBD; R2-1916516; none or one |
| RACS |  | None | - |
| NTN |  | None | Study item |
| NR Pos |  | None | - |
| NR mob |  | None | - |
| DCCAe |  | None | [108#56] |
| Power saving |  | None | [108#78] |
| SON/MDT |  | None | [108#93] |
| 2-step RACH |  | None | [108#82] |
| SRVCC |  | None | - |
| CLI |  | None | - |
| PRN |  | None | - |
| URLLC |  | None | [108#111] |

From the tables, it can be observed that at least 15 values for DL and 10 values for UL would be required for Rel-16 new MAC CEs. Note that 14 values for DL (33–46) and 19 values for UL (33–51) are reserved from Rel-15, so for the DL, the required number already exceeds the reserved values.

**Observation 1: For DL, 15+ values are required for Rel-16 while 14 values are reserved (i.e. already exceeded).**

**Observation 2: For UL, 10+ values are required for Rel-16 while 19 values are reserved.**

Hence, it is inevitable to extend the LCID space for MAC CEs from the observations above. Since the NR keeps evolving, it would be good to extend the LCID space for both DL and UL. Therefore, rapporteur proposes to extend the LCID space for both DL and UL.

**Question 1: Do you agree to extend the LCID space for both DL and UL?**

|  |  |  |
| --- | --- | --- |
| Company | Response  (Yes/No) | Comments |
| Huawei, Hisilicon | Yes | Both UL and DL LCIDs have been extended for IAB which can be reused. |
| LG | Yes |  |
| Nokia | Yes |  |
| Ericsson | Yes |  |
| QC | No | Since several of the MAC CEs that are new in Rel-16 belong to the same feature (i.e. eMIMO), we prefer to include all of these LCIDs under an eMIMO LCID. The specific function within eMIMO can be defined via an LCID subtype.  This will avoid having to extend the LCID space in this release. |
| vivo | Yes |  |
| OPPO | Yes |  |
| MediaTek | Yes |  |
| Intel | Yes |  |
| CATT | Maybe Yes | Maybe one aspect to clarity.  For IAB the ext. LCID is optional. Our understanding has been that depending on the deployment requriements the the IAB network works even without ext. LCID. Now if we introduce this also to Uu, and from the above background it looks LCID is going to be used for all the R16 feature, does that mean this is going to be mandantory for UE? |
| Samsung | Yes |  |
| ZTE | Yes |  |
| NTT DOCOMO | Yes |  |
| Lenovo | Yes |  |

**Summary of responses:**

Out of 14 companies, 13 companies support to extend the LCID space, while one company to use LCID subtype for eMIMO only. Regarding CATT question, rapporteur thinks that all the Rel-16 (onwards) UEs have to support extended LCID space (if RAN2 agrees the proposals).

**Proposal 1: LCID spaces for both DL and UL MAC CEs are extended from Rel-16.**

## 2.2 One-byte or two-byte eLCID fields

If there is consensus to extend the LCID space, RAN2 should also discussed how to define the MAC subheader for the extended MAC CEs. Already several proposals are on the table [1][2][3][4][5][6], but rapporteur think the proposals can be categorized as follows:

- Option 1: One-byte eLCID field [5];

- Option 2: Two-byte eLCID field [1][2][3][6] (i.e. to re-use IAB defined in running MAC CR [7] as shown in Figure 6.1.2-1 below).



Figure 6.1.2-1: R/F/LCID/(eLCID)/L MAC subheader with 8-bit L field [7]

Since IAB already defines two-byte eLCID field for the logical channels, to adopt Option 1 means that we have three MAC subheaders (i.e. with 0/1/2-byte eLCID field). Furthermore, Option 1 also implies that two LCID values will be used to indicate one-byte eLCID field and two-byte eLCID field unless one remaining reserved bit is used. Option 2 can avoid fragmentation of the MAC subheader format.

Option 2 has drawback to have one more byte for the eLCID field, but this might not be a problem. As indicated in subclause 2.1, still 14 values for DL (33–46) and 19 values for UL (33–51) are reserved from Rel-15. Thus, future MAC CEs which might be frequently used can still be assigned to the legacy reserved LCID value. That is, such MAC CEs would have legacy one-byte subheader.

**Question 2: Which option do you prefer for MAC CEs?**

**- Option 1: One-byte eLCID field [5];**

**- Option 2: Two-byte eLCID field [1][2][3][6] (i.e. to re-use IAB defined in running MAC CR [7]).**

|  |  |  |
| --- | --- | --- |
| Company | Response  (Option 1 or 2) | Comments |
| Huawei, Hisilicon | 2 | We can start from reusing IAB and further see if there is any serious issue. |
| LG | 2 | We can reuse the two-byte eLCID defined in the IAB. |
| Nokia | 1 | We would prefer isolating the three bytes overhead to IAB and have one LCID value (other than 33) pointing towards 1 byte eLCID for new non-IAB MAC CEs. |
| Ericsson | 2 | It seems straight-forward to reuse the IAB solution. |
| QC | Option 2 | Maintaining commonality with IAB is desirable to avoid unnecessary increase in types of headers. |
| vivo | 1 | Using two-byte eLCID to extend the MAC CE LCID seems introducing unnecessary signalling overhead. We consider that the IAB two-byte eLCID field does not have to be reused for extending the AMC CE LCID> |
| OPPO | 2 | Since two-byte eLCID has been defined in IAB, we can reuse the IAB solution. |
| MediaTek | 2 | Prefer to reuse IAB design, which is more furture-proof. |
| Intel | 2 |  |
| CATT | 2 | If it is introduced, to follow IAB design is preferred. |
| Samsung | 2 |  |
| ZTE | 2 |  |
| NTT DOCOMO | 1 | Agree with Nokia and Vivo. Given that IAB is an optional feature and is not always used in the NW, it makes sense to isolate the impact to the other Rel-16 features so that the sub-header overhead can be minimised. |
| Lenovo | 1 | Agree with Nokia that overhead should be minimized. |

**Summary of responses:**

Out of 14 companies, nine companies support to re-use IAB solution (i.e. two-byte eLCID field). Five companies (including Ericsson according to their response on the 2nd of March) prefers to have one-byte eLCID field for non-IAB MAC CEs.

After having further email discussion, RAN2 concluded to go with one-byte eLCID approach (i.e. option 1) to reduce overhead.

**Proposal 2: To extend LCID spaces for MAC CEs, a new MAC subheader with one-byte eLCID field is introduced. Tentatively LCID value 34 is used for both DL and UL for the new MAC subheader.**

## 2.3 How many/where to define in eLCID space.

With one or two-byte eLCID field, RAN2 should also determine how many values (and in which range) should be reserved for future MAC CEs.

Note that IAB has already extended maximum LCID value from 63 to 216 + 63 (= 65,599), and also defined 128 reserved values for future use, as shown in Table 6.2.1-1a/2a below.

Table 6.2.1-1a/2a Values of eLCID for DL/UL-SCH [7]

|  |  |
| --- | --- |
| Index | LCID values |
| 64 to (216 – 65) | Identity of the logical channel |
| (216 – 64) to (216 + 63) | Reserved |

There might be a number of options to allocate LCID values for MAC Ces:

- **Option 1**: 256 values; from the end; to keep Reserved values from IAB:

- In this option, LCID values (216 – 320) to (216 – 65) are allocated for MAC Ces.

- **Option 2**: 256 values; from the end; to not have separate reserved values from IAB:

- In this option, LCID values (216 – 192) to (216 + 63) are allocated for MAC Ces and reserved values.

- **Option 2bis**: 128 values; from the end:

- In this option, LCID values (216 – 64) to (216 + 63) are allocated for MAC Ces and reserved values.

- **Option 3**: 256 values; from the beginning:

- In this option, LCID values 64 to 319 are allocated for MAC Ces.

- …

Rapportuer thinks, considering one-byte eLCID candidate and possible future enhancements, to have 256 values would be sufficient, but still wants to have input from all the companies.

**Question 3: Which LCID ranges should be allocated for MAC CEs?**

|  |  |  |
| --- | --- | --- |
| Company | Response  (e.g.LCID values xx to yy) | Comments |
| Huawei, Hisilicon | No dedicated range for MAC Ces | Like the legacy LCID space, MAC Ces can use the extened LCIDs from the end to beginning, i.e. the range reserved by IAB can be used for MAC Ces and any other potential use in future.  We can also consider to have more values reserved, e.g. 256 values as suggested by rapporteur. |
| LG | No dedicated range for MAC Ces | Agree with Huawei. |
| Ericsson | Option 2bis | We can use the remaining 128 reserved values for MAC Ces (or any other future use). If companies think we need more than 128 values, then fewer values must be allocated for identity of the logical channel. That discussion must take place in the IAB-session. |
| QC | Needs discussion | We prefer to discuss this after answers to the other questions in this discussion have been resolved. |
| Vivo | No dedicated restriction | The extened LCIDs can be used for MAC Ces and any other potential use in future, e.g. logical chanle to support more RBs |
| OPPO | No dedicated range for MAC Ces | We share same view as Huawei. |
| MediaTek | No dedicated range for MAC Ces | Share same view with Huawei. |
| Intel | No dedicated range for MAC Ces | Agree with Huawei. |
| CATT | Huawei suggestion sounds reasonable. |  |
| Samsung | No dedicated range for MAC CEs (i.e. Option 2 or Option 2bis) | We tend to agree with Ericsson that to use 128 reserved values can avoid unnecessary discussion in IAB session. However, at the same time, to have additional 128 values from the values for the identity of the logical channel seems not significant (i.e. 128 values from 65,408 values (yellow-highlighted values from the table above). In addition, to reserve 256 values can avoid discussion in the future. |
| ZTE | No dedicated range for MAC CEs | Share same view with Huawei. |
| NTT DOCOMO | No dedicated range for MAC CEs | Same comments as expressed by the companies with the same opinion. |

**Summary of responses:**

Out of 12 companies, 11 companies think no dedicated range for MAC CEs is needed, and one company thinks this does not have to be discussed with their solution (i.e. by using LCID subtype in Question 1 above). Regarding the actual range, nine companies prefer to reserve the end of the eLCID space for MAC CEs (as in IAB) while two (perhaps four according to the response for Question 2) companies prefer to reserve the beginning of the eLCID space (i.e. 64 to 319) for MAC CEs. Regarding the number for the reserved values, nine companies are okay to extend it from 128 to 256, and one company prefers not to extend the range from IAB to avoid additional discussion in IAB session.

After having further email discussion, RAN2 concluded to go with one-byte eLCID field, and thus IAB running CR also has to be updated accordingly.

**Proposal 3: When the new MAC subheader with one-byte eLCID field is used, eLCID values 0 to 255 indicates LCID values 64 to 319, accordingly.**

**Proposal 4: The LCID range in IAB running CR (i.e. 64 to (216 – 65)) is updated to '320 to (216 + 319). It is FFS whether to keep reserved LCID values in IAB running CR.**

## 2.4 Way forward

If RAN2 defines additional LCID ranges for MAC CEs (xx to yy), there would be two reserved LCID spaces for MAC CEs i.e. legacy reserved value range (below 64; set1) and new reserved value range (above 64; set2). It should be noted that set2 requires one or two more octets in the MAC subheader. Therefore, RAN2 should also determine which spaces (i.e. set1 or set2) to be used for each new Rel-16 MAC CE listed in Tables 1 and 2 above. Rapporteur thinks this should be determined by each WI (or by WI rapporteur).

**Question 4: Would it be okay that each WI determines whether their MAC CE(s) should be assigned to set1 or set2? If you have a specific suggestion for a specific MAC CE, you may also indicate it to the Comments.**

|  |  |  |
| --- | --- | --- |
| Company | Response  (Yes/No) | Comments |
| Huawei, Hisiliicon | Yes | Set1 should be carefully used. It makes sense for each WI to discuss if a MAC CE is sensitive to length. |
| LG | No | Set1 should be carefully used. Thus, new MAC CEs should use set2 by default. If a specific MAC CE really requires low overhead, it can use set1 based on consensus. |
| Nokia |  | Decisions cannot be made in isolation since we only have one MAC specification. |
| Ericsson |  | We are more interested in the principle used to select set 1 or set 2. We think MAC CEs which relates to higher bitrates (e.g. many of the MIMO MAC CEs) are candidates for set 2. |
| QC | No | We should adopt a general principal for Rel-16 new MAC CEs, such that fixed length CEs use set 1 (which has lower overhead). |
| vivo |  | We have not strong preference, but consider that the set1 which introduces less signalling overhead should be used very carefully. |
| OPPO |  | It may bring extra cross-WI coordination work if the LCID set assignment is determined by each WI. And we should first discuss the principle of the LCID set selection for Rel-16 new MAC CE. |
| MediaTek |  | No strong view, but think some cross-WI coordination is required to determine a general principle for LCID allocation. |
| Intel | Yes | Agree with Huawei. |
| CATT | No | It is better we have certain principle set up for this.  Also, like previously mentioned this might relate to the optionality of ext. LCID as well as other R16 features. |
| Samsung | Yes | However, we also agree that set1 should be carefully used. |
| ZTE | Yes | Share the view with Huawei |
| NTT DOCOMO |  | Rapporteur’s summary looks reasonable. |
| Lenovo |  | We would prefer to adopt a general principle for selection of set1/set2 |

**Summary of responses:**

In general, nine companies (out of 11) think that it should be done carefully, and among them, five companies want to discuss a general prcinciple for LCID allocation first. In general, rapporteur thinks that less frequent and low priority MAC CEs should be assigned to set2, while more frequent and high priority MAC CEs (which also requires low overhead) can be assigned to set1 (based on consensus), which can also be found from the responses. However, these principles are quite subjective, and it is difficult to define concrete principles. Hence, rapporteur thinks each WI delegates can determine where to assign it (i.e. set1 or set2) with the principle above.

**Proposal 5: For the selection of set1 (below 64) or set2 (above 64), the general principle is that less frequent and low priority MAC CEs should be assigned to set2, and more frequent and high priority MAC CEs (which also requires low overhead) can be assigned to set1 based on consensus. With this principle, the final decision is made by each WI discussion.**

## 2.5 Others

R2-1915118 [4] proposes to not use R/LCID/eLCID format (i.e. without L field), and RAN2 needs to discuss whether such restriction is needed for MAC CEs assigned to set2.

**Question 5: Do you think any restriction (e.g. to always have L field) is needed for MAC CEs assigned to set2?**

|  |  |  |
| --- | --- | --- |
| Company | Response  (Yes/No) | Comments |
| Huawei, Hisilicon | No | We have not identified a problem for a fixed size MAC CE to not have L field. |
| LG | No | We do not see any problem and we want to follow the LTE principle. |
| Nokia | No |  |
| Ericsson | Not supportive | We do not support the proposal in the paper [4]. It brings additional overhead for set 2. |
| QC | Yes | Given the somewhat larger MAC header for set 2, the relative overhead of always including L field is acceptable. Please also see answer to Question 4. |
| vivo | No | For fixed size MAC CE, it is no ambiguous issue for UE/NW to understand the MAC CE if the corresponding MAC subheader does not have L field. |
| OPPO | No | We see no issue to use R/LCID/eLCID format for fixed size MAC CEs. And we can follow the way in LTE. |
| MediaTek | No | We do not see the problem. |
| Intel | No | Agree with Huawei and LG. |
| CATT | No | In our understanding MAC CE format for a specific use case can be discussed separately base on scenario. Might not need a conclusion in this thread. |
| Samsung | No | - |
| ZTE | No |  |
| NTT DOCOMO | No |  |
| Lenovo | No |  |

**Summary of responses:**

Out of 14 companies, 13 companies think no restriction is required while one company prefers always to have L field (for LCID subtype).

**Proposal 6: No restriction (e.g. always to have L field) is needed to assign MAC CE to set2.**

# 3 Conclusion

**Proposal 1: LCID spaces for both DL and UL MAC CEs are extended from Rel-16.**

**Proposal 2: To extend LCID spaces for MAC CEs, a new MAC subheader with one-byte eLCID field is introduced. Tentatively LCID value 34 is used for both DL and UL for the new MAC subheader.**

**Proposal 3: When the new MAC subheader with one-byte eLCID field is used, eLCID values 0 to 255 indicates LCID values 64 to 319, accordingly.**

**Proposal 4: The range for the identity of the logical channel in IAB running CR (i.e. 64 to (216 – 65)) is updated to '320 to (216 + 319) ', and the range for the reserved value in IAB running CR (i.e. (216 – 64) to (216 + 63) is removed.**

**Proposal 5: For the selection of set1 (below 64) or set2 (above 64), the general principle is that less frequent and low priority MAC CEs should be assigned to set2, and more frequent and high priority MAC CEs (which also requires low overhead) can be assigned to set1 based on consensus. With this principle, the final decision is made by each WI discussion.**

**Proposal 6: No restriction (e.g. always to have L field) is needed to assign MAC CE to set2.**

# 4 References

[1] R2-1916135 Consideration on remaining FFS of LCID extension LG

[2] R2-1915343 Remaining issues with extending LCID space on the backhaul Samsung

[3] R2-1915323 eLCID space and handling of IAB specific MAC CEs Nokia

[4] R2-1915118 Consideration on the Extended LCID in IAB ZTE

[5] R2-1915808 Extended MAC CE ID Qualcomm

[6] R2-1915914 Extension of the LCID LG

[7] R2-1915256 Running CR to 38.321 on Integrated Access and Backhaul for NR Samsung