**3GPP TSG RAN WG1 #117**  **R1-240xxxx**

**Fukuoka City,** **Fukuoka, Japan, May 20th – 24th, 2024**

**Source: Moderator (ZTE)**

**Title:** **Summary of discussion on RedCap initial DL BWP and NCD-SSB**

**Agenda item: 7**

**Document for:** **Discussion and decision**

# Introduction

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| **Rel-17 RedCap**R1-2405189 Discussion on Rel-17 RedCap remaining issues ZTE, SanechipsR1-2405190 Draft Rel-17 RedCap Correction on initial DL BWP ZTE, SanechipsR1-2405191 Draft shadow Rel-18 RedCap Correction on initial DL BWP ZTE, Sanechips |

Per guidance, this document summarizes the discussions during RAN1#117 based on the contributions [1][2][3] submitted to agenda item 7.

# Discussion

There are mainly two issues discussed in [1]. Issue 1 is related to the draft CR in [2] and [3] and issue 2 is to clarify the UE’s behavior for NCD-SSB reception.

## 2.1 Issue1: RedCap initial DL BWP

### Background for issue 1

In TS38.213 clause 12, the following is reused by RedCap UE.

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| If a UE is provided *controlResourceSetZero* and *searchSpaceZero* in *PDCCH-ConfigSIB1* or *PDCCH-ConfigCommon*, the UE determines a CORESET for a search space set from *controlResourcesetZero* as described in clause 13 and for Tables 13-0 through 13-10, and determines corresponding PDCCH monitoring occasions as described in clause 13 and for Tables 13-11 through 13-15. If the active DL BWP is not the initial DL BWP, the UE determines PDCCH monitoring occasions for the search space set only if the CORESET bandwidth is within the active DL BWP and the active DL BWP has same SCS configuration and same cyclic prefix as the initial DL BWP. |

Based on this, an observation is made in [1]

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| **Observation 1: Based on the current spec,** * **For NR UE, if non-initial active DL BWP contains CORESET#0, the SCS and CP of non-initial active DL should be the same as initial DL BWP for monitoring SS#0.**
* **For R17 RedCap UE, if non-initial active DL BWP contains CORESET#0, the SCS and CP of non-initial active DL should be the same as separate initial DL BWP if applicable for monitoring SS#0.**
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For RedCap UE, the initial DL BWP refers to the separate initial DL BWP, wherein the similar wording could be found in clause 17.1. However, the SCS and CP are separate configured for separate initial DL BWP, which may be different with CORESET#0. In this case, the following case may happen.



This case is observed in [1]

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| **Observation 2: If non-initial active DL BWP contains CORESET#0, it should have the same SCS and CP as separate initial DL BWP, but the separate initial DL BWP could have different SCS and CP as CORESET#0.** |

Seems the UE is not capable of processing different transmission with different SCS and CP in one BWP. To solve this issue, [1] discuss the following three solutions

Option 1: The separate initial DL BWP for RedCap should have the same SCS and CP as CORESET#0.

Option 2: The non-initial active DL BWP for RedCap should have the same SCS and CP as CORESET#0, if it contains CORESET#0.

Option 3: Define a new UE capability to support SS0 and other Searchspaces with different SCS in one BWP.

and made a proposal

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| **Proposal 3: Down-select one of the following options to solve the issue that non-initial active DL BWP may have different SCS as CORESET#0 when it contains OCRESET#0.*** **Option 1: The separate initial DL BWP for RedCap should have the same SCS and CP as CORESET#0.**
* **Option 2: The non-initial active DL BWP for RedCap should have the same SCS and CP as CORESET#0, if it contains CORESET#0.**
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Based on option1, a text proposal is provided

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| 17.1 RedCap UE proceduresProcedures for a RedCap UE are same as described for a UE in all other clauses of this document unless stated otherwise. In this clause, the term 'UE' refers to a RedCap UE.A UE expects the initial DL BWP and the active DL BWP after the UE (re)establishes dedicated RRC connection to be smaller than or equal to the maximum DL bandwidth that the UE supports. A UE can be provided a DL BWP by *initialDownlinkBWP-RedCap* in *DownlinkConfigCommonSIB*, and an UL BWP by *initialUplinkBWP-RedCap* in *UplinkConfigCommonSIB*. If *initialUplinkBWP* in *UplinkConfigCommonSIB* indicates an UL BWP that is larger than a maximum UL BWP that a UE supports, the UE expects to be provided an UL BWP by *initialUplinkBWP-RedCap* in *UplinkConfigCommonSIB* that is smaller than or equal to the maximum UL bandwidth that the UE supports.If a UE is provided *controlResourceSetZero* and *searchSpaceZero* in *PDCCH-ConfigSIB1* or *PDCCH-ConfigCommon*, the UE determines a CORESET for a search space set from *controlResourcesetZero* as described in clause 13 and for Tables 13-1 through 13-10, and determines corresponding PDCCH monitoring occasions as described in clause 13 and for Tables 13-11 through 13-15. If the active DL BWP is not the initial DL BWP, the UE determines PDCCH monitoring occasions for the search space set only if the CORESET bandwidth is within the active DL BWP and the active DL BWP has same SCS configuration and same cyclic prefix as the initial DL BWP, wherein the UE assumes the initial DL BWP has the same SCS configuration and cyclic prefix as the DL BWP provided by *initialDownlinkBWP* or as the PDCCH reception in the CORESET for Type0-PDCCH CSS set.For unpaired spectrum operation, a RedCap UE does not expect to receive a configuration where the center frequency for an initial DL BWP in which the UE is configured to monitor Type1-PDCCH CSS set, or a CSS set provided by *sdt-SearchSpace* for random-access based PUSCH transmission as described in clause 19.2, is different than the center frequency for an initial UL BWP in which the RedCap UE may transmit Msg1/Msg3 or MsgA. |

Based on option2, a text proposal is provided.

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| For each DL BWP in a set of DL BWPs of the PCell, a UE can be configured CORESETs for every type of CSS sets and for USS as described in clause 10.1. The UE does not expect to be configured without a CSS set on the PCell in the active DL BWP.If a UE is provided *controlResourceSetZero* and *searchSpaceZero* in *PDCCH-ConfigSIB1* or *PDCCH-ConfigCommon*, the UE determines a CORESET for a search space set from *controlResourcesetZero* as described in clause 13 and for Tables 13-0 through 13-10, and determines corresponding PDCCH monitoring occasions as described in clause 13 and for Tables 13-11 through 13-15. If the active DL BWP is not the initial DL BWP, the UE determines PDCCH monitoring occasions for the search space set only if the CORESET bandwidth is within the active DL BWP and the active DL BWP has same SCS configuration and same cyclic prefix as the ~~initial~~ DL BWP provided by *initialDownlinkBWP* oras the PDCCH reception in the CORESET for Type0-PDCCH CSS set.For each UL BWP in a set of UL BWPs of the PCell, or of the PUCCH-SCell, or of the PUCCH-sSCell the UE is configured resource sets for PUCCH transmissions as described in clause 9.2.1.  |

In [1], it suggests to consider text proposal based on option2 due to no limitation on the separate initial DL BWP configuration. A corresponding CR and shadow CR are provided in [2] and [3] respectively.

### Discussion for issue 1

Based on the background, companies are invited to comment on the following question. As reference, the suggested correction in [1] for Rel-17 RedCap is also copied here.

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| \*\*\* Unchanged parts are omitted \*\*\*For unpaired spectrum operation, a DL BWP from the set of configured DL BWPs with index provided by *BWP-Id* is linked with an UL BWP from the set of configured UL BWPs with index provided by *BWP-Id* when the DL BWP index and the UL BWP index are same. For unpaired spectrum operation, a UE does not expect to receive a configuration where the center frequency for a DL BWP is different than the center frequency for an UL BWP when the *BWP-Id* of the DL BWP is same as the *BWP-Id* of the UL BWP.For each DL BWP in a set of DL BWPs of the PCell, a UE can be configured CORESETs for every type of CSS sets and for USS as described in clause 10.1. The UE does not expect to be configured without a CSS set on the PCell in the active DL BWP.If a UE is provided *controlResourceSetZero* and *searchSpaceZero* in *PDCCH-ConfigSIB1* or *PDCCH-ConfigCommon*, the UE determines a CORESET for a search space set from *controlResourcesetZero* as described in clause 13 and for Tables 13-0 through 13-10, and determines corresponding PDCCH monitoring occasions as described in clause 13 and for Tables 13-11 through 13-15. If the active DL BWP is not the initial DL BWP, the UE determines PDCCH monitoring occasions for the search space set only if the CORESET bandwidth is within the active DL BWP and the active DL BWP has same SCS configuration and same cyclic prefix as the initial DL BWP.For each UL BWP in a set of UL BWPs of the PCell, or of the PUCCH-SCell, or of the PUCCH-sSCell the UE is configured resource sets for PUCCH transmissions as described in clause 9.2.1. \*\*\* Unchanged parts are omitted \*\*\* |

If you think the correction is needed, pls further share the view on the text proposals. For example, whether the corrections in [2] and [3] are acceptable, whether the correction should be based on option1 or option2, whether there are any other suggestions? If the correction is not needed, pls also further clarify the reasons.

#### Question 1-1:

**Do you think the correction for the PDCCH monitoring for SS#0 in non-initial DL BWP is needed? if Yes, pls share the view on the text proposals further.**

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| **Company** | **Comments** |
| Huawei, HiSilicon | Prefer Option 2. |
| CATT | Thanks FL for bringing this interesting discussion. However, usually the numerology (SCS and CP) is configured along with BWP, rather than being a characteristic of a search space or CORESET. Therefore, both options are not precise enough (i.e. numerology of ‘PDCCH reception in the CORESET for Type0-PDCCH CSS set’?). We cannot agree on such kind of wording.Alternatively, can we consider just clarifying that the ‘initial DL BWP’ includes both ‘*initialDownlinkBWP* and *initialDownlinkBWP-RedCap’?* Will it be enough? |
| Xiaomi | Share the similar view with CATT and can’t see the intention of this CR. The SCS and CP is BWP specific parameter which is configured by RRC signalling. For the involved sentence “If the active DL BWP is not the initial DL BWP, the UE determines PDCCH monitoring occasions for the search space set only if the CORESET bandwidth is within the active DL BWP and the active DL BWP has same SCS configuration and same cyclic prefix as the initial DL BWP”, we think it means that, for the non-initial DL BWP, only if the CORESET bandwidth is within the active DL BWP and the active DL BWP has the same SCS configuration and same cyclic prefix as the initial DL BWP, the UE could determines PDCCH monitoring occasions for the search space set. That is, “the active DL BWP has same SCS configuration and same cyclic prefix as the initial DL BWP” is a pre-condition for CSS#0 PMO determination in our view, rather than a result from the PMO determination. Besides, in our view, the initial DL BWP includes both legacy initial DL BWP and RedCap-specific initial DL BWP for RedCap and no further correction is needed. |
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## 2.2 Issue2: NCD-SSB

### Background for issue 2

In connected state, RedCap UE could be configured with the Rel-17 NCD-SSB. In [1], seems the NCD-SSB is not used to indicate SIB1, the Kssb and pdcch-ConfigSIB1 may not be needed for the RedCap UE, since anyway the RedCap UE already knows the CD-SSB’s position. And if the UE read the following text, it may cause confusion if the parameter is not set appropriately.

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| TS38.211In the frequency domain, an SS/PBCH block consists of 240 contiguous subcarriers with the subcarriers numbered in increasing order from 0 to 239 within the SS/PBCH block. The quantities $k$ and $l$ represent the frequency and time indices, respectively, within one SS/PBCH block. The UE may assume that the complex-valued symbols corresponding to resource elements denoted as 'Set to 0' in Table 7.4.3.1-1 are set to zero. The quantity $v$ in Table 7.4.3.1-1 is given by $v=N\_{ID}^{cell} mod 4$. The quantity $k\_{SSB}$ is the subcarrier offset from subcarrier 0 in common resource block $N\_{CRB}^{SSB}$ to the lowest-numbered subcarrier of the SS/PBCH block, or the SS/PBCH block after puncturing if applicable, where $N\_{CRB}^{SSB}$ is obtained from the higher-layer parameter *offsetToPointA*. - For operation with shared spectrum channel access in FR2-2 and for operation without shared spectrum channel access, the 4 least significant bits of $k\_{SSB}$ are given by the higher-layer parameter *ssb-SubcarrierOffset* and for FR1 the most significant bit of $k\_{SSB}$ is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. - For operation with shared spectrum channel access in FR1, the 4 least significant bits of $\overbar{k}\_{SSB}$ are given by the higher-layer parameter *ssb-SubcarrierOffset* and the most significant bit of $\overbar{k}\_{SSB}$ is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. If $\overbar{k}\_{SSB}\geq 24$, $k\_{SSB}=\overbar{k}\_{SSB}$ ; otherwise, $k\_{SSB}=2\left⌊{\overbar{k}\_{SSB}}/{2}\right⌋$.If *ssb-SubcarrierOffset* is not provided, $k\_{SSB}$ is derived from the frequency difference between the SS/PBCH block and Point A. |

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| TS38.213A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets. A search space set can be a CSS set or a USS set. A UE monitors PDCCH candidates in one or more of the following search spaces sets- a Type0-PDCCH CSS set on the primary cell of the MCG configured by - *pdcch-ConfigSIB1* in MIB or by *searchSpaceSIB1* in *PDCCH-ConfigCommon* or by *searchSpaceZero* in *PDCCH-ConfigCommon* for a DCI format 1\_0 with CRC scrambled by a SI-RNTI, or - *searchSpaceZero* by providing *searchSpaceID*=0 for *searchSpaceMCCH* or *searchSpaceMTCH* for a DCI format 4\_0 with CRC scrambled by a MCCH-RNTI or a G-RNTI for broadcast, or- *searchSpaceZero* by providing *searchSpaceID*=0 for *searchspaceMulticastMCCH* for a DCI format 4\_0 with CRC scrambled by a multicast-MCCH-RNTI, or by *searchSpaceMulticastMTCH* for a DCI format 4\_1 with CRC scrambled by a G-RNTI for multicast in RRC\_INACTIVE state |

Based on above, in [1], following proposal is made

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| **Proposal 1: Clarify that the RedCap UE in connected mode ignores the information related to *kssb* and *pdcch-ConfigSIB1* in MIB of Rel-17 introduced NCD-SSB.**  |

In idle state, if Rel-17 NCD-SSB frequency location configured by *absoluteFrequencySSB*, is not on the sync raster, the UE including NR UE and RedCap UE is not able to detect the Rel-17 NCD-SSB configured in connected state.

However, if it is configured on the sync raster, the NR UE and RedCap UE idle state may detect this NCD-SSB similar like legacy SSB not associated with the SIB1. In this case, the UE may detect the *kssb* and *pdcch-ConfigSIB1* to obtain some information related to CD-SSB frequency or GSCN, which may bring additional power consumption for blind decoding SSB and misleading the the CD-SSB frequency or GSCN information if *kssb* and *pdcch-ConfigSIB1* in the NCD-SSB is not configured appropriately. The following shows the related spec

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| TS38.213If a UE detects a first SS/PBCH block and determines that a CORESET for Type0-PDCCH CSS set is not present, and for $24\leq k\_{SSB}\leq 29$ for FR1 or for $12\leq k\_{SSB}\leq 13$ for FR2, the UE may determine the nearest (in the corresponding frequency direction) global synchronization channel number (GSCN) of a second SS/PBCH block having a CORESET for an associated Type0-PDCCH CSS set as $N\_{GSCN}^{Reference}+N\_{GSCN}^{Size}⋅N\_{GSCN}^{Offset}$. $N\_{GSCN}^{Reference}$ is the GSCN of the first SS/PBCH block, $N\_{GSCN}^{Size}=1$ in FR1 and FR2-1, $N\_{GSCN}^{Size}=$ 3 in FR2-2, and $N\_{GSCN}^{Offset}$ is a GSCN offset provided by Table 13-16 for FR1 and Table 13-17 for FR2. If the UE detects the second SS/PBCH block and the second SS/PBCH block does not provide a CORESET for Type0-PDCCH CSS set, as described in clause 4.1, the UE may ignore the information related to GSCN of SS/PBCH block locations for performing cell search.If a UE detects a SS/PBCH block and determines that a CORESET for Type0-PDCCH CSS set is not present, and for $k\_{SSB}=31$ for FR1 or for $k\_{SSB}=15$ for FR2, the UE determines that there is no SS/PBCH block having an associated Type0-PDCCH CSS set within a GSCN range $\left[N\_{GSCN}^{Reference}-N\_{GSCN}^{Start}, N\_{GSCN}^{Reference}+N\_{GSCN}^{End}\right]$. $N\_{GSCN}^{Start}$and $N\_{GSCN}^{End}$ are respectively determined by *controlResourceSetZero* and *searchSpaceZero* in *pdcch-ConfigSIB1*. If the GSCN range is $\left[N\_{GSCN}^{Reference}, N\_{GSCN}^{Reference}\right]$, the UE determines that there is no information for a second SS/PBCH block with a CORESET for an associated Type0-PDCCH CSS set on the detected SS/PBCH block. If a UE does not detect any SS/PBCH block providing a CORESET for Type0-PDCCH CSS set, as described in clause 4.1, within a time period determined by the UE, the UE may ignore the information related to GSCN of SS/PBCH locations in performing cell search. |

There are some potential solutions in [1] for the case when the Rel-17 NCD-SSB is configured on sync raster:

Option 1: up to implementation including gNB’s implementation and UE’s implementation. That’s to say, NCD-SSB could be configured on sync raster or not. If a UE in idle mode detects this NCD-SSB, still, up to UE implementation when the UE can not find CD-SSB.

Option 2: limit the NCD-SSB frequency location, i.e., should not be configured on the sync raster. This would brings spec impacts on RAN2 and have impacts on the current implementation and compatibility.

Option 3: NW guarantee *kssb* and *pdcch-ConfigSIB1* in the NCD-SSB is correct and No confusion would not caused when the UE detect this NCD-SSB. In this case, even the NCD-SSB is configured in connected mode for one UE, still, *kssb* and *pdcch-ConfigSIB1* should be provided appropriately. This also limit the NW implementation and may have compatibility issues.

Option 4: NW configure a reserved value for *kssb*. This also may have impacts on the current implementation and compatibility, and also have impacts on RAN1 spec.

Based on the above options for issue2 in idle state, [1] made a proposal and seems option 1 is suggested.

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| **Proposal 2: Conclude that how to configure the frequency location of Rel-17 NCD-SSB, and *kssb* and *pdcch-ConfigSIB1* in MIB of the NCD-SSB is up to gNB.** |

### Discussion for issue 2

Based on the proposal in [1],

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| **Proposal 1: Clarify that the RedCap UE in connected mode ignores the information related to *kssb* and *pdcch-ConfigSIB1* in MIB of Rel-17 introduced NCD-SSB.**  |

Companies are invited to share the views on proposal1 and the following Question 2-1.

#### Question 2-1

**In connected state, whether to clarify that the RedCap UE in connected mode should ignore the information related to *kssb* and *pdcch-ConfigSIB1* in MIB of Rel-17 introduced NCD-SSB?**

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| **Company** | **Comments** |
| Huawei, HiSilicon | The following RAN2 conclusion is sufficient. No further discussion is needed in RAN1.C:\Users\w00615726\AppData\Roaming\eSpace_Desktop\UserData\w00615726\imagefiles\2F740EE2-9604-4B1C-936F-40103E167345.png |
| CATT | Agree with HW. RAN2’s conclusion is enough. |
| Xiaomi | For the pdcch-configSIB1 in MIB, we think the RAN2 conclusion is sufficient and no further discussion is necessary. For the Kssb, we think the default value, maybe Kssb=30 for FR1 and Kssb=14 for FR2 can be implemented by the gNB scheduling and no further optimization is necessary.  |
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Based on proposal in [1],

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| **Proposal 2: Conclude that how to configure the frequency location of Rel-17 NCD-SSB, and *kssb* and *pdcch-ConfigSIB1* in MIB of the NCD-SSB is up to gNB.** |

Companies are invited to share the views on proposal 2 and the following Question 2-2.

#### Question 2-2

**In idle state, whether to clarify/conclude that how to configure the frequency location of Rel-17 NCD-SSB, and *kssb* and *pdcch-ConfigSIB1* in MIB of the NCD-SSB is up to gNB?**

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| **Company** | **Comments** |
| Huawei, HiSilicon | Same comment as above. |
| CATT | Same comment as above |
| Xiaomi  | Same view as above |
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# References

[1] R1-2405189 Discussion on Rel-17 RedCap remaining issues ZTE, Sanechips

[2] R1-2405190 Draft Rel-17 RedCap Correction on initial DL BWP ZTE, Sanechips

[3] R1-2405191 Draft shadow Rel-18 RedCap Correction on initial DL BWP ZTE, Sanechips

# Conclusion