**3GPP TSG-RAN WG2 Meeting #116bis electronic R2-22xxxxx**

**Online, Jan. 17th – Jan. 25th, 2022**

**Agenda Item: 8.1.4**

**Source: OPPO**

**Title: [AT116bis-e][028][MBS] MAC Open Issues (OPPO)**

**Document for: Discussion and decision**

# Introduction

This paper is to trigger the following email discussion of MAC open issues in MBS.

* [AT116bis-e][028][MBS] MAC Open Issues (OPPO)

 Scope: Address MAC related open issues, as captured in R2-2200022 and R2-2111414 (running CR). Take into account input to this meeting. Identify (easy) agreements, points for discussion etc.

 Intended outcome: Report

 Deadline: First Deadline Friday W1 (CB online to some important point)

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# Discussion

## 2.1 MBS HARQ process

In RAN1#104 meeting, the following agreement is made and it means the MBS and unicast shared the same HARQ process ID space.

PTM transmission + PTM retransmission 🡺 for same TB, same HARQ process id and NDI

PTM transmission +PTP retransmission 🡺 for same TB, same HARQ process id and NDI

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| Agreement:The same HARQ process ID and NDI are used for PTM scheme 1 (re)transmissions and PTP retransmissions of the same TB.Conclusion:The maximum number of HARQ processes per cell, currently supported for unicast, is kept unchanged for UE to support multicast reception.How to allocate HARQ processes between unicast and multicast is up to gNB. |

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| 5.3.1 DL Assignment receptionDownlink assignments received on the PDCCH both indicate that there is a transmission on a DL-SCH for a particular MAC entity and provide the relevant HARQ information.When the MAC entity has a C-RNTI, Temporary C-RNTI, or CS-RNTI, the MAC entity shall for each PDCCH occasion during which it monitors PDCCH and for each Serving Cell:1> if a downlink assignment for this PDCCH occasion and this Serving Cell has been received on the PDCCH for the MAC entity's C-RNTI, or Temporary C‑RNTI:2> if this is the first downlink assignment for this Temporary C-RNTI:3> consider the NDI to have been toggled.2> if the downlink assignment is for the MAC entity's C-RNTI, and if the previous downlink assignment indicated to the HARQ entity of the same HARQ process was either a downlink assignment received for the MAC entity's CS-RNTI or a configured downlink assignment:3> consider the NDI to have been toggled regardless of the value of the NDI. |

In TS 38.321, the yellow highlight part is for the case that SPS HARQ process is previous HARQ process of the dynamic scheduling HARQ process for the same HARQ process id. The NDI will be considered as toggled regardless of the value of the NDI. UE may be configured with unicast including dynamic scheduling and SPS, multicast including dynamic scheduling and MBS SPS. So, the following cases exist:

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| **For the same HARQ process id** |
| **Before**  | **now** | **Behaviour** |
| MBS SPS | Dynamic scheduling via C-RNTI | consider the NDI to have been toggled regardless of the value of the NDI. |
| Dynamic scheduling via G-RNTI |
| Dynamic scheduling via G-CS-RNTI |
| SPS | Dynamic scheduling via G-RNTI |
| MBS SPS |
| Dynamic scheduling via other G-RNTI |
| Dynamic scheduling via G-CS-RNTI |
| Dynamic scheduling via C-RNTI |

**Proposal:**

* **If the downlink assignment is for C-RNTI, and if the previous downlink assignment indicated to the HARQ entity of the same HARQ process was eithe a downlink assignment received for the MAC entity's G-CS-RNTI or G-RNTI or a configured downlink assignment for MBS, or**
* **if the downlink assignment is for G-RNTI, and if the previous downlink assignment indicated to the HARQ entity of the same HARQ process was either a downlink assignment received for the MAC entity's G-CS-RNTI or other G-RNTI or C-RNTI or a configured downlink assignment for MBS or unicast,**
* **consider the NDI to have been toggled regardless of the value of the NDI.**

**Q1: Do companies agree the above proposal?**

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| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Partially no | PTM initial Tx (G-RNTI) & PTP retransmission (C-RNTI)-> NDI value should be compared to the previous value.**If the downlink assignment is for C-RNTI, and if the previous downlink assignment indicated to the HARQ entity of the same HARQ process was eithe a downlink assignment received for the MAC entity's G-CS-RNTI ~~or G-RNTI~~ or a configured downlink assignment for MBS**We agree the other cases. |
| Ericsson | Yes | The text should simple follow the logic that e.g. when a G-RNTI (PDCCH DCI) is received for a certain HPID (and NDI), the UE consider this to be new data if the most recent reception for this HPID used a RNTI different from the received RNTI.It is logically impossible to toggle the NDI in a way (comparing) that would satisfy the toggling rule for a group of UEs with different reception success. This issue is not limited to previous reception via C-RNTI. The same conflict may arise when the earlier RNTIs are different G-RNTIs or G-RNTI and C-RNTI combinations. |
| CATT | Partially no | Agree with the Samsung on the PTP HARQ retransmission of the initial PTM transmission case. |
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## 2.2 MBS SPS

In RAN2#116 meeting, RAN2 make the following agreement. However, it is not clear whether the below agreement is also valid when MBS SPS is used? In rrapporteur’s understanding, the answer is yes.

* one-to-many mapping between G-RNTI and MBS sessions is supported and it is assumed that this does not introduce additional specification work.

**Proposal: one-to-many mapping between G-CS-RNTI and MBS sessions is supported and it is assumed that this does not introduce additional specification work.**

**Q2: Do companies agree the above proposal?**

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| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Yes | Same as G-RNTI to MBS session mapping |
| Ericsson | Yes |  |
| CATT | Yes |  |
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In RAN1 meetings, RAN1 made following agreements about SPS. There will be multiple SPS-config for MBS. However, it is not clear the mapping between G-CS-RNTI and SPS-config.

In R16, only one CS-RNTI will be configured for UE to address all SPS and also all CG configuration.

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| Agreement: (RAN1#104)For RRC\_CONNECTED UEs, more than one SPS group-common PDSCH configuration for MBS can be configured per UE subject to UE capability* The total number of SPS configurations supported by a UE currently defined for unicast is not increased due to additionally supporting MBS.

Agreement: (RAN1#106)If a SPS-config for MBS is configured in CFR, one G-CS-RNTI is associated with the SPS-config.* FFS: Multiple G-CS-RNTIs associated with one SPS-config

Agreement: (RAN1#106bis)The association between a G-CS-RNTI and a SPS-Config-Multicast is indicated by the activation GC-PDCCH for SPS GC-PDSCH, i.e., a value of the HARQ process number field in a DCI format indicates an activation for a SPS GC-PDSCH configuration for multicast with a same value as provided by *sps-ConfigIndex* in a *SPS-Config-Multicast.* |

Based on RAN1 agreements above, rapporteur made following understanding:

**Rapporteur’s understanding:** There will be multiple MBS SPS-config and there will also be multiple G-CS-RNTI. However, the association between G-CS-RNTI and MBS SPS-config will not be specified in RRC signalling. The DCI scrambled with G-CS-RNTI will indicated which MBS SPS-config will be activated via HARQ process id in this DCI and sps-ConfigIndex in a SPS-Config-Multicast. Then this G-CS-RNTI will be associated with the MBS SPS-config. It is up to network whether support one to multiple or multiple to one maping between G-CS-RNTI and MBS SPS config.

**Q3: Do companies agree the above rapporteur’s understanding? If no, do you agree to send LS to RAN1 for further confirmation?**

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| Company | Yes/No?For understanding | Yes/No?For LS | Comments |
| OPPO  | Yes  |  |  |
| Samsung | No |  | We do not agree “It is up to network whether support one to multiple or multiple to one maping between G-CS-RNTI and MBS SPS config.” due to the following FFS points:* FFS: Multiple G-CS-RNTIs associated with one SPS-config
 |
| Ericsson | comment |  | The FFS does make the question difficult to decide upon. RAN2 should decide what is supported (and why) and then check if RAN1 have concerns. |
| CATT | No |  | Agree with Samsung,we expect there will be a conclusion(either from RAN1 or RAN2) on the mapping between G-CS-RNTI and SPS-config |
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In RAN1#105 and RAN1#107meeting, RAN1 make following agreements on how to use CS-RNTI for multicast MBS. CS-RNTI will be used in PTP for PTM retransmission when MBS SPS is for PTM transmission and CS-RNTI is also used to deactivate the MBS SPS per UE.

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| Agreement:For PTP retransmission of SPS group-common PDSCH, CS-RNTI is used for CRC scrambling of PDCCH with the NDI bit set to 1. |
| **Agreement**For multicast in RRC\_CONNECTED state, * Only SPS-Config-Multicast(s) configured in CFR for multicast can be activated/deactivated by GC-PDCCH with G-CS-RNTI.
* SPS-Config-Multicast(s) configured in CFR for multicast cannot be activated by unicast PDCCH with CS-RNTI, but can be deactivated by unicast PDCCH with CS-RNTI.
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**Q4: Do companies agree to capture the CS-RNTI usage in table, i.e. for PTP for PTM retransmission and MBS SPS deactivation when MBS SPS is configured, for MBS in section 7.1 in MBS MAC running CR?**

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| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Yes | We do not see any issues in MAC. |
| Ericsson | Yes, comment | How to capture and if best in table can be discussed with running CR. |
| CATT | Yes |  |
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The CS-RNTI will be used for MBS, e.g. MBS SPS deactivation, PTM retransmission via PTP leg. The next question is what is the UE behaviour when CS-RNTI is not configured for one UE? E.g. there is no requirement to configure CG and/or SPS for unicast for this UE.

**Option 1**: If MBS SPS is configured, the CS-RNTI must be configured.

**Option 2**: If MBS SPS is configured and CS-RNTI is not configured, the retransmission of SPS via PTP is not supported and MBS SPS deactivation via CS-RNTI is not supported.

**Q5: Which option do companies prefer?**

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| Company | Option 1/2? | Comments |
| OPPO | Option 2 | It is simple. MBS SPS and unicast SPS are decoupled.  |
| Samsung | Option 2 | Can be up to NW whether to config CS-RNTI |
| Ericsson | Option 2 | The RAN1 agreement leads to deactivation(/activation) only by GC-PDCCH with G-CS-RNTI if CS-RNTI is not configured. |
| CATT | Option 2 | From the network perspective, if retransmission of SPS via PTP is supported, CS-RNTI should be configured. Otherwise, it is simple to apply G-CS-RNTI based retransmission/deactivation. |
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The CS-RNTI will be used for MBS SPS deactivation and HARQ process id filed in DCI will be indicated which MBS SPS will be deactivated according to the sps-ConfigIndex in a SPS-Config-Multicast. In order to address the target SPS for deactivation, the sps-ConfigIndex should unique between uncast SPS and MBS SPS.

**Q6: Do companies agree that the sps-ConfigIndex should unique in UE no matter the SPS is for unicast or multicast?**

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| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Yes |  |
| Ericsson | Yes |  |
| CATT | Yes |  |
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## 2.3 MBS DRX

### 2.3.1 MBS DRX command MAC CE

In MAC running CR for MBS, there is an editor note about DRX command for MBS DRX.

Editor’s note: FFS to support DRX Command MAC CE for MBS DRX.

In rapporteur’s understanding, DRX command MAC CE can make UE enter DRX more quickly to achieve more power saving for UE.

In R16, dual DRX is introduced for unicast and common DRX command will be applied to two DRX. In MBS, the multiple DRX are configured per G-RNTI except unicast DRX. It is clear whether apply DRX command and how to apply DRX command.

**Option 1**: Any DRX command MAC CE will not impact MBS DRX.

**Option 2**: legacy DRX command MAC CE will also be used for MBS DRX.

**Option 3.1:** MBS specific DRX command MAC CE is defind, and the MBS specific DRX command MAC CE is common for all MBS DRX associated different G-RNTI, and one new LCID is defined to identify the MBS spefic DRX command MAC CE.

**Option 3.2:** MBS specific DRX command MAC CE is defind, and the MBS specific DRX command MAC CE is common for all MBS DRX associated different G-RNTI, and R bit in MAC subheader for DRX command MAC CE is used to indicate the DRX command MAC CE is for MBS or unicast.

**Option 4:** MBS specific DRX command MAC CE is defind per G-RNTI, i.e. if the PDCCH for TB including DRX command MAC CE is scrambled by a G-RNTI, the DRX command MAC CE is for MBS DRX corresponding to this G-RNTI.

**Q7: Which option do companies prefer?**

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| Company | Option 1/2? | Comments |
| OPPO | Option 3.2, Option 4 is acceptable  | First, DRX command MAC CE should be supported for MBS.At least, the DRX command MAC CE should be separate from unicast DRX command MAC CE.Both option 3.2 and option 4 can be agreed for different purpose.  |
| Samsung | Option 1 | In MBS with multiple MBS flows, MAC CE-based immediate sleep is not so beneficial but complicated. Also, it is not clear how gNB deduces the exact data arrival time. |
| Ericsson | Option 4 | As activity is service specific, and G-RNTI maps to a MRB or set of MRBs reflecting this activity (qos etc), it seems natural to have a possible MAC-CE DRX command per G-RNTI. Text for 3.x is somewhat difficult to follow, but seems also 3.2 is ok..Better proposal would be to state e.g.:When the UE receives a DRX command MAC CE with DCI scrambled with G-RNTI then the UE stops drx-onDurationTimerPTM and drx-InactivityTimerPTM timer for that G-RNTI. |
| CATT | Option 1 | We think the benefits may be marginal considering there are multiple DRX configurations for MBS. |
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### 2.3.2 Short DRX

In MAC running CR for MBS, there is an editor note about short DRX for MBS DRX.

Editor’s note: FFS to support short DRX for MBS.

**Q8: Do companies agree to support short DRX for MBS, and please input the comments?**

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| Company | Yes/No? | Comments |
| OPPO | No, | In our understanding, there is no problem to support short DRX for multicast MBS DRX but it will introduce complexity in MBS DRX operation.MBS service is not delay sensitive service as URLLC. So no need to use short DRX especially in R17.If RAN2 cannot reach the consensus for short DRX, RAN2 should send LS to SA2 for confirmation.  |
| Samsung | No | Short DRX cycle may also have a mismatch problem among multiple UEs. We do not prefer to have such complexity. |
| Ericsson | Yes | The main use case for Short DRX is that can be used for voice during a talk burst (should be common in public safety), while long DRX is used during silence periods. If some UEs in the PTM group are in short DRX while others are in long DRX, then all UEs in the group anyway wake-up at the same time, but some wake-up more frequent then others. Support for Short DRX cycle is optional with explicit UE capability signalling for unicast in NR and can also be reused for MBS. |
| CATT | No | We think there is no great benefits to support short DRX in MBS.  |
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### 2.3.3 DRX operation in PTP for PTM retransmission case

In RAN1#104 meeting, the following agreement is made and it means:

PTM transmission + PTM retransmission 🡺 for same TB, same HARQ process id and NDI

PTM transmission +PTP retransmission 🡺 for same TB, same HARQ process id and NDI

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| Agreement:The same HARQ process ID and NDI are used for PTM scheme 1 (re)transmissions and PTP retransmissions of the same TB.Conclusion:The maximum number of HARQ processes per cell, currently supported for unicast, is kept unchanged for UE to support multicast reception.How to allocate HARQ processes between unicast and multicast is up to gNB. |

However, it is not clear whether the PTP for PTM retransmission is configured in RRC signalling or can be changed dynamically, e.g. in DCI.

**Option 1**: PTP for PTM retransmission is configured in RRC signalling per G-RNTI.

**Option 2**: PTM retransmission, i.e. via PTM or PTP, can be changed per TB or per TB per transmission.

Option 1 is simple, but RAN1 did not conclude the configuration in RRC for option 1 and this is not discussed in RAN1 yet. It is also not clear whether PTP for PTM retransmission is mandatory for UE who support multicast or it is optional even if the UE support multicast.

**Q9: Which option do companies prefer? If option 1 is chosen, please comment whether the LS to RAN1 is required?**

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| Company | Option 1/2? | Comments |
| OPPO | Option 2 | RAN1 did not conclude such RRC signalling for PTP for PTM retransmission. |
| Samsung | Option 1 | Option 1 is simple as the rapporteur mentioned. This is what RAN2 can decide. |
| Ericsson | Option 2 | One could consider on/off signaling by RRC, but do not think that is needed. If the functionality for handling HARQ operation modes and retransmission rely on RRC, the system becomes very inefficient and slow. |
| CATT | Option 2 | PTP for PTM retransmission should only be a RAN1 dynamic scheduling decision. |
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In RAN2#116 meeting, the following FFS are left and the following FFS is based on above option 1.

* [050] FFS how UE monitors UE specific PDCCH/C-RNTI for possible PTP transmission for PTM HARQ retransmission in active time of multicast DRX, the following alternatives are on the table (one to be selected):

Option 2: the UE monitors UE specific PDCCH/C-RNTI only when drx-RetransmissionTimerDLPTM is running and PTP retransmission is expected.

Option 3: the UE monitors UE specific PDCCH/C-RNTI only during unicast DRX’s active time. Unicast DRX’s RTT timer can be started when PTP retransmission is expected.

In PTP for PTM retransmission case, the UE will receive PTM via PTM leg scheduled in DCI scrambled with G-RNTI and receive PTM retransmission via PTP leg scheduled in DCI scrambled with C-RNTI if NACK.

In PTP for PTM retransmission case, if option 1 is chosen, there are 3 options to fix this issue:

**Option 1**: The per G-RNTI DRX is not configured if PTP for PTM retransmission is configured in RRC, and both PTM reception and PTP reception are controlled by unicast DRX.

**Option 2**: The per G-RNTI DRX is configured if PTP for PTM retransmission is configured in RRC and parameter *drx-RetransmissionTimerDLPTM* is also configured, and the UE monitors UE specific PDCCH/C-RNTI only when drx-RetransmissionTimerDLPTM is running and PTP retransmission is expected.

**Option 3**: The per G-RNTI DRX is configured if PTP for PTM retransmission is configured in RRC and parameter *drx-RetransmissionTimerDLPTM* is not configured, and the UE monitors UE specific PDCCH/C-RNTI only during unicast DRX’s active time. Unicast DRX’s RTT timer can be started when PTP retransmission is expected.

**Option 4:** The per G-RNTI DRX is configured if PTP for PTM retransmission is configured in RRC and parameter *drx-RetransmissionTimerDLPTM* is not configured, it is up to network to schedule PTP for PTM retransmission in active time of unicast DRX.

**Q10: Which option do companies prefer if PTP for PTM retransmission is configured in RRC signalling per G-RNTI?**

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| Company | Option 1/2/3/4? | Comments |
| OPPO | Option 4 | For option 1, there is only unicast DRX for both unicast reception and PTM reception. For option 2, UE will monitor UE specific PDCCH/C-RNTI when drx-RetransmissionTimerDLPTM is running. For option 3, PTM NACK will impact unicast DRX, i.e. drx-RetransmissionTimerDL.For simplicity, we prefer option 4 and ensure the MBS DRX is independent from unicast DRX. So drx-HARQ-RTT-TimerDLPTM and drx-RetransmissionTimerDLPTM are not useful any more for MBS DRX. The multicast DRX operation in PTM leg is similar as broadcast DRX. Furthermore, RAN2 once agreed that MBS DRX operation is independent from unicast DRX. |
| Samsung | Option 3 but | We do not see any problem on “PTM NACK will impact unicast DRX, i.e. drx-RetransmissionTimerDL.” If a retransmission is expected, the corresponding RTT timer should be started.We are wondering why we do not start the discussion based on original Option 2 and Option 3* [050] FFS how UE monitors UE specific PDCCH/C-RNTI for possible PTP transmission for PTM HARQ retransmission in active time of multicast DRX, the following alternatives are on the table (one to be selected):

Option 2: the UE monitors UE specific PDCCH/C-RNTI only when drx-RetransmissionTimerDLPTM is running and PTP retransmission is expected. Option 3: the UE monitors UE specific PDCCH/C-RNTI only during unicast DRX’s active time. Unicast DRX’s RTT timer can be started when PTP retransmission is expected. Samsung supported original Option 3 above. We think in the new options, the scope is reduced or distorted by limiting conditions such as “PTP for PTM retransmission is configured in RRC” and parameter *drx-RetransmissionTimerDLPTM* is not configured” We think it would be better to select one of original two options. |
| Ericsson | Comment | Agree with Samsung. Unicast DRX is independent, but the UE should monitor for PTP retransmissions when expected (based on HARQ etc). So original Option 2, 3 seems ok. The listed options are just to convoluted to be agreed as is. |
| CATT | None | See comments to Q9 |
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If PTM retransmission, i.e. via PTM or PTP, can be changed per TB or per TB per transmission and it is up to gNB to decide, i.e. option 2 is chosen. The UE will not know the PTM transmission is from PTM leg or PTP leg. So the gNB will monitor G-RNTI and C-RNTI. So the MBS DRX configuration should include drx-onDurationTimerPTM, drx-InactivityTimerPTM, drx-LongCycleStartOffsetPTM, drx-SlotOffsetPTM and also drx-HARQ-RTT-TimerDLPTM and drx-RetransmissionTimerDLPTM.

The MBS DRX operation will be same as PTM for PTM retransmission becaue the UE will not know whether there is PTM retranmission or not next. For PTP reception for PTM retransmission, it is also not foreseeable.

**Q11: Which option do companies prefer in above question if PTM retransmission, i.e. via PTM or PTP, can be changed per TB or per TB per transmission?**

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| --- | --- | --- |
| Company | Option 1/2/3/4? | Comments |
| OPPO | Option 4 | For option 1, there is only unicast DRX for both unicast reception and PTM reception. For option 2, UE will monitor UE specific PDCCH/C-RNTI when drx-RetransmissionTimerDLPTM is running. For option 3, PTM NACK will impact unicast DRX, i.e. drx-RetransmissionTimerDL.For simplicity, we prefer option 4 and ensure the MBS DRX is independent from unicast DRX. So drx-HARQ-RTT-TimerDLPTM and drx-RetransmissionTimerDLPTM are not useful any more for MBS DRX. The multicast DRX operation in PTM leg is similar as broadcast DRX. Furthermore, RAN2 once agreed that MBS DRX operation is independent from unicast DRX. |
| Samsung | Option 3 but | We prefer to decouple unicast DRX and MBS DRX as much as possible. RNTI monitoring is allowed during that RNTI’s Active Time - UE monitors UE-specific PDCCH by using C-RNTI during unicast DRX Active Time- UE monitors group-common PDCCH by using G-RNTI during MBS DRX Active Time for the G-RNTIWe think Option 3 is the closest.  |
| Ericsson | Comment | See previous input for Q9-10 |
| CATT |  | The UE monitors UE specific PDCCH/C-RNTI only when drx-RetransmissionTimerDLPTM(i.e. the option 2 from last meeting) |
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### 2.3.4 DRX operation in NACK only case

In RAN2#116 meeting, RAN2 made following agreement for DRX operation in NACK only case.

* [050] For group common PTM Multicast HARQ PUCCH resources (NACK only feedback), the same group of UEs have aligned HRAQ RTT and DL Re-Tx timer configuration. HARQ RTT timer counting starts from end of common PUCCH resource based NACK transmission (i.e. same as Unicast DRX behaviour). FFS for case of disabled HARQ FB.

However, this agreement is not captured in MBS MAC running CR because different companies have different understanding.

RAN1 agreed that if NACK only based HARQ feedback is configured but PUCCH resource for NACK only is not configured, then PUCCH resource for unicast is used for NACK only based HARQ feedback.

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| Agreement:For UE supporting both ACK/NACK based and NACK-only basedfeedback for multicast, for the same G-RNTI, support the following* UE can be configured with either ACK/NACK based or NACK-only feedback for a single G-RNTI.
	+ Note: Case1-1: if configured with ACK/NACK based feedback, UE can be optionally configured a separate *PUCCH-Config/PUCCH-ConfigurationList* for multicast. Otherwise, *PUCCH-Config/PUCCH-ConfigurationList* for unicast applies (This has been agreed.)
	+ Case 1-2: if configured with NACK-only based feedback, when separate *PUCCH-Config/PUCCH-ConfigurationList* for NACK-onlyis not configured, *PUCCH-Config/PUCCH-ConfigurationList* for unicast applies.
 |

No matter it is NACK only based HARQ feedback or ACK/NACK based HARQ feedback, if there is real HARQ feedback transmission, it is same and the RTT timer will be started in the first symbol after the end of the corresponding transmission carrying the DL multicast HARQ feedback.

|  |
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| 2> if the PDCCH indicates a DL multicast transmission:3> start the *drx-HARQ-RTT-Timer-DL-PTM* for the corresponding multicast HARQ process in the first symbol after the end of the corresponding transmission carrying the DL multicast HARQ feedback. |

If there is no real HARQ feedback transmission due to ACK, it is not clear whether to start RTT timer and what is the time point to start.

In unicast DRX, no matter the HARQ feedback is ACK or NACK, the UE will start the DRX RTT timer for power saving purpose in DRX RTT timer running period. If the MAC PDU is not decoded successfully, the DRX retransmission timer will be started after DRX RTT timer expiries, otherwise, the DRX retransmission timer will be not started.

In MBS reception, if NACK only based HARQ feedback is configured, the ACK UE does not know if there is other UE feedback NACK and the ACK UE also does not know whether the next transmission in this HARQ process is new transmission or retransmission. No matter the next transmission is new transmission or retransmission, the UE does not need to monitor the PDCCH in the RTT timer period for UE power saving purpose. After DRX RTT timer expiries, the UE can start DRX retransmission timer to receive the new transmission or retransmission. Some companies may think no need to start DRX retransmission timer because there is no need to receive retransmission due to ACK. However, if the UE does not start RTT timer, the UE may keep active and results in power consumption during RTT running period.

**Option 1**: If there is no real HARQ feedback transmission due to ACK in NACK only case, the UE will not start DRX RTT timer.

**Option 2**: If there is no real HARQ feedback transmission due to ACK in NACK only case, the UE start the DRX RTT timer in the first symbol after the end of the corresponding PUCCH resource for NACK only feedback (the PUCCH resource can be NACK only PUCCH resource if configured or unicast PUCCH resource if PUCCH resource for NACK only based HARQ feedback is not configured).

**Q12: Which option do companies support if there is no real HARQ feedback transmission due to ACK in NACK only case?**

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| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Option 2 | If the UE does not start RTT timer due to ACK in NACK only case, the UE may keep active and results in power consumption during RTT running period. |
| Samsung | Option 1 | Option 1 is the same as unicast. There is no need to start the HARQ RTT timer, because DRX Retransmission Timer will not be started. |
| Ericsson | Option 1 | Agree with Samsung. Very unclear what the resulting proposal of specification text into MAC would be if not, especially for Option 2. |
| CATT | Option 1 | We understand it is obvious that RTT timer should not be started if the PDSCH data is decoded correctly. |
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After DRX RTT timer expiries, whether to start DRX retranmission timer?

**Option 1:** After DRX RTT timer expiries, UE will not start DRX retranmission timer if the corresponding MAC PDU is decoded sucessfully?

**Option 2:** After DRX RTT timer expiries, no matter the MAC PDU is decoded successfully or not, the UE will start DRX retransmission timer, if the HARQ process id and NDI indicate it is a retransmission, the UE can ignore the DCI.

**Q13: Which option do companies support whether to start DRX retranmission timer after DRX RTT timer expiries?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Option 2 | In MBS reception, if NACK only based HARQ feedback is configured, the ACK UE does not know if there is other UE feedback NACK and the ACK UE also does not know whether the next transmission in this HARQ process is new transmission or retransmission.  |
| Samsung | Option 1 | Option 1 is the same as unicast. There is no reason to start the Retransmission Timer in case of the successful reception. We do not see any reason to change the unicast behaviour. |
| Ericsson | Option 1 | Agree w Samsung |
| CATT | Option 1 | Follow the same principle as unicast |
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In RAN1#106 bis, RAN1 made following agreement. UE will Transform NACK-only into ACK/NACK HARQ bits if more than one NACK-only based feedback are available for transmission in the same PUCCH slot and use UE specific PUCCH resource.

|  |
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| Agreement:When more than one NACK-only based feedback are available for transmission in the same PUCCH slot, further decide based on the following subset of alternatives (from previous agreement) with potential further down-selection:* Alt1: Support UE multiplexing the HARQ-ACK bits by transforming NACK-only into ACK/NACK HARQ bits.
 |

In my understanding, there will be real HARQ feedback transmission no matter the HARQ feedback is ACK or NACK, so the legacy behaviour can be followed and no spec impact.

**Q14: Do commanies agree that there is no spec impact when more than one NACK-only based feedback are available for transmission in the same PUCCH slot, UE will transform NACK-only into ACK/NACK HARQ bits.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Yes |  |
| Ericsson | Yes |  |
| CATT | Yes |  |
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### 2.3.5 DRX operation for HARQ disable case

In RAN1#106bis, RAN1 made following agreement. It means that the HARQ enabling/disabling indication can be indicated in RRC signalling or DCI.

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| Agreement:If the group-common DCI indicating the enabling/disabling ACK/NACK based HARQ-ACK feedback is not configured, enabling/disabling ACK/NACK based HARQ-ACK feedback is configured per G-RNTI by UE RRC signalling.  |

In RAN1#107, RAN1 made following agreement. It means that HARQ enabling/disabling can be changed in each PTM (re)transmission.

|  |
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| **Agreement*** For PTM retransmission,
	+ if UE is configured to enable/disable HARQ-ACK per group-common DCI indication for initial transmission, whether HARQ-ACK is enabled/disabled for PTM retransmission also follows the indication in the group-common DCI scheduling the PTM retransmission.
	+ if UE is configured directly whether the HARQ-ACK is enabled/disabled, it applies to both PTM initial transmission and retransmission.
* For PTP retransmission, the HARQ-ACK is always enabled.
 |

If the HARQ is disable for PTM leg via RRC signalling, it means there is no HARQ feedback and no PTM retransmission in PTM leg. So the *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM* are not useful any more for MBS DRX. The multicast DRX operation in PTM leg is similar as broadcast DRX.

**Proposal: For ACK/NACK based HARQ feedback, if RRC based HARQ disable/enable is configured in RRC signalling, the MBS DRX configuration for PTM leg only includes *drx-onDurationTimerPTM*, *drx-InactivityTimerPTM*, *drx-LongCycleStartOffsetPTM*, *drx-SlotOffsetPTM*. The multicast DRX operation in this case is similar as broadcast MBS.**

**Q15: Do companies agree the above proposal for HARQ ACK/NACK based feedback?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | No | Even if HARQ feedback is disabled for a UE, gNB can retransmit the data for other UEs or perform blind retransmission. In this case, UE should be able to receive the retransmission. Especially, cell-edge or poor-coverage UEs without HARQ FB can be benefited.  |
| Ericsson | No | Agree with Samsung |
| CATT | No | Agree with Samsung |
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If the HARQ is disable for PTM leg via DCI, the *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM* are useful. When HARQ is disable in DCI, there is no HARQ feedback and also no retransmission, so no need to start the *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM* timer and should be stopped if running. When HARQ is enable in DCI, there is HARQ feedback and also retransmission, so need to start the *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM* timer as legacy behaviour.

**Proposal: For ACK/NACK based HARQ feedback, if DCI based HARQ disable/enable is controlled in DCI, the MBS DRX configuration for PTM leg includes *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM and also drx-onDurationTimerPTM*, *drx-InactivityTimerPTM*, *drx-LongCycleStartOffsetPTM*, *drx-SlotOffsetPTM*. When HARQ is disable in DCI, do not start the *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM* timer and stop the two timers if running.**

**Q16: Do companies agree the above proposal for HARQ ACK/NACK based feedback?**

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| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | No | Even if HARQ feedback is disabled for a UE, gNB can retransmit the data for other UEs or perform blind retransmission. In this case, UE should be able to receive the retransmission. Especially, cell-edge or poor-coverage UEs without HARQ FB can be benefited.  |
| Ericsson | No | Again, agree with Samsung |
| CATT | No | Agree with Samsung |
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In RAN1#107 meeting, RAN1 make the following agreement for NACK only based HARQ feedback.

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| **Agreement**Support enabling/disabling HARQ-ACK for NACK-only based feedback. * The relevant agreements made for ACK/NACK based feedback can be extended for the support of NACK-only, including:
	+ RRC signalling configures the presence of the field “enabling/disabling HARQ-ACK feedback indication” in the group-common DCI and the configuration is per G-RNTI.
	+ RRC signalling configures directly whether the HARQ-ACK feedback is enabled or disabled and the configuration is per G-RNTI.
 |

For the same reason as ACK/NACK based HARQ feedback, the following proposal is for HARQ enable/disable in NACK only case.

**Proposal: For NACK only based HARQ feedback, it is same as ACK/NACK based feedback:**

* **If RRC based HARQ disable/enable is configured in RRC signalling, the MBS DRX configuration for PTM leg only includes *drx-onDurationTimerPTM*, *drx-InactivityTimerPTM*, *drx-LongCycleStartOffsetPTM*, *drx-SlotOffsetPTM*. The multicast DRX operation in this case is similar as broadcast MBS.**
* **If DCI based HARQ disable/enable is configured in RRC signalling, the MBS DRX configuration for PTM leg includes *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM and also drx-onDurationTimerPTM*, *drx-InactivityTimerPTM*, *drx-LongCycleStartOffsetPTM*, *drx-SlotOffsetPTM*.**
* **When HARQ is disable in DCI, do not start the *drx-HARQ-RTT-TimerDLPTM* and *drx-RetransmissionTimerDLPTM* timer and stop the two timers if running.**

**Q17: Do companies agree the above proposal for NACK only based feedback?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | No | Even if HARQ feedback is disabled for a UE, gNB can retransmit the data for other UEs or perform blind retransmission. In this case, UE should be able to receive the retransmission. Especially, cell-edge or poor-coverage UEs without HARQ FB can be benefited.  |
| Ericson | No | See earlier input |
| CATT | No | Same view as that for the HARQ ack/nack case. |
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### 2.3.6 CSI and SRS reporting due to MBS DRX

In MAC running CR for MBS, there is an editor note about CSI and SRS reporting due to MBS DRX.

Editor’s note: FFS to CSI and SRS reporting due to MBS DRX.

RAN2 once agreed that the MBS DRX will be independent from unicast DRX. It is not clear whether the MBS DRX will also impact the CSI and SRS reporting like below text.

|  |
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| 1> if *drx-onDurationTimer* associated with the current DRX cycle is not started as specified in this clause:2> if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause:3> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7];3> not report semi-persistent CSI configured on PUSCH;3> if *ps-TransmitPeriodicL1-RSRP* is not configured with value *true*:4> not report periodic CSI that is L1-RSRP on PUCCH.3> if *ps-TransmitOtherPeriodicCSI* is not configured with value *true*:4> not report periodic CSI that is not L1-RSRP on PUCCH.1> else:2> in current symbol n, if a DRX group would not be in Active Time considering grants/assignments scheduled on Serving Cell(s) in this DRX group and DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause:3> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7] in this DRX group;3> not report CSI on PUCCH and semi-persistent CSI configured on PUSCH in this DRX group.2> if CSI masking (*csi-Mask*) is setup by upper layers:3> in current symbol n, if *drx-onDurationTimer* of a DRX group would not be running considering grants/assignments scheduled on Serving Cell(s) in this DRX group and DRX Command MAC CE/Long DRX Command MAC CE received until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause; and4> not report CSI on PUCCH in this DRX group.NOTE 4: If a UE multiplexes a CSI configured on PUCCH with other overlapping UCI(s) according to the procedure specified in TS 38.213 [6] clause 9.2.5 and this CSI multiplexed with other UCI(s) would be reported on a PUCCH resource either outside DRX Active Time of the DRX group in which this PUCCH is configured or outside the on-duration period of the DRX group in which this PUCCH is configured if CSI masking is setup by upper layers, it is up to UE implementation whether to report this CSI multiplexed with other UCI(s). |

**Q18: Do companies agree that the similar text in above box should also be captured in MAC running CR for MBS DRX in section 5.7b?**

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| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | No | CSI reporting/SRS can follow unicast DRX. We do not think MBS DRX should additionally affect them. |
| Ericsson | No | We do not see why the unicast mechanism is impacted and why not the same principles can be reused also for MBS |
| CATT | No | SRS/CSI reporting should not be considered in MBS DRX. |
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### 2.3.7 Active Time in MBS

In MAC running CR for MBS, there is an editor note about active time for MBS DRX.

Editor’s note: FFS other condition to define the Active Time.

For now, rapporteur cannot see other condition to define the active time for MBS DRX.

**Q19: Do companies agree to remove this editor note about active time for MBS DRX?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Yes |  |
| Ericsson  | Yes |  |
| CATT | Yes |  |
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## 2.4 Others

### 2.4.1 The necessary to specify to define subPDU discarding

In #67 email discussion on the MBS MAC running CR, some companies propose that UE should discard some subPDU and the subPDU is not for the UE based on following agreement made in RAN2#116.

* one-to-many mapping between G-RNTI and MBS sessions is supported and it is assumed that this does not introduce additional specification work.

So the following spec change is made:

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| 5.3.3 Disassembly and demultiplexingThe MAC entity shall disassemble and demultiplex a MAC PDU as defined in clauses 6.1.2 and 6.1.5a.When a MAC entity receives a MAC PDU scrambled by a G-RNTI containing one or more LCIDs corresponding to the MBS sessions that the UE is not interested in, the MAC entity shall:1> discard the received subPDU. |

However, some companies think that smart network implementation would avoid the case where the UE receives a service that it is not interested in.

The following questions need RAN2 further to confirm.

Q1: Whether the above agreement is valid for both multicast and broadcast?

Q2: Network ensure that all MBS sessions associated one G-RNTI are interested by UE?

For Q1, it depends on Q2. Anyway, it is hard for network to ensure that all MBS sessions associated one G-RNTI are interested by all UEs in MBS broadcast. If the answer to Q2 is yes, then the above agreement is not valid for broadcast case and only one to one mapping is supported in broadcast MBS. If the answer to Q2 is no, the above agreement is also valid for broadcast MBS and RAN2 should confirm the above change is captured in MBS MAC running CR or not.

**Option 1:** Network ensure that all MBS sessions associated one G-RNTI are interested by UE for both multicat MBS and broadcast MBS. Only one to one mapping between G-RNTI and MBS sessions is supported for broadcast MBS.

**Option 2:** Network may not ensure that all MBS sessions associated one G-RNTI are interested by UE, the above spec change is captured in MBS MAC running CR.

**Q20: Which option do companies agree?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Option 2 | It is simple and no restriction to network.  |
| Samsung | Option 1 | UE can be configured with multiple G-RNTIs. Thus, NW can avoid the multiplxing of interested service and non-interested service. Also, UE does not need to decode data in which UE is not interested. This unnecessary decoding just increase UE’s power consumption and processing. |
| Ericsson | Option 2 | A reasonable NW and MBS Session and RB configuration would not lead to any big issues in most cases. In any case, the specification allows for UEs to discard unknown or errorneus payload |
| CATT | Option 1,but | Option 1 is preferred, but even Network may not ensure that all MBS sessions associated one G-RNTI are interested by UE, the UE can discard the MAC subPDUs that the UE is not interested in per the existing mechanism,no additional spec change is needed. |
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### 2.4.2 Impact on BWP switching inactivity timer due to multicast and broadcast reception

According to RAN1 agreements in RAN1#107, the multicast MBS reception will impact BWP switching inactivity timer, but the broadcast MBS reception will not. RAN2 should confirm it.

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| **Agreement**For multicast, if a UE is configured with a CFR in the active DL BWP, for timer-based active DL BWP switching to a default BWP, option 1 is supported.* Option 1: UE also starts or restarts BWP-InactivityTimer when it successfully decodes a GC-PDCCH addressed to group-common RNTI (e.g., G-RNTI or G-CS-RNTI) for multicast on/for the active BWP or when a MAC PDU for is received in a configured downlink assignment for multicast.
	+ UE does not start or restart BWP-InactivityTimer when it successfully decodes a GC-PDCCH addressed to group-common RNTI (e.g., G-RNTI or G-CS-RNTI) for broadcast.
 |

**Q21: Do companies confirm the multicast MBS reception will impact BWP switching inactivity timer, but the broadcast MBS reception will not, and capture it in MAC running CR?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | Yes |  |
| Ericsson | Yes, comment | It is unclear what is to be captured in the specification in the above. Suggest this to be part of the running CR discussion. |
| CATT | Yes |  |
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Furthermore, if the UE is receiving broadcast reception and the default BWP is not initial BWP, whether the UE should active initial BWP instead of default BWP for broadcast BWP reception, when the BWP inactivity timer expiry.

**Option 1**: If the UE is receiving the broadcast MBS when enter RRC\_CONNECTED state, the network will not configure the default BWP not contain the initial BWP.

**Option 2**: If the UE is receiving the broadcast MBS in RRC\_CONNECTED state, UE should active initial BWP instead of default BWP when BWP-InactivityTimer expiries.

**Q22: Which option do companies agree?**

|  |  |  |
| --- | --- | --- |
| Company | Option 1/2? | Comments |
| OPPO | Option 1 | Option 1 is simple and is up to network. |
| Samsung | none | We think broadcast can be a best-effort manner. It’s up to NW whether to guarantee the ongoing broadcast reception. What is only needed is MII reporting UE’s interested/ongoing broadcast service to the gNB. |
| Ericsson |  | Agree with Samsung. The options are also unclear in what is assumed in reception of BC in connected and what can be simultaneous etc |
| CATT | Option 1 |  |
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### 2.4.3 MBS support in MR-DC

In RAN2#111 meeting, RAN2 left a TBD for NR-DC and NE-DC to support MBS in MCG side.

* Focus initially on NR SA, TBD to what extent other scenarios NR DC, NE DC can be supported.

In rapporteur’s understanding, there is no spec impact to support multicast MBS in MCG side in NE-DC and NR-DC scenarios.

**Q23: Do companies agree that MBS can be supported in MCG side in NE-DC and NR-DC scenarios, i.e., MN terminated MCG bearer kind of MRB?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes |  |
| Samsung | No strong view |  |
| Ericsson |  | Think this needs a bit more discussion. What does “MBS” mean here w.r.t “sub” functionality in Multicast and BC. |
| CATT | Yes |  |
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### 2.4.4 LCID for broadcast MRB

In RAN2#115 meeting, RAN2 achieve the following agreements for LCID for MRB.

* Single bearer ID is used for each Multicast RB.
* Multicast PTP and Unicast DTCH/DRB share common LCID space.
* Broadcast PTM/MTCH uses reserved LCID(s), which is different than Unicast DTCH/DRB LCID space.
* Broadcast MCCH uses reserved LCID .

During Email discussion of MAC running CR, one new table of LCID is defined for broadcast MRB.

Table 6.2.1-1c Values of LCID for NR broadcast MBS on DL-SCH

|  |  |
| --- | --- |
| Codepoint/Index | LCID values |
| 0 | MCCH |
| 1–32 | Identity of the logical channel for PTM MTCH via broadcast |
| 33–63 | Reserved |

Editor’s note: FFS new table for broadcast MBS and the maximal value.

Some companies think the new table should be defined for broadcast MRB based on following reasons:

* The MRBs for broadcast is multiple and multiple LCID will be used.
* The reserved LCID is limited, it is from 35 to 46.

However, some companies think the reserved LCID for DRB, i.e. in table “Table 6.2.1-1”, should be used for broadcast.

Consider the extension in the future, it is better to use new table as MAC running CR captured for MCCH, MTCH of broadcast.

**Q24: Do companies agree to remobe the editor notes for LCID in broadcast?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No? | Comments |
| OPPO | Yes  |  |
| Samsung | No strong view |  |
| Ericsson | Yes | Seems ok, no strong view |
| CATT | Yes |  |
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# Conclusions

Based on the discussion above, we propose:

# Reference