[100b-e-NR-5G\_V2X\_NRSL-PHYstructure-03]

Email discussion/approval regarding signaling of resource pool

[100b-e-NR-5G\_V2X\_NRSL-PHYstructure-03] Email discussion/approval regarding signaling of resource pool
   - A. Periodicity of resource pool bitmap, length of the bitmap, excluded slots, reserved slots

till 4/24, with potential TP till 4/29 – Jeongho (SS)

This document has the following questions.

A. What is the periodicity of resource pool bitmap?

B. What is the length of the bitmap for resource pool configuration?

C. How to obtain the excluded slots?

D. Is the reserved slot needed?

# **A. What is the periodicity of resource pool bitmap?**

Based on the submitted contributions, there are the following alternatives and supporting companies.

* Alt A-1. 10240 ms, i.e., 10240×2^μ slots
	+ ~~[Huawei, HiSilicon],~~ [ZTE, Sanechips], [vivo], [OPPO], [LGE], [TCL], [CATT], [Apple], [Panasonic], [Sharp], [Qualcomm]
* Alt A-2. 20 ms
	+ [CMCC]
* Alt A-3. Depending on TDD UL/DL patterns
	+ [Spreadtrum], [NEC], [Huawei, HiSilicon]
* Alt A-4. 10240 slots
	+ [NEC]

Based on the contributions, the following proposal can be made.

*Proposal 1. For the periodicity of resource pool bitmap, 10240 ms is used.*

Please share your views if Proposal 1 is agreeable or, if not, please share your views on the reason why it is not workable.

|  |  |
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| **Company** | **Views** |
| Huawei, HiSilicon | No, and our paper does not state Alt A-1. We clarify in relation to A-3 here:* When SL is transmitted in a UL carrier, If NR sidelink is defined on a SFN period, it implies that *TDD-UL-DL-ConfigCommon* does not change or rarely changes within a SFN period, and this is not the assumption in NR Uu design. Instead, to accommodate NR Uu design rather than LTE-V design in a NR shared carrier, there should be a bitmap which applies once per period of *TDD-UL-DL-ConfigCommon* with a slot-by-slot mapping (combined periodicity is applied if pattern1 and pattern2 are both configured) to indicate which UL slots are used for SL, after exclusion of SLSS slots and slots not having at least Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols in a slot for UL.
* When SL is transmitted on ITS carrier, LTE-V solution can be reused, e.g. period can be $10240∙2^{μ}$.
 |
| LG | Yes. Considering that the periodicity of S-SSB, the periodicity of resource pool bitmap needs to be larger than at least 160ms. Otherwise, it is unclear how to apply the bitmap for the slot duration containing S-SSB slot. For instance, the periodicity of resource pool bitmap is the same as that of TDD-UL-DL-ConfigCommon, and the number of UL slots available for SL is N. Then, the bitmap length could be set to N. In this case, when the period of TDD-UL-DL-ConfigCommon includes one S-SSB slot, then the number of slots available for SL is changed into N-1. In this case, N-1 slots would be reserved slots.  |
| vivo | Yes.Based on the analysis in our paper, the periodicity of 10240ms can be applied without any reserved slots if proper lengths of bitmap are defined. Moreover, it is favorable to use the same periodicity as LTE for TDM based coexistence. |
| Ericsson | Agreeable to us. |
| Spreadtrum | We support that the bitmap is repeated within 10240ms. The bitmap is one to one mapping to the UL slots in a period of P, where P can be equal to the periodicity of the TDD UL/DL pattern. It is necessary to clarify the statement of “periodicity of resource pool bitmap” first.  |
| InterDigital | Support the proposal |
| Sharp | We support the proposal. |
| OPPO | Agree.In LTE V2X, the periodicity is one SFN cycle, i.e. 10240 subframes, within this range excluded subframes and reserved subframes are determined. We did not see any need to change this periodicity in NR V2X. Please note that the resource pool bitmap is applied to a slot set without DL slot, SLSS slot, slot not having at least Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols in a slot for UL, and/or reserved slots, i.e. all the slots within the set are available for SL, TDD-UL-DL-ConfigCommon periodicity is not related. |
| CMCC | No, and our paper proposes Alt A-3 as well.In contrast to LTE, NR Uu can flexibly configure the TDD-UL-DL pattern with different periodicities and number of DL/UL slots/symbols, and can even support the configuration of dual periodicity. The derivation of SL slots in NR should also consider this flexibility. Instead of reuse the 10240ms in LTE, we prefer the periodicity of resource pool bitmap should be dependent on that provided by *TDD-UL-DL-ConfigCommon.* |
| Panasonic | Yes, we are ok with the proposal although we think Alt-A-3 would be sufficient. |
| Apple | Agree the proposal.  |
| ZTE, Sanechips | Agreed. 10240ms from legacy LTE and the corresponding bitmap length [8,16,32,64] is proposed such that no reserved slots are needed.. |
| TCL | Agree. |

# **B. What is the length of the bitmap for resource pool configuration?**

Based on the submitted contributions, there are the following alternatives and supporting companies.

* Alt B-1. 8, 16, 32, 64
	+ [ZTE, Sanechips]
* Alt B-2. 16, 32, 64, 128, 256, 512
	+ [vivo]
* Alt B-3. 10, 16, 20, 30, 40 ,50, 60, 100
	+ [OPPO]
* Alt B-4. [1], 2, 3, 4,…, 160
	+ [LGE]
* Alt B-5. Different value depending on SCS
	+ [TCL], [CATT], [Apple]
* Alt B-6. 20 ms
	+ [CMCC]
* Alt B-7. Different value depending on TDD UL/DL patterns
	+ [Spreadtrum], [Panasonic](also for 160 ms), [Sharp]

The values proposed are quite diverging. Please share your views on this issue and the reason of your views on why some specific values are needed.

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| **Company** | **Views** |
| Huawei, HiSilicon | * When SL is transmitted in a UL carrier, the bitmap has the same length as the number of slots in the periodicity of *TDD-UL-DL-ConfigCommon*, excluding SLSS slots and slots not having at least Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols in a slot for UL.
* In case that SL is transmitted on ITS carrier, bitmap and its length can reuse that of LTE-V.
 |
| LG | First of all, it needs to clarify what is the reference SCS for resource pool bitmap. In other words, each bit of the bitmap is associated with which slot duration. For simplicity, it can be considered that the SCS of SL BWP is used for the reference SCS for resource pool bitmap. We think this clarification needs to be confirmed before discussing the bitmap length. In our understanding, whether S-SSB is present in a carrier is up to network choice as in LTE V2X. In other words, S-SSB slot would not always exists in a SL carrier. According to LTE V2X, the bitmap length is determined by frame structure type and TDD configuration without a consideration of SLSS slots. To be specific, the bitmap length is the number of UL subframes within 100ms. For configuration flexibility, the minimum bitmap length is set to be 10, which is used for TDD UL-DL configuration 5. In this case, the number of UL subframes within 100ms is 10. In this case, when SLSS is not configured, the bitmap can be applied to the multiple of TDD periods. Similarly, we are supportive to reuse the LTE principle. In NR, the TDD pattern will be repeated at least every 20ms. Considering SCS of 120kHz, there are 160 slots within 20ms. Considering TDD UL-DL-ConfigCommon, the slot available sidelink would have granularity of 1 slot. In that point of view, the possible bitmap length would be 1, 2, …, 160. Considering configuration flexibility, the minimum length of the bitmap could be large (e.g. 8 or 16).  |
| vivo | The set of unavailable slots such as S-SSB slots, DL slots or slots without sufficient UL symbols should be excluded before bitmap mapping. In NR Uu, the configuration of TDD-UL-DL-ConfigCommon is quite flexible, while the number of S-SSB within a period of 160 ms ranges from 1 to 64, thus allowing an arbitrary number of remaining slots after the exclusion of the unavailable slots. As the periodicity of TDD pattern divides 20ms evenly, the number of DL slots and slots without sufficient UL symbols in each 20ms remains the same. Assuming that:* Number of DL slot and slot without sufficient UL symbols in 20ms: M
* Number of S-SSB in sync resource1 in a S-SSB period: L1
* Number of S-SSB in sync resource2 in a S-SSB period: L2
* SCS: 15\*2μ kHz

Then, within a wrap-around period of 1024 frame:* Number of DL slot in 20ms: M\*(10240/20) = M\*512
* Number of S-SSB in sync resource1: L1\*(10240/160) = L1\*64
* Number of S-SSB in sync resource2: L2\*(10240/160) = L2\*64

Thus, the number of available slots for sidelink resource pool within 1024 frames is 10240\*2μ-(L1+L2)\*64-M\*512=64\*(160\*2μ-(L1+L2)-M\*8). It is obvious that the number of available resources is always divisible by 64 and can also be divided evenly by factor of 64, such as {32,16,8,4,2,1}.In this case, a resource pool bitmap with size ={64, 32, 16, 8, 4, 2, 1} can be repeated several times with the same content within a wrap-around period of SFN or DFN without any remainder – As a result, there is no need to define reserved slots as LTE, which is desirable to avoid waste of spectrum resource. |
| Ericsson | Alt B-3. We do not see the need to tie the bitmap length with SCS. |
| Spreadtrum | We prefer Alt B-7 (Different value depending on TDD UL/DL patterns). Other values are also acceptable to us.***Proposal 1: The bitmap length L\_bitmap is equal to N\_ul + N\_flx in a period of P,*** ***where**** ***The candidate values of period P are 100ms, 160ms, 20ms, the periodicity of TDD UL/DL pattern if only one pattern is configured, the combined periodicity if two patterns are configured.***
* ***The period P can be (pre-) configured or specified in the specification.***
* ***N\_ul is the number of UL slots in the period.***
* ***N\_flx is the number of flexible slots in the period satisfying condition that “the Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols are semi-statically configued as UL”.***

***Proposal 2: S-SSB slots are excluded after applying bitmap.*** On the other hand, the reference SCS for resource pool bitmap can be the same as the ref SCS of the TDD-UL-DL-ConfigCommon. |
| Sharp | In LTE V2X, the bitmap length = (number of UL subframes per frame) \* 10. In our view the same principle (but not the values) should be reused in NR V2X. Setting the bitmap length to be an integer multiple of the UL subframes/slots makes it easier to configure the bitmap (i.e. setting some bits to “1” and others to “0”). The configuration is basically a matter of splitting the available UL subframes/slots between Uu and SL, or between different SL resource pools, i.e. it is a matter of deciding a “pattern” which is repeatedly applied in the frame structure. It would be much more natural to decide the pattern if it is within one (or a few consecutive) TDD UL-DL patterns. |
| OPPO | We prefer to reuse LTE V2X bitmap length, i.e. Alt B-3.Same as LTE V2X, reservation period values 100:100:1000ms are also supported in NR V2X, hence NR V2X should support at least one bitmap length that can divide 100, such that if subframe n belongs to the resource pool, then the subframe after the corresponding reservation period also belongs to the resource pool. This is an important mechanism to avoid the interruption of periodic reservation chain. |
| CMCC | Alt B-7. As we commented for Question A, considering the configuration flexibility of the NR TDD patterns, the L\_bitmap is derived from the periodicity, i.e., L\_bitmap is the number of UL slots after excluding the S-SSB slots and slots not having at least Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols in a slot for UL. |
| Panasonic | If Alt A-3. TDD UL/DL patterns is taken, the length of bit map should be Alt B-7. Different value depending on TDD UL/DL patterns. If Alt A-1. 10240 ms is taken, the length of bit map should be Alt B-3. 10, 16, 20, 30, 40 ,50, 60, 100. |
| Apple | The largest periodicity of NR TDD UL-DL configuration is 20 ms. From the common multiple of all possible combination of periodicity, we prefer $L\_{bitmap}=20⋅2^{μ}$, where $μ$ is the sidelink SCS. Though we prefer Alt B-5, we are also fine with Alt B-7.  |
| ZTE, Sanechips | Alt B-1. For NR sidelink, as flexible D/F/U slot allocation is indicated in TDD-UL-DL-ConfigCommon, it is hard to reuse the legacy rule as shown in table 1 to set a few values as the length of bitmap given diverse available slots for NR SL. Table 1 Resource allocation bitmap length in LTE TDD system

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| TDD UL/DL configuration  | #0 | #1 | #2 | #3 | #4 | #5 | #6 |
| Number of UL subframes in a frame | 6 | 4 | 2 | 3 | 2 | 1 | 5 |
| Bitmap length | 60 | 40 | 20 | 30 | 20 | 10 | 50 |

Furthermore, even with a certain D/F/U slot allocation, the potential maximum length of bitmap should at least align with the number of available slots within a D/F/U slot allocation period which may need hundreds of bits. The bitmap length set in Alt B-1 is proposed such that no reserved slots are introduced to ensure the SL slots in the periodicity in proposal 1 is an integer multiple of the bitmap length, indicating the bitmap to SL slot association pattern repeats itself within the period. The rationale behind is elaborated in R1-2001577 and copied below, As SLSS period is 160 ms and the D/F/U slot allocation period is a factor of 20 ms,the reserved slot determination formula can be deformed as:where is the number of SLSS slot within a period = 160 ms, is the number of non-SL slot in 160 ms which can be determined according to D/F/U slot allocation.Based on the above formula derivation, we can obtain a simple rule to define the bitmap length for NR sidelink resource pool allocation. By setting the as a factor of 64, e.g., [64,32,16,8], the bitmap length can be (pre-)configured per resource pool with sufficient flexibility to indicate SL slot allocation. Besides, for an arbitrary D/F/Uslot allocation, the number of reserved slots is zero and thus more available slots canbe used for sidelink.  |
| TCL | Alt B-5, with Alt B-3 as a baseline. Also depends on outcome of A. |

# **C. How to obtain the excluded slots?**

Based on the submitted contributions, there are the following alternatives and supporting companies.

For “slots not having at least Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols in a slot semi-statically for UL as indicated in TDD-UL-DL-ConfigCommon ”,

* Alt C-1. Replace TDD-UL-DL-ConfigCommon by SL-TDD-Config in PSBCH
	+ [vivo]
* Alt C-2. Confirm WA
	+ [OPPO], [Nokia, NSB], [Panasonic]
* Alt C-3. Use TDD-UL-DL-ConfigCommon or PSBCH
	+ [CMCC]
* Alt C-4. Use different configurations according to in-coverage or out-of-coverage
	+ [LGE]

Please share your views on this issue and the reason of your views with necessity of each alternative.

|  |  |
| --- | --- |
| **Company** | **Views** |
| Huawei, HiSilicon |  Confirm the WA (as indicated in our paper) |
| LG | We are supportive of C-1 and modification of WA for the purpose of enabling the same understanding on the set of UL slots available for SL between in-coverage UE and out-of-coverage for partial coverage scenario. Due to the signaling overhead of PSBCH, TDD pattern indicated by PSBCH is not always the same as TDD pattern provided by TDD-UL-DL-ConfigCommon. For instance, when two pattern is used with periodicity of 10ms, even though the reference SCS of TDD-UL-DL-ConfigCommon is 60kHz, the reference SCS of TDD pattern in PSBCH could be 15kHz. In this case, four slots of TDD-UL-DL configuration will be overlapped with a slot of TDD pattern in PSBCH. In this case, when last two slots of TDD-UL-DL-ConfigCommon overlapping with a slot of TDD pattern in PSBCH are available for SL, these four slots of TDD-UL-DL-ConfigCommon needs to be excluded slots as shown in following Figure. Another simple approach is that the in-coverage UE is configured with TDD-Config which can be used for PSBCH contents.  |
| vivo | Clearly Alt C-2 is not workable in out-of-coverage case. For the issue pointed out by LG that the TDD patterns may be different between the TDD-UL-DL-ConfigCommon and SL-TDD-Config in PSBCH, our assumption is that the SL-TDD-Config is directly provided by network, so the network can ensure the alignment between them. If I understand correctly, this is same as the “simple approach” mentioned by LG.  |
| Ericsson | Alt C-2. Confirm the WA |
| Spreadtrum | Alt C-2.  |
| InterDigital | Confirm the WA |
| Sharp | We think LG and vivo have a point there which should be seriously considered. Fine to confirm the WA if the question on partial coverage scenario can be answered (i.e. for an out-of-coverage UE “A” using another SyncRef UE as sync source, does UE “A” always use the pre-configured TDD-UL-DL-ConfigCommon and ignore the sl-TDD-Config which UE “A” reads from MIS-SL? If so what is the point of indicating sl-TDD-Config in MIB-SL?) |
| OPPO | We suggest to confirm the WA, network configuration can ensure the alignment between in coverage and out of coverage. |
| CMCC | We believe that directly confirm the WA may cause issues in partial coverage cases as mentioned by LG.In our understanding, when a UE is triggered by sidelink communications, it should transmit S-SSB so that the Tx/Rx sides are able to get synchronized for the communication. Meanwhile, in the content of the MIB message, the UE would set the inCoverage filed to TRUE or FALSE according to the synchronization source. Therefore, the Tx/Rx UEs should have the knowledge of the coverage type (an in-coverage or out-of-coverage UE) of each other. Then, for the partial coverage scenario, the in-coverage UE which knows the TDD indication carried by the PSBCH, can derive the SL slots that have the same understanding of the out-of-coverage UE; otherwise, the SL slots are derived from UL slots indicated by TDD-UL-DL-ConfigCommon. |
| Panasonic | By taking into account the broadcasted PSBCH contents for the network deployment, this can be resolved. Therefore, we think WA can be confirmed without additional enhancement i.e. Alt C-2. |
| ZTE, Sanechips | Our understanding is that the listed solution C-1and C-2 addressed two issues that are closely related.C-1 is to ensure the interpretation of SL slots is aligned between InC and OoC UE and we support this solution. With C1, we feel the working assumption reflecting the same principle should be revised into " slots not having at least Y-th, (Y+1)-th, ....., (Y+X-1)-th symbols in a slot semi-statically for UL should not be included in the slots indicated by SL-TDD-Config in PSBCH ” to which we agree |
| TCL | Confirm WA, i.e. Alt C-2  |

# **D. Is the reserved slot needed?**

Based on the submitted contributions, there are the following alternatives and supporting companies.

* Alt A-1. No need to define.
	+ [ZTE, Sanechips], [vivo]
* Alt A-2. Use reserved slot similarly as defined LTE-V2X procedure.

Please share your views on this issue and the reason of your views with necessity of each alternative.

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| **Company** | **Views** |
| Huawei, HiSilicon | * In case that SL is transmitted in a UL carrier, it is not needed, since a slot-by-slot bitmap with the *TDD-UL-DL-ConfigCommon* period can provide directly the UL-to-SL mapping.
* In case that SL is transmitted on ITS carrier, reserved slots are defined same way as LTE-V.
 |
| LG | We are supportive of A-2. Considering configuration flexibility compared with LTE V2X, we think that large bitmap length (e.g. 100) is needed. In this case, it is up to network implementation whether or not to allow the existence of reserved slots.  |
| vivo | We support Alt A-1. As analyzed in question B): It is obvious that the number of available resources is always divisible by 64 and can also be divided evenly by factor of 64, such as {32,16,8,4,2,1}.In this case, a resource pool bitmap with size ={64, 32, 16, 8, 4, 2, 1} can be repeated several times with the same content within a wrap-around period of SFN or DFN without any remainder – As a result, there is no need to define reserved slots as LTE, which is desirable to avoid waste of spectrum resource. |
| Ericsson | We are supportive of Alt A-2.  |
| Spreadtrum | If S-SSB slots are excluded after applying bitmap, no need to define reserved slots. Otherwise, We are supportive of Alt A-2. |
| InterDigital | Alt A-2 |
| Sharp | Alt A-2. |
| OPPO | For a resource pool where reservation of a sidelink resource for an initial transmission of a TB by an SCI associated with a different TB is enabled, reserved slots should be precluded as LTE V2X, otherwise, there is no need to preclude reserved slots. |
| CMCC | Note that the periodicity of S-SSB is 160ms, in case that the periodicity is fixed into the periodicity provided by the *TDD-UL-DL-ConfigCommon* and from which the L\_bitmap is derived, for those periodicities containing S-SSB slots, the reserved slots cannot be avoided. We don’t agree with HW that no reserved slots are needed in such cases. However, in order to reduce the number of reserved slots to improve utilization efficiency of SL resources, we are also open to solutions that no reserved slots are needed, see the one mentioned by Spreadtrum. |
| ZTE, Sanechips | Reserved slots are not needed with the periodicity in proposal 1 and bitmap length Alt B-1 under discussion point B |
| TCL | Support Alt A-2. |