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

**e-Meeting, April 20th –30th, 2020**

**Source: Moderator (Ericsson)**

**Title: Discussion on the reply LS on preamble-to-PRU mapping for 2-step CFRA**

**Agenda item: 5**

**Document for:** **Discussion/Decision**

# Introduction

During RAN2#109e, an LS on preamble-to-PRU mapping for 2-step CFRA was sent to RAN1[1]. In this LS, RAN2 asks RAN1 to take into account the agreements made in RAN2 and provides 2 alternatives assuming the preamble to PRU mapping is needed.

Per chairman’s guidance, this summary is to collect companies’ views on this LS and try to make a conclusion for drafting the reply based on companies’ input.

[100b-e-LS-03] Email approval of the reply LS for [R1-2001508](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001508.zip) by 4/23 (Ericsson, Zhipeng)

# Company’s input

Proposals from related contributions summarized in [2] on AI 5:

|  |  |  |
| --- | --- | --- |
| **Tdoc** | **Proposal** | **Companies** |
| [R1-2001639](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001639.zip) | Alt.1 in LS R2-2002204. | vivo |
| [R1-2001948](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001948.zip) | Only support preamble only MsgA transmission | LG Electronics |
| [R1-2002102](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002102.zip) | For 2step CFRA, the PUSCH occasion index and the DMRS resource index are explicitly indicated to UE and the ordering of the PO and DMRS resource are reused the one captured in TS38.213. The following signalling parameters are required:  *PUSCH-Occasion-Index*  The PUSCH occasions corresponding to a PRACH slot are sequentially numbered, first, in increasing order of frequency resource indexes for frequency multiplexed PUSCH occasions; second, in increasing order of time resource indexes for time multiplexed PUSCH occasions within a PUSCH slot and Third, in increasing order of indexes for PUSCH slots corresponding to a PRACH slot.  *DMRS-resource-Index*  The DMRS resource index in each PUSCH occasion are sequentially numbered, 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. | Samsung |
| [R1-2002311](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002311.zip) | Adopt Alt 1 to support the preamble-to-PRU mapping for 2-step CFRA. | Apple |
| [R1-2002374](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002374.zip) | only one msgA PUSCH occasion with one DMRS resource, i.e. single PRU, is needed per PRACH slot. | Ericsson |
| [R1-2002659](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002659.zip)  R1-2002574 | it is RAN2 possibility to work out with a solution without RAN1 impact [1], with respect to the WID that CFRA is not pursued in RAN1 | Huawei, HiSilicon |

Proposals from related contributions summarized in [3] on AI 7.2.1:

|  |  |  |
| --- | --- | --- |
| **Tdoc** | **Proposal** | **Company** |
| [R1-2001766](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001766.zip) | Alt 1(Reusing the preamble-to-PRU mapping rule) is adopted. | OPPO |
| [R1-2001976](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001976.zip) | Respond to RAN2 with reference to [2] that Alt1 is the preferred method for indicating the allocation of dedicated MsgA PUSCH resources. | Nokia, Nokia Shanghai Bell |
| [R1-2002112](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002112.zip) | 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:  PUSCH-Occasion-Index  The PUSCH occasions corresponding to a PRACH slot are sequentially numbered, first, in increasing order of frequency resource indexes for frequency multiplexed PUSCH occasions; second, in increasing order of time resource indexes for time multiplexed PUSCH occasions within a PUSCH slot and Third, in increasing order of indexes for PUSCH slots corresponding to a PRACH slot.  DMRS-resource-Index  The DMRS resource index in each PUSCH occasion are sequentially numbered, 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. | Samsung |
| [R1-2002259](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002259.zip) | 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;  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;  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. | Spreadtrum Communications |
| [R1-2002369](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002369.zip) | 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.  A set of TPs (TP1 to TP4) in RAN1 are provided to complete the RAN1 work related MsgA PUSCH in 2-step CFRA. | Ericsson |
| [R1-2002371](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002371.zip) | Configure a single PRU in a single PO per PRACH slot for MsgA PUSCH transmission in CFRA of 2-step RA type | Ericsson |
| [R1-2002574](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002574.zip) | Neither alternative recommended by RAN2 should be pursued in RAN1 for support of CFRA 2-step RACH | Huawei, HiSilicon |

# Discussions

RAN1 has discussed the technical details of a set of following options and alternatives, including the two from RAN2 LS (Alt A, A1, B, B1, revisited by RAN1), for MsgA PUSCH resource determination for 2-step CFRA:

* Option 1: Configure multiple PRUs (including one PRU case) per PRACH slot via msgA-CFRA-PUSCH
  + Alt A: Select one single PRU based on the preamble to PRU mapping similar to CBRA
    - One to one mapping or multiple to one mapping can be supported
    - For multiple to one mapping, the mapping ratio is calculated per PRACH slot (note for CBRA, the mapping ratio is calculated per SSB to RO association pattern period)
    - Preamble group is defined in MsgA PUSCH config full signaling, i.e. it’s up to RAN2 to define the pool of preambles for CFRA with this existing preamble group signaling.
  + Alt A1: Select one single PRU based on the preamble to PRU mapping similar to CBRA
    - One to one mapping or multiple to one mapping can be supported
    - For multiple to one mapping, the mapping ratio is calculated per PRACH slot (note for CBRA, the mapping ratio is calculated per SSB to RO association pattern period)
    - Specify that preamble group comprises the preambles in the ssb-ResourceList and/or csirs-ResourceList for a single UE for the preamble to PRU mapping CFRANote : some RAN1 impact is detected.
  + Alt B: Select one PRU via explicit dedicated signaling
    - Required RRC signaling: PUSCH-Occasion-Index, DMRS-resource-Index (reuse the ordering of PUSCH occasions and DMRS for CBRA) are explicitly defined as proposed in R1-2002112 to determine one single PRU per PRACH slot.
  + Alt B1: Select one PRU via explicit dedicated signaling
    - Required RRC signaling: PUSCH-resource-Index is explicitly defined (reuse the ordering of PUSCH occasions and DMRS for CBRA)
  + Note: no RAN1 impact for alt.B and B1, all the signaling and ordering, resource determination are captured in RAN2 spec.
* Option 2: Only configure single PRU per PRACH slot in *msgA-CFRA-PUSCH*
  + No additional signaling or mapping rules are needed
  + Need RAN2 to introduce some restrictions of some parameters in the full signaling for MsgA PUSCH, which can be specified through the use of field descriptions or need codes and no change in current RRC fields are needed.
  + Note that since there is only one PRU (PUSCH occasion and DMRS resource) configured per PRACH slot, there could be a limitation to gNB scheduling other PUSCH FDMed to this PRU if the gNB only has one antenna panel (i.e., one beam at a time); the limitation is in this case, gNB cannot determine the rx beam of PRU until it detects this preamble, then gNB finally knows which SSB/CSI-RS UE selects for the preamble transmission.
  + Note: no RAN1 impact for option 2, all the signaling and ordering, resource determination are captured in RAN2 spec.
* Option 3: Support the MsgA with only preamble part
  + It’s up to RAN2 to decide whether the dedicated signaling on MsgA PUSCH is optional or to revert the agreement to not configure the MsgA PUSCH configuration at all
  + If RAN2 decides that MsgA PUSCH configuration is never configured, the explanation for msgA with preamble for 2-step CFRA can be described in the description of CFRA field descriptions (e.g.,totalNumberOfRA-Preambles) in TS38.331.
    - Minor RAN1 impact is required for preamble-to-PRU mapping in this case.
* Option 4: Ask RAN2 to make a solution different from the two alternatives in the RAN2 LS without any RAN1 impact.
  + See [4] for details.

Note: for all the alternatives and options above, preamble index in ssb-ResourceList or csirs-ResourceList in CFRA-TwoStep is assumed to be used to determine the preamble index for CFRA of 2-step RA type.

* Multiple PRUs are not needed (i.e. those not supporting alt A & B) is supported by 4 companies (Ericsson, LGE, Huawei, Qualcomm)

Some detail comments from some companies are summarized in the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Is it necessary to configure multiple PRUs per PRACH slot?** | **Option 1, or option 2, or option 3 or option 4** | **Alt A, or Alt B?**  **Only valid when option 1 is selected** |
| Ericsson | No.  Since the dedicated signaling for MsgA PUSCH is only for one single UE, only one PRU is needed per PRACH slot, and the PRU is always after the corresponding PRACH slot according to the agreed *msgA-CFRA-PUSCH*. | Option 2   * The simplest way to have minimum RAN1 and RAN2 impact. Single PRU can be configured with some restrictions on some parameters in RAN2 which can be specified through the use of field descriptions or need codes and no change in current RRC fields are needed. * Avoids unnecessary waste of PUSCH resources. | N/A |
| ZTE | Yes.  Multiple PRUs are supported for CBRA. We do not think there is any RAN1 impact if we reuse the same configurations for CFRA. And single PRU per PRACH slot can be supported well by setting the parameters properly. | Option 1  One general comment is that, to minimize our work in RAN1, we think the simplest way is to select between the two alternatives in the LS, as RAN2 specifically asked us to implement one of the alternatives.  ------------  For CFRA, RAN2 respectfully asks RAN1 to take the above alternatives into consideration and to implement one of the above solutions for CFRA preamble-to-PRU mapping and respond to RAN2 on the required signaling in order for the UE to successfully identify a PRU based on a dedicated preamble in respective SSB(s)/CSI-RS(s). | Alt A is preferred.  There is no need to revisit the mapping ratio calculation, mapping definitions, etc  Alt B can be acceptable if the PRU ordering is reused. |
| LGE | No | **Option 3** Only support the MsgA with only preamble part  In WI for 2-step RACH [RP-2000085], ‘RAN1 work addresses only CBRA (i.e. not considering CFRA)’ is described as a part of objective. As we observed, both option 1 and 2 bring RAN1 impact. We cannot accept any solution(s) for CFRA which bring RAN1 impact.  On the other hand, for option 3, **no discussion is needed in RAN1.** In addition,option 3 has an advantage of early starting RA monitoring window than option 1 and option 2. | N/A |
| Qualcomm | NO | Option 2 | N/A |
| Samsung | This is not a question for us to answer. RAN2 already agreed to have msgA PUSCH configuration dedicated for CFRA. | The key message from the LS is ask RAN1 to evaluate the two alternatives discussed in RAN2, to find which one is less impact to RAN1. So our focus is the compare these alternatives.  Alt.1 intends to configure a preamble set for contention free random access which is never done before and will limit the flexibity as well as having more impact to ran1; while alt.2 just requires to provides the dedicated PO index and DMRS index, in which the ordering are purely reuse we have defined in 213. | Alt.B  Indicate the dedicated PO index and DMRS index.  Reusing the ordering defined in 213. |
| Intel | N/A | We share similar view as ZTE and Samsung that it would be good to focus on the selection of two alternatives from RAN2 in the reply LS.  We agree with ZTE that both alternatives can work if a single PRU is dedicatedly configured for a UE for CFRA.  Between the two alternatives, we slightly prefer Alt. B as long as we can configure a dedicated PRU (PO + DMRS index) to a UE. | Alt. B |
| Nokia | Yes. | **Option 1:** As highlighted by ZTE and Samsung, RAN2 asked RAN1 to indicate the selected solution from the provided alternatives. | Alternative 1 seems simpler and does not rely on PRU ordering. |
| Spreadtrum | Yes  RAN2 agreed full msgA PUSCH configuration dedicated for CFRA, how to configure it up to NW.  A single PRU per PRACH slot is a special configuration | Option1  Since Alt1 is preferred for RAN2, we may focus on alt1 and analyze impacts to ran1. Some issues need to be clarified from RAN1’s perspective:   1. Whether dedicated PUSCH resources for CFRA are used by a single UE which will impact the mapping between preamble and PRU. 2. Whether it is necessary to take the number of contention free preambles per SSB reserved for CFRA into account. | AltA  Mapping ratio and mapping can be determined based on the configuration. |
| vivo | RAN2 already made agreements that for dedicated msgA PUSCH resources, the full msgA PUSCH configuration is signaled in RACH-ConfigDedicated. From our understanding, it is up to gNB implementation to configure the number of dedicated PRUs for 2-step CFRA. | Option 1.  We share the same view as ZTE. | Alt.A is preferred as less RAN1 impact is expected.  Alt.B has to define the PRU ordering. |
| Sony | Yes. | **Option 1.**  Strive to minimize RAN1 impact. | **Alt.A** |
| Huawei, HiSi | No | Option 4 with details in [4]  RAN1 should work based on both RANP decision and RAN2 LS, thus not necessary to follow RAN2 recommended schemes.  From our side a pure RAN2 solution is possible. It seems Option2 is kind of our view while we do not want to be specific to Option 2 with details, as final decision up to RAN2.  Our recommended solution can be found in [4]. | N/A |
| Apple | Yes. Share the view with Samsung, RAN2 already agreed the dedicated PUSCH resource can be configured for CFRA. | Option 1. Another alternative provided by RAN2 is not clear enough. | Alt. A |

# Conclusion

Based on the discussion above, RAN1 concludes that

* Both alternative 1 and alternative 2 provided in LS [2] (corresponding to Alt A and A1 in the email discussion summarized in [1]) have impacts on RAN1 specifications.
  + Although only one PRU is needed for one UE in 2-step RACH CFRA, the RAN2 signaling allows multiple PRUs to be configured, which leads to the RAN1 specification impact in Alts A, and A1.
* To follow the guidance from RAN plenary, RAN2 should avoid any RAN1 specification impact on the MsgA resource determination in CFRA.
  + Some options are expected to avoid RAN1 impacts.

An LS capturing this outcome is given in [5].

# Reference

1. R2-2002204, “LS to RAN1 on preamble-to-PRU mapping for 2-step CFRA”, Ericsson, RAN2 #109-e, February 2020.
2. R1-2002736, “Outcome of RAN1#100b-e preparation phase on incoming LS”, 3GPP TSG RAN1 Chairman, RAN1 #100bis-e, April.
3. R1-2001712, “FL summary on the maintenance of 2-step RACH channel structure”, ZTE, RAN1 #100bis-e, April.
4. R1-2002574, “Further considerations on 2-step RACH”, Huawei, HiSilicon, RAN1#100bis-e.
5. R1-200xxxx, “LS Response on preamble-to-PRU mapping for 2-step CFRA”, RAN1, RAN1#100bis-e.