3GPP TSG-RAN WG1 Meeting #101-e R1-20xxxxx

e-Meeting, 25th May – 5th June, 2020

Agenda Item: 7.2.2.1.3

Source: Moderator (Ericsson)

Title: FL Summary for [101-e-NR-unlic-NRU-ULSignalsChannels-01] Email discussion/approval

Document for: Discussion, Decision

# 1 Introduction

Based on the conclusion of the e-meeting preparation phase [18] and the vice-Chairman’s guidance, the following e-mail discussion has been kicked-off:

[101-e-NR-unlic-NRU-ULSignalsChannels-01] Email discussion/approval on the following from R1-2003842 until 5/29; if necessary, endorse associated TPs by 6/4 – Steve (Ericsson)

* Issue #1: RB set allocation when interlaced transmission is configured for PUSCH scheduled by RAR UL grant, PUSCH scheduled by DCI 0\_0 addressed to TC\_RNTI, and cell-specific PUCCH
* Issue #2: RB set allocation for PUSCH scheduled by DCI 0\_0 in a CSS to accomodate CORESET bandwidth spanning more than one UL RB set

The following topics are included in this email discussion

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| **Issue****#** | **Description** | **Tdoc****References** |
| 1 | RB set allocation when interlaced transmission configured for PUSCH scheduled by RAR UL grant, PUSCH scheduled by DCI 0\_0 addressed to TC\_RNTI, and cell-specific PUCCH* Requires discussion on supporting the two configuration alternatives for initial DL/UL BWP specified in 38.331 – Please see Appendix A of this summary.

TPs needed to 38.213 §8.3, 9.2.1 and 38.214 §6.1.2.2.3 | R1-2004041: P2-P4, TP2-TP4R1-2003511: TP#2R1-2003727: P2R1-2004012: P1,P2R1-2004084: P1,P2R1-2004442: P2R1-2003859: P2R1-2004323: P3-P6, TP1-3R1-2004003: P1R1-2003449: P1, TPR1-2003369: P1R1-2003841: P1,P3,P5,TP1,TP3,TP5 |
| 2 | PUSCH allocation rule for PUSCH scheduled by DCI 0\_0 in a CSS to accomodate CORESET bandwidth spanning more than one UL RB set, e.g., for carrier configured without intra-cell guardbandsTPs needed to 38.214 §6.1.2.2.3 | R1-2004041: P1, TP1R1-2003511: TP#1R1-2003727: P1R1-2004012: P3R1-2003822: P2,P3R1-2004274: P2,P3R1-2004084: P3R1-2004442: P1R1-2003859: P1R1-2004323: P7R1-2003841: P4,TP4 |

# 2 Discussion

## 2.1 UL RB Set Allocation Rules

## 2.1.1 Issue #1-1: RB set allocation for PUSCH scheduled by RAR UL grant and DCI 0\_0 addressed to TC\_RNTI

**Description**:

In RAN1#100b-e, the following agreement was made, but the FFS between Alt-1 and Alt-2 was not resolved:

Agreement:

To resolve the FFS in TP#1, support one of the following two alternatives for the PUSCH allocation rule.

* When UL resource allocation Type 2 is configured, the UE assumes that PUSCH is allocated as follows:
	+ Alt-1: PUSCH is allocated to the RB set of the active UL BWP that intersects the RB set of the active DL BWP in which the DCI 0\_1 that schedules the PDSCH containing the RAR UL grant is received. If there is no intersection, PUSCH is allocated to RB Set 0 of the active UL BWP.
	+ Alt-2: PUSCH is allocated to the initial UL BWP if the active UL BWP fully overlaps the initial UL BWP, otherwise PUSCH is allocated to RB Set 0 of the active UL BWP.
* FFS: Rule for PUSCH allocation for an UL carrier without intra-cell guard bands.

During the meeting, it was observed that Alt-1 by itself has a technical issue where it can happen, e.g., with SUL, that there is an ambiguity on which UL RB set the gNB should expect to receive Msg3 in the case of two different users in contention (CBRA) using different BWPs.

In the same meeting, the following alternative Alt-3 was proposed as a hybrid (compromise) between Alt-1 and Alt-2 to solve the technical issue with Alt-1, and also benefit from increased chance of LBT success for Msg3 transmission.

Alt-3 Proposal:

* When UL resource allocation Type 2 is configured, the UE assumes that PUSCH scheduled by a RAR UL grant is allocated as follows:
	+ If the active UL BWP fully overlaps the initial UL BWP, PUSCH is allocated to the initial UL BWP
	+ Otherwise, PUSCH is allocated to the RB set of the active UL BWP that intersects the RB set of the active DL BWP in which the DCI 0\_1 that schedules the PDSCH containing the RAR UL grant is received. If there is no intersection, PUSCH is allocated to RB Set 0 of the active UL BWP

During the meeting is was also discussed to have a common rule for RB set allocation for PUSCH scheduled by a RAR UL grant and PUSCH scheduled by DCI 0\_0 addressed to TC-RNTI. The rationale is that Msg3 and Msg3 re-transmissions should use the same UL RB set. Based on this observation, the following proposal was made in the FL summary in the last meeting (see [19]).

Proposal 8 Further discuss next meeting whether or not PUSCH scheduled by DCI 0\_0 in a CSS addressed to TC-RNTI should be allocated differently than for C-RNTI / CS-RNTI / MCS-RNTI.

### Unified Rule for PUSCH scheduled by RAR UL Grant and DCI 0\_0 addressed to TC-RNTI

For this meeting, multiple companies have provided input on these issues, and there is strong support for a common RB set allocation rule, hence the FL suggestion is to make the following intermediate proposal. Please comment if you have technical concerns with this proposal.

1. For the case of UL resource allocation Type 2, adopt a common RB set allocation rule for PUSCH scheduled by a RAR UL grant and PUSCH scheduled by DCI 0\_0 with CRC scrambled by TC-RNTI to ensure that initial and re-transmissions of PUSCH occur in the same UL RB set.

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| **Company** | **View/Position** |
| Moderator(Ericsson) | Support this intermediate proposal in order to make further progress |
| Huawei | Support the proposal |
| LG | Support the proposal to keep design consistency with Rel-15 NR |
| Sharp | We support it in principle. We can directly discuss the issue below. |
| Fujitsu | Support the proposal |
| OPPO | OK in principle, unless it is impossible to do it.  |
| Lenovo, Motorola Mobility | Support the proposal. |
| ZTE | Support it in principle |
| Qualcomm | Support |
| Samsung  | Support it in principle |
| Intel | Support the proposal |

### Capturing NR-U Study Item Agreement on 20 MHz Initial UL/DL BWP

As described in Appendix A, it is still an open issue how to capture the NR-U study item agreement that is listed in Section 7.2.1 of TR 38.889 [16]:

Initial active DL/UL BWP is approximately 20MHz for 5GHz band, though the final value will be quantized to number of PRBs. Initial active DL/UL BWP is approximately 20MHz for 6GHz band if similar channelization as 5GHz band is used for 6GHz band.

As described in Appendix A, this agreement is already captured implicitly for the initial DL BWP with existing Rel-15 specifications and Rel-16 agreements on the configuration of CORESET0. The way it is captured in specifications is to place limitations on what part of the initial DL BWP can be used for transmissions prior to the UE entering RRC\_CONNECTED mode, i.e., Msg2, Msg4 (Note: the restrictions are that the addressable PRBs must be confined to the bandwidth location of CORESET0. This is to be consistent with the Option 1 and Option 2 BWP configuration options specified in Rel-15 (see Appendix A,B).

* 38.212 Section 7.3.1.2.1 specifies that DCI 1\_0 addressed to SI-RNTI / RA-RNTI / TC-RNTI restricts the FDRA to the size of CORESET0
	+ e.g., for TC-RNTI the following is specified:

- Frequency domain resource assignment – bits

-  is the size of CORESET 0

* 38.214 Section 5.1.2.2 specifies that the PDSCH scheduled by DCI 1\_0 in CSS is restricted to the bandwidth of CORESET0 by virtue of the RB numbering, i.e.,

For a PDSCH scheduled with a DCI format 1\_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.

Since for NR-U it has been agreed and already specified that the CORESET0 configuration is always within an LBT bandwidth of 20 MHz, the above agreement limiting the “initial active DL BWP of approximately 20 MHz” is implicitly captured.

However, the above agreement is not yet captured for the UL. To be consistent with the DL, it is straight forward to place restrictions on the UL transmissions prior to the UE entering RRC\_CONNECTED mode, i.e., Msg3 PUSCH initial transmission, Msg3 PUSCH re-transmission(s), and PUCCH for HARQ-ACK of Msg4). As for the DL, the restriction would be such that the UL transmissions are within the same bandwidth location as occupied by CORESET0. This can be achieved with a straightforward modification of Alt-2 and Alt-3 proposals discussed in the previous meeting.

### Modification of Alt-2 and Alt-3 to capture NR-U Study Item Agreement

Multiple companies have provided input on Issue #1, but there is a split between companies supporting Alt-2 and those supporting Alt-3, hence further discussion is needed to down-select. In addition, it is needed to account for the NR-U study item agreement (see previous section) which restricts the bandwidth location of UL transmissions prior to the UE entering RRC\_CONNECTED mode. This should be done in a consistent way as for the DL which already captures the SI agreement. The following also assumes that a common RB set allocation rule is adopted for PUSCH scheduled by a RAR UL grant or by DCI 0\_0 with CRC scrambled by TC-RNTI.

1. Down select to one of {Alt-2’ and Alt-3’} in the following proposal which are based on modified versions of Alt-2 and Alt-3 discussed in RAN1#100b-e. This assumes intermediate Proposal 1 is agreed.
* For PUSCH scheduled by a RAR UL Grant (conveyed via PDSCH scheduled by DCI 1\_0 with CRC scrambled by RA-RNTI) or by DCI 0\_0 with CRC scrambled by TC-RNTI when UL Resource Allocation Type 2 is configured, the PUSCH is transmitted as follows:
	+ If the active UL BWP and the initial UL BWP have the same SCS and the active UL BWP includes all RBs of the initial UL BWP, or the active UL BWP is the initial UL BWP, the initial UL BWP is used for PUSCH, otherwise the active UL BWP is used.
	+ If the initial UL BWP is used:
		- PUSCH is allocated to the RB set of the initial UL BWP that intersects the lowest-indexed RB in the initial DL BWP of the CORESET in which the UE detects the DCI. If there is no intersection, PUSCH is allocated to RB set 0 of the initial UL BWP.
	+ Otherwise, if the active UL BWP is used:
		- Alt-2’
			* PUSCH is allocated to RB Set 0 of the active UL BWP
		- Alt-3’
			* PUSCH is allocated to a single RB set of the active UL BWP as per the intersection rule in [Alt-1 or Alt-2 or Alt-3 for Issue #2 (need to down-select)]. If there is no intersection, PUSCH is allocated to RB set 0 of the active UL BWP.

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| **Company** | **View/Position** |
| Moderator (Ericsson) | Alt-3’Provides a unified solution with Issue #2 for the active UL BWP. |
| Huawei | We agree to capture the 20MHz restriction for initial UL BWP, but we don’t think that “ intersect ” needs to be specified, clarification like “ UE assumes that the initial UL BWP is same as initial DL BWP ” is enough. Besides, the original agreement acheived in RAN1#99 was:Agreement:* The UE transmits PUSCH scheduled by fallback DCI in CSS within the initial BWP on the interlaces indicated by the X bits of the FDRA field
* Note: The FDRA field for fallback DCI in CSS does not include Y bits

During the WI, the above agreement is based on the assumption that only 20MHz initial UL BWP is considered, therefore the Y bits is truly meaningless. In RAN1#100e, “the initial BWP” was changed to “the active BWP”. Since the assumption has already been changed, it is unnecessarily to restrict that Y bits cannot be included. Currently, the proposed alternatives are diverse and it is difficult to make the consensus. Introducing Y bits can achieve a unified design for RAR grant, and DCI 0\_0 in both CSS and USS, and provide more flexibility for scheduling, also can reduce the complexity.  |
| LG | Agree with Huawei on the point that applying “intersect“ behavior is not necessary for the case where the active UL BWP includes the initial UL BWP, based on the agreement in SI phase listed in Section 7.2.1 of TR 38.889: * *Initial active DL/UL BWP is approximately 20MHz for 5GHz band, though the final value will be quantized to number of PRBs. Initial active DL/UL BWP is approximately 20MHz for 6GHz band if similar channelization as 5GHz band is used for 6GHz band.*

Therefore, it is required to modify the above proposal 2 as following:

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| * For PUSCH scheduled by a RAR UL Grant (conveyed via PDSCH scheduled by DCI 1\_0 with CRC scrambled by RA-RNTI) or by DCI 0\_0 with CRC scrambled by TC-RNTI when UL Resource Allocation Type 2 is configured, the PUSCH is transmitted as follows:
	+ If the active UL BWP and the initial UL BWP have the same SCS and the active UL BWP includes all RBs of the initial UL BWP, or the active UL BWP is the initial UL BWP, the initial UL BWP is used for PUSCH, ~~otherwise the active UL BWP is used.~~
	+ ~~If the initial UL BWP is used:~~
		- ~~PUSCH is allocated to the RB set of the initial UL BWP that intersects the lowest-indexed RB in the initial DL BWP of the CORESET in which the UE detects the DCI. If there is no intersection, PUSCH is allocated to RB set 0 of the initial UL BWP.~~
	+ Otherwise, ~~if the active UL BWP is used:~~
		- Alt-2’
			* PUSCH is allocated to RB Set 0 of the active UL BWP
		- Alt-3’
			* PUSCH is allocated to a single RB set of the active UL BWP as per the intersection rule in [Alt-1 or Alt-2 or Alt-3 for Issue #2 (need to down-select)]. If there is no intersection, PUSCH is allocated to RB set 0 of the active UL BWP.
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Given the above modification, Alt-3‘ is strongly preferred in terms of technical benefit for sharing gNB’s COT to improve UE’s LBT success rate in case when the gNB/UE schedules/transmits the PUSCH including this Msg. 3 PUSCH. In addition, applying the intersection rule could also be benifitial to align UL RB set among the UEs with contention for Msg. 3 PUSCH transmission.It should be noted that the above Alt-3‘ is consistent/aligned with the rule applied in legacy Rel-15 as below: * If the active UL BWP contains the initial UL BWP, the Msg. 3 PUSCH is allocated to the initial UL BWP. Otherwise, the Msg. 3 PUSCH is allocated as for the PUSCH scheduled by CSS DCI format 0\_0.
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| Sharp | We share Ericsson’s view that „Initial active DL BWP“ indicates CORESET0. On the other hand, we need to discuss what is „Iniital active UL BWP“. Until Jule 2018 (before publication of V15.6.0 for each RAN1 specs), „initial active UL BWP“ was used to indiate the initial UL BWP. At RAN1 meeting in May 2019, R1-1907500 and R1-1907501 was agreed for alignment of Initial UL BWP and Initial active UL BWP. Based on this understanding, we think that RAN1 common understanding is Initial UL BWP having 20 MHz.For 1st bullet, shouldn’t we say „msg3“ rather than „PUSCH scheduled by RAR UL grant“?For 1st sub-bullet, „the same SCS“ should be „the same SCS/CP“. Msg3 can be transmitted with a BWP with 60 kHz SCS and normal/extended CP for connected UEs.For 2nd sub-bullet, If we agree support for an initial UL BWP wider than 20 MHz, we are fine with that. If not, we can remove this sub-bullet.For 3ed sub-bullet, Alt-3‘ is prefered for common solution as the CSS. Anyway, this option is for a BWP which doesn’t share the bandwidth for initial access (e.g., PSCell). On the other hand, 1st and 2nd sub-bullet intends to solve potential ambiguity for RRC connected and idle UEs. We may discuss those separetely. |
| Fujitsu | For the second bullet, in our understanding, according to the previous agreement, configuration of initial DL/UL BWP based on either Option 1 or Option 2 in Appendix A should be under the restriction of ‘approximately 20MHz’. That is, the initial UL BWP should include only one RB set (and this should be clarified in the spec.), no matter how to configure it. If so, it is unnessary to detemine the single RB set for PUSCH among multiple RB sets in the initial UL BWP and the second bullet can be removed. But if most companies agree to support initial UL BWP including multiple RB sets, we are fine with the second bullet.For the third bullet, support Alt-3‘. Compared with Alt-2‘, Alt-3‘ can provide benefit on COT sharing and more flexibility for gNB implemention, e.g. on BWP configuration. |
| OPPO | We agree with Huawei that the current wording in the proposal seems not necessary. But the most important thing to clairfy first is: for idle UE, how does the UE determine the RB set boundaries in initial UL BWP? How to configure? All these are not clear for the moment. This has also been commented by several companies. From our point of view, the initial UL BWP contains only 1 RB set. Then the original Alt-2 is our preference, i.e. for active UE, if the active UL BWP fully includes initial UL BWP (with SCS, CP condition), the PUSCH in transmitted in the RB set overlaps with the initial UL BWP, otherwise, PUSCH in RB set 0. For idle UE, PUSCH is in initial UL BWP. But, if we will go for the case where initial UL BWP includes more than one RB sets, the proposed solution by FL seems very complicted. And we should also look at more concise alternatives. Here we propose another alternative:Alt- 4: the PUSCH for Msg3 initial transmission and retransmissin are allocated in the same RB set as the Msg1. Or similar to Huawei’s proposal: Alt-5: Y bits in RAR to indicate RB set for PUSCH transmission. |
| Lenovo, Motorola Mobility | At this moment, maybe we need to reach consensus on whether to support more than 20MHz bandwidth configured for initial UL BWP. From our side, we support only 20MHz bandwidth is configured for initial UL BWP. Due to single RB set in initial UL BWP, there is no need to add the restriction of “intersect…”. We suggest to remove 2nd bullet.For the 3rd bullet, Alt 3 is slightly preferred since it has potential benefit of COT sharing. |
| ZTE | Similar as Huawei and OPPO, we also support to include Y bits in RAR to indicate RB set for PUSCH transmission, and also for DCI 0\_0 in CSS to achieve the unified design. If the agreement is not changeable, the simplified slotuion alt.4 mentioned by OPPO is preferred. |
| Qualcomm | To capture SI agreement, it is fine to align initial UL BWP to initial DL BWP, but in that case, the initial UL BWP will be limited to 48 RBs, which as 2 interlaces with 9 RBs only. We may want to allow UL BWP to be 50RBs as well. In current NR, we already have the mechanism to indicating the initial UL BWP. Why not just reuse that mechanism, while adding the restrictions that* The initial UL BWP RBs include the initial DL BWP RBs, and
* The initial UL BWP is up to 50RBs wide. Note that initial DL/UL BWP have to align in the center, so 51 RB size is not possible.
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| Samsung  | Agree with HW, LG, Fujitsu, OPPO and Qualcomm that “ intersect ” is not necessary. We understand that current spec supports both opt 1 and 2 for licensed band which allows more than 20MHz, but it does not mean NR-U needs to follow the same thing.For NR-U, we had a specific agreement of approximately 20MHz initial active DL/UL BWP. To correctly capture this agreement, it can be simply specified from the configuration of UL BWP without any addtional modification of original Alt 2 and Alt 3. We can send an LS to RAN2 to ask them to capture our agreement in RAN2 spec, i.e. for for the reconfiguration of initial BWP in SIB, it is the same BW as CORESET0 configured by MIB. |
| Intel | Since we have the agreements that initial DL/UL BWP is 20MHz, we share LG’s view that the proposal could be simpilified as LG proposed. Alt-2’ is preferred due to its simplicity. On the other hand, if it is hard to converge, Alt-5 (from Huawei and OPPO), i.e. adding Y bits in RAR UL grant and DCI 1-0 in CSS may be considered to have a unified design for all UL DCI in any search space.  |
| Fujitsu2 | It seems most companies think that the initial UL BWP should include only 1 RB set, and it is unnecessary to have a rule for determining RB set in initial UL BWP. But if we will support the case where the initial UL BWP include multiple RB set, we tend to agree that Alt-4 proposed by OPPO is simpler, also with consideration that Alt-5 may need to further discuss how to interpret the Y bits and how to guarantee the indicated RB set is within UE’s active UL BWP. Furthermore, we noticed that with modification as below, Alt-4 is applicable to all cases, no matter whether the active UL BWP is overlapping with the initial UL BWP and whether the initial UL BWP includes only one or multiple RB sets. And it can provide more flexibility for gNB implementation, e.g. on BWP configuration. Considering those above, Alt-4 with the modification is a simple way to resolve the issues of Msg3 scheduling. Alt- 4 (with modification): the PUSCH for Msg3 initial transmission and retransmissin are allocated in the same RB set of the active UL BWP as the Msg1.  |
| vivo | Agree with HW, LG, Fujitsu, OPPO, Qualcomm and Samsung that “ intersect ” is not necessary. We agree to capture the 20MHz restriction for initial UL BWP. The proposed solution by FL seems to be too complicted based on the condition that initial UL BWP can include more than one RB set.If we can have a common understanding that initial DL/UL BWP is 20MHz, Alt 2 is preferred due to its simplicity. On the other hand, if it is hard to converge, we agree to support Alt-5 (from Huawei and OPPO), i.e. adding Y bits in RAR UL grant and DCI 1-0 in CSS to have a unified design for all UL DCI in any search space. |

## 2.1.2 Issue #1-2: RB set allocation for cell-specific PUCCH

As discussed in the previous section, the NR-U study item agreement is not yet captured for the UL. To be consistent with the DL and Proposal 2 above for PUSCH, it is straight forward to constrain the cell-specific PUCCH transmissions that are used prior to the UE entering RRC\_CONNECTED mode, i.e., for HARQ-ACK of Msg4. The constraint is that PUCCH is transmitted within the same bandwidth location as occupied by CORESET0.

1. Support the following proposal and associated TP#1.
* For cell-specific PUCCH resources used prior to dedicated configuration when *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* is configured, PUCCH is allocated to the RB set of the initial UL BWP that intersects the lowest-indexed RB in the initial DL BWP of the CORESET in which the UE detects the DCI scheduling a PDSCH reception. If there is no intersection, PUCCH is allocated to RB set 0 of the initial UL BWP.

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| **Company** | **View/Position** |
| Moderator (Ericsson) | Support the proposal |
| Huawei | There is no need to specify the “intersect“ , just clarify that UE assumes that the initial UL BWP is same as initial DL BWP  |
| LG | We have similar view with Huawei that the initial UL BWP consists of a single UL RB set of 20 MHz. |
| Sharp | The proposal is not necessary if wider than 20 MHz is not supported for the initial UL BWP. |
| Fujitsu | Similar to our comment on the second bullet of Proposal 2 in 2.1.1. According to the previous agreement, the initial UL BWP should include only one RB set, no matter how to configure it. If so, it is unnessary to detemine the single RB set for PUCCH among multiple RB sets in the initial UL BWP.  |
| OPPO | Not support this proposal. If the initial UL BWP contains only one RB set, this is no ambiguity. If the initial UL BWP contains more than one RB set, PUCCH can use the Msg1 RB set.  |
| Lenovo, Motorola Mobility | Not necessary.From our side, we support only 20MHz bandwidth is configured for initial UL BWP. Due to single RB set in initial UL BWP, there is no need to add the restriction of “intersect…”.  |
| ZTE | We share the similar views as above that initial UL BWP contains a single RB set. |
| Qualcomm | Not needed. The initial UL BWP can be either align with initial DL BWP or one RB more on each side. |
| Samsung | As commented in proposal 2 of 2.1.1, initial UL BWP is not wider than 20MHz, i.e. it contains a single UL RB set of 20MHz, so no need of this proposal. |
| Intel | No need the proposal assuming initial UL BWP is a just 20MHz, i.e. a RB set. The 20MHz for initial UL BWP should be clarified in RAN1 or RAN2 spec |
| vivo | Agree with views as above that initial UL BWP contains a single RB set. |

Reason for changes

Implementation of agreement from NR-U study item to ensure transmissions prior to the UE entering RRC connected mode are restricted to ~20 MHz including HARQ ACK of Msg4 on cell-specific PUCCH resource

Summary of changes

Introduction of RB set allocation rule for cell-specific PUCCH resource

Specs/Sections impacted

38.213 Section 9.2.1

Consequences if not approved

Undefined RB set allocation for cell-specific PUCCH

--------------------------------------- Text Proposal (TP#1) for 38.213, Section 9.2.1 ---------------------------------

\*\*\* Unchanged text omitted \*\*\*

If a UE is provided a PUCCH resource by *pucch-ResourceCommon* and is provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon*

- the UE determines for the PUCCH resource an interlace index $m$ as $m=\left(m\_{0}+\left⌊{r\_{PUCCH}}/{N\_{CS}}\right⌋\right)modM$ where $M$ is a number of interlaces [4, TS 38.211] and $m\_{0}=RB\_{BWP}^{offset}$ is an interlace index offset and $RB\_{BWP}^{offset}$ is as given in Table 9.2.1-1

- the UE determines the PRB allocation for the PUCCH resource from the intersection of the RBs corresponding to interlace $m$ and the RBs of a single UL RB set within the initial UL BWP. The UL RB set is the one that intersects with the lowest-indexed RB in the initial DL BWP of the CORESET in which the UE detects the DCI format. If there is no intersection, the UL RB set is RB set 0 in the initial UL BWP.

- the UE determines an initial cyclic shift index in a set of initial cyclic shift indexes as $r\_{PUCCH}modN\_{CS}$, where $N\_{CS}$ is the total number of initial cyclic shifts indexes in the set of initial cyclic shift indexes in Table 9.2.1-1

- if *pucch-ResourceCommon* indicates

- index 0: the first symbol is 9 for a PUCCH resource with PUCCH format 0 if $r\_{PUCCH}\geq 10$

- index 1 or 2: the first symbol is 9 for a PUCCH resource with PUCCH format 0 if $r\_{PUCCH}=15$

- index 3, 7, or 11: an orthogonal cover code with index 1 is used for a PUCCH resource with PUCCH format 1 if $r\_{PUCCH}\geq 10$

- the UE does not expect *pucch-ResourceCommon* to indicate index 15

\*\*\* Unchanged text omitted \*\*\*

------------------------------------------------------ End Text Proposal -------------------------------------------------------

## 2.2 Issue #2: PUSCH allocation rule for PUSCH scheduled by DCI 0\_0 in a CSS to accomodate CORESET bandwidth spanning more than one UL RB set

**Description**:

In RAN1#100bis-e, the following proposal was made in the FL summary [19] for further discussion in this meeting:

Proposal 9 Further discuss next meeting whether or not the PUSCH allocation rule corresponding to DCI 0\_0 in a CSS requires modification to facilitate a CORESET not confined to a single RB set.

Multiple companies have provided input on this issue, and there is strong support to adapt the PUSCH allocation rule for DCI 0\_0 in a CSS to accommodate CORESET bandwidth that is not confined to a single DL RB set. Companies have observed that this would be a typical configuration for a DL carrier without intra-cell guard bands where a legacy (Rel-15) CORSET would be configured in an arbitrary bandwidth, either localized or distributed.

The proposals from the different companies are quite similar for how to specify to which UL RB set the PUSCH is allocated. Paraphrasing to some extent, the following proposals have been made

The UL RB set to which PUSCH is allocated is the one:

* that intersects the first REG (or lowest-indexed REG) of the detected DCI 0\_0
* that intersects the first REG of the lowest indexed CCE of the detected DCI 0\_0
* that intersects the first (or lowest indexed) DL RB set of the detected DCI 0\_0
* that intersects the first RB of the CORESET in which the DCI 0\_0 is detected
* that is the lowest indexed UL RB set that intersects one or more DL RB sets in which the DCI 0\_0 is detected
* that is the lowest indexed UL RB set amongst UL RB set(s) that intersect any RB in which DCI 0\_0 is detected

All companies have proposed that if there is no intersection, the PUSCH is allocated to RB set 0 of the active UL BWP.

As can be seen, several of these proposals make reference to DL RB sets; however, there is ongoing discussion in the Wideband agenda item about whether or not RB sets even need to be defined for a DL carrier without intra-cell guard bands. Hence, it would be desirable to make the RB set allocation rule for PUSCH independent from whether or not RB sets are defined for the DL.

Eliminating the approaches that rely on the definition of DL RB sets, and merging the above approaches that are similar, there ends up being essentially 3 alternatives that can be discussed. Note that the discussion here is intentionally restricted to DCI 0\_0 in a CSS addressed to C-RNTI / CS-RNTI / MCS-C-RNTI since it proposed for Issue #1 to handle TC-RNTI separately.

The first alternative is similar to what is proposed in [11],[3],[5],[15],[7] which uses the wording “the first REG (or lowest indexed REG)”

The second alaternative is similar to what is proposed in [13] which uses the wording “the first RB of the CORESET in which the DCI 0\_0 is detected.”

The third alternative is similar to what is proposed in [10] which uses the wording “the lowest indexed UL RB set amongst UL RB set(s) that intersect any RB in which DCI 0\_0 is detected.”

1. Down select to one of {Alt-1, Alt-2, Alt-3} in the following proposal. Support associated text proposal TP#2 corresponding to selected alternative.

For PUSCH with UL resource allocation Type 2 scheduled by DCI 0\_0 with CRC scrambled by C-RNTI / CS-RNTI / MCS-RNTI received in a CSS, PUSCH is allocated to a single UL RB set in the active UL BWP where the UL RB set is

* **Alt-1**: the one that intersects the lowest-indexed REG of the PDCCH in the active DL BWP in which the UE detects the DCI
* **Alt-2**: the one that intersects the lowest-indexed RB in the active BWP of the CORESET in which the UE detects the DCI
* **Alt-3**: the lowest indexed one amongst UL RB set(s) that intersect any RB of the PDCCH in the active DL BWP in which the UE detects the DCI

If there is no intersection, PUSCH is allocated to RB set 0 of the active UL BWP.

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Moderator (Ericsson) | Alt-1 |
| Huawei | Considering that we have spent a lot of time on this topic, and it is difficult to achieve the consensus, like issue 1-1, we propose to introduce Y bits in CSS. A unified design for USS and CSS would reduce the complexity for implementation.  |
| LG | Alt-3 is desirable to acquire more chances of sharing the gNB’s COT for both contiguous and non-contigous CORESET configured for the DCI transmission. For example, as shown the figures below, if the PRBs for PDCCH (or CORESET or any DL RBs) in which the DCI 0\_0 is received are non-consecutive, the results of UL RB set for PUSCH would be different.According to above figures, three Cases are provided. Regarding to Case 3, the PUSCH will be transmitted in the UL RB set #0 using both Alt-1 and Alt-2, but those alternatives cannot achieve the benifit to share the gNB’s COT. However, using Alt-3, the PUSCH will be transmitted in the UL RB set #1 and this alternative can achieve the sharing of the gNB’s COT. |
| Sharp | Alt-3 is slightly prefered since Alt-3 uses similar approach for PUSCH allocation in a case where there is no intersection between DL RB-sets and UL RB-sets. From the functionality point of view, we think Alt.1 and Alt.3 achieves the same goal. Alt.2 has less flexibility than Alt.1 and Alt.3 since it relies on the semi-static RB allocation for CORESET. |
| Fujitsu | Support Alt-1. And we are also fine with Alt-3. |
| OPPO | We are fine with Huawei’s proposal. |
| Lenovo, Motorola Mobility | Alt 3 is preferred.  |
| ZTE | We are also fine to introduce Y bits in CSS. |
| Qualcomm | Alt 1. For Alt 3, the issue is for AL8 and AL16, the UE may not be able to figure out the set of RBs carry the PDCCH, as AL16 can decode as AL8 and AL8 can decode as AL16. |
| Samsung | To take advantage of gNB’s COT, we propose to modify Alt-2 as follows,Alt-2’: the one that intersects the lowest-indexed RB of the PDCCH in the active BWP in which the UE detects the DCIWe’re also fine with Alt-1. |
| Intel | We prefer Alt-1. It is not clear what *lowest-indexed REG* means? Is it the REG with lowest physical PRB index of the PDCCH, or lowest REG of the first CCE of the PDCCH? In interleaved CCE to REG mapping, lowest physical REG can be differnet from lowest REG of first CCE for a PDCCH. As Huawei and OPPO commented, relying Y bits for flexible indication is also fine for us.  |
| vivo | Alt 3 is preferred. In addition, we are also fine to introduce Y bits in CSS. |

Reason for changes

* Support for legacy (Rel-15) CORESET in a DL carrier without intra-cell guard bands
* Removal of dependency of PUSCH allocation rule on DL RB sets
* Restriction of rule to DCI 0\_0 addressed to C-RNTI, CS-RNTI, MCS-C-RNTI (PUSCH allocation rule for TC-RNTI to be agreed and specified separately)

Summary of changes

* Restriction of PUSCH allocation rule to to DCI 0\_0 addressed to C-RNTI, CS-RNTI, MCS-C-RNTI (PUSCH allocation rule for TC-RNTI to be agreed and specified separately)
* Modification of UL RB set determination rule

Specs/Sections impacted

38.214 Section 6.1.2.2.3

Consequences if not approved

PUSCH allocation does not work for legacy (Rel-15) CORESET spanning more than one DL RB set

PUSCH allocation rule broken if RB sets are not specified for DL carrier without intra-cell guard bands

---------------------------- Text Proposal (TP#2) for 38.214, Section 6.1.2.2.3 -----------------------------

\*\*\* Unchanged text omitted \*\*\*

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 $ N\_{RB-set,UL}^{BWP}$ 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 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.

[Alt-1]

For DCI 0\_0 with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI, monitored in a common search space the UE shall determine the resource allocation in frequency domain 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 the lowest-indexed REG of the PDCCH in the active downlink BWP in which the UE detects the DCI ~~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.

[Alt-2]

For DCI 0\_0 with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI, monitored in a common search space the UE shall determine the resource allocation in frequency domain 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 the lowest-indexed RB in the active downlink BWP of the CORESET in which the UE detects the DCI ~~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.

[Alt-3]

For DCI 0\_0 with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI, monitored in a common search space the UE shall determine the resource allocation in frequency domain 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 lowest-indexed one amongst uplink RB set(s) that intersect~~s~~ any RB of the PDCCH in the active downlink BWP in which the UE detects the DCI ~~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 text omitted \*\*\*

------------------------------------------------------ End Text Proposal -------------------------------------------------------

# References

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2. R1-2003449 Remaining issues on the UL channels for NR-U ZTE, Sanechips
3. R1-2003511 Maintenance on uplink signals and channels Huawei, HiSilicon
4. R1-2003655 Remaining issues on UL signals and channels for NR-U MediaTek Inc.
5. R1-2003727 UL signals and channels for NR-unlicensed Intel Corporation
6. R1-2003822 Text proposals for UL signals and channels for NR-U Lenovo, Motorola Mobility
7. R1-2003841 UL signals and channels Ericsson
8. R1-2003859 UL signals and channels for NR-U Samsung
9. R1-2004003 Remaining issues in UL signals and channels for NR-U Spreadtrum Communications
10. R1-2004012 Remaining issues of UL signals and channels for NR-U LG Electronics
11. R1-2004041 Remaining issues on UL signals and channels for NR-U Fujitsu
12. R1-2004084 Discussion on the remaining issues of UL signals and channels OPPO
13. R1-2004274 Remaining Issues on UL Signals and Channels for NR-U Nokia, Nokia Shanghai Bell
14. R1-2004323 Remaining issues on UL signals/channels for NR-U Sharp
15. R1-2004442 TP for UL signals and channels for NR-U Qualcomm Incorporated
16. 3GPP TR 38.889, “Study on NR-based access to unlicensed spectrum,” v.16.0.0, December 2018.
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18. R1-2003842, “Feature lead summary for Maintenance of UL Signals and Channels,” Moderator (Ericsson), RAN1#101-e, May 2020.
19. R1-2003055, “FL Summary #2 for [100b-e-NR-unlic-NRU-ULSignalsChannels-01] Email discussion/approval,” Moderator (Ericsson), RAN1#100bis-e, April 2020.
20. R1-2003056, “FL Summary #2 for [100b-e-NR-unlic-NRU-ULSignalsChannels-02] Email discussion/approval,” Moderator (Ericsson), RAN1#100bis-e, April 2020.

# Appendix A Configuration Options for Initial DL/UL BWP

In Section 7.2.1 of the TR from the NR-U study item, it is stated that the initial DL/UL BWP is ~20 MHz (see Section 7.2.1 of [16]):

This originated from an NR-U agreement during RAN1#93, which was the same meeting in which RAN1 discussed an LS from RAN2 on two possible configuration options for the initial DL/UL BWP. RAN1 ended up agreeing to support the two configuration options (Option 1 and Option 2) listed in Appendix B.2 of 38.331. This is copied into Appendix B below for convenience.

Initial active DL/UL BWP is approximately 20MHz for 5GHz band, though the final value will be quantized to number of PRBs. Initial active DL/UL BWP is approximately 20MHz for 6GHz band if similar channelization as 5GHz band is used for 6GHz band.

For the case of UL resource allocation Type 2 (interlace transmission), these configuration options are relevant for the discussion on RB set allocation for the following cases which make use of the initial UL BWP:

* RB set allocation rule for PUSCH scheduled by RAR UL Grant, i.e., Msg3 of the RACH procedure
* RB set allocation rule for PUSCH scheduled by DCI 0\_0 addressed to TC-RNTI, i.e., for Msg3 re-transmissions
* RB set allocation rule for PUCCH transmissions prior to dedicated configuration, e.g., for HARQ ACK of Msg4

Since Rel-15 supports both Option 1 and Option 2, it should be further discussed how to capture the NR-U agreement on 20 MHz initial DL/UL BWP in consideration of both of these options. As it turns out, this is fairly straight forward to do, as will be discussed here. In fact, the Rel-15 spec already supports that the DL transmissions prior to the UE entering RRC\_CONNECTED mode (e.g., Msg2 and Msg4) are confined to the same bandwidth as CORESET0 (~20 MHz for NR-U), regardless of whether Option 1 or Option 2 is used, i.e., regardless of the size of the initial DL BWP:

* 38.212 specifies that DCI 1\_0 addressed to SI-RNTI / RA-RNTI / TC-RNTI restricts the FDRA to the size of CORESET0
* 38.214 Section 5.1.2.2 specifies that the PDSCH scheduled by DCI 1\_0 in CSS is restricted to the bandwidth of CORESET0.

Hence, what is left to discuss is UL transmissions prior to the UE entering RRC\_CONNECTED mode (see above 3 bullets). To help with the discussion, consider the basic UE BWP capability, i.e., support of single “RRC configured” UL/DL BWP. This basic capability is described in FG 6-1 in 3GPP TR 38.822. Whether or not the UE supports additional BWPs (up to 2 or up to 4) doesn’t affect the discussion. Figure 1 below illustrates Option 1 and Option 2 adapted to the NR-U scenario, i.e., CORESET0 confined to a single RB set (~20 MHz). It shows the case for UEs that support a single “RRC configured” DL/UL BWP of bandwidth 80 MHz (spanning 4 RB sets) which the UE will uses once in CONNECTED mode for PxSCH/PxCCH transmission/reception.

The diagram shows time on the x-axis and frequency on the y-axis to illustrate the sequence in moving from IDLE to CONNECTED mode and the size of the various BWPs along the way. The main difference between Option 1 and Option 2 is that two BWPs are configured in Option 1, i.e., DL/UL BWP #0 (1 RB set) and #1 (4 RB sets), whereas only a single BWP is configured in Option 2, i.e., DL/UL BWP #0 (4 RB sets). As per 38.331, in Option 1, BWP#0 is not configured with dedicated parameters – i.e., only *BWP-DownlinkCommon* and *BWP-UplinkCommon* are configured in this BWP. This can be viewed as a “temporary BWP,” that is typically not used again after initial access since it has quite limited functionality. Despite the fact that Option 1 has two BWPs, it is still counted (in terms of UE capability) as a single “RRC configured BWP” (see extract from 38.331 in Appendix B below).

As discussed previously, despite the fact that the DL BWP #0 is >20 MHz for Option 2, according to the Rel-15 specifications, the DL transmission prior to the UE entering RRC\_CONNECTED mode (e.g., Msg2, Msg4) are already restricted to be within the bandwidth of CORESET0. Hence, the agreement in TR is already captured by virtue of the fact that in NR-U it was agreed (and specified) that the CORESET0 bandwidth is 48 PRBs (~20 MHz). Note that Rel-15 specifies that the initial DL BWP must completely overlap CORESET0 (see parameter *initialDownlinkBWP* in *DownlinkConfigCommonSIB*).

Discussion Points:

What is left to discuss further is how to implement the agreement for the UL for both Option 1 and Option 2. A straightforward approach would be for NR-U to make a similar restriction that PUSCH/PUCCH transmissions prior to the UE entering connected mode (e.g., Msg3, HARQ ACK of Msg4) are restricted to an RB set that is contained within the bandwidth of CORESET0. This would then ensure that the agreement from the TR works for both Option 1 and Option 2.

1. For PUSCH transmission prior to dedicated configuration (e.g., Msg3 PUSCH and potential Msg3 re-transmissions), we are already discussing RB set allocation rules for PUSCH scheduled by RAR UL grant and DCI 0\_0 addressed to TC-RNTI (Issue #1 in the table in Section 2), and it should be straight forward to ensure that the rules apply to both Option 1 and Option 2.
	* Both Alt-2 or Alt-3 discussed in the last meeting can be easily be modified to apply to both Option 1 and Option 2 such that the PUSCH is transmitted within the initial UL BWP within the bandwidth of CORESET0 (if the active UL BWP overlaps the initial UL BWP or the active UL BWP is the initial UL BWP)
2. For PUCCH transmissions prior to dedicated configuration (PF0/1 configured via SIB1), a simple rule that would work for both Option 1 and Option 2 and is consistent to the already PUCCH resource configuration after dedicated configuration, could be the following (this text would go into 38.213 Section 9.2.1)
	* The UE determines the PRB allocation for the PUCCH resource from the intersection of the RBs corresponding to interlace $m$ and the RBs of a single UL RB set within the initial UL BWP. The UE expects that the intersection results in either 10 or 11 RBs. The UL RB set is the one that intersects with the CORESET in which the DCI format is detected. [If there is no intersection, the UL RB set is RB set 0 in the initial UL BWP]

Note that the UE is aware of RB sets prior to dedicated configuration, since when the parameter *intraCellGuardBandUL-r16* is not configured, the UE assumes the default guard band configuration from RAN4 specifications (38.101-1) according to the carrier bandwidth, from which the UE determines RB sets.

1. For PRACH transmissions, the Rel-15 specifications already support that PRACH resources can be configured within an UL RB set that is contained within the bandwidth of CORESET0, so both Option 1 and Option 2 already work.



Figure 1: Configuration options for initial and first active BWP for UEs capable of a single "RRC configured" BWP (according to Basic FG 6-1). Option 1 and Option 2 are according to Annex B.2 of 38.331 for the case of an 80 MHZ UL/DL BWP used in RRC\_CONNECTED mode.

# Appendix B Extract of Appendix B.2 from 38.331

B.2 Description of BWP configuration options

There are two possible ways to configure BWP#0 (i.e. the initial BWP) for a UE:

1) Configure *BWP-DownlinkCommon* and *BWP-UplinkCommon* in *ServingCellConfigCommon*, but do not configure dedicated configurations in *BWP-DownlinkDedicated* or *BWP-UplinkDedicated* in *ServingCellConfig*.

2) Configure both *BWP-DownlinkCommon* and *BWP-UplinkCommon* in *ServingCellConfigCommon* and configure dedicated configurations in at least one of *BWP-DownlinkDedicated* or *BWP-UplinkDedicated* in *ServingCellConfig*.

The same way of configuration is used for UL BWP#0 and DL BWP#0 if both are configured.

With the first option (illustrated by figure B2-1 below), the BWP#0 is not considered to be an RRC-configured BWP, i.e. UE only supporting one BWP can still be configured with BWP#1 in addition to BWP#0 when using this configuration. The BWP#0 can still be used even if it does not have the dedicated configuration, albeit in a more limited manner since only the SIB1-defined configurations are available. For example, only DCI format 1\_0 can be used with BWP#0 without dedicated configuration, so changing to another BWP requires RRCReconfiguration since DCI format 1\_0 doesn't support DCI-based switching.

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**Figure B2-1: BWP#0 configuration without dedicated configuration**

With the second option (illustrated by figure B2-2 below), the BWP#0 is considered to be an RRC-configured BWP, i.e. UE only supporting one BWP cannot be configured with BWP#1 in addition to BWP#0 when using this configuration. However, UE supporting more than one BWP can still switch to and from BWP#0 e.g. via DCI normally, and there are no explicit limitations to using the BWP#0 (compared to the first option).

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**Figure B2-2: BWP#0 configuration with dedicated configuration**

For BWP#0, the *BWP-DownlinkCommon* and *BWP-UplinkCommon* in *ServingCellConfigCommon* should match the parameters configured by MIB and SIB1 (if provided) in the corresponding serving cell.