**3GPP TSG RAN WG1 #102-e R1-200xxxx**

**August 17th – 28th, 2020**

**Agenda item:** 7.2.4.4

**Source:** Moderator (Qualcomm)

**Title:** Summary of Discussion for In-device Coexistence Aspects in NR-V2X

**Document for:** Discussion and Decision

# Introduction

This document provides a summary of the email discussion [102-e-NR- 5G\_V2X\_NRSL-InDevice-Coex-01]:

[102-e-NR- 5G\_V2X\_NRSL-InDevice-Coex-01] Email discussion/approval regarding

* processing time for prioritization of LTE sidelink and NR sidelink (Issue #1 in the summary)

by 8/20, followed by potential TPs, also including

* issue #2 (to start after 8/20) regarding capturing the agreement on prioritization of multiple overlapping transmissions between NR sidelink and LTE sidelink

by 8/25 – Gabi (Qualcomm)

# Discussion on Issue #1: Prioritization Timeline

The first issue to discuss is the value of UE processing time when performing prioritization between LTE sidelink and NR sidelink. TS 38.213 discusses the prioritization procedure in subclause 16.2.4.1 and uses the variable *T* to reference the processing time [1]:

16.2.4.1 Simultaneous NR and E-UTRA transmission/reception

If a UE

- would transmit a first channel/signal using E-UTRA radio access and a second channel/signal using NR radio access, and

- a transmission of the first channel/signal would overlap in time with a transmission of the second channel/signal, and

- the priorities of the two channels/signals are known to the UE msec prior to the start of the earlier of the two transmissions

the UE transmits only the channel/signal with the higher priority as determined by the SCI formats scheduling the transmissions or, in case of a S-SS/PSBCH block or a sidelink synchronization signal using E-UTRA radio access, as indicated by higher layers or, in case of PSFCH, equal to the priority of the corresponding PSSCH.

If a UE

- would respectively transmit or receive a first channel/signal using E-UTRA radio access and receive or transmit a second channel/signal using NR radio access, and

- a transmission or reception of the first channel/signal would respectively overlap in time with a reception or transmission of the second channel/signal, and

- the priorities of the two channels/signals are known to the UE msec prior to the start of the earlier transmission or reception

the UE transmits or receives only the channel/signal with the higher priority as determined by the SCI formats scheduling the transmissions or, in case of a S-SS/PSBCH block or a sidelink synchronization signal using E-UTRA radio access, as indicated by higher layers or, in case of PSFCH, equal to the priority of the corresponding PSSCH

Some contributions discussed this issue and proposed solutions on how to complete specification regarding the value *T* [2][3][4][5].

Section 2.1 presents the outcome of the discussion. Sections 2.2--2.4 summarize the discussions that lead to that outcome.

## Discussion Outcome

During the third round of discussion, the majority of companies expressed the desire a value without brackets to fully resolve this discussion. Also, the majority was ok with some value < 10 ms and there was a preference towards 4ms instead of 6 ms, because 4ms is the LTE V2X processing timeline and companies noted that no further timeline padding is needed. One company noted that measuring T from packet arrival at the UE instead of after the priorities are known to both RATs would simplify IODT. However, it was decided to keep the agreement definition of T.

Agreement:

* T is up to UE implementation subject to a specified upper bound.
* Note: per prior agreements, T is measured after the priorities are known to both RATs.

Agreement:

* The upper bound on T is 4ms

## Initial Discussion

Potential values for UE processing time based on company submissions are:

* Alt 1: , where is 2ms +1 slot, i.e. {3, 5, 9, 17} slots for {15, 30, 60, 120} kHz sub-carrier spacing, respectively. This is based on the maximum value required to prepare an NR sidelink transmission.
* Alt 2: ms, based on the maximum value required to prepare an LTE sidelink transmission.
* Alt 3: ms based on the maximum inter-module communication delay.
* Alt 4: Leave up to UE implementation.
* Alt 5: Others.

Table 1 Company views on values for T

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments |
| OPPO | Alt 4 | In NR V2X, or is the preparation time for encoding PSCCH / PSSCH and 4ms in LTE without considering the inter-module communication delay. But for the case of cross-RAT prioritization, the inter-module delay can vary from 0 to up to 20ms depending on UE capability reporting of a timing delay. Therefore, it would be difficult to impose a single timing requirement ms prior to the start of the earlier transmission or reception. Furthermore, the issue of ms in cross-RAT prioritization is related to in-device coexistence and therefore does not impact to other UEs or network scheduling. Also, in many instances it is agreed when the priorities of both LTE and NR sidelink transmissions are not known to both RATs prior to time of transmission, it is then up to UE implementation to handle the overlap.  So based on the above, it is not critical to define a value for ms in the spec and it can be leave it to UE implementation. |
| LG Electronics | Alt 3 | First of all, the exact meaning of “T msec prior to” in the specification should be clarified. To be specific, which of followings is correct?   * (a) Timing at which each module knows its priority **before** exchanging the priority information between different modules * (b) Timing at which a module knows both its own priority and that of another module **after** exchanging the priority information between different modules   In case of (a), when defining T value, the inter-module communication delay should be taken into account. Since the maximum value of X was defined as 20ms in the agenda of NR Uu controlling LTE SL, T value can be set to 20ms. |
| CATT |  | We think LGE raise a good question, the exact meaning of T msce should be clarified.  In case of b) we think 4ms is enough.  In case of a), the additional timing should be introduced due to inter-module coordination. However, we think the 20ms is too large for in-device coexistence. For example, in pre-crash use case, the maximum latency is 20ms, which will be impossible to perform in-device coexistence due to such a large T value. |
| vivo | Alt 2 | Firstly, it is our understanding anyway a time limit to differentiate the long- and short- term TDM operations is needed and should be specified, otherwise, a UE may declare support of short-term TDM with a processing time of minutes or hours, which is totally meaningless. This processing time is also needed for testing. So we think Alt 4 is not acceptable.  Regarding LG’s question, our understanding is interpretation b). With this understanding, Alt 2 (i.e., based on the preparation time of LTE) is more suitable than Alt 1, considering that the processing time should be applicable to both NR and LTE modules. In the case of interpretation a), Alt 3 (20ms) is acceptable to us. |
| Ericsson | Alt 4 | In our view, the value T is subject to the processing time restriction of the UE and its value does not impact the functionality of other UEs. Therefore, we propose to leave the value T up to UE implementation. |
| ZTE, Sanechips | Alt 4 | The parameter T may be related to UE processing capability. It is also an internal implementation consequence whose different values do not lead to different spec logics and different UE behaviors. In addition, it seems all first three Alternatives above have good reasons. So we prefer to leave T up to UE implementation.  In our view, how to interpret “T prior to…” as mentioned by LGE also depends on how the inter-module communication is done inside UE implementation. So Alt-4 does not require RAN1 to decide which interpretation should be mandated. |
| Futurewei | Alt 4 | We do not see a system benefit in specifying the parameter T. Consequently, it can be left up to the implementation |
| Huawei, HiSilicon | Alt 4 | We haven’t see any necessary and benefit to specify the detailed values of T. This is purely UE implementation issue. |
| Qualcomm | Alt 3 | We agree with LG, CATT, and Vivo that the answer depends on the reference point for T. 20 ms is sufficient to address both interpretations in LG’s list; whereas 4 ms would only apply for Interpretation (b). Therefore, while we think that a value less than 20ms could be selected, it is simplest to go with 20 ms at this point. |
| NTT DOCOMO | Alt 2 or Alt 3 | We share the view with vivo, that short-term TDM with a large processing time should be prohibited. In our understanding, short-term TDM could have impact on gNB scheduling, or other UE’s NR transmission requesting HARQ feedback. So Alt 4 is not good, and at least maximum value should be defined. Actual value supported by each UE can be up to UE implementation. |
| NEC | Alt 2 | 20ms is the max inter-module communication delay which is not proper for some UEs.  Besides, we think 4ms for encoding PSCCH / PSSCH is what we need to consider. Regarding the inter-module delay, wording ''*the priorities of the two channels/signals are known to the UE T msec prior to the start of the earlier of the two transmissions*'' has the precondition ''known'', which already includes the inter-module delay in our view. |
| Apple | Alt 4 | We prefer the T value is up to UE implementation, as it is related to UE processing time. |
| ASUSTeK | Alt 2 | Regarding LG’s question, we share the same view with vivo, and it’s interpretation b). We think a maximum processing time between NR and LTE is required and thus, T=4 ms.  If majority view thinks it’s up to UE implementation, we think spec change could be done by aligning previous agreement wording (i.e., prior to time of transmission subject to processing time restriction) rather than using notation T. |
| Samsung | Alt 4 | We think this is up to UE implantation.  If we will define the specific processing time as Alt 1 to Alt 3, we should also define what “known” means here. (e.g., just receive or decode successfully?)  This definition is not needed. |
| Intel | Alt.3 with modifications | In our view, the clarifications mentioned by LGE are needed. Our understanding was that interpretation (a) is discussed and therefore in our UE feature tdoc we proposed to reuse values of inter-RAT communication delay which are up to UE capability. Given the discussion in this thread we can take Alt.3 with modifications. Considering that 10ms are supported as a minimum transmission period for LTE it is desirable to support coexistence with this period as well and thus 10ms is a better choice in our view. We are also OK to leave T up to UE capability and take the values from inter-RAT communication delay discussion. |
| Nokia, Nokia Shanghai Bell | Alt 3 | We think that delays related to information exchange between modules should be included in the processing time definition (interpretation a). We think that maximum time limit for processing time of short term TDM should be defined. Preferably T should be less than 20ms. |

## Round 2 of Discussion

The views expressed in Table 1 were split between defining a number and leaving *T* up to UE implementation, with a majority preferring the second. One issue with leaving *T* completely up to implementation is that the feature becomes untestable. Of the companies that expressed support for 20ms, many mentioned that it would be preferable use a smaller value. On the other hand, companies pointed out that defining an exact value requires defining a reference point and could limit implementation flexibility.

It is not possible to use the values reported for inter-module delay when NR-Uu controls LTE sidelink since that is an independent feature that the UE does not need to support in order to support in-device coexistence. Introducing capability signalling for the value of *T* was also precluded during the UE capability discussions in RAN1 101bis-e.

Defining a maximum value for *T* was mentioned in the comments, leaving the exact value up to UE implementation. This compromise would enable testability and some planning ability while allowing for additional flexibility in UE implementation.

**Proposal**: the exact value of is up to UE implementation, where:

* 20 ms, and
* includes any inter-module information exchange delay

Table 2 Company views on Proposal 1

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| Company | Comments |
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## Round 3 of Discussion

During the email discussion on the proposal in Section 2.2, it was noted that the agreements regarding prioritization timeline already state that it is relative to when both RATs become aware of all priorities. Any ambiguity in specification wording could be addressed during TP preparation.

Agreements**:**

* Unless packet priorities of both LTE and NR sidelink are known to both RATs prior to time of collision (subject to processing time restriction), then
  + It is up to UE implementation to handle LTE Tx/NR Rx overlap.
  + It is up to UE implementation to handle NR Tx and LTE Rx overlap.

Agreements:

* For Tx/Rx overlap,
  + If packet priorities of both LTE and NR sidelinks are known to both RATs prior to time of transmission/reception (subject to processing time restrictions), then the packet with a higher relative priority is transmitted/received
    - In case the priorities of LTE and NR sidelink packets are the same, then it is up to UE implementation as to which packet is transmitted/received

The proposal is updated to reflect this timeline referece. The bound is also reduced since it does not need to consider inter-module communication delay.

**Proposal:**

* T is up to UE implementation subject to a specified upper bound.
* The upper bound on T is [6ms]
* Note: per prior agreements, T starts after the priorities are known to both RATs.

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| Company | Comments |
| NEC | Thank you for your efforts on this issue.  Hopefully companies are also on the same page regarding the note bullet based on the quoted agreements.  Regarding the bound of T, we're ok to put a upper bound of T and value could be 6ms, 10ms or an even larger one if majority support.  In addition, we would like to specify is a lower bound of T (e.g. 4ms in LTE) considering T should be at least sufficient for preparing PSSCH transmission. The upper bound was raised at the first round because companies thought T includes the inter-module exchange time and the time will not be larger than 20ms. So, a upper bound make sense at that time.  [FL]: The UE can do better than the number we define here, but isn’t required to. I don’t think we need to/can set a lower bound on how fast the UE performs the prioritization.  [NEC] Thanks for the relay and other companies' comments. We have a better understating now and support the current FL proposal. |
| vivo | We are fine with FL’s proposal.  Regarding the lower bound of T proposed by NEC, we don’t understanding why it is needed. The value of T is up to UE implementation, and can be a very small value if the UE can do (to achieve better performance during coexistence). The spec should not forbid the UE to do something better. |
| Ericsson | We agree with FL’s proposal. We think that the value of T should be up to UE implementation and we are ok to have an upper limit on it, but we do not think there is a need to specify any other constraint, e.g., lower bound. Since some companies argue that 20ms is too long, we are ok with 6ms or 10 ms depending on the majority view. |
| CATT | If the time reference point is after the inter-module coordination, we think 4ms is sufficient. From our understanding, if the resource and priority information is known by both RATs, we think the transmission preparation and dropping operation is only performed by each RAT internal, could you illustrate more on what’s the additional information to be exchanged for the additional 2ms.  [FL]: I reused the number proposed by OPPO. If companies prefer 4ms we can go with that.    Another aspects is that this email discussion is related with the UE feature discussion[15-6], from my understanding, the capability discussion is related to the inter-coordination time between RATs, do we want to define anther time value for UE feature?  [FL]: There will not be a capability for this. It was agreed to remove the corresponding component from FG 15-6 and to handle it in specifications instead. |
| ZTE, Sanechips | We are ok with FL's proposal, and do not think a lower bound is needed.  We do not have strong preference on whether a upper bound is really needed, but if it is the majority preference, we prefer NOT to leave the value pending for next meeting.  One question: if NR V2X has such a value T with specified upper bound, should the similar specification go to LTE V2X spec as well?  [FL] I would like a final number as well, but we have the brackets for now and if everyone is comfortable with the value, they can be removed. Otherwise, we can keep the brackets for further checking.  For the other point, I don’t think we need to update LTE V2X spec, could you please elaborate why that would be needed and why it wasn’t previously?  [ZTE2] Previously, the processing time restriction of T can be totally UE implementation issue, so there seems no big motivation to change LTE spec (for LTE side, it is also an implementation issue). But now there is a specified upper bound of processing time restriction. It seems a bit strange for LTE processing time restriction to be specified in NR spec.  On the other hand, I realized the whole section of 16.2.4.1 is supposed to be applicable, from spec point of view, to both RATs or to a RAT-independent UE functionality that controls both RAT modules. So I can be ok with no further touch to LTE spec. |
| Qualcomm | We’re ok with the proposal.  On the value itself, 6ms works and we’re also ok with other values close to it. |
| Huawei, HiSilicon | We share the same views with NEC and CATT, since T is measured after the priorities are known to both RATs, 4ms is enough.  And we also like to set T no more than 4ms without the bracket. It is much more desirable to deal with the decision fully this meeting, rather than have a [] which prolongs this relatively small discussion until November. |
| ASUSTeK | We are fine with FL's proposal, and regarding to upper bound of T, we are fine as 4ms or 6/10ms depending on majority view. |
| OPPO | We are fine with the proposal to finalize the value for T msec in the 38.213. Since this FG in the UE feature list is only intended for IODT purpose, I wonder how could they test this feature according to [6ms], because this value is only account for the UE processing time to prepare NR or LTE sidelink transmission. The amount of time required for a UE to perform inter-RAT module information exchange is still uncertain. Or do we assume to use the reported Xms from the cross-RAT scheduling for IODT test?  Alternatively, we can update the description for T msec in 38.213 to also include the time required for inter-RAT module information exchange and set T to [10ms], then it will give a good reference on how to perform IODT test. |
| NTT DOCOMO | We support FL's proposal. Lower bound would be unnecessary. 6ms is OK if majority companies support it. |

# Discussion on Issue 2

The second issue in the email discussion is about capturing the agreement on prioritization of multiple overlapping transmissions between NR sidelink and LTE sidelink:

Agreements:

* When NR multiple transmissions (if supported) are overlapped with LTE SL TX/RX and if these NR multiple transmissions have different priorities (which are known in advance to the UE), the highest priority value of NR multiple transmissions is used for comparing that of LTE SL TX/RX and then SL operation with a higher relative priority is performed.

There are two parts to addressing this topic:

* Should the agreement be explicitly captured in specifications?
* TP preparation.

The discussion will be split according the above.

**Q1. Should the agreement on multiple-transmission prioritization be explicitly captured in specifications?**

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| **Company** | **Comments** |
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**Q2. If the answer to Q1 is yes, can the following text proposal discussed in RAN1 #101-e be used to capture the agreement?**

----------------------------------------------------begin text proposal for 38.213---------------------------------------------------

16.2.4.1 Simultaneous NR and E-UTRA transmission/reception

<<<<<<unchanged text omitted>>>>>>

If a UE

- would transmit multiple channels/signals using NR radio access and receive or transmit a channel/signal using E-UTRA radio access, and

- transmission of the multiple channels/signals using NR radio access would overlap in time with a reception or transmission of the channel/signal using E-UTRA radio access, and

- the priorities of all the sidelink channels/signals are known to the UE msec prior to the start of the earliest transmission or reception

the UE transmits or receives only the channels/signals using the radio access associated with the highest priority of all the channels/signals as determined by the SCI formats scheduling the transmissions/receptions or, in case of a S-SS/PSBCH block or a sidelink synchronization signal using E-UTRA radio access, as indicated by higher layers or, in case of PSFCH, equal to the priority of the corresponding PSSCH.

-----------------------------------------------------end text proposal for 38.213----------------------------------------------------

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| **Company** | **Comments** |
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# References

1. 3GPP TS 38.213 V16.2.0, NR, Physical Layer Procedures for Control (Release 16).
2. R1-2005744, “Discussion on essential corrections in in-device coexistence,” LG Electronics.
3. R1-2006438, “Correction for in-device coexistence in SL,” Ericsson.
4. R1-2006771, “In-device Coexistence between LTE and NR sidelink,” Qualcomm Incorporated.
5. R1-2006869, “Discussion on processing time restriction for in-device coexistence,” ASUSTeK.