**3GPP TSG-RAN WG1 Meeting #106-eR1-210XXXX**

e-Meeting, August 16th – 27th, 2021

**Agenda item: 8.3**

**Source: Moderator (Nokia)**

**Title: [Post-106-e-Rel17-RRC-03] Enhanced IIoT and URLLC**

**Document for: Discussion and Decision**

# Introduction

As per chairman’s guidance, the email discussion

* [Post-106-e-Rel17-RRC-03] Enhanced IIoT and URLLC

is planned according to the following guidelines:

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| *As announced during RAN1#106-e, there will be a number of email threads on Rel-17 RRC parameters. For each Rel-17 work item, the work item rapporteur will kick off the email thread. The email discussions on RRC parameters will start from September 1 until September 10 (of course excluding the weekend). The purpose of these email discussions is to initiate our preparations to send the first LS to RAN2 on Rel-17 RRC parameters in October (e.g. tabulate agreed RRC parameters so far and identify ones that RAN1 should discuss whether or not to define).**Please note that RAN1 will NOT be making any decision with regards to the Rel-17 RRC parameters during the email discussions. Intention is to have the work item rapporteurs provide their initial assessment and collect company views if there are any. I am hoping that this discussion will help companies better prepare for RAN1#106bis-e. For each email thread, the rapporteur is to provide a tdoc collecting company views along with a draft list of RRC parameter at the end of the email discussion.* |

This document is there to support the RAN1 email discussion on the RRC parameter list for the Rel-17 URLLC/IIoT WI. Companies are encouraged to provide their comments on the latest version of the RRC parameter sheet in the respective AI specific drafts folder and the changes to the RRC parameter sheet will only be done by the AI moderator based on the received comments in each round or iteration of email discussions on this issue.

**This document is structured as follows:**

* Section 2 contains the email discussion for HARQ-ACK enhancements (AI 8.3.1.1)
* Section 3 contains the email discussion for CSI enhancements (AI 8.3.1.2)
* Section 4 contains the email discussion for NR-U enhancements (AI 8.3.2)
* Section 5 contains the email discussion for Intra-UE periodization enhancements (AI 8.3.3)
* Section 6 contains the email discussion for Other / Propagation delay compensation (AI 8.3.4)

# HARQ-ACK enhancements (AI 8.3.1.1)

VOID

# CSI enhancements (AI 8.3.1.2)

VOID

1. NR-U Enhancements (AI 8.3.2)

VOID

1. Intra-UE multiplexing & priorization enh. (AI 8.3.3)
	1. Multiplexing UCIs of different priorities in a PUCCH

### 1st Round

The following need for RRC parameters has been identified by the moderator:

1. Enable the feature (explicit agreement is not yet available, but it seems the common sense of the group)
2. Configure an additional *maxCodeRate* for LP HARQ-ACK in the second PUCCH-Config per PUCCH format.
* *maxCodeRateList-R17* is added in PUCCH-FormatConfig with size=2. And the field is absent for the 1st entry of PUCCH-ConfigurationList-r16.

On these and in case of having missed some aspect, please comment below as well:

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| *Company* | *Comments* |
| Nokia/NSB | Thanks, seems nothing is missing. ***maxCodeRate* (row 3):** We just would like to understand, why we need to configure a list here. The Rel-15 parameter in the 2nd PUCCH config is anyhow applicable to HP HARQ-ACK already. Wouldn’t it be simpler just to configure a single parameter for LP HARQ only, i.e. something indicating that this is for LP only? *maxCodeRateLP-r17*  *PUCCH-MaxCodeRate*as also the changes to the current specs would thereby be minimized. If we configure both values, we need to change the specs to just get the max. coderate behavior for HP HARQ in the 2nd PUCCH config??But maybe worth hearing also other companies opinions here.  |
| Samsung | 1. OK in principle although it should be first discussed/concluded whether enabling multiplexing of HP SPS HARQ-ACK / HP DG HARQ-ACK with LP HARQ-ACK can be separately configured. That is because a solution addressing the LP HARQ-ACK reliability issue (e.g., DCI missing for Type-2 HARQ-ACK CB) can be different for HP SPS HARQ-ACK and HP DG HARQ-ACK.
2. We would like to clarify that PF 0/1/[2] can only be configured with 1 value of maxCodeRateList-R17. We are also fine with Nokia’s suggestion.
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### 2nd Round

Taking comments from Nokia on maxCodeRate, the newly-added parameter is changed to *maxCodeRateLP-r17*, rather than *maxCodeRateList-R17*. For the RRC parameter enabling the feature, as mentioned, the explicit agreement is still missing. So we can preliminarily list the parameter here, and try to agree on the enabling signalling (incl. for the cases Samsung mentioned). Then the need for RRC parameters is changed to below:

1. Enable the feature (explicit agreement is not yet available, but it seems the common sense of the group)
2. Configure an additional *maxCodeRate* for LP HARQ-ACK in the second PUCCH-Config per PUCCH format.
* *maxCodeRateLP-r17* is added in PUCCH-FormatConfig with the same value range as *maxCodeRate*. And the field is absent for the 1st entry of PUCCH-ConfigurationList-r16.

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| *Company* | *Comments* |
| LG | We are fine with the latest update in above. |
| OPPO | We agree |
| Huawei/Hisi | OK in principle. |
| Ericsson | Suggest to clarify that the new parameter *maxCodeRateLP-r17* is only applicable to the multiplexing of UCI combination {HP HARQ-ACK, LP HARQ-ACK}. There is a need to differentiate from existing parameter, since the existing parameter *maxCodeRate* is very generic, i.e., for multiplexing HARQ-ACK, SR, and CSI report (part1, part2). |
| ZTE | Fine with the *maxCodeRateLP-r17* and agree Ericsson’s comment on further clarification in Excel. |
| Quectel | We are fine with the latest update. Perhaps it is necessary to clarify that there is no explicit agreement on “*maxCodeRateLP-r17* is with the same value range as *maxCodeRate*” , although we support the same value range.  |
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### 3rd Round

Added some wordings in the “value range” column to note the applicability of only HARQ-ACK multiplexing and note the lack of explicit agreement on value range. Please have a final check in the last round discussion.

1. Enable the feature (explicit agreement is not yet available, but it seems the common sense of the group)
2. Configure an additional *maxCodeRate* for LP HARQ-ACK in the second PUCCH-Config per PUCCH format.
* *maxCodeRateLP-r17* is added in PUCCH-FormatConfig with the same value range as *maxCodeRate*. And the field is absent for the 1st entry of PUCCH-ConfigurationList-r16.
* Note: It is only agreed that *maxCodeRateLP-r17* is used for HARQ-ACK multiplexing.
* Note: There is no explicit agreement that the value range of *maxCodeRateLP-r17* is same as *maxCodeRate*.

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| *Company* | *Comments* |
| Sony | Fine with v003 for these parameters. |
| Intel  | We are fine with v003.  |
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* 1. Multiplexing UCIs of different priorities in a PUSCH

### 1st Round

The following need for RRC parameters has been identified by the moderator:

1. Enable the feature (explicit agreement is not yet available, but it seems the common sense of the group)
2. Configure 2 new set of beta offset values for the following cases:
* Multiplexing LP HARQ-ACK on HP PUSCH
* Multiplexing HP HARQ-ACK on LP PUSCH

Following new parameters are suggested:

* *UCI-OnPUSCH-r17* and *UCI-OnPUSCH-DCI-0-2-r17* are added to only consist of betaOffsets, and no scaling, compared to *UCI-OnPUSCH.*
* *UCI-OnPUSCH-ListDCI-0-1-r17* and *UCI-OnPUSCH-ListDCI-0-2-r17* are added with size=2.

On these and in case of having missed some aspect, please comment below as well:

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| *Company* | *Comments* |
| Nokia/NSB | Row 7 & 9, dynamic & semi-static beta offsets for cross PHY priority multiplexing.* First, maybe it would be better to actually call these now as UCI on PUSCH as the scaling is missing (so it is not the same) – so maybe we could use some wording as ‘betaOffsetsCrossPri-r17’ and ‘betaOffsetsCrossPri-DCI-0-2-r17’ or similar
* Column K ‘Value range’: Maybe sufficient to say here ‘Defined as in betaOffsets of UCI-OnPUSCH’ and ‘Defined as in betaOffsetsDCI-0-2-r16 of UCI-OnPUSCH-DCI-0-2-r16’
* i.e. columns G & K could look like:

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|  | Parameter name in the spec | Value range |
| 7 | betaOffsetsCrossPri-r17 | Defined as in *betaOffsets* of *UCI-OnPUSCH* |
| 9 | betaOffsetsCrossPriDCI-0-2-r17 | Defined as in *betaOffsetsDCI-0-2-r16* of *UCI-OnPUSCH-DCI-0-2-r16* |

Row 8 & 10:* Same comment here, maybe no need to call it ‘UCI on PUSCH’ as this would include the scaling, so also for the lists we could name this directly to indicate we talk about beta offset only.
* **Do we need another RRC parameter applicable to DCI 0\_0 (in row 11 below)?** (not as list but only a single parameter?) Or do we use the same value of LP with DCI format 0\_0 as for DCI format 0\_1? If separately configurable, then we may need another RRC parameter (in row 11 below). But this may need some more discussion between companies
* So something like this? (assuming changes of the names shown above)

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|  | Parameter name in the spec | Value range |
| 8 | betaOffsetsCrossPri-ListDCI0-1-r17 | SEQUENCE (SIZE (1..2)) OF betaOffsetsCrossPri-r17 |
| 10 | betaOffsetsCrossPri-ListDCI0-2-r17 | SEQUENCE (SIZE (1..2)) OF betaOffsetsCrossPriDCI-0-2-r17 |
| 11 (New – if needed) | betaOffsetsCrossPriDCI0-0-r17 | betaOffsetsCrossPri-r17 |

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| Samsung | 1. OK in principle although it should be first discussed/concluded whether enabling of multiplexing of HP CG PUSCH / HP DG PUSCH with LP HARQ-ACK can be separately configured. That is because a solution addressing the LP HARQ-ACK reliability issue (e.g., DCI missing for Type-2 HARQ-ACK CB) can be different for HP CG PUSCH and HP DG PUSCH.
2. The parameters should be configured in UCI-OnPUSCH/ UCI-OnPUSCH-DCI-0-2-r16. We didn’t agree to introduce additional UCI-OnPUSCH parameter.
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### 2nd Round

Taking comments from Nokia on betaOffsets, the newly-added parameter is changed to *betaOffsetsCrossPri-r17* and *betaOffsetsCrossPri-ListDCI0-1-r17*, rather than *UCI-OnPUSCH-r17* and *UCI-OnPUSCH-ListDCI-0-1-r17*. For the betaOffsets for DCI format 0\_0, it is suggested to further discuss it in next meeting.

Regarding Samsung’s comment on configuring the new parameters in UCI-OnPUSCH/UCI-OnPUSCH-DCI-0-2-r16, the question to be answered is: Is it reasonable to put a “-r17” parameter into a “-r16” parent IE? So far the parent IE remains PUSCH-config. Your comments/clarifications are welcome.

For the RRC parameter enabling the feature, as mentioned, the explicit agreement is still missing. So we can preliminarily list the parameter here, and try to agree on the enabling signalling (incl. for the cases Samsung mentioned).

Then the need for RRC parameters is changed to below:

1. Enable the feature (explicit agreement is not yet available, but it seems the common sense of the group)
2. Configure 2 new set of beta offset values for the following cases:
* Multiplexing LP HARQ-ACK on HP PUSCH
* Multiplexing HP HARQ-ACK on LP PUSCH

Following new parameters are suggested:

* *betaOffsetsCrossPri-r17* and *betaOffsetsCrossPriDCI-0-2-r17* are added with the same value range as *betaOffsets* and *betaOffsetsDCI-0-2-r16.*
* *UCI-OnPUSCH-ListDCI-0-1-r17* and *UCI-OnPUSCH-ListDCI-0-2-r17* are added with size=2.

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| *Company* | *Comments* |
| LG | We are fine with the latest update in above.And, we also think that DCI 0\_0 would follow Rel-15/16 rule without introducing additional parameter. |
| OPPO | The following agreements was achieved in RAN1. So to better understand “pusch-HARQ-ACK-MuxWithDifferentPriority”, we suggest to add the following scenarios in description.Agreements:Support multiplexing for following scenarios in R17:* Multiplexing a low-priority HARQ-ACK in a high-priority PUSCH (conveying UL-SCH only).
* Multiplexing a high-priority HARQ-ACK in a low-priority PUSCH (conveying UL-SCH only)
* Multiplexing a low-priority HARQ-ACK, a high-priority PUSCH conveying UL-SCH, a high-priority HARQ-ACK and/or CSI.
* Multiplexing a high-priority HARQ-ACK, a low-priority PUSCH conveying UL-SCH, a low-priority HARQ-ACK and/or CSI.
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| Huawei/Hisi | * For proposal 1, do we need to introduce two RRC parameters (pucch-HARQ-ACK-MuxWithDifferentPriority and pusch-HARQ-ACK-MuxWithDifferentPriority) to separately enable/disable multiplexing of UCI on PUCCH with different priorities and UCI on PUSCH with different priorities, or one parameter (like HARQ-ACK-MuxWithDifferentPriority) to uniformly enable/disable PUCCH and PUSCH? It has not been discussed how to handle the case where pucch-HARQ-ACK-MuxWithDifferentPriority is enabled while pusch-HARQ-ACK-MuxWithDifferentPriority is disabled (or the other way around). From our side we think one parameter to enable/disable both could be a simple way, and we want to hear the voices of other companies.
* For proposal 2, we are OK with the updated version. The last bullet of the proposal may also be modified as ‘*~~UCI-OnPUSCH-ListDCI-0-1-r17~~* *betaOffsetsCrossPri-ListDCI0-1-r17* and *~~UCI-OnPUSCH-ListDCI-0-2-r17~~ betaOffsetsCrossPri-ListDCI0-2-r17* are added with size=2’ accordingly.
* A typo in row 6 column I. should be **pus~~c~~ch**-HARQ-ACK- MuxWithDifferentPriority
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| Ericsson | **First**, there is no agreement to define different beta offset for DCI format 0\_1 and 0\_2. In our view, it’s simpler that DCI 0\_1 and 0\_2 share the same. To allow flexible bitwidth in DCI, the new beta offset can follow the manner betaOffsetsDCI-0-2-r16 is defined.**Second**, the value range of betaOffsetsCrossPri-r17 shouldn’t be “Defined as in betaOffsets of UCI-OnPUSCH”. Rel-15/Rel-16 BetaOffsets have beta offsets for CSI, see below. However, Rel-17 new beta offsets need to provide for HARQ-ACK only.BetaOffsets ::= SEQUENCE {betaOffsetACK-Index1 INTEGER(0..31) OPTIONAL, -- Need SbetaOffsetACK-Index2 INTEGER(0..31) OPTIONAL, -- Need SbetaOffsetACK-Index3 INTEGER(0..31) OPTIONAL, -- Need SbetaOffsetCSI-Part1-Index1 INTEGER(0..31) OPTIONAL, -- Need SbetaOffsetCSI-Part1-Index2 INTEGER(0..31) OPTIONAL, -- Need SbetaOffsetCSI-Part2-Index1 INTEGER(0..31) OPTIONAL, -- Need SbetaOffsetCSI-Part2-Index2 INTEGER(0..31) OPTIONAL -- Need S} |
| ZTE | The question on whether the “pucch-HARQ-ACK-MuxWithDifferentPriority” is coupled with “pusch-HARQ-ACK-MuxWithDifferentPriority” could be further discussed. By now, if no coupling rule is defined, it is default decoupled. From our perspective, no restriction rule is more flexible and gNB can freely enable the two multiplexing modes as needed. |
| Quectel | OK with the latest updates. We are fine with different beta offsets for different DCI formats (also including format 0\_0). For the value range of betaOffsetsCrossPri-r17, “defined as in betaOffsets of UCI-OnPUSCH” could be OK for now, as whether CSI (if exists) will be multiplexed in the PUSCH is still open. We think the details of the RRC design could anyway be subject to further discussions.For same or different enabling/disabling of multiplexing in PUCCH and PUSCH, we share the same view as ZTE. |
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### 3rd Round

Taking OPPO’s comments and added the agreements in the description.

Considering Huawei’s comments on combining pucch-HARQ-ACK-MuxWithDifferentPriority and pusch-HARQ-ACK-MuxWithDifferentPriority, a note is added in the description but the two parameters are preliminarily kept. This issue can be discussed in next meeting. And the typos pointed out by Huawei are corrected.

Considering Ericsson’s comments on betaoffset IE format, a note is added in the description but the parameters for DCI0-1 and DCI-2 are preliminarily kept. This issue can be discussed in next meeting. The value range is left for FFS.

Then the need for RRC parameters is changed to below:

1. Enable the feature (explicit agreement is not yet available, but it seems the common sense of the group)
2. Configure 2 new set of beta offset values for the following cases:
* Multiplexing LP HARQ-ACK on HP PUSCH
* Multiplexing HP HARQ-ACK on LP PUSCH

Following new parameters are suggested:

* *betaOffsetsCrossPri-r17* and *betaOffsetsCrossPriDCI-0-2-r17* are added with the same value range as *betaOffsets* and *betaOffsetsDCI-0-2-r16.*
* *betaOffsetsCrossPri-ListDCI-0-1-r17* and *betaOffsetsCrossPri-ListDCI-0-2-r17* are added with size=2.

Note: It has been agreed to support multiplexing for following scenarios in R17:

* Multiplexing a low-priority HARQ-ACK in a high-priority PUSCH (conveying UL-SCH only).
* Multiplexing a high-priority HARQ-ACK in a low-priority PUSCH (conveying UL-SCH only)
* Multiplexing a low-priority HARQ-ACK, a high-priority PUSCH conveying UL-SCH, a high-priority HARQ-ACK and/or CSI.
* Multiplexing a high-priority HARQ-ACK, a low-priority PUSCH conveying UL-SCH, a low-priority HARQ-ACK and/or CSI.

Note: It has not been agreed whether pucch-HARQ-ACK-MuxWithDifferentPriority and pusch-HARQ-ACK-MuxWithDifferentPriority should be combine into one enabling parameter HARQ-ACK-MuxWithDifferentPriority.

Note: It has not been agreed whether the new betaoffset values are separately defined for DCI0-1 and DCI0-2.

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| *Company* | *Comments* |
| Sony | Fine with v003 on these parameters.We would think it is more flexible to have separate configuration of PUCCH mux and PUSCH mux but of course we need further discussion to get more clarity. |
| Nokia, NSB | Row 6: the ‘CSI’ in red has to be removed, as the description is talking about multiplexing of a different priority (and there seems to be no support for multiplexing CSI of one priority on a PUSCH of a different priority)Row 8: It is slightly unclear, if this applies to DCI format 0\_1 only or at least would include also DCI format 0\_0? Maybe no need to change this now, but maybe this could be somehow color coded in the final version to make sure this is not fixed yet. Row 9: What would be the reason to have a different value set that can be configured for DCI format 0\_2 than 0\_1 (& 0\_0?)?. Isn’t row 7 enough to defined the list here. **If it is unclear if this is needed or supported, would propose to mark this row in yellow.** Row 10: Similar here, as other companies commented we have not agreed to have separate list for DCI format 0\_2. **So maybe better to have this row marked in yellow.**  |
| Intel  | For Row 6, we agree with Nokia to delete CSI, because there is no agreement to support multiplexing CSI on a PUSCH with different priority. In addition to existing rows, we suggest to add one row for parameter betaOffsetsCrossPri-r17 in *ConfiguredGrantConfig* IE. In our understanding, HARQ-ACK multiplexing in a PUSCH with different priority is supported for both dynamic scheduled PUSCH and CG PUSCH, no matter it is enabled by a single RRC parameter or separate RRC parameters in proposal 1. Therefore, we think new beta offsets should be introduced in both *PUSCH-Config* and *ConfiguredGrantConfig* respectively. For DG PUSCH, the beta offsets for cross-priority should be the list, while single beta offset IE for cross-priority in CG PUSCH is sufficient. |
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* 1. Simultaneous PUCCH/PUSCH transmissions

### 1st Round

The following need for RRC parameters has been identified by the moderator:

1. Enable the feature

On these and in case of having missed some aspect, please comment below as well:

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| *Company* | *Comments* |
| Nokia/NSB | Looking good. Maybe a bit too earlier, but in case we support this for same priority and different priority, there should be then independent RRC parameter for same & different priority simultaneous PUSCH/PUCCH. But just not to forget.  |
| Samsung | OK |
| Huawei/Hisi | Agree. To be more specific, it can be described as ‘simultaneous PUCCH and PUSCH transmissions with different priorities’ as per the current agreement. |
| Ericsson | Fine with the parameter as a starting point.The final description may need to clarify inter-band or intra-band (if supported). |
| ZTE | Fine with the parameter. More specific description can be added as Huawei and Ericsson’s suggestion. |
| Quectel | Fine |

### 2nd Round

Void.

### 3rd Round

Taking the comments from companies, the following notes are added.

1. Enable the feature

Note: Still FFS whether the feature is supported for same priority.

Note: Still FFS whether the feature is supported for intra-band CA.

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| *Company* | *Comments* |
| Sony | Fine with v003 for this parameter. |
| Intel  | We are fine with v003.  |
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1. Propagation delay compensation (AI 8.3.4)

VOID