3GPP TSG-RAN WG2 #116-e Tdoc draft R2-2111348

Electronic meeting, 1st – 12th November 2021

Agenda Item: 8.12.2.2

Source: Ericsson (Rapporteur)

Title: Report - Using NCD-SSB instead of CD-SSB for RedCap UEs (PH2)

Document for: Discussion, Decision

# 1 Introduction

RAN1 sent an LS to RAN2 and RAN4 on use of NCD-SSB instead of CD-SSB in [R2-2110727](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_116-e/Docs//R2-2110727.zip). RAN1 discussed the following options related to configuration and use of DL BWPs for RedCap:

|  |
| --- |
| * **For FR1, following options:**   + **Option 1:**     - **For a separate initial DL BWP (if it does not include CD-SSB and the entire CORESET#0),**       * **RedCap UE does NOT expect it to contain SSB/CORESET#0/SIB.**     - **For an RRC-configured active DL BWP (if it does not include CD-SSB and the entire CORESET#0),**       * **RedCap UE does NOT expect it to contain SSB/CORESET#0/SIB.**   + **Option 2:**     - **For a separate initial DL BWP (if it does not include CD-SSB and the entire CORESET#0),**       * **If it is configured for random access while not for paging in idle/inactive mode, RedCap UE does NOT expect it to contain SSB/CORESET#0/SIB.**         + **FFS: For BWP#0 configuration option 1, whether the UE can expect SSB transmission in the separate initial DL BWP when it is used in connected mode.**       * **If it is configured for paging, RedCap UE expects it to contain NCD-SSB for serving cell but not CORESET#0/SIB.**     - **For an RRC-configured active DL BWP in connected mode (if it does not include CD-SSB and the entire CORESET#0),**       * **RedCap UE expects it to contain NCD-SSB for serving cell [FFS: or CSI-RS or measurement gap configuration] but not CORESET#0/SIB.**   + **Note: if a separate initial/RRC configured DL BWP is configured to contain the entire CORESET#0, CD-SSB is expected by RedCap UE.**   + **Note: The network may choose to configure SSB or MIB-configured CORESET#0 or SIB1 to be within the respective DL BWP.**   + **FFS: For Option 1 and Option 2, whether RedCap UE can/cannot expect SSB under certain other conditions, e.g., for SSB monitoring periodicity (i.e., SMTC configuration) and DRX cycle**   + **FFS: Whether additional mechanism for SI update or how SI update notifications and/or SI updates are signaled to RedCap UEs**   + **FFS: FR2 case** |

In the LS, RAN1 asks for feedback from RAN2 and RAN4 on the following questions:

|  |
| --- |
| RAN1 respectfully requests RAN2 and RAN4 to provide feedback about the use of NCD-SSB instead of CD-SSB in terms of functionality feasibility, performance/coexistence, and specification/implementation impacts (when applicable) for idle/inactive/connected mode procedures for serving and non-serving cells for a Rel-17 RedCap UE operating with an initial or non-initial DL BWP not containing CD-SSB. Specifically, RAN1 would like RAN2/RAN4 to respond to the following questions before the RAN1#107-e meeting:   1. [RAN2/4] whether it is feasible to use NCD-SSB for serving and non-serving cell measurements for idle, inactive, and/or connected mode for all or some of RRM, RLM, BFD, link recovery, RO selection, mobility, time/frequency tracking and AGC 2. [RAN2/4] whether it is feasible to use NCD-SSB as QCL source of other DL channels/signals and as spatial relation (for UL channels/signals) transmitted in idle, inactive, and/or connected mode in the initial/non-initial DL BWP of RedCap UE 3. [RAN2] whether/when the PCIs indicated by the NCD-SSB and CD-SSB can be the same/different, if both NCD-SSB and CD-SSB are transmitted on the serving cell of RedCap UE 4. [RAN2/4] whether/when periodicities and/or TX power and/or block indexes (provided by *ssb-PositionsInBurst* in SIB1 or in *ServingCellConfigCommon*) and/or QCL sources of NCD-SSB can be same/different from those of CD-SSB, if both NCD-SSB and CD-SSB are transmitted on the serving cell of RedCap UE 5. [RAN2/4] whether it is necessary to introduce configuration limitations for NCD-SSB (e.g., regarding frequency locations, periodicity), e.g., to ensure coexistence with legacy UEs 6. [RAN2/4] if CD-SSB is not transmitted in the non-initial DL BWP of RedCap UE, whether it is feasible to transmit periodic CSI-RS for UE to use as an alternative of SSB in the non-initial BWP of RedCap UE or rely on UE performing RF retuning as in measurement gap outside active BWP for BWP without SSB nor CORESET#0 operation 7. [RAN2/4] whether it is feasible for a RedCap UE to retune to a CD-SSB rather than use an NCD-SSB of larger periodicity 8. [RAN2/4] any other potential impacts identified by RAN2/4 on support NCD-SSB for measurement   In order for the RAN1 work within the Rel-17 RedCap WI to be finalized in December 2021 as expected, RAN1 would need responses from RAN2 and RAN4 already before RAN1#107-e, which starts 11th November 2021. |

In RAN2#116-e, an offline discussion took place to summarize the Tdocs listed below with an intention to come up with a list of proposals that are agreeable and a list of proposals that require further discussion during the online discussion that followed.

* [1] [R2-2109576](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109576.zip), Definition and reduced capabilities for RedCap UE, and NCD-SSB related LS, Huawei, HiSilicon
* [2] [R2-2109741](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109741.zip), Discussion on NCD SSB and UE type for RedCap UEs, vivo, Guangdong Genius
* [3] [R2-2109448](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109448.zip), Reply LS on use of NCD-SSB instead of CD-SSB for RedCap UE, Qualcomm Incorporated
* [4] [R2-2109451](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109451.zip), NCD-SSB and RedCap-specific BWPs, Qualcomm Incorporated
* [5] [R2-2110095](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2110095.zip), Making ND-SSB work for RedCap in Rel-17, Apple
* [6] [R2-2110773](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2110773.zip), Use of NCD-SSB instead of CD-SSB for RedCap UEs, Ericsson

The report from the offline discussion was provided in [R2-2111334](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs/R2-2111334.zip) and during the online discussion that followed, the following was agreed:

RAN2 confirmed understanding of the current situation:

(FFS if any of the following will be included in a reply LS to RAN1

1. For idle/inactive UEs, the concept of non-cell-defining SSB (NCD-SSB) and the corresponding procedures, i.e., measurements, cell (re-)selection, do not exist in the current RAN2 specifications.
2. For idle/inactive UEs, using NCD-SSB for measurements and cell (re-)selection would still require the UE to re-tune to the CORESET#0 for reading SIBs.
3. In connected mode, current RRC signalling allows configuring SSB-based RRM measurements on any (CD- or NCD-) SSB, but it does not allow using an NCD-SSB for RLM, BFD, link recovery, RO selection, mobility (mobility here refers to the frequency indicated in FreqDLInfo in HO command), in TCI-states or for any other functionality (other than RRM measurements).
4. It would be feasible to inform IDLE, INACTIVE and CONNECTED UEs about a NCD-SSB, however it is up to RAN1 and RAN4 to decide whether it is possible to use a NCD-SSB as QCL source.
5. According to the current RRC specification, PCIs indicated by other SSB and CD-SSB may be either the same or different if both other SSB and CD-SSB are transmitted on the serving cell.
6. PCIs indicated by the NCD-SSB and CD-SSB should be configured as same if both NCD-SSB and CD-SSB are transmitted on the serving cell.
7. According to the current RRC specification, periodicities and/or TX power and/or block indexes (provided by ssb-PositionsInBurst in SIB1 or in ServingCellConfigCommon) and/or QCL sources of other SSB may be either the same or different from those of CD-SSB, if both other SSB and CD-SSB are transmitted on the serving cell.
8. Use of CSI-RS for cell and beam RLM and measurements is already supported from RAN2 signalling standpoint.

In this document, we continue the discussion based on the agreements above with the intention to draft the replies to questions from RAN1 provided in the LS.

# 2 Discussion on draft replies to questions from RAN1

## 2.1 Question 1

**RAN1 Q1:** *[RAN2/4] whether it is feasible to use NCD-SSB for serving and non-serving cell measurements for idle, inactive, and/or connected mode for all or some of RRM, RLM, BFD, link recovery, RO selection, mobility, time/frequency tracking and AGC*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R1:** In connected mode, current RRC signalling allows configuring SSB-based RRM measurements on any (CD or NCD) SSB. For RLM, BFD, link recovery, RO selection, mobility, which refers to the frequency indicated in *FreqDLInfo* in HO command), in TCI-states or for any other functionality (other than RRM measurements), current RRC signalling does not using NCD-SSB, however it would be feasible to inform the UE about an NCD-SSB which it shall use instead of the CD-SSB.

In idle/inactive mode it would be feasible to inform UEs about an NCD-SSB from signalling standpoint. The concept of non-cell-defining SSB (NCD-SSB) and the corresponding procedures, i.e., measurements, cell (re-)selection, do not exist in the current RAN2 specifications and using NCD-SSB for measurements and cell (re-)selection would still require the UE to re-tune to the CORESET#0 for reading SIBs.

**Q1** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung |  | The proposal can be revised to highlight the fact and to avoid misunderstanding of RAN2 response by RAN1:  *RAN2 R1: In connected mode, current RRC signalling allows configuring SSB-based RRM measurements on any (CD or NCD) SSB. However, for RLM, BFD, link recovery, RO selection, mobility, which refers to the frequency indicated in FreqDLInfo in HO command), in TCI-states or for any other functionality (other than RRM measurements), current RRC signalling does not use NCD-SSB.*  *In idle/inactive mode it would be feasible to inform UEs about an NCD-SSB from signalling standpoint. The concept of non-cell-defining SSB (NCD-SSB) and the corresponding procedures, i.e., measurements, cell (re-)selection, do not exist in the current RAN2 specifications and using NCD-SSB for measurements and cell (re-)selection would still require the UE to re-tune to the CORESET#0 for reading SIBs.* |
| DENSO | Yes | We prefer the original sentence, as it reflects what is supported in the current spec and what would be feasible from signaling standpoint. |
| Qualcomm | Yes |  |
| OPPO | Yes |  |
|  |  |  |
|  |  |  |

**Summary - Q1**

TBD

## 2.2 Question 2

**RAN1 Q2:** *[RAN2/4] whether it is feasible to use NCD-SSB as QCL source of other DL channels/signals and as spatial relation (for UL channels/signals) transmitted in idle, inactive, and/or connected mode in the initial/non-initial DL BWP of RedCap UE*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R2:** It would be feasible to inform UEs in idle, inactive and/or connected mode about an NCD-SSB, however it is up to RAN1 and RAN4 to decide whether it is possible to use an NCD-SSB as QCL source.

**Q2** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes in principle | *RAN2 R2: It would be feasible to inform UEs in idle, inactive and/or connected mode about an NCD-SSB from signalling perspective, however it is up to RAN1 and RAN4 to decide whether it is possible to use an NCD-SSB as QCL source.* |
| DENSO | Yes in principle | Agree on Samsung’s text proposal. |
| Qualcomm | Yes in principle | We would like to suggest the following rewording:  “From signaling perspective, it is feasible to configure an NCD-SSB as QCL source for UEs in idle, inactive and/or connected mode . However, it is up to RAN1 and RAN4 to decide whether it is possible to use an NCD-SSB as QCL source.” |
| OPPO | Yes in principle | Agree on Qualcomm’s text proposal. |
|  |  |  |
|  |  |  |

**Summary – Q2**

TBD

## 2.3 Question 3

**RAN1 Q3:** *[RAN2] whether/when the PCIs indicated by the NCD-SSB and CD-SSB can be the same/different, if both NCD-SSB and CD-SSB are transmitted on the serving cell of RedCap UE.*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R3:** According to the current RRC specification, PCIs indicated by NCD-SSB and CD-SSB may either be same or different if both NCD-SSB and CD-SSB are transmitted on the serving cell. However, RAN2 thinks that PCIs indicated by the NCD-SSB and CD-SSB should be configured as same if both NCD-SSB and CD-SSB are transmitted on the serving cell.

**Q3** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | - |
| DENSO | Yes |  |
| Qualcomm | Yes |  |
| OPPO | Yes in principle | Prefer to add something like “…, in order to use NCD-SSB for serving and non-serving cell measurements for idle, inactive, and/or connected mode.” at the end of the last sentence. Otherwise, the answer sounds not so logical.  Suggested R3:  According to the current RRC specification, PCIs indicated by NCD-SSB and CD-SSB may either be same or different if both NCD-SSB and CD-SSB are transmitted on the serving cell. However, RAN2 thinks that PCIs indicated by the NCD-SSB and CD-SSB should be configured as same if both NCD-SSB and CD-SSB are transmitted on the serving cell, in order to use NCD-SSB for serving and non-serving cell measurements for idle, inactive, and/or connected mode. |
|  |  |  |
|  |  |  |

**Summary – Q3**

TBD

## 2.4 Question 4

**RAN1 Q4:** *[RAN2/4] whether/when periodicities and/or TX power and/or block indexes (provided by ssb-PositionsInBurst in SIB1 or in ServingCellConfigCommon) and/or QCL sources of NCD-SSB can be same/different from those of CD-SSB, if both NCD-SSB and CD-SSB are transmitted on the serving cell of RedCap UE*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R4:** According to the current RRC specification, periodicities and/or TX power and/or block indexes (provided by *ssb-PositionsInBurst* in SIB1 or in *ServingCellConfigCommon*) and/or QCL sources of NCD-SSB may either be same or different from those of CD-SSB, if both NCD-SSB and CD-SSB are transmitted on the serving cell. RAN2 thinks that it would be the simplest to configure those parameters same, otherwise further consideration is required to investigate the impact on signalling and procedures.

**Q4** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | - |
| DENSO | Yes in principle | The intention looks O.K. For this question, is it up to RAN1/4 to make a final decision? |
| Qualcomm | Yes |  |
| OPPO | Yes in principle | Same view aw DENSO. |
|  |  |  |
|  |  |  |

**Summary – Q4**

TBD

## 2.5 Question 5

**RAN1 Q5:** *[RAN2/4] whether it is necessary to introduce configuration limitations for NCD-SSB (e.g., regarding frequency locations, periodicity), e.g., to ensure coexistence with legacy UEs*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R5:** RAN2 could not reach consensus on whether it is necessary to introduce configuration limitations for NCD-SSB. Some companies think that NCD-SSB should not be on the sync raster and/or periodicity of NCD-SSB should be equal to or larger than that of CD-SSB whereas others think that there seems to be no need to have any limitations in the configurations, other than PCI as mentioned above or even if so this should be up to RAN1/4 to decide.

**Q5** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | - |
| DENSO | Yes |  |
| Qualcomm | - | Maybe we can have some online discussion to see if companies can converge before we agree or disagree on the above proposed reply? |
| OPPO | Yes |  |
|  |  |  |
|  |  |  |

**Summary – Q5**

TBD

## 2.6 Question 6

**RAN1 Q6:** *[RAN2/4] if CD-SSB is not transmitted in the non-initial DL BWP of RedCap UE, whether it is feasible to transmit periodic CSI-RS for UE to use as an alternative of SSB in the non-initial BWP of RedCap UE or rely on UE performing RF retuning as in measurement gap outside active BWP for BWP without SSB nor CORESET#0 operation.*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R6:** Use of CSI-RS for cell and beam RLM and measurements is already supported from RAN2 signalling standpoint. Regarding UE re-tuning to CD-SSB and CORESET#0; it is possible for the network to allow the UE to use gaps for intra-frequency measurements however whether those gaps are needed or feasible is up to RAN4 to decide.

**Q6** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | - |
| DENSO | Yes |  |
| Qualcomm | - | We’d like to suggest the following change:  “Use of CSI-RS for cell and beam RLM and measurements is already supported from RAN2 signalling standpoint. However, its use is an optional UE capability and may not be supported by all UEs. Regarding UE re-tuning to CD-SSB and CORESET#0; it is possible for the network to allow the UE to use gaps for intra-frequency measurements however whether those gaps are needed or feasible is up to RAN4 to decide.“ |
| OPPO | Yes |  |
|  |  |  |
|  |  |  |

**Summary – Q6**

TBD

## 2.7 Question 7

**RAN1 Q7:** *[RAN2/4] whether it is feasible for a RedCap UE to retune to a CD-SSB rather than use an NCD-SSB of larger periodicity*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R7:** It is feasible for a RedCap UE to retune to a CD-SSB rather than use an NCD-SSB of larger periodicity from RAN2 standpoint.

**Q7** Do you agree with the draft reply above? “Yes”, “Yes in principle” or “No”. If “Yes in principle” please provide suggestions on how to improve the text. If “No”, please explain why and provide a text proposal.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | - |
| DENSO | Yes |  |
| Qualcomm | - | We’d like to suggest the following changes:  “From RAN2 standpoint, it is possible for network to configure measurement gaps for a RedCap UE to retune to a CD-SSB rather than use an NCD-SSB of larger periodicity. However, it is up to RAN1/4 to decide whether it is more sensible/efficient to retune to a CD-SSB or to configure an NCD-SSB with a periodicity comparable to that of CD-SSB.“ |
| OPPO |  | OK with Qualcomm’s text proposal. |
|  |  |  |
|  |  |  |

**Summary – Q7**

TBD

## 2.8 Question 8

**RAN1 Q8:** *[RAN2/4] any other potential impacts identified by RAN2/4 on support NCD-SSB for measurement*

Based on the discussion so far, the rapporteur proposes the reply below for this question:

**RAN2 R8:** None

**Q8** Do you agree with the draft reply above? If “No”, please provide a text proposal for further discussion.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | - |
| DENSO | Yes |  |
| Qualcomm | Yes |  |
| OPPO | Yes |  |
|  |  |  |
|  |  |  |

**Summary – Q8**

TBD

# 3 Conclusion

Based on the discussion above rapporteur suggests the following:

TBD

# References

1. [R2-2109576](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109576.zip), Definition and reduced capabilities for RedCap UE, and NCD-SSB related LS, Huawei, HiSilicon, RAN2#116e, November 2021

1. [R2-2109741](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109741.zip), Discussion on NCD SSB and UE type for RedCap UEs, vivo, Guangdong Genius, RAN2#116e, November 2021

1. [R2-2109448](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109448.zip), Reply LS on use of NCD-SSB instead of CD-SSB for RedCap UE, Qualcomm Incorporated, RAN2#116e, November 2021

1. [R2-2109451](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2109451.zip), NCD-SSB and RedCap-specific BWPs, Qualcomm Incorporated, RAN2#116e, November 2021

1. [R2-2110095](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2110095.zip), Making ND-SSB work for RedCap in Rel-17, Apple, RAN2#116e, November 2021

1. [R2-2110773](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs//R2-2110773.zip), Use of NCD-SSB instead of CD-SSB for RedCap UEs, Ericsson, RAN2#116e, November 2021