**3GPP TSG-RAN WG2 Meeting #113bis-eR2-210xxxx**

**Electronic, 12th - 20th April, 2021**

Agenda Item: 8.1.x

Source: Huawei

**Title: (Report of) [Post113-e][053][MBS17] MCCH scheduling and MCCH change notification (Huawei)**

Document for: Discussion and decision

# Introduction

This document is intended for gathering input for the following email discussion:

* [Post113-e][053][MBS17] MCCH scheduling and MCCH change notification (Huawei)

Scope: Address: 1) how MCCH is transmitted in NR. 2) Options for MCCH change notification, including identification of potential R1 impacts.

Intended outcome: Report

Deadline: Long

In RAN2#113e, based on the discussion in [1], it was agreed to use MCCH based solution for the configuration for Delivery mode 2:

Agreements

* The two-step based approach (i.e. BCCH and MCCH) as adopted by LTE SC-PTM is reused for the transmission of PTM configuration for NR MBS delivery mode 2.
* Assume it is possible to reuse LTE SC-PTM mechanism for the CONNECTED UEs to receive the PTM configuration for NR MBS delivery mode 2, i.e. broadcast based manner.
* Assume that MCCH change notification mechanism is used to notify the changes of MCCH configuration due to session start for delivery mode 2 of NR MBS (other cases FFS, if any).

In RAN1-103e and RAN1-104e, some agreements regarding the CFR (common frequency resource) for group-common PDCCH/PDSCH are extracted as below:

 Agreements**:** For RRC\_IDLE/RRC\_INACTIVE UEs, CSS is supported for group-common PDCCH.

* FFS: reuse current CSS type, define a new CSS type, etc.
* FFS other details.

Agreements: For RRC\_IDLE/RRC\_INACTIVE UEs, define/configure common frequency resource(s) for group-common PDCCH/PDSCH.

* the UE may assume the initial BWP as the default common frequency resource for group-common PDCCH/PDSCH, if a specific common frequency resource is not configured.
* FFS: the relation of the common frequency resource(s) (if configured) and initial BWP.
* FFS: whether to configure one/more common frequency resources
* FFS: configuration and definition details of the common frequency resource

Agreements**:** For RRC\_IDLE/RRC\_INACTIVE UEs, CSS is supported for group-common PDCCH.

* FFS: reuse current CSS type, define a new CSS type, etc.
* FFS other details.

Agreements: For RRC\_IDLE/RRC\_INACTIVE UEs, a CORESET can be configured within the common frequency resource for group-common PDCCH/PDSCH. CORESET0 is used by default if the common frequency resource for group-common PDCCH/PDSCH is the initial BWP and the CORESET is not configured.

* FFS: configuration details of the CORESET for group-common PDCCH/PDSCH

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, the UE may assume that group-common PDCCH/PDSCH is QCL’d with SSB.

* It is up to UE implementation whether UE monitors monitoring occasions corresponding to all SSB indexes or monitoring occasions corresponding to a subset of all SSB indexes.
* FFS: association rules between SSB indexes and UE monitoring occasions.
* FFS: group-common PDCCH/PDSCH is QCl’d with TRS if configured

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, further study the following cases of a configured/defined specific common frequency resource (CFR) for group-common PDCCH/PDSCH, and identify which case(s) will be supported:

* [Case E] the case where a CFR is defined based on a configured BWP.
  + In particular, study the following:
    - whether a configured BWP for MBS is needed or not.
    - whether BWP switching is needed or not.
  + In this study, the configured BWP has the following properties:
    - The configured BWP is different than the initial BWP where the frequency resources of this initial BWP are configured smaller than the full carrier bandwidth.
    - The CFR has the frequency resources identical to the configured BWP.
    - The configured BWP needs to fully contain the initial BWP in frequency domain and has the same SCS and CP as the initial BWP.
  + Note: The configured BWP is not larger than the carrier bandwidth
* the case where the initial BWP fully contains the CFR in the frequency domain.
  + In this study the following sub-cases are considered:
    - [Case B] A CFR with smaller size than the initial BWP, where the initial BWP has the same frequency resources as CORESET0. In this case the CFR has the frequency resources confined within the initial BWP and have the same SCS and CP as the initial BWP.
    - [Case D] A CFR with smaller size than the initial BWP, where the initial BWP has the frequency resources configured by SIB1. In this case the CFR has the frequency resources confined within the initial BWP and have the same SCS and CP as the initial BWP.
  + In particular, study the following:
    - Whether the considered two options with a CFR with smaller size than the initial BWP are needed or not for MBS.
* the case where the initial BWP has same size as the CFR in the frequency domain.
  + In this study the following two sub-cases are considered:
    - [Case A] A CFR with the same size as the initial BWP, where the initial BWP has the same frequency resources as CORESET0. In this case the CFR has the same frequency resources and same SCS and CP as the initial BWP.
    - [Case C] A CFR with same size as the initial BWP, where the initial BWP has the frequency resources configured by SIB1. In this case the CFR has the same frequency resources and same SCS and CP as the initial BWP.
  + In particular, study the following:
    - Whether the considered two options with a CFR with the same size as the initial BWP are needed or not for MBS.

This email discussion aims to discuss the MCCH scheduling and change notification for MCCH based on the LTE baseline design and the RAN1 progress.

# MCCH transmission and configuration

## 2.1 MCCH transmission window

MCCH Repetition Period

Duration

sc-mcch-Offset

（SFN boundary）

Figure x SC-MCCH transmission window

sc-mcch-FirstSubframe

MCCH Modification Period

SFNx

In LTE SC-PTM, the following parameters are provided by the network in SIB20 to indicate the time window in which SC-MCCH can be scheduled:

* SC-MCCH repetition period (sc-mcch-RepetitionPeriod),
* radio frame offset (sc-mcch-Offset),
* the first subframe in the radio frame for MCCH scheduling (sc-mcch-FirstSubframe)
* duration (sc-mcch-duration).

In RAN2#113e, it was agreed LTE SC-PTM is used as a baseline for transmission of MCCH and BCCH, but the detailed configuraiton parameters were not yet discussed.

It is proposed that RAN2 first confirms whether a similar SC-MCCH transmission window mechanism, as recalled above, can be reused for NR MCCH. i.e. the NR MCCH transmission window is defined by a starting slot and a duration (e.g. expressed in the number of slots).

### **Question 1**

Do you agree that that the MCCH transmission window should be defined for MCCH?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| QC | Yes |  |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Nokia | Yes (duration, repetition period), Yes for possibility to signal offset (but maybe just one parameter) | UE needs to be told where to look for MCCH thus we consider that repetition period and duration (if agreed) are needed at minimum.  Then we consider that it would be good to be possible to schedule MCCH not “colliding” in time with BCCH to not congest some specific subframes. Thus some sort of offset would be good to have. How to configure that can be discussed further but most clear solution would be to have explicit signaling for those parameters e.g. just one parameter indicating slot offset or then slot+frame signaling. No strong opinion on which way to go and this is not that urgent to decide anyway. |
| Kyocera | Yes |  |
| Samsung | Yes |  |
| NEC | Yes |  |
| Spreadtrum | Yes |  |
| vivo | Yes | This is similar to the NR SI window mechanism. |
| TD Tech & Chengdu TD Tech | Yes with some comments | We think it’s better to use the transmission period to define each transmission window of MCCH in NR due to the following reasons.  The repettion period for SC-MCCH in LTE has the two meanings: (1) SC-MCCH is transmitted in each repettion period (2) Within each modification period, SC-MCCH in each repetition period has the same content.  In NR, MCCH can be transmitted preirodically. But whether or not the different MBS service types can have the different repettion periods and the different modification periods need to be discussed. Therefore, the transmission period for defining the MCCH transmission window in NR is better because reusing of the repetition period for MCCH in NR may lead to the misunderstanding that the discussion on the different repetition periods and different modification periods for the different MBS service types is ruled out. |
| Huawei, HiSilicon | Yes |  |

Regarding how to configure the MCCH transmission window, RAN2 needs to confirm whether the similar parameters as defined for LTE SC-PTM can be reused. Note that, in NR, slot is used instead of subframe, so this has to be considered when discussing the definitions of the parameters.

### **Question 2**

Do you agree to confirm that that the following parameters can be configured in the MBS SIB to determine the transmission window in which SC-MCCH is scheduled:

* MCCH repetition period
* radio frame offset
* the first slot in the radio frame where MCCH can be scheduled
* duration during which MCCH can be scheduled (e.g. expressed in the number of slots)

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Not all | In NR broadcast MBS, only MCCH repetition period and radio frame offset can be used for define the radio frame where the MCCH is shceduled as LTE defined, i.e.SFN mod sc-*mcch-RepetitionPeriod* = *sc-mcch-Offset.*  For first slot and duration, we think they are not required, because MCCH will be deliveried via beam sweeping, and exact location of MCCH PDCCH will be defined when define MCCH beam sweeping. |
| QC | Yes | During MCCH on duration, our understanding is it is upto UE implementation to monitor any specific slot assuming beam sweeping used for transmitting MCCH duing on period. |
| Xiaomi | Yes |  |
| CATT | Yes with comments | Details of the parameters should be discussed further. |
| Nokia | Yes (duration, repetition period), Yes for possibility to signal offset (but maybe just one parameter) | UE needs to be told where to look for MCCH thus we consider that repetition period and duration (if agreed) are needed at minimum.  Then we consider that it would be good to be possible to schedule MCCH not “colliding” in time with BCCH to not congest some specific subframes. Thus some sort of offset would be good to have. How to configure that can be discussed further but most clear solution would be to have explicit signaling for those parameters e.g. just one parameter indicating slot offset or then slot+frame signaling. No strong opinion on which way to go and this is not that urgent to decide anyway. |
| Kyocera | Yes |  |
| Samsung | Yes, but | First slot and duration should consider the beam sweeping impact |
| NEC | Yes | Agree with QC that beam sweeping can be monitored by UE implementation. The first slot and during are still needed. |
| Spreadtrum | Yes |  |
| vivo | Yes | All these parameters are needed for network scheduling flexibility. We think the terminology “first frame” is supposed to re-interpreted as slot offset. |
| TD Tech &Chendu TD Tecch | Yes but with some comments. | (1) Use “MCCH transmisison period” to replace “MCCH repettion period”.  The discussion on the different repetition periods and the different modification periods for the different MBS service types needs to be carried out based on the post-RAN2#112-e email discussion on delivery mode 2. Therefore “MCCH repetition period” is not suitbale in NR. The corresponding proposal made in the corresponding email discussion is abstracted as below.  **R2-2100177:Final proposals of email disc. [Post112-e][069][MBS] Delivery mode 2**  **Turquoise issues (open issues for further discussion)**  **Open issue 3:RAN2 further discuss the need and the method of PTM configuration to handle diverse requirement of different MBS service for NR MBS delivery mode 2 e.g. multiple MCCH based PTM configuration, one MCCH with diverse modification periods and repetition periods, etc.**  (2) Use “Number of the MCCH segments” to replace “duration during which MCCH can be scheduled”.  UE shall know the duration for MCCH in each transmission window. Actaully duration=K\*m where K is the number of the beams used by the PBCH/SS blocks and m is the number of the MCCH segments. Therefore, UE just needs to know “m”. Furthermore, m needs the fewer bits to represent than “duration”.  If the maximum value of “m” is defined in NR, maybe there’s no need to broadcast “m” to UE.  (3) A new question for MCCH can be added as below or discuss the different repetition and modification periods for the different MBS types in both question 12 and question 13.  Question: whether or not to support N group(s) of the repetition period and modificaton period for the different MBS service types where N>=1? |
| Huawei, HiSilicon | Yes | We think we need parameters to define MCCH repetition period, MCCH window duration and starting frame/slot. Even though in order to define the exact locations of PDCCH occasions per SSB, some mapping rules are required, MCCH window duration is still needed, similarly as we have SI window for SI delivery. We agree with Nokia that the indication of frame/slot could be combined into a single parameter, which can be further discussed. |

## 2.2 MCCH scheduling

In LTE SC-PTM, SC-RNTI with fixed value (FFFB) is introduced to schedule the transmission of SC-MCCH message. RAN2 should confirm whether the same mechanism is used in NR.

### **Question 3**

Do you agree to confirm that a new MCCH-RNTI (name FFS) with fixed value is introduced to schedule MCCH messages?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Maybe yes | We agree that MCCH-RNTI will be define for MCCH signallling scheduling, but the number of MCCH-RNTI and whether the value of MCCH-RNTI is fixed or not are FFS. |
| QC | may be | If multiple MCCHs are supported, we have 2 options: specifiy fixed MCCH-RNTI for each MCCH or flexible configuration of MCCH-RNTI corresponding to each MCCH. |
| Xiaomi | Yes |  |
| CATT | Maybe | To define new RNTI(s) for MCCH scheduling is necessary.  But,the details of the new RNTI(e.g.number,value) is to be discussed further. |
| Nokia | Yes (Maybe multiple if multiple MCCHs) | We assume we need a RNTI for MCCH but also it seems to be possible that multiple MCCH-RNTIs (or multiple common search spaces) are needed in case would have multiple MCCHs. |
| Kyocera | Yes, but… | We agree with OPPO, QC, CATT and Nokia, i.e., it’s FFS whether multiple MCCH-RNTIs are defined. |
| Samsung | Yes |  |
| NEC | Yes | For the above comment regarding multiple MCCH-RNTI, we should discuss and confirm the scenario. |
| Spreadtrum | Yes |  |
| vivo | Partially Yes | Anyway, a new RNTI is needed. But, considering a separate common search space may be delicately configured for MBS reception in delivery mode 2 (to avoid impact to the legacy UEs), we think the new RNTI can be configurable for flexible RNTI allocation. |
| TD Tech&Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | Yes | We think a single MCCH-RNTI with a fixed value should be a baseline and additional RNTIs might be introduced in case multiple MCCHs get agreed. |

## 2.3 MCCH search space

In NR, for common channels (BCCH, PCCH), common search spaces are defined in 38.331 for paging, SIB1 and other SIBs.

commonSearchSpaceList SEQUENCE (SIZE(1..4)) OF SearchSpace OPTIONAL, -- Need R

searchSpaceSIB1 SearchSpaceId OPTIONAL, -- Need S

searchSpaceOtherSystemInformation SearchSpaceId OPTIONAL, -- Need S

pagingSearchSpace SearchSpaceId OPTIONAL, -- Need S

Given that MCCH is another kind of common channel, RAN2 should first discuss whether another common search space should be defined for MCCH.

### **Question 4**

Do you agree that a common search space (e.g. mcchSearchSpace) can be configured for scheduling MCCH?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Maybe | It is up to RAN1. |
| QC | Yes but | This depends on whether CFR is associated with Initial BWP or other configured BWP. The CSS used for MCCH GC-PDCCH can be configured separately. Better wait for RAN1 discussion on this. |
| Xiaomi | Yes |  |
| CATT |  | It should be decided by RAN1 |
| Nokia | Yes (new common search space should e configurable but also mapping to searchspace 0 should be possible) | New search space may not be needed always so possible to map to searchspace 0 should be possible as well.  Also this question relates to MTCH search space as it might be good to be able to have MTCH and MCCH on same search space. RAN1 has not concluded on search space discussion completely yet so probably before making final agreement on search space for MCCH we need to consult RAN1 |
| Kyocera | Maybe | We agree with OPPO, QC, CATT and Nokia, i.e., it’s up to RAN1. |
| Samsmung | RAN1 scope | RAN1 is discussing about search space for MBS. It should be discussed in RAN1 together with MTCH. |
| NEC | Maybe | It is up to RAN1. |
| Spreadtrum |  | It should be decided by RAN1. |
| vivo | Yes | Similar to Type-0A/2 CSS for OSI/paging, we think a new CSS for MCCH reception should be supported. Anyway, it seems this topic is out of RAN2 scope. |
| TD Tech&Chengdu TD Tech | Yes with some clarificaton | Clarfication from our side:  The common SS for MCCH shall be supported. But the common SS for MCCH can multiplex the same frequency resource with one existing common SS. For example, the comon SS for MCCH multiplexes the same frequency resource with TYPE0/TYPE 1A CSS.  One comment for the title of section 2.3: the current section has no relation with PDCCH occasions and the SSBs. |
| Huawei, HiSilicon | Yes | It is clear that a common search space is required for MCCH monitoring. This CSS can be further configured to SS#0 or any other common search space ID, like for paging and other SI. Currently in each BWP, there are at most 5 common search spaces configured.  PDCCH-ConfigCommon ::= SEQUENCE {  …  searchSpaceZero SearchSpaceZero OPTIONAL, --;; Cond InitialBWP-Only  commonSearchSpaceList SEQUENCE (SIZE(1..4)) OF SearchSpace OPTIONAL, --;; Need R  …  }  RAN2 can confirm there will be a common search space configured/used for MCCH and further consult with RAN1 if new common search spaces need to be added on top of the existing common search spaces.  The search space used for MTCH should be discussed in RAN1. If RAN1 agrees to use the common search spaces (i.e. existing common search spaces and/or new defined ones) for MTCH, it would be up to network whether a common search space ID can be configured for both MCCH and MTCH, i.e. it would be a configuration issue. . |
|  |  |  |

## 2.4 Association between PDCCH occasions in MCCH search space and SSBs

In NR, for common search spaces for the common channels (BCCH, PCCH), PDCCH occasions are associated with SSBs in a pre-defined manner, so the network can sweep PDCCH in the beam directions associated with SSBs. The UE is aware of the pre-defined mapping, and can receive SI messages and paging on PDCCH occasions according to its detected SSBs for the purpose of power saving.

For SI messages, the association between PDCCH occasions and SSBs was discussed in RAN2 and the following is specified in TS 38.331:

|  |
| --- |
| <TS 38.331>.  5.2.2.3.2 Acquisition of an SI message  For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for *SIB1* where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The [x×N+K]th PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the Kth transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to CEIL(number of PDCCH monitoring occasions in SI-window/N). The actual transmitted SSBs are sequentially numbered from one in ascending order of their SSB indexes. The UE assumes that, in the SI window, PDCCH for an SI message is transmitted in at least one PDCCH monitoring occasion corresponding to each transmitted SSB and thus the selection of SSB for the reception SI messages is up to UE implementation. |

For paging, the following is specified in TS 38.304:

|  |
| --- |
| <TS 38.304, clause 7.1>.  The PDCCH monitoring occasions for paging are determined according to *pagingSearchSpace* as specified in TS 38.213 [4] and *firstPDCCH-MonitoringOccasionOfPO* and *nrofPDCCH-MonitoringOccasionPerSSB-InPO* ifconfigured as specified in TS 38.331 [3]. When *SearchSpaceId* = 0 is configured for *pagingSearchSpace*, the PDCCH monitoring occasions for paging are same as for RMSI as defined in clause 13 in TS 38.213 [4].  When *SearchSpaceId* = 0 is configured for *pagingSearchSpace*, Ns is either 1 or 2. For Ns = 1, there is only one PO which starts from the first PDCCH monitoring occasion for paging in the PF. For Ns = 2, PO is either in the first half frame (i\_s = 0) or the second half frame (i\_s = 1) of the PF.  When *SearchSpaceId* other than 0 is configured for *pagingSearchSpace,* the UE monitors the (i\_s + 1)th PO. A PO is a set of 'S\*X ' consecutive PDCCH monitoring occasions where 'S' is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is the *nrofPDCCH-MonitoringOccasionPerSSB-InPO* if configured or is equal to 1 otherwise. The [x\*S+K]th PDCCH monitoring occasion for paging in the PO corresponds to the Kth transmitted SSB, where x=0,1,…,X-1, K=1,2,…,S. The PDCCH monitoring occasions for paging which do not overlap with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from zero starting from the first PDCCH monitoring occasion for paging in the PF. When *firstPDCCH-MonitoringOccasionOfPO* is present, the starting PDCCH monitoring occasion number of (i\_s + 1)th PO is the (i\_s + 1)th value of the *firstPDCCH-MonitoringOccasionOfPO* parameter; otherwise, it is equal to i\_s \* S\*X. If X > 1, when the UE detects a PDCCH transmission addressed to P-RNTI within its PO, the UE is not required to monitor the subsequent PDCCH monitoring occasions for this PO. |

If there is a search space configured for MCCH, RAN2 should discuss if the same principle of PDCCH occasions and and SSB association as used for SI and paging can be applied to MCCH, i.e. PDCCH occasions for MCCH search space can be associated with SSBs in a pre-defined way so that the UE can receive MCCH scheduling on PDCCH occasions according to its detected SSB to save power.

Please note this is a topic which can be discussed either in RAN1 or in RAN2. Considering that the same issue for system information and paging was discussed in RAN2 in the past, we think it makes sense this is first discussed in RAN2 and RAN1 can be informed of our agreements and further discuss details if needed.

### **Question 5**

Do you agree that PDCCH occasions for MCCH search space can be associated with SSBs in a pre-defined manner so that the UE can receive MCCH scheduling on PDCCH occasions according to its detected SSB?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Beam sweeping for MCCH is same with SI and paging. |
| QC | Yes |  |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Nokia | Yes | We see no need to deviate from BCCH. Anyway MCCH is quite similar to BCCH just conveying different control message. |
| Kyocera | Yes | We wonder if RAN2 can only have an assumption before RAN1 is involved, even though we tend to agree with the rapporteur’s plan. |
| Samsung | Yes |  |
| NEC | Maybe | It is up to RAN1. |
| Spreadtrum | Yes |  |
| vivo | Yes | During the normative work for NR, it is RAN2 that designed the association relation between SSB and PDCCH occasion due to limited time in RAN1.  We think the situation of the MBS discussion is quite similar, Thus, We think RAN2 can determine the beam sweeping mechanism for MCCH as a working assumption and send an LS to RAN1 for confirmation. |
| TD Tech&Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | Yes |  |

In NR, there are several examples for mapping between PDCCH occasions and associated SSB as following:

**SIB1:** SIB1 uses search space#0 and the mapping between PDCCH occasions and associated SSB is predefined in clause 13 of TS 38.213

**OSI:** OSI uses either searchSpace#0 or other configured common searchSpace (searchSpaceOtherSystemInformation). If searchSpace#0 is used for OSI, the mapping between PDCCH occasions and SSB is the same as for SIB1. Otherwise, the mapping is restricted to the SI window and the beam sweeping is performed in the SI window, i.e., PDCCH monitoring occasions for SI message which are not overlapping with UL symbols are sequentially numbered from one in the SI window and mapped to SSB according to the rule defined in TS 38.331.

SI window

PDCCH occasions

SSB1

SSB2

SSB3

SSB4

SSB1

SSB2

SSB3

SSB4

1

2

3

4

5

6

7

8

Figure 2 Association between PDCCH occasions and SSBs for OSI search spaces

**Paging:** Paging uses either searchSpace#0 or other configured common searchSpace. If searchSpace#0 is used for Paging, the mapping between PDCCH occasions and SSB is the same as for SIB1. Otherwise, the beam sweeping is performed in a Paging Occasion, i.e., the PDCCH monitoring occasions for paging which do not overlap with UL symbols are sequentially numbered from zero starting from the first PDCCH monitoring occasion for a PO and mapped to SSB according to the rule defined in TS 38.304 as shown in the following figure. A PO ends after one round of beam sweeping.

PF

PDCCH occasions

SSB1

SSB2

SSB3

SSB4

0

1

2

3

*firstPDCCH-MonitoringOccasionOfPO*

POx

Figure 2 Association between PDCCH occasions and SSBs for Paging search space

Regarding mapping between PDCCH occasions and SSBs for MCCH, multiple PDCCH occasions for one SSB might be needed considering the segmentation of MCCH messages. In addition, if the answer to Q1 is yes, the MCCH transmission window would be very similar to the SI window. Therefore, it would be rather straightforward to use the same PDCCH occasions to SSB mapping principles for MCCH as used for OSI.

### **Question 6a**

Do you agree that in case searchSpace#0 is configured for MCCH, the mapping between PDCCH occasions and SSBs is the same as SIB1?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | No | The detailed maping between MCCH PDCCH and SSB index should be discussed further. |
| QC | Yes |  |
| Xiaomi | ? | This should be decided by RAN1. Using searchSpace#0 for MCCH may cause some impacts on the PDCCH capacity of searchSpace#0. |
| CATT |  | It should be decided by RAN1 |
| Nokia | Yes |  |
| Kyocera | Yes | We wonder if RAN2 can only have an assumption before RAN1 is involved, even though we tend to agree with the rapporteur’s plan. |
| Samsung | RAN1 scope | RAN1 is discussing about search space for MBS. It should be discussed in RAN1 together with MTCH. |
| NEC | Maybe | It should be decided by RAN1 |
| Spreadtrum | Maybe | It should be decided by RAN1. |
| vivo | Yes | We think the legacy principle can be reused. |
| TD Tech&Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | Yes | We think the same principle as for BCCH can be reused. Please note this is a topic which was discussed in RAN2 previously for SI, given that RAN2 defined parameters like SI window and paging frames which have impacts on the association. Now similarly the MCCH transmission window also needs to be introduced. |

### **Question 6b**

Do you agree that if search space other than searchSpace#0 is configured for MCCH, the PDCCH monitoring occasions for MCCH message which are not overlapping with UL symbols are sequentially numbered from one in the MCCH transmission window (discussed in Q1/2) and mapped to SSBs using the similar rule as defined for OSI in TS 38.331?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| QC | Yes |  |
| Xiaomi | ? | It seems ok for the proposal. However we still think that RAN1 needs to discuss the detailed searching space configuration for the MCCH. |
| CATT |  | It should be decided by RAN1 |
| Nokia | Yes |  |
| Kyocera | Yes | We wonder if RAN2 can only have an assumption before RAN1 is involved, even though we tend to agree with the rapporteur’s plan. |
| Samsung | Yes |  |
| NEC | Yes |  |
| Spreadtrum | Yes |  |
| vivo | Yes | We think the legacy principle can be reused. |
| TD Tech&Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | Yes | We think the same principle as for BCCH can be reused. As above, this is a topic that was discussed in RAN2 for SI previously, so we think the same can be done for MCCH. We can then inform RAN1 about the agreements and they can check further. |

## 2.5 MCCH transmission bandwidth

RAN1 has discussed the CFR (Common Frequency Resource) used for group-common PDCCH/PDSCH and several options were discussed. Using the initial BWP as CFR for group-common PDCCH/PDSCH was agreed to be supported, and it shall be noted that the bandwidth for the initial BWP can be configured larger than CORESET0, in which case CFR used for group-common PDCCH/PDSCH can be larger than CORESET0. Other possible configurations of CFR for group-common PDCCH/PDSCH are still under discussion. The general principle is that CRF for group-common PDCCH/PDSCH needs to be compatible with CORESET0/initial BWP to allow the UE to monitor Paging/SI and to receive MBS simultaneously without BWP switch. The discussion in RAN1 was mostly for MTCH, but it is understood that this principle is applicable to both traffic and control channels. Therefore, RAN2 is requested to confirm that CFR where MCCH is provided should allow the UE to monitor Paging/SI and to receive MCCH simultaneously without BWP switch.

### **Question 7**

Do you agree that the transmission bandwidth for MCCH shall be configured in the way allowing the UE to monitor Paging/SI and to receive MCCH simultaneously without BWP switch?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes, but | It should be up to RAN1 decision. |
| QC | Yes but | To be confirmed by RAN1 |
| Xiaomi | ? | To be discussed by RAN1. |
| CATT |  | It should be decided by RAN1 |
| Nokia | Yes |  |
| Kyocera | Yes, but… | We agree with OPPO, QC, Xiaomi and CATT, i.e., it’s up to RAN1. |
| Samsung | RAN1 scope | RAN1 is discussing about MBS BWP. It should be discussed in RAN1 together with MTCH. |
| NEC | Yes | It should be up to RAN1 decision. |
| Spreadtrum |  | It should be decided by RAN1. |
| vivo | Yes but | We are fine with no BWP switching. However, the frequency resource allocation issue was warmly discussed in RAN1. It is better to leave to RAN1. |
| TD Tech&Chengdu TD Tech | Yes |  |
| Huawei, HiSilicon | Yes | UE needs to be able to receive MCCH notifications and SI/Paging notifications at the same time. |

If the answer to Q7 is yes, the next question would be: should MCCH be scheduled like SIBs/Paging, i.e. the transmission is within CORESET#0, or can the MCCH transmission bandwidth be different, e.g. using CFR defined by RAN1?

### **Question 8**

Do you think that MCCH transmission bandwidth should be within CORESET#0, similarly as for SI/Paging?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes, but | It should be up to RAN1 decision. |
| QC | Maybe | This is up to RAN1 |
| Xiaomi | ? | To be discussed by RAN1. |
| CATT |  | It should be decided by RAN1. |
| Nokia | No | We see no reason to limit the bandwidth for the MCCH – in fact we do not yet know all the contents sent over MCCH(s) e.g. neighbor cell information it might be challenging to fit in the CORESET#0. Thus it should be possible to use wider bandwidth thnt CORESET#0. |
| Kyocera | Yes, but… | We agree with OPPO, QC, Xiaomi and CATT, i.e., it’s up to RAN1. |
| Samsung | RAN1 scope |  |
| NEC | Yes | This is up to RAN1 |
| Spreadtrum |  | It should be decided by RAN1. |
| vivo |  | The frequency resource allocation modeling was still being discussed in RAN1. It is better to leave to RAN1. |
| TD Tech&Chengdu TD Tech | No | We think the MCCH transmission bandwidth within CORESET#0 is just one possible MCCH configuration. |
| Huawei, HiSilicon | Yes, but | At least CORESET#0 can be an option, given that MCCH is also used to broadcast cell/group information, which is similar to SIBs.  On the other hand, we are also open to configure bandwidth wider than CORESET#0 if the information is too much to be delivered on CORESET#0, and in this case RAN1 can be consulted with. |

If the answer to Q8 is no, there are several other possible options for the bandwidth used for MCCH transmission, including but not limited to:

Option 1: the bandwidth used for MCCH transmission can be the initial BWP bandwidth configured in SIB1

Option 2: the bandwidth used for MCCH transmission can be configured in the MBS SIB and the bandwidth either covers CORESET0 or is covered by CORESET0.

Option 3: the bandwidth used for MCCH transmission is the same as the bandwidth used for MTCH, FFS MCCH transmission bandwidth when multiple CFRs for MTCH are configured

Option 4: leave to RAN1 discussion

### **Question 9**

If the answer to Question 8 is no, which option(s) above do you prefer for the bandwidth used for MCCH transmission?

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| OPPO |  | It should be up to RAN1 decision. |
| QC | Option 4 | Discuss in RAN1 |
| Xiaomi |  | This is up to RAN1 to discuss. |
| CATT |  | It should be decided by RAN1 |
| Nokia | Option 2 | It should be possible to configure MCCH bandwidth to be different from CORESET#0 – logical place to configure is SIB including MCCH configuration. |
| vivo | Option 4 | RAN2 should wait for RAN1 input. |
| TD Tech&Chengdu TD Tech | Option 4: leave to RAN1 discussion |  |
| Huawei, HiSilicon | Open to option 2 | If a wider bandwidth than CORESET#0 is preferred, we prefer the network to configure a bandwidth for MCCH, which is not necessarily initial BWP bandwidth, to improve the flexibility. |

# MCCH Change notification

## 3.1 MCCH change notification for session start

In MBSFN, M-RNTI is used to send the notification for MCCH change and an 8-bit bitmap is contained in DCI for M-RNTI corresponding to 8 MBSFN areas configured in one cell.

In LTE Rel-13, following the same logic defined for MBSFN, the change notification for SC-MCCH uses a new introduced SC-N-RNTI and the DCI format for M-RNTI is reused for SC-N-RNTI but only one bit in the 8-bit bitmap is used considering that there is only one SC-MCCH in a cell for SC-PTM. The SC-MCCH change notification scrambled by SC-N-RNTI shall be transmitted in the first subframe of MCCH transmission window to notify the change of SC-MCCH scheduled in the same subframe.

In Rel-14, to reduce the RNTI detection complexity for MTC/NB-IoT UEs to support SC-PTM, the notification function is integrated into SC-RNTI which is used to schedule both SC-MCCH and SC-MCCH change notification.

Therefore, there are several options for MCCH change notification in NR based on the LTE SC-PTM mechanisms:

Option 1: a new RNTI different from MCCH-RNTI is introduced for MCCH change notification and NO additional information (such as the 8 bits bitmap in LTE) is needed. The details of DCI design can be left for RAN1 to discuss.

Option 2: a new RNTI different from MCCH-RNTI is introduced for MCCH change notification and some additional information (such as the 8 bits bitmap) is needed.

Option 3: the notification function is integrated into MCCH-RNTI which is used to schedule MCCH The details of DCI design can be left for RAN1 to discuss.

Option 4: The change notification is integrated with Paging.

In RAN2#113e, it was agreed that “Assume that MCCH change notification mechanism is used to notify the changes of MCCH configuration due to session start for delivery mode 2 of NR MBS (other cases FFS, if any)”. RAN2 should then discuss which option above is used for session start.

### **Question 10**

Which option do you prefer for MCCH change notification for session start?

|  |  |  |
| --- | --- | --- |
| Company | Preferred Option | Comments |
| MediaTek | Option 1 |  |
| OPPO | Option 1, but… | We agree the notification RNTI can be introduced in NR as LTE SC-PTM. But the number of notification RNTI is FFS. |
| QC | Option 2 | If multiple MCCHs are to be supported, then we need multiple DCI bits to indicate which MCCH is changing. |
| Xiaomi | Option 4 | If we use paging message to indicate the session start, then we could have a unified solution to indicate the session start for both multicast and broadcast. |
| CATT | Option 1 as baseline | SC-PTM solution(i.e.SC-N-RNTI) as basline,whether need enhancment is to be discussed further. |
| Nokia | Option 1 (maybe a RNTI per MCCH) (possibly 3) | If no additional information is needed then it would be possible to include the information in the same notification message as ETWS/CMAS/SI update i.e. part of Short Message and then we could reuse notification mechanisms for those. But this would not work well requirement for reach about 20ms latency it would be difficult (or impossible) to achieve with short message.  8 bit information in the LTE MCCH was related to the MBSFN specific change and thus not needed for NR. we do not think option 2 is viable for NR. Option 1 seems most logical solution but also option 3 could work but would need more coordination with RAN1 if we consider RNTI space is scarce and should be saved.  If we would have multiple MCCH. Then we would possibly need multiple different notification indications e.g. separate RNTI for each MCCH. |
| Kyocera | Option 1 or 2 | We assume some additional information would be helpful, if multiple MCCH is introduced. In this sense, for Option 1 we agree with OPPO and Nokia, i.e., number of new RNTIs is FFS. |
| Samsung | Option 1 |  |
| NEC | Option 1 or 2 | Whether we need multple DCI bit is up to whether we have multiple MCCH. |
| Spreadtrum | Option 1 or 2 | If multiple MCCHs are introduced, some additional information is needed. |
| vivo | Option 2 or 3 | For option 1, if no additional information is needed, we are wondering what key info should be included in DCI? In LTE, the SC-N-RNTI PDCCH for notifying SC-MCCH change only contains the 8-bit bitmap and reserved bits.  Regarding option 4, we think it is just a specific design based on option 1/2. |
| TD Tech&Chengdu TD Tech | Option 1 or option 2 |  |
| Huawei, HiSilicon | Option 3 | We prefer reusing the same RNTI as for scheduling MCCH. Thanks to that we avoid having to use up RNTI space further (as in options 1 and 2) and we avoid impacting legacy UEs (as in the case of P-RNTI / Short Message reuse). |

## 3.2 MCCH change notification for session update/stop

In LTE Rel-13 SC-PTM, SC-MCCH change notification is only used to notify the SC-MCCH change due to session start. Once a UE starts to receive MBMS, the UE is required to monitor at least one SC-MCCH repetition period in every SC-MCCH modification period. Therefore, no change notification is needed for session stop or MCCH message modification for ongoing services.

In LTE Rel-14, for MTC/NB-IoT UEs, due to the fact that SC-MCCH and SC-MTCH can be sent in different narrow bands, the UE is not be able to monitor both G-RNTI and SC-RNTI at the same time. Additional change notifications using G-RNTI were added for the following cases:

* Change notification for service start
* Change of SC-MCCH message for the ongoing services

Based on the above description, there are several options for change notification for MCCH update for “non-session start” cases:

Option 1: same as Rel-13 SC-PTM, i.e. no change notification for session stop or MCCH message modification for ongoing services and the UE is required to monitor at least one MCCH repetition period in every MCCH modification period.

Option 2: same as MTC/NB-IoT SC-PTM, i.e. introduce G-RNTI based notification for MCCH modification for ongoing services.

Option 3: apply the same change notification mechanism as used for session start also for service stop and MCCH modification for ongoing services.

### **Question 11**

Which option do you prefer for notification of MCCH change for ongoing MBS services?

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| MediaTek | Option 1 |  |
| OPPO | Option 1 |  |
| QC | Option 1 or Option 3 | Option 3 if there is on demand MCCH (i.e MCCH is not broadcast all the time to avoid overhead and also UE actively receiving Broadcast service may not need to regularly monitor MCCH) |
| Xiaomi | Option 1 |  |
| CATT | Option 1 | Mechanism in Rel-13 SC-PTM for normal UE is sufficient |
| Nokia | Option 1 | There does not seem to be need to optimize this and we could reuse LTE principle |
| Kyocera | Option 2 or 3 | We think either Option 2 or 3 is beneficial for UE power saving since the UE can skip decoding MCCH, i.e., PDSCH, at every modification period if the change notification is absent. We wonder if Option 2 depends on the CFR (Common Frequency Resource) which is being discussed in RAN1; Otherwise, we assume Option 3 can be supported for NR UEs. |
| Samsung | Option 1 |  |
| NEC | Option 1 |  |
| Spreadtrum | Option 1 |  |
| vivo | Option 3 with comments | From UE perspective, notification for session start and MCCH modification is needed to reduce UE blind decoding on MCCH monitoring. |
| TD Tech&Chengdu TD Tech | Option 1 or option 3 |  |
| Huawei, HiSilicon | Option 1 |  |

## 3.3 Timing to update MCCH message

In LTE SC-PTM, the modification principles of SC-MCCH are similar to the ones applied for SIBs, i.e. the modification period has been defined for SC-MCCH. SC-MCCH is transmitted every SC-MCCH repetition period but is only allowed to be modified at each modification period boundary, like system information.

### **Question 12**

Do you agree to confirm that the modification period as defined in LTE SC-PTM is reused for NR MCCH?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| QC | Yes |  |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Nokia | Yes |  |
| Kyocera | Yes |  |
| Samsung | Yes |  |
| NEC | Yes |  |
| Spreadtrum | Yes |  |
| vivo | Yes |  |
| TD Tech&Chengdu TD Tech | See our comments. | We think the discussion on the different repetition periods and the different modification periods for the different MBS service types can be combined with question 12 as below.  Updated question 12: Do you agree to confirm that the repetition period and the modification period as defined in LTE SC-PTM are reused for NR MCCH? If yes, do you agree to support N (N>=1) group(s) of the repetition and modificaton periods for the transmissions of the MBS configuration informations of the MBSs of the different MBS service types?  Why and how to support N>1 group(s) of the repetition and modification periods for all MBS service types is given in R2-2100960. The benefits for N>1 groups of the repetition and modifcatoin periods are abstracted as below.  (1) In order to satisfy the QOS requirement (both delay and reliability requirements ) of each MBS service type, it’s better to support N>1 groups of the repetition and modification periods.  (2) N>1 groups of the repetition and modification periods gives UE the chance to only monitor the PDCCH occasions for the interested MBS service types according to the repetition and modification periods for the interested MBS service types, which can reduce the UE power consumption.  (3) N>1 groups of the repetition and modification periods can save the MCCH specific PDSCH resources.  N=1 means that the unique repetition/modification period needs to be set according to the MBS service type with the lowest delay requirement and the MBS service type with the highest reliability requirement. For each MCCH transmission, MCCH carries the configuration informatings of all MBSs of all MBS service types even if some MBS service types don’t need so frequently tran smission, which means more MCCH specific PDSCH resource consumption.  The following figure is used to illustrate N>1 groups of the repetition and mdofication periods. |
|  | |
| Huawei, HiSilicon | Yes |  |

In LTE SC-PTM, regardless of whether SC-N-RNTI or SC-RNTI is used for MCCH change notification, the notification shall be transmitted in the first subframe of SC-MCCH transmission window. The updated contents of SC-MCCH are then sent already in the same modification period where the notification was sent, which is beneficial for MCCH update latency reduction. It seems straightforward to reuse such mechanism for MCCH update, i.e. the updated MCCH contents should be sent in the same MCCH modification period where the change notification is sent.

### **Question 13**

Do you agree that the updated MCCH message should be sent in the same MCCH modification period where the change notification is sent?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| QC | Yes |  |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Nokia | No | All Ues should be receiving service based on same parameters and thus UE should not apply new values until modification period boundary. In fact in our understanding above description is not entirely true for LTE – NW updates MCCH information only at next modification boundary. |
| Kyocera | Yes |  |
| Samsung | Yes |  |
| NEC | Yes |  |
| Spreadtrum | Yes |  |
| vivo | Yes |  |
| TD Tech&Chengdu TD Tech | See our comments | We think question 13 can be combined with the discussion on the different repetition periods and the different modification periods for the different MBS service types as below.  Updated question 13: For each group of the repetition and modification periods，do you agree that both the MCCH change notification and the updated MCCH for the associated MBS service types should be sent in the same modification period where the associated MBS service types use this group of of the repetition and modification periods?  The figure we presents for question 12 is reshown below to illustrate how to transmit the MCCH change notification according to the corresponding group of the repetition and modification periods. |
|  |  | |
| Huawei, HiSilicon | Yes | We think the description above is correct. As per TS 36.331:  *“Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe. The UE applies the previously acquired SC-MCCH information until the UE acquires the new SC-MCCH information.”*  It is true that in case the UE fails to receive new SC-MCCH in the first repetition of the modification period, then it might not be able to decode MTCH it is interested in right away, but this does not justify delaying new service delivery for all UEs (including the ones that decoded new MCCH successfully). This is also a similar situation as for SI change notification, which becomes applicable right away, not waiting for the next modification period. Sending a notification in one period and the modified MCCH in the next one also does not seem to help. |

# Conclusion

The following proposals are made based on the email discussion:

TBD

# References

1. *R2-2100177 Email Report of [Post112-e][069][MBS] Delivery mode 2 MediaTek Inc. discussion Rel-17 NR\_MBS-Core*
2. *Chairman’s Notes, RAN2 #112-3*