3GPP TSG-RAN WG1 Meeting #109-e R1-22xxxxx

e-Meeting, 9th – 20th May 2022

**Agenda Item: 8.6.1**

**Title: FL summary for incoming LS (R1-2203046) on introduction of an offset to transmit CD-SSB and NCD-SSB at different times**

**Source: Moderator (Ericsson)**

**Document for: Discussion, Decision**

# 1 Introduction

This feature lead (FL) summary (FLS) concerns the Rel-17 work item (WI) for support of reduced capability (RedCap) NR devices [1]. Earlier RAN1 agreements for this WI are summarized in [2], which also includes links to earlier FLSs. The latest Rel-17 NR higher-layer parameter list sent from RAN1 to RAN2 can be found in [3].

This document captures the following email discussion for the incoming LS [4] and related contributions [5] – [14]:

|  |
| --- |
| [109-e-R17\_RedCap-02] Email discussion on incoming LS ([R1-2203046](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_109-e/Docs/R1-2203046.zip)) on introduction of an offset to transmit CD-SSB and NCD-SSB at different times by May 12 – Johan (Ericsson)   * Relevant tdocs: R1-2203120, R1-2203495, R1-2203590, R1-2204271, R1-2204434, R1-2203053, R1-2203109, R1-2203517, R1-2204711, and R1-2204771 |

The issues in this document are tagged and color coded with High Priority or Medium Priority. The issues that are in the focus of this round of the discussion are furthermore tagged FL5.

**FL5 Question 1-1a: Please consider entering contact info below for the points of contact for this email discussion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Point of contact** | **Email address** |
| Nordic | Karol Schober | karol.schober@nordicsemi.no |
| Qualcomm | Jing Lei | leijing@qti.qualcomm.com |
| Nokia | Rapeepat Ratasuk | rapeepat.ratasuk@nokia-bell-labs.com |
| CATT | Yongqiang FEI | feiyongqiang@catt.cn |
| Samsung | Feifei Sun | Feifei.sun@samsung.com |
| MediaTek | Chiou-Wei Tsai | cw.tsai@mediatek.com |
| ZTE | Youjun Hu | hu.youjun1@zte.com.cn |
| NTT DOCOMO | Mayuko Okano | mayuko.okano.ca@nttdocomo.com |
| CMCC | Lijie Hu | hulijie@chinamobile.com |
| FUTUREWEI | Vip Desai | vipul.desai@futurewei.com |
| Intel | Debdeep Chatterjee | debdeep.chatterjee@intel.com |
| NEC | Takahiro Sasaki | takahiro.sasaki@nec.com |
| Ericsson | Sandeep Narayanan Kadan Veedu | sandeep.narayanan.kadan.veedu@ericsson.com |
| LGE | Jay KIM | jaehyung.kim@lge.com |

# 2 Discussion

RAN1 and RAN4 have received an LS [4] from RAN2 with the following content:

|  |
| --- |
| **1. Overall Description:**  In RAN2#117-e, it was concluded that, from RAN2 signalling standpoint, CD-SSB and NCD-SSB(s) may be transmitted at different times by configuring an offset. RAN2 would like to ask RAN4 and RAN1 whether such offset is feasible/needed.  **2. Actions:**  **To RAN4 and RAN1**  **ACTION:** RAN2 kindly asks RAN4 and RAN1 to take the information above into consideration and provide feedback. |

Contributions [5] – [14] express views on the topic raised in the LS. This topic has also been brought up in the previous RAN1 meeting in contribution [15] and discussed on pages 94-106 in the FLS in [16], where the discussion ended with an FL note that “RAN1 can come back to these topics if necessary once they have been treated in RAN2”.

Regarding the ***necessity*** of a configurable time offset between CD-SSB and NCD-SSB, some contributions [11, 12, 14] express that it is beneficial or even needed to have the possibility to transmit CD-SSB and NCD-SSB at different times to avoid power shortage at the gNB side, especially if/when power boosting is used for SSB the transmission.

Contribution [5] expresses that there is no strong need for a time offset and that in many cases it will be desired to have zero offset to minimize the ON time for power saving purposes, but that it would be OK if it is up to the gNB whether to configure a time offset and the UE cannot expect a time offset.

Contribution [7] expresses that there is no need for a time offset and points out that CD-SSB and NCD-SSB are configured without offset in legacy.

**FL1 High Priority Question 2-1a: Is a configurable time offset between CD-SSB and NCD-SSB *needed*? Please elaborate on your answer in the Comments field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic | N | Assuming e.g. 60Mhz channel BW and 162RB of 30kHz SCS there  1 SSB can be boosted 8x while 2SSB only 4x. In our opinion boosting SSB 6dB is enough, or at least benefit to bootst 3dB more is not really clear to us.  Therefore we think offset is not essential. |
| Qualcomm | N | In NR R15/16, a CD-SSB can be FDMed with other DL channels/signals with power boosting on the same set of symbols. Therefore, we don’t think it is necessary to configure such a time offset between CD-SSB and NCD-SSB.  On the other hand, such time offset can only be configured with half-frame granularity, which does not provide much flexibility for scheduler but incurs DL resource fragmentation for legacy UEs. |
| Nokia, NSB | N | We don’t think time offset is necessary. First, SSB coverage is robust compared to other DL channels and generally power boosting is not necessary. Even if power boosting is used, it is our view that there is sufficient power for sharing between CD-SSB and NCD-SSB. Second, introducing an offset increases implementation complexity and introduces further scheduling restrictions due to e.g. QCL relationship between CD-SSB and NCD-SSB, resource fragmentation, different collision handling between BWPs, etc. |
| CATT |  | The question ‘*needed’* is a little ambiguous. In our view, without time offset the system may still work (although maybe reluctantly). But a configurable time offset is more flexible and can ease the deployment of NCD-SSB. |
| Samsung | N | We don’t think this is necessary.  Introducing offset may increase RO validation, semi-DL determination issues. This will also increase the implementation effort for both UE and gNB. |
| Huawei, HiSilicon | Y | It is very necessary to enable NCD-SSB(s) and CD-SSBs transmitted at different time, by network configurations. Because in current commercial network, to guarantee the coverage of SSB, the network will likely perform power boosting for SSB with up to even higher level than what one may consider. Considering only CD-SSB have been deployed in most networks, the impact on gNB implementation can be accepted. However, now multiple NCD-SSBs can be transmitted additionally since R17. If the SSBs are transmitted at same time, the network has to perform power boosting for multiple SSBs simultaneously. On one hand, it may bring great challenge to gNB implementation. On the other hand, the power of the other channels may be reduced, which means that the performance of these channels will suffer performance loss. Thus, it is not practical to ALWAYS require gNB to always transmit CD-SSB and NCD-SSB(s) at same time instance. To solve the above issue, NCD-SSB(s) should be allowed to be transmitted at different time instances.  There is no such BWP collisions or compelxibity issue – from single UE perspective it is same as CD-SSB in terms of rate matching, RO collision/validation. |
| MediaTek |  | After hearing companies’ views, we are becoming less and less convinced that a configurable time offset is indeed needed. But we are open for discussion. What we really concern is the related technical details (i.e. feasibility) should be well taken care of and clarified which may be complicated and time consuming. |
| ZTE, Sanechips | N | gNB still have the ability to let UE camp on the CD-SSB and configure less NCD-SSB to make sure that the impacts on gNB is acceptable. |
| DOCOMO | N | We don’t think the time offset is necessary. We agree that the time domain configuration (e.g., periodicity) of NCD-SSB can be configured independently from that of CD-SSB, and NCD-SSB and CD-SSB may not be always transmitted at the same time by gNB, however, we don’t see any issue on simultaneous transmission of NCD-SSB and CD-SSB. |
| CMCC |  | A time offset between CD-SSB and NCD-SSB is not neccessary but configurable by gNB. If gNB concerns about power boosting, it has the flexibility to configure an offset. |
| FUTUREWEI |  | We understand the point about power boosting. If NCD-SSB and CD-SSB are located on the same symbols and if they are boosted, the remaining REs will have decreased power, which impacts the performance of the channels using those REs. In addition, power boosting over non-adjacent RBs may lead to unwanted 3rd order modulation products (in RF). Thus, having a time offset can mitigate these two issues. |
| Intel |  | Same view as CATT – it is not strictly necessary, but can provide flexibility to the gNB. |
| NEC | N | It would not be needed for the purpose of power boosting of SSB, as in our understanding, SSB is not bottle-neck of DL coverage. It would not be essential in CR phase. |
| Ericsson | Not *needed* | Although we do not see a strong need for such an offset, we are fine with introducing the offset as long as a zero offset can be configured. |
| LGE | N | It may be useful in some cases, but we don’t think it is needed. |
| FL2 | Most received responses indicate that a configurable time offset between CD-SSB and NCD-SSB is not needed. One response expresses that a time offset is needed to allow for enough power boosting to ensure the desired coverage. Two responses indicate that SSB coverage is robust compared to other channels and that it is therefore not a bottleneck for coverage and thus power boosting is generally not necessary. Three responses express that there is enough margin to do power boosting of both CD-SSB and NCD-SSB without a time offset if this would be needed.  **High Priority Question 2-1b: Companies are invited to comment further on:**   1. **Whether there is a need for SSB power boosting** 2. **Whether there is enough margin to do the necessary power boosting for both CD-SSB and NCD-SSB without a time offset between the two** | |
| Huawei, HiSilicon | We feel RAN1 should either discuss means to mitigate other implementation’s concern, or provide more time in e.g. RAN1 and RAN4 to investigate the spec and performance impact of NCD-SSB itself.  Most of the potential RAN1 spec impact (in FL question **2-3b**) in our view are not due to the time offset. On the other hand, the potential impact of e.g. 3rd order modulation products require more check.  Our response to question 2-1b is:  1. Yes.  It is well understood that SSB is the most crical DL channel that require coverage insurance for mobility, measurement, connecitive etc. And, for other issues if without the offset, e.g. 3rd order modulation products.  2. It also depends on how much an exising CD-SSB is already boosted and how many NCD-SSB will be additionally configured. There is no assessment and no restriction when NCD-SSB was agreed. | |
| Nordic | 1. Is more a network vendor question than chipset vendor. 2. We do not think more than 1 NCD-SSB is needed in practice. Nevertheless for every 20MHz BW chunk of channel BW, a gNB can boost SSB by 3-4dB. | |
| Qualcomm | Q1) It depends.  As commented by Nordic, Nokia and other companies, SSB coverage is robust compared to other DL channels and generally power boosting more than 3 dB is not necessary. Furthermore, the impacts of SSB power boosting on NW energy consumption (currently being studied in NR R18), inter-cell interference and mobility need to be taken into account.  Q2) Yes, as long as the range of power boosting is rational and logical. | |
| FUTUREWEI | Q2) Without supporting an offset, the RF channel may have to be large and/or a large dynamic range at the base station may be needed to support power boosting of the SSBs.  As an example, the plot below shows that the minimum number of RBs in a channel increases with the number of SSBs and boosting amounts. More importantly, there can be a big number of dB difference in power between the boosted and non-boosted RBs. Here, we show two boosting values (3 and 6 dB), and 1 and 2 SSBs. | |
| DOCOMO | For both Q1 and Q2, it depends on the deployment. More specifically, the need for SSB power boosting and/or the margin for power boosting would vary depending on the gNB deployment scenario and operating band. | |
| CMCC | 1) SSB power boosting may be needed when comparatively small number of wide SSB beams is transmitted.  2) Power boosting for both CD-SSB and NCD-SSB without a time offset can be performed, but the gain of power boosting reduces. | |
| ZTE, Sanechips | In legacy, the energy for SSB transmission is mainly determined by ssb-PositionsInBurst, ssb-periodicityServingCell, and ss-PBCH-BlockPower, which are cell specific configured. Therefore, in the network, due to lack of dynamic adjusting, the SSB power would be enough robust for the good coverage for a long time.  Power boosting can be achieved by appropriate RRC configuration of NCD-SSB, and also can be achieved by appropriate resource scheduling. CD-SSB and NCD-SSB are configured without offset in legacy also works well in the network. | |
| Samsung | 1. Current RAN 4 requirement doesn’t require SSB with power boosting. 2. We also don’t think more than one NCD-SSB is needed. and it should be fine with CD-SSB and one NCD-SSB at the same time with power boosting.   We think RAN 4 is the proper WG to answer the two questions. | |
| Ericsson | We tend to agree with DOCOMO and CMCC on both aspects. | |

Regarding the ***feasibility*** of a configurable time offset between CD-SSB and NCD-SSB, several contributions [6, 8, 11, 12, 14] express that it is feasible.

The following issues (concerns or other aspects to consider) are brought up in the contributions [5, 7, 9, 12, 13]:

1. Impacts on mapping pattern for SSB in slots within a half-frame [5]
2. Impacts on the QCL relationship [7]
3. RAN1 specification impacts on SSB starting symbols [7]
4. No support for offset resulting in collision between CD-SSB and NCD-SSB with different TCI states [9]
5. Collision handling between SSB and UL transmissions for HD-FDD [12]
6. Available slot determination for PUCCH/PUSCH repetitions for HD-FDD [12]
7. RACH occasion validation and SSB-RO association [13]
8. PDSCH rate matching around SSB [13]

**FL1 High Priority Question 2-2a: Is a configurable time offset between CD-SSB and NCD-SSB *feasible*? Please elaborate on the issues listed above in the Comments field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic | Y |  |
| Qualcomm |  | To solve the issues listed above, such time offset can only be configured with half-frame granularity by RRC. The half-frame granularity does not provide much flexibility for the scheduling of NCD-SSB, but incurs additional issues for NW and UE, such as:   1. DL resource fragmentation 2. complicating the rate matching/collision handling procedures 3. imposing additional constraints on the configuration of TDD slot format 4. potential degradation of UL throughput in TDD |
| vivo | Y | It is feasible to configure time offset of NCD-SSB relative to CD-SSB, and the offset is half-frame level. |
| Nokia, NSB | Y | While we think it’s feasible to configure a time offset, our preference is not to support time offset. |
| CATT | Y | We do not see serious issues if (1) Time offset is in half-frame level (2) RedCap UE is required to deal with only one SSB (either CD- or NCD- one) within the active BWP. |
| Samsung | Y | We think it is feasible, but may increase a lot of uncessary effort.  Agree with vivo and Qc that, such time offset can only be configured with half-frame granularity by RRC. |
| Huawei, HiSilicon | Y | The SSB pattern within half-frame can be kept same with R15/16, NCD-SSBs and CD-SSBs can locate at different half-frames within same SF or different SFs, it can be up to network implementation. It won’t impact pattern for SSB nor QCL relationship.  Repley to Qualcomm’s concern:   1. There won’t be DL resource fragmentation issue, because discontinuous frequeney resource allocation is mandatorily supported for all UEs. 2. Rate matching/collision handling for (N)CD-SSB is already supported in Rel-15/16, it will cause any additional complexity. 3. The configurations of TDD slot format and NCD-SSB can be up to network implementation, network will tradeoff between these two issue, from network’s perspective, it is not a problem. 4. Same as Q3, it can be up to network implementation. |
| MediaTek |  | Before deciding the feasibility of NCD-SSB, we first should at least discuss whether NCD-SSB should be taken into consideration for determining valid RACH occasion in TDD as described in Clause 8.1 of TS38.213.  Let’s assume an UL BWP is configured with RACH occasions which physically are shared between legacy UEs and RedCap UEs (from the network perspective). Its paired DL BWP for legacy UEs contains CD-SSB while its paired DL BWP for RedCap UEs contains NCD-SSB. Note NCD-SSB is configured to RedCap UEs via dedicated signalling. Should RedCap UEs take NCD-SSB into consideration and ruling out (i.e. invalidating) RACH occasions that collide with NCD-SSBs or are within Ngap symbols of NCD-SSBs? (See 38.213 for detailed rules.)  If NCD-SSB is not considered, it is not aligned with the original design principle in R15 that PRACH transmission should not interfere SSB reception.  On the other hand, if NCD-SSB is considered, to our understanding, legacy UEs always take SSBs in account for valid RO determination. As legacy UEs are not configured with NCD-SSB and hence only CD-SSBs have been considered. In this case, if there is a non-zero time offset between CD-SSB and NCD-SSB, it may wind up with different mappings between SSBs and valid ROs for legacy UEs and RedCap UEs.  Some discussions and agreements are needed at least for this aspect before making agreements to support for configurable time offsets. |
| ZTE, Sanechips | Y | It is feasible but would bring out massive discussions. For example, the offset value should be determined, and QCL relationship should be discussed. |
| DOCOMO | Y | We think the time offset between CD-SSB and NCD-SSB is feasible and should be the half-frame level if configured. |
| CMCC | Y | It is feasible and up to gNB to configure time offset of NCD-SSB. |
| FUTUREWEI | Y |  |
| Intel | Y | We think it’s feasible to configure non-zero offsets between CD- and NCD-SSB, and all of the raised concerns can be avoided by proper choice of the offset value or are natural consequences of such a configuration, should the gNB choose to configure such.  However, if we are risking opening new long discussions in RAN1 on how to configure the offsets reasonably, then we’d prefer not to pursue such a track, instead assume zero-offset case only, and respond to RAN2 accordingly. |
| NEC |  | It is not clear for us what the offset is. Multiple companies assume it half-frame level. Half-frame level offset would be feasible, though in case periodicity of CD- and NCD-SSB are different, offset between CD- and NCD-SSB would vary. |
| Ericsson | Y | We think the time offset could be feasible.  However, some time offset values would have more impact than the other. Currently, different SSB indexes have fixed (for a particular SCS) time-domain locations in the slots within a half-frame. Therefore, if the offset value is, for e.g., less than a half-fame, the transmission of NCD-SSB and CD-SSB may still occur at the same time (but with different indexes). Assuming a half-frame granularity of the time offset could help to avoid concurrent transmission of NCD-SSB and CD-SSB (which is the main motivation for introducing the offset) and minimize the impact on SSB mapping pattern. |
| LGE | Y | Even if we are not in favor of configuring the time offset, we don’t think there is a feasibility issue here. |
| FL2 | Most received responses indicate that a configurable time offset between CD-SSB and NCD-SSB is feasible, at least if the time offset has half-frame granularity. Three responses (from Qualcomm, MediaTek, and NEC) do not reply yes or no and express concerns with the feasibility.  **High Priority Question 2-2b: Companies are invited to comment on the concerns expressed in the responses above from Qualcomm, MediaTek, and NEC.** | |
| Huawei, HiSilicon | Reply to Qualcomm’s concern:   1. There won’t be DL resource fragmentation issue, because discontinuous frequeney resource allocation is mandatorily supported for all UEs. Since there is one SSB to be referred by UE, either CD or NCD, there is no additnioal issue to us. 2. Rate matching/collision handling for (N)CD-SSB is already supported in Rel-15/16, it will cause any additional complexity. 3. The configurations of TDD slot format and NCD-SSB can be up to network implementation, network will tradeoff between these two issue, from network’s perspective, it is not a problem.   Reply to MTK concern:  We will the question is not for offset, but more for NCD-SSB. Whether NCD-SSB is considered or not for RO validiation itself is pending discussion – for this aspect, we think both approaches are possible. If the UE uses CD-SSB for association, this is similar to NR R15 CA where a UE can RACH from SCell where there is no SSB. If NCD-SSB is considered, a separate mapping between NCD-SSB and RO seems anyway needed, or by gNB configuration that the same SSB indices are mapped to a same RO index. In this case, the offset does not seem to affect.  Reply to NEC, Ericsson concern:  Ok to have zero value as one candidate and half-frame as granularity. | |
| Qualcomm | If CD-SSB and NCD-SSB are transmitted on different slots/symbols, the DL resource fragmentation issues will occur for other signals/channels in frequency and time domains, which reduces the flexibility of NW/scheduler. For example,   * there will be more restrictions on the configurations of periodic and wide-band RS, which need to avoid the overlapping with CD-SSB and NCD-SSB on more slots/symbols. * there will be more restrictions on the resource mapping and SS configuration of PDCCH, especially CORESET with 3 symbols   Moreover, since more slots/symbols in TDD need to be configured as DL to support CD-SSB and NCD-SSB transmissions with time offsets, there will be less resources available for UL. As a result, the UL throughput and coverage will be degraded in TDD, which defeats the purpose of UL coverage enhancement in NR R17/R18. | |
| MediaTek | @HW, the issue is related to RACH occasion validation rather than SSB-RO association. Validation of RACH occasions depends on the SSB *time* occasions. Periodicity of NCD-SSB is not smaller than that of CD-SSB. If there is no time offset between NCD-SSB and CD-SSB. UE can simply use CD-SSB to determine which ROs are valid. See text box below for detailed text from TS38.213.    If only CD-SSB is taken into account, it will be a simpler discussion. If NCD-SSB is considered as well, there are more cases to be discussed. Either way, agreements may be needed to clarify whether CD-SSB or NCD-SSB from *BWP-DownlinkDedicated* is used for determing valid ROs if configurable time offsets are supported. | |
| CMCC | Reply to Qualcomm’s concern:  1) DL resource fragmentation can be tackled with discontinuous frequeney resource allocation.  3) The configuration of offset and TDD pattern can be up to gNB. For example, with SCS 30kHz, the period of TDD pattern is half frame, so when offset has half-frame granularity, there is no constraint on the configuration of TDD slot format. With SCS 15kHz, the period of TDD pattern is one frame, when offset has frame granularity, there is no constraint on the configuration of TDD slot format.  [Qualcomm] Thanks for the comments. I think you might have missed an important scenario for SCS 15kHz and the time offset is half-frame. In this case, NW has to configure more DL slots in both the 1st and 2nd half frames to accommodate the time offset between CD-SSB and NCD-SSB.  Reply to MTK’s concern:  The SSB-to-RO mapping configuration for NCD-SSB can be the same as SSB-to-RO mapping for CD-SSB. Existing definition of valid RO is based on CD-SSB, if RedCap employs the same definition of valid RO and RO collides with NCD-SSB, the access latency of RedCap may increase, but it is acceptable since RedCap is delay insentive. For a specific RO, PRACH partition can be used to distinguish different UE type. | |
| Huawei, HiSilicon | @MTK  Thanks for correcting. It seems I’m indeed discussing association after starting from validation. Having said so, validation aspect of NCD-SSB requires some calrifiaction regardless of time-offset, but still differs as long as NCD-SSB is assumed, since they have different periodicity; not sure whether there is RO waste if the RO deteremined by CD-SSB is reused. | |
| Samsung | We don’t agree HW/CMCC on RO related issue.  If there is no offset between CD-SSB and NCD-SSB, i.e., they are FDMed, there is no need to check NCD-SSB since they are only at the symbols of CD-SSB. However, if they have offset, UE might need to check NCD-SSB location, or UE doesn’t check NCD-SSB location in idle/inactive mode for RO validation. In current spec, NCD-SSB can only be signaling in connected mode. That is, UE cannot know whether there is NCD-SSB or not for RO validation. Following this logic, UE will not use NCD-SSB for anything in idle/inactive mode, RO validation. For connect mode, we need to further study on whether to check UL/DL direction.  Although this can be resolved by gNB implementation, i.e., only transmit NCD-SSB on semi-DL symbols. But this introduce uncessary complexity for the NW. | |
| Ericsson | @Huawei/HiSilicon Thanks for the clarification. | |

Regarding the ***impacts*** on RAN1 specifications and the RRC parameter list [3] from a configurable time offset between CD-SSB and NCD-SSB, the submitted contributions do not contain any detailed text proposals. Companies are invited to describe the expected impacts in detail, were such a configurable time offset to be introduced.

**FL1 High Priority Question 2-3a: If a configurable time offset between CD-SSB and NCD-SSB is introduced, what are the *impacts* on the RAN1 specifications and the RRC parameter list [3]? Please be as detailed as possible.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nordic | With assumption that there is only one SSB within UEs BWP, NCD or CD, the spec should just work fine, given that UE assumes that only SSB within BWP matters, for collisions for RO handling, etc. But of course, having offset between CD and NCD would mean that UE must treat collisions differently depending on BWP, which is clearly not desirable. |
| Qualcomm | Please see our comments on Question 2-2a. |
| Samsung | Agree with Qc on   1. complicating the rate matching/collision handling procedures 2. imposing additional constraints on the configuration of TDD slot format   we need to clarify UE behavior on how to deterimate slot format, and whether some of the configuration is error case or not, and further clarify HD-FDD |
| Huawei, HiSilicon | From RRC perspective, an offset between CD-SSB and NCD-SSB is needed per NCD-SSB, to be signaled to UE. RAN1 specification does not seem to require changes. |
| ZTE, Sanechips | 1. The offset value should be determined 2. The UE behavior for NCD-SSB detection also should be determined. 3. Impacts on QCL relationship should be discussed. |
| DOCOMO | As pointed out by companies, at least the rate matching and collision handling needs to be clarified further. |
| CMCC | Candidate values of offset need to be determined. |
| Intel | Mainly in terms of signalling of the offset itself, and collision handling between DL/UL link directions. However, for rate-matching and DL-UL conflicts, NCD-SSB needs to be captured in specs in addition to CD-SSB. Thus, *spec impact* may be limited (we do not deny there would be different impact to operations for the gNB and UE though). |
| Ericsson | Regarding RAN1 specification impacts, we tend to agree with Nordic. Please also see our response to Q2-2a.  Regarding RRC parameter list impacts, there would be impacts due to introduction of a new RRC parameter and due to introduction of new candidate values for the time offset (which may require further discussions in RAN1/RAN2). |
| FL2 | The following potential impacts are brought up in the received responses:   1. New RRC parameter(s) 2. Candidate offset value(s) 3. SSB starting symbols and mapping pattern 4. UE behavior for rate matching 5. UE behavior for collision handling (including HD-FDD cases) 6. UE behavior for determination of TDD slot format 7. UE behavior for NCD-SSB detection 8. QCL relationship 9. RO validation   It can be expected that the potential impacts #1 and #2 listed above will have impacts on the RRC parameter list. Companies are invited to comment on which ones of the potential impacts #3 through #9 that will have impacts on RAN1 specifications if the proposed configurable time offset is introduced.  **High Priority Question 2-3b: Which ones of the potential impacts #3 through #9 listed above will have impacts on the RAN1 specifications if the proposed configurable time offset is introduced?** |
| Huawei, HiSilicon | It is not clear any of others are specific to the offset or require significant discussion. They, if any RAN1 impact, seem to belong to NCD-SSB itself, since NCD-SSB is already different from CD-SSB in frequency domain. |
| Nordic | Would like humbely remind that, TDD and collision handling for HD-FDD are time domain aspects, not frequency. |
| Qualcomm | If NCD-SSB is transmitted on slots/symbols different from CD-SSB in TDD, more slots/symbols need to be configured as DL to support CD-SSB and NCD-SSB transmissions with time offsets. As a result, there will be less resources available for UL, and the UL throughput and coverage will be degraded in TDD. This defeats the purpose of UL coverage enhancement in NR R17/R18.  In addition, 4, 5, 8 and 9 have potential impacts on RAN1 specifications if the time offset is introduced.  Considering the non-trivial spec (and implementation) impacts of introducing “configurable time offset between CD-SSB and NCD-SSB,” we suggest not to pursue such discussion further in RAN1 and respond to RAN2 only zero time offset is assumed. The assumption of zero time offset is beneficial to reduce the signaling overhead for RedCap UE as well. |
| DOCOMO | It may or may not have spec impact but clarification discussions would be needed at least for rate-matching with NCD-SSB and collision handling if non-zero time offset for CD-SSB and NCD-SSB is introduced. |
| CMCC | At least 4, 5 have potential impacts on RAN1 specifications, but they exist even for offset 0. |
| ZTE, Sanechips | At least the candidate offset values should be determined in RAN1  For the QCL relationship, the corresponding CD-SSB index may need discussion due to the time offset.  For NCD-SSB detection, due to the introduced time offset, now it is not clear that where to detect the NCD-SSB. |
| Huawei, HiSilicon | @Nordic  Right. Was trying to say, NCD-SSB differ from CD-SSB in frequency domain already. So it is not clear why more slots/symbols are needed to avoid collision since they are aleady FDMed and NCD-SSB is with larger peridocity. Sorrfy for being unclear.  @ZTE  Candidate values are proposed in the above. Perhaps the detection can be the same since the granularity is half-frame. |
| Samsung | In our understanding,  2/3 may need to be checked by RAN 1.  5, 6, 8, need RAN 1 discussion.  9 need to clarify that it shall not be used for RO validation. We cannot agree on anything else.  4 is common for NCD-SSB without offset |
| Ericsson | As we commented earlier, the extent of RAN1 impact would depend on the candidate time offset values. Also, at a minimum, some of #3 through #9 needs further checking/discussion to ensure that RAN1 specifications would not be impacted. |

Based on the received responses to the questions above, the following proposal can be considered.

**FL3 High Priority Proposal 2-4a: Capture the following in a response LS to RAN2 and RAN4:**

* **There is no consensus in RAN1 regarding the potential need for configurable time offset(s) between CD-SSB and NCD-SSB(s).**
* **It is feasible from RAN1 perspective to introduce configurable time offset(s) between CD-SSB and NCD-SSB(s), but the associated impacts on RAN1 specifications have not been fully analyzed.**
* **If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, RAN1 recommends that the offset values have at least half-frame granularity, including an offset value of zero (i.e., no offset).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| CATT | Y |  |
| NEC | Y |  |
| DOCOMO | Y |  |
| Nordic | Y |  |
| ZTE, Sanechips | Y with minor updates | As discussed above, if the time offset is introduced, there would be much spec impacts needed to be further checked. Therefore, it is suggested to also capture it in the LS.   * **If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, RAN1 recommends that the offset values have at least half-frame granularity, including an offset value of zero (i.e., no offset), and additional RAN1 discussion for spec impacts is needed.** |
| LGE |  | We think “at least half-frame granularity” is a bit misleading in that it implies other finer or coarser granularity can also considered. If that is not the intention, consider removing the “at least” in the last bullet. |
| Ericsson | Y | We are also fine with updates suggested by ZTE/Sanechips and LGE. |
| Huawei, HiSilicon | Y | It is propobaly better to only have half-frame granularity as other values may lead to UE detection complexity. No such issue with half frame offset.  Thus, ok with removing “at least” if there is such preference.  We’d remove or use one of the suggestion from ZTE (with modification as 🡺 potential additional RAN1 discussion may be needed) or from FL, since there is already one text about potenail spec impact (**have not been fully analyzed**), and so far there is no consensus that there will be spec impact, even if the offset is included, it can be captured in e.g. 331. |
| MediaTek | Y but | We are also fine with ZTE’s updated version. In addition, if configurable time offsets are introduced, they should be at a half-frame granularity, in other words, interger multiples of 5ms. Otherwise, it requires additional UE implementation efforts for detection on top of changes caused by potential specification impacts. |
| vivo | Y | We support the FL3 proposal.  ZTE’s addition seems to contradict with the statement in the 2nd bullet “**but the associated impacts on RAN1 specifications have not been fully analyzed.**”, and given this statement, Huawei’s addition is redundant. We prefer to not add any conflict or redundant statement and just endorse the FL3 proposal as it is. |
| FL4 | Based on received responses, the following updated proposal can be considered.  **High Priority Proposal 2-4b: Capture the following in a response LS to RAN2 and RAN4:**   * **There is no consensus in RAN1 regarding the potential need for configurable time offset(s) between CD-SSB and NCD-SSB(s).** * **It is feasible from RAN1 perspective to introduce configurable time offset(s) between CD-SSB and NCD-SSB(s), but the associated impacts on RAN1 specifications have not been fully analyzed and require additional RAN1 discussion.** * **If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, RAN1 recommends that the offset values have ~~at least~~ half-frame granularity, including an offset value of zero (i.e., no offset).** | |
| vivo | Y |  |
| Nokia, NSB | Y |  |
| CMCC | Y |  |
| Huawei, HiSilicon | Almost | It is a bit unclear how to reach a statement that this require additional RAN1 discussion – almost half-half about the potential RAN1 impact in previous discussions while two companies do not think the additions from ZTE is necessary.  It is for sure that companies can always bring this up to next ran1 meeting. Some may also propose no further impact or action needed, which is subject to further analysis. With almost the same comments, we suggest to remove the red part in the second bullet, or add “may” ahead of “require additional…” as wayfoward. |
| ZTE, Sanechips | Y | Additional RAN1 discussion is for sure, since as seen no consensus for RAN1 spec is made currently. We need to further check and discuss the potential spec impacts that we have mentioned.  So, we think RAN1 spec impacts may be needed or not needed, and actually additional RAN1 discussion is for sure. |
| Samsung | Y |  |
| MediaTek | Y |  |
| Ericsson | Y |  |
| Nordic | Y, but we think we answer something RAN2 did not ask. | We think the following bullet should be removed.  ~~If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, RAN1 recommends that the offset values have at least half-frame granularity, including an offset value of zero (i.e., no offset).~~  This because RAN2 question has been the following.  “RAN2 would like to ask RAN4 and RAN1 whether such offset is feasible/needed.” |
| Intel | Y |  |
| CATT | Y | The 3rd bullet should be kept, which is the basic of feasibility. Finer granularity of the offset would make this feature infeasible. |
| Qualcomm | Y without the third bullet | We agree with the comments of Nordic.  RAN2 did not ask RAN1 to provide configurations for the time offset. Besides, RAN1 needs further discussion to evaluate the spec impacts of non-zero time offset. Half-frame granularity is a starting point for discussion, instead of conclusion. RAN4’s consideration should also be considered. |
| NEC | Y | We are fine with the proposal, while we are also fine to remove the third bullet. The third bullet could be merged to the second bullet by adding “with half-frame granularity, including an offset value of zero (i.e., no offset)” to the second bullet. |
| LGE | Y with modification | If there is a concern on the third bullet, we can consider merging the third bullet as part of the second bullet as follows:  **High Priority Proposal 2-4b: Capture the following in a response LS to RAN2 and RAN4:**   * **There is no consensus in RAN1 regarding the potential need for configurable time offset(s) between CD-SSB and NCD-SSB(s).** * **It is feasible from RAN1 perspective to introduce configurable time offset(s) between CD-SSB and NCD-SSB(s) unless the granularity of the time offset value(s) is smaller than half frame, but the associated impacts on RAN1 specifications have not been fully analyzed and require additional RAN1 discussion.** * **~~If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, RAN1 recommends that the offset values have~~ ~~at least half-frame granularity, including an offset value of zero (i.e., no offset).~~** |
| DOCOMO | Y |  |
| Panasonic | Y |  |
| FL5 | It should be noted that because of the upcoming ASN.1 freeze (in June), RAN2 needs to be able to make decisions on the RRC parameter details in connection to the ongoing RAN2 meeting. Therefore, it is good to include details already in this LS reply, if possible, rather than postponing the discussion. Based on received responses, the following updated proposal can be considered.  **High Priority Proposal 2-4c: Capture the following in a response LS to RAN2 and RAN4:**   * **There is no consensus in RAN1 regarding the potential need for configurable time offset(s) between CD-SSB and NCD-SSB(s).** * **It is feasible from RAN1 perspective to introduce configurable time offset(s) between CD-SSB and NCD-SSB(s)** **with half-frame granularity, including an offset value of zero (i.e., no offset), but the associated impacts on RAN1 specifications have not been fully analyzed and is expected to require additional RAN1 discussion and may require RAN1 specification updates.** * **~~If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, RAN1 recommends that the offset values have half-frame granularity, including an offset value of zero (i.e., no offset).~~** | |
| Ericsson | Y |  |
| Nokia, NSB | Y |  |
| Nordic | Y |  |
| Huawei, HiSi | Y |  |
| Intel | Y |  |

**FL4 High Priority Question 2-5a: If configurable time offset(s) between CD-SSB and NCD-SSB(s) are introduced, what range of offset values should be supported?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | It might be sufficient to allow only one non-zero offset avalue, which is half-frame offset, i.e. the value range for the time-offset configuration can be {zero, one half-frame}. |
| CMCC | Offset zero and half-frame granularity can be considered to reduce impact on TDD pattern, such as {zero, one half-frame, two half-frame }. |
| Huawei, HiSilicon | As previously commented, Ok to limited to half-frame granularity. No strong view to how many intergers. |
| ZTE, Sanechips | TDD configuration and CD-SSB periodicity may need to be taken into consideration. We are not sure one or two value can satisfy the requirement for different scenarios. Therefore, we may need more time to further study if time offset is introduced. |
| Samsung | We share similar view as vivo, and think {zero, one half-frame} in enough.  We don’t think more than one NCD-SSB is needed so far. |
| MediaTek | We are fine with vivo’s proposal.  One question to the feature lead and the group: which WG will decide whether configurable time offsets are supported or not? Usually, I think it would be RAN1. However, in this case, it is not clear to me. |
| Ericsson | From RAN1 perspective, fine with suggestion from CMCC (if time-offset is introduced). As being discussed in RAN4, if NW wants the UE to measure both CD-SSB and NCD-SSB(s), the time offset between the SSBs should be the MGRP of the configured MG. So, RAN4’s input should also be taken into consideration. |
| Intel | Fine with CMCC’s proposal. |
| CATT | Considering that the default periodicity of CD-SSB is 20ms, we think CMCC’s suggestion is fine. |
| Qualcomm | Agree with ZTE. RAN1 should wait for the reply LS from RAN4. RAN1 can further discuss this issue together with the potential spec impacts at next RAN1 meeting. |
| LGE | Wait for reply LS from RAN4. |
| DOCOMO | We are fine with CMCC’s proposal from RAN1 perspective if time-offset is introduced. |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | [RP-220966](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_95e/Docs/RP-220966.zip) | Revised WID on support of reduced capability NR devices | Ericsson |
| [2] | [R1-2202535](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2202535.zip) | RAN1 agreements for Rel-17 NR RedCap | Rapporteur (Ericsson) |
| [3] | [R1-2202759](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2202759.zip) | Consolidated higher layers parameter list for Rel-17 NR | Moderator (Ericsson) |
| [4] | [R1-2203046](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203046.zip) | LS on introduction of an offset to transmit CD-SSB and NCD-SSB at different times | RAN2, Ericsson |
| [5] | [R1-2203120](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203120.zip) | On introduction of an offset to transmit CD-SSB and NCD-SSB at different times | Ericsson |
| [6] | [R1-2203495](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203495.zip) | Draft Reply LS on introduction of an offset to transmit CD-SSB and NCD-SSB at different times | Vivo |
| [7] | [R1-2203590](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203590.zip) | Discussion on NCD-SSB offset | ZTE, Sanechips |
| [8] | [R1-2204271](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204271.zip) | Discussion on RAN2 LS on introduction of an offset to transmit CD-SSB and NCD-SSB at different times | CMCC |
| [9] | [R1-2204434](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204434.zip) | Discussion on LS on introduction of an offset to transmit CD-SSB and NCD-SSB at different times | NEC |
| [10] | [R1-2203053](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203053.zip) | Remaining aspects of Bandwidth Reduction for RedCap UEs | Futurewei |
| [11] | [R1-2203109](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203109.zip) | Remaining issues on UE complexity reduction | Huawei, HiSilicon |
| [12] | [R1-2203517](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203517.zip) | Remaining issues on reduced maximum UE bandwidth | Vivo, Guangdong Genius |
| [13] | [R1-2204711](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204711.zip) | On RedCap UE complexity reduction | MediaTek Inc. |
| [14] | [R1-2204771](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204771.zip) | Remaining details on UE complexity reduction for Rel-17 RedCap | Intel Corporation |
| [15] | [R1-2200918](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2200918.zip) | On RAN1 aspects of RAN2 led issues for RedCap | Huawei, HiSilicon |
| [16] | [R1-2202532](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2202532.zip) | FL summary #5 on reduced maximum UE bandwidth for RedCap | Moderator (Ericsson) |