3GPP TSG-RAN WG1 Meeting #113 R1-2306087

Incheon, Korea, May 22nd – 26th, 2023

Agenda Item: 9.8

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); |

Note that in addition to these objectives, it was agreed that two additional power saving enhancements can be discussed in working groups:

1. PDCCH monitoring resume if UE transmits NACK after PDCCH skipping starts (RAN1);
2. CG without retransmissions for uplink XR traffic (RAN2).

Among the above objectives, RAN1 is tasked to carry out the normative work for the enhancements defined by the following two objectives:

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| - Multiple 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 UCI by the UE (RAN1, RAN2); |

RAN1 is also tasked to discuss regarding the following enhancement:

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| PDCCH monitoring resume if UE transmits NACK after PDCCH skipping starts (RAN1); |

This document provides a summary of the contributions submitted to RAN1#113 under Agenda item 9.8. It is also intended to facilitate the discussions regarding the topics under Agenda Item 9.8 with respect to the following assignment by the RAN1 Chair:

[113-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 the revised version of R1-2306086.

# 2 PDCCH monitoring resume after UL NACK

This section captures the summary of the discussions regarding the following enhancement:

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| PDCCH monitoring resume if UE transmits NACK after PDCCH skipping starts (RAN1, see e.g. **Error! Reference source not found.**); |

## 2.1 Proposal and summary of views

This enhancement was discussed last meeting and no consensus was achieved in RAN1.

**Proposal 2-1:** **Resume PDCCH monitoring if UE transmits NACK after PDCCH skipping starts.**

With respect to this enhancements, proponents in [1], [2], [3] support the proposed enhancement.

* **Support:** vivo, MediaTek, Ericsson, Xiaomi, ZTE, Sanechips, China Telecom, China Unicom, Qualcomm, LGE, Huawei, HiSilicon, Google, Meta, Apple, Nokia/NSB
* **Corresponding TPs:**
  + **Draft CR (vivo, et. al [1])**
  + **Draft CR (Nokia/NSB [2])**

### Draft CR (vivo, et. al [1])

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| **Reason for Change**:  **Background:**  In Rel-17, the PDCCH skipping feature has been introduced under the power saving enhancements. The UE can be indicated to skip monitoring for a duration by the scheduling DCI format X-1/X-2. Although this Rel-17 feature was introduced for power saving purposes, it also impacts scheduling latency especially for retransmission requests.    **Figure 1. Impact of PDCCH skipping on DL retransmission**  However, in the current Spec, no additional PDCCH monitoring for retransmission is allowed when PDCCH skipping is triggered. As shown in Figure 1, if a PDSCH is not decoded successfully right before the PDCCH skipping, the retransmission would be delayed until the PDCCH skipping duration is ended. This brings in severe impact to services with low latency requirement, e.g., XR and URLLC, where instant HARQ retransmission is critical.  Note: this CR is intended for Rel-18.  **Summary of Change:**  When UE is indicated to skip PDCCH monitoring, if any NACK is transmitted, UE resumes the PDCCH monitoring and cancels the PDCCH skipping.  An RRC configuration parameter [*PdcchMornitoringResumptionAfterNack*] to enable/disable this feature and a corresponding UE behaviour can also be added to TS 38.331 to control when the UE shall operate the feature.  **TP-A:**  10.4 Search space set group switching and skipping of PDCCH monitoring  \*\*\* Unchanged text is omitted \*\*\*  When the PDCCH monitoring adaptation field indicates to a UE to skip PDCCH monitoring for a duration on the active DL BWP of a serving cell, the UE starts skipping of PDCCH monitoring at the beginning of a first slot that is after the last symbol of the PDCCH reception providing the DCI format with the PDCCH monitoring adaptation field. If the UE transmits a PUCCH providing a positive SR before the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of the serving cell, the UE shall monitor PDCCH regardless of PDCCH skipping indication on all serving cells of the corresponding Cell Group when the SR is pending [11, TS 38.321]. If the UE transmits a PUCCH providing a positive SR after the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of the serving cell, the UE resumes PDCCH monitoring starting at the beginning of a first slot that is after a last symbol of the PUCCH transmission in all serving cells of the corresponding Cell Group. When the UE is configured with [*PdcchMornitoringResumptionAfterNack*], after the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of a serving cell, if the UE transmits a PUCCH or a PUSCH providing a NACK value due to incorrectly decoding a PDSCH scheduled by a DCI format received from the serving cell, the UE terminates PDCCH skipping, starting from the beginning of a first slot that is after a last symbol of the PUCCH or PUSCH transmission in the serving cell. During the time of *ra-ResponseWindow* or *msgB-ResponseWindow* or the duration where *ra-ContentionResolutionTimer* is running, the UE shall not skip PDCCH monitoring on SpCell. After the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of a SpCell, when contention resolution is successful [11, TS 38.321], the UE resumes PDCCH monitoring on the SpCell. After the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of a serving cell, when a pending SR is cancelled [11, TS 38.321], the UE resumes PDCCH monitoring in all serving cells of the corresponding Cell Group. If UE transmits a RACH due to positive SR, the UE shall not skip PDCCH monitoring on any serving cell of the corresponding Cell Group during the time of *ra-ResponseWindow* or *msgB-ResponseWindow* or the duration where *ra-ContentionResolutionTimer* is running. If the DRX group of the serving cell is configured and enters outside Active Time, the UE terminates PDCCH skipping for the serving cell.  \*\*\* Unchanged text is omitted \*\*\* |

### Draft CR (Nokia/NSB [2])

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| **Reason for Change**:  If UE is indicated to skip PDCCH monitoring for a duration by scheduling DCI, before the UE sends a NACK, the network cannot schedule re-transmission before the PDCCH skipping duration expires. It was conlcuded in the RAN#99 that RAN1 to discuss the CR proposals intriducing this functionality:   |  | | --- | | It is understood that this functionality is rather minor. Interested companies are encouraged to bring in CR proposals to RAN1 to show the impacts of adding this functionality. RAN1 chair confirmed to handle these proposals in the XR session, and RAN1 is expected to make a decision on these proposals as per normal process |   **Summary of Change:**  Introduce wording that if the UE transmits NACK on PUCCH or PUSCH due to incorrectly decoding PDSCH, the UE shall terminate PDCCH skipping in scehduling cells . The change determines that the skipping is terminated in all scheduling cells, to cover SpCell (i.e. PCell) that can be self-scheduled and cross-carrier scehduled.     |  | | --- | | ***schedulingCellId***  If configured for an SpCell, this field indicates which SCell, in addition to the SpCell, signals the downlink allocations and uplink grants, if applicable, for the concerned SpCell. If configured for an Scell, this field indicates which cell signals the downlink allocations and uplink grants, if applicable, for the concerned SCell. In case the UE is configured with DC, the scheduling cell is part of the same cell group (i.e. MCG or SCG) as the scheduled cell. In case the UE is configured with two PUCCH groups, the scheduling cell and the scheduled cell are within the same PUCCH group. If *drx-ConfigSecondaryGroup* is configured in the *MAC-CellGroupConfig* associated with this serving cell, the scheduling cell and the scheduled cell belong to the same Frequency Range. In addition, the serving cell with an aperiodic CSI trigger and the PUSCH resource scheduled for the report are on the same carrier and serving cell, but the cell for which CSI is reported may belong to the same or a different Frequency Range. The network should not trigger a CSI request for a serving cell in the other Frequency Range when that serving cell is outside Active Time. |   **TP-B:** 10.4 Search space set group switching and skipping of PDCCH monitoring **<Unchanged part omitted>**  When the PDCCH monitoring adaptation field indicates to a UE to skip PDCCH monitoring for a duration on the active DL BWP of a serving cell, the UE starts skipping of PDCCH monitoring at the beginning of a first slot that is after the last symbol of the PDCCH reception providing the DCI format with the PDCCH monitoring adaptation field. If the UE transmits a PUCCH providing a positive SR before the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of the serving cell, the UE shall monitor PDCCH regardless of PDCCH skipping indication on all serving cells of the corresponding Cell Group when the SR is pending [11, TS 38.321]. If the UE transmits a PUCCH providing a positive SR after the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of the serving cell, the UE resumes PDCCH monitoring starting at the beginning of a first slot that is after a last symbol of the PUCCH transmission in all serving cells of the corresponding Cell Group. When the UE is configured with [*PdcchMornitoringResumptionAfterNack*], if the UE transmits a PUCCH or a PUSCH providing a NACK value due to incorrectly decoding a PDSCH from a serving cell, after the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP, the UE terminates PDCCH skipping in the scheduling cell(s) of the serving cell, starting from the beginning of a first slot that is after a last symbol of the PUCCH or PUSCH transmission. During the time of *ra-ResponseWindow* or *msgB-ResponseWindow* or the duration where *ra-ContentionResolutionTimer* is running, the UE shall not skip PDCCH monitoring on SpCell. After the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of a SpCell, when contention resolution is successful [11, TS 38.321], the UE resumes PDCCH monitoring on the SpCell. After the UE detects a DCI format providing the PDCCH monitoring adaptation field indicating to the UE to skip PDCCH monitoring for the duration on the active DL BWP of a serving cell, when a pending SR is cancelled [11, TS 38.321], the UE resumes PDCCH monitoring in all serving cells of the corresponding Cell Group. If UE transmits a RACH due to positive SR, the UE shall not skip PDCCH monitoring on any serving cell of the corresponding Cell Group during the time of *ra-ResponseWindow* or *msgB-ResponseWindow* or the duration where *ra-ContentionResolutionTimer* is running. If the DRX group of the serving cell is configured and enters outside Active Time, the UE terminates PDCCH skipping for the serving cell.  **<Unchanged part omitted>** |

### 2.1.1 Initial Discussions

**Questions: Please provide your view regarding the proposal and proposed TPs.**

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

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| **Company** | **Comment** |
| **ZTE, Sanechips** | It’s OK to support Draft CR (vivo, et.[1])  And one version of CR is preferable. E.g.,related to UE terminate PDCCH skipping in the scheduling cell(s) of the serving cell, we can consider whether or not support this feature, and try to merge it with the first version. |
| **Xiaomi** | Fine with the proposed TP. |
| **Nokia, NSB** | Like raised earlier, the main reason why we proposed separate wording was to consider this also in case of multiple scheduling cells, but if that is not seen necessary by majority, we are fine to limit to one serving cell case.  Beyond that, if we assume that the scheduling cell also triggers skipping, we think the differences between the TPs are minor. TP#A limits to dynamic scheduling case (*scheduled by a DCI format*), while TP#B covers also SPS (*PDSCH from a serving cell*), as a generalization. There is also some difference in ordering, which is probably more of a matter of taste. |
| **Qualcomm** | We support that PDCCH monitoring should be resumed if the UE transmits NACK after PDCCH skipping starts.  Between the two versions, the first one is more preferrable. |
| **Samsung** | Prefer to merge the suggestions of the TP from Nokia, at least to cover SPS PDSCH, into the TP from Vivo. |
| **Google** | We support the TP from vivo. |

# 3 Multiple transmission occasions per CG period

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); |

## 3.1 TDRA design

**Moderator summary:**

In previous meeting, the following agreement was made:

**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

**Companies’ view:**

* **Alt-A1 (3+7):** **CATT, TCL, MTK**, FW(A1/B), FGI(A1/C2), xiaomi (A1/B), NEC (A1/B), Honor (A1/B), Spreadtrum (A1/B) , [ZTE(A1/B/C2)]
* **Alt-B (13+2):** FW, Nokia, HW/HiSi, Lenovo, Google, xiaomi, Spreadtrum, CMCC, Samsung, Sony, NEC, New H3C, Honor, IDC(Type 1), [ZTE(A1/B/C2)]
* **Alt-C-2 (13+2):** Qualcomm, E///, vivo, LG, Sharp, ZTE, CAICT, CMCC, DCM, OPPO, DENSO, Sony, FGI, Panasonic (w defer), IDC(Type 2)
  + - * Type-1: QC, E///, vivo, ZTE, OPPO, DENSO
      * Type-2: QC, E///, vivo, ZTE, IDC, DCM, OPPO

**Moderator’s observations:**

* **Observation 1:** Alt-C2 and Alt-B has most of the support. Alt-A1 has less support and some of the proponents of Alt-A1 prefer to apply a unified solution for A1/B.
* **Observation 2:** Regarding Alt-A1/B, proponents views are summarized a below. Please see below the Moderator’s assessment on specification impact for enhanced Alt-A1/B.
  + Apply Alt-A1/B as it is, i.e. transmit over available slots (Nokia)
  + Enh. 1) Apply *AvailableSlotCounting* from repetition framework to support non-consecutive PUSCHs (Nokia)
  + Enh. 2) Configure single (MTK) or multiple offset(s) for PUSCHs to support non-consecutive PUSCHs (CATT)
  + Enh. 3) Configure bitmap for PUSCHs to support non-consecutive PUSCHs (CATT)
  + Enh. 4) Configure number of TOs in TDRA (TCL)
* **Observation 3:** Regarding Alt-A1/B and Type-2 CG, only SLIV can be changed by activation DCI. The same number of PUSCHs per slots or across slots remain the same, except for Enh. 4 that requires introducing new TDRA
* **Observation 4:** Regarding support of Alt-C2, proponents views are summarized a below. Please see below the Moderator’s assessment on specification impact.
  + For Type-1, apply configuration of multiPUSCH TDRA.
  + For Type-2, allow multiple SLIVs for activation DCI.
  + For determining slots for PUSCHs in a period, the first PUSCH is determined as legacy. For remaining PUSCHs, followings are proposed based on applying corresponding K2:
    - Applying corresponding K2 as compared to the first PUSCH (Ericsson, QC, differently expressed), or the preceding PUSCH (vivo) in the period.
      * **Moderator’s view: Both options work. Somewhat using “first PUSCH” as reference for K2 as compared to “preceding PUSCH” is simpler and more aligned with definition of K2.**
* **Observation 5:** Regarding Alt-C2, it is proposed to apply deferring (Panasonic). It is not clear the need for additional for deferring when Alt-C2 can adjust timing of PUSCHs to available UL slots.

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

For assessment regarding specification impact, related descriptions from specifications are captured inTable 1 to facilitate the discussions.

**Comments on Alt-A1/B**

* **Comment 1)** Requires introducing new RRC parameters, different from repetition/NR-U.
* **Comment 2)** To determine corresponding slots for PUSCHs in a period:
  + For the first PUSCH in the period as the legacy.
  + For remaining PUSCHs in the period, requires specifying procedures that reuses corresponding procedures for repetition/NR-U, respectively (e.g. for Alt-B, the highlighted blue text for NR-U in 38.214 and 38.321should be applied to new RRC parameters).

**Comments on Alt-C2**

* **Comment 3)** Does not require introducing new RRC parameters (reusing multiPUSCH TDRA)
* **Comment 4)** For Type-1, specify support of multi-PUSCH. For Type-2, specify allow activation for multiple SLIVs.
* **Comment 5)** To determine corresponding slots for PUSCHs in a period:
  + For the first PUSCH in the period as the legacy.
  + For remaining PUSCHs in the period
    - For Type-1, specify one of the options as in Observation 4.
    - For Type 2, specify to apply corresponding K2 as for 1st PUSCH.

**Comments on enhanced Alt-A1/B and Alt-C2:**

* **Comment 6)** Regarding Enh. 1 for Alt-A1/B:
  + Based on current specification, *AvailableSlotCounting* is applicable for repetition (K>1), and not applicable for NR-U. it seems additional specification is needed to make this method work when NR-U framework is reused (Alt-B) or repetition.
* **Comment 7)** Regarding Enh. 2 or 3:
  + - For Type-2, only SLIV can be changed by activation DCI. The offsets for non-consecutive PUSCHs across slots remain the same. Otherwise, the corresponding offsets/bitmaps parameters needs to be included in TDRA which requires introducing new TDRA
* **Comment 8)** Regarding Enh. 4, introducing new TDRA is required.
* **Comment 9)** Regarding enhancement in Observation 5 for Alt-C2, additional specification is needed since such a procedure is not supported. If the intention is to reuse *AvailableSlotCounting,* please see Comment 6.

Table 1: Descriptions form specifications regarding Type-1/Type-2 CG

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| **TS 38.214****6.1.2.3 Resource allocation for uplink transmission with configured grant** When PUSCH resource allocation is semi-statically configured by higher layer parameter *configuredGrantConfig* in *BWP-UplinkDedicated* information element, and the PUSCH transmission corresponding to a configured grant, the following higher layer parameters are applied in the transmission:  - For Type 1 PUSCH transmissions with a configured grant, the following parameters are given in *configuredGrantConfig* unless mentioned otherwise:  - For the determination of the PUSCH repetition type, if the higher layer parameter *pusch-RepTypeIndicator* in *rrc-ConfiguredUplinkGrant* is configured and set to 'pusch-RepTypeB', PUSCH repetition type B is applied; otherwise, PUSCH repetition type A is applied;  - For PUSCH repetition type A, the selection of the time domain resource allocation table follows the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1.  - For PUSCH repetition type B, the selection of the time domain resource allocation table is as follows:  - If *pusch-RepTypeIndicatorDCI-0-1* in *pusch-Config* is configured and set to *'*pusch-RepTypeB*'*, *pusch-TimeDomainAllocationListDCI-0-1* in *pusch-Config* is used;  - Otherwise, *pusch-TimeDomainAllocationListDCI-0-2* in *pusch-Config* is used.  - It is not expected that *pusch-RepTypeIndicator* in *rrc-ConfiguredUplinkGrant* is configured with *'*pusch-RepTypeB*'* when none of *pusch-RepTypeIndicatorDCI-0-1* and *pusch-RepTypeIndicatorDCI-0-2* in *pusch-Config* is set to *'*pusch-RepTypeB*'*.  - The higher layer parameter *timeDomainAllocation* value *m* provides a row index *m*+1 pointing to the determined time domain resource allocation table, where the start symbol and length are determined following the procedure defined in Clause 6.1.2.1;  - Frequency domain resource allocation is determined by the *N* LSB bits in the higher layer parameter *frequencyDomainAllocation*, forming a bit sequence , where is the LSB, according to the procedure in Clause 6.1.2.2 and *N* is determined as the size of frequency domain resource assignment field in DCI format 0\_1 for a given resource allocation type indicated by *resourceAllocation,* except if *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated* is configured, in which case uplink type 2 resource allocation is used wherein the UE interprets the LSB bits in the higher layer parameter *frequencyDomainAllocation* as for the frequency domain resource assignment field of DCI 0\_1 according to the procedure in Clause 6.1.2.2.3*;*  - The *IMCS* is provided by higher layer parameter *mcsAndTBS;*  - Number of DM-RS CDM groups, DM-RS ports, SRS resource indication and DM-RS sequence initialization are determined as in Clause 7.3.1.1.2 of [5, TS 38.212], and the antenna port value, the bit value for DM-RS sequence initialization, precoding information and number of layers, SRS resource indicator are provided by *antennaPort, dmrs-SeqInitialization, precodingAndNumberOfLayers*, and *srs-ResourceIndicator* respectively; When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2,* precoding information and number of layers (applicable when higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook') associated with the first and second SRS resource set is provided by *precodingAndNumberOfLayers and precodingAndNumberOfLayers2,* respectively, and SRS resource indicators associated with the first and second SRS resource sets are provided by *srs-ResourceIndicator* and *srs-ResourceIndicator2,* respectively. When both *srs-ResourceSetToAddModList* and *srs-ResourceSetToAddModListDCI-0-2* are configured with two SRS resource sets, the two SRS resource sets configured by *srs-ResourceSetToAddModList* is used to determine the SRS resource indications by *srs-ResourceIndicator* and *srs-ResourceIndicator2.*  - If two SRS resource sets with usage set to 'codebook' or 'noncodebook' are configured in *srs-ResourceSetToAddModList*, the two SRS resource sets are used to determine the SRS resource indications by *srs-ResourceIndicator* and *srs-ResourceIndicator2*.  - otherwise, the two SRS resource sets with usage set to 'codebook' or 'noncodebook' configured in *srs-ResourceSetToAddModListDCI-0-2* are used to determine the SRS resource indications by *srs-ResourceIndicator* and *srs-ResourceIndicator2*.  - When frequency hopping is enabled, the frequency offset between two frequency hops can be configured by higher layer parameter *frequencyHoppingOffset.*  - For Type 2 PUSCH transmissions with a configured grant: the resource allocation follows the higher layer configuration according to [10, TS 38.321], and UL grant received on the DCI.  - The PUSCH repetition type and the time domain resource allocation table are determined by the PUSCH repetition type and the time domain resource allocation table associated with the UL grant received on the DCI, respectively, as defined in Clause 6.1.2.1. The value of Koffset, if configured, is applied when determining the first transmission opportunity.  For PUSCH transmissions with a Type 1 or Type 2 configured grant, the number of (nominal) repetitions *K* to be applied to the transmitted transport block is provided by the indexed row in the time domain resource allocation table if *numberOfRepetitions* is present in the table; otherwise *K* is provided by the higher layer configured parameters *repK.*  …  A set of allowed periodicities *P* are defined in [12, TS 38.331]. The higher layer parameter *cg-nrofSlots*, provides the number of consecutive slots allocated within a configured grant period. The higher layer parameter *cg-nrofPUSCH-InSlot* provides the number of consecutive PUSCH allocations within a slot, where the first PUSCH allocation follows the higher layer parameter *timeDomainAllocation* for Type 1 PUSCH transmission or the higher layer configuration according to [10, TS 38.321], and UL grant received on the DCI for Type 2 PUSCH transmissions, and the remaining PUSCH allocations have the same length and PUSCH mapping type, and are appended following the previous allocations without any gaps. The same combination of start symbol and length and PUSCH mapping type repeats over the consecutively allocated slots. **TS 38.214** Table 6.1.2.1.1-1: Applicable PUSCH time domain resource allocation for common search space and DCI format 0\_0 in UE specific search space   |  |  |  |  |  | | --- | --- | --- | --- | --- | | RNTI | PDCCH search space | *pusch-ConfigCommon* includes *pusch-TimeDomainAllocationList* | *pusch-Config* includes *pusch-TimeDomainAllocationList* | PUSCH time domain resource allocation to apply | | PUSCH scheduled by MAC RAR as described in clause 8.2 of [6, TS 38.213] or MAC fallbackRAR as described in clause 8.2A of [6, 38.213] or for MsgA PUSCH transmission | | No | - | Default A | | Yes |  | *pusch-TimeDomainAllocationList* provided in *pusch-ConfigCommon* | | C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI | Any common search space associated with CORESET 0 | No | - | Default A | | Yes |  | *pusch-TimeDomainAllocationList* provided in *pusch-ConfigCommon* | | C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI | Any common search space not associated with CORESET 0,  DCI format 0\_0 in  UE specific search space | No | No | Default A | | Yes | No | *pusch-TimeDomainAllocationList* provided in *pusch-ConfigCommon* | | No/Yes | Yes | *pusch-TimeDomainAllocationList* provided in *pusch-Config* |   Table 6.1.2.1.1-1A: Applicable PUSCH time domain resource allocation for DCI format 0\_1 in UE specific search space scrambled with C-RNTI, MCS-C-RNTI, CS-RNTI or SP-CSI-RNTI   |  |  |  |  |  | | --- | --- | --- | --- | --- | | *pusch-ConfigCommon* includes *pusch-TimeDomainAllocationList* | *pusch-Config* includes *pusch-TimeDomainAllocationList* | *pusch-Config* includes *pusch-TimeDomainAllocationListDCI-0-1* | *pusch-Config* includes *pusch-TimeDomainAllocationListForMultiPUSCH* | PUSCH time domain resource allocation to apply | | No | No | No | No | Default A | | Yes | No | No | No | *pusch-TimeDomainAllocationList* provided in *pusch-ConfigCommon* | | No/Yes | Yes | No | No | *pusch-TimeDomainAllocationList* provided in *pusch-Config* | | No/Yes | No | Yes | - | *pusch-TimeDomainAllocationListDCI-0-1* provided in *pusch-Config* | | No/Yes | No | - | Yes | *pusch-TimeDomainAllocationListForMultiPUSCH* provided in *pusch-Config* |  **TS 38.213****10.2 PDCCH validation for DL SPS and UL grant Type 2** A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if  - the CRC of a corresponding DCI format is scrambled with a CS-RNTI provided by *cs-RNTI* or a G-CS-RNTI provided by g-cs-RNTI, and  - the new data indicator field in the DCI format for the enabled transport block is set to '0', and  - the DFI flag field, if present, in the DCI format is set to '0', and  - the time domain resource assignment field in the DCI format indicates a row with single SLIV, and  - if validation is for scheduling activation and if the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format is present, the PDSCH-to-HARQ\_feedback timing indicator field does not provide an inapplicable value from *dl-DataToUL-ACK-r16*.  .... **TS 38.321****5.8.2 Uplink** There are two types of transmission without dynamic grant:  - configured grant Type 1 where an uplink grant is provided by RRC, and stored as configured uplink grant;  - configured grant Type 2 where an uplink grant is provided by PDCCH, and stored or cleared as configured uplink grant based on L1 signalling indicating configured uplink grant activation or deactivation.  Type 1 and Type 2 are configured by RRC for a Serving Cell per BWP. Multiple configurations can be active simultaneously in the same BWP. For Type 2, activation and deactivation are independent among the Serving Cells. For the same BWP, the MAC entity can be configured with both Type 1 and Type 2.  ….  Upon configuration of a configured grant Type 1 for a BWP of a Serving Cell by upper layers, the MAC entity shall:  1> store the uplink grant provided by upper layers as a configured uplink grant for the indicated BWP of the Serving Cell;  1> initialise or re-initialise the configured uplink grant to start in the symbol according to *timeDomainOffset*, *timeReferenceSFN*, and *S* (derived from *SLIV* or provided by *startSymbol* as specified in TS 38.214 [7]), and to reoccur with *periodicity*.  After an uplink grant is configured for a configured grant Type 1, the MAC entity shall consider sequentially that the Nth (N >= 0) uplink grant occurs in the symbol for which:  [(SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  (*timeReferenceSFN* × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  + *timeDomainOffset* × *numberOfSymbolsPerSlot* + S + N × *periodicity*)  modulo (1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  …..  After an uplink grant is configured for a configured grant Type 2, the MAC entity shall consider sequentially that the Nth (N >= 0) uplink grant occurs in the symbol for which:  [(SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  [(SFNstart time × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  + slotstart time × *numberOfSymbolsPerSlot* + symbolstart time) + N × *periodicity*]  modulo (1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  where SFNstart time, slotstart time, and symbolstart time are the SFN, slot, and symbol, respectively, of the first transmission opportunity of PUSCH where the configured uplink grant was (re-)initialised.  If *cg-nrofPUSCH-InSlot* or *cg-nrofSlots* is configured for a configured grant Type 1 or Type 2, the MAC entity shall consider the uplink grants occur in those additional PUSCH allocations as specified in clause 6.1.2.3 of TS 38.214 [7].  NOTE: In case of unaligned SFN across carriers in a cell group, the SFN of the concerned Serving Cell is used to calculate the occurrences of configured uplink grants. |

Table 2: Summary of Contributions inputs for Section 3.1

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Qualcomm | **Observation 1**: Configuration of consecutive CG PUSCH occasions is needed by NR-U but too restrictive for licenced spectrum.  \* Configuration of non-consecutive CG PUSCH occasions in licenced spectrum is beneficial for multiple user scheduling with traffics of different periodicities, priorities, and delay requirements.  \* Alt-C2 can also be used to enable consecutive CG PUSCH occasions if needed.  **Observation 2**: Unlike PUSCH repetition and TBoMS which prefers a consistent equivalent coding rate for all TBs, it is unclear why the same number of available PUSCH occasions (i.e., PUSCH occasions not colliding with DL symbols) needs to be maintained across CG periods.  **Observation 3**: Even in FDD where the number of available PUSCH occasions is same across CG periods, there is also size mismatch between the XR data burst and the reserved UL resources. Common solutions should be considered for both FDD and TDD.  **Proposal 1**: Support Alt-C2 for the determination of TDRA for multiple PUSCH occasions in the CG period  \* Alt-C2: Follow Rel-17 single DCI scheduling multiple PUSCHs.  **Proposal 2**: For Type 2 multi-PUSCH CG, TDRA field in the activation DCI indicates a row with multiple {K2, SLIV, PUSCH mapping types} combinations.  \* RRC configuration pusch-TimeDomainAllocationListForMultiPUSCH-r16 can be reused as the TDRA table for multi-PUSCH CG configuration.  \* Remove the restriction that the TDRA field in the CG activation DCI format indicates a row with single SLIV.  \* RAN1 discusses if multiple fields of RV and NDI are included in the activation and release DCI.  **Proposal 3**: For the Type 1 multi-PUSCH CG, time domain resource for PUSCH occasions is determined by:  \* RRC configuration timeDomainAllocation in the rrc-ConfiguredUplinkGrant in ConfiguredGrantConfig indicates a row in the TDRA table with multiple combinations of {SLIV, K2, PUSCH mapping type} each for a PUSCH occasion in the CG period.  \* RRC configuration pusch-TimeDomainAllocationListForMultiPUSCH-r16 can be reused as the TDRA table.  \* For the Nth multi-PUSCH CG period, the CG PUSCH occasion that is configured with K2 and start symbol S starts at the symbol with "SFN", "slot number in the frame" and "symbol number in the slot" given by the formula:  [(SFN × numberOfSlotsPerFrame × numberOfSymbolsPerSlot) + (slot number in the frame × numberOfSymbolsPerSlot) + symbol number in the slot] = (timeReferenceSFN × numberOfSlotsPerFrame × numberOfSymbolsPerSlot + (timeDomainOffset + K2) × numberOfSymbolsPerSlot + S + N × periodicity) modulo (1024 × numberOfSlotsPerFrame × numberOfSymbolsPerSlot) |
| Ericsson | **Observation 1** Alt-A1, Alt-B and Alt-C are comparable with respect to complexity and specification impacts are comparable, with slight differences.  **Observation 2** Alt-A1 is a special case of Alt-B. Both Alt-A1 and Alt-B are special case of Alt-C2. Alt-A1 and Alt- B are not suitable for TDD operation as opposed to Alt-C2. Modification in Alt-A1 and Alt-B for operation on TDD band, mimics Alt-C2 with a same SLIV configuration  **Observation 3** The design choice should ensure the usefulness of the feature for realistic scenarios.  \* For TDD operation, the UL opportunities occur in different slots, and typically, one CG PUSCH is used per slot.  \* For proper resource management, there may be a need of different sizes of UL resources in different slots.  **Observation 4** Alt-C2 provides the needed flexibility to make the feature useful for different scenarios, as opposed to Alt-A1 and Alt-B which inherit simplifications and restrictions by design.  **Observation 5** The specification impacts to support Alt-C2 are straightforward. With Alt-C2, the multi-PUSCH CG configuration would be a useful feature otherwise the specifications would result in a feature with limited applicability.  **Proposal 1** Multi-PUSCHs scheduling by a single DCI in Rel-17 is considered as the baseline for the design of multi-PUSCHs CG in Rel-18 (i.e., Alt-C2).  **Proposal 2** A row with multiple SLIVs of a TDRA table determines the SLIVs associated to the PUSCHs within a period of a multi-PUSCHs CG.  \* pusch-TimeDomainAllocationListForMultiPUSCH for non-consecutive slots is used for the TDRA table.  \* For Type-2, the activation DCI format 0\_1 can indicate a row with multiple SLIVs.  \* For Type-1, as in legacy, the timeDomaiAllocation parameter can indicates a row of the TDRA table.  \* the slot of the 1st PUSCH in a period is determined following the legacy rules.  \* the slot of the any other PUSCH in the period is determined based on the corresponding indicated k2 value in reference to the slot with the first PUSCH in the period. |
| Futurewei | **Observation 1**: Both the repetition framework (i.e., Alt-A1) and NR-U framework in Rel-16 (i.e., Alt-B) can support the configuration of multiple CG PUSCH transmission occasions in a period of a single CG PUSCH in Rel-18 XR Enhancements.  **Proposal 1**: Support at least the same symbol allocation for the multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration in Rel-18 XR Enhancements.  **Proposal 2**: The configured multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration in Rel-18 XR Enhancements can take repetition framework (i.e., Alt-A1) or NR-U framework in Rel-16 (i.e., Alt-B) as the baseline. |
| 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**: For multiple CG PUSCH occasions in a period of a single CG configuration, Alt-C2 is supported.  \* Alt-C2: Follow Rel-17 single DCI scheduling multiple PUSCHs  o TDRA configured by pusch-TimeDomainAllocationListForMultiPUSCH-r16 with extendedK2-r17  o 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.  o FFS details, including related RRC parameters  **Proposal 2**: For multiple CG PUSCH occasions in a period of a single CG configuration, if Alt-C2 is supported, for Type 1 CG, the following options can be considered to determine the TDRA of each CG PUSCH occasion within a CG period.  \* Option 1: K2s in the TDRA table is used to determine the slot of each CG PUSCH occasion and each K2 is relative to the starting of the CG period or timeReferenceSFN.  \* Option 2: For the first configured CG PUSCH occasion within the CG period, its position is determined based on timeDomainOffset by reusing the same mechanism as legacy. For the remaining CG PUSCH occasion(s) within the CG period, the corresponding slot(s) is determined based on K2s in TDRA table and each K2 is relative to the slot of preceding CG PUSCH occasion within the same CG period.  **Proposal 3**: For multiple CG PUSCH occasions in a period of a single CG configuration, if Alt-C2 is supported, further discussion on the validation of DCI scrambled by CS-RNTI for activation/release of CG configuration(s) is needed, e.g., how to set the value of NDI field in case of multiple NDI bits. |
| CATT | **Observation 1**: The same SLIV between the different PUSCH occasions in the CG configuration is sufficient for UL XR traffic periodic arrival, i.e. the Alt-A1 and Alt-B can be further considered for XR Specific capacity improvements.  **Observation 2**: The Alt-C2 with single DCI scheduling multi-PUSCHs can only be used for the Type 2 CG enhancement with DCI for CG activation to be enhanced with single DCI scheduling multiple PUSCHs. Type 1 CG has no DCI for CG activation and would not be used by Alt-C2 single DCI scheduling multi-PUSCHs.  **Proposal 1**: The Alt-A1: TDRA determination based on repetition framework should be supported for the SLIV determination, in which  \* N PUSCH occasions in a CG period with the same SLIV can be configured by higher layers or indicated by activation DCI;  \* The single TB transmission over multiple CG occasions should be supported.  **Proposal 2**: Multi-PUSCHs CG configuration should be supported including:  \* The configuration of consecutive and non-consecutive CG PUSCH occasions should both be supported to provide the flexibility of gNB implementation for the adaptation of different XR traffic;  \* There are two alternatives to determine the first occasions of each non-consecutive CG PUSCH occasion sets can be considered as following:  \* Alt-1: Multiple offsets configured for the first occasions of the non-consecutive CG PUSCH occasion sets.  \* Alt-2: The bitmap configured for the non-consecutive CG PUSCH occasions. |
| 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**: Follow the time domain resource mapping of Type A repetition can be used for multiple TOs within a CG configuration.  \* N indicated by activation DCI  \* Single SLIV is determined from TDRA  \* The same SLIV in N PUSCH in consecutive slots per CG period  **Proposal 2**: The number of multiple TOs within a CG configuration can be indicated by TDRA. |
| Nokia/NSB | **Observation 1**: Alt-C framework (TDRA determination based on single DCI scheduling multiple PUSCHs) is only applicable to Type 2 CG configuration. For Type 1 CG configuration, such framework will not work as it requires DCI to provide the entry to TDRA list.  **Observation 2**: It is not feasible to optimize SLIV when CG configuration is decided as there is not enough information about traffic (i.e., the exact frame size) at that point. Therefore, supporting different SLIVs for each slot as in Alt-C (TDRA determination based on single DCI scheduling multiple PUSCHs) is not motivated.  **Observation 3**: In Alt B (TDRA determination based on NR-U framework), by transmitting over available slots and continue counting each slot, it is possible to transmit over up to 8 UL slots per CG period, which shall be enough for video frame in UL (e.g., with max 40 slots per CG period as per current RRC specification, TDD structure DDDSU, and 30 kHz).  **Observation 4**: The feature AvailableSlotCounting from repetition framework allows counting available slots only (e.g., UL slots) and can support transmission over consecutive available UL slots in Alt-B (TDRA determination based on NR-U framework).  **Proposal 1**: Consider NR-U framework to support multi-PUSCHs per CG period in licensed band.  \* FFS: Number of occasions per slot.  **Proposal 2**: To transmit over consecutive available slots when configuring multi-PUSCHs per CG, consider the following solutions: (i) AvailableSlotCounting from repetition framework or (ii) transmitting over available slots (e.g., UL slot) and continue counting each slot. |
| LG | **Proposal 1**: Support multiple CG occasions in a period based on a TDRA table where each row includes multiple SLIV values for CG.  \* FFS : DMRS mapping type, repetition type, numberOfRepetitions  **Proposal 2**: It is necessary to investigate how to support the repetition for each of multiple SLIVs in a same TDRA row.  **Proposal 3**: It is necessary to investigate how to determine TDRA table for Type-1 CG for new resource allocation method.  **Proposal 4**: Discuss how to apply the enhanced TDRA for Type-1 CG. |
| Sharp | **Proposal 1**: TDRA determination based on single DCI scheduling multiple PUSCHs in Rel-17 to allow non-consecutive PUSCHs and/or in non-consecutive slots.  \* A row of TDRA with N entries determines the time domain resources allocation of N PUSCH TOs per period. |
| Huawei/HiSilicon | **Observation 1**:The framework based on NR-U (Alt-B) can apply to both CG Type 1 and CG Type 2.  **Observation 2**: The framework based on repetition Type A (Alt-A1) is similar with the framework based on NR-U (Alt-B) without the parameter M.  **Observation 3**: The framework based on single DCI scheduling multiple CG PUSCH (Alt-C2) is not suitable for CG Type 1 and additional workload is needed.  **Observation 4**: The number of CG PUSCH occasions may vary in different CG periods due to TDD configuration, thus bring inaccuracy and difficulty for gNB configuration.  **Proposal 1**: For TDRA design for multi-CG PUSCH, a unified design for CG type 1 and CG type 2 is preferred, and Alt-A1/Alt-B are supported.  **Proposal 2**: RAN1 to address the case where the configured CG PUSCH occasion(s) may overlap with DL symbol(s)/slot(s) due to TDD configuration.  \* The same number of CG PUSCH transmission occasions in each CG period shall be ensured. |
| ZTE/Sanechips | **Observation 1**: Consecutive CG PUSCHs should be configured for XR UL video service to address the stringent PDB requirement.  **Observation 2**: Instead of mini-slot based CG PUSCH, slot-based CG PUSCH configuration is suitable for XR video traffic.  **Observation 3**: The constraint of using same SLIV value may lead to inefficient resource usage and limited TDRA.  **Observation 5**: For Alt-A1 and Alt-B, using single SLIV value is not reasonable because this constraint may rule out allocation of UL symbols in flexible slots in TDD configuration for CG PUSCH.  **Observation 6**: For Alt-C2, flexible SLIV values for different for CG PUSCH can be supported.  **Observation 7**: TDRA table of current CG Type 1 includes only single SLIV table.  **Proposal 1**: Different SLIV values for different CG PUSCHs in one CG period should be supported for multi-PUSCHs CG.  **Proposal 2**: Support Alt-C2 for TDRA determination for multi-PUSCHs CG Type 2, i.e., following Rel-17 single DCI scheduling multiple PUSCHs.  **Proposal 3**: Support to extend the timeDomainAllocationList to multi-SLIVs table for CG Type 1.  **Proposal 4**: Alt-A1 and Alt-B for TDAR determination of multi-PUSCHs CG can be considered if different SLIV values for different CG PUSCHs in one CG period is supported. |
| IDC | **Proposal 1**: TDRA design based on Alt-B (NR-U framework) can be considered at least for Type-1 multi-PUSCH CG enhancements  **Proposal 2**: TDRA based on Alt-C2 (Rel-17 single SCI scheduling multiple PUSCH) can be considered for Type-2 multi-PUSCH CG enhancements  **Proposal 3**: The following parameters are configured for multi-PUSCH CG configuration:  - Number of consecutive PUSCH occasions per slot  - Number of consecutive UL slots per CG period |
| Apple | **Proposal 5**: CG PUSCH occasions with the same CG configuration can be associated different number of OFDM symbols.  **Proposal 6**: Consider both licensed spectrum access and unlicensed/shared spectrum access in the TDRA design. For unlicensed spectrum access, only those TDRA patterns allowed in NR-U design can be configured. |
| Lenovo | **Proposal 1**: Support Alt-B for time domain resource allocation of CG PUSCHs associated to multi-PUSCHs CG.  \* Semi-statically available UL slots are considered for the purpose of TDRA. |
| Google | **Proposal 1**: The TDRA determination based on NR-U framework should be extended to XR with some enhancements.  **Proposal 2**: The legacy configuredGrantTimer can be used for each PUSCH occasion of the multiple CG PUSCH transmission occasions instead of the cg-RetransmissionTimer used in NR-U. |
| xiaomi | **Proposal 1**: Alt-A1 and Alt-B should be prioritized for determination of the TDRA of CG PUSCHs associated to a multi-PUSCHs CG. |
| MTK | **Observation 1**: XR UL video traffic characteristics based on large and varying packet size and strict latency requirements are the underlying motivations for XR-specific configured grant enhancements in Rel-18.  **Proposal 1**: TDRA framework uses PUSCH repetition type-A as baseline (Alt-A1).  **Proposal 2**: A time offset parameter configured semi-statically by the network indicates the time gap between the 1st and the 2nd PUSCH TOs in number of slots.  **Proposal 3**: The rest of the PUSCH TOs from the 2nd TO onwards (i.e., the 2nd, 3rd, etc. TOs) are assigned in back-to-back UL slots (based on Alt-A1 PUSCH repetition type-A framework as baseline). |
| Spreadtrum | **Proposal 1**: For TDRA design for multi-CG PUSCH, prioritize Alt-A1, Alt-B for further down-scoping. |
| CAICT | **Proposal 1**: Support Alt-C2 (Follow Rel-17 single DCI scheduling multiple PUSCHs) for determination of TDRA for multi-PUSCHs CG. |
| CMCC | **Proposal 1**. For determination of the time domain resource allocation of CG PUSCHs associated to a multi-PUSCHs CG, one of the following alternatives can be supported:  \* Alt-B with modifications to configure N PUSCH occasions in non-consecutive slots within a CG period  \* Alt-C2 for TDRA determination of multi-PUSCHs CG. |
| DCM | **Proposal 1**: Support Alt C-2 for TDRA of multiple CG PUSCHs in one CG period, i.e. following Rel-17 single DCI scheduling multiple PUSCHs.  **Proposal 2**: Relax the limitation for validation of CG PUSCH activation DCI, when the TDRA field in the activation DCI indicates multiple SLIVs. |
| OPPO | **Proposal 1**: Support Alt-C2 to determine time domain resource allocation of multiple CG PUSCHs in one CG period,  \* For Type-1 CG, timeDomainAllocation in the rrc-ConfiguredUplinkGrant indicates a row of TDRA configured by pusch-TimeDomainAllocationListForMultiPUSCH-r16 with extendedK2-r17.  \* For Type-2 CG, relax the limitation that the time domain resource assignment field in CG activation DCI indicates a row with single SLIV. |
| Samsung | **Proposal 1**: Extend the Rel-16 NR-U design using cg-nrofSlots and cg-nrofPUSCH-InSlot to non-shared spectrum to support "multi-PUSCH CG". |
| Panasonic | **Proposal 1**: Alt-C2 should be considered for designing the time domain resource allocations for multi-PUSCHs CG. In addition, each PUSCH collided with a DL slot/symbol should be deferred to a next available slot similar to Type A repetition (Alt-A1). A maximum deferral value should be defined as a CG configuration. |
| DENSO | **Observation 1**: For TDRA design, Type-A repetition framework (Alt-A1) and NR-U framework (Alt-B) can be merged for down-selection.  **Observation 2**: In terms of XR traffic characteristics, PUSCH transmission in non-consecutive slots would be useful to accommodate non-integer periodicity with a single CG configuration.  **Observation 3**: TDRA determination based on Rel-17 single DCI scheduling multiple PUSCHs (Alt-C2) can be applied to CG Type 1 by extending the legacy equation for determining the time domain of Nth CG PUSCH occasion with the parameter K2.  **Proposal 1**: For TDRA design, Alt-C2 can be prioritized. |
| 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 may require 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**: Different type of TDRA determination of CG PUSCHs associated to a multi-PUSCHs CG can be supported for different type of CG types (i.e., CG Type-1 and CG Type-2).  **Proposal 1**: Support TDRA determination based on NR-U framework (Alt-B) and TDRA determination based on single DCI scheduling multiple PUSCHs (Alt-C2): |
| FGI | **Proposal 1**: Adopt Alt-A1 or Alt-C2 for determination of the time domain resource allocation of CG PUSCHs associated to a multi-PUSCHs CG. |
| NEC | **Proposal 1**: support consecutive time domain resource allocation based on Alt-A1 or Alt-B. |
| New H3C | **Proposal 1**: For determination of the time domain resource allocation of CG PUSCHs associated to a multi-PUSCHs CG, 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 |
| Honor | **Observation 1**: Alt-A1 or Alt-B and Alt-C have comparable specification impact, while Alt-C provides flexibility with respect to different SLIV.  **Observation 2**: TDD configuration issue could be solved by changing the consecutive slots to consecutive available uplink slots for Alt-A1 or Alt-B and Alt-C1 while it is more complicated for Alt-C2.  **Proposal 1**: If Alt-C1 is an excluded option, we support either Alt-A1 or Alt-B. |

### 3.1.1 Initial Discussions

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

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

* **Suggestion 1)** Moderator recommends focusing on Alt-B and Alt-C2.
* **Suggestion 2)** Consider to complete solution for each of Alt-B and Alt-C2.
  + Note: Moderator provides initial proposals for this purpose (P3-1-1 and P3-1-2) to be refined based on feedback.
* **Suggestion 3)** Consider discussion to support **both Alt-B and Alt-C2 without additional enhancements**.
  + This suggestion is based on the observations that these two alternatives provide possibility for configuration of multi-PUSCH CG with different properties as discussed in previous section.
  + Another aspect is depending which TDRA is applied for operation (see Table 6.1.2.1.1-1A in 38.214 for example), there will be a possibility for configuration of multi-PUSCHs CG.

**Proposal 3-1-1:**

**For multi-PUSCH CG configuration, if Alt-B (from RAN1#112 agreement) is supported:**

* For TDRA determination (based on NR-U framework)
  + 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
* 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 *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16*
* 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.
* 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 and M, instead.
  + ~~FFS details, including related RRC parameters~~

**Proposal 3-1-2:**

**For multi-PUSCH CG configuration, if Alt-C2 (from RAN1#112 agreement) is supported:**

* For TDRA determination (based on single DCI scheduling multiple PUSCHs)
  + Follow Rel-17 TDRA for 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~~
* 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
    - For Type-1, apply the corresponding K2 as compared to the first PUSCH.
    - For Type 2, apply corresponding K2 as for the 1st PUSCH.
* For Type-2, relax the limitation for validation of CG PUSCH activation DCI, when the TDRA field in the activation DCI indicates multiple SLIVs.

**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 of properties of different alternatives and status of companies’ support?
* **Q3:** What is your view on **Proposal 3-1-1** and **Proposal 3-1-2**? What is your suggestion for improvement, correction and/or simplification?
* **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** |
| Futurewei | Q1: We are ok with Moderator’s observations and assessments of needed specifications  Q2: We are ok with Moderator’s suggestions  Q3: We are ok with Proposal 3-1-1. For Proposal 3-1-2, it looks like that the proposal can only be applied to Type 2 CG, can you please clarify how to apply it to Type 1 CG?  Q4: We prefer a unified solution for both Type 1 CG and Type 2 CG, additionally, Alt-B can also easily support non-consecutive PUSCHs if *AvailableSlotCounting* rule reused, obviously Alt-B is preferred compared to Alt-C2, which needs much more standard efforts for *K2* indications for different non-consecutive PUSCHs. |
| **ZTE, Sanechips** | Thanks for collection of corresponding spec impact for each solution. And they are reflected at Proposal 3-1-1, Proposal 3-1-2 respectively.  **For Proposal 3-1-1(enhanced Alt B),** we suggest to consider to support multiple SLIVs in case of allocating symbols in both S slots and U slots for multi PUSCH CG.  **For Proposal 3-1-2(enhanced Alt C1),** we think legacy procedure can be reused for determine **the slot** of first PUSCH for both Type-1 and Type 2. And for **the slots** of remaining PUSCHs in the period, they can be determined via the number of configured/valid PUSCHs in a period. In that respect,we think K2 parameter(s) are not necessary, and the spec change is minor. So we suggest:  For slots of remaining PUSCHs in the period   * Option 1: Not apply K2 at least for type-1 CG. * Option 2: apply K2 for type-1 CG and type-2 CG respectively. |
| **DOCOMO** | Q1: Agree with Moderator’s observations and assessments of needed specifications.  Q2: Fine with Moderator’s suggestions.  Q3: Fine with Proposal 3-1-1 and Proposal 3-1-2.  We understand that some enhancement is needed to apply Alt-C2 for type 1 CG, e.g. using multi-PUSCH TDRA table for type 1 CG. But we think the specification impact is not large. Such specification impact is fine for us. Therefore, we are fine with Alt-C2 applied to type 1 and type 2 CG.  Regarding whether unified solution or not for type 1 and type 2 CG as proposed by some companies, we don’t think it is a must issue. Anyway there are many different rules applied for type 1 CG and type 2 CG in the current specification, e.g. different TDRA table determination rule and different parameter determination method (e.g. by configuration or by activation DCI indication). Therefore, we don’t think it necessary to restrict same rule must be applied for type 1 CG and type 2 CG. In summary, if majority companies don’t want Alt-C2 for type 1 CG, we are fine with using different solutions for type 1 and type 2 CG, i.e. Alt-B for type 1 CG and Alt-C2 for type 2 CG. |
| **Xiaomi** | Thanks for your summary of spec impact for each solution.  We are fine with Proposal 3-1-1. |
| **Nokia, NSB** | We thank the moderator for providing a nice summary! Below please, find our answers to the questions.  **Q1:**  Regarding Observation 2, Enh1: in our view, AvailableSlotCounting is a way to count slots and not exactly to support non-consecutive available slots. With or without AvailableSlotCounting, the available slots shall be consecutive if enough resources in each slot.  **Spec impact:**  **Comment 3:** Regarding no New RRC parameters needed. Is that the case for type 1 CG with Multi-PUSCH? We think new parameters for TDRA list and K2 values will be needed to be included if the option is supported.  **Q2:**  **Suggestion 3:** It is not clear what does enhancement mean here, some tuning will be needed for both alternatives, if that is not excluded, we are ok.  **Q3:**  We support Proposal 3-1-1. The solution that was adopted for NR-U framework is simple and provides necessary support of multi-PUSCH CG. Although, another alternative provides additional flexibility such as different SLIV, K2 values, it is not obvious that such optimization is possible for the whole CG configuration. When configuring the parameters for CG NW does not know what will be the frame size every period, the load during XR operation. Therefore, such optimization will be unnecessary as it will not reflect the real conditions in any way, it will only complicate the configuration. Also, from the assessment, it looks like Proposal 3-1-2 requires more spec changes than Proposal 3-1-1.  **For Proposal 3-1-2:**  It seems that the type 1 CG multi-PUSCH support details are missing from the proposal. |
| **vivo** | Q1: we generally agree with Moderator’s observations and assessments of needed specifications regarding spec impact  Q2: We are fine with Moderator’s suggestions. For suggestion 3, although we don’t see the need to support both alternatives, we can accept the suggestion considering the current state. Also, we think both Alt-A1 and Alt-C2 are supported in unlicensed spectrum in current specification.  Q3: for Proposal 3-1-1, the following redundant part should be removed.  M consecutive PUSCH TOs with same duration in slot. The M PUSCH TOs are used in N consecutive slots per CG period ~~cg-nrofSlots-r16 and cg-nrofPUSCH-InSlot-r16~~  Proposal 3-1-2, we are fine with the proposed solution, i.e., apply the corresponding K2 as compared to the first PUSCH, to determine the slot of the remaining PUSCHs in the period. |
| **Panasonic** | Q1: We are fine with the FL's observations and assessments.  Q2: We are generally fine with the FL’s Suggestions. Regarding the Suggestion 3, we propose to discuss whether further modifications are required, especially for handling the collided PUSCH TOs with DL symbols/slots.  Q3: We are fine with the proposals. |
| **TCL** | Q1: We are fine with Moderator’s observations and assessments of needed specifications regarding spec impact.  Q2: We are generally fine with the FL’s Suggestions.  Q3: Fine with Proposal 3-1-2, according to the agreed traffic model of XR in Rel-17, mean packet size is very large, so, large TB size for XR transmission is suitable, for Alt B, more than one PUSCH TOs within a slot means a large TB need to split into multiple small size of TBs within a slot, it seems no obvious advantage can be achieved. |
| **LG** | Q1: Agree with the FL’s assessments.  Q2: We are fine with the FL’s suggestions.  Q3:  Regarding 3-1-1, we think following bullets should be subject to type-1 CG since type-2 CG would use the TDRA table corresponding to its activation DCI.   * + 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   For proposal 3-1-2, we are fine with the proposal in general. For the clarification, could you bit more elaborate the difference between ‘apply K2 as compared …’ and ‘apply K2 as for’ ?   * + - For Type-1, apply the corresponding K2 as compared to the first PUSCH.     - For Type 2, apply corresponding K2 as for the 1st PUSCH. |
| **Qualcomm** | Q1: we agreed with Moderator’s observations and assessments of needed specifications.  Q2: we agreed with Moderator’s suggestions.  Q3: we support Alt-C2 and agree that discussion of the spec design can be based on Proposal 3-1-2.  Q4: Alt-C2 has minimal (at least not larger than the other alternatives) spec impact for both Type-1 and Type-2 CG. Alt-C2 can be configured to support Alt-B for continuous PUSCH occasions with the CG period but not the other way round. As for implementation, we do not see additional difficulty for UE or gNB to support Alt-C2 in comparison to Alt-B. Hence, Alt-C2 should be adopted. |
| **Lenovo** | Ok with the proposals 3-1-1, 3-1-2 |
| **Samsung** | Q1: Overall OK although we do not have fully aligned view for some specifics of the observations/assessments.  Q2: “Suggestion 3” needs further discussion. In general, having duplicated solutions for a same functionality are not appropriate but can further discuss the case of Alt-B and Alt-C2  Q3: The proposals are fine to start discussions |
| **NEC** | Thanks for the summary, we prefer Proposal 3-1-1. |
| **Google** | **Q1:**  In the observation section, we would have preferred to have the observations for Alt A1 and Alt B listed separately (i.e., mainly Observation 2) to not confuse the two options.  Regarding the specification impact for Alt-B, retransmission may need some specification changes and this could be captured in the Proposal.  Regarding the retransmission for Alt-B, we propose to use legacy CG mechanism instead of the NR-U retransmission mechanism. Same question should be clarified for Alt-C2.  **Q2:**  We agree with the Moderator’s suggestion to focus on Alt-B and Alt-C2. It is good that the moderator provided an initial assessment of the needed specification impact for companies to understand the required changes for each option. However, it would be good to decide between options Alt-B and Alt-C2 during this meeting.  **Q3:**  We agree with Proposal 3-1-1 and Proposal 3-1-2. However, we suggest to add the retransmission aspects for both proposals to get the full picture. |
| **Sharp** | We are fine with the moderator’s observations and proposals. We prefer 3-1-2, but is also fine to support both 3-11 and 3-1-2. There are pros and cons on each method. |
| **SONY** | We are fine with the moderator’s observations and proposals. In our view, both proposals should be supported as each of the proposal can be applied in different case (i.e., ALT-B is for for Type-1 and ALT-C2 is for Type-2). |
| **OPPO** | We are OK with Moderator’s observations and suggestions. We support Proposal 3-1-2, because Alt-C2 has more flexibilities, such as:   1. Reduce the invalid PUSCH TO caused by the collision with DL symbol(s); 2. Non-integer period can be solved by one CG configuration. 3. Allocated different numbers of symbols in different PUSCH TOs, which may be useful to reduce latency. |
| **Moderator** | FW: Moderator to Explain how Proposal 3-1-2 applied to Type-1  ZTE: Moderator to provide clarifications  Nokia: Moderator to explain on spec impact: configuration of TDRa based on existing RRC. New description needed in 38.214.  LG/vivo comments to improve proposal  This topic was discussed offline.  **Proposal 3-1-1:**  **For multi-PUSCH CG configuration, if Alt-B (from RAN1#112 agreement) is supported:**   * 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 38.213.     - 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 and M are configured by higher layers * A single SLIV is determined from TDRA.   + The SLIV used for 1st PUSCH per CG period. * M consecutive PUSCH TOs with same duration of PUSCHs are used in a slot. The M PUSCH TOs are used in N consecutive slots per CG period *~~cg-nrofSlots-r16~~* ~~and~~ *~~cg-nrofPUSCH-InSlot-r16~~* * 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. * 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 and M, instead of *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16*, respectively.   + ~~FFS details, including related RRC parameters~~ * FFS: Whether/How to further enhance for operation on TDD   **Proposal 3-1-2:**  **For multi-PUSCH CG configuration, if Alt-C2 (from RAN1#112 agreement) is supported:**   * For TDRA determination (based on single DCI scheduling multiple PUSCHs)   + Follow Rel-17 TDRA for 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~~ * 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 CG procedures as described in TS 38.321, clause 321.   + For any remaining PUSCH in the period with corresponding K2     - For Type-1, apply the legacy CG procedures by using (timeDomainOffset+K2) instead of timeDomainOffset.     - For Type 2, apply corresponding K2 as for the 1st PUSCH. * For Type-2, relax the limitation for validation of CG PUSCH activation DCI, when the TDRA field in the activation DCI indicates multiple SLIVs. |

#### 3.1.1.1 Online discussion

**Companies’ view:**

* **Alt-A1 (3+7):** **CATT, TCL, MTK**, FW(A1/B), FGI(A1/C2), xiaomi (A1/B), NEC (A1/B), Honor (A1/B), Spreadtrum (A1/B) , [ZTE(A1/B/C2)]
* **Alt-B (13+2):** FW, Nokia, HW/HiSi, Lenovo, Google, xiaomi, Spreadtrum, CMCC, Samsung, Sony, NEC, New H3C, Honor, IDC(Type 1), [ZTE(A1/B/C2)]
* **Alt-C-2 (13+2):** Qualcomm, E///, vivo, LG, Sharp, ZTE, CAICT, CMCC, DCM, OPPO, DENSO, Sony, FGI, Panasonic (w defer), IDC(Type 2)
  + - * Type-1: QC, E///, vivo, ZTE, OPPO, DENSO
      * Type-2: QC, E///, vivo, ZTE, IDC, DCM, OPPO

**Moderator recommendation:**

* Request to close the discussion by deciding either Alt-B (Proposal 3-1-11), or Alt-C2 (Proposal 3-1-2) or both Alt-B and Alt-C2 (Proposals 3-1-1 and 3-1-2).

**Proposal 3-1-1:**

**For multi-PUSCH CG configuration, if Alt-B (from RAN1#112 agreement) is supported:**

* 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 38.213.
    - 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 and M are configured by higher layers
* A single SLIV is determined from TDRA.
  + The SLIV used for 1st PUSCH per CG period.
* M consecutive PUSCH TOs with same duration of PUSCHs are used in a slot. The M PUSCH TOs are used in each of N consecutive slots per CG period *~~cg-nrofSlots-r16~~* ~~and~~ *~~cg-nrofPUSCH-InSlot-r16~~*
* 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.
* 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 and M, instead of *cg-nrofSlots-r16* and *cg-nrofPUSCH-InSlot-r16*, respectively.
  + ~~FFS details, including related RRC parameters~~
* FFS: Whether/How to further enhance for operation on TDD

**Proposal 3-1-2:**

**For multi-PUSCH CG configuration, if Alt-C2 (from RAN1#112 agreement) is supported:**

* For TDRA determination (based on single DCI scheduling multiple PUSCHs)
  + Follow Rel-17 TDRA for 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~~
* 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 CG procedures as described in TS 38.321, clause 321.
  + For any remaining PUSCH in the period with corresponding K2
    - For Type-1, apply the legacy CG procedures by using (timeDomainOffset+K2) instead of timeDomainOffset.
    - For Type 2, apply corresponding K2 as for the 1st PUSCH.
* For Type-2, relax the limitation for validation of CG PUSCH activation DCI, when the TDRA field in the activation DCI indicates multiple SLIVs.

## 3.2 HARQ process ID determination

**Moderator’s summary:**

In previous meeting, the following agreement was made:

**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*.

**Companies’ view:**

* **X inside/outside floor function:**
  + - * **Inside (as WA): (7+1)** E///, FW, Nokia, LG, CMCC, FGI, NEC, [CATT]
      * **Outside: (5)** Vivo, Google, DCM, OPPO, Panasonic (if X=#PUSCHs)
    - **X value:**
      * **X=1: (10)** Vivo, TCL, ZTE, Apple, Spreadtrum, CAICT, Samsung, Panasonic, DENSO, New H3C
      * **X=#PUSCHs/period: (14)** QC, E///, FW, CATT, Nokia, LG, Sharp, ZTE, Lenovo, xiaomi, DCM, DENSO, FGI, NEC
      * **Other:** HW/HiSI (RRC), Honor (RRC)
    - **Y**
      * **Y=1: (20)** QC, E///, Nokia, LG, HW/HiSi, Sharp, ZTE, Lenovo, Google, xiaomi, Spreadtrum, CAICT, CMCC, DCM, OPPO, Samsung, Panasonic, FGI, NEC, New H3C
      * **Y>1 (RRC): (4)** Vivo, CATT, TCL, Honor
      * **Other:** MTK(another formulation), DENSO (depends on X)
    - **Offset 1**
      * **Offset 1=0: (21)** QC, E///, CATT, Nokia, HW/HiSi, ZTE, Lenovo, Google, xiaomi, MTK, Spreadtrum, CAICT, CMCC, DCM, OPPO, Samsung, DENSO, FGI, NEC, New H3C, Honor
      * **Offset 1 (RRC): (3)** FW, LG, Sharp
    - **Offset 2**
      * **Offset 2=0: (20)** QC, E///, CATT, Nokia, LG, Sharp, Lenovo, google, xiaomi, MTK, Spreadtrum, CAICT, CMCC, DCM, OPPO, Samsung, DENSO, FGI, NEC, New H3C
      * **Offset 2 (Other solutions): (2)** HW/HiSi (formula), Honor (RRC)
      * **Other:** ZTE (depends on X)

**Moderator’s observations:**

* **Observation 1:** Based on the inputs, clear majority supports Y=1, Offset 1= Offset 2=0.
* **Observation 2:** Whether it matters X is inside or outside floor function, depends on the decision on value X. Views on value of X is split.

Table 3: Summary of Contributions inputs for Section 3.2

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Qualcomm | **Observation 4**: It is beneficial from network scheduling flexibility perspective if the number of HARQ processes is configured to be larger than the number of CG PUSCH occasions in the CG period.  \* Note this is also the case for legacy CG PUSCH with a single PUSCH occasion in the CG period.  **Observation 5**: In comparison to X = 1, X = number of CG PUSCH occasions in a CG period has better separation in time for two CG PUSCH occasions that are assigned with the same HARQ ID.  **Observation 6**: None zero offset 1 in the HARQ ID formula for multi-PUSCH CG configuration may introduce a circular shift to HARQ IDs over CG PUSCH occasions. It is unclear how it is necessary for scheduling in comparison to offset 1 = 0.  **Observation 7**: There was no offset 2 in HARQ ID determination for legacy single PUSCH occasion CG period.  \* For legacy CG, HARQ ID is allowed to be non-consecutive between CG periods.  \* HARQ ID bookkeeping across CG periods by offset 2 introduces implementation and operational complexity without clear benefit.  **Observation 8**: Both Y = 1 and Y =2 can achieve similar effect for maximizing the time separation between two CG PUSCHs that are assigned with the same HARQ ID.  \* Y = 1 is more straightforward as a later CG PUSCH is associated with a larger HARQ ID.  \* Y = 2 alternates between even and odd HARQ IDs between CG periods.  **Proposal 4**: Support the following for HARQ Process ID determination for the multi-PUSCH CG configuration.  \* X = number of configured PUSCH occasions in a CG period  \* Y = 1  \* Offset 1 = 0  \* Offset 2 = 0 |
| Ericsson | **Proposal 3** With respect to RAN1#112bis-e agreement, apply the followings for HARQ process ID determination of multi-PUSCHs CG:  \* Confirm the Working assumption  \* Support X=number of PUSCHs in a period, Y=1, Offset1=Offset2 =0.  \* Send an LS to RAN2 to inform about RAN1’s proposed solution for HARQ process ID determination for multi-PUSCH CG. |
| Futurewei | **Observation 2**: Due to the regular periodicity of the configured CG resources for CG PUSCH configuration being not guaranteed, the legacy HARQ process ID determination mechanism based on regular periodic resource allocation can’t be applied directly to the multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration for uplink XR traffic.  **Proposal 3**: Support that the periodicity of CG resources in the formula of HARQ process ID determination can be replaced with non-integer periodicity of XR traffic or a nominal periodicity of CG resources which is the same as non-integer periodicity of XR traffic.  **Observation 3**: To overcome (or reduce) jitter impacts on CG PUSCH resource allocation, a time offset value, between the regular arrival time of XR traffic and the CG PUSCH resource allocation, needs to be introduced, which may impact the HARQ process ID determination results for formula based HARQ process ID determinations, at least for the determined HARQ process ID order.  **Proposal 4**: Support that a time offset value (i.e., offset1) is introduced for the formula based HARQ process ID determination to avoid (or reduce) jitter impacts on CG PUSCH resource allocation and HARQ process ID determination at least for the determined HARQ process ID order.  **Proposal 5**: Support that the number (i.e., X), of the multiple CG PUSCH transmission occasions in a period of a single CG PUSCH configuration in HARQ process determination formulas, is inside floor operation.  **Proposal 6**: Confirm the work assumption in the agreement, for determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG, achieved in last RAN1 meeting. |
| Vivo | **Proposal 5**: For determination of HARQ process IDs associated to CG PUSCHs of multi-PUSCHs CG assuming one TB per CG 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  o HARQ Process ID = [X\*floor(CURRENT\_symbol / periodicity)] modulo nrofHARQ-Processes  o HARQ Process ID = [X\*floor(CURRENT\_symbol / periodicity)] modulo nrofHARQ-Processes + harq-ProcID-Offset2  \* 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.  O X=1  o Y =1 is a value larger than 1, e.g. Y=2. Y is determined based on RRC ignaling. |
| CATT | **Observation 3**: When the non-zero Offset1 is considered, the HPID of the first CG PUSCH in the CG period are quite different for the X outside and inside the floor operation in the HPID determination formula, except for X=1.  **Observation 4**: When the Offset1 is with zero value, the HPIDs of the first CG PUSCH in the CG period are the same for the X outside and inside the floor operation in the HPID determination formula.  **Observation 5**: The Offset1 and Offset2 based on the RRC configuration would not helpful for improving the HPID utilization in the multi-PUSCHs CG configuration.  **Proposal 3**: The following HPID determination method for one TB per PUSCH could be supported:  \* 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  where X can be outside floor operation when Offset1 and Offset2 are with zero value.  \* Confirm the 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. Y is determined based on RRC.  \* In the formulas above, X is equal to the number of configured PUSCHs in the CG period.  \* In the formulas above, Offset1 and Offset2 should be a zero value. |
| TCL | **Proposal 4**: For XR, when multiple Tos within a CG is configured, the HARQ-ID for the first configured/valid PUSCH within a CG configuration is determined based on current mechanism which is defined in TS 38.321, 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.  \* X =1  \* Y can be larger than 1 and is determined based on RRC |
| Nokia/NSB | **Observation 5**: Based on calculation of HARQ process IDs for a number of cases with the parameters given in Table 1, no mismatch between two variants (X is inside or outside floor operation) was observed  **Proposal 3**: Confirm that in HARQ process ID determination formula, X is inside floor operation unless the example where a mismatch/error occurs is provided.  **Proposal 4**: For HARQ process ID determination formula in multi-PUSCH CG support the following:  \* X = the number of configured PUSCHs in one CG period.  \* Y = 1, where Y is the value determining the increment of HARQ ID for the remaining configured/valid CG PUSCHs in CG period.  \* offset1 = 0 and offset2 = 0.  **Proposal 5**: Confirm the working assumption for HARQ process ID determination and support incrementing HARQ IDs for the next configured/valid Tos by one.  **Proposal 6**: RAN1 sends an LS to RAN2 with its view on HARQ process ID determination for multi-PUSCH CG. |
| LG | **Proposal 5**: Consider “configured” CG occasion for HARQ process ID determination.  **Proposal 6**: Confirm working assumption with the following aspect.  \* 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  o HARQ Process ID = [floor(X\*(CURRENT\_symbol – offset1) / periodicity) + offset2] modulo nrofHARQ-Processes  o 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  \* 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.  O X= the number of configured PUSCHs in the CG period  o Y=1  o Offset 1 is configured by RRC.  O Offset 2= 0 |
| Huawei/HiSilicon | **Proposal 3**: Further study HARQ process ID determination mechanism with the following principles  \* Maximize the gap between CG PUSCH occasions using the same HARQ process ID, considering the number of unused occasions in a period  \* Minimize the total number of HARQ process used by CG  **Proposal 4**: For the determination of the HARQ process ID formula, the parameters in the formula should be:  X is RRC configured, and value range includes {1, the number of configured PUSCHs in the CG period};  Y = 1;  Offset1 = 0;  Offset2 can be a non-zero value and is determined as below  \* offset2 = (HPID\_1st + nrofPUSCH – M) modulo nrofHARQ-Processes  \* where, HPID\_1st is the HARQ process ID of the first CG PUSCH of the previous CG period, nrofPUSCH is the number of configured CG PUSCHs within a CG period and M is the number of unused PUSCH occasion(s) in the previous period |
| Sharp | **Proposal 5**: Consider “configured” CG occasion for HARQ process ID determination.  **Proposal 6**: Confirm working assumption with the following aspect.  \* 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  o HARQ Process ID = [floor(X\*(CURRENT\_symbol – offset1) / periodicity) + offset2] modulo nrofHARQ-Processes  o 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  \* 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.  O X= the number of configured PUSCHs in the CG period  o Y=1  o Offset 1 is configured by RRC.  O Offset 2= 0 |
| ZTE/Sanechips | **Observation 4**: There is no difference on indicating explicitly the time offset by DCI or RRC signaling and indicating implicitly the time offset by slot validation.  **Observation 8**: A cyclic-shifted HARQ process ID pattern for each CG period is capable of achieving maximum gap among CG PUSCH occasions using the same HARQ process ID and having minimum total number of HARQ process ID associated to CG PUSCHs, if unused transmission occasions exist in CG periods.  **Observation 9**: Y > 1 will increase the number of configured HP ID, which is more likely to cause HARQ process ID starvation.  **Proposal 5**: Support the following two options for HP ID determination of the first configured/valid CG PUSCH in one CG period for multi-PUSCHs CG:   * Option 1: X denotes the number of transmission occasions in one CG period and offset2 is determined by UCI indication for unused transmission occasions in the formula, i.e., * HARQ Process ID = [floor(X\*CURRENT\_symbol / periodicity)+offset2] modulo nrofHARQ-Processes * HARQ Process ID = [floor(X\*CURRENT\_symbol / periodicity)+offset2] modulo nrofHARQ-Processes + harq-ProcID-Offset2 * Option 2: X = 1 and offset2 = 0 in the formula, i.e., * HARQ Process ID = [floor(CURRENT\_symbol / periodicity)] modulo nrofHARQ-Processes * HARQ Process ID = [floor(CURRENT\_symbol / periodicity)] modulo nrofHARQ-Processes + harq-ProcID-Offset2   **Proposal 6**: Support offset1 = 0, since actually instant jitter value cannot be obtained.  **Proposal 7**: Support Y = 1 for the increasing step for the HP IDs of the remaining CG PUSCHs for HP ID determination for multi-PUSCHs CG. |
| Apple | **Proposal 7**: for the HPID determination of the first TO’s, X=1. |
| Lenovo | **Observation 1**: For determination of HARQ process ID, HARQ process collision (between a re-transmission of a TB of an earlier CG occasion and a TB of a latter CG occasion) for small number of configured HARQ processes should be considered.  **Proposal 2**: For determination of HARQ process ID, X= ‘the number of configured PUSCHs in the CG period’, Y=1, and offset 1=offset 2=0. |
| Google | **Proposal 3**: For the HPI determination, support the HPI formula with X outside the 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  **Proposal 4**: The HPI of the remaining PUSCHs in the CG period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period and this can also be captured in the formula with CG occasion index I as below  o HARQ Process ID = [X \* floor(CURRENT\_symbol/periodicity) + I ] modulo nrofHARQ-Processes |
| xiaomi | **Proposal 3**: If the HARQ process ID of the remaining CG PUSCHs in the period is determined by incrementing the HARQ process ID of the first configured/valid PUSCH in the period, the maximum HARQ process ID cannot be exceed 16.  **Proposal 4**: Support Y=1 for determining the HARQ process ID of the remaining CG PUSCHs.  **Proposal 5**: Support X= the number of configured PUSCHs in the CG period.  **Proposal 6**: Support to remove Offset 1 or Offset 2 for determining the HARQ process ID of the remaining CG PUSCHs. |
| MTK | **Proposal 4**: RAN1 shall send an LS to RAN2 to consult them about the feasibility of the RAN1 agreement on the HARQ ID determination formula modification.  **Proposal 5**: HARQ ID formula for the 1st PUSCH TO should also be used to determine the HARQ ID for the remaining PUSCH Tos in a CG period by including the parameter Y into the formula.  **Proposal 6**: The parameter “Y” should be written in a formulated form for each of the remaining PUSCH Tos rather than stating that “each PUSCH TO increments the previous HARQ ID by Y”.  **Proposal 7**: The parameters “offset1” and “offset2” are removed from the HARQ ID formula. |
| Spreadtrum | **Proposal 2**: For determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG assuming one TB per PUSCH:  • {X=1, Y = 1, offset1= 0, offset2= 0} should be the baseline. Otherwise, {Y, offset1, offset2} are determined based on RRC signaling. |
| CAICT | **Proposal 2**: For determination of HARQ process Ids, X=1, Y=1, Offset 1= 0, and Offset 2= 0 in the formulation. |
| CMCC | **Proposal 2**. Support the following approach for determination of HARQ process IDs associated to PUSCHs in multi-PUSCHs CG.  \* For the first configured/valid PUSCH in a CG period:  o HARQ Process ID = [floor(X×CURRENT\_symbol / periodicity)] modulo nrofHARQ-Processes, where X equals the number of configured PUSCHs in a CG period;  o HARQ Process ID = [floor(X×CURRENT\_symbol / periodicity)] modulo nrofHARQ-Processes + harq-ProcID-Offset2, where X equals the number of configured PUSCHs in a CG period.  \* For the remaining PUSCHs in the CG period:  o HARQ Process ID = (increment the HARQ process ID of the preceding PUSCH in the period) modulo nrofHARQ-Processes;  o HARQ Process ID = (increment the HARQ process ID of the preceding PUSCH in the period) modulo nrofHARQ-Processes + harq-ProcID-Offset2. |
| DCM | **Proposal 4**: For HP ID determination of multiple CG PUSCHs in one CG period,  \* For HARQ process ID calculation for the first valid CG PUSCH,  \* “multiplying X” is outside the floor operation, and X= number of configured PUSCHs in one CG period.  \* offset1 = 0, and offset2 = 0.  \* The HARQ process ID of the remaining valid PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding valid PUSCH in the period, with Y=1. |
| OPPO | **Proposal 2**: 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  \* The HARQ process ID of the remaining configured CG PUSCHs in the period is determined by incrementing the HARQ process ID of the preceding PUSCH in the period by 1 with module operation with nrofHARQ-Processes or module operation with (nrofHARQ-Processes + harq-ProcID-Offset2), whichever applicable. |
| Samsung | **Proposal 2**: There is no change to the Rel-17 CG procedure when cg-RetransmissionTimer is not configured for determining the HARQ process ID for the first configured PUSCH in a period. |
| Panasonic | **Proposal 2**: The same HARQ IDs should be reused within CG periods, i.e., X=1. If X=1 is not agreeable, the X value should be placed outside of the floor function.  **Proposal 3**: A dedicated HARQ ID should be assigned for each of the remaining PUSCH Tos, even though the TO is not used/valid for the transmission, using the incremental operation with Y=1. |
| DENSO | **Proposal 2**: The following working assumption can be confirmed with the underlined modification.  - 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) followed by the addition of harq-ProcID-Offset2, whichever applicable.  **Proposal 3**: The following combinations of X and Y can be considered to avoid the collision of HARQ process IDs in adjacent CG periods.  - Alt.1: X= the number of configured PUSCHs in the CG period and Y=1  - Alt.2: X=1 and Y>1  **Proposal 4**: For determination of HARQ process ID, both offset1 and offset2 can be removed from the formula. |
| FGI | **Proposal 2**: Confirm the working assumption with the following, X= the number of configured PUSCHs in the CG period, Y=1, Offset 1= 0, and Offset 2= 0. |
| NEC | **Proposal 4**: regarding the HP ID determination, support X = the number of configured PUSCHs in the CG period, Y = 1, offset 1 = 0 and offset 2 = 0. |
| New H3C | **Proposal 2**: Work assumption on 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 can be confirmed  **Proposal 3**: 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, X=1, Y =1, Offset 1= 0 and Offset 2= 0. |
| Honor | **Proposal 2**: X, Y and offset2 are configured semi-statically via RRC.  **Proposal 3**: offset1 is unnecessary or offset1=0. |

### 3.2.1 Initial Discussions

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

Considering the summary and observations above, Moderator suggests the following for discussion:

**Aim for decision at this meeting.**

* **Suggestion 1:** Recommend Y=1, Offset 1=0, Offset 2= 0.Focus on Alt. 1-1 and Alt. 1-2. Therefore, Proposal 3-2-1 is suggested.
* **Suggestion 2:** Discuss further on value of X , and consequently whether X should be inside or outside floor function.

**Proposal 3-2-1:**

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
* Offset 2= 0

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

* **Q1:** What is your view regarding Moderator’s suggestions for progress on HARQ ID determination design?
* **Q2:** What is your view regarding **Proposal 3-2-1**?
* **Q3:** 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** |
| Futurewei | Q1:We are ok with Moderator’s suggestions for progress on HARQ ID determination design.  Q2: We are ok with Proposal 3-2-1, except for the value of Offset 1. From our point of view, Offset 1= non-zero value needs to be introduced to reduce jitter impacts on HARQ ID determination. |
| **ZTE, Sanechips** | We are fine with Moderator’s suggestions and we support Proposal 3-2-1. |
| **DOCOMO** | We are fine with Moderator’s suggestions and support Proposal 3-2-1. |
| **Xiaomi** | We are fine with Proposal 3-2-1. To make the description clearer, we suggest the following modification:  **Proposal 3-2-1:**  With respect to the agreement on HARQ process ID determination for multi-PUSCH C~~g~~G in RAN1#112bis-e, support the following:   * Y=1 * ~~Offset 1= 0~~ Remove Offset 1 and Offset 2 * ~~Offset 2= 0~~ |
| **Nokia, NSB** | We support Proposal 3-2-1 and agree with moderators suggestions. |
| **Vivo** | We support Offset 1=0, Offset 2= 0. For X, Y value, we prefer to support X=1 and Y>1. We can only accept X>1 with X outside floor function. Floor (CURRENT\_symbol / periodicity) is part in the current spec formula to determine the HARQ ID for CG PUSCH, it equals to the period index of current CG period, e.g. 0,1,2,3, …. If X is outside the floor operation, X\*floor (CURRENT\_symbol / periodicity) can explicitly express the number of HARQ process IDs reserved in the previous CG periods. That means, HARQ process ID is determined based on incrementing the HARQ process ID of the preceding CG PUSCH across all CG periods with module operation. Considering this physical meaning, X should be outside floor operation in the formulas of HARQ process ID determination if it is introduced. |
| **Panasonic** | Q1: We are fine with the FL’s suggestions.  Q2: We are fine with the FL’s proposal. |
| **TCL** | We are fine with Moderator’s suggestions and we support Proposal 3-2-1. |
| **LG** | **Q1:** For suggestion 2, we would like to add “X is RRC configurable between 1 and #PUSCHs/period” as an option for compromise.  **Q2:** We are fine with the proposal. |
| **Qualcomm** | Q1: we agree with Moderator’s suggestions.  Q2: we support Proposal 3-2-1.  Q3: we support X = number of PUSCH occasions in the CG period. Our analysis shows that “X = number of PUSCH occasions” (Figure 2 below from R1-2305351) in the CG period maximizes the time separation between two PUSCH occasions with the same HARQ ID so that the same HARQ ID is not repeated between CG periods before the PDB (e.g., PDB=30ms, periodicity=16.66ms) expires for the first transmission of the XR UL video in the previous CG period. |
| **Lenovo** | Ok with proposal 3-2-1 |
| **Samsung** | Q1/Q2: Support the Moderator’s suggestion and support Proposal 3-2-1. |
| **NEC** | We are fine with moderator’s suggestions and we support proposal 3-2-1. |
| **Google** | We still prefer Y to be included in the formula and defined as the index of the CG occasion in the CG period.  Also, we prefer X to be outside the floor function to avoid the rounding issues, and also as explained by vivo: when X is outside the floor operation it explicitly express the number of HARQ process IDs reserved in the previous CG period  We are Ok with Proposal 3-2-1 if there is majority support. |
| **Sharp** | We are fine with moderator’s suggestions and the proposal 3-2-1. |
| **OPPO** | We are OK with Moderator’s suggestions and Proposal 3-2-1. |
| **Moderator** | **Proposal 3-2-1:**  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) |

#### 3.2.1.1 Online discussion

**Companies’ view:**

* **X inside/outside floor function:**
  + - * **Inside (as WA): (7+1)** E///, FW, Nokia, LG, CMCC, FGI, NEC, [CATT]
      * **Outside: (5)** Vivo, Google, DCM, OPPO, Panasonic (if X=#PUSCHs)
    - **X value:**
      * **X=1: (10)** Vivo, TCL, ZTE, Apple, Spreadtrum, CAICT, Samsung, Panasonic, DENSO, New H3C
      * **X=#PUSCHs/period: (14)** QC, E///, FW, CATT, Nokia, LG, Sharp, ZTE, Lenovo, xiaomi, DCM, DENSO, FGI, NEC
      * **Other:** HW/HiSI (RRC), Honor (RRC)
    - **Y**
      * **Y=1: (20)** QC, E///, Nokia, LG, HW/HiSi, Sharp, ZTE, Lenovo, Google, xiaomi, Spreadtrum, CAICT, CMCC, DCM, OPPO, Samsung, Panasonic, FGI, NEC, New H3C
      * **Y>1 (RRC): (4)** Vivo, CATT, TCL, Honor
      * **Other:** MTK(another formulation), DENSO (depends on X)
    - **Offset 1**
      * **Offset 1=0: (21)** QC, E///, CATT, Nokia, HW/HiSi, ZTE, Lenovo, Google, xiaomi, MTK, Spreadtrum, CAICT, CMCC, DCM, OPPO, Samsung, DENSO, FGI, NEC, New H3C, Honor
      * **Offset 1 (RRC): (3)** FW, LG, Sharp
    - **Offset 2**
      * **Offset 2=0: (20)** QC, E///, CATT, Nokia, LG, Sharp, Lenovo, google, xiaomi, MTK, Spreadtrum, CAICT, CMCC, DCM, OPPO, Samsung, DENSO, FGI, NEC, New H3C
      * **Offset 2 (Other solutions): (2)** HW/HiSi (formula), Honor (RRC)
      * **Other:** ZTE (depends on X)

**Moderator’s recommendation:**

* Request Chair to conclude discussion on P3-2-1. If time allows, also I request to discuss/decide for X.

**Proposal 3-2-1:**

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)

## 3.3 Other topics

**Moderator’s summary:**

With respect to the feature multi-PUSCHs CG, companies have raised other aspects for discussions and decisions similar to the previous meeting. The topics are listed below including the direction of expressed views:

**Topic 1) Repetition for a multi-PUSCHs CG configuration**

* Support: QC, xiaomi, Spreadtrum, TCL
* Not support: E///, DCM

**Topic 2) Retransmission of multiple TBs with a single DCI with corresponding initial transmissions with CG PUSCHs**

* Support: QC, E///, vivo, IDC

**Topic 3)** **Extend SPS PDSCHs collision resolution for CG PUSCHs**

* Support: Samsung

**Topic 4) One TB over multiple slots**

* Support: CATT
* Not support: E///, Nokia, Samsung

**Other topics …**

Table 4: Summary of Contributions inputs for Section 3.3

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Qualcomm | **Observation 9**: Repetition and TBoMS are useful for capacity enhancements of AR UL video transfer in Urban Macro scenario.  **Observation 10**: CBG based retransmission has capacity benefit for the transfer of large size XR UL video data.  **Observation 11**: Frequency hopping for legacy CG can be inherited by the multi-PUSCH CG with minimal specification impact.  **Proposal 5**: Support retransmission of multiple TBs scheduled by a single DCI with corresponding initial transmissions in CG PUSCHs  \* A bitmap is used to indicate the scheduled PUSCH retransmissions with each bit associated with a CG PUSCH occasion where the UE has transmitted an initial transmission of the PUSCH.  \* If Rel-17 single DCI scheduling multiple PUSCHs is used for CG PUSCH retransmission scheduling, the NDI field can be used as the bitmap.  o NDI bit = 1 for PUSCH to be retransmitted and UE retransmits associated PUSCH.  o NDI bit = 0 for PUSCH that does not need retransmission.  o FFS: RV indications for multiple re-scheduled PUSCHs by a single DCI. |
| Ericsson | **Proposal 4** 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 5** PUSCH repetition is not supported. The same redundancy version (i.e., RV=0) is applied for the configured grant PUSCHs.  **Proposal 6** Support of CBG based transmission for multi-PUSCH CG is down-prioritized.  **Proposal 7** Down prioritize one TB over multiple slots. |
| vivo | **Proposal 4**: Scheduling multiple PUSCHs for retransmission by a DCI scrambled by CS-RNTI can be considered. |
| CATT | **Proposal 4**: The single TB transmission mapping to one or more CG occasions could reduce the number of HARQ process ID and should be further studied based on the repetition framework. |
| TCL | **Proposal 3**: Repetition for multi-PUSCHs transmissions within a CG configuration can be supported. |
| IDC | **Proposal 4**: A single CG timer is used for multi-PUSCH CG, that is started by UE after transmitting N TBs in N PUSCH occasions  **Proposal 5**: The HARQ feedback for multiple PUSCHs and dynamic grants for retransmissions in multi-PUSCH CG are provided in single DCI  **Proposal 6**: UE monitors for PDCCH carrying the HARQ feedback for multi-PUSCH CG in the DL slot that is L slots after transmitting N TBs in N PUSCH occasions |
| Apple | **Observation**: as the tempo mismatch issue for configured grants may not be addressed through the support of new CG periodicity in Rel-18, it is expected that the start time of a CG period may not be aligned with the arrival of traffic.  **Proposal 1**: study enhancement to CG-UCI to support indication of MCS and/or PRB adjustment for configured grant.  **Proposal 2**: UCI signaling supports the indication of the starting occasion and the number of occupied occasion(s).  **Proposal 3**: support partial resource/occasion usage in the frequency domain to allow statistical multiplexing of UE traffics minimizing collision.  **Proposal 4**: support partial resource/occasion usage in the time domain to allow statistical multiplexing of UE traffics minimizing collision.  **Proposal 8**: RAN1 discusses and decides whether retransmission of a transport block previously carried by CG-PUSCH can be sent by a CG-PUSCH. |
| xiaomi | **Proposal 2**: TB repetition for uplink transmissions of PUSCH repetition Type A with multi-PUSCHs CG configuration should be studied in RAN1. |
| Spreadtrum | **Proposal 3**: Support repetition for a multi-PUSCHs CG configuration. |
| DCM | **Proposal 3**: Not support joint operation of multiple CG PUSCH occasions in a CG period and CG PUSCH repetitions.  \* For example, if rep-K is configured with value K in ConfiguredGrantConfig, and the TDRA field in the activation DCI indicates multiple SLIVs, UE may transmit on the multiple CG PUSCH occasions in one CG period, with each CG PUSCH occasion with single repetition. |

### 3.3.1 Initial Discussions

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

Considering the topics, Moderator’s observation and suggestions are as the following:

* **Suggestion 1)** Regarding Topic 1, Moderator suggests considering this discussion after TDRA design is settled. Note that a decision for repetition is needed for core design of feature.
* **Suggestion 2)** Regarding Topic 2, Moderator suggests seeking the group view for discussion on this topic. Note that this topic can be discussed independently from the progress on the code feature design.
* **Suggestion 3)** Regarding Topic 3, Moderator suggests discussing more this topic to understand better if it is multi-PUSCH CG related or general issue to be resolved for CG PUSCH. Note that this topic can be discussed independently from the progress on the code feature design.
* **Suggestion 4)** Regarding Topic 4, Moderator suggest seeking the group view whether this topic can be down prioritized, considering the concerns raised. Moderator’s understanding is that the baseline is one TB per CG PUSCH. It is helpful to know whether the design of multi-PUSCHs CG should accommodate one TB over multiple PUSCHs in a way that is different from TBoMs. Clarity on this aspect is important for the decisions regarding HARQ process ID, etc.

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

* **Q1:** Please indicate your view regarding Moderator’s **suggestions** regarding the topics above. Please provided additional input to help the discussion.
* **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** |
| Futurewei | Q1: We are ok with Moderator’s suggestions regarding the topics above.  Q2: The scope of CG enhancement is for capacity enhancement, not for reliability enhancement, in that sense, Topic 1 is not needed in Rel-18. |
| **DOCOMO** | Q1: Fine with Moderator’s suggestions.  For Topic 2, we are fine to support the Retransmission of multiple TBs with a single DCI with corresponding initial transmissions with CG PUSCHs.  For Topic 3, we think it is a general issue, and we don’t see the necessity to define SPS collision rule for CG collision. It can be up to UE to select a CG PUSCH among colliding CG PUSCHs. |
| **Xiaomi** | For topic 1, repetition as an already supported feature in legacy CG is effective for enhancing reliability. Repetition for a multi-PUSCHs CG configuration needs to be further studied.  For topic 4, we don't find any motivation to support one TB over multiple slots. |
| **Nokia, NSB** | **Q1:**  In our view Topic 1, 2, 4 are out of scope of this WI. Topic 2 is ReTx with DG enhancement, where the benefits for capacity is also not clear. Topic 1, 4 will not be able to provide capacity enhancements as well and shall be deprioritized in Rel18. These topics can be discussed in further releases if the benefits are shown or if time allows in Rel18.  **Topic 3:** it is not clear which collision resolution is needed for CG PUSCH? In TS 38 213, Clause 9, there are already collision resolution rules for CG PUSCH. Further clarification will be helpful to understand the spec impact. |
| **TCL** | **For Topic1:** high reliability is also a key requirement for XR service, to improve the reliability of XR traffic, one of the most straightforward way is enabled repetition of multi-PUSCHs within a CG configuration. Thus, repetition need to support. |
| **LG** | **Q1:** For topic 1 and 4, we are fine with the FL’s suggestions.  For topic 2 and 3, we think those topics can be de-prioritized.  Regarding topic 2, it would be rare case to re-transmit multiple transport blocks for XR video frame, considering its reliability requirements and packet delay budget.  Regarding topic 3, collision handling of CG PUSCHs are currently handled by RAN2 including UE implementation. We think the change of the collision handling would make an impact on RAN2 without technical reasons. |
| **Qualcomm** | We agree with Moderator’s suggestions.  On suggestion 1), we agree that TB repetition can be discussed after TDRA determination for multi-PUSCH CG is completed first.  On suggestion 2), we see the benefits of supporting retransmission of multiple CG PUSCHs by the same scheduling DCI. We agree that this can be discussed separately.  On suggestion 3), this is not an issue specific to multi-PUSCH CG but general for any CG including the legacy CG period with a single PUSCH occasion. As we proposed for the UTO-UCI design, the UTO-UCI can be used to indicate the used and unused CG occasion when multiple CG occasions overlap in time. We think this issue can be discussed within the scope of Rel-18 XR WI for UTO-UCI.  On suggestion 4), TBoMS can be helpful for AR UL video transfer in Urban Macro scenarios where 0 throughput was seen during Rel-17 XR SI. So, we think TBoMS also belongs to capacity enhancements for XR. |
| **Lenovo** | Agree with the moderator’s view that these topics (1-3) can be discussed after basic TDRA design is settled. |
| **Samsung** | Q1: Fine with the moderator’s suggestions. It should be possible to have a quick discussion/conclusion offline for those proposals as they have already been discussed. |
| **Google** | Regarding topic 1, we agree with the moderator’s suggestion to consider this discussion after TDRA design is settled.  For topic 2, we suggest to discuss it jointly with the main TDRA scheme design as retransmissions can help getting the full picture for the TDRA scheme selection. We prefer to use the legacy configured grant timer for retransmissions if the NR-U TDRA scheme is selected, but we are happy to also discuss the single DCI scheduling multiple TBs as well.  For topic 3, collision between UL AR video packets and XR pose/control information could be further discussed.  Topic 4 can be deprioritized as we don’t see much benefit. |
| **Sharp** | Agree with moderator’s views. These issues can be discussed after TDRA design. |
| **OPPO** | We are OK with Moderator’s suggestions. |

# 4 Indication of unused transmission occasions

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); |

## 4.1 What information the UCI contains? (UCI content)

**Moderator’s summary:**

In previous meeting, the following agreement was made:

**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.

**Moderator’s observation:**

**Observation 1**: With respect to relationship between UTO-UCI Indicator and indicated TOs:

* Option A: Sliding indicator within a window
* Option B: Indicator to a sliding window

**Observation 2**: With respect to configuration based on “number of TOs”:

* Option A: Sliding indicator within a window, and configuration based on “number of TOs”
  + Option A-1, A-2
* Option B: Indicator to a sliding window, and configuration based on “number of TOs”
  + Option B-1, B-2

**Observation 3**: With respect to configuration based on “time window/period”:

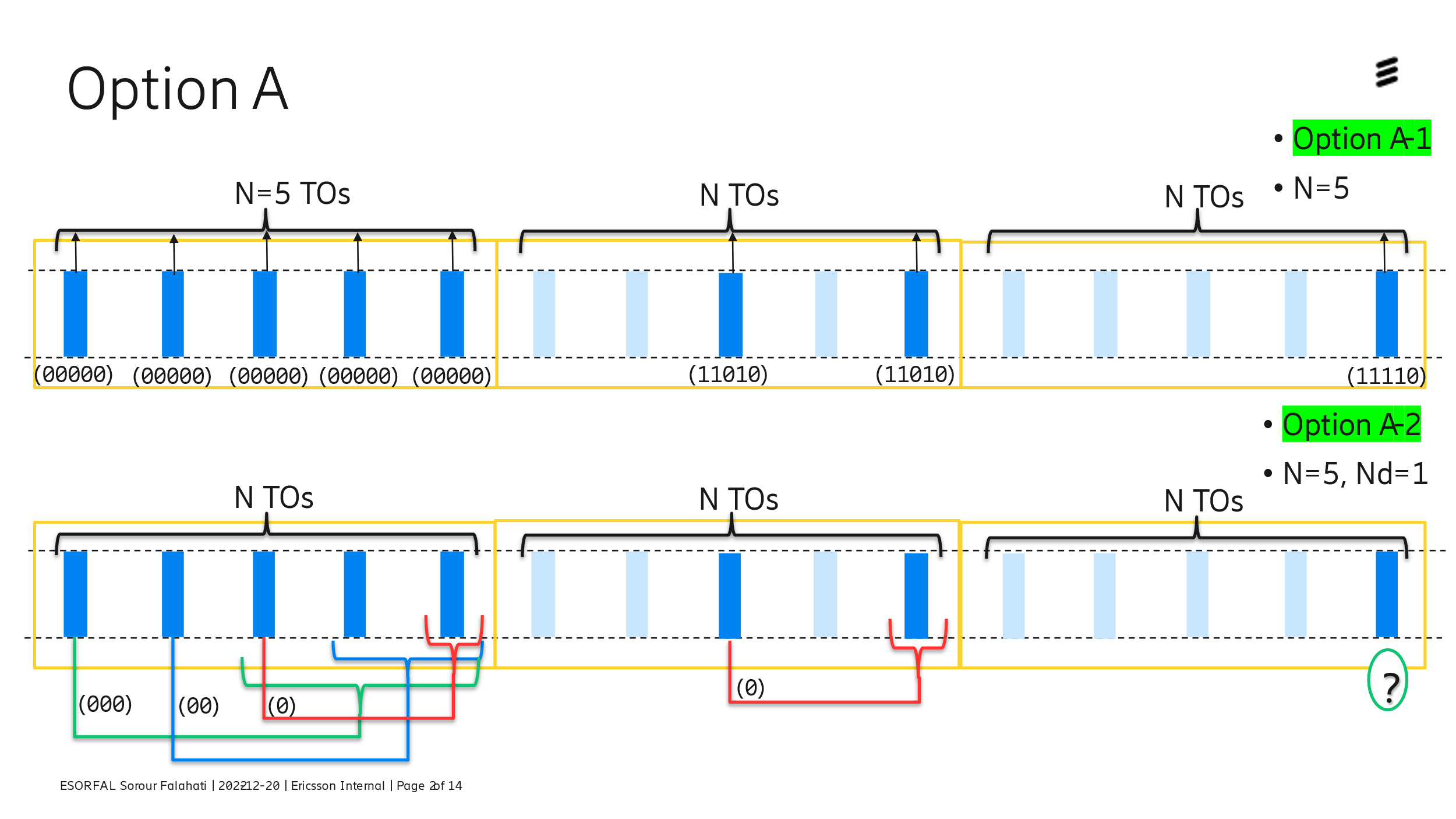
* Option A: Sliding indicator within a window, and configuration based on “time window/period”
  + Option A-3, A-4
* Option B: Indicator to a sliding window, and configuration based on “time window/period”
  + Option B-3, B-4

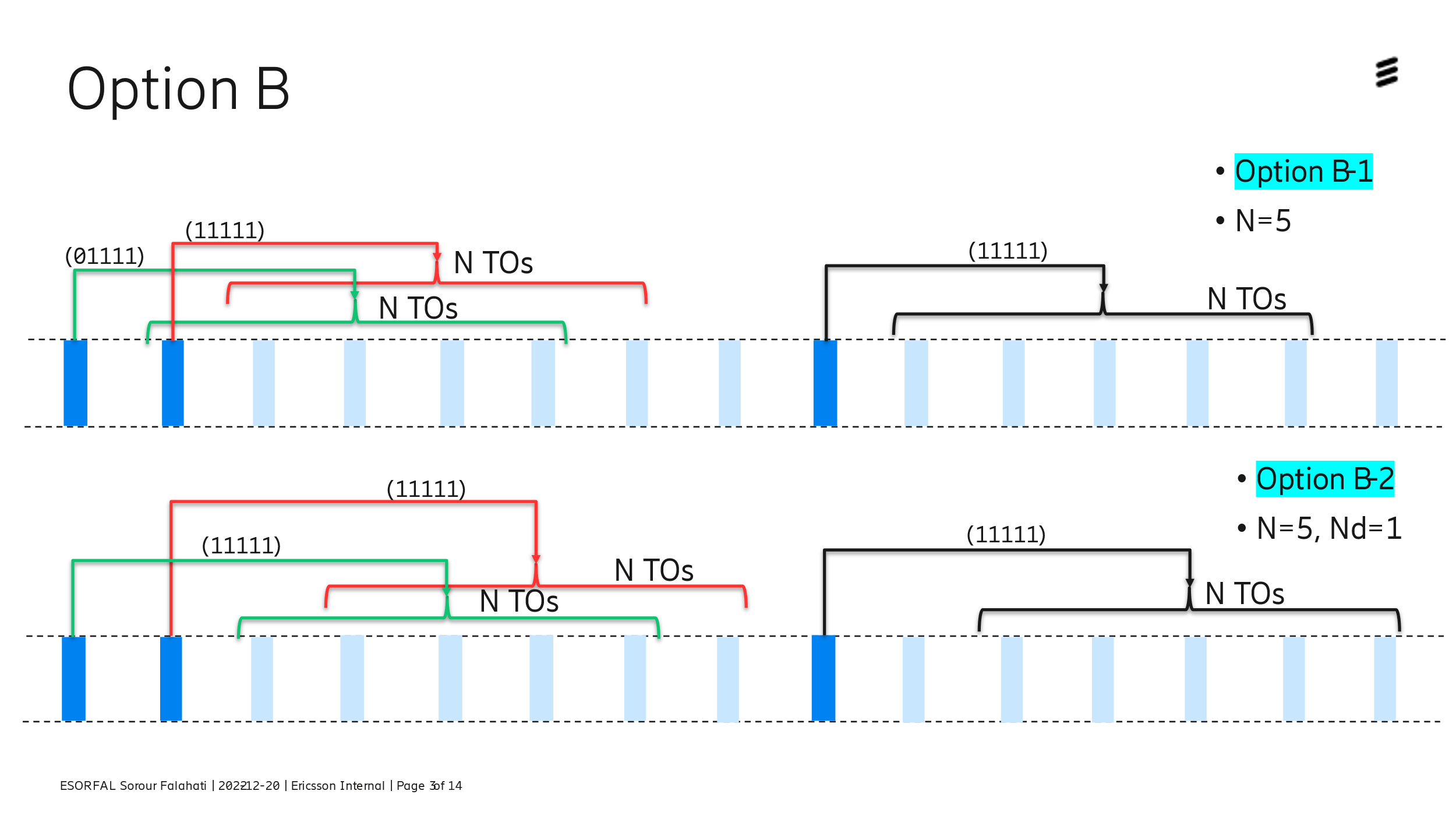
**Observation 4:** With respect to the bits constructing UTO-UCI:

* A bit-map is determined from UTO-UCI .
  + Alt-1) The UTO-UCI includes a bit-map
    - Alt-1A)The bit-map includes N bits
    - Alt-1B)The bit-map includes maximum N bits
  + Alt-2) The UTO-UCI includes an index to an RRC configured bit-map table with M rows.
    - Alt-2A) Each row includes a bit-map of N bits
    - Alt-2B) Each row includes a bit-map of maximum N bits
  + Note: A bit in the bit-map with value “1” implies that the corresponding CG PUSCH TO is indicated as “unused”. A bit in the bit-map with value “0” implies that the corresponding CG PUSCH TO is indicated as “ NOT unused”.

|  |  |
| --- | --- |
| **Configuration based on number of TOs** | |
| * **Option A-1** * **Configure a number of TOs (N)** * **For every N [consecutive] CG PUSCH TOs, starting from the first CG PUSCH in the CG configuration:** * **A transmitted CG PUSCH among the N CG PUSCH TOs, carries UTO-UCI that is applicable to the N CG PUSCH TOs.** | * **Option A-2** * **Configure a number of TOs (N), and a number of TO offset (Nd).** * **For every N [consecutive] CG PUSCH TOs, starting from the first CG PUSCH in the CG configuration:** * **A transmitted CG PUSCH among the N CG PUSCH TOs, carries UTO-UCI that is applicable to the CG PUSCH TOs starting from Nd TO after the transmitted CG PUSCH and ending with the last TO the N TOs.** |
| * **Option B-1** * **Configure a number of TOs (N)** * **A transmitted CG PUSCH carries UTO-UCI that is applicable to the N [consecutive] CG PUSCH TOs, starting from the next TO.** | * **Option B-2** * **Configure a number of TOs (N) and Configure a number of TO offset (Nd).** * **A transmitted CG PUSCH, carries UTO-UCI that is applicable to the N [consecutive] CG PUSCH TOs, starting from Nd TO after the transmitted CG PUSCH.** |

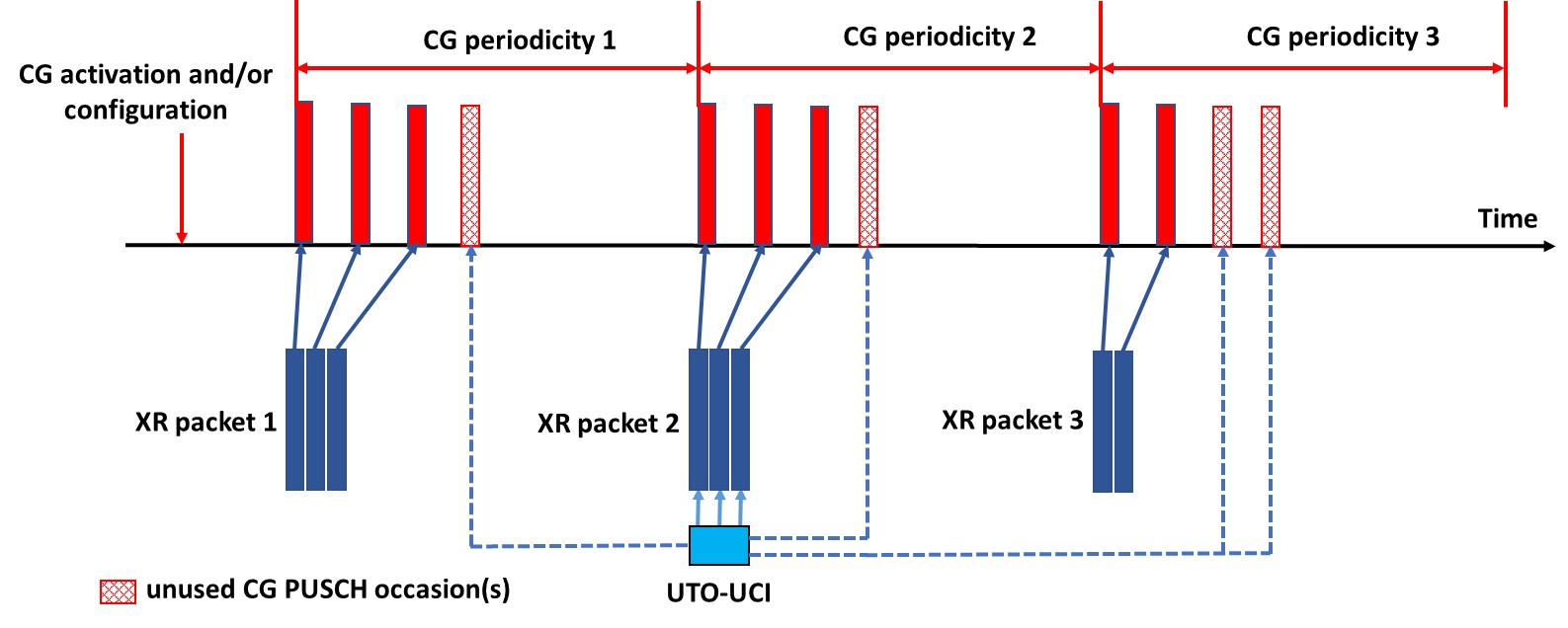
|  |  |
| --- | --- |
| **Configuration based on time window/duration** | |
| * **Option A-3:** * **Configure a UTO periodicity with duration of UTO\_duration** * **The starting time of the first period of UTO periodicity is the same as starting time of the first period of CG configuration.** * **A transmitted 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-4:** * **Configure a UTO periodicity with duration of UTO\_duration, and a TO offset with duration UTO\_offset.** * **The starting time of the first period of UTO periodicity is the same as starting time of the first period of CG configuration.** * **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-3** * **Configure a UTO periodicity with duration of UTO\_duration** * **A transmitted CG PUSCH carries UTO-UCI that is applicable to the CG PUSCH TOs that are confined within UTO\_duration starting from strat of the next CG PUSCH TO.** | * **Option B-4** * **Configure a UTO periodicity with duration of UTO\_duration, and a TO offset with duration UTO\_offset.** * **A transmitted CG PUSCH carries UTO-UCI that is applicable to the CG PUSCH TOs that are confined within UTO\_duration starting from UTO\_offset from the end of the transmitted CG PUSCH.** |





**Examples of inputs:**

#### FW:



**Figure 3: Different possibility examples of unused CG PUSCH occasion(s) indicated by UTO-UCI**

**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) periodicity with the UTO-UCI.**

Sorour: CG periodicity is aligned with XR periodicity.

New H3C (nothing).

#### Vivo



Figure 3. Illustration of options to determine starting time of time duration corresponding to a UTO-UCI



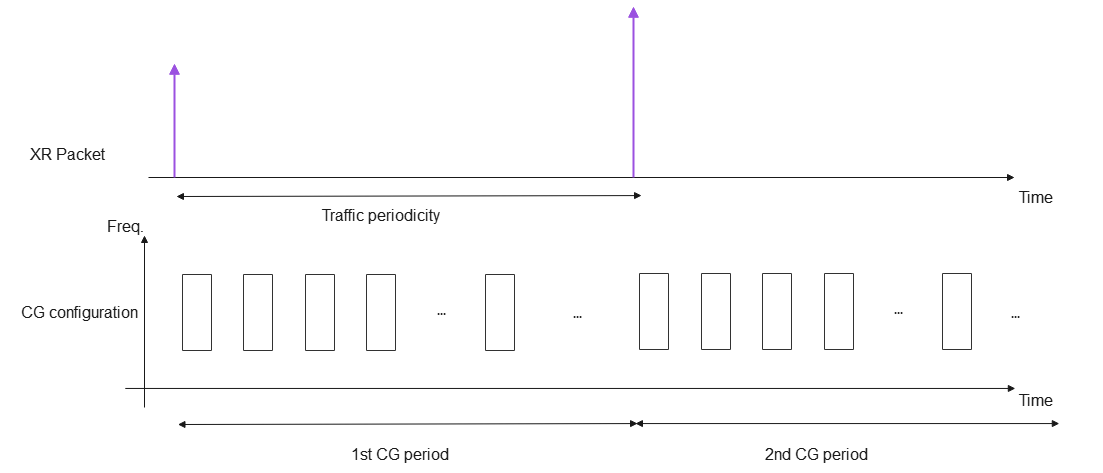
Figure 4. Illustration of options to determine starting time of time duration corresponding to a UTO-UCI

***Proposal 11: A configurable time offset can be introduced as the offset between the CG PUSCH conveying a UTO-UCI and the start of the time duration corresponding to the UTO-UCI, to accommodate a minimum duration required for gNB processing, e.g. decoding of the UCI, and recycling of unused time-frequency resources.***

***Proposal 13: To organize 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: A separate sub-bitmap is provided for CG PUSCH occasions corresponding to each of N CG configurations, and the bitmap provided by the UTO-UCI includes N sub-bitmaps.***
* ***Option 2: A single bitmap is provided for CG PUSCH occasions corresponding to N CG configurations, and the single bitmap is provided directly by the UTO-UCI.***

#### ZTE



#### Spreadtrum



Figure 2-1: the consecutive unused CG PUSCH TOs in time domain



Figure 2-2: the non-consecutive unused CG PUSCH TOs in time domain

***Proposal 4: The time duration/range of the dynamic indication should be a CG period, and the bitwidth of the bitmap in the UTO-UCI is equal to the number of the multiple CG PUSCH TOs.***

#### Panasonic



Figure 1. An example scenario for using unused indication.

#### Huawei

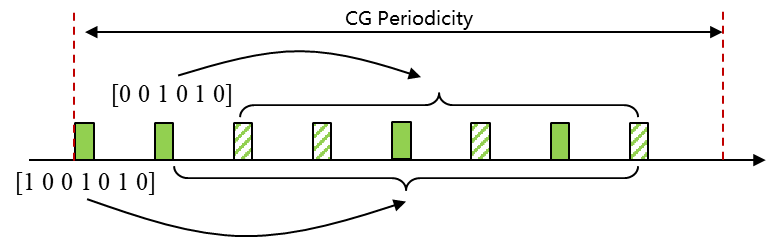


Figure 7. Bitmap where a bit corresponds to a TO within a same CG period

#### CATT



(a) The UCI is used to indicate each CG PUSCH within a CG period



(b) The UCI is used to indicate each CG PUSCH within a time duration

Figure 6: The bitmap indication carried in UCI

#### Xiaomi



Figure 1: CG PUSCH TOs that needs to be indicated for dynamic indications in different TOs

**Observation 1: The number of CG PUSCH TOs that needs to be indicated in a CG period varies with the change of the CG PUSCH TO where UTO-UCI is located.**

**Proposal 7: The corresponding valid bits of UTO-UCI in different CG PUSCH TOs need to be studied in RAN1.**

**Proposal 8: The size of the bitmap in UTO-UCI can be configured less than the number of CG PUSCH TO in a CG period.**



Figure 2: CG period includes multiple sub-durations corresponding to different dynamic indications

#### CMCC

* Alt. 1: constant-length UCI: The UCI bitmap length equals the number of configured PUSCH occasions in a CG period and a bit corresponds to one configured PUSCH occasion within a CG period. An example of this solution is provided in Figure 6.
* Alt. 2: variable-length UCI: The UCI bitmap length equals the number of configured PUSCH occasions from the current PUSCH occasion to the last PUSCH in the CG period. Here, the current PUSCH occasion refers to the CG PUSCH including this UCI. Figure 7 gives an example of this variable-length solution. Compared to Alt. 1, the variable-length UCI in Alt. 2 has less signaling overhead.

**Figure 6. Illustration of the constant-length UCI solution**



**Figure 7. Illustration of the variable-length UCI solution**

***Proposal 3. Considering the following two options for determine the bit-length of UTO-UCI:***

* ***Option 1: The bit-length of each UTO-UCI on each valid CG PUSCH is equal to the number of configured PUSCH TOs in one CG period;***
* ***Option 2: The bit-length of each UTO-UCI on each valid CG PUSCH is equal to the number of configured PUSCH TOs from the current PUSCH TO to the last PUSCH TO in a CG period.***

#### TCL

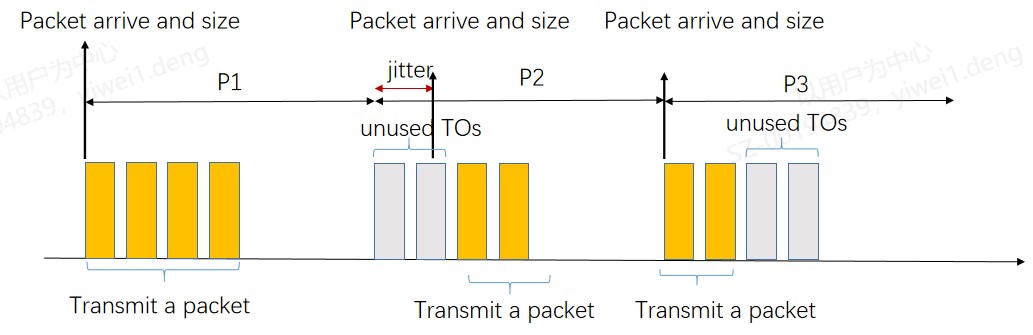


Figure 1. Variable size and jitter for XR frame size with CG

#### LG

Proposal 10: URI provides a bitmap where a bit corresponds to a TO within a time duration/range, where the time duration range has following aspects:

* The time duration starts after X symbols from the CG PUSCH carrying URI. The number X is configured by gNB.
* The end of the time duration could be following from starting :
  + Option 1: the time duration for bitmap is separately determined per CG PUSCHs (e.g. URI on PUSCH can indicate usages of upcoming N CG PUSCHs, and accordingly the time duration for bitmap would be changed across CG PUSCHs)
    - Option 1-1: after Y symbol.
    - Option 1-2: after Y configured/valid CG PUSCH.
  + Option 2: the ending of time duration can be same for a group of CG PUSCHs (e.g. URI on PUSCH can indicate usages of remaining CG PUSCHs in a period, and accordingly the time duration for bitmap may not be changed across CG PUSCHs in period)
    - Option 2-1: every Y period.
    - Option 2-2: end of the period.

#### Lenovo

The starting TO of the time domain window (assuming option 1 above) can be:

1. The first configured TO in the CG period in case UTO-UCI indicates unused occasions within a single CG period.
2. Determined based on a periodicity and offset
   1. The periodicity can be a multiple of the CG period in which UTO-UCI is sent
   2. The offset can be configured with respect to a reference time; the reference time can be
      1. the time DCI activating the CG configuration is sent for Type2 CG; FFS Type1 CG
      2. Beginning of the CG period in which UTO-UCI is sent

The duration of the time window can be determined based on:

1. Periodicity of the CG configuration
2. RRC configuration

Proposal 6: UTO-UCI indicates unused CG occasions within a time window defined by a duration and a start time; wherein

* the duration is determined based on the configured bitmap size
* and the start time is the beginning of a CG period of the CG configuration.
  + FFS beginning is subject to a TO offset >=0

#### Apple

**Proposal 10: Consider two options in UTO-UCI design:**

* + **Alt. E-1**
    - **The UTO-UCI bitmap size is fixed for a CG configuration.**
  + **Alt. E-2:**
    - **The UTO-UCI bitmap size may vary, e.g., for different CG periods.**

**Proposal 11: consider two options in UTO-UCI bitmap to TO mapping:**

* + **Alt. F-1**
    - **The first bit b1 refers to the TO where the CG PUSCH carrying the current UTO-UCI is transmitted. The rest bits are mapped to the first, second, … TOs after that TO;**
  + **Alt. F-2**
    - **The first bit b1 refers to the first TO in a CG period, and the rest bits are mapped to the second, third, … TOs in the CG period.**

**Proposal 12: the UTO-UCI bitmap size is according to the number of configured TOs in a CG period.**

#### Qualcomm

***Proposal 6: The UTO-UCI can indicate unused CG PUSCH occasions associated with more than one CG period for multiple active CG configurations. The feature can be enabled by***

* ***Configuration to determine CG configuration(s) on which the UE can transmit the UTO-UCI.***
* ***Configuration to determine CG configuration(s) whose PUSCH occasions can be indicated by the UTO-UCI.***
* ***Configuration to determine a time duration containing the indicated CG PUSCH occasions or the number of indicated CG PUSCH occasions that are associated with multiple CG configurations, TRPs and carriers starting from the end of the UTO-UCI.***
* ***Indexing rule for CG PUSCH occasions over multiple CG configurations, TRPs and carriers.***
* 
* Figure 10: Indexing of CG PUSCH occasions in a time duration/range across CG configurations

#### OPPO

***Proposal 5: UTO-UCI should be configured per CG configuration and used to indicates the unused TO(s) within one CG period.***

Then the UTO-UCI provides a bitmap where a bit corresponds to a TO within a time duration/range, and the following detail designs can be considered:

* Option 1: The payload size of UTO-UCI equals to the number of CG PUSCH TOs within a CG period. Each bit in the bitmap is associated to a TO within the CG period.
* Option 2: The payload size of UTO-UCI is configured by RRC. When a UTO-UCI is transmitted in TO n, the first bit in the UTO-UCI corresponds to the TO n+k, where the value of k can be RRC configured or determined based on a timeline.
* Option 3: The payload size of UTO-UCI equals to the remaining configured CG PUSCHs in the period. The remaining configured CG PUSCHs can also be determined based on a timeline.

Obviously, option 1 leads to redundant UTO-UCI information and option 3 has the highest efficiency. The flexibility and overhead of option 2 can be properly controlled by gNB.

***Proposal 6: The payload size of UTO-UCI can be configured by RRC or equals to the remaining configured CG PUSCHs in the period.***

#### DCM

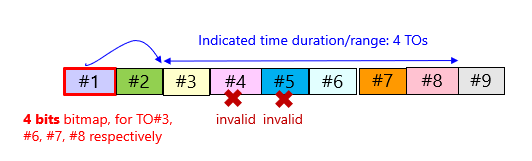


Fig 1: Option 1 example

图示

描述已自动生成

Fig 2: Option 2 example

图示

描述已自动生成

Fig 3: Option 3 example

#### Nokia

***Proposal 9:*** *For a UCI indication, decide the number of bits in a bitmap solution for UTO-UCI. Consider the following options:*

* *Number of bits is fixed and equal to N. FFS: exact value for N.*
* *Number of bits is RRC configured and equal to N = 1, 2, 3, 4, 5, …, N\_max. FFS: exact value for N\_max.*

***Proposal 10:*** *For a UCI indication, decide a time relation between bits and occasions these bits correspond to. Consider the following options:*

* *The first bit in a bit map corresponds to the next occasion after the occasion that transmitted UCI;*
* *The first bit in a bit map corresponds to the occasion that is Delta (where delta can be e.g., number of TOs) after the occasion that transmitted UCI. FFS: exact values for Delta.*

Table 5: Summary of Contributions inputs for Section 4.1

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Qualcomm | **Observation 12**: If multiple CG PUSCH occasions overlap in time, the UTO-UCI that indicates unused CG PUSCH occasions can indicate one of these PUSCH occasions as not unused, e.g., the UE selects one of the overlapping PUSCH occasion that has the least amount of UL resources sufficient for transmitting the buffered UL data.  **Observation 13**: The UTO-UCI indicating unused CG PUSCH transmission occasion(s) is beneficial because:  \* gNB can reallocate resources of the unused PUSCH occasion to other UEs.  \* UE can save power by selecting a proper number of resources for PUSCH transmission.  \* gNB can save power by skipping PUSCH blind detection on the unused PUSCH occasion.  **Observation 14**: Use cases for the UTO-UCI indicating CG PUSCH occasions over multiple CG periods of multiple active CG configurations at least include:  \* Indication of 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.  \* Indication of unused CG PUSCH occasions due to jitter time.  \* Robust UTO-UCI transmission in FR1 carrier indicating PUSCH occasions in FR2 carrier.  **Observation 15**: The UTO-UCI can indicate CG PUSCH occasions over multiple CG periods of multiple active CG configurations if the time/duration containing the indicated CG PUSCH occasions is explicitly configured.  **Observation 16**: 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 17**: It is beneficial for network UL resource allocation and power saving if the UTO-UCI indicates unused PUSCH occasions for all active CG configurations.  **Observation 18**: 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 XR UL pose information.  **Observation 19**: It is possible to configure the UE with multiple overlapping CG PUSCH occasions in current specs but the gNB has to blind detect the PUSCH.  **Observation 20**: Overlapping CG PUSCH occasions can be associated with the same CG configuration or different CG configurations.  **Observation 21**: 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).  **Observation 22**: 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.  **Observation 23**: A same CG PUSCH occasion may be indicated by multiple UTO-UCIs included in multiple early CG PUSCH transmissions.  **Proposal 6**: The UTO-UCI can indicate unused CG PUSCH occasions associated with more than one CG period for multiple active CG configurations. The feature can be enabled by  \* Configuration to determine CG configuration(s) on which the UE can transmit the UTO-UCI.  \* Configuration to determine CG configuration(s) whose PUSCH occasions can be indicated by the UTO-UCI.  \* Configuration to determine a time duration containing the indicated CG PUSCH occasions or the number of indicated CG PUSCH occasions that are associated with multiple CG configurations, TRPs and carriers starting from the end of the UTO-UCI.  \* Indexing rule for CG PUSCH occasions over multiple CG configurations, TRPs and carriers.  **Proposal 7**: For multiple overlapping PUSCH occasions, a UE is allowed to utilize the CG PUSCH occasion with the smallest RB allocation that best fits the size of its buffered data.  **Proposal 8**: 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.  **Proposal 9**: 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 indicated by bit i in the bitmap.  **Proposal 11**: Do not support the explicit indication of "used" CG PUSCH occasion(s). |
| Ericsson | **Observation 6** 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 resources or reducing blind detection.  **Observation 7** 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 8** 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 9** The periodicity of CG configuration, irrespective of whether legacy CG configuration or multiple 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 CG periodicity.  **Observation 10** Indicating unused/used for past TOs by UTO-UCI provide no useful information for gNB.  **Observation 11** A TO indicated as unused by UTO-UCI must be indicated with a good time in the future to enable gNB to benefit from the information.  **Observation 12** The followings, list the alternative solutions to determine associated TOs with an indicated UTO-UCI:  **Observation 13** Number of needed bitmap patterns of length X can be lower than 2^X.  **Proposal 8** The UTO-UCI in a CG PUSCH is associated to X consecutive CG PUSCH TOs, where the 1st TO among the X TOs is Y TO(s) after the CG PUSCH with UTO-UCI and Y=1 (that is Alt. 1 based on approach 1).  **Proposal 9** UTO-UCI is an indicator for an index/row in RRC configured table of bitmap patterns. Each row provides a pattern with X bits.  **Proposal 10** The UE is expected to provide consistent information when indicating the UTO patterns. |
| 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) periodicity with the UTO-UCI.  **Observation 4**: 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, indicated by gNB, between UCI and the unused CG PUSCH occasion(s). |
| vivo | **Proposal 8**: The dynamic indication in a UTO-UCI can be applied to the configured CG PUSCH occasions corresponding to one or multiple CG configurations, and locating on one or multiple serving cells.  **Proposal 9**: The length of time duration corresponding to a UTO-UCI is configurable, e.g. by RRC signalling.  **Proposal 10**: To determine the starting time of time duration corresponding to a UTO-UCI, the following two options can be considered:  \* Option 1: The starting time is determined based on a periodicity and an offset.  \* Option 2: The starting time is determined based on the CG PUSCH conveying the UTO-UCI.  **Proposal 11**: A configurable time offset can be introduced as the offset between the CG PUSCH conveying a UTO-UCI and the start of the time duration corresponding to the UTO-UCI, to accommodate a minimum duration required for gNB processing, e.g. decoding of the UCI, and recycling of unused time-frequency resources.  **Proposal 12**: 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 13**: To organize 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: A separate sub-bitmap is provided for CG PUSCH occasions corresponding to each of N CG configurations, and the bitmap provided by the UTO-UCI includes N sub-bitmaps.  \* Option 2: A single bitmap is provided for CG PUSCH occasions corresponding to N CG configurations, and the single bitmap is provided directly by the UTO-UCI.  **Proposal 14**: It is configurable whether or not a CG configuration supports resource recycling, and whether or not CG PUSCHs corresponding to a CG configuration include UTO-UCI, respectively. |
| CATT | **Proposal 6**: Either of following alternatives could be supported:  \* Alt-1: A UCI transmitted in every CG PUSCH occasion provides a bitmap, where a bit corresponds to a CG PUSCH occasion within a CG period.  \* Alt-2: A UCI transmitted in every CG PUSCH occasion provides a bitmap, where a bit corresponds to a CG PUSCH occasion within a time duration. The time duration can be configured by RRC, such as the duration of a frame period, i.e. 16.67ms. |
| TCL | **Proposal 5**: Both a set of unused TOs located in the front and the end of a CG configuration can be considered for CG enhanced for XR.  **Proposal 6**: The UCI determines the CG PUSCH TO(s) that are indicated as "unused" based on bitmap, and the UCI provides a bitmap where a bit corresponds to a TO within a time duration/range.  **Observation 2**:There is a gap between XR periodic UL traffic and CG configuration.  **Proposal 8**: A fixed transmission pattern of CG within an integer periodicity for XR can be considered.  **Proposal 9**: Additional TOs after the end of the configured TO within a CG period and activate more than one CG configurations simultaneously can be considered. |
| Nokia/NSB | **Observation 6**: Defining extra time duration in the bitmap solution for UCI indication of unused resources is unnecessary as it can be directly calculated from the TDD configuration, SCS, and number of bits in a bitmap, which corresponds to the number of occasions.  **Proposal 8**: Do not limit the indication of CG PUSCH TO(s) to one period only.  **Proposal 9**: For a UCI indication, decide the number of bits in a bitmap solution for UTO-UCI. Consider the following options:  \* Number of bits is fixed and equal to N. FFS: exact value for N.  \* Number of bits is RRC configured and equal to N = 1, 2, 3, 4, 5, ..., N\_max. FFS: exact value for N\_max.  **Proposal 10**: For a UCI indication, decide a time relation between bits and occasions these bits correspond to. Consider the following options:  \* The first bit in a bit map corresponds to the next occasion after the occasion that transmitted UCI;  \* The first bit in a bit map corresponds to the occasion that is Delta (where delta can be e.g., number of TOs) after the occasion that transmitted UCI. FFS: exact values for Delta. |
| LG | **Proposal 10**: URI provides a bitmap where a bit corresponds to a TO within a time duration/range, where the time duration range has following aspects:  \* The time duration starts after X symbols from the CG PUSCH carrying URI. The number X is configured by gNB.  \* The end of the time duration could be following from starting :  \* Option 1: the time duration for bitmap is separately determined per CG PUSCHs (e.g. URI on PUSCH can indicate usages of upcoming N CG PUSCHs, and accordingly the time duration for bitmap would be changed across CG PUSCHs)  \* Option 1-1: after Y symbol.  \* Option 1-2: after Y configured/valid CG PUSCH.  \* Option 2: the ending of time duration can be same for a group of CG PUSCHs (e.g. URI on PUSCH can indicate usages of remaining CG PUSCHs in a period, and accordingly the time duration for bitmap may not be changed across CG PUSCHs in period)  \* Option 2-1: every Y period.  \* Option 2-2: end of the period.  **Proposal 11**: If URI indicate a time window or a CG occasion as unused, UE treats other PUSCHs overlapped in a time with the indicated time window or the indicated CG occasion as unused. |
| Sharp | **Proposal 4**: The UTO-UCI bitmap indicates a bit map of CG PUSCH TOs in a duration after a start point  \* The start point is after the current PUSCH transmission with a processing delay or the next CG PUSCH TO.  \* The duration is defined as a time range in a number of slots or a number of CG PUSCH TOs.  **Proposal 5**: The UTO-UCI indication includes a deterministic range where the "unused" CG PUSCH TO indication cannot be changed in later UTO-UCI indications, and an informative region where the "unused" indication can be updated in later UTO-UCI indications. |
| ZTE/Sanechips | **Proposal 5**. The UTO-UCI on each CG PUSCH has a bitmap to indicate the used/unused situation of CG PUSCH occasions within a time duration:  The start of time duration is fixed offset slots/ms later than the time where the UCI is sent.  The end of time duration is the end time of the current CG period. |
| IDC | **Proposal 7**: UTO-UCI indicates the unused CG PUSCHs corresponding to at least one CG period  **Proposal 8**: The time duration/range of the bitmap associated with UTO-UCI spans at least one CG period  **Proposal 9**: UTO-UCI can be updated/overridden at least for the case where the PUSCH occasions previously indicated as 'used' can be updated to 'unused'  **Proposal 10**: The maximum number of times the UTO-UCI is allowed to be updated is configured via RRC  **Proposal 11**: UTO-UCI indicates the unused TOs associated with only one CG configuration |
| Apple | **Proposal 9**: UTO-UCI signaling is for a single CG period.  **Proposal 10**: Consider two options in UTO-UCI design:  o Alt. E-1  \* The UTO-UCI bitmap size is fixed for a CG configuration.  o Alt. E-2:  \* The UTO-UCI bitmap size may vary, e.g., for different CG periods.  **Proposal 11**: consider two options in UTO-UCI bitmap to TO mapping:  o Alt. F-1  \* The first bit b1 refers to the TO where the CG PUSCH carrying the current UTO-UCI is transmitted. The rest bits are mapped to the first, second, ... TOs after that TO;  o Alt. F-2  \* The first bit b1 refers to the first TO in a CG period, and the rest bits are mapped to the second, third, ... TOs in the CG period.  **Proposal 12**: the UTO-UCI bitmap size is according to the number of configured TOs in a CG period. |
| Lenovo | **Proposal 3**: The size of UTO-UCI is the same for different instances of UTO-UCI.  **Proposal 4**: UTO-UCI bitmap size is configured as part of UTO-UCI configuration.  **Proposal 5**: All UTO-UCI instances within the same CG period indicate the same bitmap.  **Proposal 6**: UTO-UCI indicates unused CG occasions within a time duration defined by a length and a start time; wherein  \* the length is determined based on the configured bitmap size  \* and the start time is the beginning of a CG period of the CG configuration  o FFS beginning is subject to a TO offset >=0  **Proposal 7**: 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.  **Proposal 8**: UTO-UCIs associated with the same set of CG occasions provide consistent information.  **Proposal 9**: Discuss invalid UTO-UCI indications. |
| Google | **Proposal 6**: The time duration/range is:  o One CG period for the Rel-18 multi-PUSCHs CG configuration  o One or multiple CG periods for the legacy CG configuration (with single PUSCH per CG)  **Proposal 7**: If the information provided by UTO-UCI should be consistent, then the exact definition of consistency should be defined. |
| xiaomi | **Observation 1**: The number of CG PUSCH TOs that needs to be indicated in a CG period varies with the change of the CG PUSCH TO where UTO-UCI is located.  **Observation 4**: The resource of the unused CG PUSCH transmission occasion can be allocated flexibly based on gNB's implementation.  **Proposal 7**: The corresponding valid bits of UTO-UCI in different CG PUSCH TOs need to be studied in RAN1.  **Proposal 8**: The size of the bitmap in UTO-UCI can be configured less than the number of CG PUSCH TO in a CG period.  **Proposal 9**: The sub-duration corresponding to dynamic indication information should be discussed in RAN1. |
| MTK | **Proposal 9**: The last PUSCH TO does not carry UTO-UCI since there is no more PUSCH TO is left to point in the current CG period.  **Proposal 10**: The bitmap carried by the UTO-UCI indicates PUSCH TOs within the current single CG period only (i.e., the bitmap indication is limited to a time duration/range, which is one CG period). |
| Spreadtrum | **Proposal 4**: The time duration/range of the dynamic indication should be a CG period, and the bitwidth of the bitmap in the UTO-UCI is equal to the number of the multiple CG PUSCH TOs.  **Proposal 6**: It is unnecessary to consider a time offset between UCI and the indicated unused CG PUSCH occasion(s) to guarantee the unused CG PUSCH TO(s) can be re-cycled. |
| CAICT | **Proposal 3**: The offset between UTO-UCI and the indicated CG PUSCHs is absolute time and is configured by gNB to at least cover the transmission time of the UTO-UCI, the transmission time of rescheduling information, and the gNB processing intervals.  **Proposal 4**: The time duration within which the UTO-UCIs indicated would correspond to a sliding window. |
| CMCC | **Proposal 3**. Considering the following two options for determine the bit-length of UTO-UCI:  \* Option 1: The bit-length of each UTO-UCI on each valid CG PUSCH is equal to the number of configured PUSCH TOs in one CG period;  \* Option 2: The bit-length of each UTO-UCI on each valid CG PUSCH is equal to the number of configured PUSCH TOs from the current PUSCH TO to the last PUSCH TO in a CG period. |
| DCM | **Proposal 5**: To determine the indicated TOs for the bitmap indication,  \* The offset of the first indicated TO relative to the CG PUSCH carrying the UCI can be configured by RRC or indicated by activation DCI, where the offset can be number of symbols/slots/TOs.  \* The number of consecutive TOs corresponding to the bitmap can be configured by RRC or indicated by activation DCI. |
| OPPO | **Proposal 5**: UTO-UCI should be configured per CG configuration and used to indicates the unused TO(s) within one CG period.  **Proposal 6**: The payload size of UTO-UCI can be configured by RRC or equals to the remaining configured CG PUSCHs in the period. |
| Samsung | **Proposal 3**: The indication of unused TOs is for the CG configuration associated with the CG-PUSCH providing the UTO-UCI.  **Proposal 4**: The number of UTO-UCI bits is configured by RRC with a maximum value of 8 or 16. The bitmap indicates TOs in RRC-based available UL slots from the end of the CG period.  **Proposal 5**: The indications by UTO-UCI in CG-PUSCHs within a CG period are independent.  **Proposal 6**: Consider one of the following:  (a) A TO previously indicated as 'unused' can be switched to 'used' when it is after a last TO previously indicated as 'used'.  (b) A UE automatically extends used TOs in a period when the UE cancels a CG-PUSCH transmission for a CG configuration. |
| Panasonic | **Proposal 4**: The unused indication should be applied to the PUSCH TOs of the current CG period or the next one.  **Proposal 5**: The unused indication should be applicable to multiple CG configuration. A list of CG configurations should be provided, in which the unused indication is applicable to them.  **Proposal 6**: The unused indication should consist of n bits that are mapped to following PUSCH TOs in time domain, while the minimum time delay is considered. |
| DENSO | **Proposal 6**: The UCI can provide the indications to  - Alt.1: all configured CG PUSCH TOs in one CG period.  - Alt.2: the remaining configured CG PUSCH TOs in one CG period. |
| Sony | **Proposal 2**: The bitmap indicated in UTO-UCI should represent the range in terms of the number of CG PUSCH Transmission Occasions. |
| FGI | **Proposal 3**: Time duration/range of the bitmap takes into account the processing time of UTO-UCI. |
| NEC | **Proposal 2**: support UE indicating the first one or more TOs and/or the last one or more TOs as unused TOs based on the bitmap. |
| Honor | **Proposal 4**: Extend the UTO-UCI to contain two parts of indications in which  the first part provides a first level information such as:  whether the second part exists or  which CG configuration it belongs  the second part provides a bitmap where a bit corresponds to a TO within a time duration/range.  **Proposal 6**: Support dynamic indication of unused CG PUSCH occasion(s) for multiple CG configurations using the method in Proposal 4. |
| KT Corp. | **Proposal 1**: Determining whether to send UTO-UCI or not at PUSCH in CG with multiple PUSCH occasion in a period is configurable by RRC.  **Proposal 4**: The bitmap in a UTO-UCI contains whole TOs in the current CG period.  **Observation 4**-1: For the indication of 'unused' for the past occasions, if it exists, the UE expects:  • Option 4-1-1: The BS ignores the indication for the past occasions.  • Option 4-1-2: The BS discards or does not receive the TB transmitted at the occasion.  • Option 4-1-3: The BS behavior is changed by the configuration.  **Observation 4**-2: For the indication of 'unused' for the current occasion, if it exists, the UE expects:  • Option 4-2-1: The BS ignores the indication for the current occasions.  • Option 4-2-2: The BS discards or does not receive the TB transmitted at the occasion.  • Option 4-2-3: The BS behavior is changed by the configuration.  **Proposal 4**-3: Option 4-1-1 and Option 4-2-2 are adopted for the indication of 'unused' for the past and current occasions.  **Proposal 4**-4: For the indication of 'unused' for the future occasion, the UE expects that the latter UTO-UCI always overwrite the former indications. |

### 4.1.1 Initial Discussions

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

* **Suggestion 1)** Consider the approach based on configuration of number of TOs, because it seems to be simpler.
* **Suggestion 2)** Discuss to decide whether to have Option A or Option B
* **Suggestion 3)** Discuss on the structure of bits in UTO-UCI

## 4.2 How the UCI is sent? (UCI type, encoding, mux)

**Moderator’s summary:**

In previous meeting, the following agreements were made:

**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.

**Companies’ view:**

**Issue 1) Sequence generation order btw UTO-UCI and HARQ-ACK:**

**Option 1)** Additional spec impact (different from previous agreement) is needed. **First HARQ-ACK, then UTO-UCI.**

* **TCL, ~~ZTE, DCM,~~ OPPO**

**Option 2)** Additional spec impact (different from previous agreement) is not needed. Reusing CG-UCI framework implies: **first UTO-UCI, then HARQ-ACK**:

* **QC, E///, vivo, Nokia, CATT, Sharp, Lenovo, Samsung**

**Issue 2) Dropping rule btw UTO-UCI and HARQ-ACK:**

**Option 1)** Need to enable with an RRC (similar/same as cg-UCI-Multiplexing) joint encoding of UTO-UCI and HARQ-ACK mux:

* + **When disabled,** 
    - Option 1-1) the UE temporarily disables UTO-UCI transmission on the CG PUSCH occasion and falls back to existing HARQ-ACK multiplexing in CG PUSCH behaviour.
      * QC, LG, [MTK], DCM
    - Option 1-2) 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.
      * Vivo, [MTK], DCM
    - Option 1-3) the UE transmits the Cg PUSCH with UTO-UCI and drops HARQ-ACK
      * Google
  + **When disabled,** Other behaviors for different priority
    - Sharp, CATT, Nokia, Honor, OPPO

**Option 2)** No Need to enable with an RRC (similar/same as cg-UCI-Multiplexing) joint encoding of UTO-UCI and HARQ-ACK mux:

* E///, Samsung, [QC]

**Other aspects**

**Proposal 15 (QC)**: Support puncturing based UCI multiplexing for UTO-UCI when its size is equal to or smaller than 2.

**Proposal 11 (Nokia):** RAN1 to specify the way of handling the cancelled/dropped UTO-UCI in a similar way as HARQ-ACK when the CG PUSCH (suppose carrying 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.

**Moderator’s observation**

**Observation 1:** Regarding **Issue 1**, There is a difference between UTO-UCI and CG-UCI, where CG-UCI is essential for decoding of CG PUSCH, while UTO-UCI is an optional information that it not critical. Therefore, it is important to discuss whether providing enough resources should not be handled by gNB and current agreements are sufficient (i.e., Option 1). And if it occurs, how critical it is to specify a different order for encoding (i.e., Option 2)

**Observation 2:** Regarding **Issue 2**, There is a difference between UTO-UCI and CG-UCI, where CG-UCI is essential for decoding of CG PUSCH, while UTO-UCI is an optional information that it not critical. Therefore, it is important to discuss first that while encoding, multiplexing procedures of CG-UCI are agreed to be reused, is it necessary to introduce functionality to enable/disable joint coding of UTO-UCI and HARQ-ACK (Option 1), or not (i.e., Option 2).

**Observation 3:** Proposal 15 by QC needs to be addressed if based on the outcome of discussion in section 4.1, the size of UTO-UCI can be max 2 bits.

Table 6: Summary of Contributions inputs for Section 4.2

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Qualcomm | **Observation 24**: 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.  **Proposal 13**: RAN1 clarifies whether insufficient reserved resources for UTO-UCI and HARQ-ACK multiplexing on CG PUSCH should be considered as a corner case or not. If yes, sequence generation order between UTO-UCI and HARQ-ACK follows the sequence generation order between CG-UCI and HARQ-ACK based on the agreement to reuse the CG-UCI encoding and multiplexing procedure for the UTO-UCI.  **Proposal 14**: If UTO-UCI and HARQ-ACK multiplexing on PUSCH is not configured, when a HARQ-ACK collides with a UTO-UCI on a CG PUSCH occasion, the UE temporarily disables UTO-UCI transmission on the CG PUSCH occasion and falls back to existing HARQ-ACK multiplexing in CG PUSCH behaviour.  **Proposal 15**: Support puncturing based UCI multiplexing for UTO-UCI when its size is equal to or smaller than 2. |
| Ericsson | **Proposal 11** Do not support dropping or sequence ordering rules between UTO-UCI and HARQ-ACK. |
| vivo | **Proposal 16**: 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 17**: 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. |
| CATT | **Proposal 5**: When cg-RetransmissionTimer is not configured, the UTO-UCI could be multiplexed in PUSCH as following:  \* If the UTO-UCI is jointly encoded with HARQ-ACK and the PHY priority is equal, the sequence generation order for UTO-UCI is similar as CG-UCI, i.e. O= OUTO-UCI + OHARQ.  \* If the UTO-UCI is not jointly encoded with HARQ-ACK and the PHY priority is different from that of HARQ-ACK, there would be some cases to be considered as following:  \* If there are both the UTO-UCI associated with high priority index 1 and HARQ-ACK associated with high priority index 0, the UCI bit sequence can be determined as O= OUTO-UCI., where OUTO-UCI is number of UTO-UCI bits. The HARQ-ACK  \* If there are both the UTO-UCI associated with high priority index 0 and HARQ-ACK associated with high priority index 1, the UCI bit sequence can be determined as O= OHARQ-HP, where OHARQ-HP is number of HARQ-ACK bits associated with priority index 1. |
| TCL | **Proposal 7**: UCI bits sequence generate can be HARQ-ACK first, then UTO-UCI. |
| Nokia/NSB | **Observation 7**: UTO-UCI and HARQ-ACK are always jointly coded if they are with the same priority.  **Proposal 11**: RAN1 to specify the way of handling the cancelled/dropped UTO-UCI in a similar way as HARQ-ACK when the CG PUSCH (suppose carrying 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 12**: Mapping UTO-UCI bits to the UCI sequence before mapping HARQ-ACK bits when UTO-UCI and HARQ-ACK are jointy encoded.  **Proposal 13**: When joint coding is not configured, dropping the one with low priority. |
| LG | **Proposal 14**: if cg-UCI-Multiplexing is not configured, drop URI and HARQ-ACK is multiplexed into PUSCH when the HARQ-ACK PUCCH and PUSCH with URI are overlapped in a time. |
| Sharp | **Proposal 6**: If cg-UCI-Multiplexing is provided, UTO-UCI and HARQ-ACK are jointly encoded with the sequence order of UTO-UCI and HARQ-ACK.  \* The beta offset for joint coding is determined by the priorities of the HARQ-ACK and the CG PUSCH.  **Proposal 7**: If cg-UCI-Multiplexing is provided, and if the CG PUSCH overlaps with both high priority HARQ-ACK and low priority HARQ-ACK, only high priority HARQ-ACK is jointly coded with UTO-UCI.  **Proposal 8**: 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.  \* The HARQ-ACK is multiplexed on the CG PUSCH if the HARQ-ACK has the same priority as or a higher priority than the CG PUSCH, and the UTO-UCI is dropped.  \* The UTO-UCI is multiplexed on the CG PUSCH if the HARQ-ACK has lower priority than the CG PUSCH, and the low priority HARQ-ACK is dropped.  **Proposal 9**: If a PUCCH with a HARQ-ACK overlaps with a CG PUSCH with UTO-UCI, and cg-UCI-Multiplexing is not provided, further study the following  \* When both high priority HARQ-ACK and low priority HARQ-ACK are present.  \* Whether separate coding chains can be applied for multiplexing HARQ-ACK and UTO-UCI on CG PUSCH. |
| ZTE/Sanechips | **Proposal 6**: Regarding sequence generation order between UTO-UCI and HARQ-ACK, HARQ-ACK is prior to UTO-UCI. |
| Lenovo | **Proposal 10**: Handling of UTO-UCI and HARQ-ACK is similar to that of CG-UCI and HARQ-ACK. |
| Google | **Proposal 8**: When joint encoding between UTO-UCI and HARQ-ACK is not configured, UTO-UCI should be transmitted and the eMBB HARQ-ACK can be deprioritized and retransmitted by the UE on demand from the gNB.  **Proposal 9**: 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 |
| xiaomi | **Observation 3**: The design of dropping rule needs to consider the impact on legacy system performance. |
| MTK | **Proposal 8**: If joint encoding is not supported or configured, UTO-UCI should be dropped when HARQ-ACK is available. |
| CAICT | **Proposal 6**: The dropping rule between UTO-UCI and HARQ-ACK when joint encoding is based on UE-specific configuration. |
| DCM | **Proposal 7**: For encoding/multiplexing of UTO-UCI,  - If joint encoding of HARQ-ACK and UTO-UCI is configured, the UTO-UCI bits are after HARQ-ACK bits.  - If joint encoding of HARQ-ACK and UTO-UCI is configured, two options can be considered:  \* Option 1: Reuse CG-UCI rule, i.e. UE will drop the CG PUSCH and multiplex the HARQ-ACK in PUCCH or another PUSCH if they have same priority index.  \* Option 2: UE will drop the UTO-UCI and multiplex the HARQ-ACK in the CG PUSCH. |
| OPPO | **Proposal 8**: When HARQ-ACK is multiplexed into a CG PUSCH with the same priority, UTO-UCI is appended to the HARQ-ACK.  **Proposal 9**: If a UE is provided uci-MuxWithDiffPrio, reuse R17 intra-UE multiplexing procedure, where UTO-UCI is appended to the HARQ-ACK with the same priority, and treat them as R17 HARQ-ACK with priority X. |
| Samsung | **Observation 1**: 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. |
| Honor | **Proposal 5**: Support the UTO-UCI with lower priority than HARQ-ACK. |
| KT Corp. | **Proposal 2**: UTO-UCI and CG-UCI are disjointly transmitted. That is, UTO-UCI is not transmitted at PUSCHs with CG-UCI.  **Proposal 3**: 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.  **Proposal 3**-1: 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. |

### 4.2.1 Initial Discussions

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

Based on the observations, the followings are suggested.

* **Suggestion 1)** First decide whether for Issue 1 and Issue 2 in previous section, there is a need for additional agreements, i.e. Option 1 or Option 2.
* **Suggestion 2)** If additional agreement is needed, provide your preference for Option 1.

**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** and **suggestions**?
* **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** |
| Futurewei | Q1: We are ok with Moderator’s observations and suggestions  Q2: If additional agreement is needed, we prefer option 2 for both issue 1 and issue 2 |
| **ZTE, Sanechips** | For issue 1, we think no additional spec change is needed. We had the proposal in contributions:  **Proposal 6**: Regarding sequence generation order between UTO-UCI and HARQ-ACK, HARQ-ACK is prior to UTO-UCI. |
| **DOCOMO** | Q1: Agree with Moderator’s observations and suggestions.  Q2: For Issue 2, we think additional agreements by option 1 is beneficial for XR performance. |
| **Xiaomi** | We are fine with both suggestions. Issue 1 and issue 2 need to be clarified in RAN1.  For Issue 1, since each CG PUSCH will include the UTO-UCI and gNB can try to receive multiple times, so the HARQ-ACK should be prioritized.  For Issue 2, UTO-UCI should not have an impact on existing system performance in our understanding, so it is reasonable to drop the UTO-UCI first. |
| **Nokia, NSB** | **Q1:**  We are fine with moderators suggestion.  **Q2:**  We added another aspect for discussion above (see Other aspects). Particularly, the discussion on the dropping rule for UTO-UCI when CG PUSCH was canceled/dropped is needed. |
| **vivo** | For Issue 1, we don’t see the need to change the spec, either. option 2 is supported. For Issue 2, we prefer to reuse the same rule as that for CG-UCI and HARQ-ACK. |
| **TCL** | For Issue 1, as the UTO-UCI needn’t to carry HARQ-ID as CG-UCI, gNB does not need to obtain the HARQ-ID from the UTO-UCI, when the resource reserved for UCI is not enough, this will be caused HARQ-ACK will be dropped first, the latency for a corresponding PDSCH or others transmission will be increased, thus, the UCI bits sequence generate can be HARQ-ACK first, then UTO-UCI. |
| **LG** | Q1: We are fine with FL’s observation and suggestion.  Q2: Considering the similarity of CG-UCI and UTO-UCI, UE may need to have certain capability to joint encoding UTO-UCI with HARQ-ACK. Therefore, we think both issue 1 and 2 are valid. Especially, it seems beneficial to have specification impact for issue 2, considering the possibility of collision between HARQ-ACK and CG-PUSCH when multiple CG occasion in a period is used.  Regarding to issue 3, we think it is necessary to discuss how to handle UTO-UCI less than 2 bits.  Regrading to different priorities of UTO-UCI, we don’t see any issue if UTO-UCI follows existing rule of different priority multiplexing for CG-UCI |
| **Qualcomm** | We agree with Moderator’s observations and suggestions.  We agreed that the previous agreement (multiplexing and encoding of UTO-UCI follows that for the CG-UCI design) should be stick to as much as possible.  For generation order of UTO-UCI and HARQ-ACK, we agree that the gNB can configure enough resource (hence, the dropping can be considered as a corner case) to avoid the dropping of either of the two UCIs when joint encoding/multiplexing of UTO-UCI and HARQ-ACK is configured.  For the collision between HARQ-ACK in PUCCH and UTO-UCI in CG PUSCH when encoding/multiplexing of UTO-UCI and HARQ-ACK is not configured, this may not be fully avoided by gNB and not considered as a corner case. Hence, a dropping of either HARQ-ACK or UTO-UCI needs to be determined. For that, we think the introduction of UTO-UCI does not need to impact existing behavior given that UTO-UCI is not that critical (like CG-UCI for NR-U), i.e., when collision occurs, UE multiplexes and transmits HARQ-ACK in the CG PUSCH. |
| **Lenovo** | We don’t see a need to divert from what is specified for CG-UCI in this regard. |
| **Samsung** | Q1/Q2: Agree with the Moderator’s summary and justifications. |
| **Google** | Q1: Fine with Moderator’s observations and suggestions.  Regarding issue 1, we are OK to have Option 2.  Regarding issue 2, and to clarify Option 1-3), we need to differentiate between HARQ-ACK associated with XR or URLLC traffic and HARQ-ACK associated with the eMBB traffic. The HARQ-ACK associated with the eMBB traffic can be dropped or deferred but the HARQ-ACK associated with the XR or URLLC traffic can be prioritized and the UTO-UCI dropped in this case. |
| **Sharp** | We agree with moderator’s summary and suggestions.  Q1: for joint coding, the sequence order has no impact on the performance. So it is better to reuse legacy order for CG-UCI, i.e. Option 1. How questions need to be clarified for joint coding of HARQ-ACK and UTO-UCI, esp.   * If the HARQ-ACK and CG PUSCH have different priorities, how the beta offset for HARQ-ACK is determined. * What if the HARQ-ACK includes both high priority and low priority HARQ-ACK? Joint coding of HARQ-ACK with different priorities is not supported currently on either PUCCH (except total 2-bit case) or PUSCH.   Q2: We prefer Option 1, since UTO-UCI is not that critical. It may be dropped by HARQ-ACK at least in some cases. More details are needed, e.g.   * Do we need to pick one from HARQ-ACK and UTO-UCI? * What if there are HARQ-ACK of both high priority and low priority bits? * Is it possible to separate code HARQ-ACK and UTO-UCI by different coding chains if the total number of coding chains are not exceeded? |
| **OPPO** | We are OK with Moderator’s observations and suggestions. We think both issue 1 and issue 2 need further discussion. Since UTO-UCI is an optional information that it not critical, we believe that more flexibility needs to be provided to the gNB to control the number of reserved RE for UCI transmission and whether to transmit the UTO-UCI. Therefore, for issue 1, we slightly prefer option 1.  For issue 2, no additional RRC signal is needed. Once UTO-UCI is enabled, it should be jointly coded with HARQ-ACK of the same priority if PUCCH carrying the HARQ-ACK overlaps with the CG PUSCH, and then R16 prioritization or R17 multiplexing should be further performed. |

## 4.3 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) Timeline impact and/or requirements
  + 1-1) Introduce timeline for indication of “unused” TOs
    - Support: LG, xiaomi, Sony, NEC, Panasonic
    - Not support: E///, QC
  + 1-2) Impact on existing timelines due to “unused” Tos
    - E///, NEC
* Topic 2) Introduce Overriding “unused” indications
  + Support: CMCC, xiaomi
  + Not support: QC, E///, IDC, ~~xiaomi,~~ LG, vivo, OPPO
  + Needs study: Nokia
* Topic 3) Applicability to multiple CG configurations
  + Support: QC, vivo, TCL, LG, Apple, Google, xiaomi, Spreadtrum, Sony, Honor, Panasonic
  + Not support: Nokia, OPPO, DENSO, Samsung, DCM
  + Needs study: E///
* Other topics including
  + Interaction with uplink skipping (OPPO)
  + Applicability to unlicensed (QC)
  + Applicability of feature to TboM on Type-2 CG (QC, DCM)
  + Partial CG resource usage (Apple)
  + …

**Moderator’s observation:**

* **Observation 1:** Regarding topic 1 on timeline, there are two different topics. Detailed solutions regarding topic 1-1 is proposed by proponents. Discussion is needed to determine whether new timeline should be introduced or not. Regarding topic 1-2, the discussion is about the impact on UTO on existing timeline which needs to be discussed.
* **Observation 2:** Regarding topic 2,It seems there is not strong support to enable overriding.
* **Observation 3:** Regarding topic 3, there is a good support as well as resistance.

Table 7: Summary of Contributions inputs for Section 4.3

|  |  |
| --- | --- |
| **Company** | **Contributions inputs** |
| Qualcomm | **Observation 25**: Explicit timeline between UTO-UCI and unused PUSCH occasion has no impact to UE implementation for skipping a PUSCH occasion and hence can be left to gNB implementation.  \* If the gNB does not receive the UTO-UCI early enough it can always do blind detection of PUSCH.  **Observation 26**: Optimization for existing timelines due to UTO-UCI transmission has impacts to UE implementation of existing specification.  \* It may not be critical to specify optimizations for existing timelines before the basic UTO-UCI feature is completed.  **Proposal 10**: UE can provide different indication for a CG PUSCH occasion in multiple UTO-UCIs. gNB uses the most recent UTO-UCI received from the UE.  \* Support the case that a CG PUSCH occasion previously indicated as NOT unused in one UTO-UCI is later indicated as unused in another UTO-UCI.  \* Do not support the case that a CG PUSCH occasion previously indicated as unused in one UTO-UCI is later indicated as NOT unused in another UTO-UCI.  **Proposal 12**: UTO-UCI is also beneficial for capacity enhancements and network energy saving in unlicenced spectrum. UTO-UCI design should be specified for unlicenced spectrum.  **Proposal 16**: An explicit timeline between the UTO-UCI and the indicated unused CG PUSCH occasion(s) is not needed for the UE to skip the CG PUSCH occasion(s).  **Proposal 17**: If a CG PUSCH is skipped due to collision with other higher priority resource or operation such as semi-static DL symbol, DG scheduled DL symbol, SFI DL or flexible symbol, etc., the UE is not required to indicate this CG PUSCH occasion as unused in the UTO-UCI.  **Proposal 18**: Support the indication of unused CG PUSCH occasion(s) by the UTO-UCI when TboMS and repetition are configured for Type-1 and Type-2 CG. |
| Ericsson | **Observation 14** A previous UCI has indicated a CG PUSCH TO as “unused”. Overriding means that a later UCI indicates the CG PUSCH TO as NOT “unused”.  **Observation 15** Support of overriding is conditioned on satisfying at least the following design principles:  **Observation 16** The benefit of overriding is not justified to be supported.  **Proposal 12** 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.  \* Commitment to transmit: When a CG PUSCH TO is previously indicated “unused”, if a later UCI overrides the previous indication corresponding to the CG PUSCH TO, the UE shall “use” that CG PUSCH for transmission.  \* Satisfying timeline: When a CG PUSCH TO is previously indicated “unused”, if a later UCI overrides the previous indication corresponding to the CG PUSCH TO, the time between the end of a CG PUSCH carrying the later UCI and the start of the overridden CG PUSCH shall not be less than a time duration provided by configuration.  \* Simplicity: The key design choices regarding e.g., content and timing of UCI, should not complicate enabling overriding if supported.  \* FFS on other conditions and disciplines from UE  **Proposal 13** 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. |
| Vivo | **Proposal 6**: When a CG PUSCH occasion is indicated as “unused”, the UE is expected not to transmit 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 PUSCH on that CG PUSCH occasion as per legacy specification.  **Proposal 7**: A CG PUSCH occasion indicated as unused earlier is not expected to be changed as NOT unused later.  **Proposal 15**: When it is configured that CG PUSCHs corresponding to a CG configuration include UTO-UCI, it is configurable for which CG configuration(s) the UTO-UCI indicates unused CG PUSCH occasion(s). |
| TCL | **Proposal 10**: When more than one CG configuration activation simultaneously, a UCI to indicate un-used Tos within more than one CG configurations can be considered. |
| Nokia/NSB | **Proposal 7**: The indicated unused CG PUSCH TO(s) is for one CG configuration only.  **Proposal 14**: Overriding previous indication from used to unused is allowed.  FFS: Overriding a previous indication from unused to used. |
| LG | **Proposal 7**: Following two principles are to be considered for the URI indication for a same PUSCH occasion.  \* Once a PUSCH occasion has been indicated as unused, it cannot be indicated as non-unused by URI  \* Only the PUSCH occasion previously not indicated as unused, can be indicated as unused by URI  **Observation**: The re-scheduling time (in gNB side) should be guaranteed in between where UE transmit URI and the beginning of unused resources indicated by the URI.  **Observation**: The range of unused resource that can be indicated by URI might be limited without XR-awareness information.  **Proposal 8**: The range of unused resource that can be indicated by URI is determined based on where URI is transmitted.  \* The first CG PUSCH indicated by URI starts no earlier than X symbol after where URI transmission ends, where X is re-scheduling time required by gNB.  \* The last CG PUSCH starts no later than Y symbol after the beginning of the first CG PUSCH, where Y is provided by gNB configuration based on UE capability  \* FFS: How to define X and Y  **Proposal 9**: No URI information is created/constructed for a resource in a time window starting from the end of PUSCH where URI transmitted and which ends after X symbols, where X is re-scheduling time required by gNB.  **Proposal 12**: Support to apply URI transmitted via a CG configuration to the other CG configuration.  \* A parameter indicating CG configuration to which URI applies can be provided by gNB.  **Proposal 13**: a PUSCH indicated by URI and other PUSCH overlapped with the PUSCH are assumed to be dropped.  \* No MAC PDU is generated for those CG PUSCHs. |
| Sharp | **Proposal 3**: A UTO-UCI is associated with a configured multi-PUSCH CG, and cannot be associated with multiple CG configurations.  \* In a UTO-UCI, a bit of “1” is used to indicate “unused”, and “0” for “not unused” for a CG PUSCH TO. |
| IDC | **Observation 1**: Enhanced CG scheme based on updating/overriding of the UTO-UCI indication with flexible (re)allocation of CG PUSCH occasions outperforms the baseline CG scheme and the enhanced CG scheme where UTO-UCI updating is not supported. |
| Apple | **Proposal 13**: regarding multiple CG configurations on the same cell, consider the following two options:  \* Alt. G-1  o 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-2  o 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 carrier. |
| Lenovo | **Observation 2**: 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. |
| Google | **Proposal 5**: Support the UCI indication of the unused TO(s) to operate for multiple CG configurations |
| xiaomi | **Observation 2**: The time-frequency resources corresponding to the reserved TO will be wasted if the overriding indication are not supported for dynamic indication for Multi-PUSCHs CG.  **Proposal 10**: Whether the overriding indication is supported for dynamic indication for Multi-PUSCHs CG should be discussed in RAN1.  **Proposal 11**: RAN1 should prioritize the discussion of the timeline for dynamic indication.  **Proposal 12**: 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  **Proposal 13**: How to enable dynamic indication needs to be studied to ensure that dynamic indication can be applied in reasonable scenarios.  **Proposal 14**: Support a single UTO-UCI to provide information for a CG configuration which doesn’t include the single UTO-UCI.  **Proposal 15**: Dynamic indication for more than one CG configuration should be discussed in RAN1.  **Proposal 16**: If needed, a RRC signaling can be used as an indication that UTO-UCI is protected first.  **Proposal 17**: The gNB can allocate reusable resources to any UE, including the UE that sends UCI carrying the dynamic indication. |
| Spreadtrum | **Proposal 5**: For dynamic indication of unused CG PUSCH transmission occasion(s) based on UTO-UCI with multiple CG configuration:  \* Reporting period: the time duration/range of indicating the unused CG PUSCH occasions (reporting period) can refer to one of multiple CG-PUSCH configuration period;  \* Reporting order: following the order of multiple CG configurations indexes to report the unused CG PUSCH occasions during the reporting period;  \* Reporting field: the field to report the unused CG PUSCH occasions can also be a bitmap in UTO-UCI, in which each bit of the bitmap is associated with one CG transmission occasion with one CG configuration. |
| CAICT | **Proposal 5**: Consider UTO-UCI transmission in an empty CG PUSCH to improve the efficiency of recycling. |
| CMCC | **Proposal 4**. Support to introduce a UTO-UCI overriding mechanism, which allows UE to transmit later UTO-UCI to override the indication of the unused CG PUSCH occasions in previous UTO-UCI. |
| DCM | **Proposal 6**: For a TO overlapping with semi-static DL or SSB symbols within the indicated TO range, UE skips the bit for the TO.  **Proposal 8**: UTO-UCI indicates unused Tos of the same CG configuration as CG PUSCH carrying the UCI. |
| OPPO | **Proposal 3**: If uplink skipping is enabled and no data is available for a CG PUSCH, the MAC does not generate a MAC PDU if there is no HARQ-ACK/CSI to be multiplexed in the CG PUSCH.  **Proposal 4**: If a DG PUSCH overrides a CG PUSCH in the PUSCH TO which is determined to transmit the UCI, as allowed in R17, the UCI should be multiplexed in the DG PUSCH.  **Proposal 5**: UTO-UCI should be configured per CG configuration and used to indicates the unused TO(s) within one CG period.  **Proposal 6**: The payload size of UTO-UCI can be configured by RRC or equals to the remaining configured CG PUSCHs in the period.  **Proposal 7**: If one CG PUSCH TO is indicated as unused by an early UTO-UCI, it cannot be indicated as used by a later UTO-UCI. |
| Samsung | **Proposal 3**: The indication of unused Tos is for the CG configuration associated with the CG-PUSCH providing the UTO-UCI.  **Proposal 7**: Extend the collision resolution procedure for SPS PDSCHs to CG-PUSCHs. XR-specific enhancements may also be considered. |
| Panasonic | **Proposal 7**: The collided PUSCH Tos with (static or semi-statically configured) DL slots/symbols should be removed from the unused indication. |
| DENSO | **Proposal 5**: The UCI indication associated with multiple CG configurations is not supported. |
| Sony | **Proposal 3**: Specify a timeline for a UE to indicate unused CG occasions in a period of a single CG configuration.  **Proposal 4**: In case of multiple CG configuration, support a UTO-UCI in one of the CG configurations could also indicate the unused CG transmission occasions belonging to other CG configurations. |
| NEC | **Proposal 3**: consider repetition and retransmission mechanism for the UTO-UCI.  **Proposal 5**: study the timeline issues due to the multi-PUSCHs CG, including  a) how to handle the unused CG PUSCH occasion(s) and the UCI content if the time offset from the UCI to the unused CG PUSCH occasion(s) is smaller than the minimum preparation time for reusing the unused CG PUSCH occasion  b) if a high priority DG-PUSCH indicated by a scheduling DCI would overlap in time with a low priority CG-PUSCH occasion, how the PUSCH preparation time of the DG-PUSCH will be impacted if the low priority CG-PUSCH occasion is indicated as unused before the scheduling DCI. |
| Honor | **Proposal 4**: Extend the UTO-UCI to contain two parts of indications in which  the first part provides a first level information such as:  whether the second part exists or  which CG configuration it belongs  the second part provides a bitmap where a bit corresponds to a TO within a time duration/range. |

### 4.3.1 Initial Discussions

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

Considering the topics and observations on companies’ view, Moderator’s suggests the followings for discussion:

* Suggestion 1) Support **Proposal 4-3-1** and **Proposal 4-3-2** that are needed to clarify the UE behaviour.
* **Suggestion 2)** Discuss two independent topics under timeline topic, and express your view regarding Topic 1-1 and Topic 1-2
* **Suggestion 3)** Down-prioritize overriding (Topic 2), and instead consider **Proposal 4-3-3.**
* **Suggestion 4)** Discuss your view to make a decision regarding whether to support extension to multiple CG configurations or not. The decision impacts the core design in section 4.1. Consider **Proposal 4-3-4** and study the proposed solutions by proponents.

**Proposal 4-3-1:**

When a CG PUSCH occasion is indicated as “unused”, the UE is expected not to transmit 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 PUSCH on that CG PUSCH occasion as per legacy specification.

**Proposal 4-3-2:**

If a CG PUSCH is skipped due to collision with other higher priority resource or operation such as semi-static DL symbol, DG scheduled DL symbol, SFI DL or flexible symbol, etc., the UE is not required to indicate this CG PUSCH occasion as unused in the UTO-UCI.

**Proposal 4-3-3:**

A CG PUSCH occasion indicated as “unused” earlier, is not expected to be indicated as NOT unused later.

**Proposal 4-3-4:**

**Select one of the following options:**

* **Option 1:** The unused CG PUSCH Tos indicated by a UTO-UCI in a CG PUSCH in a CG configuration can be associated to multiple CG configurations.
  + **FFS on details**
* **Option 2:** The unused CG PUSCH Tos indicated by a UTO-UCI in a CG PUSCH in a CG configuration are associated only to the CG configuration.

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

* **Q1:** Please indicate your view regarding the moderator’s **observations/suggestions** regarding the topics above.
* **Q2**: Please share your view regarding **Proposal 4-3-1, Proposal 4-3-2, Proposal 4-3-3 and Proposal 4-3-4.**
* **Q3:** 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** |
| Futurewei | Q1: Timeline topics 1-1 and 1-2 both needs to be discussed with high priority  Q2: We are ok with Proposal 4-3-1, Proposal 4-3-2, and Proposal 4-3-3. For Proposal 4-3-4, we prefer Option 2 since multiple CG configurations are not discussed and agreed yet.  Q3: Multiple CG configurations can be discussed after all details of single CG configuration are settled |
| **ZTE, Sandchips** | **For proposal 4-3-3,**  According to Moderator’s observation, there is not strong support to enable overriding. In our view, there is no clear use case that UE changes the indication later on. (E.g., we are not convinced by the case that the UCI indicates usage of Tos within two CG periods, and updates the information for second CG period when the packet really arrives).  For other proposals, we’re fine to further discuss. |
| **DOCOMO** | Q1: Fine with moderator’s suggestions.  Q2: Fine with Proposal 4-3-1, Proposal 4-3-3 and Proposal 4-3-4.  Regarding Proposal 4-3-2, we hope more clarification on the result of the Proposal. What does it mean by “not required to”? Moreover, we think separate discussion for skipped/cancelled CG occasion due to semi-static collision and dynamic collision is better. For example, if CG occasion is cancelled due to collision with semi-static DL symbol, UE can skip the bit for the CG occasion to reduce UCI payload size. |
| **Xiaomi** | For Q1, we would like to clarify some of our understandings.  For topic 1, the reserved time for gNB to reschedule unused TO(s) needs to include at least the time for gNB to send a DCI and the time for UE to process the DCI and prepare the PUSCH. The time range from the TO including the UCI to the first unused TO can be used to determine timeline. This has contributed to a smaller latency.  For topic 2, we support to introduce overriding indication for Multi-PUSCHs CG. Overriding indication contains two options, Option 1: “used” TO is rewritten as “unused” TO. Option 2: “unused” TO is rewritten as “used” TO. From our perspective, at least Option 1 needs to be supported. For its own interests, UE may reserve some Tos and notify the gNB that these TO are “used”. When UE clearly does not use these TO, it can change the state of these Tos by a later indication, which further increases the utilization rate of resources.  For Q2, we are fine with Proposal 4-3-1 and Proposal 4-3-4.  We suggest that Proposal 4-3-3 be modified as follows:  **Proposal 4-3-3:**  A CG PUSCH occasion indicated as “unused” earlier, is not expected to be indicated as NOT unused later.  FFS: Whether a CG PUSCH occasion indicated as NOT unused earlier can be indicated as unused later. |
| **Nokia, NSB** | **Q1:** We are fine with observations/suggestions.  **Q2:** We support Proposals 4-3-1, 4-3-2.  For Proposal 4-3-2, further study is needed. In case UE had indicated some occasion is unused, but due to collision, the occasion indicated earlier as “unused” can be needed again. There are options to send an SR which will increase the delay and compromise the delay budget or revert the indication. We propose to further discuss this issue.  For Proposal 4-3-4, we support Option 2.  **Q3:**  It is also important to discuss the overriding from used to unused, since UE may not know in advance which occasions it will not use and therefore may send used indication for some time. |
| **Panasonic** | Q1: We think Timeline for Topic 1-1 should be discussed.  Q2: Regarding the Proposal 4-3-2, we think skipped slots indicated by SFI should not be dropped from the unused indication to avoid misalignment between the UE and gNB when the UE misses the SFI.  Regarding Proposal 4-3-4, our preference is Option 1 to support the unused indication for multiple CG configurations. For this, a CG configuration could include a list of CG IDs that the unused indication is applicable to them. |
| **TCL** | Q1: We are fine with the observations/suggestions.  Q2: We are ok with Proposal 4-3-1, Proposal 4-3-2, and Proposal 4-3-3. For Proposal 4-3-4, we prefer Option 1. |
| **LG** | **Q1:** We are fine with the FL’s assessments.  **Q2:** We support proposal 4-3-1, 4-3-3, 4-3-4. For proposal 4-3-4, we support Option 1.  Regarding proposal 4-3-2, it is unclear why UTO-UCI need to indicate status of past CG PUSCHs. If previous CG PUSCH is transmitted or skipped, it would be better to omit the bit corresponding to the previous CG PUSCH from the UTO-UCI  **Q3:** As we mentioned above, 4-3-2 can be discussed after the discussion of section 4.1 |
| **Qualcomm** | We support all proposals from Moderator.  On suggestion 2), for the impact to existing timelines, we suggest companies first identify all existing timelines that are potentially impacted. It is highly preferred that unified solutions are provided for the existing timelines if any optimization is necessary to address the impact to existing timelines.  On suggestion 3), we agree that an overriding operation from unused to not unused should not be allowed.  On suggestion 4), we think UTO-UCI indicating a single CG configuration is too restrictive for multi-flow multi-media traffics. There are many use cases for UTO-UCI to indicates multiple CG configurations.   * Indication of 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. * Indication of unused CG PUSCH occasions due to jitter time. * Robust UTO-UCI transmission in FR1 carrier indicating PUSCH occasions in FR2 carrier.   Besides, UTO-UCI indicating multiple CG configurations allows the UE to transmit an earliest possible indication for unused PUSCH occasions across CG configurations. This is beneficial for the gNB to skip blind PUSCH detection and reallocate unused PUSCH resources.  To support UTO-UCI indicating multiple CG configurations, an indexing rule of CG PUSCH occasions can be designed as simple as shown in the figure below (e.g., within CG configuration first, then across CG configurations). Considering the huge flexibility and potential benefit, we think it is worthwhile to support UTO-UCI indicating multiple CG configurations.    Figure 10: Indexing of CG PUSCH occasions in a time duration/range across CG configurations [R1-2305351] |
| **Lenovo** | Agree with all suggested proposals (4-3-x). |
| **Samsung** | Q1/Q2: OK in general with the proposals – overall, simple solutions are preferred as there are practically no benefits from over-optimizing UTO-UCI reporting (overhead is negligible to begin with).  For Proposal 4-3-4 and Option 1, we would like to discuss further the (a) applicable/feasible scenarios, and (b) reason/benefits to have the solution on top of the baseline one for Option 2 (i.e., it is not whether to support Option 2 – that is default – the issue is whether to support Option 1 in addition to Option 2). |
| **NEC** | We agree with observation 1 that the timeline issue should be discussed.  We support proposal 4-3-1, 4-3-2, and 4-3-3. For proposal 4-3-4, we prefer option 2. |
| **Google** | We support overriding but only in the case of an occasion indicated initially as “Not Unused” to be overwritten as “Unused”.  Regarding the timeline, it is better to leave it to gNB implementation as difficult to specify any timeline requirements.  We support extending the UTO-UCI indication in a CG PUSCH in a CG configuration to multiple legacy CG configurations (with a single PUSCH per CG period). The objective is to enable this feature for the legacy CG configurations if used for the XR traffic instead of the CG configuration with multiple PUSCHs per CG period.  We support Proposal 4-3-1, Proposal 4-3-2 and Proposal 4-3-3 and option 1 of Proposal 4-3-4. |
| **Sharp** | **Q1:** A basic timeline by processing time should be discussed, No complicated design is needed.  **Q2**: We support **Proposal 4-3-1, Proposal 4-3-2,**  For **Proposal 4-3-3,** it is valid argument that the “unused’ status should not be changed very dynamically in a very short time, but it should be allowed to override when the traffic load changes. Thus, a timeline condition should be applied, e.g.  A CG PUSCH occasion indicated as “unused” earlier, is not expected to be indicated as NOT unused later within a time range X.  For **Proposal 4-3-4,** we prefer Option 2 for easy implementation. |
| **SONY** | On Q1: We are fine with the moderator’s suggestions.  On Q2: We support proposal 4-3-1 and 4-3-4 and support Option 1 in proposal 4-3-4 |
| **OPPO** | Q2: We support Proposal 4-3-1, Proposal 4-3-2 and Proposal 4-3-3. For Proposal 4-3-4, considering UTO-UCI is not critical information, we prefer Option 2 for simplicity.  Q3: We think one more topic is needed to be discussed, i.e. if a DG PUSCH overrides a CG PUSCH, as allowed in R17, whether the UTO-UCI should be multiplexed in the DG PUSCH? |
| **Moderator** | **Summary of views:**  P4-3-1: FW, xiaomi, TCL, LG, Lenovo, NEC, Google, Sharp, Sony, OPPO  P4-3-2: FW, TCL, Lenovo, NEC, Google, Sharp, OPPO   * FFS: DCM, Nokia, Panasonic, FSS   P4-3-3: FW, TCL, LG, Lenovo, NEC, Google, OPPO  P4-3-4:   * Option 1: Panasonic, TCL, LG, QC, Google, Sony * Option 2: FW, Nokia, NEC, Sharp, OPPO   **Proposal 4-3-1:**  When a CG PUSCH occasion is indicated as “unused”, the UE is expected not to transmit 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 PUSCH on that CG PUSCH occasion as per legacy specification.  **Proposal 4-3-2:**  If a CG PUSCH is skipped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*. the UE is not required to indicate this CG PUSCH occasion as unused in the UTO-UCI.   * FFS on collision other higher priority resource, DG scheduled DL symbol, SFI DL or flexible symbol   **Proposal 4-3-3:**  A CG PUSCH occasion indicated as “unused” earlier, is not expected to be indicated as NOT unused later.  A CG PUSCH occasion indicated as “NOT unused” earlier, can be indicated as “unused” later.  **Proposal 4-3-4:**  **Select one of the following options:**   * **Option 1:** The unused CG PUSCH TOs indicated by a UTO-UCI in a CG PUSCH in a CG configuration can be associated to multiple CG configurations.   + **FFS on details** * **Option 2:** The unused CG PUSCH Tos indicated by a UTO-UCI in a CG PUSCH in a CG configuration are associated only to the CG configuration. |

#### 4.3.1.1 Online discussion

**Moderator’s recommendation:**

**Proposal 4-3-1:**

When a CG PUSCH occasion is indicated as “unused”, the UE is expected not to transmit 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 PUSCH on that CG PUSCH occasion as per legacy specification.

**Proposal 4-3-2:**

If a CG PUSCH is skipped due to collision with DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated or SSB*. the UE is not required to indicate this CG PUSCH occasion as unused in the UTO-UCI.

* FFS on collision other higher priority resource, DG scheduled DL symbol, SFI DL or flexible symbol

**Proposal 4-3-3:**

A CG PUSCH occasion indicated as “unused” earlier, is not expected to be indicated as NOT unused later.

A CG PUSCH occasion indicated as “NOT unused” earlier, can be indicated as “unused” later.

# 5 Conclusion

TBD

# References

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Agenda item: 9.8** | | |
| 1 | [**R1-2304494**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304494.zip) | Draft CR on PDCCH monitoring resumption after NACK | vivo, MediaTek, Ericsson, Xiaomi, ZTE, Sanechips, China Telecom, China Unicom, Qualcomm, LGE, Huawei, HiSilicon, Google, Meta, Apple |
| 2 | [**R1-2305864**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305864.zip) | Draft CR for Introducing PDCCH monitoring resumption after UL NACK | Nokia, Nokia Shanghai Bell |
| 3 | [**R1-2305257**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305257.zip) | Discussion on PDCCH monitoring resumption after UL NACK | Apple |
|  | **Agenda item: 9.8.1** | | |
| 4 | [**R1-2304354**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304354.zip) | XR-specific capacity enhancements | FUTUREWEI |
| 5 | [**R1-2304384**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304384.zip) | Discussions on XR-specific capacity enhancements | New H3C Technologies Co., Ltd. |
| 6 | [**R1-2304413**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304413.zip) | Capacity Enhancements for XR | Ericsson |
| 7 | [**R1-2304495**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304495.zip) | Discussion on XR specific capacity enhancements | vivo |
| 8 | [**R1-2304529**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304529.zip) | Discussion on XR specific capacity enhancements | ZTE, Sanechips |
| 9 | [**R1-2304572**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304572.zip) | Discussion on XR-specific capacity enhancements | Spreadtrum Communications |
| 10 | [**R1-2304617**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304617.zip) | Discussion on XR capacity enhancement techniques | Panasonic |
| 11 | [**R1-2304665**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304665.zip) | Discussion on CG enhancements for XR capacity | Huawei, HiSilicon |
| 12 | [**R1-2304745**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304745.zip) | Design of Multiple CG Occasions and unused CG occasion feedback | CATT |
| 13 | [**R1-2304915**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304915.zip) | Discussion on XR-specific capacity enhancements | xiaomi |
| 14 | [**R1-2304980**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304980.zip) | Discussion on XR-specific capacity enhancements | Honor |
| 15 | [**R1-2304981**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304981.zip) | Discussion on XR-specific capacity enhancements | DENSO CORPORATION |
| 16 | [**R1-2304993**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304993.zip) | Discussion on XR-specific capacity enhancements | NEC |
| 17 | [**R1-2305022**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305022.zip) | Discussion on XR specific capacity enhancements | CAICT |
| 18 | [**R1-2305047**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305047.zip) | On XR-specific capacity enhancements techniques | Sony |
| 19 | [**R1-2305074**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305074.zip) | On XR-specific capacity enhancements techniques | Google Inc. |
| 20 | [**R1-2305108**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305108.zip) | Discussion on XR-specific capacity enhancements | CMCC |
| 21 | [**R1-2305135**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305135.zip) | XR-specific capacity enhancements techniques | TCL Communication Ltd. |
| 22 | [**R1-2305145**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305145.zip) | Discussion on XR-specific capacity enhancements | LG Electronics |
| 23 | [**R1-2305175**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305175.zip) | Discussion on XR-specific capacity enhancements | InterDigital, Inc. |
| 24 | [**R1-2305196**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305196.zip) | Remaining issues on XR-specific capacity enhancements | Sharp |
| 25 | [**R1-2305211**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305211.zip) | XR-related CG Enhancements | Lenovo |
| 26 | [**R1-2305258**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305258.zip) | XR-specific capacity enhancements | Apple |
| 27 | [**R1-2305351**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305351.zip) | Capacity Enhancement Techniques for XR | Qualcomm Incorporated |
| 28 | [**R1-2305468**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305468.zip) | Discussion on XR specific capacity enhancements | OPPO |
| 29 | [**R1-2305528**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305528.zip) | Capacity  enhancements for XR | Samsung |
| 30 | [**R1-2305554**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305554.zip) | On XR-specific capacity enhancements | KT Corp. |
| 31 | [**R1-2305610**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305610.zip) | Discussion on XR-specific capacity enhancements | NTT DOCOMO, INC. |
| 32 | [**R1-2305663**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305663.zip) | On XR capacity enhancements | MediaTek Inc. |
| 33 | [**R1-2305781**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305781.zip) | Discussion on XR-specific capacity enhancements | FGI |
| 34 | [**R1-2305863**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305863.zip) | XR-specific capacity enhancements | Nokia, Nokia Shanghai Bell |

# 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.