**3GPP TSG RAN WG1 #101 R1-200xxxx**

**e-Meeting, May 25th – June 5th, 2020**

**Agenda Item:** 7.2.2.2.5

**Source:** Moderator (LG Electronics)

**Title:** Summary of email discussion [101-e-NR-unlic-NRU-WB-01] on DL/UL cell without intra-cell guard bands

**Document for:** Discussion and decision

# Introduction

[101-e-NR-unlic-NRU-WB-01] Email discussion on DL/UL cell without intra-cell guard bands (Issue A1+A2 in R1-2004018) focusing on the following until 5/29; if necessary, endorse associated TPs by 6/4 – Seonwook (LGE)

* How to set RRC parameters and whether/how to define RB set for DL cell with no GB
* Resolution of FFS from RAN1#100bis-e on BWP configuration for UL cell with no GB

This email discussion [101-e-NR-unlic-NRU-WB-01] is to discuss the following issues identified from [14].

* Issue #1: How to set RRC parameters and whether/how to define RB set for DL carrier with no GB
* Issue #2: Resolution of FFS from RAN1#100bis-e on BWP configuration for UL cell with no GB

# Issue #1: How to set RRC parameters and whether/how to define RB set for DL carrier with no GB

## <Background>

1. In RAN1#100bis-e meeting, the following agreement was made for DL carrier without intra-cell guard bands, but still 1) how to set RRC parameters and 2) whether/how to define RB set are open issues for DL carrier without intra-cell guard bands.

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| Agreement: (RAN1#100bis-e)  For a DL cell without intra-cell guard bands   * The bit-width of available RB-set indicator (if configured) in DCI format 2\_0 is equal to 1 * UE does not expect to be configured with search space with *freqMonitorLocations-r16* |

1. In RAN1#100bis-e meeting, the following agreement was made for UL carrier without intra-cell guard bands.

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| Agreement: (RAN1#100bis-e)  For an UL carrier without intra-cell guard bands when the parameter *useInterlacePUCCH-PUCCH* is configured in any of *BWP-UplinkCommon* and *BWP-UplinkDedicated*:   * The UL carrier can be configured with non-overlapping RB set(s) * For each RB set except for RB set 0, the starting CRB index is given by *startCRB-r16*   + For RB set 0, the starting CRB index is given by * The UE expects *nrofCRBs-r16* set to 0 for all GBs between two adjacent RB sets within the UL carrier. * The UE expects N RBs contained in each interlace of each RB set, wherein 10 <= N <= 11.   + For 30 kHz SCS, the number of RBs within any RB set is between 50 and 55, and for 15 kHz SCS, the number of RBs within any RB set is between 100 and 110 * Note: This configuration may be used for the case where transmission only occurs in a BWP if LBT is successful in all RB sets within the BWP (from RAN1#99 agreement) * Note: It’s up to gNB’s configuration to fulfill RAN4 requirement with  e.g., on maximum transmission bandwidth configuration, spectral emission mask, and so on. * Note: In order to reuse existing PUCCH/PUSCH resource allocation mechanisms, this proposal applies to all supported carrier bandwidths except 10 MHz * FFS: Whether BWP can be configured to be partially overlapping with a RB set |

## <Proposals in contributions>

As described in [14], at least following three alternatives are identified to define RB set for a DL carrier without intra-cell guard bands.

* Alt 1: The DL carrier without intra-cell guard bands consists of no RB set.
* Alt 2: The DL carrier without intra-cell guard bands consists of a single RB set.
* Alt 3: The DL carrier without intra-cell guard bands consists of one or multiple RB sets, same as UL carrier without intra-cell guard bands.

From signalling perspective,

* For Alt 3, the same mechanism introduced for UL carrier without intra-cell guard bands can be applied.
* For Alt 1 or Alt 2, even though the mechanism same as UL can be applied, an explicit signalling (rather than indicating starting CRB index and GB size) seems sufficient in order to reduce signalling overhead.

It should be noted that RB set definition for DL carrier without intra-cell guard bands may have an impact at least on UL signal/channel AI to finalize DCI 0\_0 in CSS design. Also, the corresponding TP can be discussed once one of alternatives is chosen in this week.

## <1st round comments>

Companies are encouraged to express preference among above three alternatives or other technical discussion points. In addition, companies are encouraged to provide views on how to set RRC parameters for DL carrier without intra-cell guard bands.

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| Company | Comments |
| LG Electronics | Object to Alt 2 since we have several agreements that RB set corresponds to LBT bandwidth. For Alt 2, if DL carrier has 40 MHz bandwidth, only one RB set is defined while the number of channels operating channel access procedure defined in TS 37.213 can be equal to two. Between Alt 1 and Alt 3, Alt 1 is slightly preferred but Alt 3 can be OK.  For signalling, we can reuse signalling mechanism for UL carrier without intra-cell guard bands. |
| Nokia, NSB | Alt1 is the simplest here, because in last meeting we agreed that CORESET/SS mirroring is not allowed, and we introduced concept of available/unavailable carrier/serving-cell. |
| Sharp | We object to Alt.2. Alt.2 violates the agreement for PUSCH scheduled by CSS at the last meeting. The impacted part of the agreement is highlighted as follows:  Agreement:   * For PUSCH scheduled by DCI 0\_0 received in a CSS when UL resource allocation Type 2 is configured, PUSCH is allocated to the RB set of the active UL BWP that intersects the RB set of the active DL BWP in which DCI 0\_0 is received. If there is no intersection, PUSCH is allocated to RB Set 0 of the active UL BWP. * FFS1: PUSCH allocation within the active UL BWP corresponding to an UL carrier without intra-cell guard bands * FFS2: Whether or not the first bullet is modified to “…the active DL BWP in which the first REG of the received DCI 0\_0 is located,” in order to facilitate a CORESET not confined to a single RB set.   Between Alt.1 and 3, we slightly prefer Alt.1. If Alt.3 win the majority, we are fine with it. |
| MediaTek | Alt1. However, some spec changes are still needed at least for PDCCH monitoring and CSI-RS reception on a DL carrier with no RB set. |
| Samsung | Alt 1 is preferred but Alt 3 can be ok. |
| ZTE, Sanechips | For Alt1, it actually does not have “RB set” concept. For this case or for large bandwidth, we want to know which type of LBT operation should be performed, wideband LBT or 20MHz LBT? If wideband is 20MHz, then current 20MHz LBT can be used and we can support Alt1;. Otherwise, maybe we need to introduce a new LBT operation for wideband in Rel-16 in addition to 20MHz LBT. for such spec change, we can not accept Alt1.  If the above issue for Alt1 cannot be solved, then we prefer to support Alt 3. |
| Lenovo, Motorola Mobility | Firstly, Alt 2 may violate the agreement of 20MHz bandwidth for a RB set.  Alt 3 is preferred.  For Alt 1, we share similar view with ZTE. Alt 1 is not clear on the LBT operation when the DL carrier has multiple 20MHz of bandwidth. |
| Ericsson | Alt-1 for the case of carrier bandwidth >20 MHz (for 20 MHz carriers, the absence of the RRC parameter indicates no guard bands).  Regarding Sharp and MediaTek’s comments, I agree, a spec change is needed if we agree to Alt-1 due to the PUSCH RB set allocation rule for DCI 0\_0 in CSS. However, in the FL summary for UL Signals and Channels (Thread-01), 3 different alternatives are being discussed for this rule, and all 3 remove the dependence on the definition of DL RB sets. Hence, I believe we should assume that this dependence will be removed.  For Alt-1, it would be helpful to tell RAN2 (e.g., in the RRC parameter spreadsheet), that for a DL carrier with bandwidth >20 MHz configured without guardbands, that there is no need to configure a list of zero-width guard bands (*nrofCRBS-r16* = 0); a list size of 1 would be sufficient.  IntraCellGuardBand-r16 ::= SEQUENCE (SIZE (1..ffsValue)) OF GuardBand-r16  GuardBand-r16 ::= SEQUENCE {  startCRB-r16 INTEGER (0..ffsValue), --FFS upper range 275  nrofCRBs-r16 INTEGER (1..ffsValue) |
| Qualcomm | We prefer Alt 3. This is the same problem as UL. Don’t see why we need two solutions to make the spec more complex. |

# Issue #2: Resolution of FFS from RAN1#100bis-e on BWP configuration for UL cell with no GB

## <Background>

1. In the agreement below, we have one remaining issue to resolve FFS point.

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| Agreement: (RAN1#100bis-e)  For an UL carrier without intra-cell guard bands when the parameter *useInterlacePUCCH-PUCCH* is configured in any of *BWP-UplinkCommon* and *BWP-UplinkDedicated*:   * The UL carrier can be configured with non-overlapping RB set(s) * For each RB set except for RB set 0, the starting CRB index is given by *startCRB-r16*   + For RB set 0, the starting CRB index is given by * The UE expects *nrofCRBs-r16* set to 0 for all GBs between two adjacent RB sets within the UL carrier. * The UE expects N RBs contained in each interlace of each RB set, wherein 10 <= N <= 11.   + For 30 kHz SCS, the number of RBs within any RB set is between 50 and 55, and for 15 kHz SCS, the number of RBs within any RB set is between 100 and 110 * Note: This configuration may be used for the case where transmission only occurs in a BWP if LBT is successful in all RB sets within the BWP (from RAN1#99 agreement) * Note: It’s up to gNB’s configuration to fulfill RAN4 requirement with  e.g., on maximum transmission bandwidth configuration, spectral emission mask, and so on. * Note: In order to reuse existing PUCCH/PUSCH resource allocation mechanisms, this proposal applies to all supported carrier bandwidths except 10 MHz * FFS: Whether BWP can be configured to be partially overlapping with a RB set |

## <Proposals in contributions>

As described in [14], companies expressed their preferences on the following two alternatives for an UL carrier without intra-cell guard bands.

* Alt 1: UL BWP within the UL carrier can be configured to include parts of a RB set, with some restriction such as at least 10 RBs in [at least one or each] interlace in a RB set.
  + Supported by vivo [1], ZTE [2], Ericsson [5], Samsung [6], LG Electronics [7], Sharp [10]
* Alt 2: The UE does not expect that UL BWP within the UL carrier is configured to include parts of a RB set, same as for a carrier with intra-cell guard bands.
  + Supported by Huawei [3], Nokia [9], Qualcomm, Samsung

Alt 2 takes advantage of minimizing spec change since we can have a common rule of BWP configuration not only for an UL carrier with intra-cell guard bands but also for an UL carrier without intra-cell guard bands. However, it would be restrictive for BWP configuration considering RAN4 requirement on maximum PRB configuration. For an instance, for a UL cell with 217 PRBs having 30 kHz SCS, 4 RB sets may have [52 55 55 55] or [54 54 54 55] PRBs, respectively, where any BWP satisfying Alt 2 but smaller than 80 MHz cannot be configured due to RAN4 requirement on maximum PRB configuration.

On the other hand, Alt 1 allows BWP partially overlapping with a RB set, which results in making BWP configuration flexible. For the instance where 4 RB sets may have [52 55 55 55] or [54 54 54 55] PRBs, respectively, 51 or 106 PRBs BWP can be configured, which leads to un-alignment between RB set boundary and BWP boundary but the number of un-aligned PRBs can be minimised.

## <1st round comments>

Companies are encouraged to express preference between two alternatives or other technical discussion points.

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| Company | Comments |
| LG Electronics | Alt 1 is preferred considering more flexible BWP configuration. |
| Nokia, NSB | Alt 2 is our preference, to maintain common design for NR-U. It should be firstly discussed whether there would be different capabilities in terms of how many LBT sub-bands in UL UE is capable to perform, however, R15 UEs support up to 100MHz channel band with 30kHz SCS in R15 as mandatory.  If the co-existence issue of UEs with mixed capabilities occurs, it may be addressed by re-configuring UL carrier in UE-specific way, as we pointed out in our contribution, or by UEs supporting non-nominal BWP size. Both are not optimal, but feasible in principle. Finally, as gNB vendor we could be fine with not having the restriction of aligning RB-set with BWP (i.e. Alt1), if the restriction is removed also for carrier with non-zero GB.  For carrier with non-zero GBs, if gNB operates 50-6-50-5-50-6-50 for one UE 80MHz, it cannot operate 50-5-50 in the middle for other UE with 40MHz BWP, because nominal BWP size is 106, gNB needs to configure 1 RB of BWP on top of edge GB. This one RB would not be scheduled, since it is on top of GB, but BWP size could be configured as nominal. |
| Sharp | Alt.2 makes severe restriction on BWP configuration. In the example raised above, 80 MHz carrier with 4 RB sets each comprising [52 55 55 55] or [54 54 54 55] PRBs, the network cannot configure 20 MHz initial UL BWP. Since the mandatory bandwidth for 20 MHz BWP is 51 RBs as per FG6-1. Specification change for Alt.1 is small as indicated by TP#1 in [10]. |
| ZTE, Sanechips | Support Alt1. Further, in order to reuse existing PUCCH/PUSCH resource allocation mechanisms, some restrictions can be made, e.g, restriction start CRB index of BWP aligns with start CRB index of a RB set as same as the case with intra-cell GB (). |
| Lenovo, Motorola Mobility | Regarding Alt 1, for a BWP with 20MHz bandwidth, it may be configured with part of a RB set. Therefore, one question for clarification is how to perform LBT for the BWP? |
| Ericsson | We prefer Alt-1 in order to avoid a bit messy per-UE carrier configuration. Having a restriction of 10 RBs in [at least one or each] interlace in a RB set is a reasonable relaxation to avoid this kind of configuration and be able to utilize the BWP sizes by RAN4.  Regarding Nokia’s suggestion to relax the strict requirement for carriers with non-zero guardbands, it seems like it would be okay in principle to allow the BWP to bleed into a GB if needed, since it should be understood that the GB on the edge is not scheduled to the UE. Is that the only relaxation that is needed, or is the intention that the BWP could overlap, say, only ½ of an RB set? I guess not. Having some sort of bounded relaxation seems important (analogous to Alt-1). |
| Qualcomm | Prefer Alt 2. Initial UL BWP does not need to follow this as it comes before this RB set configuration. |

# Conclusion

# Reference

1. R1-2003374 Remaining issues on wideband operation in NR-U vivo
2. R1-2003454 Remaining issues on the wideband operation for NR-U ZTE, Sanechips
3. R1-2003516 Maintenance on the wideband operation procedures Huawei, HiSilicon
4. R1-2003659 Remaining issues on wideband operation for NR-U MediaTek Inc.
5. R1-2003847 Wideband operation Ericsson
6. R1-2003864 Wide-band operation for NR-U Samsung
7. R1-2004017 Remaining issues of wide-band operation for NR-U LG Electronics
8. R1-2004089 Discussion on the remaining issues of wide-band operations OPPO
9. R1-2004256 Remaining issues on Wideband operation in NR-U Nokia, Nokia Shanghai Bell
10. R1-2004324 Remaining issues on wideband operation for NR-U Sharp
11. R1-2004447 TP for Wideband operation for NR-U operation Qualcomm Incorporated
12. R1-2004511 Remaining issues on Rel-16 NR-U wideband operations Panasonic
13. R1-2004041 Remaining issues on UL signals and channels for NR-U Fujitsu
14. R1-2004702 Summary#2 on maintenance of wide-band operation for NR-U LG Electronics

# Appendix A: Text proposals corresponding to Issues #1 and #2

## Issue #1

### From MediaTek [4],

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| ================================**Text Proposal 1 Starts**==================================  10 UE procedure for receiving control information  **<Unchanged parts are omitted>**  If a UE is provided *availableRB-SetPerCell-r16* for a serving cell*,* and   * if *intraCellGuardBandDL-r16* for the serving cell indicates no intra-cell guard-bands are configured, the UE is not required to monitor PDCCH candidates on the serving cell that are indicated as unavailable for receptions by DCI format 2\_0 as described in Clause 11.1.1. * if *intraCellGuardBandDL-r16* for the serving cell indicates intra-cell guard-bands are configured, the UE is not required to monitor PDCCH candidates that overlap with any RB from RB sets on the serving cell that are indicated as unavailable for receptions by DCI format 2\_0 as described in Clause 11.1.1.   **<Unchanged parts are omitted>**  =============================== **Text Proposal 1 Ends**===================================  ================================**Text Proposal 2 Starts**==================================  11.1.1 UE procedure for determining slot format  **<Unchanged parts are omitted>**  If *intraCellGuardBandDL-r16* for a serving cell indicates intra-cell guard-bands are configured and a UE is configured by higher layers to receive a CSI-RS or detects a DCI format 0\_1 indicating to the UE to receive a CSI-RS in one or more RB sets and a set of symbols of a slot in the serving cell, and the UE detects a DCI format 2\_0 with bitmap indicating that any RB set from the one or more RB sets is not available for reception, the UE cancels the CSI-RS reception in the set of symbols of the slot in the serving cell.  If *intraCellGuardBandDL-r16* for a serving cell indicates no intra-cell guard-bands are configured and a UE is configured by higher layers to receive a CSI-RS or detects a DCI format 0\_1 indicating to the UE to receive a CSI-RS in a set of symbols of a slot in the serving cell, and the UE detects a DCI format 2\_0 with one bit indicating that the serving cell is not available for reception, the UE cancels the CSI-RS reception in the set of symbols of the slot in the serving cell.  **<Unchanged parts are omitted>**  =============================== **Text Proposal 2 Ends**=================================== |

### From Nokia [9],

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| 7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  This sub-clause applies to carrier operating with shared spectrum channel access.  ~~For operation with shared spectrum channel access, w~~When the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. When UE is provided *nrofCRBs-r16=0,* carrier does not include intra-cell guard bands.  The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size . When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size . When UE is provided *nrofCRBs-r16=0* in *intraCellGuardBandUL-r16,* UE expects RB set to include 10 or 11 RBs for each interlace index defined in Clause 4.4.4.6 in [4, TS 38.211]. When UE is provided *nrofCRBs-r16=0* in *intraCellGuardBandDL-r16,* there are no RB sets present on the carrier.  For a carrier ~~with intra-cell guard band(s)~~, the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  ~~[The configuration of~~ *~~intraCellGuardBandDL-r16~~* ~~and~~ *~~intraCellGuardBandUL-r16~~* ~~can indicate to the UE that no intra-cell guard-bands are configured.]~~  <unchanged text omitted> |

## Issue #2

### From Sharp [10],

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| **Text proposal#1**  --------- beginning of text proposal for TS 38.214  6.1.2.2.3 Uplink resource allocation type 2  In uplink resource allocation of type 2, the resource block assignment information defined in [5, TS 38.212] indicates to a UE a set of up to *M* interlace indices, and for DCI 0\_0 monitored in a UE-specific search space and DCI 0\_1 a set of up to contiguous RB sets, where *M* and interlace indexing are defined in Clause 4.4.4.6 in [4, TS 38.211]. For DCI 0\_0 monitored in a UE-specific search space and DCI 0\_1, the UE shall determine the resource allocation in frequency domain within the active uplink BWP as an intersection of the resource blocks of the indicated interlaces and the indicated set of RB sets and intra-cell guard bands defined in Clause 7 between the indicated RB sets, if any. For DCI 0\_0 monitored in a common search space, the UE shall determine the resource allocation in frequency domain within the active uplink BWP as an intersection of the resource blocks of the indicated interlaces and a single uplink RB set of the active UL BWP. The uplink RB set is the one that intersects with the downlink RB set of the active downlink BWP in which the UE detects the DCI 0\_0. If there is no intersection, the uplink RB set is RB set 0 in the active uplink BWP.  -------- Unchanged contents are omitted  --------- end of text proposal |
| Text proposal#2  --------- beginning of text proposal for TS 38.214  7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  For operation with shared spectrum channel access, when the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size . When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size .  For a carrier with intra-cell guard band(s), the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  For a carrier without intra-cell guard band(s), RB sets that overlaps at least partially with the BWP *i* are numbered in increasing order from 0 to . The UE shall adjust to when is larger than . The UE shall adjust to when is smaller than .  [  -------- Unchanged contents are omitted  --------- end of text proposal |