3GPP TSG-RAN WG2 #109-e R2-2001879

Electronic meeting, 24 February – 6 March 2020

Agenda Item: 7.1.7

Source: Qualcomm (Offline rapporteur)

Title: Report of [AT109e][414][eMTC] MPDCCH performance imp: Open issues

Document for: Discussion, Decision

# Introduction

This document is the report of following offline discussion:

* [AT109e][414][eMTC] MPDCH performance imp: Open issues (Qualcomm)

Scope: Further discussion on proposals 1 and 2 and identify potential agreements

Intended outcome: Report with a list of proposals categorized as agreeable, need further discussion, postpone. The outcome can be provided in R2-2001879

Deadline: Tuesday, Mar 3rd 17:00 CET

# Background

[6] explains the background of the issue which is summarized here. The Rel-16 work item (WI) on “Additional MTC enhancements for LTE” [1] has the following objective:

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| **Improved DL transmission efficiency and/or UE power consumption:**   * […] * Specify MPDCCH performance improvement by using CRS [RAN1, RAN2, RAN4] * […] |

RAN1 started the discussion on this objective in RAN1#94 and in subsequent meetings until RAN1#99 reached the following agreements relevant to RAN2 for this discussion [2]:

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| **Agreement**  For distributed MPDCCH, mapping between CRS and DMRS is defined in specifications.   * FFS the details (e.g. number of PRBs over which mapping applies, fixed or configurable)   **Agreement**  Power offset between CRS and DMRS antenna ports of MPDCCH is signaled by eNB. FFS the signaling details (e.g. provisioning for default power offset value).  **Agreement**  For UE in Connected/Idle mode, the power offset between CRS and DMRS antenna ports of MPDCCH is indicated by SIB.  **Agreement**   * For UE in Idle mode, the configuration of CRS for MPDCCH performance improvement is indicated via SIB/SI. FFS the details of configuration. * For UE in Connected mode, the configuration of CRS for MPDCCH performance improvement is indicated via UE-specific RRC signalling. FFS the details of configuration.   **Agreement** [36.213, 36.331]  The higher layer parameter mpdcch-crs-power-ratio can be configured to values in the set {-4.77, -3, -1.77, 0, 1, 2, 3, 4.77} dB.  **Agreement (RRC impact)** [36.211, 36.213, 36.331]  For TDD operation, enable closed loop operation with reciprocity-based beamforming:   * The close loop candidates do not have an association with CRS ports. * A separate RRC signalling is introduced to enable this feature |

RAN2#103bis started the discussion on the feature from RAN2 point of view which continued also in RAN2#104 and RAN2#106 and reached the following agreements relevant to this discussion [3]:

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| RAN2#103bis agreements:   * eNB enables CRS for improving channel estimation on MPDCCH via broadcasted RRC signalling.   RAN2#104 agreements:   * CRS for improving channel estimation on MPDCCH is configured via SIB2. This agreement can be revisited if RAN2 identifies that it would be more reasonable to configure it via SIB1-BR. It is FFS whether configuration would implicitly mean to enable the feature.   RAN2#106 agreements:   * No need to introduce a separate indication to enable the feature. Configuration of CRS for MPDCCH performance improvement enables the feature implicitly for UEs in Idle mode.   RAN2#107bis agreements:   * UE shall consider the feature disabled in idle mode when configuration in idle mode is not broadcasted.   RAN2#108 agreements:   * If a dedicated configuration is not provided, the UE uses the broadcasted configuration. |

This offline discussion is aimed at discussing signalling details based on RAN1 progress and agreements focusing on the interpretation of the various parameters in IDLE and CONNECTED mode.

# Discussion

This feature aims both idle and connected mode so that UEs can use CRS for improved MPDCCH channel estimation both when they are in connected mode and for example while monitoring paging and during the RA procedure prior to entering the connected mode.

## Current running CR

In the running CR for TS 36.331, a new IE (*CRS-ChEstMPDCCH-Config*) in *RadioResourceConfigDedicated* and *SystemInformationBlockType2-BR* has been introduced [4]. The current text from the CR is shown below.

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| --- | --- | --- | --- |
| – *CRS-ChEstMPDCCH-Config* The IE *CRS-ChEstMPDCCH-Config* is used to configure and enable use of CRS for MPDCCH performance improvement, see TS 36.211 [21], clause 6.8B.5 and TS 36.213 [23], clause 9.1.5.  *CRS-ChEstMPDCCH-Config* information elements  -- ASN1START  CRS-ChEstMPDCCH-Config-r16 ::= SEQUENCE {  powerRatio-r16 ENUMERATED {dB-4dot77, dB-3, dB-1dot77, dB0, dB1, dB2, dB3, dB4dot77} OPTIONAL, -- Need ON  -- Editor’s Note: the field below should apply only in CONNECTED mode only for localized MPDCCH. (In IDLE mode, MPDCCH is distributed.) TBD whether the following field should be included in SIB, and if not, how to provide it to UE when dedicated signalling is absent.  localizedMappingType-r16 ENUMERATED {predefined, csi-based, reciprocityBased} DEFAULT predefined  }  -- ASN1STOP   | *CRS-ChEstMPDCCH-Config* field descriptions | | --- | | ***powerRatio***  Power ratio in dB between DMRS and CRS antenna ports of MPDCCH, see TS 36.213 [23], clause 5.2. Value dB-4dot77 corresponds to -4.77 dB, value dB-3 corresponds to -3 dB and so on. | | ***localizedMappingType***  DMRS mapping type for MPDCCH performance improvement with localized MPDCCH allocation for CE mode A/B in RRC\_CONNECTED, see TS 36.213 [23], clause 9.1.5. Value *predefined* corresponds to predefined mapping, value *csi-based* corresponds to CSI-based mapping, and value *reciprocityBased* corresponds to reciprocity based mapping. Reciprocity based mapping is only applicable for TDD. | |

The L1 parameter list [5] contains the following parameters for this feature. (for simplicity in discussion, first column is added by offline discussion rapporteur)

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| --- | --- | --- | --- | --- |
| #1 | mpdcch-crs-idle-config | New | MPDCCH DMRS/CRS based demodulation is enabled in RRC\_IDLE | If enabled, MPDCCH performance improvement can be achieved by using CRS (beside DMRS) for CE mode A/B in RRC\_IDLE. |
| #2 | mpdcch-crs-power-ratio | New | MPDCCH DMRS/CRS power ratio | DMRS-to-CRS power ratio in dB for MPDCCH performance improvement for CE mode A/B in RRC\_IDLE and RRC\_CONNECTED. |
| #3 | mpdcch-crs-connected-config | New | MPDCCH DMRS/CRS based demodulation is enabled in RRC\_CONNECTED | If enabled, MPDCCH performance improvement can be achieved by using CRS (beside DMRS) for CE mode A/B in RRC\_CONNECTED. |
| #4 | mpdcch-crs-~~connected~~localized-mapping-type | New | MPDCCH ~~DMRS/CRS~~localized mapping type in RRC\_CONNECTED | DMRS mapping type for MPDCCH performance improvement with localized MPDCCH allocation for CE mode A/B in RRC\_CONNECTED. If CSI-based mapping type is selected then the DMRS/CRS combining is based on CSI feedback, ~~otherwise~~and if Predefined mapping type is selected then a predefined cycling is used. |

#1 and #3 do not need to be explicitly added, as already agreed by RAN2. There are some parameters which remain to be captured fully in the running CR.

Following observations can be made based on the above description:

1. Power ratio is applicable in both RRC\_IDLE and in RRC\_CONNECTED.
2. CRS localized mapping type is applicable only in RRC\_CONNECTED and is UE specific.

## Power ratio

RAN1 parameter list indicates power ratio is “cell-specific”. Based on that, [6] argues “the *mpddch-crs*-*power-ratio* is configured only through SIB2 both for idle and connected mode, and is a cell-specific parameter”. However, it is not clear with such proposal how the signalling works when the feature is to be disabled in IDLE, but only enabled in CONNECTED (see observation 1 above in light of RAN2 agreement “UE shall consider the feature disabled in idle mode when configuration in idle mode is not broadcasted.”).

**Question 1: What is companies views on whether power ratio should be possible to be signalled in dedicated signalling?**

Option 1: power ratio is possible to be included only in SIB2. Not included in dedicated signalling. If not broadcasted in SIB2, power ratio does not apply in CONNECTED mode.

Option 2: power ratio can be included in dedicated signalling (in addition to SIB2).

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| **Company** | **Option** | **Explain** |
| Qualcomm | Option 2 | If it is not possible to include power ratio in dedicated, then to configure this value, idle configuration shall always be present, which means feature in idle mode cannot be turned off. |
| Huawei, HiSilicon | Option 2 | It’s simpler to include in dedicated signalling and we can avoid uneccessary restrictions and special handing. |
| Ericsson | Option 2 | Opt 2 is OK to us. Likely the same parameter would be signalled in dedicated configuration however and there doesn't seem to be reason to enable the feature in connecte but not in idle mode. |

1. Power ratio can be included in dedicated signalling (in addition to SIB2).

## Localized mapping type

It is clear that localized mapping type is applicable only in RRC\_CONNECTED and is UE specific. However, what is not clear is whether this should be possible to be included in SIB. Given that this is only applicable to CONNECTED, it does not seem much beneficial to include in SIB. On the other hand, if it cannot be included, how to provide it to UE when dedicated signalling is absent (recall RAN2 agreement “If a dedicated configuration is not provided, the UE uses the broadcasted configuration).

**Question 2: What is companies views on whether localized mapping type should be possible to be signalled in SIB2?**

Option 1: localized mapping type can be included in SIB2 (in addition to dedicated). The value does not apply in IDLE but in case SIB signals the value but dedicated does not, the value applies in CONNECTED mode.

Option 2: localized mapping type is possible to be included only in dedicated signalling. If not included in dedicated but feature is enabled (due to presence of *CRS-ChEstMPDCCH-Config* in broadcast), is a DEFAULT value needed?

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| **Company** | **Option** | **Explain** |
| Qualcomm | Option 2 | This value is never used in IDLE. To cover the case of what if the feature is enabled based on broadcast signalling, but dedicated is not provided, a default is needed. The default should be „predefined“. |
| Huawei, HiSilicon | Option 2 | This could be achieved with a common IE containing all necessary fields, with a conditional statement to say it is not present in SIB2. |
| Ericsson | Option 2 | Default can be "predefined". |

1. Localized mapping type is possible to be included only in dedicated signalling. Value “predefined” is DEFAULT.

## Enable in IDLE, disable in CONNECTED

Another aspect that is not clear in the current running CR is how to signal such that the feature is enabled in IDLE but disabled in CONNECTED? According to current running CR, it is not possible, because if the Broadcast is included but dedicated is not, then the broadcast applies.

**Question 3: Should it be possible to enable the feature for IDLE mode UEs but disable in CONNECTED mode?**

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| **Company** | **Yes/No** | **Explain** |
| Qualcomm | Yes | This means there needs to be method to setup/release dedicated config for handling the case when broadcast is also signalled. |
| Huawei, HiSilicon | Yes | This is not a specific use case that we think must be supported, just a consequence of the simpler signalling approach. There is no real problem if we allow it even if it is not used in practise. |
| Ericsson | Yes | OK, although doesn't seem to be specific use case as commented by HW really. |

1. It should be possible to enable the feature for IDLE mode UEs but disable in CONNECTED mode.

## Text proposal

Based on your answers above, please provide your TP below, taking the current CR text as baseline. (I.e., please try to not mark current CR text as new text. Only your changes should be marked.)

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| **Company** | **TP and comments/explanation** |
| Qualcomm  (TP1) | Based on the above explanation, we think the following should be adopted in the running CR.  RadioResourceConfigCommonSIB ::= SEQUENCE {  <<skip>>  [[ crs-ChEstMPDCCH-ConfigCommon-r16 CRS-ChEstMPDCCH-ConfigCommon-r16 OPTIONAL, -- Need OR  wus-Config-v16xy WUS-Config-v16xy OPTIONAL -- Need OR  ]]  }   | *RadioResourceConfigCommon* field descriptions | | | --- | --- | | ***crs-ChEstMPDCCH-ConfigCommon***  Presence of this field indicates use of CRS for improving channel estimation on MPDCCH is enabled in RRC\_IDLE and RRC\_CONNECTED mode for UEs indicating support of *ce-CRS-ChannelEstMPDCCH*. |   RadioResourceConfigDedicated ::= SEQUENCE {  <<skip>>  [[ crs-ChEstMPDCCH-ConfigDedicated-r16 CRS-ChEstMPDCCH-ConfigDedicated-r16 OPTIONAL -- Need OP  ]]  }   | *RadioResourceConfigDedicated* field descriptions | | | --- | --- | | ***crs-ChEstMPDCCH-ConfigDedicated***  Presence of this field indicates use of CRS for improving channel estimation on MPDCCH is enabled in RRC\_CONNECTED mode for UEs indicating support of *ce-CRS-ChannelEstMPDCCH*. If this field is absent, the field *crs-ChEstMPDCCH-ConfigCommon* in *SystemInformationBlockType2* applies, if present. |  – *CRS-ChEstMPDCCH-Config* The IE *CRS-ChEstMPDCCH-Config* is used to configure and enable use of CRS for MPDCCH performance improvement, see TS 36.211 [21], clause 6.8B.5 and TS 36.213 [23], clause 9.1.5.  *CRS-ChEstMPDCCH-Config* information elements  -- ASN1START  CRS-ChEstMPDCCH-ConfigCommon-r16 ::= SEQUENCE {  powerRatio-r16 ENUMERATED {dB-4dot77, dB-3, dB-1dot77, dB0, dB1, dB2, dB3, dB4dot77}  }  CRS-ChEstMPDCCH-ConfigDedicated-r16 ::= CHOICE {  release NULL,  setup SEQUENCE {  powerRatio-r16 ENUMERATED {dB-4dot77, dB-3, dB-1dot77, dB0, dB1, dB2, dB3, dB4dot77} OPTIONAL, -- Cond setup  localizedMappingType-r16 ENUMERATED {predefined, csi-based, reciprocityBased} DEFAULT predefined  }  -- ASN1STOP   | *CRS-ChEstMPDCCH-Config* field descriptions | | --- | | ***powerRatio***  Power ratio in dB between DMRS and CRS antenna ports of MPDCCH, see TS 36.213 [23], clause 5.2. Value dB-4dot77 corresponds to -4.77 dB, value dB-3 corresponds to -3 dB and so on. | | ***localizedMappingType***  DMRS mapping type for MPDCCH performance improvement with localized MPDCCH allocation for CE mode A/B in RRC\_CONNECTED, see TS 36.213 [23], clause 9.1.5. Value *predefined* corresponds to predefined mapping, value *csi-based* corresponds to CSI-based mapping, and value *reciprocityBased* corresponds to reciprocity based mapping. Reciprocity based mapping is only applicable for TDD. |  | Conditional presence | Explanation | | --- | --- | | setup | The field is mandatory present if *CRS-ChEstMPDCCH-ConfigDedicated* is set to *setup* and this field has not been configured in *CRS-ChEstMPDCCH-ConfigCommon*; otherwise the field is optional, need ON. | |
| Huawei, HiSilicon  (TP2) | QC TP is OK. It can be made even simpler by keeping the common IE, making both sub-IEs OPTIONAL and specifying the conditions under which they are included (similar conditional presence is used in many other places). Top level IE is need OR. This way we do not need to have the maintaining of SI signalled value to RRC Connected, simply if top level IE is not received, then the configuration is released.  CRS-ChEstMPDCCH-Config-r16 ::= SEQUENCE {  powerRatio-r16 ENUMERATED {dB-4dot77, dB-3, dB-1dot77, dB0, dB1, dB2, dB3, dB4dot77} OPTIONAL, -- Need OR  localizedMappingType-r16 ENUMERATED {predefined, csi-based, reciprocityBased} OPTIONAL -- Cond dedicated  }   | Conditional presence | Explanation | | --- | --- | | dedicated | The field is mandatory present in dedicated signalling, otherwise the field is absent | |
| Ericsson | Either suggestion on TP seems to work, with HW suggestion would it mean powerRatio would always need to be present in dedicated configuration though? |

Summary, two companies provided TP. Regarding condensed proposed text TP2, localizedMappingType field needs to be marked as absent in SIB although it is never useful. powerRatio needs to be always included in dedicated. Further, there seems to be no existing instance of similar conditional presence (i.e., same field always absent in SIB but mandatory in dedicated.)

All companies agree the TP1 provided by RRC running CR rapporteur is ok.

1. TP1 (with separate IEs CRS-ChEstMPDCCH-ConfigCommon-r16 and CRS-ChEstMPDCCH-ConfigDedicated-r16) is baseline for running CR.

# 3 Conclusion

Based on the discussion in the previous sections following is proposed:

**Proposal 1 Power ratio can be included in dedicated signalling (in addition to SIB2).**

**Proposal 2 Localized mapping type is possible to be included only in dedicated signalling. Value “predefined” is DEFAULT.**

**Proposal 3 It should be possible to enable the feature for IDLE mode UEs but disable in CONNECTED mode.**

**Proposal 4 TP1 (with separate IEs CRS-ChEstMPDCCH-ConfigCommon-r16 and CRS-ChEstMPDCCH-ConfigDedicated-r16) is baseline for running CR.**

# 4 References

1. [RP-192875](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_86/Docs/RP-192875.zip" \o "http://www.3gpp.org/ftp/tsg_ran/tsg_ran/tsgr_86/docs/rp-192875.zip" \t "_blank), “Revised WID: Additional MTC enhancements for LTE”, Ericsson, RAN#86, Sitges, Spain, December 2019

1. [R1-1913594](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_99/Docs/R1-1913594.zip), RAN1 agreements for Rel-16 Additional MTC Enhancements for LTE, Reno, USA, November 2019

1. [R2-1916424](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_108/Docs/R2-1916424.zip), RAN2 agreements for Rel-16 additional enhancements for NB-IoT and MTC, Reno, USA, November 2019
2. R2-2000433, eMTC RRC running CR, Qualcomm

1. [R1-1913673](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_99/Docs/R1-1913673.zip), Updated consolidated parameter list for Rel-16 LTE, Reno, Nevada, US, 18 – 22 November 2019
2. R2-2000978, Stage-3 details for MPDCCH performance improvement, Ericsson, RAN2#109e, February 2020