**3GPP TSG RAN WG1 #104-bis-e R1-210xxxx**

**e-Meeting, April 12th – 20th, 2021**

**Source: Moderator (Intel Corporation)**

**Title: Discussion on**

**Agenda item: 7.2.4**

**Document for:** **Discussion and Decision**

Introduction

This document provides discussion on the following approved email thread as part of RAN1#104bis-e Release 16 NR V2X maintenance discussion:

[104b-e-NR-5G\_V2X-03] Email discussion/approval on issue M2-1: Infinite loop due to excessive resource exclusion in step 5) till 4/15, with potential CRs till 4/19 – Sergey (Intel)

Outcome

TBD

Discussion

## Round 1

The issue of an infinite loop of the resource identification procedure captured in section 8.1.4 of TS 38.214 was highlighted in contributions [1][4][5][11] for this meeting.

The main concern is that due to “hard” exclusion in step 5), the X% resource ratio on the selection window may not be achievable after any number of RSRP threshold adjustments, that practically leads to unsatisfied loop completion condition, i.e. infinite loop behaviour.

It is noted that at this stage it is unwelcomed to debate on optimizations of the exclusion procedure, such as a smarter exclusion of period values, which were already discussed in past. From FL perspective, the main aim would be to introduce a simple and efficient loop breaking condition, rather than optimize the hard exclusion step.

Finally, the context of the discussion assumes that a UE could not find the selection window size $[T\_{1}, T\_{2}]$ that is valid and does not enter the infinite loop condition. If this condition is not met, then the UE is first expected to adjust the selection window size.

The first phase of the discussion is to express preferences about the possible solution approaches:

Approach 1:

* Introduce a loop breaking condition

Approach 2:

* Refine step 5 (and potentially step 6) to decrease or eliminate infinite loop chances

In contributions, and as identified by FL, the following flavours of the approaches 1 and 2 are presented:

Approach 1 conditions:

* Option 1-1 [1]: If the number of resources in $S\_{A}$ is already less than or equal to $X⋅M\_{total}$ after step 5), UE will report the current $S\_{A}$ to high layers immediately and not perform other steps (i.e. step 6 and 7)
* Option 1-2 [1]: If the number of resources remaining in $S\_{A}$ will be less than $X⋅M\_{total}$ after performing step 5), UE will not perform / skips step 5)
* Option 1-3 [5]: Introduce a maximum RSRP threshold of 0 dBm to ensure UE does not enter an infinite loop when performing resource selection in Mode 2 operation
* Option 1-4 [FL]: If the number of resources in $S\_{A}$ is already less than or equal to $X⋅M\_{total}$ after step 5), UE will report the $S\_{A}$ to high layers after performing steps 6 and 7 once
	+ *FL comment: this option was added based on modified option 1-1, with the difference that a UE executes steps 6 and 7 at least once to preclude collisions above the initial RSRP threshold*

Approach 2 conditions:

* Option 2-1 [1]: A subset of the (pre-)configured periodicities for reservation should be used to exclude resources in slots not monitored during sensing
* Option 2-2 [1]: Replace $Q=\left⌈\frac{T\_{scal}}{P\_{rsvp\\_RX}}\right⌉$ with $Q=\left⌈\frac{T\_{scal}}{max⁡(20, P\_{rsvp\\_RX})}\right⌉$ to avoid excessive exclusion
* Option 2-3 [4]: In step 5) of resource selection procedure, the number of hypothetical SCI format 1-A resulting from a non-monitored slot is extended with only a single period (letting Q=1) for all configured resource reservation periods
* Option 2-4 [11]: If the number of candidate single-slot resources excluded from the set $S\_{A}$ is larger than (1-$ $X)⋅$ M\_{total}$, randomly selected resources from those excluded in step 5) are added to set $S\_{A}$ until the number of the candidate single-slot resources remaining in the set $S\_{A}$ is not smaller than $X⋅M\_{total}$

**Q1: Do you agree that the infinite loop breaking is expected to kick in only when there is no valid selection window size** $[T\_{1}, T\_{2}]$ **that can be chosen by the UE which does not lead to the infinite loop?**

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| --- | --- | --- |
| Source | Answer | Comment |
| NTT DOCOMO | (Technically YES, but) NO | In current spec, it seems that UE determines one window [T1, T2] then step 1 to 6 are applied for this window. There is no description to update the window when the UE is in the infinite loop of step 5.For better performance, the answer should be YES, but it seems ‘optimization’ as mentioned by FL. The window is selected by UE implementation, so we can expect smart UEs for this aspect. |
| Ericsson | Yes | There is a possibility of infinite loop, and therefore, a procedure to break the loop should be triggered under certain condition(s). |
| Huawei, HiSilicon | Clarification needed on Q1 | We are not sure if the proposed pre-condition can be real, in the sense that we only know the UE has arrived in the infinite loop under the condition of its implementation choices. It does not matter how many sizes of selection window it has first tried without success (e.g. a single size, or many sizes). It only matters what to do once the infinite loop is found.We suggest not discussing Q1, and proceeding with Q2 directly. |
| QC | NO | [T1, T2] is chosen before entering the loop. If there is infinite loop, UE cannot break out of the loop to reselect another window of [T1, T2] |
| Apple |  | The selection window size is initially determined, and then the infinite loop is detected due to step 5. In other words, the infinite loop may happen after the selection window size is selected.  |

**Q2: Please answer which of the above approaches to fix the infinite loop issue should be pursued in R16 V2X maintenance?**

* **Approach 1: Introduce a loop breaking condition**
* **Approach 2: Refine step 5 (and potentially step 6) to decrease or eliminate infinite loop chances**
* **Combination (please specify)**

**Please also express the views on the detailed handling option (1-1, 1-2, etc.)**

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| Source | Comment |
| NTT DOCOMO | Approach 1 is preferred. Original concept of step 5 should be maintained and only addressing this issue is better. Approach 2 might lead to new issue, unless careful studies/evaluations.Among approach 1, we prefer option 1-3/1-4. |
| Ericsson | Approach 1 is preferred at this point. Option 1-2 looks like a simple approach to avoid the infinite loop skipping step 5) under the condition that $S\_{A}$ will be less than $X⋅M\_{total}$ after performing step 5) |
| Huawei, HiSilicon | First of all, to avoid any misunderstanding, it’s necessary to clarify that all the options shall only apply to the “infinite loop” issue, i.e., if “infinite loop” issue does not happen, none of the options will be effective. Therefore, we suggest to add “If the number of the excluded resources in step 5) is larger than $(1-X)· M\_{total}$ , …” to each option.Otherwise, the options except Option 2-4 seem to change R16 Mode 2 behaviours in all cases, i.e., regardless of whether “Infinite loop” issue happen or not. Any such general change is out of the scope of this thread.We support Option 2-4, which can well solve the “infinite loop” issue and provides MAC layer $X⋅M\_{total}$ candidate single-slot resources.The main drawbacks of other options are:* For all the Option 1-1/2/3/4:
	+ One major problem is the final number of resources in SA could be much smaller than $X⋅M\_{total}$, e.g., when the periodicity value is very small. Consequently, MAC layer has very few candidate resources to be selected, resulting in large collision chance and some timing restrictions cannot be satisfied (e.g., HARQ RTT, chain reservation, etc.)
* Option 2-1:
	+ If the sub-set is obtained by RRC configuration, then this solution shall not be considered due to RRC impact.
	+ If the sub-set is derived based some predefined rule, e.g., the first X periodicity values as proposed by [1], then it’s possible that even we apply this sub-set, the infinite loop issue still exists since the first X periodicity values may still include very small periodicity values.
* Option 2-2, 2-3:
	+ This changes the basic design principle of sensing procedure, and could face serious collision issue since resources corresponding to Q>1 or $Q=\left⌈\frac{T\_{scal}}{P\_{rsvp\\_RX}}\right⌉$ are not considered.
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| QC | Approach 1 is preferred |
| Apple | Prefer a combination of Approach 1 and Approach 2. If the infinite loop does not occur, i.e., the number of candidate resources after step 5 is larger than $X⋅M\_{total}$, then nothing needs to be done. Otherwise, step 5 is modified (e.g., Option 2-x) so that the number of candidate resources after modified step 5 is larger than $X⋅M\_{total}.$  |
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References

1. R1-2102369 Remaining open issues and corrections for mode 2 RA OPPO
2. R1-2102589 Discussion and TPs on resource allocation in NR V2X CATT, GOHIGH
3. R1-2102941 Maintenance on NR sidelink mode-2 resource allocation mechanism vivo
4. R1-2103081 On Remaining Issues of Mode 2 Resource Allocation Apple
5. R1-2103143 Remaining Issues in Mode 2 Resource Allocation Qualcomm Incorporated
6. R1-2103467 Remaining issues on resource allocation for NR sidelink Sharp
7. R1-2103501 Draft CR of TS38.214 ZTE, Sanechips
8. R1-2103516 Remaining issues on resource allocation mode 2 NEC
9. R1-2103639 Remaining issues on sidelink mode 2 ASUSTeK
10. R1-2103750 Correction on resource exclusion for other TBs Huawei, HiSilicon
11. R1-2103751 Correction on step 5 of mode 2 resource allocation Huawei, HiSilicon
12. R1-2103765 Maintenance for Resource allocation for sidelink - Mode 2 Nokia, Nokia Shanghai Bell