3GPP TSG RAN WG1 #101 R1-200xxxx

e-Meeting, May 20th – June 5th, 2020

Source: Moderator (OPPO)

Title: Discussion on Issue#a-2 in Email Thread 2

Agenda Item: 7.2.6.2

Document for: Discussion and Decision

1. Introduction

Rel-16 enhancement on MIMO WID includes objectives of enhancing multi-TRP/Panel transmission with ideal and non-ideal backhaul. During the work of rel-16, designs for multiple-PDCCH based and single-PDCCH based multi-TRP/Panel transmission were discussed and specified. This document provides the discussion for Issue #a-2 in multi-TRP email thread 2:

* Discuss issue #a-2 to align the understanding on whether single-DCI and multi-DCI can be configured on one UE simultaneously and discuss whether or not to introduce restriction on simultaneous configuration of multi-DCI based and single-DCI based M-TRP into RAN1 specification

# Issue#a-2: whether configuring multi-DCI based and single-DCI based M-TRP simultaneously

**Background**:

Companies CATT [4], CMCC [10], OPPO [12], Apple [13] and Ericsson [17] disused the issue of whether multi-DCI based M-TRP and single-DCI based M-TRP can be configured to one UE simultaneously.

* CATT [4] proposed that, when a UE is configured with two different values of CORESETPoolindex, the UE can only be indicated with one TCI state in DCI. [4] proposed corresponding TP.
* CMCC [10] proposed to clarify that single-DCI and multi-DCI based multi-TRP cannot be configured simultaneously and also proposed corresponding TP.
* OPPO [12] proposed that from RAN1 point of view, simultaneous configuration of single-DCI and multi-DCI based M-TRP is not supported and also proposed corresponding TP.
* Apple [13] thinks that simultaneous single-DCI and multi-DCI configuration shall be avoided and they proposed that for multi-TRP operation, the UE is not expected to be configured to operate in single-DCI and multi-DCI operation simultaneously. Corresponding TP is proposed by [13].
* In contrast, Ericsson [17] proposed to conclude that current RAN1 specs allows simultaneous configuration of single-DCI and multi-DCI.

Furthermore, from the comments collected during prep email:

* ZTE: RAN2 has discussed this issue and is waiting for RAN1’s decision.
* HW: we need to a clear conclusion since it leads to very different UE implementation/complexity and NW expectation.
* Nokia commented in FL summary [20] that simultaneous support of both single-DCI and multi-DCI mode is not valid because MAC CE activation for TCI-states are different for single-DCI based multi-TRP and multi-DCI based.
* MediaTek commented that they support that simultaneous configuration of single-DCI and multi-DCI is not supported.
* LG: companies have different understanding on this issue and clarification is critical and needed.
* If the UE supports both schemes, such a restriction may require the network to reconfigure RRC to change the multi-TRP mode.
* SS: UE can report M-DCI or S-DCI capabilities separately and gNB can configure the UE as it prefers. We think there’s no need to add exclusion rule on top of that, either in RAN1 or RAN2 sides.
* CMCC: Agree with FL’s suggestion and we should conclude in this meeting. Support Alt 1. If S-DCI and M-DCI is simultaneously configured, there will be many ambiguous understandings in the current spec, such as the default TCI for PDSCH.
* OPPO: RAN1 discussed this issue and is waiting for RAN1’s decision. Thus, RAN1 should have a clear conclusion
* FUTUREWEI: need clarification for UE support

FL’s assessment:

1. We do have different understanding on whether these two multi-TRP mode in RAN1, thus a clear conclusion to align the understanding is necessary.
2. From the viewpoint of FL, I agree with Nokia’s comments that simultaneous configuration of these two modes are not valid because of the design of MAC CE for PDSCH state activation in TS 38.321:
   1. The MAC CE used for multi-DCI based M-TRP is the MAC CE of Section 6.1.3.14. It has a 1-bit field “CORESET Pool ID” and it only activates one TCI state for each DCI codepoint. So this MAC CE can only be used when only multi-DCI based is configured.
   2. The MAC CE used for single-DCI based M-TRP is the MAC CE of Section. It can activate one or two TCI states for each DCI codepoint. But it does not have the bit field of “CORESET Pool ID”. So, this MAC CE can only be used when only single-DCI based mode is configured.

**Proposal 1: On configuration of multi-TRP transmission, down-select one from the following two alts:**

* **Alt 1: Simultaneous configuration of single-DCI based and multi-DCI based M-TRP is not supported. Update TS 38.214 to clarify that.**
* **Alt 2: No restriction to prevent configuring multi-DCI and single-DCI based M-TRP simultaneously is needed in RAN1 spec TS 38.214. Whether to support single-DCI +multi-DCI mixed mode operation is up to UE capability.**

Please input your views and comments on these two alternatives:

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| Company | Views and comments |
| Apple | We support Alt1.  For Alt2, our understanding is that sDCI and mDCI would be dynamically switched by MAC CE for TCI indication. However, if gNB configures 5 CORESETs by RRC, and uses a MAC CE to enable sDCI mode, UE has to monitor 5 CORESETs even for sDCI mode. This is not aligned with our previous agreement.  In addition, it has been agreed that 2-port PT-RS is only applicable for sDCI mode, which is also included in LS of RRC parameters to RAN2. But if gNB uses a MAC CE to enable mDCI mode, this would result in 2-port PT-RS for mDCI mode. From UE perspective, such can be considered as an incorrect configuration. So to switch to mDCI, gNB still has to use RRC reconfiguration to avoid such kind of incompatible configurations. |
| MediaTek | Support Alt 1. During Rel-16 discussion, most of agreements were reached conditioned on either 1) S-DCI based M-TRP transmission or 2) M-DCI based M-TRP transmission. To our best understanding, we seldom make decision assuming both of them are simultaneously configured. If configuring simultaneously is allowed, a UE has to be ready for any possible combinations, e.g., two DCIs supporting Rel-16 URLLC may be received in the same/different slot, or the case with one S-DCI based eMBB + one S-DCI URLLC. It will take huge effort to identify/conclude which combinations are beneficial. It is also too late to introduce capability signaling for this mixed mode operation, and we believe such a capability signaling is not a simple bit and is controversial. |
| OPPO | Support Alt.1. We agree with Apple and MTK. Two different MAC CEs were separately designed for S-DCI and M-DCI based TRP transmission. UE should know which MAC CE to use based on RRC configuration of S-DCI or M-DCI based, e.g. whether two *CORESETPoolIndex* are configured. It is straightforward that the two schemes are switched via RRC and not simultaneously configured. At least we should make a conclusion in RAN1 as guidance for RAN2 signaling design. |
| ZTE | Alt.1 should be supported.   * MACCE issue for Alt.2: In current 38.321, different MACCE formats are designed for S-DCI and M-DCI. In MACCE for MDCI, CORESET pool index is indicated by one bit. In MACCE for SDCI, one TCI pair may exist for each TCI codepoint and there is no such CORESET pool index. If Alt2 is supported, a new MACCE should be supported. That is, a MACCE including TCI pair also need to carry CORESET pool index. We don’t think MACCE enhancement can be considered in such late state. * PTRS issue for Alt.2 as Apple provided. * Alt.2 doesn’t work in FR2 because UE cannot support four receive beams (two beams for each TRP1). |
| CMCC | Support Alt 1  We also think that simultaneous configuration of S-DCI and M-DCI is not valid by considering the MAC CE issue proposed by Nokia and the PTRS issue proposed by Apple. Besides, when S-DCI and M-DCI are simultaneous configured, the PDSCH default beam is also confused, follow the CORESET beam or follow the two TCI states indicated by MAC CE? Considering the limit time for Rel-16, it is not a good way to support Alt 2 at this time, which may cause more problem for current spec. |

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| CATT | If simultaneous configuration of single-DCI based and multi-DCI based M-TRP is possible, CORESETpoolindex can be configured for the CORESET intended for S-DCI. Therefore, it would be more flexible to network side, as dynamic switching between S-DCI and M-DCI can be supported.  However, the issues listed above should be addressed, if such simultaneous configuration is to be supported.  No matter such configuration is supported or not, in our view, we should preclude the overlapped scheduling with more than 2 TCI states. To be more specific, at least it should be clarified that for a UE configured with CORESETs with different IDs, it does not expect to be scheduled with fully/partially overlapped PDSCH resources by CORESETs with different CORESETpoolindices, if  two TCI states are indicated by any of the DCI in these CORESETs.  So, Alt 1 is preferred. |
| Spreadtrum | Support Alt.1. The benefit of Alt.2 is not clear to us while it will bring more spec workload in such late stage, and require much higher UE capability. |
| vivo | From the scenario perspective, dynamic switching between S-DCI and M-DCI based MTRP is applicable to ideal backhaul scenario. S-DCI based MTRP is surely beneficial for URLLC type of services. While M-DCI based MTRP provides scheduling flexibility in ideal backhaul. For example, two TRPs can independently schedule PDSCHs for the UE to achieve higher throughput, and can activate up to 8 TCI states per TRP which is larger than the S-DCI case. So there is need to support both in ideal backhaul network.  From the signaling perspective, when a UE is configured with two different values of CORESETPoolIndex, for the UE received the MAC CE of Section 6.1.3.14 command and the activated TCI states of the associating MAC CE are valid. When a UE receives a MAC CE of Section 6.1.3.24 with at least one TCI codepoint contains 2 TCI states later on, the MAC CE of Section 6.1.3.14 command would be invalidated and any DCI with TCI indication which is(are) activated by the new MAC CE command can be transmitted from either TRP from RAN2 understanding so that the UE switches to S-DCI-based MTRP.  In our understanding, current specification without further clarification by TS38.214, supporting both S-DCI and M-DCI based MTRP simultaneously is not supported but dynamic switching between the two is supported.  In summary, our preference is:  **Alt 3: No update in TS 38.214, which means dynamic switching between S-DCI and M-DCI based MTRP is supported.** |
| QC | Support Alt1. If there are valid use cases for simultaneous operation of s-DCI and m-DCI, it can be further studied in Rel. 17. There can be many different combinations when different schemes of s-DCI as well as non/partial/full-overlapping of m-DCI are considered. There is no time in Rel. 16 to start this big scoping effort.  As for dynamic switching between s-DCI and m-DCI (regarding Vivo’s comment above), note that the MAC-CE in 6.1.3.24 cannot suddenly switch m-DCI to s-DCI mode. What happens to HARQ-Ack (both separate and joint) as CORESETPoolIndex determines the procedures? How about PDSCH scrambling or CRS rate matching? What about BD/CCE limits? Are all of these operations supposed to go back to s-DCI mode once the MAC-CE in 6.1.3.24 is received? |
| Ericsson | We cannot agree to introducing any scheduling restriction to 38.214 as proposed in Alt-1. We support a modified version of Alt 2 which is given below:  **Modified Alt 2: ~~No restriction to prevent~~ cConfiguring multi-DCI and single-DCI based M-TRP simultaneously is possible ~~needed~~ in RAN1 spec TS 38.214. ~~Whether to support single-DCI +multi-DCI mixed mode operation is up to UE capability.~~**  Note that the RAN2 conclusion basically means that RAN2 signaling design are not final and they are waiting for RAN1 understanding on whether simultaneous configuration of single-DCI based and multi-DCI based MTRP is possible in RAN1 specs or not.  *“From RAN2 point of view it's unclear whether simultaneous configuration of single-DCI based and multi-DCI based M-TRP is supported. We wait for RAN1 decision before working on this.”*  In our view, simultaneous configuration of S-DCI and M-DCI based MTRP is allowed according to TS 38.214. This is also acknowledged by the proponents of Alt 1 in their contributions (e.g., see R1-2004229 and R1-2004047). So it is sufficient to conclude that simultaneous configuration of S-DCI and M-DCI is supported as per current version of 38.214.  As per UE capability signaling, we do not think new capability signaling needs to be added. We already have sufficiently flexible UE capability reporting in which a UE can report whether it supports M-DCI (and which flavor of M-DCI among fully/partially/non-overlapping) and only S-DCI (and which URLLC scheme the UE supports). If a UE is not capable of S-DCI and M-DCI simultaneously, the UE can indicate this with existing capability.  As for the use case, supporting single-PDCCH + multi-PDCCH mixed mode multi-TRP operation can be beneficial when the UE is served with mixed URLLC + eMBB traffic. For example, one PDSCH can be used to schedule eMBB traffic from one of the CORESET pools while from the other CORESET pool PDSCH(s) can be used to schedule URLLC traffic via using one of the URLLC schemes.  Given this use case, we cannot agree on the restriction proposed in Alt 1. Our interpretation of Alt 2 and Alt3 (proposed by Vivo) are that these two Alts do not require any spec change. It is already clear from different company responses that achieving consensus on introducing the restriction proposed in Alt 1 is highly unlikely. In this even, the conclusion to this issue should be based on an alternative that doesn’t not require any specification change to 38.214. We think it is sufficient to conclude the following:  **Modified Alt 2: ~~No restriction to prevent~~ cConfiguring multi-DCI and single-DCI based M-TRP simultaneously is possible ~~needed~~ in RAN1 spec TS 38.214. ~~Whether to support single-DCI +multi-DCI mixed mode operation is up to UE capability.~~** |
| Huawei | Support Alt1. In general at this stage we shall avoid potential complexity by mixing multiple functionalities/schemes which may lead to more issues of RAN1/RAN2 clarification and UE implementation. For singe-DCI or multi-DCI based solutions, one of them can be sufficient to the NW without dynamic switching between them.  Also we don’t think that we will need more RAN1 specification changes for above RAN2 restriction. A simple RAN1 conclusion can be sufficient and RAN2 can take into account, if need, if RAN1 conclusion can be made. So far UE cap design for M-TRP is pretty much per scheme already. |
| Nokia | As FL already highlighted, **simultaneous support of s-DCI and m-DCI multi-TRP modes are not possible due to different MAC-CE commands**. Not sure why we discuss this issue more.  If our discussion is more focused on RRC configurations, we do not see any strong need of limiting the RRC configurations. It is hard to see the justifications on Alt.1. Alt.1 would lead to RRC reconfiguration when switching between modes for a UE supporting both s-DCI and m-DCI multi-TRP modes. Also, original Alt.2, it is not clear why this Alt.2 needs a mixed operation as a UE capability. There is already UE capabilities capturing different Schemes, and we do not have to talk about anything more given that we do not have the time to enhance any other simultaneous operations. We think E/// suggestion is good enough. Basically, that means we do not agree on anything on restricting the configurations as there is no strong reason to do that.  **Modified Alt 2: ~~No restriction to prevent~~ cConfiguring multi-DCI and single-DCI based M-TRP simultaneously is possible ~~needed~~ in RAN1 spec TS 38.214. ~~Whether to support single-DCI +multi-DCI mixed mode operation is up to UE capability.~~** |
| LG | Support Alt 1.  Firstly, we need to clarify whether Alt 2 means simultaneous operation of M-DCI and S-DCI MTRP or dynamic switching between the two. If it is simultaneous operation, it needs a huge impact on UE implementation and spec effort since UE should be able to receive PDSCHs from 3 or 4 TRP transmission simultaneously, which may be considered as further enhancement in further release. Even if Alt 2 means dynamic switching, it is not easy to address in CR phase. Just MAC-CE overriding commented by VIVO does not solve the remaining issues. As commented by QC, it has an impact on a whole package for M-DCI configurations such as A/N, CRS RM, scrambling and so on. |
| Samsung | Share the similar view with Ericsson and Nokia.  Support modified Alt 2 from Ericsson.  We believe that we need to focus on fixing critical error in this maintenance phase rather than imposing a new restriction. However, in our understanding, Alt1 is just to specify that some sorts of misconfigurations are not allowed, which should be able to avoided by gNB implementation. Note that according to the number of agreed rows for UE capability signaling on mTRP supports, we already have enough level of details for the gNB implementation to handle any misconfigurations. Rather, Alt1 blocks one of the possible scenarios, e.g. TDMed supports of mDCI for eMBB and sDCI for URLLC. Given that Alt.1 does not simplify UE implementations but restricts possible gNB operations only, we cannot support Alt.1.  Frankly speaking, we do not see any motivation for new agreements on this issue. The current specification is well aligned with the modified Alt.2 from Ericsson already and there is no ambiguity from both gNB and UE sides. No further discussions are needed. |
| NTT DOCOMO | Support Alt.1.  Agree with MTK that Rel.16 discussion is conditioned on either single PDCCH based MTRP or multiple PDCCH based MTRP, we seldom make any decision on simultaneous configuration of single PDCCH and multiple PDCCH based MTRP. In order to support simultaneous configuration, we need to do a lot of rechecking work. As pointed by many companies, current spec. cannot be directly extended to support simultaneous configuration of S-DCI and M-DCI. In addition, another unclear aspect is about the default TCI states. Current spec. only defines default TCI states for either single DCI or multi-DCI. If simultaneous configuration is allowed, clarification on default TCI states is needed. Considering the potential spec impact, it is too late to introduce such operation at this stage. |
| Intel | Our understanding is that even though RAN2 has different MAC CE commands, it does allow simultaneous support of s-DCI and m-DCI under certain situations. An example is when only s-DCI MAC-CE is indicated and no MAC-CE is necessary for m-DCI (2 active states configured by RRC). Modified Alt-2 from Ericsson is okay. |
| vivo1 | Response to QC and LGE:  First of all, in our understanding based on current spec, when a UE is configured two different values of CORESETPoolIndex and receives the MAC CE in 6.1.3.24 with at least one TCI codepoint mapping to 2 TCI states,  1. What happens to HARQ-Ack (both separate and joint) as CORESETPoolIndex determines the procedures?  A: same as M-DCI based MTRP procedure even if a UE is scheduled with any S-DCI based MTRP scheme. We can’t see any problem now as HARQ-ACK feedback for any S-DCI based MTRP scheme is specified in the procedure of S-DCI based scheduling per TRP.  2. How about PDSCH scrambling or CRS rate matching?  A: as TS 38.211 states:  - the higher-layer parameter *dataScramblingIdentityPDSCH* if the codeword is scheduled using a CORESET with *CORESETPoolIndex* equal to 0;  - the higher-layer parameter *AdditionaldataScramblingIdentityPDSCH* if the codeword is scheduled using a CORESET with *CORESETPoolIndex* equal to 1;  Meanwhile, we also agreed that the CRS rate matching rule when two CORESETPoolIndex are configured. Therefore, we think it is clear that the PDSCH scrambling and CRS rate matching depends on the CORESETPoolIndex to which scheduling PDCCH carried in the CORESET is associated.  3. What about BD/CCE limits?  A: The limits of M-DCI based MTRP are applied as there are two CORESETPoolIndex configured.  We tend to agree with E///, Nokia and Samsung but with some restrictions on scheduling to prevent scheduling of overlapping between a PDSCH of S-DCI MTRP scheme and another PDSCH of any other schemes.  **Updated Modified Alt 2: ~~No restriction to prevent~~ cConfiguring multi-DCI and single-DCI based M-TRP simultaneously is possible ~~needed~~ in RAN1 spec TS 38.214. ~~Whether to support single-DCI +multi-DCI mixed mode operation is up to UE capability.~~**   * A UE does not expect to receive overlapping PDSCH of scheme 1a/2a/2b/3/4 with any other PDSCH. |

1. Reference
2. R1-2003397 On remaining issues on M-TRP vivo
3. R1-2003469 Maintenance of multi-TRP enhancements ZTE
4. R1-2003531 Remaining issues on multi-TRP in R16 Huawei, HiSilicon
5. R1-2003627 Discussion on remaining issues of multi-TRP/panel transmission CATT
6. R1-2003660 Remaining issues on multi-TRP transmission MediaTek Inc.
7. R1-2003742 Corrections to multi-TRP Intel Corporation
8. R1-2003819 Remaining issues on multi-TRP/panel transmission Lenovo, Motorola Mobility
9. R1-2003881 On Rel.16 multi-TRP/panel transmission Samsung
10. R1-2003928 Text proposals on enhancements on multi-TRP/panel transmission LG Electronics
11. R1-2003954 Remaining issues on multi-TRP/panel transmission CMCC
12. R1-2003987 Discussion on remaining issues of multi-TRP operation Spreadtrum Communications
13. R1-2004047 Text proposals for enhancements on multi-TRP and panel Transmission OPPO
14. R1-2004229 Remaining issues for Multi-TRP enhancement Apple
15. R1-2004265 Maintenance of Rel-16 Multi-TRP operation Nokia, Nokia Shanghai Bell
16. R1-2004311 Remaining issues on multi-TRP transmission NEC
17. R1-2004395 Remaining issues on multi-TRP/panel transmission NTT DOCOMO, INC
18. R1-2004432 Remaining issues on Multi-TRP/Panel Transmission Ericsson
19. R1-2004463 Multi-TRP Enhancements Qualcomm Incorporated
20. R1-2004592 Clarification on Multi-TRP URLLC Scheme 4 Convida Wireless
21. R1-2004719 FL summary #2 for Multi-TRP/Panel Transmission Moderator(OPPO)