**3GPP TSG-RAN WG1 Meeting #100bis R1-200xxxx**

**e-meeting, April 20th – 30th, 2020**

**Agenda Item: 7.2.1.1**

**Source: Moderator (ZTE)**

**Title: FL summary on the maintenance of 2-step RACH channel structure**

**Document for: Discussion**

# Introduction

This document contains the feature lead summary of issues related to maintenance of the channel structure under Rel-16 2-step RACH WI.

The issues mentioned in the submitted TDocs are collected and summarized in Section 2, and the feature lead recommendation for the first round email discussion can be found in Section 3.

# Channel structure maintenance issues

## Potential issues to be handled

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| Issue # | Issue | Description | Related TDoc # |
| 1 | PRACH/PUSCH validation rule | 1. Additional PUSCH validation rule2. PRACH occasions not associated with SSB are considered as invalid | R1-2001524R1-2001983R1-2001710R1-2002319R1-2001648 |
| 2 | PUSCH overlapping with other UL signal | 1. Handling of MsgA PUSCH overlapping with PUSCH/PUCCH/SRS.2. UE behavior of MsgA PUSCH transmission if the gap is not satisfied | R1-2001647R1-2001710R1-2001949R1-2001983R1-2002112R1-2002369 |
| 3 | PRACH/PUSCH conflicting with slot format | 1. Define the UE behavior when MsgA PRACH or PUSCH is conflicting with slot format, and the UE behavior if transmission of MsgA PRACH is cancelled.2. N symbols before valid PO should be protected from being indicated as downlink | R1-2001647R1-2001710R1-2001766R1-2002112R1-2002319 |
| 4 | Intra-slot Frequency hopping | 1. Mapping order is based on the first hop2. Guard band between hops3. Align the description of first and second hop in the specs | R1-2001524R1-2001710R1-2002369R1-2002431 |
| 5 | Reference point of slot offset | 1. Continue the discussion from the last meeting | R1-2001647R1-2002064R1-2002112R1-2002431 |
| 6 | DMRS configuration | 1. Determination of the sequence quantity in 38.2112. Restriction on the configuration of DMRS parameters MsgA-maxLength and msgA-DMRS-AdditionalPosition | R1-2001524R1-2002064 |
| 7 | New PRACH configuration index | 1. Correct the description in 38.211 | R1-2001710R1-2002431 |
| 8 | Gap between PRACH and PUSCH for NR-U | 1. Requirement of gap for NR-U | R1-2002369R1-2001951 |
| 9 | Guard band | 1. Clarify the guard band is applied for each PUSCH occasion in each PUSCH slot | R1-2001647 |
| 10 | MCS determination | 1. Delete q=2 for CP-OFDM | R1-2002319 |
| 11 | PRACH mapping procedure | 1. Correct Section 8.1A of TS 38.213 to clarify the PRACH mapping procedures for Type-2 random access2. Criterion for preamble selection in case of multiple-to-one mapping | R1-2002526 |
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## Issues triggered by the LSs from RAN2

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| Issue # | Issue | Description | Related TDoc # |
| L1 | Long Preamble root sequence | Based on the LS from RAN2 R1-2001237 | R1-2001647R1-2001710R1-2002369R1-2002526R1-2002310R1-2002373 |
| L2 | Resource for CFRA | Based on the LS from RAN2 R1-2001508 | R1-2001766R1-2001976R1-2002112R1-2002259R1-2002369R1-2002371R1-2002574R1-2001639R1-2001948R1-2002102R1-2002311R1-2002374R1-2002659 |
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# Summary and recommendation

It is supposed that the following two reply LSs are to be handled in AI 5.

**L1. Support of two new PRACH root sequence (R1-2001237)**

Reply LS needed

**L2. Resource of CFRA (R1-2001508)**

Reply LS needed

The # of topics to be discussed for 2-step RACH WI including both sub-AIs is up to 4. Apart from the 2 LSs to be handled separately, the following 4 email threads can be considered based on the popularity. The other issues can be left to May meeting, e.g. Issue #2, 7, 9, 11. Issue#8 will be handled in NR-U session.

Email thread #1:

**Validation of MsgA PRACH/PUSCH**

Corresponding to the issues #1

1. Additional PUSCH validation rule

2. PRACH occasions not associated with SSB are considered as invalid

Email thread #2:

**PRACH/PUSCH conflicting with slot format**

Corresponding to the issue #3

1. Define the UE behavior when MsgA PRACH or PUSCH is conflicting with slot format, and the UE behavior if transmission of MsgA PRACH is cancelled.

2. N symbols before valid PO should be protected from being indicated as downlink

Email thread #3:

**Intra-slot frequency hopping**

Corresponding to the issue #4

1. Mapping order is based on the first hop

2. Guard band between hops

3. Align the description of first and second hop in the specs

Email thread #4:

**Issue left from the last meeting**

Corresponding to the issue #5 and #6

1. Reference point of slot offset

2. DMRS configuration

In addition, it seems that companies were fine with the TP in issue#10 in the last meeting, but somehow it was not reflected in the updated spec. We can propose to the editor again.

The editorial changes in Issue #10 can be directly proposed to the editors.

Any further comments?

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| Company | Comment |
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# References

1. R1-2001524 Corrections on channel structure of 2-step RACH Huawei, HiSilicon
2. R1-2001647 Remaining issues on channel structure for 2-step RACH vivo
3. R1-2001710 Remaining issues of the channel structure for 2-step RACH ZTE, Sanechips
4. R1-2001766 Discussion on Channel Structure for Two-step RACH OPPO
5. R1-2001949 Remaining details of Channel Structure for 2-step RACH LG Electronics
6. R1-2001976 Discussion on Two-step RACH related LS received from RAN2 Nokia, Nokia Shanghai Bell
7. R1-2001983 Remaining details of channel structure for 2-step RACH Intel Corporation
8. R1-2002064 Remaining issues on 2-step RACH channel structure CATT
9. R1-2002112 Channel Structure for Two-Step RACH Samsung
10. R1-2002259 Remaining issue on preamble and PRU mapping for 2-step CFRA Spreadtrum Communications
11. R1-2002319 Remaining issues on channel structure for 2-step RACH Apple
12. R1-2002369 Channel Structure Related Corrections For 2-Step RACH Ericsson
13. R1-2002431 Maintenance for Channel Structure for Two-Step RACH NTT DOCOMO, INC.
14. R1-2002526 Remaining issues and clarification on channel structure for Two-Step RACH Qualcomm Incorporated
15. R1-2002574 Further considerations on 2-step RACH Huawei, HiSilicon
16. R1-2001508 LS to RAN1 on preamble-to-PRU mapping for 2-step CFRA RAN2, Ericsson
17. R1-2001639 Discussion on preamble-to-PRU mapping for 2-step CFRA vivo
18. R1-2001948 Draft Reply LS on preamble-to-PRU mapping for 2-step CFRA LG Electronics
19. R1-2002102 Draft reply LS on preamble-to-PRU mapping for 2-step CFRA Samsung
20. R1-2002311 Discussion on preamble-to-PRU mapping for 2-step CFRA Apple
21. R1-2002374 [DRAFT] LS Response on preamble-to-PRU mapping for 2-step CFRA Ericsson
22. R1-2002659 Draft LS reply to RAN2 on preamble-to-PRU mapping for 2-step CFRA Huawei, HiSilicon
23. R1-2002310 Discussion on NR-U PRACH root sequence and random access procedure for 2-step RACH Apple
24. R1-2002373 [DRAFT] LS Response on NR-U PRACH root sequence for 2-step RA Ericsson

# Appendix

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| TDoc/Company | Issue # | Proposals |
| [1524, 2574]HW | 1,4,6L2 | ***Proposal 1:*** *To complete the validation rule of msgA PUSCH, adopt TP#1 in the Appendix.****Proposal 2:*** *To correct the operations of DMRS for msgA PUSCH, adopt TP#2 in the Appendix.****Proposal 3:*** *To correct the operations of intra-slot frequency hopping of msgA PUSCH, adopt TP#3 and TP#4 in the Appendix.****Observation 1: Neither alternative recommended by RAN2 should be pursued in RAN1 for support of CFRA 2-step RACH.*** |
| [1647, 1648, 1639]vivo | 1,2,3,5,9 L1 | **Proposal 1: It is up to UE implementation when MsgA PUSCH and PUSCH/PUCCH/SRS are overlapping in time within a same slot or when a gap between MsgA PUSCH transmission and the PUSCH/PUCCH/SRS transmission is separated by less than *N* symbols, where *N* = 2 for **= 0 or **= 1, *N* = 4 for **= 2 or **= 3, and ** is the SCS configuration for the active UL BWP.****Proposal 2: Adopt the following text proposal in Section 8.1A in 38.213.****Proposal 3: If the configuration for start of MsgA PRACH slot not aligned with slot boundary of PUSCH slot is supported, a UE determines the slot of MsgA PUSCH as** $\left⌊n⋅\frac{2^{μ\_{PUSCH}}}{2^{μ\_{PRACH}}}\right⌋+K$**, where *n* is the PRACH slot with at least one valid RO, *K* is provided by *msgAPUSCH-TimeDomainOffset* based on the numerology of PUSCH, and** $μ\_{PUSCH}$ **and** $μ\_{PRACH}$ **are the subcarrier spacing configurations for PUSCH and PRACH, respectively.****Proposal 4: Adopt the following text proposal #1 in Section 8.1A in 38.213.****Proposal 5: Clarify that the guard period configured by *guardPeriodMsgAPUSCH* is applied for each PUSCH occasion in each PUSCH slot.****Proposal 6: Adopt the following text proposal #2 in Section 8.1A in 38.213.****Proposal 7: For a set of symbols of a slot corresponding to a valid MsgA PUSCH occasion and *N*gap symbols before the valid MsgA PUSCH occasion, receive PDCCH, PDSCH, or CSI-RS in the slot if a reception would overlap with any symbol from the set of symbols. The UE does not expect the set of symbols of the slot to be indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*.****Proposal 8: If a UE is configured by higher layers to transmit MsgA PUSCH in a set of symbols of a slot, and the UE detects a DCI format 1\_0/1\_1/1\_2 or DCI format 0\_1/0\_2, indicating to the UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, UE cancels the MsgA PUSCH transmission** **from the set of symbols if the timeline is met; otherwise, UE transmits the MsgA PUSCH.*** + **The timeline for cancellation defined in Rel.15 is reused.**

**Proposal 9: For a set of symbols of a slot corresponding to a valid MsgA PUSCH occasion and *N*gap symbols before the valid MsgA PUSCH occasion, the UE does not expect to detect a DCI format 2\_0 with an SFI-index field value indicating the set of symbols of the slot as downlink.****Proposal 10: If a UE is configured by higher layers to transmit MsgA PUSCH in a set of symbols of a slot, and the UE detects a DCI format 2\_0 indicating a subset of symbols from the set of symbols as downlink or flexible, UE cancels the MsgA PUSCH transmission** **from the set of symbols if the timeline is met; otherwise, UE transmits the MsgA PUSCH.*** + **The timeline for cancellation defined in Rel.15 is reused.**

**Proposal 11:** **If a UE is scheduled to transmit a PUSCH by a fallbackRAR UL grant in MsgB in a set of symbols of a slot, which are indicated as flexible by *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* if provided, or when *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* are not provided to the UE, the UE does not expect to detect an SFI indicating one or more symbols from the set of symbols as DL.****Proposal 12: For a set of symbols of a slot that are indicated as flexible by *tdd-UL-DL-ConfigurationCommon*, and *tdd-UL-DL-ConfigurationDedicated* if provided, or when *tdd-UL-DL-ConfigurationCommon*, and *tdd-UL-DL-ConfigurationDedicated* are not provided to the UE, and if the UE does not detect a DCI format 2\_0 providing a slot format for the slot*** **UE transmits PUSCH in the set of symbols if UE receives indication by a fallbackRAR UL grant in MsgB.**

**If a UE is configured by higher layers to transmit a MsgA PUSCH in the set of symbols, the UE does not transmit the MsgA PUSCH in the set of symbols if timeline is met.****Proposal 13: Long PRACH preamble is also supported for 2-step RACH in shared spectrum.****Proposal 3: Adopt the following text proposal** **#2 in Section 8.1A in 38.213.****Proposal 1: Alt.1 in LS R1-2001508 is supported.*** **Alt 1: Reusing the preamble-to-PRU mapping rule defined by RAN1 for CBRA and signaling the number of contention free preambles per SSB (field *msgA-TotalNumberOfCFRAPreambles*), and an offset, if needed, to be used for the start of the contention free preamble in each RACH occasion (field *msgA-PreambleStartIndex*)[2]. And it is noted that for CFRA dedicated configuration may include 1-to-1 mapping between a preamble index and a PUSCH resource unit.**
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| [1710]ZTE | 1,2,3,4,7L1,L2 | ***Proposal 1:**** The two new root sequences introduced in Rel-16 NR-U are applicable to 2-step RA for NR-U.

***Proposal 2:**** For the resource of CFRA, down-select between:
	+ Alt.1, i.e. reusing the preamble-to-PRU mapping rule for CBRA defined by RAN1. Confirm to RAN2 that the parameters *msgA-TotalNumberOfCFRAPreambles* and *msgA-PreambleStartIndex* shall be included in the ASN.1 signalling for 2-step CFRA.
	+ Alt.2 with the following modification. The ordering of PUSCH and DMRS resource follows that of CBRA defined by RAN1, and confirm to RAN2 that the parameter to indicate the PUSCH and DMRS resource index shall be included in *RACH-ConfigDedicated* in addition to *ra-PreambleIndex*.

***Proposal 3:*** * If frequency hopping for msgA PUSCH is enabled, the first hop is used to determine the ordering of POs in frequency domain.
* Adopt the TP#1 for 38.213.

***Proposal 4:*** * For type-2 random access procedure, PRACH occasions not associated with SS/PBCH blocks after an integer number of association periods, if any, are not mapped to PUSCH occasions, i.e. considered as invalid ROs.

***Proposal 5:*** * If MsgA PUSCH and PUSCH/PUCCH/SRS are overlapping in time within a same slot or when a gap between the first or last symbol of a MsgA PUSCH transmission is separated by less than *N* symbols from the last or first symbol, respectively, of a PUSCH/PUCCH/SRS transmission, it is up to UE implementation to transmit msgA PUSCH or other UL signal (PUSCH/PUCCH/SRS).

***Proposal 6:*** * For MsgA PUSCH conflicting with slot format
	+ The UE behavior is as same as that for Rel-15 PUSCH transmission.
* For MsgA PRACH conflicting with slot format
	+ The UE behavior is as same as that for Rel-15 msg1 PRACH transmission
	+ If the UE cancels the PRACH transmission, the UE shall also cancel PUSCH transmission associated with the PRACH.

***Proposal 7:*** * There is no need to revise the reference point for the slot offset.

***Proposal 8:*** * Adopt the TP#2 for 38.211, to correct the applicable tables for the new PRACH configuration index.
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| [1766]OPPO | 3L2 | * For type2 random access procedure, if the UE cancels the PRACH transmission, the UE shall also cancel PUSCH transmission associated with the PRACH.

***Proposal 2: Alt 1(Reusing the preamble-to-PRU mapping rule) is adopted.*** |
| [1949, 1948]LGE | 2L2 | ***Proposal 1:*** * UE cannot transmit both magA PUSCH and PUSCH/PUCCH/SRS in same slot or within certain gap for 2-step RACH.
* Adopt the TP#1 to capture the random access response in TS 38.213.

RAN1 observed that both alternatives for CFRA for 2-step RACH are impact to RAN1 spec. Also, it is expected to increase RAN1 work for supporting CFRA for 2-step RACH. According to the objective of 2-step RACH (‘RAN1 work addresses only CBRA (i.e. not considering CFRA)’ [RP-2000085]), these two alternatives are not accepted in RAN1’s perspective. Instead of two alternatives, if ‘msgA Preamble only transmission’ which is not mapped to PUSCH resource is allowed for CFRA, any signalling and RAN1 work are not required.  |
| [1976]Nokia | L2 | **Proposal 2: Respond to RAN2 with reference to [2] that Alt1 is the preferred method for indicating the allocation of dedicated MsgA PUSCH resources.** |
| [1983]Intel | 1,2 | **Proposal 1***For RRC\_CONNECTED state, when MsgA PUSCH overlaps with PUCCH, MsgA PUSCH is dropped.***Proposal 2*** *PRACH occasions not associated with SS/PBCH blocks after an integer number of association periods, if any, are not mapped to PUSCH occasions.*
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| [2064]CATT | 5,6 | **Proposal 1: For msgA PUSCH for Type-2 random access procedure, if MsgA-maxLength is configured, the number of additional DM-RS for PUSCH provided by higher layer parameter msgA-DMRS-AdditionalPosition is not expected to be 'pos2', 'pos3'.****Proposal 2: Adopt below TP to clarify the mapping between msgA PRACH and PUSCH in TS 38.213 Section 8.1A.**  |
| [2112, 2102]Samsung | 2,3,5L2 | ***Proposal 1: the determination of the first msgA PUSCH slot is referring to the start of PUSCH slot which includes the RACH slot.*** ***Proposal 2: adopted following TP in section 8.1A of TS 38.213:******Proposal 3: the valid PUSCH occasion in msgA and the Ngap before a valid PUSCH occasion should be protected from being indicated as downlink.*** ***Proposal 4:Adopt following TP in section 11.1 in TS38.213:******Proposal 5: msgA PRACH should have same priority with PUSCH/PUCCH with larger priority index and the priority consideration in Table 1 should be supported.******Proposal 6: Adopt following TPs in section 8.1 and section 8.1A in TS38.213:******Proposal 7: UE should also not transmit the msgA PUSCH if the corresponding msgA PRACH get cancelled.******Proposal 8: Adopt following TP in section 8.1A in TS38.213:******Proposal 9: the PUSCH occasion index and the DMRS resource index are explicitly indicated to UE for 2step CFRA and the ordering of the PO and DMRS resource are reused the one captured in TS38.213, and capture following contents in the reply LS to RAN2:*** |
| 2259[Spreadtrum] | L2 | ***Proposal1: If reusing the preamble-to-PRU mapping rule, the dedicated MsgA PUSCH resources for 2-step CFRA configured by dedicated RRC signalling should be used by a single UE.******Proposal2：If dedicated MsgA PUSCH resources for 2-step CFRA are used by a single UE, it is unnecessary to take the number of contention free preambles per SSB into account when determining the preamble pool, only the indicated preambles associated with the SS/PBCH block index may be considered.******Proposal3: One-to-one mapping and multiple-to-one mapping between preamble(s) associated with the SS/PBCH block index and PRU may be supported for 2-step CFRA.*** |
| [2319, 2310, 2311]Apple | 1,3,10L1, L2 | **Proposal 1: Adopt the proposed text proposal on MsgA PUSCH MCS determination for CP-OFDM waveform.****Proposal 2: Adopt the proposed text proposal in section 11.1 and 11.1.1 of TS38.213.****Proposal 3: For type-2 random access procedure, the RO without associated SSB is not valid RO.****Proposal 1: Not introduce the NR-U PRACH root sequence to 2-step RACH random access.****Proposal 1: Adopt Alt 1 to support the preamble-to-PRU mapping for 2-step CFRA.** |
| [2369, 2373]Ericsson | 2,4,8L1, L2 | 1. Only one PRU per PRACH slot is used for MsgA PUSCH transmission in CFRA and all preambles in a PRACH slot are mapped to the PRU for CFRA.
2. In a MsgA PUSCH transmission in CFRA, UE is configured with only one PUSCH occasion, assuming only one “*MsgA-PUSCH-Resource*” in “*msgA-PUSCH-ResourceList*”, neglects “*msgA-PUSCH-PreambleGroup*”, and assumes “*nrofSlotsMsgA-PUSCH*”, “*nrofMsgA-PO-PerSlot*”, “*nrofMsgA-PO-FDM*” are equal to one, according to text proposal TP1.
3. For MsgA PUSCH transmission in CFRA, UE uses DMRS port 0 and only one DMRS sequence, assuming “*msgA-PUSCH-NrofPort*”, “*nrofDMRS-Sequences*” are equal to one, “*msgA-PUSCH-DMRS-CDM-group*” is equal to 0, and the DMRS sequence is provided by *msgA-ScramblingID0* in case of CP-OFDM, according to text proposal TP1.
4. Clarify in 38.213 that “*interlaceIndexFirstPOMsgAPUSCH”* determines the 1st interlace index of the single PO when UE is enabled with interlace PUSCH and clarify in 38.214 that MsgA PUSCH frequency domain resource allocation is determined according to clause 8.1A of 38.213, according to text proposals TP1 and TP2.
5. Data scrambling of MsgA PUSCH in CFRA does not need to be associated to preamble ID or RA-RNTI, and should be associated to C-RNTI instead, according to text proposal TP3.
6. For MsgA PUSCH transmission in CFRA, the usage of time domain resource allocation tables should be similar to a normal PUSCH scheduled by DCI 0\_0, according to text proposal TP4.
7. When frequency hopping of MsgA PUSCH is enabled, the first hop is selected to determine the preamble to MsgA PUSCH mapping, according to text proposal TP5.
8. If the MsgA resource the UE determines does not meet the gap requirement between MsgA preamble and PUSCH, the PUSCH is not transmitted, according to text proposal TP6.
9. The presently specified zero-symbol gap (N = 0) requirement between the PRACH and PUSCH parts of MsgA, i.e. gap-less MsgA, is not changed for 2-step RA for operation with shared spectrum channel access, but the operation is clarified according to text proposal TP6.
10. Support the long PRACH root sequence in 2-step RACH for operation with shared spectrum channel access.

RAN1 respectfully requests that RAN2 reflect in their specifications the two new PRACH root sequences (of length 571 and 1151) are supported in 2-step RA for operation with shared spectrum channel access. |
| [2431]DCM | 4,5,7 | **Proposal 1: Following text proposal is applied to section 6.3.3.2 in TS 38.211.****Proposal 2: Following text proposal is applied to section 8.1A in TS 38.213.****Proposal 3: Following text proposal is applied to section 8.1A in TS 38.213.** |
| [2526]QC | 11,L1 | ***Proposal 1: Correct Section 6.3.2.1 of TS 38.211 to specify the PRACH formats applicable to Type-1 or Type-2 random access procedure with or without shared spectrum channel access, according to the text proposal TP1.******Proposal 2: Correct Section 8.1A of TS 38.213 to clarify the PRACH mapping procedures for Type-2 random access, according to the text proposal TP2.*** |
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