3GPP TSG RAN WG1 #102 DRAFT R1-20xxxx

e-Meeting, August 17th – 28th, 2020

**Agenda item: 7.2.10**

**Source: Moderator (Nokia)**

**Title: FL summary on cross-carrier scheduling with different numerology**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is the pre-meeting feature-lead summary of the proposals submitted for the AI7.2.10 that are related to cross-carrier scheduling with different numerologies.

# 2 Summary of issues addressed in the Tdocs

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| **Issue #** | **Description** | **Source** |
| 1 | Proposal 1: If a DCI indicates BWP change for a scheduled cell, there is no other DCI for that cell in the same PDCCH monitoring occasion (i.e., only one DCI – the BWP changing DCI – for one scheduled cell is allowed in a monitoring occasion). | vivo [1] |
| Proposal 2: If more than one DCI is transmitted within the same MO with K1 indicating the same PUCCH slot, PDSCH starting time in addition to the existing MO index and Cell index is applied to determine the “last DCI” for PUCCH resource determination. | ZTE [2] |
| 2 | Proposal #1: Adopt the following TP for TS38.213 spec to handle the DCI not scheduling PDSCH transmission in terms of determining DAI counting order.A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) or SPS PDSCH release associated with the DCI formats is present up to the current serving cell and current PDCCH monitoring occasion, first if the UE indicates support for *PDSCH-Number-perMOperCell* in increasing order of the PDSCH reception starting time indicated in the DCI for the same {serving cell, PDCCH monitoring occasion} pair, second in ascending order of serving cell index, and then in ascending order of PDCCH monitoring occasion index $m$, where $m$ $0\leq m<M$. | LGE [5] |
| 3 | Proposal 1: Remove Component 2 from FG 18-5 and FG 18-5b.Proposal 2: In FG 18-9 “Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion”, modify “DL DCI” to be “unicast DL DCI” for clarification.Proposal 3: For FG 18-5a and FG 18-6a, the candidate value should be {same numerology, different numerology, both}. | MTek [3] |
| 4 | Proposal 5: The symbol duration for timeline for dynamic grant PDSCH overriding SPS PDSCH is based on the smallest SCS between the scheduling and scheduled cell. | Samsung [4] |
| 5 | Based on current TS 38.214, it is unclear which TCI state is used for a PDSCH a PDSCH is cross carrier scheduled by a DCI without TCI field present and the offset between the DCI and the PDSCH is equal to or greater than the threshold.Proposal: fix the issue by limiting the Rel-15 behavior to “same carrier scheduling”. | ASUS [6] |

# 3 Discussion on the scope of the RAN1#102

## #1 Scheduling DCI and a BWP change DCI in the same MO [1,2]

In this case, if one of the scheduling DCIs triggering BWP switching, there may be some problem. For example, if the DCI-1 indicates a BWP change of cell-1, it is not clear how to derive the DCI size of DCI-2, because the active BWP of DCI-2 is different from that of DCI-1. Another problem is how to determine the HARQ codebook if one of these DCIs scheduling the same cell indicates a BWP change, especially considering up to four DCIs can be detected in a monitoring occasion.

**Proposal 1**: If a DCI indicates BWP change for a scheduled cell, there is no other DCI for that cell in the same PDCCH monitoring occasion (i.e., only one DCI – the BWP changing DCI – for one scheduled cell is allowed in a monitoring occasion). [1]

**Proposal 2:** If more than one DCI is transmitted within the same MO with K1 indicating the same PUCCH slot, PDSCH starting time in addition to the existing MO index and Cell index is applied to determine the “last DCI” for PUCCH resource determination. [2]

**FL proposal:** Discuss the proposals

Comments on the FL proposal

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| **Company** | **Comments** |
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## #2 DAI counting order for the DCI not scheduling PDSCH [5]

For the support of cross-carrier scheduling with different numerology, it was agreed in RAN1#101-e that “the time of the first symbol of the PDSCH” is used to determine the DAI counting order (used for the HARQ-ACK bit ordering on Type-2 dynamic HARQ-ACK codebook) among the multiple DCIs, which are to schedule a same serving cell and transmitted in a same PDCCH MO. However, **with current TS38.213 specification, it is unclear how to determine the DAI counting order for the DCI not scheduling PDSCH transmission, for example, SPS PDSCH release DCI.**

One simple way to address this issue is to refer the PDSCH starting symbol timing indicated by the TDRA field in the DCI just for the purpose of determining DAI counting order, even though the PDSCH is not actually scheduled/transmitted. With this consideration, the part “the PDSCH reception starting time” in current spec can simply be updated as “the PDSCH reception starting time indicated in the DCI”.

**Proposal #1:** Adopt the following TP for TS38.213 spec to handle the DCI not scheduling PDSCH transmission in terms of determining DAI counting order.

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| A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) or SPS PDSCH release associated with the DCI formats is present up to the current serving cell and current PDCCH monitoring occasion, first if the UE indicates support for *PDSCH-Number-perMOperCell* in increasing order of the PDSCH reception starting time indicated in the DCI for the same {serving cell, PDCCH monitoring occasion} pair, second in ascending order of serving cell index, and then in ascending order of PDCCH monitoring occasion index $m$, where $m$ $0\leq m<M$. |

**FL proposal:** Discuss the proposal

Comments on the FL proposal

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| **Company** | **Comments** |
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## #3 Cross-carrier scheduling related FGs [3]

Proposal 1: Remove Component 2 from FG 18-5 and FG 18-5b.

Proposal 2: In FG 18-9 “Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion”, modify “DL DCI” to be “unicast DL DCI” for clarification.

Proposal 3: For FG 18-5a and FG 18-6a, the candidate value should be {same numerology, different numerology, both}.

**FL proposal:** Defer the FG discussions to the UE features agenda item as these FGs are discussed there

Comments on the FL proposal

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| **Company** | **Comments** |
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## #4 Reference SCS for dynamic grant overriding SPS PDSCH timeline [4]

In current Spec. the timeline for dynamic grant PDSCH overriding SPS PDSCH is fixed and defined as 14 symbols according to TS 38.214. In Rel-16, CCS with different numerologies between the scheduling cell and the scheduled cell is supported. With different OFDM symbols durations, it needs to be specified which SCS is considered for the 14 symbols.

**Proposal 5:** The symbol duration for timeline for dynamic grant PDSCH overriding SPS PDSCH is based on the smallest SCS between the scheduling and scheduled cell.

**FL proposal:** Discuss the proposal

Comments on the FL proposal

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| **Company** | **Comments** |
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## #5 TCI state for X-carrier scheduled PDSCH scheduled without a TCI field present [6]

Based on current TS 38.214, it is unclear which TCI state is used for a PDSCH is cross carrier scheduled by a DCI without TCI field present and the offset between the DCI and the PDSCH is equal to or greater than the threshold.

Proposal: fix the issue by limiting the Rel-15 behavior to “same carrier scheduling” with the TP below

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| 5.1.5 Antenna ports quasi co-location[unchanged part omitted]If a UE is configured with the higher layer parameter *tci-PresentInDCI* that is set as 'enabled'for the CORESET scheduling the PDSCH, the UE assumes that the TCI field is present in the DCI format 1\_1 of the PDCCH transmitted on the CORESET. If a UE is configured with the higher layer parameter *tci-PresentInDCI-ForFormat1\_2* for the CORESET scheduling the PDSCH, the UE assumes that the TCI field with a DCI field size indicated by *tci-PresentInDCI-ForFormat1\_2* is present in the DCI format 1\_2 of the PDCCH transmitted on the CORESET. If the PDSCH is scheduled by a DCI format not having the TCI field present, and the time offset between the reception of the DL DCI and the corresponding PDSCH of a serving cell is equal to or greater than a threshold *timeDurationForQCL* if applicable, where the threshold is based on reported UE capability [13, TS 38.306], for determining PDSCH antenna port quasi co-location, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the TCI state or QCL assumption whichever is applied for the CORESET used for the PDCCH transmission within the active BWP of the serving cell.  |

**FL proposal:** Discuss the proposal

Comments on the FL proposal

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| **Company** | **Comments** |
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# References

1. R1-2005360 Remaining issues on MR-DC, vivo
2. R1-2005421 Remaining Issues of SCell Dormancy and Cross-carrier Scheduling, ZTE
3. R1-2005626 Remaining issues on Rel-16 carrier aggregation, MediaTek Inc.
4. R1-2006123 On maintenance of Scell dormancy and CCS with different SCSs, Samsung
5. R1-2006297 Remaining issue on cross-carrier scheduling with different numerology, LG Electronics
6. R1-2006753 Remaining issue for cross-carrier scheduling, ASUSTEK COMPUTER

# Annex – Proposals related to cross-carrier scheduling with different SCS

## [1] R1-2005360 Remaining issues on MR-DC, vivo

In the previous meeting, it has been agreed to enable a UE detecting more than one DCI for a cell in a monitoring occasion, and to count the PDSCH starting time in addition to the cell index for counter DAI in this case.

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| Agreement:* Introduce a new FG for Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion as follows:
	+ Components:
		- For HARQ-ACK type 2 codebook: Usage of the PDSCH starting time in addition to the existing MO and Cell index to order the HARQ-ACK feedback.
	+ Pre-requisites: 3-1
	+ FDD/TDD separation N/A
	+ FR1/FR2 differentiation: N/A
	+ Type: Per UE
	+ Mandatory/Optional: Optional with capability signalling
	+ Note: The UE capability is introduced with following assumption:
		- Specification reflects that UE behavior is modified only for UEs supporting this capability.
		- UE behavior of a UE supporting this capability is different from UE behavior of a UE not supporting this capability only for following case:
			* Type-2 HARQ-ACK codebook when HARQ-ACK feedback in a codebook corresponds to more than one DL DCI for same scheduled cell in a MO of a scheduling cell.
* FFS: check if any update is needed in the related Pseudo codeand handling of PDSCH starting time for ordering with existing functionality for multi-TRP operation

Agreement:Adopt the following text proposal for Clause 9.1.3.1 of TS 38.213:A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) or SPS PDSCH release associated with the DCI formats is present up to the current serving cell and current PDCCH monitoring occasion, first, if the UE indicated support for [NEW FG] in increasing order of the time of the first symbol of the PDSCH for the same {serving cell, PDCCH monitoring occasion} pair, second in ascending order of serving cell index, and then in ascending order of PDCCH monitoring occasion index, where. |

One example is shown in Figure 1, where a UE detects DCI-1 and DCI-2 in the same PDCCH monitoring occasion scheduling cell-1.



Figure 1 Examples of more than one DCI in a monitoring occasion

In this case, if one of the scheduling DCIs triggering BWP switching, there may be some problem. For example, if the DCI-1 in Figure 1 indicates a BWP change of cell-1, it is not clear how to derive the DCI size of DCI-2, because the active BWP of DCI-2 is different from that of DCI-1. Another problem is how to determine the HARQ codebook if one of these DCIs scheduling the same cell indicates a BWP change, especially considering up to four DCIs can be detected in a monitoring occasion.

There are some approaches to avoid these problems, i.e., by introducing some scheduling restrictions.

Alt.1: BWP switching is only allowed for the last DCI (in increasing order of the time of the first symbol of the PDSCH) of the scheduled cell in a monitoring occasion. In this case, gNB can guarantee that the DCI size remains unchanged among DCIs for a scheduled cell.

Alt.2: If a DCI indicates BWP change for a scheduled cell, there is no other DCI for that cell in the same PDCCH monitoring occasion (i.e., only one DCI – the BWP changing DCI – is allowed in a monitoring occasion).

We slightly prefer Alt.2 for its simplicity.

*Proposal 1:* *If a DCI indicates BWP change for a scheduled cell, there is no other DCI for that cell in the same PDCCH monitoring occasion (i.e., only one DCI – the BWP changing DCI – for one scheduled cell is allowed in a monitoring occasion).*

The associated TP is provided below:

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| 9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channelA UE determines monitoring occasions for PDCCH with DCI format scheduling PDSCH receptions or SPS PDSCH release on an active DL BWP of a serving cell $c$, as described in Clause 10.1, and for which the UE transmits HARQ-ACK information in a same PUCCH in slot $n$ based on- PDSCH-to-HARQ\_feedback timing indicator field values for PUCCH transmission with HARQ-ACK information in slot $n$ in response to PDSCH receptions or SPS PDSCH release- slot offsets $K\_{0}$ [6, TS 38.214] provided by time domain resource assignment field in a DCI format scheduling PDSCH receptions or SPS PDSCH release and by *pdsch-AggregationFactor* or *RepNumR16*, when provided.The set of PDCCH monitoring occasions for a DCI format scheduling PDSCH receptions or SPS PDSCH release is defined as the union of PDCCH monitoring occasions across active DL BWPs of configured serving cells. PDCCH monitoring occasions are indexed in an ascending order of start time of the search space sets associated with a PDCCH monitoring occasion. The cardinality of the set of PDCCH monitoring occasions defines a total number $M$ of PDCCH monitoring occasions.A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) or SPS PDSCH release associated with the DCI formats is present up to the current serving cell and current PDCCH monitoring occasion, first if the UE indicates support for *PDSCH-Number-perMOperCell* 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 then in ascending order of PDCCH monitoring occasion index $m$, where $m$ $0\leq m<M$. If, for an active DL BWP of a serving cell, the UE is not provided *CORESETPoolIndex* or is provided *CORESETPoolIndex* with value 0 for one or more first CORESETs and is provided *CORESETPoolIndex* with value 1 for one or more second CORESETs, and is provided *ACKNACKFeedbackMode = JointFeedback*, the value of the counter DAI is in the order of the first CORESETs and then the second CORESETs for a same serving cell index and a same PDCCH monitoring occasion index. If a UE indicates support of *PDSCH-Number-perMOperCell*, in a PDCCH monitoring occasion for each scheduled cell, the UE is not required to detect more than one DCI format, if the DCI format indicating an active DL BWP change for that scheduled cell. |

*Proposal 2:* *Agree the TP above for TS 38.213 to clarify the UE behavior.*

## [2] R1-2005421 Remaining Issues of SCell Dormancy and Cross-carrier Scheduling, ZTE

During RAN1#101bis-e meeting, the following agreements and the corresponding draft TP were endorsed. It has been agreed that the PDSCH starting time is introduced to order the HARQ-ACK codebook when more than 1 DCIs are transmitted in the same MO and the corresponding HARQ-ACKs would be constructed in the same UL slot. In this clause, some remaining issues on this issue are further analysed.

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| Agreement:·        Introduce a new FG for Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion as follows:·        Components:·        For HARQ-ACK type 2 codebook: Usage of the PDSCH starting time in addition to the existing MO and Cell index to order the HARQ-ACK feedback.·        Pre-requisites: 3-1·        FDD/TDD separation N/A·        FR1/FR2 differentiation: N/A·        Type: Per UE·        Mandatory/Optional: Optional with capability signalling·        Note: The UE capability is introduced with following assumption:·        Specification reflects that UE behavior is modified only for UEs supporting this capability.·        UE behavior of a UE supporting this capability is different from UE behavior of a UE not supporting this capability only for following case:·        Type-2 HARQ-ACK codebook when HARQ-ACK feedback in a codebook corresponds to more than one DL DCI for same scheduled cell in a MO of a scheduling cell.·        FFS: check if any update is needed in the related Pseudo codeand handling of PDSCH starting time for ordering with existing functionality for multi-TRP operation Agreement:Adopt the following text proposal for Clause 9.1.3.1 of TS 38.213:A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) or SPS PDSCH release associated with the DCI formats is presentup to the current serving cell and current PDCCH monitoring occasion, first, if the UE indicated support for [NEW FG] in increasing order of the time of the first symbol of the PDSCH for the same {serving cell, PDCCH monitoring occasion} pair, second in ascending order of serving cell index, and then in ascending order of PDCCH monitoring occasion index, where. |

In Rel-15, the MO index and Cell index are applied to order the HARQ-ACK feedback and also applied to order the DCIs to determine the “last DCI” to determine the PUCCH resource index. According to the above agreements, the PDSCH starting time in addition to the existing MO index and Cell index is applied to order the HARQ-ACK feedback, then in this case, more than one DCI can be transmitted with the same MO with K1 indicting the same PUCCH slot. However, if the DSCH starting time in addition to the existing MO index and Cell index is not applied to determine the “last DCI”, then network has to indicate the same PRI in these different DCIs in this MO. This kind of restriction on network implementation has no justification. Thus, it is preferred that the PDSCH starting time in addition to the existing MO index and Cell index can also be applied to determine the “last DCI”.

***Proposal 2****: If more than one DCI is transmitted within the same MO with K1 indicating the same PUCCH slot, PDSCH starting time in addition to the existing MO index and Cell index is applied to determine the “last DCI” for PUCCH resource determination. (Note: The corresponding TP can be found in TP2 below.)*

***TP2****: {38.213, 9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channel}*

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| For a PUCCH transmission with HARQ-ACK information, a UE determines a PUCCH resource after determining a set of PUCCH resources for  HARQ-ACK information bits, as described in Clause 9.2.1. The PUCCH resource determination is based on a PUCCH resource indicator field [5, TS 38.212], if present, in a last DCI format, among the DCI formats that have a value of a PDSCH-to-HARQ\_feedback timing indicator field, if present, or a value of *dl-DataToUL-ACK*, or a value of *dl-DataToUL-ACKForDCIFormat1\_2* for DCI format 1\_2, indicating a same slot for the PUCCH transmission, that the UE detects and for which the UE transmits corresponding HARQ-ACK information in the PUCCH where, for PUCCH resource determination, detected DCI formats are first indexed in increasing order of the PDSCH reception starting time for the same serving cell and PDCCH monitoring occasion if the UE indicates support for *PDSCH-Number-perMOperCell*, second in an ascending order across serving cells indexes for a same PDCCH monitoring occasion and are then indexed in an ascending order across PDCCH monitoring occasion indexes. For indexing DCI formats within a serving cell for a same PDCCH monitoring occasion, if the UE is not provided *CORESETPoolIndex* or is provided *CORESETPoolIndex* with value 0 for one or more first CORESETs and is provided *CORESETPoolIndex* with value 1 for one or more second CORESETs on an active DL BWP of a serving cell, and with *ACKNACKFeedbackMode* = *JointFeedback* for the active UL BWP, detected DCI formats from PDCCH receptions in the first CORESETs are indexed prior to detected DCI formats from PDCCH receptions in the second CORESETs. |

As the PDSCH starting time is applied to order the HARQ-ACK feedback and to determine the “last DCI”, another remaining issue is how to handle the HARQ-ACK for SPS release and HARQ-ACK for dormancy indication, which don’t schedule PDSCH at all. It is well understood that the SPS release and dormancy indication are not frequently happened in the practical network. In this sense, it may be unnecessary to enhance this specifically for HARQ-ACK for SPS release and HARQ-ACK for dormancy indication, just similar as what we did in Rel-15 for SPS release. The order of HARQ-ACK feedback for SPS release and dormancy indication can be left to implementation, e.g., network can try to avoid transmitting other DCIs in the same MO with SPS release with K1 indicating the same PUCCH slot. Similarly, network can avoid the ambiguity of “last DCI” determination for SPS release and dormancy indication, e.g., indicating the same PRI value in the concerned DCIs.

***Observation 1****: If more than one DCI including at least one DCI indicating SPS release or SCell dormancy is transmitted within the same MO with K1 indicating the same PUCCH slot, how to order the HARQ-ACK for SPS release or SCell dormancy indication and how to determine the “last DCI” can be left to network implementation.*

## [3] R1-2005626 Remaining issues on Rel-16 carrier aggregation, MediaTek Inc.

In the latest RAN1 UE feature list [R1-2005110], the following UE capabilities structure for DL/UL cross carrier scheduling is applied:



It can be seen that the enhanced DCI processing capability (component 2 highlighted in yellow) is still in bracket and not stable yet. Since FG 18-5 and FG 18-5b are basic features for cross-carrier scheduling, and with the late state in Rel-16, we do not think the enhanced DCI processing capability should be included inside the basic features.

**Proposal 1: Remove Component 2 from FG 18-5 and FG 18-5b.**

In the latest RAN1 UE feature list [R1-2005110], a new UE feature FG 18-9 “**Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion**” is defined in RAN1 #101e [Chairman’s Notes, RAN1 #101e] as shown below:



To our understanding, in the feature group description, the “**DL DCI**” should be modified to be “**unicast DL DCI**”.

During RAN1 online email discussion in RAN1 #101e, the original FL proposal is:

* **Feature lead proposal: introduce a resolution based on option 1:**
	+ If the maximum number of unicast DCIs per MO per scheduled cell is increased to larger than one, the PDSCH starting time in addition to the existing MO and Cell index is introduced to order the HARQ-ACK feedback.
	+ Introduce separate UE capability as being discussed under the UE feature session

After a lengthy discussion, the “unicast” is lost due to no reason. Thus, the DCI mentioned in FG 18-9 here should be “unicast” DCI.

**Proposal 2: In FG 18-9 “Type2 HARQ-ACK codebook for >1 DL DCIs in same Monitoring Occasion”, modify “DL DCI” to be “unicast DL DCI” for clarification.**

In the latest RAN1 UE feature list [R1-2005110], the candidate values for FG 18-5a and FG 18-6a are still FFS:



We thus have the following proposal:

**Proposal 3: For FG 18-5a and FG 18-6a, the candidate value should be {same numerology, different numerology, both}.**

## [4] R1-2006123 On maintenance of Scell dormancy and CCS with different SCSs, Samsung

In current Spec. the timeline for dynamic grant PDSCH overriding SPS PDSCH is fixed and defined as 14 symbols according to TS 38.214. In Rel-16, CCS with different numerologies between the scheduling cell and the scheduled cell is supported. With different OFDM symbols durations, it needs to be specified which SCS is considered for the 14 symbols. One option is to consider the smallest SCS between the scheduling and scheduled cell to provide UE with the most time to drop processing of the SPS PDSCH, so we propose the TP below based on this. Alternatively, to reduce potential inefficiency with this option, an extra offset can be considered on top of the 14 symbols acknowledging extra PDCCH decoding delay on the scheduling cell.

**Proposal 5: The symbol duration for timeline for dynamic grant PDSCH overriding SPS PDSCH is based on the smallest SCS between the scheduling and scheduled cell.**

**Proposed TP4 for 38.214 Section 5.1**

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| The UE is not expected to decode a PDSCH scheduled in a serving cell with C-RNTI or MCS-C-RNTI and another PDSCH scheduled in the same serving cell with CS-RNTI if the PDSCHs partially or fully overlap in time except if the PDCCH scheduling the PDSCH with C-RNTI or MCS-C-RNTI ends at least 14 symbols before the start of the PDSCH with CS-RNTI without the corresponding DCI, where the symbol duration is based on the smallest numerology between the scheduling PDCCH and the PDSCH, in which case the UE shall decode the PDSCH scheduled with C-RNTI or MCS-C-RNTI. |

## [5] R1-2006297 Remaining issue on cross-carrier scheduling with different numerology, LG Electronics

For the support of cross-carrier scheduling with different numerology, it was agreed in RAN1#101-e that “the time of the first symbol of the PDSCH” is used to determine the DAI counting order (used for the HARQ-ACK bit ordering on Type-2 dynamic HARQ-ACK codebook) among the multiple DCIs, which are to schedule a same serving cell and transmitted in a same PDCCH MO. However, with current TS38.213 specification, it is unclear how to determine the DAI counting order for the DCI not scheduling PDSCH transmission, for example, SPS PDSCH release DCI.

One simple way to address this issue is to refer the PDSCH starting symbol timing indicated by the TDRA field in the DCI just for the purpose of determining DAI counting order, even though the PDSCH is not actually scheduled/transmitted. With this consideration, the part “the PDSCH reception starting time” in current spec can simply be updated as “the PDSCH reception starting time indicated in the DCI”.

**Proposal #1: Adopt the following TP for TS38.213 spec to handle the DCI not scheduling PDSCH transmission in terms of determining DAI counting order.**

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| A value of the counter downlink assignment indicator (DAI) field in DCI formats denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) or SPS PDSCH release associated with the DCI formats is present up to the current serving cell and current PDCCH monitoring occasion, first if the UE indicates support for *PDSCH-Number-perMOperCell* in increasing order of the PDSCH reception starting time indicated in the DCI for the same {serving cell, PDCCH monitoring occasion} pair, second in ascending order of serving cell index, and then in ascending order of PDCCH monitoring occasion index $m$, where $m$ $0\leq m<M$. |

## [6] R1-2006753 Remaining issue for cross-carrier scheduling, ASUSTEK COMPUTER

In [38.214], the following are used to derive the new default beam in Rel-16 for cross-carrier scheduling [38.2141]:

If the PDCCH carrying the scheduling DCI is received on one component carrier, and the PDSCH scheduled by that DCI is on another component carrier and the UE is configured with [*enableDefaultBeamForCCS*]:

- The *timeDurationForQCL* is determined based on the subcarrier spacing of the scheduled PDSCH. If µPDCCH < µPDSCH an additional timing delay is added to the *timeDurationForQCL*, where *d* is defined in 5.2.1.5.1a-1, otherwise *d* is zero;

- For both the cases, when the offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL,* and when the DL DCI does not have the TCI field present, the UE obtains its QCL assumption for the scheduled PDSCH from the activated TCI state with the lowest ID applicable to PDSCH in the active BWP of the scheduled cell.

In other words, as long as a PDSCH is cross carrier scheduled by a DCI without TCI field present, the new default beam , an activated TCI state with the lowest ID would be used for PDSCH reception, irrespective of the offset between the DCI and the PDSCH.

However, this situation is also covered by an old Rel-15 behavior, when TCI field is absent and the offset between the DCI and the PDSCH is equal to or greater than the threshold :

“ If the PDSCH is scheduled by a DCI format not having the TCI field present, and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than a threshold *timeDurationForQCL* if applicable, where the threshold is based on reported UE capability [13, TS 38.306], for determining PDSCH antenna port quasi co-location, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the TCI state or QCL assumption whichever is applied for the CORESET used for the PDCCH transmission.”

In other words, the above two paragraphs could cover a same case, i.e. “ a PDSCH is cross carrier scheduled by a DCI without TCI field present and the offset between the DCI and the PDSCH is equal to or greater than the threshold”, while different TCI states for the PDSCH are defined. Note that for Rel-15, a cross-carrier scheduling DCI shall comprise TCI state, so that the second paragraph does not cover the case of cross-carrier scheduling. While this restriction is removed in Rel-16, the confusion/conflict arises.

**Observation: Based on current TS 38.214, it is unclear which TCI state is used for a PDSCH** **a PDSCH is cross carrier scheduled by a DCI without TCI field present and the offset between the DCI and the PDSCH is equal to or greater than the threshold.**

Therefore, we propose to fix the issue with the following TP, by limiting the Rel-15 behavior to “same carrier scheduling”.

**Proposal: Adopt the following TP for Section 5.1.5 of TS 38.214**

\*\*\*\*\*\*\*\*\*\*\*Beginning of TP\*\*\*\*\*\*\*\*\*\*\*

5.1.5 Antenna ports quasi co-location

[unchanged part omitted]

If a UE is configured with the higher layer parameter *tci-PresentInDCI* that is set as 'enabled'for the CORESET scheduling the PDSCH, the UE assumes that the TCI field is present in the DCI format 1\_1 of the PDCCH transmitted on the CORESET. If a UE is configured with the higher layer parameter *tci-PresentInDCI-ForFormat1\_2* for the CORESET scheduling the PDSCH, the UE assumes that the TCI field with a DCI field size indicated by *tci-PresentInDCI-ForFormat1\_2* is present in the DCI format 1\_2 of the PDCCH transmitted on the CORESET. If the PDSCH is scheduled by a DCI format not having the TCI field present, and the time offset between the reception of the DL DCI and the corresponding PDSCH of a serving cell is equal to or greater than a threshold *timeDurationForQCL* if applicable, where the threshold is based on reported UE capability [13, TS 38.306], for determining PDSCH antenna port quasi co-location, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the TCI state or QCL assumption whichever is applied for the CORESET used for the PDCCH transmission within the active BWP of the serving cell.

[unchanged part omitted]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*End of TP\*\*\*\*\*\*\*\*\*\*\*\*\*