**3GPP TSG RAN WG1 #107-e R1-21xxxxx**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 8.8**

**Source: Moderator (China Telecom, Sharp, Nokia, Qualcomm, ZTE)**

**Title: [107-e-R17-RRC-CovEnh] Email discussion on Rel-17 RRC parameters for Coverage Enhancement**

**Document for: Discussion**

1. Introduction

RAN1 has sent an LS to RAN2 with an agreed list of new higher layers parameters and updates on the existing higher-layer parameters for Rel-17 work items [1]. RAN1 will further discuss and refine the RAN1 RRC parameters. Recommendations for RAN1 RRC Parameter are given in [2].

This contribution is a summary of the following email discussion:

[107-e-R17-RRC-CovEnh] Email discussion on Rel-17 RRC parameters for Coverage Enhancement

* Email discussion to start on November 15

1. Discussion on RRC parameters for AI 8.8.1.1

As the outcome from [106bis-e-R17-RRC-CovEnh] Email discussion on Rel-17 RRC parameters for Coverage Enhancement, the following two RRC parameters for AI 8.8.1.1 were identified.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **WI code** | **Sub-feature group** | **RAN1 specification** | **Section** | **RAN2 Parant IE** | **RAN2 ASN.1 name** | **Parameter name in the spec** | **New or existing?** | **Parameter name in the text** | **Description** | **Value range** | **Default value aspect** | **Per (UE, cell, TRP, …)** | **UE-specific or Cell-specific** | **Specification** | **Comment** |
| NR\_cov\_enh-Core | Enhancement on PUSCH repetition Type A |  |  |  |  | *numberOfRepetitions-17* | existing |  | Support the increased maximum number of repetitions  The field is optionally present if pusch-RepTypeIndicatorDCI-0-1/ pusch-RepTypeIndicatorDCI-0-2 is set to pusch-RepTypeA. It is absent otherwise.  Note: If this field is present, numberOfRepetitions-16 field is absent | 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 |  |  | [UE-specific] | 38.331 | Agreements: Rel-17 PUSCH repetition Type A supports the increase of maximum number of repetitions with repetition factors configured in a TDRA list with a row index indicated either by the configured grant configuration or by TDRA field in a DCI. Ø FFS: increasing the maximum number of repetitions with repetition factor configured in PUSCH-Config and/or ConfiguredGrantConfig.  Agreement: In addition to {1, 2, 3, 4, 7, 8, 12, 16} and {32}, the following additional value set for repetition factor is supported in Rel-17. • {20, 24, 28}  Agreement DCI format 0\_1 and DCI format 0\_2 support Rel-17 PUSCH repetition Type A with the increased maximum repetition numbers configured in TDRA lists. |
| NR\_cov\_enh-Core | Enhancement on PUSCH repetition Type A |  |  |  |  | *AvailableSlotCounting* | new |  | Enabling PUSCH repetitions counted on the basis of available slots | ENUMERATED {enabled, disable } |  | in [PUSCH-Config] | [UE-specific] | 38.331 | Agreement: • Each available slot identified by the UE is considered as a transmission occasion for PUSCH repetition. o RV is cycled across transmission occasions, irrespective of whether PUSCH transmission in the transmission occasion is further omitted or not.  Note: if separate FGs are defined for DG-PUSCH and CG-PUSCH, this field may be necessary for each of them. |

## 2.1 1st round discussion

## Issue #1: UE-specific or Cell-specific

We have been assuming that enhancements introduced in AI 8.8.1.1 can be configured after establishing the connection, and so far no parameter which needs to be provided with cell-specific manner has been identified. Therefore, it is suggested that all the RRC parameters for AI 8.8.1.1 are UE-specific.

**FL proposal 1:**

* All the RRC parameters for AI 8.8.1.1 are UE-specific.

Companies are invited to provide their views.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Vivo | Support |
| QC | Support |
| Ericsson | We support the proposal. |
| NTT DOCOMO | We are fine with the FL proposal. |
| Intel | We are fine with the proposal. |
| Sharp | Support |
| LG | We support the proposal. |

## Issue #2: Parent IE of *AvailableSlotCounting*

It was discussed that whether a single parameter *AvailableSlotCounting* is applied to both DG-PUSCH and CG-PUSCH or a separate parameters are necessary. The conclusion in RAN1#106bis-e was that a single parameter *AvailableSlotCounting* is applied to both DG-PUSCH and CG-PUSCH but the note saying “if separate FGs are defined for DG-PUSCH and CG-PUSCH, this field may be necessary for each of them” is added in “Comment” column of *AvailableSlotCounting* in the table. Given that the current *AvailableSlotCounting* is applied to at least DG-PUSCH, it is straightforward that this parameter is included in *PUSCH-Config*. If another parameter *AvailableSlotCounting* which is applied only to CG-PUSCH is agreed later on, that parameter could be included in *ConfiguredGrantConf* instead of *PUSCH-Config*.

**FL proposal 2:**

* “Per (UE, cell, TRP, …)” column of *AvailableSlotCounting* is “in *PUSCH-Config*”.

Companies are invited to provide their views.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Vivo | Generally fine.  Prefer to add FFS that ‘whether *AvailableSlotCounting* is applicable for both DG and CG depends on UE feature discussion’. |
| QC | If it is easier for RAN2 to drop a parameter than to add a new one, we prefer to also say that a separate parameter is added under ConfiguredGrantConfig (conditional on UE feature separation between DG and CG).  At the very least, lets capture that whether this also applies to CG-PUSCH is not decided yet. |
| Ericsson | We support the proposal. |
| NTT DOCOMO | We are fine with the FL proposal. |
| Intel | We are fine with the proposal. |
| Sharp | Support the proposal. Also, fine to add an FFS as suggested by vivo and Qualcomm. |
| LG | We support the proposal. |

## Issue #3: Other additional RRC parameters

According to the contributions in AI 8.8.1.1 for RAN1#107-e, the following issues which have potential impacts on RRC parameters were raised.

* Support of *pusch-AggregationFactor-r17*
* Support of *repK-r17*

In addition, for *AvailableSlotCounting*, whether to have a single FG or separate FGs for DG-PUSCH repetitions and CG-PUSCH repetitions is also under discussions in AI 8.16.8, and that affects whether a single RRC parameter in *PUSCH-Config* is sufficient for both DG-PUSCH and CG-PUSCH or another RRC parameter in *ConfiguredGrantConf* is necessary for CG-PUSCH.

* Support of *AvailableSlotCounting* for CG-PUSCH

However, all the above issues are still under discussions in AI 8.8.1.1, and they should not be captured in the list yet from the FL perspective. If there is any other issue which potentially requires additional RRC parameters for AI 8.8.1.1, please comment below.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | Okay to wait. |
| NTT DOCOMO | We are fine with the FL proposal. |

## 2.2 2nd round discussion

1. Discussion on RRC parameters for AI 8.8.1.2

## 3.1 1st round discussion

As the outcome from [106bis-e-R17-RRC-CovEnh] Email discussion on Rel-17 RRC parameters for Coverage Enhancement, the following two RRC parameters for AI 8.8.1.2 were identified.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **WI code** | **Sub-feature group** | **RAN1 specification** | **Section** | **RAN2 Parant IE** | **RAN2 ASN.1 name** | **Parameter name in the spec** | **New or existing?** | **Parameter name in the text** | **Description** | **Value range** | **Default value aspect** | **Per (UE, cell, TRP, …)** | **UE-specific or Cell-specific** | **Specification** | **Comment** |
| NR\_cov\_enh-Core | TB processing over multi-slot PUSCH |  |  |  |  | *numberOfSlotsTBoMS-r17* | new |  | Number of slots allocated for TB processing over multi-slot PUSCH for DCI format 0\_1/0\_2 (see TS 38.214 [X], clause XX) | 1, 2, 4, 8 |  | Per UE, Parent IE: PUSCH-TimeDomainResourceAllocationList | UE-specific | 38.331 | "Agreement  The number N of allocated slots for TBoMS is indicated via a new column added to the TDRA table configured via PUSCH-TimeDomainAllocationList. The existing column for configuring the number of repetitions in the TDRA for Rel-17 PUSCH repetition Type A, i.e., numberOfRepetitions, is used for indicating the number of repetitions M of a single TBoMS, when TBoMS transmission is enabled.  FFS: supported values of N and M.  FFS: how to enable the TBoMS transmission  FFS: details of retransmission of TBoMS    Agreement  At least the following values are supported in Rel-17 for the number N of allocated slots for the single TBoMS:  • {2,4,8}  FFS: whether N=1 is also supported depends on how TBoMS transmission feature is enabled (or disabled)  FFS: other values, if any.  FFS: further constraints on N\*M  Agreement  For TBoMS transmission in Rel-17:  • TBoMS feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.  • TBoMS transmission is enabled when N>1, where N is the number of allocated slots for a single TBoMS.  • Single-slot PUSCH transmission is enabled when N=1.  • Supported combinations of N and M that can be configured in the TDRA table, these combinations are constrained by retransmission are to be further discussed  " |
| NR\_cov\_enh-Core | TB processing over multi-slot PUSCH |  |  |  |  | *numberOfRepetitions* | existing |  | Number of repetitions of a single TB over multi-slot PUSCH (see TS 38.214 [X], clause XX) | 1,2,3,4,7,8,12,16 |  | Per UE, Parent IE: PUSCH-TimeDomainResourceAllocationList | UE-specific | 38.331 | "Agreement  The number N of allocated slots for TBoMS is indicated via a new column added to the TDRA table configured via PUSCH-TimeDomainAllocationList. The existing column for configuring the number of repetitions in the TDRA for Rel-17 PUSCH repetition Type A, i.e., numberOfRepetitions, is used for indicating the number of repetitions M of a single TBoMS, when TBoMS transmission is enabled.  FFS: supported values of N and M.  FFS: how to enable the TBoMS transmission  FFS: details of retransmission of TBoMS    Agreement  The following values are supported in Rel-17 for the number M of repetitions of the single TBoMS:  • {1,2,3,4,7,8,12,16}  FFS: further constraints on N\*M, e.g., N\*M is a valid value according to agreements in AI 8.8.1.1" |

## Issue #1: Descriptions of the agreed RRC parameters

From FL’s perspective, the RRC parameters for TBoMS are stable. The remaining issue that needs to be resolved is the reference to the clauses in TS 38.214 in the descriptions of *numberOfSlotsTBoMS-r17* and *numberOfRepetitions*. Given that the first draft CR for TS 38.214 was endorsed, FL would like to update the two descriptions as follows.

**FL’s proposal 1:**

* **The description of *numberOfSlotsTBoMS-r17* is updated as follows:**
  + **Number of slots allocated for TB processing over multi-slot PUSCH for DCI format 0\_1/0\_2 (see TS 38.214 [X], clause 6.1.2.1)**
* **The description of *numberOfRepetitions* is updated as follows:**
  + **Number of repetitions of a single TB over multi-slot PUSCH (see TS 38.214 [X], clause 6.1.2.1)**

Companies are invited to provide their views.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support |
| QC | Support |
| Ericsson | We would like clarify that *numberOfRepetitions* refers to “Number of repetitions of a single TB over multi-slot PUSCH”, *if numberOfSlotsTBoMS-r17* is larger than 1. |
| NTT DOCOMO | Support |
| Intel | We are fine with the proposal. |
| Sharp | Support |
| LG | Support |
| FL | @Ericsson: Good catch. However, I am not sure what you propose can solve the problem. What we agreed is that no new IE will be introduced for indicating the number of TBoMS repetitions, and existing IE will be used. For this reason, I now wonder if we shouldn’t simply suggest RAN2 to keep the current description and defer all explanations to TS 38.214. The proposal could then be reformulated as:  **FL’s proposal 1v2:**   * **The description of *numberOfSlotsTBoMS-r17* is updated as follows:**   + **Number of slots allocated for TB processing over multi-slot PUSCH for DCI format 0\_1/0\_2 (see TS 38.214 [X], clause 6.1.2.1)** * **The description of *numberOfRepetitions* is updated as follows:**   + **Number of repetitions for DCI format 0\_1/0\_2 (see TS 38.214 [19], clause 6.1.2.1)**   **@All: could you please check the above and confirm that you are still OK with FL’s proposal 1-v2? Thanks!** |
| Ericsson | Support |

## Issue #2: Any other issues on RRC parameters for TBoMS

Companies are encouraged to provide their view on any other remaining issues on RRC parameters for TBoMS.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We agreed to a UE capability to indicate whether DMRS bundling and TBOMS could be enabled at the same time. Should we have a counterpart to this capability in RRC parameters? It seems to be the recommended practice by RAN2 (as stated by Ericsson in an earlier discussion). |
| FL | From my understanding, we already have the possibility to configure both DMRS bundling and TBoMS (separately), hence I am not sure that creating a redundant RRC parameter to activate both at the same time, which may then trigger discussions on UE behavior in case of inconsistent behavior and so on. Furthermore, I doubt that RAN2 recommended to fragment RRC parameters in such a way that all UE capabilities are mapped 1:1 to a parameter (with no case-by-case discrimination). While I acknowledge this may be helpful in some cases, it would certainly lead to an explosion of the number of RRC parameters if it were applied with no case-by-case discrimination.  Having said this, I invite other companies to express their views on what Qualcomm wrote. |
| Ericsson | The RAN2 guidance was ‘Avoid defining functionality that has no RRC configuration but is dependent on capability bits.’ I think having two RRC parameters controlling DMRS bundling and TBoMS, respectively, allows the network to configure the UE to match its TBoMS+bundling capability. |

## 3.2 2nd round discussion

1. Discussion on RRC parameters for AI 8.8.1.3

The following RRC parameters for AI 8.8.1.3 have been agreed in [1].

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **WI code** | **Sub-feature group** | **Parameter name in the spec** | **New or existing?** | **Description** | **Value range** | **Default value aspect** | **Per (UE, cell, TRP, …)** | **UE-specific or Cell-specific** |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-DMRS-Bundling* | new | Enabling/disabling of DM-RS bundling and time domain window for PUSCH. | ENUMERATED {enabled, disabled} |  |  | [UE-specific] |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-TimeDomainWindowLength* | new | Length of a configured time domain window in slots for DMRS bundling for PUSCH. | FFS |  | in [PUSCH-Config] | [UE-specific] |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-Window-Restart* | new | [UE bundles PUSCH DM-RS remaining in a bundling window after event(s) that violate power consistency and phase continuity requirements] | ENUMERATED {enabled, disabled} |  | in [PUSCH-Config] | [UE-specific] |

## 4.1 1st round discussion

**FL comments:** Based on the guideline in [2], default values are primarily important for cases where the NW has not yet provided a (UE-specific) configuration. In other cases, it can help clarify what the UE does when a parameter or feature is not configured. Companies are encouraged to provide the comments on the default value for each RRC parameter, the entries in square brackets and other entries not filled yet.

**Proposal 1:**

* Remove all the square brackets in the table.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| vivo | Fine. |
| QC | Support |
| Ericsson | Ok to remove the square brackets. |
| Intel | We are fine with the proposal. |
| Sharp | Support |
| LG | Support. |

**Proposal 2:**

* For PUSCH repetition type A, if *PUSCH-TimeDomainWindowLength* is not configured, the default value of *PUSCH-TimeDomainWindowLength* is the minimum value between the duration of all repetitions and the maximum duration defined in TS38.101-1/2.
* For TBoMS, if *PUSCH-TimeDomainWindowLength* is not configured, the default value of *PUSCH-TimeDomainWindowLength* is the minimum value between the duration of TBoMS transmission (including repetition of TBoMS) and the maximum duration defined in TS38.101-1/2.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| vivo | Fine |
| QC | Support |
| Ericsson | Support in principle.  The following agreement was reached to determine the time duration for PUSCH repetition with configured grant in RAN1#106bis-e. Similar discussion on TBoMS is ongoing.   |  | | --- | | Agreement   * The existing restriction “The UE is not expected to be configured with the time duration for the transmission of K repetitions larger than the time duration derived by the periodicity P” applies to both the counting based on physical slots and the counting based on available slots.   The above “the time duration for the transmission of K repetitions” means the time duration between the start of the 1st slot of the K repetitions and the end of the last slot of the K repetitions for any instance of a CG period. |   For the first bullet, we suggest to use “the time duration for the transmission of K repetitions” instead of “the duration of all repetitions”. |
| FL | Based on Ericsson’s comments, proposal 2 is updated as follows.  **Proposal 2-v2:**   * For PUSCH repetition type A, if *PUSCH-TimeDomainWindowLength* is not configured, the default value of *PUSCH-TimeDomainWindowLength* is the minimum value between ~~the duration of all repetitions~~ the time duration for the transmission of K repetition and the maximum duration defined in TS38.101-1/2. * For TBoMS, if *PUSCH-TimeDomainWindowLength* is not configured, the default value of *PUSCH-TimeDomainWindowLength* is the minimum value between the duration of TBoMS transmission (including repetition of TBoMS) and the maximum duration defined in TS38.101-1/2. |
| NTT DOCOMO | Support the updated proposal. |
| Intel | Our understanding is that the original proposal is based on the agreement. We are fine with the original proposal 2. |
| Sharp | Fine with the updated proposal. |
| LG | Fine with the updated proposal. |
| Ericsson | Support the revised proposal. Thanks to FL for taking our comment into account. |

**FL comments:** We have agreed each configured TDW consists of one or multiple consecutive physical slots. Companies are encouraged to provide comments on how to define the default value of *PUSCH-TimeDomainWindowLength* for PUSCH repetition type B.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| vivo | Same as that for type-A PUSCH repetition. |
| QC | Same default value should work. Please also see additional comment below. |
| Ericsson | We have agreed that PUSCH repetition Type B is supported if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A. Therefore, the default values should be determined according to what has been agreed for Type A, which is the minimum value between the time duration for the transmission of K repetitions and the maximum duration defined in TS38.101-1/2. |
| FL | Different from PUSCH repetition type A and TBoMS, the unit for PUSCH repetition type B is symbol-level, which is not aligned with the unit of configured TDW and the maximum duration. Is it necessary to do round up operation for PUSCH repetition type B to match configured TDW and the maximum duration? |
| NTT DOCOMO | We prefer configured TDW determination with symbol-level for PUSCH repetition type B. If it is against the agreement to reuse PUSCH repetition type A, fine with round up operation. |
| Intel | We prefer to align/reuse the mechanism as defined for PUSCH repetition type A. In this case, it is based on slot level. |
| Sharp | Same as that for PUSCH repetition Type A. |
| LG | Reusing specification enhancements means no dedicated specification enhancement to us. Therefore it is our understanding that if the PUSCH repetition type B is not matched to specification enhancements for PUSCH repetition type A, PUSCH repetition type B is not supported. Making other enhancement for operation of PUSCH repetition type B or TBoMS seems violation of previous agreement. |

**Proposal 3:**

* Revise the domain “**Per (UE, cell, TRP, …)**” for *PUSCH-TimeDomainWindowLength* as follows:
  + Per BWP, in *PUSCH-Config*

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| vivo | Fine |
| QC | Makes sense |
| Ericsson | Support |
| NTT DOCOMO | Fine |
| Intel | Support. |
| Sharp | Support |
| LG | Support. |

Any other comments?

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| QC | Are we assuming that these parameters are shared between Type A and Type B repetitions? Do we want to enable bundling for both at the same time? For Type B, the trade-off between diversity and DMRS bundling is an interesting consideration. It might make sense to separate them.  Suggest using the current set of parameters only for Type A rep and TBOMS.  Introduce separate set of parameters for Type B. Also, preferred window length for Type B could be different. Good to build this flexibility in. |
| Sharp | Either Type A or Type B is configured with semi-static manner. We are not sure why a separate set of parameters for Type B is necessary. |
|  |  |

## 4.2 2nd round discussion

1. Discussion on RRC parameters for AI 8.8.2

In the post RAN1 106bis email discussion on RRC parameters, the following PUCCH coverage enhancement related RRC parameters were discussion.



However, due to some controversial issues. None of the above RRC parameters were marked as stable. Hence they were not send in the LS to RAN2. Given RAN1#107e is the meeting that RAN1 suppose to finalize RRC parameters, it is expected to finalize the RRC parameters for PUCCH coverage enhancement in this meeting.

In this document, a summary of companies’ proposals for PUCCH coverage enhancement RRC parameters is provided.

## 5.1 1st round discussion

**RRC parameter “PUCCH-nrofSlots-r17”**

On this RRC parameter, there is a small issue of whether/how to indicate repetition factor = 1.

The following proposals were proposed in submitted contributions to RAN1 107e.

[R1-2111623](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111623.zip) Proposal 1:

* The mechanism to indicate no repetitions should be discussed for PUCCH. Both including the repetition factor 1 into the set and additional indication could be considered.

[R1-2110866](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110866.zip) Proposal 2: support PUCCH repetition factor equal to 1 in Rel-17

[R1-2112038](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112038.zip) Proposal 4:

* Update RRC parameters for PUCCH dynamic repetition according to Table 1
  + Add a note, such as the following, to indicate RAN1’s intent to support a dynamically indicated PUCCH repetition factor of 1
    - “Note: a PUCCH resource not configured with *PUCCH-nrofSlots-r17* can attain the value of 1 according when the Rel-15/16 parameter *nrofSlots* is not configured”

Table 1: RRC Parameters for Dynamic PUCCH Repetition

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sub-feature group** | **RAN2 Parent IE** | **Parameter name in the spec** | **Description** | **Value range** |
| PUCCH enhancements | PUCCH-Resource | *PUCCH-nrofSlots-r17* | A new repetition parameter corresponding to Rel-17 dynamic PUCCH repetition factor indication. The new repetition parameter is configured per PUCCH resource and should be in PUCCH-Resource.  Note: a PUCCH resource not configured with PUCCH-nrofSlots-r17 can attain the value of 1 according when the Rel-15/16 parameter nrofSlots is not configured | ENUMERATED {2, 4, 8} |

During the discussion in last RAN1 meeting, i.e., RAN1#106bis-e, the following FL proposal was proposed.

FL proposal 1-1: In column J of RRC parameter “PUCCH-nrofSlots-r17”, add a note as the following:

* Note: a PUCCH resource not configured with PUCCH-nrofSlots-r17 can attain the value of 1 according to when the Rel-15/16 parameter nrofSlots is not configured.

To the above proposal, Samsung had a commented that “We think there is no need for the note because the default value of K=1 is already possible. If PUCCH-nrofSlots-r17 is not configured, Rel-15/16 applies (and if PUCCH-nrofSlots is not configured, the default value is K=1).”

FL’s understanding of the situation is that no company is against supporting PUCCH repetition factor =1, which is the default fallback behavior anyway. The debating point is whether a specific note is needed. Majority companies seem fine to add such a note. On the other hand, Samsung’s comment also makes sense technically. Therefore, FL would like to see companies view on this issue by collecting answers to the following question.

**FL question 1: Do you see PUCCH repetition factor of 1 cannot be supported if the above note in FL proposal 1-1 is not added?**

Companies are welcome to provide comments to the above FL proposal in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | Prefer to have K=1 for PUCCH-nrofSlots-r17. And it provides higher flexibility to indicate PUCCH transmission without repetition. |
| Ericsson | We think the note might save RAN2 or other WGs some confusion. Without the note, they may think that a PUCCH resource in dynamic PUCCH repetition operation can’t have a repetition factor of 1, since the value range is 2, 4, 8. |
| Intel | If PUCCH factor of 1 is not configured, this indicates there is no repetition. Similar mechanism as in Rel-15/16 nrofSlots can be reused |
| Sharp | Agree with Ericsson. The note avoid confusion in RAN2. |
| LG | We also think the note is necessary to prevent confusion. |

**RRC parameter “PUCCH-DMRS-Bundling”**

On RRC parameter “PUCCH-DMRS-Bundling”, the main debating point is what is the configuration granularity of this parameter.

In RAN1 106bis, companies’ views are collected as the following in FL summary.

The RRC configuration for DMRS bundling across PUCCH repetitions is

* Option 1: per UE
  + Support by: Intel
* Option 2: per UL BWP
  + Support by: Huawei/Hisi, ZTE, CATT, Samsung, Intel, DCM, Nokia/NSB, Sharp, Ericsson
* Option 3: per PUCCH resource format
  + Support by: VIVO, Sharp
* Option 4: per PUCCH resource
  + Support by: VIVO, CMCC, Apple, QC

For RAN1 107e, not all companies express view on this issue. The views from companies submitted contributions to 107e are summarized as below.

The RRC configuration for DMRS bundling across PUCCH repetitions is

* Option 1: per UE
  + Support by:
* Option 2: per UL BWP
  + Support by: Intel, DCM
* Option 3: per PUCCH resource format
  + Support by: Ericsson
* Option 4: per PUCCH resource
  + Support by: QC

Based on the above input from both RAN1 106bis and RAN1 107e, the following FL proposal is made.

**FL proposal 1: Down select from the following two options in RAN1 107e**

* **Option 2: The RRC parameter “PUCCH-DMRS-Bundling” is per UL BWP**
* **Option 3: The RRC parameter “PUCCH-DMRS-Bundling” is per PUCCH resource format**

Companies are welcome to provide comments to the above FL proposal in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | We support per PUCCH resource or per PUCCH format, and we are fine with option 2 if format 0 is excluded.  While PUCCH format 0 is a kind of DMRS less format, maintaining phase continuity and power consistency does not necessarily lead to better performance, especially we may consider postponing/ignoring the action of TPC command in the DMRS bundling TDW, which may degrade performance of PUCCH, especially for PUCCH format 0 without DMRS. |
| QC | Okay to downselect between the two options. We think its good to have flexibility across formats. Gain from DMRS bundling comes at the expense of diversity, so we expect gNB vendors to prefer different settings for different formats. We also need to be mindful of FR2 networks where beam sweeping across short repetitions might be preferred. |
| Ericsson | Support. We prefer option 3. |
| NTT DOCOMO | We prefer Option 2. |
| Intel | We prefer Option 2. Option 3 may imply dynamic enabling/disabling DMRS bundling in case of dynamic HARQ-ACK feedback, e.g., when a new PUCCH resource is generated |
| Sharp | Support. We prefer Option 2. |
| LG | We prefer option 2. Since it was agreed that “Strive for common design for PUSCH/PUCCH with DMRS bundling as much as possible” and considering time domain window length for PUSCH is configured per UL BWP, we think per UL BWP would be supported. |

Besides the main debating point, a minor editor change should be made to remove the square bracket for “PUCCH-DMRS-Bundling”. Therefore, the following FL proposal is made.

**FL proposal 2: In column G of RRC parameter “PUCCH-DMRS-Bundling”, adopt the following change:**

~~[~~PUCCH-DMRS-Bundling~~]~~

Companies are welcome to provide comments to the above FL proposal in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | Support |
| QC | Support |
| Ericsson | Support |
| NTT DOCOMO | We are fine with the FL proposal. |
| Intel | Support. |
| Sharp | Support |

**RRC parameter “PUCCH-TimeDomainWindowLength”**

For RRC parameter “PUCCH-TimeDomainWindowLength”, similar to the discussion for “PUCCH-DMRS-Bundling”, the main debating point is the granularity of this RRC parameter.

FL have raised the following question in RAN1 106bis.

FL question 1: For DMRS bundling across PUCCH repetitions, whether the RRC parameter “PUCCH-TimeDomainWindowLength” should be configured per PUCCH format/PUCCH resource, or per PUCCH-config, or with other granularity?

Companies’ feedback were collected in the following table.

|  |  |
| --- | --- |
| **Company name** | **Answer** |
| CATT | We think it should be configured per BWP (i.e. per PUCCH-config of one specific BWP), which is aligned with the former handling of ‘**PUCCH-DMRS-Bundling**’. |
| vivo | Same as our comments to FL proposal 2, the RRC parameter may be “PUCCH-TimeDomainWindowLength” rather than “PUCCH-DMRS-Bundling”.  Besides, we prefer “PUCCH-TimeDomainWindowLength”configured per PUCCH resource to achieve higher flexibility. |
| Lenovo, Motorola Mobility | Our preference is to configure **“PUCCH-TimeDomainWindowLength”** per PUCCH resource. |
| ZTE | As commented above, only one RRC parameter PUCCH-TimeDomainWindowLength is needed. In Rel-16, it can configure up to two PUCCH-config per BWP, and we slightly prefer to configure PUCCH-TimeDomainWindowLength per PUCCH-config level. |
| Intel | It seems more appropriate to configure TDW duration as per PUCCH-config. Finer granularity may not be necessary. |
| Samsung | Same as for “PUCCH-DMRS-Bundling”. |
| NTT DOCOMO | We prefer per PUCCH format/PUCCH resource for flexible configuration for PUCCH format/resource. |
| Sharp | We prefer per PUCCH-config. |
| QC | Same response as before, we prefer to retain flexibility to configure per format/resource. Short formats may benefit more from diversity than DMRS bundling.  Prefer to configure per format/resource. |
| Ericsson | We think the window length is a separate issue from whether bundling is configured or not for the bwp/format/resource. So, while we can discuss further, at this stage per BWP seems like it could be enough. |
| Nokia/NSB | Agree with Ericsson. |
| Apple | We prefer per PUCCH resource/format |
| Samsung2 | To clarify our previous input – we think it is sufficient to configure both PUCCH-DMRS-Bundling and PUCCH-TimeDomainWindowLength per BWP. |
| LG | We prefer per BWP with similar reasons from other companies. |

Based on the feedback from companies, FL propose a similar proposal as for “PUCCH-DMRS-Bundling” to move forward.

**FL proposal 3: Down select from the following two options in RAN1 107e**

* **Option 2: The RRC parameter “PUCCH-TimeDomainWindowLength” is per UL BWP**
* **Option 3: The RRC parameter “PUCCH-TimeDomainWindowLength” is per PUCCH resource format**
* Companies are welcome to provide comments to the above FL proposal in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | We prefer DMRS bundling configured per resource.  Per resource configuration is a more appropriate choice, since it can provide more flexibility by configuring different window lengths for different PUCCH resources configured with different repetition numbers. |
| QC | We prefer per resource, but are okay to go with per format. Fine tuning L per resource based on number of repetitions would be ideal (this is also the point that DCM was making in the context of PUSCH repetitions). |
| Ericsson | Somewhat prefer per BWP. |
| NTT DOCOMO | We prefer Option 3 for flexible configuration for PUCCH format/resource. |
| Intel | We prefer Option 2. Similar comment as above. Option 3 may indicate the dynamic change of time domain window length for DMRS bundling, e.g., when a new PUCCH resource is generated |
| Sharp | Support. We prefer Option 2. |
| LG | We prefer per UL BWP. |

Furthermore, for RRC parameter “PUCCH-TimeDomainWindowLength”, there is a small FFS for column J. On this, FL make the following proposal to finalize column J.

**FL proposal 4: In column J of RRC parameter “PUCCH-TimeDomainWindowLength”, adopt the following change:**

~~[Enabling/disabling of DM-RS bundling and time domain window for PUCCH.]~~  
Length of a configured time domain window in slots for DMRS bundling for PUCCH.

Companies are welcome to provide comments to the above FL proposal in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | Support |
| QC | Can we leave configured in square brackets? We are trying to use the term “nominal” in the spec. Also depending on whether we go with per BWP or per format we need to make this a bit more descriptive. |
| Ericsson | Agree in principle. This aligns with the decision made to have two parameters and the decision for PUSCH to determine a default value for L.  However, ‘nominal’ is better terminology as QC points out. |
| NTT DOCOMO | We are fine with the FL proposal to follow the PUSCH structure. |
| Intel | Support. |
| Sharp | Support |
| LG | We are fine with the proposal since it is aligned to PUSCH. |

**New RRC parameter “PUCCH-Window-Restart”**

Similar to the agreed RRC parameter “PUSCH-Window-Restart”, [R1-2112038](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112038.zip) proposed to add a new parameter “PUCCH-Window-Restart” for PUCCH. FL’s initial assessment is that this is a reasonable proposal. Therefore, the following FL proposal is made.

**FL proposal 5: For DMRS bundling for PUCCH, add an RRC parameter to enable/disable PUCCH DMRS bundling restarts.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sub-feature group** | **RAN2 Parent IE** | **Parameter name in the spec** | **Description** | **Value range** |
| DM-RS bundling for PUCCH | [PUCCH-Config] | *PUCCH-Window-Restart* | UE bundles PUCCH DM-RS slots remaining in a bundling window after a slot for which events violate power consistency and phase continuity requirements | ENUMERATED {enabled, disable } |

Companies are welcome to provide comments to the above FL proposal in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | Fine. |
| QC | Support |
| Ericsson | Support |
| NTT DOCOMO | We are fine with the FL proposal to follow the PUSCH structure. |
| Intel | Support |
| Sharp | Support |
| LG | Support |

## 5.2 2nd round discussion

**RRC parameter “PUCCH-nrofSlots-r17”**

The following proposal is stable in first round of email discussion. So it is listed for email approval.

**Stable FL proposal 0 for email approval: In column J of RRC parameter “PUCCH-nrofSlots-r17”, add a note as the following:**

* **Note: a PUCCH resource not configured with PUCCH-nrofSlots-r17 can attain the value of 1 according to when the Rel-15/16 parameter nrofSlots is not configured.**

For last check, please add input to the following table if you object the above FL proposal.

|  |  |
| --- | --- |
| **Objecting companies** |  |

So far, no further open issue is identified for this RRC parameter, besides the FL proposal 0 listed in email for approval. Companies are welcome to list any missing issue for this RRC parameter in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
|  |  |
|  |  |

**RRC parameter “PUCCH-DMRS-Bundling”**

**Stable FL proposal 1 for email approval: Down select from the following two options in RAN1 107e**

* **Option 2: The RRC parameter “PUCCH-DMRS-Bundling” is per UL BWP**
* **Option 3: The RRC parameter “PUCCH-DMRS-Bundling” is per PUCCH resource format**

For last check, please add input to the following table if you object the above FL proposal.

|  |  |
| --- | --- |
| **Objecting companies** |  |

**Stable FL proposal 2 for email approval: In column G of RRC parameter “PUCCH-DMRS-Bundling”, adopt the following change:**

* ~~[~~PUCCH-DMRS-Bundling~~]~~

For last check, please add input to the following table if you object the above FL proposal.

|  |  |
| --- | --- |
| **Objecting companies** |  |

Assuming all companies are fine with FL proposal 1 in 1st round email discussion, the remaining open issue is to down selection between option 2 and option 3. On this, FL would like to collect more input from more companies in the following table, given only 7 companies express views in first round email discussion.

**FL question: The RRC parameter “PUCCH-DMRS-Bundling” is configured per UL BWP or per PUCCH resource format?**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | We support per PUCCH resource or per PUCCH format, and we are fine with option 2 if format 0 is excluded.  While PUCCH format 0 is a kind of DMRS less format, maintaining phase continuity and power consistency does not necessarily lead to better performance, especially we may consider postponing/ignoring the action of TPC command in the DMRS bundling TDW, which may degrade performance of PUCCH, especially for PUCCH format 0 without DMRS. |
| QC | Okay to downselect between the two options. We think its good to have flexibility across formats. Gain from DMRS bundling comes at the expense of diversity, so we expect gNB vendors to prefer different settings for different formats. We also need to be mindful of FR2 networks where beam sweeping across short repetitions might be preferred. |
| Ericsson | Support. We prefer option 3. |
| NTT DOCOMO | We prefer Option 2. |
| Intel | We prefer Option 2. Option 3 may imply dynamic enabling/disabling DMRS bundling in case of dynamic HARQ-ACK feedback, e.g., when a new PUCCH resource is generated |
| Sharp | Support. We prefer Option 2. |
| LG | We prefer option 2. Since it was agreed that “Strive for common design for PUSCH/PUCCH with DMRS bundling as much as possible” and considering time domain window length for PUSCH is configured per UL BWP, we think per UL BWP would be supported. |

So far, no further open issue is identified is for this RRC parameter, besides the above issues being discussed. Companies are welcome to list any missing issue for this RRC parameter in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
|  |  |
|  |  |

**RRC parameter “PUCCH-TimeDomainWindowLength”**

**Stable FL proposal 3 for email approval: Down select from the following two options in RAN1 107e**

* **Option 2: The RRC parameter “PUCCH-TimeDomainWindowLength” is per UL BWP**
* **Option 3: The RRC parameter “PUCCH-TimeDomainWindowLength” is per PUCCH resource format**

For last check, please add input to the following table if you object the above FL proposal.

|  |  |
| --- | --- |
| **Objecting companies** |  |

Assuming all companies are fine with FL proposal 3 in 1st round email discussion, the remaining open issue is to down selection between option 2 and option 3. On this, FL would like to collect more input from more companies in the following table, given only 7 companies express views in first round email discussion.

**FL question: The RRC parameter “PUCCH-TimeDomainWindowLength” is configured per UL BWP or per PUCCH resource format?**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| vivo | We prefer DMRS bundling configured per resource.  Per resource configuration is a more appropriate choice, since it can provide more flexibility by configuring different window lengths for different PUCCH resources configured with different repetition numbers. |
| QC | We prefer per resource, but are okay to go with per format. Fine tuning L per resource based on number of repetitions would be ideal (this is also the point that DCM was making in the context of PUSCH repetitions). |
| Ericsson | Somewhat prefer per BWP. |
| NTT DOCOMO | We prefer Option 3 for flexible configuration for PUCCH format/resource. |
| Intel | We prefer Option 2. Similar comment as above. Option 3 may indicate the dynamic change of time domain window length for DMRS bundling, e.g., when a new PUCCH resource is generated |
| Sharp | Support. We prefer Option 2. |
| LG | We prefer per UL BWP. |

FL proposal 4 is slightly updated as below. Companies are welcome to provide comments, if any, in the table below.

**Update FL proposal 4: In column J of RRC parameter “PUCCH-TimeDomainWindowLength”, adopt the following change:**

~~[Enabling/disabling of DM-RS bundling and time domain window for PUCCH.]~~  
Length of a [~~configured~~ nominal] time domain window in slots for DMRS bundling for PUCCH.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Ericsson | Agree with ‘nominal’. To be more precise, it is actually the maximum length, since it can be shortened according to scheduling. However, the current description may be good enough for the RRC parameter list, since the precise behavior is given in 38.214. |
|  |  |

So far, no further open issue is identified for this RRC parameter, besides the above issues being discussed. Companies are welcome to list any missing issue for this RRC parameter in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
|  |  |
|  |  |

**New RRC parameter “PUCCH-Window-Restart”**

The following proposal is stable in first round of email discussion. So it is listed for email approval.

**Stable FL proposal 5 for email approval: For DMRS bundling for PUCCH, add an RRC parameter to enable/disable PUCCH DMRS bundling restarts.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sub-feature group** | **RAN2 Parent IE** | **Parameter name in the spec** | **Description** | **Value range** |
| DM-RS bundling for PUCCH | [PUCCH-Config] | *PUCCH-Window-Restart* | UE bundles PUCCH DM-RS slots remaining in a bundling window after a slot for which events violate power consistency and phase continuity requirements | ENUMERATED {enabled, disable } |

For last check, please add input to the following table if you object the above FL proposal.

|  |  |
| --- | --- |
| **Objecting companies** |  |

One FFS for this new RRC parameter *PUCCH-Window-Restart* is what is the Parent IE for this RRC parameter. On this open issue, companies are welcome to provide input in the table below.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Ericsson | PUCCH-Config seems OK |
|  |  |

So far, no further open issue is identified for this RRC parameter, besides the above issues being discussed. Companies are welcome to list any missing issue for this RRC parameter in the following table.

|  |  |
| --- | --- |
| **Company name** | **Comments** |
|  |  |
|  |  |

1. Discussion on RRC parameters for AI 8.8.3

## 6.1 1st round discussion

In RAN1#106bis-e, the following RRC parameter for the number of repetitions for Msg3 PUSCH repetition is agreed.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **WI code** | **Sub-feature group** | **Parameter name in the spec** | **New or existing?** | **Description** | **Value range** | **Per (UE, cell, TRP, …)** | **UE-specific or**  **Cell-specific** | **Specification** | **Comment** |
| *NR\_cov\_enh-Core* | *Type A PUSCH repetitions for Msg3* | *numberOfMsg3Repetitions* | new | The number of repetitions for Msg3 PUSCH repetition, including Msg3 initial transmission and Msg3 re-transmission. | FFS | FFS | Cell-specific | 38.331 | Working Assumption  Down-select only one from the following methods for indication of the number of repetitions of Msg3 initial transmission.   * Alt 1: If TDRA information field is chosen, Option 2 is supported.   + The candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, [12], [16]} * Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.   + 2 MSB bits of the MCS information field are used for selecting one repetition factor from a SIB1 configured set with 4 candidate values.     - The set of candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, [12], [16]}   Note: Whether ‘1’ is included depends on the outcome of interpretation of the selected information field. |

### **Issue#1: Value range of *numberOfMsg3Repetitions***

One remaining issue is the value range of RRC parameter *numberOfMsg3Repetitions*. This has been discussed extensively in previous meetings, and majority companies also support values {12, 16} in addition to the already agreed values. The arguments include:

1. This could be potentially useful and necessary for FR2.
2. During SI phase, the payload size for Msg3 PUSCH is assumed as 56 bits. With increasing of potential payload size for Msg3, larger repetition factors may be required.

* Group B payload size, which could be hundreds of bits, has been supported for Msg3 PUSCH repetition by RAN2.
* Small data transmission could be potentially supported for Msg3 PUSCH repetition.

1. Anyway, it needs 3 RRC bits for indicating each candidate values.

Considering above motivations and also there is no any harm to support larger values, FL suggests to go with the following proposals. Note that, how to support value {1} is to be separately discussed.

***Proposal 1: In addition to {2, 3, 4, 7, 8}, additionally support {12, 16} for the value range of numberOfMsg3Repetitions for Msg3 PUSCH repetition.***

***Note: how to support value {1} is to be separately discussed.***

#### First round

Companies are encouraged to provide comments if any below.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Vivo | Support |
| CMCC | We do not support this proposal.  There is no need to increase the value range, and it may even cause more collision issue. It was agreed that only TDD-UL-DL-Configuration is considered for Msg 3 repetition, larger repetition factors may induce more collisions and limited gNB’s scheduling.  For the larger payload size, it was assumed to be transmitted when the pathloss is smaller and coverage is good enough to support the higher data rate. It is not proper to assume a higher data rate but with more repetitions.  As illustrated in the SI, Msg 3 has much better coverage than PUSCH, even with 10dB in addition. Msg 3 does not need such a large repetition factor. Then maximum 8 for repetition factor is enough for Msg 3. |
| Ericsson | Support |
| NTT DOCOMO | Support |
| Intel | Support |
| Sharp | Support |
| LG | Same opinion with CMCC. We think that maximum value 8 is enough for the motivations 1) and 2) which are summarized above. |

Regarding the parent IE, it will be further discussed depending on which alternative (TDRA or MCS) is chosen.

### **Issue#2: Default value of *numberOfMsg3Repetitions***

Another remaining issue is whether/how to define the default value for *numberOfMsg3Repetitions.*

* For TDRA based solution, it has been agreed that, if a new TDRA table is not configured, the legacy default TDRA table is used, and repetition factor K=1 is applied. However, it has not been discussed whether a default value is defined if the new TDRA table is configured while *numberOfMsg3Repetitions* is not configured for some of rows of the new TDRA table.
* Similar situation happens for MCS based solution, if the four candidate values are not configured by SIB1.

#### First round

Companies are encouraged to provide comments regarding 1) whether do you think a default value should be defined, and 2) if defined, which the default value should be, e.g., K=2?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Vivo | 1. YES 2. The default value can be K=1. |
| Ericsson | It depends on the open issue on how to interpret the information field, which has not been agreed yet.  If option 1, which requires K=1 included in the new TDRA table, is agreed for the issue, a default value can be 1.  Otherwise, if K=1 is not included in the new TDRA table, and we can consider a default value larger than 1. |
| NTT DOCOMO | 1. Yes only for TDRA based indication. 2. The default value can be K=1. |
| Intel | Suggest to wait the final decision on whether TDRA or MCS is used for repetition factor indication. |
| Sharp | 1. Yes 2. The default value can be K=1. |
| LG | 1) Yes, default value should be defined for TDRA based solution and MCS bases solution in order to reduce configuration overhead.  2) We think if K=1 is set as default value, msg3 PUSCH repetition can be same as normal msg3 PUSCH. In this sense, we prefer  - if TDRA table based solution is approved, one value larger than 1 (e.g. K = 2) can be set a default value.  - or, if MCS bases solution is approved, four values (e.g., {1, 2, 4, 8}) can be set as default value. |

## 6.2 2nd round discussion

1. References
2. R1-2110575, LS on Re-17 LTE and NR higher-layers parameter list, RAN1, Ericsson, RAN1#106b-e, October 11th – 19th, 2021.
3. R1-2111193, Recommendations for RAN1 RRC Parameter Preparation, Ericsson, RAN1#107-e, November 11th – 19th, 2021.