**3GPP TSG-RAN WG2 #113-e *R2-21xxxxx***

**E-meeting, January 2020**

Agenda Item: 6.4.3

Source: OPPO (rapporteur)

Title: Summary of email [AT113-e][711][V2X]SL CG related issues

Document for: Discussion, Decision

# Introduction

This is to kick off following email discussion:

* [AT113-e][711][V2X/SL] SL CG related issues (OPPO)

**Scope:** discuss SL CG related issues with details and attempt to make conclusions.

**Intended outcome:** discussion summary in R2-2102190. If we have consensus, we can do email approval otherwise it will come-back next week.

**Deadline:** Feb 04 0430 (UTC)

# Configured grant

In discussion papers [1][2] sidelink resources are categorized into 3 levels:

Level\_1: physical slots including both uplink and downlink slots

Level\_2: only sidelink logical slots which contain both SSB and reserved slots

Level\_3: only sidelink logical slots which belong to one specific resource pool excluding SSB and reserved slots and expressed by a bitmap whose length is configured in RRC signaling

To better understand the difference between Level\_2 and level\_3 logical slots, here are steps to form a resource pool. The detail can be found in section 8 of 38.214:

Step1: The number of reserved slots of one specific resource pool is equal to TL2%BL, where TL2 means total number of Level\_2 logical slots within one SFN period after removing SSB slots and BL means the bitmap length of a resource pool;

Step2: Those reserved slots are scattered evenly within one SFN period.

Step3: a bitmap define logical slots of a resource pool every BL slots after removing SSB slots and reserved slots.

In the example illustrated in Figure one, there are 10 slots within 20ms could be sidelink slots and the bitmap length is 10.



Figure 1 resource pool and CG (just for illustration)

As pointed out in [1] the main problem for current equations is that allocated CG resource slots could be out of resource pool. This is caused by the fact that Level\_2 logical slots contains SSB slots and reserved slots of one specific resource pool. So it is possible that CG resource slot could be overlapped with SSB slot or reserved slot directly. And the main problem is that periodic CG resource slot in Level\_2 is not periodic any more in the associated resource pool i.e. Level\_3 due to the fact that SSB slots and reserved slots are excluded in Level\_3 which scatters sparsely without periodical pattern in Level\_2.

In the example illustrated in Figure 1, CG slots in Level\_2 (red one) are #0, #10, #20 and #30. #20 and #30 is out of intended resource pool.

Alternative solution proposed in [1] is to define CG resource slot in Level\_3 logical slots. In this way all the CG resource slots (with red slash) will be located within resource pool. Note in alternative solution periodicity of CG need be further transformed by taking the occupancy ratio of bitmap into account as indicated in equation (6) in [1].

In the example illustrated in Figure 1, CG slots in Level\_3 ( red slash one) are #0,#4,#8 and #12 whose corresponding slot index in Level\_2 are #0,#11,#22 and #33. All of them are in the resource pool by nature.

**Question 1: The equation to define CG resource slot should be defined based on which level logical slots?**

Option1: Level\_2 logical slots

Option2: Level\_3 logical slots

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| Ericsson (Min) | Option 2 |  |
| vivo (Jing) | Option 1 | Defining the CG resource based on Level\_3 logical slots seems a little bit over-optimized to us. Equation based on level-2, which is also the approach in current MAC specification, can be modified to further consider how to ensure the CG resources are within resource pools. |
| Samsung | Option 1 |  |
| HW | Option 2 |  |
| CATT | Option 2 |  |
| Sharp | Option 1 | In [Post111-e][705][V2X] for SL CG occasions, one of the agreements is “Recommendation 5: RAN2 agree that N refers to the number of slots that can be used for SL transmission within 20ms, if configured, of TDD-UL-DL-ConfigCommon as specified in TS 38.331 [5] and clause 8.1.7 of TS 38.214 [7].” and it clearly revealed Level 2 logical slots(i.e. Option 1) are adopted in SL CG occasions. At this stage, we are not sure whether the former agreement should be reverted with no technical reason. Also, one agreement on SL CG was on definition of RRC parameter (i.e. “Recommendation 8: RAN2 confirms sl-TimeOffsetCG-Type1 refers to the number of logical slots that can be used for SL transmission, as specified in current specification.” ), which means Option 2 would somehow lead to ASN.1 impact and is not expected ideal solution.  [Sharp’s further comments]:  Regarding Option 2, from our perspective, we don’t think it can work well on top of Level 3 logical slots, 1) If Option 2 is going to be agreed, in current equation (2) seems lack of relation with the RRC parameter *sl-TimeReferenceSFN-Type1*, does it mean that *sl-TimeReferenceSFN-Type1* with 512 corresponds to ? 2) More importantly, we don’t think resource pool slots are always equally distributed among first and second 512 frames, since is always a divisor of 10240ms, instead of 5120ms and can even be an odd number. For Option 1, there would be no such issue. |
| OPPO | Option2 | We think option2 is not just optimization of optio1.From the example in Figure 1, it is likely that many CG slots will fall out of resource pool especially when occupy ratio of slot with value 1 in the bitmap is low. If those invalid CG slots are dropped, then SL CG basically doesn’t work in reality. Note multiple SL configured grants are allowed in Rel16 which are likely TDMed with each other.  The clarification of the RRC parameters doesn’t necessary means RAN2 agreed option1. |
| Apple | Option 2 | We think the CG is configured per Tx pool, so the parameters are based on the logical slots defined for the TX resource pool. |
| ZTE | Option2 | According to the LS(R1-2101922) from RAN1, Option 2 is preferred by RAN1, we think it is ok for us. |
| Intel | Option2 | We share the view with Apple that it makes sense to have define based on logical slots for the resource pool. |
| LG | Option 2 | In this meeting, RAN1 discussed the issue on how to determine the location of periodically reserved resources in Mode2, and they made the conclusion that this is calculated based on the number of SL slots belonging to the resource pool (see RAN1 LS of R1-2101922) with the condition that RAN2 can do the necessary specification update. From our perspective, there is no reason to define the different principle for Mode 1 CG operation. |
| Qualcomm | Option 2 | Agree RAN2 should follow RAN1 recommendation. |

Summary: among 12 companies 9 company prefer option 2. One company think option2 is optimization of option1 and another company believe some clarification on the parameter “N” and “TimeOffsetCG-Type1” hints that RAN2 agreed option 1 which is not true. Apart from concern on invalid CG slot, another reason to support option2 is to align the interpretation of period between mode 1 and mode 2.

Proposal1: The equation to define CG resource slot should be defined based on Level\_3 logical slots i.e. logical slots within one resource pool

If option1 is chosen, one issue need be resolved is how to deal with invalid CG resource slot which is not located in associated resource pool of CG? Basically there are 2 options:

Option A: to replace the invalid CG resource slot with a slot of the associated resource pool which is closest to the invalid CG resource slot in Level\_2 time domain

Option B: do nothing i.e. to simply drop the invalid CG resource slot

**Question 2: If option1 is chosen, which option do you prefer to treat invalid CG resource slot?**

|  |  |  |
| --- | --- | --- |
| Company | Options | Comments |
| Ericsson (Min) | Option B |  |
| vivo (Jing) | Option B | Option B seems a simple solution as dropping the invalid CG resource will not cause any serious problems. |
| Samsung | Option B |  |
| Sharp | Option B |  |
| OPPO | Option B |  |
| Qualcomm | Option B |  |

Summary: all involving company agree if option1 is concluded that option B should be adopted that is do nothing i.e. to simply drop the invalid CG resource slot

Proposal2: if option 1 is concluded, UE simply drops the invalid CG resource slot(s)

The rest issues apart from issues in section 2.2 of R2-2100098 had been discussed in email discussion ”[POST112-e][701][V2X] RAN1 related discussion (OPPO)” and are quite aligned among companies. In order to proceed with potential CR during this meeting, proposal3, proposal4 and proposal5 are reconfirmed as following:

**Question 3: if option1 is concluded, do you agree with proposal3 and proposal4 from the email summary R2-2100098 as following:**

Proposal3: if option1 is concluded, the accumulation granularity is changed from numberOfSLSlotsPerFrame to be parameter N and to replace “logical slot number in the frame” to be “logical slot number in two frames” in the equation.

Proposal4: if option1 is concluded, further clarify that the 1st frame of two radio frames where N is a constant value should be an even radio frame.

|  |  |  |
| --- | --- | --- |
| Company | Position (yes or no) | Comments |
| Ericsson (Min) | Yes |  |
| vivo (Jing) | Yes |  |
| Samsung | Yes |  |
| Sharp | Yes |  |
| OPPO | Yes |  |
| Qualcomm | Yes |  |

Summary: all involving companies confirm proposal3 and proposal4 from the email summary R2-2100098

Proposal3: if option1 is concluded, the accumulation granularity is changed from numberOfSLSlotsPerFrame to be parameter N and to replace “logical slot number in the frame” to be “logical slot number in two frames” in the equation.

Proposal4: if option1 is concluded, further clarify that the 1st frame of two radio frames where N is a constant value should be an even radio frame.

**Question 4: if option2 is concluded, do you agree with proposal5 from the email summary R2-2100098 as following:**

Proposal5: If option2 is concluded, the equation (1) , (2) and (3) as listed below are agreed in principle. RAN2 can further discuss detail in CR phase.

The equation to transfer d to be a period applied to logical slots of a resource pool:

(1)

Where:

* K is the total number of slots within the bitmap marked with 1
* L is the bitmap length

The detail equation for CG type1 is as following:

(2)

Where:

* :the total number of logical slots of the associated resource pool within SFN period
* :the slot offset between the first CG resource slot and
* :the period of SL CG resources. Please refer to equation (1)
* :current logical slot in the resource pool whose value range is [0, ]
* S :the index of CG radio resource, S>=0
* : the reference slot which could be either 1st slot within associated resource pool i.e. zero or the slot index equals to

For CG type2, the equation is as following:

(3)

Where:

Parameters *Current\_slot, S, sl\_periodCG\_RP* share the same meaning as those in equation (2). *Slot\_start* refers the slot index of the first PSSCH duration after the configured sidelink grant was (re-)initialised.

|  |  |  |
| --- | --- | --- |
| Company | Position (yes or no) | Comments |
| Ericsson (Min) | Yes |  |
| HW | Partially yes | We think equation 2 and 3 are OK. But for equation 1, RAN1 has already concluded on how to determine the number of logical slots for a reservation period for Mode-2 and they send a LS (R1-2101921, Option 1’.) to ask RAN2 to update the spec accordingly. Therefore, we propose to REUSE the way concluded by RAN1 in the LS for calculating also the periodicity of mode-1 CG resources, such that we can apply a unified mechanism for mode 1 and mode 2 logical slots interpretation. This could be a very important aspect from UE implementation point of view, as this introduces less complexity, otherwise, the UE needs to implement two different mechanisms for the resource periodicity interpretation mode-1 CG and mode-2 resource reservation respectively.  With above being said, the equation 1 should be updated as shown below.  where N is the number of slots belonging to the resource pool within 10240ms.  Plead do note that what we proposed above is to Reuse the method concluded by RAN1 (i.e. Option 1’ in R1-2101921) as a common definition of the periodicity for both mode-1 CG and mode-2 resource reservation. This HAS NOTHING to do with how mode-1 sets “Resource reservation period” field in the SCI. |
| CATT | Yes |  |
| OPPO | Yes with comment | We also think Huawei’s proposal is technically reasonable and fine to change the equation (1) as suggested by Huawei. |
| Apple | Yes |  |
| ZTE | Partially Yes with comments | According to the LS(R1-2101922) from RAN1, Option 2 is prefered by RAN1, RAN2 just needs to confirm whether agree to the option 2, the detail equation will be discussed by RAN1. in addition, if option 2 is selected, the following equation seems better for sl\_periodCG  where N is the number of slots belonging to the resource pool within 10240ms. |
| Intel | Yes |  |
| LG | No | According to RAN1 LS of R1-2101922, at this moment, there could be a possibility to modify the following equation (currently used for SL CG Type 1 in TS 38.321) as well as the definition of N. Note that even if RAN2 confirms RAN2 can do the necessary specification update for Option 1’ in R1-2101922, RAN1 still needs to have further discussion on whether/how to change “20 ms” in the denominator of equation below.  In this sense, we are doubtful whether it is possible for RAN2 to finalize the modification of equation for SL CG Type 1/2 in this meeting. Our preference is to discuss this issue in the next RAN2 meeting after RAN1 makes the agreement on the value of denominator in the equation above. |
| Qualcomm | See comment | Our view is RAN2 can agree in principle, but needs to rely on RAN1 input for the detailed definition. |

Summary: involving companies agree that equation (2) and (3) are agreeable. 5 companies agree with listed equation (1). 3 companies think modification is needed to improve the accuracy of period as RAN1 did for mode 2. 2 companies think we’d better wait for RAN1’s progress since RAN1 is also changing the scaling equation for mode 2 and they would like to align the equation to RAN1’s conclusion. Rapporteur noticed the name of parameter can also be aligned with RAN1 if we go this way.

Proposal5: if option2 is concluded, equation (2) and (3) are agreed with potential modification on parameter name in CR stage.

Proposal6: if option2 is concluded, scaling equation (1) of CG period could be revised once scaling equation for mode 2 period is concluded.

# Conclusion

Based on the discussion, RAN2 intend to agree on option2 listed under question 1. The batch of proposals for option2 are:

Proposal1: The equation to define CG resource slot should be defined based on Level\_3 logical slots i.e. logical slots within one resource pool

Proposal5: if option2 is concluded, equation (2) and (3) are agreed with potential modification on parameter name in CR stage.

Proposal6: if option2 is concluded, scaling equation (1) of CG period could be revised once scaling equation for mode 2 period is concluded.

If RAN2 conclude option1, then the batch of proposals for option1 can be agreed:

Proposal2: if option 1 is concluded, UE simply drops the invalid CG resource slot(s)

Proposal3: if option1 is concluded, the accumulation granularity is changed from numberOfSLSlotsPerFrame to be parameter N and to replace “logical slot number in the frame” to be “logical slot number in two frames” in the equation.

Proposal4: if option1 is concluded, further clarify that the 1st frame of two radio frames where N is a constant value should be an even radio frame.

# Reference

[1] R2-2008800 Discussion on resource and HARQ process id of configured grant OPPO

[2] R2-2009044 Discussion on CG resource calculation ZTE Corporation, Sanechips

[3] R2-2009045 CR for TS 38.321 on calculation of CG type1 and type 2 ZTE Corporation, Sanechips

[4] R2-2009318 Discussion on resource determination of SL configured grant SHARP Corporation

[5] R2-2010310 Correction on HARQ process ID calculation for SL CG Huawei, Hisilicon

[6] R2-2009253 Correction to pre-emption check for Sidelink resource allocation mode 2 LG Electronics France

[7]R1-2009460 LS reply on SL CG handling

[8]R1-2009474 LS on R16 V2X Mode-2 agreements to capture in MAC specification

[9]R1-2009475 LS reply on RAN2 agreements and RAN1 related issues

[10]R1-2009661 LS reply on RAN1 agreement on pre-emption

[11]R2-2010948 Corrections to 5G V2X with NR Sidelink LG Electronics Inc.

[12]R2-2010949 Corrections to 5G V2X with NR Sidelink LG Electronics Inc.

[13] R2-2008586 LS to RAN1 on sidelink configured grant handling

[14] R2-2007918 Discussion on sidelink grant handling

[15] LS on RAN1 agreement on pre-emption

# Annex

5.8.3 Sidelink

There are two types of transmission without dynamic grant:

- configured grant Type 1 where an sidelink grant is provided by RRC, and stored as configured sidelink grant;

- configured grant Type 2 where an sidelink grant is provided by PDCCH, and stored or cleared as configured sidelink grant based on L1 signalling indicating configured sidelink grant activation or deactivation.

Type 1 and/or Type 2 are configured with a single BWP. Multiple configurations of up to 8 configured grants (including both Type 1 and Type 2, if configured) can be active simultaneously on the BWP.

RRC configures the following parameters when the configured grant Type 1 is configured, as specified in TS 38.331 [5] or TS 36.331 [21]:

- *sl-ConfigIndexCG*: the identifier of a configured grant for sidelink;

- *sl-CS-RNTI*: SLCS-RNTI for retransmission;

- *sl-NrOfHARQ-Processes*: the number of HARQ processes for configured grant;

- *sl-PeriodCG*: periodicity of the configured grant Type 1;

- *sl-TimeOffsetCG-Type1*: Offset of a resource with respect to SFN = *sl-TimeReferenceSFN-Type1* in time domain, referring to the number of logical slots that can be used for SL transmission;

- *sl-TimeResourceCG-Type1*: time resource location of the configured grant Type 1;

- *sl-CG-MaxTransNumList*: the maximum number of times that a TB can be transmitted using the configured grant;

*- sl-HARQ-ProcID-offset*: offset of HARQ process for configured grant Type 1;

- *sl-TimeReferenceSFN-Type1*: SFN used for determination of the offset of a resource in time domain. The UE uses the closest SFN with the indicated number preceding the reception of the sidelink configured grant configuration Type 1.

RRC configures the following parameters when the configured grant Type 2 is configured, as specified in TS 38.331 [5]:

- *sl-ConfigIndexCG*: the identifier of a configured grant for sidelink;

- *sl-CS-RNTI*: SLCS-RNTI for activation, deactivation, and retransmission;

- *sl-NrOfHARQ-Processes*: the number of HARQ processes for configured grant;

- *sl-PeriodCG*: periodicity of the configured grant Type 2;

- *sl-CG-MaxTransNumList*: the maximum number of times that a TB can be transmitted using the configured grant;

*- sl-HARQ-ProcID-offset*: offset of HARQ process for configured grant Type 2.

Upon configuration of a configured grant Type 1, the MAC entity shall for each configured sidelink grant:

1> store the sidelink grant provided by RRC as a configured sidelink grant;

1> initialise or re-initialise the configured sidelink grant to determine PSCCH duration(s) and PSSCH duration(s) according to *sl-TimeOffsetCG-Type1* and *sl-TimeResourceCG-Type1*, and to reoccur with *sl-periodCG* for transmissions of multiple MAC PDUs according to clause 8.1.2 of TS 38.214 [7].

NOTE 1: If the MAC entity is configured with multiple configured sidelink grants, collision among the configured sidelink grants may occur. How to handle the collision is left to UE implementation.

After a sidelink grant is configured for a configured grant Type 1, the MAC entity shall consider sequentially that the first slot of the Sth sidelink grant occurs in the logical slot for which:

[(SFN × *numberOfSLSlotsPerFrame*) + logical slot number in the frame] =  
 (*sl-TimeReferenceSFN-Type1* × *numberOfSLSlotsPerFrame* *+* *sl-TimeOffsetCGType1*+ S × *PeriodicitySL*) modulo (1024 × *numberOfSLSlotsPerFrame*).

where , *numberOfSLSlotsPerFrame* refers to the number of logical slots that can be used for SL transmsission in the frame and *N* refer to the number of slots that can be used for SL transmsission within 20ms, if configured, of *TDD-UL-DL-ConfigCommon*, as specified in TS 38.331 [5] and clause 8.1.7 of TS 38.214 [7].

After a sidelink grant is configured for a configured grant Type 2, the MAC entity shall consider sequentially that the first slot of Sth sidelink grant occurs in the logical slot for which:

[(SFN × *numberOfSLSlotsPerFrame*) + logical slot number in the frame] =  
[(SFNstart time × *numberOfSLSlotsPerFrame* + slotstart time) + S × *PeriodicitySL*] modulo (1024 × *numberOfSLSlotsPerFrame*).

where SFNstart time and slotstart time are the SFN and logical slot, respectively, of the first transmission opportunity of PSSCH where the configured sidelink grant was (re-)initialised.

When a configured sidelink grant is released by RRC, all the corresponding configurations shall be released and all corresponding sidelink grants shall be cleared.

The MAC entity shall:

1> if the configured sidelink grant confirmation has been triggered and not cancelled; and

1> if the MAC entity has UL resources allocated for new transmission:

2> instruct the Multiplexing and Assembly procedure to generate a Sidelink Configured Grant Confirmation MAC CE as defined in clause 6.1.3.34;

2> cancel the triggered configured sidelink grant confirmation.

For a configured grant Type 2, the MAC entity shall clear the corresponding configured sidelink grant immediately after first transmission of Sidelink Configured Grant Confirmation MAC CE triggered by the configured sidelink grant deactivation.

5.22.1.1 SL Grant reception and SCI transmission

…(deleted part)

For configured sidelink grants, the HARQ Process ID associated with the first slot of a SL transmission is derived from the following equation:

HARQ Process ID = [floor(CURRENT\_slot / *sl-PeriodCG*)] modulo *sl-NrOfHARQ-Processes* + *sl-HARQ-ProcID-offset*

where CURRENT\_slot = (SFN × *numberOfSlotsPerFrame* + slot number in the frame), and *numberOfSlotsPerFrame* refer to the number of consecutive slots per frame as specified in TS 38.211 [8].