**3GPP TSG RAN WG1 Meeting #103-e R1-200xxxx**

**Oct 26th – Nov 13th, 2020**

**Agenda item: 7.2.2**

**Source: Moderator (Qualcomm Incorporated)**

**Title: Email discussion 01 for NR-U**

**Document for: Discussion and Decision**

# Introduction

This paper covers the email discussion for the following:

[103-e-NR-NRU-01] Email discussion/approval on issues IA-A and IA-B in R1-2008888 until 10/29 with potential CRs by 11/4 – Jing (Qualcomm)

To simplify the discussion, we split the email discussion into two phases.

* The first phase of the discussion will focus on the technical issues – Week 1
* The second phase of the discussion will focus on TPs for agreed issues – Week 2

# ROs and POs

## Issue A. On FDM ROs under multiple RB sets

In [1] and [2], it is proposed to support FDM ROs when PRACH sequence length is 139.

***Proposal from [1]: For connected mode UE, for PRACH sequence length of 139, support configuring multiple FDMed ROs in active UL BWP over multiple RB sets. The RO(s) overlapping with the UL intra cell guard should not be used. The corresponding TP#1 is provided in Appendix.***

The supporting TP is captured as TP A.1

***Proposal from [5]: adopt the above TP in TS38.213 for the RO configuration for PRACH sequence length-139.***

The supporting TP is captured as TP A.2

In [6], it is proposed to use nominal intra-cell guard band for multi-RB set RO configuration.

***Proposal from [6]: For connected mode UE, assume nominal intra-cell guard bands for RO mapping of PRACH with sequence length 1151 and 571.***

The supporting TP is captured as TP A.3

### First round discussion on issue A

For length 139 sequence, with current spec, we can place 4 FDM ROs within one RB set for 30KHz SCS and 8 FDM ROs (maximum allowed) for 15KHz SCS. Even for 30KHz case, the current spec can still support 8 FDM ROs, though inevitably, there will be ROs falls into intra-cell guard band. Thus the question becomes if we need to further support configuring 8 FDM ROs for 30KHz case, while avoiding intra-cell guard band.

**Question 1. Do we support FDM ROs over multiple RB sets when the PRACH sequence length is 139, while RO locations avoid intra-cell guard band by design.**

* **Note: The result of this discussion can be carried over to the 2-step RACH discussion in issue B as well. If any company has different view (support 139 sequence for 4-step RACH but not for 2-step RACH, please state it here)**

|  |  |
| --- | --- |
| Company | View |
| vivo | No need. There is no strong motivation since it already supports FDM ROs within one RB set for PRACH length 139. |
| Samsung | Fine to support, if the standard impact is marginal.  |
| ZTE, Sanechips | There is no need to further enhance RO location design just for the single case of 8 FDM ROs with 30kHz SCS, the current supportive configuration is enough for length 139 sequence.  |
| CATT | Current 4 FDM ROs within one RB set for 30KHz SCS are already supported. We hope to clarify what is the purpose of supporting FDM ROs within one RB set for PRACH length 139. |
| OPPO | For L=139, we support FDM ROs over multiple RB sets. We think the simplest way is to follow R15 RO configuration. If an RO is in guard band, the UE cannot transmit PRACH in this RO. |
| Nokia, NSB | We do support FDM ROs mapping according to legacy, if FDM RO overlaps at least partially with intra-cell GB, UE should invalidate the FDM RO.  |
| LG | Yes. It is beneficial to support the FDMed ROs on multiple UL RB sets because of PRACH capacity. To be specific, the number of PRACH preambles per beam will be increased if the number of ROs is increased and the SSB to RO mapping can be configured as one-to-many mappings.Moreover, the configuration of the FDMed ROs on multiple UL RB sets can be supported simply using the same principles applied for long ZC sequence (i.e., L1151 and L571) in previous meeting.For example, as shown in following figure, assuming total 8 ROs are configured, the maximum number of consecutive ROs (4 ROs in this example) that can be confined within the single RB set are allocated in the UL RB set (based on the parameters “*msg1-FrequencyStart*”or“*frequencyStartMsgA-PUSCH*”), then the remaining consecutive ROs are allocated in the next UL RB set.Example of 8 FDMed ROs on multiple UL RB set for 30 kHz SCS with L139 sequence |
| Sharp | NR-U works well without this change. We don’t think the proposal as an essential correction. |
| Qualcomm | Given we already can support 4 FDM ROs, it may not be essential to optimize the design to support 8 FDM ROs anymore, given the potential spec impact. Additionally, the 8 FDM RO in legacy may still work, when an RO crosses RB set boundary. UE may be able to transmit in that RO if the LBT passes on both adjacent RB sets. |
| Ericsson | The spec impact seems high. Currently, if L\_RA is configured as 139, there is a defined mapping of ROs in 38.211 that does not account for RB sets and the gNB should be responsible for configuring the frequency domains starting position for the first RO and number of ROs such that ROs do not overlap guard bands.If we adopt the same multiple-RB set configuration as for L\_RA = 571/1151, how should the UE differentiate between legacy mapping and new mapping – is a new RRC parameter needed? |

For PRACH of sequence length 571 and 1151, multiple RB set support was agreed in RAN1 102-e. The resulting design will place one FDM RO in each RB set, and the location of the RO in an RB set will depend on the configured intra-cell guard band. There is proposal to use nominal intra-cell guard band instead.

**Question 2. Shall we use nominal intra-cell guard band for RO mapping of PRACH with sequence length 1151 and 571?**

|  |  |
| --- | --- |
| Company | View |
| vivo | Yes. |
| Samsung  | Yes |
| ZTE, Sanechips | Yes. |
| CATT | Yes |
| OPPO | Support using nominal intra-cell guard band  |
| Nokia, NSB | Yes |
| LG | Yes.BTW, this issue is the same as that being addressed in [103-e-NR-NRU-03], so we think that it is better to discuss this issue in [103-e-NR-NRU-03]. |
| Sharp | Yes, but as indicated by LG, the same issue has been included in [103-e-NR-NRU-03] led by Steve. I also guess [103-e-NR-NRU-03] is better suited because it is dedicated for the issue on alignment of UE assumption on RB set configuration for PRACH. |
| Qualcomm | Yes. Agree with LG that the TP can be discussed in email thread 03. |
| Ericsson | There is already a TP on this being discussed in Email Thread #3. No need to discuss here. |

## 2.2. Issue B. On multiple RB set PO configuration for 2-step RACH

[1], [2], [4], [7], [8] discussed PO configuration for 2-step RACH.

In [1], it is further proposed to support multiple RB set PO configuration, while the associated ROs and POs are confined within the same RB set.

***Proposal from [1]: For both interlaced and non-interlaced PUSCH, the MsgA PUSCH should be confined within the same RB set as its associated RO.***

***Proposal from [1]: For non-interlaced PUSCH, the RO to PO mapping sequence should be restricted within the RB set.***

The supporting TP are TP B.1 below.

In [2], it is proposed to restrict that for 2-step RACH, both ROs and POs are constrained within a single RB set.

***Proposal from [2]: Adopt the TP#1a or TP#1b in 38.213, to capture the missed agreement in RAN1 #98b meeting***

The TPs are captured as TP B.2 and TP B.3 below.

In [4], it is proposed to support multiple RB set RO/PO configuration with per RB set RO to PO mapping

***Proposal from [4]: Support PRACH and PUSCH configuration over multiple RB sets for 2-step RACH.***

***Proposal from [4]: Support one interlaced Msg A PUSCH confined within one RB set.***

* ***The RB sets of all MsgA PUSCHs are the same RB sets of all Msg A PRACHs.***
* ***The number of FDMed POs per RB set is derived by existing parameter Nf (nrMsgA-PO-FDM).***
* ***The start interlace of 1st PO in each RB set is derived by existing parameter interlaceIndexFirstPO-MsgA-PUSCH.***

***Proposal from [4]: Adopt the following TP2 (The RB set of one Msg A PUSCH is the same as associated Msg A PRACH) or TP3 (No change of PRACH-to-PUSCH association) for TS 38.213.***

Supporting TP is captured as TP B.4 and TP B.5.

In [7], it is proposed to support 2-step RACH RO/PO configuration over multiple RB sets for connected mode UE with legacy RO/PO mapping.

***Proposal from [7]: Re-interpret the current RRC parameters to support configuring MsgA PUSCH over multiple RB sets for connected mode UEs.***

***Proposal from [7]: Legacy RO to PO mapping is reused to associate multiple RB set Msg A PRACH configuration and multiple RB set Msg A PUSCH configuration. No spec impact identified.***

The supporting TPs are captured in TP B.6.

In [8], it is proposed to interpret the freq domain resource allocation for PO and RO using nominal intra-cell guard band definition.

***Proposal from [8]: For PRACH preamble (RO) as well as Msg. A PUSCH (PO) transmissions, the UL RB set size/range is determined based on nominal intra-cell guard band configuration.***

The supporting TPs are captured as TP B.7 and B.8

### First round discussion on issue B

In RAN1 #102-e, we agreed to support FDM RO configuration for length 571 and 1156 PRACH over multiple RB set. There is proposal to support that for 2-step RACH as well. Note that in the current spec, it is possible to support multiple RB set configuration for RO (if the PRACH sequence is 571 and 1151). For PO configuration, if legacy waveform is used, it is still possible to configure FDM PO, but there might be PO overlap with RBs in intra-cell guard band. If interlaced waveform is used, the current spec does not support multiple RB set PO configuration.

**Question 1. Shall we support 2-step RACH configuration with ROs and POs in multiple RB set?**

|  |  |
| --- | --- |
| Company | View |
| vivo | I think current spec already support this. First, as moderator states, it is already supported that multiple RB set configuration for RO (if the PRACH sequence is 571 and 1151). Second, for legacy waveform, FDM POs in multiple RB sets are already possible and the only concern is the PO overlap with RBs in intra-cell guard band. Third, for interlace waveform, PO will span multiple RB sets if the BWP includes multiple RB sets. In this case, UE could transmit in the PO when LBT succeeds in both RB sets.  |
| Samsung  | Yes, we shall support. For interlaced case, the current spec can not work if a PO spans all RB sets of an active BWP. For different UEs, the active BWP can be different. Then, how can gNB know the bandwidth of a PO, if gNB can’t tell the detected PRACH is from which UE ?  |
| ZTE, Sanechips | There is an agreement in RAN1#98b meeting under 2-step RACH WI, we should first confirm that if it is still the common understanding,* Agreements:

All msgA PUSCH occasions and the associated msgA RACH occasions are confined within a single 20 MHz carrier/LBT bandwidth.Considering current spec already supports FDMed ROs in multiple RB sets and each RO confined in one RB set, the simplest way to resolve this issue is to confine all POs in one RB set.  |
| CATT | We have the similar with VIVO and ZTE. |
| OPPO | support |
| Samsung | Thanks ZTE for pointing out the agreement made in 2-step RACH WI. However, from our point of view, we think it is just indicated that each PO is within a single RB set, but different ROs can be in different RB sets. Let’s hear more opinions. |
| Nokia, NSB | Agreements:* All msgA PUSCH occasions and the associated msgA RACH occasions are confined within a single 20 MHz carrier/LBT bandwidth

While above agreement can have different understandings. We understand that all ROs and its POs are configured in single RB-set, in this case PO allocation using interlace are within the same RB-set as ROs and also legacy mapping of RO to PO can be used. This resulting in very little specification impact at this late stage. |
| LG | Yes.Regarding Msg. A PRACH, since it was already agreed in the previous meeting that the FDMed ROs can be configured over multiple UL RB sets, the same multiple RB set configuration should also be applied for Msg. A PRACH. Regarding Msg. A PUSCH, it seems undesirable to restrict Msg. A PUSCH in only one RB set since many TDMed POs would be required to support the association with multiple ROs, and the TDMed POs might restrict flexible DL-UL configuration from gNB perspective.For these reasons, we prefer to support PO allocation over multiple RB sets based on configuration without any modifying/changing of the current RO-to-PO mapping design. |
| Qualcomm | We support the proposal. For the 2-step RACH agreement, we suspect it was reached without taking into consideration of connected mode UE. Given that we already support FDM RO over multiple RB sets for 2-step RACH, we can loosely interpret that agreement to extend the agreement.  |
| Ericsson | Fine with extending multiple-RB set configuration for L = 571/1151 to PRACH part of MsgA (2-step RACH)Regarding POs in multiple RB sets see comment below. |

**Question 2. If FDM PO over multiple RB sets are supported, shall we restrict each PO to be within one RB set**

* **For POs with legacy waveform, we modify the frequency domain resource allocation so intra-cell guard band is avoided**
* **For POs with interlaced waveform, only interlaces within one RB set can be assigned for a PO**

|  |  |
| --- | --- |
| Company | View |
| vivo | No strong view. Understand the intention but it seems an optimization. If the legacy PO overlaps with RBs in intra-cell guard band, UE can transmit RACH only and not transmit PUSCH in that PO. If the interlace spans multiple RB sets, UE transmits PUSCH when LBT on both RB sets succeeds. |
| Samsung  | Yes.  |
| ZTE, Sanchips | If the common understanding is to support FDMed POs over multiple RB sets, we prefer not to restrict each PO within one RB set and leave it up to implementation. |
| CATT | we needn’t restrict each PO to be within one RB set because current spec can work well. When PO isn’t valid, only RACH can be transmitted. For POs with interlaced waveform, LBT for multiple RB sets can be executed. |
| OPPO | We think for legacy waveform (interlace is not configured), the PO configuration can follow legacy configuration, and the UE shall select a PO that is within a RB set for transmission.For interlaced waveform, for support only interlaces within a RB can be assigned for a PO. |
| Samsung  | As we comment to question 1, if FDMed POs over multiple RB sets is supported, we need a mechanism to determine the bandwidth of PO, i.e. over which RB set(s). It is not just whether performing LBT over single or multiple RB sets, it is about whether the system can work or not. For interlaced waveform, if we simply allow a PO over the whole bandwidth, e.g. UE1 is configured with active BWP with 2 RB sets, UE2 is configured with active BWP with 4 RB sets, how can gNB knows whether the detected PO is over 2 or 4 RB sets? Do we expect gNB to perform blind detection? Or, do we expect that gNB configures the same active BWP for all UEs? |
| Nokia, NSB | All POs are within single RB-set based on existing agreement, so “if” condition is false and question becomes irrelevant |
| LG | Basically yes.Especially for PO with interlaced waveform, assigning each of POs within one RB set can be done by the following way.Firstly, one interlace in one RB set is considered as a unit interlace, and the unit interlaces are indexed in {interlace index-first, RB set index-second} manner. For example, as shown in following Figure, the interlace x in the RB set y can be the unit interlace index y × M + x, where M is the number of interlaces for the given SCS. Given that, the RRC parameters such as the starting interlace index, number of interlaces per PO, and number of FDMed POs, are interpreted based on the unit interlace index. Unit interlace index for Msg. A PUSCH allocation. (assuming M=5 for 30 kHz SCS)By doing so, the POs can be allocated over multiple RB sets, and given that, the current RO-to-PO mapping is just applied for the POs without any change and without causing any resource inefficiency. |
| Qualcomm | Support, but we prefer a way to avoid RRC change when supporting this feature. |
| Ericsson | For interlaced waveform, yes, restrict PO to single RB set, and it should be the RB set in which PRACH is transmitted to be consistent PUSCH scheduled by RAR UL Grant for 4-step RACH.For legacy waveform, is any spec change needed, or can collision avoidance with guard bands be handled by proper configuration? |

**Question 3. If FDM PO over multiple RB sets are supported, how to associate ROs and POs**

* **Alt 1. Legacy association (no spec change)**
* **Alt 2. Modify the association such that the ROs and POs in the same RB set are associated**

|  |  |
| --- | --- |
| Company | View |
| vivo | Alt. 1. RO and PO could have separate LBT. |
| Samsung  | Alt. 2. as 1st preference. We can live with Alt.1, if most companies prefer no spec change.  |
| ZTE, Sanechips | Alt.1 |
| CATT | Alt.1 |
| OPPO | Support Alt-2 for interlace case. Or Alt-1 with gNB implementation to realize the association of RO and PO in a same RB set. |
| LG | Alt 1.As explained in the above Q2, it is preferred to support PO allocation over multiple RB sets based on configuration without any changing of the current RO-to-PO mapping design. |
| Qualcomm | Alt 1. No spec impact |
| Ericsson | Alt-1 |

**Question 4. If FDM PO over multiple RB sets are supported, Shall we use nominal intra-cell guard band for RO and PO mapping?**

|  |  |
| --- | --- |
| Company | View |
| vivo | Yes if PO mapping rule is modified to be related with intra-cell guard band. |
| Samsung | Yes.  |
| CATT | Yes |
| OPPO | Support using nominal intra-cell guard band |
| LG | Yes.The idle mode UE and the connected mode UE should assume the same UL RB set size/range for PO, and moreover, the idle mode UE and the connected mode UE should assume the same UL RB set size/range for RO, due to the same reason as for the Msg. 3 PUSCH transmission. |
| Qualcomm | This may not be necessary. These are UE specific RRC configured ROs and POs. The gNB has the capability to choose parameters to align with cell specific RRC configurations if it intends to. |
| Ericsson | Yes |

# TPs from contributions

#### ****TP A.1 from [1]****

==============TP#A.1: TS38.213 ================================

**8.1 Random access preamble**

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

For unpaired spectrum,

- if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last SS/PBCH block reception symbol, where is provided in Table 8.1-2 and, if *ChannelAccessMode-r16* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* , as described in Clause 4.1

- If a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if

- it is within UL symbols, or

- it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last downlink symbol and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2, and if *ChannelAccessMode-r16* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where there shall not be any transmissions, as described in [15, TS 37.213]

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*, as described in Clause 4.1.

- For operation with shared spectrum channel access, if a UE is configured with *intraCellGuardBandUL-r16* or determines the nominal intra-cell guard band and RB set pattern as specified in [8, TS 38.101-1], a PRACH occasion with PRACH sequence length of 139 in a PRACH slot is valid if the PRACH occasion is not overlapped with the intra-cell guard band.

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

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#### ****TP A.2 from [5]****

------------------------------------------------------TP1 TS 38.213 --------------------------------------------------------

8.1 Random access preamble

**<Unchanged parts are omitted>**

For unpaired spectrum,

- if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last SS/PBCH block reception symbol, and if it does not overlap with intra-cell guard bands if configured, where is provided in Table 8.1-2 and, if *ChannelAccessMode-r16* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* , as described in Clause 4.1

- If a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PRACH occasion in a PRACH slot is valid if

- it is within UL symbols, or

- it does not overlap with intra-cell guard bands if configured, or

- it does not precede a SS/PBCH block in the PRACH slot and starts at least symbols after a last downlink symbol and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2, and if *ChannelAccessMode-r16* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where there shall not be any transmissions, as described in [15, TS 37.213]

- the candidate SS/PBCH block index of the SS/PBCH block corresponds to the SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*, as described in Clause 4.1.

**<Unchanged parts are omitted>**

--------------------------------------------------------- END -----------------------------------------------------------

#### ****TB A.3 from [6]****

--------- beginning of text proposal for TS 38.212

5.3.2 OFDM baseband signal generation for PRACH

The time-continuous signal  on antenna port for PRACH is defined by

where  and

-  is given by clause 6.3.3;

-  is the subcarrier spacing of the initial uplink bandwidth part during initial access. Otherwise,  is the subcarrier spacing of the active uplink bandwidth part;

- is the largest value among the subcarrier spacing configurations by the higher-layer parameter *scs-SpecificCarrierList*;

-  is the lowest numbered resource block of the initial uplink bandwidth part and is derived by the higher-layer parameter *initialUplinkBWP* during initial access. Otherwise,  is the lowest numbered resource block of the active uplink bandwidth part and is derived by the higher-layer parameter *BWP-Uplink*;

- is the frequency offset of the lowest PRACH transmission occasion in frequency domain with respect to physical resource block 0 of the active uplink bandwidth part. The quantity is given by the higher-layer parameter *frequencyStartMsgA-PUSCH* if configured and a type-2 random-access procedure is initiated as described in clause 8.1 of [5, TS 38.213], otherwise by *msg1-FrequencyStart* as described in clause 8.1 of [5 TS 38.213];

-  is the PRACH transmission occasion index in frequency domain for a given PRACH transmission occasion in one time instance as given by clause 6.3.3.2;

-  is the number of resource blocks occupied and is given by the parameter allocation expressed in number of RBs for PUSCH in Table 6.3.3.2-1.

- is the start CRB index of UL RB set defined as in Clause 7 for the case when the UE is not configured with *intraCellGuardBandUL-r16*. [6, TS 38.214]

- is the index of the RB set which contains the lowest PRACH transmission occasion in frequency domain indicated by . The UE expects that is configured such that each PRACH transmission occasion is fully contained within an RB set.

-------- Unchanged contents are omitted

--------- end of text proposal--------------------

#### ****TB B.1 from [1]****

========================Start of TP for TS38.213===============================

**8.1A PUSCH for Type-2 random access procedure**

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

A UE determines a first interlace or first RB for a first PUSCH occasion in an active UL BWP respectively from *interlaceIndexFirstPO-MsgA-PUSCH* or from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of interlaces or a number of RBs provided by *nrofInterlacesPerMsgA-PO* or by *nrofPRBs-perMsgA-PO*, respectively. Consecutive PUSCH occasions in the frequency domain of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. A number of PUSCH occasions in the frequency domain of an UL BWP is provided by *nrMsgA-PO-FDM*. If a UE is configured with *intraCellGuardBandUL-r16* or determines the nominal intra-cell guard band and RB set pattern as specified in [8, TS 38.101-1], the PUSCH occasion in an active UL BWP is confined in the RB set same as its associated PRACH occasion.

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

Each consecutive number of preamble indexes from valid PRACH occasions in a PRACH slot and in a RB set if configured

- first, in increasing order of preamble indexes within a single PRACH occasion

- second, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- third, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot

are mapped to a valid PUSCH occasion and the associated DMRS resource in the same RB set if configured

- first, in increasing order of frequency resource indexes for frequency multiplexed PUSCH occasions

- second, in increasing order of DMRS resource indexes within a PUSCH occasion, where a DMRS resource index is determined first in an ascending order of a DMRS port index and second in an ascending order of a DMRS sequence index [4, TS 38.211]

- third, in increasing order of time resource indexes for time multiplexed PUSCH occasions within a PUSCH slot

- fourth, in increasing order of indexes for PUSCH slots

where , is a total number of valid PRACH occasions in a RB set if configured per association pattern period multiplied by the number of preambles per valid PRACH occasion provided by *msgA-PUSCH-PreambleGroup*, and is a total number of valid PUSCH occasions in the same RB set if configured per PUSCH configuration per association pattern period multiplied by the number of DMRS resource indexes per valid PUSCH occasion provided by *msgA-DMRS-Configuration*.

A PUSCH occasion is valid if it does not overlap in time and frequency with any PRACH occasion associated with either a Type-1 random access procedure or a Type-2 random access procedure. Additionally, for unpaired spectrum and for SS/PBCH blocks with indexes provided by *ssb-PositionsInBurst* in *SIB1* or by *ServingCellConfigCommon*

- if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion

- does not precede a SS/PBCH block in the PUSCH slot, and

- starts at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2

- if a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion

- is within UL symbols, or

- does not precede a SS/PBCH block in the PUSCH slot, and

- starts at least symbols after a last downlink symbol and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2 and, if *ChannelAccessMode-r16* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].

- For operation with shared spectrum channel access, if a UE is configured with *intraCellGuardBandUL-r16* or determines the nominal intra-cell guard band and RB set pattern as specified in [8, TS 38.101-1], a PUSCH occasion in a PUSCH slot is valid if the PUSCH occasion is not overlapped with the intra-cell guard band.

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#### ****TB B.2 form [2]****

**Reasons for change**

To capture the agreement in the specification

**Summary of changes**

All msgA PUSCH occasions are confined within a single RB set

**Specs/Sections impacted**

TS 38.213, Section 8.1A

**Consequences if not approved:**

MsgA PUSCH may across multiple RB sets

======================== Start of TPB.2 for TS 38.213 ===============================

8.1A PUSCH for Type-2 random access procedure

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

A UE determines a first interlace or first RB for a first PUSCH occasion in an active UL BWP respectively from *interlaceIndexFirstPO-MsgA-PUSCH* or from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of interlaces or a number of RBs provided by *nrofInterlacesPerMsgA-PO* or by *nrofPRBs-perMsgA-PO*, respectively. Consecutive PUSCH occasions in the frequency domain of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. A number of PUSCH occasions in the frequency domain of an UL BWP is provided by *nrofMsgA-PO-FDM*. For operation with shared spectrum channel access, all PUSCH occasions are confined within a single RB set.

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

======================== End of TPB.2 ===============================

#### TP B.3 from [2]

**Reasons for change**

To capture the agreement in the specification

**Summary of changes**

All msgA PUSCH occasions and the associated msgA RACH occasions are confined within a single RB set

**Specs/Sections impacted**

TS 38.213, Section 8.1A

**Consequences if not approved:**

MsgA PUSCH may across multiple RB sets

======================== Start of TS 38.213 ===============================

8.1A PUSCH for Type-2 random access procedure

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

A UE determines a first interlace or first RB for a first PUSCH occasion in an active UL BWP respectively from *interlaceIndexFirstPO-MsgA-PUSCH* or from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of interlaces or a number of RBs provided by *nrofInterlacesPerMsgA-PO* or by *nrofPRBs-perMsgA-PO*, respectively. Consecutive PUSCH occasions in the frequency domain of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. A number of PUSCH occasions in the frequency domain of an UL BWP is provided by *nrofMsgA-PO-FDM*. For operation with shared spectrum channel access, all PUSCH occasions and the associated RACH occasions are confined within a single RB set.

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

======================== End of TP B.3 ===============================

#### TP B.4 from [4]

=========================== Start of TPB.4 for TS 38.213 ===================================

8.1A PUSCH for Type-2 random access procedure

============================= Unchanged Texts Omitted =================================

A UE determines time resources and frequency resources for PUSCH occasions in an active UL BWP from *msgA-PUSCH-Config* for the active UL BWP. If the active UL BWP is not the initial UL BWP and *msgA-PUSCH-Config* is not provided for the active UL BWP, the UE uses the *msgA-PUSCH-Config* provided for the initial UL BWP. If a UE is configured with *interlaceIndexFirstPO-MsgA-PUSCH*, the RB set for a MsgA PUSCH occasion is the RB set of the associated Msg A PRACH occasion.

A UE determines a first interlace for a first PUSCH occasion in a RB set or first RB for a first PUSCH occasion in an active UL BWP respectively from *interlaceIndexFirstPO-MsgA-PUSCH* or from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of interlaces within the RB set or a number of RBs provided by *nrofInterlacesPerMsgA-PO* or by *nrofPRBs-perMsgA-PO*, respectively. Consecutive PUSCH occasions in the frequency domain of a RB set or of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. A number of PUSCH occasions in the frequency domain of a RB set or of an UL BWP is provided by *nrMsgA-PO-FDM*.

============================= Unchanged Texts Omitted =================================

Each consecutive number of preamble indexes from valid PRACH occasions in a PRACH slot

- first, in increasing order of preamble indexes within a single PRACH occasion

- second, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions

- third, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot

are mapped to a valid PUSCH occasion and the associated DMRS resource

- first, in increasing order of frequency resource indexes for frequency multiplexed PUSCH occasions

- second, in increasing order of DMRS resource indexes within a PUSCH occasion, where a DMRS resource index is determined first in an ascending order of a DMRS port index and second in an ascending order of a DMRS sequence index [4, TS 38.211]

- third, in increasing order of time resource indexes for time multiplexed PUSCH occasions within a PUSCH slot

- fourth, in increasing order of indexes for PUSCH slots

where , is a total number of valid PRACH occasions per association pattern period multiplied by the number of preambles per valid PRACH occasion provided by *msgA-PUSCH-PreambleGroup*, and is a total number of valid PUSCH occasions per PUSCH configuration per association pattern period multiplied by the number of DMRS resource indexes per valid PUSCH occasion provided by *msgA-DMRS-Configuration*. If a UE is configured with *interlaceIndexFirstPO-MsgA-PUSCH*, the PRACH to PUSCH association is performed per RB set.

======================== End of TP B.4 for TS 38.213 ==================================

#### TP B.5 from [4]

========================== Start of TP B.5 for TS 38.213 ===================================

8.1A PUSCH for Type-2 random access procedure

============================ Unchanged Texts Omitted =================================

A UE determines time resources and frequency resources for PUSCH occasions in an active UL BWP from *msgA-PUSCH-Config* for the active UL BWP. If the active UL BWP is not the initial UL BWP and *msgA-PUSCH-Config* is not provided for the active UL BWP, the UE uses the *msgA-PUSCH-Config* provided for the initial UL BWP. If a UE is configured with *interlaceIndexFirstPO-MsgA-PUSCH*, the RB set(s) for MsgA PUSCH is the RB set(s) for Msg A PRACH. A PUSCH occasion is confined within one RB set.

A UE determines a first interlace for a first PUSCH occasion in a RB set or first RB for a first PUSCH occasion in an active UL BWP respectively from *interlaceIndexFirstPO-MsgA-PUSCH* or from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of interlaces within the RB set or a number of RBs provided by *nrofInterlacesPerMsgA-PO* or by *nrofPRBs-perMsgA-PO*, respectively. Consecutive PUSCH occasions in the frequency domain of a RB set or of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. A number of PUSCH occasions in the frequency domain of a RB set or of an UL BWP is provided by *nrMsgA-PO-FDM*.

============================ Unchanged Texts Omitted =================================

=========================== End of TP B.5 for TS 38.213 ==================================

#### TP B.6 from [7]

==========TP to TS 38.213 8.1A=================================

8.1A PUSCH for Type-2 random access procedure

For a Type-2 random access procedure, a UE transmits a PUSCH, when applicable, after transmitting a PRACH. The UE encodes a transport block provided for the PUSCH transmission using redundancy version number 0. The PUSCH transmission is after the PRACH transmission by at least symbols where for or , for or , and is the SCS configuration for the active UL BWP.

A UE does not transmit a PUSCH in a PUSCH occasion if the PUSCH occasion associated with a DMRS resource is not mapped to a preamble of valid PRACH occasions or if the associated PRACH preamble is not transmitted as described in Clause 7.5 or Clause 11.1. A UE can transmit a PRACH preamble in a valid PRACH occasion if the PRACH preamble is not mapped to a valid PUSCH occasion.

A mapping between one or multiple PRACH preambles and a PUSCH occasion associated with a DMRS resource is per PUSCH configuration.

A UE determines time resources and frequency resources for PUSCH occasions in an active UL BWP from *msgA-PUSCH-Config* for the active UL BWP. If the active UL BWP is not the initial UL BWP and *msgA-PUSCH-Config* is not provided for the active UL BWP, the UE uses the *msgA-PUSCH-Config* provided for the initial UL BWP.

If a UE is not provided with *useInterlacePUCCH-PUSCH*, the UE determines a first RB for a first PUSCH occasion in an active UL BWP respectively from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of RBs provided by *nrofPRBs-perMsgA-PO*. A number of PUSCH occasions in the frequency domain of an UL BWP is provided by *nrofMsgA-PO-FDM*.

1. For operation without shared spectrum channel access, consecutive PUSCH occasions in the frequency domain of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*.
2. For operation with shared spectrum channel access, assume the first PUSCH occasion is located in the RB set . is the RB offset from the first RB of the first PUSCH occasion and the lowest RB of RB set . Within each RB set, consecutive PUSCH occasions in the frequency domain are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. If the current RB set does not have enough RBs to fit in all the remaining PUSCH occasions, placing remaining PUSCH occasions starting from RB of the next RB set, still all PUSCH occasions are identified.

If a UE is provided with *useInterlacePUCCH-PUSCH*, RB set is the RB set contains the first PRACH occasion used for Type-2 random access procedure. Within an RB set, PUSCH occasions start with interlace provided by *interlaceIndexFirstPO-MsgA-PUSCH* and each PUSCH occasion contains a number of interlaces provided by *nrofInterlacesPerMsgA-PO*. A number of PUSCH occasions in the frequency domain of an UL BWP is provided by *nrofMsgA-PO-FDM*. If the current RB set does not have enough interlaces for all remaining PUSCH occasions, the next RB set is used starting from interlace provided by *interlaceIndexFirstPO-MsgA-PUSCH*.

------------Unchanged part omitted---------------------

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#### TP B.7 from [8]

============= TP B.7 for 38.211==========================

5.3.2 OFDM baseband signal generation for PRACH

[…]

The time-continuous signal  on antenna port for PRACH is defined by

where  and

-  is given by clause 6.3.3;

-  is the subcarrier spacing of the initial uplink bandwidth part during initial access. Otherwise,  is the subcarrier spacing of the active uplink bandwidth part;

- is the largest value among the subcarrier spacing configurations by the higher-layer parameter *scs-SpecificCarrierList*;

-  is the lowest numbered resource block of the initial uplink bandwidth part and is derived by the higher-layer parameter *initialUplinkBWP* during initial access. Otherwise,  is the lowest numbered resource block of the active uplink bandwidth part and is derived by the higher-layer parameter *BWP-Uplink*;

- is the frequency offset of the lowest PRACH transmission occasion in frequency domain with respect to physical resource block 0 of the active uplink bandwidth part. The quantity is given by the higher-layer parameter *msgA-RO-FrequencyStart* if configured and a type-2 random-access procedure is initiated as described in clause 8.1 of [5, TS 38.213], otherwise by *msg1-FrequencyStart* as described in clause 8.1 of [5 TS 38.213];

-  is the PRACH transmission occasion index in frequency domain for a given PRACH transmission occasion in one time instance as given by clause 6.3.3.2;

-  is the number of resource blocks occupied and is given by the parameter allocation expressed in number of RBs for PUSCH in Table 6.3.3.2-1.

- is the start CRB index of uplink RB set . The UE assumes that the uplink RB set is defined as when the UE is not provided *intraCellGuardBandUL-r16.* [6, TS 38.214]

- is the index of the RB set which contains the lowest PRACH transmission occasion in frequency domain indicated by . The UE may assume that is configured such that each PRACH transmission occasion is fully contained within an RB set.

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#### TP B.8 from [8]

===================TP B.8 for 38.213===========================

8.1A PUSCH for Type-2 random access procedure

[…]

A UE determines time resources and frequency resources for PUSCH occasions in an active UL BWP from *msgA-PUSCH-Config* for the active UL BWP. If the active UL BWP is not the initial UL BWP and *msgA-PUSCH-Config* is not provided for the active UL BWP, the UE uses the *msgA-PUSCH-Config* provided for the initial UL BWP.

A UE determines a first interlace or first RB for a first PUSCH occasion in an active UL BWP respectively from *interlaceIndexFirstPO-MsgA-PUSCH* or from *frequencyStartMsgA-PUSCH* that provides an offset, in number of RBs in the active UL BWP, from a first RB of the active UL BWP. A PUSCH occasion includes a number of interlaces or a number of RBs provided by *nrofInterlacesPerMsgA-PO* or by *nrofPRBs-perMsgA-PO*, respectively. Consecutive PUSCH occasions in the frequency domain of an UL BWP are separated by a number of RBs provided by *guardBandMsgA-PUSCH*. A number of PUSCH occasions in the frequency domain of an UL BWP is provided by *nrofMsgA-PO-FDM*. If a UE is provided with *useInterlacePUCCH-PUSCH* by *BWP-UplinkCommon* or *BWP-UplinkDedicated,* the UE assumes that the RB set is defined as when the UE is not provided *intraCellGuardBandUL-r16* [6, TS 38.214].

If a UE does not have dedicated RRC configuration, or has an initial UL BWP as an active UL BWP, or is not provided *startSymbolAndLengthMsgA-PO*, *msgA-PUSCH-timeDomainAllocation* provides a SLIV and a PUSCH mapping type for a PUSCH transmission by indicating

- one of the first *maxNrofUL-Allocations* values from *PUSCH-TimeDomainResourceAllocationList*, if *PUSCH-TimeDomainResourceAllocationList* is provided in *PUSCH-ConfigCommon*

- one of the entries from table 6.1.2.1.1-2 or table 6.1.2.1.1-3 in [6, TS 38.214], if *PUSCH-TimeDomainResourceAllocationList* is not provided in *PUSCH-ConfigCommon*

else, the UE is provided a SLIV by *startSymbolAndLengthMsgA-PO*, and a PUSCH mapping type by *mappingTypeMsgA-PUSCH* for a PUSCH transmission.

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# Reference

[1]. R1-2007606, Maintenance on initial access signals and channels, Huawei, HiSilicon

[2]. R1-2007959, Text proposals on the initial access for NR-U, ZTE, Sanechips

[3]. R1-2007978, Initial Access Signals and Channels, Ericsson

[4]. R1-2008125, Remaining issues on Initial access signals and channels, Samsung

[5]. R1-2008246, Discussion on the remaining issues of initial access signal/channel, OPPO

[6]. R1-2008385, Remaining issues on initial access and UL signals/channels for NR-U, Sharp

[7]. R1-2008600, PO configuration for 2-step RACH over multiple RB sets, Qualcomm Incorporated

[8]. R1-2008042, Remaining issues of random access for NR-U, LG Electronics