**3GPP TSG RAN WG1 #105-e**  **R1-21XXXX**

**e-Meeting, May 10th – 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#104b-e:

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

In this contribution, we summarize the related issues and proposals based on the contributions submitted in RAN1#105-e under the agenda item 8.12.1 [3]-[27]. 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 for MBS

## Background and submitted proposals

***Background***

In RAN1#104&104bis meetings, the following agreements were achieved for CFR for multicast of 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:

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:

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

Conclusion:

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

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.

***Submitted Proposals***

* *Huawei, HiSilicon*
  + Proposal 1: Option 2B is supported regarding the CFR definition:
    - 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.
  + Proposal 2: For CFR for multicast scheduling confined within a dedicated unicast BWP,
    - One CFR per a dedicated BWP is sufficient.
    - 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 comparing to the number UE supported in Rel-16.
* *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.
  + Proposal 2: Support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities.
  + Proposal 3: Multicast is not supported in a dedicated unicast BWP when no CFR is configured for that BWP.
* *ZTE*
  + Proposal 1: CFR configured for broadcast service for a UE in RRC\_IDLE/RRC\_INACTIVE states should be still valid after the UE enters RRC\_CONNECTED state.
  + Proposal 2: NR should support the reception of multicast and broadcast sharing the same MBS BWP.
  + Proposal 3: Forward compatibility should also be considered during the determination of configuration signaling structure for the CFR. And one subcarrierSpacing and one cyclicPrefix separate from that of the dedicated unicast BWP should be included in the CFR configuration.
  + Observation 1: No BWP switching is required between reception of MBS BWP and unicast BWP by defining the following features for MBS BWP,
    - The MBS BWP is confined within the frequency resource of the dedicated unicast BWP.
    - The MBS BWP is associated with the dedicated unicast BWP and using the same numerology (SCS and CP).
    - No RF retuning between reception of MBS BWP and unicast BWP.
  + Proposal 4: A BWP ID is configured for the MBS BWP for activating/deactivating it dynamically and independently.
* *vivo*
  + Proposal 1: For RRC\_CONNECTED UEs, when defining/configuring common frequency resource for group-common PDCCH/PDSCH, Option 2B is preferred.
    - 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.
  + 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 2: More than one CFR is supported based on UE capability per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.
* *CATT*
  + Observation 1: BWP switching is needed between MBS specific BWP and dedicated unicast BWP according to Rel-15/16 principle because they are two independent BWPs and configurations.
  + Observation 2: MBS specific BWP may not be feasible when a UE can support to be configured with only one BWP.
  + Proposal 3: Option 2B, MBS frequency region, is supported to define MBS common frequency resource for RRC\_CONNECTED UEs.
  + Proposal 4: For MBS frequency region, the starting PRB is referenced to the starting PRB of the dedicated unicast BWP.
  + Proposal 5: RIV indication mechanism in Rel-15 NR can be reused to indicate MBS frequency region, and one field can be added to BWP-DownlinkDedicated IE.
  + Proposal 6: PDSCH-Config for CFR can share the common fields in PDSCH-Config for unicast to reduce signaling payload size for MBS.
  + Proposal 7: PDCCH-Config for CFR can share the common fields in PDCCH-Config for unicast to reduce signaling payload size for MBS.
  + Proposal 8: Common frequency resource for multicast is optional.
  + Proposal 9: If configured, at most one MBS common frequency resource is supported per UE/per dedicated unicast BWP based on UE capability.
  + Proposal 10: It is up to gNB that multicast can be scheduled in a dedicated unicast BWP when no CFR is configured for that BWP.
  + Proposal 11: Common frequency resource configuration can be used for PTM scheme 2. The bounding information between UE-specific PDCCH and group-common PDSCH should be further studied.
* *Nokia*
  + Observation-1: The key difference between option 2A and 2B is related to the RRC signaling of the common frequency resources:
    - Option 2A requires the signaling of MBS specific BWP with parameters possibly taken from current BWP configurations and would possibly require BWP switching based on center frequency alignment.
    - Option 2B requires the signaling of the MBS frequency region – in terms of the starting PRB and length of PRBs within each UE’s dedicated unicast BWP, and PDCCH/PDSCH-config parameters.
    - The impact of option 2A on the number of BWPs that can be configured for a UE needs to be studied and clarified.
  + Observation-2: Currently it is not clear whether simultaneous reception of unicast and multicast traffic within the same slot is possible with option 2A.
  + Observation-3: Option 2B satisfies all the requirements defined for the CFR, requires minimal specification effort and does not require further clarifications from other RAN working groups.
  + Proposal-1: Agree on selecting option 2B for configuring multicast common frequency resources, due to the additional complexities involved in the use of option 2A related to BWP switching.
  + Observation-4: Multiple common frequency resources can be configured per UE based on gNB implementation – even though the motivations for doing so are not clear, with the maximum limit dependent on UE capabilities and available system resources.
  + Observation-5: For multicast traffic, the motivation for configuring multiple CFRs per UE requires further clarification, and for broadcast traffic, there are potential benefits in terms of power savings from having multiple overlapping CFRs configured per UE, depending on UE capabilities and traffic characteristics.
  + Proposal-2: Agree to limit CFRs to one per UE per BWP, considering factors such as additional signaling required for configuring multiple CFRs, and that a single CFR could be utilized to configure multiple MBS services.
  + Proposal-3: 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-19: 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-20: The starting PRB should be referenced to the starting PRB of the dedicated unicast BWP (option 2 for MBS CFR option 2B).
  + Proposal-21: Further study and agree on the commonalities identified between the multicast and broadcast CFR design.
* *MediaTek*
  + Proposal 1: Option 2B mechanism is supported for CFR configuration for multicast of RRC-CONNECTED UEs.
  + Proposal 2: Network implementation guarantee the allocation of common frequency resource for UEs in connected mode to receive the PTM transmission.
  + Proposal 3: Not support more than one common frequency resources for NR MBS.
  + Proposal 4: Point A is referenced to the starting PRB of the dedicated unicast BWP.
* *FUTUREWEI*
  + Proposal 1: 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.
  + Proposal 2: Both starting location and the length can be jointly encoded to reduce overhead in the signaling.
  + Proposal 3: Only 1 CFR per unicast BWP per UE can be configured.
  + Proposal 4: 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.
* *ETRI*
  + Proposal1: The 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 should be supported for the common frequency resource.
  + Proposal2: 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 1. Support Option 2B for CFR for multicast of RRC-CONNECTED UEs.
  + Proposal 2. Don’t support more than one CFR for multicast service per dedicated unicast BWP.
  + Proposal 3. Multicast cannot be supported in a dedicated unicast BWP when no CFR is configured for that BWP.
  + 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.
  + 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.
  + 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.
* *Intel*
  + Proposal 1: A default CFR identical to active unicast BWP can be defined for UEs when no CFR configuration is provided
  + Proposal 2: RAN1 should strive for unified CFR for CONNECTED and IDLE mode UEs
  + Proposal 3: The UE expects no restriction on unicast reception within the CFR since it is contained within the active DL BWP of the UE.
  + Proposal 4: One CFR per dedicated BWP is sufficient for scheduling MBS transmissions.
* *Apple*
  + Proposal 1: The starting PRB of CFR is referenced to the Point A.
* *Qualcomm*
  + Proposal 1: Option 2A is defined as CFR to enable simultaneous reception of unicast, multicast and broadcast in a dedicated BWP if the MBS CFR/BWP for multicast and the MBS CFR/BWP for broadcast are both associated with the dedicated BWP.
  + Proposal 2: Two MBS CFR can be configured per dedicated BWP subject to UE capability.
  + Proposal 3:
    - If Opt2A is supported, MBS BWP can be activated/deactivated in the associated active dedicated BWP.
    - If Opt2B is supported, GC-PDCCH monitoring on/off in a CFR can be supported.
  + Proposal 4: For RRC\_CONNECTED UEs, the LBRM for GC-PDSCH TBS is determined per CFR.
  + Proposal 5: For RRC\_CONNECTED UEs, the xOverhead for GC-PDSCH TBS determination is configured per CFR.
  + Proposal 6: For RRC\_CONNECTED UEs, the MAC-CE over GC-PDSCH can be used to active SPS ZP CSI-RS configured per CFR.
* *Samsung*
  + Proposal 1: A UE is configured an MBS frequency region within the active DL BWP (Option 2B).
  + Observation 1: There is no need to support more than one CFR per active DL BWP for a UE.
  + Observation 2: 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.
* *LGE*
  + Observation 1: For SL, both UL/DL BWP and SL BWP are being activated for a UE under the condition that both SL BWP and UL BWP use a same numerology in a same carrier of a same cell. If the active UL BWP numerology is different than the SL BWP numerology, the SL BWP is deactivated.
  + Observation 2: No BWP switching between SL BWP and DL/UL BWP is specified.
  + Proposal 1: In Option 2A, both MBS BWP and DL BWP are being activated for a UE without support of BWP switching between MBS BWP and DL BWP. With this, no fundamental difference between Option 2A and Option 2B is identified.
  + Observation 3: Option 2A can offer all benefits that Option 2B can offer. Even, Option 2A can offer more benefits than Option 2B in term of extensibility to various cases, including support of a wider CFR than UE’s active DL BWP or initial DL BWP, support of broadcast as well as multicast, and support of all RRC states.
  + Observation 4: A connected UE can switch to initial DL BWP shared by idle/inactive UEs according to the current specification. If CFR is associated to the initial DL BWP for multicast, CFR equal to or smaller than the initial DL BWP would lead to low multicast capacity in CFR and potentially cause overload in initial DL BWP. Thus, it is beneficial to support configuration of a wider CFR than initial DL BWP as well as CFR equal to or smaller than the initial DL BWP.
  + Proposal 2: Option 2A is supported. If Option 2A is not supported, Option 2B is supported with the term ‘MBS BWP’ without introduction of a new term ‘CFR’
  + Proposal 3: The supported CFR option is applicable to both multicast and broadcast for any applicable RRC state, whichever CFR option is finally agreed.
  + Proposal 4: For a connected UE receiving multicast, 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, whichever CFR option is finally agreed.
  + Proposal 5: 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: 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.
  + Proposal 7: 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 (whichever CFR option is agreed).
  + Proposal 8: For multicast, MBS capable UE activates only one CFR at a time for REL-17 regardless of whether or not more than one CFR is configured by gNB can be supported (whichever CFR option is agreed).
* *Convida*
  + Proposal 4: Unified CFR design should be used for MBS for RRC\_IDLE/INACTIVE and RRC\_CONNECTED UEs.
  + Proposal 5: Dedicated MBS BWP (option 2A) should be supported for RRC\_CONNECTED UEs and RRC\_IDLE/INACTIVE UEs in NR MBS.
* *Lenovo*
  + Proposal 1: An MBS frequency region with contiguous PRBs confined within the dedicated unicast BWP is configured for MBS, i.e., Option 2B is supported.
  + 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.
  + Proposal 6: RB numbering within the common frequency region is with reference to the lowest RB of the common frequency region.
* *NTT Docomo*
  + Proposal 1: Support Option 2A to define a common frequency resource for group-common PDCCH/PDSCH.
    - The MBS specific BWP is “virtual” BWP.
      * The MBS specific BWP is automatically switched along with switching of the associated dedicated unicast BWP.
      * The MBS specific BWP associated with the active dedicated unicast BWP is used.
  + Proposal 2: Support at most one common frequency resource per dedicated unicast BWP.
  + 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 3: Multicast is not supported when no CFR is configured.
* *ASUSTeK*
  + 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.
* *Chengdu TD Tech*
  + Proposal 7: More than one CFRs can be supported per unicast BWP.
  + Proposal 8: If MBS is supported in the cell, for the scenario that no CFR is configured for a unicast BWP, the unicast BWP can be used as the CFR for MBS.
* *Google*
  + Proposal 1: Support Option-2B for MBS scheduling configuration with an additional note that the detailed signaling design is up to RAN2, which includes reusing current BWP structure in the spec.
  + Proposal 2: At the end of RAN #105-e meeting, if RAN1 cannot achieve consensus on down selecting Option-2A/2B for CFR configuration, take the agreement made in RAN1 #104-e meeting (i.e. as shown below) as the final decision.
* *Sony*
  + Proposal 3: The network shall support both Option 2A and Option 2B for MBS.
* *Ericsson*
  + Observation 7: With Option 2A, the UE would need to have two simultaneously active BWPs, which is preferable to BWP switching.
  + Observation 8: The use of two active BWPs will have significant MAC layer impact and require significant RAN2 work
  + Proposal 8: If 2A is selected, when the unicast and multicast BWs are the same, it should be possible to configure MBS on the unicast BWP alone, i.e. without using an MBS BWP.
  + Proposal 9: If 2A is selected, when MBS is configured on the unicast BWP, it should be possible to use MBS-specific RRC configurations of PDCCH, PDSCH and SPS on the unicast BWP.
  + Proposal 10: If 2A is selected, when MBS is configured on the unicast BWP, it should be possible to reuse the unicast RRC configurations of PDCCH, PDSCH and SPS for MBS by not using any MBS-specific RRC configurations for MBS.
  + Observation 9: When multicast uses the same frequency range as unicast, there is no need to explicitly RRC configure a CFR (frequency range), since the unicast frequency range, as given by the unicast BWP, then applies for both unicast and MBS.
  + Proposal 11: If 2B is selected, explicit configuration of the CFR (frequency range) is optional when the CFR is the same as the unicast BWP.
  + Proposal 12: If 2B is selected, it should be possible, as a special case, to reuse the unicast RRC configurations of PDCCH, PDSCH and SPS for MBS, in which case MBS-specific configurations are not used.
  + Proposal 13: If 2A is selected, and no MBS BWP has been configured (i.e. for multicast), the UE should receive the broadcast BWP like an MBS BWP, which should allow parallel reception of unicast and broadcast.
  + Proposal 14: If 2A is selected, when the UE is RRC configured with an MBS BWP and MCCH configured with a broadcast BWP, these BWPs need to be aligned in the sense of using the same frequency range. In this case the MBS BWP “inherits” the broadcast BWP, so that the broadcast BWP is not counted as an additional BWP in the overall number of BWPs that the UE is configured with.
  + Proposal 15: The frequency range and broadcast configurations of PDCCH, PDSCH and SPS, as indicated by MCCH, are inherited by the unicast BWP and become additional configurations of the unicast BWP, which allows parallel reception of unicast, multicast and broadcast using a single active BWP.
  + Proposal 16: Downselect to Option 2B for the unicast & MBS multicast use case.
  + Proposal 17: Extend Option 2B to support also broadcast, to allow UEs in RRC Connected to receive in parallel unicast, multicast and broadcast transmissions using the unicast BWP as the active BWP. The broadcast CFR and PDCCH, PDSCH and SPS configurations are inherited by the unicast BWP as additional configurations.
  + Proposal 18: If 2B is selected, the reference point for the starting PRB of the CFR is Point A.
  + Proposal 19: Limit number of CFRs to one in Rel.17.
  + Observation 10: With Option 2A, when the MBS BWP is the same as the unicast BW, MBS can be supported on the dedicated unicast BWP without configuring a dedicated MBS BWP, using additional PDCCH/PDSCH/SPS configurations for MBS on the dedicated unicast BWP.
  + Proposal 20: If Option 2A is selected, for the case with the same BW for MBS and unicast, support additional PDCCH/PDSCH/SPS configurations for MBS on the dedicated unicast BWP to allow MBS operation without configuring a dedicated MBS BWP.
  + Observation 11: With Option 2B, 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 21: With Option 2B, MBS is supported also when no CFR (frequency region) is configured for the case where the unicast and MBS BWs are the same.

## Initial Proposals based on contributions

***Summary***

We have agreed in the last meeting that 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. Base on the submitted contributions in this meeting, 11 companies explicitly propose to down-select to Option 2B, 5 companies explicitly propose to down-select to Option 2A, and 1 company proposes to support both. From moderator point of view, the situation does not change much compared with last meeting. Companies still have different understandings and continued concerns on Option 2A, even among the supporting companies, including whether BWP switching is needed between MBS specific BWP and dedicated unicast BWP if only one active BWP at a time is allowed for the UE in the specification according to Rel-15/16 principle, and whether the specification needs to be enhanced to support two active BWPs for UE supporting multicast, and whether LS to RAN2/RAN4 is needed on these issues, etc. Considering the current situation, moderator suggests to down-select to Option 2B.

Regarding the FFS whether more than one CFR is supported per dedicated unicast BWP subjected to UE capabilities, 10 companies explicitly propose that one CFR per dedicated BWP is sufficient. 3 companies [OPPO, vivo, Chengdu TD Tech] propose to support more than one CFR per dedicated BWP subject to UE capability, and 1 company [Qualcomm] proposes two CFR can be configured 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, 4 companies [OPPO, Futurewei, CMCC, NTT Docomo] propose multicast is not supported when no CFR is configured for that BWP. 5 companies [CATT, Nokia, Intel, Chengdu TD Tech, Ericsson] 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. 1 company [Samsung] thinks 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, and moderator tends to agree with this. I think currently it is unclear, if no CFR configuration is provided in this dedicated unicast BWP, whether the UE should not receive multicast in this BWP or the UE should receive multicast in this BWP using the RRC configurations of PDCCH/PDSCH/SPS for unicast. This can be up to RAN2 design or we can further discuss this issue when the RAN2 signaling structure is more clear.

Regarding the reference point of the starting PRB of Option 2B for CFR, 7 companies have explicit proposals, 3 [MediaTek, Ericsson, Apple] of them propose to take Point A as the reference for the starting PRB of the CFR (i.e., option 1), others propose to take the starting PRB of the dedicated unicast BWP as the reference point (i.e., option 2). Moderator suggests to discuss this issue after the down-selection of Option 2A and 2B for CFR.

Additionally, 1 company [Qualcomm] proposes the follows for group-common PDSCH rate matching:

* For RRC\_CONNECTED UEs, the LBRM for GC-PDSCH TBS is determined per CFR.
* For RRC\_CONNECTED UEs, the *xOverhead* for GC-PDSCH TBS determination is configured per CFR.
* For RRC\_CONNECTED UEs, the MAC-CE over GC-PDSCH can be used to active SPS ZP CSI-RS configured per CFR.

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

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

Option 2B for CFR is supported for multicast of RRC-CONNECTED UEs.

**[High] Initial Proposal 1-2 (for conclusion)**:

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

**[High] Initial Proposal 1-3**:

For multicast of RRC\_CONNECTED UEs,

* the LBRM for GC-PDSCH TBS is determined per CFR.
* the xOverhead for GC-PDSCH TBS determination is configured per CFR.

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

For multicast of RRC\_CONNECTED UEs, the MAC-CE over GC-PDSCH can be used to active semi-persistent ZP CSI-RS configured per CFR.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | 1-1: Support.  1-2: Support.  1-3: Regarding the 1st sub-bullet, we are not sure whether LBRM needs to be determined based on CFR. For a UE, since CFR is not wider than the associated dedicated unicast BWP, the maximum TBS determined based on the associated BWP is larger than that based on the CFR. It is not necessary to align LBRM based on CFR. For the 2nd sub-bullet, it is OK to us.  1-4: The motivation to configure ZP CSI-RS per CFR is not clear to us. |
| Qualcomm | 1-1: not support it. We prefer to discuss this together with the CFR discussion in 8.12.3.  1-2: We think the issue should be discussed in RAN1 first because it is part of the functionality of CFR.   * + - * Our view is the CFR has the function to indicate the multicast can be received in the associated dedicated BWP; otherwise, the UE does not receive MBS in the dedicated BWP.       * Even using same BW size and same pdsch-config, the pdcch-config of MBS is need for GC-PDCCH monitoring, where at least the SS is configured based on the MBS traffic and priority. Similarly, sps-config for MBS is needed according to MBS traffic.   1-3: support it.   * + - * Reply to Lenovo’s comment, currently the LBRM is based on unicast BWP. Different unicast BWP among the multicast group will result in different LBRM for multicast. So it is necessary to align the LBRM based on CFR.   1-4: support it. |
| CMCC | 1-1: Support, since option 2A still has many issues needs common understanding among RAN1 group. In addition, we don’t think it is critical to discuss CFR of 8.12.1 and 8.12.3 together.  1-2: Support.  1-3: Generally support.  1-4: Has no strong motivation, since Rel-15/16 MAC-CE can be used to active SP ZP-CSI-RS per UE active BWP and the CFR is always confined within UE active BWP, it is redundant to introduce new group-common MAC-CE with the same function. |
| ZTE | For Proposal 1-1, we share the same view as Qualcomm. To keep commonality between IDLE and CONNECTED states, we need to discuss the issue in IDLE first to determine whether the CFR can be larger than CORESET#0.  Besides, as commented several times, if switching delay is needed for Option 2A even if same SCS and CP is configured, then we think switching is also needed for Option 2B because Option 2A and Option 2B are the same in this case.  For Proposal 1-2, we also think it is more like a RAN1 issue. Besides, it may have dependency on the Option 2A and Option 2B selection. If companies can’t down-select between Option 2A and Option 2B, then the unicast BWP/initial BWP becomes the default CFR. We propose to discuss this issue after down-selection between Option 2A and 2B.  For Proposal 1-3 and 1-4, we propose to mark them as low priority for now as it seems they won’t impact the basic MBS scheduling mechanism. We can discuss them in future meetings if needed to give companies more time to check. |
| LG | For P1-1, we still prefer Option 2A. We have a concern on introduction of a new term ‘CFR’ in the specification. However, we understand we have to make progress.  In our view, main difference between Option 2A and Option 2B is how to configure CFR, how to name CFR in the specifications, and possibility of a larger CFR than unicast BWP or initial BWP.  In addition, we need to consider how to support CFR in broadcast and how to associate initial BWP to CFR for all RRC states.  So, we could live with the following change to P1-1:  **[High] Initial Proposal 1-1**:  Option 2B for CFR is supported as ‘MBS BWP’ in the specification for multicast of RRC-CONNECTED UEs.   * New configuration other than existing BWP configuration can be used to configure MBS BWP.   The MBS BWP is used for broadcast as well for UEs regardless of RRC states. |
| Spreadtrum | 1-2:fine  1-3:fine  1-4:fine. Reply to Lenovo, in Rel-15 ZP CSI-RS is introduced for rate matching. The same mechanism and MAC CE could be directly reused. |
| OPPO | Proposal 1-1: Share similar view as Qualcomm and ZTE, we should consider CFR for multicast and CFR for broadcast jointly to make the decision.  Proposal 1-2:  Fine with the principle of the proposal, but we do not think a specific agreement is need, as signaling design is always up to RAN2.  Proposal 1-3 and Proposal 1-4: We also prefer to postpone the 2 proposals. |
| Google | 1-1: Support. We also fine to discuss this topic with IDLE mode scenario.  1-2: Support |
| Apple | Proposal 1-2: according to the definition of CFR, it does not only configure frequency resources for MBS, but also includes the configurations of PDSCH-config, PDCCH-config, SPS-config for MBS. We have on such agreement if the MBS dedicated configurations are not provided, then unicast configurations are applied. For example, PUCCH resources for NACK-only feedback are not provided, then no PUCCH resource could be used for NACK feedback. So before all the potential issues are identified, we can’t make this conclusion. |
| CATT | 1-1: Support.  1-2: Support.  For proposal 1-3 and 1-4, we share the same views with ZTE to mark them as low priority. We need more time to check them. |
| NTT DOCOMO | **Proposal 1-1**: We are fine with the proposal in principle. We prefer Option 2A, but we have to say that it will be difficult to agree on 2A during this meeting.  **Proposal 1-2:** We are fine with the proposal.  **Proposal 1-3**: The proposal may be interpreted as supporting multiple CFRs. So we prefer to change the wording. Also, “LBRM” is not clear to us. We prefer to name specific parameters (e.g., *mcs-Table*).  **Proposal 1-4**: We prefer to postpone the proposal. We need more time to study the need for the proposal. |

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

# Issue #2: PDCCH configuration for MBS

## Background and submitted proposals

***Background***

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

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:

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:

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:

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:

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

***Submitted Proposals***

* *Huawei, HiSilicon*
  + Proposal 2: For CFR for multicast scheduling confined within a dedicated unicast BWP,
    - One CFR per a dedicated BWP is sufficient.
    - 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 comparing to the number UE supported in Rel-16.
  + Proposal 4: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state,
    - Reuse Type3-CSS with monitoring priority kept the same as the current specification defined.
  + Proposal 5: Both of DCI formats 1\_1 and 1\_2 can be used for scheduling multicast with necessary modifications:
    - One of the modifications is the FDRA field in DCI which should be dimensioned per the CFR.
  + Proposal 6: The existing “3+1” DCI size budget should be kept for multicast, and DCI size should be aligned at least for DCI format 1\_0 for unicast and multicast scheduling.
* *OPPO*
  + Proposal 8: A new DL DCI format should be defined for the scheduling of group-common PDSCH.
  + Proposal 9: The G-RNTI is counted as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.
  + Proposal 10: The size of the group common DCI is configurable up to 126 bits.
  + Proposal 11: For a UE receiving group-common PDSCH transmitted with PTM scheme 1, a TPC-PUCCH-RNTI different from that for unicast should be configured.
  + Proposal 12: 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.
  + Proposal 13: A new CSS type is defined for group-common PDCCH transmission, the monitoring priority of the new CSS is determined based on the index associated with the CSS.
* *Spreadtrum*
  + Proposal 3: For search space type for Rel-17 MBS, support to define a new search space type for multicast.
  + Proposal 4: The monitoring priority of search space set for multicast is the same as existing Rel-15/16 USS.
  + Proposal 5: For connected UE, DCI 1\_0 can be directly reused as group-common PDCCH for MBS, where
    - If DCI 1\_0 is scheduled in CSS, then the bitwidth and interpretation of ‘FDRA’ field depends on the CORESET configuration and CFR configuration for MBS in idle state
    - If DCI 1\_0 is scheduled in USS, then the bitwidth and interpretation of ‘FDRA’ field depends on the CFR configuration for MBS in RRC connected
  + Proposal 6: For connected UE, DCI 1\_1 or 1\_2 can be directly reused as group-common PDCCH for MBS, where
    - 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 group-common PDCCH,
    - The fields of ‘Identifier for DCI formats’ and ‘TPC command for scheduled PUCCH’ are useless for MBS scheduling and can be re-interpreted to indicate HARQ-ACK feedback and PDSCH repetition related functions.
    - Using DCI format 1\_2 as a baseline for designing a non-fallback DCI of MBS scheduling.
  + Proposal 6: About search space set and corresponding priority for GC PDCCH, Alt 3 should be supported with the following details,
    - Alt 3: support both Type-3 CSS and a new Type-x CSS
      * If Type-3 CSS is used for group-common PDCCH, the monitoring priority is the same as existing Rel-15/16 CSS, only DCI format 1\_0 of group-common PDCCH is configured in Type-3 CSS
      * If a new Type-x CSS is used for group-common PDCCH, the monitoring priority is determined based on the existing Rel-15/16 rule, i.e., based on the SS set index, only non-fallback DCI format of group-common PDCCH is configured in the new Type-x CSS
  + Proposal 7: About CORESET sharing between multicast transmission and unicast transmission, option 4 should be supported,
    - 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.
  + Proposal 8: For MBS group-common PDCCH, the budget of BDs/CCEs of an CC for group-common PDCCH can be counted as X CCs for UEs supporting CA capability in Rel-17 MBS. The value of X is related to UE capability and can be reported by the UE.
  + Proposal 9: Regarding DCI size alignment used for group-common PDCCH,
    - DCI format 1\_0: it is counted as “C-RNTI”, and current mechanism can be reused for determining the size of DCI format 1\_0 for group-common PDCCH and unicast PDCCH.
    - DCI format 1\_x: it is counted as “other RNTI”, and gNB will ensure that the number of DCI sizes does not exceed budget.
* *vivo*
  + Proposal 9: 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.
  + Proposal 10: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, Alt 2 is preferred.
    - 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.
* *CATT*
  + Proposal 18: When MBS frequency region (Option 2B) is supported, up to one CORESET can be configured specifically for MBS service on a dedicated unicast BWP.
  + Proposal 19: When MBS frequency region (Option 2B) is supported, shared CORESET by MBS service and unicast service can be supported on a dedicated unicast BWP.
  + Proposal 20: Option 1 is supported that 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 21: USS can also be considered for group-common PDCCH of PTM scheme 1.
  + Proposal 22: Both Type-3 CSS and new Type-x CSS can be supported for group-common PDCCH of PTM scheme 1 for multicast.
  + Proposal 23: Whether the budget sharing of DBs/CCEs of an unused CC can be supported is based on per UE capability.
  + Proposal 24: G-RNTI is counted as one of the “other RNTIs” in 3+1 DCI size budget rule for group-common PDCCH.
* *Nokia*
  + Observation-6: 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-4: The existing limits on the total number of CORESETs for UE-specific BWPs are also applied to those BWPs with MBS CFR, and the number of CORESETs configured within the MBS CFR should be left to gNB implementation.
  + Observation-7: The gNB should have the flexibility to decide whether to use the CORESETs within CFR of the dedicated unicast BWP for both unicast and MBS, since restricting CORESETs to a particular type of traffic would limit the overall availability of PDCCH resources within the BWP, which would be detrimental to the operation of the network.
  + Proposal-5: Agree to support option 1 where 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.
  + Observation-13: Format 1\_2 has lower number of fields and reduced complexity in terms of the interpretations of various fields based on higher layer configurations.
  + Observation-14: Format 1\_2 is currently used for C-RNTI and CS-RNTI, hence a new baseline format for MBS could consider support for CRC scrambled by both G- and G-CS-RNTI.
  + Proposal-13: Agree on DCI format 1\_2 as the baseline for the second DCI format with CRC scrambled with G-RNTI and G-CS-RNTI.
  + Observation-15: Reuse the existing fields in DCI format 1\_0 with the following exceptions:
    - FDRA field interpreted based on the CFR rather than the unicast DL BWP.
    - ChannelAccess-CPext assumed to be set to 0 bits if the CRC is scrambled by G- or G-CS-RNTI
  + Proposal-14: Agree to reuse existing fields in DCI format 1\_0.
    - FFS: Interpretation of FDRA based on CFR and ChannelAccess-CPext fields.
  + Observation-16: For format 1\_2, fields such as carrier indicator, BWP indicator could be assumed to be set to 0 bits and FDRA field interpretation could be done based on CFR size similar to format 1\_0.
  + Observation-17: Some of the fields for format 1\_2 such as: TDRA, VRB-to-PRB mapping, PRB bundling size indicator, Rate matching indicator, ZP CSI-RS trigger, RV, HARQ process number, DAI, TPC command for scheduled PUCCH, PRI, priority indicator, etc., the size of the field is determined based on higher layer configuration which could be different for different UEs receiving the same multicast service which might lead to different DCI size estimation.
  + Proposal-15: Discuss further whether fields with variable size depending on higher-layer configuration should be assumed to have fixed size for multicast or use current interpretation with synchronized higher layer configurations across all UEs receiving a particular multicast service.
    - FFS: Interpretation of FDRA based on CFR
    - FFS: Whether fields such as carrier indicator, BWP indicator could be assumed to be set to 0 bits
    - FFS: Issues related to DCI size alignment
  + Observation-18: Reusing an existing CSS type would imply that all multicast traffic scheduled using PTM scheme 1 would have higher monitoring priority as compared to traffic scheduled over USS.
  + Observation-19: If DCI format 1\_1 or 1\_2 is used to schedule group-common PDCCH for multicast, the use of type-3 CSS could lead to backward compatibility issues and added UE complexity.
  + Observation-20: CSS is configured with a longer periodicity as compared to USS, hence a new type of CSS as compared to reusing an existing format would have minimal impact on existing search space monitoring occasions / periodicities.
  + Proposal-17: Agree on Alt 2 to define a new type-x CSS for multicast, rather than reusing an existing Rel-15/16 CSS type.
  + Proposal-18: Agree that the monitoring priority is determined based on the search space set indexes of search space set(s) for multicast and USS sets.
* *MediaTek*
  + Proposal 5: The maximum number of CORESETs per BWP is not increased for UE supporting MBS.
  + Proposal 6: 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.
  + Proposal 7: Define a new Type-x PDCCH CSS type (e.g., Type-4 PDCCH CSS) for UE supporting multicast service.
  + Proposal 8: Keep the “3+1” DCI size defined in Rel-15 for Rel-17 MBS and “G-RNTI” is counted as “C-RNTI”.
  + Proposal 9: Both of DCI format 1\_1 and 1\_2 can be separate as a baseline for UE supporting MBS.
* *FUTUREWEI*
  + Proposal 5: The monitoring priority of group-common PDCCH is based on search space set indices and a new CSS type is defined to avoid fixed higher PTM scheme 1 priority over USS.
  + Observation 1: The number of CORESET(s) for group-common PDCCH within the common frequency resource for group-common PDSCH should be considered during UE capability discussions for MBS-enabled UE.
* *CMCC*
  + Proposal 6. For CSS of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, support Alt 2: a new Type-x CSS.
  + 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.
  + Proposal 9. For PTM transmission scheme 1, support DCI format 1\_2 to be used as the baseline for the second DCI format with CRC scrambled with G-RNTI.
  + Proposal 10. For DCI format 1\_0 with CRC scrambled by G-RNTI, the following information is transmitted:
    - - Identifier for DCI formats
    - - Frequency domain resource assignment
    - - Time domain resource assignment
    - - VRB-to-PRB mapping
    - - Modulation and coding scheme
    - - New data indicator
    - - Redundancy version
    - - HARQ process number
    - - Downlink assignment index
    - - PUCCH resource indicator
  + Proposal 11. For DCI format 1\_2 with CRC scrambled by G-RNTI, the following information is transmitted:
    - - Identifier for DCI formats
    - - Carrier indicator
    - - Frequency domain resource assignment
    - - Time domain resource assignment
    - - VRB-to-PRB mapping
    - - PRB bundling size indicator
    - - Rate matching indicator
    - - ZP CSI-RS trigger
    - - Modulation and coding scheme
    - - New data indicator
    - - Redundancy version
    - - HARQ process number
    - - Downlink assignment index
    - - PUCCH resource indicator
    - - PDSCH-to-HARQ\_feedback timing indicator
    - - Antenna port(s)
    - - Transmission configuration indication
    - - SRS request
    - - DMRS sequence initialization
    - - Priority indicator
  + Proposal 12. Confirm the working assumption of keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS.
    - The G-RNTI is counted as “C-RNTI”.
  + Proposal 13. For DCI format 1\_0 with G-RNTI, its DCI size equals to DCI format 1\_0 with C-RNTI monitored in a common search space.
  + Proposal 14. For DCI format 1\_2 with G-RNTI, align the DCI size of DCI format 1\_2 with C-RNTI equals to the DCI size of DCI format 1\_2 with G-RNTI after current steps in Rel-16 DCI size alignment procedure.
    - The G-RNTI DCI format 1\_2 size can be configured by gNB, which is larger than the original calculation of bitlength of DCI fields according to configurations.
* *Intel*
  + Proposal 9: For delivery mode 2, MBS configuration is provided via a MCCH carried over a PDSCH scheduled by a PDCCH using DCI format 1\_0 with CRC scrambled with a new SC-RNTI. Change in configuration can be notified through a PDCCH carrying another DCI 1\_0 with CRC scrambled with SC-N-RNTI.
  + Proposal 10: The PDCCH scheduling the MCCH is monitored in Type0 CSS set configure by searchSpaceZero or Type0A CSS set or alternately on new mcch-searchSpace which is a CSS configured by the MBS specific PDCCH-ConfigCommon.
  + Proposal 11: MBS capable UEs may support an additional CFR CORESET for monitoring MBS PDCCH and the support of the additional CORESET can be a UE capability.
  + Proposal 12: If UE can support additional CFR CORESET, Option 3 can be supported. Otherwise Option 1 should be considered as the default for MBS and unicast reception.
  + Proposal 13: For PTP or PTM scheme 2, the CORESET scheduling MBS (re)transmission can be configured outside the MBS frequency region.
  + 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.
  + Proposal 15: Search space set configuration for monitoring DCI scheduling multicast PDSCH can re-use NR Type 3 CSS configuration while additionally supporting monitoring of DCI with CRC scrambled by SC-RNTI, SC-N-RNTI and G-RNTI. Alternately, a new NR CSS Type can be defined for monitoring multicast DCI with CRC scrambled by SC-RNTI, SC-N-RNTI and G-RNTI
  + Proposal 16: The monitoring priority of search space set for multicast is the same as existing Rel-15/16 CSS and USS (if supported)
  + Proposal 17: DCI format 1\_1 should be used as the baseline for the second DCI format for group scheduling.
* *Apple*
  + Proposal 2: Define a new common search space type for multicast. The monitoring priority is determined based on the search space set indexes of search space set(s) for multicast and USS sets.
  + Proposal 3: Confirm the working assumption: Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS.
  + Proposal 4: DCI format 1\_2 can be considered for multicast PDSCH scheduling.
  + Proposal 5: CORESET sharing option 3 is supported, i.e., 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.
* *Qualcomm*
  + Proposal 7: For RRC\_CONNECTED UEs, more than one CORESET for GC-PDCCH can be configured per MBS CFR.
    - Keep the maximum total number of CORESETs per MBS CFR same as that of unicast BWP.
    - Keep the maximum total number of CORESETs per UE unchanged.
  + Proposal 8: 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.
  + Proposal 9: For RRC\_CONNECTED UEs, define a new type of CSS for MBS GC-PDCCH.
    - The monitoring priority of GC-PDCCH in case of overbooking is determined based on the search space set indexes.
  + Proposal 10: For RRC\_CONNECTED UEs, support both DCI format 1\_1 and 1\_2 for GC-PDCCH.
    - Confirm the WA: Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS
    - 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).
  + Proposal 11: 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*
  + Proposal 2: A UE can be configured to monitor PDCCH for multicast PDSCH scheduling according to USS.
  + Proposal 3: The monitoring priority of CSS sets for multicast PDSCH is determined based on the CSS set index.
  + Observation 3: Whether or not a UE monitors PDCCH for detection of unicast DCIs and multicast DCIs in a same CORESET is a gNB implementation issue.
  + Observation 4: Increasing the number of CORESETs to support multicast operation increases UE hardware complexity, requires additional specifications that are applicable only for FR2, and is not in scope.
  + Observation 5: Increasing and does not relate to CA capability of a UE - it is a core aspect of a UE implementation that is hard-coded in the specifications - any increase would have substantial impact on modem design and is precluded by the WID.
  + Observation 6: DCI formats scheduling multicast PDSCH can have same size with any unicast DCI format (i.e. any unicast DCI format can be used as ‘baseline’).
  + Observation 7: DCI formats scheduling multicast PDSCH have configurable fields and can follow DCI formats 0\_2/1\_2. This maximizes functionality and minimizes specification impact as size matching procedures do not need to be defined.
  + Proposal 4: The fields of DCI formats are based on the fields of DCI formats 0\_2/1\_2.
  + Proposal 5: The sizes of the DCI formats scheduling multicast PDSCH are counted together with the unicast ones and are such that the budget of 3 sizes is not exceeded.
* *LGE*
  + Proposal 9: A CORESET ID is unique across all CFRs and the associated UE active BWPs for a serving cell.
  + Proposal 10: It is up to gNB configuration whether a CORESET ID is configured for both a CFR and the UE active BWP associated to the CFR. However, if the CFR is confined within UE active BWP, CORESET used by the CFR should be confined within the CFR in frequency.
  + Proposal 11: support new CSS type 4 for multicast of which monitoring priority is handled like USS.
  + Proposal 12: the G-RNTI is “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH for less impact. If necessary, the total number of different DCI sizes configured to monitor could be increased up to 5 for the cell where CFR is configured, while the total number of different DCI sizes with C-RNTI configured to monitor is kept as 3.
  + Proposal 13: G-CS-RNTI is “other RNTI”.
  + Proposal 14: 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.
  + Proposal 15: 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 16: Multiple TCI states can be configured in PDSCH-config for group common PDSCH for the CFR.
  + Proposal 17: 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 18: Multiple TCI states can be configured for a CORESET ID for a Search Space of group common PDCCH by RRC.
* *Lenovo*
  + 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: A common CORESET is configured within the common frequency region for MBS for the group of UEs.
  + Proposal 9: A common search space is configured associated with the common CORESET for MBS for the group of UEs.
  + Proposal 10: DCI format 1-0 with CRC scrambled by G-RNTI is used as the group-common DCI.
  + Proposal 11: For DCI size alignment, DCI format with CRC scrambled by G-RNTI is counted as the DCI format with CRC scrambled by C-RNTI.
* *NTT Dococmo*
  + Proposal 4: Support Alt 2 for CSS of group-common PDCCH of PTM scheme 1 for multicast.
  + Proposal 5: Support Option 4 for sharing CORESETs between PDCCH-Config for unicast and PDCCH-Config for multicast.
  + Proposal 6: Align the size of DCI format 1\_0 for multicast with the size of DCI format 1\_0 for unicast transmitted in CSS.
  + Proposal 7: Align the size of the second DCI format (i.e., DCI format 1\_1 or 1\_2) for multicast with the size of DCI format 2\_0/2\_1/2\_4/2\_5/2\_6.
* *ASUSTeK*
  + Proposal 5: For the down-selection of the usage of the CORESET configured in PDCCH-config for unicast and the CORESET configured in PDCCH-config for MBS in the CFR, option 3 is supported.
* *Chengdu TD Tech*
  + Proposal 5: The CORESETs for MBS can be used for unicast scheduling. If a CORESET for MBS is not permitted to be used for unicast scheduling, the related indicator should be sent to UE.
  + Proposal 6: For a CORESET for unicast, if it’s within the CFR, it can be used for MBS scheduling. If such a CORESET is NOT permitted to be used for MBS scheduling, the related indicator should be sent to UE.
  + Proposal 9: The CSS for the group common PDCCH of PTM scheme 1 is by default same as the Type3-PDCCH CSS.
  + Proposal 10: If the monitoring priority of a CORESET for MBS can be set flexibly, the detailed monitoring priority for the CORESET can configured and indicated to UE.
    - Monitoring priority is configured per CORESET
    - Monitoring priority is configured per CFR: the CORESETS for MBS on the same CFR have the same monitoring priority.
    - Monitoring priority is configured per BWP: the CORESETS for MBS on the same BWP have the same monitoring priority.
    - Monitoring priority is configured per cell: the CORESETS for MBS in the same cell have the same monitoring priority.
* *Convida*
  + Proposal 6: Dedicated CORESET(s) should be configured for NR MBS in addition to the existing CORESETs in UE dedicated BWP.
* *Ericsson*
  + Proposal 35: The CORESET for group common PDCCH is counted toward of the already existing CORESET capability of the UE. No additional number of CORESET capability is defined for MBS only.
  + Proposal 36: Group common PDCCH and unicast PDCCH can be configured within the same CORESET
  + Proposal 37: Extend the existing type3 CSS from Rel-15/16 to support
    - Additional DCIs for scheduling via group common PDCCH
    - Support of G-RNTI(s)
  + Proposal 38: The priority of search space for multicast is higher than UE specific search space but lower than the existing common search space defined in R15/R16.
  + Proposal 39: Based on UE capability, a UE may use the budget of BDs/CCEs of an unused CC for a group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration.
  + Proposal 40: Specify one fall-back and one non-fallback DCI for group scheduling of PDSCH via group-PDCCH.
  + Proposal 41: The G-RNTI is counted as “C-RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.
  + Proposal 42: A new, non-fallback DCI format for MBS downlink scheduling is introduced e.g. DCI 1\_3, present in the common search space and based on DCI 1\_1
    - FFS: details of the fields in DCI 1\_3
  + Proposal 43: The determination of DCI 1\_3, monitored in the common search space is inserted as step ”2B” in the DCI alignment procedure
  + Observation 18: For MBS Fallback DCI format, legacy DCI format 1\_0, can be reused in the CSS without requiring additional Blind decoding and without requiring DCI size alignment between unicast and multicast.
  + Proposal 44: Reuse DCI 1\_0 as fallback DCI format for MBS, with CRC scrambled with G-RNTI.
    - FFS: details of the MBS fallback DCI format fields.
  + Proposal 45: 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 46: Scrambling parameters n\_ID and n\_RNTI for group PDSCH schedule by the multicast non-fallback DCI in CSS is given by
    - N\_RNTI is given by G-RNTI
    - n\_ID = the higher-layer parameter dataScramblingIdentityPDSCH if CORESETPoolIndex is not configured
    - if the higher-layer parameters dataScramblingIdentityPDSCH and dataScramblingIdentityPDSCH2 are configured together with the higher-layer parameter CORESETPoolIndex containing two different values
      * n\_ID = the higher-layer parameter dataScramblingIdentityPDSCH if the codeword is scheduled using a CORESET with CORESETPoolIndex equal to 0
      * 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 had the following proposal but no conclusion in last meeting:

*Regarding the CORESETs for support of MBS, take Option 1 as baseline, and Option 2 is optionally supported.*

* *Option 1: The maximum number of CORESETs per BWP is not increased for support of MBS. The CORESETs include the CORESETs configured in the dedicated unicast BWP and the CORESETs configured in the CFR which is confined within the dedicated unicast BWP.*
* *Option 2: The maximum number of CORESETs per serving cell is not increased for support of MBS, but the maximum number of CORESETs per BWP can be increased to up to N (N>3) based on UE capability for support of MBS. The CORESETs include the CORESETs configured in the dedicated unicast BWP and the CORESETs configured in the CFR which is confined within the dedicated unicast BWP.*
  + *FFS: the value of N*
* *Note: this is applied to both Option 2A and Option 2B of CFR*

Based on contributions in this meeting, at least 6 companies propose to not increase the maximum number of CORESETs per BWP for support of MBS (i.e., option 1), it seems 3 companies [CMCC, Intel, QC] support option 2, and one company thinks that this issue should be considered during UE feature discussions for MBS-enabled UE. Based on majority view, moderator suggests to support option 1 (see initial proposal 2-1).

Regarding whether the CORESETs can be shared for unicast and multicast, 4 options were listed for further study in last meeting. 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 [ZTE, QC, NTT Docomo] support the principle of option 4 and 3 companies [Intel, Apple, ASUSTEK] support option 3. Based on majority view, moderator suggests initial proposal 2-2.

Regarding the three alternatives for CSS of group-common PDCCH of PTM-1 for multicast in RRC\_CONNECTED state, which were agreed in last meeting to be down-selected in this meeting, at least 12 companies explicitly support Alt 2, 2 companies [ZTE, CATT] explicitly support Alt 3, and 2 companies [Huawei, Chengdu TD Tech] explicitly support Alt1. Based on majority view, moderator suggests to support Alt 2 (see initial proposal 2-3).

Regarding which of DCI format 1\_1 or 1\_2 is used as the baseline for the second DCI format with CRC scrambled with G-RNTI, 3 companies [Huawei, MTK QC] support both DCI format 1\_1 and 1\_2, 5 companies [ZTE, Nokia, CMCC, Apple, Samsung] support DCI format 1\_2, and 2 companies [Intel, Ericsson] support DCI format 1\_1. Based on majority view, moderator suggests the fields of the second DCI format can at least be based on the fields of DCI format 1\_2, and companies can further study whether some of the fields of DCI format 1\_1 can be reused for the second DCI format (see initial proposal 2-4).

Regarding the details of the reuse (or not) of DCI format 1\_2 fields for the second DCI format of multicast, 2 companies [Huawei, Nokia] propose that the FDRA field interpretation could be done based on CFR size. 1 company [ZTE] proposes ‘Identifier for DCI formats’ is useless, 2 companies [ZTE, CMCC] propose ‘TPC command for scheduled PUCCH’ is useless. 1 company [Nokia] proposes ‘carrier indicator’ could be assumed to be set to 0 bits. 2 companies [Nokia, CMCC] propose ‘Bandwidth part indicator’ could be assumed to be set to 0 bits. 1 company [ZTE] proposes indicators for HARQ-ACK feedback and PDSCH repetition related functions can be added to the second DCI format of multicast (see initial proposal 2-4).

Regarding the details of the reuse (or not) of DCI format 1\_0 fields for the first DCI format of multicast, 1 company [Spreadtrum] proposes the interpretation of ‘FDRA’ field may need modification, and 1 company [Nokia] proposes FDRA field should be interpreted based on the CFR rather than the unicast DL BWP, 2 companies [Nokia, CMCC] propose ‘ChannelAccess-CPext’ is useless. 1 company [CMCC] proposes ‘TPC command for scheduled PUCCH’ is useless (see initial proposal 2-5).

Regarding the FFS of maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell, the following proposal was discussed in last meeting but some companies propose to postpone the discussion. Based on contributions in this meeting, 7 companies [OPPO, ZTE, CATT, Intel, QC, LGE, Ericsson] support the principle but the wording of the proposal may need improved. 1 company [Samsung] still thinks any increase of and have substantial impact on modem design and is precluded by the WID. I refined the wording and will try it again in this meeting, and if more companies raise concern, the discussion will be postponed (see initial proposal 2-6).

*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 X times.*
* *The maximum BD/CCE numbers are increased as X times and X 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*
* *FFS the value of X, which may be related to UE capability*

Regarding the working assumption for DCI size budge, at least 10 companies propose to confirm it. Regarding whether the G-RNTI is counted as “C-RNTI” or as “other RNTI”, it seems companies’ views diverge. 6 companies [MTK, CMCC, QC, Samsung, Lenovo, Ericsson] explicitly propose to count the G-RNTI as “C-RNTI”, 3 companies [OPPO, CATT, LGE] propose to count the G-RNTI as “other RNTI”, 1 company [ZTE] proposes that for fallback DCI the G-RNTI is counted as “C-RNTI”, while for non-fallback DCI the G-RNTI is counted as “other-RNTI”. Moderator suggest to first confirm this working assumption and give companies time to converge on whether the G-RNTI is counted as “C-RNTI” or as “other RNTI” (see Initial Proposal 2-7).

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

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

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.

* Note: this is applied to both Option 2A and Option 2B of CFR

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

For multicast of RRC\_CONNECTED UEs, it is up to gNB implementation to use the same or different CORESETs for unicast and multicast scheduling.

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

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

* 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.

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

The fields of second DCI format with CRC scrambled with G-RNTI are at least based on the fields of DCI format 1\_2.

* The FDRA field is interpretated based on CFR
* FFS: Whether or not some fields of DCI format 1\_1 can be reused for the second DCI format
* FFS: Details of the reuse (or not) of DCI format 1\_2 fields, e.g., whether to remove ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’, ‘Carrier indicator’ and ‘Bandwidth part indicator’.

**[High] Initial Proposal 2-5**:

Reuse existing fields in DCI format 1\_0 for the fields of first DCI format with CRC scrambled with G-RNTI.

* FFS: Interpretation of FDRA field.
* FFS: Whether ‘TPC command for scheduled PUCCH’ and ‘ChannelAccess-CPext’ are needed.

**[High] Initial Proposal 2-6**:

For RRC\_CONNECTED multicast UEs supporting CA capability, the maximum BD/CCE numbers are increased as X times and X 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

* FFS the value of X, which may be related to UE capability

**[High] Initial Proposal 2-7**:

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.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | 2-1: Generally OK with us. Based on the current proposal, one question from our side is what the UE behavior is when the number of CORESETs within the CFR is 0 since there is no any restriction on gNB?  2-2: OK.  2-3: OK.  2-4: We are OK with the main bullet and the first sub-bullet. For the 1st FFS, which fields in DCI 1-1 are referring to? For the 2nd FFS, what do you mean “reuse”? for which purpose?  2-5: We are OK with the main bullet and the first sub-bullet. For the FFS, “ChannelAccess-CPext” can be removed from the bullet because it is purely dependent on spectrum, i.e., exists in unlicensed spectrum; otherwise, no.  2-6: Generally OK with us.  2-7: Support. We also support counting “G-RNTI” as “C-RNTI”. |
| Qualcomm | 2-1: not support it. Even if a CORESET in a CFR can be used for multicast and unicast, it sacrifices the flexibility of unicast CORESET. It is beneficial for UE to support Opt2 who is capable to support it. We don’t see the reason to set strong restriction for now.  2-2: Not support it. The current wording is not clear. Based on the RAN1 agreement, the CFR includes the configuration of the CORESET(s) for MBS. The unicast CORESET configured in dedicated BWP if can be used for MBS, it is contradictory to the previous agreement to our understanding.  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:   * … * One PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP) * …   2-3: support it.  For 2-4/2-5, we think RAN1 has agreed that FDRA is based on CFR. Is there different understanding?  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.  2-4: if we discuss the DCI fields, we think the fields of DCI 1\_2 are also the fields of DCI 1\_1. Many fields in DCI 1\_2/1\_1 are optional, based on the RRC configuration. Currently, no need to limit to DCI 1\_2.  2-6: fine in principle.  2-7: ok |
| CMCC | 2-1: Support.  2-2: Support. Echo the concern from Qualcomm, the previous agreement about PDCCH-config for MBS does not preclude to configure a same CORESET with PDCCH-config of unicast dedicated BWP. For example, gNB can configure a CORESET with index 1 under PDCCH-config of the dedicated unicast BWP and also configure CORESET#1 under PDCCH-config for MBS with the same configuration parameters, e.g., frequency domain allocation, ofdm symbols, thus CORESET#1 can both used for unicast and multicast.  2-3: Support.  2-4: Support.  2-5: Support in general. Regarding the “interpretation of ‘FDRA’ field”, it is also related to DCI size alignment, e.g., the CFR has different size with initial DL BWP/unicast active BWP, but the bitlength of FDRA filed is according to initial DL BWP.  2-6: Support  2-7: Support, prefer count in “C-RNTI” |
| ZTE | For Proposal 2-1: It is difficult for MBS and unicast to share the same CORESET in some cases considering that the beam for unicast PDCCH and multicast PDCCH are likely to be different. For example, multicast PDCCH may use wider beam to cover more UEs while unicast PDCCH may use finer beam to increase coverage. Thus, from network perspective, 3 CORESETs for both unicast and MBS is too restrictive, we propose to support more than 3 CORESETs as an optional UE capability.  For Proposal 2-2: In general, we are ok with the direction of this proposal. However, as also commented by other companies, the proposal itself is not very clear. For example, it doesn’t explain the detailed conditions in which case unicast and multicast can share the same CORESET.  For Proposal 2-3: We do not support this proposal.  Under Alt 2, the monitoring priority for MBS always has a lower priority than CSS. Currently, the unicast service can be scheduled either in USS or CSS, and the same flexible should also be provided for MBS service scheduled by a group-common PDCCH. So we think Alt 3 is supportable with the following details.  If Type-3 CSS is used for GC PDCCH, it is important to fully follow the existing rules, including e.g., mapping rule, DCI format restriction, i.e., only DCI format 1\_0 can be configured in it. Otherwise, it will be anyway a new Type CSS.  Then, for non-fallback DCI, it can be configured within the new Type-x CSS, and the mapping rule can follow that of USS.  Based on this, we prefer Alt.3, which is a compromised solution.  For 2-4 and 2-5, RAN1 has already agreed to interpret FDRA based on CFR size. The corresponding bullets in proposal 2-4 and 2-5 seem to be redundant.  For Proposal 2-5, the fields for different RNTI for DCI format 1\_0 are different, it is better to clarify the RNTI when we discuss the existing fields. Also, the “Identifier for DCI formats” in DCI format 1\_0 can also be re-interpreted.  We are ok with Proposal 2-6 and 2-7. |
| LG | For P2-2, we think that a same CORESET can be shared by unicast and multicast with the same CORESET ID. In addition, if a same CORESET ID is used for unicast and multicast scheduling, the CORESET addressed by the CORESET ID needs to be confined in the CFR for multicast scheduling. Thus, we propose to add one restriction as follows:  **[High] Initial Proposal 2-2**:  For multicast of RRC\_CONNECTED UEs, it is up to gNB implementation to use the same or different CORESETs for unicast and multicast scheduling.   * If a same CORESET ID is used for unicast and multicast scheduling, the CORESET addressed by the CORESET ID needs to be confined in the CFR for multicast scheduling.   For P2-3, we are fine with **Initial Proposal 2-3**  For P2-5, we propose to change to:  **[High] Initial Proposal 2-5**:  Reuse existing fields in DCI format 1\_0 for the fields of first DCI format with CRC scrambled with G-RNTI.   * FFS: Interpretation of existing fields ~~FDRA field.~~ * ~~FFS: Whether ‘TPC command for scheduled PUCCH’ and ‘ChannelAccess-CPext’ are needed.~~   For P2-6, we think that scalable maximum BD/CCE number is currently ‘unrelated’ with CA capability. It could be related to MBS UE capability. Thus, we propose to remove ‘supporting CA capability’ while keeping FFS for UE capability aspect.  **[High] Initial Proposal 2-6**:  For RRC\_CONNECTED multicast UEs ~~supporting CA capability~~, the maximum BD/CCE numbers are increased as X times and X 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   * FFS the value of X, which may be related to UE capability   For P2-7, we are fine with **[High] Initial Proposal 2-7** |
| Spreadtrum | 2-1: fine  2-2: fine in principle.  2-3: fine  2-4: fine  2-5:  In proposal 2-4, whether ‘Identifier for DCI formats’ field exits is FFS. For consistence, we suggest the following revisions,  **[High] Initial Proposal 2-5**:  Reuse existing fields in DCI format 1\_0 for the fields of first DCI format with CRC scrambled with G-RNTI.   * FFS: Interpretation of FDRA field. * FFS: Whether ‘TPC command for scheduled PUCCH’, ~~and~~ ‘ChannelAccess-CPext’ , and ‘Identifier for DCI formats’, are needed.   2-6:  The proposal only refers to UEs supporting CA. We prefer unified solution for UEs supporting CA and not supporting CA. Thus, we suggest to discuss them together.  2-7: fine |
| OPPO | Proposal 2-1: OK.  Proposal 2-2: OK.  Proposal 2-3: OK  Proposal 2-4:  Fine in general, but the first sub-bullet should be removed as it has already been agreed in RAN1#103.  *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.*  Proposal 2-5:  Similar comment as above, the first FFS should be removed.  Proposal 2-6: OK.  Proposal 2-7: OK. |
| Apple | Proposal 2-1: We just want to clarify this proposal, up to 3 CORESETs can be configured in a BWP, we have CORESET#0, CORESET for beam failure recovery, then only one CORESET is left. With this proposal, the CORESET for unicast PDSCH needs to be reconfigured to adapt the bandwidth of CFR, and this CORESET is always shared between unicast and multicast. This restriction is really limiting the MBS usage. Is this intention of this proposal?  Proposal 2-3: We support this proposal.  Proposal 2-4: We support this proposal.  Proposal 2-6: This proposal seems not aligned with previous agreements “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.”  BD/CCE increase X times for a serving cell supporting multicast reception, if most of the serving cells support MBS, the BD/CCE budget will be beyond the UE CA capability.  Proposal 2-7: We support this proposal. |
| CATT | 2-1: Support.  2-2: Support.  2-3: NOT Support. It is agreed that either Type-3 CSS or a new Type-x CSS is supported for multicast. Both alternatives can be considered based on different cases. Down selection to one CSS type makes the system not flexible. For example, a mount of multicast services can be divided into two sets based on different service types and priorities. One set applies Type-3 CSS and the other set applies new Type-x CSS. Thus, we support Alt 3.  2-4: OK.  2-5: We are OK with the main bullet.  For the first sub-bullet, we share the same views with Qualcomm/ZTE/OPPO that since it has been agreed in #103e meeting that the FDRA field of group-common PDCCH is interpreted based on the CFR, so the first sub-bullet can be removed.  OK with the second sub-bullet  2-6: OK.  2-7: Support. We prefer the G-RNTI is counted as “other RNTI”. |
| NTT DOCOMO | **Proposal 2-1**: We are fine with the proposal.  **Proposal 2-2**: We are fine with the proposal.  **Proposal 2-3**: We are fine with the proposal.  **Proposal 2-4**, **Proposal 2-7**: RAN1 should prioritize the discussion of DCI size alignment procedure. It is not acceptable to confirm the working assumption without discussing how to keep the “3+1” DCI size budget.  **Proposal 2-5**: We prefer to introduce a priority indicator to DCI format 1\_0. Otherwise, DCI format 1\_0 cannot be used for multicast purpose in eMBB/URLLC coexistent scenario.We also suggest to make the k1 list for DCI format 1\_0 configurable. In Rel-16, the list of k1 values for DCI format 1\_0 is fixed in the specification (i.e., {1, 2, 3, 4, 5, 6, 7, 8}). PUCCH scheduling flexibility is low if the list is reused for multicast.  **Proposal 2-6**: We are fine with the proposal. |

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

# Issue #3: Transmission scheme and HARQ process management

## Background and submitted proposals

***Background***

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

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

Conclusion:

The maximum number of HARQ processes per cell, currently supported for unicast, is kept unchanged for UE to support multicast reception.

* How to allocate HARQ processes between unicast and multicast is up to gNB.

***Submitted Proposals***

* *Huawei, HiSilicon*
  + Proposal 3: UE could receive another PDSCH via PTM for a given HARQ process before the end of the expected HARQ-ACK transmission.
  + Proposal 7: 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 4: PTM transmission scheme 2 is not supported.
  + Proposal 5: For re-transmission of PTM scheme 1 and SPS group-common PDSCH, PTM scheme 1 and PTP should NOT be used simultaneously for different UEs in the same MBS group.
* *Spreadtrum*
  + Proposal 1: For RRC\_CONNECTED UEs for NR MBS, not support PTM2 transmission scheme.
  + 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.
* *ZTE*
  + Proposal 11: Regarding HARQ process management for NR multicast, HPNs are separated for unicast and each multicast service, and a multicast service specific HPN entity is required for each multicast service.
  + Proposal 12: A distinguishing indication among unicast and different multicast services should be introduced into DCI of PTP transmission for associating the PTM scheme 1 and PTP transmitting the same TB.
* *vivo*
  + Proposal 4: For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast.
  + Observation 2: The retransmission scheme with dynamically selected C-RNTI/g-RNTI brings about 6.23% and 1.11% gain in term of RU compared to the g-RNTI only and C-RNTI only retransmission scheme respectively.
  + Observation 3: For the cell spectral efficiency, the performances of the three kinds of MBS HARQ retransmission schemes are similar.
  + Proposal 5: 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 1: PTM transmission scheme 2 group scheduling is supported in NR MBS when the group is small.
  + Proposal 2: Multi-group-common PDCCH scheduling mechanism is supported in NR MBS to reduce PDCCH overhead when the group is large.
  + Observation 3: From UE’s perspective, PTM transmission scheme 2 used as retransmission is considered as initial transmission, if the DCI for initial transmission using PTM scheme 1 is missed by the UE.
  + Proposal 12: When PTM transmission scheme 1 is used for initial transmission, PTM scheme 2 can be supported for retransmission(s) for the whole group of UEs.
  + Proposal 13: PTM scheme 2 and PTP can be combined as retransmission schemes for all the UEs in the same group for a TB.
  + Proposal 14: The UE is NOT expected to receive unicast TB by PTP for a given HPN between the end of the transmission of HARQ-ACK of the previous TB#1, which is initially transmitted by PTM scheme 1, and the start of a new TB#2 transmitted by PTM scheme 1 for that HPN.
* *Nokia*
  + Proposal-8: 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-9: 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-10: The network can dynamically modify the signaling used to configure a UE to access a group-common PDSCH.
  + Proposal-11: Avoid simultaneous support and use of PTM scheme 1 and PTP based retransmissions of the same transport block.
  + Proposal-12: For PTP based retransmissions, confirm whether CS-RNTI or C-RNTI would be used.
* *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.
  + Observation 2: Further study of the UE timeline with regards to the transmission of HARQ-ACK feedback for a previous multicast TB#1 and reception of a new multicast TB#2 is needed.
  + Proposal 7: PTM transmission scheme 2 for initial transmission of MBS is not supported for Connected UEs.
* *CMCC*
  + Proposal 15. PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group.
  + Proposal 16. 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.
  + Proposal 17. Support using a DCI field in DCI format 1\_0/1\_2 with C-RNTI to differentiate the HARQ process number used for unicast service transmission or for multicast PTP retransmission.
* *Intel*
  + Proposal 5: PTM Scheme 2 should be supported when ACK/NACK based HARQ feedback is configured or enabled for the UEs within a group.
  + Proposal 6: 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 7: 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 8: Different group RNTIs corresponding to high and low QoS delivery modes are configured for RRC\_CONNECTED UEs
* *Qualcomm*
  + Proposal 12: Retransmission schemes based on PTP and PTM-1 can be supported for different UEs in the same group.
  + Proposal 13: For HARQ process management,
    - Not support OOO between PTM-1 and PTP for a given HPID
    - Support dynamic HPID management for unicast and multicast without increasing soft buffer size.
    - A DCI field is used to differentiate the HARQ process ID used for PTP unicast data or for PTP multicast retransmission.
* *Samsung*
  + Observation 8: There is no need to specify a UE behavior for a case where the UE receives a new TB for a HARQ process before the UE provides a positive acknowledgement for a previous TB for the HARQ process.
  + Observation 9: There is no need to define a UE behavior for simultaneous receptions of PDSCHs that are scheduled by different DCI formats and provide a same TB.
  + Observation 10: In Rel-16, when a UE would simultaneously receive two TBs, it is an error case when the TBs are associated with same priority; otherwise, the UE drops reception of the TB associated with low priority. The Rel-16 UE behavior can remain applicable regardless of whether the TBs are provided by multicast PDSCH or by unicast PDSCH.
* *LGE*
  + Proposal 19: 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.
  + Proposal 20: 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 21: 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 22: 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.
* *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.
* *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.
  + 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.
* *NTT Dococmo*
  + Observation 2: 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 3: If simultaneous transmissions of retransmission using PTM scheme 1 and retransmission using PTP are supported, there are several issues that need to be considered.
  + Proposal 8: Not support PTM scheme 2 as retransmission scheme for PTM scheme 1.
* *Google*
  + Proposal 3: For the discussion on whether a UE can receive multiple PDSCH retransmissions in PTM-1 and PTP transmission schemes simultaneously (i.e. receiving a second PDSCH before the end of a HARQ-ACK response of a first PDSCH for the same HARQ process), further study the case that both NACK-only and ACK/NACK based HARQ-ACK feedbacks are configured to the same MBS group.
* *Ericsson*
  + Observation 1: 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 1: Based on UE capability, a UE in a G-RNTI-based scheduling group may receive both PTM and PTP with same HARQ process and NDI, within the same HARQ-ACK feedback bundling window determined via dlDataToUL-ACK.
  + Observation 2: 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 2: 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.
  + Observation 3: 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 3: 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 of the same HPID.
  + Observation 4: 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 4: 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
    - When PTM PDCCH is missed, the data of PTP ReTx is detected as new data
  + Proposal 5: Downselect from the following options:
    - Keep existing NDI agreement and add further support
    - Keep existing NDI agreement and add further support, possibly using new PTP DCI signaling bit
    - Change existing NDI agreement
    - Other solutions not precluded
  + Observation 5: PTM-1 is more efficient than PTM-2 for initial transmission and retransmissions of group-common PDSCH
  + Observation 6: 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***

Regarding the HARQ process management, 1 company [Huawei] proposes that UE could receive another PDSCH via PTM for a given HARQ process before the end of the expected HARQ-ACK transmission, 1 company [LGE] proposes to specify UE behavior for such kind of cases. 3 companies [QC, CATT, Lenovo] propose not to support out-of-order between PTM-1 and PTP for a given HPID. 1 company [Samsung] pointed out that, in Rel-16, when a UE would simultaneously receive two TBs, it is an error case when the TBs are associated with same priority; otherwise, the UE drops reception of the TB associated with low priority. The Rel-16 UE behavior can remain applicable regardless of whether the TBs are provided by multicast PDSCH or by unicast PDSCH. Although this issue has been discussed in last meeting, it seems few companies propose to specify new UE behavior for it in this meeting, moderator suggests to postpone the discussion until more companies propose to do so.

Regarding whether PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group, it seems 6 companies [OPPO, Spreadtrum, Nokia, Samsung, Lenovo, NTT Docomo] do not support this, 5 companies [vivo, 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. Considering the situation does not change much compared to last meeting, moderator suggests to postpone the discussion in this meeting.

4 companies [Qualcomm, Ericsson, ZTE, CMCC] pointed out a similar NDI issue with respect to PTM initial transmission followed by PTP retransmission for a given HPID, and the miss detection of the PDCCH of PTM initial transmission may cause UE to erroneously soft-combine the received TB with PTP retransmission and previous received TB in the HARQ buffer, and cause performance degradation. 3 of them [Qualcomm, Ericsson, CMCC] propose that a DCI field should be introduced into the DCI of PTP transmission to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast. 1 of them [Ericsson] proposes to down-select from the following options. Based on these proposals, moderator suggest the initial proposal 3-1.

* Keep existing NDI agreement and add further support
* Keep existing NDI agreement and add further support, possibly using new PTP DCI signaling bit
* Change existing NDI agreement
* Other solutions not precluded

Regarding PTM scheme 2, 5 companies explicitly propose to support PTM scheme 2 for initial transmission and retransmission, while 4 companies explicitly 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] Initial Proposal 3-1**:

For HARQ process management, a DCI field can be introduced into the DCI of PTP transmission to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | 3-1: we don’t agree with this proposal.  For a given HARQ process ID, if it is firstly used for unicast then for multicast, it implies UE has sent the feedback of ACK for unicast so that this process ID can be used for scheduling initial transmission of a multicast. Assuming the GC-PDCCH for the multicast is missed by the UE, then UE does not transmit ACK or NACK to gNB. Since no NACK is detected at gNB side, why does gNB use PTP for retransmission to this UE? Even gNB did such, why does UE combine the current received data with previous received data which has been acknowledged with ACK to gNB? |
| Qualcomm | 3-1: support it |
| CMCC | 3-1: support |
| ZTE | Support Proposal 3-1.  For a given HARQ process ID, if it is firstly used for unicast then for multicast, if UE misses the multicast, then gNB would use PTP to retransmit the MBS TB. In this case, UE is not sure whether the PTP is for unicast retransmission (in case the ACK for unicast is missed by gNB) or for PTM retransmission. |
| LG | RAN1 previously agreed that the same HARQ process ID and NDI are used for PTM scheme 1 (re)transmissions and PTP retransmissions of the same TB.  Thus, if initial HARQ transmission has been received by PTM, UE could differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast. However, UE may miss initial PTM transmission but receive PTP retransmission. In this case, a DCI field could be used to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast. |
| Spreadtrum | 3-1, not support.  We don’t understand the motivation. Actually UE **would not** erroneously soft-combine the received TB with PTP retransmission and previous received TB in the HARQ buffer for the use case described by FL. The NDI for PTP retransmission has been toggled, compared with the previous PTP. |
| OPPO | Not support.  If PTM initial transmission is missing, there is no HARQ-ACK feedback for the transmission, in this case gNB can use PTM instead of PTP for re-transmission to avoid the issue. |
| Google | 3-1, postpone the discussion  We think it’s too early to take this proposal. As addressed in the companies’ documents, there are several ways of HARQ ID assignment between unicast and multicast, and we have not discussed whether unicast shares the same HARQ ID with multicast yet. For example, if gNB can configure mutually exclusive HARQ ID sets to unicast and multicast, than a PTP scheduled with multicast HARQ ID can only be retransmission. Therefore, our suggestion is to discussion the HARQ process ID configuration between unicast and multicast first. |
| Apple | Maybe the issue needs to be clarified first. From moderator’s comments, the issue is confusion between (re)transmission via PTP or PTM for MBS PDSCH. But the above discussion is related to unicast PDSCH and multicast PDSCH via PTP transmission confusion issue. |
| CATT | 3-1: Support. |
| NTT DOCOMO | We think that incorrect soft-combining can be avoided by other methods (e.g., assign different TBS to PTM TB and PTP TB). The benefit of introducing the new DCI field seems small. |

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

# Issue #4: SPS for MBS

## Background and submitted proposals

***Background***

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

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

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:

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.

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 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

***Submitted Proposals***

* *Huawei, HiSilicon*
  + Proposal 8: CS-RNTI can be used for scrambling the retransmission for SPS multicast.
* *OPPO*
  + Proposal 6: The same G-CS-RNTI used for a SPS group-common PDSCH is used for its PTP re-transmission.
  + Proposal 7: SPS configuration for MBS is only activated/deactivated by group common DCI, HARQ feedback mode for the group common DCI is indicated by the DCI.
* *Spreadtrum*
  + Proposal 7: Not support simultaneously scheduling unicast and group-common retransmission for SPS group-common PDSCH.
* *ZTE*
  + Proposal 13: UE-specific PDCCH should not be supported for activation/deactivation of an SPS group-common PDSCH.
  + Proposal 14: For retransmission scheme for an SPS group-common PDSCH,
    - PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group
    - CS-RNTI can be used for PTP retransmission of SPS group-common PDSCH
* *vivo*
  + Proposal 6: 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 per SPS configuration.
  + Proposal 7: For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state, UE-specific PDCCH is supported
  + Proposal 8: For MBS for RRC\_CONNECTED UEs, HARQ-ACK for SPS group-common PDSCH is configurable. (Enabling/disabling HARQ-ACK for SPS group-common PDSCH)
* *CATT*
  + Proposal 15: PTM scheme 1 retransmission and PTP retransmission cannot be used simultaneously for different UEs in the same MBS group.
  + Proposal 16: Both group-common PDCCH and UE-specific PDCCH (if supported) can be used for SPS activation for MBS for RRC\_CONNECTED UEs.
  + Proposal 17: Group-common PDCCH is used for SPS deactivation for MBS for RRC\_CONNECTED UEs.
* *Nokia*
  + Proposal-6: Missed SPS activation/deactivation could be handled using blind repetition of the SPS group-common PDCCH activation / deactivation messages – in case NACK-only feedback is utilized, and/or using UE-specific PDCCH for SPS group-common PDSCH – if 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-7: 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:
    - 1. 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
    - 2. Enables the support of seamless mobility and switching from multicast to unicast
    - 3. Enables simultaneous BWP switching and scheduling of MBS PDSCH resources using the same DCI
    - 4. 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-8: 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-9: 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-10: The network can dynamically modify the signaling used to configure a UE to access a group-common PDSCH.
  + Observation-11: Simultaneous support for PTM scheme 1 and PTP based retransmissions of the same transport block would lead to additional complexities – since the PTM scheme 1 based retransmission could be received by all the UEs whereas PTP based retransmission could be received by only those UEs for which the retransmission is being sent.
  + Observation-12: If UE-specific RNTI is utilized, the UE needs to be aware of the association between the retransmitted data with the SPS group-common PDSCH.
  + Proposal-11: Avoid simultaneous support and use of PTM scheme 1 and PTP based retransmissions of the same transport block.
  + Proposal-12: For PTP based retransmissions, confirm whether CS-RNTI or C-RNTI would be used.
  + Proposal-22: Inherit uplink HARQ feedback configuration for SPS-based MBS from SPS for unicast in combination with uplink feedback configuration for non-SPS-based MBS, augmented by mechanisms for reliable SPS activation / deactivation.
  + Proposal-23: Support HARQ retransmissions on SPS-allocated resources.
  + Proposal-24: Possibilities to add in-band control signaling on PDSCH to facilitate retransmissions on SPS-allocated PDSCH resources should be studied.
* *MediaTek*
  + Proposal 10 UE-specific PDCCH with G-CS-RNTI is optional supported for activation of MBS group common PDSCH.
  + Proposal 11: MBS SPS activation/deactivation’s feedback mechanism only support ACK/NACK based HARQ feedback mode.
  + Proposal 12: MBS SPS PDSCH without PDCCH scheduling can support ACK/NACK or common NACK only feedback mode.
* *FUTUREWEI*
  + Proposal 8: 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.
  + Proposal 9: At least UE-specific PDCCH is supported for deactivation of SPS group-common PDSCH.
  + Proposal 10: Support of more than one SPS group-common PDSCH configuration.
* *CMCC*
  + Proposal 18. UE-specific PDCCH can be used for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state.
  + Proposal 19. HARQ-ACK feedback for multicast SPS deactivation PDCCH can be supported.
  + Proposal 20. PTM transmission scheme 1 and PTP can be used as retransmission for SPS group-common PDSCH.
* *Intel*
  + Proposal 19: 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.
* *Qualcomm*
  + Proposal 14: Support one or more activated SPS GC-PDSCH configurations per CFR subject to UE capability.
  + Proposal 15: 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.
      * For retransmission of GC-PDCCH activation or UE-specific PDCCH activation, a slot offset or HPID offset can be configured by RRC and indicated in DCI.
    - Support joint and separate release of SPS GC-PDSCH by using GC-PDCCH or UE-specific PDCCH.
* *LGE*
  + Proposal 23: 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 24: 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 25: For a UE not confirming SPS activation, gNB can schedule PTP initial transmission of missed TB(s).
  + Proposal 26: 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.
  + Proposal 27: 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 28: 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.
* *Chengdu TD Tech*
  + Proposal 1: Support the following HARQ-ACK feedback methods for each SPS MRB of the PTM bearer for an MBS session:
    - ACK/NACK based HARQ-ACK feedback with the different SPS PUCCH resources for the different RRC\_CONNECTE UEs.
      * FFS: details for the ACK/NACK based HARQ-ACK feedback: SPS PUCCH resource allocation, timing between SPS PDSCH and SPS PUCCH, other aspects.
    - NACK-ONLY based HARQ-ACK feedback with the different RRC\_CONNECTED UEs sharing the same SPS PUCCH resources
      * FFS: details for the NACK-ONLY based HARQ-ACK feedback: SPS PUCCH resource allocation, timing between SPS PDSCH and SPS PUCCH, other aspects.
      * FFS: whether or not other information can be fed back with the NACK-ONLY information.
  + Proposal 2: The HARQ-ACK feedback method for each SPS MRB of the PTM bearer of an MBS session can be set independently. The HARQ-ACK feedback method for each SPS MRB can be signalled to UE by
    - Option 1: Use RRC signalling to enable one of the HARQ-ACK feedback method
    - Option 2:
      * Use RRC signalling to enable one of the HARQ-ACK feedback method
      * Use DCI format to enable/disable the HARQ-ACK feedback method dynamically
    - FFS: Which option to use
  + Proposal 3: For the ACK/NACK based HARQ-ACK feedback for an SPS MRB of the PTM bearer of the MBS session, both the PTP bearer and the PTM bearer with PTM scheme 1 can be used for the retransmission of the NACKed TB.
  + Proposal 4: For the NACK-ONLY based HARQ-ACK feedback for an SPS MRB of the PTM bearer of the MBS session, the PTM bearer with PTM scheme 1 can be used for the retransmission of the NACKed TB, where PTM scheme 1 can use beam sweeping or partial beam sweeping.
  + Proposal 11：The following methods can be used to detect the missed activation/deactivation of SPS group common PDSCH. The system frame number, subframe number and timeslot number for the application of the new SPS group common PDSCH should be attached in the activation/deactivation information of SPS group common PDSCH.
    - Option 1: If the activation/deactivation of SPS group common PDSCH is sent with group common PDCCH scrambled with G-CS-RNTI, the PUCCH resource for the acknowledgement of the activation/deactivation of SPS group common PDSCH is allocated to each UE as the configuration information of the SPS group common PDSCH.
    - Option 2: The MAC CE is used for the activation/deactivation of SPS group common PDSCH. The MAC CE needs to be sent before the new SPS group common PDSCH is applied. Once the NACK information is received for the TB containing the MAC CE, the retransmission is done. The enough time for the retransmissions of the MAC CE should be booked before the new SPS group common PDSCH is applied.
* *Convida*
  + Proposal 7: UE-specific PDCCH should be supported for activation/deactivation DCI for MBS SPS.
  + Proposal 8: PTM transmission scheme 2 should be considered for the MBS SPS PDSCH retransmission.
* *Lenovo*
  + Proposal 12: 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 13: 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 14: CS-RNTI is used for scheduling PTP based retransmission of a given SPS group-common PDSCH.
* *NTT Dococmo*
  + Proposal 9: 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.
  + Proposal 10: Use CS-RNTI for PTP retransmission of SPS group-common PDSCH.
  + Proposal 11: Support UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH.
* *ASUSTeK*
  + Proposal 4: A UE monitors PDCCHs with CRC-scrambled by the G-CS-RNTI within the UE-dedicated CORESET when the UE expects to receive retransmission(s) of SPS group-common PDSCH(s).
* *Ericsson*
  + Observation 14: Group-based SPS need to separately address UEs missing the original SPS activation group PDCCH
  + Observation 15: The activation recovery message needs to contain slot, MCS information of the original activation
  + Proposal 24: For group based SPS, UEs missing the PDCCH activation message are sent an activation recovery message via MAC-CE containing the original PDCCH information and the slot number where it was transmitted. For deactivation, UE specific PDCCH deactivation order can be sent to UEs not responding to the group de-activation PDCCH.
  + Observation 16: Unicast PDCCH scrambled with C-RNTI is not supported for group-common PDSCH
  + Proposal 25: Do not support unicast PDCCH scrambled with CS-RNTI for transmission of group SPS PDSCH.
  + Proposal 26: PTP retransmission for SPS group common PDSCH can use CS-RNTI with the NDI bit set to 1.
  + Proposal 27: G-CS-RNTI is configured per SPS configuration. If not configured, the UE assumes CS-RNTI is used for PDSCH.
  + Proposal 28: 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.
  + Proposal 29: PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group
  + Proposal 30: The simultaneous reception of PTP and PTM retransmission for a given UE is up to UE implementation, pending a UE capability.
  + Proposal 31: The UE is expected to provide feedback via HARQ for all PDCCH associated with a PDCCH activation or deactivation order for SPS
  + Proposal 32: The network can RRC configures each UE in the group an additional PDSCH-to-HARQ time offset so that when UEs receive group common PDCCH activate/deactivate command, they can acknowledge this command in different slots to avoid PUCCH resource congestion.
  + Proposal 33: The UE can be configured to either transmit or not transmit HARQ for the SPS PDSCH not corresponding to a SPS PDCCH activation or deactivation.
  + Observation 17: 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 34: The SPS UL feedback framework for the SPS scheduled (i.e. PDCCH-less) PDSCH is the same as for non-SPS MBS PDSCH scheduling.

## Initial Proposals based on contributions

***Summary***

Regarding the FFS whether CS-RNTI can be used for PTP retransmission of SPS group-common PDSCH, 5 companies [Huawei, ZTE, Lenovo, NTT Docomo, Ericsson] propose CS-RNTI is used for CRC scrambling for PDCCH of PTP retransmission of SPS group-common PDSCH. Moderator suggests the initial proposal 4-1 based on this.

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, Nokia] do not support it and 4 companies [ZTE, Futurewei, CMCC, Ericsson] support it. Moderator suggests to postpone the discussion in this meeting.

Regarding the missed activation and deactivation issue when group-common PDCCH is used for activation/deactivation,

* 6 companies [vivo, Nokia, CMCC, Qualcomm, Convida, NTT DoCoMo] propose to also support UE-specific PDCCH for both activation and deactivation.
* 2 companies [MTK, CATT] propose to support UE-specific PDCCH for activation.
* 2 companies [Futurewei, Ericsson] propose to support UE-specific PDCCH for deactivation.
* 1 company [Qualcomm] proposes, for retransmission of GC-PDCCH activation or UE-specific PDCCH activation, a slot offset or HPID offset can be configured by RRC and indicated in DCI.
* 1 company [Ericsson] proposes that UEs missing the PDCCH activation message are sent an activation recovery message via MAC-CE containing the original PDCCH information and the slot number where it was transmitted.

Based on these, moderator suggests the initial proposal 4-2 and 4-3.

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

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

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

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

For UE who missed 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 containing the original PDCCH information and a slot offset or HPID offset that can be configured by RRC.
* Alt 2: retransmit the activation command via UE-specific PDCCH containing the original PDCCH information and a slot offset or HPID offset that can be configured by RRC.
* Alt 3: retransmit the activation command via MAC-CE containing the original PDCCH information and the slot number where it was transmitted.

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

Support UE-specific PDCCH in addition to group-common PDCCH for deactivation of SPS group-common PDSCH.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | 4-1: Support.  4-2: don’t support. The prerequisite of this proposal is how gNB knows which UE missed the GC-PDCCH for activating the SPS without confirmation mechanism.  4-3: Considering we have agreed GC-PDCCH for activating the SPS, it seems no need to support UE-specific PDCCH for deactivating the SPS. |
| Qualcomm | 4-1: support it  4-2: fine to list up the alternatives for now  4-3: support it |
| CMCC | 4-1: support  4-2: support  4-3: support |
| ZTE | Ok with Proposal 4-1.  For Proposal 4-2, we are ok to list all potential alternatives. However, the current alternative is too detailed. From our perspective, “containing the original PDCCH information and a slot offset or HPID offset that can be configured by RRC” can be removed for now, it can be a separate discussion. In this proposal, we can first focus on whether UE specific activation is needed or not.  Updated proposal from ZTE:  *For UE who missed 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 ~~containing the original PDCCH information and a slot offset or HPID offset that can be configured by RRC~~.* * *Alt 2: retransmit the activation command via UE-specific PDCCH ~~containing the original PDCCH information and a slot offset or HPID offset that can be configured by RRC~~.* * *Alt 3: retransmit the activation command via MAC-CE ~~containing the original PDCCH information and the slot number where it was transmitted~~.*   *FFS other details.*  For proposal 4-3: We suggest to discuss it after resolving the issue of Proposal 4-2. If UE specific activation (DCI/MAC-CE) is introduced for activation, then it makes sense to reuse the same mechanism for deactivation. |
| LG | For P4-2, we think that the activation command could be retransmitted based on either blind repetition or HARQ-ACK confirmation. We could discuss how to retransmit after selecting one alternative. Thus, we prefer to change to:  **[High] Initial Proposal 4-2**:  For ~~UE who missed~~ 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 containing the original PDCCH information ~~and a slot offset or HPID offset that can be configured by RRC~~. * Alt 2: retransmit the activation command via UE-specific PDCCH containing the original PDCCH information ~~and a slot offset or HPID offset that can be configured by RRC~~. * Alt 3: retransmit the activation command via MAC-CE containing the original PDCCH information and the slot number where it was transmitted.   In addition, for Alt 3, we wonder if MAC-CE is group common or UE specific.  For P4-3, we are skeptical about UE-specific PDCCH for deactivation. Instead, considering missed group common DCI for deactivation, UE could implicitly release group common SPS. |
| Spreadtrum | 4-1: support  4-3: not support. GC-PDCCH has been supported. Function duplication should be avoided. |
| OPPO | Proposal 4-1: OK.  Proposal 4-2: OK.  Proposal 4-3:  Not support, why UE-specific PDCCH for deactivation of SPS group-common PDSCH is so necessary? |
| Google | 4-1: Support  4-2: Alt 1 and 2 seems to be gNB implementation issues. As for Alt 3, we need more clarification on whether the MAC CE is scheduled by G-RNTI or G-CS-RNTI. If it were scheduled by G-CS-RNTI, than it would be better to apply Alt 1 or 2 directly.  4-3: Support |
| Apple | 4-1: ok with this proposal.  4-2: agree with ZTE’s update. |
| CATT | 4-1: Support.  4-2: OK with it. We prefer Alt 2.  4-3: Ok with it. |
| NTT DOCOMO | **Proposal 4-1**: We are fine with the proposal.  **Proposal 4-2**: We are generally fine with the proposal. We don’t see clear benefit of Alt 3. We think that UE-specific PDCCH(Alt 2) would be sufficient.  **Proposal 4-3**: We are fine with the proposal. It will be useful to use UE-specific PDCCHs for retransmission of activation/deactivation to a small number of UEs, and for individual UE joining and releasing. |

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

# Issue #5: Simultaneous operation with unicast reception

## Background and submitted proposals

***Background***

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

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

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

***Submitted Proposals***

* *Spreadtrum*
  + Proposal 8: The number of TDMed multiplexing group-common PDSCHs and unicast PDSCHs should not exceed R15 UE capability.
* *vivo*
  + Proposal 3: 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 25: When the simultaneous reception of unicast and multicast is out of a UE’s capability, a dropping principle should be considered.
* *Nokia*
  + Proposal-16: Agree not to define M, N, K and L parameters in specification and leave the upper limits of these parameters to gNB implementation.
* *CMCC*
  + Proposal 28. The maximum number of PDSCHs in a slot simultaneous received per UE can be 2, 4, or 7 based on UE capability, and regardless that the PDSCH is unicast PDSCH or group-common PDSCH.
  + Proposal 29. 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.
* *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 18: The reception of MBS and unicast in FDM mode should be a UE capability
* *Ericsson*
  + Observation 12: The support of case 1,2,3 depends on the UE capabilities to monitor multiple PDCCH candidates with different G-RNTI and C-RNTI
  + Observation 13: The current minimum capability of 2 PDSCH per slot cannot fulfill case 1 (3 PDSCH in total) or case 3 (4 PDSCH in total).
  + Proposal 22: Inter-slot TDM is supported with existing UE capability. The support of intra-slot TDM cases for MBS are up to UE capability.
  + Proposal 23: The capability for maximum number of PDSCH per slot is kept as for rel16, i.e. {2,4,7}.

## Initial Proposals based on contributions

***Summary***

Regarding the simultaneous operation with unicast reception, 3 companies [Spreadtrum, CMCC, Ericsson] share similar view that the number of TDMed PDSCH receptions (including unicast PDSCH and group-common PDSCH) in a slot is the same as for the corresponding Rel-16 UE capability. However, in previous meeting discussion, some companies suggested to discuss this issue in the UE feature discussion phase.

Regarding the case 4 and case 5, 1 company [vivo] support and 1 company [CMCC] do not support.

***Initial Proposals***

The following moderator recommendations are made.

[Moderator’s recommendation]

**[Medium] Initial Proposal 5-1**:

For Rel-17 MBS UE, the UE capability of maximum number of TDMed PDSCH receptions, including PTP PDSCH(s) and group-common PDSCH(s), that can be supported in a slot per CC is kept as for Rel-16, i.e., {2/4/7}.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Qualcomm | 5-1: ok in principle, although we think it can be discussed in UE feature |
| CMCC | 5-1: support |
| ZTE | For proposal 5-1: Ok in principle. But we would prefer to leave it to UE feature discussion. |
| Spreadtrum | It should be kept as for Rel-15, not Rel-16. |
| OPPO | OK |
| Apple | OK with this proposal. |
| CATT | We are OK to put 5-1 as the medium priority. But we think the FDMed PDSCH receptions including PTP PDSCH(s) and group-common PDSCH(s) should also be considered since it has been discussed in MBS agenda 8.12.2. |
| NTT DOCOMO | We are fine with the proposal. |

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

# Issue #6: Other issues (multi-beam, broadcast for RRC\_CONNECTED UEs, etc.)

## Background and submitted proposals

***Submitted Proposals***

* *OPPO*
  + Proposal 14: A separate TCI states space is activated by MAC CE for group common PDSCH.
* *ZTE*
  + Proposal 10: Association between MOs of group-common PDCCH and SSBs or CSI-RSs should be defined for beam sweeping transmission of NR MBS.
    - Considering full beam sweep for broadcast transmission.
    - Considering partial beam sweep for multicast transmission.
  + Proposal 15: RAN1 further studies whether to support HARQ-ACK feedback for broadcast service for UEs under RRC\_CONNECTED state.
* *CMCC*
  + Proposal 24. Define a new CSS type for group-common PDCCH of PTM transmission scheme 1 for broadcast in RRC\_CONNECTED state.
  + Proposal 25. 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.
  + Proposal 26. Broadcast service does not occupy the configured maximum number of HARQ processes per cell.
  + Proposal 27. For broadcast, dedicated HARQ process(es) are assigned and the HARQ process number is not indicated in the group-common PDCCH.
* *Intel*
  + Proposal 20: 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 21: For NR MBS support of multi-layer MIMO transmission with rank adaptation (from UE perspective) is not precluded.
  + Proposal 22: 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 23: Advanced transmission schemes like multiuser superposition transmission (MUST) for improving group spectral efficiency are not precluded
* *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.
* *NTT Dococmo*
  + Proposal 12: 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.
  + Proposal 2: A “group-common TDRA table” is configured per MBS group for NR MBS group-scheduling.
* *TCL*
  + Proposal 1: RAN1 requests RAN2 for a further discussion regarding the transport channel design for MBS.
  + Proposal 2: If DL-SCH is agreed for NR MBS, a UE can be configured with a UE-specific PDCCH scrambled with C-RNTI to schedule both a PDSCH (i.e., scrambled by C-RNTI) carrying MBS and a PDSCH (i.e., scrambled by C-RNTI) carrying unicast.
  + Proposal 3: If DL-SCH is agreed for NR MBS, a UE can be configured with a UE-specific PDCCH scrambled with C-RNTI to schedule both a group common PDSCH (i.e., scrambled by g-RNTI) carrying MBS and a PDSCH (i.e., scrambled by C-RNTI) carrying unicast for simultaneous reception at the UE side.
  + Proposal 4: If MCH is agreed for NR MBS, the network may switch the transport block of MCH channel to use UE-specific PDSCH, and the UE can be configured with UE-specific PDCCH scrambled by C-RNTI to schedule a PDSCH carrying MBS and a PDSCH carrying the unicast service.
  + Proposal 5: If MCH is agreed for NR MBS, the network may map MCH TB directly to a group-common PDSCH, and the UE can be configured with UE-specific PDCCH scrambled by C-RNTI to schedule a group-common PDSCH carrying MBS and a PDSCH carrying the unicast service.

## 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. R1-2104195 Group Scheduling Aspects for Connected UEs FUTUREWEI
4. R1-2104248 Resource configuration and group scheduling for RRC\_CONNECTED UEs Huawei, HiSilicon, CBN
5. R1-2104336 Discussion on Mechanisms to Support Group Scheduling for RRC\_CONNECTED UEs ZTE
6. R1-2104387 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs vivo
7. R1-2104442 Discussion on MBS group scheduling for RRC\_CONNECTED UEs Spreadtrum Communications
8. R1-2104491 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs in MBS CATT
9. R1-2104550 Group Scheduling Mechanisms to Support 5G Multicast / Broadcast Services for RRC\_CONNECTED Ues Nokia, Nokia Shanghai Bell
10. R1-2104632 Discussion on group scheduling mechanisms CMCC
11. R1-2104695 Views on group scheduling for Multicast RRC\_CONNECTED UEs Qualcomm Incorporated
12. R1-2104759 Group scheduling for NR Multicast and Broadcast Services OPPO
13. R1-2104865 On group scheduling mechanism for NR MBS Lenovo, Motorola Mobility
14. R1-2104928 NR-MBS Group Scheduling for RRC\_CONNECTED UEs Intel Corporation
15. R1-2105069 Discussion on Group Scheduling and Simultaneous MBS and Unicast Reception TCL Communication Ltd.
16. R1-2105128 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Apple
17. R1-2105179 Considerations on MBS group scheduling for RRC\_CONNECTED UEs Sony
18. R1-2105336 Support of group scheduling for RRC\_CONNECTED Ues Samsung
19. R1-2105381 Discussion on NR MBS group scheduling for RRC\_CONNECTED UEs MediaTek Inc.
20. R1-2105437 Support of group scheduling for RRC\_CONNECTED UEs LG Electronics
21. R1-2105600 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Convida Wireless
22. R1-2105647 Discussion on common frequency resource for multicast of RRC\_CONNECTED UEs ETRI
23. R1-2105670 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Google Inc.
24. R1-2105720 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs NTT DOCOMO, INC.
25. R1-2105838 Discussion on group scheduling for RRC\_CONNECTED UEs CHENGDU TD TECH LTD.
26. R1-2105844 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs ASUSTeK
27. R1-2105914 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;