**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 |
|  |  |   |

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 |
|  |  |   |

## 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 |
|  |  |   |

## 2.3 MCCH search space and association between PDCCH occasions and SSBs

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 |
|  |  |   |

## 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 messageFor 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 |
|  |  |   |

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 |
|  |  |   |

### **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 |
|  |  |   |

## 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 |
|  |  |   |

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 |
|  |  |   |

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 |
|  |  |   |

# 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.

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 |
|  |  |   |

## 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 |
|  |  |   |

## 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 |
|  |  |   |

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 |
|  |  |   |

# 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*