3GPP TSG-RAN WG2 #116-bis R2-21xxxxx

Electronic meeting, 2022-01-17 - 2021-01-25

Agenda Item: 8.21.2

Source: Ericsson

Title: Post116-e][087][TEI17] Explicit SI start position for SI Scheduling (Ericsson)

Document for: Discussion, Decision

# 1 1 Introduction

This document is to kick off the following email discussion:

* [Post116-e][087][TEI17] Explicit SI start position for SI Scheduling (Ericsson)

Scope: Make progress, based on R2-2111248, and comments provided, e.g. in discussion R2-2111537. Include both problem aspects and solution aspects. Attempt to conclude for which scenarios in reality a solution is needed, Attempt to conclude on solution.

Intended outcome: Report (can contain TP parts for solution discussion/report)

Deadline: Dec 17

# 2 Contact Information

|  |  |
| --- | --- |
| Company | Contact: Name (E-mail) |
| vivo | yangxiaodong5g@vivo.com |
| MediaTek | Nathan Tenny ([nathan.tenny@mediatek.com](mailto:nathan.tenny@mediatek.com)) |
| Huawei, HiSilicon | Dawid Koziol ([dawid.koziol@huawei.com](mailto:dawid.koziol@huawei.com)) |
| Qualcomm Incorporated | Masato Kitazoe (mkitazoe@qti.qualcomm.com) |
| CATT | Jianxiang Li([lijianxiang@catt.cn](mailto:lijianxiang@catt.cn)) |
| SoftBank | Katsunari Uemura (katsunari.uemura@g.softbank.co.jp) |
| Intel | Sudeep.k.palat@intel.com |
| Deutsche Telekom | Efi Nikolitsa ([enikolitsa@cosmote.gr](mailto:enikolitsa@cosmote.gr)) |
| Ritesh Shreevastav | Ritesh.shreevastav@ericsson.com |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 3 References

1. R2-2111248, " On the need of providing explicit SI start position for SI Scheduling ", Ericsson, Verizon, Deutsche Telekom, Softbank, Swift Navigation, ESA, T-Mobile USA.
2. R2-2110799, “SIB and posSIB scheduling constraints”, MediaTek Inc
3. R2-2111537, “[AT116-e][049][TEI17] TEI17 NR proposals RAN2 Chair”, MediaTek Inc.

# 4 Discussions

From [1] and [2] it is clear that a large extent of the functionality is based upon broadcast support. [1] shows that there can be up to 27 SIs that NW needs to consider for SI scheduling. [2] provides the view that realistic Rel-16 deployment could be expected to require ~12 SI messages, with the occasional addition of 1-2 SI messages for PWS. However, rapporteur’s view is that it does not really matter if PWS is “occasional” or not. If PWS is valid in a NW, then there is a need to incorporate the scheduling for it at the beginning anyhow, i.e. it will require 1-2 SI messages independently if/when it occurs. So realistically it should be ~14 SI messages as conclusion for [2].

Form both paper analysis, it is clear that the situation is severe in DSS based deployment and in addition deployment where posSIBs need to be broadcast. The current NR SI scheduling is constrained to the parameters shortest SI periodicity and configured SI Window length.

Further, the discussion here should not be short sighted; i.e NR will evolve for many years to come and it is expected every release there will be addition of new SIBs. Rel-17 is proposing to add around 10 more new SIBs (non-Positioning SIBs) and around 5 to 10 new positioning SIBs. Hence, any discussion (solution) should take this into consideration. For example, for Rel.17; below table shows the feature and corresponding new SIBs that are being proposed to be added.

|  |  |
| --- | --- |
| Features | Number of New SIBs |
| MBS | 2 |
| UE Power Savings | 1 |
| NTN | 1 (at least) |
| MINT | 1 |
| NPN | 1 |
| Slicing | 1 (Tentative) |
| Sidelink | 1 |
| Positioning | 5 to 13 (NaVIC 2, Integrity 2 to 10, On-Demand PRS 1) |

## 4.1 NW Deployment where Constraints are seen

In this section, we attempt to gather input from companies (especially operators); on which sort of deployment do they see the problem:

1. In DSS deployment even without posSIBs
2. In DSS deployments with posSIBs
3. Non-DSS Deployments even without posSIBs (considering future releases will add more NR SIBs)
4. Non-DSS Deployment with posSIBs
5. All of the above
6. Any other, please mention in the comments

**Question 1: Companies are invited to provide input on which NW deployment they see the severity of the issue?**

|  |  |  |
| --- | --- | --- |
| Company | Options | Comments |
| vivo | Deployment a, b, d | For deployment c, it may be an issue, but it is not critical so far. |
| MediaTek | a/b/d + comment | We have a number of observations on when and how the problem occurs:   * Some DSS deployments may already be in trouble from Rel-16, as analysed in Ericsson’s contribution to RAN2#116-e. If DSS deployments with certain assumptions can only schedule 2-3 SIBs, it is clear that even Rel-16 features can easily exceed this limit, and such deployments will have to accept some tradeoffs (e.g. longer SI periodicities, denser MBSFN subframes). * It is theoretically possible to deploy a lot of posSIBs and cause a serious scheduling crunch. However, we think it is unlikely that any real deployment will need to broadcast assistance data for multiple versions of RTK + multiple GNSS constellations + UE-based and UE-assisted DL positioning all at once. So we agree that case d can occur even in Rel-16, but it should be an unusual situation. It seems not unreasonable to say that a deployment that wants to get really adventurous with scheduling of many posSIBs will have to accept some tradeoffs in other areas. * We do not see a serious problem for non-DSS deployments without posSIBs even in Rel-17. It is theoretically possible for a network to deploy every imaginable feature, and then it will need to make some scheduling adjustments like lengthening the minimum SI periodicity. * Deployments with posSIBs are not an all-or-nothing proposition. A network that wants to deploy a lot of positioning features may need to make prioritization decisions regarding which ones to broadcast the assistance data for, vs. expecting UEs to request assistance data via unicast. It is kind of misleading if we give the impression that posSIBs cannot be used without changing the scheduling; it would be more accurate to say that there is a ceiling on how many posSIBs can be used with a given set of deployment and scheduling constraints. |
| Huawei, HiSilicon | b) | We fully agree with the comments from Mediatek. We should not try to address some unrealistic deployments, especially with NBC changes. Furthermore, it should be noted the problem occurs mainly in DSS deployments which are supposed to be a temporary solution during a migration from LTE to NR. It is then natural that, in time, there will be less and less resources allocated to LTE and more and more resources allocated to NR and the severity of the problem will decrease. |
| Apple | b) | We agree with Huawei |
| CATT |  | From posSIB deployment perspective, agree with MTK, it is unlikely that any real deployment will need to broadcast assistance data for multiple versions of RTK + multiple GNSS constellations + UE-based and UE-assisted DL positioning all at once.  So far we didn’t observe the real deployment issues of case d).  As for case a) and b), agree with Huawei that the problem occurs mainly in DSS deployments which are supposed to be a temporary solution during a migration from LTE to NR. It is then natural that, in time, there will be less and less resources allocated to LTE and more and more resources allocated to NR and the severity of the problem will decrease.  At least for now, we don’t see a problem in realistic deployments. But we are open to review it if there is an issue of deployment in the future. |
| SoftBank | a/b/d, possibly c) | We acknowledge the issue mainly happens in DSS deployments. However, as LTE will be used for a long time, DSS is already not a temporary solution. We should consider DSS as a long-term solution now. That is a reason that DSS enhancements is approved with a lot of supporters even in Rel-18, so it will be reasonable and helpful to address this issue before Rel-17 finalizing.  We agree it would be no problem in case of non-DSS deployments without posSIBs for now, but it would be good to resolve root cause for the future. |
| Intel | b) | We are also not sure about the severity of the issue beyond the worst case combination. |
| Deutsche Telekom | a, b, d | We are especially concerned that we are quite restricted in DSS deployments when posSIBs are required. Obviously, operators want to introduce enhanced positioning in the entire network and not limited to certain regions where there is no DSS deployment.  In addition, we believe that the problem faced by DSS deployments will exist until the migration phase to SA is completed. The duration of this phase, obviously, depends on each operator’s strategy and plans (rollout, refarming/migration plans to SA). However, it should be noted that, for some frequency bands, it is more attractive to keep DSS even for a longer period, while the missing Option 4 support in some scenarios urges operators to adopt a less aggressive strategy.  So, we think a solution is needed to address this problem. |
| Ericsson | e | We need to be also forward looking i.e the outlook suggests the number of SIs needed will increase as the trend is so in Rel-17.  In addition we think that deployments using DSS are not only a temporary solution, but may be valid for a long time. Hence, it is important to limit the number of tradeoffs (as mentioned by MediaTek) required to support DSS together with other features |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## 

## 4.2 How to solve the problem

In RRC specification, positioning SIBs are inserted in positioning Scheduling list for scheduling which is different than the NR scheduling list. It is possible to partially limit the problem by only considering the SI scheduling for positioning SIBs; i.e only SIs that would be scheduled via positioning scheduling list from Rel-16. Further, it is possible to partially limit the problem by only considering NR SIBs (any new NR SIBs from Rel-17). It is further possible to solve the SI scheduling problem for both NR Rel-17 SIBs and NR Rel-16 posSIBs using a common scheduling list.

Note: Here it is assumed that, there will be no impact for NR Rel-15 and NR Rel-16 SIBs apart from positioning SIBs which were introduced in Rel-16.

There is possibility to provide solution to:

1. only provide solution to limit the problem for posSI scheduling from Rel-16 (Motivation ([6.1](#_6.1_Motivation)) including brief description of solution ([6.2](#_6.2_Brief_Description)) and (Text Proposal) ([6.3](#_6.3_Solution)): [Annex A](#_6_Annex_A) Offset based)
2. combined solution for positioning SIBs from Rel-16 and NR SIBs from Rel-17 (Motivation ([7.1](#_7.1_Motivation)) including brief description of solution ([7.2](#_7.2_Solution)) and Text Proposal ([7.3](#_7.3_Solution)): [Annex B](#_7.2_Solution_1) Explicit Indication)
3. both a and b; where for b the SIBs considered are from Rel-17; i.e combined Solution for NR Rel-17 SIBs and positioning SIBs from Rel-17
4. only provide solution to limit the problem for posSI scheduling from Rel-16 with maging sentence so that the existing offsetToSI-Used is simply applied based on the shortest configured SI periodicity, rather than on the fixed value of 80 ms. This solution is simplified version of solution a) with minimum spec change
5. only provide solution to limit the problem considering new SIBs added from Rel-17 as solution provided in [Annex B](#_7.2_Solution_1) but without Rel-16 posSIBs.
6. solution (Motivation ([8.1](#_7.1_Motivation)) including brief description of solution ([8.2](#_7.2_Solution)) and Text Proposal ([8.3](#_7.3_Solution)): [Annex C](#_7.2_Solution_1) Null entry), further considering which SIBs can be applied for the new scheme, there are two branches:

f1): only provide solution to limit the problem considering new SIBs added from Rel-17

f2): combined solution for positioning SIBs from Rel-16 and NR SIBs from Rel-17

**Question 2: Companies are invited to provide input on which option is preferred.**

**Note: The final outcome of the selected solution would be dependent upon 4.1**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments |
| vivo | Solution f1 | Actually, there are two questions involved in this section. One question is whether to consider Rel-16 SIBs, or only consider new-added SIBs from Rel-17. The other is which solution is acceptable. Unfortunately, the two questions are mixed into one question. For the former question, similar to Huawei’s opinion, we think that backward compatibility issue raises if we consider Rel-16 SIBs. For the later question, we present a null-entry based solution for consideration.  Null entry based solution is further evolution of the existing scheme. It allows NW to avoid collision via null entry. Introduce new scheduling list for new SIBs. Each entry of the scheduling list can be a choice structure: one corresponds to null (actually placeholder) and the other corresponds to one SI message, e.g.,  schedulingInfoList2-r17 SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo2-r17 OPTIONAL -– Need R  SchedulingInfo2-r17 ::= CHOICE {  null NULL,  schedulingInfo-r17 SchedulingInfo  }  The new scheduling list is appended to *schedulingInfoList* to get the concatenated list. Based on existing scheme (i.e., SI-window is determined by the order of entry in the concatenated list of SI messages), when there is collision for one entry, the position of the entry can be set to null to avoid collision.  It has the following advantages:   * It can utilize the most rooms for SI scheduling than other solutions. * It is common solution, i.e., can be for both of positioning SI messages and traditional SI messages. * It does not break the existing scheme (i.e., SI-window is determined by the order of entry in the list of SI messages), but just further evolution. * There is less specification impact, e.g., using the existing scheme to determine the SI-window, not introducing new field (e.g., *si-WindowStart*) so that existing IE *SchedulingInfo* can be reused. * Less signalling overhead compared with explicit indication based solution since SI-message-specific *si-WindowStart* consumes more overhead. |
| MediaTek | Solution d first | Solution d is low-hanging fruit. The offset should originally have been tied to the minimum SI periodicity instead of a hardcoded 80 ms, and it’s clear how this can be corrected for Rel-17:   * Correct the text in section 5.2.2.3.2 as follows:   2> else if the concerned SI message is configured by the *posSchedulingInfoList* and *offsetToSI-Used* is configured:  3> determine the number *m* which corresponds to the number of SI messages with an associated *si-Periodicity* equal to the minimum *si-Periodicity* configured by *schedulingInfoList* in *SIB1*;  3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *posSchedulingInfoList* in *SIB1*;  3> determine the integer value *x* = *m* *× w +* (*n* – 1*)* *× w*, where *w* is the *si-WindowLength;*  3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N) +M, where *T* is the *posSI-Periodicity* of the concerned SI message, N is the number of slots in a radio frame as specified in TS 38.213 [13], and M is the minimum configured *posSI-Periodicity* in radio frames;   * Update the following field descriptions under PosSI-SchedulingInfo:  |  | | --- | | ***posSI-Periodicity***  Periodicity of the SI-message in radio frames, such that rf8 denotes 8 radio frames, rf16 denotes 16 radio frames, and so on. If the *offsetToSI-Used* is configured, the *posSI-Periodicity* must be greater than the minimum configured *SI-periodicity* for any SI message. | | ***offsetToSI-Used***  This field, if present indicates that all the SI messages in *posSchedulingInfoList* are scheduled with an offset of M radio frames compared to SI messages in *schedulingInfoList*, where M is the minimum configured *SI-periodicity* for any SI message. If SI offset is used, this field is present in each of the SI messages in the *posSchedulingInfoList*. |   We consider that this change could be made with the magic sentence. The potential compatibility issue is when a non-updated Rel-16 UE faces an updated network: The UE may receive the offsetToSI-Used when the posSI-Periodicity is not equal to rf8. The UE will then be unable to locate the advertised posSIBs, because it will either disregard the offset as a network error or follow the procedural text and look for the posSI window in the wrong place, and it will need to rely on unicast LPP to request the posSIBs. This is a graceful failure that does not cause a compatibility issue, and it is also the same thing that a Rel-16 UE would need to do if the posSIBs were transplanted to a new Rel-17 scheduling list. So we consider that solution d is in a sense a superior version of solution a, with the significant advantage that Rel-16 UEs can benefit from it.  If companies have a strong feeling that there is a residual problem after the posSIBs are dealt with, we could consider a further solution for Rel-17 (non-pos)SIBs. However, we already have three different SI scheduling lists, and there should be a good justification for adding a fourth. Ericsson’s original proposal took it as granted that many deployments *must* have an 80-ms minimum SI periodicity and a 10-ms SI window; we would like to look at this assumption and understand if operators intend to deploy many Rel-17 features with broadcast support in systems that have this particular set of hard constraints. |
| Huawei, HiSilicon | Solution e) limited to posSIBs introduced in Rel-17 | We cannot accept any solution which requires NBC changes to Rel-16 UE behaviour to optimize performance in some selected types of network deployments, especially that there are means for such networks to address the issue already. If scheduling capacity is too low for some special network deployments in Rel-16 to accommodate all the required posSIBs, then there are at least two ways for the network to deal with this:   1. Providing some of the positioning information via unicast. 2. Increase the scheduling capacity, e.g. by increasing the number of MBSFN frames in DSS deployment.   In order not to aggravate the issue in Rel-17, we can have a solution for new posSIBs introduced in Rel-17. As mentioned by MTK, we would need to understand better whether the issue can really happen for normal SIBs in real network deployments. At least, from our side we have not seen SI scheduling as an issue thus far. |
| Apple | Solution d or e, but only limited to Rel-17 posSIBs | Even if offsetToSI-Used is set to true in SIB1, when thet minimum SI periodicity is not 80ms, the posSIBs will still not be scheduled using offset. This is the default R16 behavior and cannot be modified. The solution shall aim to mitigate worsening of the problem by scheduling more posSIBs in this way. So, we think the soluton d is in the right direction, but the NBC change cannot be applied to legacy R16 UEs. In other words, if a gNB is unsure whether there is a Rel-16 UE in its cell coverage, then it cannot use the new R17 mechanism for posSI which includes Rel-16 posSIBs. The new change needs to be limited to only new posSIBs added in Rel-17. |
| Qualcomm Incorporated | See comment. | Our high-level view is the following.   * No change to the scheduling of pre-R17 non-Pos SIBs. * Can accept changes to the R16 Pos-SIB scheduling. * Avoid multiple scheduling mechanisms for the same SIB type.   The above leaves us the following options.   * Solution a), where the existing PosSI scheduling mechanism is removed. * Solution c), where the existing PosSI scheduling is mechanism removed. * Solution d) * Solution e) * Solution d) + e) |
| CATT | Solution d or e, but only limited to Rel-17 posSIBs | We are doubt if it is a problem in realistic deployments. Hence, NBC change should be avoided. But if majority companies think it is a serious issue in a future deployment scenario, we are ok with solution d or e but only limited to Rel-17 posSIBs considering the number of required SIs for posSIBs may be not small. |
| SoftBank | c), e) | OK to start from Rel-17 (pos)SIBs if majority companies have concerns to change Rel-16 behaviors. |
| Intel | d or e | These are simplest solutions and should be sufficient to address the issue in the intermediate term (until DSS becomes less used).  From the comments from other companies, if NBC is really important, we can go for e. Otherwise d should be considered. |
| Ericsson | Solution d + e | The source of the problem is in Rel-16 posSIBs with so many posSIBs that have been added. A solution exists in Rel-16 but it is limited to 80ms shortest SI periodicity only. As indicated by MTK; the solution d is more a correction and we are fine with the solution proposed by MTK to solve it only in Rel-17 (i.e change done only in Rel-17 specification) and early implementation allowed.  However, this will not solve the problem as it is limited to only positioning SIBs those were introduced in Rel-16.  For Rel-17 SIBs; we need to have a solution. We can solve it with e.  Solution f can also solve but the solution is in essence same as solution e. Both provides the option to create (virtual) long list and place the SI the list.  However, Solution f will have higher signaling cost as compared to explicit indication. Assuming 20 SIs that needs to be scheduled. As per solution f, if we would like to place one of the SIs at a SI windows start position 120; the number of nulls required that would be inserted are 100; and hence it would cost 200 bits as each null occurrence indication will occupy 2-bits. For explicit indication; the total cost would be 140 bits (number of SI X 7bits).  Pls note that the advantage the solution e has is to give flexibility to NW to exploit regions which are not crowded with SI occurrence as indicated in R2-2111248. There are some empty/unused regions where one can place SIs (especially some of the SIBs/posSIBs which does not need to be repeated that often e.g. 256/512ms periodicity. The intention is thus to also address an uneven distribution of the load imposed by SI broadcast as analyzed in R2-2111248.  Having said that solution f is also acceptable to us, if majority goes with this. |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## 4.3 80ms Offset

One question that RAN2 should answer is whether it is ok to remove (dummy) the 80ms offset based solution if one of the above solutions (a or b) gets agreed.

**Question 3: Companies are invited to provide input on whether the 80ms offset can be removed; if the solution a or b gets agreed.**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments |
| vivo |  | The offset was introduced from Release-16. Considering backward compatibility, the offset (i.e., *offsetToSI-Used-r16* field) can not be removed from the ASN.1. However, the operators can choose to use either the 80ms offset scheme or new solution if new solution is agreed. |
| MediaTek | No | As described above, we think the existing offset can be used to solve the problem. Even if we do something else besides solution d, however, we should keep the Rel-16 offset, so that deployments that intend to cater to Rel-16 UEs with posSIBs can schedule the posSIBs separately from the other SIBs. There is no benefit to dummifying the field. |
| Huawei, HiSilicon | No | We cannot accept NBC changes for Rel-16 in order to optimize performance in some selected network deployments. |
| Apple | NO | We share the concerns of other companies that the NBC change will not work for legacy UEs in need of acquiring posSIB(s). |
| Qualcomm Incorporated | Yes | We do not observe this will cause backward compatibility problems in practice.  But we will not push this if other companies do see problems. |
| CATT | No | We are doubt if it is a serious issue. Hence NBC change should be avoided. |
| SoftBank |  | We think it doesn’t cause any serious problem, but we accept it if majority companies have concerns to change Rel-16 behaviors. |
| Intel | No | It is not essential to dummify this field. And if d or e is agreed, this question is not relevant anyway. |
| Ericsson |  | We can go with majority but may be this can be checked again based upon what solution is agreed as mentioned by Intel. |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## 4.4 Any other comments

**Question 4: Companies are invited to provide any additional input/comments.**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments |
|  |  | According to current SI scheduling scheme, idle SI windows are always consecutive till the tail of the periodicities. Explicit indication method in annex B configures *si-WindowStart* for each SI message, which causes more signalling overhead. Whether it is necessary? |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# 5 Conclusion

Based on the discussion in the previous sections we propose the following:

# 6 Annex A

### 6.1 Motivation

Correction for Offset based solution (replacing hardcoded 80ms with configurable shortest SI periodicity) may help alleviate problem for scheduling positioning SIs in certain deployment where large SI Periodicity and large SI Window length is configured (for example in some NR deployment and DSS based deployments).

### 6.2 Brief Description of Solution

In order to be backward compatible, a new positioning scheduling list is proposed which schedules the positioning SI with an offset of shortest configured SI Periodicity.

### 6.3 Text Proposal

##### 5.2.2.3.2 Acquisition of an SI message

For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for *SIB1* where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The [x×N+K]th PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the Kth transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to CEIL(number of PDCCH monitoring occasions in SI-window/N). The actual transmitted SSBs are sequentially numbered from one in ascending order of their SSB indexes. The UE assumes that, in the SI window, PDCCH for an SI message is transmitted in at least one PDCCH monitoring occasion corresponding to each transmitted SSB and thus the selection of SSB for the reception SI messages is up to UE implementation.

When acquiring an SI message, the UE shall:

1> determine the start of the SI-window for the concerned SI message as follows:

2> if the concerned SI message is configured in the *schedulingInfoList*

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *si-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured in the *posSchedulingInfoList* and neither *offsetToSI-Used* nor *shortestOffsetToSI-Used* is configured:

3> create a concatenated list of SI messages by appending the *posSchedulingInfoList* in *posSI-SchedulingInfo* in *SIB1* to *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the concatenated list;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured by the *posSchedulingInfoList* and *offsetToSI-Used* is configured:

3> determine the number *m* which corresponds to the number of SI messages with an associated *si-Periodicity* of 8 radio frames (80 ms), configured by *schedulingInfoList* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *posSchedulingInfoList* in *SIB1*;

3> determine the integer value *x* = *m* *× w +* (*n* – 1*)* *× w*, where *w* is the *si-WindowLength*

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N) +8, where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured by the *posSchedulingInfoList2* and *shortestOffsetToSI-Used* is configured:

3> determine the number *m* which corresponds to the number of SI messages with an associated shortest *si-Periodicity* configured by *schedulingInfoList* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *posSchedulingInfoList* in *SIB1*;

3> determine the integer value *x* = *m* *× w +* (*n* – 1*)* *× w*, where *w* is the *si-WindowLength*

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N) + shortest *si-Periodicity*, where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

1> receive the PDCCH containing the scheduling RNTI, i.e. SI-RNTI in the PDCCH monitoring occasion(s) for SI message acquisition, from the start of the SI-window and continue until the end of the SI-window whose absolute length in time is given by *si-WindowLength*, or until the SI message was received;

1> if the SI message was not received by the end of the SI-window, repeat reception at the next SI-window occasion for the concerned SI message in the current modification period;

NOTE 1: The UE is only required to acquire broadcasted SI message if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located.

NOTE 2: The UE is not required to monitor PDCCH monitoring occasion(s) corresponding to each transmitted SSB in SI-window.

NOTE 3: If the concerned SI message was not received in the current modification period, handling of SI message acquisition is left to UE implementation.

NOTE 4: A UE in RRC\_CONNECTED may stop the PDCCH monitoring during the SI window for the concerned SI message when the requested SIB(s) are acquired.

NOTE 5: A UE capable of NR sidelink communication and configured by upper layers to perform NR sidelink communication on a frequency, may acquire *SIB12* from a cell other than current serving cell (for RRC\_INACTIVE or RRC\_IDLE) or current PCell (for RRC\_CONNECTED), if *SIB12* of current serving cell (for RRC\_INACTIVE or RRC\_IDLE) or current PCell (for RRC\_CONNECTED) does not provide configuration for NR sidelink communication for the frequency, and if the other cell providing configuration for NR sidelink communication for the frequency meets the S-criteria as defined in TS 38.304 [20] and TS 36.304 [27].

1> perform the actions for the acquired SI message as specified in sub-clause 5.2.2.4.

*<Unmodified sections omitted>*

*<Unmodified sections omitted>*

#### – *PosSI-SchedulingInfo*

-- ASN1START

-- TAG-POSSI-SCHEDULINGINFO-START

PosSI-SchedulingInfo-r16 ::= SEQUENCE {

posSchedulingInfoList-r16 SEQUENCE (SIZE (1..maxSI-Message)) OF PosSchedulingInfo-r16,

posSI-RequestConfig-r16 SI-RequestConfig OPTIONAL, -- Cond MSG-1

posSI-RequestConfigSUL-r16 SI-RequestConfig OPTIONAL, -- Cond SUL-MSG-1

... ,

[[

posSchedulingInfoList2-r17 SEQUENCE (SIZE (1..maxSI-Message)) OF PosSchedulingInfo2-r17 OPTIONAL -– Need R

shortestOffsetToSI-Used-r17 ENUMERATED {true} OPTIONAL, -- Need R

]]

}

PosSchedulingInfo-r16 ::= SEQUENCE {

offsetToSI-Used-r16 ENUMERATED {true} OPTIONAL, -- Need R

posSI-Periodicity-r16 ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

posSI-BroadcastStatus-r16 ENUMERATED {broadcasting, notBroadcasting},

posSIB-MappingInfo-r16 PosSIB-MappingInfo-r16,

...

}

PosSchedulingInfo2-r17 ::= SEQUENCE {

posSI-BroadcastStatus-r17 ENUMERATED {broadcasting, notBroadcasting},

posSI-Periodicity-r17 ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

posSIB-MappingInfo-r17 PosSIB-MappingInfo-r16

}

PosSIB-MappingInfo-r16 ::= SEQUENCE (SIZE (1..maxSIB)) OF PosSIB-Type-r16

PosSIB-Type-r16 ::= SEQUENCE {

encrypted-r16 ENUMERATED { true } OPTIONAL, -- Need R

gnss-id-r16 GNSS-ID-r16 OPTIONAL, -- Need R

sbas-id-r16 SBAS-ID-r16 OPTIONAL, -- Need R

posSibType-r16 ENUMERATED { posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6,

posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4,

posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10,

posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15,

posSibType2-16, posSibType2-17, posSibType2-18, posSibType2-19, posSibType2-20,

posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType4-1,

posSibType5-1,posSibType6-1, posSibType6-2, posSibType6-3,... },

areaScope-r16 ENUMERATED {true} OPTIONAL -- Need S

}

GNSS-ID-r16 ::= SEQUENCE {

gnss-id-r16 ENUMERATED{gps, sbas, qzss, galileo, glonass, bds, ...},

...

}

SBAS-ID-r16 ::= SEQUENCE {

sbas-id-r16 ENUMERATED { waas, egnos, msas, gagan, ...},

...

}

-- TAG-POSSI-SCHEDULINGINFO-STOP

-- ASN1STOP

|  |
| --- |
| *PosSI-SchedulingInfo* field descriptions |
| ***areaScope***  Indicates that a posSIB is area specific. If the field is absent, the posSIB is cell specific. |
| ***encrypted***  The presence of this field indicates that the *pos-sib-type* is encrypted as specified in TS 37.355 [49]. |
| ***gnss-id***  The presence of this field indicates that the positioning SIB type is for a specific GNSS. Indicates a specific GNSS (see also TS 37.355 [49]) |
| ***posSI-BroadcastStatus***  Indicates if the SI message is being broadcasted or not. Change of *posSI-BroadcastStat*us should not result in system information change notifications in Short Message transmitted with P-RNTI over DCI (see clause 6.5). The value of the indication is valid until the end of the BCCH modification period when set to *broadcasting*. |
| ***posSI-RequestConfig***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to notBroadcasting. |
| ***posSI-RequestConfigSUL***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to notBroadcasting. |
| ***ShortestOffsetToSI-Used***  This field, if present indicates that the SI messages in *posSchedulingInfoList* are scheduled with an offset of shortest configured *posSI-Periodicity* compared to SI messages in *schedulingInfoList*. *shortestoffsetToSI-Used* may be present only if *offsetToSI-Used* is absent. |
| ***posSIB-MappingInfo***  List of the posSIBs mapped to this *SystemInformation* message. |
| ***posSibType***  The positioning SIB type is defined in TS 37.355 [49]. |
| ***posSI-Periodicity***  Periodicity of the SI-message in radio frames, such that rf8 denotes 8 radio frames, rf16 denotes 16 radio frames, and so on. If the *offsetToSI-Used* is configured, the *posSI-Periodicity* of rf8 cannot be used. |
| ***offsetToSI-Used***  This field, if present indicates that the SI messages in *posSchedulingInfoList* are scheduled with an offset of 8 radio frames compared to SI messages in *schedulingInfoList*. *offsetToSI-Used* may be present only if the shortest configured SI message periodicity for SI messages in *schedulingInfoList* is 80ms. |
| ***sbas-id***  The presence of this field indicates that the positioning SIB type is for a specific SBAS. Indicates a specific SBAS (see also TS 37.355 [49]). |

| Conditional presence | Explanation |
| --- | --- |
| *MSG-1* | The field is optionally present, Need R, if *posSI-BroadcastStatus* is set to *notBroadcasting* for any SI-message included in *PosSchedulingInfo*. It is absent otherwise. |
| *SUL-MSG-1* | The field is optionally present, Need R, if *supplementaryUplink* is configured in *ServingCellConfigCommonSIB* and if *posSI-BroadcastStatus* is set to *notBroadcasting* for any SI-message included in *PosSchedulingInfo*. It is absent otherwise. |

# **7** Annex B

### 7.1 Motivation

Explicit Indication based solution allows NW to calculate the necessary offset (i.e avoid collision) and provide the start position of SI to UE. It can create more rooms for SI scheduling than offset based. The offset based solution is limited to positioning whereas explicit Indication can be for both.

The offset based solution can at max create room for () number of SI whereas the explicit indication based can create more room for SI scheduling than offset based solution.

### 7.2 Brief Description of Solution

In order to minimize the overhead with different scheduling lists, a common scheduling list is proposed which contains SIB types of both NR SIBs (Non-Positioning SIBs) and Positioning SIBs. NW indicates the start position of each SI. Of-course, SI is not mixed with non-positioning and positioning SIB types. They will be in separate SIs.

### 7.3 Text Proposal

##### 5.2.2.3.2 Acquisition of an SI message

For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for *SIB1* where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The [x×N+K]th PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the Kth transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to CEIL(number of PDCCH monitoring occasions in SI-window/N). The actual transmitted SSBs are sequentially numbered from one in ascending order of their SSB indexes. The UE assumes that, in the SI window, PDCCH for an SI message is transmitted in at least one PDCCH monitoring occasion corresponding to each transmitted SSB and thus the selection of SSB for the reception SI messages is up to UE implementation.

When acquiring an SI message, the UE shall:

1> determine the start of the SI-window for the concerned SI message as follows:

2> if the concerned SI message is configured in the *schedulingInfoList*

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *si-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured in the *explicitschedulingInfoList*

3> determine the integer value *x = (si-WindowStart -1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *si-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured in the *posSchedulingInfoList* and *offsetToSI-Used* is not configured:

3> create a concatenated list of SI messages by appending the *posSchedulingInfoList* in *posSI-SchedulingInfo* in *SIB1* to *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the concatenated list;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured by the *posSchedulingInfoList* and *offsetToSI-Used* is configured:

3> determine the number *m* which corresponds to the number of SI messages with an associated *si-Periodicity* of 8 radio frames (80 ms), configured by *schedulingInfoList* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *posSchedulingInfoList* in *SIB1*;

3> determine the integer value *x* = *m* *× w +* (*n* – 1*)* *× w*, where *w* is the *si-WindowLength*

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N) +8, where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];1> receive the PDCCH containing the scheduling RNTI, i.e. SI-RNTI in the PDCCH monitoring occasion(s) for SI message acquisition, from the start of the SI-window and continue until the end of the SI-window whose absolute length in time is given by *si-WindowLength*, or until the SI message was received;

1> if the SI message was not received by the end of the SI-window, repeat reception at the next SI-window occasion for the concerned SI message in the current modification period;

NOTE 1: The UE is only required to acquire broadcasted SI message if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located.

NOTE 2: The UE is not required to monitor PDCCH monitoring occasion(s) corresponding to each transmitted SSB in SI-window.

NOTE 3: If the concerned SI message was not received in the current modification period, handling of SI message acquisition is left to UE implementation.

NOTE 4: A UE in RRC\_CONNECTED may stop the PDCCH monitoring during the SI window for the concerned SI message when the requested SIB(s) are acquired.

NOTE 5: A UE capable of NR sidelink communication and configured by upper layers to perform NR sidelink communication on a frequency, may acquire *SIB12* from a cell other than current serving cell (for RRC\_INACTIVE or RRC\_IDLE) or current PCell (for RRC\_CONNECTED), if *SIB12* of current serving cell (for RRC\_INACTIVE or RRC\_IDLE) or current PCell (for RRC\_CONNECTED) does not provide configuration for NR sidelink communication for the frequency, and if the other cell providing configuration for NR sidelink communication for the frequency meets the S-criteria as defined in TS 38.304 [20] and TS 36.304 [27].

1> perform the actions for the acquired SI message as specified in sub-clause 5.2.2.4.

*<Unmodified sections omitted>*

#### – *SI-SchedulingInfo*

The IE *SI-SchedulingInfo* contains information needed for acquisition of SI messages.

*SI-SchedulingInfo* information element

-- ASN1START

-- TAG–SI-SCHEDULINGINFO-START

SI-SchedulingInfo ::= SEQUENCE {

schedulingInfoList SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo,

si-WindowLength ENUMERATED {s5, s10, s20, s40, s80, s160, s320, s640, s1280},

si-RequestConfig SI-RequestConfig OPTIONAL, -- Cond MSG-1

si-RequestConfigSUL SI-RequestConfig OPTIONAL, -- Cond SUL-MSG-1

systemInformationAreaID BIT STRING (SIZE (24)) OPTIONAL, -- Need R

..., explicitSchedulingInfoList-r17 SEQUENCE (SIZE (1..maxSI-Message)) OF ExplicitSchedulingInfo-r17 OPTIONAL -– Need R

}

SchedulingInfo ::= SEQUENCE {

si-BroadcastStatus ENUMERATED {broadcasting, notBroadcasting},

si-Periodicity ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

sib-MappingInfo SIB-Mapping

}

ExplictSchedulingInfo-r17 ::= SEQUENCE {

si-BroadcastStatus-r17 ENUMERATED {broadcasting, notBroadcasting},

si-WindowStart-r17 INTEGER (1..128),

si-Periodicity-r17 ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

si-MappingInfo-r17 SIB-Mapping-r17

}

SIB-Mapping ::= SEQUENCE (SIZE (1..maxSIB)) OF SIB-TypeInfo

SIB-Mapping-r17 ::= SEQUENCE (SIZE (1..maxSIB)) OF SIB-TypeInfo-r17

SIB-TypeInfo ::= SEQUENCE {

type ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType6, sibType7, sibType8, sibType9,

sibType10-v1610, sibType11-v1610, sibType12-v1610, sibType13-v1610, sibType14-v1610,

spare3, spare2, spare1,... },

valueTag INTEGER (0..31) OPTIONAL, -- Cond SIB-TYPE

areaScope ENUMERATED {true} OPTIONAL -- Need S

}

SIB-TypeInfo-r17 ::= SEQUENCE {

sibType-r17 CHOICE {

type1-r17 ENUMERATED {sibTypeMBS1, sibTypeMBS2, sibTypePowerSaving, sibTypeMINT,sibTypeNPN, sibTypeNTN...}

type2-r17 SEQUENCE {

posSIBType-r17 ENUMERATED {posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6,

posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4,

posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10,

posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15,

posSibType2-16, posSibType2-17, posSibType2-18, posSibType2-19, posSibType2-20,

posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType4-1,

posSibType5-1,posSibType6-1, posSibType6-2, posSibType6-3,... }

encrypted-r17 ENUMERATED { true } OPTIONAL, -- Need R

gnss-id-r17 GNSS-ID-r16 OPTIONAL, -- Need R

sbas-id-r17 SBAS-ID-r16 OPTIONAL, -- Need R

}

valueTag-r17 INTEGER (0..31) OPTIONAL, -- Cond SIB-TYPE areaScope-r17 ENUMERATED {true} OPTIONAL -- Need S

}

-- TAG-SI-SCHEDULINGINFO-STOP

-- ASN1STOP

|  |
| --- |
| *SchedulingInfo* field descriptions |
| ***areaScope***  Indicates that a SIB is area specific. If the field is absent, the SIB is cell specific. |
| ***si-BroadcastStatus***  Indicates if the SI message is being broadcasted or not. Change of *si-BroadcastStat*us should not result in system information change notifications in Short Message transmitted with P-RNTI over DCI (see clause 6.5). The value of the indication is valid until the end of the BCCH modification period when set to *broadcasting*. |
| ***si-Periodicity***  Periodicity of the SI message in radio frames. Value *rf8* corresponds to 8 radio frames, value *rf16* corresponds to 16 radio frames, and so on. |

|  |
| --- |
| *SI-RequestResources* field descriptions |
| ***ra-AssociationPeriodIndex***  Index of the association period in the si-RequestPeriod in which the UE can send the SI request for SI message(s) corresponding to this *SI-RequestResources*, using the preambles indicated by *ra-PreambleStartIndex* and rach occasions indicated by *ra-ssb-OccasionMaskIndex*. |
| ***ra-PreambleStartIndex***  If N SSBs are associated with a RACH occasion, where N > = 1, for the i-th SSB (i=0, …, N-1) the preamble with preamble index = *ra-PreambleStartIndex* + i is used for SI request; For N < 1, the preamble with preamble index = *ra-PreambleStartIndex* is used for SI request. |

|  |
| --- |
| *SI-SchedulingInfo* field descriptions |
| ***si-RequestConfig***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *si-BroadcastStatus* is set to notBroadcasting. |
| ***si-RequestConfigSUL***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *si-BroadcastStatus* is set to notBroadcasting. |
| ***si-WindowLength***  The length of the SI scheduling window. Value *s5* corresponds to 5 slots, value *s10* corresponds to 10 slots and so on. The network always configures *si-WindowLength* to be shorter than or equal to the *si-Periodicity*. |
| ***systemInformationAreaID***  Indicates the system information area that the cell belongs to, if any. Any SIB with *areaScope* within the SI is considered to belong to this *systemInformationAreaID*. The systemInformationAreaID is unique within a PLMN. |

|  |
| --- |
| *ExplicitSchedulingInfo* field descriptions |
| ***encrypted***  The presence of this field indicates that the pos-sib-type is encrypted as specified in TS 37.355 [49]. |
| ***gnss-id***  The presence of this field indicates that the positioning SIB type is for a specific GNSS. Indicates a specific GNSS (see also TS 37.355 [49]) |
| ***posSibType***  The positioning SIB type is defined in TS 37.355 [49] mapped to SI for scheduling using*explicitSchedulingInfoList*. |
| ***type1***  The SIBs mapped to SI for scheduling using*explicitSchedulingInfoList*. |
| ***sbas-id***  The presence of this field indicates that the positioning SIB type is for a specific SBAS. Indicates a specific SBAS (see also TS 37.355 [49]). |

# 8 Annex C

### 8.1 Motivation

Null entry based solution allows NW to avoid collision via null entry. It has the following advantages:

* It can utilize the most rooms for SI scheduling than other solutions.
* It is common solution, i.e., can be for both of positioning SI messages and traditional SI messages.
* It does not break the existing scheme (i.e., SI-window is determined by the order of entry in the list of SI messages), but just further evolution.
* There is less specification impact, e.g., using the existing scheme to determine the SI-window, not introducing new field (e.g., *si-WindowStart*) so that existing IE *SchedulingInfo* can be reused.
* Less signalling overhead compared with explicit indication based solution since SI-message-specific *si-WindowStart* consumes more overhead.

### 8.2 Brief Description of Solution

Null entry based solution allows NW to avoid collision via null entry. Introduce new scheduling list for new SIBs. Each entry of the scheduling list can be a choice structure: one corresponds to null (actually placeholder) and the other corresponds to one SI message. The new scheduling list is appended to *schedulingInfoList* to get the concatenated list. Based on existing scheme (i.e., SI-window is determined by the order of entry in the concatenated list of SI messages), when there is collision for one entry, the position of the entry can be set to null to avoid collision.

### 8.3 Text Proposal

##### 5.2.2.3.2 Acquisition of an SI message

For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for *SIB1* where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The [x×N+K]th PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the Kth transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to CEIL(number of PDCCH monitoring occasions in SI-window/N). The actual transmitted SSBs are sequentially numbered from one in ascending order of their SSB indexes. The UE assumes that, in the SI window, PDCCH for an SI message is transmitted in at least one PDCCH monitoring occasion corresponding to each transmitted SSB and thus the selection of SSB for the reception SI messages is up to UE implementation.

When acquiring an SI message, the UE shall:

1> determine the start of the SI-window for the concerned SI message as follows:

2> if the concerned SI message is configured in the *schedulingInfoList*

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *si-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured in the *schedulingInfoList2*:

3> if both the *posSchedulingInfoList* and *offsetToSI-Used* is configured:

4> create a concatenated list of SI messages by appending the *schedulingInfoList2* in *si-SchedulingInfo* in *SIB1* to *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

NOTE: Network ensures that the entries in the *schedulingInfoList2* are set to NULL whose SI windows collide with the ones corresponding to posSIs in the *posSchedulingInfoList*.

3> else:

4> create a concatenated list of SI messages by appending in turn the *posSchedulingInfoList* (if configured) in *posSI-SchedulingInfo* in *SIB1* and the *schedulingInfoList2* in *si-SchedulingInfo* in *SIB1* to *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the concatenated list;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured in the *posSchedulingInfoList* and *offsetToSI-Used* is not configured:

3> create a concatenated list of SI messages by appending the *posSchedulingInfoList* in *posSI-SchedulingInfo* in *SIB1* to *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the concatenated list;

3> determine the integer value *x = (n – 1) × w*, where *w* is the *si-WindowLength*;

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

2> else if the concerned SI message is configured by the *posSchedulingInfoList* and *offsetToSI-Used* is configured:

3> determine the number *m* which corresponds to the number of SI messages with an associated *si-Periodicity* of 8 radio frames (80 ms), configured by *schedulingInfoList* in *SIB1*;

3> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *posSchedulingInfoList* in *SIB1*;

3> determine the integer value *x* = *m* *× w +* (*n* – 1*)* *× w*, where *w* is the *si-WindowLength*

3> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N) +8, where *T* is the *posSI-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];1> receive the PDCCH containing the scheduling RNTI, i.e. SI-RNTI in the PDCCH monitoring occasion(s) for SI message acquisition, from the start of the SI-window and continue until the end of the SI-window whose absolute length in time is given by *si-WindowLength*, or until the SI message was received;

1> if the SI message was not received by the end of the SI-window, repeat reception at the next SI-window occasion for the concerned SI message in the current modification period;

NOTE 1: The UE is only required to acquire broadcasted SI message if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located.

NOTE 2: The UE is not required to monitor PDCCH monitoring occasion(s) corresponding to each transmitted SSB in SI-window.

NOTE 3: If the concerned SI message was not received in the current modification period, handling of SI message acquisition is left to UE implementation.

NOTE 4: A UE in RRC\_CONNECTED may stop the PDCCH monitoring during the SI window for the concerned SI message when the requested SIB(s) are acquired.

NOTE 5: A UE capable of NR sidelink communication and configured by upper layers to perform NR sidelink communication on a frequency, may acquire *SIB12* from a cell other than current serving cell (for RRC\_INACTIVE or RRC\_IDLE) or current PCell (for RRC\_CONNECTED), if *SIB12* of current serving cell (for RRC\_INACTIVE or RRC\_IDLE) or current PCell (for RRC\_CONNECTED) does not provide configuration for NR sidelink communication for the frequency, and if the other cell providing configuration for NR sidelink communication for the frequency meets the S-criteria as defined in TS 38.304 [20] and TS 36.304 [27].

1> perform the actions for the acquired SI message as specified in sub-clause 5.2.2.4.

*<Unmodified sections omitted>*

#### – *SI-SchedulingInfo*

The IE *SI-SchedulingInfo* contains information needed for acquisition of SI messages.

*SI-SchedulingInfo* information element

-- ASN1START

-- TAG–SI-SCHEDULINGINFO-START

SI-SchedulingInfo ::= SEQUENCE {

schedulingInfoList SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo,

si-WindowLength ENUMERATED {s5, s10, s20, s40, s80, s160, s320, s640, s1280},

si-RequestConfig SI-RequestConfig OPTIONAL, -- Cond MSG-1

si-RequestConfigSUL SI-RequestConfig OPTIONAL, -- Cond SUL-MSG-1

systemInformationAreaID BIT STRING (SIZE (24)) OPTIONAL, -- Need R

...,

schedulingInfoList2-r17 SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo2-r17 OPTIONAL -– Need R

}

SchedulingInfo ::= SEQUENCE {

si-BroadcastStatus ENUMERATED {broadcasting, notBroadcasting},

si-Periodicity ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

sib-MappingInfo SIB-Mapping

}

SchedulingInfo2-r17 ::= CHOICE {

null NULL,

schedulingInfo-r17 SchedulingInfo,

posSchedulingInfo-r17 PosSchedulingInfo-r16,

spare NULL

}

SIB-Mapping ::= SEQUENCE (SIZE (1..maxSIB)) OF SIB-TypeInfo

SIB-TypeInfo ::= SEQUENCE {

type ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType6, sibType7, sibType8, sibType9,

sibType10-v1610, sibType11-v1610, sibType12-v1610, sibType13-v1610, sibType14-v1610,

spare3, spare2, spare1,... },

valueTag INTEGER (0..31) OPTIONAL, -- Cond SIB-TYPE

areaScope ENUMERATED {true} OPTIONAL -- Need S

}

-- TAG-SI-SCHEDULINGINFO-STOP

-- ASN1STOP

|  |
| --- |
| *SchedulingInfo* field descriptions |
| ***areaScope***  Indicates that a SIB is area specific. If the field is absent, the SIB is cell specific. |
| ***si-BroadcastStatus***  Indicates if the SI message is being broadcasted or not. Change of *si-BroadcastStat*us should not result in system information change notifications in Short Message transmitted with P-RNTI over DCI (see clause 6.5). The value of the indication is valid until the end of the BCCH modification period when set to *broadcasting*. |
| ***si-Periodicity***  Periodicity of the SI message in radio frames. Value *rf8* corresponds to 8 radio frames, value *rf16* corresponds to 16 radio frames, and so on. |

|  |
| --- |
| *SI-RequestResources* field descriptions |
| ***ra-AssociationPeriodIndex***  Index of the association period in the si-RequestPeriod in which the UE can send the SI request for SI message(s) corresponding to this *SI-RequestResources*, using the preambles indicated by *ra-PreambleStartIndex* and rach occasions indicated by *ra-ssb-OccasionMaskIndex*. |
| ***ra-PreambleStartIndex***  If N SSBs are associated with a RACH occasion, where N > = 1, for the i-th SSB (i=0, …, N-1) the preamble with preamble index = *ra-PreambleStartIndex* + i is used for SI request; For N < 1, the preamble with preamble index = *ra-PreambleStartIndex* is used for SI request. |

|  |
| --- |
| *SI-SchedulingInfo* field descriptions |
| ***si-RequestConfig***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *si-BroadcastStatus* is set to notBroadcasting. |
| ***si-RequestConfigSUL***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *si-BroadcastStatus* is set to notBroadcasting. |
| ***si-WindowLength***  The length of the SI scheduling window. Value *s5* corresponds to 5 slots, value *s10* corresponds to 10 slots and so on. The network always configures *si-WindowLength* to be shorter than or equal to the *si-Periodicity*. |
| ***systemInformationAreaID***  Indicates the system information area that the cell belongs to, if any. Any SIB with *areaScope* within the SI is considered to belong to this *systemInformationAreaID*. The systemInformationAreaID is unique within a PLMN. |

|  |
| --- |
| *SchedulingInfo2* field descriptions |
| ***SchedulingInfo2***  Choice of *null* corresponds to a placeholder, which can be used for avoiding the collision of SI window or other purpose. |

*<Unmodified sections omitted>*

#### – *PosSI-SchedulingInfo*

-- ASN1START

-- TAG-POSSI-SCHEDULINGINFO-START

PosSI-SchedulingInfo-r16 ::= SEQUENCE {

posSchedulingInfoList-r16 SEQUENCE (SIZE (1..maxSI-Message)) OF PosSchedulingInfo-r16,

posSI-RequestConfig-r16 SI-RequestConfig OPTIONAL, -- Cond MSG-1

posSI-RequestConfigSUL-r16 SI-RequestConfig OPTIONAL, -- Cond SUL-MSG-1

...

}

PosSchedulingInfo-r16 ::= SEQUENCE {

offsetToSI-Used-r16 ENUMERATED {true} OPTIONAL, -- Need R

posSI-Periodicity-r16 ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

posSI-BroadcastStatus-r16 ENUMERATED {broadcasting, notBroadcasting},

posSIB-MappingInfo-r16 PosSIB-MappingInfo-r16,

...

}

PosSIB-MappingInfo-r16 ::= SEQUENCE (SIZE (1..maxSIB)) OF PosSIB-Type-r16

PosSIB-Type-r16 ::= SEQUENCE {

encrypted-r16 ENUMERATED { true } OPTIONAL, -- Need R

gnss-id-r16 GNSS-ID-r16 OPTIONAL, -- Need R

sbas-id-r16 SBAS-ID-r16 OPTIONAL, -- Need R

posSibType-r16 ENUMERATED { posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6,

posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4,

posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10,

posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15,

posSibType2-16, posSibType2-17, posSibType2-18, posSibType2-19, posSibType2-20,

posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType4-1,

posSibType5-1,posSibType6-1, posSibType6-2, posSibType6-3,... },

areaScope-r16 ENUMERATED {true} OPTIONAL -- Need S

}

GNSS-ID-r16 ::= SEQUENCE {

gnss-id-r16 ENUMERATED{gps, sbas, qzss, galileo, glonass, bds, ...},

...

}

SBAS-ID-r16 ::= SEQUENCE {

sbas-id-r16 ENUMERATED { waas, egnos, msas, gagan, ...},

...

}

-- TAG-POSSI-SCHEDULINGINFO-STOP

-- ASN1STOP

|  |
| --- |
| *PosSI-SchedulingInfo* field descriptions |
| ***areaScope***  Indicates that a posSIB is area specific. If the field is absent, the posSIB is cell specific. |
| ***encrypted***  The presence of this field indicates that the *pos-sib-type* is encrypted as specified in TS 37.355 [49]. |
| ***gnss-id***  The presence of this field indicates that the positioning SIB type is for a specific GNSS. Indicates a specific GNSS (see also TS 37.355 [49]) |
| ***posSI-BroadcastStatus***  Indicates if the SI message is being broadcasted or not. Change of *posSI-BroadcastStat*us should not result in system information change notifications in Short Message transmitted with P-RNTI over DCI (see clause 6.5). The value of the indication is valid until the end of the BCCH modification period when set to *broadcasting*. |
| ***posSI-RequestConfig***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to notBroadcasting. |
| ***posSI-RequestConfigSUL***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to notBroadcasting. |
| ***posSIB-MappingInfo***  List of the posSIBs mapped to this *SystemInformation* message. |
| ***posSibType***  The positioning SIB type is defined in TS 37.355 [49]. |
| ***posSI-Periodicity***  Periodicity of the SI-message in radio frames, such that rf8 denotes 8 radio frames, rf16 denotes 16 radio frames, and so on. If the *offsetToSI-Used* is configured, the *posSI-Periodicity* of rf8 cannot be used. |
| ***offsetToSI-Used***  This field, if present indicates that the SI messages in *posSchedulingInfoList* are scheduled with an offset of 8 radio frames compared to SI messages in *schedulingInfoList*. *offsetToSI-Used* may be present only if the shortest configured SI message periodicity for SI messages in *schedulingInfoList* is 80ms. *offsetToSI-Used* is not present in the *schedulingInfoList2*. |
| ***sbas-id***  The presence of this field indicates that the positioning SIB type is for a specific SBAS. Indicates a specific SBAS (see also TS 37.355 [49]). |