**3GPP TSG RAN WG1 #106-e**  **R1-210xxxx**

**e-Meeting, August 16th – 27th, 2021**

**Agenda item:** 8.12.1

**Source:** Moderator (CMCC)

**Title:** Summary# on mechanisms to support group scheduling for RRC\_CONNECTED UEs for NR MBS

**Document for:** Discussion/decision

# Introduction

The WI NR\_MBS was approved in RAN plenary #86 meeting [1], and the WID was revised in RAN plenary #88 e-meeting [2]. One of the objectives is to specify a group scheduling mechanism to allow UEs to receive Broadcast/Multicast service, and this objective also includes specifying necessary enhancements that are required to enable simultaneous operation with unicast reception.

The following email thread for group scheduling is announced by chairman in RAN1#106-e:

[106-e-NR-MBS-01] Email discussion/approval on mechanisms to support group scheduling for RRC\_CONNECTED UEs with checkpoints for agreements on August 19, 24 and 27 – Fei (CMCC)

In this contribution, we summarized the related issues and proposals based on the contributions submitted in RAN1#106-e under the agenda item 8.12.1 [4]-[30]. The reply LS on G-RNTI and G-CS-RNTI for MBS from RAN2 [3] was also be taken into account, the response from RAN2 is as follows:

**During RAN2#114-e meeting, RAN2 agreed that in order to receive multiple MBS services, UE need to support multiple G-RNTIs and/or G-CS-RNTIs. And it is FFS whether this depends on UE capability.**

Based on the contributions, the following sections are structured as follows:

From section 2 to 7, we categorized the key issues raised by contributions into 6 kinds and each section covers one kind of issues. In each section, we first provide the background and related proposals submitted in this meeting in sub-section X.1, then one or several initial proposals related to this issue are recommended by moderator in sub-section X.2, and then in sub-section X.3 one or more tables are provided to collect company views for the initial proposals in the 1st round email discussion, and then in sub-section X.4 the proposals will be updated based on companies’ inputs. As email discussion goes on, we may add more sub-sections for companies to provide views for the next round email discussion and for moderator to provide further updated proposals.

In section 8, some proposals will be selected for discussion in the GTW session.

If possible, please try to provide your replies within 24h. Moderator will try to update the proposals based on companies’ inputs on a daily basis.

# Issue #1: CFR and general configurations for MBS

## Background and submitted proposals

***Background***

In RAN1#104&104bis&105 meetings, the following agreements were achieved for CFR for multicast of RRC-CONNECTED UEs.

**Option 2A vs 2B for CFR:**

Agreement (#104):

For multicast of RRC-CONNECTED UEs, a common frequency resource for group-common PDCCH / PDSCH is confined within the frequency resource of a dedicated unicast BWP to support simultaneous reception of unicast and multicast in the same slot

* Down select from the two options for the common frequency resource for group-common PDCCH/ PDSCH
  + Option 2A: The common frequency resource is defined as an MBS specific BWP, which is associated with the dedicated unicast BWP and using the same numerology (SCS and CP)
    - FFS BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP
  + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.
    - FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region
* FFS whether UE can be configured with no unicast reception in the common frequency resource
* FFS on details of the group-common PDCCH / PDSCH configuration
* FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities
* FFS whether the use of a common frequency resource for multicast is optional or not
* FFS whether the common frequency resource is applicable for PTM scheme 2 (if supported) or not

Agreement (#104):

* If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the starting PRB and the length of PRBs of the MBS frequency region within a dedicated unicast BWP are configured via UE-specific RRC signaling.
  + The starting PRB is referenced to one of the two options:
    - Option 1: Point A
    - Option 2: the starting PRB of the dedicated unicast BWP
  + FFS the detailed signaling
* If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of the starting PRB and the length of PRBs of the MBS frequency resource reuse the legacy BWP configuration.

Agreement (#104):

From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes the following configurations:

* Starting PRB and the number of PRBs
* One PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP)
* One PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP)
* SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP)
* FFS: Other configurations and details including whether signaling of starting PRB and the length of PRBs is needed when CFR is equal to the unicast BWP
* FFS: Whether a unified CFR design is also used for broadcast reception for RRC\_IDLE/INACTIVE and RRC\_CONNECTED
* FFS: Whether Coreset(s) for CFR in addition to existing Coresets in UE dedicated BWP is needed
* Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2
* Note: This agreement does not negate any previous agreements made on CFR

Conclusion (#104b):

It is based on gNB implementation to schedule unicast on the frequency resources covered by CFR configured for multicast.

Agreement (#104b):

The down-selection of Option 2A and Option 2B for CFR for multicast of RRC-CONNECTED UEs will be made before the end of RAN1#105-e.

Working assumption (#105):

Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.

* FFS: CFR associated with initial BWP
* FFS: CFR larger than initial BWP

**Number of CFRs and optionality of CFR:**

Agreement(#104b):

One CFR is supported per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.

* FFS: Whether more than one CFR is supported per dedicated unicast BWP
* FFS: Whether multicast can be supported or not in a dedicated unicast BWP when no CFR is configured for that BWP

**Rate matching and TBS determination:**

Agreement:

For multicast of RRC\_CONNECTED UEs, further study

* How the LBRM (Limited buffer rate-matching) for GC-PDSCH TBS is determined.
* How the xOverhead for GC-PDSCH TBS determination is configured.
* Whether MAC-CE over GC-PDSCH is needed for activation/deactivation of semi-persistent ZP CSI-RS resource set if the semi-persistent ZP CSI-RS resource set is configured in PDSCH-Config in CFR.

***Submitted Proposals***

***Option 2A vs 2B for* CFR:**

* *Huawei, HiSilicon*
  + Proposal 1: For the common frequency resource configuration for multicast
    - Confirm the Working Assumption of Option 2B:
      * The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.
* *OPPO*
  + Observation 1: Even though CFR is configured as MBS specific BWP, it is not necessarily to activate the BWP for MBS reception.
  + Proposal 1: Option 2A should be agreed for CFR configuration, where MBS specific BWP should not occupy BWP ID 0~4 and should not be activated.
* *CATT*
  + Proposal 1: Confirm the working assumption that Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.
* *Nokia*
  + Proposal-1: Confirm the working assumption related to option 2B for configuring multicast common frequency resources, due to the additional complexities involved in the use of option 2A related to BWP switching.
* *MediaTek*
  + Proposal 1: Confirming the following working assumption:
    - Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.
* *FUTUREWEI*
  + Proposal 2: Confirm the Working Assumption on the support of Option 2B.
* *ETRI*
  + Observation1: The option 2A requires BWP switching which causes huge overhead for unicast and MBS multiplexing.
  + Proposal1: Confirm the working assumption:
    - Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.
      * FFS: CFR associated with initial BWP
      * FFS: CFR larger than initial BWP
* *CMCC*
  + Proposal 1. Confirm the working assumption:
    - Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.
      * FFS: CFR associated with initial BWP
      * FFS: CFR larger than initial BWP
* *Intel*
  + Proposal 1: The working assumption on adoption of Option 2B for CFR associated with UE active BWP other than initial BWP should be confirmed.
* *Samsung*
  + Observation 1: The WA on the CFR has no technical problem and can be confirmed.
* *Lenovo*
  + Proposal 1: Confirm the working assumption that Option 2B is supported for CFR configuration.
* *Ericsson*
  + Proposal 10: Confirm the working assumption about Option 2B and turn this into an agreement
* *Sony*
  + Proposal 4: RAN1 to agree that both Option 2A and Option 2B are supported for MBS and inform RAN2 of this decision.
* *NEC*
  + Proposal 1: Confirm the following working assumption for the definition of CFR.
    - Working assumption:
      * Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.
* *Xiaomi*
  + Proposal 1: Confirm the following working assumption with the following updates:
    - Working assumption:
      * Option 2B for CFR associated with UE active BWP ~~other than initial BWP~~ is supported at least for multicast of RRC-CONNECTED UEs.
        + ~~FFS: CFR associated with initial BWP~~
        + ~~FFS: CFR larger than initial BWP~~

***Relation between CFR and initial BWP:***

* *Huawei, HiSilicon*
  + Proposal 1: For the common frequency resource configuration for multicast
    - Support CFR associated with initial BWP and is not larger than the SIB1 configured initial BWP.
* *OPPO*
  + Proposal 4: The association between CFR and initial BWP is up to network configuration.
* *ZTE*
  + Proposal 1: CFR can be configured larger than active downlink BWP, if the active downlink BWP is the initial BWP defined by CORESET#0.
    - Prioritize the corresponding discussion in RRC IDLE/INACTIVE state to strive for a consistent solution for all RRC states
* *CATT*
  + Proposal 2：CFR associated with initial BWP is also supported at least for multicast of RRC-CONNECTED UE, and bandwidth of the CFR associated with initial BWP shall not be larger than initial BWP.
  + Proposal 3: when CFR is not associated with initial BWP by RRC configuration, the bandwidth of CFR can be larger than initial BWP, it is gNB implement issue.
* *Nokia*
  + Observation-4: Initial BWP is configured using SIB1 and could be used for initial access RRC connection is established, and CFR is configured using RRC configurations after initial access and establishing the RRC connection, in order to receive multicast traffic.
  + Observation-5: If a case UE is simultaneously receiving broadcast and multicast traffic, the CFR could be overlapping in the frequency domain with initial BWP.
  + Proposal-2: The association between CFR and initial BWP should be left to gNB implementation.
  + Observation-6: The association of CFR is with the UE’s dedicated unicast BWP and not the initial BWP.
  + Proposal-3: The size of the CFR relative to the initial BWP could also be left to gNB implementation.
* *MediaTek*
  + Proposal 2: For multicast reception, the CFR can be flexible configured, which can be larger, smaller or equal to initial BWP.
* *Intel*
  + Proposal 2: The UE does not expect a CFR larger than the initial BWP if the initial BWP is the active BWP of the UE. In case of a CFR larger than initial BWP, it should be configured within an unicast BWP which can fully contain the CFR and the UE is expected to be switched this BWP before MBS reception within the CFR.
* *LGE*
  + Proposal 1: For a connected UE receiving multicast (as well as idle/inactive UEs receiving broadcast), CFR associated to initial DL BWP can be configured with a wider bandwidth than the initial DL BWP or a bandwidth equal to or smaller than the initial DL BWP.
  + Proposal 4: For broadcast, CFR of a cell is associated at least to initial DL BWP of the cell for any RRC state.
    - FFS whether broadcast CFR is associated to UE’s active DL BWP for UE in RRC\_CONNECTED.
* *Ericsson*
  + Proposal 8: A CFR may be associated with the Initial BWP, provided the CFR and Initial BWP occupy identical frequency regions.
  + Proposal 9: When the active BWP is other than the initial BWP, a configured CFR (on the active BWP) may be larger than the Initial BWP, provided the Initial BWP is contained within the CFR.

***Starting PRB and length of PRBs* of Option 2B for CFR*:***

* *ZTE*
  + Proposal 2: Regarding the CFR configuration,
    - The reference of starting PRB for CFR is Point A.
* *vivo*
  + Proposal 1: For CFR for multicast of RRC-CONNECTED UEs, the starting PRB of the CFR within a dedicated unicast BWP configured via UE-specific RRC signaling is referenced to the starting PRB of the dedicated unicast BWP.
* *CATT*
  + Proposal 6: For MBS CFR, the starting PRB is referenced to the Point A.
  + Proposal 7: RIV indication mechanism in Rel-15 NR can be reused to indicate CFR.
* *Nokia*
  + Proposal-24: The key requirement for receiving multicast data using group common PDCCH is to signal the starting PRB relative to the UE-dedicated BWP as a frequency resource / PRB offset parameter, and the length of PRBs or CFR size for the MBS CFR.
    - Note: The signaling details of these parameters could be RAN2 decision.
  + Proposal-25: The starting PRB should be referenced to the starting PRB of the dedicated unicast BWP.
* *MediaTek*
  + Proposal 7: Point A is referenced to the starting PRB of the dedicated unicast BWP.
* *FUTUREWEI*
  + Proposal 3: The starting PRB and the number of PRBs of the CFR within the unicast BWP is signaled in the SIB as a baseline. Additional configuration using RRC can also be considered. In the absence of SIB signaling, the starting PRB and the number of PRBs of the CFR equal the unicast BWP. Both starting location and the length can be jointly encoded to reduce overhead in the signaling.
* *ETRI*
  + Observation2: It is natural to indicate location of the MBS frequency region refer to the BWP which includes the MBS frequency region.
  + Proposal3: The starting PRB of the dedicated unicast BWP is used as a reference point to indicate the starting PRB of the MBS frequency region.
* *CMCC*
  + Proposal 4. If the CFR is equal to the unicast BWP, the signalling of starting PRB and the length of PRBs is not needed, which UE assumes the bandwidth of CFR equals to the unicast BWP.
* *Apple*
  + Proposal 1: The starting PRB of CFR is referenced to the Point A.
* *Lenovo*
  + Proposal 2: The starting PRB index and the number of contiguous PRBs of the MBS frequency region are configured within the dedicated unicast BWP via RRC signaling.
  + Proposal 3: The starting PRB of the MBS frequency region is configured with reference to the starting PRB of the dedicated unicast BWP.
* *Ericsson*
  + Proposal 11: We therefore propose to support Option 1 for functionality reasons and for having a common solution for multicast and broadcast. The reference point for the starting PRB of the CFR is Point A.
* *Xiaomi*
  + Proposal 2: The starting PRB of CFR should be referenced to point A.

**Number of CFRs:**

* *Huawei, HiSilicon*
  + Proposal 2: For CFR for multicast scheduling confined within a dedicated unicast BWP,
    - One CFR per a dedicated BWP is sufficient in Rel-17.
* *OPPO*
  + Proposal 2: Support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities.
* *ZTE*
  + Proposal 2: Regarding the CFR configuration,
    - More than one CFR can be supported per dedicated unicast BWP.
* *vivo*
  + Observation 1: When considering whether to support more than one CFR per UE / per dedicated unicast BWP subjected to UE capabilities, the issue of power consumption should be considered.
  + Proposal 3: More than one CFR is supported based on UE capability per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.
* *CATT*
  + Proposal 4：At most one CFR can be associated with a dedicated unicast BWP.
  + Proposal 5: One CFR configuration can be present when CFR is associated with more than one BWP.
* *MediaTek*
  + Proposal 5: Not support more than one common frequency resources for NR MBS.
* *FUTUREWEI*
  + Proposal 4: Only 1 CFR per unicast BWP per UE can be configured.
* *CMCC*
  + Proposal 2. Don’t support more than one CFR for multicast service per dedicated unicast BWP.
* *Intel*
  + Proposal 6: One CFR per dedicated BWP is sufficient for scheduling MBS transmissions.
* *Samsung*
  + Observation 2: There is no need to support more than one CFR per active DL BWP for a UE.
* *LGE*
  + Proposal 3: If a CFR is confined within more than one UE active BWP with a same numerology, the CFR can be associated to more than one BWP.
    - Upon unicast BWP switching between UE’s active BWPs associated to the same CFR, UE does not change CFR and continues to receive PTM/PTP (re-)transmissions on the CFR during/after unicast BWP switching.
* *NTT Docomo*
  + Proposal 1: Support at most one common frequency resource per dedicated unicast BWP.
* *Chengdu TD Tech*
  + Proposal 3: More than one CFRs can be supported per unicast BWP.
* *Ericsson*
  + Proposal 12: Limit number of CFRs for multicast to one in Rel.17.

**Optionality of CFR:**

* *OPPO*
  + Proposal 3: Multicast is not supported in a dedicated unicast BWP when no CFR is configured for that BWP.
* *ZTE*
  + Proposal 2: Regarding the CFR configuration,
    - The parameters configured under the dedicated unicast BWP can be used for MBS transmission if these parameters are not configured under the CFR.
* *Nokia*
  + Proposal-4: Agree that CFR for multicast defaults to the UE-dedicated unicast BWP, and when there is no explicit unicast traffic scheduled within the BWP.
  + Proposal-5: Agree that it is up to RAN2 decision regarding the provisioning of CFR configurations when the CFR is same as the dedicated unicast BWP.
* *MediaTek*
  + Proposal 6: CFR should be configured if UE wants to receive multicast broadcast services.
* *FUTUREWEI*
  + Proposal 5: Without CFR configured, multicast reception by default is not supported. In combination with Proposal 3, the support of Option 4 (listed above) is proposed i.e., the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *CMCC*
  + Proposal 3. Multicast cannot be supported in a dedicated unicast BWP when no CFR is configured for that BWP.
  + Proposal 5. If the PDSCH-config/PDCCH-config for MBS is not configured, the PDSCH-Config/PDCCH-config of the dedicated unicast BWP can be re-used for group-common PDCCH/PDSCH.
* *CATT*
  + Proposal 8: When some fields in PDSCH-Config for MBS are same as the fields in PDSCH-Config of the dedicated unicast BWP, the corresponding fields in PDSCH-Config of the dedicated unicast BWP can be the default configuration.
  + Proposal 9: When some fields in PDCCH-Config for MBS are same as the fields in PDCCH-Config of the dedicated unicast BWP, the corresponding fields in PDCCH-Config of the dedicated unicast BWP can be the default configuration.
* *Intel*
  + Proposal 3: A default CFR identical to active unicast BWP can be defined for UEs when no CFR configuration is provided
* *Samsung*
  + Observation 3: RAN2 can determine whether or not configuration for a CFR is provided to a UE when the CFR is same as the active DL BWP for the UE.
* *NTT Docomo*
  + Observation 1: In order to support multicast when no CFR is configured, it is needed to specify how does a UE decide whether or not to perform multicast reception processing.
  + Proposal 2: Multicast is not supported when no CFR is configured.
* *Chengdu TD Tech*
  + Proposal 4: If the current cell supports MBS, for the scenario that no CFR is configured for a unicast BWP, the unicast BWP can be by default used as the CFR for MBS.
* *Ericsson*
  + Observation 8: If the unicast BW is considered default for MBS BW, no CFR (frequency region) needs to be configured for the case where the unicast and MBS BWs are the same.
  + Proposal 13: PDCCH-config, PDSCH-config and SPS-config for MBS that are partly or wholly the same as their unicast counterparts do not need to be explicitly configured, but can be inferred from unicast configurations
  + Proposal 14: MBS is supported also when no CFR (frequency region) is configured for the case where the unicast and MBS BWs are the same.
* *Xiaomi*
  + Proposal 3: Multicast can be supported in a dedicated unicast BWP when no CFR is configured for that BWP.

**Rate matching and TBS determination:**

* *vivo*
  + Proposal 2: For multicast of RRC\_CONNECTED UEs,
    - LBRM (Limited buffer rate-matching) for GC-PDSCH TBS is determined based on bandwidth of CFR.
    - xOverhead in PDSCH-config in CFR is used for GC-PDSCH TBS determination if it is configured.
    - It is up to gNB to guarantee the activation/deactivation of semi-persistent ZP CSI-RS resource set at the same time if the semi-persistent ZP CSI-RS resource set is configured in PDSCH-Config in CFR.
* *Nokia*
  + Proposal-23: The parameters such as mcs-table, xOverhead, size of BWP indicator field, priority indicator, etc., which would have a mismatch between the configurations for UE-dedicated BWP and CFR could be synchronized across all the UEs receiving MBS traffic.
* *MediaTek*
  + Proposal 8: The LBRM for GC-PDSCH TBS is determined by CFR configuration.
  + Proposal 9: Define a xOverhead-MBS value within CFR for GC-PDSCH TBS determination.
* *Qualcomm*
  + Proposal 3: For RRC\_CONNECTED UEs, the LBRM for GC-PDSCH TBS is determined per CFR.
  + Proposal 4: For RRC\_CONNECTED UEs, the xOverhead for GC-PDSCH TBS determination is configured per CFR.
  + Proposal 5: For RRC\_CONNECTED UEs, the MAC-CE over GC-PDSCH can be used to active SP ZP CSI-RS configured per CFR.
* *Samsung*
  + Proposal 7: For LBRM determination and TBS calculation for GC-PDSCH:
    - The maximum number of layers can be provided by maxMIMO-Layers in PDSCH-Config for MBS; if not provided, a default value is defined.
    - The maximum modulation order can be determined from mcs-Table in PDSCH-Config for MBS; if mcs-Table in PDSCH-Config for MBS is not provided, a default value or a value determined from mcs-Table in PDSCH-Config for the active DL BWP is used.
    - xOverhead can be provided in PDSCH-Config for MBS; if not provided, a default value of zero or the value for the active DL BWP is used.
    - The number of PRBs is determined based on the size of CFR.
  + Observation 12: For LBRM/TBS determination, a UE can receive a TB according to MBS parameters when the TB is provided by a GC-PDSCH and according to unicast parameters when the TB is provided by a unicast PDSCH.
  + Proposal 8: PDSCH-Config for MBS provides two rate matching groups.
  + Observation 13: Whether or not the PDSCH-Config for multicast includes configuration of semi-persistent ZP CSI-RS resource sets would depend or whether or not support of CSI reports for multicast is specified.
* *Ericsson*
  + Proposal 39: All the parameters that affect TBS of LBRM for group PDSCH need be configured within CFR.
  + Proposal 40: xOverhead for group PDSCH TBS determination need be configured within CFR.
  + Proposal 41: ZP-CSI-RS configuration should be UE specific and thus shall not be configured in PDSCH-Config in CFR. Due to this, MAC-CE to activate/deactivate semi-persistent ZP CSI-RS resource set should be still transmitted over UE specific PDSCH.
* *Xiaomi*
  + Proposal 4: BWP should be used to determine the LBRM for GC-PDSCH TBS.
  + Proposal 4: BWP should be used to determine the LBRM for GC-PDSCH TBS.
  + Proposal 5: The xOverhead configured per BWP should be reused for GC-PDSCH TBS determination.
  + Proposal 6: The current mechanism for semi-persistent ZP CSI RS is reused, i.e. do NOT introduce common trigger signalling for ZP CSI-RS within CFR.

**BWP-InactivityTimer related issues:**

* *Qualcomm*
  + Proposal 1: For timer-based activation/deactivation of BWP for a UE to switch its active BWP to a default BWP
    - If a UE is configured with an MBS CFR associated with the active DL BWP, the UE maintains the active BWP timer for both unicast and MBS within the active DL BWP.
      * A UE starts or restarts the timer when it successfully decodes a PDCCH addressed to unicast RNTI (e.g., C-RNTI or CS-RNTI) or a GC-PDCCH addressed to group RNTI (e.g., G-RNTI or G-CS-RNTI) in the MBS CFR within the active DL BWP.
* *Samsung*
  + Proposal 1: Introduce MBS-BWP-InactivityTimer for multicast PDCCH receptions.
  + Proposal 2: Support search space set group switching for multicast PDCCH.

**Broadcast for RRC\_CONNECTED UEs:**

* *Nokia*
  + Observation 17: Broadcast and multicast or unicast can be on separate BWPs – with broadcast CFR associated with initial BWP / CORESET0, and multicast or unicast associated with UE’s dedicated unicast BWP, if a UE is receiving different services simultaneously.
  + Proposal 21: Agree to support separate CFRs and associated BWPs for simultaneous reception of broadcast and multicast / unicast.
  + Proposal 22: Support for broadcast and unicast reception in different frequency bands require enhanced signaling to avoid unnecessary BWP switching.
* *MediaTek*
  + Proposal 3: For broadcast reception, the unified CFR is supported for RRC\_CONNECTED and RRC\_IDLE/INACTIVE UEs (e.g., CFR is equal to or smaller than the initial BWP).
* *CMCC*
  + Proposal 21. For RRC\_CONNECTED UEs, the same CFR with RRC\_IDLE/INACTIVE UEs is used for broadcast reception when the same group-common PDCCH and the corresponding scheduled group-common PDSCH are received by both RRC\_IDLE/RRC\_INACTIVE UEs and RRC\_CONNECTED UEs, but can be different from the CFR used for multicast reception.
  + Proposal 22. For RRC\_CONNECTED UEs, the group-common PDCCH and the corresponding scheduled group-common PDSCH for broadcast reception are transmitted in UE-specific active BWP, which can be different from the group-common PDCCH/PDSCH received by RRC\_IDLE/RRC\_INACTIVE UEs when UE-specific active BWP of RRC\_CONNECTED UE does not totally contain the common frequency resource of RRC\_IDLE/INACTIVE UEs.
  + Proposal 23. For RRC\_CONNECTED UEs, the same CFR is used for broadcast reception and multicast reception, when UE-specific active BWP of RRC\_CONNECTED UE does not totally contain the common frequency resource of RRC\_IDLE/INACTIVE UEs.
  + Proposal 24. For RRC\_CONNECTED UEs, only the group-common PDCCHs belong to broadcast service reported in MBS Interest Indication procedure are counted in the monitored CSS PDCCH candidates and non-overlapping CCEs  in a slot or span.

**Other issues:**

* *OPPO*
  + Proposal 20: A separate TCI states space is activated by MAC CE for group common PDSCH.
* *MediaTek*
  + Proposal 4: Network implementation guarantee the allocation of CFR for UEs in RRC\_CONNECTED mode to receive the MBS transmission.
* *Intel*
  + Proposal 4: RAN1 should strive for unified CFR for CONNECTED and IDLE mode UEs
  + Proposal 5: The UE expects no restriction on unicast reception within the CFR since it is contained within the active DL BWP of the UE.
* *Qualcomm*
  + Proposal 2: GC-PDCCH monitoring on/off in a CFR can be supported.
  + Proposal 10: Discuss whether/how to share the TCI-state pool for unicast and multicast within a dedicated BWP.
  + Proposal 15: Discuss whether G-RNTI(s)/G-CS-RNTI(s) for multicast is(are) configured per DL BWP, per serving cell or per cell Group
* *LGE*
  + Proposal 2: At least for multicast, unicast BWP switching between UE’s active BWPs may immediately triggers CFR change between different CFRs associated to different UE’s active BWPs.
  + Proposal 6: support transmission of multiple TDMed group-common PDSCHs carrying a same TB with selectively different RSs for both broadcast and multicast.
    - Different UE in the group selectively receive same or different PDSCHs among TDMed PDSCHs carrying the TB.
  + Proposal 7: Multiple TCI states can be configured in PDSCH-config for group common PDSCH for the CFR.
* *NTT Docomo*
  + Observation 9: In the current specification, the QCL assumption of group-common PDSCH will not be aligned among UEs in the same group if the offset between the group-common PDCCH and the corresponding PDSCH is less than the threshold timeDurationForQCL.
  + Proposal 17: The default QCL assumption of group-common PDSCH should be specified for the case that the time offset between the group-common PDCCH and the corresponding PDSCH is less than the threshold timeDurationForQCL.
* *ASUSTeK*
  + Proposal 1: For NR MBS group-scheduling, a reference TDRA table for mapping the group-common PDSCH transmission occasion in time domain needs to be identified and known to a corresponding group of UEs.
  + Observation 1: Using the default TDRA tables, the cell-specific TDRA table, or the UE-specific TDRA table may not be possible or efficient or may limit the flexibility and the capacity of NR MBS group-scheduling.
  + Proposal 2: A “group-common TDRA table” is configured per MBS group for NR MBS group-scheduling.
  + Observation 2: A UE is not able to receive multicast PDCCHs/PDSCHs if the UE’s active BWP is switched to an MBS-incapable BWP.
  + Proposal 3: If a UE’s active BWP is switched from an MBS-capable BWP to an MBS-incapable BWP, it needs some studies for the UE to resume multicast PDCCH/PDSCH receptions.
* *Sony*
  + Proposal 1: Support dedicated beam configuration for MBS beam report to identify suitable beams for group-common PDSCH/PDCCH in addition to unicast.
  + Proposal 2: The network shall configure time/frequency resources of the beam sweeping for the group common PDCCH/PDSCH.
  + Proposal 3: When the UE in RRC CONNECTED mode, it shall report preference/capability to keep same MBS content reception in IDLE/RRC\_INACTIVE.
* *NEC*
  + Proposal 2: When the UE constructs a Type-1 HARQ-ACK codebook for unicast service, the PDSCH configured outside CFR should not be included in the occasions for candidate PDSCH receptions if the HARQ-ACK feedback for MBS is disabled by gNB.

## Initial Proposals based on contributions

***Summary***

Regarding down-selection of option 2A and 2B of CFR for RRC\_CONNECTED state, option 2B was agreed as working assumption in RAN1#105-e. Based on contributions submitted in this meeting, 13 companies propose to confirm the working assumption, 1 company [OPPO] proposes to support option 2A, 1 company [Sony] proposes to support both 2A and 2B. Moderator proposes to confirm the working assumption (Initial proposal 1-1).

Regarding the two FFS in the working assumption of CFR, i.e., ‘FFS: CFR associated with initial BWP’ and ‘FFS: CFR larger than initial BWP’, companies expressed different views from different perspectives. From moderator perspective, based on the working assumption, when the active BWP is other than initial BWP, it is up to gNB implementation that the CFR configured in the active BWP may be larger, smaller or equal to the initial BWP. For the case that the initial BWP is the active BWP, we can reuse the CFR design for RRC\_IDLE/INACTIVE state as much as possible, so it is proposed to prioritize the corresponding discussion in RRC\_IDLE/INACTIVE state first, and then to determine what else needs to be done based on the agreement of CFR in RRC\_IDLE/INACTIVE state.

Regarding the reference point of the starting PRB of Option 2B for CFR, 10 companies have explicit proposals, 6 [ZTE, CATT, MediaTek, Ericsson, Apple, Xiaomi] of them propose to take Point A as the reference for the starting PRB of the CFR (i.e., option 1), 4 [vivo, Nokia, ETRI, Lenovo] propose to take the starting PRB of the dedicated unicast BWP as the reference point (i.e., option 2). Based on majority view, moderator suggests to take option 1 (Initial proposal 1-2). Regarding the indication mechanism of the starting PRB and the length of PRBs of CFR, 1 company [CATT] proposes that RIV indication mechanism can use used (Initial proposal 1-2).

Regarding the FFS whether more than one CFR is supported per dedicated unicast BWP subjected to UE capabilities, 6 companies propose that one CFR per dedicated BWP is sufficient. 4 companies [OPPO, ZTE, vivo, Chengdu TD Tech] propose to support more than one CFR per dedicated BWP subject to UE capability. Based on majority view, moderator thinks it is not possible to agree supporting more than one CFR per dedicated BWP for multicast of RRC-CONNECTED UEs subject to UE capability at this moment, and we do not need to discuss this issue in this meeting.

Regarding the FFS whether multicast can be supported or not in a dedicated unicast BWP when no CFR is configured for that BWP, 5 companies [OPPO, Futurewei, CMCC, MediaTek, NTT Docomo] propose multicast is not supported when no CFR is configured for that BWP, 4 companies [Intel, Chengdu TD Tech, Ericsson, Xiaomi] propose that the CFR for multicast is optional and it can default to the dedicated unicast BWP if no CFR configuration is provided in this dedicated unicast BWP, 2 companies [Samsung, Nokia] think RAN2 can determine whether or not configuration for a CFR is provided to a UE when the CFR is the same as the active DL BWP for the UE, 1 company [NTT Docomo] thinks, in order to support multicast when no CFR is configured, it is needed to specify how does a UE decide whether or not to perform multicast reception. The situation seems not change much compared with last meeting. This issue was also discussed in the 1st round email discussion in RAN1#105-e, in which moderator proposed an initial proposal that it is up to RAN2 whether or not configuration for a CFR is provided to a UE when the CFR is the same as the dedicated unicast BWP for the UE. However no conclusion was made in RAN1#105. Based on proposals in this meeting and comments in last meeting, moderator thinks it would be better that companies who think CFR is optional for multicast reception can clarify that how does a UE decide whether or not to perform multicast reception if no CFR is configured in the active BWP (Question 1-3), e.g., is it possible that the MTCH configuration provided by RRC signalling to CONNECTED UEs can be used to indicate the UE to perform multicast reception even if no CFR is configured in the active BWP? The signalling design regarding the CFR and the MTCH configuration is more relevant to RAN2 and is not clear at this moment. It should be noted that, based on agreements until now, the CFR not only includes the starting PRB and the number of PRBs, but also includes PDCCH-config / PDSCH-config / SPS-config(s) for MBS.

Regarding the LBRM and TBS determination for GC-PDSCH, based on companies’ proposals, all the parameters that affect LBRM and TBS determination for GC-PDSCH need to be aligned across all the UEs in the same MBS group. Moderator suggests initial proposal 1-4. Regarding whether MAC-CE over GC-PDSCH is needed for activation/deactivation of semi-persistent ZP CSI-RS resource set, companies have different views, 3 companies [vivo, Ericsson, Xiaomi] think MAC-CE over GC-PDSCH is not needed, 1 company [Qualcomm] thinks it is needed, 1 company [Samsung] thinks it depends on whether or not support of CSI reports for multicast is specified. Moderator thinks companies may need more time to study on this. Additionally, 1 company [Samsung] also proposes *PDSCH-Config* for MBS can include two rate matching groups (e.g., *MBS-rateMatchPatternGroup1* and *MBS-rateMatchPatternGroup2)* to indicate unavailable REs within a CFR. Companies are recommended to further study on this.

A UE may change the active unicast DL BWP to the default/initial DL BWP when *BWP-InactivityTimer* expires, and the default/initial BWP may not contain the CFR. This is because in Rel-16, *BWP-InactivityTimer* is reset upon reception of a DCI format with CRC scrambled by C-RNTI or CS-RNTI, but G-RNTI of GC-PDCCH of PTM scheme 1 is not supported. 1 company [Qualcomm] proposes a UE also starts or restarts the *BWP-InactivityTimer* when it successfully decodes a GC-PDCCH addressed to G-RNTI or G-CS-RNTI in the CFR associated with the active DL BWP. 1 company [Samsung] thinks that will partially cancel the reason for having a default DL BWP, and result in unnecessary power consumption. Samsung proposes to introduce *MBS-BWP-InactivityTimer* for multicast PDCCH receptions, and the UE does not switch to the default/initial DL BWP unless both *MBS-BWP-InactivityTimer* and *BWP-InactivityTimer* expire, but it seems more clarifications are needed for the UE behavior when one of the two timers expires. Moderator suggests to further study this issue (Initial proposal 1-5)

1 company [Nokia] raises a question whether for a UE receiving both multicast and broadcast services simultaneously, the broadcast CFR and multicast CFR need to be overlapping, and proposes to support separate CFRs and associated BWPs for simultaneous reception of broadcast and multicast/unicast. It seems the question is based on a prerequisite that the initial BWP in which a broadcast CFR is configured is not within the active DL BWP in which a multicast CFR is configured. However, it is not clear whether to support UE simultaneously receiving both multicast and broadcast if the initial BWP is not within the active DL BWP. Moderator suggests companies to further study on this issue (Question 1-6).

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

**[High] Initial Proposal 1-1**:

Confirm the working assumption:

Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED Ues.

* FFS: CFR associated with initial BWP
* FFS: CFR larger than initial BWP

**[High] Initial Proposal 1-2**:

For indication of the starting PRB and the length of PRBs of CFR for multicast of RRC-CONNECTED UEs,

* the starting PRB is referenced to Point A.
* RIV (Resource indicator value) indication mechanism is used.

**[High] Question 1-3**: If no CFR configuration is provided in the active BWP, how does UE decide whether or not to receive multicast?

* Note: ‘no CFR configuration’ here means all the elements of CFR such as the starting PRB, the number of PRBs, PDCCH-config, PDSCH-config and SPS-config(s) for MBS are not configured.

**[High] Initial Proposal 1-4**: For LBRM and TBS determination for GC-PDSCH:

* The maximum number of layers can be provided by *maxMIMO-Layers* in *PDSCH-Config* for MBS in CFR; if not provided, a default value is defined.
* The maximum modulation order can be determined from *mcs-Table* in *PDSCH-Config* for MBS in CFR; if *mcs-Table* in *PDSCH-Config* for MBS is not configured in CFR, a value determined from *mcs-Table* in *PDSCH-Config* for unicast in the active DL BWP is used.
* *xOverhead* can be provided in *PDSCH-Config* for MBS in CFR; if not provided, the value for the active DL BWP is used.
* The number of PRBs is determined based on the size of CFR.

**[High] Initial Proposal 1-5**: If a UE is configured with a CFR in the active DL BWP, for timer-based active DL BWP switching to a default BWP, further study the following options:

* 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).
* Option 2: Introduce a new *MBS-BWP-InactivityTimer* for GC-PDCCH receptions.

**[High] Question 1-6**: Whether/How to support simultaneous reception of broadcast and multicast for RRC\_CONNECTED UE if the broadcast CFR associated with the initial BWP is not within the active DL BWP?

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| OPPO | **Proposal 1-1:** Only support to confirm the main bullet of the WA, and the two sub-bullets of FFS should be removed. The design target of CFR and initial BWP are totally different respectively for multicast and unicast. Whether CFR is larger than initial BWP or not is up to network’s configuration based on various requirements.  **[High] Initial Proposal 1-1**:  Confirm the working assumption:  Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED Ues.   * ~~FFS: CFR associated with initial BWP~~ * ~~FFS: CFR larger than initial BWP~~   **Proposal 1-2:** Support the first sub-bullet “Point A” and the second sub-bullet “indication mechanism” can be further studied. The first step is to determine on the selection of starting point in frequency domain, and the indication mechanism may related to more detailed design. We would like to propose the following update on the proposal:  **[High] Initial Proposal 1-2**:  For indication of the starting PRB and the length of PRBs of CFR for multicast of RRC-CONNECTED UEs,   * the starting PRB is referenced to Point A. * FFS: Indication mechanism. ~~RIV (Resource indicator value) indication mechanism is used.~~   **Question 1-3:**   1. The question implies that even CFR is not configured on an active BWP, UE still can support to receive multicast. The question is about “how does UE decide whether to receive…”, so it means that gNB may schedule multicast to UEs, and UEs can determine whether to receive it or not. 2. Even multicast (the cast-type) is not supported when no CFR is configured on an active BWP, unicast/PTP can be used to transmit MBS services on the active BWP. That is to say, multicast is not supported but MBS services/data can still be transmitted to UEs. The target is reached by using different cast-types.   **[High] Question 1-3**: If no CFR configuration is provided in the active BWP, whether or not to receive multicast services on the active BWP?   * Note: ‘no CFR configuration’ here means all the elements of CFR such as the starting PRB, the number of PRBs, PDCCH-config, PDSCH-config and SPS-config(s) for MBS are not configured.   **Proposal 1-5: May need more discussion/clarification.**   1. If the Rel-16 timer-based BWP switching mechanism is supported in Rel-17, it seems like a UE anyway will switch from an active BWP to the default/initial BWP whenever the timer is expired. It is more reasonable that a CFR should be configured in the default DL BWP if timer-based mechanism is supported in Rel-17 MBS. Even the timers for DL BWPs of UEs may different/misaligned with each other, gNB can make it feasible by proper configuration. With network implementation, it seems like that such timer issue can be avoided. 2. For option 1, one issue is that UE may not receive the GC-PDCCH. This issue may happen when the GC-PDCCH is transmitted on the CFR after *BWP-InactivityTimer* expires and UE has already switched to default/initial BWP, so UE may not be able to start/restart the timer while the GC-PDCCH is missed. 3. For option 2, introducing a new timer for MBS CFR can be a solution to compensate the impact of DL BWP timer, but how to deal with the relationship between these two timers should be further considered. A UE may have to support two different timers on an active DL BWP, one timer is for unicast while the other timer is for CFR within the DL BWP. When one of the timers is expired and the other timer is still on, whether to do BWP switching?   **Question 1-6:** As moderator analysis, this question is based on a prerequisite that the initial BWP in which a broadcast CFR is configured is not within the active DL BWP in which a multicast CFR is configured. It is not clear that why should we support the simultaneous reception of multicast and broadcast under this situation. If this kind of CFR/BWP configuration is not fulfilling the prerequisite, what is the motivation/benefit to support simultaneous reception? |
| Xiaomi | Proposal 1-1: we are generally fine with the proposal. We share the same views as the other companies that we should not put any restrictions on the configuration of CFR for the UEs in CONNECTED mode, i.e. it can be larger, smaller or equal to initial DL BWP. We should focus on the CONNECTED mode UE and we are not clear why should we consider the initial DL BWP. We still think the wording related to initial DL BWP should be removed.  Proposal 1-2: support  Question 1-3: If a UE is configured with MBS traffic, e.g. it was configured with G-RNTI, it knows it should try to receive the PDCCH with CRC scrambled by G-RNTI to schedule MBS traffic. The PDCCH-config and PDSCH-config configured for the BWP can be directly reused. Network can guarantee all the UE-dedicated BWPs align with each other. It totally depends on gNB’s decision.  Proposal 1-4: For the first two bullets, we are OK as MBS traffic may not need advanced mechanism from reliability perspective. For the last two bullets, we don’t think any enhancement is needed compared to the current mechanisms.  For xOverhead, it is configured per BWP and actually applied to each RB. The CFR is definitely contained within the active BWP. For the number of RBs to determine LBRM buffer, the current mechanism may leads to a larger buffer sizes for MBS than necessary. However, there is no harm for MBS. On the other hand, the buffer size saved by the CFR-based buffer cannot be used for the unicast data.  Proposal 1-5: The ‘*BWP-InactivityTimer*’ is optional, in the other word, what kind of BWP switching is totally under control of network. Additionally, the value of *BWP-InactivityTimer* can be aligned across BWPs if timer based BWP switching is configured. The motivation here is not crystal clear.  Question 1-6: We are not sure why a UE needs to receive broadcast MBS and multicast MBS simultaneously, which targets to idle/inactive mode UE and CONNECTED UE respectively. |
| Lenovo, Motorola Mobility | 1-1: Support  1-2: We have concern on the first bullet. Since the CFR configuration is associated with a unicast BWP and the unicast BWP is RRC configured per UE, it implies the CFR configuration is also configured per UE. Then the starting PRB can be referenced to the starting PRB of the associated unicast BWP so that the signaling overhead can be reduced.  1-3: We think “no CFR configuration” means “no MBS reception”.  1-5: Option 1 is preferred.  1-6: The motivation is not clear to us. Why does not gNB transmit the broadcast data also in multicast manner to the group of UEs? |
| ZTE | Proposal 1-1: OK to confirm the working assumption.  Proposal 1-2: Support. As also mentioned by many companies, reference to Point A can have the following benefits,  1) Avoid unnecessary reconfiguration in case of BWP configuration update;  2) Keep consistent configuration between IDLE and CONNECTIVE;  3) Save configuration overhead, e.g., one CFR configuration is applicable to multiple unicast BWPs.  Question 1-3: A RRC parameter (e.g., *MBS-Reception*) can be used to indicate whether UE needs to receive MBS or not. If MBS-Reception is included and CFR is configured, UE receives MBS via following the CFR configuration. If MBS-Reception is included and CFR is NOT configured, then UE receives MBS via following the configuration in unicast BWP.  Proposal 1-4: We are generally ok with the proposal. But we just want to mention, the handling for maxMIMO-Layers is not aligned with that for mcs-Table and xOverhead, i.e., if not configured in CFR, mcs-Table and xOverhead will following the corresponding configuration for unicast, while maxMIMO-Layers will follow a default value. Maybe we can try to use the same handling for all parameters. That is, if not configured in CFR, maxMIMO-Layers can also follow the value configured for unicast PDSCH.  Proposal 1-5: Some more clarification is needed at least for Option 2, for example, how to use this new timer. In this stage, we prefer a more general proposal like below.  **[High] Initial Proposal 1-5**: If a UE is configured with a CFR in the active DL BWP, further study whether enhancement for timer-based active DL BWP switching to a default BWP~~, further study the following options:~~   * ~~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).~~ * ~~Option 2: Introduce a new~~ *~~MBS-BWP-InactivityTimer~~* ~~for GC-PDCCH receptions.~~   Question 1-6: We see it as an implementation issue for now. If network wants the UE to receive broadcast and multicast simultaneously, network needs to make sure broadcast and multicast can be transmitted in the same BWP. But we are also open if companies can agree to support multiple active BWPs for MBS reception, where one BWP is for broadcast and another is for multicast. |
| CMCC | 1-1: Support  1-2: Support  1-3: We think if there is no CFR configuration, UE will not receive MBS services.  1-4: Support  1-5: Prefer Alt 1. It is not necessary to introduce another MBS BWP timer.  1-6: We think in this case, the group-common PDCCH and the corresponding scheduled group-common PDSCH for broadcast reception are transmitted in UE-specific active BWP. Otherwise, UE will always switch to the CFR configured for RRC\_IDLE/INACTIVE UEs to receive broadcast service, but this will cause the BWP switching and service delay. In addition, the BWP switching signalling will introduce large useless PDCCH overhead, gNB will send the BWP switching signalling each time between the transaction of multicast service and broadcast service. |
| Spreadtrum | Proposal 1-1: Generally ok to confirm the WA. But for the first FFSs, it is better to leave it to be discussed in AI8.12.3, instead of AI8.12.1. For the second FFS, it is not necessary to set the restriction, and it can be up to gNB implementation.  Proposal 1-2: Ok.  Question 1-3: For clarification, does the main bullet mean ‘whether or not to receive multicast service’, or mean to receive the MBS by multicast type?  Proposal 1-4: Generally Ok for the proposal.  Proposal 1-5: Support option 1.  Question 1-6: We have not seen necessarity. In addition, support simultaneously two active BWPs obviously would increase UE’s complexity, and even change UE’s implementation architecture. It is against the WID. |
| Samsung | 1-1: Support  1-2: Support  1-3: At least the PDSCH/PDCCH/PUCCH configurations need to be provided  1-4: Support  1-5: Option 2.  With option 1, a main purpose of having a default BWP (reduce PDCCH monitoring) is lost for either multicast or unicast and corresponding UE power consumption is not reduced.  1-6: If “simultaneous” means overlapping receptions (FDMed), that should not be supported.  Otherwise, if the receptions are at different times, the support is up to the NW. |

## Updated Proposals (after 1st round of inputs)

# Issue #2: GC-PDCCH configuration for MBS

## Background and submitted proposals

***Background***

In RAN1#104&104bis&105 meetings, the following agreements were achieved.

**CORESET:**

Agreement (#104b):

If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP, further study the following options.

* Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* Option 2: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR cannot be used for unicast transmission.
* Option 3: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR cannot be used for unicast transmission.
* Option 4: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.

Working assumption: (#105)

The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.

**Search space set:**

Agreement (#104):

For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, at least support CSS

* FFS: reuse existing CSS type(s) in Rel-15/16 or define a new Type CSS
* FFS: Two options for monitoring priority:
  + Option 1: the monitoring priority is the same as existing Rel-15/16 CSS
  + Option 2: the monitoring priority is determined based on the search space set indexes of search space set(s) for multicast and USS sets.

Agreement (#104b):

For CSS of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, down-select from the following alternatives (to be decided in RAN1#105):

* Alt 1: support Type-3 CSS
  + The monitoring priority of Type-3 CSS for group-common PDCCH is the same as existing Rel-15/16 CSS, regardless of which DCI format of group-common PDCCH is configured in Type-3 CSS
* Alt 2: support a new Type-x CSS
  + The monitoring priority of new Type-x CSS is determined based on the search space set indexes of the new Type-x CSS set and USS sets, regardless of which DCI format of group-common PDCCH is configured in the new Type-x CSS.
* Alt 3: support both Alt 1 and Alt 2

Agreement (#105):

For CSS of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, Alt 2 is supported:

* Alt 2: support a Type-x CSS
  + The monitoring priority of Type-x CSS is determined based on the search space set indexes of the Type-x CSS set and USS sets, regardless of which DCI format of group-common PDCCH is configured in the Type-x CSS.
* FFS: Whether the Type-x CSS is a Type-3 CSS

**DCI formats:**

Agreement (#104b):

For group-common PDCCH of Rel-17 MBS, support at least two DCI formats.

* DCI format 1\_0 is used as the baseline for the first DCI format with CRC scrambled with G-RNTI.
* DCI format 1\_1 or 1\_2 is used as the baseline for the second DCI format with CRC scrambled with G-RNTI
  + FFS: Which of DCI format 1\_1 or 1\_2 is used as the baseline
* FFS: Details of the reuse (or not) of DCI format 1\_0, 1\_1 or 1\_2 fields

Agreement (#105):

As a baseline, reuse existing fields in DCI format 1\_0 with CRC scrambled by C-RNTI for the fields of first DCI format with CRC scrambled with G-RNTI.

* FFS: how to determine the bitlength of FDRA field.
* FFS: Whether ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ are needed.
* FFS: How to perform DCI size alignment
* FFS: Whether to include new DCI fields
* Note: All of the fields may not be reused and the size of the fields may not be the same

Agreement (#105):

As a baseline, reuse existing fields in DCI format 1\_1 for the fields of the second DCI format with CRC scrambled with G-RNTI.

* FFS: whether ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’, ‘Carrier indicator’ and ‘Bandwidth part indicator’ are needed.
* FFS: How to perform DCI size alignment
* FFS: Whether to include new DCI fields for the second DCI format
* Note: All of the fields may not be reused and the size of the fields may not be the same

**Maximum number of BD/CCE:**

Agreement (#104):

The maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 is kept unchanged for Rel-17 MBS.

* FFS whether the budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration, which is similar to the method used for multi-DCI based multi-TRP in Rel-16.

**DCI size budget and DCI size alignment:**

Working Assumption (#104):

Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS.

* FFS: Whether the G-RNTI is counted as “C-RNTI” or as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.

Agreement (#105):

Confirm the working assumption:

Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS.

* FFS: Whether the G-RNTI is counted as “C-RNTI” or as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.

***Submitted Proposals***

**CORESET:**

* *Huawei, HiSilicon*
  + Proposal 2: For CFR for multicast scheduling confined within a dedicated unicast BWP,
    - It is up to gNB to configure the same or different CORESETs for unicast and multicast scheduling within the CFR.
    - The total number of CORESETs is not expected to be increased in Rel-17 comparing to the number UE supported in Rel-16.
* *OPPO*
  + Proposal 16: The working assumption on CORESETS in RAN1#104b-e is confirmed:
    - The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.
  + Proposal 17: It is up to gNB on the configuration of CFR, e.g. CORESETS, and the dedicated unicast BWP that contains this CFR.
  + Proposal 18: A CORESET can be used by multicast and unicast transmission, when the CORESET is fully contained in frequency domain in a CFR which is configured in a dedicated unicast BWP.
* *Spreadtrum*
  + Proposal 6: Confirm the working assumption: The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.
* *vivo*
  + Proposal 12: If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP, option 1 is supported.
    - Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *CATT*
  + Proposal 17: The CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *Nokia*
  + Observation-7: It would be beneficial to maintain currently defined limits for the total number of CORESETs within PDCCH-config for unicast and MBS, in order to minimize UE and gNB complexity and to ensure backward compatibility.
  + Proposal-6: Confirm the working assumption that the maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.
* *MediaTek*
  + Proposal 10: Confirming the working assumption as following:
    - The maximum number of CORESETs per BWP is not increased for supporting of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.
  + Proposal 11: No need to define an extra explicit rule whether the CORESETs can be shared for unicast and multicast and it is up to network implementation.
* *FUTUREWEI*
  + Observation 1: The number of CORESET(s) for group-common PDCCH within the common frequency resource for group-common PDSCH is left to gNB implementation, subjected to the restriction that the maximum number of CORESETs per BWP is not increased.
* *CMCC*
  + Proposal 7. Support Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
  + Proposal 8. The mandatary maximum number limit of CORESETs per BWP (i.e., 3 for single-TRP or 5 for multi-TRP) is kept for Rel-17 MBS. Additional CORESETs for MBS can be optionally supported.
* *Intel*
  + Proposal 11: The CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
  + Proposal 12: For PTP or PTM scheme 2, the CORESET scheduling MBS (re)transmission can be configured outside the MBS frequency region.
* *Qualcomm*
  + Proposal 6: If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP,
    - Option 4: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for PTM-1 multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission including PTP transmission for unicast and PTP retransmission for multicast.
* *Samsung*
  + Proposal 6: Confirm the WA that the number of CORESETs remains as in Rel-16 and that it is a gNB choice how to configure CORESETs.
  + Observation 7: Whether or not a UE monitors PDCCH for detection of unicast DCIs and multicast DCIs in a same CORESET is a gNB implementation issue. No further discussion is needed.
* *LGE*
  + Proposal 8: From gNB perspective, gNB may configure multiple CORESETs and transmit group common PDCCHs to multiple UEs in a group. The DCI can be repeated on multiple CORESETs with same or different TCI states
  + Proposal 9: Multiple TCI states can be configured for a CORESET ID for a Search Space of group common PDCCH by RRC.
* *Lenovo*
  + Proposal 12: A common CORESET is configured within the common frequency region for MBS for the group of UEs.
* *NTT Dococmo*
  + Proposal 3: Support Option 4 for sharing CORESETs between PDCCH-Config for unicast and PDCCH-Config for multicast.
* *Chengdu TD Tech*
  + Proposal 1: The CORESETs for MBS can be used for unicast scheduling.
  + Proposal 2: For a CORESET for unicast, if it’s within the CFR, it can be used for MBS scheduling.
* *Ericsson*
  + Proposal 27 Group common PDCCH for multicast can be configured in CORESET0 if CORESET0 is within a CFR.
  + Proposal 28 Group common PDCCH and unicast PDCCH can be configured within the same CORESET
  + Proposal 29 Support option 1 from RAN1#104b regarding using CORESETs from unicast with multicast:
    - a. If a CFR is configured in a dedicated unicast BWP for multicast in RRC-CONNECTED state, the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for PTM-1 transmission if the CORESET is fully contained in the CFR in frequency domain.
    - b. the CORESET configured in PDCCH-config for MBS in the CFR can be used for PTP transmission.
  + Proposal 30 The UE does not expect a search space configured with multicast DCIs to be configured in a CORESET with bandwidth not corresponding to a CFR bandwidth.
* *ETRI*
  + Proposal2: Confirm the working assumption:
    - The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.
* *Futrurewei*
  + Proposal 5: Without CFR configured, multicast reception by default is not supported. In combination with Proposal 3, the support of Option 4 (listed above) is proposed i.e., the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *Xiaomi*
  + Proposal 8: Confirm the following working assumption:
    - Working assumption:
      * The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.
  + Proposal 9: If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP, the following option1 should be adopted:
    - Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.

**Search space set:**

* *OPPO*
  + Proposal 20: For CSS of GC-PDCCH of PTM scheme 1 for multicast in NR MBS, the Type-x CSS is not configured as a Type-3 CSS.
* *Spreadtrum*
  + Proposal 3: For search space type for Rel-17 MBS, support to define a new search space type for multicast.
* *ZTE*
  + Proposal 7: If the type-x CSS is defined as a type-3 CSS, the following UE behavior on Type-3 CSS monitoring should be defined,
    - For DCI format 1\_0 with CRC scrambled by C-RNTI and G-RNTI within type-3 CSS, it should always be monitored by the UE.
    - For DCI format 1\_1 (and 1\_2) with CRC scrambled by G-RNTI within type-3 CSS, the UE determines monitoring priority according to search space index and further decides whether to monitor
  + Proposal 4: For NR multicast, introduce beam sweeping via defining association between MOs of GC-PDCCH and SSBs or CSI-RSs.
  + Proposal 3: Monitoring configurations (e.g., CORESETs, Search Spaces, etc.) for GC-PDCCH of PTM retransmission can be configured separately from that for GC-PDCCH of PTM initial transmission.
* *vivo*
  + Proposal 13: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, only DCI formats with CRC scrambled with g-RNTI for multicast scheduling can be monitored in the search space.
* *CATT*
  + Proposal 18: A Type-3A/Type-MBS CSS can be introduced for the CSS of group-common PDCCH of PTM scheme1 for multicast in RRC\_CONNECTED state.
  + Proposal 19: If the Type-2 HARQ-ACK codebook is configured, the g-NB is not allowed scheduling the group-common PDCCH when the Type-3A/Type MBS CSS of the group-common PDCCH was dropped by any UE in the multicast group.
* *Nokia*
  + Observation-14: Search space defined for multicast has different characteristics in terms of monitoring priority as compared to currently defined common search space.
  + Observation-16: In the scenario where DCI format 1\_1 is used for PTP retransmissions of the PTM scheme 1 initial transmission and the new common / multicast search space is used for scheduling the retransmissions, it would be straightforward for the UE to assume that the received TB is actually the PTP retransmission of PTM traffic.
  + Proposal-18: Clarify whether PTP retransmission of PTM scheme 1 initial transmission would be scheduled using CSS or USS.
  + Proposal 20: Define a new type-x CSS or multicast search space with differentiated monitoring priority based on SS index and FDRA field size of the downlink DCIs associated with this search space calculated based on the size of the CFR.
* *MediaTek*
  + Proposal 12: Define a new Type-x PDCCH CSS type (e.g., Type-4 PDCCH CSS not Type-3 PDCCH CSS) for UE supporting multicast service.
* *FUTUREWEI*
  + Proposal 1: A new Type-x CSS is defined. It should be clear that this Type-x is not a Type-3 CSS and the rule of monitoring priority of Type-x CSS is determined based on the search space set indexes of the Type-x CSS set and USS sets, as agreed.
* *CMCC*
  + Proposal 6. The Type-x CSS of group-common PDCCH of PTM scheme 1 for multicast can both be monitored on PCell/PSCell and SCell.
    - The Type-x CSS is not a Type-3 CSS.
* *Intel*
  + Proposal 13: Type-x CSS is a new CSS type different from Type 3 CSS which can be treated similar to USS in case of PDCCH overbooking.
* *Apple*
  + Proposal 2: The new Type-x CSS set for MBS is the same as type-3 CSS set.
* *Qualcomm*
  + Proposal 7: For RRC\_CONNECTED UEs, Type-x CSS can be configured with 1st and/or 2nd DCI format with G-RNTI(s) for multicast.
* *Samsung*
  + Observation 4: There is no reason to introduce a new Type-x CSS for MBS scheduling.
  + Observation 5: PDCCH monitoring for multicast PDSCH scheduling according to CSS requires material specification and UE implementation support while it can be as in Rel-16 if the PDCCH monitoring is according to USS.
  + Proposal 3: Support PDCCH monitoring for multicast PDSCH scheduling according to USS.
  + Proposal 4: For PDCCH monitoring according to CSS for multicast PDSCH scheduling, when a UE monitors PDCCH only according to USS sets and CSS sets for multicast in CORESETs with qcl-Type set to same 'typeD' properties, the CORESETs are the ones having same 'typeD' properties as the CORESET corresponding to the USS set or CSS set with the lowest index.
  + Proposal 5: For PDCCH monitoring for multicast PDSCH scheduling according to CSS, consider how to avoid constant collisions among PDCCH candidates for different multicast services.
* *Lenovo*
  + Proposal 13: A common search space is configured associated with the common CORESET for MBS for the group of UEs.
* *NTT Dococmo*
  + Proposal 4: For CSS of group-common PDCCH of PTM scheme 1, define a new type CSS.
* *Chengdu TD Tech*
  + Proposal 5: The group common PDCCH of PTM scheme 1 and the SPS group common PDCCH have the same CSS.
* *Convida*
  + Proposal 4: Type-x CSS is a new type of CSS.
* *Ericsson*
  + Proposal 31 Extend the existing type3 CSS from Rel-15/16 to support additional DCIs for scheduling via group common PDCCH
* *Xiaomi*
  + Proposal 7: Type-x CSS should not be a type 3 CSS.

**DCI formats:**

* *OPPO*
  + Proposal 12: A new DL DCI format should be defined for the scheduling of group-common PDSCH.
  + Proposal 15: For a UE receiving group-common PDSCH transmitted with PTM scheme 1, a TPC-PUCCH-RNTI different from that for unicast should be configured.
* *Spreadtrum*
  + Proposal 4: For connected UE, when DCI 1\_0 is used as group-common PDCCH for MBS,
    - the bitwidth and interpretation of ‘FDRA’ field depends on the CORESET configuration and CFR configuration for MBS in idle state
  + Proposal 5: For connected UE, when DCI 1\_1 is used as group-common PDCCH for MBS,
    - The bitwidth for each field in the DCI is common to all member UEs in a group, and
    - For each member UE, each field could be interpreted in light of its specific configuration
* *ZTE*
  + Proposal 5: For MBS GC-PDCCH,
    - The bit-length of FDRA field of DCI format 1\_0 in Type-x CSS is determined according to the legacy mechanism (It is based on the size of CORESET#0 if CORESET#0 is configured for the cell. Otherwise, the size is determined basing on the size of initial DL BWP. )
    - The fields of ‘Identifier for DCI formats’ and ‘TPC command for scheduled PUCCH’ in DCI format 1\_0 and 1\_1 can be reserved for other functionalities for MBS, e.g., HARQ-ACK feedback activation/deactivation..
    - The fields of ‘carrier indicator’ and ‘Bandwidth part indicator’ in DCI format 1\_1 can be reused in the second DCI format with CRC scrambled with G-RNTI.
    - DCI format 1\_2 can be further supported according to UE capability.
* *vivo*
  + Proposal 14: For the fields of first DCI format and second DCI format with CRC scrambled with G-RNTI,
    - FDRA field is determined based on the configuration of CFR.
    - ‘Identifier for DCI formats’ is not needed.
    - ‘TPC command for scheduled PUCCH’ can be included in the DCI format for NACK only feedback.
    - ‘Carrier indicator’ and ‘Bandwidth part indicator’ can leave to gNB to configuration.
  + Proposal 15: When UE is configured with multiple g-RNTIs, it is supported to configured two DCI formats with CRC scrambled different g-RNTIs. Otherwise, there is no need to configure two DCI formats for a UE simultaneously
* *CATT*
  + Proposal 21: Reuse the entire field in DCI format 1\_0 for the fields of the first DCI format.
  + Proposal 22: The fields of the first DCI format with CRC scrambled with G-RNTI/G-CS-RNTI which may not be needed can be reserved or applied for other indications.
  + Proposal 23: The bitlength of FDRA field of first DCI format is determined based on CORESET0/initial bandwidth part.
  + Proposal 24： The fields of second DCI format with CRC scrambled with G-RNTI/G-CS-RNTI i.e. ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ and ‘Carrier indicator’ are not present.
* *Nokia*
  + Proposal-15: UE should assume that the FDRA field of the DCI format 1\_0 scheduled within a multicast search space is dimensioned based on the size of the CFR.
  + Proposal 16: Repurpose existing unused fields such as ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ for both DCI formats 1\_0 and 1\_1, and ‘Carrier indicator’ and ‘Bandwidth part indicator’ for DCI format 1\_1, for indicating PTP retransmission of PTM initial transmission.
* *MediaTek*
  + Proposal 13: Define a new field (e.g., “HARQ feedback option”) within MBS DCI format to indicate which HARQ feedback option will be used by multicast services.
  + Proposal 14: Define a new field (e.g., “HARQ feedback enable/disable”) within MBS DCI format to indicate whether HARQ feedback is used for multicast services.
  + Proposal 15: Not define “Identifier for DCI formats” field within MBS DCI format for MBS transmission.
  + Proposal 16: The bit length of FDRA field within MBS DCI format is based on CFR size.
* *CMCC*
  + Proposal 10. Regarding DCI format 1\_0 with CRC scrambled with G-RNTI,
    - The bitlength of FDRA field is determined by CORESET#0 or initial DL BWP.
    - ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ are not needed.
  + Proposal 11. The RIV value in DCI format 1\_0 with CRC scrambled by G-RNTI is defined by a K scaling factor similar to TS 38.214 chapter 5.1.2.2.2, when the bitlength of FDRA field is determined by CORESET#0 or initial DL BWP but applied to the CFR.
  + Proposal 12. Regarding DCI format 1\_1 with CRC scrambled with G-RNTI, ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’, and ‘Bandwidth part indicator’ are not needed.
* *Intel*
  + Proposal 15: For DCI 1\_0 and 1\_1 when used for MBS scheduling, the “identified for DCI formats” field can be assumed to be reserved.
  + Proposal 16: When HARQ feedback is disabled by RRC, the following fields of DCI format 1\_0 can be assumed to be reserved:
    - PUCCH resource Indicator
    - PDSCH-to-HARQ timing indicator
    - TPC command for scheduled PUCCH
    - HARQ Process Number
    - New Data Indicator
    - Redundancy Version
* *Apple*
  + Proposal 3: The following fields can be removed from DCI format 1\_0 and/or DCI format 1\_1 for multicast PDSCH scheduling, including Identifier for DCI formats, TPC command for scheduled PUCCH, Carrier indicator BWP indicator, SRS request, CBG transmission information and CBG flushing out information.
* *Samsung*
  + Observation 8: For multicast PDSCH, the FDRA field needs to address the CFR, there is no need for a TPC command field, and there is no need for UL/DL differentiation for a DCI format with CRC scrambled by a G-RNTI.
  + Observation 9: For the second DCI format to be meaningful, the sizes for at least some of the fields need to be configurable (and smaller than the corresponding ones for DCI format 1\_0). The second DCI format can be an optional UE feature.
* *Lenovo*
  + Proposal 6: RB numbering within the common frequency region is with reference to the lowest RB of the common frequency region.
  + Proposal 7: The number of bits for frequency domain resource assignment indicator in DCI is determined based on the bandwidth of the common frequency region.
  + Proposal 8: DCI with CRC scrambled by G-RNTI does not include one-bit identifier.
  + Proposal 9: DCI with CRC scrambled by G-RNTI does not include two-bit TPC field.
  + Proposal 10: DCI with CRC scrambled by G-RNTI does not include carrier indicator.
  + Proposal 11: DCI with CRC scrambled by G-RNTI does not include BWP indicator.
  + Observation 1: DCI with CRC scrambled by G-RNTI is a new DCI and each field can be configurable.
  + Observation 2: Each field of the DCI with CRC scrambled by G-RNTI should be same for UEs in same group.
* *NTT Dococmo*
  + Proposal 7: The following DCI fields are not included in DCI format 1\_0 for multicast.
    - Identifier for DCI formats
    - TPC command for scheduled PUCCH
  + Proposal 8: The following DCI fields are not included in DCI format 1\_1 for multicast.
    - Identifier for DCI formats
    - TPC command for scheduled PUCCH
    - Bandwidth part indicator
    - Carrier indicator
  + Proposal 9: For DCI format 1\_0 for multicast, include following new DCI fields.
    - Priority indicator (1bit)
    - Number of layers (1bit)
  + Observation 2: If the existing RB numbering rule for PDSCH is reused, there may be RBs that cannot be allocated with DCI format 1\_0 for multicast.
  + Proposal 10: For PDSCH scheduled with DCI format 1\_0 for multicast, RB numbering starts from the lowest RB of the CFR.
  + Observation 3: If the granularity of PDSCH allocation is 1RB, there may be RBs that cannot be allocated with DCI format 1\_0 for multicast.
  + Proposal 11: For PDSCH scheduled with DCI format 1\_0 for multicast, support resource allocation with granularity of multiple RBs.
  + Observation 4: If the existing k1 list for DCI format 1\_0, which is fixed as {1, 2, 3, 4, 5, 6, 7, 8} is reused for MBS, PUCCH scheduling flexibility is low since a larger slot offset cannot be indicated and HARQ feedback slot becomes the same among UEs receiving a group-common PDSCH.
  + Proposal 12: A list of k1 values for DCI format 1\_0 for multicast is configurable.
* *Ericsson*
  + Proposal 32 The non-fallback DCI for multicast is using the same fields as DCI1\_1 with the following modification:’
    - a. TPC command for PUCCH is removed
    - b. UL DL identifier bit is removed.
    - c. SRS request is removed
    - d. The FDRA field uses the PRB size and start PRB of the CFR (or the DL BWP if CFR is not configured) in the definition of the FDRA.
  + Proposal 33 The fallback DCI for multicast is using the same fields as DCI 1\_0 with the following modification:
    - TPC command for PUCCH is removed
    - UL DL identifier bit is removed.
    - The FDRA field for the DCI in the common search space is given by
      * the size of CORESET 0 if CORESET 0 is configured for the cell; and
      * the size of CFR if CORESET 0 is not configured for the cell.
        + The size of the initial BWP if no CFR is configured.

**Maximum number of BD/CCE:**

* *OPPO*
  + Proposal 19: The budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration.
* *CATT*
  + Proposal 20: The budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration.
* *FUTUREWEI*
  + Observation 2: Both options, Option 1 and 2, are applicable for the limit of BDs/CCEs for Rel-17 MBS.
* *Intel*
  + Proposal 14: For determining BD/CEE limits for NR MBS in Rel-17, Option 1 should be supported for UEs without CA capability and Option 2 should be supported for UEs with CA capability. Down-selection is not necessary.
* *Qualcomm*
  + Proposal 9: For RRC\_CONNECTED multicast UEs supporting CA capability, support the following principles for determining /   and the maximum numbers of BD/CCE UE is required to monitor per slot for a serving cell supporting multicast reception:
    - When determining /   defined in 38.213, the number of DL serving cell(s) supporting multicast reception is increased as R times.
    - The maximum BD/CCE numbers are increased as R times and R times for a serving cell supporting multicast reception, where and  are defined in Table 10.1-2 and Table 10.1-3 in 38.213
    - R is a value reported by the UE
* *Samsung*
  + Observation 6: Increasing and for a UE does not relate to CA capability and there is no need to introduce such UE capability to support multicast scheduling in Rel-17.
* *LGE*
  + Proposal 5: The maximum BD/CCE numbers are increased as R times and R times for a serving cell supporting multicast reception, where and  are defined in Table 10.1-2 and Table 10.1-3 in 38.213
    - R is a value reported by the UE as part of MBS related UE capability, regardless of whether UE supports CA capability.

**DCI size budget and DCI size alignment:**

* *OPPO*
  + Proposal 13: The G-RNTI is counted as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.
  + Proposal 14: The size of the group common DCI is configurable up to 126 bits.
* *ZTE*
  + Proposal 6: Regarding DCI size alignment for GC-PDCCH,
    - DCI format 1\_0: it is counted as “C-RNTI”. The following two alternatives can be considered
      * Alt.1: aligning the size of DCI format 1\_0 with CRC scrambled by G-RNTI with DCI format 1\_0 with CRC scrambled by C-RNTI monitored in CSS first, and then aligning the size of DCI format 1\_0 with CRC scrambled by C-RNTI in USS with CSS
      * Alt.2: aligning the size of DCI format 1\_0 with CRC scrambled by C-RNTI in USS with CSS first, and then aligning the size of DCI format 1\_0 with CRC scrambled by G-RNTI with DCI format 1\_0 with CRC scrambled by C-RNTI monitored in CSS
    - DCI format 1\_1/1\_2: they are counted as “other RNTI”, and gNB will ensure that the number of DCI sizes does not exceed budget.
* *vivo*
  + Proposal 16: For the DCI size alignment, g-RNTI is counted as “C-RNTI”.
    - For the first DCI format, its size is aligned with the size of DCI 0\_0/1\_0 in CSS
    - For the second DCI format, the size of DCI format 1\_1/0\_1 or 1\_2/0\_2 in USS is aligned with the second DCI format by zero padding.
* *CATT*
  + Proposal 25: For first DCI format, G-RNTI is counted as “C-RNTI”; DCI size is aligned to DCI 1\_0 on CSS
  + Proposal 26: UE expect that at least one of the sizes of DCI with “C-RNTI” and “other RNTI” is smaller than the size of the second DCI.
  + Proposal 27: For second DCI format, G-RNTI can be counted as “C-RNTI” or “other RNTI” depending on RRC configuration.
* *Nokia*
  + Proposal 19: Count G-RNTI as C-RNTI, since it provides the most flexibility for the gNB to align DCI sizes among UE-specific and group-common PDCCHs.
    - FFS: whether other options need to be considered based on additional gNB complexity for size alignment
* *MediaTek*
  + Proposal 17: “G-RNTI” used for MBS is counted as “C-RNTI”.
* *CMCC*
  + Proposal 9. For“3+1” DCI size budget, the G-RNTI is counted as “C-RNTI”.
  + Proposal 10. Regarding DCI format 1\_0 with CRC scrambled with G-RNTI,
    - The DCI size equals to the size of DCI format 1\_0 with CRC scrambled with C-RNTI in CSS.
  + Proposal 13. Regarding DCI format 1\_1 with CRC scrambled with G-RNTI, align the DCI size of DCI format 1\_1 with C-RNTI equals to the DCI size of DCI format 1\_1 with G-RNTI after current steps in Rel-16 DCI size alignment procedure.
    - The G-RNTI DCI format 1\_1 size can be configured by gNB, which is larger than the original calculation of bitlength of DCI fields according to configurations.
    - Zero bits are appended to DCI format 1\_1 with C-RNTI until the payload size equals that of the DCI format 1\_1 with G-RNTI.
* *Intel*
  + Proposal 17: For DCI 1\_0 DCI size alignment can be performed by either zero-padding or truncating the MSBs of the FDRA field, depending on the relative size of the CFR with respect to CORESET#0 or the initial BWP, such that the DCI size aligns with that of unicast DCI format 1\_0 corresponding to the CORESET#0 or the initial BWP.
  + Proposal 18: For DCI format 1\_0 and 1\_1, the DCI size can be aligned to a size which is configured by the network to the UE.
  + Proposal 19: For DCI size budget of “3+1”, the UE may be configured to align DCI size with either “3” scheduling DCIs or “1” other group-common DCI depending on network implementation.
* *Qualcomm*
  + Proposal 8: For RRC\_CONNECTED UEs, both DCI format 1\_1 and 1\_2 can be supported for GC-PDCCH.
    - DCI size if over the size budget is aligned between GC-PDCCH and unicast PDCCH using the same DCI format (G-RNTI is counted as C-RNTI).
* *Samsung*
  + Observation 10: There is no need to specify how to count the sizes of DCI formats with CRC scrambled by G-RNTI – the Rel-16 specifications are sufficient.
* *Lenovo*
  + Proposal 14: For DCI size alignment, G-RNTI for the first DCI format is counted as C-RNTI.
  + Proposal 15: For DCI size alignment, G-RNTI for the second DCI format is counted as other RNTI.
* *NTT Dococmo*
  + Proposal 5: Align the size of DCI format 1\_0 for multicast with the size of DCI format 1\_0 for unicast in CSS.
  + Proposal 6: Align the size of DCI format 1\_1 for multicast with the size of DCI format 2\_0/2\_1/2\_4/2\_5/2\_6.
* *Ericsson*
  + Proposal 34 The G-RNTI is counted as “C-RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.
  + Proposal 35 The determination of non-fallback multicast DCI size, monitored in the common search space is inserted as step ”2B” in the DCI alignment procedure
  + Proposal 36 The fallback DCI for multicast is aligned in size with DCI 1\_0 and differentiated via the G-RNTI-based CRC check.
* *Potevio*
  + Proposal 1: The G-RNTI should be counted as C-RNTI when considering the “3+1” DCI size budget rule for group-common PDCCH.
  + Proposal 2: For DCI format 1\_0 with G-RNTI, its DCI size should be equal to the size for DCI format 1\_0 with C-RNTI monitored in a common search space.
  + Proposal 3: The DCI size of DCI format 1\_2 with C-RNTI should be aligned to be equal to the DCI size of DCI format 1\_2 with G-RNTI after current steps in Rel-16 DCI size alignment procedure.
  + Proposal 4: The DCI size of DCI format 1\_2 with G-RNTI should be configured by gNB, which is larger than the original calculation of bit length of DCI fields according to configurations.
* *Xiaomi*
  + Proposal 10: G-RNTI is counted as C-RNTI despite of DCI formats.

**Initializing scrambling of PDCCH:**

* *Huawei, HiSilicon*
  + Proposal 5: For initializing scrambling sequence generator for group common PDCCH for scheduling multicast in Type-x CSS,
    - nID should be configurable, and equals to a higher layer parameter pdcch-DMRS-ScramblingID if configured.
    - nRNTI is given by the G-RNTI.
* *Ericsson*
  + Proposal 37 When scheduling with non-fallback DCI, Scrambling parameters n\_ID and n\_RNTI for group PDCCH DMRS in the CSS is given by pdcch-DMRS-ScramblingID and the group PDCCH G-RNTI, respectively.
  + Proposal 38 Scrambling parameters n\_ID and n\_RNTI for group PDSCH schedule by the multicast non-fallback DCI in CSS is given by
    - a. N\_RNTI is given by G-RNTI
    - b. n\_ID = the higher-layer parameter dataScramblingIdentityPDSCH if CORESETPoolIndex is not configured
    - c. if the higher-layer parameters dataScramblingIdentityPDSCH and dataScramblingIdentityPDSCH2 are configured together with the higher-layer parameter CORESETPoolIndex containing two different values
      * i. n\_ID = the higher-layer parameter dataScramblingIdentityPDSCH if the codeword is scheduled using a CORESET with CORESETPoolIndex equal to 0
      * ii. n\_ID = the higher-layer parameter dataScramblingIdentityPDSCH2 if the codeword is scheduled using a CORESET with CORESETPoolIndex equal to 1;

## Initial Proposals based on contributions

***Summary***

Regarding whether the maximum number of CORESETs per BWP can be increased or not for support of MBS, we made a working assumption in RAN1#105-e. Based on submitted contributions in this meeting, 10 companies propose to confirm the working assumption.

Regarding whether the CORESETs can be shared for unicast and multicast, 4 options were listed for further study in RAN1#104bis-e. In RAN1#105-e it was further discussed but with no conclusion. Based on contributions in this meeting, 11 companies support option 1 or think it is up to gNB implementation to use the same or different CORESETs for unicast DCIs and multicast DCIs. 3 companies [Futurewei, QC, NTT Docomo] support option 4. Based on majority view and the related discussion in last meeting, moderator suggests initial proposal 2-2.

Regarding the FFS whether the Type-x CSS is a Type-3 CSS, 11 companies [OPPO, Spreadtrum, CATT, Nokia, MediaTek, Futurewei, CMCC, Intel, NTT Docomo, Convida, Xiaomi] propose that Type-x CSS is a new type CSS, 3 companies [Apple, Samsung, Ericsson] propose to extend the existing Type-3 CSS from Rel-16 to support functionality of Type-x CSS. 1 company [ZTE] propose that if the type-x CSS is defined as type-3 CSS the UE behavior on Type-3 CSS monitoring should be clarified. In my understanding, since the monitoring priority of legacy type-3 CSS is different from the that of Type-x CSS, if Type-x CSS is type-3 CSS, it should be clarified in which condition the legacy monitoring priority is applied and in which condition the new monitoring priority is applied, and it should also be clarified whether both DCI format 0\_0/1\_0/2\_x and DCI formats for multicast (including the first DCI format and the second DCI format) can be configured in the same search space set. 1 company [vivo] proposes only DCI formats with CRC scrambled with G-RNTI for multicast can be monitored in the search space used for multicast. Based on majority view, moderator suggests the initial proposal 2-3.

In addition, 1 company [Samsung] raises that PDCCH monitoring for multicast PDSCH scheduling according to CSS requires material specification and UE implementation support while it can be as in Rel-16 if the PDCCH monitoring is according to USS, and proposes to support PDCCH monitoring for multicast PDSCH scheduling according to USS (Initial proposal 2-4). It was also raised that, for PDCCH monitoring according to CSS for multicast PDSCH scheduling, when a UE monitors PDCCH only according to USS sets and CSS sets for multicast in CORESETs with qcl-Type set to same 'typeD' properties, the CORESETs are the ones having same 'typeD' properties as the CORESET corresponding to the USS set or CSS set with the lowest index. It was proposed to consider how to avoid constant collisions among PDCCH candidates for different multicast services for PDCCH monitoring for multicast PDSCH scheduling according to CSS. Moderator recommends companies to consider this issue.

Regarding the first DCI format for GC-PDCCH, most companies propose to reuse existing fields in DCI format 1\_0 with CRC scrambled by C-RNTI with some modifications, e.g., ‘Identifier for DCI formats’ and ‘TPC command for scheduled PUCCH’ can be removed or ignored, and the 3 bits can be reserved for other functionalities. 1 company [Intel] proposes to also assume ‘PDSCH-to-HARQ timing indicator’, ‘HARQ Process Number’, ‘New Data Indicator’ and ‘Redundancy Version’ to be reserved. For FDRA field of the first DCI format, there are basically two alternatives for determining , one alternative is to reuse the mechanism used for DCI format 1\_0 monitored in CSS, i.e.,  is given by the size of CORESET 0 if CORESET 0 is configured for the cell, and the size of initial DL bandwidth part if CORESET 0 is not configured for the cell. The other alternative is that  is given by the size of CFR. Based on majority view, moderator suggests the initial proposal 2-5.

Regarding the newly introduced fields, 1 company [MediaTek] proposes to define a new field (e.g., “HARQ feedback option”) to indicate which HARQ feedback option will be used by multicast services, and a new field (e.g., “HARQ feedback enable/disable”) to indicate whether HARQ feedback is used for multicast services. 1 company [NTT Docomo] proposes to introduce ‘Priority indicator (1bit)’ and ‘Number of layers (1bit)’ in first DCI format for multicast, and support that the list of k1 values in the first DCI format for multicast is configurable. Moderator thinks we can give companies more time to study which functionalities need to be indicated in DCI format for multicast.

Regarding the second DCI format for GC-PDCCH, companies’ views diverge a lot on which fields in the existing DCI format 1\_1 are not needed. Based on the contributions, moderator suggests initial proposal 2-6.

Regarding the FFS of maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell, it has been discussed in RAN1#104b and RAN1#105 but with no conclusion. Based on contributions in this meeting, 6 companies [OPPO, CATT, Intel, QC, LGE, Futurewei] propose to support this, but 1 company [Samsung] still thinks there is no need to introduce a UE capability to support increasing and for multicast scheduling in Rel-17. The situation does not change much. Moderator suggests to defer this discussion.

Regarding the DCI size alignment for the first DCI format, most companies propose to align its size with DCI format 1\_0 with CRC scrambled by C-RNTI monitored in CSS. Moderator suggests initial proposal 2-7.

Regarding the DCI size alignment for the second DCI format, 4 alternatives are proposed as follows based on the contributions:

* Alt-1: G-RNTI is counted as “C-RNTI”
  + Supporting companies: Nokia, MediaTek, CMCC, Nokia, Ericsson
* Alt-2: G-RNTI is counted as “other RNTI”
  + Supporting companies: Lenovo, NTT Docomo, OPPO
* Alt-3: G-RNTI is counted as “C-RNTI” or “other RNTI” depending on RRC configurations
  + Supporting companies: CATT, Intel
* Alt-4: No need to specify how to count the size of the second DCI format - the Rel-16 specifications are sufficient
  + Supporting companies: Samsung

Based on these, moderator suggests initial proposal 2-8 for a compromise.

Regarding the scrambling parameters n\_ID and n\_RNTI for GC-PDCCH and GC-PDSCH, 2 companies [Ericsson, Huawei] raise similar issues. It was proposed in [30] that, when scheduling with non-fallback DCI, scrambling parameters n\_ID and n\_RNTI for GC-PDCCH in type-x CSS is given by pdcch-DMRS-ScramblingID and G-RNTI, respectively. Similarly, scrambling parameters n\_ID and n\_RNTI for GC-PDSCH scheduled by the non-fallback DCI in type-x CSS is given by dataScramblingIdentityPDSCH / dataScramblingIdentityPDSCH2 and G-RNTI. Moderator suggest to first discussion this issue for GC-PDCCH. Then, based on progress, it may be easier to further discuss the similar issue for GC-PDSCH. Moderator suggests initial proposal 2-9.

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

**[High] Initial Proposal 2-1**: Confirm the working assumption:

* The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.

**[High] Initial Proposal 2-2**:

If a CFR is configured in a dedicated unicast BWP for multicast in RRC-CONNECTED state,

* the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP and fully contained in the CFR in frequency domain can be used for multicast transmission only when no CORESET is configured in PDCCH-config for MBS in the CFR
* the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* Note: A CORESET ID is unique across all BWPs and CFRs for a serving cell.

**[High] Initial Proposal 2-3**:

For type-x CSS for GC-PDCCH in RRC\_CONNECTED state, Option 2 is supported.

* Option 1: The type-x CSS is a type-3 CSS
  + Only DCI formats of GC-PDCCH can be monitored in a type-3 CSS if the type-3 CSS is used for GC-PDCCH monitoring.
* Option 2: The type-x CSS is a new type CSS
  + FFS: whether DCI formats other than the DCI formats of GC-PDCCH can also be monitored in a type-x CSS if the type-x CSS is used for GC-PDCCH monitoring

**[High] Initial Proposal 2-4**: Additionally support USS for GC-PDCCH monitoring for multicast in RRC\_CONNECTED state.

**[High] Initial Proposal 2-5**: The first DCI format for GC-PDCCH uses the same fields as DCI format 1\_0 with CRC scrambled by C-RNTI with the following modifications:

* ‘Identifier for DCI formats’ and ‘TPC command for scheduled PUCCH’ are ignored and the 3 bits are reserved
  + FFS: whether/how the reserved bits are repurposed for other functionalities
* For FDRA determination,

* +  is given by
    - the size of CORESET 0 if CORESET 0 is configured for the cell; and
    - the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
  + If the size of CFR (i.e. ) is larger than the size of CORESET0/initial DL bandwidth part, the resource indication value (*RIV*) is defined as in section 5.1.2.2.2 in TS38.214, where K is the maximum value from set {1, 2, 4, 8} which satisfies ;otherwise,

**[High] Initial Proposal 2-6**: The second DCI format for GC-PDCCH uses the same fields as DCI format 1\_1 at least with the following modifications:

* ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ and ‘SRS request’ are removed.
* Note: At least the configurable fields in DCI format 1\_1 remain configurable for the second DCI format

**[High] Initial Proposal 2-7**: Align the size of the first DCI format with DCI format 1\_0 with CRC scrambled by C-RNTI monitored in CSS.

**[High] Initial Proposal 2-8**: For DCI size alignment for the second DCI format, G-RNTI is counted as “C-RNTI” or “other RNTI” depending on RRC configurations.

* The size of the second DCI format can be configured by gNB
* Based on RRC configurations, if both DCI format 1\_1 and DCI format 2\_x have smaller DCI size than the second DCI format for multicast, the DCI format 1\_1 or 2\_x with larger DCI size is aligned to the size of the second DCI format for multicast.
* Based on RRC configurations, between DCI format 1\_1 and DCI format 2\_x, if one of them has smaller DCI size than the second DCI format for multicast and the other one has larger DCI size than the second DCI format for multicast, the DCI format 1\_1 or 2\_x with smaller DCI size is aligned to the size of the second DCI format for multicast.

**[High] Initial Proposal 2-9**: For initializing scrambling sequence generator for GC-PDCCH with the second DCI format in Type-x CSS,

* equals the higher layer parameter *pdcch-DMRS-ScramblingID* if configured; otherwise.
* is given by the G-RNTI.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| OPPO | **Proposal 2-1:** Support to confirm the WA.  **Proposal 2-2:** Support it.  **Proposal 2-3:** Support Option 2.   1. If this proposal is to support Option 2, there is no necessary to keep option 1 as another sub-bullet which should be removed from the proposal. 2. For the FFS under option 2: If this Type-x CSS is introduced for multicast services reception, the motivation/benefit is not clear to support monitoring other DCI formats rather than GC-DCI. If Type-x CSS supports GC-DCI formats and other DCI formats, what is the difference between Type-x CSS and other Types of CSS (e.g. Type-3 CSS)?   **Proposal 2-4:** Not support.  **Proposal 2-5:** OK with the direction.  **Proposal 2-7:** OK.  **Proposal 2-8:** Not support. This compromised proposal introduces more decoding complexity/effort for UEs. Down-selection between “C-RNTI” and “other RNTI” for G-RNTI is more valid. |
| Xiaomi | Proposal 2-1: support  Proposal 2-2: support. The note seems obvious which aligns with the current mechanism. If no additional information can be provided, we propose to delete the note.  Proposal 2-3: support the spirit of proposal 2-3. We share the similar views as OPPO that the wording can be further refined as what is proposed is option 2. Option 1 is already discussed in the previous meeting and should not be included in the proposal. Hence we propose the following updates:  **Updated Proposal 2-3**  For type-x CSS for GC-PDCCH in RRC\_CONNECTED state, Option 2 is supported.   * ~~Option 1: The type-x CSS is a type-3 CSS~~   + ~~Only DCI formats of GC-PDCCH can be monitored in a type-3 CSS if the type-3 CSS is used for GC-PDCCH monitoring.~~ * Option 2: The type-x CSS is a new type CSS * FFS: whether DCI formats other than the DCI formats of GC-PDCCH can also be monitored in a type-x CSS if the type-x CSS is used for GC-PDCCH monitoring   Proposal 2-4: support. It provide more flexibility for network when scheduling MBS traffic.  Proposal 2-5: The determination on FDRA bit field is premature which needs further discussion. DCI format 1\_0 with CRC scrambled with C-RNTI can be transmitted in a USS, in which case the bit width of FDRA can be determined by the active BWP. There is a possibility that the FDRA of a DCI with G-RNTI should be determined by the active BWP, wherein the same active BWP is configured for all the UEs belong to the same group. We propose to keep FFS for the FDRA determination.  **Updated Proposal 2-5**: The first DCI format for GC-PDCCH uses the same fields as DCI format 1\_0 with CRC scrambled by C-RNTI with the following modifications:   * ‘Identifier for DCI formats’ and ‘TPC command for scheduled PUCCH’ are ignored and the 3 bits are reserved   + FFS: whether/how the reserved bits are repurposed for other functionalities * ~~FFS~~ For FDRA determination   For proposal 2-6: we are agree that the information fields mentioned in the proposal are not useful for MBS scheduling. However, we think it may be better to use the same wording as DCI format 1-0, i.e. these information fields are reserved, from alignment point of view.  For proposal 2-7, as mentioned aforementioned, there is a possibility that the first DCI format can be aligned with the DCI format 1\_0 with CRC scrambled by C-RNTI in USS. Hence we do not support the proposal.  For proposal 2-8, we don’t see the necessity to introduce RRC signaling to configure how to count DCI size. It introduce additionally UE complexity as UE has to maintain two different procedure to align DCI size.  For proposal 2-9, support. |
| Lenovo, Motorola Mobility | 2-1: Support  2-2: We think there is no need to add the limitation of “only when no CORESET is configured in PDCCH-config for MBS in the CFR”.  2-3: We agree with the proposal in principle. The FFS is not clear to us. Does GC-PDCCH (e.g., DCI format 2-x) can be monitored in Type-x CSS? Or the intention of this FFS is to cover this issue?  2-4: Don’t support.  2-5: Don’t support. We think the payload size of the first DCI format can be same to that of DCI format 1-0 with C-RNTI. We don’t know why the first DCI format should use the same field as DCI format 1-0 with C-RNTI. For the 1st bullet, we think the two fields should be removed instead of reserved. To align with proposal 2-6, we propose to remove the two fields. For FRDA determination, we think it should be based on CFR not initial BWP.  2-6: Don’t support. Same reason as above.  2-7: Support.  2-8: Don’t support. Detailed DCI size alignment should be not based on RRC configuration.  2-9: support. |
| ZTE | Proposal 2-1: Ok to confirm the working assumption.  Proposal 2-2: Support.  Proposal 2-3: We proposed a compromised solution in our tdoc as shown below, which tries to merge both options and reuse the existing spec as much as possible. If companies can’t converge on either Option1 or Option2, we would suggest to consider it.  *Proposal 7: If the type-x CSS is defined as a type-3 CSS, the following UE behavior on Type-3 CSS monitoring should be defined,*  * For DCI format 1\_0 with CRC scrambled by C-RNTI and G-RNTI within type-3 CSS, it should always be monitored by the UE.*  * For DCI format 1\_1 (and 1\_2) with CRC scrambled by G-RNTI within type-3 CSS, the UE determines monitoring priority according to search space index and further decides whether to monitor*  For progress, we can also go with Option 2.  We are ok with Proposal 2-5, Proposal 2-6 and Proposal 2-7.  Proposal 2-8: It seems we may need to first determine whether we need to configure a size for the second DCI format. If companies can agree to have such a configuration, we can further determine how to perform size alignment with such DCI size. Thus, we propose the following proposal.  **[High] Initial Proposal 2-8**: For DCI size alignment for the second DCI format, ~~G-RNTI is counted as “C-RNTI” or “other RNTI” depending on RRC configurations~~.   * The size of the second DCI format can be configured by gNB * FFS: Based on RRC configurations, if both DCI format 1\_1 and DCI format 2\_x have smaller DCI size than the second DCI format for multicast, the DCI format 1\_1 or 2\_x with larger DCI size is aligned to the size of the second DCI format for multicast. * FFS: Based on RRC configurations, between DCI format 1\_1 and DCI format 2\_x, if one of them has smaller DCI size than the second DCI format for multicast and the other one has larger DCI size than the second DCI format for multicast, the DCI format 1\_1 or 2\_x with smaller DCI size is aligned to the size of the second DCI format for multicast.   Proposal 2-9: Is the RRC parameter pdcch-DMRS-ScramblingID a new parameter dedicated for MBS, or it is the same parameter for unicast PDCCH. Clarification is needed. |
| CMCC | 2-1: Support  2-2: Support  2-3: Support  2-4: Not support, there is a need of enhancement on hash function if USS is supported in order to align the CCE index calculation among UEs in the same MBS group  2-5: Support  2-6: Support  2-7: Support  2-8: We prefer to down select from “C-RNTI” and “other RNTI”  2-9: Support. |
| Spreadtrum | Proposal 2-1: Support  Proposal 2-2: Just for clarification, for the first sub-bullet, why to set the restriction ‘only when no CORESET is configured in PDCCH-config for MBS in the CFR’.  Proposal 2-3: Support option 2. It is one clean solution.  Proposal 2-4: Not support. The motivation is not clear to us, and also if supported, there is much spec work to do.  Proposal 2-5: Fine  Proposal 2-6: Fine  Proposal 2-7: Fine  Proposal 2-8: Not support. If the comprised scheme is supported, obviously it increase UE’s complexity for maintaining two DCI size alignment mechanisms.  Proposal 2-9: Same question as ZTE. |
| Samsung | 2-1: Support  2-2: Support  2-3: Do not support. It is not a technical issue and does not require any agreement.  2-4: Support. Removes a large number of specification/implementation impacts for multicast scheduling without any drawback.  2-5: Requires further discussion.  2-6: Requires further discussion – the number of fields in DCI format 1\_1 is large. It may be better to first identify what fields the second DCI format should have that the first DCI format does not have.  2-7: Support  2-8: OK with the direction but requires further discussion. Size alignment may be up to the gNB and need not be specified.  2-9: Support |

## Updated Proposals (after 1st round of inputs)

# Issue #3: Retransmission and HARQ process management

## Background and submitted proposals

***Background***

In RAN1#104&104bis&105 meetings, the following agreements were achieved.

**Retransmission and HARQ process management:**

Agreement (#104):

For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTP transmission.

* The HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB.

Agreement (#104b):

The same HARQ process ID and NDI are used for PTM scheme 1 (re)transmissions and PTP retransmissions of the same TB.

Conclusion (#104b):

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.

Agreement (#105):

For HARQ process management, further study whether/how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.

***Submitted Proposals***

**NDI conflicts issue** **for PTM reception when different UEs have different “latest” NDI bit status for the same HPID:**

* *Ericsson*
  + Observation 1: NDI conflicts may occur for PTM reception, when different UEs have different “latest” NDI bit status for the HPID. A new rule, based on new received RNTI overriding the NDI bit toggling for the HPID, can solve the identified issue.
  + Proposal 1: Downselect from the following two options, which both can be used to solve the NDI issue when a switch occurs from unicast transmission to group transmission or from one group transmission to another group transmission.
    - a) When a G-RNTI DCI is received with a given HPID in the DCI, the data shall be considered new, i.e. be treated as if the NDI bit had been toggled, irrespective of actual NDI toggling, if the G-RNTI is different from the most recent earlier received RNTI (i.e. C-RNTI or another G-RNTI) of the same HPID. When the received G-RNTI is the same as the most recent use of the HPID, legacy NDI toggling is used to indicate new data or retransmission.
    - b) Irrespective of earlier used RNTIs for the HPID, NDI bit ‘0’ means new data transmission, NDI bit ‘1’ means retransmission.
* *OPPO*
  + Proposal 7: It is up to gNB to avoid NDI collision between multicast and unicast crossed scheduling with the same HPID.
* *Nokia*
  + Observation-15: NDI toggling between transmissions and retransmissions within the group-common DCI having the same HARQ process ID cannot be applied for multicast.
  + Proposal-17: For multicast, mechanism similar to SPS needs to be utilized where NDI=1 in the group-common DCI indicates new transmission and NDI=0 indicating retransmission.
* *CMCC*
  + Proposal 16. If a same HPN is used for different DL grants corresponding to new transmissions of different G-RNTIs, UE will consider the NDI in DCI format with G-RNTI to have been toggled regardless of the value of the NDI.
  + Proposal 17. If a same HPN is used for different DL grants corresponding to unicast new transmission and multicast new transmission, UE will consider the NDI in DCI format with G-RNTI or C-RNTI to have been toggled regardless of the value of the NDI.
* *NTT Dococmo*
  + Observation 5: If a situation that UEs in the UE group before performing an initial PTM transmission have different NDI values is valid, and if the UEs ignore toggling of the NDIs, NDI management does not work as intended.
  + Proposal 13: RAN1 should discuss whether to consider different NDI values in the UE group for a certain HARQ PID before performing an initial PTM transmission.

**Whether/how to differentiate the HARQ process ID used for PTP (Re)Tx for unicast and PTP ReTx for multicast:**

* *Ericsson*
  + Observation 2: When the PDCCH of the PTM initial transmission is missed, a PTP retransmission of PTM may result on data corruption in the HARQ buffer depending on the NDI of the last PTP transmission prior to the PTM initial transmission
  + Observation 3: There are NDI issues with respect to PTM initial transmission followed by PTP retransmission, which may cause performance degradation. There are several different ways to handle this.
  + Proposal 2: RAN1 to study possible ways of ensuring that with PTM initial Tx followed by PTP ReTx, the following functionalities are simultaneously supported:
    - When PTM PDCCH is correctly received, soft-combining of PTM and PTP ReTx is supported, as well as detection of new data on PTP
    - When PTM PDCCH is missed, the data of PTP ReTx is detected as new data
  + Proposal 3: For the possible solutions, downselect from the following options:
    - Keep existing NDI agreement
    - Keep existing NDI agreement and add further enhancements (e.g. using new PTP DCI signaling bit)
    - Change existing NDI agreement and add further enhancements
    - Other solutions not precluded
* *Huawei, HiSilicon*
  + Proposal 3: Support DCI scheduling PTP transmission indicates whether the transmission is for unicast (re)transmission or for multicast retransmission.
    - For UE configured with multiple G-RNTIs, the DCI should further differentiate the PTP transmission is for which G-RNTI retransmission.
* *OPPO*
  + Proposal 8: There is no necessary to introduce any mechanism to differentiate the HPID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *ZTE*
  + Proposal 8: Regarding how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast,
    - The value of the NDI in the PTP PDCCH for scheduling the retransmission of multicast TB can is toggled relative to the NDI in the UE’s latest PTP PDCCH for scheduling a unicast TB with the same HPID.
* *vivo*
  + Proposal 7: For HARQ process management, there is no need differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *CATT*
  + Proposal 12: A DCI field or different TB sizes can be applied to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *Nokia*
  + Proposal 16: Repurpose existing unused fields such as ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ for both DCI formats 1\_0 and 1\_1, and ‘Carrier indicator’ and ‘Bandwidth part indicator’ for DCI format 1\_1, for indicating PTP retransmission of PTM initial transmission.
* *CMCC*
  + Proposal 18. Support using a DCI field in DCI format 1\_0/1\_1 with C-RNTI to differentiate the HPN is used for unicast transmission or for multicast PTP retransmission.
* *Intel*
  + Proposal 9: The HARQ process ID is used to associate PTM Scheme 2 based retransmission with the initial transmission using PTM Scheme 1. The UE does not expect to receive a unicast transmission using the same HARQ process ID as the ongoing MBS transmission.
  + Proposal 10: A UE does not expect PTM Scheme 1 based initial transmission or a PTP based retransmission of a MBS TB using a HARQ process number which is in use for an ongoing unicast transmission.
* *Qualcomm*
  + Proposal 12: For HARQ process management,
    - Support dynamic HPID management for unicast and multicast can be supported without increasing soft buffer size.
      * If the HPID for multicast is configured with NACK-only or no HARQ-ACK feedback, PTP cannot be used for PTM retx. So, PTP with the same HPDI can be used for unicast data transmission only.
      * If the HPID for multicast is configured with ACK/NACK-based feedback, the PTP with the same HPID can be used for PTM retransmission and select Alt1 or Alt2 subject to UE capability.
        + Alt1: PTP with the same HPID cannot be used for unicast data
        + Alt2: PTP with the same HPID can be used for unicast data, one DCI bit is used to differentiate PTP for multicast retransmission and PTP for unicast
* *Samsung*
  + Observation 11: The tradeoff from adding bit(s) to unicast DCI formats vs. using a multicast DCI format for a multicast TB retransmission when a gNB cannot differentiate NACK from DTX is negative.
* *Xiaomi*
  + Observation: There is no issue on differentiating the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *Google*
  + Observation 1: For PTP retransmission, the transmission received by UE-b in Phase-3 is a mistake gNB behavior. The soft-combining mistake can be avoid, if gNB is properly configured.
  + Observation 2: Error case may happen due to insufficient number of HARQ processes and mistake gNB behavior. Since companies have no problem on the maximum number of HARQ process, there is no need to introduce a feature to differentiate MBS and unicast transmission in physical layer.
  + Proposal 1: Increase the maximum number of HARQ processes, if HARQ ID collision between unicast and PTP is a concern to MBS

**Whether to simultaneously support PTP ReTx and PTM-1 ReTx for different UEs in the same group for the same TB:**

* *Huawei, HiSilicon*
  + Proposal 6: It is up to gNB to retransmit the failed TB via PTM scheme 1 or PTP.
    - UE does not need to be configured with PTM scheme 1 or PTP or both for retransmission.
* *OPPO*
  + Proposal 6: When PTM scheme 1 is used as initial transmission, PTM scheme 1 and PTP are not supported to be used simultaneously for the same TB for different UEs in the same multicast group.
* *Spreadtrum*
  + Proposal 2: If initial transmission for multicast is based on PTM transmission scheme 1, not simultaneously support PTM1 and PTP together as the retransmission scheme.
* *vivo*
  + Proposal 6: For the retransmission of group-common PDSCH for MBS service, the retransmission scheme(s) is configured:
    - Only PTM scheme 1 is supported, or
    - Only PTP is supported, or
    - Both PTM scheme 1 and PTP are supported
* *CATT*
  + Proposal 10: PTM scheme 1 retransmission and PTP retransmission cannot be used simultaneously for different UEs in the same MBS group.
* *FUTUREWEI*
  + Proposal 6: Different retransmission schemes (e.g., PTM scheme 1 and PTP) can be used simultaneously for different UEs in the same group.
    - The same HARQ process ID and NDI bit (not toggled) are used to signal transmission of the same TB.
    - The soft combining of the same TB from the PTM scheme 1 and PTP retransmissions is left up to UE implementation.
* *CMCC*
  + Proposal 14. PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group.
  + Proposal 15. PTM scheme 1 retransmission and PTP retransmission are simultaneously for different UEs in the same MBS group, the PUCCH used for retransmission HARQ-ACK is determined by UE-specific PDCCH which for PTP retransmission.
* *Qualcomm*
  + Proposal 11: Retransmission schemes based on PTP and PTM-1 can be supported for different UEs in the same group.
* *LGE*
  + Proposal 10: Upon receiving PTP retransmission of a TB with a HPN, UE expects PTP retransmission of the TB after sending NACK to the TB.
    - It is up to UE whether to additionally receive retransmission of the same TB on group common PDSCH with the same HPN and non-toggled NDI.
* *Lenovo*
  + Proposal 4: A UE receiving multicast does not expect to receive both PTM scheme 1 based retransmission and PTP based retransmission at a same time for a same TB.
* *NTT Dococmo*
  + Observation 6: If simultaneous retransmissions of PTM scheme 1 and PTP are performed, a UE which receives retransmission using PTP might also receive retransmission using PTM scheme 1 in the same slot or in an adjacent slot before HARQ feedback for the retransmission by PTM scheme 1.
  + Observation 7: If simultaneous transmissions of retransmission using PTM scheme 1 and retransmission using PTP are supported, there are several issues that need to be considered.
* *Xiaomi*
  + Proposal 12: Do not support PTM scheme 1 based retransmission and PTP scheme based retransmission simultaneously for dynamic MBS transmission in the same MBS group.
* *Ericsson*
  + Observation 4: In the current specification, the UE is not expected to receive another PDSCH associated with the same HARQ process before it has decoded that process and responded with HARQ-ACK if configured to do so.
  + Proposal 4: Based on UE capability, a UE in a G-RNTI-based scheduling group may receive both PTM and PTP with same HARQ process, within the same HARQ-ACK feedback bundling window determined via dlDataToUL-ACK.
  + Observation 5: The existing type-1 or semi-static HARQ codebook construction supports HARQ feedback for different PDSCHs, so no additional specification work is required for the HARQ reporting in the case of combined PTM/PTP reception of the same TB.
  + Proposal 5: Within the same HARQ feedback cycle, a UE may assume that two PDSCH transmitted with the same HARQ process ID corresponds to the same transport block, irrespective of NDI or RNTI used, for the purpose of combining.

**Whether UE is expected to receive a new TB#2 transmitted by PTM-1 for a given HPN before the end of the expected transmission of HARQ-ACK of the previous TB#1, which is initially transmitted by PTM-1, for that HPN:**

* *Huawei, HiSilicon*
  + Proposal 4: For multicast services, when UE is scheduled to receive a PTM1 initial transmission and a PTP retransmission with the same HPN at the same time, UE should receive the PTP retransmission.
* *CATT*
  + Proposal 11: For a given HARQ process number, a UE is not expected to receive a new TB with the same HARQ process number before the completion of the transmission of a previous TB.
* *Qualcomm*
  + Proposal 12: For HARQ process management,
    - Not support OOO between PTM-1 and PTP for a given HPID
* *LGE*
  + Proposal 11: After transmitting PTP retransmission with a HPN, it is up to gNB whether group common DCI with the same HPN and a toggled NDI can be transmitted to schedule new TX of group common PDSCH.
    - If new TX has a lower priority than the PTP retransmission, a UE does not receive new TX of group common PDSCH before successfully sending ACK to PTP retransmission.
    - If new TX has a higher priority than the PTP retransmission, a UE receives new TX of group common PDSCH even before successfully sending ACK to PTP retransmission.
    - Otherwise (e.g. if new TX has an equal priority with the PTP retransmission), a UE does not receive new TX of group common PDSCH before successfully sending ACK to PTP retransmission.
  + Proposal 12: After transmitting unicast transmission with a HPN, it is up to gNB whether group common DCI with the same HPN and a toggled NDI can be transmitted to schedule new TX of group common PDSCH.
    - If new TX has a lower priority than the unicast transmission, a UE does not receive new TX of group common PDSCH before successfully sending ACK to unicast transmission.
    - If new TX has a higher priority than the unicast transmission, a UE receives new TX of group common PDSCH even before successfully sending ACK to unicast transmission.
    - Otherwise, a UE does not receive new TX of group common PDSCH before successfully sending ACK to unicast transmission.
  + Proposal 13: After transmitting group common PDCCH/PDSCH with a HPN, it is up to gNB whether UE specific DCI with the same HPN and a toggled NDI can be transmitted to schedule new TX of unicast PDSCH.
    - If new TX has a lower priority than the group common transmission, a UE does not receive new TX of unicast PDSCH before successfully sending ACK to the group common PDSCH.
    - If new TX has a higher priority than the group common transmission, a UE receives new TX of unicast PDSCH even before successfully sending ACK to the group common PDSCH.
    - Otherwise, a UE receives new TX of unicast PDSCH even before successfully sending ACK to the group common PDSCH.
* *Lenovo*
  + Proposal 5: For a given HARQ process number, a UE is not expected to receive a new TB with the same HARQ process number before the completion of the transmission of a previous TB.

**PTM scheme 2:**

* *OPPO*
  + Proposal 5: PTM scheme 2 is NOT supported as a (re)transmission scheme for NR MBS.
* *Spreadtrum*
  + Proposal 1: For RRC\_CONNECTED UEs for NR MBS, not support PTM2 transmission scheme.
* *vivo*
  + Proposal 5: For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast.
* *Nokia*
  + Observation-9: Having a UE-specific PDCCH that can schedule UEs to use a group-common PDSCH is desirable for the following reasons:
    - In scenarios where there is a low density of users receiving multicast traffic with high data rates and requiring uplink feedback, gNB will have the flexibility to choose the appropriate control channel signaling mechanism
    - Enables the support of seamless mobility and switching from multicast to unicast
    - Enables simultaneous BWP switching and scheduling of MBS PDSCH resources using the same DCI
    - For SPS, it ensures the reliable reception of the SPS activation, deactivation and modification messages.
  + Observation-10: In order to support both signaling options to access the same group-common PDSCH, new signaling mechanisms will be required to allow the network to configure and modify on a dynamic basis the use of either PTM schemes 1 or 2.
  + Proposal-9: For RRC\_CONNECTED UEs, support UE-specific PDCCH with CRC scrambled by a C-RNTI for dynamic scheduling and CS-RNTI for SPS, to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on a common RNTI.
  + Proposal-10: The same group-common PDSCH for PTM transmission can be simultaneously accessed by:
    - A set of UEs using the same group-common PDCCH with CRC scrambled by a common RNTI, or
    - A set of UEs, where each UE uses a UE-specific PDCCH with CRC scrambled by a C-RNTI or CS-RNTI
  + Proposal-11: The network can dynamically modify the signaling using Alt 1 / group-common or Alt 2 / UE-specific PDCCH to configure a UE to access a group-common PDSCH.
* *Intel*
  + Proposal 7: PTM Scheme 2 should be supported when ACK/NACK based HARQ feedback is configured or enabled for the UEs within a group.
  + Proposal 8: Only one among PTP or PTM Scheme 2 can be supported for UE specific retransmission when the initial transmission was based on PTM Scheme 1. The support of PTP or PTM Scheme 2 can be configured by UE-specific RRC signaling. Different UEs in a group can potentially support different retransmission schemes but not both simultaneously.
  + Proposal 9: The HARQ process ID is used to associate PTM Scheme 2 based retransmission with the initial transmission using PTM Scheme 1. The UE does not expect to receive a unicast transmission using the same HARQ process ID as the ongoing MBS transmission.
* *Convida*
  + Proposal 1: PTP transmission and PTM transmission scheme 2 should be supported for initial transmission for MBS.
  + Proposal 2: PTM transmission scheme 2 should be supported for retransmission for MBS.
  + Proposal 3: 1-bit field is introduced in the DCI format for the UE to distinguish between the UE-specific PDCCH scheduling the MBS PDSCH and scheduling the unicast PDSCH.
* *NTT Dococmo*
  + Proposal 14: Not support PTM scheme 2 as retransmission scheme for PTM scheme 1.
* *Xiaomi*
  + Proposal 11: Do not support PTM transmission scheme 2.
* *ASUSTeK*
  + Proposal 5: PTM transmission scheme 2 for initial transmissions and retransmissions is supported for multicast.
* *Ericsson*
  + Observation 6: PTM-1 is more efficient than PTM-2 for initial transmission and retransmissions of group-common PDSCH
  + Observation 7: PTP is more efficient than PTM-2 for retransmission to individual UEs
  + Proposal 6: PTM-2 based initial transmission is not supported.
  + Proposal 7: PTM-2 based retransmission is not supported.

## Initial Proposals based on contributions

***Summary***

Several companies raise a similar issue that NDI conflict may occur for PTM reception, when different UEs have different “latest” NDI bit status for the HPID. As explained in [30], before receiving the G-RNTI DCI, two different UEs may have each received a TB using the same HPID, which for UE1 resulted in NDI bit status ‘0’ whereas for UE2 in NDI bit status ‘1’. When the gNB uses the same HPID for a new TB, with a G-RNTI that both UEs belong to, it is then logically impossible to toggle the NDI in a way that would satisfy the toggling rule for both UEs. 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. In my understanding, this issue may happen unless the HARQ processes are semi-statically split among unicast and different multicast services, which means a HPID can only be exclusively used by C-RNTI or one of the multiple G-RNTIs. It has been agreed in RAN1#104 meeting that how to allocate HARQ processes between unicast and multicast is up to gNB. If gNB dynamically allocates HARQ processes among unicast and different multicast services, this issue may happen. Therefore, moderator suggests RAN1 first to decide whether to solve this issue based on specification enhancement or just rely on gNB implementation to avoid such issue [Question 3-1a]. If we decide to solve this issue based on specification enhancement, then two options can be considered as follows [Question 3-1b]:

* Option 1: When a G-RNTI DCI is received with a given HPID in the DCI, the data shall be considered new, i.e. be treated as if the NDI bit had been toggled, irrespective of actual NDI toggling, if the G-RNTI is different from the most recent earlier received RNTI (i.e. C-RNTI or another G-RNTI) of the same HPID. When the received G-RNTI is the same as the most recent use of the HPID, legacy NDI toggling is used to indicate new data or retransmission.
* Option 2: Irrespective of earlier used RNTIs for the HPID, NDI bit ‘0’ means new data transmission, NDI bit ‘1’ means retransmission.

Regarding the FFS in last meeting that whether/how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast, it depends on the discussion result of question 3-1a and 3-1b. Companies’ views diverge based on submitted contributions. Some companies [OPPO, vivo, Samsung, Xiaomi] think there is no need to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast. Some companies [Ericsson, Huawei, CATT, Nokia?, CMCC] are fine to introduce a DCI bit to differentiate PTP (re)transmission for unicast and PTP retransmission for multicast. 2 companies [ZTE, Ericsson] propose to change the existing agreement in a way so that the NDI of PTP ReTx is then not set to be the same as for PTM to indicate re-transmission, but to a value which is always different (i.e. toggled) from the latest earlier (PTP) use of the current HPID. 1 company [Google] propose to change existing agreement to increase the maximum number of HARQ processes. Moderator suggest to discuss this issue after we have decisions on Question 3-1a and 3-1b. If the decision on Question 3-1a is option 1 (i.e., rely on gNB implementation to avoid such issue), then we do not need to discussion this FFS. If the decision on Question 3-1a is option 2 (i.e., Resolve this issue with potential specification enhancement), then based on whether option 1 or option 2 is adopted for Question 3-1b we can further discuss how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.

Regarding whether PTM-1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group, it seems 6 companies [OPPO, Spreadtrum, CATT, Lenovo, NTT Docomo, Xiaomi] do not support this, 4 companies [Futurewei, CMCC, Qualcomm, Ericsson] propose to support this, 1 company [Huawei] thinks it is up to gNB to retransmit the failed TB via PTM scheme 1 or PTP, and UE does not need to be configured with PTM scheme 1 or PTP or both for retransmission. 1 company [LGE] proposes that upon receiving PTP retransmission of a TB with a HPID, UE expects PTP retransmission of the TB after sending NACK to the TB, and it is up to UE whether to additionally receive retransmission of the same TB on group common PDSCH with the same HPN and non-toggled NDI. Considering the situation does not change much compared to last meeting, moderator suggests to postpone the discussion in this meeting.

Regarding whether UE is expected to receive a new TB#2 transmitted by PTM-1 for a given HPN before the end of the expected transmission of HARQ-ACK of the previous TB#1, which is initially transmitted by PTM-1, for that HPN, 3 companies [CATT, Qualcomm, Lenovo] do not support this, 2 companies [Huawei, LGE] propose to specify some rules to support this. Considering the situation, moderator suggests to postpone the discussion in this meeting.

Regarding PTM scheme 2, 5 companies propose to support PTM-2 for initial transmission or retransmission, while 5 companies propose to not support it. It seems the situation does not change much compared with the last meeting. Moderator proposes to postpone the discussion.

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

**[High] Question 3-1a**: Regarding the NDI conflict issue that different UEs in a group may have different NDI values for a certain HPID before performing an initial PTM transmission, which option should be adopted?

* Option 1: Rely on gNB implementation to avoid such issue.
* Option 2: Resolve this issue with potential specification enhancement.

**[High] Question 3-1b**: If the answer is Option 2 for question 3-1a, which option do you prefer for the specification enhancement?

* Option 1: When a G-RNTI DCI is received with a given HPID in the DCI, the data shall be considered new, i.e. be treated as if the NDI bit had been toggled, irrespective of actual NDI toggling, if the G-RNTI is different from the most recent earlier received RNTI (i.e. C-RNTI or another G-RNTI) of the same HPID. When the received G-RNTI is the same as the most recent use of the HPID, legacy NDI toggling is used to indicate new data or retransmission.
* Option 2: Irrespective of earlier used RNTIs for the HPID, NDI bit ‘0’ means new data transmission, NDI bit ‘1’ means retransmission.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| OPPO | **Question 3-1a:** Option 1 is supported that such kind of issue will not happen based on gNB’s implementation. The mentioned issue is clear to us, and it is said that such issue may be happened according to gNB’s cross scheduling on the HPID/NDI among the group of UEs between multicast and unicast. Meanwhile, gNB has the whole picture of the HPID/NDI allocation for all the UEs, gNB can also make smart decision to avoid it. Furthermore, occupying 16 HARQ processing simultaneously by all the UEs in the same group seems like quite a rarely case, because it challenges the UE’s buffer capability.  **Question 3-1b:** NO necessary for this question. |
| Xiaomi | Question 3-1a: option 1. gNB has full power to decide which HPN is allocated for MBS and unicast respectively. A proper scheduling mechanism should avoid the NDI collision. As mentioned by several companies, the issue is actually out of order which is already precluded in the previous meetings. |
| Lenovo, Motorola Mobility | 3-1a: Option 1 should be baseline. Whether other solutions are needed can be FFS.  3-1b: can be deferred due to dependent on outcome of 3-1a. |
| ZTE | Question 3-1a: Purely relying on network implementation may cause low HARQ process utilization efficiency. We would prefer to specify something to increase the HARQ process utilization efficiency, i.e., Option 2.  Question 3-1b: Another way to handle this issue is to toggle the NDI relative to the latest PDCCH with the same RNTI and HARQ process ID. In such case, the NDI toggle is performed independently between different RNTIs and HARQ process ID. While with the same RNTI and same HARQ process ID, the legacy toggling mechanism is reused.  Thus, we propose to add the following option for question 3-1b.  Option3: The NDI is toggled relative to the latest PDCCH with the same RNTI and HARQ process ID. With the same RNTI and same HARQ process ID, the legacy toggling mechanism is reused |
| CMCC | 3-1a: Option 2.  Considering the number of UEs in one MBS group may be huge, and the HPN/NDI of UEs’ unicast services are various among them, it may not possible for gNB to find a proper HPN for MBS service, therefore, we think some spec enhancement is needed.  3-1b: Option 1 is preferred.  One concern about Option 2, in Type-1 HARQ codebook, if UE miss detects the initial transmission DL grant DCI, UE will send a NACK, but gNB doesn’t know whether UE doesn’t decode PDSCH correctly or miss the DCI. If gNB thinks UE doesn’t decode PDSCH correctly, gNB will resend the DCI with NDI equals to 1, but this will cause UE’s ambiguity in soft buffer combination. |
| Spreadtrum | Question 3-1a: Support option 1. |
| Samsung | 3-1a: Option 1.  The suggested issue does not exist in practice as there is no issue with shortage of HARQ processes. The capability for PDSCH receptions within a time period is basically same as in R16. There is also no reason, and it is highly undesirable for UE implementation, to support out-of-order operation for MBS. |

## Updated Proposals (after 1st round of inputs)

# Issue #4: SPS for MBS

## Background and submitted proposals

***Background***

In RAN1#104&104bis&105 meetings, the following agreements were achieved.

**SPS configuration:**

Agreement (#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.
* FFS: How to allocate the total SPS configurations between MBS and unicast.

Agreement (#104b):

For RRC\_CONNECTED UE supporting MBS, support up to 8 configured SPS configurations in a BWP of a serving cell for unicast and MBS in total.

* It is up to gNB implementation to configure the SPS configuration indexes for unicast and MBS, respectively.

Agreement (#104b):

Define G-CS-RNTI at least for SPS group-common PDSCH and activation/deactivation of SPS group-common PDSCH, different from CS-RNTI for unicast SPS PDSCH.

* G-CS-RNTI is used for PTM scheme 1 based dynamic retransmission of SPS group-common PDSCH
* FFS: Whether CS-RNTI can be used for PTP retransmission of SPS group-common PDSCH.
* FFS: Number of G-CS-RNTI.

Agreement (#104b):

Send an LS to RAN2 regarding at least the following questions:

* Whether RAN1 should take into account the case of UE supporting multiple G-RNTIs?

Agreement (#104b):

Include the following in the LS to RAN2:

* Whether RAN1 should consider the case of UE supporting multiple G-CS-RNTIs?
* The agreements related to SPS will also be included in the LS for information

**R1-2104045 LS on G-RNTI and G-CS-RNTI for MBS RAN1, CMCC**

**Decision:** As per email decision posted on April 22nd, the LS is approved.

**Reliability of SPS GC-PDSCH:**

Agreement (#104):

For RRC\_CONNECTED UEs, support HARQ-ACK feedback for SPS group-common PDSCH for MBS

* FFS: The retransmission scheme(s)
* FFS: The HARQ-ACK details for SPS PDSCH and activation/deactivation, which can be discussed in AI 8.12.2

Agreement (#104b):

The retransmission scheme for a given SPS group-common PDSCH can be either PTM scheme 1 or PTP.

* FFS: Whether PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group

Agreement (#105):

For PTP retransmission of SPS group-common PDSCH, CS-RNTI is used for CRC scrambling of PDCCH with the NDI bit set to 1.

**Activation/deactivation of SPS GC-PDSCH:**

Working assumption: (#104)

For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* At least group-common PDCCH is supported
  + FFS: Whether and how to address the missed activation and deactivation
* FFS: Whether UE-specific PDCCH is supported for activation/deactivation

Agreement (#104b):

Confirm the working assumption:

For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* At least group-common PDCCH is supported
  + FFS: Whether and how to address the missed activation and deactivation
* FFS: Whether UE-specific PDCCH is supported for activation/deactivation

Agreement (#105):

For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support at least one of the following alternatives.

* Alt 1: retransmit the activation command via group-common PDCCH.
* Alt 2: retransmit the activation command via UE-specific PDCCH.
* Alt 3: retransmit the activation command via MAC-CE.
* FFS other details.
* Note: Down-selection can take into account the HARQ-ACK feedback scheme for SPS activation

***Submitted Proposals***

**SPS configuration:**

* *vivo*
  + Proposal 8: For an SPS PDSCH configuration, it is indicated as a group-common SPS by RRC configuration.
  + Proposal 9: When a UE is configured with multiple SPS group-common PDSCHs, it should be supported to configure group-common RNTI for each SPS group-common PDSCH.
* *Nokia*
  + Observation-11: Configuration of uplink HARQ feedback for SPS-based MBS can be inherited from SPS for unicast in combination with uplink feedback for non-SPS-based MBS.
* *FUTUREWEI*
  + Proposal 10: Support of more than one SPS group-common PDSCH configuration.
* *Qualcomm*
  + Proposal 13: Support one or more activated SPS GC-PDSCH configurations per CFR subject to UE capability.
* *Ericsson*
  + Proposal 19: G-CS-RNTI is configured per SPS configuration. If not configured, the UE assumes CS-RNTI is used for PDSCH.
  + Proposal 20: CS-RNTI and G-CS-RNTI can be configured for the same SPS configuration.
  + Proposal 21: The number of supported G-CS-RNTI per UE up to UE capability. The maximum number of G-CS-RNTI can be aligned with the number of G-RNTI per UEs.

**Activation/deactivation of SPS GC-PDSCH:**

* *Huawei, HiSilicon*
  + Proposal 7: Support Alt 3: Retransmit the activation command via MAC-CE for reliability of multicast SPS.
* *OPPO*
  + Proposal 9: UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH is not considered in Rel-17 MBS.
  + Proposal 10: Retransmission of activation command via GC-PDCCH can be considered when ACK/NACK-based feedback scheme is enabled for multicast SPS.
* *Spreadtrum*
  + Proposal 8: Regarding the reliability of the group-common PDCCH activation of SPS group-common PDSCH, at least one of Alt.1 and Alt.2 could be supported.
* *ZTE*
  + Proposal 9: UE-specific PDCCH is not needed for activation/deactivation of an SPS GC-PDSCH given that group-common PDSCH has already been supported.
  + Proposal 10: NR MBS supports to retransmit the activation command via GC-PDCCH.
* *vivo*
  + Proposal 10: For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state, UE-specific PDCCH is supported
  + Proposal 11: For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support Alt 1and Alt 2.
    - Alt 1: retransmit the activation command via group-common PDCCH.
    - Alt 2: retransmit the activation command via UE-specific PDCCH.
* *CATT*
  + Proposal 14: UE-specific PDCCH can be also used for SPS activation for MBS for RRC\_CONNECTED UEs.
  + Proposal 15: UE-specific PDCCH cannot be used for SPS deactivation for MBS for RRC\_CONNECTED UEs.
  + Proposal 16: Both Alt 1 and Alt 2 can be supported for reliability of the group-common PDCCH retransmitted activation of SPS group-common PDSCH.
* *Nokia*
  + Proposal-7: For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support Alt 1 whereby missed SPS activation/deactivation could be handled using blind repetition of the SPS group-common PDCCH activation / deactivation messages – in case HARQ NACK-only feedback is utilized, and both Alt 1 and Alt 2 using UE-specific or group-common PDCCH for SPS group-common PDSCH – if HARQ ACK/NACK feedback option is used.
  + Observation-8: If the UE-specific PDCCH is used for SPS group-common PDSCH, there needs to be an association between the CS-RNTI and group-common G-CS-RNTI using higher layer signaling.
  + Proposal-8: RAN2 to consider how to associate CS-RNTI and group-common G-CS-RNTI using higher layer signaling when UE-specific PDCCH is used for SPS group-common PDSCH.
  + Observation-9: Having a UE-specific PDCCH that can schedule UEs to use a group-common PDSCH is desirable for the following reasons:
    - In scenarios where there is a low density of users receiving multicast traffic with high data rates and requiring uplink feedback, gNB will have the flexibility to choose the appropriate control channel signaling mechanism
    - Enables the support of seamless mobility and switching from multicast to unicast
    - Enables simultaneous BWP switching and scheduling of MBS PDSCH resources using the same DCI
    - For SPS, it ensures the reliable reception of the SPS activation, deactivation and modification messages.
  + Observation-10: In order to support both signaling options to access the same group-common PDSCH, new signaling mechanisms will be required to allow the network to configure and modify on a dynamic basis the use of either PTM schemes 1 or 2.
  + Proposal-9: For RRC\_CONNECTED UEs, support UE-specific PDCCH with CRC scrambled by a C-RNTI for dynamic scheduling and CS-RNTI for SPS, to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on a common RNTI.
  + Proposal-10: The same group-common PDSCH for PTM transmission can be simultaneously accessed by:
    - A set of UEs using the same group-common PDCCH with CRC scrambled by a common RNTI, or
    - A set of UEs, where each UE uses a UE-specific PDCCH with CRC scrambled by a C-RNTI or CS-RNTI
  + Proposal-11: The network can dynamically modify the signaling using Alt 1 / group-common or Alt 2 / UE-specific PDCCH to configure a UE to access a group-common PDSCH.
* *MediaTek*
  + Proposal 18: UE-specific PDCCH with G-CS-RNTI is optional supported for activation of MBS group common PDSCH.
  + Proposal 19: MBS SPS activation/deactivation’s feedback mechanism only support ACK/NACK based HARQ feedback mode.
* *FUTUREWEI*
  + Proposal 8: At least UE-specific PDCCH is supported for deactivation of SPS group-common PDSCH.
  + Proposal 9: Re-sending of the activation command via group-common PDCCH (Alt1) and UE-specific PDCCH (Alt 2) should be supported.
* *CMCC*
  + Proposal 19. For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support at least one of the following alternatives, support Alt 2: retransmit the activation command via UE-specific PDCCH.
* *Intel*
  + Proposal 21: For DL SPS configuration for NR MBS
    - Group common PDCCH is used for SPS activation with HARQ ID field set to all 0’s and RV field set to 00 for the TB being scheduled
    - PUCCH resource for HARQ feedback may be configured via RMSI, OSI or RRC
    - For SPS release, similar group common PDCCH can be used with HARQ ID set to all 0s, MCS and FDRA set all 1’s and RV set 0. For SPS release DCI, UE can be configured with PUCCH resource via RRC
    - The PUCCH resources for HARQ feedback for SPS PDSCH as well as the SPS release DCI can be UE-specific for ACK/NACK based feedback or a common PUCCH resource can be configured for the case when NACK-only feedback is configured.
* *Samsung*
  + Observation 14: For SPS GC-PDSCH activation/deactivation, the agreement from RAN1#104-bis-e to support GC-PDCCH is sufficient.
* *Qualcomm*
  + Proposal 14: For SPS GC-PDSCH activation/release,
    - Support UE-specific PDCCH in addition to GC-PDCCH.
    - Support separate activation of SPS GC-PDSCH by using GC-PDCCH or UE-specific PDCCH.
    - Support joint and separate release of SPS GC-PDSCH by using GC-PDCCH or UE-specific PDCCH.
* *LGE*
  + Proposal 14: For group common SPS, UE specific confirmation to group common SPS (de-)activation can be supported by PUCCH A/N.
    - UE specific PUCCH resource is allocated by DCI indicating SPS (de-)activation.
  + Proposal 15: For group common SPS activation/deactivation to multiple UEs in a group, (de)activation DCI can be repeated on multiple CORESETs with same TCI state or different TCI states.
  + Proposal 16: For a UE not confirming SPS activation, gNB can schedule PTP initial transmission of missed TB(s).
  + Proposal 17: After group common SPS activation, all UEs autonomously release the group common SPS right after a pre-determined slot
    - The pre-determined time is determined by RRC and/or DCI.
* *Chengdu TD Tech*
  + Proposal 6：The repetitions of the SPS group common PDCCH for the activation/deactivation of the SPS group common PDSCH is supported.
  + Proposal 7: The PUCCH resource for the HARQ-ACK feedback of the SPS group common PDSCH is used by UE to indicate whether or not the PDCCH is decoded correctly.
* *Convida*
  + Proposal 5: UE-specific PDCCH should be supported for activation/deactivation DCI for MBS SPS.
  + Proposal 6: PTM transmission scheme 2 should be considered for the MBS SPS PDSCH retransmission.
  + Proposal 7: Retransmitting the activation command via both group-common PDCCH and UE-specific PDCCH should be supported, i.e., both Alt.1 and Alt.2 should be supported.
* *Lenovo*
  + Proposal 16: For group-common SPS configuration, a UE-specific PUCCH resource is configured for each UE to transmit ACK upon reception of activation/deactivation DCI.
  + Proposal 17: For group-common SPS configuration, the UE-specific PUCCH resource for confirming reception of activation/deactivation DCI is used for the UE to transmit ACK for the SPS PDSCH.
  + Proposal 18: For group-common SPS configuration activated by group-common PDCCH, gNB can retransmit the group-common PDCCH if no ACK is detected from one UE.
* *NTT Dococmo*
  + Proposal 15: Use ACK/NACK based feedback for HARQ-ACK feedback for activation/deactivation of SPS group-common PDSCH regardless of feedback configuration/indication for SPS group-common PDSCH.
  + Observation 8: If a UE stops receiving SPS PDSCH without a deactivation command, it can lead to a mismatch in the HARQ-ACK feedback bits.
  + Proposal 16: Support UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH.
* *Ericsson*
  + Observation 9: When activation command is re-transmitted via either group common PDCCH or UE specific PDCCH, UE might not able to derive the right SPS parameters in the original activation command.
  + Proposal 15: For group based SPS, MAC-CE should be used to retransmit the SPS activation command. This MAC-CE CE containing the same SPS related parameters that was carried in the original SPS activation command, which includes slot number where it was transmitted and the MCS/PRB allocation.
  + Proposal 16: For deactivation, UE specific PDCCH deactivation order can be sent to UEs not responding to the group de-activation PDCCH.
  + Proposal 17: For deactivation, UE specific PDCCH deactivation order can be used to deactivate a group-based SPS.
  + Observation 10: Unicast PDCCH scrambled with C-RNTI is not supported for group-common PDSCH
  + Proposal 18: Do not support unicast PDCCH scrambled with CS-RNTI for activation of group SPS PDSCH.
  + Proposal 24: The UE is expected to provide HARQ-ACK feedback for all PDCCH associated with a PDCCH activation or deactivation command for SPS whatever UE is configured to send ACK/NACK HARQ feedback, NACK-only HARQ feedback, or no HARQ feedback at all.
* *Xiaomi*
  + Proposal 14: For reliability of the group-common PDCCH activation of SPS group-common PDSCH, retransmit the activation command via UE-specific PDCCH.

**Reliability of SPS GC-PDSCH:**

* *OPPO*
  + Proposal 11: PTM scheme 1 and PTP are not supported to be used as retransmission scheme simultaneously for a given SPS group-common PDSCH.
* *Spreadtrum*
  + Proposal 7: Not support simultaneously scheduling unicast and group-common retransmission for SPS group-common PDSCH.
* *CATT*
  + Proposal 13: PTM scheme 1 retransmission and PTP retransmission cannot be used simultaneously for different UEs in the same MBS group.
* *FUTUREWEI*
  + Proposal 7: The retransmission scheme for a given SPS group-common PDSCH can be either PTM scheme 1 or PTP for different UEs in the same group.
* *CMCC*
  + Proposal 20. PTM transmission scheme 1 and PTP can be used as retransmission for SPS group-common PDSCH.
* *Ericsson*
  + Proposal 22: PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group
  + Proposal 23: The simultaneous reception of PTP and PTM retransmission for a given UE is up to UE implementation, pending a UE capability.
  + Proposal 25: The UE can be configured to either transmit HARQ-ACK feedback, NACK-only feedback, or no HARQ feedback at all for the SPS PDSCH not corresponding to a SPS PDCCH activation or deactivation.
  + Observation 11: For the PDCCH-less SPS-PDSCH the mechanism to support HARQ and HARQ-less or NACK-only can reuse what is designed for non-SPS MBS PDSCH scheduling.
  + Proposal 26: The SPS UL feedback framework for the SPS scheduled (i.e. PDCCH-less) PDSCH is the same as for non-SPS MBS PDSCH scheduling.
* *Xiaomi*
  + Proposal 13: Do not support PTM scheme 1 based retransmission and PTP scheme based retransmission simultaneously for SPS MBS transmission in the same MBS group.

**Other Issues:**

* *Nokia*
  + Observation-12: Significantly higher spectral efficiency can be achieved when relying heavily on HARQ retransmissions compared to operation with conventional first HARQ transmission BLER targets for the worst UE in the cell.
  + Proposal-12: Support HARQ retransmissions on SPS-allocated resources.
  + Proposal-13: Add in-band control signaling on PDSCH to facilitate retransmissions on SPS-allocated PDSCH resources.
  + Observation-13: The conventional NDI definition is not ideal in terms of the impact that an NDI decoding error has on the reliability of the MBS data delivery via SPS, especially when the NDI error occurs on the first transmission of a MAC PDU.
  + Proposal-14: At least for delivery of MBS traffic over SPS allocated resources, a new NDI definition is used that is toggled between HARQ transmissions belonging to one MAC PDU to HARQ transmissions belonging to the next MAC PDU on the same HARQ process. Further enhancements of in-band control signaling in case of SPS are FFS.
* *LGE*
  + Proposal 18: For a group common SPS configuration, UE can be optionally configured with either pdsch-AggregationFactor or TDRA table with repetitionNumber as part of the TDRA table.
  + Proposal 19: Discuss whether different TCI states can be configured for group common SPS received by different UE, e.g. different slots of group common SPS PDSCH repetitions or different SPS configurations can be associated to different TCI states for the same group of UEs.

## Initial Proposals based on contributions

***Summary***

Regarding SPS configuration for multicast, RAN1 has agreed more than one SPS group-common PDSCH configuration for MBS can be configured per UE subject to UE capability, 1 company [Qualcomm] proposes that one or more SPS GC-PDSCH can be activated per CFR subject to UE capability. Moderator suggests initial proposal 4-1. In addition, some companies propose that G-CS-RNTI is configured per SPS configuration for MBS. Moderator suggests initial proposal 4-2.

For reliability of the group-common PDCCH activation of SPS group-common PDSCH, 3 alternatives were listed for further study in last meeting. Based on contributions submitted in this meeting, it seems 11 companies [Spreadtrum, vivo, CATT, Nokia, Futurewei, CMCC, Qualcomm, Convida, MediaTek, NTT Docomo, Xiaomi] support both Alt1 (GC-PDCCH) and Alt2 (UE-specific PDCCH), 3 companies [OPPO, ZTE, Samsung] support only Alt1, and 2 companies [Huawei, Ericsson] support Alt3 (MAC-CE). Moderator suggests initial proposal 4-3.

Regarding whether PTM-1 retransmission and PTP retransmission for SPS group-common PDSCH can be used simultaneously for different UEs in the same MBS group, this situation is similar as for non-SPS group-common PDSCH, 4 companies [OPPO, Spreadtrum, CATT, Xiaomi] do not support it and 4 companies [ZTE, Futurewei, CMCC, Ericsson] support it. Moderator suggests to postpone the discussion in this meeting.

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

**[High] Initial Proposal 4-1**:

For RRC\_CONNECTED UEs, one or more SPS GC-PDSCH can be activated per CFR subject to UE capability.

**[High] Initial Proposal 4-2**:

If a SPS-config for MBS is configured in CFR, one or more G-CS-RNTIs should be configured in the SPS-config.

**[High] Initial Proposal 4-3**:

For reliability of the group-common PDCCH activation of SPS group-common PDSCH, both Alt 1 and Alt 2 are supported.

* Alt 1: retransmit the activation command via group-common PDCCH.
* Alt 2: retransmit the activation command via UE-specific PDCCH.
* For SPS GC-PDSCH corresponding to a SPS activation PDCCH and SPS release PDCCH, only ACK/NACK based HARQ-ACK feedback is supported, irrespective of the HARQ-ACK feedback method used for SPS GC-PDSCH without PDCCH scheduling

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| OPPO | **Proposal 4-1:** More clarification of motivation/benefit are needed.  It was agreed in RAN1#104b-e as follows that how to configure SPS indexes for unicast and MBS is up to gNB implementation. Why do we need to agree this proposal to restrict the configuration/activating multiple SPS **per CFR**? gNB has all the UEs’ capabilities information, the corresponding configuration/scheduling must take all the UEs into account. Therefore, a proper gNB implementation can also be applied.  Agreement (#104b):  For RRC\_CONNECTED UE supporting MBS, support up to 8 configured SPS configurations in a BWP of a serving cell for unicast and MBS in total.   * It is up to gNB implementation to configure the SPS configuration indexes for unicast and MBS, respectively.   **Proposal 4-2:** More clarification of motivation/benefit are needed.  Even only one G-CS-RNTI is configured, multiple SPS procedures still can be supported. Please correct me if it is not working.  Furthermore, if my understanding is correct, the intention of the initial proposal is to support one/more G-CS-RNTI(s) for one/more SPS configuration(s). The current wording seems like that one SPS configuration needs one/more G-CS-RNTI(s).  **Proposal 4-3:** Only Alternative 1 is supported. The third sub-bullet can be considered as a starting point. |
| Xiaomi | For proposal 4-1 and proposal 4-2, we don’t see the motivation. The purpose of supporting multiple active SPS in Rel-16 is to support low latency traffic, i.e. URLLC. We are not sure why do we need this for MBS. Furthermore, considering the SPS allocation is up to gNB, it will complicate the multiplexing between MBS and unicast.  For proposal 4-3, don’t support alt.1. If the activation command is transmitted via group-common PDCCH, it will introduce additional effort for the UEs who successfully decode the MBS PDSCH, as it will re-initialized the SPS again according to the newly received activation PDCCH. Furthermore, the power consumption also goes up because of the unnecessary PDCCH monitoring. |
| Lenovo, Motorola Mobility | 4-1: the proposal is not clear to us. Do you mean one or more SPS configuration are activated by one DCI or configured within one CFR?  4-2: is it better to be discussed firstly in RAN2?  4-3: Alt 1 should be the baseline. Then we can discuss whether other solutions are needed. For the third bullet, we support it in principle. |
| ZTE | Proposal 4-1: The proposal is not needed.  Rel-16 already has UE capability to indicate the max number of activated SPS per BWP. It can be up to network implementation to configure how many SPS within CFR as long as the total number of SPS is not exceeded.  Proposal 4-2: Is the intention of this proposal to say that, each SPS configuration can be associated with one or more G-CS-RNTIs? If yes, then we are supportive of this proposal.  Proposal 4-3: Based on our observation, all companies agree that activation command via group-common PDCCH should be supported. Companies have different understandings on whether UE-specific PDCCH for activation is needed. We can first agree on Alt.1 and FFS Alt.2.  Regarding the 3rd bullet, it seems better to be discussed under 8.12.2. Thus, the following proposal is proposed from our side.  **[High] Initial Proposal 4-3**:  For reliability of the group-common PDCCH activation of SPS group-common PDSCH, ~~both~~ Alt 1 ~~and Alt 2 are~~ is supported.   * Alt 1: retransmit the activation command via group-common PDCCH. * FFS whether to additionally support Alt 2: retransmit the activation command via UE-specific PDCCH. * ~~For SPS GC-PDSCH corresponding to a SPS activation PDCCH and SPS release PDCCH, only ACK/NACK based HARQ-ACK feedback is supported, irrespective of the HARQ-ACK feedback method used for SPS GC-PDSCH without PDCCH scheduling~~ |
| CMCC | 4-3: Support. |
| Spreadtrum | Proposal 4-1: Support. Given that there are some difference between SPS for MBS and SPS for unicast, e.g., HARQ-ACK feedback mechanism, one SPS for MBS capable of be associated with one or multiple RNTI as proposal 4-2 while not for unicast, we slightly prefer one separate UE capability for MBS, not reusing R16 UE capability for unicast.  Proposal 4-2: We are fine that one or more G-CS-RNTIs can be configured for a SPS-config for MBS.  Proposal 4-3: Support. Alt.1 and Alt.2 could be applied for different cases. For example, if a few of group member missed the activated group-common PDCCH, Alt.2 could be considered. UE specific PDCCH with higher aggregation level could be considered to improve the probability of successfully decoding. If the majority of group member missed the activated group-common PDCCH, Alt.1 is preferred, to alleviate the overhead cost. |
| Samsung | 4-1: Support  4-2: Support  4-3: Do not support.  Alt. 1 is sufficient. Unlike PDSCH scheduling, there is no benefit from UE-specific PDCCH for link adaptation as there is no spectral efficiency gain and the event is infrequent. Such support will only result to unnecessary specifications and UE complexity. |

## Updated Proposals (after 1st round of inputs)

# Issue #5: Simultaneous operation with unicast reception

## Background and submitted proposals

***Background***

In RAN1#104&104bis&105 meetings, the following agreement was achieved.

Agreements (#103):

Further study the following cases for simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs.

* Case 1: support TDM between multiple TDMed unicast PDSCHs and one group-common PDSCH in a slot
* Case 2: support TDM among multiple group-common PDSCHs in a slot
* Case 3: support TDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
* Case 4: support FDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
* Case 5: support FDM among multiple group-common PDSCHs in a slot
* FFS: maximum number of PDSCHs in a slot simultaneous received per UE

Agreement (#104b):

At least support the following cases for PDSCH reception for MBS in a slot based on UE capability for RRC\_CONNECTED UEs

* Case 1: support TDM between M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC
  + FFS: the value(s) of M
* Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC
  + FFS: the value(s) of N
* Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC
  + FFS: the value(s) of K and L

Agreement (#105):

For Rel-17 MBS UE, the UE maximum number of TDMed PDSCH receptions capability in a slot per CC is kept as for Rel-15/Rel-16, i.e., {2/4/7} based on UE FG5-11/5-11a/5-11b.

* Note:   Group-common PDSCH(s) are counted as unicast PDSCH(s).

***Submitted Proposals***

* *vivo*
  + Proposal 4: For simultaneous reception of unicast PDSCH and group-common PDSCH in a slot for RRC\_CONNECTED UEs, support the following cases.
    - Case 4: support FDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
    - Case 5: support FDM among multiple group-common PDSCHs in a slot
* *CATT*
  + Proposal 28: When the simultaneous reception of unicast and multicast is beyond a UE’s capability, a dropping principle should be considered.
* *Intel*
  + Observation 1: The use case for multiple simultaneous MBS PDSCH reception should be clarified further. If the intention is to support delivery modes 1 and 2, N, L =2 is sufficient. The total number of PDSCHs that can be simultaneously received may be subject to UE capability.
  + Proposal 20: The reception of MBS and unicast in FDM mode should be a UE capability
* *CMCC*
  + Proposal 25. Not support the following cases for simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs.
    - Case 4: FDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot;
    - Case 5: FDM among multiple group-common PDSCHs in a slot.
* *Qualcomm*
  + Proposal 16: The maximum PDSCH data rate of multicast and unicast in a slot per CC per UE is subject to UE capability.

## Initial Proposals based on contributions

***Summary***

Regarding the case 4 and case 5 for simultaneous operation with unicast reception, 1 company [vivo] support and 1 company [CMCC] do not support.

1 company [Intel] proposes that the reception of MBS and unicast in FDM mode should be a UE capability. However, in RAN1#102, we have agreed that at least support FDM between unicast PDSCH and group-common PDSCH in a slot based on UE capability. Therefore, I think it is clear that the reception of MBS and unicast in FDM mode is a UE capability.

1 company [Qualcomm] proposes the maximum PDSCH data rate of multicast and unicast in a slot per CC per UE is subject to UE capability. I’m not sure whether we need to discussion this issue now.

Moderator does not plan to discuss these issues in this meeting currently, if more companies propose to discuss some of the proposals, moderator will take that into account in the next round discussion.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| OPPO | Agree with moderator that it is not such urgent discussing this issue in this meeting. |
| Samsung | Support the moderator’s proposal. |

## Updated Proposals (after 1st round of inputs)

# Issue #6: Other issues

## Background and submitted proposals

***Submitted Proposals***

* *ZTE*
  + Proposal 11: RAN1 further studies whether to support HARQ-ACK feedback for broadcast service for UEs under RRC\_CONNECTED state.
* *Intel*
  + Proposal 22: NR MBS uses PDSCH Mapping Type A with DM-RS Type 1 as a baseline. PDSCH Mapping Type B and use of Type 2 DM-RS are not precluded.
  + Proposal 23: For NR MBS support of multi-layer MIMO transmission with rank adaptation (from UE perspective) is not precluded.
  + Proposal 24: For groupcast transmission, all UEs within the group share the same DM-RS port(s). Additionally, UEs receiving unicast transmission are multiplexed on remaining orthogonal DM-RS ports.
  + Proposal 25: Advanced transmission schemes like multiuser superposition transmission (MUST) for improving group spectral efficiency are not precluded
* *ASUSTeK*
  + Observation 3: A UE may only be configured to monitor multicast PDCCHs of PTM scheme 1 on a PCell.
  + Observation 4: When a UE requires more and more MBS/multicast services, the traffic on the PCell may become congested.
* *LGE*
  + Proposal 20: UE configured with CA can support reception of multicast transmission depending on UE capability.

## Initial Proposals based on contributions

***Summary***

Moderator does not plan to discuss these issues in this meeting currently, if more companies propose to discuss some of the proposals, moderator will take that into account in the next round discussion.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |

# Proposals for GTW session

# References

1. RP-193248 New WID proposal: NR Multicast and Broadcast Services
2. RP-201038 Revised WID: Core part: NR multicast and broadcast services
3. R1-2106408 Reply LS on G-RNTI and G-CS-RNTI for MBS RAN2, CMCC
4. R1-2106438 Resource configuration and group scheduling for RRC\_CONNECTED UEs Huawei, HiSilicon, CBN
5. R1-2106623 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED Ues vivo
6. R1-2106662 Group Scheduling Mechanisms to Support 5G Multicast / Broadcast Services for RRC\_CONNECTED Ues Nokia, Nokia Shanghai Bell
7. R1-2106716 Discussion on MBS group scheduling for RRC\_CONNECTED UEs Spreadtrum Communications
8. R1-2106745 Discussion on Mechanisms to Support Group Scheduling for RRC\_CONNECTED UEs ZTE
9. R1-2106820 Considerations on MBS group scheduling for RRC\_CONNECTED UEs Sony
10. R1-2106912 Support of group scheduling for RRC\_CONNECTED Ues Samsung
11. R1-2106945 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs in MBS CATT
12. R1-2106996 Common frequency resource configuration for multicast of RRC\_CONNECTED Ues ETRI
13. R1-2107093 Group Scheduling Aspects for Connected UEs FUTUREWEI
14. R1-2107137 Discussion on Group Scheduling Mechanisms for RRC\_CONNECTED Ues NEC
15. R1-2107160 On group scheduling mechanism for NR MBS Lenovo, Motorola Mobility
16. R1-2107201 Discussion on group scheduling mechanisms for RRC\_CONNECTED UEs Potevio Company Limited
17. R1-2107229 Discussion on group Scheduling mechanism for RRC\_CONNECTED UEs OPPO
18. R1-2107369 Views on group scheduling for Multicast RRC\_CONNECTED UEs Qualcomm Incorporated
19. R1-2107382 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Google Inc.
20. R1-2107425 Discussion on group scheduling mechanisms CMCC
21. R1-2107456 Support of group scheduling for RRC\_CONNECTED UEs LG Electronics
22. R1-2107514 Discussion on NR MBS group scheduling for RRC\_CONNECTED UEs MediaTek Inc.
23. R1-2107611 NR-MBS Group Scheduling for RRC\_CONNECTED UEs Intel Corporation
24. R1-2107763 Discussion on group scheduling mechanism for RRC\_CONNECTED Ues Apple
25. R1-2107881 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs NTT DOCOMO, INC.
26. R1-2107902 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UE Xiaomi
27. R1-2107950 Group scheduling related discussion for RRC\_CONNECTED UEs CHENGDU TD TECH LTD.
28. R1-2108026 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Convida Wireless
29. R1-2108046 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs ASUSTeK
30. R1-2108170 Mechanisms to support MBS group scheduling for RRC\_CONNECTED Ues Ericsson

# Appendix 1: Agreements in #102 e-meetings

**RAN1#102-e**

Agreements:

For RRC\_CONNECTED UEs, HARQ-ACK feedback is supported for multicast and no additional evaluation is needed to justify this.

* + FFS: The detailed HARQ-ACK feedback solutions, e.g., ACK/NACK based, NACK-only based.
  + FFS: HARQ-ACK feedback can be optionally disabled and/or enabled.

Agreements:

For RRC\_CONNECTED UEs, at least support group-common PDCCH with CRC scrambled by a common RNTI to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on the same common RNTI.

o   FFS: whether to support UE-specific PDCCH to schedule a PDSCH for MBS.

Agreements:

* For RRC\_CONNECTED UEs, define/configure common frequency resource for group-common PDSCH.
  + FFS: whether to reuse the BWP framework or not
  + FFS: the relation between the common frequency resource and UE dedicated BWP, e.g., the common frequency resource is a MBS specific BWP, or the common frequency resource is confined within UE’s dedicated BWP, etc.
  + FFS: whether more than one common frequency resource can be configured per UE

Agreements:

* For RRC\_CONNECTED UEs, at least support FDM between unicast PDSCH and group-common PDSCH in a slot based on UE capability.
  + FFS: TDM or SDM in a slot.

Agreements:

* For RRC\_CONNECTED UEs, at least support slot-level repetition for group-common PDSCH.
  + FFS: whether enhancement is needed

Agreements:

* For RRC\_CONNECTED UEs, existing CSI feedback can be used for multicast transmission.
  + FFS: whether enhancement is needed

# Appendix 2: Agreements in #103 e-meetings

**RAN1#103-e**

**Mechanisms to support group scheduling for RRC\_CONNECTED UEs**

**Agreements:** For convenience of discussion, consider the following clarification as RAN1 common understanding.

* **PTP transmission**: For RRC\_CONNECTED UEs, use UE-specific PDCCH with CRC scrambled by UE-specific RNTI (e.g., C-RNTI) to schedule UE-specific PDSCH which is scrambled with the same UE-specific RNTI.
* **PTM transmission scheme 1**: For RRC\_CONNECTED UEs in the same MBS group, use group-common PDCCH with CRC scrambled by group-common RNTI to schedule group-common PDSCH which is scrambled with the same group-common RNTI. This scheme can also be called group-common PDCCH based group scheduling scheme.
* **PTM transmission scheme 2**: For RRC\_CONNECTED UEs in the same MBS group, use UE-specific PDCCH with CRC scrambled by UE-specific RNTI (e.g., C-RNTI) to schedule group-common PDSCH which is scrambled with group-common RNTI. This scheme can also be called UE-specific PDCCH based group scheduling scheme.
* Note: The ‘UE-specific PDCCH / PDSCH’ here means the PDCCH / PDSCH can only be identified by the target UE but cannot be identified by the other UEs in the same MBS group with the target UE.
* Note: The ‘group-common PDCCH / PDSCH’ here means the PDCCH / PDSCH are transmitted in the same time/frequency resources and can be identified by all the UEs in the same MBS group.
* FFS whether or not to have additional definition of transmission scheme(s)

Agreements**:** For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 1, at least support retransmission(s) can use PTM transmission scheme 1.

* FFS: whether to support PTP transmission for retransmission(s).
* FFS: whether to support PTM transmission scheme 2 for retransmission(s).
* FFS: How to indicate the association between PTM scheme 1 and PTP transmitting the same TB.
* FFS: If multiple retransmission schemes are supported, then can different retransmission schemes be supported simultaneously for different UEs in the same group?

**Working assumption:**

For multicast of RRC-CONNECTED UEs, a common frequency resource for group-common PDCCH / PDSCH is confined within the frequency resource of a dedicated unicast BWP to support simultaneous reception of unicast and multicast in the same slot

* Down select from the two options for the common frequency resource for group-common PDCCH/ PDSCH
  + Option 2A: The common frequency resource is defined as an MBS specific BWP, which is associated with the dedicated unicast BWP and using the same numerology (SCS and CP)
    - FFS BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP
  + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.
    - FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region
* FFS whether UE can be configured with no unicast reception in the common frequency resource
* FFS on details of the group-common PDCCH / PDSCH configuration
* FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities

Agreements: Support TDM between one unicast PDSCH and one group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs.

Agreements: Support SPS group-common PDSCH for MBS for RRC\_CONNECTED UEs

* FFS: use group-common PDCCH or UE-specific PDCCH for SPS group-common PDSCH activation/deactivation
* FFS: whether to support more than one SPS group-common PDSCH configuration per UE
* FFS: whether and how uplink feedback could be configured
* FFS: retransmission of SPS group-common PDSCH

Agreements: For PTM transmission scheme 1, the CORESET for group-common PDCCH is configured within the common frequency resource for group-common PDSCH.

* FFS: number of CORESET(s) for group-common PDCCH within the common frequency resource for group-common PDSCH

Agreements: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, the CCE indexes are common for different UEs in the same MBS group.

Agreements: Down select from the two options for BDs/CCEs limit for Rel-17 MBS

* Option 1: the maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 is kept unchanged for Rel-17 MBS.
* Option 2: For UEs supporting CA capability, the budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs, which is similar to the method used for multi-DCI based multi-TRP in Rel-16.

Agreements:For RRC\_CONNECTED UEs, support inter-slot TDM between unicast PDSCH and group-common PDSCH in different slots (mandatory for the UE supporting MBS).

Agreements:Further study the following cases for simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs.

* Case 1: support TDM between multiple TDMed unicast PDSCHs and one group-common PDSCH in a slot
* Case 2: support TDM among multiple group-common PDSCHs in a slot
* Case 3: support TDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
* Case 4: support FDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
* Case 5: support FDM among multiple group-common PDSCHs in a slot
* FFS: maximum number of PDSCHs in a slot simultaneous received per UE

Agreements:For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, further study the following options.

* Option 1: Define a new search space type specific for multicast
* Option 2: Reuse the existing CSS type(s) in Rel-15/16
  + FFS: whether modifications are needed for multicast
* Option 3: Reuse the existing USS in Rel-15/16 with necessary modifications for MBS
  + FFS: detailed modifications

Agreements:No specification enhancement in Rel-17 to support SDM between unicast PDSCH and group-common PDSCH in a slot for RRC\_CONNECTED UEs.

Agreements**:** For PTM transmission scheme 1, if Option 2A or Option 2B for common frequency resource for group-common PDCCH/PDSCH is agreed, the FDRA field of group-common PDCCH is interpreted based on the common frequency resource.

Agreements: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, further study the following options for the monitoring priority of search space set

* Option 1: The monitoring priority of search space set for multicast is the same as existing Rel-15/16 CSS
* Option 2: The monitoring priority of search space set for multicast is the same as existing Rel-15/16 USS
* Other options are not precluded
* The monitoring priority is used at least for PDCCH overbooking case
  + FFS for other cases (e.g., to prune PDCCH in terms of whether it’s unicast or multicast, etc.)

**Mechanisms to improve reliability for RRC\_CONNECTED UEs**

Agreements:

For RRC\_CONNECTED UEs receiving multicast, at least for PTM scheme 1, support at least one of the following:

* ACK/NACK based HARQ-ACK feedback for multicast,
  + From per UE perspective, UE feedback ACK or NACK.
  + From UEs within the group perspective,
    - FFS: PUCCH resource configuration for ACK/NACK feedback e.g., shared or separate PUCCH resources.
  + FFS details including conditions for it to be used
* NACK-only based HARQ-ACK feedback for multicast,
  + From per UE perspective, UE only feedback NACK.
  + From UEs within the group perspective~~, further down-select between:~~
    - FFS: PUCCH resource configuration for NACK only feedback.
  + FFS details including conditions for it to be used
* To decide in RAN1#104-e whether or not to support only one or both of the above schemes
  + If both are supported, FFS configuration/selection of ACK/NACK-based and NACK-only based HARQ-ACK feedback

Agreements:

For RRC\_CONNECTED UEs receiving multicast, for ACK/NACK based HARQ-ACK feedback if supported for group-common PDCCH scheduling, PUCCH resource configuration for HARQ-ACK feedback from per UE perspective is, down-select one of the following options:

* Option 1: shared with PUCCH resource configuration for HARQ-ACK feedback for unicast
* Option 2: separate from PUCCH resource configuration for HARQ-ACK feedback for unicast
* Option 3: Option 1 or option 2 based on configuration

Agreements:

For RRC\_CONNECTED UEs receiving multicast, for NACK-only based HARQ-ACK feedback if supported for group-common PDCCH scheduling, PUCCH resource configuration for HARQ-ACK feedback from per UE perspective is separate from PUCCH resource configuration for HARQ-ACK feedback for unicast.

* FFS PUCCH format

Agreements:

Enabling/disabling HARQ-ACK feedback for MBS is supported, further down-select between:

* Option 1: DCI
* Option 2: RRC configures enabling/disabling
* Option 3: RRC configures the enabling/ disabling function and DCI indicates enabling /disabling
* FFS: Option 4: MAC-CE indicates enabling/disabling
* FFS: Option 5: RRC configures the enabling/ disabling function and MAC-CE indicates enabling /disabling

Agreements:

For slot-level repetition for group-common PDSCH of RRC\_CONNECTED UEs, for indicating the repetition number, further down-select among:

* Opt 1: by DCI
* Opt 2: by RRC
* Opt 3: by RRC+DCI
* FFS: Opt 4: by MAC-CE
* FFS: Opt 5: by RRC+MAC-CE
* FFS details for each option.
* FFS further enhancements for configuration of slot-level repetition

Agreements:

From the perspective of RRC\_CONNECTED UEs receiving multicast, at least for PTM scheme 1 initial transmission, retransmission supports, for the purpose of down-selection, options are:

* Option 1: group-common PDCCH scheduled group-common PDSCH
* Option 2: UE-specific PDCCH scheduled PDSCH
  + Alt 1: PDSCH is UE-specific PDSCH
  + Alt 2: PDSCH is group-common PDSCH
* Option 3: both option 1 and option 2
* FFS other options
* FFS CBG based retransmission

Agreements:

FFS whether CSI feedback enhancement is needed for MBS, including but not limited:

* New CQI measurement
* New CSI report formats
* Targeted BLER
* CSI-RS configuration
* A-CSI-RS transmission triggering
* SRS configuration

Agreements:

For ACK/NACK based HARQ-ACK feedback if supported, both Type-1 and Type-2 HARQ-ACK codebook are supported for RRC\_CONNECTED UEs receiving multicast,

* FFS details of HARQ-ACK codebook design.
* FFS whether enhanced Type-2 and/or Type-3 HARQ-ACK codebook is supported or not.

**Basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs**

Agreements:For RRC\_IDLE/RRC\_INACTIVE UEs, support group-common PDCCH with CRC scrambled by a common RNTI to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on the same common RNTI.

* FFS details

Agreements:

* For RRC\_IDLE/RRC\_INACTIVE Ues, beam sweeping is supported for group-common PDCCH/PDSCH.
  + FFS: Details for support of beam sweeping for group-common PDCCH/PDSCH.

**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:** From physical layer perspective, for broadcast reception, the same group-common PDCCH and the corresponding scheduled group-common PDSCH can be received by both RRC\_IDLE/RRC\_INACTIVE UEs and RRC\_CONNECTED UEs.

* FFS details.

 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

# Appendix 3: Agreements in #104 e-meetings

**RAN1#104-e**

**Mechanisms to support group scheduling for RRC\_CONNECTED UEs**

Agreement:

For multicast of RRC-CONNECTED UEs, a common frequency resource for group-common PDCCH / PDSCH is confined within the frequency resource of a dedicated unicast BWP to support simultaneous reception of unicast and multicast in the same slot

* Down select from the two options for the common frequency resource for group-common PDCCH/ PDSCH
  + Option 2A: The common frequency resource is defined as an MBS specific BWP, which is associated with the dedicated unicast BWP and using the same numerology (SCS and CP)
    - FFS BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP
  + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.
    - FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region
* FFS whether UE can be configured with no unicast reception in the common frequency resource
* FFS on details of the group-common PDCCH / PDSCH configuration
* FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities
* FFS whether the use of a common frequency resource for multicast is optional or not
* FFS whether the common frequency resource is applicable for PTM scheme 2 (if supported) or not

Agreement:

* If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the starting PRB and the length of PRBs of the MBS frequency region within a dedicated unicast BWP are configured via UE-specific RRC signaling.
  + The starting PRB is referenced to one of the two options:
    - Option 1: Point A
    - Option 2: the starting PRB of the dedicated unicast BWP
  + FFS the detailed signaling
* If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of the starting PRB and the length of PRBs of the MBS frequency resource reuse the legacy BWP configuration.

Agreement:

For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTP transmission.

* The HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB.

Agreement:

The maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 is kept unchanged for Rel-17 MBS.

* FFS whether the budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration, which is similar to the method used for multi-DCI based multi-TRP in Rel-16.

Working Assumption:

Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS.

* FFS: Whether the G-RNTI is counted as “C-RNTI” or as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.

Agreement:

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.
* FFS: How to allocate the total SPS configurations between MBS and unicast.

Agreement:

For RRC\_CONNECTED UEs, support HARQ-ACK feedback for SPS group-common PDSCH for MBS

* FFS: The retransmission scheme(s)
* FFS: The HARQ-ACK details for SPS PDSCH and activation/deactivation, which can be discussed in AI 8.12.2

Agreement:

From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes the following configurations:

* Starting PRB and the number of PRBs
* One PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP)
* One PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP)
* SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP)
* FFS: Other configurations and details including whether signaling of starting PRB and the length of PRBs is needed when CFR is equal to the unicast BWP
* FFS: Whether a unified CFR design is also used for broadcast reception for RRC\_IDLE/INACTIVE and RRC\_CONNECTED
* FFS: Whether Coreset(s) for CFR in addition to existing Coresets in UE dedicated BWP is needed
* Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2
* Note: This agreement does not negate any previous agreements made on CFR

Agreement:

For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, at least support CSS

* FFS: reuse existing CSS type(s) in Rel-15/16 or define a new Type CSS
* FFS: Two options for monitoring priority:
  + Option 1: the monitoring priority is the same as existing Rel-15/16 CSS
  + Option 2: the monitoring priority is determined based on the search space set indexes of search space set(s) for multicast and USS sets.

Working assumption:

For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* At least group-common PDCCH is supported
  + FFS: Whether and how to address the missed activation and deactivation
* FFS: Whether UE-specific PDCCH is supported for activation/deactivation

**Mechanisms to improve reliability for RRC\_CONNECTED UEs**

Agreement:

For ACK/NACK based feedback if supported for RRC\_CONNECTED UEs receiving multicast, UE can be optionally configured a separate *PUCCH-Config* for multicast. Otherwise, *PUCCH-Config* for unicast applies.

Agreement:

The priority for HARQ-ACK feedback for RRC\_CONNECTED UE receiving multicast can be,

* Lower, higher than or equal to the HARQ-ACK feedback for unicast
  + FFS: How to reflect the priority in specification, e.g., whether it is configured or indicated to the UE
  + FFS: The total number of priorities across multicast and unicast
* FFS the priority between HARQ-ACK feedback for multicast and other UCI for unicast (SR, CSI) or PUSCH for unicast.

Agreement:

For ACK/NACK based feedback if supported for multicast, for Type-2 HARQ-ACK feedback construction for PTM scheme 1,

* DAI for unicast and DAI for multicast are separately counted.
* Concatenation of Type-2 HARQ-ACK codebook for unicast and multicast is supported.
  + FFS details on concatenating the codebooks.
* FFS whether to support concatenating more than one Type-2 HARQ-ACK codebook for multicast.

Agreement:

For RRC\_CONNECTED UEs receiving multicast, support the following:

* ACK/NACK based HARQ-ACK feedback for multicast,
  + It is up to network to configure orthogonal PUCCH resources among UEs within the same group.
* FFS: NACK-only based HARQ-ACK feedback for multicast,
  + It is up to network to configure the PUCCH resources and the PUCCH resources can be shared among UEs within the same group.
* FFS details.

Agreement:

For the cases of HARQ-ACK feedback (at least for ACK/NACK based feedback) is available for multicast and unicast for a given UE receiving multicast, for determining the PUCCH resource,

* Support multiplexing for the same priority and prioritizing for different priorities at least when the corresponding PUCCH resources overlap in time in a slot.
  + FFS whether it is subject to UE capability.
* FFS the case of non-overlapping PUCCHs resources for HARQ-ACK in the same slot.
* FFS whether sub-slot based PUCCH transmission for HARQ-ACK is supported.
* FFS the case of HARQ-ACK feedback for multicast and other UCI for unicast.

Agreement:

For ACK/NACK based feedback if supported for multicast, construction of Type-1 HARQ-ACK codebook based on the union of the PDSCH TDRA sets of the unicast service and the multicast service (if they are separately configured), at least of the same priority, is supported

* FFS details of Type-1 HARQ-ACK codebook construction for FDM-ed unicast and multicast.
* FFS details of Type-1 HARQ-ACK codebook construction for FDM-ed multicast and multicast if supported.
* FFS: whether/how to optimize the Type-1 codebook construction to reduce the HARQ-ACK feedback payload size.

Agreement:

For enabling/disabling HARQ-ACK feedback for RRC\_CONNECTED UE receiving multicast,

* Option 3: RRC signalling configures the enabling/ disabling function of DCI indicating the enabling /disabling HARQ-ACK feedback.
  + If RRC signalling configures the function, DCI indicates (explicitly or implicitly) whether HARQ-ACK feedback is enabled/disabled
    - FFS details on RRC signalling and DCI indicating.
  + If RRC signalling does not configure the function, DCI does not indicate enabling/disabling the HARQ-ACK feedback.
    - FFS whether enabling or disabling the feedback is the default mode.
* Option 2: RRC indicates enabling/disabling.
* FFS: whether down-selection between option 3 and option 2 is needed or support the both options.
* FFS: enabling/disabling by MAC-CE.

Agreement:

For slot-level repetition for group-common PDSCH for RRC\_CONNECTED UEs receiving multicast,

* (Config A) UE can be optionally configured with *pdsch-AggregationFactor*.
* (Config B) UE can be optionally configured with TDRA table with *repetitionNumber* as part of the TDRA table.
* If UE is configured with Config B, UE does not expect to be configured with Config A for the same group-common PDSCH.

**Basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs**

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, one common frequency resource for group-common PDCCH/PDSCH can be defined/configured.

* FFS: whether to define/configure more than one common frequency resources

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 broadcast reception, the same group-common PDCCH and the corresponding scheduled group-common PDSCH can be received by both RRC\_IDLE/RRC\_INACTIVE UEs and RRC\_CONNECTED UEs when UE-specific active BWP of RRC\_CONNECTED UE contains the common frequency resource of RRC\_IDLE/INACTIVE UEs and the SCS and CP are the same.

* FFS: the case when UE-specific active BWP of RRC\_CONNECTED UE does not contain the common frequency resource of RRC\_IDLE/INACTIVE UEs.

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.

# Appendix 4: Agreements in #104b e-meetings

**RAN1#104b-e**

**Mechanisms to support group scheduling for RRC\_CONNECTED UEs**

Agreement:

For group-common PDCCH of Rel-17 MBS, support at least two DCI formats.

* DCI format 1\_0 is used as the baseline for the first DCI format with CRC scrambled with G-RNTI.
* DCI format 1\_1 or 1\_2 is used as the baseline for the second DCI format with CRC scrambled with G-RNTI
  + FFS: Which of DCI format 1\_1 or 1\_2 is used as the baseline
* FFS: Details of the reuse (or not) of DCI format 1\_0, 1\_1 or 1\_2 fields

Agreement:

The same HARQ process ID and NDI are used for PTM scheme 1 (re)transmissions and PTP retransmissions of the same TB.

Agreement:

At least support the following cases for PDSCH reception for MBS in a slot based on UE capability for RRC\_CONNECTED UEs

* Case 1: support TDM between M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC
  + FFS: the value(s) of M
* Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC
  + FFS: the value(s) of N
* Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC
  + FFS: the value(s) of K and L

Agreement:

If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP, further study the following options.

* Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* Option 2: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR cannot be used for unicast transmission.
* Option 3: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR cannot be used for unicast transmission.
* Option 4: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.

Agreement:

One CFR is supported per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.

* FFS: Whether more than one CFR is supported per dedicated unicast BWP
* FFS: Whether multicast can be supported or not in a dedicated unicast BWP when no CFR is configured for that BWP

Agreement:

The retransmission scheme for a given SPS group-common PDSCH can be either PTM scheme 1 or PTP.

* FFS: Whether PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group

Agreement:

Define G-CS-RNTI at least for SPS group-common PDSCH and activation/deactivation of SPS group-common PDSCH, different from CS-RNTI for unicast SPS PDSCH.

* G-CS-RNTI is used for PTM scheme 1 based dynamic retransmission of SPS group-common PDSCH
* FFS: Whether CS-RNTI can be used for PTP retransmission of SPS group-common PDSCH.
* FFS: Number of G-CS-RNTI.

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.

Agreement:

Send an LS to RAN2 regarding at least the following questions:

* Whether RAN1 should take into account the case of UE supporting multiple G-RNTIs?

Agreement:

Include the following in the LS to RAN2:

* Whether RAN1 should consider the case of UE supporting multiple G-CS-RNTIs?
* The agreements related to SPS will also be included in the LS for information

**R1-2104045 LS on G-RNTI and G-CS-RNTI for MBS RAN1, CMCC**

**Decision:** As per email decision posted on April 22nd, the LS is approved.

Agreement:

For CSS of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, down-select from the following alternatives (to be decided in RAN1#105):

* Alt 1: support Type-3 CSS
  + The monitoring priority of Type-3 CSS for group-common PDCCH is the same as existing Rel-15/16 CSS, regardless of which DCI format of group-common PDCCH is configured in Type-3 CSS
* Alt 2: support a new Type-x CSS
  + The monitoring priority of new Type-x CSS is determined based on the search space set indexes of the new Type-x CSS set and USS sets, regardless of which DCI format of group-common PDCCH is configured in the new Type-x CSS.
* Alt 3: support both Alt 1 and Alt 2

Agreement:

The down-selection of Option 2A and Option 2B for CFR for multicast of RRC-CONNECTED UEs will be made before the end of RAN1#105-e.

Conclusion:

It is based on gNB implementation to schedule unicast on the frequency resources covered by CFR configured for multicast.

Agreement:

For RRC\_CONNECTED UE supporting MBS, support up to 8 configured SPS configurations in a BWP of a serving cell for unicast and MBS in total.

* It is up to gNB implementation to configure the SPS configuration indexes for unicast and MBS, respectively.

Agreement:

Confirm the working assumption:

For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* At least group-common PDCCH is supported
  + FFS: Whether and how to address the missed activation and deactivation
* FFS: Whether UE-specific PDCCH is supported for activation/deactivation

**Mechanisms to improve reliability for RRC\_CONNECTED UEs**

Agreement:

Support NACK-only based HARQ-ACK feedback for RRC\_CONNECTED UEs receiving multicast.

Agreement:

Two priority indexes are introduced for multicast, with

* Index 0 meaning low priority and index 1 meaning high priority.
* Priority index can be included in DCI formats scheduling the group-common PDSCH.
  + FFS details for DCI formats.
* FFS: the priority comparison between multicast and unicast with the same priority index.

Agreement:

For a separate *PUCCH-ConfigurationList* for multicast that is optionally configured, at least for ACK/NACK based HARQ-ACK feedback,

* The separate *PUCCH-ConfigurationList* for multicastconfigurationcan be a list which includes up to 2 *PUCCH-Config* configurations corresponding low priority codebook and high priority codebook, respectively.
* FFS other configurations

Agreement:

For Type-2 HARQ-ACK codebook concatenation to be multiplexed in the same PUCCH resource,

* The first Type-2 HARQ-ACK sub-codebook for unicast precedes the second Type-2 HARQ-ACK sub-codebook for multicast.
* FFS: The number of Type-2 HARQ-ACK sub-codebooks for multicast.
* Note: The case of SPS PDSCH will be discussed separately.

Agreement:

For multiplexing the ACK/NACK-based HARQ-ACK feedback for multicast and unicast, determining the PUCCH resources for transmission is based on the PRI indicated in the “last DCI”, where the “last DCI” refers to, down-select the following alternatives:

* Alt.1: the last DCI for unicast;
* Alt.2: the last DCI across unicast and multicast;

# Appendix 5: Agreements in #105 e-meetings

**RAN1#105-e**

**Mechanisms to support group scheduling for RRC\_CONNECTED UEs**

Agreement:

For CSS of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, Alt 2 is supported:

* Alt 2: support a Type-x CSS
  + The monitoring priority of Type-x CSS is determined based on the search space set indexes of the Type-x CSS set and USS sets, regardless of which DCI format of group-common PDCCH is configured in the Type-x CSS.
* FFS: Whether the Type-x CSS is a Type-3 CSS

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:

As a baseline, reuse existing fields in DCI format 1\_0 with CRC scrambled by C-RNTI for the fields of first DCI format with CRC scrambled with G-RNTI.

* FFS: how to determine the bitlength of FDRA field.
* FFS: Whether ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ are needed.
* FFS: How to perform DCI size alignment
* FFS: Whether to include new DCI fields
* Note: All of the fields may not be reused and the size of the fields may not be the same

Working assumption:

Option 2B for CFR associated with UE active BWP other than initial BWP is supported at least for multicast of RRC-CONNECTED UEs.

* FFS: CFR associated with initial BWP
* FFS: CFR larger than initial BWP

Agreement:

For multicast of RRC\_CONNECTED UEs, further study

* How the LBRM (Limited buffer rate-matching) for GC-PDSCH TBS is determined.
* How the xOverhead for GC-PDSCH TBS determination is configured.
* Whether MAC-CE over GC-PDSCH is needed for activation/deactivation of semi-persistent ZP CSI-RS resource set if the semi-persistent ZP CSI-RS resource set is configured in PDSCH-Config in CFR.

Agreement:

Confirm the working assumption:

Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS.

* FFS: Whether the G-RNTI is counted as “C-RNTI” or as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.

Agreement:

For Rel-17 MBS UE, the UE maximum number of TDMed PDSCH receptions capability in a slot per CC is kept as for Rel-15/Rel-16, i.e., {2/4/7} based on UE FG5-11/5-11a/5-11b.

* Note:   Group-common PDSCH(s) are counted as unicast PDSCH(s).

Agreement:

For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support at least one of the following alternatives.

* Alt 1: retransmit the activation command via group-common PDCCH.
* Alt 2: retransmit the activation command via UE-specific PDCCH.
* Alt 3: retransmit the activation command via MAC-CE.
* FFS other details.
* Note: Down-selection can take into account the HARQ-ACK feedback scheme for SPS activation

Working assumption:

The maximum number of CORESETs per BWP is not increased for support of MBS, and the number of CORESETs configured within the CFR is left to gNB implementation.

Agreement:

As a baseline, reuse existing fields in DCI format 1\_1 for the fields of the second DCI format with CRC scrambled with G-RNTI.

* FFS: whether ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’, ‘Carrier indicator’ and ‘Bandwidth part indicator’ are needed.
* FFS: How to perform DCI size alignment
* FFS: Whether to include new DCI fields for the second DCI format
* Note: All of the fields may not be reused and the size of the fields may not be the same

Agreement:

For HARQ process management, further study whether/how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.

**Mechanisms to improve reliability for RRC\_CONNECTED UEs**

Agreement:

The signalling for URLLC feature can be reused to configure separate codebooks for unicast and multicast, respectively, at least for the case of different priorities, at least for Type-2 HARQ codebook

* FFS: The case for the same priority.
* FFS: The case of Type-1 HARQ codebook
* FFS: Whether this applies to separate PUCCH transmissions only

Agreement:

Support PUCCH format 0 and format 1 for NACK-only based HARQ-ACK feedback for multicast.

Agreement:

Support NACK-only based HARQ-ACK feedback at least for multicast SPS PDSCH without PDCCH scheduling.

* FFS for SPS activation/deactivation.

Agreement:

The priority of multicast is the same as the priority of unicast for the same priority index of HARQ-ACK at least for ACK/NACK based feedback.

Agreement:

NR supports at least the following cases for UE supporting multicast:

* UE supports two non-overlapping slot-based PUCCHs for ACK/NACK based HARQ-ACK feedback for multicast with different priorities in a slot subject to UE capability.
* UE supports two non-overlapping slot-based PUCCHs for ACK/NACK based HARQ-ACK feedback for multicast and unicast with different priorities, respectively, in a slot subject to UE capability.

Agreement:

For Type-1 HARQ-ACK codebook construction for FDM-ed unicast and multicast with the same priority from the same TRP, support

* Opt 4: HARQ-ACK bits for all the PDSCH occasions over all the slots for all serving cells for unicast, precede, HARQ-ACK bits for all the PDSCH occasions over all the slots for all serving cells for multicast. (This is similar to the joint Type-1 codebook for mTRP).
* FFS: If UE reports the capability of supporting the FDM-ed unicast and multicast in the same slot, UE can be indicated semi-statically to generate Type-1 HARQ-ACK codebook as FDM-ed manner (i.e., Opt 4).
  + Otherwise, UE does not expect unicast and multicast are to be scheduled in FDM-ed.

**Conclusion:**

PUCCH resource for NACK-only can be shared by UEs transmitting the NACK-only based HARQ-ACK feedback.

Agreement:

For ACK/NACK based HARQ-ACK feedback for multicast, the multiplexing/prioritizing rule between the HARQ-ACK for multicast and SR/CSI can reuse Rel-16 multiplexing/ prioritizing rule between the HARQ-ACK for unicast and SR/CSI.

Agreement:

For support of ACK/NACK based HARQ-ACK feedback for SPS multicast,

* the HARQ-ACK codebook index corresponding the HARQ-ACK codebook for SPS PDSCH is included in the configuration for SPS multicast.
  + UE determines a priority index from the HARQ-ACK codebook index
* UE can be optionally configured a separate SPS-PUCCH-AN-List for all SPS multicast configurations. Otherwise, a common SPS-PUCCH-AN-List applies to all SPS unicast and SPS multicast configurations.

Agreement:

For TDM-ed unicast and multicast, for Type-1 HARQ-ACK codebook construction for ACK/NACK-based unicast and multicast to be multiplexed in the same PUCCH resource, determining PDSCH reception candidate occasions is based on down-selecting one of the two alternatives as follows:

* Alt 1:
  + for slot timing values in the intersection of set for unicast (termed set *A*) and set for multicast (termed set *B*), based on union of the PDSCH TDRA sets,
  + for slot timing values in set A but not in set B, based on PDSCH TDRA set for unicast, and
  + for slot timing values in set B but not in set A, based on PDSCH TDRA set for multicast.
* Alt 2: for slot timing values in the union of set for unicast and set for multicast, based on the union of the PDSCH TDRA sets.
* Companies are encouraged to continue discussion of pros and cons for each alternative for further down-selection in the next meeting.

assumption:

For enabling/disabling ACK/NACK-based HARQ-ACK feedback for RRC\_CONNECTED UE receiving multicast via dynamic group-common PDSCH:

* RRC signalling configures the enabling/ disabling function of group-common DCI indicating the enabling /disabling ACK/NACK based HARQ-ACK feedback.
  + If RRC signalling configures the function of group-common DCI based indication, group-common DCI indicates (explicitly or implicitly) whether ACK/NACK based HARQ-ACK feedback is enabled/disabled
  + Otherwise, enabling/disabling ACK/NACK based HARQ-ACK feedback is configured by RRC signalling.
  + FFS details on RRC signalling and group-common DCI indicating.
* FFS whether/how this option is extended to apply to NACK-only based feedback and multiple G-RNTI cases.
* FFS the relation to the HARQ-ACK codebook types and HARQ-ACK codebook construction.
* FFS the relation to the enabling/disabling ACK/NACK based HARQ-ACK feedback for retransmission.
* FFS whether/how to allow UE not to react to the DCI signalling, but instead follow UE-specific RRC configuration for HARQ feedback.
* FFS whether/how to apply it to SPS group-common PDSCH.

**Basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs**

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, both searchSpace#0 and common search space other than searchSpace#0 can be configured for GC-PDCCH scheduling MCCH.

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, DCI format 1\_0 is used as baseline for GC-PDCCH of MCCH and MTCH.

* FFS details of FDRA.

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, RAN1 confirms the following assumptions made by RAN2

* RAN2 assumes, in case searchSpace#0 is configured for MCCH (if allowed, pending RAN1 decision), the mapping between PDCCH occasions and SSBs is the same as for SIB1.
* RAN2 assumes that if common search space other than searchSpace#0 is configured for MCCH (if allowed, pending RAN1 decision), the PDCCH monitoring occasions for MCCH message which are not overlapping with UL symbols are sequentially numbered from one in the MCCH transmission window and mapped to SSBs using the similar rule as defined for OSI in TS 38.331.

Agreement:

For broadcast reception, RRC\_IDLE/RRC\_INACTIVE UEs support the same CSS type for MCCH and MTCH.

* FFS support of different CSS types for MCCH and MTCH channels for broadcast reception.

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, study the following alternatives for MCCH change notification indication due to session start:

* Alt 1: Define a dedicated RNTI to scramble the CRC of a DCI indicating a MCCH change notification;
* Alt 2: Use of a field in a DCI format scheduling a MCCH without a dedicated RNTI for MCCH change notification;

Other solutions are not precluded and it is also not precluded whether to support both Alt1 and Alt2.

**Conclusion:**

It is up to RAN2 to decide the specific contents of the MCCH change notification, e.g, whether notification only informs about session start, whether or not notification also informs about session modification/stop or whether or not the notification informs about any other information.

Agreement:

For broadcast reception, RRC\_IDLE/RRC\_INACTIVE UEs can use a configured/defined CFR with the same size as the initial BWP, where the initial BWP has the same frequency resources as CORESET0 (i.e., Case A), to receive GC-PDCCH/PDSCH carrying MCCH.

* Note: GC-PDCCH/PDSCH transmission within a narrower portion of the Initial BWP (where the initial BWP has the same frequency resources as CORESET0) is possible by implementation via appropriate scheduling.

Agreement:

For broadcast reception, RRC\_IDLE/RRC\_INACTIVE UEs can use a configured/defined CFR with the same size as the initial BWP, where the initial BWP has the same frequency resources as CORESET0 (i.e., Case A), to receive GC-PDCCH/PDSCH carrying MTCH.

* Note: GC-PDCCH/PDSCH transmission within a narrower portion of the Initial BWP (where the initial BWP has the same frequency resources as CORESET0) is possible by implementation via appropriate scheduling.

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, the CORESET index can be the same for GC-PDCCH of MCCH and MTCH.

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, the same beam can be used for group-common PDCCH and the corresponding scheduled group-common PDSCH for carrying MCCH or MTCH.

* UE may assume that DMRS ports of the group-common PDCCH/PDSCH for MCCH is QCL’d with SSB.
* UE may assume that DMRS ports of the group-common PDCCH/PDSCH for MTCH is QCL’d with SSB.
* FFS: group-common PDCCH/PDSCH for MTCH is QCL’d with periodic TRS if configured

Agreement:

For Rel-17, for broadcast reception, RRC\_IDLE/RRC\_INACTIVE UEs do not exceed the maximum number of CORESETs mandatorily (in the minimum capability) supported for Rel-15/Rel-16 UEs, i.e., 2 CORESETs.

* If the CFR has the same frequency range as the initial BWP, where the initial BWP has the same frequency resources as CORESET0 or where the initial BWP has the frequency resources configured by SIB1, RRC\_IDLE/RRC\_INACTIVE UEs can be configured with the following options:
  + CORESET#0 (default option if CFR is the initial BWP and CORESET is not configured); or
  + CORESET configured by *commonControlResourceSet;* or
  + CORESET#0 and CORESET configured by *commonControlResourceSet*.