3GPP TSG-RAN WG1 Meeting #114 R1-2308332

Toulouse, France, August 21st – 25th, 2023

Agenda Item: 9.8.1

Source: Moderator (Ericsson)

Title: Moderator Summary#2 – XR Specific Enhancements

Document for: Discussion, Decision

# 1 Introduction

In RAN plenary 98-e, the Rel-18 WI on eXtended Reality (XR) was agreed and was further revised in RAN#99, with the following objectives:

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| Specify the enhancements related to power saving:- DRX support of XR frame rates corresponding to non-integer periodicities (through at least semi-static mechanisms e.g. RRC signalling) (RAN2).Specify the enhancements related to capacity:- Multiple Configured Grant (CG) PUSCH transmission occasions in a period of a single CG PUSCH configuration (RAN1, RAN2); - Dynamic indication of unused CG PUSCH occasion(s) based on Uplink Control Information (UCI) by the UE (RAN1, RAN2);- Buffer Status Report (BSR) enhancements including at least new Buffer Status Table(s) (RAN2);- Delay reporting of buffered data in uplink (RAN2);- Discard operation of PDU Sets for DL and UL (RAN2, RAN3);Specify the enhancements for XR Awareness:- Signalling by CN of semi-static information per QoS flow (e.g. PDU set QoS parameters), dynamic information per PDU set (PDU Set information and Identification) and End of Data Burst indication (RAN3, RAN2);- Impact of identifying by UE of PDU Sets, Data bursts and PSI, as needed (RAN2);- Provisioning by UE of XR traffic assistance information e.g. periodicity, UL traffic arrival information (RAN2, RAN3);- Support signalling the congestion information from RAN to the CN in alignment with SA2 (RAN3); |

This document provides a summary of the contributions submitted to RAN1#114 under Agenda item 9.8.1. It is also intended to facilitate the discussions regarding the topics under with respect to the following assignment by the RAN1 Chair:

[114-R18-XR] Email discussion on XR – Sorour (Ericsson)

* To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc

This document is updated version of R1-2308331.

# 2 Multi-PUSCHs configured grant

This section captures the summary of the discussions regarding the design aspects of the following WID objective:

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| - Multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration (RAN1, RAN2);  |

## 2.1 Support of Repetition

**Moderator summary:**

In previous meeting, the following agreement was made. Based on this agreement whether/how to support repetition for multi-PUSCH CG is an open is an open issue which needs to be resolved.

**Agreement**

For time domain resource allocation for multi-PUSCH CGs, support

* For TDRA determination (based on NR-U framework)
	+ For Type-1, follow the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1 of TS 38.214.
		- Note: To determine the configuration of TDRA, PUSCH repetition type A is assumed according to description in 6.1.2.3 in 38.214 for Type-1.
			* It is still an open issue whether repetition is supported. If it is decided repetition is not supported, it implies the corresponding repetition factor for is one.
	+ For Type-2, the TDRA table is determined by the TDRA table associated with activation DCI, as defined in Clause 6.1.2.1 of TS 38.214.
		- Note: The DCI format for activation DCI with pusch-RepTypeA is applicable.
			* It is still an open issue whether repetition is supported. If it is decided repetition is not supported, it implies the corresponding repetition factor for is one.
* N is configured by higher layers
* A single SLIV is determined from TDRA.
	+ The SLIV used for 1st PUSCH per CG period.
* The PUSCH is used in each of N consecutive slots per CG period
* Note: N is configured independently from *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16,* respectively*.* N configuration is independent from *cgRetransmissionTimer* configuration.
* To determine corresponding slots for CG PUSCHs in a period of a multi-PUSCH CG configuration:
	+ For the first PUSCH in the period, follow the legacy procedures.
	+ For remaining PUSCHs in the period
		- ForType-1 and Type-2, reuse the corresponding procedures for NR-U by applying the RRC parameters N, instead of *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16*, respectively.

**Companies’ view:**

**Whether to support repetition:**

* **Yes:** Ericsson, Nokia/NSB, TCL, Lenovo, xiaomi, ZTE, Spreadtrum comm., IDC, CAICT, Panasonic, Honor, Apple
* **No:** FW, QC, vivo, CMCC, OPPO, MTK, DCM

**Moderator’s observations:**

**Observation 1:** Motivation to not support repetition:

* Repetition improves reliability and not capacity (CMCC, QC, FW, vivo, MTK)
* Repetition increases delay (vivo, CMCC)
* Repetition type A can be realized by existing specification, there is no point to specify it additionally in Rel-18 (DCM: needs clarification)
* Additional spec impact (vivo, DCM: needs clarification)
* HARQ process ID determination not directly applicable with repetition (OPPO: needs clarification)

**Observation 2:** Motivations to support repetitions:

* Minimum spec impact by reusing exiting (NR-U) procedures, straightforward to support repetition (E///, Nokia/NSB, TCL, Lenovo, xiaomi, ZTE, IDC, CAICT, Panasonic, Apple)
* Leave the choice to implementation to enable/disable (E///, Nokia/NSB, CAICT)
* Supported already for unlicensed. No need for limitation in license band (Nokia/NSB, Apple)
* Good to improve reliability within delay budget/ reduces the need for retransmission (TCL, xiaomi, ZTE, Spreadtrum, IDC, Panasonic, Honor)

**Observation 3:** Proponents of supporting repetition consider reusing NR-U methods with exceptions or differences summarized below:

* + ZTE: NR-U method or Rel-15 Type A method (N.K slots)
	+ Spreadtrum: Rel-15 Type A (N.K slots)
	+ Xiaomi: Rel-17 TBoMs method (with differing for available slots)
	+ Lenovo: NR-U methods with additional enhancements
	+ Honor: Partial repetition (gNB or UE controlled)

**Moderator’s assessment of specification impact:**

With respect to whether to support repetitions, companies have different views. For example, the proponents of repetition consider repetition as a mean to reduce the risk of retransmission and hence, in turn improve the capacity within delay budget, while the opponents consider the repetition as increasing delay. Other reasons are summarized above.

One key issue is the specification impact in case of support of repetition. Moderator provides an analysis below from specification perspective on possible options to support repetition. The intention is to have a common understanding on spec impact for proper assessment.

Please see the excerpt from clause 6.1.2.3.1 from TS 38.214 that is the baseline for the discussion.

* Repetition of a TB is confined within a CG period per legacy procedures (highlighted text in green).
* Proposals to support repetition:
	+ Option 1: NR-U based (mimicking procedures highlighted below in cyan)
	+ Option 2: Rel-15 Type A repetition based (mimicking procedures highlighted below in yellow)
	+ Option 3: Rel-17 Type A repetition on available slots based (mimicking procedures highlighted below in gray)
	+ Option 4: Any of options above with additional enhancements

**Option 1** has minimum spec impact. Basically, as shown in figure below, in case of repetition the available PUSCH TOs configured with N are used.

**Option 2** has additional spec impact (clearly more than Option 1), even though it reuses Rel-15 Type A repetition. The reason is that the TOs used for repetition are from the original N TOs, or extension of them in the period if they are not enough. Whether the extended TOs in a period are used for repetition, in fact depends on the number and starting time of the TBs UE is transmitting in that period. For example, in the figure shown below for Option 2, UE transmits 4 TBs and all 4 with repetition. The situation can be different if UE transmits one TB or 2 TBs, then no need to extending the TOs in the period. The main point is all these cases, even though are doable and maybe straightforward, but would need additional discussions and clarifications how to realize.

**Option 3** has additional spec impact for the same reasons explained for Option 2. Moreover, this option is suited for optimizing multi-PUSCH CG in utilizing available slots. However, as it was discussed last meeting, as part of the consensus for adopting Alt-B for TDRA design, it was concluded not to consider any optimization for TDD (and in principle better utilization of available slots). Hence, for that reason this option is not in alignment of the understandings to support Alt-B.

**Option 4** includes solutions proposed by companies (see Observation 3) that clearly will have more spec impact without going into details.

**Moderator’s recommendation:** Based on the assessment, any option to support repetition other than Option 1 (NR-U based) either results in additional design discussions and/or spec impact that are not recommended considering the limited time for completing the WI as well as concerns from companies not favoring support of repetition. **Hence, it is reasonable from Moderator point of view, for discussion on whether to support repetition or not, to consider only Option 1 as the simplest option.**

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| 6.1.2.3.1 Transport Block repetition for uplink transmissions of PUSCH repetition Type A with a configured grantThe procedures described in this clause apply to PUSCH transmissions of PUSCH repetition Type A with a Type 1 or Type 2 configured grant. ….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*. If the UE determines that, for a transmission occasion, the number of symbols available for the PUSCH transmission in a slot is smaller than transmission duration *L*, the UE does not transmit the PUSCH in the transmission occasion.For both Type 1 and Type 2 PUSCH transmissions with a configured grant, when *K >* 1*,* - For unpaired spectrum:- If *AvailableSlotCounting* is enabled, the UE shall repeat the TB across the $N∙K$ slots determined for the PUSCH transmission applying the same symbol allocation in each slot.- A slot is not counted in the number of $N∙K$ slots if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.- Otherwise, the UE shall repeat the TB across the $N∙K$ consecutive slots applying the same symbol allocation in each slot, except if the UE is provided with higher layer parameters *cg-nrofSlots* and *cg-nrofPUSCH-InSlot*, in which case the UE repeats the TB in the *repK* earliest consecutive transmission occasion candidates within the same configuration. |



Option 1: Repetition for multi-PUSCHs CG (Similar as Type A repetition for legacy CG in NR-U)



Option 2: Repetition for multi-PUSCHs CG (Similar as Type A repetition for legacy CG in license band)

Table : Summary of Contributions’ inputs for Section 2.1

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Observation 1** Support of repetition for multi-PUSCHs CG, would minimize the specification impact by reusing legacy procedures for NR-U CG and would result in a design with a choice to enable/disable repetition whichever better suited for operation.**Proposal 2** Repetition is supported for Type-1 and Type-2 multi-PUSCH CG, reusing the existing procedures for NR-U CG. |
| Futurewei | **Proposal 5**: Do not support repetition configuration for multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration. |
| Qualcomm | **Observation 1**: Repetition for configured grant PUSCH is more of a coverage enhancement than a capacity enhancement technique. Features like this can be discussed in Rel-19.**Proposal 1**: Do not support PUSCH repetition for the multi-PUSCH CG period within Rel-18 timeline. |
| Nokia/NSB | **Proposal 1**: Support repetition type A for multi-PUSCH CG (type 1 and type 2) in licensed band similar to current specification of multi-PUSCH CG in unlicensed band. |
| vivo | **Observation 1**: To serve XR UL traffic including that of pose/control stream and/or video stream, CG PUSCH occasions configured by one or multiple CG configurations, and from one or multiple serving cells are desirable.**Proposal 1**: Repetition operation is not supported for multi-PUSCHs CG configurations for Rel-18 XR. |
| TCL | **Observation 1**: XR services have the following characteristics.* The non-integer periodicity
* Jitter of packet arrival time
* Low latency and large packet size
* Varying packet size
* Multiple flows

**Proposal 1**: Repetition for multi-PUSCHs transmissions within a CG configuration can be supported. |
| Lenovo | **Proposal 1**: TB repetition is supported.* Further discuss multiple TB retransmission pattern based on the already specified repetition patterns.

**Proposal 2**: If a transmission occasion candidate is invalid (e.g., due to collision with semi-static DL symbols), the UE does not transmit that repetition instance. |
| xiaomi | **Observation 1**: It is beneficial from the high reliability requirement of XR traffic perspective to support repetition for a multi-PUSCHs CG configuration.**Observation 2**: No more resources are wasted because the resource corresponding to repetitions can be reused by a dynamic indication based on UTO-UCI.**Proposal 1**: Support repetition for multi-PUSCHs CG configuration* The higher layer configured parameter repK is used to indicate the repetition number of each CG PUSCH occasion.

**Proposal 2**: The number of CG PUSCH TOs in a CG period should be applied to the calculation of available slots. |
| CMCC | **Proposal 1**. PUSCH repetition is not supported for multi-PUSCHs CG. |
| ZTE/Sanechips | **Observation 1**: Repetition mechanism can guarantee the reliability transmission for the UEs at the edge of cell in XR use case.**Proposal 1**: Support repetition mechanism for multi-PUSCHs CG. |
| Spreadtrum comm. | **Proposal 1**: Support repetition for a multi-PUSCHs CG configuration. |
| OPPO | **Proposal 3**: PUSCH repetition is not supported in Rel-18 for multiple CG-PUSCH TOs per CG period. |
| IDC | **Proposal 1**: Repetition can be configured for Type-1 and Type-2 multi-PUSCH CG |
| LG | **Proposal 2**: It is necessary to investigate how to support the repetition for each of multiple TOs in a period |
| MTK | **Observation 1**: TB repetitions are not useful to improve system capacity.**Proposal 1**: TB repetitions are not supported in multi-PUSCH per CG in XR. |
| Honor | **Observation 1**: Repetition is a tradeoff between system capacity and reliability,so Partial repetition or UE-decided repetition is recommended to support.**Proposal 2**: Support Partial repetition of PUSCHs in a CG and gNB configure the number of last PUSCHs to do repetition. |
| CAICT | **Proposal 1**: Support PUSCH repetition with multiple transmission occasions per CG period. |
| Panasonic | **Proposal 1**: The PUSCH repetitions should be supported for multi-PUSCHs CG to avoid extensive data retransmissions. A new time constraint should be considered for PUSCH repetitions over a multi-PUSCHs CG. |
| NTT DOCOMO | **Observation 1**: Joint operation of PUSCH repetition with multi-PUSCH scheduling in Rel-16/17 is not supported.- Repetition factor is always one for DCI 0\_1 configured with multi-PUSCH scheduling.**Observation 2**: Joint operation of PUSCH repetition with multiple CG PUSCH occasions in Rel-16 NR-U is not supported.- When UE is configured with higher layer parameters cg-nrofSlots and cg-nrofPUSCH-InSlot, if K>1 is determined, UE only applies PUSCH repetition, i.e. UE repeats single TB on the first K PUSCH occasions.**Proposal 1**: Repetition factor for multi-PUSCH CG is always 1. |

### 2.1.1 Initial Discussions

**Moderator’s suggestions for initial discussion:**

Based on the observations and assessments provided above, Moderator suggests the following:

* **Suggestion 1)** Based on the assessment in previous section, Moderator recommends considering **only Option 1** (NR-U based) as the simplest option for discussion on whether to support repetition or not.
* **Suggestion 2)** Proposal below is formulated based on Option 1 in case, suggestion 1 sounds reasonable. Consider this proposal to decide whether it is agreeable (hence repetition for Multi-PUSCH CG is supported), or not (repetition for multi-PUSCH CG is not supported). Of course, the discussion can include improvement of the proposal.

**Proposal 1-1:**

Type-A repetition is supported for Type-1 and Type-2 multi-PUSCH CG configuration.

* For a repetition factor K>1, a UE repeats a TB across K consecutive transmission occasions in a period of a multi-PUSCH CG configuration.
	+ Note: The redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, … *K*-1, is determined according to table 6.1.2.1-2 of 38.214 as in legacy procedures.
	+ Note: The repetition of a TB is confined within a multi-PUSCH CG period as in legacy procedures.

**Questions: Please review the summary and analysis provided in previous section, as well as this section before providing feedback.** Please provide your view in the table below regarding the following questions:

* **Q1:** What is your view regarding Moderator’s **observations** and **assessments of needed specifications** regarding spec impact?
* **Q2:** What is your view regarding Moderator’s **suggestions**? If you disagree, what is your suggestion considering the analysis and status of companies’ views?
* **Q3:** What is your view on **Proposal 1-1**? What is your suggestion for improvement, correction and/or simplification if you can consider supporting the proposal?
* **Q4:** Discuss any clarification/correction/comment/question on Moderator’s summary, observation, assessment and suggestions or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | Do not support proposal 1-1.We did not address the topic in our Tdoc as we thought it was a non-issue. We also do not support introducing specifications related to repetitions for “multi-PUSCH CG” in XR for same reasons as mentioned by companies with the same opinion in their Tdocs.  |
| InterDigital | We are fine with the observations and suggestions made by FL, and support Proposal 1-1 |
| ZTE, Sanechips | **Q1,**We agree with the assessments that **PUSCH** **repetitions improve the capacity within delay budget**, which may be applied to various XR applications. Even given poor channel condition of edge UEs in a cell, XR service can be supported for UEs. Moreover, gNB should have the flexibility to determine the repetition number according to the location of the UE.Then regarding the specification impact, we noted that the collected concerns were considered. e.g., how to maintain legacy repetition (moderator mentioned option 1~3), and whether or not modify HARQ process ID determination based on selected option. **Q2,**We think Proposal 1-1 can be further improved to support repetitions, e.g., Type A repetition for legacy CG can be maintained, and we don’t need to modify HARQ ID aspect. |
| **Nokia, NSB** | We thank moderator for a nice feature lead’s summary!**Q1:** We support moderator’s observations and assessments of needed specifications.**Q2:** We support to re-use NR-U framework for multi-PUSCH CG including to support repetition type A. In our view, this will help the readability of specs having the same procedures being applied for the same feature in licensed and unlicensed band. Otherwise, this may create confusion when reading the specs.**Q3:** Support the proposal. |
| Sharp | We think the repetition is not a critical issue for XR. Considering the HARQ process ID of each PUSCH TO is derived based on TO location, there may be ambiguity issues on the HARQ process for repetitions for mis-detection cases with initial transmission and repetitions. |
| **vivo** | Regarding the repetition for multi-CG PUSCH, we think it is different from NRU. For NRU, HARQ process ID is indicated in CG-UCI, but for multi-CG PUSCH, HARQ-process ID is determined based on predefined rule agreed in last meeting, where HARQ process ID for subsequent occasion rather than the first configured occasion is increased based on the **valid** occasion. If repletion is supported based on NRU mechanism, a UE repeats a TB across K consecutive transmission occasions, where K is counted based on **configured** occasion. Then there would some misalignment between HARQ process ID determination and counting of number of occasions for repetition. |
| **DOCOMO** | Q1: Agree with Moderator’s observations and assessments. Q2: Fine with moderator’s suggestions. Q3: We can support Proposal 1-1 only if no additional specification impact is required. But it seems vivo’s comment is valid for HP ID determination issue. |
| **Xiaomi** | Fine with proposal 1-1.To avoid unnecessary ambiguity, we modify Proposal 1-1 as follows.**Proposal 1-1:**Type-A repetition is supported for Type-1 and Type-2 multi-PUSCH CG configuration.* For a repetition factor K>1, a UE repeats a TB across K consecutive transmission occasions in a period of a multi-PUSCH CG configuration.
	+ Note: The redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, … *K*-1, is determined according to table 6.1.2.1-2 of 38.214 as in legacy procedures.
	+ Note: The repetition of a TB is confined within a multi-PUSCH CG period as in legacy procedures.
	+ Note: The repetition factor applies to each PUSCH in the multi-PUSCH CG period.
 |
| **LG** | * **Q1:** First of all, we cannot directly use NR-U description. Because *cg-nrofSlots* and *cg-nrofPUSCH-InSlot* are irrespective with the number of TBs, while the number of TO are exactly same as the number of TO. At least we need to specify that “N\*K TOs would be allocated where K is the number of repetition and N is the number of TO in a CG period”.In general, for any of options, we need to revisit the equation of HARQ process ID determination and UTO-UCI bitmap generation.
* **Q2:** We support Figure of Option 1, thus we can support moderator’s view if all we have same understanding of option 1.
* **Q3:** we need to specify that “N\*K TOs would be allocated where K is the number of repetition and N is the number of TO in a CG period”. Also, we need to add FFS point about HARQ process ID equation and UTO-UCI bitmap generation.
 |
| Panasonic | Q3) We are fine with the proposal to support the PUSCH repetitions. This feature is helpful to avoid sending many DCIs for the failed multi-PUSCH retransmissions, since a DCI can only schedule a single failed transmission. |
| **Qualcomm** | We agree that repetition is useful, but maybe for a different purpose, i.e., the UL coverage enhancement. Both FDD and TDD should be considered. However, based on the following agreement, TDD enhancement is not agreed. As a result, the number of actual repetitions for each UL TB will be inconsistent in TDD when some of the allocated slots in the multi-PUSCH CG period collides with DL or SSB symbols. Because of this, we prefer not to specify repetition in Rel-18 but leave this issue in future release dedicated to XR coverage enhancement and have a proper design for both FDD and TDD.**Conclusion**For time domain resource allocation for multi-PUSCH CGs, there is no consensus for further enhancement for operation on TDD |
| NEC | We support moderator’s proposal. |
| **Lenovo** | **Agree with the moderator. HARQ-ID determination needs to be clarified (e.g., by adding the red text) in the corresponding agreement made last meeting:*** The HARQ process ID of the remaining configured and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH carrying initial transmission of a TB in the period by one with module operation with *nrofHARQ-Processes* or module operation with (*nrofHARQ-Processes* + *harq-ProcID-Offset2*), whichever applicable.
 |
| Futurewei | Do not support proposal 1-1.We do not support repetition transmission for multi-PUSCH CG configuration because of two main reasons. One reason is that reliability issue is out of the scope of the current WI. Another reason is that even if repetition is supported, the exact repetition number cannot be accurately preconfigured before XR traffic arrival. |
| TCL | We support moderator’s proposal. |
| OPPO (copied from FLS v003) | We do not support proposal 1-1.The determination of HARQ process ID for multi-PUSCH CGs, agreed in RAN1 #112bis and 113, cannot be directly applied to PUCCH repetition. Given available TUs for WI are limited, we do not prefer to support PUSCH repetition for multiple CG-PUSCH TOs. |
| **Moderator** | **Summary of views:*** **Support:** IDC, NEC, ZTE\*, Nokia/NSB, [DCM], xiaomi, Panasonic, Lenovo
* **Not support:** Samsung, Sharp, QC, vivo\*, LG\*, FW, OPPO

**Moderator comments:*** Some companies do not support repetition.
* There is not common understanding on HP ID determination in case of Proposal 1-1.
* First, Discussion is needed to get a common understanding on the HP ID.
* Then, make a decision whether to support repetition or not.
 |
| **TCL** | We support moderator’s proposal. |
| **Moderator** | **Moderator suggestion after offline session:*** Based on offline discussion, it seems more discussion is needed to determine how the HP IDs are associated to TBs when multiple TBs are transmitted/repeated within a period.
* Therefore, Proposal 1-1 is updated with an FFS to address this issue.

**Proposal 1-1:**Type-A repetition is supported for Type-1 and Type-2 multi-PUSCH CG configuration.* For a repetition factor K>1, a UE repeats a TB across K consecutive transmission occasions in a period of a multi-PUSCH CG configuration.
	+ FFS HARQ process ID association to TBs when more than one TB is transmitted/repeated within a period of the multi-PUSCH CG configuration.
	+ Note: The redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, … *K*-1, is determined according to table 6.1.2.1-2 of 38.214 as in legacy procedures.
	+ Note: The repetition of a TB is confined within a multi-PUSCH CG period as in legacy procedures.
 |
| ZTE, Sanechips | As I commented earlier, if we go with Type A repetition for legacy CG, the FFS/concern can be addressed, in other words, there is not impact on the agreed HARQ process ID, (Given we define the HARQ process ID for configured CG PUSCHs, I see multiple companies would not like to change it). Moreover, it’s clear and true that the initial PUSCH transmission and PUSCH repetition use **same** HARQ process ID.So the suggestion can be:* For a repetition factor K>1, a UE repeats a TB after configured CG PUSCH occasions in a period of a multi-PUSCH CG configuration.
 |
| Moderator | **@ZTE/All:** I will include both proposals as below. I am not sure if everything is cristal clear. I will but FFS in [] for companies review.**Proposal 1-1 (updated)**Type-A repetition is supported for Type-1 and Type-2 multi-PUSCH CG configuration.* Alt-1: For a repetition factor K>1, a UE repeats a TB across K consecutive transmission occasions in a period of a multi-PUSCH CG configuration.
	+ FFS HARQ process ID association to TBs when more than one TB is transmitted/repeated within a period of the multi-PUSCH CG configuration.
* Alt-2: For a repetition factor K>1, a UE repeats a TB after configured CG PUSCH occasions in a period of a multi-PUSCH CG configuration.
	+ [FFS details]
* Note: The redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, … *K*-1, is determined according to table 6.1.2.1-2 of 38.214 as in legacy procedures.
* Note: The repetition of a TB is confined within a multi-PUSCH CG period as in legacy procedures.
 |
| Moderator | Outcome of online session:**Conclusion**For Type-1 and Type-2 multi-PUSCH CG configuration, Type-A repetition is NOT supported in Rel-18**This discussion is concluded.** |

## 2.2 Remaining issues

**Companies’ views and Moderator’s Observations:**

Companies have raised few issues captured in the proposals in Table below that need clarification and discussion since they seem to be important for completing the core feature design. The first two issues are useful for correction and completeness of specifications, and the last two issues are RRC/capability related.

**Issue#1: Correction**

* **Observation 1**) Moderator recommends considering following observation that corrects the description of HARQ-ID process determination.
	+ Observation 1 (**Qualcomm**)

**Issue#2: Completeness of specifications**

* **Observation 2**) Moderator recommends considering following proposal/observation that is useful for drafting specifications and avoid potential issues.
	+ Observation 1/Proposal 1 (**Ericsson)**

**Issue#3: Specification of parameter N (RRC related)**

* **Observation 3-1)** To complete the design, the range value of N should be determined.
	+ Regarding the range value, **OPPO** proposes upper limit of 16 using maximum number of HARQ processes as reference and proposes the supported maximum number based on capability. See Proposal 1 below.
	+ Reflecting on OPPO’s input, another approach would be to have a range large enough similarly to cg-nrofSlots-r16 being maximum 40 in current specifications, motivated by the underlying design principle for TDRA (i.e., reusing NR-U framework). In this case, it is not clear whether additional capability for maximum supported value is needed.
	+ Therefore, we need to discuss to determine maximum value and whether additional capability is needed.
* **Observation 3-2)** Regarding **Apple** proposal in Table below, it seems there is a misunderstanding. Effectively the design is based on Option 2. But it is important to note that we agreed early on not to couple the design to NR-U parameters since that causes additional complications (e.g. dependency to *cgRetransmissionTimer* and related functionalities) . In other words, the design of multi-PUSCH CG replicas the time domain resource allocation properties from NR-U without borrowing other properties. In that sense, for implementation, the simplified time domain resource allocation for NR-U can be reused. How that is done, is up to implementation. But from specification perspective, we do not create dependency between specification of NR-U CG and Rel-18 multi-PUSCH CG.

**Issue# 4: Number of multi-PUSCH CG configurations (RRC related)**

* **Observation 4)** OPPO raises the issue of having a limitation on maximum number of CG configurations that can be configured with multi-PUSCHs and the related capability**.** See Proposal 2 below.
* Therefore, we need to discuss to decide whether additional capability is needed.

Table 2: Summary of Contributions’ inputs for Section 2.2

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Observation 1** Support of repetition for multi-PUSCHs CG, would minimize the specification impact by reusing legacy procedures for NR-U CG and would result in a design with a choice to enable/disable repetition whichever better suited for operation.**Proposal 1** Endorse the following proposed conclusion:* Proposed conclusion: For completeness of the core design of multi-PUSCH CG and ease of specifications, the common understanding is that the legacy parameters/procedures are applied for any parameters/procedures that lack a specific agreement/conclusion during this WI for multi-PUSCH CG design, unless an inconsistency is identified.
* Note: Support of repetition for multi-PUSCH CG should be discussed and concluded separately.

**Proposal 15:** Adopt the following RRC parameter for multi-PUSCH CG* nrofTOs\_InCGperiod: number of TOs per period (N in agreement)
 |
| Qualcomm | **Observation 2**: There is a typo in the HARQ ID agreement (related part is included below) for multi-PUSCH CG period in which the brackets should be removed.* The HARQ process ID of the remaining configured/ and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with nrofHARQ-Processes or module operation with (nrofHARQ-Processes + harq-ProcID-Offset2), whichever applicable.
 |
| OPPO | **Proposal 1**: The maximum number of CG-PUSCH TOs in one period of a CG configuration is based on UE capability, and never exceeds 16 by specification.**Proposal 2**: The maximum number of CG configurations with multiple CG-PUSCH TOs is based on UE capability, and never exceeds 9 by specification. |
| Apple | **Proposal 1**: Consider the following two options to clarify the RAN1 #113 agreement:* Option 1: introducing M as in the original feature lead proposal. {M,N} are mapped to { cg-nrofSlots-r16 and cg-nrofPUSCH-InSlot-r16} to minimize specification impact. To minimize implementation complexity, N = 1 should be agreed as part of the basic UE feature, and N>1 involves optional UE capability.
* Option 2: when the NR-U procedures are applied for Rel-18 XR CG enhancement, it is assumed cg-nrofPUSCH-InSlot-r16 = 1.
 |

### 2.2.1 Initial Discussions

**Moderator’s suggestions for initial discussion:**

Based on the observations and assessments provided above, Moderator suggests the following proposals for discussion:

**Regarding Issue#1:**

* **Proposal 2-1:**
* Consider the corrections in red for the following agreement made in RAN1#113.
* ~~Send an LS to RAN2 to inform correction for their information.~~

**Agreement (RAN1#113)**

From RAN1 perspective, for determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:

* The HARQ process ID for the first configured PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured, and applying the following formula, whichever is applicable
	+ HARQ Process ID = [X\*floor( (CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes*
	+ HARQ Process ID = [X\*floor((CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*
		- X= the number of configured PUSCHs in the CG period
* The HARQ process ID of the remaining configured and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with *nrofHARQ-Processes* ~~or module operation~~ and adjusted with ~~(~~*~~nrofHARQ-Processes~~* ~~+~~ *harq-ProcID-Offset2*~~)~~, ~~whichever~~ when applicable.
* Note: A configured CG PUSCH is invalid if the CG PUSCH is dropped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*.

Send an LS to RAN2 to convey the above RAN1 agreement. Final LS is in R1-2306233.

**Regarding issue#2:**

* **Proposed conclusion 2-2:**
* For completeness of the core design of multi-PUSCH CG and ease of specifications, the common understanding is that the legacy parameters/procedures are applied for any parameters/procedures that lack a specific agreement/conclusion during this WI for multi-PUSCH CG design, unless an inconsistency is identified.
	+ Note: Support of repetition for multi-PUSCH CG should be discussed and concluded separately.

**Regarding issue#3: Proposals below are intended to understand companies’ views in initial discussions.**

* **Proposal 2-3-1:**
* For a multi-PUSCH CG configuration, minimum number of CG PUSCH transmission occasions in a period of the multi-PUSCH CG configuration ~~(N in previous agreements)~~ if provided by higher layer, is ~~one~~ X.
* **Proposal 2-3-2:**
* The upper limit on the number of CG PUSCH transmission occasions (N in previous agreements) in a period of a multi-PUSCH CG configuration is:
	+ Alt-1: 16
	+ Alt-2: 40
	+ Alt-3: Other values (Moderator’s note: please provide your suggestion if any)
* **Proposal 2-3-3:**
* Alt-1: Support a UE capability for the maximum number of CG PUSCH transmission occasions in a period of a multi-PUSCH CG configuration
	+ Discuss the candidate maximum numbers (Moderator’s note: please provide your suggestion if any)
* Alt-2: Do not support a UE capability for the maximum number of CG PUSCH transmission occasions in a period of a multi-PUSCH CG configuration

**Regarding issue#4: Proposals below are intended to understand companies’ views in initial discussions.**

* **Proposal 2-4:**
* Alt-1: Support a UE capability for the maximum number of multi-PUSCH CG configurations that a UE can be configured with.
	+ Discuss the candidate maximum numbers (Moderator’s note: please provide your suggestion if any)
* Alt-2: Do not support a UE capability for the maximum number of multi-PUSCH CG configurations that a UE can be configured with.

**Questions: Please review the summary and analysis provided in previous section, as well as this section before providing feedback.** Please provide your view in the table below regarding the following questions:

* **Q1:** What is your view regarding Moderator’s **observations**?
* **Q2:** What is your view on **Proposals** above for different Issue#1 to Issue#4? Please note that proposals for **Issue#3 and Issue#4** are intended to understand companies’ views for these topics. Please share your suggestion for improvement, correction and/or simplification.
* **Q3:** Discuss any clarification/correction/comment/question on Moderator’s summary, observation, assessment and suggestions or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | Proposal 2-3-1: OKProposal 2-3-2: Support Alt.3. A maximum value of 4 or 8 is sufficient considering this will be applicable to TDD and that the gNB will have BSR well before and can apply DG.Proposal 2-3-3: Support Alt. 2 – Not clear why a UE capability is needed.Proposal 2-4: Support Alt-2. One “multi-PUSCH” CG configuration per cell. |
| InterDigital | OK with Proposals 2-1 and 2-2.Proposal 2-3-1: OKProposal 2-3-2: Open to both Alt-1 and Alt-2, with some preference towards Alt-2 for alignment with NR-U framework. Proposal 2-3-3: Alt-2Proposal 2-4: Alt-2 |
| ZTE, Sanechips | **Issue #1:** Fine with proposal 2-1. **Issue #3:**Firstly, as per the agreements, **N** denotes configured **N consecutive slots** based on NR-U framework, it is not correct to define N as a number of CG PUSCH transmission occasions in a CG period. Secondly, regarding the maximum value of number of CG PUSCH TOs, it is related to XR packet size and parameters of a CG configuration (e.g., periodicity). Hence, the number of CG TOs can be in a wide range.**For Proposal 2-3-3: we support Alt. 2.** |
| Nokia, NSB | **Proposal 2-1:** OK**Proposal 2-2:** OK**Proposal 2-3-1:** We support min number equal to 1 similar to cg-nrofSlots**Proposal 2-3-2:** We support Alt-2. Since we are re-using the NR-U framework, where each slot is counted (not only available one), we need a large max number to account for different TDD configurations.Proposal 2-3-3: Support Alt-2, it is as in NR-U framework where we do not have an extra capability for max number.**Proposal 2-4:** Support Alt-2. |
| Sharp | Fine with proposal 2-1 and 2-2.Proposal 2-3-1: OKProposal 2-3-2: Support Alt.1. Proposal 2-3-3: Support Alt. 2. No need to further configure by UE capability.Proposal 2-4: Support Alt-2. A number, e.g. 2, can be defined instead. No need to further configure by UE capability. |
| **vivo** | * **Proposal 2-1:**

it is aligned with RAN1 common understanding. Based on the latest RAN2 draftCR, RAN2’s understanding is also in this way. not sure additional LS is necessary.* **Proposed conclusion 2-2:**

Generally fine.* **Proposal 2-3-1:**

Fine* **Proposal 2-3-2:**

We think the maximum number depends on whether repetition is supported or not. If repetition is not supported. The maximum number of N should not beyond the maximum of supported HARQ processes per CC for PUSCH transmission, i.e., 16.* **Proposal 2-4:**

Alt-1 is preferred. |
| **DOCOMO** | Agree with all of Moderator’s observations.Proposal 2-1: OKProposed conclusion 2-2: OKProposal 2-3-1, Proposal 2-3-2: OKProposal 2-3-3: Support Alt 2. We don’t see the necessity to introduce separate UE capability.Proposal 2-4: Support Alt 2. |
| **Xiaomi** | Proposal 2-1: Fine Proposed conclusion 2-2: Is that means all legacy features will be support in multi-PUSCH CG design?Proposal 2-3-1: OK Proposal 2-3-2: A smaller value such as 2 or 4Considering indication overhead and the prediction accuracy of UE, the maximum of value N should not be too large.Proposal 2-3-3: Support Alt-2Proposal 2-4: Support Alt-2 |
| LG | Proposal 2-3-1: Support Proposal 2-3-2: Support Alt. 1Proposal 2-3-3: Support Alt. 2 Proposal 2-4: Support Alt-2 : the maximum number of multi-PUSCH CG would be same as the maximum number of CG configuration.  |
| Panasonic | Proposal 2-3-1: Fine with the proposalProposal 2-3-2: Fine with the proposal. We think the proper maximum number of transmission occasions depends on whether the repetition is supported or not. Considering the possibility of collisions with DL slots, up to 16 occasions (Alt-1) should be sufficient if repetition is not supported. F repetition is supported, more than 16 occasions might be required. Proposal 2-3-3: Our preference is Alt-2Proposal 2-4: Our preference is Alt-2 |
| **Qualcomm** | Proposal 2-1: Support.Proposed conclusion 2-2: we are fine with the basic principle, but there may not be a need to make it an explicit conclusion.Proposal 2-3-1: If N = 1, the multi-PUSCH CG falls back to a legacy CG configuration. Then it seems the minimum N configured for a multi-PUSCH CG configuration should be 2.Proposal 2-3-2: Alt-1: 16Proposal 2-3-3: Alt-1Proposal 2-4: In general, the multi-PUSCH CG configuration is equivalent to multiple legacy active single-PUSCH CG configurations. So there is a feature redundancy between multi-PUSCH CG configuration and multiple active CG configurations. For this, we support to define a UE capability for jointly supporting these two features. At least, we can discuss whether multi-PUSCH CG is supported or not separately for the case that UE supports multiple active legacy CG configurations or not. |
| NEC | Proposal 2-1: OKProposal 2-2: OKProposal 2-3-1: OKProposal 2-3-2: we slightly prefer Alt 1, which may be a good tradeoff between the UCI overhead and the flexibilityProposal 2-3-3: support Alt.2 without UE capability reportingProposal 2-4: support Alt.2 without UE capability reporting |
| **Lenovo** | **2-1: ok****2-2: ok****2-3-1: ok****2-3-2: we can further discuss, probably we do not want to have a large bit-field size for UTO-UCI****2-3-3: Alt-1 seems reasonable****2-4: Alt-1 seems reasonable** |
| Futurewei | Proposal 2-1: only the bracket can be deleted, other sentences/words can be kept as legacy specification in MAC layer quoted as below:TS 38.321 V.17.205.4 UL-SCH data transfer5.4.1 UL Grant reception“For configured uplink grants neither configured with *harq-ProcID-Offset2* nor with *cg-RetransmissionTimer*, the HARQ Process ID associated with the first symbol of a UL transmission is derived from the following equation: HARQ Process ID = [floor(CURRENT\_symbol/*periodicity*)] modulo *nrofHARQ-Processes*For configured uplink grants with *harq-ProcID-Offset2*, the HARQ Process ID associated with the first symbol of a UL transmission is derived from the following equation: HARQ Process ID = [floor(CURRENT\_symbol / *periodicity*)] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*where CURRENT\_symbol = (SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot* + slot number in the frame × *numberOfSymbolsPerSlot* + symbol number in the slot), and *numberOfSlotsPerFrame* and *numberOfSymbolsPerSlot* refer to the number of consecutive slots per frame and the number of consecutive symbols per slot, respectively as specified in TS 38.211 [8].”Proposed conclusion 2-2: Fine.Proposal 2-3-1: FineProposal 2-3-2: Fine with Alt-1.Proposal 2-3-3: Fine with Alt. 2.Proposal 2-4: Support Alt-2. Multiple CG configurations with “multi-PUSCH” per cell are not agreed yet. |
| OPPO (copied from FLS v003) | Proposal 2-1: OK.Proposal 2-3-1: OK.Proposal 2-3-2: Support Alt-1. Given the typical XR video with a periodicity of 60 fps (i.e. 16.67 ms) and the maximum number of HARQ processes supported in FR1 is 16, we think 16 CG-PUSCH TOs in one period of a CG configuration are enough.Proposal 2-3-3: Support Alt-1. The candidate maximum numbers can be 4, 8 and 16.Proposal 2-4: Support Alt-1. XR frame rates (15, 30, 45, 60, 72, 90 and 120 frames per second) correspond to rational periodicity of 200/3, 100/3, 200/9, 50/3, 125/9, 100/9 and 25/3 ms respectively, where the maximum denominator is 9. To solve the issue of non-integer traffic periodicity, we propose that the candidate maximum numbers at least include 1, 3, and 9. |
| **Moderator** | **Summary of views:*** Proposal 2-1: IDC, ZTE, Nokia, Sharp, [vivo], DCM, xiaomi, QC, NEC, Lenovo, [FW], OPPO
* Proposal 2-2: IDC, Nokia, Sharp, [vivo], DCM, xiaomi, NEC, Lenovo, FW, [QC: no need]
* Proposal 2-3-1:
	+ Samsung, Sharp, vivo, DCM, xiaomi, LG, Panasonic, QC, NEC, Lenovo, FW, OPPO
	+ Nokia (min 1)
* Proposal 2-3-2:
	+ Alt 1: Sharp, [vivo], LG, QC, NEC, FW, OPPO
	+ Alt 2: Nokia
	+ Alt 3
		- Samsung (4, 8): clarified w Samsung those values are reasonable for bitmap size. Perhaps larger value here.
		- Xiaomi: 2, 4 (note that this is number of slots, not bitmap)
* Proposal 2-3-3:
	+ Alt-1: Lenovo, OPPO
	+ Alt-2: Samsung, IDC, ZTE, Nokia, Sharp, DCM, LG, Panasonic, NEC, FW
* Proposal 2-4:
	+ Alt-1: vivo, Lenovo, OPPO
	+ Alt-2: Samsung, IDC, Nokia, Sharp, DCM, LG, Panasonic, NEC, FW
	+ Alt-3: QC
 |
| **TCL** | **Proposal 2-1:** OK**Proposal 2-2:** OK**Proposal 2-3-1:** OK**Proposal 2-3-2:** We support Alt-1. Proposal 2-3-3: Support Alt-2.**Proposal 2-4:** Support Alt-2. |
|  | **Moderator’s suggestion after offline session:*** Proposal 2-1, no need for LS.
* Proposed conclusion 2-2: Captures the common understanding. No need for endorsement. Better wait to see if there is a need after reviewing draft CRs when available.
* Proposals 2-3-1 and 2-3-3 are combined and reformulated to reflect the range value as the following. Descriptions needs to be improved to ensure N is the number of slots. More time is needed for companies about the reasonable values.
	+ **Proposal 1-2-3:**
	+ For a multi-PUSCH CG configuration, the range value of the higher layer parameter indicating number of consecutive slots with SLIV (N in previous agreements) is:
		- Alt-1: (2, …, Y)
			* Decide Y=16 or 40 or some other value
		- Alt-2: (1, ...., Y)
			* Decide Y=16 or 40 or some other value
* Proposal 2-3-3 and 2-4 can be handled by UE feature discussions.
 |
| ZTE, Sanechips | Proposal 1-2-1The correction can be aligned with the discussion of running CR of 38.321 in RAN2. The following change is suggested as highlighted:* The HARQ process ID of the remaining configured and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with *nrofHARQ-Processes* ~~or module operation,~~ and then add ~~(~~*~~nrofHARQ-Processes~~* ~~+~~ *harq-ProcID-Offset2*~~)~~, ~~whichever~~ when applicable.
 |
| ZTE, Sanechips | **Proposal 1-2-3:**As we’ve discussed the formulation of Proposal 2-3-1 on Monday (offline session), the definition of **N** was clearly clarified. Thus one way to go is to reuse the outcome of the formulation of Proposal 2-3-1 for this proposal.Again, I drawn a figure to clarify the definition of N in previous agreements. (Note we agreed to borrow the definition of cg-nrofSlots-r16). It seems Nokia also mentioned this clarification when we discussed the maximum values.Thus the suggested formulation for the main sentence is:* For a multi-PUSCH CG configuration, number of CG PUSCH transmission occasions in a period of the multi-PUSCH CG configuration if provided by higher layer, is:
 |
| Moderator | **@ZTE/All: P2-1: OK****@ZTE: (P2-3)**Thanks forsuggestion. However, agreement is about N and at this stage, it is not recommended to change that. I also noticed that my formulations in previous proposals were confusing (although the intention was N), but the description was mentioning CG PUSCH TOs.**@All: I fixed numbering of proposals** |
| Moderator | **Proposal 1-2-3 is stable.****Continue discussion for Proposal 1-2-3.** |

### 2.2.2 Intermediate Discussions

Proposal 1-2-1(updated) is stable.

Proposal 1-2-1 (updated):

* The corrections in red are applied for the following agreement made in RAN1#113.

**Agreement (RAN1#113)**

From RAN1 perspective, for determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:

* The HARQ process ID for the first configured PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured, and applying the following formula, whichever is applicable
	+ HARQ Process ID = [X\*floor( (CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes*
	+ HARQ Process ID = [X\*floor((CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*
		- X= the number of configured PUSCHs in the CG period
* The HARQ process ID of the remaining configured and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with *nrofHARQ-Processes* ~~or module operation~~ and then  ~~with~~ ~~(~~*~~nrofHARQ-Processes~~* ~~+~~ *harq-ProcID-Offset2*~~)~~ is added, ~~whichever~~ when applicable.
* Note: A configured CG PUSCH is invalid if the CG PUSCH is dropped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*.

**Moderator suggestion:**

Focus the discussion on the following proposals to determine the range value.

Proposal 1-2-3:

* + For a multi-PUSCH CG configuration, the range value of the higher layer parameter indicating number of consecutive slots with SLIV (N in previous agreements) is:
	+ Alt-1: (2, …, Y)
		- Decide Y=16 or 40 or some other value
	+ Alt-2: (1, ...., Y)
		- Decide Y=16 or 40 or some other value

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding Proposal 1-2-3 and indicate what the range value should be.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Xiaomi** | Support Alt-2.As we identified optionB-b2 as the baseline online yesterday, even if a multiple-CG configuration is configured with only one TO, it can be indicated by a UTO-UCI due to the sliding window design. We did not find any additional complexity introduced by the value 1. |
| OPPO | Between Alt-1 and Alt-2, given RAN1 agrees on UTO-UCI scheme Alt B-b2, N=1 becomes meaningful (N=1 is not for UTO-UCI scheme Alt-A). The only catch here is that: because there is no additional signaling to turn of UTO-UCI, when N=1, the UTO-UCI may only point to a TO in the next (or even next after next due to non-zero UTO\_offset) CG period, which may make UE incapable to predict the TO usage and therefore leave the indication bit information-less. In addition, value=1 is a build-in value for a standard SLIV indication. So **Alt-2 is now our preference**. For the value Y, we do not think it should be larger than the maximum number (i.e., 16) of HARQ processes. If Y is larger than 16, there would be >16 consecutive TOs per CG period. Then because the HPID is (unconditionally) incremented per each TO, it is possible for a failed TO transmission to lose its re-transmission due to its HPID being over-written by a later TO’s initial-transmission. The larger of Y over 16, the more likely the HPID over-written can happen. So **we support Y=16**.  |
| **ZTE, Sanechips** | Please take following update into account from formulation perspective:For a multi-PUSCH CG configuration, the range value of the higher layer parameter indicating number of consecutive slots (N in previous agreements) is: |
| **Moderator** | Proposal 1-2-3:* For a multi-PUSCH CG configuration, the range value of the higher layer parameter indicating number of consecutive slots (N in previous agreements) is:
* Alt-1: (2, …, Y)
	+ Decide Y=16 or , 32, 40
* Alt-2: (1, ...., Y)
	+ Decide Y=16 or , 32, 40
* Alt-3: (X, ...., Y)
	+ X= Whether the Min value is 1 or 2 is up to RAN2,
	+ Y=16 or32, or 40

**@All : The proposal is updated as the above based on the offline discussion.****Moderator’s recommendaiton:*** +
 |
|  |  |
|  |  |
|  |  |

#### 2.2.2.1 Offline discussion

Based on offline discussion, proposal 1-2-3 is updated as the following:

**Proposal 1-2-3 (updated):**

* For a multi-PUSCH CG configuration, the range value of the higher layer parameter indicating number of consecutive slots (N in previous agreements) is:
* Alt-1: (2, …, Y)
	+ Decide Y=16 or , 32, 40
* Alt-2: (1, ...., Y)
	+ Decide Y=16 or , 32, 40
* Alt-3: (X, ...., Y)
	+ X= Whether the Min value is 1 or 2 is up to RAN2,
	+ Y=16 or32, or 40

**Moderator’s recommendation:**

* For min value, endorse Alt-1.
* For max value, 16 or 32 (i.e. skip 40)
	+ To select between 16 and 32, aim to select one value.
	+ If not possible to reach consensus, support max 16. But support of 32 depends on UE capability.

**Question:** Please share your view in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

## 2.3 Other topics

**Moderator’s summary:**

With respect to the feature multi-PUSCHs CG, companies have raised other aspects for discussions and decisions suggested additional enhancements being proposed mostly in previous meetings. The topics are listed below including the direction of expressed views:

**Topic 1) Retransmission of multiple TBs with a single DCI with corresponding initial transmissions with CG PUSCHs**

* Support: Ericsson, IDC, Honor, [LG]
* Not Support: FW, CMCC, Spreadtrum, MTK

**Topic 2)** **Extend SPS PDSCHs collision resolution for CG PUSCHs**

* Support: Samsung
* Not Support: CMCC; Spreadtrum

**Topic 3) One TB over multiple slots**

* Not support: E///, CMCC, Spreadtrum, MTK

**Other topics (proposed by CATT, FW, Apple, …)**

Table 3: Summary of Contributions’ inputs for Section 2.3

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Proposal 3** Scheduling re-transmission of multiple TBs for corresponding initial transmission of the TBs by configured grant is supported for DCI format 0\_1 scrambled with CS-RNTI.* NDI bit to "1" indicates retransmission for corresponding HARQ process.

**Proposal 4** Support of CBG based transmission for multi-PUSCH CG is down prioritized.One TB over multiple slots improves coverage and does not bring capacity improvements. Currently, retransmission of partial TB is not possible, and if some PUSCH fails, then retransmission will require retransmission of all PUSCHs (whole TB) which degrades the capacity.**Proposal 5** Down prioritize one TB over multiple slots. |
| Futurewei | **Observation 1**: The periodicity relationship between non-integer periodicity of XR traffic and the legacy integer CG periodicity has the same problem as DRX, and can be solved in the same way, regardless of single or multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration.**Proposal 1**: Support that the periodicity of CG resources can be configured with new values of CG periodicities in rational numbers, which is the same as the non-integer periodicity of XR traffic.**Proposal 2**: Support that the rounding operations (e.g., ceiling operation or flooring operation) based on the rational number periodicity, or nested configuration with multiple periodicities can be used to guarantee the finally configured resources of the CG configuration with integer periodicities, if the finally configured resources of the CG configuration require integer periodicities.**Observation 2**: When the rounding operations or nested configuration with multiple periodicities are conducted by UE, the first PUSCH transmission occasion of the multiple PUSCH transmission occasions may be conflicted with a downlink (DL) resource.**Proposal 3**: Support that UE can shift all of the PUSCH transmission occasions of the multiple PUSCH transmission occasions to the next closest available uplink (UL) slot(s) if the first PUSCH transmission occasion of the multiple PUSCH transmission occasions conflicted with a downlink (DL) resource based on rounding operations or nested configuration.**Proposal 4**: Support that the shifting performed by UE for the first PUSCH transmission occasion, of the multiple PUSCH transmission occasions, conflicted with the downlink (DL) resource can be confined in a time window configured by RRC messages.**Proposal 6**: Retransmissions of the multiple CG PUSCH transmission occasions, in a period of a single CG PUSCH configuration, can be based on dynamic uplink grant(s) via dynamic grant resources and UE assumes ACK(s) in absence of reception of feedback after a timer expires if retransmissions for the multiple CG PUSCH transmission occasions supported.**Proposal 7**: Do not support single DCI scheduling retransmissions for multiple CG PUSCH transmission occasions, at least for Rel-18. |
| CATT | **Proposal 1**: Multi-PUSCHs CG configuration should be supported including:* The configuration of non-consecutive CG PUSCH occasions should be supported to provide the flexibility of gNB implementation for the adaptation of different XR traffic;
* There are two alternatives to determine the non-consecutive CG PUSCH occasions should be considered as following:
	+ Alt-1: Multiple offsets configured for the non-consecutive CG PUSCH occasions in a CG period.
	+ Alt-2: The bitmap configured for the non-consecutive CG PUSCH occasions in a CG period or in certain time period, e.g. 50ms for 60FPS.
 |
| CMCC | **Proposal 2**. For the design of multi-PUSCHs CG, the retransmission of multiple TBs with a single DCI, the extension of SPS PDSCHs collision resolution to CG PUSCHs, and one TB over multiple slots are not supported. |
| Spreadtrum Comm. | **Proposal 2**: Support retransmission of multiple TBs with a single DCI with corresponding initial transmissions with CG PUSCHs.**Proposal 3**: It is not necessary to enhance SPS PDSCHs collision resolution for CG PUSCHs.**Proposal 4**: It is not necessary to support one TB over multiple slots for multi-PUSCH CGs in a CG period. |
| IDC | **Proposal 2**: Dynamic grants for retransmissions of multiple TBs are provided in single DCI **Proposal 3**: UE monitors PDCCH starting from the L’th slot after transmitting M TBs in M PUSCH occasions in multi-PUSCH CG  |
| LG | **Proposal 1**: If it is necessary to support triggering the re-transmission of multiple CG PUSCHs by using a single DCI, following options can be considered to indicate whether the DCI triggers the re-transmission of single CG PUSCH or multiple CG PUSCHs.* Option 1: Introduce new CS-RNTI to indicate the re-transmission of multiple TOs
* Option 2: Always perform re-transmission of all the TOs in a period if the corresponding CG configuration is configured with multiple TOs in a period.
* Option 3: Re-interpret the number of repetitions as the indication of the re-transmission of multiple TOs. For example, if the number of repetitions is indicated as K (> 1) in a DCI, it is re-interpreted that the DCI triggers the re-transmission of K TOs.
 |
| MTK | **Proposal 2**: Single-DCI scheduling multiple PUSCHs for TB re-transmissions is not supported in R18 XR.**Proposal 3**: Do not support single TB transmission over multiple slots in Rel-18 XR. |
| Honor | **Proposal 1**: Support retransmission of multiple TBs with a single scheduling DCI when a multi-PUSCH CG is used for the initial transmission* The DCI is scrambled with CS-RNTI
* Rel-17 single DCI scheduling multiple PUSCHs can be used for scheduling CG PUSCH retransmission, in which,

NDI field can be used as the bitmap and NDI bit set to "1" indicates retransmission of the corresponding PUSCH of a multi-PUSCH CG.One or two RV bits per retransmission PUSCH. |
| Apple | **Proposal 6**: Support using rational numbers for matching CG periodicity to traffic period. |
| Samsung | **Proposal 4**: Define a collision resolution procedure for CG-PUSCHs |

### 3.3.1 Initial Discussions

**Moderator’s suggestions for initial discussion:**

Considering the status, moderator suggest the following:

* **Suggestion)** Moderator suggests down-prioritizing these enhancements due to the limited time for completion of the work item and lack of strong support and/or presence of opposition for any of the proposed enhancement.

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding Moderator’s **suggestion** regarding the topics above. In case of concern, please provide your view that helps in changing the situation.
* **Q2:** Discuss any clarification/correction/comment/question on Moderator’s summary and suggestions or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | No need to re-discuss items that were extensively discussed during the SI and concluded to not provide any meaningful benefit.For CG-PUSCH collisions, the issue is not whether or not there is benefit - it is whether: 1. RAN1 thinks collisions cannot happen hence no need to discuss – a RAN1 conclusion is then needed as to how collisions cannot happen among CG-PUSCHs for pose/audio/video
2. RAN1 thinks collisions can happen but a resolution does not need to be specified – a RAN1 conclusion is then needed on what a UE can do by implementation and whether that can work
 |
| **Nokia, NSB** | We agree with moderator’s recommendation. At this meeting it is important to resolve all issues that are critical for competition of the features that are part of objectives and not continue the discussion for the features that are not part of the main feature design. |
| **DOCOMO** | Agree with moderator’s recommendation. |
| **Xiaomi** | We share the same view with moderator.  |
| **Panasonic** | We support the FL suggestion. |
| **Qualcomm** | Support the suggestion.  |
| **Lenovo** | **Agree with the moderator** |
| Futurewei | In our view, the collision between CG-PUSCHs and downlink resource needs to be addressed in RAN1, however, based on the limited time, we are fine with FL suggestion. |
| **Moderator** | **Need to follow-up on Topic 2 to have a clear understanding in RAN1.** |
| **TCL** | Support the suggestion. |
| **Moderator** | **@All:** After further discussion, Moderator understand the collision issue is related to configuration of multiple CG. However, if there is already this issue in existing spec (need further checking), it maybe worsen when a CG configuration uses multi-PUSCHs CG.Understanding of the current specifications regarding this issue is helpful to better understand whether any specification work in needed in case of multi-PUSCHs CG.Overall, it does not seem to be critical for core feature design. |

# 3 UTO-UCI indication

This section captures the summary of the discussions regarding the design aspects of the following WID objective:

|  |
| --- |
| - Dynamic indication of unused CG PUSCH occasion(s) based on UCI by the UE (RAN1, RAN2); |

## 3.1 Design option

**Moderator’s summary:**

In previous meeting, the following agreement was made, listing candidate design options to determine the indicated CG PUSCH by a UTO-UCI. The discussion is for decision on the design option.

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, consider the following options for further down-selection:

**Option A-1a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt-2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
	+ The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
	+ A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period.

**Option A-2a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt -2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
* Configure the RRC parameter UTO\_offset.
	+ FFS range value of UTO\_offset
* The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
* A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period and after UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-a:**

* Configure the RRC parameter UTO\_period.
	+ FFS range value of UTO\_period
		- Alt-1: values in time unit (e.g., XR traffic periodicity)
		- Alt -2: one or multiple of CG periodicity given by integer value (n=1, 2, ..)
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH carries UTO-UCI that is applicable to the valid CG PUSCH TOs that are confined within UTO\_period starting with UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-b2:**

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations

**Companies’ view:**

**Summary of views on design option:**

* Option A-1a [12]: vivo, CATT, Lenovo, ZTE, Spreadtrum, Sony, IDC, Google, MTK, Honor, New H3C, KT Corp
* Option A-2a [6]: FW, HW/HiSilicon, ZTE, Spreadtrum, OPPO, NEC
* Option B-a [6]: Ericsson (2nd), FW, QC, IDC, LG, CAICT
* Option B-b2 [9+1]: Ericsson (1st), QC, Nokia/NSB, vivo, xiaomi, CMCC, Samsung, Honor, DCM, Panasonic
* Summary of views on design parameters:

Table : Summary of Contributions inputs for Section 3.1

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Observation 2** The UTO-UCI feature can be regarded useful if the information received by UTO-UCI can be applied by the gNB for useful functionalities such as repurposing CG PUSCH resources or reducing blind detection of CG PUSCHs.**Observation 3** Repurposing resources requires more time than skipping blind detection, however the required time is gNB implementation specific and not to be specified. The gNB can guide the UE by providing useful configurations needed for UTO-UCI reporting.**Observation 4** In configuration of resources, e.g., CG resources, different parameters are involved. The assumption that the gNB always configures CG configuration such that it is optimized for serving XR traffic, reflects misunderstanding of NW operation.**Observation 5** The periodicity of CG configuration, irrespective of whether legacy CG configuration or multi-PUSCH CG configuration is used, should not be coupled with the periodicity that a UTO-UCI is applicable to, where the latter can be the same or different from the CG periodicity.**Observation 6** Both Option A-1a and option A-2a provide the same properties regarding the ability of indicating unused TOs. The UCI overhead reduction in Option A-2a comes at the cost of additional complexity at both UE and gNB without justifying performance gain or additional capability in terms of indicating unused TOs**Observation 7** Summary of assessments of Options A-1a/B-a/B-b2:* Option B-a and Option B-b2 are both superior as compared to Option A-1a that compromises the usefulness of enabling the UTO indication for a configured grant.
* The perception that providing information on usability of TOs for upcoming TOs is complicated for Option B-a/B-b2 as compared to option A-1a is not founded, since for Option A-1a, the UE provides information about all the TOs in that period at the start of each UTO period, including the latest ones in the period.
* Option B-b2 provides slightly lower complexity due to ensuring a fixed size of UTO-UCI as compared to Option B-a.

**Observation 8** With respect to UTO\_period and UTO\_offset, if applicable, if Alt-1 is adopted additional adjustments should be considered by design or by gNB to allow/apply configurations not resulting a UTO period starts/ends within the duration of a CG PUSCH TO. Selecting Alt-2 results in a simpler design while maintaining the benefits of the feature.**Proposal 6** For a CG configuration with UTO-UCI indication enabled, the candidate Option A-2a to determine the indicated CG PUSCH by a UTO-UCI indication is not supported.**Proposal 7** For a CG configuration with UTO-UCI indication enabled, one of the candidates Option B-a or Option B-b2 is supported with slight preference towards Option B-b2.**Proposal 8** With respect to UTO\_period and/or UTO\_offset, adopt Alt-2 if applicable for the selected design option for UTO-UCI indication.**Proposal 16** Adopt the following RRC parameters for UTO-UCI indication* UTO\_indication: Enable/disable UTO indication
* UTO\_period: If Option A-1a or Option B-a is supported
* nrof\_UTO\_UCI: Maximum number of UTO-UCI bits
 |
| Futurewei | **Proposal 8**: Support that, for a bitmap provided by UTO-UCI, a bit of the bitmap corresponds to a transmission occasion (TO) within the same configured grant (CG) period with the UTO-UCI.**Observation 3**: To guarantee the indicated unused CG PUSCH occasion(s) to be really recycled to other UEs (or the same UE based on dynamic grant), time offset between UCI and the indicated unused CG PUSCH occasion(s) should be equal to or greater than the PUSCH preparing time for at least one of the other UEs (or the same UE).**Proposal 9**: Indicating unused CG PUSCH occasion(s) to gNB can be determined based on a time offset threshold, configured by gNB, between UCI and the unused CG PUSCH occasion(s).**Observation 4**: Option A-2a is the same as Option B-a (with Alt-1 for UTO\_Offset).**Proposal 10**: Option A-2a and Option B-a (with Alt-1 for UTO\_Offset) are preferred. |
| Qualcomm | **Observation 9**: UTO\_UCI can be configured to indicate PUSCH occasions across CG periods.* if Option A-1a and A-2a are configured with UTO\_period equal to multiple of the CG periodicity
* by Option B-b and B-b2.

**Observation 10**: The sliding window-based solution (Option B-a and B-b2) allows network to skip the first PUSCH occasion(s) associated with the UL video traffic when UL jitter is present, which is more resource and energy efficient for network.* In the periodic window-based solution (Option A-1a and A-2a), resource and energy used to detect PUSCH occasions before the UL jitter time are wasted.

**Observation 11**: The explicit configuration of UTO\_offset provides minor signaling overhead benefit.**Proposal 8**: Support the sliding window-based options (Option B-b or B-b2) for the UTO-UCI content design. |
| Nokia/NSB | **Observation 1**: The parameter UTO\_period in Option A-1a, Option A-2a, Option B-a:- if UTO\_period is given in time unit (Alt-1), the number of bits for indication may vary from one UTO\_period to another due to TDD configuration that has different number of UL occasions, complicating the decoding of UTO\_UCI.- If UTO\_period is given in number of CG periods (Alt-2), then the mismatch between XR frame arrival and UTO\_period will happen after some time (similar issue as in DRX) for Options A-1a and A-2a.- if UTO\_period does not cover all possible transmission occasions of one XR video frame and the first transmission occasions in the next UTO\_period are unused, gNB will not receive the timely indication about such occasions for Options A-1a and A-2a.**Observation 2**: If sliding window covers the transmission occasions that are in the next XR frame arrival (UE does not know the status of such transmission occasions), the indication "not unused" is applied and changed whenever the information about the transmission occasions is available at UE side.**Observation 3**: According to Table 1, Option A-1a, Option A-2a, Option B-a require (i) more parameters to be configured, (ii) varying number of bits in each UTO\_period and/or every UTO-UCI transmission, and (iii) larger number of bits as compared to Option B-b2.**Observation 4**: There is no practical difference from UE perspective for UTO-UCI indication determination between fixed and sliding window approaches.**Proposal 3**: Support the indication of CG PUSCH TO(s) over multiple CG periods, i.e., legacy CG configuration.**Proposal 4**: UTO\_Offset can be configured to ensure enough time for the gNB to reschedule the indicated unused TOs.**Proposal 5**: Support Option B-b2 as the solution for UTO-UCI indication since it requires less parameters to configure, has a fixed bitmap size, provides a timely indication of "unused" occasions, and can be configured with smaller number of bits as compared to Options A-1a, A-2a, B-a.**Proposal 11**: Consider RRC parameters provided in Table 2. |
| vivo | **Proposal 2**: For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCHs by a UTO-UCI, support either Option B-b2 or Option A-1a. |
| TCL | **Proposal 2**: Support a UTO-UCI use to indicate the un-used TOs within a CG period.**Proposal 3**: For the UTO-UCI to indicate un-used TOs within a CG period, a time offset later than the location where the UTO-UCI sent is needed. |
| CATT | **Observation 1**: For the two alternatives for the non-consecutive CG PUSCH occasions, the bitmap used in the indication of CG PUSCH occasion configuration could be much simpler than the multiple offsets configuration for the non-consecutive and valid CG PUSCH occasions.**Observation 2**: The bitmap used in the indication of CG PUSCH occasion configuration for the non-consecutive CG PUSCH occasion pattern in a certain time period could align with the non-integer XR packet generation period and CG period.**Observation 3**: The UTO-UCI indicator within the configured period could be much simpler implementation for gNB and could provide the additional information for alignment between gNB and UE.**Observation 4**: The drawbacks for Option B-a and Option B-b2 would not be neglected, such as the non-alignment between gNB and UE, the UTO\_period disassociated with the CG period etc.**Proposal 2**: The time offset between the UTO\_UCI indicator and the start time of UTO\_period should not be specified, i.e, UTO\_Offset = 0.**Proposal 3**: The UTO\_period should not be longer than the CG period, i.e. XR traffic periodicity, and not extended outside the CG period due to uncertain XR packet arrival time and packet size.**Proposal 4**: The Option A-1a as following should be supported, in which the value of UTO\_period would not larger than XR traffic periodicity:Option A-1a:* Configure the RRC parameter UTO\_period.
* Alt-1: values in time unit (e.g., XR traffic periodicity)
* The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
* A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period.
 |
| Lenovo | **Proposal 3**: Used/unused status of CG PUSCH occasions is indicated via Option A-1a defined in RAN1#113.**Proposal 4**: UTO-UCI indicates TO occasions not farther away than 'T' seconds/symbols. |
| Sharp | **Proposal 2**: In a UTO-UCI, a "Unused" is indicated as "1", and "Not Unused" as "0" for a CG PUSCH TO.**Proposal 3**. For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication,* Configure the RRC parameter UTO\_period.
* The range value of UTO\_period is defined by a value in time unit (e.g., XR traffic periodicity).
* UTO\_offset is the offset value, provided by configuration.
* A transmitted CG PUSCH carries UTO-UCI that is applicable to the valid CG PUSCH TOs that are confined within UTO\_period starting with UTO\_offset from the end of the transmitted CG PUSCH.
 |
| Huawei/HiSilicon | **Observation 1**: In Option A-1a, the UTO-UCI at later occasions still indicate whether the past CG PUSCHs are used or not, which is unnecessary and waste of signaling.**Observation 2**: The applicable range of the UTO-UCI may cross multiple CG periods in the following cases:* Option B (Option B-a and Option B-b2).
* Option A (Option A-1a and Option A-2a) if UTO\_period is not equal to CG period.

**Observation 3**: On how UE determines a CG PUSCH is used or unused:* If it is left up to UE implementation, UE will probably always indicate future CG PUSCH are "used" since there is no penalty and only benefits. As a result, the feature of dynamic indication of unused CG PUSCH occasion(s) is useless.
* Therefore, RAN2 will probably specify how to determine a CG PUSCH is used or unused, e.g., based on current buffer size. If so, options whose applicable range of UTO-UCI may cross multiple CG periods will have serious issues in terms of transmission delay and capacity, and shall be precluded.

**Proposal 1**: To determine the indicated CG PUSCH by a UTO-UCI indication, Option A-2a is supported with following further details:* The value of UTO\_period is always equal to CG periodicity (i.e., Alt-2 with n=1).
* Configure the RRC parameter UTO\_offset (unit is slots or ms, i.e. 1, 2, ... 16 slots).
 |
| xiaomi | **Observation 3**: The direct indication for CG PUSCH occasion can make the specification description more intuitive.**Observation 4**: Determining the indication range directly according to the size of the bitmap can reduce the signaling overhead.**Observation 5**: The gNB cannot be guaranteed to reuse the resource corresponding to the unused CG PUSCH TOs without UTO\_offset.**Observation 6**: Configuration of UTO\_offset is necessary by UTO-UCI, and the configuration needs to satisfy the timeline.**Observation 7**: Only indicating valid TO does not reduce the UTO-UCI overhead, nor does it provide other benefits.**Observation 8**: Only indicating valid TO will make it difficult for the UE to predict whether the resource corresponding to the valid TO is not needed.**Proposal 3**: Nu needs to be supported for determining the indication range first.**Proposal 4**: Support configuration of UTO\_offset as the offset value* A higher layer parameter is used to configure the offset value.
* The maximum value of UTO\_offset is not greater than the number of CG PUSCH TO in a CG period.

**Proposal 5**: The UTO-UCI should be applicable to the Nu consecutive CG PUSCH TOs.**Proposal 6**: The following scheme for UTO-UCI needs to be supported in RAN1:Option B-b2:* Configure the RRC parameter Nu (Nu is the size of bit-map)
* FFS range value of Nu
* UTO\_offset is the offset value.
* Alt-1: UTO\_Offset is provided by configuration.
* FFS range value of UTO\_offset
* Alt-2: UTO\_Offset = 0

? A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH. |
| CMCC | **Proposal 4**. With respect to the relationship between UTO-UCI indicator and indicated TOs, support Option B category with indicator to a sliding window.**Proposal 5**. With respect to the configuration of time window corresponding to the indicated TOs, support the configuration based on the number of valid CG PUSCH TOs.**Proposal 6**. For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, prioritize Option B-b2 from the RAN1#113 agreement. |
| ZTE/Sanechips | **Observation 2**: It is hard for UE to predict unused/used status of the CG PUSCHs through UTO-UCI if the parameters (e.g., TDRA, FDRA and MCS level )of CG occasions within one CG period can be dynamically re-initialized by activation DCI.**Observation 3**: Option B (including e.g., Option B-1a and Option B-b2) would cause unexpected signaling overhead.**Observation 4**: UTO\_Offset is helpful for reducing UCI overhead for both Option A-1a and Option A-2a.**Proposal 2**: It should be discussed how/when to apply the re-initialized parameters by indicated activation DCI.**Proposal 3**: Support Option A-1a , Option A-2a due to less concern compared to option B.**Proposal 4**: Support UTO\_period equals to the values in time unit (e.g., XR traffic periodicity) or value of one CG period for multi-PUSCHs CG.**Proposal 5**: Support UTO\_Offset can be provided by configuration for Option A-1a as well. |
| Spreadtrum comm. | **Proposal 5**: For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, support either Option A-1a and Option A-2a.**Proposal 6**: Configure the RRC parameter UTO\_period, and the range value of UTO\_period is in time unit (e.g., XR traffic periodicity).**Proposal 7**: To determine the indicated CG PUSCH by a UTO-UCI indication, support that UTO\_offset = 0.**Proposal 8**: For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, support one of the following alternatives:* Alt-1 with Option A-1a.
	+ Alt-1) The UTO-UCI includes a bit-map of Nx bits. Nx is ¨determined by configuration.
* Note: The size of bit-map is the same for different UTO-UCI indication.
* Alt-2 with Option A-2a.
	+ Alt-2) The UTO-UCI includes a bit-map of Nx bits. The maximum value of Nx is Nx\_max. Nx\_max is determined by configuration.
* Note: The size of bit-map may vary for different UTO-UCI indication.
* Note: Option A-1a and Option A-2a corresponding to the agreement in RAN1#113.
 |
| OPPO | **Proposal 4**: Support Option A-2a for UTO-UCI indication:* UTO periodicity equals to the CG periodicity;
* The values of UTO\_offset can be 1~4 in unit of TO;
* The payload size of UTO-UCI transmitted in a CG PUSCH equals to the number of CG PUSCH TOs within the UTO period and after UTO\_offset from the end of the CG PUSCH.
 |
| Sony | **Observation 1**: The non-integer and jitter characteristics of XR traffic (also known as a quasi-periodic traffic) may require enhancements of the existing NR.**Observation 2**: CG-PUSCH transmission as in legacy NR requires enhancements to support XR traffic, particularly on supporting the payload of a quasi-traffic that may not be the same but varies within a range.**Observation 3**: There can be a large gap between the last TO of a CG period and the first TO of the subsequent CG period. Configuring a UE with UTO period across CG period can create an issue, as the UE may not be able to predict whether to use or not a TO of a subsequent CG period (i.e., too far to predict).**Proposal 1**: The bitmap indicated in UTO-UCI should represent the range in terms of the number of CG PUSCH Transmission Occasions (TOs).**Proposal 2**: Support Option A-1a for the determination of CG-PUSCH by a UTO-UCI indication (as agreed in RAN1#113).**Proposal 3**: Specify a timeline for a UE to indicate unused CG occasions in a period of a single CG configuration.**Proposal 4**: Support the UCI indication of the unused TO(s) to operate for multiple CG configurations**Proposal 5**: Support a UTO-UCI in one of the CG configurations could also indicate the unused CG transmission occasions belonging to other CG configurations. |
| Samsung | **Proposal 2**: For a CG configuration with "UTO-UCI" enabled, to determine the indicated CG PUSCH* Configure the RRC parameter Nu (Nu is the size of bit-map) with maximum value of 8
* A transmitted CG PUSCH carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting from the end of the transmitted CG PUSCH

**Observation 2**: There is no need or benefit to extend the indication by "UTO-UCI" into a next CG-PUSCH period. Bits of the bitmap that do not correspond to TOs in the current CG-PUSCH period are ignored (no specification impact). |
| IDC | **Proposal 4**: For the UTO-UCI indication, downselect either Option A-1a or Option B-a**Proposal 5**: The range for UTO period corresponds to one or multiple of CG periodicity given by integer values (Alt-2) |
| Google Inc. | **Proposal 1**: Adopt Option A-1a with a sliding indicator within a window and with a fixed bitmap size.**Proposal 3**: The time duration/range is:o One CG periodicity for the Rel-18 multi-PUSCHs CG configurationo One or multiple of CG periodicity given by integer value (n=1, 2, ..) for the legacy CG configuration (with single PUSCH per CG) |
| LG | **Proposal 3**: For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, adopt Option B-a.**Proposal 4**: Introduce the RRC parameter UTO\_offset to configure time gap between CG PUSCH carrying UTO-UCI and UTO period. |
| MTK | **Proposal 5**: The last PUSCH TO in a UTO-UCI indication period window does not carry UTO-UCI (if Option A-1a or Option A-2a is agreed for UTO-UCI indication).**Proposal 6**: Support Option A-1a.**Proposal 7**: The range of values for UTO-UCI indication period is configured by an integer value (n=1, 2, ..) as one or multiple of CG periodicity values (Alt-2). |
| Apple | **Proposal 2**: UTO-UCI signaling is supported for a single CG period.**Proposal 3**: Adopt Option A-1a for UTO-UCI signaling.**Proposal 3a**: UTO offset is zero for A-2a, B-a and B-b2 if any of them is adopted.**Proposal 4**: Discuss and decide whether there is any dependence between UTO-UCI signaling on them needs to be decided, and whether the UTO signaling for one CG configuration affects PUSCH generation on another CG configuration needs discussion. |
| Honor | **Observation 2**: The mechanism of Option A is sliding indicator within the window while Option B is Sliding window.**Observation 3**: Option B continuously reports indication of TOs because of sliding window.**Observation 4**: Except Option A-1a, the other three options do not waste reporting bits.**Observation 5**: The number of UTO-UCI bits reported by A-1a and B-b2 is basically fixed.**Proposal 4**: For UTO-UCI indication design, support either Option B-b2 or Option A-1a. |
| CAICT | **Proposal 2**: Option B-a is accepted. Configure RRC parameter UTO\_period and UTO\_offset. The UTO\_offset should at least cover the transmission time of the UTO-UCI, the transmission time of the rescheduling information, and the gNB processing intervals. |
| New H3C | **Proposal 1**: For a CG configuration with UTO-UCI indication enabled, the following option A-1a is used to determine the indicated CG PUSCH by a UTO-UCI indication as follow.* Option A-1a:
* Configure the RRC parameter UTO\_period.
* FFS range value of UTO\_period
* Alt-1: values in time unit (e.g., XR traffic periodicity)
* Alt-2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
* The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
* A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period.
 |
| Panasonic | **Proposal 2**: Option B-b2 should be selected for the UTO indication to map the UTO-UCI bits to the PUSCH occasions. A variable UTO offset should be defined to consider the gNB's processing time for rescheduling the unused PUSCH occasions. |
| NTT DOCOMO | **Proposal 2**: Support option B-b2 for UTO-UCI indication. |
| KT Corp. | **Proposal 4**: Support Option A-1a with Alt. 2 to determine the indicated CG PUSCH by a UTO-UCI indication.**Observation 5**-1: For the indication of 'unused' for the past occasions, if it exists, the UE expects:• Option 5-1-1: The BS ignores the indication for the past occasions.• Option 5-1-2: The BS discards or does not receive the TB transmitted at the occasion.• Option 5-1-3: The BS behavior is changed by the configuration.**Observation 5**-2: For the indication of 'unused' for the current occasion, if it exists, the UE expects:• Option 5-2-1: The BS ignores the indication for the current occasions.• Option 5-2-2: The BS discards or does not receive the TB transmitted at the occasion.• Option 5-2-3: The BS behavior is changed by the configuration.**Proposal 5**-3: Option 5-1-1 and Option 5-2-2 are adopted for the indication of 'unused' for the past and current occasions, i.e., the BS ignores the indication for the past occasions, and discards or does not receive the TB transmitted at the occasion for the indication of 'unused' for the current occasion. |
| NEC | **Proposal 1**: support option A-2a, and do not support UTO periodicity is larger than one CG periodicity, i.e., support Alt-1 with a value of time unit not larger than a CG periodicity. |

### 3.1.1 Initial Discussions

**Moderator’s suggestion for initial discussion:**

Based on the observations provided above, Moderator suggests the following:

* **Suggestion:**
* Decision on the design option has the highest priority at this meeting. It is crucial to converge to one option first. The decision on the detailed parameters of the design, depends on the preferred option.
* Moderator recommends companies carefully review and study the motivations and justifications elaborated by companies in contributions to assess the reasonable arguments to base the decision on.
* Please consider the reasonable arguments while being flexible for promoting an option for final decision that meets at least the following criteria:
	+ **Usefulness**
	+ **Feasibility**
	+ **Simplicity**

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding Moderator’s **suggestion** regarding the decision on the design option.
* **Q2:** Discuss any clarification/correction/comment/question on Moderator’s summary and suggestion or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Agree with the suggestion by the moderator. The proposals are clear and mature for discussion and a down-selection at this meeting. |
| InterDigital | Fine with FL’s suggestion |
| **ZTE, Sanechips** | We support Moderator’s suggestions.From the perspective of usefulness and feasibility, the methods in Option A is comparable with Option B, because in option B, the bits for transmission occasions crossing the CG period/XR traffic period are always padding bits(e.g., “0”), so in fact, the valid indication is similar with that in Option A. For simplicity aspect, it is clear that the implementation of Option A-1a is simplest no matter from UE perspective or from gNB perspective. |
| **Nokia, NSB** | Agree with the moderator’s suggestion. Based on the analysis of 4 options, we provide the following summary for usefulness, feasibility, simplicity. All options are feasible in our view. However, when we compare the options in terms of simplicity, **Option B-b2** requires less parameters to configure (in the basic design only N number of bits is configured which is equal to the number of valid occasions); although it is the only option that have fixed number of bits every UTO-UCI transmission. From gNB point view, this is the most simple solution, since the decoding of UTO-UCI will be much more simple.For other options, UTO-period provides additional complexity, since it will affect the number of bits every UTO-period. Although, the problem with UTO-UCI mismatch and actual traffic arrival may rise, which further complicates the configuration of this option. |
| Sharp | Support moderator’s suggestions.We prefer Option B variations with a sliding windows of further PUSCH TO indications. Option A methods do not provide benefits in the later part of the configured UTO duration.  |
| **DOCOMO** | Agreewith moderator’s recommendation. |
| **Xiaomi** | Fine with moderator’s suggestion.We prefer Option B. |
| **LG** | Fine with FL’s suggestion. We are fine with Option B-b2 as well.  |
| **Panasonic** | We are fine with the FL suggestion. |
| **Qualcomm** | Agree with Moderator’s suggestion. We support Option B. |
| NEC | Support moderator’s suggestion. We can be flexible to either option A-2a (1st choice) or option A-1a (2nd choice). |
| **Lenovo** | **Agree with the moderator** |
| Futurewei | Fine with FL suggestion |
| **Moderator** | **Discuss offline if time allows, otherwise defer to offline session for decision** |
| **TCL** | Fine with FL suggestion, we support Option B. |
| **Moderator** | Option B-b2 was agreed during online session.**Agreement:**For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication:* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurationsStrong concerns have been raised on the above proposal in terms of benefit and UE complexity by CATT, ZTE, Huawei, Apple, MTK, and Google.The remaining issue is regarding the FFS for UTO\_Offset and Nu. |

### 3.1.2 Intermediate Discussions

**Moderator’s suggestions:**

With respect to agreement below, address the remaining open issues highlighted below (UTO\_Offset, Nu).

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication:

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
	+ Nu Range value( X, …, Y)
		- Alt-1: (3, …, 8)
		- Alt-2: (3, …, 16)
		- Alt-3: (1, …, 8)
		- Alt-4: (1, …, 16)
		- Alt-5: (1,..4)
			* This one is applicable only if Offset is supported.
		- Note: For Alt-3, Alt-4 additional Proposal A for support of puncturing is needed to be supported.
* UTO\_offset is the offset value. , Alt-5
	+ Alt-1: UTO\_Offset is provided by configuration.
		- Range value of UTO\_offset 0 to 16 slots
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations

Proposal A:

When UCI is multiplexed in a CG PUSCH and the UCI includes UTO-UCI and the size of the UCI (with or without HARQ-ACK) is equal to or smaller than 2 bits:

* Follow the mechanism of 1 or 2 bits HARQ-ACK encoding and multiplexing in PUSCH.

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding open issues in agreement above (range values for Nu, and preferred Alt for UTO\_Offset) and indicate what the range value should be.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Xiaomi** | **Open issue 1:**We suggest that N ranges from 1 to 2. The maximum bitmap size should not be too large to prevent distortion of XR service prediction. In addition, a large bitmap size will also cause the UTO-UCI signaling overhead to be intolerable.**Open issue2:**Support Alt-1. UTO\_Offset can guarantee the flexibility of UE for unused TO indication, while avoiding large bitmap size. More importantly, it will take some processing time for the gNB to reuse resources corresponding to the unused TO, and UTO\_Offset is conducive to the gNB to make full use of the resources released by UE. |
| OPPO | Our preference for the value range of Nu is [3,X]. * The reason for Nu>2 comes from the following facts:
	+ For multiplexing of UCI to PUSCH leads to puncturing when UCI length is no more than 2 and to rate-matching when otherwise. But CG-UCI is not associated with puncturing operation.
	+ RAN1 #112 agreed that “The existing CG-UCI encoding and multiplexing procedures are reused for encoding the “UTO-UCI” in a configured grant PUSCH in absence or presence of other UCIs ...”
* For X, we prefer X should make the total size of UTO-UCI to be no larger than the maximum size of legacy CG-UCI, given it is desirable to use the legacy guard for coverage of PUSCH+CGUCI to ensure the coverage of PUSCH+UTOUCI. In case RAN1 cannot agree on a criteria in deciding X, it can be left to RAN2.

For UTO\_Offset, we prefer UTO\_Offset=0. Because UE has the freedom to indicate an actually-unused TO as “not unused”, and gNB also has the freedom to treat an indicatedly unused TO as “not unused”, we do not see a need for configurable UTO\_Offset.  |
| Apple | UTO\_Offset = 0 is enough. |

#### 3.1.2.1 Offline discussion

Based on the offline discussion, the remaining issues related to RRC parameters for UTO-UCI are addressed by proposal below:

**Proposal 2-1-1:**

For a CG configuration with UTO-UCI indication enabled:

* Select of the following parameters for the range value for the RRC parameter Nu (Nu is the size of bit-map):
	+ - Alt-1: (3, …, 8)
		- Alt-2: (3, …, 16)
		- Alt-3: (1, …, 8)
		- Alt-4: (1, …, 16)
		- Alt-5: (1,..4)
			* This one is applicable only if Offset is supported.
		- Note: For Alt-3, Alt-4, Alt-5 additional Proposal 2-1-2 should also be supported.
* Select of one the following for the RRC parameter UTO\_offset:
	+ Option 1: UTO\_Offset is provided by configuration.
		- Range value of UTO\_offset 0 to 16 slots
	+ Option 2: The RRC parameter UTO\_offset is not needed. Assume UTO\_Offset = 0 in the previous agreement.

**Proposal 2-1-2 (Note: This proposal is only needed if any of Alt-3, Alt-4, Alt-5 is Proposal 2-1-1 is adopted):**

When UCI is multiplexed in a CG PUSCH and the UCI includes UTO-UCI and the size of the UCI (with or without HARQ-ACK) is equal to or smaller than 2 bits:

* Follow the mechanism of 1 or 2 bits HARQ-ACK encoding and multiplexing in PUSCH.

**Moderator’s recommendation:**

* For Nu: Endorse Alt-1 or Alt-2.
* For UTO\_Offset: Endorse Option 1.

**Question:** Please share your view in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
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|  |  |
|  |  |
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|  |  |

## 3.2 Encoding and multiplexing

**Moderator’s summary:**

In previous meeting, the following agreements were made:

**Agreement**

The existing CG-UCI encoding and multiplexing procedures are reused for encoding the “UTO-UCI” in a configured grant PUSCH in absence or presence of other UCIs being multiplexed in the PUSCH, by applying the following adjustments:

* The “UTO-UCI” is used instead of CG-UCI in the corresponding procedures for encoding of CG-UCI and/or HARQ-ACK, whichever is present.
* For determining the beta-offset,
	+ Beta offset is configured for the “UTO-UCI”
		- If UTO-UCI and HARQ-ACK is not jointly encoded, the beta offset for the “UTO-UCI” is used in the procedures instead of CG-UCI beta offset
		- If UTO-UCI and HARQ-ACK is jointly encoded, HARQ-ACK beta offset is used in the procedures instead of CG-UCI beta offset
* FFS on sequence generation order between UTO-UCI and HARQ-ACK
* FFS on dropping rule between UTO-UCI and HARQ-ACK when joint encoding is not configured
* Note: The term “UTO-UCI” refers to the “UCI that provides information about unused CG PUSCH transmission occasions” for convenience.

**Companies’ view:**

**Issue 1) Sequence order btw UTO-UCI and HARQ-ACK when both are multiplexed in a CG-PUSCH**

**Option 1) First UTO-UCI, then HARQ-ACK** Additional spec impact (different from previous agreements) is not needed by reusing CG-UCI framework.

* Ericsson, QC, Nokia/NSB, vivo, CMCC, ZTE/Sanechips, Samsung, sharp, Google, Honor, CAICT, DCM, KT. Corp

**Option 2) First HARQ-ACK, then UTO-UCI.** Additional spec impact (different from previous agreements) is needed.

* TCL, HW/HiSi

**Issue 2) Enabling/disabling UTO-UCI and HARQ-ACK joint coding**

**Option 1)** Need to enable with an RRC parameter (similar to cg-UCI-Multiplexing) to enable/disable joint encoding of UTO-UCI and HARQ-ACK mux when HARQ-ACK would be multiplexed in a CG PUSCH

* **Nokia/NSB, vivo, CMCC, QC, LG, Honor, DCM, KT. Corp, CAICT**
* **When joint encoding by RRC is disabled,**
	+ The UE drops UTO-UCI transmission on the CG PUSCH occasion and multiplexes HARQ-ACK in the CG PUSCH if same priority. Otherwise, drop the one with smaller priority.
		- Nokia/NSB
		- No mention of different priority: QC, CMCC, LG, Honor, DCM, KT. Corp
	+ The UE does not transmit the CG PUSCH including the UTO-UCI and transmits the HARQ-ACK in a PUCCH transmission
		- Vivo
	+ At least if the HARQ-ACK has the same or a higher priority than the CG PUSCH, the HARQ-ACK is multiplexed on the CG PUSCH, and the UTO-UCI is dropped.
		- if the HARQ-ACK has lower priority than the CG PUSCH, select one from
			* The LP HARQ-ACK is dropped, UTO-UCI is multiplexed on CG PUSCH.
			* The LP HARQ-ACK is multiplexed on CG PUSCH, UTO-UCI is dropped.
		- Sharp

**Option 2)** No Need to enable with an RRC (similar/same as cg-UCI-Multiplexing) joint encoding of UTO-UCI and HARQ-ACK mux when HARQ-ACK would be multiplexed in a CG PUSCH

* **Ericsson, vivo**

**Issue 3) UTO-UCI handling in case of CG PUSCH collision with channels of different priority**

* Reuse legacy procedures as for CG PUSCH with CG-UCI and collision with channels of different priority
	+ Ericsson, Lenovo, ZTE/SaneChips, Samsung, OPPO
* Multiplexing UTO-UCI on high priority channel (dropping due to collision with higher priority channel)
	+ Nokia/NSB
* Enabling gNB to explicitly request for example one-shot UTO-UCI report with DCI ((dropping due to collision with higher priority channel)
	+ Nokia/NSB

**Moderator’s observations and recommendations:**

**Regarding issue 1:**

* **Observation 1:** Based on the views expressed, it seems reasonable to adopt Option 1. In that sense, the already existing procedures for CG-UCI can be reused which simplifies specifications as well as implementation.
* **Recommendation 1:** Regarding issue 1, Moderator recommends considering Option 1. The proposal in next section is based on this recommendation.

**Regarding issue 2 & 3:**

* **Observation 2:** After reviewing the inputs and existing specifications, Moderator would like to share the following comments and thoughts:
	+ **Comment A:** In Rel-16, CG-UCI was introduced. As part of the work, cg-UCI-Multiplexing was introduced to enabling multiplexing HARQ-ACK on CG PUSCH or dropping CG PUSCH instead when PUCCH with HARQ-ACK and CG PUSCH collide. Note that such mechanism does not exist when PUCCH with HARQ-ACK and CG PUSCH collide in licensed band.
		- Ericsson questions whether it is necessary to introduce this mechanism for licensed band without any precedence since Rel-15 when CG is enabled with UTO-UCI. Most of companies assumes it should be introduced.
	+ **Comment B:** In Rel-17, when UCI multiplexing between different priorities was introduced under eURLLC WI, simultaneously operation on unlicensed channel was enhanced under the same WI. It was discussed how to handle cases for unlicensed operation regarding UCI multiplexing between different priorities. As the outcome of that discussion, the following agreement under unlicensed operation was made where clearly tries not to affect any UCI multiplexing rules with different priorities. Such approach has extremely simplified the integrations of different features and specifications.

|  |
| --- |
| **Agreement (RAN1#106bis-e)*** When performing Intra-UE multiplexing procedure, if a PUCCH withHARQ-ACK overlaps with a CG-PUSCH and the cg-RetransmissionTimer is configured:
	+ If the HARQ-ACK and the CG-PUSCH have the same priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- * If cg-UCI-Multiplexing is enabled for that CG-PUSCH, HARQ-ACK would be multiplexed in CG-PUSCH.
			* Otherwise, CG-PUSCH would be dropped.
	+ If the HARQ-ACK and the CG-PUSCH have different priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is not indicated,
			* The LP channel between PUCCH or CG-PUSCH would be dropped as in Rel-16.
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is indicated,
			* + If cg-UCI-Multiplexing is enabled for that CG-PUSCH, HARQ-ACK would be multiplexed in CG-PUSCH.
				+ Otherwise, the LP channel would be dropped.
 |

* + **Comment C:** Considering the current specifications and the descriptions in clause 9 of 38.213, one can clearly see that when collision between PUSCH and PUCCH is handled, **PUSCH is considered as one entity** regardless of if it carries CG-UCI or not.
		- Note that CG-UCI may include Channel access occupancy information that is useful for other transmissions (DL or UL). In other words, the information in CG-UCI can be of use for other transmission (similarly to UTO-UCI).

In other words, the procedures regarding UCI with different or same priority are about HARQ-ACK, SR and CSI, all originally carried by a PUCCH channel. Whether PUSCH includes CG-UCI or A-CSI, does not affect the collision resolution procedures.

* The outcomes of procedures in 38.213 determines whether a UCI (HARQ-ACK or CSI) should be multiplexed on a CG PUSCH or not.
* In case of multiplexing, if the CG PUSCH includes CG-UCI, the procedures in 38.212 determines how to perform encoding and multiplexing. Note that the priority of CG PUSCH (and hence CG-UCI) can be different from the priority of HARQ-ACK.

Therefore, proposals to treat the UTO-UCI differently and not as part of one PUSCH entity when it comes to UCI multiplexing, complicates the specifications considerably. Please review clause 9 of 38.213 and all the changes that are needed to be implemented based on this approach.

* **Recommendation 2:** Based on the comments above, Moderator recommends adopting similar approach as the Agreement made in RAN1#106bis-e for CG-UCI and aim to reuse the existing procedures as much as possible. It is also recommended to reflect whether the unlicensed feature (cg-UCI-Multiplexing) should be introduced for operation in licensed band. The proposals in next section are based on this recommendation.

Table 5: Summary of Contributions inputs for Section 3.2

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Observation 9** There is no strong motivation for additional rules in design to ensure transmission of UTO-UCI in case its transmission may be dropped.**Proposal 9** For sequence generation order between UTO-UCI and HARQ-ACK to form a UCI to multiplex in the corresponding CG PUSCH, additional specification impact is not needed. Reusing CG-UCI framework based on previous agreements implies that the UCI is ordered by first UTO-UCI, and then HARQ-ACK.**Proposal 10** No Need to enable with an RRC (similar/same as cg-UCI-Multiplexing) for joint encoding of UTO-UCI and HARQ-ACK multiplexing.**Proposal 11** When a CG PUSCH is cancelled/dropped due to e.g. collision with higher priority transmission, the corresponding UTO-UCI, if present, is dropped with the CG PUSCH.**Proposal 12** Support puncturing based UCI multiplexing for a UCI including UTO-UCI when the size of UCI is equal to or smaller than 2 bits.\* Note that the 1-2 bits UCI includes UTO-UCI, but may or may not include HARQ-ACK. |
| Qualcomm | **Observation 8**: Based on existing agreements on UTO-UCI encoding and multiplexing, at least in licenced spectrum, the UTO-UCI will follow the same encoding and multiplexing procedure as that for the NR-U CG-UCI.- New RRC parameter corresponding to cg-UCI-Multiplexing will be defined for UTO-UCI multiplexing with HARQ-ACK.**Proposal 5** Sequence generation order between UTO-UCI and HARQ-ACK follows the sequence generation order between CG-UCI and HARQ-ACK.**Proposal 6**: If multiplexing between UTO-UCI and HARQ-ACK on same PUSCH is not configured, when a HARQ-ACK collides with a UTO-UCI on a CG PUSCH occasion, the UE skips UTO-UCI transmission on the CG PUSCH occasion and follows existing HARQ-ACK multiplexing in CG PUSCH behaviour.**Proposal 7**: Support puncturing based UTO-UCI multiplexing into CG PUSCH when the UTO-UCI has a size equal to or smaller than 2. |
| Nokia/NSB | **Observation 5**: UTO-UCI and HARQ-ACK are always separately coded if they are with different PHY priorities.**Proposal 6**: RAN1 to specify the way of handling the cancelled/dropped UTO-UCI transmission in a similar way as HARQ-ACK when the CG PUSCH (supposed to carry UTO-UCI) overlapping with other high priority UL channel(s). Different options can be considered, e.g.,:• Option 1: multiplexing UTO-UCI on high priority channel;• Option 2: enabling gNB to explicitly request for example one-shot UTO-UCI report with DCI.**Proposal 7**: Mapping UTO-UCI bits to the UCI sequence before mapping HARQ-ACK bits when UTO-UCI and HARQ-ACK are jointly encoded.**Proposal 8**: Dropping the one with smaller priority index if UTO-UCI and HARQ-ACK are with different PHY priorities.**Proposal 9**: Introduce additional parameter UTO-UCI-Multiplexing to enable joint encoding of UTO-UCI and HARQ-ACK and multiplexing on CG-PUSCH similar to cg-UCI-Multiplexing parameter.**Proposal 10**: When joint encoding is not configured, always dropping UTO-UCI if UTO-UCI and HARQ-ACK are with the same PHY priority and one of them has to be dropped. |
| Vivo | **Proposal 7**: When UTO-UCI and HARQ-ACK are jointly encoded, HARQ-ACK bit sequence is concatenated after UTO-UCI bit sequence, by reusing the same mechanism adopted for CG-UCI.**Proposal 8**: For joint encoding of UTO-UCI and HARQ-ACK, the following two options can be considered for further down-selection:\* Option 1: When joint encoding of UTO-UCI and HARQ-ACK is not configured, the UE does not transmit the CG PUSCH including the UTO-UCI and multiplexes the HARQ-ACK in a PUCCH transmission or in another PUSCH transmission.\* Option 2: Joint encoding of UTO-UCI and HARQ-ACK is always assumed, i.e. no RRC parameter is needed to configure if joint encoding of UTO-UCI and HARQ-ACK is enabled or not, or, the UE expects that joint encoding of UTO-UCI and HARQ-ACK is always configured. |
| TCL | **Proposal 4**: UCI bits sequence generate can be HARQ-ACK first, then UTO-UCI. |
| Lenovo | **Proposal 6**: Discuss invalid UTO-UCI indications.**Proposal 7**: Handling of UTO-UCI and HARQ-ACK is similar to that of CG-UCI and HARQ-ACK.**Proposal 8**: If a CG-PUSCH occasion carrying a UTO-UCI is dropped due to collision with a higher priority channel, the UTO-UCI is NOT multiplexed in the higher priority channel |
| Sharp | **Proposal 4**: If a HARQ-ACK collides with a CG PUSCH with UTO-UCI, and cg-UCI-Multiplexing is provided, joint coding is performed with the sequence order of UTO-UCI before HARQ-ACK.**Proposal 5**: RAN1 to clarify that the beta offset for joint coding is determined by HARQ-ACK considering the priorities between the HARQ-ACK and the CG PUSCH, i.e.* Offsets ß\_offset^(HARQ-ACK) if the HARQ-ACK and UTO-UCI have same priority.
* Offsets ß\_offset^(HARQ-ACK,0) if HARQ-ACK with priority 0 and CG PUSCH with priority 1.
* Offsets ß\_offset^(HARQ-ACK,1) if HARQ-ACK with priority 1 and CG PUSCH with priority 0.

**Proposal 6**: If cg-UCI-Multiplexing is provided, and if the CG PUSCH overlaps with both HP HARQ-ACK and LP HARQ-ACK, only HP HARQ-ACK is jointly coded with UTO-UCI.If joint coding of UTO-UCI and HARQ-ACK on CG PUSCH is not supported,**Proposal 7**: If a PUCCH with a HARQ-ACK overlaps with a CG PUSCH with UTO-UCI and cg-UCI-Multiplexing is not provided, one UCI from UTO-UCI and HARQ-ACK is selected and multiplexed on the CG PUSCH considering the UCI priorities.* At least if the HARQ-ACK has the same or a higher priority than the CG PUSCH, the HARQ-ACK is multiplexed on the CG PUSCH, and the UTO-UCI is dropped.
* if the HARQ-ACK has lower priority than the CG PUSCH, select one from
* Option 1: the LP HARQ-ACK is dropped, UTO-UCI is multiplexed on CG PUSCH.
* Option 2: the LP HARQ-ACK is multiplexed on CG PUSCH, UTO-UCI is dropped.

**Proposal 8**: If a PUCCH with a HARQ-ACK overlaps with a CG PUSCH with UTO-UCI, and cg-UCI-Multiplexing is not provided, RAN1 should further study* The UCI dropping rules if both HP HARQ-ACK and LP HARQ-ACK are present.
* Whether and how to apply separate coding chains for multiplexing HARQ-ACK(s) and UTO-UCI on CG PUSCH.
 |
| Huawei/HiSilicon | **Proposal 3**: Regarding sequence generation order between UTO-UCI and HARQ-ACK, HARQ-ACK is prior to UTO-UCI. |
| CMCC | **Proposal 7**. With respect to the sequence generation order between UTO-UCI and HARQ-ACK, support reusing the CG-UCI framework, i.e., first UTO-UCI, then HARQ-ACK.**Proposal 8**. With respect to the dropping rule between UTO-UCI and HARQ-ACK when joint encoding is not configured, support temporarily disabling UTO-UCI transmission on the CG PUSCH occasion and falling back to the existing behavior of HARQ-ACK multiplexing in CG PUSCH. |
| ZTE/Sanechips | **Proposal 6**: Reuse the sequence generation order between CG-UCI and HARQ-ACK when considering the sequence generation order between UTO-UCI and HARQ-ACK.**Proposal 7**: Support to reuse legacy dropping rule that dropping the information with low priority when joint encoding of UTO-UCI and HARQ-ACK is not configured.**Proposal 8**: Reuse the multiplexing rule of CG-UCI for the multiplexing rule of UTO-UCI when UCI-MuxWithDifferentPriority is configured. |
| OPPO | **Proposal 5**: If both UTO-UCI and uplink skipping are enabled and no data is available for a CG PUSCH, the MAC is not expected to generate a MAC PDU if there is no HARQ-ACK/CSI to be multiplexed in the CG PUSCH.**Proposal 6**: If UTO-UCI is enabled and a DG PUSCH overrides a CG PUSCH in the PUSCH TO as allowed in R17, the UTO-UCI should be multiplexed in the DG PUSCH.**Proposal 7**: When HARQ-ACK is multiplexed into a PUSCH with UTO-UCI of the same priority, the multiplexing treats UTO-UCI as CG-UCI and reuses the legacy mechanisms.* Additional dropping of UTO-UCI is not supported.

**Proposal 8**: If a UE is provided uci-MuxWithDiffPrio and HARQ-ACK of priority X is multiplexed into a PUSCH with UTO-UCI of priority *Y (≠X),** First step: append HARQ-ACK of priority Y, if any, to the UTO-UCI.
* Second step: reuse R17 intra-UE multiplexing procedure by treating the output of the first step as R17 HARQ-ACK of priority Y.
 |
| Samsung | **Observation 3**: The baseline agreement from RAN1#112 that "encoding and multiplexing for UTO-UCI in a CG-PUSCH applies encoding and multiplexing procedures for CG-UCI" is sufficient. |
| Google | **Proposal 4**: When joint encoding between UTO-UCI and HARQ-ACK is not configured:\* UTO-UCI is transmitted and the eMBB HARQ-ACK is deprioritized and retransmitted by the UE on demand from the gNB.\* UTO-UCI is dropped and HARQ-ACK associated with the XR or URLLC traffic is prioritized.**Proposal 5**: Support differentiated treatement of HARQ-ACK associated to the XR or URLLC traffic and the HARQ-ACK associated to the eMBB traffic.o FFS: dynamic signalling of the joint-encoding indication**Proposal 6**: Support re-using the NR-U CG-UCI encoding and multiplexing procedure for the Sequence generation order btw UTO-UCI and HARQ-ACK. |
| LG | **Proposal 5**: If cg-UCI-Multiplexing is not configured, UTO-UCI is dropped and HARQ-ACK is multiplexed into CG PUSCH when the HARQ-ACK PUCCH and the CG PUSCH with UTO-UCI are overlapped in time.**Proposal 6**: It is necessary to discuss how to handle the case of less than or equal to 2 bits UTO-UCI and/or 2 bits jointly coded UTO-UCI and HARQ-ACK bits. |
| Honor | **Proposal 7**: Support to reuse the same generation order between CG-UCI and HARQ-ACK for multiplexing of UTO-UCI and HARQ-ACK.**Proposal 8**: Support the UTO-UCI have lower priority than HARQ-ACK. When the collision occurs between HARQ-ACK and UTO-UCI when multiplexing is not configured, the UE temporarily disables UTO-UCI transmission on the CG PUSCH occasion and falls back to existing HARQ-ACK multiplexing in CG PUSCH behavior. |
| CAICT | **Proposal 3**: Sequence generation of UTO-UCI and HARQ-ACK can reuse that of CG-UCI and HARQ-ACK. The dropping rule between UTO-UCI and HARQ-ACK is based on UE-specific configuration when jointly encoded. |
| NTT DOCOMO | **Proposal 3**: For encoding/multiplexing of UTO-UCI,- If joint encoding of HARQ-ACK and UTO-UCI is configured, the HARQ-ACK bits are after UTO-UCI bits.- If joint encoding of HARQ-ACK and UTO-UCI is configured, UE will drop the UTO-UCI and multiplex the HARQ-ACK in the CG PUSCH. |
| KT Corp. | **Proposal 2**: The sequence generation order between UTO-UCI and HARQ-ACK and the dropping rule between UTO-UCI and HARQ-ACK follows procedure with CG-UCI. (Issue 1 - Option 2)**Proposal 3**: UTO-UCI is not transmitted when any other UCIs are to be transmitted at CG PUSCHs, except for the configuration of joint encoding. That is, UTO-UCI is always dropped first. (Issue 2 - Option 1-2) |

### 3.2.1 Initial Discussions

**Moderator’s suggestions for initial discussion:**

Please review the Moderator’s observations and recommendations provided above that are motivations for the suggestions and proposals.

* **Suggestion 1)** Regarding the order of UTO-UCI and HARQ-ACK when jointly encoded, Moderator suggests Proposal 2-2-1 based on Recommendation 1.
* **Suggestion 2)** Regarding collision resolution between PUCCH/CG PUSCH with same or different priority Moderator suggests Proposal 2-2-2 based on Recommendation 2 which also includes two alternatives to select from to address possibility to disable the joint coding:
	+ **Alt-1:** Disabling joint coding of UTO-UCI and HARQ-ACK by RRC is introduced for CG PUSCH with UTO-UCI similarly to NR-U CG for unlicensed (cg-UCI-Multiplexing).
	+ **Alt-2:** Joint coding of UTO-UCI and HARQ-ACK is assumed enabled similarly to licensed CG.
	+ **Note:** Alt-1 and Alt-2 descriptions differ only by blue texts.

**Proposal 2-2-1:**

* When UTO-UCI and HARQ-ACK are jointly encoded, HARQ-ACK bit sequence is concatenated after UTO-UCI bit sequence, by reusing the same mechanism adopted for joint encoding of CG-UCI and HARQ-ACK.

**Proposal 2-2-2:**

If present, this field indicates that in the case of PUCCH overlapping with CG-PUSCH(s) within a PUCCH group, the CG-UCI and HARQ-ACK are jointly encoded (see TS 38.213 [13], clause 9).

**Select Alt-1 or Alt-2:**

**Alt-1:**

* Introduce a new RRC parameter UTO-UCI-Multiplexing to enable/disable multiplexing of HARQ-ACK in a CG PUSCH with UTO-UCI.
* When performing Intra-UE multiplexing procedure, if a PUCCH withHARQ-ACK overlaps with a CG-PUSCH with UTO-UCI:
	+ If the HARQ-ACK and the CG-PUSCH have the same priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- If UTO-UCI-Multiplexing is enabled for that CG-PUSCH, HARQ-ACK would be multiplexed in CG-PUSCH.
		- Otherwise, CG-PUSCH would be dropped.
	+ If the HARQ-ACK and the CG-PUSCH have different priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is not indicated,
			* The LP channel between PUCCH or CG-PUSCH would be dropped as in Rel-16.
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is indicated,
			* + If UTO-UCI-Multiplexing is enabled for that CG-PUSCH, HARQ-ACK would be multiplexed in CG-PUSCH.
				+ Otherwise, the LP channel would be dropped.
* [Note that encoding/multiplexing of UTO-UCI and HARQ \_ACK (when reusing CG-UCI procedures as agreed) are different.]

**Alt-2:**

* When performing Intra-UE multiplexing procedure, if a PUCCH withHARQ-ACK overlaps with a CG-PUSCH with UTO-UCI:
	+ If the HARQ-ACK and the CG-PUSCH have the same priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- HARQ-ACK would be multiplexed in CG-PUSCH.
	+ If the HARQ-ACK and the CG-PUSCH have different priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is not indicated,
			* The LP channel between PUCCH or CG-PUSCH would be dropped as in Rel-16.
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is indicated,
			* HARQ-ACK would be multiplexed in CG-PUSCH.
* [Note that encoding/multiplexing of UTO-UCI and HARQ \_ACK (when reusing CG-UCI procedures as agreed) are different.]

**Question:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please provide your view regarding the Moderator’s summary. **Particularly,** what is your view regarding Moderator’s **observations, recommendations,** and **suggestions**? Please share your view and alternative suggestions if you find the moderator’s recommendations and suggestions unreasonable.
* **Q2:** What is your view regarding **Proposal 2-2-1?**
	+ Assuming there is no strong objective towards moderator’s recommendations.
* **Q3:** What is your view regarding **Proposal 2-2-2**? Do you prefer **Alt-1 or Alt-2**?
* **Q4:** Discuss any clarification/correction/comment/question on Moderator’s summary and suggestions or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Support proposal 2-2-1. We do not identify any reason to do otherwise but can discuss if any company thinks there is such reason.Support Alt-2 for proposal 2-2-2. For coding/multiplexing purposes, HARQ-ACK and UTO-UCI are effectively a same type of UCI – that UCI either has payload A (e.g. HARQ-ACK only) or payload B (e.g. HARQ-ACK + UTO-UCI). There is no need to introduce an RRC parameter to enable/disable such joint coding/multiplexing as there is no UE procedure affected.  |
| InterDigital | Proposal 2-2-1: SupportProposal 2-2-2: Support Alt-2 |
| ZTE, Sanechips | We support Proposal 2-2-1. |
| **Nokia, NSB** | **Proposal 2-2-1:** Support the proposal. The scenario when not enough resources for to carry both UTO-UCI and HARQ-ACK is considered as corner case in our view. UTO-UCI size is envisioned relatedly small, e.g., up to 10 bit, so it is unlikely that there are not enough resources for both UTO-UCI and HARQ-ACK.**Proposal 2-2-2**: We support Alt-1 that is the current procedure for the CG-UCI and HARQ-ACK and we already agreed to follow the same rules for multiplexing and dropping as for CG-UCI. Otherwise, the multiplexing and dropping rules will be different for UTO-UCI and CG-UCI. Please, find the TS 38213 extract:“TS 38213: When a UE would multiplex HARQ-ACK information in a PUSCH transmission that is configured by a *ConfiguredGrantConfig*, and includes CG-UCI [5, TS 38.212], the UE multiplexes the HARQ-ACK information in the PUSCH transmission if the UE is provided *cg-UCI-Multiplexing*; otherwise, if the HARQ-ACK information and the PUSCH have same priority index, the UE does not transmit the PUSCH and multiplexes the HARQ-ACK information in a PUCCH transmission or in another PUSCH transmission; if the HARQ-ACK information and the PUSCH have different priority indexes, the UE does not transmit the channel with the smaller priority index.” |
| Sharp | Proposal 2-2-1: SupportProposal 2-2-2: Support Alt-2 |
| **vivo** | **Proposal 2-2-1:**Support**Proposal 2-2-2:**We are fine with either alt 1 or alt 2. Although we think it may be unnecessary to introduce a parameter like cg-UCI-Multiplexing for UTO-UCI, we can accept alt 1 which follows the same way as CG-UCI. |
| **DOCOMO** | Proposal 2-2-1: SupportProposal 2-2-2: Prefer Alt 1 which is the CG-UCI procedure. Also fine with Alt 2 if majority companies like Alt 2. |
| **Xiaomi** | proposal 2-2-1: Fineproposal 2-2-2: Alt-1 |
| **Panasonic** | Proposal 2-2-1: We support the proposal.Proposal 2-2-2: We prefer Alt-2. |
| **Qualcomm** | Proposal 2-2-1: SupportProposal 2-2-2: Support Alt-1 |
| **Lenovo** | **Agree with the moderator in general****2-2-1: ok****2-2-2: fine with both, slight preference on Alt-2** |
| **LG** | Proposal 2-2-1:Support the proposalProposal 2-2-2:First of all, the *cg-UCI-Multiplexing* is introduced basically due to UE limitation. It is not reasonable to assume that UE can always support. Thus, we cannot support Alt. 2. At least, we should specify how HARQ-ACK is multiplexed into CG PUSCH, jointly encoded with UTO-UCI or separately encoded from UTO-UCI For Alt. 2. It also makes differences between the case of same priority and case of the different priorities. In the case of the same priority, UTO-UCI and HARQ-ACK are assumed to be jointly encoded. In the case of the different priorities, once {LP UTO-UCI and/or LP HARQ-ACK} or {HP UTO-UCI and/or HP HARQ-ACK} is jointly encoded, UE would multiplex LP HARQ-ACK and HP UTO-UCI+HARQ-ACK or HP HARQ-ACK and LP UTO-UCI+HARQ-ACK in separate encoding. These differences should be specified in the proposal. Regarding FL’s observation2, below in comment C seems not aligned with our understanding.“Whether PUSCH includes CG-UCI or A-CSI, does not affect the collision resolution procedures.”As Nokia mentioned, the spec clearly says that UE need to drop PUSCH and transmit PUCCH unlike the case of the PUSCH not including CG-UCI. This procedure is not only CG-UCI specific, but also NR-U specific. Due to uniqueness of CG-UCI in NR-U, UE need to drop CG PUSCH only if CG UCI cannot be transmitted. On the other hand, if we bring this UE behavior onto licensed band, gNB need to consider CG PUSCH for scheduling HARQ-ACK PUCCH meaninglessly and UE may need to drop CG PUSCH without any benefit, even with impact on PUSCH prioritization in MAC layer. Thus, we would like to propose to modify Alt. 1 as following.**Alt-1:*** Introduce a new RRC parameter UTO-UCI-Multiplexing to enable/disable multiplexing of HARQ-ACK in a CG PUSCH with UTO-UCI.
* When performing Intra-UE multiplexing procedure, if a PUCCH withHARQ-ACK overlaps with a CG-PUSCH with UTO-UCI:
	+ If the HARQ-ACK and the CG-PUSCH have the same priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- If UTO-UCI-Multiplexing is enabled for that CG-PUSCH, HARQ-ACK would be multiplexed in CG-PUSCH by joint encoding with UTO-UCI.
		- Otherwise, ~~CG-PUSCH would be dropped.~~ UTO-UCI would be dropped and HARQ-ACK would be multiplexed in CG-PUSCH.
	+ If the HARQ-ACK and the CG-PUSCH have different priority and the CG-PUSCH is selected for HARQ-ACK multiplexing:
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is not indicated,
			* The LP channel between PUCCH or CG-PUSCH would be dropped as in Rel-16.
		- If multiplexing HARQ-ACK on the CG-PUSCH with different priority is indicated,
			* + If UTO-UCI-Multiplexing is enabled for that CG-PUSCH, HARQ-ACK would be multiplexed with separated encoding from LP UTO-UCI in CG-PUSCH.
				+ Otherwise, the LP channel would be dropped.
 |
| Futurewei | Proposal 2-2-1: FineProposal 2-2-2: Fine with Alt-2, and it is not necessary to introduce a new RRC parameter UTO-UCI-Multiplexing to enable/disable multiplexing of HARQ-ACK in a CG PUSCH with UTO-UCI. |
| OPPO (copied form FLS v003) | Proposal 2-2-1: OK.Proposal 2-2-2: Support Alt-2. |
| Moderator | **Summary of views:****Proposal 2-2-1:*** Samsung, IDC, ZTE, Nokia/NSB, Sharp, vivo, DCM, xiaomi, Panasonic, QC, Lenovo, FW, OPPO

**Proposal 2-2-2:*** Alt-1: Nokia/NSB, vivo(2nd?), DCM, xiaomi, QC, LG (modified)
* Alt-2: Samsung, IDC, Sharp, vivo(1st?), Panasonic, Lenovo, FW, OPPO
 |
| TCL | Although we prefer UTO-UCI bit sequence is concatenated after HARQ-ACK bit sequence when UTO-UCI and HARQ-ACK are jointly encoded, for the sake of discussing process, we also can accept **Proposal 2-2-1**Proposal 2-2-2: Fine with Alt-2. |
| **Moderator** | **Moderator suggestion after offline session:*** Proposal 2-2-1 is stable.
* Proposal 2-2-2:
	+ No need for an agreement if Alt-2 is adopted. Hence, proposal is modified as the following to reflect Alt-1 to introduce new RRC parameter.

**Proposal 2-2-2:*** + Introduce a new RRC parameter UTO-UCI-Multiplexing (similar to cg-UCI-Multiplexing) to enable/disable joint coding of HARQ-ACK and UTO-UCI in a CG PUSCH with the UTO-UCI.
 |
| **Moderator** | **Outcome of online session:**AgreementWhen UTO-UCI and HARQ-ACK are jointly encoded, HARQ-ACK bit sequence is concatenated after UTO-UCI bit sequence, by reusing the same mechanism adopted for joint encoding of CG-UCI and HARQ-ACK.**Conclusion**There is no consensus on the following proposal:Introduce a new RRC parameter UTO-UCI-Multiplexing (similar to cg-UCI-Multiplexing) to enable/disable joint coding of HARQ-ACK and UTO-UCI in a CG PUSCH with the UTO-UCI.**This discussion is concluded.** |

## 3.3 Extension to multiple CG configuration

**Moderator’s summary:**

In previous meeting, the following agreement was made. There is an open issue whether/how the UTO-UCI indication can be extended to more than one CG configuration.

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, consider the following options for further down-selection:

**Option A-1a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt-2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
	+ The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
	+ A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period.

**Option A-2a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt -2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
* Configure the RRC parameter UTO\_offset.
	+ FFS range value of UTO\_offset
* The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
* A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period and after UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-a:**

* Configure the RRC parameter UTO\_period.
	+ FFS range value of UTO\_period
		- Alt-1: values in time unit (e.g., XR traffic periodicity)
		- Alt -2: one or multiple of CG periodicity given by integer value (n=1, 2, ..)
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH carries UTO-UCI that is applicable to the valid CG PUSCH TOs that are confined within UTO\_period starting with UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-b2:**

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations

**Companies’ view:**

**Whether to support UTO-UCI extension to multiple CG configurations:**

* **Yes (10):** QC, vivo, TCL, Lenovo, xiaomi, Google, Apple, Honor, New H3C, Panasonic
* **No (9+1):** [Ericsson], FW. Nokia/NSB, Sharp, HW/HiSi, CMCC, Samsung, IDC, MTK, DCM

**Moderator’s observation:**

**Observation 1:** Motivation NOT to extend to multiple CG configurations:

* Not critical, unnecessary complexity
* Risk completion of the work on time
* Traffic associated to different CG with different properties.
* Enabling UTO-UCI for CG associated to pose/control traffic not reasonable.
* Per CG UTO-UCI, workable in case of multiple CG
* unclear how a UE can know at the time of a CG-PUSCH preparation for a first CG configuration with pose/control information whether a video stream will not have arrived at a later TO of a second CG configuration with video data
* ….

**Observation 2:** Motivation to extend to multiple CG configurations:

* XR traffic map to Multiple CG configurations (e.g. pose/control or video/steam. UTO-UCI on different CGs)
* Multiple CG configurations may have overlapping resources or less or more frequent TOs
* Possibility for earlier indication of the unused TOs
* Possibility to indicate unused TO for the first TO of a CG configuration.
* Possibility to indicate multiple unused CG PUSCH occasions for legacy single-PUSCH CG periods
* Reliable UTO-UCI transmission in FR1 carrier indicating CG PUSCH occasions in FR2 carrier
* …

**Observation 3:** Proposed solution to enable extensions.

* Few companies (e.g., QC, vivo, xiaomi, Lenovo, Honor) describes solutions to realize the extensions.
* The solutions include RRC configuration and ordering procedures to determine the correspondence between the bits in UTO-UCI and corresponding CG configuration.

 Table : Summary of Contributions inputs for Section 3.3

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Proposal 14** Whether to support capability of indication of unused CG PUSCH TOs for multiple CG configurations, study at least the following:\* whether multiple CG configuration belong the same or different cells\* whether the key design choices regarding e.g., content and timing of UCI, complicates support of multiple CG configurations.\* Whether the UCI is carried by all CG PUSCHs associated to all the CG configurations or a sub-set of them.\* FFS on other conditions. |
| Futurewei | **Proposal 11**: Multiple CG configurations should be deprioritized before all the critical issues of single CG configuration are settled. |
| Qualcomm | **Observation 3**: Use cases for the UTO-UCI indicating CG PUSCH occasions of multiple active CG configurations at least include:\* Indication of multiple unused CG PUSCH occasions for legacy single-PUSCH CG periods.\* Indication of unused CG PUSCH occasions across multiple active CG configurations associated with different types of traffic.\* Reliable UTO-UCI transmission in FR1 carrier indicating CG PUSCH occasions in FR2 carrier.**Observation 4**: The UTO-UCI indicating PUSCH occasions of multiple active CG configurations allows the network to know unused CG PUSCH occasions earlier than the UTO-UCI that only indicates PUSCH occasions of the same CG configuration.**Observation 5**: UTO-UCI indicating unused CG PUSCH occasions for multiple CG configurations can be included at least in the CG PUSCH for XR UL video traffic and may not be included in the CG PUSCH for haptic data or UL pose information.**Observation 6**: It is possible to configure the UE with overlapping CG PUSCH occasions associated with the same CG configuration or different CG configurations in current specs but the gNB has to blind detect the PUSCH.**Observation 7**: For the dynamic indication of the unused CG PUSCH occasion(s) among a set of PUSCH occasions, the CG PUSCH occasions can be overlapping in time. The overlapping PUSCH occasions allow for higher resource efficiency. Indication of unused CG PUSCH occasion(s) of multiple overlapping PUSCH occasions is useful for UE power savings and for reducing blind decoding at gNB (network energy savings).**Proposal 2**: The UTO-UCI can indicate unused CG PUSCH occasions associated with multiple active CG configurations. The feature can be enabled by\* Configuration to indicate which CG configuration(s) can be indicated by the UTO-UCI.\* Indexing rule for CG PUSCH occasions of multiple CG configurations, TRPs and carriers.**Proposal 3**: For the UTO-UCI design, RAN1 should consider the case that multiple PUSCH occasions overlap in time. The UE indicates at most one of the overlapping PUSCH occasions is not unused.\* The UE is allowed to utilize the PUSCH occasion with the smallest RB allocation that best fits the size of its buffered UL data.**Proposal 4**: For CG PUSCH occasions within a duration/time that are indicated by the same UTO-UCI, determine an index for each CG PUSCH occasion based on its start symbol, location of the {SLIV, K2, mapping type} combination in the row in the TDRA table that is used to configure the multi-PUSCH CG, CG configuration index, TRP index, and carrier index. A CG PUSCH occasion with index i is mapped to bit i in the UTO-UCI bitmap. |
| Nokia/NSB | **Proposal 2**: The indicated unused CG PUSCH TO(s) is for one CG configuration only. |
| vivo | **Proposal 3**: The dynamic indication in a UTO-UCI can be applied to the configured CG PUSCH occasions corresponding to one or multiple CG configurations on one or multiple serving cells.**Proposal 4**: To determine the information provided by a UTO-UCI, support a unified solution for the case of single CG configuration and the case of multiple CG configurations.**Proposal 5**: For the information provided by a UTO-UCI indicating unused CG PUSCH occasion(s) for N (N >= 1) CG configurations, the following two options can be considered:\* Option 1: The UTO-UCI includes N separate sub-bitmaps where each sub-bitmap corresponds to the CG PUSCH occasions from each of N CG configurations.\* Option 2: The UTO-UCI includes a bitmap for the CG PUSCH occasions corresponding to N CG configurations, where the bits in the bitmap are mapped to the CG PUSCH occasions of N CG configurations based on predefined rules.**Proposal 6**: Unused CG PUSCH occasion(s) for a CG configuration can be indicated by UTO-UCIs carried by CG PUSCHs corresponding to other CG configuration(s). For which CG configuration(s) the corresponding unused CG PUSCH occasion(s) is indicated by a UTO-UCI can be configured by RRC signalling. |
| TCL | **Proposal 5**: Additional TOs after the end of the configured TO within a CG period and activate more than one CG configurations simultaneously can be considered.**Proposal 6**: When more than one CG configuration activation simultaneously, a UCI use to indicate un-used TOs within more than one CG configurations can be considered. |
| Lenovo | **Observation 1**: UTO-UCI indicating unused CG occasions of multiple CG configurations can help gNB schedule the unused CG occasions faster at the cost of more specification impact including ordering of CG occasions.**Proposal 5**: If a UTO-UCI indicates unused CG occasions of only a CG configuration, decide whether handling of overlapped CG occasions across the CG configuration and another CG configuration is needed. |
| Sharp | **Proposal 1**: The UTO-UCI is enabled by RRC configuration for a multi-PUSCHs CG, and cannot be associated to multiple CG configurations. |
| Huawei/HiSilicon | **Proposal 2**: Do not support the indication of UTO-UCI extend to multiple CG configurations. |
| xiaomi | **Observation 9**: UTO-UCI configuration should be unbundled from the CG configuration for the potential backward compatibility.**Proposal 9**: Support a UTO-UCI to provide information for a CG configuration which doesn't include the UTO-UCI.**Proposal 10**: Support a UTO-UCI for more than one CG configuration.**Proposal 11**: CG configurations should be sorted according to the CG index for the UTO-UCI with multiple CG configurations.**Proposal 12**: CG PUSCH TOs in multiple CG configurations should be cascaded in order.**Proposal 13**: An additional indication is required to determine the UTO-UCI and its corresponding CG configuration.\* Channel multiplexing for Multi-PUSCHs CG**Observation 10**: The design of dropping rule needs to consider the impact on legacy system performance.**Proposal 14**: If needed, a RRC signaling can be used as an indication that UTO-UCI is protected first. |
| CMCC | **Proposal 3**. The unused CG PUSCH TOs indicated by a UTO-UCI in a CG PUSCH are associated only to a single CG configuration. |
| Samsung | **Observation 1**: There is no need or benefit to support indication by "UTO-UCI" for multiple CG configurations. |
| IDC | **Proposal 6**: UTO-UCI indicates the unused PUSCH occasions in only one CG configuration  |
| Google | **Proposal 2**: Support the UCI indication of the unused TO(s) to operate for multiple CG configurations |
| MTK | **Proposal 8**: Do NOT support UTO-UCI indication across multiple CG configurations. |
| Apple | **Proposal 5**: regarding multiple CG configurations on the same cell, consider the following two options for UL, SUL or {NUL and SUL}:\* Alt. G-1o There is no dependence between UTO-UCI signaling carried by a CG PUSCH with one CG configuration and UTO-UCI signaling carried by a CG PUSCH with another CG configuration.o The consistency of UTO-UCI is maintained for UTO UCI signaling carried by CG PUSCHs with the same CG configurations, e.g., a later UTO-UCI cannot revert a TO to "used" or "non-unused" if that TO was previously indicated by another UTO-UCI as "unused".\* Alt. G-2o There is dependence between UTO-UCI signaling carried by a CG PUSCH with one CG configuration and UTO-UCI signaling carried by a CG PUSCH with another CG configuration. Effectively any UTO-UCI provides usage-information of an uplink carrier at the OFDM symbol level, if an OFDM symbol is within a CG PUSCH TO which is indicated as "unused", then the UE will not transmit any CG PUSCH colliding with that OFDM symbol on the same carrier.o The consistency of UTO-UCI is maintained across UTO-UCI signaling carried by CG PUSCHs for CG configurations on the same cell. |
| Honor | **Proposal 5**: Support dynamic indication of unused CG PUSCH occasion(s) for multiple CG configurations.**Proposal 6**: RRC configured Parameters and rules regarding how to extend UTO-UCI reporting to multiple CG configurations include:- Through which CG configuration the UE can send the UTO-UCI.- The sent UTO-UCI indicates which CG configurations TO usage.- Encode the UTO-UCI bits for different CG configurations. |
| New H3C | **Proposal 2**: UTO-UCI indication mechanism for single CG configuration can be extended to multiple CG configurations case. |
| Panasonic | **Proposal 3**: The UTO should be applicable to PUSCH occasions of a single or more CG configurations. The UTO configuration should contain the applicable CGs for the UTO-UCI. |
| DCM | **Proposal 4**: UTO-UCI indicates unused TOs of the same CG configuration as CG PUSCH carrying the UCI. |

### 3.3.1 Initial Discussions

**Moderator’s suggestion for initial discussion:**

Based on the observations provided above, Moderator suggests the following:

* **Suggestion:**
* Consensus is needed to support the extension. The current status is that the views are evenly divided.
* Moderator recommends companies to carefully review the motivations and justifications presented, as well as proposed solutions to assess the reasonable arguments to decide whether/how support the extension to multiple CG configuration. Please consider the reasonable arguments while being flexible when making decision.

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding Moderator’s **suggestion** regarding whether/how support the extension to multiple CG configuration.
* **Q2:** Discuss any clarification/correction/comment/question on Moderator’s summary and suggestion or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | We can discuss motivations in an offline session and make a conclusion.We continue to not identify any benefit for extending UTO-UCI indication for multiple “multi-PUSCH” CG configurations while there can be substantial specification complexity from doing so.  |
| **InterDigital** | Share similar views with Samsung. The spec impact of extending the UTO-UCI to multiple CG configurations does not seem to justify the benefit, if any.  |
| **ZTE, Sanechips** | We can discuss the use cases and motivations. And we can make a conclusion if this feature is supported, otherwise, we don’t need a conclusion at all. |
| **Nokia, NSB** | We agree with moderator’s suggestion. In our view, the competition of UTO-UCI during this meeting is of special importance. There are still many open items for the basic design of UTO-UCI. It will be impossible to finalize this on time is we start discussing the design for UTO-UCI for multiple CG configurations. The motivation for extending to multiple CG configurations is also not strong to motivate the complicated design. Each CG configuration can have its own UTO-UCI. If we start mixing this among different CG-UCI the procedure will be very confusing. |
| **Sharp** | We still don’t see the benefit of associating multiple CG configurations to UTO-UCI. |
| **DOCOMO** | Agree with moderator’s suggestion. We think completing design of single CG configuration should be prioritized. |
| **Xiaomi** | UTO-UCI for multiple CG configurations is significant, as many companies have observed. Of course, there is an objective existence of limited time. Maybe we can talk about a UTO-UCI for another CG configuration first. This would greatly reduce specification complexity while capturing most of the benefits. |
| **Qualcomm** | We see benefits of the extension mainly to multi-modal periodic XR traffics. I.e., UE can use UTO-UCI in CG PUSCH of a heavy traffic such as video to indicate whether CG PUSCH occasions for light traffic can be skipped. In this case, it is preferable to only send UTO-UCI in the heavy traffic due to its relative low resource overhead. |
| NEC | We think the extension to multiple CG configuration is not essential, discussions on this issue should be de-prioritized. |
| **Lenovo** | **Agree with the moderator** |
| **LG** | Agree with the moderator’s suggestion. We think multiple CG scenario is usual case of XR, for various service or supporting non-integer periodicity or keeping low latency.  |
| Futurewei | Multiple CG configurations should be deprioritized before all the critical issues of single CG configuration are settled, as much more new issues would be introduced if multiple CG configurations supported and considering the limited time in RAN1.  |
| OPPO (copied form FLS v003) | We agree with Moderator’s Observation 1, and do not support UTO-UCI extension to multiple CG configurations. |
| **Moderator** | **Discuss offline if time allows, otherwise defer to offline session for decision** |
| **TCL** | Fine with the moderator’s suggestion. Multiple CG configurations can be used for XR to match the multiple flows, low latency and jitter characteristics.  |

### 3.3.2 Intermediate Discussions

With respect to agreement below, address the remaining open issues highlighted below (extension to multiple CG configuration).

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication:

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding the open issue in agreement above for applicability of UTO-UCI indication to multiple CG configurations and indicate.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Xiaomi** | We suggest that we can first discuss UTO-UCI for another CG configuration. This will greatly reduce the complexity of the specification while reaping most of the benefits of multiple CG configuration. |
| OPPO | Due to limited time available, we do not support “one UTO-UCI to be extended to multiple CG configuration”.  |
| **Apple** | On the FFS part, even the UTO-UCI is for a single CG configuration, whether that can affect the CG generation at another CG configuration should be discussed and decided. If UTO-UCI signaling are independent for different CG-configurations, while UE implementation flexibility is achieved, the resource sharing among different UEs may not be ideal and in the end this feature is likely to be deployed. Over a slot (say slot *n*) containing a TO (TO-1), the UE may indicate it as “unused” by a UTO-UCI (UTO-UCI-1) for one CG configuration (CG-1), but there can be a later UTO-UCI (UTO-UCI-2) for another CG configuration (CG-2) indicates another TO (TO-1’) as “Not used”, and TO-1’ is also contained in in slot *n*. That is then similar to the case where a TO is indicated as “unused” by a UTO-UCI for a CG configuration on a cell, a later UTO-UCI for the same CG configuration is allowed to revert the TO to “not unused”.Figure 5 Can TO-1 and TO-3 be effectively converted to "Not unused"? |
| **ZTE, Sanechips** | If we have more time, discussion is necessary to justify the benefits(if any) and details, at least including:* Issue1: ordering of multiple CG configurations in a UTO-UCI
* Issue2: dependence of indications for same CG-PUSCHs configured by different CG configurations
 |
|  |  |
|  |  |
|  |  |

## 3.4 Other topics

**Moderator’s summary:**

With respect to the feature supporting indication of unused PUSCHs by UCI, companies have raised other aspects for discussions and decision. Some of these topics were discussed last meeting. Few of them are listed below:

* + Topic 1) Accurate and compact terminology for “UTO-UCI” (Samsung)
	+ Topic 2) UE decided PUSCH repetition and indication via UTO-UCI (Honor)
	+ Topic 3) Partial CG resource usage (Apple)
	+ Topic 4) Introduce timeline for indication of “unused” TOs (xiaomi)
	+ Topic 5) Impact on existing timelines due to “unused” TOs (Ericsson)
	+ Topic 6) Determination of “un-used/used” TOs up to UE implementation (Samsung)
	+ …

Table 7: Summary of Contributions inputs for Section 3.4

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Ericsson | **Proposal 13** Revisit the existing timeline constraints due to configured grant PUSCH to ensure the corresponding constraints are not applicable when a configured grant PUSCH transmission occasion is indicated unused. |
| xiaomi | **Proposal 7**: RAN1 should prioritize the discussion of the timeline for dynamic indication.**Proposal 8**: Three potential options can be considered to define the timeline for dynamic indication, as follows:> Option 1: From the TO including the UCI to the time window\* FFS details> Option 2: From the TO including the UCI to the first TO in the time duration\* FFS details> Option 3: From the TO including the UCI to the first unused TO in the time duration\* FFS details\* Dynamic indication for the other CG configuration(s) |
| Samsung | **Proposal 1**: RAN1 to discuss an accurate and compact name for "UTO-UCI".**Proposal 3**: The determination of "used"/"unused" CG-PUSCH TOs by a UE is up to the UE implementation. |
| Apple | **Proposal 3b:** support partial resource/occasion usage in the frequency domain to allow statistical multiplexing of UE traffics minimizing collision.**Proposal 3c:** overlapping CG configurations are supported to support frequency domain resource sharing among UEs.**Proposal 3d:** support partial resource/occasion usage in the time domain to allow statistical multiplexing of UE traffics minimizing collision.**Proposal 3e:** gNB can put UTO-UCI subset restriction on the UTO-UCI pattern to facilitate resource sharing among UEs. For a single UE, the UTO-UCI subset restriction set can be {[1111],[0011],[0011],[0001]} for a 4 bit pattern |
| Honor | **Proposal 3**: Support UE-decided PUSCHs repetition and inform the gNB via UTO-UCI. |

### 3.4.1 Initial Discussions

**Moderator’s suggestions for initial discussion:**

Considering the topics and observations on companies’ view, Moderator’s provides the following observations and suggestions:

* **Topic 1:**
	+ **Observation 1:** The proponent explains “Before considering specifics on the functionality of “UTO-UCI”, the naming of that control information needs to be improved considering subsequent agreements and particularly the one that “UTO-UCI” is a bitmap. First, the term “UCI” is redundant, that control information is a “UCI” by default. Second, the term “UTO”, for unused transmission occasion, is incorrect as the bitmap indicates both used and unused transmission occasions for a “multi-PUSCH CG”.
	+ Moderator shares the following comments:
		- Regarding first comment, it is true that the term “UCI” is technically redundant, comparing with terminologies used for control information carried by PUCCH (HARQ-ACK, CSI, SR) that represent accurately the associated information. But the naming “UTO-UCI” uses same style as “CG-UCI” where both refer to control information in PUSCH. Due to very similarities in related procedures, using the same style seemed a natural choice.
		- Regarding second comment, true that the bitmap indicates both used and unused, however the informative part of the bit-map is the information about “unused”.
	+ **Suggestion 1:** Hence, based on above comments, and the widely usage of term “UTO-UCI” in agreements, RRC/UE features preparations and most importantly RAN2 running CRs, it is not clear if changing the terminology is necessary. However, companies are encouraged to share their views and provide suggestions if they consider usage of a new terminology necessary.
* **Topic 2:**
	+ **Observation 2:** The proposed enhancement is out-of-scope of WID objectives. Given the limited time for completion of the normative, spending time for discussion regarding the proposed enhancement is not reasonable.
	+ **Suggestion 2:** Hence, Moderator suggests deprioritizing the corresponding discussions**.**
* **Topic 3, 4, 5, 6:**
	+ **Observation 3:** These topics were previously proposed by proponents for discussions. Moderator observes lack of interest among companies to discuss these topics. Specially regarding topic 6, the understanding is that the discussion is on-going in RAN2 as it is a MAC decision.
	+ **Suggestion 3:** Hence, Moderator suggests deprioritizing discussions on the corresponding enhancements**.**

**Questions:** Please provide your view in the table below regarding the following questions:

* **Q1:** Please indicate your view regarding the moderator’s **observations/suggestions**, especially **Suggestion 1**.
* **Q2:** Discuss any clarification/correction/comment/question on Moderator’s summary and suggestions or any other aspect helping the discussion and needed decisions.

**Note: Please ensure the information in companies’ contributions are considered for discussions.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Regarding the UTO-UCI, we think that name is a poor choice both for its length (“UCI” is clearly redundant, it was more needed for “CG-UCI” due to the lack of a better name for “CG”, and that mistake does not need to propagate) and for its functionality (the bitmap of “UTO-UCI” indicates both “used” and “unused” TOs). |
| **ZTE, Sanechips** | We are fine with moderator’s suggestions. |
| **Nokia, NSB** | **Topic 1**: We are fine with current name of UTO-UCI and support suggestion 1.**Topic 2**: We are ok not to go to any enhancements since it is the last meeting for WI. However, the interaction of UTO-UCI with repetitions shall be clarified since legacy CG supports repetitions.**Topics 3**: Was already discussed in SI and decided not to go to partial CG reuse in WI.**Topic 4, 5**: Ok to discuss if time allows.**Topic 6**: Is important to understand how this will work, however, this is up to RAN2 and it shall be left to RAN2. |
| **Sharp** | We are fine with moderator’s suggestions. For UTO-UCI, the bit should be defined clearly first, e.g. “Unused”=1 and “Not Unused”=0 (or vice versa).  |
| **DOCOMO** | Support Moderator’s suggestions. |
| **Xiaomi** | As mentioned in our contribution, the ultimate purpose of UTO-UCI feature is to rescheduled the unused TO by the gNB, otherwise the UTO-UCI feature is meaningless. From this perspective, we need to discuss whether we need to introduce timeline. |
| **Qualcomm** | It is fine to us to deprioritize all these issues. |
| **Moderator** | * Follow up on Nokia and xiaomi comment
* Moderator discussed offline w Samsung, maybe OK with UTO-UCI
 |

# 4 Others

This section covers general remaining issues needed to for the normative work to be completed.

## 4.1 Stage 2 specification

The proposal below is intended for Stage 2 specification. According to Work plan, RAN1 is to provide this input to RAN2.

Proposal 4-1:

The following TP with stage 2 description for physical layer enhancements is endorsed in principle for TS 38.300. Send an LS to RAN2.

===============< Start of TP>=============

**16.X.4    Capacity**

**16.X.4.1        Physical Layer Enhancements**

The following enhancements for configured grant-based transmission are introduced:

-     Support of multiple CG PUSCH transmission occasions within a single period of a CG configuration

-     Dynamic indication of unused CG PUSCH occasion(s) of a CG configuration, based on a new Uplink Control Information [UTO-UCI] multiplexed in a CG PUSCH transmission of the CG configuration.

 ===============< Start of TP>=============

**Question:** Please provide your view on Proposal 4-1.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |
|  |  |

# 5 Online sessions

## 5.1 First online session

### List of proposals for online session

Proposals for the online session are as the following in order of priority.

Proposal 2-1:

**Select one of the options below:**

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, consider the following options for further down-selection:

**Option A-1a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt-2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
	+ The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
	+ A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period.

**Option A-2a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt -2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
* Configure the RRC parameter UTO\_offset.
	+ FFS range value of UTO\_offset
* The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
* A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period and after UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-a:**

* Configure the RRC parameter UTO\_period.
	+ FFS range value of UTO\_period
		- Alt-1: values in time unit (e.g., XR traffic periodicity)
		- Alt -2: one or multiple of CG periodicity given by integer value (n=1, 2, ..)
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH carries UTO-UCI that is applicable to the valid CG PUSCH TOs that are confined within UTO\_period starting with UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-b2:**

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations

Proposal 2-2-1:

* When UTO-UCI and HARQ-ACK are jointly encoded, HARQ-ACK bit sequence is concatenated after UTO-UCI bit sequence, by reusing the same mechanism adopted for joint encoding of CG-UCI and HARQ-ACK.

Proposal 2-2-2:

* Introduce a new RRC parameter UTO-UCI-Multiplexing (similar to cg-UCI-Multiplexing) to enable/disable joint coding of HARQ-ACK and UTO-UCI in a CG PUSCH with the UTO-UCI.

Proposal 1-1 (updated):

Type-A repetition is supported for Type-1 and Type-2 multi-PUSCH CG configuration.

* Alt-1 : For a repetition factor K>1, a UE repeats a TB across K consecutive transmission occasions in a period of a multi-PUSCH CG configuration.
	+ FFS HARQ process ID association to TBs when more than one TB is transmitted/repeated within a period of the multi-PUSCH CG configuration.
* Alt-2: For a repetition factor K>1, a UE repeats a TB after configured CG PUSCH occasions in a period of a multi-PUSCH CG configuration.
	+ [FFS details]
* Note: The redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, … *K*-1, is determined according to table 6.1.2.1-2 of 38.214 as in legacy procedures.
* Note: The repetition of a TB is confined within a multi-PUSCH CG period as in legacy procedures.

Proposal 1-2-3:

* + For a multi-PUSCH CG configuration, the range value of the higher layer parameter indicating number of consecutive slots with SLIV (N in previous agreements) is:
	+ Alt-1: (2, …, Y)
		- Decide Y=16 or 40 or some other value
	+ Alt-2: (1, ...., Y)
		- Decide Y=16 or 40 or some other value

Proposal 1-2-1 (updated):

* The corrections in red are applied for the following agreement made in RAN1#113.

**Agreement (RAN1#113)**

From RAN1 perspective, for determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:

* The HARQ process ID for the first configured PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured, and applying the following formula, whichever is applicable
	+ HARQ Process ID = [X\*floor( (CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes*
	+ HARQ Process ID = [X\*floor((CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*
		- X= the number of configured PUSCHs in the CG period
* The HARQ process ID of the remaining configured and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with *nrofHARQ-Processes* ~~or module operation~~ and then  ~~with~~ ~~(~~*~~nrofHARQ-Processes~~* ~~+~~ *harq-ProcID-Offset2*~~)~~ is added, ~~whichever~~ when applicable.
* Note: A configured CG PUSCH is invalid if the CG PUSCH is dropped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*.

### Outcome of online session

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication:

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations

Strong concerns have been raised on the above proposal in terms of benefit and UE complexity by CATT, ZTE, Huawei, Apple, MTK, and Google.

Agreement

When UTO-UCI and HARQ-ACK are jointly encoded, HARQ-ACK bit sequence is concatenated after UTO-UCI bit sequence, by reusing the same mechanism adopted for joint encoding of CG-UCI and HARQ-ACK.

**Conclusion**

There is no consensus on the following proposal:

Introduce a new RRC parameter UTO-UCI-Multiplexing (similar to cg-UCI-Multiplexing) to enable/disable joint coding of HARQ-ACK and UTO-UCI in a CG PUSCH with the UTO-UCI.

**Conclusion**

For Type-1 and Type-2 multi-PUSCH CG configuration, Type-A repetition is NOT supported in Rel-18

# 6 Conclusion

TBD

# References

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | [**R1-2306403**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306403.zip) | Discussions on XR-specific capacity enhancements | New H3C Technologies Co., Ltd. |
| 2 | [**R1-2306427**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306427.zip) | XR-specific capacity enhancements | FUTUREWEI |
| 3 | [**R1-2306526**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306526.zip) | Discussion on CG enhancements for XR capacity | Huawei, HiSilicon |
| 4 | [**R1-2306607**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306607.zip) | Capacity Enhancements for XR | Ericsson |
| 5 | [**R1-2306628**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306628.zip) | Discussion on XR capacity enhancement techniques | Panasonic |
| 6 | [**R1-2306659**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306659.zip) | Discussion on XR-specific capacity enhancements | Spreadtrum Communications |
| 7 | [**R1-2306698**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306698.zip) | Discussion on XR-specific capacity enhancements | Honor |
| 8 | [**R1-2306764**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306764.zip) | Discussion on XR specific capacity enhancements | vivo |
| 9 | [**R1-2306918**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306918.zip) | Remaining Issues on XR specific capacity enhancements | Sony |
| 10 | [**R1-2307101**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307101.zip) | Design of Multiple CG Occasions and unused CG occasion feedback | CATT |
| 11 | [**R1-2307115**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307115.zip) | Discussion on XR-specific capacity enhancements | NEC |
| 12 | [**R1-2307141**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307141.zip) | Discussion on XR specific capacity enhancements | ZTE, Sanechips |
| 13 | [**R1-2307209**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307209.zip) | Discussion on XR-specific capacity enhancements | CMCC |
| 14 | [**R1-2307398**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307398.zip) | Discussion on XR-specific capacity enhancements | xiaomi |
| 15 | [**R1-2307405**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307405.zip) | On XR-specific capacity enhancements | KT Corp. |
| 16 | [**R1-2307485**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307485.zip) | Discussion on XR specific capacity improvement enhancements | NTT DOCOMO, INC. |
| 17 | [**R1-2307574**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307574.zip) | Discussion on XR specific capacity enhancements | OPPO |
| 18 | [**R1-2307597**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307597.zip) | XR specific capacity enhancements | TCL |
| 19 | [**R1-2307612**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307612.zip) | XR-specific capacity enhancements | Nokia, Nokia Shanghai Bell |
| 20 | [**R1-2307692**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307692.zip) | Capacity enhancements for XR | Samsung |
| 21 | [**R1-2307771**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307771.zip) | On XR-specific capacity enhancements techniques | Google Inc. |
| 22 | [**R1-2307794**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307794.zip) | Discussion on XR-specific capacity enhancements | LG Electronics |
| 23 | [**R1-2307815**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307815.zip) | XR-related CG Enhancements | Lenovo |
| 24 | [**R1-2307819**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307819.zip) | Remaining issues on UTO-UCI content and reporting | Sharp |
| 25 | [**R1-2307820**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307820.zip) | Discussion on XR-specific capacity enhancements | InterDigital, Inc. |
| 26 | [**R1-2307866**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307866.zip) | Discussion on XR specific capacity enhancements | CAICT |
| 27 | [**R1-2307941**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307941.zip) | Remaining Issues on Capacity Enhancement Techniques for XR | Qualcomm Incorporated |
| 28 | [**R1-2308063**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2308063.zip) | XR capacity enhancements | MediaTek Inc. |
| 29 | R1-2308202 | XR-specific capacity enhancements | Apple |

# Appendix

## RAN1#112 agreements and conclusions

### The 1st objective

- Multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration (RAN1, RAN2);

**TDRA design:**

**Agreement**

For determination of the time domain resource allocation of CG PUSCHs associated to a **multi-PUSCHs CG**, the following alternatives for further study:

* **Alt-A:** TDRA determination based on repetition framework.
	+ **Alt-A1:** Follow the time domain resource mapping of Type A repetition
		- N configured by higher layers or indicated by activation DCI
		- Single SLIV is determined from TDRA
		- The same SLIV in N PUSCH in consecutive slots per CG period
			* FFS for non-consecutive slots
		- FFS details, including related RRC parameters
	+ **Alt-A2:** Follow the time domain resource mapping of Type B repetition
		- N configured by higher layers or indicated by activation DCI
		- Single SLIV is determined from TDRA
			* The SLIV used for 1st PUSCH per CG period.
		- N consecutive nominal PUSCHs with same duration per CG period
	+ Note: N is not necessarily the repetition factor.

FFS details, including related RRC parameters

* **Alt-B:** TDRA determination based on NR-U framework
	+ - N and M configured by higher layers
		- Single SLIV is determined from TDRA.
			* The SLIV used for 1st PUSCH per CG period.
		- M consecutive PUSCH TOs with same duration in slot. The M PUSCH TOs are used in N consecutive slots per CG period
		- Note: N and M are configured independently from *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16,* respectively*.* M and N configuration is independent from *cgRetransmissionTimer* configuration.
		- FFS details, including related RRC parameters
* **Alt-C:** TDRA determination based on single DCI scheduling multiple PUSCHs
	+ **Alt-C1:** Follow Rel-16 single DCI scheduling multiple PUSCHs
		- TDRA configured by pusch-TimeDomainAllocationListForMultiPUSCH-r16 with k2-r16
		- A row of TDRA with N entries determines the time domain resources allocation of N PUSCH TOs per period
			* Note: N PUSCH TOs should be consecutive PUSCH TOs in consecutive slots.
		- FFS details, including related RRC parameters
	+ **Alt-C2:** Follow Rel-17 single DCI scheduling multiple PUSCHs
		- TDRA configured by pusch-TimeDomainAllocationListForMultiPUSCH-r16 with extendedK2-r17
		- A row of TDRA with N entries determines the time domain resources allocation of N PUSCH TOs per period
			* Note: N PUSCH TOs can be non-consecutive PUSCHs and/or in non-consecutive slots.
		- FFS details, including related RRC parameters

**HARQ ID design:**

**Conclusion**

RAN1 discusses to decide how to determine the HARQ process ID of CG PUSCHs of a multi-PUSCHs CG.

**Agreement**

For determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH, consider the following alternatives:

* **Alt. 1:** The HARQ process ID for the first configured/valid PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured, and applying "the period duration divided by X instead of the period duration.
	+ The HARQ process ID of the remaining PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period.
	+ Alt 1-1; X = 1
	+ Alt 1-2: X is the number of configured PUSCHs in a period
	+ Alt 1-3: X is provided by RRC configuration.
	+ FFS details
* **Alt. 2:** Support that UE can decide, as in NR-U, the HARQ IDs for the multiple CG PUSCH transmission occasions and indicate the decided HARQ IDs to gNB if multiple HARQ processes are used for the multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration
	+ FFS details
* **Alt. 3:** The HARQ process ID for the configured PUSCHs in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured.
	+ FFS on potential enhancements different from previous alternatives
	+ Alt 3-1: Note: Same HP ID would be used for all PUSCHs within a period.
		- FFS details
	+ Alt 3-2: Note: Different HP ID could be used for all PUSCHs within a period.
		- FFS details
* Alt. 4: The HARQ process ID for the first configured/valid PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured.
	+ The HARQ process ID of the remaining PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period
	+ FFS on potential enhancements different from previous alternatives
* Alt 5: Support that UE can decide, as in NR-U, the HARQ IDs for the first CG PUSCH transmission occasions and indicate the decided HARQ IDs to gNB if multiple HARQ processes are used for the multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration
	+ The HARQ process ID of the remaining PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period
	+ FFS details
* Alt 6**:** FFS other solutions

**MCS/FDRA, other design parameters:**

**Agreement**

For the PUSCHs parameters in a multi-PUSCHs CG configuration, the configuration/indication parameters except MCS and FDRA of CG PUSCHs in a multi-PUSCHs CG configuration are the same

* FFS: For MCS and FDRA, study further to decide whether/how to be different.
* FFS: Applicability to type-1 and type-2
* Note: TDRA and HP ID are not in this scope of the above statement.

### The 2nd objective:

- Dynamic indication of unused CG PUSCH occasion(s) based on UCI by the UE (RAN1, RAN2);

**What information UTO-UCI contains:**

**Agreement**

For dynamic indication of unused CG PUSCH transmission occasion(s) based on a UCI, the following options for further down-scoping, are considered for the information provided by the UCI:

* **Option 1:** The UCI determines the consecutive CG PUSCH TO(s) that are indicated as “unused”
	+ **Option 1-1:** The UCI provides the number of consecutive TO(s) in time domain.
		- Applicable numbers can be determined from information obtained from configuration.
		- FFS details
	+ **Option 1-2**: The UCI provides a time duration/range that includes the consecutive TO(s) in time domain.
		- Applicable time duration/range can be determined from information obtained from configuration
		- FFS details
* **Option 2:** The UCI determines the CG PUSCH TO(s) that are indicated as “unused” (consecutive/non-consecutive TO(s) in time domain)
	+ **Option 2-1**: The UCI provides a bitmap where a bit corresponds to a TO within a time duration/range. The bit indicates whether the TO is “unused”.
		- Applicable time duration/range can be determined from information obtained from configuration
		- FFS details
	+ **Option 2-2:** The UCI provides a bitmap where a bit corresponds to TOs within a time duration/range. The bit indicates whether all TOs within the time duration/range are “unused”.
		- Applicable time duration/range can be determined from information obtained from configuration
		- FFS details
* FFS whether/how the unused TO(s) can be associated to multiple CG configuration.
* Other options are not precluded. Proponent companies to provide details.

**When UTO-UCI is sent:**

**Agreement**

For dynamic indication of unused CG PUSCH occasion(s) based on a UCI, the following options for further down-scoping with possible revision, are considered for the transmission occasion of the UCI:

* **Option 1:** A transmitted CG PUSCH, includes the UCI.
	+ FFS details
* **Option 2:** A transmitted CG PUSCH includes the UCI, if it is transmitted in an occasion determined by RRC.
	+ FFS details
* **Option 3:** A transmitted CG PUSCH includes the UCI, if it is transmitted in a pre-defined transmission occasion.
	+ FFS details
		- Example of a pre-determined occasion: 1st configured PUSCH TO in a CG period or 1st configured PUSCH TO in a multiple CG periods
* **Option 4:** A transmitted CG PUSCH includes the UCI, if it is transmitted in a transmission occasion determined satisfying given condition(s).
	+ FFS details
		- Examples of a condition: A first transmitted PUSCH in a CG period, or a first PUSCH transmission within a multiple of CG periods.

Other options are not precluded. Proponent companies to provide details.

**How UTO-UCI is sent:**

**Agreement**

The physical channel that carries the UCI that provides information about unused CG PUSCH transmission occasions is CG PUSCH.

**Agreement**

Encoding and multiplexing for “the UCI that provides information about unused CG PUSCH transmission occasions” in a CG PUSCH applies encoding and multiplexing procedures for CG-UCI as baseline.

* FFS on details

**Agreement**

Consider the following alternatives for “the UCI that provides information about unused CG PUSCH transmission occasions” for down-selection or revision

* Alt. 1: “The UCI that provides information about unused CG PUSCH transmission occasions” is defined as a new UCI.
	+ FFS on details
* Alt. 2: “The UCI that provides information about unused CG PUSCH transmission occasions” is added as new field(s) to the CG-UCI.
	+ FFS on details
* Alt. 3: “The UCI that provides information about unused CG PUSCH transmission occasions” replaces/re-purposes some field(s) of the CG-UCI.
	+ FFS on details

## RAN1#112bis-e agreements and conclusions

### The 1st objective

- Multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration (RAN1, RAN2);

**TDRA design:**

**Agreement:**

For TDRA design for multi-CG PUSCH, prioritize Alt-A1, Alt-B, and Alt-C2 for further downscoping and/or modification from corresponding agreement in RAN1#112.

* FFS: How to address TDD configuration issue

**MCS design:**

**Agreement:**

For CG PUSCHs in a multi-PUSCHs CG configuration, MCS of the CG PUSCHs in the CG configuration are the same between different PUSCH occasions

**FDRA design:**

**Agreement:**

For CG PUSCHs in a multi-PUSCHs CG configuration, FDRA of the CG PUSCHs in the CG configuration are the same between different PUSCH occasions

**HARQ ID design:**

**Agreement:**

From RAN1 perspective, for determination of HARQ process Ids associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:

* The HARQ process ID for the first configured/valid PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured, and applying the following formula, whichever is applicable
	+ HARQ Process ID = [floor(X\*(CURRENT\_symbol – offset1) / *periodicity*) + offset2] modulo *nrofHARQ-Processes*
	+ HARQ Process ID = [floor(X\*(CURRENT\_symbol – offset1) / *periodicity*) + offset2] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*
		- FFS whether in formulas above X is outside or inside floor operation, i.e.
			* HARQ Process ID = [X\*floor( (CURRENT\_symbol – offset1) / *periodicity*) + offset2] modulo *nrofHARQ-Processes*
			* HARQ Process ID = [X\*floor((CURRENT\_symbol – offset1) / *periodicity*) + offset2] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*
	+ (Working Assumption) The HARQ process ID of the remaining configured/valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by Y with module operation with *nrofHARQ-Processes* or module operation with (*nrofHARQ-Processes* + *harq-ProcID-Offset2*), whichever applicable.
		- FFS whether X=1 or X= the number of configured PUSCHs in the CG period
		- FFS whether Y =1 or a value larger than 1, e.g. Y=2.
			* FFS: If Y>1, Y is determined based on RRC
		- FFS whether Offset 1= 0 or can be a non-zero value.
			* FFS: If offset1 is non-zero, how offset1 is determined (i.e., based on RRC)
		- FFS whether Offset 2= 0 or can be a non-zero value.
			* FFS: If offset2 is non-zero, how offset2 is determined (i.e., based on RRC or dynamically)
* Note1: The equations will be updated accordingly when FFSs are clarified, e.g., if X=1, remove X; if Y=1, remove Y; if non-zero offset1 or Offset 2 is not supported, remove offset 1 or Offset 2.
* Note2: A configured CG PUSCH is invalid if the CG PUSCH is dropped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*.

### The 2nd objective:

- Dynamic indication of unused CG PUSCH occasion(s) based on UCI by the UE (RAN1, RAN2);

**What information UTO-UCI contains:**

**Agreement**

For dynamic indication of unused CG PUSCH transmission occasion(s) based on a UCI, the indicated “unused” CG PUSCH TO(s), if any, by the UCI in a CG PUSCH for a CG configuration

* can be consecutive or non-consecutive CG PUSCH TO(s) in time domain [in one CG period]
* FFS whether/how the unused TO(s) can be associated to multiple CG configuration.

Note: FFSs and further details in corresponding agreement in RAN1#112 for the selected option are remained for further discussion

Note: Above corresponds to Option 2 (w.r.t. agreement in RAN1#112)

**Agreement**

The UTO-UCI provides a bitmap where a bit corresponds to a TO within a time duration/range. The bit indicates whether the TO is “unused”.

* FFS: Details including time duration/range

Note: The term “UTO-UCI” refers to the “UCI that provides information about unused CG PUSCH transmission occasions” for convenience.

**When UTO-UCI is sent:**

**Agreement**

* **Option 1**: For a CG PUSCH configuration, the UTO-UCI is included in every CG PUSCH that is transmitted (that is Option 1 in corresponding agreement in RAN1#112)
	+ FFS details
* Note: The term “UTO-UCI” refers to the “UCI that provides information about unused CG PUSCH transmission occasions” for convenience.

**How UTO-UCI is sent:**

**Agreement**

The UCI that provides information about unused CG PUSCH transmission occasions is defined as a “new UCI” (i.e. Alt. 1 of previous agreement).

**Agreement**

* With respect to PHY two-level priority, for a configured grant PUSCH configuration, the “UTO-UCI” has the same priority level as the configured grant PUSCH.
* Note: The term “UTO-UCI” refers to the “UCI that provides information about unused CG PUSCH transmission occasions” for convenience.

**Agreement**

The existing CG-UCI encoding and multiplexing procedures are reused for encoding the “UTO-UCI” in a configured grant PUSCH in absence or presence of other UCIs being multiplexed in the PUSCH, by applying the following adjustments:

* The “UTO-UCI” is used instead of CG-UCI in the corresponding procedures for encoding of CG-UCI and/or HARQ-ACK, whichever is present.
* For determining the beta-offset,
	+ Beta offset is configured for the “UTO-UCI”
		- If UTO-UCI and HARQ-ACK is not jointly encoded, the beta offset for the “UTO-UCI” is used in the procedures instead of CG-UCI beta offset
		- If UTO-UCI and HARQ-ACK is jointly encoded, HARQ-ACK beta offset is used in the procedures instead of CG-UCI beta offset
* FFS on sequence generation order between UTO-UCI and HARQ-ACK
* FFS on dropping rule between UTO-UCI and HARQ-ACK when joint encoding is not configured
* Note: The term “UTO-UCI” refers to the “UCI that provides information about unused CG PUSCH transmission occasions” for convenience.

## RAN1#113 agreements and conclusions

### The 1st objective

Multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration (RAN1, RAN2);

**TDRA design:**

Working Assumption

For time domain resource allocation for multi-PUSCH CGs, support

* For TDRA determination (based on NR-U framework)
	+ For Type-1, follow the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1 of TS 38.214.
		- Note: To determine the configuration of TDRA, PUSCH repetition type A is assumed according to description in 6.1.2.3 in 38.214 for Type-1.
			* It is still an open issue whether repetition is supported. If it is decided repetition is not supported, it implies the corresponding repetition factor for is one.
	+ For Type-2, the TDRA table is determined by the TDRA table associated with activation DCI, as defined in Clause 6.1.2.1 of TS 38.214.
		- Note: The DCI format for activation DCI with pusch-RepTypeA is applicable.
			* It is still an open issue whether repetition is supported. If it is decided repetition is not supported, it implies the corresponding repetition factor for is one.
* N is configured by higher layers
* A single SLIV is determined from TDRA.
	+ The SLIV used for 1st PUSCH per CG period.
* The PUSCH is used in each of N consecutive slots per CG period
* Note: N is configured independently from *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16,* respectively*.* N configuration is independent from *cgRetransmissionTimer* configuration.
* To determine corresponding slots for CG PUSCHs in a period of a multi-PUSCH CG configuration:
	+ For the first PUSCH in the period, follow the legacy procedures.
	+ For remaining PUSCHs in the period
		- ForType-1 and Type-2, reuse the corresponding procedures for NR-U by applying the RRC parameters N, instead of *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16*, respectively.
* FFS: Whether/How to further enhance for operation on TDD

**Agreement**

For time domain resource allocation for multi-PUSCH CGs, support

* For TDRA determination (based on NR-U framework)
	+ For Type-1, follow the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1 of TS 38.214.
		- Note: To determine the configuration of TDRA, PUSCH repetition type A is assumed according to description in 6.1.2.3 in 38.214 for Type-1.
			* It is still an open issue whether repetition is supported. If it is decided repetition is not supported, it implies the corresponding repetition factor for is one.
	+ For Type-2, the TDRA table is determined by the TDRA table associated with activation DCI, as defined in Clause 6.1.2.1 of TS 38.214.
		- Note: The DCI format for activation DCI with pusch-RepTypeA is applicable.
			* It is still an open issue whether repetition is supported. If it is decided repetition is not supported, it implies the corresponding repetition factor for is one.
* N is configured by higher layers
* A single SLIV is determined from TDRA.
	+ The SLIV used for 1st PUSCH per CG period.
* The PUSCH is used in each of N consecutive slots per CG period
* Note: N is configured independently from *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16,* respectively*.* N configuration is independent from *cgRetransmissionTimer* configuration.
* To determine corresponding slots for CG PUSCHs in a period of a multi-PUSCH CG configuration:
	+ For the first PUSCH in the period, follow the legacy procedures.
	+ For remaining PUSCHs in the period
		- ForType-1 and Type-2, reuse the corresponding procedures for NR-U by applying the RRC parameters N, instead of *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16*, respectively.

**HARQ ID design:**

**Agreement:**

With respect to the agreement on HARQ process ID determination for multi-PUSCH Cg in RAN1#112bis-e, support the following:

* Y=1
* Offset 1=0 (i.e., remove Offset 1)
* Offset 2=0 (i.e., remove Offset 2)

**Agreement**

For determination of HARQ process Ids associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:

* X is outside the floor operation
* X= the number of configured PUSCHs in the CG period

Send an LS to RAN2 to inform this agreement. LS is endorsed in R1-230XXXX.

**Agreement**

The following working assumption is confirmed

(Working Assumption) The HARQ process ID of the remaining configured/valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with *nrofHARQ-Processes* or module operation with (*nrofHARQ-Processes* + *harq-ProcID-Offset2*), whichever applicable.

**Agreement**

From RAN1 perspective, for determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:

* The HARQ process ID for the first configured PUSCH in a period is determined based on the legacy CG procedure when cg-RetransmissionTimer is not configured, and applying the following formula, whichever is applicable
	+ HARQ Process ID = [X\*floor( (CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes*
	+ HARQ Process ID = [X\*floor((CURRENT\_symbol ) / *periodicity*)] modulo *nrofHARQ-Processes* + *harq-ProcID-Offset2*
		- X= the number of configured PUSCHs in the CG period
* The HARQ process ID of the remaining configured and valid CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by one with module operation with *nrofHARQ-Processes* or module operation with (*nrofHARQ-Processes* + *harq-ProcID-Offset2*), whichever applicable.
* Note: A configured CG PUSCH is invalid if the CG PUSCH is dropped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*.

Send an LS to RAN2 to convey the above RAN1 agreement. Final LS is in R1-2306233.

### The 2nd objective:

Dynamic indication of unused CG PUSCH occasion(s) based on UCI by the UE (RAN1, RAN2);

**General**

**Agreement**

* When a CG PUSCH occasion is indicated as “unused”, the UE is not allowed to transmit CG PUSCH on that CG PUSCH occasion.
* For any other CG PUSCH occasion that is NOT indicated as “unused”, the UE is allowed to transmit or not to transmit CG PUSCH on that CG PUSCH occasion as per legacy specification.
	+ No RAN1 specification impact

**Agreement**

* A CG PUSCH occasion indicated as “unused” earlier, is not allowed to be indicated as “NOT unused later”.
* A CG PUSCH occasion indicated as “NOT unused” earlier, can be indicated as “unused” later.
	+ FFS: Whether there is specification impact

**Agreement:**

The UTO-UCI indication for a CG configuration is applicable to only valid CG PUSCH TOs, if any.

* Note: A configured CG PUSCH is invalid if the CG PUSCH is dropped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*. Otherwise, it is valid.

Agreement

Indication of UTO-UCI by CG PUSCHs associated to a CG configuration, is enabled by configuration of an RRC parameter.

* FFS on whether/how to extend to multiple CG configurations

**What information UTO-UCI contains:**

**Agreement:**

For a CG configuration with UTO-UCI indication enabled, to determine the indicated CG PUSCH by a UTO-UCI indication, consider the following options for further down-selection:

**Option A-1a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt-2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
	+ The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
	+ A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period.

**Option A-2a:**

* + Configure the RRC parameter UTO\_period.
		- FFS range value of UTO\_period
			* Alt-1: values in time unit (e.g., XR traffic periodicity)
			* Alt -2: one or multiple of CG periodicity given by integer values (n=1, 2, ..)
* Configure the RRC parameter UTO\_offset.
	+ FFS range value of UTO\_offset
* The starting time of the first period of UTO periodicity starts at the same as starting time of the first period of the CG configuration and ends after UTO\_period. The next UTO period(s) are followed after the first UTO period.
* A transmitted CG PUSCH that is confined within a UTO period, carries UTO-UCI that is applicable to the CG PUSCH TOs within the UTO period and after UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-a:**

* Configure the RRC parameter UTO\_period.
	+ FFS range value of UTO\_period
		- Alt-1: values in time unit (e.g., XR traffic periodicity)
		- Alt -2: one or multiple of CG periodicity given by integer value (n=1, 2, ..)
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH carries UTO-UCI that is applicable to the valid CG PUSCH TOs that are confined within UTO\_period starting with UTO\_offset from the end of the transmitted CG PUSCH.

**Option B-b2:**

* Configure the RRC parameter Nu (Nu is the size of bit-map)
	+ FFS range value of Nu
* UTO\_offset is the offset value.
	+ Alt-1: UTO\_Offset is provided by configuration.
		- FFS range value of UTO\_offset
	+ Alt-2: UTO\_Offset = 0
* A transmitted CG PUSCH, carries UTO-UCI that is applicable to the Nu consecutive and valid CG PUSCH TOs, starting with UTO\_offset from the end of the transmitted CG PUSCH.

FFS on whether/how to extend to multiple CG configurations