**3GPP TSG RAN WG1 Meeting #118bis R1-24XXXXX**

**Hefei, China, October 14th – 18th, 2024**

**Source: Moderator (Lenovo)**

**Title: Feature lead summary #1 on multi-cell scheduling with a single DCI**

**Agenda item:** **9.12.1**

**Document for:** **Discussion and Decision**

# Introduction

This document summarizes the open issues on multi-cell scheduling from contributions submitted under the agenda item of “**9.12 Multi-Carrier Enhancements for NR Phase 2**” for Rel-19 WI Multi-carrier enhancements.

The Rel-19 WI Multi-carrier enhancements was approved during RAN#105 meeting in RP-242408, where the objective is targeted to specify the support of multi-cell PUSCH/PDSCH scheduling with a single DCI including scheduling of different SCS/carrier types and one or multiple PUSCHs/PDSCHs per scheduled cell. The detailed objectives in the WID are listed below:

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| ***1. Specify the support of the following for multi-cell PUSCH/PDSCH scheduling with a single DCI [RAN1]**** ***Different SCS/carrier type among co-scheduled cells by the single DCI.***
* ***One or multiple PUSCHs/PDSCHs per scheduled cell by the single DCI.***
	+ ***The maximum number of PUSCHs/PDSCHs per scheduled cell is [4 or 8].***
	+ ***Note: Type-1 HARQ-ACK codebook is not enhanced for Rel-19 multi-cell scheduling.***
	+ ***Note: The maximum number of sub-codebooks for Type-2 HARQ-ACK codebook is not increased for Rel-19 multi-cell scheduling.***
	+ ***Note: UE does not expect to be configured with both single-cell multi-PUSCH/PDSCH scheduling and multi-cell multi-PUSCH/PDSCH scheduling on the same or different cells within a same PUCCH group.***
* ***Note: No new DCI format is introduced.***
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In this contribution, the related issues and proposals are summarized based on the contributions submitted in RAN1#118bis under the agenda item 9.12 [1]-[19]. The whole feature lead summary is structured as follows:

From section 2 to 4, the main issues raised by company contributions are divided into 3 sections. In each section, the background and related proposals submitted in this meeting are listed firstly in the corresponding sub-section, then summary on one or several sub-issues is provided in the next sub-section from moderator’s perspective. Based on the above summary, a set of proposals is recommended by moderator followed by one or multiple tables to collect company views for the initial proposals in the first round of e-mail discussion. If present, in each sub-section, the proposals will be updated round by round based on companies’ inputs. As e-mail discussion goes on, more sub-sections may be provided for further e-mail discussion and update.

In section 5, some proposals are selected for discussion in the online/offline sessions.

In Section 7, the agreements made in previous RAN1/RAN meetings on multi-cell scheduling are listed for reference.

Companies are highly encouraged to provide views as soon as possible. Moderator will try to update the proposals based on companies’ inputs at least on daily basis.

# Scenarios and general aspects

## Background and submitted proposals

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| **Spreadtrum:***Proposal 1: Specify case 1-3/1-4 on SCS and case 2-3/2-4 on carrier type in Rel-19** *Case 1-3: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.*
* *Case 1-4: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells not including the scheduling cell and different SCS is used among the co-scheduled cells.*
* *Case 2-3: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells including the scheduling cell and different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among the co-scheduled cells including the scheduling cell.*
* *Case 2-4: A DCI format 0\_3/1\_3 on a scheduling cell can schedule~~s~~ multiple cells not including the scheduling cell and different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among the co-scheduled cells.*

*Proposal 4: A cell in one set of cells can be configured with either single-PUSCH/PDSCH scheduling or multi-PUSCH/PDSCH scheduling.** *Single-PUSCH/PDSCH scheduling and multi-PUSCH/PDSCH scheduling on different cells in the set of cells are allowed*

**vivo:***Proposal 1: In Rel-19, the DCI format 0-3/1-3 supports to schedule different carrier types among the co-scheduled cells, where the carrier types can be any combinations of {FR1 licensed FDD, FR1 licensed TDD, FR1 unlicensed TDD, FR2-1 or FR2-2}.**Proposal 2: Support all the different SCSes from 15kHz to 960kHz among the cells co-scheduled by a DCI format 0-3/1-3.**Proposal 3: For multi carrier scheduling with mix SCSes, the number of unicast DCI(s) to be monitored is defined per N consecutive slots, where the N is based on the lowest SCS among the cells.***CMCC:***Proposal 1. UL/SUL indicator as Type-2 field is supported in DCI format 0\_3 in Rel-19.* * *Simultaneous transmission between {SUL and SUL} and between {SUL and NUL} is not supported in Rel-19.*

**CATT:***Proposal 1: For Rel-19 multi-cell scheduling, co-scheduled cells with different SCS can be supported without RAN1 specification impact.**Proposal 2: For Rel-19 multi-cell scheduling, co-scheduled cells with different carrier types can be supported without RAN1 specification impact.***OPPO:***Proposal 2: Whether these two bullets in WID can work simultaneously should be clarified, i.e., whether multiple PUSCHs/PDSCHs can be scheduled per co-scheduled cell with different SCS/carrier type by DCI format 0\_3/1\_3.**Proposal 3: Whether to support multi-PDSCH scheduling per scheduled cell by DCI format 1\_3 in FR1 should be discussed.***Nokia:***Proposal 2.1: Support the following MC-DCI scheduling enhancements in Rel-19* * *A single DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs on (i) FR1 licensed band FDD cell(s) and FR1 licensed band TDD cell(s) of the (ii) same and/or different SCS*
	+ *For DCI format 0\_3, (iii) this includes multi-PUSCH scheduling*
* *Multi-PUSCH scheduling using DCI format 0\_3 for FR1 unlicensed TDD cells of the same SCS*
* *A single DCI format 0\_3/1\_3 scheduling of PUSCHs/PDSCHs for FR2-1 cells of (i) same and/or different SCS and (ii) multi-PDSCH/multi-PUSCH*
* *Multi-PUSCH/PDSCH scheduling using DCI format 0\_3/1\_3 for FR2-2 cells of the same SCS*

*Proposed Conclusion 2.2: The following combinations on Rel-19 MC-enhancements are not supported in Rel-19** *A single DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs on*
	+ *FR1 licensed FDD/TDD cells and FR1 unlicensed TDD (i.e. shared spectrum access)*
	+ *FR1 cells and FR2-1 cells*
	+ *FR1 cells and FR2-2 cells*
	+ *FR2-1 cells and FR2-2 cells*
	+ *FR1 unlicensed TDD cells of different SCS*
	+ *FR2-2 cells of different SCS*

*Proposal 3.1: Support Rel-18 Case 1-3 and Case 1-4 on different SCS in Rel-19** *Case 1-3: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.*
* *Case 1-4: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells not including the scheduling cell and different SCS is used among the co-scheduled cells.*

*Proposal 3.2: For PDCCH monitoring capabilities, the scheduled CC SCS for scheduling of cells with different SCS is defined as the largest SCS among the cells of the set of cells.* *Proposal 5.1: Multi-PDSCH and multi-PUSCH scheduling combined with multi-cell scheduling using DCI format 0\_3/1\_3 is only to be supported for frequency range, SCS and carrier type combinations where also multi-PxSCH scheduling using DCI formats 0\_1/1\_1 is supported.**Proposal 5.2: Support scheduling using DCI format 0\_3 of multiple cells, where a subset of the co-scheduled cells may be configured for multi-PUSCH scheduling and the remaining co-scheduled cells may be configured with (single) PUSCH scheduling including repetitions & TBoMS (using numberOfSlotsTBoMS, AvailableSlotCounting, numberOfRepetitions or pusch-AggregationFactor).* *Proposal 5.3: Support scheduling using DCI format 1\_3 of multiple cells, where a subset of the co-scheduled cells may be configured for multi-PDSCH scheduling and the remaining co-scheduled cells may be configured with (single) PDSCH scheduling including aggregation (using pdsch-AggregationFactor or repetitionNumber).* **Lenovo:***Proposal 1: Rel-19 supports a DCI format 0\_3/1\_3 schedules one cell with multiple PUSCHs or PDSCHs on the cell.* **Panasonic:***Proposal 1: At least the following cases are supported in Rel.19.** *Case 1-3 (in Rel.18): A DCI format 0-3/1-3 on a scheduling cell can schedule multiple cells including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.*
	+ *Case 1-3-1: SCS of co-scheduled cells are same or larger than SCS of scheduling cell.*
* *Case 1-4 (in Rel.18): A DCI format 0-3/1-3 on a scheduling cell can schedule multiple cells not including the scheduling cell and different SCS is used among the co-scheduled cells.*
	+ *Case 1-4-1: SCS of co-scheduled cells are same or larger than SCS of scheduling cell.*

*Proposal 2: Whether to support the following cases should be further discussed.** *Case 1-3-2/1-4-2: SCS of co-scheduled cells are same or smaller than SCS of scheduling cell.*
* *Case 1-3-3/1-4-3: Scheduling cell schedules any of SCS scheduled cells.*

**Apple:***Proposal 1: RAN1 to consider supporting multiple reference cells within the set of cells corresponding to each of the different SCS associated with the cells within the set**Proposal 2: RAN1 consider supporting up to two different SCS associated with the cells within the set of cells**Proposal 3: For a UE, overall BD/CCE budget is not increased relative to Rel-18, even with support of different SCS for cells within the set**Proposal 4: RAN1 to study the procedure to determine the maximum number of unicast DCIs that the UE is expected to process within the monitoring slot**Proposal 5: RAN1 to study DCI format 0\_3/1\_3 fields and corresponding higher-layer configuration to determine whether/how cells associated with different SCS and/or carrier type within the set can be scheduled* **Samsung:***Proposal 1: Multi-cell scheduling with different SCS or different carrier types among the set of co-scheduled cells can be supported without new RAN1 specification impact.** *FFS whether to update the field type of the ‘minimum scheduling offset indicator’ field (e.g., to Type-1B);*
* *New FGs to indicate the UE capability to support MC-DCI with different SCS / carrier type.*

**TCL:***Proposal 1: Same/different duplex mode between the co-scheduled cells can be considered.* *Proposal 2: The scenario of different frequency range between FR1 and FR2 among scheduling and scheduled cells can be considered.***MediaTek:***Proposal 1: Agree to maintain the design constraints of the Rel-18 MC-DCI design unless unavoidable for enabling multi-SCS and multi-PxSCH scheduling with MC-DCI.**Proposal 2: For multi-pxSCH scheduling with MC-DCI, agree to not exceed the original design constraints/applicability multi-pxSCH scheduling with SC-DCI.**Proposal 3: Limit multi-PDSCH/PUSCH scheduling with MC-DCI to scheduled FR2 cells.**Proposal 4: Consider whether enabling MC-DCI scheduling of multiple PxSCHs only across ”contiguous” slots would be sufficient to satisfy the commercial needs within Rel-19.**Proposal 5: Consider practical Scheduling Cell vs Scheduled Cell SCS ratio when determining the maximum number of PxSCHs to specify for multi-PxSCH scheduling with MC-DCI for a given band combination.***NTT DOCOMO:***Proposal 1: According to the principle of additional Rel-19 WIs, only specific cases/combinations of SCSs/carrier types among scheduling cell and each of co-scheduled cells should be selected/supported based on commercial demand from operators.**Proposal 2: Specification impacts to support different SCS/carrier type among co-scheduled cells include at least followings.** *updating TS38.300 to remove the restriction*
* *introducing new UE capability(es) for the support of different SCS/carrier type among co-scheduled cells*

*Proposal 7: According to the principle of additional Rel-19 WIs, multi-cell multi-PUSCH/PDSCH scheduling should be applicable to only cases with FR2 scheduled cells.***Qualcomm:***Proposal 1:** *Support multi-cell PUSCH scheduling with different SCS/carrier type among co-scheduled cells by DCI format 0\_3.*
* *Support multi-cell PDSCH scheduling with different SCS/carrier type among co-scheduled cells by DCI format 1\_3.*
* *Discuss and identify if any functional enhancements are necessary on top of Rel-18 specifications*

*Proposal 6:** *Investigate if there are any specification impacts for SCS 480/960kHz on the scheduling cell with DCI format 0\_3/1\_3 for multi-cell PDSCH/PUSCH scheduling.*

**Ericsson:***Proposal 1: Introduce new capabilities for Rel-19 enhanced DCI 0\_3/1\_3 to support different SCS or carrier types.**Proposal 6: Repetition and TB transmission over multiple slots are not supported for the enhanced DCI 0\_3/1\_3.* |

## Moderator summary and proposals based on contributions

* On supported cases for co-scheduled PUSCHs/PDSCHs with different SCS or carrier type:

Rel-18 multi-cell scheduling via DCI formats 0\_3/1\_3 has restriction of same SCS and same carrier type (TDD/FDD, or FR1/FR2, licensed/unlicensed) among the co-scheduled cells, while allowing the scheduling cell to have a different SCS or carrier type when the scheduling cell is not included in the set of co-scheduled cells.

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| **Agreement (RAN1#110)*** At least cases 1-1 and 1-2 on SCS are supported:
* Case 1-1: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and same SCS is used among all the co-scheduled cells including the scheduling cell.
* Case 1-2: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and same SCS is used among all the co-scheduled cells which may be same or different to the SCS of the scheduling cell.
* Case 1-3: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.
* Case 1-4: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and different SCS is used among the co-scheduled cells.
* FFS: Whether Case 1-3 or 1-4 is additionally supported.

**Conclusion (RAN#97):*** Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.
* SCell schedules multiple cells including P(S)Cell
* Different SCS among co-scheduled cells
* Different carrier type (licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells
* Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell
* Support for any sidelink scheduling
 |

Rel-18 has supported both Case 1-1 and 1-2, so Case 1\_3 and 1\_4 can be supported firstly for Rel-19.

According to WID, Rel-19 has no restriction of same SCS/carrier type among co-scheduled cells. Based on companies’ contributions, almost all the companies agree there is no essential update needed for RAN1 specifications due to the introduction of different SCS or different carrier types among the co-scheduled cells.

On the other hand, there can be quite many possible cases for a set of cells including up to 4 cells in terms of SCS (i.e., 15/30/60/120/480/960 kHz) and/or carrier types (i.e., FR1 licensed FDD, FR1 licensed TDD, FR1 unlicensed TDD, FR2-1, FR2-2) of scheduling cell and co-scheduled cells. If all possible cases with arbitrary combinations of SCSs/carrier types among co-scheduled cells and scheduling cell are supported, one potential concern is UE capability design would be very complex and subsequent UE feature discussion will be lengthy.

Therefore, from moderator’s point of view, narrowing down the supported cases needs to be considered. Due to limited TU/scope for Rel-19 multi-carrier enhancements, only specific cases/combinations that have commercial demand from operators can be prioritized in Rel-19 as the starting point, e.g., 3.5GHz TDD + Sub-3GHz FDD, FR1 + FR2, as shown in the WID.

Hence, Proposal 1-1 and Proposal 1-2 are provided for discussion.

* On restriction of multi-PUSCH/PDSCH scheduling

In Rel-16 NR-U, up to 8 PUSCHs can be co-scheduled by one DCI format 0\_1 on same serving cell within FR1 unlicensed TDD spectrum; furthermore, in Rel-17 above 52.6GHz, up to 8 PUSCHs/PDSCHs can be co-scheduled by one DCI format 0\_1/1\_1 on same serving cell within FR2. For Rel-19 multi-cell scheduling, there is one open issue whether multi-PDSCH scheduling on a scheduled cell is extended to FR1.

According to companies’ inputs, three companies [Nokia, MediaTek, NTT DOCOMO] propose multi-PDSCH scheduling is only supported for FR2 cells and two companies [MediaTek, NTT DOCOMO] further propose multi-PUSCH scheduling is only supported for FR2 cells.

From moderator’s perspective, the motivation of supporting multi-PUSCH/PDSCH scheduling + multi-cell scheduling is to fully exploit the gain of power saving and PDCCH overhead reduction for FR2 cells especially for the case when scheduling cell in FR1 with a lower SCS schedules multiple cells in FR2 with higher SCS. Therefore, supporting multi-PUSCH/PDSCH scheduling only for FR2 cells is well aligned with the WID.

Hence, Proposal 1-3 is provided for discussion.

## 1st round of discussions

#### Proposal 1-1:

* Support Rel-18 Case 1-3 and Case 1-4 on different SCS in Rel-19
* Case 1-3: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.
* Case 1-4: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells not including the scheduling cell and different SCS is used among the co-scheduled cells.

Companies are encouraged to provide comments in the table below.

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| --- | --- |
| **Company** | **Comment** |
| CATT | We are ok with proposal.  |
| NTT DOCOMO | Fine with proposal 1-1 |
| Nokia | Agree in principle, but some limitations may need to be still mentioned (or at least considered): - 480/960kHz not supported for 1\_3 in Rel-18 for single SCS operation 🡪 should also not be supported in R19 for multi-SCS operation- If this should be supported for all carrier types (e.g. we don’t see benefits for TDD unlicensed to operate with mixed SCS), which may be related to Proposal 1-2. If this is only to discuss different SCS of the same carrier type (as different carrier types discussed in Proposal 1-2), then maybe the proposal change might be more clear: ***Proposal 1-1-rev1****Support Rel-18 Case 1-3 and Case 1-4 on different SCS in Rel-19** *Case 1-3: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells of the same carrier type including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.*
* *Case 1-4: A DCI format 0\_3/1\_3 on a scheduling cell can schedule multiple cells of the same carrier type not including the scheduling cell and different SCS is used among the co-scheduled cells.*
 |
| Qualcomm | OK with the proposal. |
| ZTE | We support this proposal. |
| Spreadtrum | Support. Also OK with Nokia’s clarification. It has some overlap with Proposal 1-2. |
| Apple | Ok |
| Panasonic | We are OK with the proposal 1-1. |
| TCL | We are fine with the proposal. |

#### Proposal 1-2:

* Support at least the following cases in Rel-19:
* A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs on FR1 licensed FDD cell(s) and FR1 licensed TDD cell(s) with same or different SCS.
* A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs on FR1 cell(s) and FR2 cell(s) with same or different SCS.
* A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs only on FR2 cells with different SCS.

Companies are encouraged to provide comments in the table below.

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| **Company** | **Comment** |
| CATT | We are ok with the intention of this proposal. It’s better to extend the use case of proposal 1-1 to FR2 cells, and remove the third bullets from the proposal 1-2. Then, it clear proposal 1-1 is to support co-scheduled cells with different SCSs. And the proposal 1-2 is to support co-scheduled cell with different carrier types. |
| NTT DOCOMO | Based on the discussion in first online session, we can update the third sub-bullet to “A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs only on FR2 cells with same SCS”.In addition, based on the discussion in first online session, we can discuss design principle and specification impacts based on those scenarios mentioned in WID, and whether other scenarios can also be supported or not can be discussed later (e.g., when UE capability design is discussed) as long as no additional specification impacts for supporting additional scenarios except for UE capability. |
| Nokia | 1. Support first bullet. 2. Some clarification needed: does FR2 include FR2-1 and FR2-2 or is the meaning here FR2-1? Do the FR1 cells include unlicensed band TDD – or licensed bands only (as in the first bullet) – as otherwise, the 2nd bullet may include the 1st bullet (and extend the 1st bullet for FR1 even further)? 3. Some question on FR2 definition (FR2-1 & FR2-2) as for the second bullet? |
| Qualcomm | We are not yet sure how much specification impact we can reduce by the limitations. If no RAN1 spec impact is envisioned, then the discussion is purely about UE capability. Nevertheless, if the intention is to limit to the cases where really necessary, we prefer following limitation as the starting point.* Support at least the following cases in Rel-19:
* A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs on FR1 licensed FDD cell(s) with SCS 1 and FR1 licensed TDD cell(s) with SCS 2 ~~same or different SCS~~.
* A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs on FR1 cell(s) with SCS 1 and FR2 cell(s) with SCS 2 ~~same or different SCS~~.
* A DCI format 0\_3/1\_3 scheduling PUSCHs/PDSCHs only on FR2 cells with same ~~different~~ SCS.
 |
| ZTE | Have the second bullet and third bullet been included in the proposal? |
| Spreadtrum | We support to discuss the use cases, it can be used for UE capability as a starting point. 1. FR2-1, F2-2 can be used instead of FR2.2. it has some overlap with proposal 1-1, so need some rearrangement.3. Besides what is supported, and not supported can also be listed for easy follow.  |
| Apple | Fine with QC’s suggested updates and also a clarification on whether FR2 includes both FR2-1 and FR2-2 |
| Panasonic | We agree to CATT’s comment. |
| TCL | We agree to CATT’s comment. |

#### Proposal 1-3:

* Multi-cell multi-PUSCH/PDSCH scheduling by DCI format 0\_3/1\_3 is only applicable to FR2 cells.

Companies are encouraged to provide comments in the table below.

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| **Company** | **Comment** |
| CATT | Support |
| NTT DOCOMO | Same as the proposal 1-2, we can update the proposal from “only applicable to FR2 cells” to “applicable to at least FR2 cells”. Then, whether other scenarios can also be supported or not can be discussed later (e.g., when UE capability design is discussed) as long as no additional specification impacts for supporting additional scenarios except for UE capability. |
| Nokia | Some more discussion may be needed. Multi-PUSCH scheduling is also supported for FR1 (and was initially introduced for unlicensed TDD / NR-U) operation. So would the intention be not support this?For multi-PDSCH scheduling, we do agree on the intention of the proposal. But to be more precise one could even say that multi-PDSCH scheduling is only supported for 120khz SCS, as we don’t support 480/960kHz SCS with 1\_3 (based on R18).So maybe we could update the proposal to:***Proposal 1-3-rev1**** *Multi-cell multi-~~PUSCH/~~PDSCH scheduling by DCI format ~~0\_3/~~1\_3 is only applicable to 120kHz SCS ~~FR2 cells~~ in Rel-19.*

.. and continue the discussions on multi-PUSCH support for FR1. |
| Qualcomm | In Rel-17, this limitation (only applicable to FR2) appears in the UE capability. We are not sure if the proposal intends to capture the limitation in RAN1 spec or in UE capability. Our preference is to incorporate the limitation in the UE capability (same as Rel-17).  |
| ZTE | We think ‘only’ should be changed to ‘at least’. As commented online, we think we can first discuss or support the prioritized cases. Then we can check whether there is additional spec impact to support the other cases. If not, why not support such cases. If yes, then we can make a conclusion on the support of the other cases. It may be a bit early to say some case is not supported. |
| Spreadtrum | In FR1 TDD, multi-cell multi-PUSCH can also be supported. So separate proposal for multi-PDSCH and multi-PUSCH is better. |
| Apple | Can be discussed as part of UE capability |
| Panasonic | We support Nokia’s revision. |
| TCL | Multi-PUSCH is also supported in FR1 TDD, in our understanding, at least for Multi-PUSCH, the limitation is not needed. |

# DCI field design

## Background and submitted proposals

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| **Huawei:***Proposal 1: The maximum number of PUSCHs/PDSCHs per scheduled cell by a single joint-DCI is 4 in Rel-19 MC enhancement.* * *Further limit can be discussed per each/total co-scheduled cell(s).*

*Proposal 2: Discuss whether there is a need to further reduce the DCI payload based on DCI format 0\_3/1\_3, e.g., by redefining the type of some DCI fields.***Spreadtrum:***Proposal 5: To support multi-cell multi-PDSCH/PUSCH, extending multi-cell TDRA table of DCI format 0\_3/1\_3 to have more than one TDRA indexes of each BWP per cell in the set.**Proposal 6: Maximum number of PUSCH/PDSCH per scheduled cell in multi-cell multi-PUSCH/PDSCH scheduling is 4.**Proposal 7: Number of NDI bit(s) in the block of a cell is same as legacy of DCI format 0\_1/1\_1 configuring with multi-PDSCH/PUSCH as a starting point, and bits reduction can be further studied.* * *1 bit in the block of a cell if the number of scheduled PUSCH/PDSCH indicated by the TDRA index of this cell is 1;*
* *Otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined based on the maximum number of schedulable PUSCH/PDSCH among all entries in the multi-cell multi-PUSCH/PDSCH table.*

*Proposal 8: Number of RV bit(s) in the block of a cell is same as legacy of DCI format 0\_1/1\_1 configuring with multi-PDSCH/PUSCH as a starting point, and bits reduction can be further studied.* * *2 bits as defined in Table 7.3.1.1.1-2 if the number of scheduled PDSCH/PUSCH indicated by the TDRA index is 1;*
* *otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined by the maximum number of schedulable PDSCH/PUSCHs among all entries in the multi-cell multi-PUSCH/PDSCH table.*

*Proposal 9: It needs to decide the impact to UL-SCH indicator field in DCI format 0\_3 for multi-cell multi-PDSCH/PUSCH.***ZTE:***Proposal 1: Multi-SLIV in TDRA and independent NDI/RV are supported in DCI format 0\_3 and 1\_3 for cell(s) configured with multi-PUSCH/PDSCH scheduling.***vivo:***Proposal 4: The maximum number of PUSCHs/PDSCHs per scheduled cell is 8.**Proposal 5: The TDRA and FDRA fields in DCI format 1-3 and 0-3 can be reused for multiple PDSCHs/PUSCHs scheduling.**Observation 1: The NDI and RV fields in DCI format 1-3 and 0-3 can be up to 32 bits respectively if multiple PUSCHs/PDSCHs per scheduled cell is supported,* *when maxNrofCodeWordsScheduledByDCI equals to 1.***CMCC:***Proposal 2. Reuse the method of joint TDRA table configuration and TDRA indication in Rel-18 multi-cell PUSCH/PDSCH scheduling with a single DCI for Rel-19 different SCS/carrier type among co-scheduled cells by the single DCI.**Proposal 5. To support one or multiple PUSCHs/PDSCHs per scheduled cell by the single DCI, the TDRA index for a BWP of a cell configured by TDRA-FieldIndexDCI-1-3 or TDRA-FieldIndexDCI-0-3 points to a corresponding entry in pdsch-TimeDomainAllocationListForMultiPDSCH or pusch-TimeDomainAllocationListForMultiPUSCH.**Proposal 6. Reuse the FDRA field in DCI format 0\_3/1\_3 to indicate the frequency domain resource allocation of each scheduled cell separately. The same FDRA indication is applied to the multiple PDSCHs/PUSCHs in one scheduled cell.**Proposal 7. Reuse the MCS field in DCI format 0\_3/1\_3 to indicate the MCS of each scheduled cell separately. The same MCS indication is applied to the multiple PDSCHs/PUSCHs in one scheduled cell.**Proposal 8. Reuse the HARQ process number field in DCI format 1\_3/0\_3 which is used to indicate the HARQ process number of the first PDSCH/PUSCH in each scheduled cell separately. HARQ process number is incremented by 1 for each subsequent PDSCH/PUSCH(s) in the scheduled order in each scheduled cell.**Proposal 9. The bit size of NDI/RV is equal to maximum number of schedulable PDSCH/PUSCH among all entries in TDRA-FieldIndexListDCI-1-3 or TDRA-FieldIndexListDCI-0-3.**Proposal 10. The maximum number of PUSCHs/PDSCHs per scheduled cell is 4 for Rel-19 one or multiple PUSCHs/PDSCHs per scheduled cell by the single DCI.***CATT:***Proposal 3: DCI format 0\_3/1\_3 can be enhanced to support multi-cell scheduling with one or multiple PUSCH/PDSCH per cell.**Proposal 4: For DCI format 0\_3/1\_3 enhancement, the same enhancement methods on DCI format 0\_1/1\_1 in Rel-17 can be reused for DCI format 0\_3/1\_3 as follows:** *FDRA field: each block of FDRA field corresponds to the FDRA for a cell, and it applies commonly to all the PUSCHs/PDSCHs on the cell.*
* *TDRA field: an entry applies commonly to all scheduled cells, and each entry contains the TDRA index(es) for each BWP of each cell, and then each TDRA index indicates the resource allocation in time domain for each PUSCH/PDSCH separately.*
* *MCS field: each block of MCS field corresponds to the MCS for a cell, and it applies commonly to all the PUSCHs/PDSCHs on the cell.*
* *NDI field: each block of NDI contains the NDI for a cell, and each bit in the block corresponds to the NDI for one PDSCH/PUDSCH on the cell.*
* *RV field: each block of RV contains the RV for each cell, and each bit in the block corresponds to the RV for one PDSCH/PUSCH on the cell.*
* *HARQ process number: each block of HARQ process number corresponds to the HARQ process number for a cell, and applies commonly to all the PUSCHs/PDSCHs on the cell.*

*Proposal 5: For multi-cell/multi-PUSCH scheduling, consider following options for the maximum number of PUSCHs per scheduled cell and the maximum number of cell supporting multi-PUSCH scheduling in a cell set:** *Option 1: the maximum number of PUSCHs per scheduled cell is 4, and the maximum number of cell supporting multi-PUSCHs scheduling is 4.*
* *Option 2: the maximum number of PUSCHs per scheduled cell is 8, and the maximum number of cell supporting multi-PUSCHs scheduling is 2.*

*Proposal 6: For multi-cell multi-PDSCH scheduling, consider following options for maximum number of PDSCHs per scheduled cell and the maximum number of cell supporting multi-PDSCH scheduling in a cell set:** *Option 1: the maximum number of PDSCHs per scheduled cell is 4, and the maximum number of cell supporting multi-PDSCHs scheduling is 2.*
* *Option 2: the maximum number of PDSCH per scheduled cell is 8, and the maximum number of cell supporting multi-PDSCHs scheduling is 1.*

**OPPO:***Proposal 4: From specification perspective, the maximum number of PUSCHs/PDSCHs per scheduled cell scheduled by DCI format 0\_3/1\_3 is 4.** *From UE perspective, the maximum number of PUSCHs/PDSCHS real scheduled per cell is up to UE capability.*

*Proposal 5: For TDRA table design to support multiple PUSCHs/PDSCHs per scheduled cell scheduled by DCI format 0\_3/1\_3, the following alternatives could be considered:** *Alt 1: Increase the number of configured TDRA index in tdra-FieldIndexListDCI-0-3/ tdra-FieldIndexListDCI-1-3 for each BWP of each cell in the cell set, while the TDRA index for each BWP of each cell still points to the TDRA table applicable to DCI format 0\_1/1\_1 as that in Rel-18*
* *Alt 2: There is still one TDRA index for each BWP of each cell in the cell set in one row, while the TDRA index points to a corresponding TDRA in the TDRA table for multi-PDSCH/PUSCH scheduling, similar with pusch-TimeDomainAllocationListForMultiPUSCH and pdsch-TimeDomainAllocationListForMultiPDSCH.*

**Nokia:***Proposal 5.4: Support a maximum of 8 PUSCHs/PDSCHs per scheduled cell with a maximum TDRA field size of 8 bits (i.e. max. ITDRA=256) in DCI format 0\_3/1\_3** *The underlying TDRA tables for multi-PUSCH/PDSCH scheduling using DCI formats 0\_3/1\_3 should have up to 64 entries (as for legacy multi-PUSCH/PDSCH scheduling using DCI format 0\_1/1\_1)*
* *Note: for maximum TDRA field size in DCI formats 0\_3\_1/3 of less than 8 bits (i.e. max. ITDRA=128) only a maximum of 4 PDSCH/PUSCHs per scheduled cell should be supported*

*Proposal 5.5: For multi-PUSCH scheduling using DCI format 0\_3, the size of the blocks block number 1, block number 2, … , block number* $N\_{cell}^{UL} $*of the NDI field are defined as follows* * *1bit for the cell corresponding to the block, if the cell is not configured with pusch-TimeDomainAllocationListForMultiPUSCH-DCI-0-3*
* *2 to 8 bits determined based on the maximum number of schedulable PUSCHs among all entries in the higher layer parameter pusch-TimeDomainAllocationListForMultiPUSCH-DCI-0-3 for the serving cell corresponding to the block*

*Proposal 5.6: For multi-PDSCH scheduling using DCI format 1\_3, the size of the blocks block number 1, block number 2, … , block number* $N\_{cell}^{DL} $*of the NDI field for transport block 1 and transport block 2 are defined as follows* * *1bit for the cell corresponding to the block, if the cell is not configured with pdsch-TimeDomainAllocationListForMultiPDSCH-DCI-1-3*
* *2 to 8 bits determined based on the maximum number of schedulable PDSCHs among all entries in the higher layer parameter pdsch-TimeDomainAllocationListForMultiPDSCH-DCI-1-3 for the serving cell corresponding to the block*

*Proposal 5.7: For multi-PUSCH scheduling using DCI format 0\_3, the size of the blocks block number 1, block number 2, … , block number* $N\_{cell}^{UL} $*of the RV field are defined as follows* * *0, 1 or 2 bits determined by higher layer parameter numberOfBitsForRV-DCI-0-3 configured for the cell corresponding to the block, if the cell is not configured with pusch-TimeDomainAllocationListForMultiPUSCH-DCI-0-3*
* *2 to 8 bits determined based on the maximum number of schedulable PUSCHs among all entries in the higher layer parameter pusch-TimeDomainAllocationListForMultiPUSCH-DCI-0-3 for the serving cell corresponding to the block*

*Proposal 5.8: For multi-PDSCH scheduling using DCI format 1\_3, the size of the blocks block number 1, block number 2, … , block number* $N\_{cell}^{DL} $*of the RV field for transport block 1 and transport block 2 are defined as follows* * *0, 1 or 2 bits determined by higher layer parameter numberOfBitsForRV-DCI-1-3 configured for the cell corresponding to the block, if the cell is not configured with pdsch-TimeDomainAllocationListForMultiPDSCH-DCI-1-3*
* *2 to 8 bits determined based on the maximum number of schedulable PDSCHs among all entries in the higher layer parameter pusch-TimeDomainAllocationListForMultiPDSCH-DCI-1-3 for the serving cell corresponding to the block*

*Proposal 5.9: The redundancy version corresponding to a scheduled PUSCH/PDSCH of multi-PUSCH/PDSCH scheduling using DCI format 0\_3/1\_3 is determined according to Table 7.3.1.2.3-1 (supporting RV0 & RV3)** *Note: This is aligned with the Rel-18 DCI format 0\_3/1\_3 operation of cells configured with 1bit RV by numberOfBitsForRV-DCI-0-3/1-3.*

*Proposal 5.13: Support new TDRA field index lists for DCI format 0\_3/1\_3 to (i) account for the needed increased scheduling flexibility for multi-PxSCH scheduling and (ii) to allow addressing larger underlying DL BWP specific TDRA tables for multi-PDSCH scheduling.* **Lenovo:***Proposal 2: TDRA field in DCI format 0\_3/1\_3 indicates one row from a joint TDRA table with each row in the table containing one or multiple TDRA indexes for each cell within the set of cells. Each TDRA index within the indicated row corresponds to one PUSCH/PDSCH scheduled on one corresponding cell and points to one time domain resource allocation in the TDRA table applicable for DCI format 0\_1/1\_1 for the cell.**Proposal 3: The number of scheduled PUSCHs/PDSCHs for a cell is implicitly indicated by the number of indicated valid SLIVs for the cell.**Proposal 4: Common FDRA is applied to all the co-scheduled PUSCHs/PDSCHs on each scheduled cell.**Proposal 5: Common MCS is applied to all the co-scheduled PUSCHs/PDSCHs on each cell scheduled by DCI format 0\_3/1\_3.**Proposal 6: Separate NDI for each scheduled PUSCH/PDSCH is included in DCI format 0\_3/1\_3.**Proposal 7: Separate RV field for each scheduled PUSCH/PDSCH is included in DCI format 0\_3/1\_3.**Proposal 8: HARQ process number indicated for a scheduled cell is applied to the first scheduled PUSCH/PDSCH and then incremented by 1 for subsequent PUSCHs/PDSCHs in the scheduled order on the scheduled cell (with modulo operation if needed).**Proposal 9: The maximum number of PUSCHs/PDSCHs per scheduled cell by a DCI format 0\_3/1\_3 in Rel-19 is 8.**Proposal 10: For a UE, the maximum number of PUSCHs/PDSCHs per scheduled cell by a DCI format 0\_3/1\_3 can be smaller than or equal to 8.**Proposal 11: It is up to gNB to guarantee the payload size of a DCI format 0\_3/1\_3 not exceeding 140.***Apple:***Proposal 6: RAN1 to consider support for scheduling up to 8 PUSCH/PDSCH with single-cell DCI format 0\_3/1\_3, provided there is no proportional increased in the DCI field size**Proposal 7: RAN1 to consider if any additional limitation on the maximum number of PUSCH/PDSCH across all the co-scheduled cells within the set is needed or not***Panasonic:***Proposal 3: No need to enhance the current TDRA mechanism for the support of different SCS among co-scheduled cells by the single DCI.**Proposal 5: For the determination of the maximum number of PUSCHs/PDSCH per scheduled cell, at least DCI size, especially how NDI and RV is indicated, should be taken into account.**Proposal 6: No need to enhance the current TDRA mechanism (i.e., joint indication) for the support of multiple PUSCHs/PDSCH per scheduled cell by the single DCI. FFS whether maximum number of entries for PDSCH is extended to 64.***TCL:***Proposal 4. For Rel-19 different SCS/carrier type among co-scheduled cells by the single DCI, similar mechanism of time domain resource allocations for Rel-18 can be re-used.**Proposal 5: Re-using DCI format 0\_3/1\_3 to support one or multiple PUSCHs/PDSCHs per scheduled cell within the co-scheduled cells in Rel-19.* *Proposal 6:* *The maximum number of PUSCHs/PDSCHs per scheduled cell within the co-scheduled cells needs to take* *the DCI overhead into consideration .* **LGE:***Proposal #1: Discuss how to configure multiple sets of TDRA parameters for the cell configured with multi-PUSCH/PDSCH scheduling (by DCI 0\_3/1\_3), within each row in the multi-cell TDRA table associated with DCI 0\_3/1\_3.**Proposal #2: Discuss how to determine the size of RV field per TB for the cell configured with multi-PXSCH scheduling (by DCI 0\_3/1\_3), and how to perform RV (and NDI) bit mapping (in the DCI 0\_3/1\_3 payload) across co-scheduled cells.**Proposal #3: Discuss how to determine multiple HARQ IDs corresponding to multiple PXSCHs scheduled for the cell configured with multi-PXSCH scheduling (by DCI 0\_3/1\_3), in terms of modulo operation applied to the HARQ ID determination.**Proposal #4: Discuss how to determine the size of UL-SCH field for the cell configured with multi-PUSCH scheduling (by DCI 0\_3).***NTT DOCOMO:***Proposal 3: The principle of Rel-18 mechanism such as type-1B indication of TDRA based on joint TDRA table should be reused for multi-cell multi-PUSCH/PDSCH scheduling.**Observation 4: According to WID, when UE is configured with multi-cell multi-PUSCH/PDSCH scheduling, “TDRA table applicable for DCI format 1\_1” which is referred by the joint TDRA table entries (TDRA-FieldIndexDCI-1-3-r18 or TDRA-FieldIndexDCI-0-3-r18) cannot be TDRA table for multi-PUSCH/PDSCH scheduling.**Proposal 4: Separate new TDRA table for multi-PUSCH/PDSCH scheduling for each BWP of each cell to be referred by the joint TDRA table needs to be introduced.** *New joint TDRA tables and entries like tdra-FieldIndexListDCI-1-3-r18, tdra-FieldIndexListDCI-0-3-r18, TDRA-FieldIndexDCI-1-3-r18 and TDRA-FieldIndexDCI-0-3-r18 are necessary to refer separate new TDRA table for multi-PUSCH/PDSCH scheduling for each BWP of each cell instead of “TDRA table applicable for DCI format 1\_1”.*
* *Separate new TDRA tables for multi-PUSCH/PDSCH scheduling for each BWP of each cell from PUSCH-TimeDomainResourceAllocationList-r16 and MultiPDSCH-TDRA-List-r17 are necessary to be used for multi-cell multi-PDSCH/PUSCH scheduling via DCI format 1\_3/0\_3 instead of “single-cell multi-PDSCH/PUSCH scheduling via DCI format 1\_1/0\_1”.*

*Proposal 8: The maximum number of PUSCHs/PDSCHs per scheduled cell should be carefully studied with supported cases for multi-cell multi-PUSCH/PDSCH scheduling in terms of SCS/carrier type combination between scheduling cell and co-scheduled cells, HARQ enhancements such as time-domain HARQ bundling, and DCI size.***Qualcomm:***Proposal 2:** *Support multi-cell multi-PUSCH scheduling by a single DCI using DCI format 0\_3.*
* *Support multi-cell multi-PDSCH scheduling by a single DCI using DCI format 1\_3.*
* *For co-scheduled cell(s) identification, Rel-18 multi-cell scheduling framework is re-used, i.e.:*
	+ *If RRC configures a table defining combinations of co-scheduled cells for the set of cells, co-scheduled cell(s) indicator is present in the DCI and points to one row of the table.*
	+ *Otherwise, the UE identifies the co-scheduled cell(s) based on the validity of the FDRA field of each cell of the set of cells.*
* *For a number of PUSCHs/PDSCHs identification per scheduled cell, Rel-17 multi-PUSCH/PDSCH scheduling framework is re-used, i.e.:*
	+ *TDRA field indicates a set of TDRA configurations of the scheduled PDSCH(s)/PUSCH(s) of each scheduled cell*

*Proposal 3:** *Make a following working assumption:*
	+ *Maximum number of PUSCHs/PDSCHs per scheduled cell is 8.*

*Proposal 4:** *Discuss if compression scheme(s) of NDI/RV is necessary/possible.*

**Ericsson:***Proposal 2: Allow scheduling by DCI format 0\_3/1\_3 when the applied TDRA for DCI format 0\_1/1\_1 is pusch-TimeDomainAllocationListForMultiPUSCH or pdsch-TimeDomainAllocationListForMultiPUSCH, respectively.** *Note that no change in TDRA configuration is needed and existing configurations can be applied.*

*Proposal 3: Support the value 8 as the maximum number of scheduled PUSCHs/PDSCHs on a scheduled cell in a set by an enhanced DCI 0\_3/1\_3.** *Note: It can be discussed whether to accommodate a capability for supporting the maximum value 4.*

*Proposal 4: For DCI format 0\_3/1\_3 field, to support multi-PUSCHs/ multi-PDSCHs scheduling on a scheduled cell** *The following fields descriptions should be updated as compared to Rel-18:*
	+ *Time domain resource assignment*
	+ *New data indicator*
	+ *Redundancy version*
* *The other fields descriptions remain as in Rel-18.*
	+ *For the associated procedures when multi-PUSCHs/multi-PDSCHs are scheduled on a serving cell, reuse the corresponding Rel-18 procedures when multi-PUSCHs/ multi-PDSCHs are scheduled on a serving cell by a DCI 0\_1/1\_1.*
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## Moderator summary and proposals based on contributions

Based on contributions submitted by companies, below issues are prioritized for discussion in this meeting. Within each sub-section, the summary from moderator’s perspective is listed and followed by draft proposals for further discussion round by round.

* On FDRA field

For Rel-16, up to 8 PUSCHs can be co-scheduled by one DCI format 0\_1 on same serving cell within FR1 with same FDRA indication; furthermore, in Rel-17, up to 8 PUSCHs/PDSCHs can be co-scheduled by one DCI format 0\_1/1\_1 on same serving cell within FR2 with same FDRA indication. For Rel-19 multi-cell scheduling, for overhead reduction, it is reasonable to follow same principle as previous release so as to save DCI overhead.

As mentioned by vivo, CMCC, CATT, and Lenovo, it is reasonable to apply same FDRA to all the co-scheduled PUSCHs/PDSCHs on the corresponding cell.

Hence, Proposal 2-1 is provided for further discussion.

* On MCS field

For Rel-16, up to 8 PUSCHs can be co-scheduled by one DCI format 0\_1 on same serving cell within FR1 with same MCS indication; furthermore, in Rel-17, up to 8 PUSCHs/PDSCHs can be co-scheduled by one DCI format 0\_1/1\_1 on same serving cell within FR2 with same MCS indication. For Rel-19 multi-cell scheduling, for overhead reduction, it is reasonable to follow same principle as previous release so as to save DCI overhead.

As mentioned by CMCC, CATT, and Lenovo, it is reasonable to apply same MCS to all the co-scheduled PUSCHs/PDSCHs on the corresponding cell.

Hence, Proposal 2-1 is provided for further discussion.

* On HARQ process number field

As mentioned above, HARQ process number is Type-2 field for Rel-18 multi-cell scheduling and separate HARQ process number is indicated to each scheduled cell.

Since separate HARQ process number indication for each scheduled PUSCH/PDSCH leads to larger signaling overhead, reusing same mechanism as Rel-16 NR-U and Rel-17 multi-PUSCH/PDSCH scheduling can save signaling overhead for multiple PUSCHs/PDSCHs on same scheduled cell. Hence, for multiple PUSCHs/PDSCHs on a scheduled cell, HARQ process number indicated for the cell is applied to the first scheduled PUSCH/PDSCH and then incremented by 1 for subsequent PUSCHs/PDSCHs in the scheduled order on the cell (with modulo operation if needed).

Hence, Proposal 2-1 is provided for further discussion.

* On NDI field

Regarding NDI, it is quite natural to adopt separate NDI bits for each scheduled PUSCH/PDSCH on each scheduled cell. For Rel-19, for NDI and RV in DCI formats 0\_3/1\_3, the related Rel-18 multi-cell scheduling design principles should be directly applicable as well. In detail, the size of each block for each cell is determined based on the maximum number of PUSCHs/PDSCHs on the cell.

Hence, Proposal 2-2 is provided for further discussion.

* On RV field

Regarding RV, it is quite natural to adopt separate RV for each scheduled PUSCH/PDSCH on each scheduled cell. For Rel-19, for NDI and RV in DCI formats 0\_3/1\_3, the related Rel-18 multi-cell scheduling design principles should be directly applicable as well. In detail, the size of each block for each cell is determined based on the maximum number of PUSCHs/PDSCHs on the cell and the number of bits of RV configured for the cell.

Hence, Proposal 2-3 is provided for further discussion.

* On TDRA field

As specified in Rel-18 multi-cell scheduling, for a set of cells which is configured for multi-cell scheduling using DCI format 0\_3/1\_3, a joint TDRA table is configured by RRC signaling for the set of cells with each row in the table containing TDRA indexes for all cells within the set of cells. TDRA field in the DCI format 0\_3/1\_3 belongs to Type-1B field and indicates a row from the joint TDRA table. A single TDRA index corresponding to a cell which points to a corresponding time domain resource allocation in the TDRA table applicable for DCI format 0\_1/1\_1 for the cell. The relevant agreement is shown in below:

|  |
| --- |
| **Agreement**For a set of cells which is configured for multi-cell scheduling using DCI format 0\_X/1\_X, a joint TDRA table is configured by RRC signaling for the set of cells with each row in the table containing TDRA indexes for all cells within the set of cells.* TDRA field in the DCI format 0\_X/1\_X belongs to Type-1B field.
* TDRA field in the DCI format 0\_X/1\_X indicates a row from the joint TDRA table.
* TDRA index for a cell points to a corresponding TDRA in the TDRA table applicable for DCI format 0-1/1-1.
 |

According to WID of Rel-19 Multi-carrier enhancements, there is one restriction on simultaneous configuration of both single-cell multi-PUSCH/PDSCH scheduling and multi-cell multi-PUSCH/PDSCH scheduling within same PUCCH group of a UE.

|  |
| --- |
| * One or multiple PUSCHs/PDSCHs per scheduled cell by the single DCI.
	+ The maximum number of PUSCHs/PDSCHs per scheduled cell is [4 or 8].
	+ Note: Type-1 HARQ-ACK codebook is not enhanced for Rel-19 multi-cell scheduling.
	+ Note: The maximum number of sub-codebooks for Type-2 HARQ-ACK codebook is not increased for Rel-19 multi-cell scheduling.
	+ Note: UE does not expect to be configured with both single-cell multi-PUSCH/PDSCH scheduling and multi-cell multi-PUSCH/PDSCH scheduling on the same or different cells within a same PUCCH group.
 |

For Rel-17 multi-PUSCH/PDSCH scheduling on same serving cell, the existing RRC parameters *pdsch-TimeDomainAllocationListForMultiPDSCH* and *pusch-TimeDomainAllocationListForMultiPUSCH* can’t be reused because the two RRC parameters directly configure the feature of multi-PUSCH/PDSCH scheduling by DCI format 0\_1/1\_1. Therefore, for Rel-19 multi-cell scheduling, “TDRA table applicable for DCI format 1\_1” cannot be TDRA table for multi-PUSCH/PDSCH scheduling. We have to reuse the structure of Rel-18 tables for DCI format 0\_1/0\_3.

Hence, Proposal 2-4 is provided for further discussion.

* On maximum number of PUSCHs/PDSCHs per scheduled cell

Regarding maximum number of PUSCHs/PDSCHs per scheduled cell, companies’ views are summarized as below:

* Maximum number of PUSCHs/PDSCHs per scheduled cell is 4.
	+ Supported by Huawei, Spreadtrum, CMCC, OPPO,
* Maximum number of PUSCHs/PDSCHs per scheduled cell is 8.
	+ Supported by vivo, Nokia (max 256 entries for TDRA), Lenovo, Apple, Qualcomm (WA), 8

For Rel-16, up to 8 PUSCHs can be co-scheduled by one DCI format 0\_1 on same serving cell within FR1; furthermore, in Rel-17, up to 8 PUSCHs/PDSCHs can be co-scheduled by one DCI format 0\_1/1\_1 on same serving cell within FR2. For Rel-19 multi-cell scheduling, due to introduction of FR2 for co-scheduled cells, it is reasonable to maintain same maximum number of PUSCHs or PDSCHs as previous release so as to fully utilize the spectrum resource in FR2.

According to analysis on DCI payload size, 2-cell scheduling case can support maximum 8 PDSCHs per scheduled cell. In addition, by means of using larger granularity for FDRA field or scheduling at least one cell with narrower bandwidth, 4-cell scheduling can support maximum 4 PDSCHs per scheduled cell.

Hence, for Rel-19, the specification can support maximum 8 PUSCHs/PDSCHs per scheduled cell by a DCI format 0\_3/1\_3. For a UE, the maximum number of PUSCHs/PDSCHs per scheduled cell by a DCI format 0\_3/1\_3 can be smaller than or equal to 8. It is worth noting that it is up to gNB to guarantee the payload size of a DCI format 0\_3/1\_3 does not exceed the limitation of maximum 140 bits of DCI payload size, e.g., by configuring the proper number of co-scheduled cells, configuring larger granularity for FDRA, etc.

Hence, Proposal 2-5 is provided for discussion.

## 1st round of discussions

#### Proposal 2-1:

* For multiple PUSCHs/PDSCHs scheduled on a cell by a DCI format 0\_3/1\_3,
* Common FDRA is applied to the PUSCHs/PDSCHs on the cell.
* Common MCS is applied to the PUSCHs/PDSCHs on the cell.
* HARQ process number indicated for the cell is applied to the first scheduled PUSCH/PDSCH and then incremented by 1 for subsequent PUSCHs/PDSCHs on the cell (with modulo operation if needed).

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | Support.  |
| NTT DOCOMO | We prefer to reuse the design principle of Rel-18 DCI 0\_3/1\_3 and single-cell multi-PDSCH/PUSCH scheduling as much as possible.In that sense, the proposal can be considered as baseline. But it may also be possible to have some enhancement to solve DCI size issue e.g., by compression/sharing. So, we can consider the proposal as baseline or working assumption. |
| Nokia | Support |
| Qualcomm | OK with the proposal. We also think DOCOMO’s suggestion makes sense. |
| ZTE | We are fine with the proposal in general. The common FDRA and common MCS are applied to the PUSCHs/PDSCHs on the same cell. |
| Spreadtrum | Support the intention. But for the 3rd bullet, it is not so accurate. It should be:first PDSCH not overlapping with a UL symbolfirst PUSCH not overlapping with a DL symbol |
| Apple | Agree with Docomo’s suggestion |
| Panasonic | We support the proposal. |
| TCL | Support |

#### Proposal 2-2:

* In DCI format 0\_3/1\_3, for each block of NDI field, the number of bits is equal to the maximum number of schedulable PUSCHs/PDSCHs on the corresponding cell by the DCI format 0\_3/1\_3.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | Support. |
| NTT DOCOMO | We prefer to reuse the design principle of Rel-18 DCI 0\_3/1\_3 and single-cell multi-PDSCH/PUSCH scheduling as much as possible.In that sense, the proposal can be considered as baseline. But it may also be possible to have some enhancement to solve DCI size issue e.g., by compression/sharing. So, we can consider the proposal as baseline or working assumption. |
| Nokia | Support |
| Qualcomm | Agree with DOCOMO. |
| ZTE | Don’t support. This may increase the DCI size. For DCI format 0\_3/1\_3, we have agreed the per DCI format alignment instead of the per field alignment. All the type-2 field are determined based on the scheduled cell indicator. Here this principle should be followed again. Therefore, for each block of the NDI field, the number of bits is equal to the number of scheduled PUSCH/PDSCH on this cell instead of the maximum number of the scheduled cells. The scheduled PUSCH/PDSCH on this cell is indicated by the DCI format 0\_3/1\_3. |
| Spreadtrum | The most straightforward way is the number of bit(s) in the block of a cell is same as legacy in DCI format 0\_1/1\_1 configuring with multi-PDSCH/PUSCH. Such as 1 bit in the block of a cell if the number of scheduled PUSCH/PDSCH indicated by the Time domain resource assignment field of this cell is 1; otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined based on the maximum number of schedulable PUSCH/PDSCH among all entries in the multi-cell multi-PUSCH/PDSCH table. Also fine with bits reduction suggested by DCM. |
| Apple  | Agree with Docomo’s suggestion |
| Panasonic | We agree to DOCOMO’s comment. |
| TCL | Agree with DOCOMO. |

#### Proposal 2-3:

* In DCI format 0\_3/1\_3, for each block of RV field, the number of bits is determined based on the maximum number of schedulable PUSCHs/PDSCHs on the corresponding cell by the DCI format 0\_3/1\_3 and number of bits for RV for the corresponding cell.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | OK. We think the number of block of RV field equals to the maximum number of scheduled PUSCHs/PDSCHs on the scheduled cell, and the size of each block of RV field is up to gNB configuration.  |
| NTT DOCOMO | We prefer to reuse the design principle of Rel-18 DCI 0\_3/1\_3 and single-cell multi-PDSCH/PUSCH scheduling as much as possible.In that sense, the proposal can be considered as baseline. But it may also be possible to have some enhancement to solve DCI size issue e.g., by compression/sharing. So, we can consider the proposal as baseline or working assumption. |
| Nokia | Support |
| Qualcomm | Agree with DOCOMO. |
| ZTE | See the comments for proposal 2-2. |
| Spreadtrum | Same comments for proposal 2-2 |
| Apple | Agree with Docomo’s suggestion |
| Panasonic | We agree to DOCOMO’s comment. |
| TCL | Agree with DOCOMO. |

#### Proposal 2-4:

* TDRA field in DCI format 0\_3/1\_3 indicates one row from a joint TDRA table with each row in the table containing one or multiple TDRA indexes for each BWP of each cell within the set of cells.
* Each TDRA index points to one time domain resource allocation in the TDRA table applicable for DCI format 0\_1/1\_1 for the corresponding cell.
* One example is shown in below figure.



Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | We prefer to consider multi-SLIV configuration for a cell. In this way, a TDRA index for a cell can point to resource allocation in time domain for multiple the PUSCH/PDSCH(s).  |
| NTT DOCOMO | We think that the design principle of Rel-18 DCI 1\_3/0\_3 and multi-PDSCH/PUSCH scheduling in terms of TDRA indication should be reused. The joint TDRA table for DCI 1\_3 or 0\_3 has one or multiple entries, where each entry has up to 16 indexes (each index is referring TDRA table for each BWP of each co-scheduled cell). Then, to realize multi-cell multi-PDSCH/PUSCH scheduling based on Rel-18 design principle, we can just configure multi-PDSCH/PUSCH TDRA table to be referred by the joint TDRA table entries for each BWP of each co-scheduled cell separately from TDRA table applicable to DCI format 0\_1/1\_1 for the BWP of the cell.We don’t support the proposal, since it is different from the design principle of TDRA table configuration for multi-PDSCH/PUSCH scheduling. |
| Nokia | Do not support.First, having this operation will reduce the options for the ‘non-multi-PxSCH’ table as this would then e.g. for the case of multi-PDSCH scheduling of up to 8 PDSCHs on a cell require to contain the TDRA table in pdsch-config to contain 8 out of 16 entries just for the single resource allocation. Meaning, this will impact the operation of single DCI scheduling with 0\_1/0\_2/1\_1/1\_2 quite a lot. Moreover, we think this is neither in the spirit of the multi-PxSCH resource allocation idea (i.e. only a single TDRA index value provided that maps in the BWP specific TDRA table to one ore more SLIVs/PxSCHs) nor the Rel-18 MC-enh. We think have multi-PxSCH tables configure for 0\_3/1\_3 with one or more SLIVs (as for multi-PxSCH scheduling in R16/17) and DCI format 0\_3/1\_3 providing a single TDRA index value per scheduled cell/BWP to be more aligned with the legacy operation and do not showing the limitations on the single DCI scheduling using 0\_1/1\_1. |
| Qualcomm | First of all, we wonder the figure has a typo, the second box “for BWP#2 of cell 1” should be “for BWP#2 of cell 2”. From our point of view, the first point that should be agreed is that the DCI format has a single TDRA field, where the TDRA field can indicate different TDRAs for different PDSCHs/PUSCHs of each scheduled cell of the co-scheduled cells. Detailed RRC configuration can be discussed later. |
| ZTE | We don’t support this proposal.We think the straightforward solution to combine the multi-cell scheduling and multi-cell scheduling is to combine the two TDRA tables together. The network can configure the TDRA table for multiple PUSCH/PDSCH scheduling for one scheduled cell. Then the TDRA table for multi-cell scheduling indicates the row of the configured TDRA. Note this does require to design a new TDRA table. For the proposed TDRA table, it is difficult to ensure the TDRA indicated by the index 1, index 2, …., index N are in the different slots since this is indicate the TDRA the legacy TDRA table. |
| Spreadtrum | we can discuss two methods in the first meeting, to have an aligned understanding. * Method1: Rel-18 multi-PDSCH/PUSCH TDRA table is configured, and multi-cell TDRA table of DCI format 0\_3/1\_3 use the TDRA indexes in Rel-18 multi-PDSCH/PUSCH TDRA per BWP of each cell in the set. However, according to the note of WID, a cell cannot configured with both single-cell multi-PUSCH/PDSCH and multi-cell multi-PDSCH/PUSCH. Therefore, some restrictions can be defined, such as DCI format 0\_1/1\_1 cannot use Rel-18 multi-PDSCH/PUSCH TDRA table though it is configured. It is clear that this method can work but it has irrationality.
* Method2: Extending TDRA table of DCI format 0\_3/1\_3 to have more than one TDRA indexes of each BWP per cell in the set. It is more preferred. Due to it is aligned with the above Note. Single cell multi-PDSCH/PUSCH is not configured, instead multi-cell multi-PDSCH/PUSCH is configured.
 |
| Apple | We should try to reuse Rel-18 design principle and therefore don’t support this proposal |
| Panasonic | WE share the same view as DOCOMO. The design principle of Rel.18 DCI format 0-3/1-3 and multi-PDSCH/PUSCH scheduling in terms of TDRA indication should be reused. |
| TCL | Similar mechanism of Rel-18 can be re-used. |

#### Proposal 2-5:

* For Rel-19, the maximum number of PUSCHs/PDSCHs per scheduled cell by a DCI format 0\_3/1\_3 is 8.
* For a UE, the maximum number of PUSCHs/PDSCHs per scheduled cell by a DCI format 0\_3/1\_3 can be smaller than or equal to 8.
* It is up to gNB to guarantee the payload size of a DCI format 0\_3/1\_3 not exceeding 140.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | Before we discusses the maximum number of PDSCHs per scheduled cell by a DCI format 0\_3/1\_3, whether consider 2TB is considered for multi-PDSCH scheduled? If 2TB is considered, the required bits for NDI field and RV field will be double of the 1TB case. To be safe for second Type-2 sub-codebook size, we suggest supporting 4 for the maximum number of PDSCHs per scheduled cell. And, we think the maximum number of PUSCHs per scheduled cell can be 8.  |
| NTT DOCOMO | As we commented in the first online session, it is premature to decide the maximum number of PUSCHs/PDSCHs per scheduled cell.We should discuss carefully on potential DCI size issue and corresponding potential spec impacts such as DCI field compression/sharing.If it is identified that maximum 8 PDSCHs/PUSCHs can be scheduled for multiple cells without requiring too much restriction on configurations and/or too much enhancement for compression/sharing, we can go to 8. |
| Nokia | Support |
| Qualcomm | We think the first bullet can be a working assumption.Regarding the 2nd bullet, it is unclear whether this is about UE capability or configuration. From our point of view, a UE should be allowed to support smaller than 8 per scheduled cell as a UE capability, and a network should be allowed to configure smaller than 8 per scheduled cell.Regarding the 3rd bullet, this was already agreed in Rel-18. It is not clear if explicit agreement is necessary again. Suggest to delete it. |
| ZTE | We are fine with first bullet and the third bullet. For the second bullet, we think larger values can be supported (e.g., 16). Anyway, it is up to gNB to ensure the DCI size as in the third bullet. |
| Spreadtrum | Agree with DCM.  |
| Apple | Needs further discussion  |
| Panasonic | We share the same view as DOCOMO. |
| TCL | Before to decide the maximum number of PUSCHs/PDSCHs per scheduled cell, the size of DCI and the corresponding spec impacts need to evaluate.  |

# HARQ enhancements

## Background and submitted proposals

|  |
| --- |
| **Huawei:***Proposal 3: Further study is necessary regarding the reference PDSCH used for determining the PUCCH carrying HARQ-ACK information in Rel-19 multi-carrier scheduling.**Proposal 4: In Rel-19 multi-carrier scheduling, the following issues related to Type-2 HARQ-ACK codebook need further discussion:** *Additional loop in pseudo-code in section 9.1.3.1 of TS 38.213*
* *Maximum number of HARQ-ACK information bits reported for a DCI format 1\_3.*

**Spreadtrum:***Proposal 2: When determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs by a DCI format 1\_3** *Alt1: same as Rel-18, the reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs.*
* *Alt2: new definition. E.g. the reference PDSCH is the last UL slot of PUCCH overlapping with PDSCHs as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs.*

*Proposal 3: If the ending symbol is same for more than one PDSCHs of different cells, when determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs by a DCI format 1\_3,* * *Alt1: same as Rel-18, the reference PDSCH is the PDSCH ending last and with smallest serving cell index as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs,*
* *Alt2: new definition. E.g. the reference PDSCH is the last UL slot of PUCCH overlapping with PDSCHs as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs.*

*Proposal 10: For second Type-2 HARQ-ACK sub-codebook, it includes HARQ-ACK of more than one PDSCH receptions on one serving cell scheduled by DCI format 1\_3.**Proposal 11: Support TBG based HARQ-ACK for the cell configured with multi-PDSCH scheduled by DCI format 1\_3.* **ZTE:***Proposal 2: The principle of HARQ-ACK feedback for Rel-18 multi-cell scheduling should be reused for Rel-19 multi-cell scheduling.** *When UE detects a DCI format 1\_3 scheduling a set of PDSCHs, the UE provides corresponding HARQ-ACK information in a PUCCH transmission within UL slot* $n+k$*, where* $k$ *is a number of slots and is indicated by the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format and* $n$ *is the last UL slot overlapping with the DL slot* $n\_{D}$ *for the reference PDSCH reception for slot-based PUCCH or an UL slot overlapping with the end of the reference PDSCH reception in DL slot* $n\_{D}$ *for sub-slot based PUCCH.*
	+ *The reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs.*
* *For Type-2 HARQ-ACK codebook, for a set of cells which is co-scheduled by a DCI format 1\_3, the reference PDSCH to determine DAI counting is the PDSCH with smallest serving cell index among the set of co-scheduled cells.*

*Proposal 3: For Type-1 HARQ-ACK codebook for Rel-19 multi-cell scheduling, UE expects HARQ-ACK information for all co-scheduled PDSCHs by DCI format 1\_3 can be mapped in the Type-1 HARQ-ACK codebook.**Proposal 4: For Type-2 HARQ-ACK codebook, two sub-codebooks are generated with a first sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling a single PDSCH and a second sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling multiple PDSCHs.** *Separate DAI counting for two sub-codebooks.*

*Proposal 5: The number of HARQ-ACK bits for each DCI format 1\_3 that schedules multiple PDSCHs can be determined by M, where M is the maximum number of PDSCHs which can be co-scheduled by a DCI format 1\_3 in the PUCCH group for the UE.**Proposal 6: The HARQ-ACK bits for each DCI format 1\_3 for the second sub-codebook should be ordered first in ascending order of the PDSCH reception time, second in ascending order of cell index.**Proposal 7: The maximum number of PUSCHs/PDSCHs per scheduled cell is 8.**Proposal 8: The maximum number of PUSCHs/PDSCHs per DCI can be predefined or configured if needed.***vivo:***Proposal 6: For determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs scheduled by a DCI format 1\_3, the reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs including invalid PDSCH.**Proposal 7: For type 2 HARQ-ACK codebook generation, the HARQ-ACK bits for one or multiple PDSCHs per cell scheduled by the DCI format 1-3 are contained in the second sub-codebook if more than one cells are scheduled, if more than one group is configured if HARQ bundling is configured or if HARQ bundling in time domain is not configured when only multiple PDSCHs in one cell is scheduled.***CMCC:***Proposal 3. For determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs with different SCS by a DCI format 1\_3, the reference PDSCH is the PDSCH ending last scheduled by DCI format 1\_3 among the set of co-scheduled PDSCHs.**Proposal 4. Reuse the PDSCH reception preparation time defined in Rel-16 cross carrier scheduling with different SCS for Rel-19 different SCS/carrier type among co-scheduled cells by the single DCI.***CATT:***Proposal 7: For the second Type-2 HARQ-ACK information of multiple PUSCHs/PDSCHs per scheduled cell by the single DCI, the following alternatives can be considered:** *Alt-1: the HARQ-ACK information of multiple PDSCHs on a scheduled cell can be bundled as one HARQ-ACK bit.*
* *Alt-2: the HARQ information of multiple PDSCHs on a scheduled cell can be one HARQ-ACK bit per PDSCH.*

**OPPO:***Proposal 1: For slot-based PUCCH and for determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs with different SCS by a DCI, the reference PDSCH is the PDSCH with the smallest SCS among the PDSCHs ending last.**Proposal 6: When multiple PDSCHs per cell are scheduled by DCI format 1\_3, whether to support time-domain HARQ-ACK bundling should be discussed.**Proposal 7: At least for time-domain HARQ-ACK bundling is not configured, when type-2 HARQ-ACK codebook is used for multiple PDSCHs per cell scheduled by a DCI format 1\_3,** *Reuse Rel-18 definition that* $N\_{sets}^{TB,max}$ *HARQ-ACK bits correspond to a DCI format 1\_3, where* $N\_{sets}^{TB,max}$ *is the maximum total number of TBs in PDSCH receptions that can be scheduled by a DCI format 1\_3 over more than one serving cells in a set of serving cells across the number of sets of serving cells;*

*Proposal 8:* *At least for time-domain HARQ-ACK bundling is not configured, when type-2 HARQ-ACK codebook is used for multiple PDSCHs per cell scheduled by a DCI format 1\_3, HARQ-ACK bits in the second sub-codebook can be concatenated:** *First, in ascending order of codeword index for a PDSCH,*
* *Second, in ascending order of the PDSCH reception starting time for the same {serving cell, PDCCH monitoring occasion} pair,*
* *Third, in ascending order of serving cell index, and*
* *Fourth, in ascending order of PDCCH monitoring occasion index.*

**Nokia:***Proposal 5.10: For Type-2 HARQ-ACK codebook, HARQ-ACK information of a DCI format 1\_3 is associated with* * *the first HARQ-ACK sub-codebook if*
	+ *(i) only a single PDSCH is scheduled on (only) one scheduled cell or*
	+ *(ii) multiple PDSCHs are scheduled on (only) one scheduled cell provided nrofHARQ-BundlingGroups with value of 1*
* *and associated with the second HARQ-ACK sub-codebook otherwise.*
* *Note: For the purpose of providing HARQ-ACK information corresponding to SCell dormancy indication, the UE assumes that the UE receives a PDSCH on the serving cell associated with fields in DCI format 1\_3 used for SCell dormancy indication.*

*Proposal 5.11: For Type-2 HARQ-ACK codebook, each DCI format 1\_3 associated with the second sub-codebook generates M HARQ-ACK bits, where M is maximum number of HARQ-ACK bits generated by the UE across co-scheduled cell combinations by a DCI format 1\_3 in the PUCCH group for the UE.* * *For cells configured with multi-PDSCH scheduling, to align with the Rel-16 multi-PDSCH framework the UE generated HARQ-ACK bits are assumed to be*
	+ $N\_{TB,c}^{DL}⋅N\_{HARQ−ACK,c}^{TBG,max}$ *HARQ-ACK bits for serving cell c provided with nrofHARQ-BundlingGroups*
	+ $N\_{TB,c}^{DL}⋅N\_{PDSCH,c}^{max}$ *HARQ-ACK bits for serving cell c not provided with nrofHARQ-BundlingGroups*
	+ *where* $N\_{TB,c}^{DL}$ *is the value of maxNrofCodeWordsScheduledByDCI for serving cell* $c$ *if harq-ACK-SpatialBundlingPUCCH is not provided; else,* $N\_{TB,c}^{DL}=1$

**Lenovo:***Proposal 12: For Type-2 HARQ-ACK codebook, two sub-codebooks are generated with a first sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling a single PDSCH and a second sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling more than one PDSCH. Separate DAI counting is applied for DCI(s) with each scheduling a single PDSCH and DCI(s) with each scheduling more than one PDSCH.**Proposal 13: For the second sub-codebook, the number of HARQ-ACK information bits for each DCI format 1\_3 that schedules more than one PDSCH is equal to Z, where Z is the maximum number of TBs which can be co-scheduled by a DCI format 1\_3 in the PUCCH group for the UE.* *Proposal 14: HARQ-ACK information bits for a DCI format 1\_3 that schedules more than one PDSCH are ordered firstly according to increasing order of PDSCH reception starting time on a same serving cell, then ordered according to ascending order of associated serving cell indexes.* *Proposal 15: For DCI indicating SPS PDSCH release, TCI update, or SCell dormancy, without scheduling PDSCH, the HARQ-ACK information bit for the DCI is included in the first sub-codebook.* *Proposal 16: for DCI which schedules only one PDSCH and indicates SCell dormancy by reinterpreting a set of fields (e.g., MCS/NDI/RV for TB1, HARQ process number, Antenna ports if configured as type-2), the HARQ-ACK information bits for the DCI are included in the second sub-codebook.* **Panasonic:***Proposal 4: No need to differentiate the principle of the current mechanism on transmission timing of PUCCH with HARQ-ACK, i.e., determined based on the reference PDSCH, which is the PDSCH ending last among the set of co-scheduled PDSCH. To extend the processing time is required or not should be discussed later.* **Apple:***Proposal 8: RAN to consider supporting only continuous scheduling of PUSCHS/PDSCHs per scheduled cell, i.e. without interleaving from other scheduled cells**Proposal 9: HARQ-ACK bundling corresponding to PDSCHs for a co-scheduled cell should be considered**Proposal 10: OOO HARQ-ACK feedback should not be considered for multi-PUSCH/PDSCH multi-cell scheduling***Samsung:***Proposal 2: The support of multi-PUSCH/PDSCH scheduling via DCI format 0\_3/1\_3 involves the following specification changes:** *New joint TDRA table with columns corresponding to both different PUSCHs/PDSCHs and different cells/BWPs, or with columns corresponding only to different cells/BWPs with entries that point to respective multi-PUSCH/PDSCH TDRA tables for the respective cells/BWPs;*
* *New pseudo-code for the second sub-CB of the Type-2 HARQ-ACK CB that corresponds to multi-cell scheduling with one or multiple PDSCHs per cell;*
* *New FGs to indicate the UE capability to jointly support multi-cell scheduling and multi-PUSCH/PDSCH scheduling.*

**TCL:***Proposal 3: For determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs with different SCS/carrier type by a DCI format 1\_3, the reference PDSCH is the PDSCH with the smallest SCS and ending last as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs.***LGE:***Proposal #5: Discuss how to determine (the reference PDSCH among co-scheduled PDSCHs by DCI 1\_3 for) the HARQ-ACK timing corresponding to DCI 1\_3 scheduling multiple cells with different SCS values, without ambiguity of HARQ-ACK timing.**Proposal #6: Discuss how to determine HARQ-ACK payload size corresponding to one DCI 1\_3 associated with the second sub-codebook (in Type-2 HARQ-ACK codebook), and how to perform HARQ-ACK bit mapping across co-scheduled cells in the HARQ-ACK payload, considering inclusion of the cell configured with multi-PDSCH scheduling (by DCI 1\_3).***NTT DOCOMO:***Proposal 5: In case of type-2 HARQ-ACK codebook for multi-cell multi-PDSCH scheduling, two sub-codebooks are generated as below.** *First sub-codebook: HARQ-ACK information for PDSCH(s) scheduled by DCI(s) which schedule one PDSCH and for DCI without PDSCH scheduling.*
* *Second sub-codebook: HARQ-ACK information for PDSCHs scheduled by DCI(s) which schedule more than one PDSCH.*
	+ *Number of HARQ-ACK bits for second sub-codebook per DCI is a sum of max. number of PDSCHs (TBs) for a cell in the set of cells.*

*Proposal 6: Time domain HARQ bundling should be supported for multi-cell multi-PDSCH scheduling.***Qualcomm:***Proposal 5:** *Type-2 HARQ-ACK codebook is based on two sub-codebook approach:*
	+ *The first sub-codebook is for DCI formats scheduling one PDSCH over time/frequency.*
	+ *The second sub-codebook is for DCI formats scheduling more than one PDSCHs over time/frequency.*

**Ericsson:***Proposal 5: For Type 2 HARQ-ACK codebook construction, similarly to Rel-18 only 2 sub-code books are applied. For generation of the 2nd sub-code book in the pseudo code, for any serving cell mc in a set of serving cells when a DCI 1\_3 is detected, the HARQ-ACK information bits is extended to max(𝑁PDSCH,mc) HARQ-ACK information bits where max(𝑁PDSCH,mc) is the maximum number of SLIVs amongst all rows of the TDRA table configured by pdsch-TimeDomainAllocationListForMultiPDSCH for the serving cell mc.** *Type-2 HARQ-ACK time domain bundling is supported similarly to Rel-18 when nrofHARQ-BundlingGroups is configured.*
 |

## Moderator summary and proposals based on contributions

Based on contributions submitted by companies, below issues are prioritized for discussion in this meeting. Within each sub-section, the summary from moderator’s perspective is listed and followed by draft proposals for further discussion round by round.

* On HARQ-ACK feedback timing

For Rel-18 multi-cell scheduling, for determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs by a DCI format 1\_3, the reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs. Thus, the PUCCH slot is determined based on the reference PDSCH and the indicated K1 value.

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| --- |
| **Agreement**For determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs by a DCI format 1\_X, the reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_X among the set of co-scheduled PDSCHs. |

For Rel-19 multi-cell scheduling, due to introduction of different SCS among co-scheduled cells, 3 companies [Huawei, Spreadtrum, LGE] propose further discussion on the reference PDSCH determination, and 2 companies [OPPO, TCL] propose determining reference PDSCH as the PDSCH with the smallest SCS among the PDSCHs ending last when there are multiple PDSCHs with different SCS while ended at same time instance. However, 5 companies [ZTE, vivo, CMCC, Lenovo, Panasonic] propose following Rel-18 operation. Companies’ views are summarized as below:

* Follow Rel-18 operation, i.e., reference PDSCH is the PDSCH ending last:
	+ Supported by ZTE, vivo, CMCC, Lenovo, Panasonic,
* Reference PDSCH is the PDSCH with the smallest SCS among the PDSCHs ending last
	+ Supported by OPPO, TCL,
* FFS reference PDSCH for Rel-19
	+ Supported by Huawei, Spreadtrum, LGE,

Considering Rel-18 operation, i.e., determining reference PDSCH as the PDSCH ending last among co-scheduled cells, can ensure the PDSCH processing time among co-scheduled cells. If more minimum processing time is required, this issue can be discussed at late stage. From moderator’s point of view, one issue which may need discussion is how to select one PDSCH as the reference PDSCH in case more than one PDSCH with different SCS ends last. A simple rule is to select the PDSCH with smallest SCS among the PDSCHs ending last as the reference PDSCH so that UE can have more processing time for preparing HARQ-ACK feedback.

Based on above analysis, Proposal 3-1 is provided for discussion with main bullet same as Rel-18 agreement and sub-bullet to resolve the aforementioned issue.

* On time domain HARQ-ACK bundling

In Rel-17, for multi-PDSCH scheduling, time domain HARQ-ACK bundling is supported by configuring the number of bundling groups, i.e., *nrofHARQ-BundlingGroups*. For Rel-19, since multiple PDSCHs can be scheduled on the same cell, time domain HARQ-ACK bundling may be necessary to compress the number of HARQ-ACK bits per scheduled cell, similar as Rel-17 multi-PDSCH scheduling. Therefore, time domain HARQ-ACK bundling needs to be supported for Rel-19 multi-cell multi-PDSCH scheduling as well.

Hence, Proposal 3-2 is provided for discussion.

* On Type-2 HARQ-ACK codebook

For Type-2 HARQ-ACK codebook, the main agreements for Rel-18 multi-cell scheduling with one PDSCH per cell are listed below for reference.

|  |
| --- |
| **Agreement (RAN1#110)*** For Type-2 HARQ-ACK codebook, two sub-codebooks are generated with a first sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling a single cell and a second sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling more than one cell.
* Separate DAI counting for DCI(s) with each scheduling a single cell and DCI(s) with each scheduling more than one cell.
* FFS whether a DCI scheduling more than one cell is associated with the first sub-codebook or the second sub-codebook when the number of cells with actual PDSCH reception due to collision with semi-static TDD DL/UL configuration is one.
* Type-2 HARQ-ACK codebook is generated by concatenating the first sub-codebook and the second sub-codebook.
* If at least one cell of the set of cells which can be co-scheduled by a DCI format 1\_X is configured with maximum 2 codewords per PDSCH without spatial bundling,
	+ FFS: the number of HARQ-ACK information bits for each DCI format 1\_X that schedules more than one cell;
* Otherwise, the number of HARQ-ACK information bits for each DCI format 1\_X that schedules more than one cell is equal to N, where N is the maximum number of cells which can be co-scheduled by a DCI format 1\_X in the PUCCH group for the UE.
* HARQ-ACK information bits for co-scheduled PDSCHs by a DCI format 1\_X is ordered based on serving cell indices associated with co-scheduled PDSCHs.
* HARQ-ACK bundling across co-scheduled cells is not supported for multi-cell scheduling.

**Agreement(RAN1#110bis)*** For Type-2 HARQ-ACK codebook, if at least one cell of a set of cells which can be co-scheduled by DCI format 1\_X is configured with maximum 2 codewords per PDSCH without spatial bundling, the number of HARQ-ACK information bits for each DCI format 1\_X that schedules more than one cell of the set of cells is equal to M, where M is the maximum number of TBs which can be co-scheduled by a DCI format 1\_X in the PUCCH group for the UE.
 |

Considering the difference between Rel-18 multi-cell scheduling and Rel-19 multi-cell scheduling is multiple PDSCHs can be scheduled per cell, hence, similar mechanism as Rel-18 can be reused for Rel-19 with consideration of multiple PDSCHs per cell.

Hence, Proposal 3-3 is provided for discussion without consideration of time domain HARQ-ACK bundling.

## 1st round of discussions

#### Proposal 3-1:

* For determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs by a DCI format 1\_3, follow Rel-18 operation, i.e., the reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_3 among the set of co-scheduled PDSCHs.
* If more than one PDSCH ends last among the set of co-scheduled PDSCHs, the reference PDSCH is the PDSCH with the smallest SCS among the PDSCHs ending last.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | OK to discuss the reference PDSCH. Another method is use the PDSCH with smallest serving cell index as the reference PDSCH.  |
| NTT DOCOMO | We may need further consideration on potential issue raised by some companies, e.g., in R1-2407688 |
| Nokia | We are fine with the proposal. We are also fine to consider largest instead of smallest SCS among the PDSCH ending last. |
| Qualcomm | We would like to consider the issue a bit carefully, and would prefer to keep this as FFS. The current proposal determines the HARQ-ACK PUCCH counting dynamically, depending on which cell(s) is/are scheduled, and which PDSCH ends last. We suggest to leave this decision for future meeting. |
| ZTE | We don’t think the sub-bullet is needed as if there are more than one PDSCH ending last, then the same PUCCH slot is determined following the Rel-18 operation. We can simply reuse the method for sub-slot, i.e., PUCCH slot is determined based on the last UL slot overlapping with the reference PDSCH instead of the DL slot of the reference PDSCH, considering sub-slot based solution is already there.  |
| Spreadtrum | We suggest to have some discussion first, so some potential issues can be listed, and also its solutions, to have more time for companies. |
| Apple | Seems fine in principle, but some further suggestion would be better |
| Panasonic | We are fine with the main bullet. We also fine to consider smallest SCS among the PDSCHs ending last if more than one PDSCH ends last among the set of co-scheduled PDSCHs. On the other hand, we also agree to DOCOMO’s comment that potential issue raised by Huawei in R1-2407688 should be clarified. |
| TCL | We are fine with the proposal. If more than one PDSCH ends last among the set of co-scheduled PDSCHs, the reference PDSCH is the PDSCH with the smallest SCS among the PDSCHs ending last can be supported. |

#### Proposal 3-2:

* Time domain HARQ-ACK bundling is supported.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | Support. |
| NTT DOCOMO | Fine with proposal 3-2. One clarification question is whether time domain HARQ-ACK bundling is supported for both type-1 HARQ CB case and type-2 HARQ CB case as in Rel-17 single-cell multi-PDSCH scheduling. |
| Nokia | Support |
| Qualcomm | OK with the proposal. |
| ZTE | We don’t know why this is not supported considering that it has been supported in multi-PDSCH scheduling. Is there any issue to support time domain HARQ-ACK bundling for multi-cell multi-PDSCH scheduling?  |
| Spreadtrum | Support |
| Apple | Support |
| TCL | Support |

#### Proposal 3-3:

* For Type-2 HARQ-ACK codebook, when time domain HARQ-ACK bundling is not configured, two sub-codebooks are generated with a first sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling a single PDSCH and a second sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling more than one PDSCH.
* Separate DAI counting is applied for DCI(s) with each scheduling a single PDSCH and DCI(s) with each scheduling more than one PDSCH.
* Type-2 HARQ-ACK codebook is generated by concatenating the first sub-codebook and the second sub-codebook.
* For the second sub-codebook, the number of HARQ-ACK information bits for each DCI format 1\_3 that schedules more than one PDSCH is equal to M, where M is the maximum number of TBs which can be co-scheduled by a DCI format 1\_3 in the PUCCH group for the UE.
* HARQ-ACK information bits for a DCI format 1\_3 that schedules more than one PDSCH are ordered firstly according to ascending order of codeword index of one PDSCH, secondly according to ascending order of PDSCH reception starting time on a same serving cell, then according to ascending order of associated serving cell indexes.
* Note: For DCI having associated HARQ-ACK information without scheduling PDSCH reception, the HARQ-ACK information for the DCI is included in the first sub-codebook.
* Note: For providing HARQ-ACK information corresponding to SCell dormancy indication, the UE assumes that the UE receives a PDSCH on the serving cell associated with fields in DCI format 1\_3 used for SCell dormancy indication.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | OK |
| NTT DOCOMO | Although we are fine with proposal 3-3, it may be better to first agree on high level design principle e.g., from main bullet to 3rd sub-bullet. Then remaining parts can be discussed after agreeing on the design principle. |
| Nokia | Thanks for this good proposal here, that gives the overall picturePossibly, maybe better to split this to proposal to several sub-parts here that could make agreements easier: 1. Support the first subbullet (DAI) 2. Support the second subbullet (concatenation)3. Intention of the bullet (M counting) is OK, but we may need to be more precise here. If we support the bundling of proposal 3-2 (TBG-based HARQ operation) then this bullet would not be correct anymore. 4. Ok with the bullet.5. We are not sure this note (first sub-codebook) is fully correct here, as in Rel-18 for 1\_3, we also assign it with the first sub-codebook if only a single PDSCH is scheduled (or only SCell dormancy is indicated). So there is 1\_3 associated with HARQ that is also mapped to the first sub-codebook based on our understanding. 6: Support / OK with the note  |
| Qualcomm | Agree with DOCOMO that we should first agree the main bullet to 3rd sub-bullet. |
| ZTE | For the third bullet, we agree with Nokia that TBG-based HARQ operation should also be considered. Then we can add a condition, e.g., ‘if the TBG-based operation is not configured’. |
| Spreadtrum | 2nd bullet: support3rd bullet: it is only for without *harq-ACK-SpatialBundlingPUCCH.*  |
| Apple | Agree with Docomo |
| Panasonic | We are fine with the proposal in principle. We agree to DOCOMO’s comment that at fast high-level design principle (main bullet, 1st, 2nd, and 3rd sub-bullet) can be discussed. |
| TCL | We are fine with the first and second bullet, for the third bullet, it means not to support HARQ-ACK bundling? |

# Proposals for online/offline discussion

# References

1. R1-2408261 Work plan for Rel-19 Multi-carrier enhancements Lenovo
2. R1-2407688 Discussion on Rel-19 Multi-carrier enhancements Huawei, HiSilicon
3. R1-2407726 Discussion on multi-cell PUSCH/PDSCH scheduling with a single DCI Spreadtrum Communications
4. R1-2407810 Discussion on multi-cell PUSCH/PDSCH scheduling with a single DCI ZTE Corporation, Sanechips
5. R1-2407883 Discussion on enhancement of multi-cell PUSCH/PDSCH scheduling with a single DCI vivo
6. R1-2407925 Discussion on multi-cell PUSCH/PDSCH scheduling with a single DCI CMCC
7. R1-2408038 Discussion on multi-cell PUSCH/PDSCH scheduling with a single DCI CATT
8. R1-2408157 Discussion of multi-cell scheduling with a single DCI OPPO
9. R1-2408260 On Rel-19 Multi-carrier enhancements for NR Phase 2 Nokia
10. R1-2408262 Discussion on multi-cell scheduling with a single DCI Lenovo
11. R1-2408364 Discussion on multi-carrier enhancements for NR Phase 2 Panasonic
12. R1-2408492 On multi-cell PUSCH/PDSCH scheduling with single DCI Apple
13. R1-2408668 Enhancements for multi-cell PUSCH/PDSCH scheduling Samsung
14. R1-2408669 Discussion on Multi-cell PUSCH/PDSCH scheduling with a single DCI TCL
15. R1-2408683 Discussion on single DCI based multi-cell scheduling for Rel-19 LG Electronics
16. R1-2408713 Multi-Carrier enhancements initial views MediaTek Inc.
17. R1-2408805 Discussion on multi-cell PUSCH/PDSCH scheduling with a single DCI NTT DOCOMO, INC.
18. R1-2408872 Multi-cell PUSCH/PDSCH scheduling with a single DCI Qualcomm Incorporated
19. R1-2408893 Multi-cell PxSCH scheduling with a single DCI Ericsson

# List of agreements

## Agreements made in RAN1#109-e

**Agreement**

Agree the following terminologies ONLY for convenience of discussion:

* DCI format 0\_X is used for scheduling multiple PUSCHs on multiple cells with one PUSCH per cell
* DCI format 1\_X is used for scheduling multiple PDSCHs on multiple cells with one PDSCH per cell.

The above does not imply introducing new DCI format(s) at this point.

**Agreement**

* Different TBs are scheduled on different cells by DCI format 0\_X.
* Different TBs are scheduled on different cells by DCI format 1\_X.

**Agreement**

* Fallback DCI (i.e., DCI formats 0\_0 and 1\_0) does not support multi-cell scheduling.

**Agreement**

* The DCI for multi-cell scheduling is monitored only in USS set.

**Agreement**

* PDSCH cannot be scheduled by DCI format 0\_X.
* PUSCH cannot be scheduled by DCI format 1\_X.

**Agreement**

* All the co-scheduled cells by a DCI format 1\_X and the scheduling cell are included in the same PUCCH group.
* FFS: All the co-scheduled cells by a DCI format 0\_X and the scheduling cell are included in the same [cell or PUCCH group].

**Agreement**

* DCI format 0-X/1-X on a scheduling cell can be used to schedule PUSCHs/PDSCHs on multiple cells including the scheduling cell.
* DCI format 0-X/1-X on a scheduling cell can be used to schedule PUSCHs/PDSCHs on multiple cells not including the scheduling cell.

**Agreement**

* For a UE, the maximum number of cells scheduled by a DCI format 0\_X can be same or different to the maximum number of cells scheduled by a DCI format 1\_X.

**Working Assumption**

* All HARQ-ACK codebook types (Type-1/2/3) are applicable when multi-carrier PDSCH scheduling is configured.

**Agreement**

* One value for the maximum number of co-scheduled cells by a DCI format 0\_X in Rel-18 is selected from {3, 4, 8}.
* For a UE, the maximum number of co-scheduled cells by a DCI format 0\_X can be smaller than or equal to the maximum number supported in Rel-18.

**Agreement**

* One value for the maximum number of co-scheduled cells by a DCI format 1\_X in Rel-18 is selected from {3, 4, 8}.
* For a UE, the maximum number of co-scheduled cells by a DCI format 1\_X can be smaller than or equal to the maximum number supported in Rel-18.

**Agreement**

* **(Working assumption)** DCI format 0\_X/1\_X is a new DCI format for multi-cell scheduling
* DCI format 0\_X can be used for single cell PUSCH scheduling.
* DCI format 1\_X can be used for single cell PDSCH scheduling.
* FFS: UE monitors one of or both multi-cell scheduling DCI and legacy single cell scheduling DCI for a scheduled cell.

**Agreement**

* DCI format 0-X/1-X can be transmitted on PCell.
* DCI format 0-X/1-X can be transmitted on a SCell at least when the DCI format 0-X/1-X does not schedule PUSCH/PDSCH on PCell.
* FFS whether a DCI format 0-X/1-X can be transmitted on an SCell if the DCI format 0-X/1-X schedules PUSCH/PDSCH on PCell.

**Agreement**

Further study DCI size budget including below options for multi-cell scheduling DCI:

* Option 1: Existing DCI size budget is maintained per scheduled cell.
	+ Alt 1-1: DCI size budget is maintained via DCI size alignment and DCI size budget of DCI format 0\_X/1\_X is counted for each of the co-scheduled cells.
	+ Alt 1-2: DCI size budget is maintained via configured size for multi-cell scheduling DCI and DCI size budget of DCI format 0\_X/1\_X is counted for each of the co-scheduled cells.
	+ Alt 1-3: DCI size budget is maintained via DCI size alignment and DCI size budget of multi-cell scheduling DCI is counted only in one scheduled cell.
* Option 2: Existing DCI size budget is not necessarily maintained per scheduled cell.
	+ Alt 2-1: DCI size budget of multi-cell scheduling DCI is counted only in one scheduled cell.
	+ Alt 2-2: DCI size budget of multi-cell scheduling DCI is not counted per serving cell and not considered in the related serving cell specific DCI size alignment procedure, e.g., for K co-scheduled cells, gNB guarantee the total budget of 3\*K DCI sizes is not exceeded.
	+ Alt 2-3: voiding the “3+1” limit for multi-cell scheduling
	+ Alt 2-4: the DCI size budget for DCI size alignment can be separately configured for each cell
	+ Alt 2-5: DCI size budget of the scheduling cell can be increased to account for the DCI format for multi-cell scheduling. Accordingly, the DCI size budget of a scheduled cell can be reduced.
* Other options/alternatives could be considered.

**Agreement**

Further study BD/CCE counting for multi-cell scheduling DCI based on below options:

* Alt 1: counted on each co-scheduled cell
* Alt 2: counted only in one scheduled cell
* Alt 3: scaled down to each of co-scheduled cell according to the number of co-scheduled cells
* Alt 4: counted as part of the scheduling cell instead of each scheduled cell
* Alt 5: scaled down to each of scheduled cells excluding scheduling cell
* Alt 6: counted on each co-scheduled cell excluding scheduling cell
* Other alternatives could be considered.

**Agreement**

For multi-cell scheduling, the co-scheduled cells are indicated by DCI format 0\_X/1\_X. At least the following options are considered:

* Option 1: An indicator in the DCI points to one row of a table defining combinations of scheduled cells.
	+ The table is configured by RRC signaling.
	+ FFS: Separate tables can be configured for multi-cell PDSCH scheduling and multi-cell PUSCH scheduling.
* Option 2: An indicator in the DCI is a bitmap corresponding to a set of configured cells that can be scheduled by the DCI 0\_X/1\_X
	+ FFS: Separate sets of configured cells for multi-cell PDSCH scheduling and multi-cell PUSCH scheduling.
* Option 3: using existing field (e.g., CIF, FDRA) to indicate whether one or more cells are scheduled or not
* Other options are not precluded.
* Note: It does not preclude other DCI information fields (e.g., BWP) to be jointly indicated by the indicator of the co-scheduled cells.

**Agreement**

For design of multi-cell scheduling DCI, companies are encouraged to consider following types of DCI fields:

* Type-1 field: A single field indicating common information to all the co-scheduled cells or separate information to each of co-scheduled cells via joint indication or an information to only one of co-scheduled cells
* Type-2 field: Separate field for each of the co-scheduled cells, or each sub-group comprising one or more co-scheduled cells where a single field is commonly applied to the co-scheduled cells belonging to a same sub-group
* Type-3 field: Common or separate to each of the co-scheduled cells or to each sub-group.
	+ FFS: whether it is dependent on explicit configuration or implicit condition (e.g., intra or inter band CA, FR1 or FR2).
* Other types are not precluded.

## Agreements made in RAN1#110

**Agreement**

All the co-scheduled cells by a DCI format 0\_X and the scheduling cell are included in the same PUCCH group.

**Agreement**

Confirm below working assumption reached in RAN1#109e meeting.

* **(Working assumption)** DCI format 0\_X/1\_X is a new DCI format for multi-cell scheduling

**Working Assumption**

For a cell within a set of cells which can be co-scheduled by a DCI format 0\_X/1\_X, support monitoring the DCI format 0\_X/1\_X and legacy single cell scheduling DCI format(s) from a same scheduling cell.

* The DCI format 0\_X/1\_X and the legacy DCI format(s) can be monitored simultaneously.
	+ FFS: whether monitoring of the DCI format 0\_X/1\_X and the legacy DCI format(s) is supported for one, a subset, or all cells within the set of cells.
* FFS: number of different DCI sizes for 0\_X/1\_X and for legacy DCI formats
* FFS: whether to support a subset or all legacy DCI format(s) to be monitored with DCI 0\_X/1\_X

**Working Assumption**

* The maximum number of co-scheduled cells by a DCI format 1\_X in Rel-18 is 4.
* The maximum number of co-scheduled cells by a DCI format 0\_X in Rel-18 is 4.
* FFS: The maximum number of configurable cells for co-scheduling

**Agreement**

For discussing field design of DCI format 0\_X/1\_X which schedules more than one cell, reformulate the types of DCI fields as below:

* Type-1 field:
	+ Type-1A field: A single field indicating common information to all the co-scheduled cells
	+ Type-1B field: A single field indicating separate information to each of co-scheduled cells via joint indication
	+ Type-1C field: A single field indicating an information to only one of co-scheduled cells
* Type-2 field: Separate field for each of the co-scheduled cells
* Type-3 field: Common or separate to each of the co-scheduled cells, or separate to each sub-group, dependent on explicit configuration.
	+ Note: One sub-group comprises a subset of co-scheduled cells where a single field is commonly applied to the co-scheduled cell(s) belonging to a same sub-group.
* Note: Handling of any parameters applicable to multi-cell scheduling where corresponding fields are not included in DCI format 0\_X/1\_X (if any) will be separately discussed.

**Agreement**

* For DCI format 1\_X/0\_X which can schedule more than one cell,
* Type-1 fields at least include below:
	+ Type-1A:
		- Identifier for DCI formats
		- Downlink assignment index
		- TPC for scheduled PUCCH
		- PUCCH resource indicator
		- PDSCH-to-HARQ timing indicator
		- One-shot HARQ-ACK request
* Type-2 fields at least include below:
	+ New data indicator per TB
	+ Redundancy version per TB
* FFS: Other fields to be included in DCI format 1\_X/0\_X and which type of the fields belongs to.
* FFS: size for each field

**Agreement**

* When UE detects a DCI format 1\_X scheduling a set of PDSCHs, the UE provides corresponding HARQ-ACK information in a PUCCH transmission within UL slot , where is a number of slots and is indicated by the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format and is the last UL slot overlapping with the DL slot for the reference PDSCH reception for slot-based PUCCH or an UL slot overlapping with the end of the reference PDSCH reception in DL slot for sub-slot based PUCCH.

* FFS details of reference PDSCH

**Agreement**

* For Type-2 HARQ-ACK codebook, two sub-codebooks are generated with a first sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling a single cell and a second sub-codebook comprising HARQ-ACK information bits for PDSCH(s) scheduled by DCI(s) with each scheduling more than one cell.
* Separate DAI counting for DCI(s) with each scheduling a single cell and DCI(s) with each scheduling more than one cell.
* FFS whether a DCI scheduling more than one cell is associated with the first sub-codebook or the second sub-codebook when the number of cells with actual PDSCH reception due to collision with semi-static TDD DL/UL configuration is one.
* Type-2 HARQ-ACK codebook is generated by concatenating the first sub-codebook and the second sub-codebook.
* If at least one cell of the set of cells which can be co-scheduled by a DCI format 1\_X is configured with maximum 2 codewords per PDSCH without spatial bundling,
	+ FFS: the number of HARQ-ACK information bits for each DCI format 1\_X that schedules more than one cell;
* Otherwise, the number of HARQ-ACK information bits for each DCI format 1\_X that schedules more than one cell is equal to N, where N is the maximum number of cells which can be co-scheduled by a DCI format 1\_X in the PUCCH group for the UE.
* HARQ-ACK information bits for co-scheduled PDSCHs by a DCI format 1\_X is ordered based on serving cell indices associated with co-scheduled PDSCHs.
* HARQ-ACK bundling across co-scheduled cells is not supported for multi-cell scheduling.

**Agreement**

* UE does not expect to be configured both CBG-based PDSCH/PUSCH transmission and the multi-cell PDSCH/PUSCH scheduling on the same or different cells within a same PUCCH group.

**Agreement**

* At least cases 1-1 and 1-2 on SCS are supported:
* Case 1-1: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and same SCS is used among all the co-scheduled cells including the scheduling cell.
* Case 1-2: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and same SCS is used among all the co-scheduled cells which may be same or different to the SCS of the scheduling cell.
* Case 1-3: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and different SCS is used among the co-scheduled cells including the scheduling cell.
* Case 1-4: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and different SCS is used among the co-scheduled cells.
* FFS: Whether Case 1-3 or 1-4 is additionally supported.

## Agreements made in RAN#97

**Conclusion:**

* Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.
* Enhanced Type-2 HARQ-ACK codebook is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.
* Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1\_X have same SCS/carrier type/duplex mode in Rel-18.
* Additional restriction(s) can be discussed in RAN1
* Configuring more than one scheduling cell for DCI format 0\_X/1\_X for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.

**Conclusion:**

* Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.
* SCell schedules multiple cells including P(S)Cell
* Different SCS among co-scheduled cells
* Different carrier type (licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells
* Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell
* Support for any sidelink scheduling

**Conclusion:**

* Following is excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.
* PCell schedules multiple cells by DCI format 0\_X/1\_X when a sSCell is configured to schedule PCell

## Agreements made in RAN1#110bis

**Agreement**

Confirm the following working assumption reached in RAN1#110 meeting.

**Working Assumption**

* The maximum number of co-scheduled cells by a DCI format 1\_X in Rel-18 is 4.
* The maximum number of co-scheduled cells by a DCI format 0\_X in Rel-18 is 4.
* FFS: The maximum number of configurable cells for co-scheduling

**Agreement**

At least the following fields are excluded from DCI format 1\_X/0\_X:

* CBGTI
* CBGFI
* PDSCH group index
* New feedback indicator
* Number of requested PDSCH group(s)
* Sidelink assignment index
* Second TPC command for scheduled PUSCH
* Second SRS resource indicator
* Second Precoding information
* Second PTRS-DMRS association
* Second TPC command for scheduled PUCCH

**Agreement**

For DCI format 1\_X/0\_X, Type-1 fields at least include the following:

* Priority indicator
* Indicator of co-scheduled cells
* beta offset indicator
* CSI request
* UL-SCH indicator
* FFS: ChannelAccess-CPext

**Agreement**

Confirm below working assumption reached in RAN1#110 meeting with revision.

**Working Assumption**

* For any cell within a set of cells which can be co-scheduled by a DCI format 0\_X/1\_X, RAN1 specification supports monitoring the DCI format 0\_X/1\_X and DCI format 0\_0/1\_0, 0\_1/1\_1, and/or 0\_2/1\_2 (if supported by the UE), if configured from a same scheduling cell.
* The DCI format 0\_X/1\_X and the DCI format 0\_0/1\_0/0\_1/1\_1/0\_2/1\_2 can be monitored simultaneously.
* Note: This does not mean a UE is required to support number of BDs/CCEs beyond the Rel-17 limits (i.e., $\_{}^{}\_{}^{}\_{}^{}$ and $\_{}^{}$) for PDCCH candidates for each scheduled cell.

**Agreement**

For a set of cells co-scheduled by a DCI format 0\_X/1\_X, time domain resource allocations for the set of cells are ~~jointly~~ indicated by a single TDRA field in the DCI format 0\_X/1\_X.

* Separate {SLIV, mapping type, scheduling offset K0 (or K2)} is indicated for each of co-scheduled PDSCHs/PUSCHs.
* FFS details of the TDRA table design

**Agreement**

Confirm below working assumption:

**Working Assumption**

HARQ-ACK codebook types (Type-1, Rel-15 Type-2, Rel-16 Type-3, Rel-17 Type-3) are applicable when multi-cell PDSCH scheduling is configured.

**Working Assumption**

For a set of cells which is configured for multi-cell scheduling,

* Existing DCI size budget is maintained on each cell of the set of cells.
* DCI size of DCI format 0\_X/1\_X is counted on one cell among the set of cells.
	+ FFS which cell DCI size of the DCI format 0\_X/1\_X is counted on.
* BD/CCE of DCI format 0\_X/1\_X is counted on one cell among the set of cells.
	+ FFS which cell BD/CCE of the DCI format 0\_X/1\_X is counted on.
* Search space of DCI format 0\_X/1\_X is configured on one cell of the set of cells and associated with the search space of the scheduling cell with the same search space ID.
	+ FFS which cell the SS of the DCI format 0\_X/1\_X is configured on.
* FFS: How to address Rel-17 BD/CCE limit for any given cell (operating the feature under Rel-17 BD/CCE limit)
* Note: This does not mean a UE is required to support number of BDs/CCEs beyond the Rel-17 limits (i.e., $M\_{PDCCH}^{max,slot,μ}, C\_{PDCCH}^{max,slot,μ}, M\_{PDCCH}^{total,slot,μ}$ and $C\_{PDCCH}^{total,slot,μ}$) for PDCCH candidates for each scheduled cell.

**Agreement**

* UE does not expect to be configured both multi-PDSCH scheduling and multi-cell PDSCH scheduling on the same or different cells within a same PUCCH group.

**Agreement**

* For Type-2 HARQ-ACK codebook, if at least one cell of a set of cells which can be co-scheduled by DCI format 1\_X is configured with maximum 2 codewords per PDSCH without spatial bundling, the number of HARQ-ACK information bits for each DCI format 1\_X that schedules more than one cell of the set of cells is equal to M, where M is the maximum number of TBs which can be co-scheduled by a DCI format 1\_X in the PUCCH group for the UE.

**Agreement**

* For Type-2 HARQ-ACK codebook, a DCI format 1\_X scheduling more than one cell is associated with the second sub-codebook when the number of cells with actual PDSCH reception due to collision with semi-static TDD DL/UL configuration is one.
* If a UE is scheduled by a DCI format 1\_X to receive PDSCH over multiple cells, and if tdd-UL-DL-ConfigurationCommon, or tdd-UL-DL-ConfigurationDedicated, indicates that, for a cell from the multiple cells, at least one symbol from a set of symbols where the UE is scheduled PDSCH reception in the cell is an uplink symbol, the UE does not receive the PDSCH in the cell.
* If a UE is scheduled by a DCI format 0\_X to transmit PUSCH over multiple cells, and if tdd-UL-DL-ConfigurationCommon, or tdd-UL-DL-ConfigurationDedicated, indicates that, for a cell from the multiple cells, at least one symbol from a set of symbols where the UE is scheduled PUSCH transmission in the cell is a downlink symbol, the UE does not transmit the PUSCH in the cell.

## Agreements made in RAN1#111

**Proposal 2-1 rev3:**

Confirm the RAN1#110bis-e working assumption with the following changes:

**Working Assumption**

For a set of cells which is configured for multi-cell scheduling,

* Existing DCI size budget is maintained on each cell of the set of cells.
* DCI size of DCI format 0\_X/1\_X is counted on one cell among the set of cells.
	+ DCI size of the DCI format 0\_X/1\_X is counted on the reference cell.
* BD/CCE of DCI format 0\_X/1\_X is counted on one cell among the set of cells.
	+ BD/CCE of the DCI format 0\_X/1\_X is counted on the reference cell.
* Same reference cell is used for both DCI format 0\_X and DCI format 1\_X.
* The reference cell is
	+ the scheduling cell if the scheduling cell is included in the set of cells and search space of the DCI format 0\_X/1\_X is configured only on the scheduling cell;
	+ one cell of the set of cells which search space of DCI format 0\_X/1\_X is configured on and associated with the search space of the scheduling cell with the same search space ID if search space of the DCI format 0\_X/1\_X is configured on the cell in addition to the scheduling cell.
		- It is up to gNB on which cell the SS of the DCI format 0\_X/1\_X is configured on.
* To address Rel-17 BD/CCE limit for any given cell (operating the feature under Rel-17 BD/CCE limit)
	+ For the reference cell, a total number of configured BD/CCEs for both DCI formats 0\_X/1\_X and legacy DCI formats (if configured) does not exceed the Rel-17 limits.
	+ For other cells in the sets of cells, Rel-17 limits for PDCCH/DCI monitoring and BD/CCE counting rules for legacy DCI formats (not including DCI formats 0\_X/1\_X) apply
* ~~Note: This does not mean a UE is required to support number of BDs/CCEs beyond the Rel-17 limits (i.e.,~~ $M\_{PDCCH}^{max,slot,μ}, C\_{PDCCH}^{max,slot,μ}, M\_{PDCCH}^{total,slot,μ}$ ~~and~~ $C\_{PDCCH}^{total,slot,μ}$~~) for PDCCH candidates for each scheduled cell.~~

**Agreement**

For a set of cells which is configured for multi-cell scheduling, up to 4 cells within the set of cells are supported.

* A DCI format 0\_X/1\_X can schedule PUSCH(s)/PDSCH(s) on a combination of co-scheduled cells among the same set of cells.

**Agreement**

For DCI format 1\_X/0\_X,

* Type-1 fields at least include below:
	+ ChannelAccess-Cpext
	+ TDRA
* Below fields are agreed to be supported for DCI format 0\_X/1\_X. FFS: Whether the fields are type1, type2, type configurable, or omitted. FFS: details on the fields (e.g. length, which legacy configurations are applicable), other fields.
	+ HARQ process number
	+ MCS (FFS: potential compression scheme)
	+ Bandwidth part indicator
	+ Frequency domain resource assignment (FFS: potential compression scheme)
	+ VRB-to-PRB mapping
	+ PRB bundling size indicator
	+ Rate matching indicator
	+ ZP CSI-RS trigger
	+ Antenna port(s)
	+ Transmission configuration indication
	+ DMRS sequence initialization
	+ Frequency hopping flag
	+ TPC command for scheduled PUSCH
	+ Precoding information and number of layers
	+ PTRS-DMRS association
	+ SRS request
	+ SRS resource indicator
	+ SRS offset indicator
	+ PTRS-DMRS association
	+ Open-loop power control parameter set indication
	+ UL/SUL indicator

Note: RAN1 strives to minimize the number of fields which are type configurable.

**Agreement**

For monitoring PDCCH candidates for a set of cells which is configured for multi-cell scheduling, the n\_CI in the search space equation is determined by a value configured for the set of cells by RRC signaling.

Agreement

The types for below fields in DCI format 1\_X are listed ([R1-2212924](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23112%5C%5Ctdocs%5C%5CFL%20summary%5C%5CR1-2212924.zip)):

|  |  |  |
| --- | --- | --- |
| **Field**  | **Type** | **Details(for information only)** |
| HARQ process number | Type 2 | Details in Section 7.1.1 |
| MCS  | Alt 1: Type 2 (without compression) | Details in Section 7.1.2 |
| BWP indicator | Type 1A | Details in Section 7.1.3 |
| FDRA | Type 2 * Further consider larger RBG granularity than existing maximum specified or configured value for RA type 0
* Use large RBG-based RIV for RA type 1 based on R16 configurable granularities for DCI format 1\_2
 | Details in Section 7.1.4 |
| VRB-to-PRB mapping | Type 1A | Details in Section 7.1.5 |
| PRB bundling size indicator | Type 1A | Details in Section 7.1.6 |
| Rate matching indicator | Type 1B (up to 4 bits) | Details in Section 7.1.7 |
| ZP CSI-RS trigger | Type 1B (up to 3 bits) | Details in Section 7.1.8 |
| Antenna port(s) | Configurable between Type 1A and Type 2 | Details in Section 7.1.9 |
| TCI | Type 1B (up to 4 bits) | Details in Section 7.1.10 |
| DMRS sequence initialization | Type 1A | Details in Section 7.1.11 |
| SRS request | Type 1B (up to 4 bits) | Details in Section 7.1.12 |
| SRS offset indicator | Type 1B (up to 3 bits) | Details in Section 7.1.13 |

This does not imply that payload of DCI can be larger than what is supported for polar code in Rel-17.

FFS: Details

**Agreement**

* The types for below fields in DCI format 0\_X are listed:

|  |  |  |
| --- | --- | --- |
| Field  | Type | **Details(for information only)** |
| HARQ process number | Type 2 | Details in Section 7.2.1 |
| MCS  | Alt 1: Type 2 (without compression) | Details in Section 7.2.2 |
| BWP indicator | Type 1A | Details in Section 7.2.3 |
| FDRA | Type 2 * Further consider larger RBG granularity than existing maximum specified or configured value for RA type 0
* Use large RBG-based RIV for RA type 1 based on R16 configurable granularities for DCI format 1\_2
 | Details in Section 7.2.4 |
| Frequency hopping flag | Type 1A | Details in Section 7.2.5 |
| TPC command for scheduled PUSCH | Type 2 | Details in Section 7.2.6 |
| Open-loop power control parameter set indication | Type 1A | Details in Section 7.2.7 |
| Antenna port(s) | Configurable between Type 1A and Type-2 | Details in Section 7.2.8 |
| Precoding information and number of layers | Configurable between Type 1A and Type-2 | Details in Section 7.2.9 |
| PTRS-DMRS association | Type 2 | Details in Section 7.2.10 |
| DMRS sequence initialization | Type 1A | Details in Section 7.2.11 |
| SRS request | Type 1B (up to 4 bits) | Details in Section 7.2.12 |
| SRS resource indicator | Configurable between Type 1A and Type-2 | Details in Section 7.2.13 |
| SRS offset indicator | Type 1B (up to 3 bits) | Details in Section 7.2.14 |
| UL/SUL indicator | FFS | Details in Section 7.2.15 |

This does not imply that payload of DCI can be larger than what is supported for polar code in Rel-17.

FFS: Details

## Agreements made in RAN1#112

**Agreement**

For Type-2 HARQ-ACK codebook, for a set of cells which is co-scheduled by a DCI format 1\_X, the reference PDSCH to determine DAI counting is the PDSCH with smallest serving cell index among the set of co-scheduled cells.

**Agreement**

* For a set of cells which is co-scheduled by a DCI format 1\_X, the PDSCH with the smallest serving cell index among the set of co-scheduled cells is used to determine last DCI format for PUCCH determination among DCI formats within a same PDCCH MO.
* It is up to gNB implementation to resolve the last DCI format issue when both DCI format 1\_X and other DCI format 1\_0/1\_1/1\_2/1\_X are received in a same PDCCH monitoring occasion on a same scheduling cell for scheduling PDSCHs on same scheduled cell.

**Agreement**

For determining the timing of a PUCCH carrying HARQ-ACK information corresponding to a set of co-scheduled PDSCHs by a DCI format 1\_X, the reference PDSCH is the PDSCH ending last as indicated in the DCI format 1\_X among the set of co-scheduled PDSCHs.

**Conclusion**

Type-1 HARQ-ACK codebook is supported for multi-cell scheduling without K1 extension.

* UE expects HARQ-ACK information for all co-scheduled PDSCHs by DCI format 1\_X can be mapped in the Type-1 HARQ-ACK codebook.
* Type-1 HARQ-ACK codebook is not enhanced for Rel-18 multi-cell scheduling.

**Agreement**

For a set of cells which is configured for multi-cell scheduling using DCI format 0\_X/1\_X, a joint TDRA table is configured by RRC signaling for the set of cells with each row in the table containing TDRA indexes for all cells within the set of cells.

* TDRA field in the DCI format 0\_X/1\_X belongs to Type-1B field.
* TDRA field in the DCI format 0\_X/1\_X indicates a row from the joint TDRA table.
* TDRA index for a cell points to a corresponding TDRA in the TDRA table applicable for DCI format 0-1/1-1.

**Agreement**

CSI request in DCI format 0\_X belongs to Type-1C field.

* This field is applied to the cell with smallest serving cell index among the co-scheduled cells.

**Agreement**

UL-SCH indicator in DCI format 0\_X belongs to Type-1C field.

* This field is applied to the cell with smallest serving cell index among the co-scheduled cells.

**Agreement**

Enhanced Type-3 codebook indicator in DCI format 1\_X belongs to Type-1A field.

**Agreement**

HARQ-ACK retransmission indicator in DCI format 1\_X belongs to Type-1A field.

**Agreementl**

PUCCH Cell indicator in DCI format 1\_X belongs to Type-1A field.

**Agreement**

For a set of cells configured for multi-cell scheduling using DCI format 0\_X/1\_X,

* the size of a Type-1A field in the DCI format 0\_X/1\_X is determined as maximum field size of active BWP among all cells within the set of cells.
* the size of a Type-1B field in the DCI format 0\_X/1\_X is equal to ceiling(log2(N)), where N is the number of rows in RRC-configured table with each row containing multiple indexes for all cells within the set of cells.
	+ The Type-1B field indicates one row of the configured table
	+ The Type-1B index for a cell points to a corresponding index in a RRC configured table applicable for DCI format 0\_1/1\_1 or MAC CE activated values.
* the size of a per cell Type-2 field in the DCI format 0\_X/1\_X is determined based on active BWP for each cell.

**Agreement**

For a set of cells which is configured for multi-cell scheduling using DCI format 0\_X and DCI format 1\_X, support the following:

* If table defining combinations of co-scheduled cells for the set of cells is configured,
	+ an indicator in the DCI is included and points to one row of the table.
	+ The table is configured by RRC signaling for the set of cells.
		- Separate tables are configured for downlink scheduling and uplink scheduling
	+ The size of the indicator is equal to ceil(log2(N)), where N is the number of rows in the table.
	+ The max number of rows in the table is 16
	+ The size of the per-cell Type 2 fields for each co-scheduled cell does not change according to the indicated co-scheduled cell combination
	+ The payload size of DCI format 1\_X is derived by UE based on RRC configuration of the active BWP(s) of co-scheduled cell combinations within the set of cells.
		- The payload size of DCI format 1\_X is the same for the active BWP(s) of all the co-scheduled cell combinations and equal to the largest payload size among the active BWP(s) of all the co-scheduled cell combinations determined by the co-scheduled cell combination table.
	+ The payload size of DCI format 0\_X is derived by UE based on RRC configuration of the active BWP(s) of co-scheduled cell combinations within the set of cells.
		- The payload size of DCI format 0\_X is the same for the active BWP(s) of all the co-scheduled cell combinations and equal to the largest payload size among the active BWP(s) of all the co-scheduled cell combinations determined by the co-scheduled cell combination table.
* Otherwise,
	+ The UE determines the actually scheduled cell(s) based on the FDRA field of each cell of the set of cells.
		- For Type 0 FDRA, all 0s indicates the cell is not scheduled.
		- For Type 1 FDRA, all 1s indicates the cell is not scheduled.
	+ The size of the Type 2 fields for each cell does not change according to actually co-scheduled cells.
	+ The payload size of DCI format 0\_X is derived by UE based on RRC configuration of the active BWP(s) of all cells within the set of cells.
	+ The payload size of DCI format 1\_X is derived by UE based on RRC configuration of the active BWP(s) of all cells within the set of cells.

**Agreement**

Following is supported in Rel-18 multi-cell scheduling

* A UE can be configured one or multiple sets of cells with each set configured for multi-cell scheduling using DCI format 0\_X/1\_X.
* Up to 4 sets of cells can be configured per PUCCH group.
* When multiple sets of cells are configured,
	+ a cell in one set of cells can’t be included in another set of cells.
	+ n\_CI value is independently configured for each set of cells.
	+ reference cell for counting DCI size and BD/CCE of DCI format 0\_X/1\_X is independently determined for each set of cells.
	+ search space configuration of DCI format 0\_X/1\_X is independently configured for each set of cells.
	+ DCI size of DCI format 0\_X is independently determined for each set of cells.
	+ DCI size of DCI format 1\_X is independently determined for each set of cells.
* The multiple sets of cells can be scheduled by DCI format 0\_X/1\_X from different scheduling cells.
* Up to N sets of cells can be configured and respectively scheduled by DCI format 0\_X/1\_X from a same scheduling cell.
	+ The value of N is reported as UE capability.
	+ An indicator is included in the DCI to indicate the scheduled set of cells,
		- The size of the indicator is equal to ceil(log2(N)), where N is the number of sets of cells.
	+ Unique n\_CI value is configured for each set of cells.

**Agreement**

* A new RBG size configuration “Configuration 3” is added with the following values and only used for DCI format 0\_X/1\_X for RA type 0.
* RBG size is configured per BWP per cell.
* Independent RA type configuration is applied per BWP per cell for multi-cell scheduling DCI.

 **Table 5.1.2.2.1-1 / Table 6.1.2.2.1-1: Nominal RBG size *P***

|  |  |  |  |
| --- | --- | --- | --- |
| **Bandwidth Part Size** | **Configuration 1** | **Configuration 2** | **Configuration 3** |
| 1 – 36  | *2* | 4 | 8 |
| 37 – 72 | 4 | 8 | 16 |
| 73 – 144 | 8 | 16 | 32 |
| 145 – 275 | 16 | 16 | 32 |

**Agreement**

DCI format 0\_X / 1\_X with CRC scrambled by C-RNTI and MCS-C-RNTI is supported.

**Agreement**

For a set of cells which is configured for multi-cell scheduling using DCI format 0\_X/1\_X, if DCI size budget on the reference cell can’t be maintained after performing Rel-17 DCI size alignment procedures for legacy DCI formats (after step 4C), UE applies zero padding to whichever of DCI formats 0\_X or 1\_X that has a smaller size to have equal size.

**Agreement**

* Separate search space sets for DCI format 0\_X/1\_X and legacy DCI formats are independently configured
* Separate search space sets for DCI format 0\_X and 1\_X can be independently configured

**Agreement**

If the UE is configured with two SRS resource sets with ‘codebook’ or ‘non-codebook’, a PUSCH scheduled by DCI format 0\_X is always associated with the first SRS resource set with ‘codebook’ or ‘non-codebook’.

**Conclusion**

PUSCH repetition Type B operation is not supported with DCI format 0\_X (i.e. UE cannot be configured with PUSCH repetition Type B applicable for DCI format 0\_1)

**Agreement**

New RRC parameter of RBG granularity for RA type 1 can be configured per BWP per cell for DCI format 0\_X/1\_X with same value range applicable for DCI 0\_2/1\_2.

**Agreement**

Size of RV field can be configured per BWP per cell for DCI format 0\_X/1\_X.

**Agreement**

Size of HPN field can be configured per BWP per cell for DCI format 0\_X/1\_X.

**Agreement**

Priority indicator in DCI format 0\_X belongs to Type-1A field.

* The indicated priority is applied to all the co-scheduled PUSCH(s)

Priority indicator in DCI format 1\_X belongs to Type-1A field.

* The indicated priority indicator is applied to the PUCCH.

RRC parameters is introduced to configure the presence of priority indicator in DCI format 0\_X/1\_X

* This parameter is per set of cells

**Agreement**

ChannelAccess-Cpext in DCI format 1\_X belongs to Type-1A field.

* The indicated channel access information is applied to the PUCCH and/or SRS (whichever is first).

ChannelAccess-Cpext-CAPC in DCI format 0\_X belongs to Type-1A field.

* The indicated code point is applied to all the co-scheduled PUSCHs and/or SRS (whichever is first) by DCI format 0\_X.

**Agreement**

Beta\_offset indicator in DCI format 0\_X belongs to Type-1A field.

* This field is applied to the scheduled PUSCH(s) where the UCI is multiplexed.

**Agreement**

Inclusion of SCell dormancy indication in DCI format 0\_X/1\_X is configurable

**Agreement**

Inclusion of PDCCH monitoring adaptation indication in DCI format 0\_X/1\_X is configurable

**Agreement**

Inclusion of minimum applicable scheduling offset indicator in DCI format 0\_X/1\_X is configurable

## Agreements made in RAN1#114bis

**Agreement**

For a serving cell included in *MC-DCI-SetofCells*, a UE does not expect to be configured to monitor PDCCH candidates on more than one scheduling cell for detection of DCI formats scheduling the serving cell.

**Agreement**

DCI format level padding is adopted for DCI format 0\_3 or DCI format 1\_3.

**Agreement**

For DCI format 0\_3, when *ScheduledCellCombo-ListDCI-0-3* is not configured, all '0's for FDRA Type 2 with μ=1 or all ‘1’s for FDRA Type 2 with μ=0 indicates the corresponding cell is not scheduled.

**Agreement**

Below TP on TS38.213-i00 is adopted.

* Reason for change: PDCCH monitoring adaptation indication is applicable for PDCCH monitoring on a serving cell and captured in DCI format 0\_3/1\_3 in 38.212-i00. However, TS38.213-i00 does not reflect it.
* Summary of change: Add DCI format 0\_3 and DCI format 1\_3 in Section 10 on PDCCH skipping and SSSG switching.
* Consequence if not approved: Inconsistency between TS38.212 and TS38.213.

|  |
| --- |
| **10.4 Search space set group switching and skipping of PDCCH monitoring**<Omit unchanged text>A UE can be provided a set of durations by *pdcch-SkippingDurationList* for PDCCH monitoring on an active DL BWP of a serving cell and, if the UE is not provided *searchSpaceGroupIdList-r17* on the active DL BWP of the serving cell, a DCI format 0\_1,~~and~~ a DCI format 0\_2 and a DCI format 0\_3 that schedule PUSCH transmission, and a DCI format 1\_1,~~and~~ a DCI format 1\_2 and a DCI format 1\_3 that schedule PDSCH receptions can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits. <Omit unchanged text>A UE can be provided group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on an active DL BWP of a serving cell and, if the UE is not provided *pdcch-SkippingDurationList* for the active DL BWP of the serving cell, a DCI format 0\_1,~~and~~ a DCI format 0\_2 and a DCI format 0\_3 that schedule PUSCH transmissions and a DCI format 1\_1,~~and~~ a DCI format 1\_2 and a DCI format 1\_3 that schedule PDSCH receptions can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits for the serving cell. <Omit unchanged text>A UE can be provided a set of durations by *pdcch-SkippingDurationList* and group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on an active DL BWP of a serving cell and, a DCI format 0\_1,~~and~~ a DCI format 0\_2 and a DCI format 0\_3 that schedule PUSCH transmissions, and a DCI format 1\_1,~~and~~ a DCI format 1\_2 and a DCI format 1\_3 that schedule PDSCH receptions can include a PDCCH monitoring adaptation field of 2 bits. <Omit unchanged text> |

**Agreement**

* The Minimum applicable scheduling offset indicator, if configured to be present in DCI format 0\_3/1\_3, is of Type-1A field with 1 bit.
* Below TP on TS38.212-i00 is adopted.
* Reason for change: RAN1 has agreed that inclusion of minimum applicable scheduling offset indicator is supported in DCI format 0\_3/1\_3 and this field is already captured in 38.212-i00. However, the bit size is not defined.
* Summary of change: Add the clarification to this field when the bit size is equal to 1.
* Consequence if not approved: Bit size of this field is not defined in TS38.212.

|  |
| --- |
| **7.3.1.1.4 Format 0\_3**< Unchanged parts are omitted >- Minimum applicable scheduling offset indicator – 0 or 1 bit - 0 bit if higher layer parameter *minimumSchedulingOffsetK0DCI-0-3* is not configured; - ~~x~~ 1 bit~~s~~ otherwise. The 1 bit indication is used to determine the minimum applicable K2 for the active UL BWP and the minimum applicable K0 value for the active DL BWP, if configured respectively, according to Table 7.3.1.1.2-33. If the minimum applicable K0 is indicated, the minimum applicable value of the aperiodic CSI-RS triggering offset for an active DL BWP for each scheduled cell shall be the same as the minimum applicable K0 value.< Unchanged parts are omitted >**7.3.1.2.4 Format 1\_3**< Unchanged parts are omitted >- Minimum applicable scheduling offset indicator – 0 or 1 bit - 0 bit if higher layer parameter *minimumSchedulingOffsetK0DCI-1-3* is not configured;- ~~x~~ 1 bit~~s~~ otherwise. The 1 bit indication is used to determine the minimum applicable K0 for the active DL BWP and the minimum applicable K2 value for the active UL BWP, if configured respectively, according to Table 7.3.1.1.2-33. If the minimum applicable K0 is indicated, the minimum applicable value of the aperiodic CSI-RS triggering offset for an active DL BWP for each scheduled cell shall be the same as the minimum applicable K0 value.< Unchanged parts are omitted > |

**Agreement**

Simultaneous configuration of both multicast reception and multi-cell scheduling in the same PUCCH group is not supported in Rel-18.

**Agreement**

For an enhanced Type-3 HARQ-ACK codebook triggered by a DCI format 1\_3, if the enhanced Type-3 HARQ-ACK codebook indicator is not configured, the MCS field of TB1 corresponding to a cell with smallest serving cell index ~~among the co-scheduled cells~~ with invalid FDRA field values is used to indicate the index of the enhanced Type-3 HARQ-ACK codebook.

* Note: Cells with valid FDRA fields are scheduled

**Agreement**

For HARQ-ACK retransmission triggered by a DCI format 1\_3, the MCS field of TB1 corresponding to a cell with smallest serving cell index ~~among the co-scheduled cells~~ with invalid FDRA field values is used to indicate the value of slot level offset *l*.

* Note: Cells with valid FDRA fields are scheduled

**Agreement**

The value range of *SRS-RequestCombo* is BIT STRING (2..3).

**Agreement**

* Single joint table is configured per set of cells for each of Type-1B fields other than TDRA (i.e., rateMatchListDCI-1-3, zp-CSI-RSListDCI-1-3, tci-ListDCI-1-3, srs-RequestListDCI-1-3, srs-OffsetListDCI-1-3, srs-RequestListDCI-0-3, srs-OffsetListDCI-0-3).
	+ Entries for each CC are interpreted based on the new/target BWPs per cell that is indicated by the BWP indicator field of DCI 0\_3/1\_3.
* Single joint table is configured per set of cells for TDRA (i.e., TDRA-FieldIndexListDCI-1-3, TDRA-FieldIndexListDCI-0-3).
	+ Entries of the joint table for TDRA (i.e., TDRA-FieldIndexDCI-1-3) are configured for each BWP of each CC.
	+ Columns of the indicated entry corresponding to the new/target BWPs per cell that is indicated by the BWP indicator field of DCI 0\_3/1\_3 are applied.
* The maximum size of TDRA-FieldIndexListDCI-1-3 is 32.
* The maximum size of TDRA-FieldIndexListDCI-0-3 is 64.

**Agreement**

Below TP on TS38.212-i00 is adopted.

* Reason for change: RAN1 has agreed that inclusion of SCell dormancy indication is supported in DCI format 0\_3/1\_3 and this field is already captured in 38.212-i00. However, the bit size is not defined.
* Summary of change: Add the clarification on the bit size of this field in Section 7.3.1.14 in TS38.212.
* Consequence if not approved: Bit size of this field is not defined in TS38.212.

|  |
| --- |
| **7.3.1.1.4 Format 0\_3**<omitted text>- SCell dormancy indication – 0 bit if higher layer parameter *dormancyDCI-0-3* or *dormancyGroupWithinActiveTime* is not configured; otherwise ~~x bits~~ 1, 2, 3, 4, or 5 bits bitmap determined according to the number of different *DormancyGroupID(s)* provided by higher layer parameter *dormancyGroupWithinActiveTime,* where each bit corresponds to one of the SCell group(s) configured by higher layers parameter *dormancyGroupWithinActiveTime,* with MSB to LSB of the bitmap corresponding to the first to last configured SCell group in ascending order of *DormancyGroupID*. The field is only present when this format is carried by PDCCH on the primary cell within DRX Active Time and the UE is configured with at least two DL BWPs for an SCell.<omitted text>**7.3.1.2.4 Format 1\_3**<omitted text>- SCell dormancy indication – 0 bit if higher layer parameter *~~SCell-dormancy-indication-Present~~* *dormancyDCI-1-3* or *dormancyGroupWithinActiveTime* is not configured; otherwise ~~x bits.~~ 1, 2, 3, 4, or 5 bits bitmap determined according to the number of different *DormancyGroupID(s)* provided by higher layer parameter *dormancyGroupWithinActiveTime,* where each bit corresponds to one of the SCell group(s) configured by higher layers parameter *dormancyGroupWithinActiveTime,* with MSB to LSB of the bitmap corresponding to the first to the last configured SCell group in ascending order of *DormancyGroupID*. The field is only present when this format is carried by PDCCH on the primary cell within DRX Active Time and the UE is configured with at least two DL BWPs for an SCell.<omitted text> |

**Agreement**

For MC-DCI, SCell dormancy indication Case 1 (for both DCI format 0-3 and 1-3) and Case 2 (only for DCI format 1-3) are supported.

**Agreement**

For a UE configured with a set of cells by *MC-DCI-SetofCells*,

* If the scheduling cell is active while the reference cell is indicated dormant or deactivated, the UE does not monitor DCI format 0\_3/1\_3 on the scheduling cell for the set of cells.

## Agreements made in RAN1#115

**Conclusion**

There is no consensus to support TPI field for DCI format 0\_3 in Rel-18

**Agreement**

For a UE configured with a set of cells by *MC-DCI-SetofCells*,

* If an SCell within the set of cells is deactivated and its *firstActiveDownlinkBWP-Id* is not set to dormant BWP, the UE determines the sizes of fields in DCI format 1\_3 according to the DL BWP provided by *firstActiveDownlinkBWP-Id*.
* If an SCell within the set of cells is dormant, or if an SCell within the set of cells is deactivated and its *firstActiveDownlinkBWP-Id* is set to dormant BWP,
	+ the UE determines the sizes of fields in DCI format 1\_3 according to the DL BWP provided by *firstWithinActiveTimeBWP-Id* for the SCell if provided;
	+ otherwise, according to the DL BWP provided by *firstOutsideActiveTimeBWP-Id* for the SCell.
* If an SCell within the set of cells is deactivated, the UE determines the sizes of fields in DCI format 0\_3 according to the UL BWP provided by *firstActiveUplinkBWP-Id*.

**Agreement**

Adopt the following TP to 38.214 for the support of FDRA Type 2 for PUSCH scheduled by DCI format 0\_3:

**Agreement**

* When Antenna port(s) field in DCI format 1\_3 is configured as type1a, UE expects to be configured with a common table from Tables 7.3.1.2.2-1/2/3/4 in TS38.212 is used for all cells in set of cells.
	+ The DMRS mapping type should be the same across the cells in set of cells
* When Antenna port(s) field in DCI format 0\_3 is configured as type1a, UE expects to be configured with a common table from Tables 7.3.1.1.2-6, 7.3.1.1.2-6A, 7.3.1.1.2-7, 7.3.1.1.2-7A, 7.3.1.1.2-8, 7.3.1.1.2-9, 7.3.1.1.2-10, 7.3.1.1.2-11, 7.3.1.1.2-12, 7.3.1.1.2-13, 7.3.1.1.2-14, 7.3.1.1.2-15, 7.3.1.1.2-16, 7.3.1.1.2-17, 7.3.1.1.2-18, 7.3.1.1.2-19, 7.3.1.1.2-20, 7.3.1.1.2-21, 7.3.1.1.2-22, 7.3.1.1.2-23, 7.3.1.1.2-24, and 7.3.1.1.2-25 in TS38.212 is used for all cells in set of cells.
	+ The DMRS mapping type should be the same across the cells in set of cells
* When TPMI field in DCI format 0\_3 is configured as type1a, UE expects to be configured with a common table from Tables 7.3.1.1.2-2, 7.3.1.1.2-2A, 7.3.1.1.2-B, 7.3.1.1.2-3, 7.3.1.1.2-3A, 7.3.1.1.2-4, 7.3.1.1.2-4A, 7.3.1.1.2-5, and 7.3.1.1.2-5A in TS38.212 is used for all cells in set of cells.
* When SRI field in DCI format 0\_3 is configured as type1a, UE expects to be configured with a common table from Tables 7.3.1.1.2-28, 7.3.1.1.2-29, 7.3.1.1.2-30, 7.3.1.1.2-31, 7.3.1.1.2-32, 7.3.1.1.2-32A, and 7.3.1.1.2-32B in TS38.212 is used for all cells in set of cells.

**Agreement**

For a UE configured with DCI format 1\_3, the number of HARQ-ACK bits used for PUCCH power control is derived based on a summation of the corresponding numbers of HARQ-ACK bits in the two HARQ-ACK sub-codebooks.

**Agreement**

* Alt 2: For a DCI format 1\_3 transmitted on PCell, if one-shot HARQ-ACK request is not present or set to '0', and if HARQ-ACK retransmission indicator is not present or set to ‘0’, SCell dormancy indication is provided by repurposing below fields corresponding to one ~~or more~~ serving cell with the smallest cell index with invalid FDRA values ~~in ascending order of serving cell index~~:
	+ Modulation and coding scheme of transport block 1
	+ NDI of transport block 1
	+ Redundancy version of transport block 1
	+ HARQ process number
	+ Antenna port(s) if *AntennaPortsDCI1-3* is configured as ‘*type2*’
* Note: Cells with valid FDRA fields are scheduled.

**Agreement**

Rel-18 specifications support a DCI format 1\_3 is transmitted without scheduling any PDSCH for SCell dormancy indication.

* For Type-2 HARQ-ACK codebook, the corresponding HARQ-ACK information for the DCI format 1\_3 is included in the first Type-2 sub-codebook.

**Agreement**

For a cell provided in *MC-DCI-SetofCells*, when no search space set is configured for the cell, the cell is not counted as a scheduled cell for M\_total\_μ/C\_total\_μ calculation.

**Agreement**

* BWP indicator in a DCI format 0\_3/1\_3 applies only to the scheduled cell(s) with valid FDRA value(s).
* For a cell scheduled by DCI format 0\_3/1\_3 with valid FDRA value, if the BWP indicator indicates a code point that does not correspond to a configured BWP for the cell, the UE does not perform dynamic BWP switching based on the BWP indicator and transmits/receives data on the current active BWP of the cell.

**Agreement**

In case of BWP switching, for a Type-2 field in a DCI format 0\_3/1\_3, the existing procedure for DCI field parsing (via truncation or zero-padding) is applied per “block” of the Type-2 field in the DCI format 0\_3/1\_3.

**Agreement**

* For Type-2 HARQ-ACK codebook, if a DCI format 1\_3 is transmitted with fields repurposed for SCell dormancy indication and schedules one or more PDSCHs,
	+ the corresponding HARQ-ACK information for the one or more PDSCHs is included in the second Type-2 HARQ-ACK sub-codebook.
	+ HARQ-ACK information for the SCell dormancy indication is mapped to HARQ-ACK bit position for the serving cell with the smallest cell index with invalid FDRA and included in the second Type-2 HARQ-ACK sub-codebook.

## Agreements made in RAN1#116

**Agreement**

Adopt following TP for TS38.213.

* **Change reason:** Unicast DCI formats do not include DCI format 1\_3 and 0\_3.
* **Change summary:** Add DCI format 1\_3 and 0\_3 in unicast DCI format list.
* **Consequence if not approved:** Incomplete unicast DCI format list.

|  |
| --- |
| 9 UE procedure for reporting control information<text omitted>In the following, DCI formats with CRC scrambled by C-RNTI or CS-RNTI or MCS-C-RNTI are also referred to as unicast DCI formats and DCI formats with CRC scrambled by multicast-MCCH-RNTI, G-RNTI for multicast or G-CS-RNTI are also referred to as multicast DCI formats. Corresponding unicast DCI formats are DCI formats 0\_0/0\_1/0\_2/0\_3/1\_0/1\_1/1\_2/1\_3 and multicast DCI formats are DCI formats 4\_0/4\_1/4\_2 [4, TS 38.212]. PDSCH receptions scheduled by unicast or multicast DCI formats are referred as unicast or multicast PDSCH receptions. HARQ-ACK information associated with unicast or multicast DCI formats for PDCCH receptions in RRC\_CONNECTED state are also respectively referred as unicast or multicast HARQ-ACK information.<text omitted> |

**Agreement**

Adopt the following TP for sub-clause 9.1.2.1 in TS38.213.

|  |
| --- |
| **9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel**For a serving cell $c$, an active DL BWP, and an active UL BWP, as described in clause 12, the UE determines a set of $M\_{A,c}$ occasions for candidate PDSCH receptions for which the UE can transmit corresponding HARQ-ACK information in a PUCCH in slot $n\_{U}$. If serving cell $c$ is deactivated, the UE uses as the active DL BWP for determining the set of $M\_{A,c}$ occasions for candidate PDSCH receptions a DL BWP provided by *firstActiveDownlinkBWP-Id*. The determination is based:a) on a set of slot timing values $K\_{1}$ associated with the active UL BWP on the primary cell or, if the PUCCH transmission is indicated by a DCI format to be on the PUCCH-sSCell as described in clause 9A, on a set of slot timing values $K\_{1}$ associated with the active UL BWP on the PUCCH-sSCell- If the UE is configured to monitor PDCCH for DCI format 1\_0 and is not configured to monitor PDCCH for ~~either~~ DCI format 1\_1/ ~~or DCI format~~ 1\_2/1\_3 for serving cell $c$, or the active DL BWP for serving cell $c$ is dormant BWP, $K\_{1}$ is provided by the slot timing values {1, 2, 3, 4, 5, 6, 7, 8} for SCS configuration of PUCCH transmission $μ\leq 3$, {7, 8, 12, 16, 20, 24, 28, 32} for $μ=5$, and {13, 16, 24, 32, 40, 48, 56, 64} for $μ=6$- If the UE is configured to monitor PDCCH for DCI format 1\_1/1\_3 and is not configured to monitor PDCCH for DCI format 1\_2 for serving cell $c$, $K\_{1}$ is provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-r17*- If the UE is configured to monitor PDCCH for DCI format 1\_2 and is not configured to monitor PDCCH for DCI format 1\_1/1\_3 for serving cell $c$, $K\_{1}$ is provided by *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-DCI-1-2-r17*- If the UE is configured to monitor PDCCH for DCI format 1\_1/1\_3 and DCI format 1\_2 for serving cell $c$, $K\_{1}$ is provided by the union of *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-r17* and *dl-DataToUL-ACK-DCI-1-2* or *dl-DataToUL-ACK-DCI-1-2-r17* - If an inapplicable value in dl-DataToUL-ACK-r16 or dl-DataToUL-ACK-r17 is provided, the value is excluded from $K\_{1}$ |

**Agreement**

A UE does not expect a DCI format 0\_3/1\_3 schedules an SCell with valid FDRA value and indicates the SCell to switch to dormant BWP.

**Conclusion**

For a cell scheduled by DCI format 0\_3 with valid FDRA value, UE does not expect that OLPC/CAPC/TPMI/SRI in the DCI format indicates a code point that does not correspond to a configuration for the cell.

* No spec impact

**Conclusion**

FDRA validity for a cell is determined based on the indicated BWP of the cell.

* No spec impact

**Agreement**

Adopt the following TP to 38.212 for DMRS sequence initialization in DCI format 0\_3:

|  |
| --- |
| **7.3.1.1.4 Format 0\_3**<omitted text>DMRS sequence initialization –1 bit if transform precoder is disabled at least for one cell configured by higher layer parameter ScheduledCell-ListDCI-0-3 in the scheduled cell set ~~is configured with disabled transform precoder~~; otherwise, 0 bit. This field is applied to all the scheduled cells with transform precoder disabled and indicated by Scheduled cells indicator field or Frequency domain resource assignment field independently.<omitted text> |

**Agreement**

TP1 in section 8 of [R1-2401589](https://lenovobeijing-my.sharepoint.com/personal/leihp1_lenovo_com/Documents/R1-2401589.zip) is agreed for TS38.214.

**Agreement**

Adopt the following TP covering multi-cell scheduling in TS38.300.

**10.X Multi-cell scheduling by a single DCI**

Multi-cell scheduling by a single DCI allows the PDCCH of a serving cell to schedule PDSCH(s)/PUSCH(s) on one or more serving cells with the single DCI but with the following restrictions:

* When a serving cell is configured with a PDCCH which schedules PDSCH(s)/PUSCH(s) on a cell set, the PUSCH/PDSCH on serving cells in the cell set is always scheduled by a PDCCH on the serving cell;
* When PCell is configured with a PDCCH which schedules PDSCH(s)/PUSCH(s) on serving cells in a cell set, that PCell’s PDSCH and PUSCH cannot be scheduled by a PDCCH on an SCell;
* When an SCell is configured with a PDCCH which schedules PDSCH(s)/PUSCH(s) on serving cells in a cell set, PCell is not included in the cell set;
* The scheduling PDCCH and the scheduled PDSCH(s)/PUSCH(s) can use the same or different numerologies;
* The co-scheduled PDSCH(s) with a PDCCH use the same numerology.
* The co-scheduled PUSCH(s) with a PDCCH use the same numerology.

Send an LS to RAN2 to convey the above TP. Final LS is in [R1-2401716](https://lenovobeijing-my.sharepoint.com/personal/leihp1_lenovo_com/Documents/R1-2401716.zip).

**Agreement**

TP2 in Section 8 for TS38.213 is agreed in principle. TS38.213 editor to provide final TP.

**Agreement**

* When a PDCCH MO that provides a DCI format 1\_3 is before active UL BWP change on the PUCCH cell, and the PUCCH indicated by the DCI format 1\_3 is to be transmitted after the active UL BWP change on the PUCCH cell, the corresponding HARQ-ACK information for the DCI format 1\_3 is skipped.
* FFS: When a PDCCH MO that provides a DCI format 1\_3 is before an active DL BWP change on a cell of co-scheduled cells by the DCI format 1\_3, and the DCI format 1\_3 does not trigger the active DL BWP change for the cell, and the PUCCH indicated by the DCI format 1\_3 is to be transmitted after the active DL BWP change on the cell,
	+ For type 2 codebook for generating the second sub-codebook, the corresponding HARQ-ACK information for that cell with BWP switching is generated with NACK bit
	+ For type 1 codebook and for type 2 codebook for generating the first sub-codebook, follow the legacy behaviour (the corresponding HARQ-ACK information for that cell with BWP switching is skipped)

## Agreements made in RAN1#116bis

**Agreement**

* Adopt following TP for TS38.214.

|  |
| --- |
| ***5.5 UE PDSCH reception preparation time ~~with cross carrier scheduling~~ with different subcarrier spacings for PDCCH and PDSCH in different cells***This clause applies only if the PDCCH carrying the scheduling DCI is received on one carrier with one OFDM subcarrier spacing (µPDCCH), and the PDSCH scheduled to be received by the DCI is on another carrier with another OFDM subcarrier spacing (µPDSCH).If the µPDCCH < µPDSCH, the UE is expected to receive the scheduled PDSCH, if the first symbol in the PDSCH allocation, including the DM-RS, as defined by the slot offset *K0* and the start and length indicator *SLIV* of the scheduling DCI starts no earlier than the first symbol of the slot of the PDSCH reception starting at least *Npdsch* PDCCH symbols after the end of the PDCCH scheduling the PDSCH, not taking into account the effect of receive timing difference between the scheduling cell and the scheduled cell.If the µPDCCH > µPDSCH, the UE is expected to receive the scheduled PDSCH, if the first symbol in the PDSCH allocation, including the DM-RS, as defined by the slot offset *K0* and the start and length indicator *SLIV* of the scheduling DCI starts no earlier than *Npdsch* PDCCH symbols after the end of the PDCCH scheduling the PDSCH, not taking into account the effect of receive timing difference between the scheduling cell and the scheduled cell.When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining *Npdsch*, the PDCCH candidate that ends later in time is used. <omitted text> |

**Agreement**

The following TP is agreed in principle. Final TP to be decided by the editor.

TP2 on TS38.213:

|  |
| --- |
| **[TS 38.213 V18.2.0]**9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channel< unchanged part omitted >A value of the counter downlink assignment indicator (DAI) field in DCI formats, each scheduling PDSCH receptions on respective single serving cells with associated HARQ-ACK information, or having associated HARQ-ACK information without scheduling a PDSCH reception, in a same HARQ-ACK codebook denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pairs in which PDSCH receptions that provide transport blocks with enabled HARQ-ACK information report, or HARQ-ACK information bits that are not in response for PDSCH receptions, associated with the DCI formats, excluding the SPS activation DCI, is present up to the current serving cell and current PDCCH monitoring occasion, - first, if the UE indicates by *type2-HARQ-ACK-Codebook* support for more than one PDSCH reception on a serving cell that are scheduled from a same PDCCH monitoring occasion, in increasing order of the PDSCH reception starting time for the same {serving cell, PDCCH monitoring occasion} pair, - second in ascending order of serving cell index, and - third in ascending order of PDCCH monitoring occasion index $m$, where $0\leq m<M$. A value of the counter DAI field in DCI formats, each scheduling PDSCH receptions on respective more than one serving cells with associated HARQ-ACK information in a same HARQ-ACK codebook, denotes the accumulative number of {serving cell with smallest index from the more than one serving cells, PDCCH monitoring occasion}-pairs in which PDSCH receptions are present up to the current more than one serving cells and current PDCCH monitoring occasion,- first, if the UE indicates by *type2-HARQ-ACK-Codebook* support for more than one PDSCH receptions on a serving cell that are scheduled from a same PDCCH monitoring occasion, in increasing order of the PDSCH reception starting time for the same {serving cell with smallest index from the more than one serving cells, PDCCH monitoring occasion} pair,- second in ascending order of the smallest serving cell index from the more than one serving cells, and - third in ascending order of PDCCH monitoring occasion index $m$, where $0\leq m<M$.< unchanged part omitted >The UE determines the $\tilde{o}\_{0}^{ACK}, \tilde{o}\_{1}^{ACK},\cdots ,\tilde{o}\_{O\_{ACK}−1}^{ACK}$, for a total number of $O\_{ACK}$ HARQ-ACK information bits in the second Type-2 HARQ-ACK sub-codebook according to the following pseudo-code. Set $N\_{cells,set}^{DL,max}$ to the maximum number of serving cells in *ScheduledCell-ListDCI-1-3* of a set of serving cells provided by *MC-DCI-SetofCells*, across the number of sets of serving cells, that can be scheduled PDSCH receptions by DCI format 1\_3Set $N\_{sets}^{TB,max}$ to the maximum total number of TBs in PDSCH receptions that can be scheduled by a DCI format 1\_3 over more than one serving cells in a set of serving cells across the number of sets of serving cellsSet $N\_{sets}^{DL}$ to the number of sets of serving cells *MC-DCI-SetofCells* in a PUCCH groupSet $N\_{cells}^{DL}$ to the number of serving cells, across $N\_{sets}^{DL}$ sets of serving cells in the PUCCH groupSet $c$ to the index of serving cells, $c=0,…, N\_{cells}^{DL}−1$, a lower index corresponds to a lower RRC index of a corresponding serving cell* if the UE indicates *type2-HARQ-ACK-Codebook,* and receives a number $N\_{PDSCH, c}^{m}>1$ of PDSCHs on a serving cell *c* that are scheduled by [$N\_{PDSCH, c}^{m}$] DCI formats 1\_3 in PDCCH receptions at a same PDCCH monitoring occasion *m*, wherein each of the DCI formats 1\_3 schedule more than one PDSCH receptions on respective more than one serving cells, and *c* is the same smallest cell index among the respective more than one serving cells across the [$N\_{PDSCH, c}^{m}$] DCI formats 1\_3, the serving cell *c* is counted $N\_{PDSCH, c}^{m}$ times for PDCCH monitoring occasion *m* in increasing order of the PDSCH reception starting time among the $N\_{PDSCH, c}^{m}$ PDSCHs
* if the UE indicates *type2-HARQ-ACK-Codebook,* and receives a number $N\_{PDSCH, c}^{m}>1$ of PDSCHs on a serving cell *c* that are scheduled by [$N\_{PDSCH, c}^{m}$] DCI formats 1\_3 in PDCCH receptions at a same PDCCH monitoring occasion *m*, wherein each of the DCI formats 1\_3 schedule more than one PDSCH receptions on respective more than one serving cells, and *c* is the smallest cell index among the respective more than one serving cells which is the same across the [$N\_{PDSCH, c}^{m}$] DCI formats 1\_3, the serving cell *c* is counted $N\_{PDSCH, c}^{m}$ times for PDCCH monitoring occasion *m* in increasing order of the PDSCH reception starting time among the $N\_{PDSCH, c}^{m}$ PDSCHs

Set $mc$ to the index of a serving cell, in a set of indexes of serving cells arranged in ascending order, from the set of $N\_{cells,set}^{DL,max}$ serving cells, $mc=0,…, N\_{cells,set}^{DL,max}−1$Set $m=0$ – PDCCH monitoring occasion index for detection of a DCI format 1\_3 scheduling PDSCH receptions on more than one serving cells from a set of serving cells: lower index corresponds to earlier PDCCH monitoring occasionSet $j=0$Set $V\_{temp}=0$Set $V\_{temp2}=0$Set $V\_{s}=∅$Set $M$ to the number of PDCCH monitoring occasions< unchanged part omitted > |

**Agreement**

For a UE configured with a set of cells by *MC-DCI-SetofCells*, when a cell in the set of cells is dormant or deactivated and the cell is neither the scheduling cell nor the reference cell for the set of cells, the UE can receive a DCI format 1\_3/0\_3 that schedules serving cells including the cell;

* The UE does not expect a PDSCH or a PUSCH scheduled on the cell.
* The fields of DCI format 1\_3 corresponding to the cell can be reinterpreted for indicating SCell dormancy indication, the index of the enhanced Type-3 HARQ-ACK codebook or the value of slot level offset *l.*
	+ The UE checks the field value of the cell in the DCI format 1\_3.
* Note: FDRA field of the cell in the DCI format 1\_3/0\_3 is set to invalid.

**Conclusion**

There is no consensus to support search space sharing for DCI format 0\_3/1\_3.

**Agreement**

The following TP is agreed for Rel-18 38.214.

-----------------------------Begin TP1 for 38.214, subclause 6.2.1.3-----------------------------

6.2.1.3 UE sounding procedure between component carriers

**<Unchanged parts are omitted>**

For an aperiodic SRS triggered in DCI format 1\_1 or 1\_2, if the UE is configured by *SRS-CarrierSwitching*, it transmits SRS on one serving cell not configured for PUSCH/PUCCH transmission scheduled by the DCI and the UE in the serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter ~~usage~~ *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'.

For an aperiodic SRS triggered in DCI format 1\_3, if the UE is configured by *SRS-CarrierSwitching*,

for an SRS transmission in a scheduled cell not configured for PUSCH/PUCCH transmission, the UE transmits the configured one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'.

**<Unchanged parts are omitted>**

-----------------------------End TP1 for 38.214, subclause 6.2.1.3-----------------------------

**Agreement**

* Keep the wording of TS38.212-i20 unchanged in regards to the usage of invalid FDRA for determination of scheduled / non-schedueld cells.
* RAN1 confirms that repurposed-based indication of {SCell dormancy, enhanced Type-3 HARQ-ACK CB, HARQ retransmission} is supported regardless of whether *ScheduledCellCombo-ListDCI-1-3* is configured or not.
* No RAN1 spec impact

**Agreement**

Adopt TP3 in Section 8 of **[R1-2403479](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23117%5C%5Ctdocs%5C%5CFL%20summary%5C%5CR1-2403479.zip)** for TS38.214.

**Conclusion**

For a cell scheduled by DCI format 0\_3/1\_3 with valid FDRA value, UE does not expect that a Type-1B field in the DCI format indicates a code point that does not correspond to a configuration for the cell.

* No RAN1 spec impact

## Agreements made in RAN1#117

**Agreement**

The TP in draft CR R1-2404235 for TS38.212 on correcting precoding information and number of layers in DCI format 0\_3 is agreed for **alignment CR. Editor to submit CR.**

**Agreement**

The TP in draft CR R1-2404856 for TS38.212 on correcting number of MCS/NDI/RV blocks for TB-2 in DCI 1\_3 is agreed for **alignment CR**. **Editor to submit CR.**

**Agreement**

Following TP is agreed for TS38.214. Final in CR in R1-2405734.

5.1.5 Antenna ports quasi co-location

<text omitted>

When *tci-PresentInDCI* is set as 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET, a UE configured with *dl-OrJointTCI-StateList* with activated *TCI-State* or *ul-TCI-StateList* with activated *TCI-UL-State* receives DCI format 1\_1/1\_2/1\_3 providing indicated *TCI-State(s)* and/or *TCI-UL-State(s)* for a CC or all CCs in the same CC list configured by *simultaneousU-TCI-UpdateList1-r17, simultaneousU-TCI-UpdateList2-r17, simultaneousU-TCI-UpdateList3-r17, simultaneousU-TCI-UpdateList4-r17*. The DCI format 1\_3 provides indicated *TCI state(s)* and/or*TCI-UL-State(s)* for the CC(s) in a *scheduledCellListDCI-1-3* if the UE is scheduled by the DCI format 1\_3 to receive PDSCH at least on one serving cell in the *scheduledCellListDCI-1-3*. The DCI format 1\_1/1\_2 can be with or without, if applicable, DL assignment. If the DCI format 1\_1/1\_2 is without DL assignment, the UE can assume the following:

- CS-RNTI is used to scramble the CRC for the DCI

- The values of the following DCI fields are set as follows:

- RV = all '1's

- MCS = all '1's

- NDI = 0

- Set to all '0's for FDRA Type 0, or all '1's for FDRA Type 1, or all '0's for dynamicSwitch (same as in Table 10.2-4 of [6, TS 38.213]).

After a UE receives an initial higher layer configuration of *dl-OrJointTCI-StateList* with more than one *TCI-State* and before application of an indicated TCI state from the configured TCI states:

- The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block the UE identified during the initial access procedure

\*\*\* Unchanged parts are omitted \*\*\*

**Agreement**

The TP in R1-2404855 for TS38.212 on correcting Type-2 field blocks in DCI 1\_3/0\_3 is agreed but without the addition of “counted towards $N\_{cell}^{UL}$”, “counted towards $N\_{cell}^{DL}$”. The TP is agreed for **alignment CR.**

## Agreements made in RAN1#118

**Agreement**

* When a PDCCH MO that provides a DCI format 1\_3 is before an active DL BWP change on a cell of co-scheduled cells by the DCI format 1\_3, and the active DL BWP change for the cell is not triggered in the PDCCH MO, and the PUCCH indicated by the DCI format 1\_3 starts at or after a slot for the active DL BWP change on the cell,
* For Type 1 codebook and for Type 2 codebook for generating the first sub-codebook, follow the legacy behaviour (the corresponding HARQ-ACK information for that scheduled cell with active DL BWP change is skipped)
	+ No spec impact
* For Type 2 codebook for generating the second sub-codebook,
	+ the HARQ-ACK information for that scheduled cell with active DL BWP change is generated with NACK bit.

**Agreement**

* The TP in draft CR [R1-2405930](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23118%5C%5Ctdocs%5C%5CR1-2405930.zip) for TS38.214 on corrections of DCI format 0\_3 is agreed as alignment CR.

**Agreement**

* The TP in draft CR [R1-2406796](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23118%5C%5Ctdocs%5C%5CR1-2406796.zip) for TS38.213 on corrections of UCI-onPUSCH for DCI format 0\_3 is agreed as alignment CR.

**Agreement**

* The TP in draft CR R1-2406620 for TS38.213 on correcting search space for DCI format 0\_3/1\_3 is agreed as alignment CR.

**Agreement**

* The TP in draft CR [R1-2407164](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23118%5C%5Ctdocs%5C%5CR1-2407164.zip) for TS38.212 on correcting table caption for DCI format 0\_3/1\_3 is agreed as alignment CR.

**Agreement**

* The TP in draft CR [R1-2406339](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23118%5C%5Ctdocs%5C%5CR1-2406339.zip) for TS38.213 on correcting Type-2 HARQ-ACK codebook determination is agreed as alignment CR.

**Agreement**

* The TP in draft CR [R1-2406341](file:///D%3A%5C%5CRAN1%5C%5CRAN1%23118%5C%5Ctdocs%5C%5CR1-2406339.zip) for TS38.213 on correcting Type-2 HARQ-ACK codebook determination is agreed as alignment CR.

**Agreement**

* Adopt the following TP for Section 10.1, TS38.213 on PDCCH overbooking is agreed in principle for alignment.

10.1 UE procedure for determining physical downlink control channel assignment

< Unchanged parts are omitted >

For all search space sets that a UE monitors PDCCH on the primary cell within a slot $n$, or within a group of $X\_{s}$ slots for a corresponding combination $\left(X\_{s},Y\_{s}\right)$, or within a span in slot $n$, denote by $S\_{css}$ a set of CSS sets, except for CSS sets provided by *searchSpaceMCCH*, *searchSpaceMTCH* or by *SearchSpace* in *pdcch-ConfigMulticast* for DCI formats with CRC scrambled by G-RNTI or G-CS-RNTI, with cardinality of $I\_{css}$ and by $S\_{uss}$ a set of USS sets and CSS sets provided by *searchSpaceMCCH*, *searchSpaceMTCH* or by *SearchSpace* in *pdcch-ConfigMulticast* for DCI formats with CRC scrambled by G-RNTI or G-CS-RNTI with cardinality of $J\_{uss}$ ~~for scheduling on the primary cell~~ with PDCCH candidates and non-overlapping CCEs counted on the primary cell. The location of search space sets $s\_{j}$, $0\leq j<J\_{uss}$, in $S\_{uss}$ is according to an ascending order of the search space set index.

< Unchanged parts are omitted >

**Agreement**

Adopt the following TP for Section 9.1.5, TS38.213 is agreed in principle for alignment.

< Unchanged parts are omitted >

9.1.5 HARQ-ACK codebook retransmission

With reference to slots of PUCCH transmissions on the primary cell and for Type-1 or Type-2 HARQ-ACK codebooks, a UE that transmitted or would transmit a PUCCH or a PUSCH with a first HARQ-ACK codebook in slot $m$ can be indicated by a DCI format with CRC scrambled by a C-RNTI or a MCS-C-RNTI that does not schedule a PDSCH reception [4, TS 38.212] on one or more serving cells and is received in a PDCCH ending in slot $n$, to transmit a PUCCH with the first HARQ-ACK codebook in slot $n+k$, where slot $n+k$ is after slot $m$. The UE determines $k$ and a resource for the PUCCH transmission as described in clauses 9.2.3 and 9.2.5. If the UE is provided a periodic cell switching pattern for PUCCH transmissions by *pucch-sSCellPattern*, the UE further determines a corresponding cell based on the periodic cell switching pattern as described in clause 9.A.

If the HARQ-ACK retransmission indicator field value in a DCI format is '1', the UE determines slot $m$ as $m=n−l$ where $l$ is determined by a one-to-one mapping in ascending order among the values from -7 to 24 and the values of

- the MCS field for transport block 1 if the DCI format is DCI format 1\_1

- the MCS field if the DCI format is DCI format 1\_2

- the MCS field for transport block 1 for a serving cell if the DCI format is DCI format 1\_3, where the serving cell is the one with smallest index that has

- *resourceAllocation* = *resourceAllocationType0* and all bits of the corresponding block of the frequency domain resource assignment field equal to 0, or

- *resourceAllocation* = *resourceAllocationType1* and all bits of the corresponding block of the frequency domain resource assignment field equal to 1, or

- *resourceAllocation = dynamicSwitch* and all bits of the corresponding block of the frequency domain resource assignment field equal to 0 or 1

If the DCI format includes a priority indicator field having a value, a priority value of first HARQ-ACK information in the first HARQ-ACK codebook is same as the value of the priority indicator field; otherwise, the priority value of the first HARQ-ACK information is zero.

< Unchanged parts are omitted >

**Agreement**

* Adopt the following TP for Section 5.1.5, Rel-18 TS38.214 is agreed in principle for alignment.

5.1.5 Antenna ports quasi co-location

**<Unchanged parts are omitted>**

When a UE configured with *dl-OrJointTCI-StateList* would transmit a PUCCH with positive HARQ-ACK or a PUSCH with positive HARQ-ACK corresponding to the DCI carrying the TCI State indication and without DL assignment, or corresponding to ~~the~~ one or more PDSCHs scheduled by the DCI carrying the TCI State indication, and if the indicated TCI State(s) is/are different from the previously indicated one*(s)*, the indicated *TCI-State(s)* and/or *TCI-UL-State(s)* should be applied starting from the first slot that is at least $ beamAppTime$ symbols after the last symbol of the PUCCH or the PUSCH, and if the UE receives more than one indicated TCI state for a CC/BWP to be applied starting from the first slot that is at least $ beamAppTime$ symbols after the last symbol of the PUCCH or the PUSCH, the indicated TCI state carried in the latest DCI, for the corresponding *coresetPoolIndex* value when applicable, in time corresponding to positive HARQ-ACK value is applied. The first slot and the $ beamAppTime$ symbols are both determined on the active BWP with the smallest SCS among the BWP(s) from the CCs applying the indicated *TCI-State(s)* or *TCI-UL-State(s)* that are active at the end of the PUCCH or the PUSCH carrying the positive HARQ-ACK.

**<Unchanged parts are omitted>**

**Agreement**

Draft CR in Section 11 of R1-2407227 is endorsed in principle.

**Agreement**

Final CR R1-247545 is endorsed.