**[104-e-NR-5G\_V2X-06]: PP-4: Interpretation of resource reservation period field in a SCI format 1-A (the same issue in M2-2: Clarification on UE procedure for determining the number of logical slots for a reservation period), till 1/28, with potential CRs till 2/2 – Hanbyul (LGE)**

**PP-4: Interpretation of resource reservation period field in a SCI format 1-A**

Q1: When a UE transmits a SCI format 1-A in slot n in a resource pool and “Resource reservation period” in the SCI format 1-A indicates P, what is UE’s understanding?

* Option 1: The resource reservation period P’ is calculated following 8.1.7 of 38.214, and P’ is counted in (i.e. the number of slots in the resource pool between slot n and slot n+P’ is always the same as P’ (including slot n+P’ itself)).
	+ Option 1’: Option 1 + updated equation in 8.1.7 (N is the number of slots belonging to the resource pool)
* Option 2: The resource reservation period P’ is calculated following 8.1.7 of 38.214 and P’ is counted in (i.e. the number of slots in the resource pool between slot n and slot n+P’ can be less than P’).
	+ Option 2-1: No further spec change
	+ Option 2-2: Add “UE expects belongs to the set of slots assigned to the resource pool.”
	+ Option 2-3: Add “If slot  is not in the resource pool, the next slot in the resource pool should be used instead.”
* Option 3: The resource reservation period P’ is calculated following 8.1.7 of 38.214 and P’ indicates the period in terms of ms.
	+ If the physical slot after P ms is not in the resource pool, the next slot in the resource pool should be used instead.
* Option 4: The resource reservation period P’ is calculated following 8.1.7 of 38.214 and P’ is counted in the slots that can be used for SL transmission (i.e. the gap between the slots indicated in SCI within two periods is P).
	+ Add “UE expects belong to the set of slots assigned to the resource pool.”
* Option 5: Others (please specify)

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| ZTE,Sanechips | Option 4 first preferenceOption 2-1 compromise | None of the above listed options could deliver a perfect way out as to the conflict between resource pool based jittering and always ensuring the reserved resource is actually in the resource pool. We believe technical perspective could be summarized as follows,In current NR SL structure, in our view, four levels of slot sets have been defined in the spec:* L0: physical slots.
* L1: slots can be used for SL communication.
	+ i.e., excluding any slot from L0 if at least one of Y-th, (Y+1)-th, …, (Y+X-1)-th OFDM symbols in this slot are semi-statically configured as DL or F as per *tdd-UL-DL-ConfigurationCommon* or *sl-TDD-Configuration*
* L2: slots can belong to a SL resource pool.
	+ i.e., further excluding slots and the reserved slots from L1, where the reserved slots are determined according to , the length of bitmap configured for this resource pool.
	+ L2 is denoted as in current specification.
* L3: slots belong to a SL resource pool,
	+ L3 is denoted as .

We can have the following observation as to applying different levels of slots under the leftover case c) or d) :1. 1. L0 and L1 SL slot sets are periodic in the physical duration sense, and are independent from resource pool configuration thus free from resource pool jittering
	2. L2 and L3 SL slot sets are closely related to resource pool configuration including e.g. S-SSB and bitmap setting, due to which the following issues may arise

- In case the Rx pool where SCI is detected should be different from Tx pool where mode 2 transmission takes place, ambiguity and potential collision could take place given the reservation period should be resource pool specific-The logical resource reservation period is highly likely to be deviated from the physical resource reservation period if L2 and L3 slots are used due to resource pool jitteringIn addition, from spec. change perspective, if we further examine the impact considering LTE V2X as well, we could obtain the following table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Case a)  | Case b) | Case c) | Case d) |
| Option 1’ | L3 | L3 | L3 | L3 |
| Option 2 (current specification) | L3 | L3 | L2 | L1 |
| Option 3 | L3 | L3 | L0 | L0 |
| Option 4 | L3 | L3 | L1 | L1 |
| LTE V2X | L2 | L2 | L2 | L1 |

Accordingly, Option1’ and Option 3 have larger impact than Option 2 and Option 4.(Both 8.1.4 and 8.1.7 in TS 38.214 should be updated) from both NR and LTE specification perspectiveOption 4 should be an ideal solution considering the technical perspective and spec. impact tradeoff. Alternatively, 2-1 is OK due to least spec. impact and alignment with LTE. |
| NTT DOCOMO | Option 1 is OK;option 2-3 or option 3 is conditional OK | There is no perfect solution to solve the current discussed issue.In this case, we slightly prefer option 1 so that any resource collision does not occur.We are OK with option 2-3 or option 3 as second preference if collision issue can be solved. |
| LGE | Option 1 | According to the clause 8.1.4 in TS 38.214, a UE will derive the 2nd and 3rd PSSCH resources in each reservation period from the first PSSCH resource in each reservation period by using TRIV. In this case, if Option 1 is not agreed, in this case, the resource reservation period value in the SCIs in 2nd and 3rd PSSCH resource would be no longer P since the TRIV will be interpreted as the slot offset in t’ domain. In other words, the TX UE may need to use different value of resource reservation period for 2nd and 3rd PSSCH to ensure the same resources are reserved that can be derived by the SCI in the 1st PSSCH resource. Meanwhile, it would not be ensured that these period values are supported in the resource pool.  |
| Huawei, HiSilicon | Option 1’ | For Option 1 and Option 1’, *P’* is counted in , i.e., slots belonging to the sidelink resource pool. So in Option 1 and Option 1’, the whole procedure of determining the sidelink resource pool in Clause 8 in TS 38.214 is considered, including considering slots which are not semi-statically configured as UL by the UL-DL configuration, S-SSB slots, reserved slots, and the unavailable slots determined by bitmap. Since the periods of S-SSB slots/ reserved slots/ unavailable slots as determined by bitmap may not be multiple of 20 ms, the number of slots belonging to a sidelink resource pool in different 20 ms window may be different. Thus, Option 1 does not work since different UEs may consider different 20 ms windows, resulting in misalignment among UEs.According to Option 1’, 20 ms in the existing formula of Clause 8.1.7 in TS 38.214 can be changed to 10240 ms, so that there is no misalignment among UEs. And Option 1’ further considers changing N to represent the number of slots belonging to the resource pool to be more accurate since *P’* is counted in . In general, Option 1’ works well and is proposed to be supported. The following TP is proposed for Option 1’**<Unchanged parts omitted>**8.1.7 UE procedure for determining the number of logical slots for a reservation period A given resource reservation period in milliseconds is converted to a period in logical slots as:where N is the number of slots belonging to the resource pool within 10240 msec according to Clause 8.**<Unchanged parts omitted>**Since the bitmap is not considered in Option 2 and Option 4, it is possible that may not belong to the sidelink resource pool.Option 2-3 proposes the next slot after slot  belonging to the sidelink resource pool should be used. This works as a technical solution, and writing the specification is straightforward.Option 2-2 and Option 4 add a limitation that “UE expects belong to the set of slots assigned to the resource pool”. However, considering PSSCH/PSCCH transmission can happen at any logical slot, i.e., can be any logical slot, it may impose too strict or even impractical limitations on configurations. |
| Samsung | Option 1’ | In RAN1#103-e, it was already agreed that the TRIV (Time Resource Assignment) is counted within the logical slots of a sidelink resource pool i.e.. Furthermore, it was agreed that sensing is also performed over the logical slots of a sidelink resource pool. The remaining point is how to interrupt the “resource reservation period”. The resource reservation period is in units of ms, so it should to be converted to a unit that can be used to determine the next periodic resource. It would seem natural as an extension of the agreements from the last meeting to convert into a unit of logical slots within a resource pool and count over the logical slots of a resource pool. The following reasons support this proposal:* 1. By counting over logical slots of a resource pool it is guaranteed that the slot of the next period calculated as the index of the current slot + period in logical slots is in the resource pool. This addresses the issues caused by the other options that can lead to the slot of the next period not being in the resource pool.
		1. Options 2-1, 2-2, and 4 either leave this up to UE implementation (not desirable for obvious reasons), or impose a very restrictive requirement that the configuration guarantees that all periodic instances of a logical slot are in the resource pool when the period is either based on slots that can be in a resource pool (option 2-2) or sidelink slots (option 4) and counting over the respective slots.
		2. Options 2-3 and 3, have the period in logical slots that ***can be*** in the resource pool or in ms, and counting over the respective slots. If the slot is not in the resource pool, the next available slot in the resource pool is used. There are two downsides to this approach:
			1. It can potentially lead to collisions between periodic transmissions. If two transmissions in the current period are in different slots, in the next period they can end up being in the same slot hence a collision.
			2. The selection of the next slot is biased towards making the period larger than what is should be otherwise. There is no mechanism to make the period over a long time converge to the mean. Hence, once in a while a packet might go un-transmitted due to lack of resources. Unlike option 1’, where the average period in logical slots is computed, if the physical time period is larger in one period, it would be smaller in the next periods to revert to the mean. In a well-designed system the variations in physical periodic time between consecutive periods should be small.
	2. A second issue as pointed out by LGE is that the reserved slots signaled by the first transmission of each period should have the same period. This can only be guaranteed if the counting is within the logic slots of the resource pool. This is another drawback of option 2-3 and option 3.

Option 1 counts over the logical slots, but uses the formula in section 8.1.7, with no change to that formula based on our understanding. In section 8.1.7, N is calculated over the SL slots that can be used for SL transmission in a 20 ms period. This would lead to a larger value of then should otherwise be used when the counting of the slots is over the logic slots of the resource pool. Therefore, the equation in section 8.1.7 should be updated such that N is the average number of logic slots that belong to a resource pool over a 20 ms period. Averaging is needed as the number of logical slots in a resource pool can, in general, vary from one 20 ms period to the next. This is the proposed equation update for section 8.1.7:where is the average number of slots that can be used for SL transmission for a SL resource pool within 20 ms of the configured UL-DL configuration. |
| Sharp | Option 2-2/2-3/4 | Option 1’ would collide with the agreement already made in RAN2 [POST111-e][705][V2X]. For Option 1, P is converted to P’ according to 8.1.7 of TS38.214 which is for SL logical slot conversion, instead of slots in a resource pool, while P’ is interpreted as slots of a resource pool, thus, it is incorrect from our perspective. Options 2-2/2-3/4 are preferred. Regarding the issue pointed out by LGE for option 2, in our understanding, Figure (b) is the case in current specs without further clarification. |
| QC | Option 3 | Option 1’ as second preference. |
| vivo | 1st preference: option2-3/option3 with clarifications2nd preference:Option4 | Option1 suffers from the most severe jitter problem, and the actual physical interval between two reservations can be much longer than the indicated resource reservation period, thus is not able to meet the latency requirement. As shown below, if the resource reservation period indicated in SCI format 1-A is 10ms and N=9, then, P’ = ceil (9/20\*10) = 5, gap between two reservations will be 5 sidelink slot in a pool which corresponds to 40ms.Moreover, to avoid such unbearable delay, modifications to 38.214 8.1.7 is needed. However, as we commented at the last meeting, RAN2 had already confirmed to reuse the existing RAN1 38.214 8.1.7 for SL CG configuration. Any changes to 8.1.7 will introduce misalignment between RAN1 and RAN2, and should be avoided.Due to the presence of S-SSB and reserved slots, option2 also has some jitter problems, but the delay incurred in option2 is much smaller than that of option1. Meanwhile, by allowing UE to select the next resource in the pool when the reserved resource is not in the corresponding resource pool, option 2-3 avoids the high restrictions to Uu while ensuring the performance compared to option 2-2. Regarding option3, we think the main bullet is a bit confusing and would like to ask for clarification* Option 3: The resource reservation period P’ is calculated following 8.1.7 of 38.214 and P’ indicates the period in terms of ms.
	+ If the physical slot after P ms is not in the resource pool, the next slot in the resource pool should be used instead.

In the sub-bullet, physical time Pms is directly used to derive the location of reservation, however, in the main bullet, P’ is calculated and used in for determining the reservation location. It seems the main bullet and sub-bullet are in contradiction with each other. In our understanding, there is no need to calculate P’ if P ms is used. We wonder if the original intention of option3 is as below. if so, then option3 has similar merits as option2* Option3. is changed to for resource reservation, where P indicates the period in terms of ms
	+ If the physical slot after P ms is not in the resource pool, the next slot in the resource pool should be used instead.

Regarding option4, in our understanding, the set of slot of resource reservation in LTE V2X is defined in option4 and it is up to eNB to ensure that the periodic reservation is in the same pool of the initial transmission. However, this option is restrictive and thus is our second preference. |
| Apple | Option 1’ | Among these options, Option 2-2 has a strong restriction on the resource pool configuration, which is not easy to achieve. Option 2-3 may lead to the resource collision issue. Although Option 1’ may lead to small jitter on the periodic transmissions, it is acceptable, comparing with other options. |
| OPPO | Option 2-3 is preferred. |  |
| CATT, GOHIGH | Any one in option 2 is preferred | For the slot index issue, it would be better that the slot index of TRIV indication, sensing and resource reservation period is aligned.If we follow the slot index with a Tx resource pool, then the prerequisite of this method is that the Tx pool configuration should be known by sensing UE, otherwise the sensing can not perform properly.After further considering the partial coverage case, there are some concerns on how the UE can know the out-of-coverage UE can know the Tx resource pool configuration of in-coverage UE. In general, if a UE is in-coverage UE, it can only follow the resource pool configuration from gNB; If a UE is an out-of-coverage UE, it can only follow the pre-configured resource pool configuration, the out-of-coverage UE has no knowledge about the resource pool configuration information provided by gNB. In order to ensure the aligned Tx pools configuration between in-coverage and out-of-coverage. The only way is that gNB can only pick one or a subset of Tx pools from pre-configured Tx pools. However, this manner will extremely restrict flexibility of network configuration, and largely impact V2X deployment in licensed spectrum. Because it would be very difficult and unrealistic for a vehicle to update the pre-configured resource pool timely.Therefore, we think logical slot index(the slot can belong to a resource pool) has less restriction of deployment of V2X in licensed spectrum. We can accept any one of option 2.  |
| Ericsson | Option 1 (Option 1’ as second preference) |  |
| Nokia, NSB | Option 1’ | This keeps the definition of logical slot consistent between TRIV and resource reservation period. As for the required update to the equation in 8.1.7, agree with Huawei,HiSi’s approach. |

**Others**

Q2: Other aspects with respect to the above issues.

|  |  |
| --- | --- |
| Company | Comment |
| LGE | If Option 1 in Q2 is not agreed, it is necessary to further clarify how a UE interprets a combination of TRIV and resource reservation period in the received SCI to determine reserved resource in the next reservation period.For instance, if Option 2-2 is agreed, and if the UE applies resource reservation first, then applies TRIV with respect to each initial transmission resource, the number of slots in t\_i between two resources across different periods will not be constant as shown in Figure-(a). On the other hand, if Option 2-2 is agreed, and if the UE applies TRIV first, then applies resource reservation for each retransmission resource, the number of slots in t\_i between two resources across different periods will be constant as shown in Figure-(b). |
| Huawei, HiSilicon | In RAN1#103-e discussion, companies took a long time to align on the understanding of each option. So we illustrate each option in the following figure for convenience. |
| vivo | Regarding comments from LG, our understanding is figure(b). But we have different understanding on this comment from LG*‘if the UE applies TRIV first, then applies resource reservation for each retransmission resource’*When RX UE receives a SCI indicating one or two additional resources in slot t, the RX UE applies the resource reservation period in the received SCI only to determine the periodic reservation corresponding to slot t, it does not apply the period to derive the reservation corresponding to the additional resources indicated by that SCI since they have not been received yet. In short, after applying TRIV of a received SCI, RX UE applies reservation **only** to the resource of the received SCI. |
| Nokia, NSB | According to our interpretation of 38.214 clause 8.1.4 step 6c, figure (a) is the currently specified behaviour, since the sensing UE assumes to receive the exact same SCI in the next period and then considers the resources determined by that assumed SCI – so apply period to SCI first, then interpret TRIV. |

**FL’s observation and proposal based on the first round:**

On the Options for resource reservation period, Option 1’ and Option 2-3 are supported by a number of companies, but no strong majority view was found.

FL propose to have one more round of company view check for the selection between Option 1’ and Option 2-3.

**Proposal:**

* For UE behaviour for the case when a UE transmits a SCI format 1-A in slot n in a resource pool and “Resource reservation period” in the SCI format 1-A indicates P, down-select one between Option 1’ and Option 2-3:
	+ Option 1: The resource reservation period P’ is calculated following 8.1.7 of 38.214, and P’ is counted in (i.e. the number of slots in the resource pool between slot n and slot n+P’ is always the same as P’ (including slot n+P’ itself)).
		- Option 1’: Option 1 + updated equation in 8.1.7 (N is the number of slots belonging to the resource pool)
* Option 2: The resource reservation period P’ is calculated following 8.1.7 of 38.214 and P’ is counted in (i.e. the number of slots in the resource pool between slot n and slot n+P’ can be less than P’).
	+ Option 2-3: Add “If slot  is not in the resource pool, the next slot in the resource pool should be used instead.”
		- FFS: Whether or how to ensure the same set of reserved resources across different reservation period derived by different SCI format 1-A for a TB.

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

On Step 6-c) of resource (re)selection procedure as described in the box, two different interpretations are observed as follows:

|  |
| --- |
| the SCI format received in slot or the same SCI format which, if and only if the '*Resource reservation period*' field is present in the received SCI format 1-A, is assumed to be received in slot(s) determines according to clause 8.1.5 the set of resource blocks and slots which overlaps with for *q*=1, 2, …, *Q* and *j=*0, 1, …, . |

* Interpretation 1: the sensing UE applies resource reservation first, then applies TRIV with respect to each initial transmission resource.
* Interpretation 2: the sensing UE applies TRIV first, then applies resource reservation for each retransmission resource.

FL thinks that the two interpretations are equivalent in Option 1 and Option 1’ but they may result in different operations in other options. FL asks companies view on the interpretation of the above part and the need of spec changes.

* Q3-1: Do you agree that the two interpretation may result in different operations in options other than Option 1 and Option 1’?
* Q3-2: If yes to Q3-1, which interpretation do you support in an event RAN1 decides to select an option other than Option 1 and Option 1’?
* Q3-3: If yes to Q3-1, do you think the current spec needs to be changed?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Q3-1 | Q3-2 | Q3-3 | Comments |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |