**3GPP TSG-RAN WG2 Meeting #117 electronic R2-220xxxx**

**Online, February, 2022**

**Agenda item: 8.15.3**

**Source: OPPO**

**Title: Summary of 715**

**Document for: Discussion and Decision**

# Introduction

This document is to discuss the following issue

* [POST117-e][715][V2X/SL] TP for IUC INFO and IUC REQ MAC CE format (OPPO)

**Scope:** Discuss IUC INFO and IUC REQ MAC CE format according to the latest RAN1 agreements on the fields and each field size that to be included in MAC CE. Provide 38.321 TP for IUC INFO and IUC REQ MAC CE format.

**Intended outcome:** Endorse 38.321 TP for IUC INFO and IUC REQ MAC CE format for 38.321 CR in R2-2203696 and agree discussion summary in R2-2203697 (if needed). Agreed TP will be added into MAC CR in [POST117-e][703].

**Deadline**: Short email discussion (can start it now, end until 3.9 10:00am UTC)

# Discussion

During the online discussion, we have reached the following agreement

R2-2203084 Introduction of IUC MAC CE Samsung Research America discussion

Proposal: RAN2 is asked to discuss container-based IUC MAC CE format (rather than defining each information field and the corresponding size inside of the MAC CE).

* We will design IUC INFO and IUC REQ MAC CE in legacy manner.

Firstly, we need to understand which fields are needed in the MAC-CE. For that, the R1 agreement on the MAC-CE format is copied as follows.

***Agreement***

*For Scheme 1, each bit field size of a SCI format 2-C for an explicit request for inter-UE coordination information is given by following table:*

|  |  |
| --- | --- |
| ***Field name*** | ***Field size (in bits)*** |
| *Providing/requesting indicator* | *1* |
| *Priority* | *3* |
| *Number of subchannels* | *Where is provided by the higher layer parameter sl-NumSubchannel* |
| *Resource reservation period* | *Where with that is the number of entries in the higher layer parameter sl-ResourceReservePeriodList, if higher layer parameter sl-MultiReserveResoure is configured; otherwise.* |
| *Resource selection window location* | *Where is 0, 1, 2, 3 for SCS of 15kHz, 30kHz, 60kHz, 120kHz, respectively.* |
| *Resource set type* | *1 bit if determineResourceSetTypeScheme1 is set to ‘UE-B’s request’, otherwise, 0 bit* |

* *This agreement does not imply that new field requested by RAN2 cannot be further added.*

***Agreement***

*For Scheme 1, when MAC CE only is used as the container of inter-UE coordination information, each bit field size for inter-UE coordination information is given by following table from RAN1’s perspective, and RAN1 understands that the maximum value of N resource combinations to be conveyed in inter-UE coordination information is bounded so that the total payload size of inter-UE coordination information leads not to exceed the size of TB including the MAC CE*

* *Details (e.g., whether/how to separately indicate the value of N in the inter-UE coordination information, how to put the following fields into MAC CE and the related field sizes in MAC CE) are up to RAN2*

|  |  |
| --- | --- |
| ***Field name*** | ***Field size (in bits)*** |
| *Providing/requesting indicator* | *1* |
| *Resource combination(s)* | *Where is provided by the higher layer parameter sl-NumSubchannel,*  *with that is the number of entries in the higher layer parameter sl-ResourceReservePeriodList, if higher layer parameter sl-MultiReserveResoure is configured; otherwise.* |
| *First resource location(s)* | *Where X is provided by the (pre)configured maximum value of slot offset for the case when MAC CE only is used as a container of inter-UE coordination information* |
| *Reference slot location* | *Where is 0, 1, 2, 3 for SCS of 15kHz, 30kHz, 60kHz, 120kHz, respectively.* |
| *Resource set type* | *1* |
| *Lowest subchannel indices for the first resource location of each TRIV* | *Where is provided by the higher layer parameter sl-NumSubchannel.* |

Based on that, moderator tend to ask the following questions, aiming at a minimum set of MAC-CE design to finish the core part of this issue.

Within the fields agreed by R1, moderator understand only the field of “*Providing/requesting indicator*” is not necessary since MAC-CE will use LCID to differentiate (while SCI needs that bit). Otherwise, the other fields are necessary to follow the R1 agreement.

**Q1a: In the field for IUC-info, do you agree only the field of “*Providing/requesting indicator*” can be saved for MAC-CE format design, while the other fields are needed to follow R1 agreement?**

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree | Comment |
| OPPO | Yes |  |
| Huawei HiSilicon | Yes | Agree with rapporteur. |
| CATT | Yes |  |
| vivo | Yes |  |
| Apple | Yes | We agree with that “providing/request” is not needed. But we doubt if the parameter set from R1 is sufficient from RAN2 perspective. For example, how to handle concurrent transactions? What if a condition-triggered IUC info MAC CE is to be multiplexed with request-triggered IUC info MAC CE, and how UE B distinguish those two? Do we need transaction ID in each MAC CE?  [Apple2] Apple has added a separate question for the concurrency issue in Q4  We are fine to follow other fields in RAN1 table for Q1a |
| LG Electronics | Yes |  |
| Ericsson | Yes |  |
| Intel | Yes |  |
| Samsung | Yes |  |
| Lenovo | Yes |  |

**Summary: All companies agree with it.**

**Proposal 1: In the fields for IUC-info, only the field of “*Providing/requesting indicator*” can be saved for MAC-CE, while the other fields are needed.**

**Q1b: In the field for IUC-request, do you agree only the field of “*Providing/requesting indicator*” can be saved for MAC-CE format design, while the other fields are needed to follow R1 agreement?**

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree | Comment |
| OPPO | Yes |  |
| Huawei HiSilicon | Yes | Agree with rapporteur. |
| CATT | Yes |  |
| vivo | Yes |  |
| Apple | Yes |  |
| LG Electronics | Yes |  |
| Ericsson | Yes |  |
| Intel | Yes |  |
| Samsung | Yes |  |
| Lenovo | Yes |  |

**Summary: All companies agree with it.**

**Proposal 2: In the fields for IUC-request, only the field of “*Providing/requesting indicator*” can be saved for MAC-CE, while the other fields are needed.**

Secondly, as you can see, the fields in the MAC-CE are of variable length, decided by the related formula, based on the configured value of  (for FRIV, Lowest subchannel indices for the first resource location of each TRIV, Number of subchannels), X (for First resource location(s)), (for Reference slot location, Resource selection window location),  (Resource reservation period). So the issue is how to define the MAC-CE format, i.e., the bit-length for each field, considering the main difficulty of drawing the MAC-CE format figure in MAC-spec.

For this issue, moderator mainly see two solutions:

**Table 1 Min/Max bit length for the field in IUC-Information MAC-CE**

|  |  |  |
| --- | --- | --- |
| **Field name** | **Min Bit Length** | **Max Bit length** |
| Providing/requesting indicator | Not need in MAC CE since the LCID can be used to differentiate this | |
| Resource combination(s) | The minimum size is N\*(0+9+0) | The maximum size is N\*(13+9+4) |
| First resource location(s) | The minimum size is (N-1)\*(0) | The maximum size is (N-1)\*(13) |
| Reference slot location | The minimum size is 10+4 | The maximum size is 10+7 |
| Resource set type | 1 | |
| Lowest subchannel indices for the first resource location of each TRIV | The minimum size is N\*0 | The maximum size is N\*5 |
| In total | N\*9+15 | N\*44+5 |

**Table 2 Min/Max Bit length for the fields in IUC-Request MAC-CE**

|  |  |  |  |
| --- | --- | --- | --- |
| **Field name** | **Min Bit Length** | **Max Bit length** | |
| Providing/requesting indicator | Not need in MAC CE since the LCID can be used to differentiate this | | |
| Priority | 3 | | |
| Number of subchannels | The minimum size is 0 | The maximum size is 5 | |
| Resource reservation period | The minimum size is 0 | The maximum size is 4 | |
| Resource selection window location | The minimum size is 2\*(10+4) | The maximum size is 2\*(10+7) | |
| Resource set type | 1 | | |
| In total | 32 | | 47 |

One is we still define the bit occupation for each field clearly, but only define it based on the maximum value (this is because the max value is anyway has to be supported), e.g., 26-bit (=13+9+4), and then in case not all bits are useful (due to that the  and  are not configured to the maximum value, only parts of the bits are occupied, either MSB or LSB.

It would result into the MAC-CE format figure somehow like follows, if we use IUC-info MAC-CE as an example (please do not comment on the details, I will polish it later ^^)



**Figure 1 Example of IUC-info MAC-CE format of option-1**

The other is that we do not define the bit occupation for each field of variable length clearly, by just use descriptive text to define the order of each field, and the length of each field is exactly decided based on the configured value of , X, , , and one resource set combination after the other, R-bit is inserted in the end just for byte alignment. And it would result into something like the follows (also, the detailed aspect is to be refined in the phase-2, the following figure is just to give an brief view)



**Figure 2 Example of IUC-info MAC-CE format of option-2**

Where seems the former one gives an clear definition of the MAC-CE in the spec yet may lead to some bit waste due to the fixed field length, while the latter may save some bits when the configured value is not of the maximum value, but would lead somewhat unclear figure in the MAC-spec when capturing it.

**Q2: How should we handle the fields which are of variable length depending on the configuration of , X, , ?**

**Option-1: we still define the bit occupation for each field clearly, and thus a clear bit-occupation figure is to be provided in the TP, but only define it based on the maximum value, e.g., 26-bit (=13+9+4), and then in case not all bits are useful (due to that the  and  are not configured to the maximum value), only parts of the bits are occupied, either MSB or LSB. (if this option is selected, please comment if any different view on the max value length as indicated in Table-1/2 above)**

**Option-2: we do not define the bit occupation for each field of variable length clearly, by just use descriptive text to define the order of each field, and the length of each field is exactly decided based on the configured value of , X, , by using the formula provided by R1, and one resource set combination after the other, R-bit is inserted in the end just for byte alignment.**

|  |  |  |
| --- | --- | --- |
| Company | Option(s) | Comment |
| OPPO | 1 or 2 | We are fine with either way, option-1 seems a safer one with some inefficiency issue, while option-2 seems to be efficient by somewhat new design, up to companies to pick-up. |
| Huawei HiSilicon | 1 but | Option 2 seems not some kind of legacy manner, so slightly prefer option 1. But we are also fine to follow the majority. |
| CATT | 1 or 2 | No strong view. Consideration on the length of IUC-info MAC CE, we slightly prefer option 2. |
| vivo | 1 | Option-1 is OK to us which is simple. |
| Apple | 1 |  |
| LG Electronics | 1 or 2 | We slightly prefer to adopt the simplest one, i.e., Option 1 because there is no critical difference between Option1 and Option 2. |
| Ericsson | 1 | Option 1 is more aligned with legacy MAC CE design methods |
| Intel | 2 with comment | Firstly, we assume this question is more relevant for the IUC-info MAC CE, since there should not be a big issue in supporting max size for IUC-Request MAC CE?  We think that supporting a max length IUC-Info MAC CE design is quite inefficient. In contrast, we see Option 2 as a compromise between the container-based approach proposed during the meeting and Option 1, whereby we specify the overall MAC CE structure and each resource set can be indicated individually and can be of variable length. We can discuss the detailed aspects in Phase 2 |
| Samsung | 1 or 2 | We’re ok to follow majority. |
| Lenovo | 1 | Option1 is the simple way and more align with legacy manner |

**Summary: 9/10 companies agree with option-1, vs. 5/10 companies OK to go for option-2. Rapp suggest to go for the majority view.**

**Q2a: if one selects option-1 of Q2, besides the max length, do you think any other length is to be supported?**

**- Yes (in this case, please clarify for which field, which length should be supported)**

**- No**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| OPPO | No | Indeed option-1 has this drawback, we do not see it is realistic to define MAC-CE for all candidate length of each field, so prefer a simple solution. Let’s solve it using a basic design. |
| Huawei HiSilicon | No | Agree with the rapporteur, max length should be adopted. |
| CATT | No | Agree with the rapporteur. |
| vivo | See comments | The min length can also be supported to be specified in the spec. Or, if the majority thinks that only max length is needed, we are also fine. |
| Apple | No |  |
| LG Electronics | No |  |
| Ericsson | No | Agree with RAPP, although option 1 is not perfect, but it is the most straightforward and simple one |
| Intel | No | If we go with option 1, this is the only choice (given the limited time we have to specify it). |
| Samsung | No |  |
| Lenovo | No | Agree with the rapporteur. |

**Summary: All companies agree with max-value only, except one company which is also fine to go for majority view.**

**Proposal 3: For MAC-CE design of IUC-Info and IUC-request, define the bit occupation for each field clearly based on the maximum value, and thus a bit-occupation figure is to be provided in the TP, and then in case not all bits are useful, only part of the field is occupied by using LSB bits.**

Thirdly, specifically for IUC-info MAC-CE, one left issue is how to decide the maximum length of N in the MAC-CE, i.e., it has to be bounded as addressed in the R1 agreement. So the related details have to be clarified.

According to legacy manner, MAC subheader has the L field to indicate the length, as long as it is of variable length.

[…]

A MAC subheader except for fixed sized MAC CE, padding, and a MAC SDU containing UL CCCH consists of the header fields R/F/LCID/(eLCID)/L.

And thus there is no need to include the N in the MAC-CE, and thus the only left issue is the need of maximum value of N for the MAC-CE. Moderator understand it is not preferred to have a too-long MAC-CE, so suggest to limit the length in for example 4 or 8 level.

**Q3: What is your preference on the maximum value of N for the MAC-CE?**

|  |  |  |
| --- | --- | --- |
| Company | Max values | Comment |
| OPPO | 4 or 8 | We do not see a too-long value is feasible considering the length of each resource set combination is in the level of 4~6 bytes. |
| Huawei HiSilicon | 4 or 8 | We slightly prefer Option 1 in Q2, so in order to avoid too much waste of bits, we also prefer a not too-long value N. |
| CATT | 4 or 8 | Agree with the rapporteur, maximum value of N for the MAC-CE should be specified to avoid too-long MAC-CE. |
| vivo | 11 | In our understanding, the N can be a larger value, so that when the UE-A would like to inform UE-B with a large number of resources information, it doesn’t have to send multiple IUC MAC CEs. E.g. if the N is set to 4 and the UE-A would like to inform non-preferred resources of 8 resource combinations, it has to send two MAC CEs, which is not good considering the latency aspect.  On the other hand, as N is just used to define the UPPER bound of the MAC CE size, it doesn’t mean that the MAC CE will necessarily be that large. To make N a larger number is just to make the UE don’t need to send multiple MAC CEs.  The reason why we indicate 11 here is that, for mode-2, the maximum PSSCH transmission number is 32 (given by *sl-MaxTxTransNumPSSCH-r16* in 38.331), and as one resource combination can indicate three resources (as in Rel-16 38.214 section 8.1.5), it seems that a value larger than 11 would be meaningless for N (11\*3=33).  Therefore, we understand the maximum value of N can be 11. |
| Apple | Determined by the L field of MAC subheader | If the intention is to let UE A to convey all resource sets in one transmission, then we prefer to set a value large enough to avoid artificial segmentation of IUC information. |
| LG Electronics | Comment | We are not sure whether it needs to define the maximum value of N. In other words, it can be implicitly determined/derived based on the value of L field. Also the UE can determine the value of L field by its implementation considering the payload size of MAC PDU containing IUC-info MAC-CE.  For the candidate values suggested by the moderator (e.g., 4 or 8), it seems that further clarification is necessary how they can be selected. |
| Ericsson | 8 bits or 16 bits | In the legacy it is only 8 bits or 16 bits for the L field, we can just choose one of them. But we believe 8 bits is sufficient in this release. |
| Intel | 4 or 8 | Agree with OPPO |
| Samsung | 4 or 8 |  |
| Lenovo | 4 or 8 | Agree with the rapporteur that a too-long MAC-CE is avoided. |

**Summary: There is no clear majority view on this, where 6/10 support 4 or 8. One company supports 11. Two companies tend to rely on L-field directly (after offline, LG is fine to go for majority view). One company tend to go for 8 or 16 bits (seems like a new field other than L-field, but rapp wonder why we need this)**

**Moderator suggest to further discuss this in Phase-2 to see if any feasible WF. Meanwhile, the TP would be prepared based on the majority view on 8 (considering there seems some preference on larger number), with a bracket in the TP for companies to double check.**

**Proposal 4: Discuss in Phase-2 on how to conclude on the value of N.**

Apple has added one additional question below for company’s consideration.

There is one additional key issue: how do we handle the concurrency of IUC transactions in MAC CE design? For example,

1) UE B has initiated two consecutive IUC requests for two different SL booking process with different traffic QoS priority. Assume UE A will send two different IUC-info MAC CE as response. According to current MAC CE format, there is no Priority information in the IUC-info MAC CE, then how UE B knows which response is for which IUC request?

2) UE A may happen to send both condition-triggered IUC MAC CE and requested-based IUC MAC CE. When those two are multiplexed in the same MAC PDU, how UE B knows which IUC-info MAC CE to be associated with the IUC request?

Usually this concurrency issue can be handled by linking IUC-REQ and IUC-INFO message with a transaction ID. However, there is no space for adding “transaction ID” in SCI-based IUC-request format. So, the alternative way is to make IUC-Info MAC CE itself self-explanatory so that the receiver will not have any ambiguity of the corresponding trigger for this message.

In Apple’s view, the current proposed MAC CE format is not self-contained because it lacks “Prio\_tx” information, which is used to determine resource(s) in the sensing algorithm.

By adding 3-bit “Priority” information, we can avoid all sorts of the problems above because UE B can fully understand how the resource sets in IUC info MAC CE is determined and can apply the IUC information to the resource selection process with the corresponding priority.

Q4:**, do you support to add 3-bit Prio\_TX field in IUC info MAC CE?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| Apple | Yes |  |
| LG Electronics | Comment | According to the RAN1 agreement below, we don’t think that it is necessary to have further optimization for the case when UE-B receives multiple preferred resource sets or multiple non-preferred resource set from the same UE-A.   * *Agreement*   + *For UE-B’s behavior when UE-B receives multiple preferred resource sets from the same UE-A*     - *It is up to UE-B implementation to use one or multiple of them in its resource (re)selection*   + *Conclusion: UE-B’s behavior when UE-B receives multiple non-preferred resource sets from the same UE-A*      - *No RAN1 specification change to TS38.214 is deemed necessary in RAN1#108-e*   + *For UE-B’s behavior when UE-B receives both a single preferred resource set and a single non-preferred resource set from the same UE-A*     - *FFS: It is up to UE-B implementation to use one or multiple of them in its resource (re)selection* |
| Ericsson | No | As LG mentioned, RAN1 has already made preliminary agreements for it. In addition, there are some FFS in RAN1 to further discuss “the case where multiple request or multiple response”, but RAN1 majority view that it may be sufficient to leave to UE implementation.  RAN2 has no point to discuss this now. This is not the critical issue for the WI completion. |
| Intel | No | Agree with Ericsson that this issue may not be essential to address at this stage. In any case, if there is consensus that this issue needs to be resolved, we can rely on UE implementation (as per RAN1 agreements) |
| Lenovo | No | Agree with LG’s comments, we should follow RAN1’s agreements and left it to UE implementation, RAN2 is not suggested to specify any additional optimization feature in this stage. |
|  |  |  |
|  |  |  |

**Summary: 4/5 tend to be negative on this. Moderator tend to see difficulty to conclude this issue in this short email, and thus suggest to de-prioritize it.**

**Proposal 5: De-prioritize additional fields in IUC-info, e.g., priority field.**

# Comment on the Phase-1 summary

If any further comment on the proposals, please insert it into the following table.

|  |  |  |
| --- | --- | --- |
| Company | Proposal-Number | Comment |
| ZTE | No fixed number | According to RAN1’s agreement as shown in following, the inetersection of IUC MAC CE and UE-B’s S\_A following the constraint defined in R16, i.e. larger than 20% total candidate resource in selection window. If only 8 combination(at most 24 resource) is included in the MAC CE, the constraint can not be fulfilled.   |  | | --- | | For Scheme 1 with preferred resource set Option A,  MAC layer selects resources using S\_A and the received preferred resource set  MAC layer firstly selects resources for transmissions within the intersection of S\_A and the preferred resource set until it becomes impossible to select a resource within the intersection under the constraint defined in Rel-16.  It is up to the UE whether to use the preferred resource set from SCI format 2-C and/or MAC CE  After this, if the number of selected resources is smaller than the required number of transmissions for a TB, MAC layer selects resources for the remaining transmissions outside the intersection but inside S\_A under the constraint defined in Rel-16. |   However, we also notice that this may cause signaling overhead. Our suggestion is RAN2 discss other solution to avoid signaling overhead, instead of set a fixed value. |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Summary

**Proposal 1: In the fields for IUC-info, only the field of “*Providing/requesting indicator*” can be saved for MAC-CE, while the other fields are needed.**

**Proposal 2: In the fields for IUC-request, only the field of “*Providing/requesting indicator*” can be saved for MAC-CE, while the other fields are needed.**

**Proposal 3: For MAC-CE design of IUC-Info and IUC-request, define the bit occupation for each field clearly based on the maximum value, and thus a bit-occupation figure is to be provided in the TP, and then in case not all bits are useful, only part of the field is occupied by using LSB bits.**

**Proposal 4: Discuss in Phase-2 on how to conclude on the value of N.**

**Proposal 5: De-prioritize additional fields in IUC-info, e.g., priority field.**

# Reference