**3GPP TSG RAN WG1 Meeting #100bis-E R1-2003038**

**e-Meeting, April 20th – 30th, 2020**

**Source: Moderator (Intel Corporation)**

**Title: Outcome of [100b-e-NR-5G\_V2X\_NRSL-Mode-2-04]**

**Agenda item: 7.2.4.2.2**

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

Introduction

This document provides discussion on issues in the fourth email discussion on V2X Mode-2 during RAN1#100bis-e.

[100b-e-NR-5G\_V2X\_NRSL-Mode-2-04] Email discussion/approval w.r.t. periodic reservation including aspects:

* Backward signalling option
* Periods for exclusion if a slot is not monitored in a sensing window

till 4/24, with potential TPs till 4/29 (Intel, Sergey)

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| --- |
| Agreements:* Down-select in the next meeting one of the following options
	+ Option 1: There is no separate field in the first stage SCI indicating a resource index for the purpose of backward indication, i.e., backward indication is not supported
	+ Option 2: When periodic reservations are enabled in a resource pool, a separate field of 1 bit in the first stage SCI indicates a resource index for the purpose of backward indication
	+ Option 3: When periodic reservations are enabled in a resource pool, a separate field of ceil(log2(Nmax)) bit in the first stage SCI indicates a resource index for the purpose of backward indication

Agreements:* On a per resource pool basis, when reservation of a sidelink resource for an initial transmission of a TB at least by an SCI associated with a different TB is enabled:
	+ A set of possible period values additionally includes all integer values from 1 to 99 ms

**Conclusion**Evaluate till the next meeting whether given the agreed set of configurable reservation periodicities, the change to the exclusion procedure is necessary, wherein currently all configured period values are used for exclusion as inherited from LTE |

Outcome

No consensus.

Proposal 1a (1bit)

* When periodic reservations are enabled in a resource pool, and when a (pre-)configuration indicates that “resource index” signaling is enabled in a resource pool, a separate field of 1 bit in the first stage SCI indicates a “resource index” for the purpose of backward indication
	+ If resource index = 0, then
		- For Nmax = 2 or 3: t0’ = 0, t1’ = t1
		- For Nmax = 3: t2’ = t2
	+ If resource index = 1, then
		- For Nmax = 2 or 3: t0’ = -t1 , t1’ = 0
		- For Nmax = 3: t2’ = t2 - t1
	+ where t0, t1, t2 are logical slot offsets with respect to the slot where SCI 0-1 received, obtained from “Time resource assignment”, and t0’, t1’, t2’ are actual logical slot offsets with respect to the slot where SCI 0-1 received

Proposal 1b (full)

* When periodic reservations are enabled in a resource pool, and when a (pre-)configuration indicates that “resource index” signaling is enabled in a resource pool, a separate field of ceil(log2(Nmax)) bit in the first stage SCI indicates a “resource index” for the purpose of backward indication
	+ If resource index = 0, then
		- For Nmax = 2 or 3: t0’ = 0, t1’ = t1
		- For Nmax = 3: t2’ = t2
	+ If resource index = 1, then
		- For Nmax = 2 or 3: t0’ = -t1 , t1’ = 0
		- For Nmax = 3: t2’ = t2 - t1
	+ If resource index = 2, then
		- t0’ = -t2, t1’ = t1 - t2, t2’ = 0
	+ where t0, t1, t2 are logical slot offsets with respect to the slot where SCI 0-1 received, obtained from “Time resource assignment”, and t0’, t1’, t2’ are actual logical slot offsets with respect to the slot where SCI 0-1 received

 Proposal 2

* For exclusion of slots in the selection window which correspond to slots not monitored in the sensing window, a UE applies a separately (pre-)configured sub-set (including empty and full set possibilities) of periodicities and applies the period used for transmission, if any

Discussion

The first aspect relates to the discussion in the previous meeting on support of backward indication (resource index indication) similar to LTE, in case of periodic reservations. Different level of support was expressed.

* Option 1: no backward indication
	+ Companies supporting this option argue that other mechanisms are sufficient
* Option 2: 1-bit backward indication
	+ Companies supporting this option argue that it is a good compromise between no indication and full indication, i.e. in case of Nmax = 3, only one resource can be reserved in past.
* Option 3: full backward indication
	+ Companies supporting this option argue that it was present in LTE, and if NR does not support similar mechanism, the performance SPS sidelink transmission in LTE may not be achieved by NR. There are SLS evaluation results in [13] showing that backward indication provides gains in periodic traffic environment.

**Q1: Which of the following options related to backward indication is preferred? General support can be expressed, while the detailed proposal can be worked out in the second phase.**

* Option 1: There is no separate field in the first stage SCI indicating a resource index for the purpose of backward indication, i.e., backward indication is not supported
* Option 2: When periodic reservations are enabled in a resource pool, a separate field of 1 bit in the first stage SCI indicates a resource index for the purpose of backward indication
* Option 3: When periodic reservations are enabled in a resource pool, a separate field of ceil(log2(Nmax)) bit in the first stage SCI indicates a resource index for the purpose of backward indication

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| Source | Option | Comment |  |
| Ericsson | Option 2 | OK with option 3 as well but as second preference |  |
| Intel | Option 3 is preferred | OK with option 2 as a second preference |  |
| NTT DOCOMO | Option 2 or 3 | Support backward indication |  |
| Xiaomi | Option 1 | Do not see the benefit to support backward indication |  |
| TCL | Option 3 | Ok with option 2 as second preference |  |
| Qualcomm | Option 1 | Since additional retransmissions within a period are supported, it is not clear how indicating those reservations from the last periodic resource SCI would be reconciled with backward indication. |  |
| Bosch | Option 3 or 2 | Option 3 is preferred. If not agreeable, then at least option 2. |  |
| Huawei/HiSilicon | Option 3 | Sensing UE may miss SCI, Option 3 can solve this issue and makes sensing procedure more accurate.Option 3 can cover Option 1 and Option 2.Compared to Option 2, Option 3 provides full flexibility, and there is only 1 extra bit in case of Nmax = 3, so the cost is very small. |  |
| Futurewei | Option 3 | Backward indication, which is supported in LTE, should be supported for NR as well. Either option 2 or 3 would be acceptable, but given that the additional overhead of option 3 is minimal (1 bit), we prefer option 3 |  |
| ZTE, Sanechips | Option 1 | There is not enough evidence to prove that option 2/3 can have obvious performance gain, and the introduction of additional 1-2 bits for option 2/3 will lead to overhead downgrading SCI decoding performance.If the past time resources are indicated by the backward indication, the number of reservation used to indicate the future PSCCH/PSSCH will be reduced, which is bad to sensing and more prone to resource conflicts. It was argued that backwark indication can be used when the actual number of transmission of a TB is 2. However, in HARQ feedback re-transmission, the Tx UE does not know whether a re-transmission is the last one or not. |  |
| Apple | Option 1 | The backward indication may only be used in the last retransmission in a total of up to 32 transmissions, so the benefit is marginal. The increased signalling overhead of backward indication in SCI may reduce the performance gain.  |  |
| InterDigital | Option 1 | We don’t see much benefit to support backward indication |  |
| Panasonic | Option 2 | This would be good compromise between periodic operation and SCI overhead concern from aperiodic operation. |  |
| OPPO | Option 1 | Same view as Apple that useful scenario for backward indication is very limited. We don’t see much benefit to support this. |  |
| CATT | Option 3 | We share the same views as HW and FTW, and the backward indicator is very important for periodical traffic, which is similar as that in LTE V2X.Regarding option 2 and option 3, option 3 can provide full-range indication with only 1 bit overhead.  |  |
| Sharp | Option 1 | With a fixed total number of indicated resources, by indicating a past resource in an SCI, the opportunity to indicate a resource in the future is lost. As a result, (at the cost of one or even two more bits in SCI) statistically it does not allow a sensing UE to obtain more information about the set of resources reserved by an SCI (taking the periodic indication into account or not). Hence we don’t think the benefit of “backward indication” is technically justified. |  |
| LG Electronics | Option 3 | At least, we think that there should be a NR V2X mechanism to make the performance of periodic traffic similar to that of LTE V2X. Also adding 1 or 2 bits in the first stage SCI would have a marginal or no impact on the decoding performance.  |  |
| Fujitsu | Option 1 | We don’t see the needs to have this field. |  |
| Fraunhofer | Option 2 | We support backward indication |  |

Option 1: 8

Option 2: 3 + 4 (as a second preference)

Option 3: 6 + 2 (as a second preference)

There is no clear majority. One can argue that option 2 is a compromise between full backward indication and no backward indication. Furthermore, it seems a valid argument that LTE-like scenario with a few blind retransmissions will not be reproduced by NR performance. As an attempt to find a common ground between camps, the following is proposed:

* To introduce at most 1 bit (option 2)
* Even if periodic transmissions are enabled, the mechanism can be enabled/disabled by RRC (pre-)configuration

Proposal 1

* When periodic reservations are enabled in a resource pool, and when a (pre-)configuration indicates that “resource index” signaling is enabled in a resource pool, a separate field of 1 bit in the first stage SCI indicates a “resource index” for the purpose of backward indication
	+ For Nmax = 2:
		- If the separate field is set to 0, the second resource is after the first resource in time domain
		- If the separate field is set to 1, the second resource is before the first resource in time domain
	+ For Nmax = 3:
		- If the separate field is set to 0, both the second resource and the third resource are after the first resource in time domain
		- If the separate field is set to 1, the second resource is before the first resource in time domain, and the third resource is after the first resource in time domain

The second aspect relates to the conclusion in the last meeting to evaluate the case of periodic resource exclusion for the slots not monitored in the sensing window. The following points are discussed:

* Due to support of very fine granularity of period configuration, exclusion of the full set of up to 15 different periods when a UE skipped monitoring of a slot in the sensing window may lead to excessive exclusions
* At least one contribution [27] shows performance differences between cases when LTE procedure is followed or when the set of periods for exclusion is updated
* Some companies argue that exclusion by a single period used by the TX UE may also be inappropriate due to existence of aperiodic traffic. I.e., the aperiodic traffic should not be accounted in this case.
* In general, there are the following alternatives identified
	+ Keep excluding by all configured period values
	+ Exclude only using TX UE period value
	+ Do not apply this exclusion at all
	+ Separately configure a set of periods for exclusion
	+ Apply other mechanisms for reduced exclusion rate
		- Probabilistic exclusion
		- Reduced number of excluded resources
		- A subset of periods used for exclusion

**Q2: Which of the following options related to exclusion of slots corresponding to the slots not monitored in the sensing window? General support can be expressed, while the detailed proposal can be worked out in the second phase.**

* Option 1: Do not change current procedure and apply all the periods configured for a UE
* Option 2: Change current procedure
	+ Option 2a: Exclude only based on the period used by the UE selecting the resources
	+ Option 2b: Do not apply this exclusion step
	+ Option 2c: Apply a different set of periods, e.g. a reduced sub-set or a separately configured set

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| Source | Option | Comment |  |
| Ericsson |  | For periods of 16 or more slots (i.e., 32/2), we do not see the need to make any changes to the specification.  |  |
| Intel | Option 2c | In our view the universal solution is to apply a different set of periods, e.g. a reduced sub-set or a separately configured set |  |
| vivo | Option 1 | Compared with LTE, we have some more values in 0-99ms. However, only a few value in 0~99 can be beneficial, e.g., 30, 50…, considering only a few value is configured per pool, we do not think such additional value will degrade the system performance. |  |
| NTT DOCOMO | See comments | Which option is better depends on situations. For shorter periodicity, option 1 is better than option 2 as excluding only the period used by the UE is not sufficient. For longer periodicity, option 2 is ok.  |  |
| Samsung | Option 2b | For this issue, a simple solution is not to perform step 5 in NR resource (re-)selection procedure. |  |
| TCL | Option 1 | Agree with vivo. No strong opinion here.  |  |
| Qualcomm | Option 2a | Over-exclusion is exacerbated by the additional possible period values supported in NR V2X. Our evaluation results show performance gains of using Option 2a instead of Option 1.We can also be ok with Option 2b as a second preference. |  |
| Bosch | Option 2a (or 2c) | If we can guarantee that there will be only few values selected between 1-99, then keeping current specification is possible. However, Option 2a (or 2c) may be more beneficial in all cases. |  |
| Huawei/HiSilicon | Option 1 | All configured periods should be excluded as in LTE, the ratio of candidate resource set reported to higher layer can be guaranteed by the configuration of X and the increasing on RSRP threshold. The over exclusion is not a critical issue in step 5).Option 2a is not preferred since the periods indicated on the non-monitored slots would be any period allowed by the higher layer.Option 2c is also not preferred since such sub-set may cause inaccuracy and thus collision. |  |
| ZTE, Sanechips | Option 2b | For simplicity, we support Option 2b.  |  |
| Apple | Option 1 | Since up to 16 values are configured for resource reservation period, the resource exclusion based on these periodicities may not lead to severe over-exclusion problem. On the other hand, this could protect from collision to the maximum extent.  |  |
| InterDigital | Option 2a | Since we support more values in semi-persistent reservation (e.g., 0-99ms), using LTE mechanism results in too many slots being excluded. Exclude the period used by the UE for semi-persistent reservation is enough.  |  |
| Panasonic | Mix of option 2b and option 2c | For the period supported in LTE, no change from LTE.For the period introduced in NR (e.g., 0-99ms), option 2b is applied. |  |
| OPPO | Option 2c | Excessive exclusion should be avoided since NR SL supports [1:99] reservation periodicity. No exclusion (2b) or only the periodicity used (2a) may be too few. Therefore, details for Option 2c should be discussed. |  |
| CATT | Slightly prefer Option 2a | With the consideration of potential period values and larger retransmission number, the issues due to over exclusion by skipping procedure will be more serious than that in LTE V2X.From our understanding, with the re-evaluation procedure, the resource collision for different periodicity can be resolved in most of scenario.Therefore, we slightly prefer option 2a |  |
| Sharp | Option 1 | Similar reasoning as Apple. |  |
| LG Electronics | Option 1 | As other companies already commented, considering up to 16 reservation periods can be (pre)configured for a resource pool, we are not sure whether this is a really critical issue needs to be resolved in the maintenance phase. |  |
| Fujitsu | Option 1 | We don’t see the needs. |  |
| Fraunhofer | Option 1 | Due to simplicity reason at this late stage, Option 1 is preferred |  |

Option 1: 8

Option 2: 11

* 2a: 4
* 2b: 3
* 2c: 4

Again, there is no clear consensus/majority on either option. There are more views which would like to change the LTE procedure, than keep it. In general, there could be some different handling between “good” period values (which are multiple of each other or large) and “bad” period values (which lead to excessive exclusions).

As it was pointed, there could be assistance from configuration to pick the values which are OK to be excluded, and which are not. In that sense option 2c seems the safest one, since covers options 1 and 2b.

Proposal 2

* (Pre-)configure a sub-set (including empty and full set possibilities) of periodicities specifically for exclusion of slots in the selection window which correspond to slots not monitored in the sensing window

Summary of proposals on the relevant issues

Last time the backward indication issue and periods for exclusion of slots not monitored in the sensing window were discussed. The following issues are still open based on tdoc review:

1. Backward signalling option
	* Option 1: [3][5][8][9][18][20][22]
	* Option 2: [17][24]
	* Option 3: [1][7][10][13][24]
		+ Note: [13] shows results in support if it
2. Periods for exclusion if a slot is not monitored in a sensing window
	* All configured, as in LTE: [17]
	* The one used for selection: [19][27][13]
		+ Note: [27] shows results in support if it
	* No exclusion: [16]
	* Separate set / sub-set / handling
		+ [13] (separate set)
		+ [3][15][26] - (mechanisms to reduce exclusions for small periods)

References

1. [R1-2001552](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001552.zip) Remaining details of sidelink resource allocation mode 2 Huawei, HiSilicon

1. [R1-2001661](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001661.zip) Remaining issues on mode 2 resource allocation mechanism vivo

1. [R1-2001749](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001749.zip) Discussion on remaining open issue for mode 2 OPPO

1. [R1-2001793](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001793.zip) Remaining Issues on Sidelink Mode 2 Resource Allocation Panasonic Corporation

1. [R1-2001805](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001805.zip) Remaining details of Resource allocation for sidelink - Mode 2 Nokia, Nokia Shanghai Bell

1. [R1-2001877](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001877.zip) Remaining details on mode 2 resource allocation for NR V2X Fujitsu

1. [R1-2001886](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001886.zip) Discussion on resource allocation for Mode 2 LG Electronics

1. [R1-2001896](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001896.zip) Remaining issues of mode 2 operation on sidelink ZTE, Sanechips

1. [R1-2001907](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001907.zip) Sidelink mode-2 resource allocation MediaTek Inc.

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1. [R1-2001969](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001969.zip) Discussion on resource allocation for NR sidelink Mode 2 Lenovo, Motorola Mobility

1. [R1-2001978](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001978.zip) Remaining Issues in Resource Allocation for Mode 2 NR V2X Fraunhofer HHI, Fraunhofer IIS

1. [R1-2001994](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2001994.zip) Solutions to remaining opens of resource allocation mode-2 for NR V2X sidelink design Intel Corporation
2. [R1-2002041](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002041.zip) Remianing details on mode-2 resource allocation Futurewei

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1. [R1-2002234](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2002234.zip) Resource allocation Mode 2 for NR SL Ericsson

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1. [R1-2002362](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2002362.zip) Remaining issues on resource allocation Mode 2 NEC

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2. [R1-2002487](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002487.zip) Remain details on mode-2 resource allocation for NR V2X ITL

1. [R1-2002489](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2002489.zip) Remaining issue for Mode 2 resource allocation in NR V2X ASUSTeK

1. [R1-2002539](file:///C%3A%5C%5CUsers%5C%5Cwanshic%5C%5COneDrive%20-%20Qualcomm%5C%5CDocuments%5C%5CStandards%5C%5C3GPP%20Standards%5C%5CMeeting%20Documents%5C%5CTSGR1_100b%5C%5CDocs%5C%5CR1-2002539.zip) Sidelink Resource Allocation Mechanism for NR V2X Qualcomm Incorporated