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

**e-Meeting, October 11th – 19th, 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#106bis-e:

[106bis-e-NR-MBS-01] Email discussion/approval on mechanisms to support group scheduling for RRC\_CONNECTED UEs with checkpoints for agreements on October 14 and 19 – Fei (CMCC)

In this contribution, we summarized the related issues and proposals based on the contributions submitted in RAN1#106bis-e under the agenda item 8.12.1 [3]-[28]. The following sections are structured as follows.

From section 2 to 8, we categorized the key issues raised by contributions into 7 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 9, some proposals will be selected for discussion in the GTW session.

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

# Issue #1: CFR and general issues for MBS

## Background and submitted proposals

***Submitted Proposals***

### **Frequency resources of CFR**

* *ZTE*
	+ Proposal 1: NR MBS supports the same RIV configuration method as BWP configuration to indicate frequency range of CFR and $N\_{BWP}^{size}$ is set to 275 to determine S and L for the CFR.
* *OPPO*
	+ Proposal 1: For indication of the starting PRB and the length of PRBs of CFR for multicast of RRC-CONNECTED UEs, the indication mechanism reuses Resource Indication Value (RIV) indication mechanism in Rel-15/16 by jointly indicating the starting PRB and length of PRBs of CFR.
* *CATT*
	+ Proposal 4: RIV indication mechanism in Rel-15/16 NR can be reused to indicate CFR.
* *Nokia*
	+ Proposal-1: 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.
* *Samsung*
	+ Proposal 1: RBG, RB bundle and PRG for multicast PDSCH in CFR are defined using the same procedure as for unicast PDSCH in DL BWP.
	+ Proposal 2: For a unicast RBG/PRG overlapping with CFR boundaries, a UE assumes that only RBs outside the CFR are used for unicast PDSCH reception.
* *MediaTek*
	+ Proposal 5: RIV mechanism is reused for MBS CFR indication.
* *Intel*
	+ Proposal 3: Dedicated RRC signaling is used to configure the starting PRB and length of PRBs of CFR
* *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.
* *Lenovo*
	+ Proposal 1: For CFR configuration for connected mode UEs, starting PRB and the number of contiguous PRBs of the CFR are jointly indicated by RIV mechanism via RRC signaling.
* *Ericsson*
	+ Proposal 11 The CFR frequency domain configuration reuses the configuration method of BWP frequency resources, i.e. consists of a combination of Point A, offsetToCarrier and locationAndBandwidth. The RIV of the locationAndBandwidth is defined with reference to the full carrier with a fixed number of 275 RBs.:
		- Note: If CFR frequency domain configuration is not present, the frequency resources of the CFR are identical to those of the active BWP.
* *Xiaomi*
	+ Proposal 1: The frequency resources occupied by CFR is indicated with the same way for BWP indication, i.e. a RIV indicating an offset $RB\_{start}$start and a length $L\_{RB}$ is configured via RRC.

### **Number of CFRs**

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

### **Configuration of G-RNTI(s)**

* *Qualcomm*
	+ Proposal 16: Discuss whether G-RNTI(s)/G-CS-RNTI(s) for multicast is(are) configured per DL BWP, per serving cell or per cell Group

### **Rate matching and TBS determination**

* *ZTE*
	+ Proposal 12: For LBRM and TBS determination for GC-PDSCH, the maximum modulation order can be determined from mcs-Table in PDSCH-Config for MBS in CFR; if mcs-Table in PDSCH-Config for MBS is not configured in CFR, Table 5.1.3.1-1 in TS38.214 is used.
* *CATT*
	+ Proposal 7: If mcs-Table in PDSCH-Config for MBS is not configured in CFR, Table 5.1.3.1-1 in TS38.214 can be used as default table.
* *Apple*
	+ Proposal 1: For the remaining parameters for LBRM and TBS determination, the default maximum MIMO layer is single layer; if mcs-Table in PDSCH-Config for MBS is not configured in CFR, Table 5.1.3.1-1 in TS38.214 is used.
* *MediaTek*
	+ Proposal 6: The default value is one for TBS determination if maxMIMO-Layers in PDSCH-Config for MBS is not configured.
	+ Proposal : Table 5.1.3.1-1 in TS38.214 is reused (similar as the default value in R16) for $TBS\_{LBRM}$ calculation when mcs-Table in PDSCH-Config for MBS is not configured in CFR.
* *Qualcomm*
	+ Proposal 2: For multicast RRC\_CONNECTED UEs,
		- For the maximum number of layers of MBS, the default value is 1.
		- For mcs-Table for GC-PDSCH, the default value is based on Table 5.1.3.1-1 in TS38.214 (similar as the default value in R16).
	+ Proposal 3: For multicast RRC\_CONNECTED UEs, ZP CSI-RS can be configured in pdsch-Config-Multicast for GC-PDSCH rate matching.
		- If SPS ZP CSI-RS is configured in a pdsch-Config-Multicast, the MAC-CE over GC-PDSCH can be used to active SPS ZP CSI-RS configured per CFR.
	+ Proposal 4: The PTP retransmission for multicast is based on LBRM of the PTM initial transmission using same HPID and NDI.
* *Samsung*
	+ Proposal 5: For LBRM determination and TBS calculation for GC-PDSCH:
		- For the maximum modulation order, agree to the FFS from RAN1#106-e.
		- For the maximum number of layers, agree to a similar statement as for the maximum modulation order and, for the case that no configuration is provided, set the value to 4.
	+ Observation 9: For LBRM/TBS determination, a UE can receive a TB according to MBS parameters when the TB is provided by a GC-PDSCH and according to unicast parameters when the TB is provided by a unicast PDSCH.
* *Ericsson*
	+ Proposal 38 The default value for The maximum number of layers For LBRM and TBS determination for GC-PDSCH is 1
	+ Proposal 39 Confirm the following FFS regarding the maximum modulation order for LBRM:
		- FFS: if mcs-Table in PDSCH-Config for MBS is not configured in CFR, a value determined from mcs-Table in PDSCH-Config for unicast in the active DL BWP is used; if the mcs-Table in PDSCH-Config for unicast is not configured, Table 5.1.3.1-1 in TS38.214 is used (similar as the default value in R16).
* *Intel*
	+ Proposal 6: The default value of maxMIMO-Layers is determined from the BWP configuration of the active unicast BWP containing the CFR.
* *Xiaomi*
	+ Proposal 3: If the maximum number of layers is not provided by maxMIMO-Layers in PDSCH-Config for MBS in CFR, a default value is defined as the maximum number of MIMO layer provided by UE capability.
	+ Proposal 4: If mcs-Table in PDSCH-Config for MBS is not configured in CFR, Table 5.1.3.1-1 in TS38.214 is used (similar as the default value in R16).
	+ Proposal 5: The current mechanism for semi-persistent ZP CSI RS is reused, i.e. do NOT introduce common trigger signalling for semi-persistent ZP CSI-RS within CFR.

### **BWP-InactivityTimer related issues**

* *Huawei*
	+ Proposal 2: If a UE is configured with a CFR in the active DL BWP, for timer-based active DL BWP switching to a default BWP, support,
		- Option 1: UE also starts or restarts BWP-InactivityTimer when it successfully decodes a GC-PDCCH addressed to group-common RNTI (e.g., G-RNTI or G-CS-RNTI).
* *ZTE*
	+ Observation 1: the energy saving effect is limited by introducing an independent inactivity timer for GC-PDCCH reception.
	+ Proposal 4: For timer-based BWP switching, UE starts or restarts BWP-InactivityTimer when it successfully decodes a GC-PDCCH addressed to group-common RNTI (e.g., G-RNTI or G-CS-RNTI) on/for the active BWP.
* *OPPO*
	+ Proposal 3: For timer-based active DL BWP switching to a default BWP, multicast reception has no impact on Rel-16 UE behavior related to BWP-InactivityTimer.
* *CATT*
	+ Proposal 8: The reception of multicast should not have impact on the Rel-16 timer-based DL BWP switching scheme.
* *Qualcomm*
	+ Proposal 1: If timer-based activation/deactivation of BWP for a UE is enabled
		- If a UE is configured with an MBS CFR associated with the active DL BWP, the UE maintains the active BWP timer for both unicast and MBS within the active DL BWP.
			* A UE starts or restarts the timer when it successfully decodes a PDCCH addressed to unicast RNTI (e.g., C-RNTI or CS-RNTI) or a GC-PDCCH addressed to group RNTI (e.g., G-RNTI or G-CS-RNTI) in the MBS CFR within the active DL BWP.
* *Samsung*
	+ Proposal 6: BWP-InactivityTimer is separately configured for unicast and multicast. A UE switches SSSGs, or skips PDCCH monitoring for a configured duration, for unicast or multicast in the non-default DL BWP when only the corresponding timer expires.

### **Optionality of CFR**

* *OPPO*
	+ Proposal 2: If CFR-Config-Multicast is not present in a BWP configuration, UE does not perform multicast reception in this BWP when it is active.
* *ZTE*
	+ Proposal 3: Regarding the CFR configuration,
		- The parameters configured under the dedicated unicast BWP can be used for MBS transmission if the corresponding parameters are not configured under the CFR.
* *MediaTek*
	+ Proposal 4: CFR should be configured for UE receiving multicast broadcast services.
* *FUTUREWEI*
	+ Proposal 3: Without CFR configured, multicast reception by default is not supported. Option 4 should be supported i.e., the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *CMCC*
	+ Proposal 2. If no CFR configuration is provided in the active BWP, UE will not receive multicast service through PTM scheme 1.
	+ Proposal 3. If the PDSCH-config/PDCCH-config for MBS is not configured in CFR, the PDSCH-Config/PDCCH-config of the dedicated unicast BWP can be re-used for group-common PDCCH/PDSCH.
* *CATT*
	+ Proposal 3: The UE is not expected to receive multicast in the active BWP when the new IE CFR-Config-Multicast is not configured for the active BWP.
	+ Proposal 5: When some fields in PDSCH-Config for MBS are same as the fields in PDSCH-Config of the dedicated unicast BWP, the corresponding fields in PDSCH-Config of the dedicated unicast BWP can be the default configuration.
	+ Proposal 6: When some fields in PDCCH-Config for MBS are same as the fields in PDCCH-Config of the dedicated unicast BWP, the corresponding fields in PDCCH-Config of the dedicated unicast BWP can be the default configuration.
* *Intel*
	+ Proposal 4: A default CFR identical to active unicast BWP can be defined for UEs when no CFR configuration is provided
* *Samsung*
	+ Observation 2: It is possible for a UE provided with G-RNTI/CS-G-RNTI to not be provided additional configurations of PDCCH-Config, PDSCH-Config, or PUCCH-Config for multicast.
* *Chengdu TD Tech*
	+ Proposal 4: If the current cell supports MBS, for the scenario that no CFR is configured for a unicast BWP, the unicast BWP can be by default used as the CFR for MBS.
* *Ericsson*
	+ Observation 12 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.
	+ Observation 13 PDCCH-config, PDSCH-config and SPS-config for MBS that are partly or wholly the same as their unicast counterparts do not need to be explicitly configured, but can be inferred from unicast configurations
	+ Proposal 13 A CFR is always used for multicast, but is only explicitly configured for configurations that differ from those used for unicast.
* *Xiaomi*
	+ Proposal 2: Multicast can be supported in a dedicated unicast BWP when no CFR is configured for that BWP.

### **Broadcast for RRC\_CONNECTED UEs**

* *Nokia*
	+ Observation-4: Broadcast and multicast or unicast can be on separate BWPs – with broadcast CFR associated with initial BWP / CORESET0, and multicast or unicast associated with UE’s dedicated unicast BWP, if a UE is receiving different services simultaneously.
	+ Proposal-4: Agree to support independent configuration of CFRs and associated BWPs for simultaneous reception of broadcast and multicast / unicast.
	+ Proposal-5: Autonomous switching between broadcast CFR and unicast dedicated BWP which might also contain the multicast CFR could be left to UE implementation.
	+ Proposal-6: Support for independent configuration of broadcast CFR and unicast BWP require enhanced signaling to avoid unnecessary BWP switching.
* *MediaTek*
	+ Proposal 1: For broadcast reception, the unified CFR is supported for RRC\_CONNECTED and RRC\_IDLE/INACTIVE UEs.
	+ Proposal 2: Network implementation guarantee the allocation of CFR for UEs in RRC\_CONNECTED mode to receive the MBS transmission.
* *Intel*
	+ Proposal 1: RAN1 should strive for unified CFR for CONNECTED and IDLE mode UEs
* *CMCC*
	+ Proposal 19. 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 20. 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 21. For RRC\_CONNECTED UEs, the same CFR is used for broadcast reception and multicast reception, when UE-specific active BWP of RRC\_CONNECTED UE does not totally contain the common frequency resource of RRC\_IDLE/INACTIVE UEs.
	+ Proposal 22. 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.
* *LGE*
	+ Proposal 4: For broadcast, CFR of a cell is associated at least to initial DL BWP of the cell for any RRC state.
		- FFS whether broadcast CFR is associated to UE’s active DL BWP for UE in RRC\_CONNECTED.

### **Multi-beam operation for GC-PDSCH**

* *LGE*
	+ Proposal 6: support transmission of multiple TDMed group-common PDSCHs carrying a same TB with selectively different RSs for both broadcast and multicast.
		- Different UE in the group selectively receive same or different PDSCHs among TDMed PDSCHs carrying the TB.
	+ Proposal 7: Multiple TCI states can be configured in PDSCH-config for group common PDSCH for the CFR.
	+ Proposal 8: From gNB perspective, gNB may configure multiple CORESETs and transmit group common PDCCHs to multiple UEs in a group. The DCI can be repeated on multiple CORESETs with same or different TCI states
	+ Proposal 9: Multiple TCI states can be configured for a CORESET ID for a Search Space of group common PDCCH by RRC.
* *TD Tech*
	+ Propoal 12: The POs in each monitoring period of the CSS for NR MBS are numbered in sequence with index 0 for the first PO. The PO with index k=N\*x+n is associated with the SSB with index n, where n=0,…,N-1, N is the number of the beams used by SSBs, x=0,…,INT[L/N]-1, and L is the number of the POs in each monitoring period of the CSS for NR MBS.
	+ Proposal 13: If a CSS for NR MBS is shared by unicast sessions, the mapping between POs and SSB indexes for MTCH in each monitoring period of the CSS can be disabled according to the configuration indicated by proposals 8-10. UE needs to monitor both C-RNTI and G-RNTI in each PO in each monitoring period of the CSS.

### **Default QCL assumption for group-common PDSCH**

* *NTT Docomo*
	+ Observation 6: In the current specification, the QCL assumption of group-common PDSCH scheduled with the first DCI format for multicast will not be aligned among UEs in the same group if the offset between the group-common PDCCH and the corresponding PDSCH is less than the threshold timeDurationForQCL.
	+ Proposal 18: 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.

### **Relation between CFR and initial BWP**

* *Nokia*
	+ Observation-1: Initial BWP is configured using SIB1 and could be used for initial access RRC connection is established, and CFR is configured using RRC configurations after initial access and establishing the RRC connection, in order to receive multicast traffic.
	+ Observation-2: If a case UE is simultaneously receiving broadcast and multicast traffic, the CFR could be overlapping in the frequency domain with initial BWP.
	+ Proposal-2: The association between multicast CFR, broadcast CFR, and initial BWP should be left to gNB implementation.
	+ Observation-3: The association of CFR is with the UE’s dedicated unicast BWP and not the initial BWP.
	+ Proposal-3: The size of the CFR relative to the initial BWP could also be left to gNB implementation.
* *Intel*
	+ Proposal 2: The UE does not expect a CFR larger than the initial BWP if the initial BWP is the active BWP of the UE.
* *Ericsson*
	+ Observation 11 The network can implement the CFR for the connected UE to coincide with the initial BWP’s resource allocation.
	+ Proposal: Option 2B for CFR, associated with UE active BWP equal to an RRC reconfigured initial DL BWP, is supported at least for multicast of RRC-CONNECTED UEs, at least when the CFR has identical frequency resources to the active BWP.
* *LGE*
	+ Proposal 1: For a connected UE receiving multicast (as well as idle/inactive UEs receiving broadcast), CFR associated to initial DL BWP can be configured with a wider bandwidth than the initial DL BWP or a bandwidth equal to or smaller than the initial DL BWP.

### **Other CFR related issues**

* *ZTE*
	+ Proposal 2: CFR can be configured larger than active downlink BWP when the active downlink BWP is the initial BWP defined by CORESET#0.
		- Prioritize the corresponding discussion in RRC IDLE/INACTIVE state to strive for a consistent solution for all RRC states
* *OPPO*
	+ Proposal 21: A separate TCI states space is activated by MAC CE for group common PDSCH.
* *CATT*
	+ Proposal 2: The CFR configuration (i.e., cfr-Config-Multicast) is configured separately with BWP configuration, and the CFR configuration can be associated with the dedicated unicast BWP via a CFR index.
* *Intel*
	+ Proposal 5: The UE expects no restriction on unicast reception within the CFR since it is contained within the active DL BWP of the UE.
* *Qualcomm*
	+ Proposal 10: Discuss whether/how to share the TCI-state pool for unicast and multicast within a dedicated BWP.
* *LGE*
	+ Proposal 2: At least for multicast, unicast BWP switching between UE’s active BWPs may immediately triggers CFR change between different CFRs associated to different UE’s active BWPs.
* *ASUSTeK*
	+ Observation 1: A UE is not able to receive multicast PDCCHs/PDSCHs if the UE’s active BWP is switched to an MBS-incapable BWP.
	+ Proposal 1: 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, e.g. the UE automatically switches back to the MBS-capable BWP after a certain time duration.
* *ETRI*
	+ Observation1: The common frequency resource configuration for multicast would be semi-static rather than dynamic.
	+ Proposal1: RRC configuration for common frequency resource configuration for multicast of RRC\_CONNECTED UEs is supported.
	+ Proposal2: RRC configuration for location and bandwidth of the CFR, PDCCH for the CFR, and PDSCH for the CFR are supported.
* *FGI,APT*
	+ Proposal 8: TCI states for GC-PDCCH or GC-PDSCH can be configured in PDCCH-Config for multicast and PDSCH-Config for multicast, and the TCI states are indexed to the TCI states configured in PDSCH-Config for unicast.

## Initial Proposals based on contributions

### **Frequency resources of CFR**

***Summary***

Most companies propose that the starting PRB and the length of PRBs of CFR are jointly indicated reusing the RIV indication mechanism used for *locationAndBandwidth* of a BWP. Moderator suggests the **initial proposal 1-1a**.

1 company [Samsung] raises an issue how RBG and PRG are defined for multicast PDSCH. It is proposed to follow the same procedure as for the BWP relative to CRB. Depending on the start and length of the CFR, the sizes of the first and last RBG, PRB bundle or PRG for multicast may differ from the corresponding ones for the BWP of a UE. Moderator suggests **initial proposal 1-1b** regarding this.

1 company [Samsung] raises an issue that it is not clear what the UE should assume for FDRA of the unicast PDSCH when a RBG/PRG overlaps with the start/end of the CFR. It is proposed that, for a unicast RBG/PRG overlapping with CFR boundaries, a UE assumes that only RBs outside the CFR are used for unicast PDSCH reception. Moderator suggests **initial proposal 1-1c** regarding this.

***Initial Proposals***

**Initial Proposal 1-1a:** The starting PRB and the length of PRBs of CFR are jointly indicated reusing the RIV indication mechanism in the same way as *locationAndBandwidth* of a BWP.

**Initial Proposal 1-1b:** RBG and PRG for multicast GC-PDSCH in CFR are defined using the same procedure as for unicast PDSCH in DL BWP.

**Initial Proposal 1-1c:** For a unicast RBG/PRG overlapping with CFR boundaries, a UE assumes that only RBs outside the CFR are used for unicast PDSCH reception.

### **Number of CFRs**

***Summary***

Regarding the FFS whether more than one CFR is supported per dedicated unicast BWP subjected to UE capabilities, 7 companies [Huawei, CATT, MTK, Futurewei, CMCC, Samsung, Ericsson] propose that one CFR per dedicated BWP is sufficient. 3 companies [ZTE, vivo, TD Tech] propose to support more than one CFR per dedicated BWP subject to UE capability. Based on majority view, moderator suggests **initial proposal 1-2**.

***Initial Proposals***

**Initial proposal 1-2:** Limit the number of CFRs for multicast to one per dedicated unicast BWP in Rel-17.

### **Configuration of G-RNTI(s)**

***Summary***

For multicast of RRC\_CONNECTED UEs, the G-RNTI(s)/G-CS-RNTI(s) can be configured by dedicated RRC signaling. 1 company [QC] proposes to discuss whether G-RNTI(s)/G-CS-RNTI(s) for multicast are configured per DL BWP, per serving cell or per cell Group. This also relates to the discussion of RRC parameters. **Initial question 1-3** is provided to collect views on this.

***Initial Proposals***

**Initial Question 1-3:** For multicast of RRC\_CONNECTED UEs, the G-RNTI(s)/G-CS-RNTI(s) is/are configured

* Opt.1: per BWP.
* Opt.2: per serving cell.
* Opt.3: per cell-group.
* Other options

### **Rate matching and TBS determination**

***Summary***

Regarding the default value of maximum number of layers for LBRM and TBS determination for GC-PDSCH, 4 companies [Apple, MTK, Qualcomm, Ericsson] propose 1, 1 company [Samsung] proposes 4, 1 company [Xiaomi] proposes the default value is defined as the maximum number of MIMO layer provided by UE capability. Based on majority view, moderator suggests **initial proposal 1-4a**.

Regarding the FFS of the maximum modulation order for LBRM and TBS determination for GC-PDSCH, 2 companies [Samsung, Ericsson] propose to confirm the FFS (i.e., if *mcs-Table* in *PDSCH-Config* for MBS is not configured in CFR, a value determined from *mcs-Table* in *PDSCH-Config* for unicast in the active DL BWP is used; if the *mcs-Table* in *PDSCH-Config* for unicast in the active DL BWP is not configured, Table 5.1.3.1-1 in TS38.214 is used), while 6 companies [ZTE, CATT, Apple, MTK, Qualcomm, Xiaomi] propose to use a simpler version (i.e., if *mcs-Table* in *PDSCH-Config* for MBS is not configured in CFR, Table 5.1.3.1-1 in TS38.214 is used). Based on majority view, moderator suggests **initial proposal 1-4b**.

It is clear that the LBRM and TBS determination for GC-PDSCH should be based on the LBRM/TBS configuration in a CFR, and the LBRM and TBS determination for unicast PDSCH should use the legacy configuration in the dedicated BWP. However, it is unclear whether PTP retransmission for multicast should follow the same way as PTP for unicast or PTM for multicast. 1 company [Qualcomm] proposes that the LBRM/TBS determination for PTP retransmission of multicast should be based on the LBRM/TBS determination of the PTM initial transmission using same HPID and NDI, while 1 company [Samsung] proposes the LBRM/TBS determination for PTP retransmission of multicast should be based on the LBRM/TBS determination of the legacy unicast PDSCH transmission. One question is provided to collect companies’ views on this.

***Initial Proposals***

**Initial proposal 1-4a:** For LBRM and TBS determination for GC-PDSCH, the default value of the maximum number of layers is 1 if *maxMIMO-Layers* in *PDSCH-Config* for MBS in CFR is not configured.

**Initial proposal 1-4b:** For determination of maximum modulation order for LBRM and TBS determination for GC-PDSCH,

* if *mcs-Table* in *PDSCH-Config* for MBS is not configured in CFR, Table 5.1.3.1-1 in TS38.214 is used (similar as the default value in R16).

**Initial Question 1-4c:** Which option the LBRM/TBS determination for PTP retransmission of multicast should be based on?

* Option 1: the LBRM/TBS determination of the PTM initial transmission using same HPID and NDI.
* Option 2: the LBRM/TBS determination of the legacy unicast PDSCH transmission.

### **BWP-InactivityTimer related issues**

***Summary***

If a UE is configured with a CFR in the active DL BWP, for timer-based active DL BWP switching to a default BWP,

* Option 1: UE also starts or restarts *BWP-InactivityTimer* when it successfully decodes a GC-PDCCH addressed to group-common RNTI (e.g., G-RNTI or G-CS-RNTI) on/for the active BWP.
	+ Support: Huawei, ZTE, Qualcomm
* Option 2: Introduce a new *MBS-BWP-InactivityTimer* for GC-PDCCH receptions.
	+ Support: Samsung
* Option 3: Multicast reception has no impact on Rel-16 UE behavior related to BWP-InactivityTimer.
	+ Support: OPPO, CATT

Moderator suggests **initial proposal 1-5**.

***Initial Proposals***

**Initial proposal 1-5:** If a UE is configured with a CFR in the active DL BWP, for timer-based active DL BWP switching to a default BWP, option 1 is supported.

* Option 1: UE also starts or restarts *BWP-InactivityTimer* when it successfully decodes a GC-PDCCH addressed to group-common RNTI (e.g., G-RNTI or G-CS-RNTI) on/for the active BWP.

### **Optionality of CFR**

***Summary***

Based on contributions submitted to this meeting and the discussion in last meeting, companies’ views still diverge. Considering the discussion on optionality of CFR relates to the concrete configurations of G-RNTI(s)/G-CS-RNTI(s) and CFR, which are premature now, so moderator suggests to discuss this issue after the signaling design is clear.

### **Broadcast for RRC\_CONNECTED UEs**

***Summary***

Some companies raise an issue, for a UE receiving both multicast and broadcast services simultaneously, whether the broadcast CFR and multicast CFR need to be overlapping. Some companies think that the broadcast CFR and multicast CFR may not have to be overlapping, and autonomous switching between broadcast CFR and unicast dedicated BWP which might also contain the multicast CFR could be left to UE implementation. Some companies think that it can be based on network implementation to guarantee the broadcast CFR is within the bandwidth of the active BWP for RRC\_CONNECTED UE to receive the broadcast service for which the MBS Interest Indication is sent by the RRC\_CONNECTED UE. Moderator think it may be worth to have a discuss on this, and provides the initial question 1-6 to collect views.

***Initial Proposals***

**Initial Question 1-6:** Can it be up to network implementation to guarantee the broadcast CFR is within the bandwidth of the active BWP for RRC\_CONNECTED UE to receive the broadcast service for which the MBS Interest Indication is sent by the RRC\_CONNECTED UE?

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | Proposal 1-1a: OK.Proposal 1-1b: OK. In addition, we think it may be necessary to add one bullet as below to limit PRG and RBG for multicast PDSCH are confined within the CFR:**Initial Proposal 1-1b:** RBG and PRG for multicast GC-PDSCH in CFR are defined using the same procedure as for unicast PDSCH in DL BWP.* PRG and RBG for multicast PDSCH are confined within the CFR

Proposal 1-1c: We don’t support it. As mentioned earlier, we think PRG and RBG for multicast PDSCH are confined within the CFR so that the issue of 1-1c is not a problem.Proposal 1-2: Generally fine with us. I think the intention of this proposal is to support at most one CFR per dedicated unicast BWP. So maybe add “maximum” in the bullet is better:**Initial proposal 1-2:** Limit the maximum number of CFRs for multicast to one per dedicated unicast BWP in Rel-17.Proposal 1-3: we support Option 2, i.e., per serving cell. For Option 1, we have concern it may need UE support multiple active BWPs.Proposal 1-4a: OK.Proposal 1-4b: OK.Proposal 1-4c: Option is supported for easy TBS determination.Proposal 1-5: Not sure I fully understand the intention. The current proposal seems not relevant to MBS especially the description of Option1. Seemingly, the Option 1 is legacy UE behavior.Question 1-6: Regarding the broadcast, is it received by IDLE/INACTIVE UEs? If yes, seems this issue is relevant to CFR configuration for idle/inactive UEs. One way is to wait for the conclusion from 8.12.3. |
| LG | **Initial Proposal 1-1a:** OK**Initial proposal 1-2:** OK**Initial Question 1-3:** We are fine with Opt 1 and/or Opt 2 for G-RNTI(s) for multicast as well as broadcast, except for G-CS-RNTI(s), considering that MBMS services have been mapped to frequencies in legacy MBMS. Concerning G-CS-RNTI(s), we should first clarify how G-CS-RNTI(s) are associated to services.**Initial proposal 1-4a:** OK**Initial proposal 1-4b:** OK**Initial proposal 1-5:** We do not support option 1. Currently, both *BWP-InactivityTimer* and default BWP are optionally configured. Thus, if default BWP does not currently provide group-common RNTI, gNB can avoid configuring *BWP-InactivityTimer* or default BWP. If both *BWP-InactivityTimer* and default BWP are configured, we assume that gNB may currently provide same group-common RNTI for UE active BWP for this UE and default BWP for other UE(s). Or, gNB may provide RAN2-defined PTP bearer or PTP transmission to default BWP. Thus, we can avoid service interruption. Furthermore, RAN1 would better defer this decision to RAN2 considering impact on MAC. By the way, we think that this proposal is only for multicast, not for broadcast because gNB may not exactly know when/whether UE receives SSB based broadcast transmissions.**Initial Question 1-6:** It could be basically up to network implementation to guarantee the broadcast CFR is within the bandwidth of the active BWP for RRC\_CONNECTED UE to receive the broadcast service. However, we wonder if the bandwidth of the first active BWP for RRC\_CONNECTED UE can always contain the broadcast service because UE would send MBS Interest Indication after completion of RRC establishment. We think that gNB should know whether UE is receiving broadcast during initial access i.e. before UE configures the first active BWP in RRC setup. |

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

# Issue #2: Configurations for GC-PDCCH

## Background and submitted proposals

***Submitted Proposals***

### **CORESET**

* *Huawei, HiSilicon*
	+ Proposal 1: For CFR for multicast scheduling confined within a dedicated unicast BWP,
		- It is up to gNB to configure the same or different CORESETs for unicast and multicast scheduling within the CFR.
* *OPPO*
	+ Proposal 17: It is up to gNB on the configuration of CFR, e.g. CORESETS, and the dedicated unicast BWP that contains this CFR.
	+ Proposal 18: A CORESET can be used by multicast and unicast transmission, when the CORESET is fully contained in frequency domain in a CFR which is configured in a dedicated unicast BWP.
* *vivo*
	+ Proposal 10: If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP, option 1 is supported.
		- Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *CATT*
	+ Proposal 19: 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.
* *MediaTek*
	+ Proposal 9: No need to define an extra explicit rule whether the CORESETs can be shared for unicast and multicast and it is up to network implementation.
* *FUTUREWEI*
	+ Proposal 3: Without CFR configured, multicast reception by default is not supported. Option 4 should be supported i.e., the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *CMCC*
	+ Proposal 6. If a CFR is configured in a dedicated unicast BWP for multicast in RRC-CONNECTED state,
		- the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain
		- the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
* *Intel*
	+ Proposal 11: The CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.
	+ Proposal 12: For PTP or PTM scheme 2, the CORESET scheduling MBS (re)transmission can be configured outside the MBS frequency region.
* *Qualcomm*
	+ Proposal 5: If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP,
		- Option 4: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP cannot be used for PTM-1 multicast transmission even if the CORESET is fully contained in the CFR in frequency domain, but the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission including PTP transmission for unicast and PTP retransmission for multicast.
* *Samsung*
	+ Observation 5: Whether or not a UE monitors PDCCH for detection of unicast DCIs and multicast DCIs in a same CORESET is a gNB implementation issue.
* *NTT Dococmo*
	+ Proposal 1: Support Option 4 for sharing CORESETs between PDCCH-Config for unicast and PDCCH-Config for multicast.
* *Chengdu TD Tech*
	+ Proposal 1: The CORESETs for MBS can be used for unicast scheduling.
	+ Proposal 2: For a CORESET for unicast, if it’s within the CFR, it can be used for MBS scheduling.
* *Ericsson*
	+ Proposal 31 Support option 1 from RAN1#104b regarding using CORESETs from unicast with multicast:
		- If a CFR is configured in a dedicated unicast BWP for multicast in RRC-CONNECTED state, the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for PTM-1 transmission
		- the CORESET configured in PDCCH-config for MBS in the CFR can be used for PTP transmission.
* *Xiaomi*
	+ Proposal 11: If a CFR is configured for multicast in RRC-CONNECTED state and confined within a dedicated unicast BWP, the following option1 should be adopted:
		- Option 1: the CORESET configured in PDCCH-config for unicast in the dedicated unicast BWP can be used for multicast transmission if the CORESET is fully contained in the CFR in frequency domain, and the CORESET configured in PDCCH-config for MBS in the CFR can be used for unicast transmission.

### **Search space set**

* *OPPO*
	+ Proposal 20: For CSS of GC-PDCCH of PTM scheme 1 for multicast in NR MBS, the Type-x CSS is not configured as a Type-3 CSS.
* *Spreadtrum*
	+ Proposal 3: For search space type for Rel-17 MBS, support to define a new search space type for multicast.
* *ZTE*
	+ Proposal 5: Monitoring configurations (e.g., CORESETs, Search Spaces, etc.) for GC-PDCCH of PTM retransmission can be configured separately from that for GC-PDCCH of PTM initial transmission.
	+ Proposal 6: For NR multicast, introduce beam sweeping via defining association between MOs of GC-PDCCH and SSBs or CSI-RSs.
	+ Proposal 11: If the type-x CSS is defined as a type-3 CSS, the following UE behavior on Type-3 CSS monitoring should be defined,
		- For the first DCI format with CRC scrambled by G-RNTI within type-3 CSS, it should always be monitored by the UE.
		- For the second DCI format with CRC scrambled by G-RNTI within type-3 CSS, the UE determines monitoring priority according to search space index and further decides whether to monitor.
* *vivo*
	+ Proposal 11: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, only DCI formats with CRC scrambled with g-RNTI for multicast scheduling can be monitored in the search space.
* *CATT*
	+ Proposal 20: A Type-3A/Type-MBS CSS can be introduced for the CSS of group-common PDCCH of PTM scheme1 for multicast in RRC\_CONNECTED state.
	+ Proposal 21: If the Type-2 HARQ-ACK codebook is configured, the g-NB is not allowed scheduling the group-common PDCCH when the Type-3A/Type MBS CSS of the group-common PDCCH was dropped by any UE in the multicast group.
* *Nokia*
	+ Observation-12: Search space defined for multicast has different characteristics in terms of monitoring priority as compared to currently defined common search space.
	+ Observation-14: In the scenario where DCI format 1\_1 is used for PTP retransmissions of the PTM scheme 1 initial transmission and the new common / multicast search space is used for scheduling the retransmissions, it would be straightforward for the UE to assume that the received TB is actually the PTP retransmission of PTM traffic.
	+ Proposal-20: Clarify whether PTP retransmission of PTM scheme 1 initial transmission would be scheduled using CSS or USS.
	+ Proposal-21: Define a new type-x CSS or multicast search space with differentiated monitoring priority based on SS index and FDRA field size of the downlink DCIs associated with this search space calculated based on the size of the CFR.
	+ Observation-15: The UE could interpret type-x CSS based monitoring priority based on the DCI formats configured for a SS set, the CORESET resources overlapping with MBS CFR or based on explicit SS set reservation using higher layer signaling.
* *MediaTek*
	+ Proposal 10: Define a new Type-x PDCCH CSS type (e.g., Type-4 PDCCH CSS not Type-3 PDCCH CSS) for UE supporting multicast service.
* *FUTUREWEI*
	+ Proposal 4: A ‘new’ Type-x CSS is defined. It should be clear that this Type-x is not a Type-3 CSS and the rule of monitoring priority of Type-x CSS is determined based on the search space set indexes of the Type-x CSS set and USS sets, as agreed.
* *CMCC*
	+ Proposal 4. The Type-x CSS of group-common PDCCH for multicast can be monitored both on PCell and SCell.
	+ Proposal 5. One Type-x CSS of group-common PDCCH can associate with multiple G-RNTIs, and each G-RNTI can be configured with specific monitoringSlotPeriodicityAndOffset, duration and monitoringSymbolsWithinSlot.
* *Intel*
	+ Proposal 13: Type-x CSS is a new CSS type different from Type 3 CSS which can be treated similar to USS in case of PDCCH overbooking.
* *Qualcomm*
	+ Proposal 6: For RRC\_CONNECTED UEs, Type-x CSS can be configured with 1st and/or 2nd DCI format with G-RNTI(s) for multicast.
* *Samsung*
	+ Observation 3: There are several aspects on the search space set configuration for multicast DCI formats to be concluded such as whether the first and second DCI formats can be in same and/or different search space sets, whether or not DCI format 1\_0 (based on CSS) and the first DCI format for multicast can be in a same search space set, whether or not DCI format 2\_x and the second DCI format for multicast can be in a same search space set, etc.
	+ Proposal 3: When a UE monitors PDCCH only according to USS sets and CSS sets for multicast in CORESETs with qcl-Type set to same 'typeD' properties, the CORESETs are the ones having same 'typeD' properties as the CORESET corresponding to the USS set or CSS set for multicast with the lowest index.
* *NTT Dococmo*
	+ Observation 1: In terms of specification impact, there is no significant difference between reusing type-3 CSS and defining a new type CSS.
* *Chengdu TD Tech*
	+ Proposal 5: GC-PDCCH and SPS GC-PDCCH have the same CSS(s).
* *Convida*
	+ Proposal 4: Type-x CSS is a new type of CSS.
* *Ericsson*
	+ Proposal 32 Type-x CSS is a Type3 CSS. Extend the existing type3 CSS from Rel-15/16 to support additional DCIs for scheduling via group common PDCCH

### **First DCI format and fields**

* *Huawei*
	+ Proposal 7: For FDRA determination of the first DCI format for GC-PDCCH, support Option2,
		-  is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
		- For resource indication value (RIV) of downlink resource allocation type 1, when the CFR of active BWP is larger than CORESET#0 if configured or SIB1 configured initial BWP.
			* the scaling scheme as for the case that the DCI size for DCI format 1\_0 in USS is derived from the size of DCI format 1\_0 in CSS but applied to an active BWP is applied.
* *Samsung*
	+ Proposal 4: From the RAN1#106-e agreement, the FDRA field is based on Option 2 for the first DCI format and on Option 3 for the second DCI format.
* *OPPO*
	+ Proposal 16: For a UE receiving group-common PDSCH transmitted with PTM scheme 1, a TPC-PUCCH-RNTI different from that for unicast should be configured.
* *NEC*
	+ Proposal 1: For FDRA determination of the first DCI format for GC-PDCCH, Option 3, i.e.,  is given by the size of CFR in the active DL BWP, is preferred.
	+ Proposal 2: The ‘TPC command for scheduled PUCCH’ field is not needed for the first DCI format if it reused the same fields of legacy DCI format 1\_0. This fields can be reserved for other intentions instead of removing it.
* *ZTE*
	+ Proposal 7: For the first DCI format for GC-PDCCH, two fields (i.e., Identifier for DCI formats, TPC command for scheduled PUCCH) with 3 bits can be removed from DCI format 1\_0 for unicast.
	+ Proposal 8: Option 2 is supported for FDRA determination of the first DCI format for GC-PDCCH, i.e.,
		-  is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
		- For resource indication value (RIV) of downlink resource allocation type 1, the similar scheme as for the case that the DCI size for DCI format 1\_0 in USS is derived from the size of DCI format 1\_0 in CSS but applied to an active BWP is used.
			* if the size of CFR (i.e. $N\_{CFR}$) is larger than the size of CORESET0/initial DL bandwidth part, the resource indication value (RIV) is defined as in section 5.1.2.2.2 in TS38.214, where K is the maximum value from set {1, 2, 4, 8} which satisfies $K\leq \left⌊N\_{CFR}/N\_{BWP}^{initial}\right⌋$;otherwise, $K=1.$
* *vivo*
	+ Proposal 12: For the fields of the first DCI format with CRC scrambled with G-RNTI
		- FDRA field is determined based on the configuration of CFR.
		- ‘Identifier for DCI formats’ is removed.
		- ‘TPC command for scheduled PUCCH’ can be included in the DCI format for NACK only feedback.
* *CATT*
	+ Proposal 23: The fields of the first DCI format with CRC scrambled with G-RNTI/G-CS-RNTI which may not be needed can be reserved and applied for other indications.
	+ Proposal 24: For FDRA determination of the first DCI format for GC-PDCCH, Option 2 is preferred.
* *Spreadtrum*
	+ Proposal 4: For FDRA determination of the first DCI format, support option 3.
* *Nokia*
	+ Proposal-16: UE should assume that the FDRA field of the DCI format 1\_0 scheduled within a multicast search space is dimensioned based on the size of the CFR located within the active DL BWP.
	+ Proposal-17: Unused or reserved fields that are used for the first DCI format of GC-PDCCH could be repurposed for FDRA field.
* *Xiaomi*
	+ Proposal 8: Regarding to the unnecessary information fields included in DCI format 1\_0 and DCI format 1\_1 when they are used as the first DCI format and second DCI format respectively, these information fields should be reserved as the current specification.
	+ Proposal 9: For the FDRA determination of the first DCI format for GC-PDCCH, option 2 is adopted.
	+ Proposal 10: For the first DCI format for GC-PDCCH:
		- if the size of CFR (i.e. $N\_{CFR}$) is larger than the size of CORESET0/initial DL bandwidth part, the resource indication value (RIV) is defined as in section 5.1.2.2.2 in TS38.214, where K is the maximum value from set {1, 2, 4, 8} which satisfies $K\leq \left⌊N\_{CFR}/N\_{BWP}^{initial}\right⌋$;
		- otherwise, $K=1.$
* *MediaTek*
	+ Proposal 11: Define a new field (e.g., “HARQ feedback option”) within MBS DCI format to indicate which HARQ feedback option will be used by multicast services.
	+ Proposal 12: Define a new field (e.g., “HARQ feedback enable/disable”) within MBS DCI format to indicate whether HARQ feedback is used for multicast services.
	+ Proposal 13: The unused fields in existing DCI format shall be removed for adding new MBS specific fields.
	+ Proposal 14: Option 2 is preferred for FDRA determination of the first DCI format for GC-PDCCH.
* *CMCC*
	+ Proposal 7. Option 2 is adopted for FDRA determination of the first DCI format for GC-PDCCH.
	+ Proposal 8. Regarding the first DCI format for GC-PDCCH, ‘Identifier for DCI formats’ field cannot be removed, but whether should be ignored and reserved, or should be re-purposed can be postponed and up to the HARQ-ACK feedback design in AI 8.12.2.
* *Intel*
	+ Proposal 15: When HARQ feedback is disabled by RRC, the following fields of DCI format 1\_0 can be assumed to be reserved:
		- PUCCH resource Indicator
		- PDSCH-to-HARQ timing indicator
		- TPC command for scheduled PUCCH
		- HARQ Process Number
		- New Data Indicator
		- Redundancy Version
	+ Proposal 16: For FDRA determination of first DCI format, Option 3 is supported.
* *Apple*
	+ Proposal 2: Reuse existing FDRA determination scheme for first DCI format for GC-PDCCH.
* *Lenovo*
	+ Proposal 4: One-bit identifier in the first DCI format is reserved and can be reused for other purpose.
	+ Proposal 6: The number of bits for FDRA in the first DCI format is determined based on the bandwidth of the common frequency region (Option 3 is supported).
	+ Proposal 7: The reserved fields in the first DCI format can be repurposed for FDRA in case of truncated MSB bits of FDRA.
	+ Proposal 8: Zero bits are appended to the first DCI format in case its size prior to padding is smaller than the size of DCI format 1-0 with CRC scrambled by C-RNTI and monitored in CSS.
	+ Proposal 9: The number of bits in TDRA field in the first DCI format is determined by the number of entries in the time domain resource allocation list configured for MBS.
	+ Proposal 10: VRB-to-PRB mapping in the first DCI format is 0 or 1 bit dependent on RRC configuration.
	+ Proposal 11: 5 bits MCS, 1 bit NDI, 2 bits RV and 4 bits HARQ process number are included in the first DCI format.
	+ Proposal 12: One-bit identifier in the first DCI format is reused for indicating NACK-only based feedback or ACK/NACK-based feedback.
	+ Proposal 13: PDSCH-to-HARQ\_timing indicator in the first DCI format indicates a numerical value or the non-numerical value for enabling or disabling the HARQ-ACK feedback.
	+ Proposal 14: PRI in the first DCI format is reserved and can be reused for other purpose.
	+ Proposal 15: For Type-1 HARQ-ACK codebook determination, DAI in the first DCI format is reserved and can be reused for other purpose.
	+ Proposal 16: For Type-2 HARQ-ACK codebook determination, DAI in the first DCI format is used as counter DAI as legacy operation.
	+ Proposal 17: Two-bit TPC in the first DCI format is reserved and can be reused for other purpose.
	+ Proposal 18: The priority index is not included in the first DCI format for GC-PDCCH.
	+ Proposal 19: Support fields and sizes in Table 1 for the first DCI format.

|  |  |
| --- | --- |
| DCI fields  | Size (bits) |
| Identifier  | 1, reused for indicating NACK-only feedback or ACK/NACK feedback |
| Frequency domain resource assignment | Given by CFR size |
| Time domain resource assignment | 0, 1, 2, 4 determined based on the number of entries in *pdsch-TimeDomainAllocationList* for MBS |
| VRB-to-PRB mapping | 0 or 1 |
| Modulation and coding scheme | 5 |
| New data indicator | 1 |
| Redundancy version | 2 |
| HARQ process number | 4 |
| Downlink assignment index | 2, reserved for Type-1 HARQ-ACK codebook  |
| TPC command for scheduled PUCCH | 2, reserved |
| PUCCH resource indicator | 3, reserved |
| PDSCH-to-HARQ\_feedback timing indicator | 3  |

* *NTT Dococmo*
	+ Proposal 2: Not include ‘TPC command for scheduled PUCCH’ in the first DCI format for multicast.
	+ Proposal 3: For the first DCI format for multicast, include following new DCI fields.
		- Priority indicator (1bit)
		- Number of layers (1bit)
	+ Proposal 4: For FDRA determination of the first DCI format for multicast, support Option 2.
	+ Proposal 5: For PDSCH scheduled with the first DCI format for multicast, K is the minimum value from set {1, 2, 4, 8, 16} which satisfies $K\geq \left⌈N\_{CFR}/N\_{BWP}^{initial}\right⌉$
	+ Observation 3: If the existing k1 list for DCI format 1\_0, which is fixed as {1, 2, 3, 4, 5, 6, 7, 8} is reused for the first DCI format for multicast, PUCCH scheduling flexibility is low since a larger slot offset cannot be indicated and HARQ feedback slot becomes the same among UEs receiving a group-common PDSCH.
	+ Proposal 7: A list of k1 values for the first DCI format for multicast is configurable.
* *Qualcomm*
	+ Proposal 7: For multicast GC-PDCCH,
		- For the first DCI format
			* Option 2 is used to determine the FDRA.
			* ‘TPC command for scheduled PUCCH’ is not needed
* *FGI,APT*
	+ Proposal 3: ‘Identifier for DCI formats’ field and ‘TPC command for scheduled PUCCH’ field are not present in the first DCI format.
	+ Proposal 4: For FDRA determination of the first DCI format for GC-PDCCH, option 3 is supported.
* *Ericsson*
	+ Proposal 34 The fallback DCI for multicast is using the same fields as DCI 1\_0 with the following modification:
		- TPC command for PUCCH is removed
		- UL DL identifier bit is removed.
		- The FDRA field for the DCI in the common search space $N\_{RB}^{DL,BWP}$ is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of CFR if CORESET 0 is not configured for the cell.
				+ The size of the initial BWP if no CFR is configured.
	+ Proposal DCI formats for multicast and broadcast are common, although with partly different configurations.

### **Second DCI format and fields**

* *OPPO*
	+ Proposal 12: In the second DCI format for GC-PDCCH, the two fields “Identifier for DCI formats” and “SRS request” can be kept as reserve bits.
	+ Proposal 16: For a UE receiving group-common PDSCH transmitted with PTM scheme 1, a TPC-PUCCH-RNTI different from that for unicast should be configured.
* *NEC*
	+ Proposal 3: The second DCI format for GC-PDCCH uses the same fields as DCI format 1\_1 except the following fields.
		- ‘TPC command for scheduled PUCCH’
		- ‘Carrier indicator’
		- ‘Bandwidth part indicator’

The redundant fields can be partly reserved for other intentions instead of removing them.

* *ZTE*
	+ Proposal 9: For the second DCI format for GC-PDCCH, fields (such as, Identifier for DCI formats(1 bit), scheduling information for the second transport block(8 bits), TPC command for scheduled PUCCH(2 bits), SRS request(2 bits), CBG transmission information (CBGTI)(0, 2, 4, 6 or 8 bits) and CBG flushing out information (CBGFI)(0 or 1 bit) ) can be removed from DCI format 1\_1 for unicast.
* *vivo*
	+ Proposal 13: For the fields of the second DCI format with CRC scrambled with G-RNTI,
		- ‘Identifier for DCI formats’ and ‘SRS request’ are removed.
		- ‘TPC command for scheduled PUCCH’ can be included in the DCI format for NACK only feedback.
		- ‘Carrier indicator’ and ‘Bandwidth part indicator’ can leave to gNB to configuration.
* *CATT*
	+ Proposal 25：For the second DCI format, at least ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’, ‘Carrier indicator’, ‘Bandwidth part indicator’ and ‘Transport block 2’ are not needed.
* *Nokia*
	+ Proposal-18: Repurpose existing unused fields such as ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ for both DCI formats 1\_0 and 1\_1, and ‘Carrier indicator’ and ‘Bandwidth part indicator’ for DCI format 1\_1, for indicating PTP retransmission of PTM initial transmission.
* *Xiaomi*
	+ Proposal 8: Regarding to the unnecessary information fields included in DCI format 1\_0 and DCI format 1\_1 when they are used as the first DCI format and second DCI format respectively, these information fields should be reserved as the current specification.
* *MediaTek*
	+ Proposal 11: Define a new field (e.g., “HARQ feedback option”) within MBS DCI format to indicate which HARQ feedback option will be used by multicast services.
	+ Proposal 12: Define a new field (e.g., “HARQ feedback enable/disable”) within MBS DCI format to indicate whether HARQ feedback is used for multicast services.
	+ Proposal 13: The unused fields in existing DCI format shall be removed for adding new MBS specific fields.
* *Intel*
	+ Proposal 17: The unused fields in second DCI format can be reserved
* *Samsung*
	+ Observation 6: The second DCI format for multicast is meaningful only if it has smaller size than the first DCI format.
* *Lenovo*
	+ Proposal 20: The second DCI format does not include carrier indicator.
	+ Proposal 21: The second DCI format does not include BWP indicator.
	+ Proposal 22: The second DCI format includes MCS/NDI/RV for the 2nd TB if maximum 2 TBs are supported in one PDSCH.
* *NTT Dococmo*
	+ Proposal 8: Not include following DCI fields in the second DCI format for multicast.
		- Carrier indicator
		- Bandwidth part indicator
		- TPC command for scheduled PUCCH
		- One-shot HARQ-ACK request
		- PDSCH group index
		- New feedback indicator
		- Number of requested PDSCH group(s)
		- CBG transmission information
		- CBG flushing out information
	+ Proposal 9: The presence or absence of ‘DMRS sequence initizalization’ in the second DCI format for multicast is configurable.
* *Qualcomm*
	+ Proposal 7: For multicast GC-PDCCH,
		- For second DCI format
			* For DCI size alignment, the DCI size of the second DCI format is indicated via unicast RRC.
			* ‘TPC command for scheduled PUCCH’ is not needed
* *FGI,APT*
	+ Proposal 5: For FDRA determination of the second DCI format for GC-PDCCH,  in the formula is given by the size of CFR in the active DL BWP.
* *Ericsson*
	+ Proposal 33 The non-fallback DCI for multicast is using the same fields as DCI1\_1 with the following modification:’
		- a. TPC command for PUCCH is removed
		- b. UL DL identifier bit is removed.
		- c. SRS request is removed
		- d. The FDRA field uses the PRB size and start PRB of the CFR (or the DL BWP if CFR is not configured) in the definition of the FDRA.

### **RB numbering for GC-PDSCH scheduled with the first DCI format**

* *Lenovo*
	+ Proposal 5: RB numbering within the common frequency region is with reference to the lowest RB of the common frequency region.
* *MediaTek*
	+ Proposal 8: RB numbering shall start from the lowest RB of the CFR for GC-PDSCH reception.
* *NTT Docomo*
	+ Observation 2: If the existing RB numbering rule for PDSCH scheduled with DCI format 1\_0 in CSS is reused for PDSCH scheduled with the first DCI format for multicast, there may be RBs that cannot be allocated with the first DCI format for multicast.
	+ Proposal 6: For PDSCH scheduled with the first DCI format for multicast, RB numbering starts from the lowest RB of the CFR.

### **Maximum number of BD/CCE**

* *OPPO*
	+ Proposal 19: The budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration.
* *CATT*
	+ Proposal 22: The budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs for UEs supporting CA capability based on configuration.
* *FUTUREWEI*
	+ Observation 1: Both options, Option 1 and 2, are applicable for the limit of BDs/CCEs for Rel-17 MBS.
* *Intel*
	+ Proposal 14: For determining BD/CEE limits for NR MBS in Rel-17, for CA capable UEs, the budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs.
* *Qualcomm*
	+ Proposal 8: For RRC\_CONNECTED multicast UEs supporting CA capability, support the following principles for determining $M\_{PDCCH}^{total,slot,μ}$ / $C\_{PDCCH}^{total,slot,μ}$  and the maximum numbers of BD/CCE UE is required to monitor per slot for a serving cell supporting multicast reception:
		- When determining $M\_{PDCCH}^{total,slot,μ}$ / $C\_{PDCCH}^{total,slot,μ}$  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 $M\_{PDCCH}^{mx,slot,μ}$ and R times $C\_{PDCCH}^{max,slot,μ}$ for a serving cell supporting multicast reception, where $M\_{PDCCH}^{max,slot,μ}$ and $C\_{PDCCH}^{max,slot,μ}$ are defined in Table 10.1-2 and Table 10.1-3 in 38.213
		- R is a value reported by the UE
* *Samsung*
	+ Observation 4: Increasing $M\_{PDCCH}^{max,slot,μ}$ and $C\_{PDCCH}^{max,slot,μ}$ for a UE does not relate to CA capability and any possible benefits for multicast and unicast operation would require that all corresponding UEs support larger $M\_{PDCCH}^{max,slot,μ}$ and $C\_{PDCCH}^{max,slot,μ}$
* *LGE*
	+ Proposal 5: The maximum BD/CCE numbers are increased as R times $M\_{PDCCH}^{mx,slot,μ}$ and R times $C\_{PDCCH}^{max,slot,μ}$ for a serving cell supporting multicast reception, where $M\_{PDCCH}^{max,slot,μ}$ and $C\_{PDCCH}^{max,slot,μ}$ are defined in Table 10.1-2 and Table 10.1-3 in 38.213
		- R is a value reported by the UE as part of MBS related UE capability, regardless of whether UE supports CA capability.

### **DCI size alignment**

* *Huawei*
	+ Proposal 8: For the second DCI format for GC-PDCCH,
		- it is size aligned with DCI format 1\_1 scrambled with C-RNTI in USS.
		- configuring a total payload size of the second DCI format is not necessary.
* *ZTE*
	+ Proposal 10: Regarding DCI size alignment for the second DCI format of GC-PDCCH, it is counted as “other RNTI”, and gNB will ensure that the number of DCI sizes does not exceed budget.
* *OPPO*
	+ Proposal 14: The G-RNTI is counted as “other RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.
	+ Proposal 15: The size of the group common DCI is configurable up to 126 bits.
* *vivo*
	+ Proposal 15: For the DCI size alignment, g-RNTI is counted as “C-RNTI”.
		- For the second DCI format, the size of DCI format 1\_1 or 1\_2 in USS is aligned with the second DCI format by zero padding.
* *CATT*
	+ Proposal 26: For first DCI format, G-RNTI is counted as “C-RNTI”; DCI size is aligned to DCI 1\_0 on CSS
	+ Proposal 27: UE expect that at least one of the sizes of DCI with “C-RNTI” and “other RNTI” is smaller than the size of the second DCI.
	+ Proposal 28: For second DCI format, G-RNTI can be counted as “C-RNTI” or “other RNTI” depending on RRC configuration.
* *Nokia*
	+ Proposal-15: The size of the second DCI format for multicast can be configured by RRC signaling for RRC\_CONNECTED UEs, with the size of configurable fields within the DCI format configured separately for multicast.
* *MediaTek*
	+ Proposal 15: “G-RNTI” is counted as “other RNTI” for second MBS DCI format.
* *CMCC*
	+ Proposal 9. Regarding the second DCI format for GC-PDCCH,
		- The size of the second DCI format for multicast can be configured by RRC signalling for RRC\_CONNECTED UEs.
		- For each DCI field, the bitlength is depend on RRC configuration if related parameter is configured in CFR, otherwise the upper bound of bitlength is assumed.
		- Zero bits are appended to DCI format 1\_1 with C-RNTI until the payload size equals to the size of the second DCI format.
* *Intel*
	+ Proposal 18: For DCI 1\_0 DCI size alignment can be performed by either zero-padding or truncating the MSBs of the FDRA field, depending on the relative size of the CFR with respect to CORESET#0 or the initial BWP, such that the DCI size aligns with that of unicast DCI format 1\_0 corresponding to the CORESET#0 or the initial BWP.
	+ Proposal 19: For DCI format 1\_0 and 1\_1, the DCI size can be aligned to a size which is configured by the network to the UE.
	+ Proposal 20: For DCI size budget of “3+1”, the UE may be configured to align DCI size with either “3” scheduling DCIs or “1” other group-common DCI depending on network implementation.
* *Samsung*
	+ Observation 7: There is no need to specify how to count the size of the second DCI format for multicast – the agreement that the UE expects to decode the Rel-16 limit of “3+1” DCI format sizes suffices.
	+ Proposal 4: From the RAN1#106-e agreement, the FDRA field is based on Option 2 for the first DCI format and on Option 3 for the second DCI format.
* *Lenovo*
	+ Proposal 23: For DCI size alignment, G-RNTI for the first DCI format is counted as C-RNTI.
	+ Proposal 24: For DCI size alignment, G-RNTI for the second DCI format is counted as other RNTI.
* *NTT Dococmo*
	+ Proposal 10: Align the size of the second DCI format for multicast with the size of DCI format 2\_0/2\_1/2\_4/2\_5/2\_6.
* *FGI,APT*
	+ Proposal 6: When DCI size budget is not met, the sizes of unicast DCI formats is aligned with the second DCI format for GC-PDCCH.
	+ Proposal 7: After step 4A in DCI size alignment procedure, the unicast DCI format with the closest size to the size of the second DCI format for GC-PDCCH is chosed first to perform DCI size alignment.
* *TD Tech*
	+ Proposal 8: The size of the first/second DCI format for GC-PDCCH scrambled with G-RNTI is aligned with the size of DCI format 1-0/1-1 for PDCCH scrambled with C-RNTI in a CSS for NR MBS
* *Ericsson*
	+ Proposal 35 The G-RNTI is counted as “C-RNTI” when considering the “3+1” DCI size budget rule for group-common PDCCH.
	+ Proposal 36 The determination of non-fallback multicast DCI size, monitored in the common search space is inserted as step ”2B” in the DCI alignment procedure
	+ Proposal 37 The fallback DCI for multicast is aligned in size with DCI 1\_0 and differentiated via the G-RNTI-based CRC check.
* *Xiaomi*
	+ Proposal 12: G-RNTI is counted as C-RNTI despite of DCI formats.

### **Initializing scrambling of PDCCH**

* *Huawei, HiSilicon*
	+ Proposal 3: For initializing scrambling sequence generator for GC-PDCCH with the first DCI format for RRC\_CONNECTED UEs,
		- $n\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in a RRC common IE e.g., commonControlResourceSet in PDCCH-ConfigCommon; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
		- Values for $n\_{RNTI}$ equals to the value of G-RNTI used for the GC-PDCCH.
	+ Proposal 4: For initializing sequence generator for DMRS of GC-PDCCH with the first DCI format received in Type-x CSS for RRC\_CONNECTED UEs,
		- $N\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in a RRC common IE e.g., commonControlResourceSet in PDCCH-ConfigCommon; $N\_{ID}=N\_{ID}^{cell}$ otherwise.
* *ZTE*
	+ Proposal 14: Use ‘0’ as the value of n\_"RNTI" for initializing scrambling sequence generator for GC-PDCCH with the second DCI format.
	+ Proposal 15: For initializing scrambling sequence generator for GC-PDCCH with the first DCI format,
		- $n\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in SIB used for the GC-PDCCH; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
		- $n\_{RNTI}$ equals 0.
	+ Proposal 15: For initializing sequence generator for DMRS of GC-PDCCH with the first DCI format received in Type-x CSS,
		- $N\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in SIB used for the GC-PDCCH; $N\_{ID}=N\_{ID}^{cell}$ otherwise.
* *CMCC*
	+ Proposal 11. For initializing scrambling sequence generator for GC-PDCCH with the second DCI format, $n\_{RNTI}$ is given by the G-RNTI used for the GC-PDCCH.
* *Xiaomi*
	+ Proposal 6: For initializing scrambling sequence generator for GC-PDCCH with the second DCI format, $n\_{RNTI}$ equals zero.
	+ Proposal 7: For initializing scrambling sequence generator for GC-PDCCH with the first DCI format, the same mechanism for the second DCI format should be reused.
* *MediaTek*
	+ Proposal 16: G-RNTI is used for the initialization value of n\_RNTI for GC-PDCCH with the second DCI format.
	+ Proposal : For initializing scrambling sequence generator for GC-PDCCH with the first DCI format for multicast reception,
		- $n\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in the CORESET in a CFR used for the GC-PDCCH; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
		- $n\_{RNTI}: $G-RNTI used for the GC-PDCCH
* *NTT Docomo*
	+ Proposal 12: For $n\_{RNTI}$ for calculating the initialization value for scrambling sequence for GC-PDCCH with the second DCI format, support Alt 2 or Alt 3.
	+ Proposal 13: For initializing scrambling sequence generator for GC-PDCCH with the first DCI format for multicast, use the same initialization value as for the second DCI format.
	+ Proposal 15: For initializing sequence generator for DMRS of GC-PDCCH with the first DCI format received in Type-x CSS,
		- $N\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in the CORESET in a CFR used for the GC-PDCCH; $N\_{ID}=N\_{ID}^{cell}$ otherwise.
* *Apple*
	+ Proposal 3: G-RNTI is applied to scramble both first DCI and second DCI format for GC-DPCCH.
	+ Proposal 4: For scrambling of first DCI format for GC-PDCCH, n\_ID is equal to parameter pdcch-DMRS-ScramblingID, if it is configured; otherwise, cell ID is applied for scrambling.
* *Qualcomm*
	+ Proposal 9:
		- For initializing scrambling sequence generator for GC-PDCCH with the first DCI format,
			* $n\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in the CORESET in a CFR used for the GC-PDCCH; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
			* $n\_{RNTI}=0$, similar as that of legacy CSS.
		- For initializing sequence generator for DMRS of GC-PDCCH with the first DCI format received in Type-x CSS,
			* $N\_{ID}$ equals the higher layer parameter pdcch-DMRS-ScramblingID if it is configured in the CORESET in a CFR used for the GC-PDCCH; $N\_{ID}=N\_{ID}^{cell}$ otherwise.
	+ Proposal 10:
		- For initializing scrambling sequence generator for GC-PDCCH with the second DCI format,
			* $n\_{RNTI}=0$, similar as that of legacy CSS.
* *FGI, APT*
	+ Proposal 1: For initializing sequence generator for DMRS of GC-PDCCH for the first DCI format, $N\_{ID}$ can be configured by higher layer parameter for the second DCI format. For initialization scrambling sequence for GC-PDCCH and GC-PDSCH for the first DCI format, $n\_{ID}$ can be configured by higher layer parameter.
	+ Proposal 2: The value of $n\_{RNTI}$ is 0 or a fixed value for initializing scrambling sequence for GC-PDCCH.
* *TD Tech*
	+ Proposal 9: $n\_{ID}=N\_{ID}^{cell}$ and  are used for GC-PDCCH scrambled with G-RNTI to derive a scrambling sequence in a CSS for NR MBS if the CSS is shared by unicast sessions.
	+ Proposal 10: If a CSS for NR MBS is shared by unicast sessions,  is suggested for GC-PDCCH DMRS to make GC-PDCCH scrambled with G-RNTI and PDCCH scrambled with C-RNTI have a same DMRS sequence.

### **Other DCI formats related proposals**

* *OPPO*
	+ Proposal 13: A new DL DCI format should be defined for the scheduling of group-common PDSCH.
* *vivo*
	+ Proposal 14: When UE is configured with multiple g-RNTIs, it is supported to configured two DCI formats with CRC scrambled different g-RNTIs. Otherwise, there is no need to configure two DCI formats for a UE simultaneously.

## Initial Proposals based on contributions

### **CORESET**

***Summary***

Regarding whether the CORESETs can be shared for unicast and multicast, 4 options were listed for further study in RAN1#104bis-e. In RAN1#105-e and RAN1#106-e it was further discussed but with no conclusion. Based on contributions in this meeting, 8 companies (OPPO, vivo, CATT, CMCC, Intel, TD Tech, Ericsson, Xiaomi) support option 1, 3 companies (Huawei, MTK, Samsung) think it is up to gNB implementation to use the same or different CORESETs for unicast DCIs and multicast DCIs. 3 companies [Futurewei, QC, NTT Docomo] support option 4. The situation does not change compared with previous meeting, and considering the discussion and comments in last meeting, moderator suggests to deprioritize this issue for now. After the signalling design is clear, it may be easier for us to converge or have a conclusion. If more companies think it is necessary to discuss it in this meeting, please raise it and we can discuss it in next rounds.

### **Search space set**

***Summary***

Regarding the FFS whether the Type-x CSS is a Type-3 CSS, editor of TS38.213 provides an example of the specification text in [14] using type-3A CSS (a new type CSS) and the existing type-3 CSS, respectively. Companies can check if it is OK to leave the decision to editor **(Initial proposal 2-1a**).

In [14], it is pointed out that there are several aspects on the search space set configuration for multicast DCI formats to be concluded such as whether the first and second DCI formats can be in same and/or different search space sets, whether or not DCI format 1\_0 (based on CSS) and the first DCI format for multicast can be in a same search space set, whether or not DCI format 2\_x and the second DCI format for multicast can be in a same search space set, etc. Based on these, moderator first provides two questions (**Initial question 2-1b/c**) to collect views from companies, and other aspects can be further discussed when we have conclusions for these two questions.

In [12], it is proposed to clarify whether PTP retransmission of PTM scheme 1 initial transmission would be scheduled using the type-x CSS or USS, since in current specification DCI format 1\_1 is always scheduled using USS while, for PTM scheme 1, both the first and second DCI format would be scheduled using the type-x CSS. Moderator provides an **initial question 2-1d** to collect views from companies regarding this issue.

In addition, [14] raises an issue that the prioritization is also needed for the determination of CORESETs where the UE monitors PDCCH in case the TCI state is 'typeD'. In Rel-16, if a UE is configured for single cell or intra-band CA and monitors PDCCH in overlapping occasions in multiple CORESETs with *qcl-Type* set to 'typeD', the UE monitors PDCCHs only in a CORESET, and in any other CORESET from the multiple CORESETs with *qcl-Type* set to same 'typeD' properties as the CORESET, where the CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS, if any; otherwise, to the USS set with the lowest index in the cell with lowest index. Then, as for overbooking, the issue is whether the CSS set for multicast is treated always with priority to USS sets or whether the same approach as for overbooking applies – the latter is preferable (otherwise there can even be situations where the UE prioritizes unicast for overbooking and prioritizes multicast for CORESETs and ends up not monitoring any such PDCCH). Moderator recommends the **initial proposal 2-1e** regarding this issue.

***Initial Proposals***

**Initial Proposal 2-1a**: The decision on whether the Type-x CSS is a Type-3 CSS is up to editor.

**Initial Question 2-1b**: Whether or not the first and second DCI formats for multicast can be configured in the same type-x CSS?

**Initial Question 2-1c**: Whether or not DCI format 1\_0 with CRC scrambled by C-RNTI and the first DCI format for multicast can be configured in the same type-x CSS?

**Initial Question 2-1d**: Whether PTP retransmission of PTM-1 initial transmission would be scheduled using the type-x CSS or not?

**Initial Proposal 2-1e**: When a UE monitors PDCCH only according to USS sets and CSS sets for multicast in CORESETs with qcl-Type set to same 'typeD' properties, the CORESETs are the ones having same 'typeD' properties as the CORESET corresponding to the USS set or CSS set for multicast with the lowest index.

### **First DCI format and fields**

***Summary***

Regarding the FDRA field of the first DCI format for multicast, about 9 companies (Huawei, CATT, Xiaomi, MTK, CMCC, NTT Docomo, Samsung, [Apple?]) prefer option 2, while about 6 companies (NEC, Spreadtrum, Nokia, Intel, Lenovo, APT) prefer option 3. Moderator recommend **initial proposal 2-2a** regarding this issue.

Regarding whether the field “TPC command for scheduled PUCCH” is needed for the first DCI format, at least 7 companies [NEC, ZTE, NTT Docomo, QC, APT, Lenovo, Ericsson] explicitly propose it is not needed, while 1 company [vivo] thinks it can be used for NACK-only feedback. Moderator recommends **initial proposal 2-2b** regarding this issue.

Regarding whether the unused field ‘Identifier for DCI formats’ should be reserved and repurposed for other fields, or should be removed for the first DCI format, 5 companies [Nokia, CATT, Xiaomi, CMCC, Lenovo] prefer it should be reserved and repurposed, while 4 companies [vivo, ZTE, MTK, Ericsson] prefer to remove it. Considering there is no majority view, companies may need more time to think about it, so moderator suggests to postpone the discussion for now, and we can take this into account when we discuss what new DCI fields are needed.

1 company (NTT Docomo) raises an issue that if the existing k1 list for DCI format 1\_0, which is fixed as {1, 2, 3, 4, 5, 6, 7, 8} is reused for the first DCI format for multicast, PUCCH scheduling flexibility is low since a larger slot offset cannot be indicated and HARQ feedback slot becomes the same among UEs receiving a group-common PDSCH. It is proposed that a list of k1 values for the first DCI format for multicast is configurable. Moderator suggests **initial propose 2-2c** regarding this issue.

Regarding the new DCI fields needed for the first DCI format, 2 companies [MTK, Lenovo] think that ‘HARQ feedback option’ and ‘HARQ feedback enable/disable’ should be introduced, 1 company [NTT Docomo] proposes to introduce ‘Priority indicator (1bit)’ and ‘Number of layers (1bit)’. Moderator recommends other companies to think about this and more inputs and views are welcome.

***Initial Proposals***

**Initial proposal 2-2a:** For FDRA determination of the first DCI format for GC-PDCCH, Option 2 is supported.

* + Option 2:
		-  is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
		- For resource indication value (*RIV*) of downlink resource allocation type 1, the similar scheme as for the case that the DCI size for DCI format 1\_0 in USS is derived from the size of DCI format 1\_0 in CSS but applied to an active BWP is used.
			* FFS details, e.g., if the size of CFR (i.e. $N\_{CFR}$) is larger than the size of CORESET0/initial DL bandwidth part, the resource indication value (*RIV*) is defined as in section 5.1.2.2.2 in TS38.214, where K is the maximum value from set {1, 2, 4, 8, [16]} which satisfies $K\leq \left⌊N\_{CFR}/N\_{BWP}^{initial}\right⌋$;otherwise, $K=1.$

**Initial proposal 2-2b:** The ‘TPC command for scheduled PUCCH’ field is not needed for the first DCI format for multicast.

* FFS: Whether the field should be reserved or should be removed.

**Initial proposal 2-2c:** A list of k1 values for the first DCI format for multicast is configurable via dedicated RRC signaling for RRC\_CONNECTED UEs.

### **Second DCI format and fields**

***Summary***

Regarding whether the unused field ‘Identifier for DCI formats’ and ‘SRS request’ should be reserved or should be removed for the second DCI format, no majority view can be identified for now. Moderator thinks we can postpone the discussion and take this into account when we discuss what new DCI fields are needed.

Regarding whether the field ‘TPC command for scheduled PUCCH’ is needed for the second DCI format, at least 6 companies [NEC, CATT, Nokia, NTT Docomo, QC, Ericsson] explicitly propose it is not needed, while 1 company [vivo] thinks it can be used for NACK-only feedback. Moderator recommends **initial proposal 2-3a** regarding this issue

Regarding other unused fields, several companies propose that ‘Carrier indicator’, ‘Bandwidth part indicator’, scheduling information for the 2nd TB, CBGTI and CBGFI are not needed for multicast, some companies think they can be left for gNB configuration. Moderator suggests **initial proposal 2-3b** regarding this.

1 company [NTT Docomo] proposes that the presence or absence of ‘DMRS sequence initialization’ in the second DCI format for multicast is configurable. Moderator recommend other companies to think about this proposal and more inputs and views are welcome.

Regarding the new DCI fields needed for the second DCI format, 1 company [MTK] proposes that ‘HARQ feedback option’ and ‘HARQ feedback enable/disable’ should be introduced. Moderator recommends other companies to think about this and more inputs and views are welcome.

***Initial Proposals***

**Initial proposal 2-3a:** The ‘TPC command for scheduled PUCCH’ field is not needed for the second DCI format for multicast.

* FFS: Whether the field should be reserved or should be removed.

**Initial proposal 2-3b**: For the second DCI format for multicast, the following fields are not needed and it can be based on network configuration such that 0 bit is required for them.

* ‘Carrier indicator’
* ‘Bandwidth part indicator’
* ‘Modulation and coding scheme’, ‘New data indicator’ and ‘Redundancy version’ for the second TB
* ‘CBG transmission information (CBGTI)’
* ‘CBG flushing out information (CBGFI)’

### **RB numbering for GC-PDSCH scheduled with the first DCI format:**

***Summary***

3 companies [Lenovo, MTK, NTT Docomo] propose that, for GC-PDSCH scheduled with the first DCI format for multicast, RB numbering starts from the lowest RB of the CFR. Moderator suggests the **initial proposal 2-4** regarding this.

***Initial Proposals***

**Initial Proposal 2-4**: For GC-PDSCH scheduled with the first DCI format for multicast, RB numbering starts from the lowest RB of the CFR.

### **Maximum number of BD/CCE**

***Summary***

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

### **DCI size alignment**

***Summary***

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

* Alt 1: G-RNTI is counted as “C-RNTI”
	+ Alt 1-1: The size of the second DCI format for multicast can be configured by RRC signalling for RRC\_CONNECTED UEs (similar as the configuration for the size alignment among DCI format 2\_0/2\_1/2\_4/2\_5/2\_6).
		- FFS: How to ensure different UEs in the same MBS group have the same understanding on the configurable DCI fields of the second DCI format for multicast.
			* E.g., it can be up to network implementation, or the size of some configurable fields of the second DCI format can be explicitly configured by gNB rather than derived based on RRC configurations.
	+ FFS: other alternatives.
	+ Supporting companies: Huawei, Nokia, CMCC, Ericsson, vivo, Xiaomi, TD Tech, APT
* Alt 2: G-RNTI is counted as “other RNTI”
	+ Supporting companies: ZTE, Lenovo, NTT Docomo, OPPO, MediaTek
* Alt 3: G-RNTI is counted as “C-RNTI” or “other RNTI” depending on RRC configurations
	+ Supporting companies: CATT, Intel
* Alt 4: No need to specify how to count the size of the second DCI format for multicast – the agreement that the UE expects to decode the Rel-16 limit of “3+1” DCI format sizes suffices.
	+ Supporting companies: Samsung

This issue was also discussed in RAN1#106-e with no conclusion, but based on the discussion in last meeting many companies preferred to down select from “C-RNTI” and “Other RNTI” rather than Alt 3. For Alt 1 (G-RNTI is counted as “C-RNTI”), based on the discussion in last meeting and contributions in this meeting, companies may have different understandings on this scheme, e.g., some companies (e.g., Nokia, CMCC) think that the size of the second DCI format for multicast can be configured by RRC signalling for RRC\_CONNECTED UEs (i.e., Alt 1-1, the reason was also explained in last meeting by moderator, and for the FFS in Alt 1-1, companies can refer to [12]), while it seems some other companies (e.g., Huawei) do not think so (i.e., may be some other variants in Alt 1 but moderator cannot figure out them). For simplicity and less specification efforts, moderator suggests Alt 2 in **initial proposal 2-5**. Supporting companies for Alt 1 can explain their understanding on Alt 1, e.g., if it is Alt 1-1 or some other variants.

***Initial Proposals***

**Initial Proposal 2-5**: For DCI size alignment of the second DCI format for multicast, G-RNTI is counted as “other RNTI”.

### **Initializing scrambling of PDCCH**

***Summary***

Regarding the down-selection for the value of $n\_{RNTI}$ for initializing scrambling sequence generator for GC-PDCCH with the second DCI format, 5 companies [ZTE, Xiaomi, NTT Docomo, Qualcomm, APT] propose Alt2 ($n\_{RNTI}=0$), 3 companies propose Alt1 ($n\_{RNTI}$ is given by G-RNTI used for the GC-PDCCH). Moderator suggests **initial proposal 2-6a** regarding this.

Regarding initializing scrambling sequence generator for GC-PDCCH with the first DCI format. 8 companies (Huawei, ZTE, Xiaomi, MTK, NTT Docomo, Apple, Qualcomm, APT) suggest the similar scheme as for the second DCI format can be used. Moderator suggests the **initial proposal 2-6b**.

Regarding the initializing sequence generator for DMRS of GC-PDCCH with the first DCI format, 5 companies (Huawei, ZTE, NTT Docomo, Qualcomm, APT) suggest the similar scheme as for the second DCI format can be used. Moderator suggests the **initial proposal 2-6c**.

***Initial Proposals***

**Initial proposal 2-6a**:

For initializing scrambling sequence generator for GC-PDCCH with the second DCI format for RRC\_CONNECTED UEs, $n\_{RNTI}$=0.

**Initial proposal 2-6b**:

For initializing scrambling sequence generator for GC-PDCCH with the first DCI format for RRC\_CONNECTED UEs,

* $n\_{ID}$ equals the higher layer parameter *pdcch-DMRS-ScramblingID* if it is configured in SIB used for the GC-PDCCH;$n\_{ID}=N\_{ID}^{cell}$ otherwise.
* FFS: Values for $n\_{RNTI}$. Choices include one or more of the following:
	+ Alt1: G-RNTI used for the GC-PDCCH.
	+ Alt2: 0
	+ Alt3: Other fixed values

**Initial proposal 2-6c:**

For initializing sequence generator for DMRS of GC-PDCCH with the first DCI format received in Type-x CSS for RRC\_CONNECTED UEs,

* $N\_{ID}$ equals the higher layer parameter *pdcch-DMRS-ScramblingID* if it is configured in SIB used for the GC-PDCCH; $N\_{ID}=N\_{ID}^{cell}$ otherwise.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | Proposal 2-1a: OKProposal 2-1b: is the intention to configure both formats simultaneously in same CSS?Proposal 2-1c: not necessaryProposal 2-1d: not necessary. Seems it excludes the possibility of transmitting the DCI for PTP retransmission in USS.Proposal 2-2a: Not support. Option 2 leads to too rough resource granularity in frequency domain.Proposal 2-2b: OK.Proposal 2-2c: Generally fine with us. We think the default list as DCI 1-0 in legacy behavior is needed, i.e., when such list for multicast is not configured, {1-8} is assumed.Proposal 2-3a: OK.Proposal 2-3b: Don’t support. If I remember correctly, the intention of supporting 2nd DCI format is to support MIMO. In that sense, I don’t know why MCS/NDI/RV for 2nd TB are not needed. Proposal 2-4: OK.Proposal 2-5: OK.Proposal 2-6a: OK.Proposal 2-6b: OK.Proposal 2-6c: OK. |
| LG | **Initial Proposal 2-1a**: We prefer a new Type CSS.**Initial Question 2-1d**: PTP retransmission could be basically handled as unicast, unless there is any need for differentiation. That is, PTP retransmission could use USS and CSS.**Initial proposal 2-2a:** OK**Initial proposal 2-2c:** OK**Initial proposal 2-6a**: We prefer Alt 1.**Initial proposal 2-6b**: We think that the intention of this proposal is that the parameter is cell specific in RRC. Whether this cell specific parameter is configured by SIB or dedicated signaling should be left for RAN2 decision. **Initial proposal 2-6c:** We think that the intention of this proposal is that the parameter is cell specific in RRC. Whether this cell specific parameter is configured by SIB or dedicated signaling should be left for RAN2 decision. |

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

# Issue #3: Configurations for GC-PDSCH

## Background and submitted proposals

***Submitted Proposals***

### **Initializing scrambling of PDSCH**

* *Huawei*
	+ Proposal 5: For initializing scrambling sequence generator for GC-PDSCH scheduled by the first DCI format for multicast received in Type-x CSS for RRC\_CONNECTED UEs,
		- $n\_{ID}$ equals the higher layer parameter dataScramblingIdentityPDSCH if it is configured in a RRC common IE e.g., PDSCH-ConfigCommon and the RNTI equals the G-RNTI or G-CS-RNTI; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
		- $n\_{RNTI}$ corresponds to the RNTI associated with the GC-PDSCH transmission (i.e., the G-RNTI used by the scheduling GC-PDCCH, or the G-CS-RNTI used by the SPS GC-PDSCH activation PDCCH)
	+ Proposal 6: For initializing sequence generator for DMRS of GC-PDSCH scheduled by first/second DCI format,
		- $N\_{ID}^{0} $and $N\_{ID}^{1} $are given by the higher-layer parameters scramblingID0 and scramblingID1, respectively, in the DMRS-DownlinkConfig IE if provided in PDSCH-Config in a CFR used for GC-PDSCH and the GC-PDSCH is scheduled by GC-PDCCH using the second DCI format
		- $N\_{ID}^{0}$ is given by the higher-layer parameter scramblingID0 in the DMRS-DownlinkConfig IE if provided in PDSCH-Config in a CFR used for GC-PDSCH and the GC-PDSCH is scheduled by GC-PDCCH using the first DCI format;
		- $N\_{ID}^{\overbar{n}\_{SCID}^{\overbar{λ}}}=N\_{ID}^{cell} $ otherwise;
* *NTT Docomo*
	+ Proposal 14: For initializing scrambling sequence generator for GC-PDSCH scheduled by the first DCI format for multicast received in Type-x CSS,
		- $n\_{ID}$ equals the higher layer parameter dataScramblingIdentityPDSCH if it is configured in PDSCH-Config in a CFR used for GC-PDSCH and the RNTI equals the G-RNTI or G-CS-RNTI; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
		- $n\_{RNTI}$ corresponds to the RNTI associated with the GC-PDSCH transmission.
* *Qualcomm*
	+ Proposal 9:
		- For initializing scrambling sequence generator for GC-PDSCH scheduled by the first DCI format for multicast received in Type-x CSS,
			* $n\_{ID}$ equals the higher layer parameter dataScramblingIdentityPDSCH if it is configured in PDSCH-Config in a CFR used for GC-PDSCH and the RNTI equals the G-RNTI or G-CS-RNTI; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
			* $n\_{RNTI}$ corresponds to the RNTI associated with the GC-PDSCH transmission (i.e., the G-RNTI used by the scheduling GC-PDCCH, or the G-CS-RNTI used by the SPS GC-PDSCH activation PDCCH)
* *TD Tech*
	+ Proposal 11: The same formula for initializing the scrambling sequence generator for PDSCH DMRS is reused for GC-PDSCH DMRS with $\overbar{λ}=0$ and $N\_{ID}^{\overbar{n}\_{SCID}^{\overbar{λ}}}=N\_{ID}^{cell}$.
* *CMCC*
	+ Proposal 10. For initializing sequence generator for DMRS of GC-PDSCH scheduled by the second DCI format for multicast received in Type-x CSS,
		- $N\_{ID}^{0} $and $N\_{ID}^{1} $equals the higher-layer parameters *scramblingID0* and *scramblingID1*, respectively, if it is configured in the *DMRS-DownlinkConfig*IE in a CFR used for GC-PDSCH; $N\_{ID}^{\overbar{n}\_{SCID}^{\overbar{λ}}}=N\_{ID}^{cell} $ otherwise.
* *ZTE*
	+ Proposal 15: For initializing scrambling sequence generator for GC-PDSCH scheduled by the first DCI format for multicast received in Type-x CSS,
		- $n\_{ID}$ equals the higher layer parameter dataScramblingIdentityPDSCH if it is configured in SIB used for GC-PDSCH and the RNTI equals the G-RNTI or G-CS-RNTI; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
		- $n\_{RNTI}$ corresponds to the RNTI associated with the GC-PDSCH transmission (i.e., the G-RNTI used by the scheduling GC-PDCCH, or the G-CS-RNTI used by the SPS GC-PDSCH activation PDCCH)
	+ Proposal 15: For initializing sequence generator for DMRS of GC-PDSCH,
		- $N\_{ID}^{0} $and $N\_{ID}^{1} $are given by the higher-layer parameters scramblingID0 and scramblingID1, respectively, in the DMRS-DownlinkConfig IE if provided in PDSCH-Config in a CFR used for GC-PDSCH and the GC-PDSCH is scheduled by GC-PDCCH using the second DCI format
		- $N\_{ID}^{0}$ is given by the higher-layer parameter scramblingID0 if provided in SIB used for GC-PDSCH and the GC-PDSCH is scheduled by GC-PDCCH using the first DCI format;
		- $N\_{ID}^{\overbar{n}\_{SCID}^{\overbar{λ}}}=N\_{ID}^{cell} $ otherwise;
		- FFS: $n\_{SCID}\in \left\{0, 1\right\}$ is given by the DM-RS sequence initialization field, if present, in the DCI associated with the GC-PDSCH transmission if second DCI format is used, otherwise $n\_{SCID}=0$.

## Initial Proposals based on contributions

### **Initializing scrambling of PDSCH**

***Summary***

Regarding initializing scrambling sequence generator for GC-PDSCH scheduled by the first DCI format. 5 companies (Huawei, ZTE, NTT Docomo, Qualcomm, APT) suggest the similar scheme as for GC-PDSCH scheduled by the second DCI format can be used. Moderator suggests the **initial proposal 3-1a** regarding this.

Regarding initializing sequence generator for DMRS of GC-PDSCH, 3 companies give corresponding proposals. Moderator suggests the **initial proposal 3-1b** regarding this.

***Initial Proposals***

**Initial proposal 3-1a**

For initializing scrambling sequence generator for GC-PDSCH scheduled by the first DCI format for multicast received in Type-x CSS for RRC\_CONNECTED UEs,

* $n\_{ID}$ equals the higher layer parameter *dataScramblingIdentityPDSCH* if it is configured in SIB used for GC-PDSCH and the RNTI equals the G-RNTI or G-CS-RNTI; $n\_{ID}=N\_{ID}^{cell}$ otherwise.
* $n\_{RNTI}$ corresponds to the RNTI associated with the GC-PDSCH transmission (i.e., the G-RNTI used by the scheduling GC-PDCCH, or the G-CS-RNTI used by the SPS GC-PDSCH activation PDCCH)

**Initial proposal 3-1b:**

For initializing sequence generator for DMRS of GC-PDSCH,

* $N\_{ID}^{0} $and $N\_{ID}^{1} $are given by the higher-layer parameters *scramblingID0* and *scramblingID1*, respectively, in the *DMRS-DownlinkConfig*IE if provided in *PDSCH-Config* in a CFR used for GC-PDSCH and the GC-PDSCH is scheduled by GC-PDCCH using the second DCI format
* $N\_{ID}^{0}$ is given by the higher-layer parameter *scramblingID0* if provided in SIB used for GC-PDSCH and the GC-PDSCH is scheduled by GC-PDCCH using the first DCI format;
* $N\_{ID}^{\overbar{n}\_{SCID}^{\overbar{λ}}}=N\_{ID}^{cell} $ otherwise;
* FFS: $n\_{SCID}\in \left\{0, 1\right\}$ is given by the DM-RS sequence initialization field, if present, in the DCI associated with the GC-PDSCH transmission if second DCI format is used, otherwise $n\_{SCID}=0$.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | **Initial proposal 3-1a/b:**We think that the intention of this proposal is that the parameter is cell specific in RRC. Whether this cell specific parameter is configured by SIB or dedicated signaling should be left for RAN2 decision. |
|  |  |

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

# Issue #4: Retransmission and HARQ process management

## Background and submitted proposals

***Submitted Proposals***

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

* *Ericsson*
	+ Observation 1: Flexibility and performance of multicast and unicast may be severely compromised unless special support for handling of HARQ processes and NDIs is introduced in Rel-17. It will be impossible to add such enhancements in later releases in a backwards-compatible way.
	+ Observation 2: NDI conflicts may occur for PTM reception, when different UEs have different “latest” NDI bit status for the HPID. A new rule, based on NDI toggling for an NDI done independently per G-RNTI and a new received RNTI overriding the NDI bit toggling for the HPID, can solve the identified issue.
	+ Proposal 1 For a transmitted G-RNTI, the NDI of a HARQ process is toggled when it carries new data relative to the latest earlier transmission using the same G-RNTI. The NDI toggling is therefore done independently for each G-RNTI.
	+ Proposal 2 For a received G-RNTI, the UE is expected to compare the received G-RNTI/NDI pair with the latest earlier received G-RNTI/NDI pair of the same HARQ process. If the RNTI/NDI combinations are identical this is a retransmission, else this is new data.
	+ Proposal 3 For a transmitted C-RNTI, the NDI of a HARQ process is toggled when there is new data, irrespective of the RNTI (C-RNTI or G-RNTI) of the latest earlier transmission of the HARQ process.
		- Note: Since this behavior is independent of RNTI and only dependent on new data on the HARQ process, it implies no change to existing rules for C-RNTI, but may nevertheless need to be specified.
	+ Proposal 4 For a received C-RNTI, the UE would detect new data as in legacy NR, i.e. by comparing the received NDI of the HARQ process with the latest earlier received transmission, irrespective of RNTI.
		- Note: Since this behavior is independent of RNTI and only dependent on new data on the HARQ process, it implies no change to existing rules for C-RNTI, but may nevertheless need to be specified.
* *CATT*
	+ Proposal 11: The NDI conflict issue needs to be solved though potential specification enhancement.
	+ Proposal 12: For NDI scheme of multicast, Option 1(When a G-RNTI DCI is received with a given HPID in the DCI, the data shall be considered new, i.e. be treated as if the NDI bit had been toggled, irrespective of actual NDI toggling, if the G-RNTI is different from the most recent earlier received RNTI (i.e. C-RNTI or another G-RNTI) of the same HPID. When the received G-RNTI is the same as the most recent use of the HPID, legacy NDI toggling is used to indicate new data or retransmission.) is preferred.
	+ Proposal 13: Down-selection from following options to solve the issue that the UE incorrectly soft-combine the received TB with PTP retransmission for multicast and the received TB with PTP (re)transmission for unicast when the HPID and NDI of multicast transmission and unicast transmission is same and the group-common PDCCH was missed.
		- Option 1: introduce a field in DCI 1\_1/1\_2 of PTP transmission to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
		- Option 2: use the different TB size of unicast and multicast to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *Nokia*
	+ Observation-13: NDI toggling between transmissions and retransmissions within the group-common DCI having the same HARQ process ID cannot be applied for multicast.
	+ Proposal-19: For multicast, mechanism similar to SPS needs to be utilized where NDI=1 in the group-common DCI indicates new transmission and NDI=0 indicating retransmission.
* *CMCC*
	+ Proposal 14. If a same HPN is used for different DL grants corresponding to new transmissions of different G-RNTIs, UE will consider the NDI in DCI format with G-RNTI to have been toggled regardless of the value of the NDI.
	+ Proposal 15. If a same HPN is used for different DL grants corresponding to unicast new transmission and multicast new transmission, UE will consider the NDI in DCI format with G-RNTI or C-RNTI to have been toggled regardless of the value of the NDI.
* *Samsung*
	+ Observation 8: HPN process sharing between unicast PDSCHs and multicast PDSCHs can be handled by gNB implementation without actual scheduling constraints for the Rel-17 framework.
* *FGI, APT*
	+ Proposal 9: When a DCI with CRC scrambled by G-RNTI is received with a given HARQ process ID (HPID) in the DCI, the data shall be considered new, i.e. be treated as if the NDI bit had been toggled, irrespective of actual NDI toggling, if the G-RNTI is different from the most recent earlier received RNTI (i.e. C-RNTI or another G-RNTI) of the same HPID. When the received G-RNTI is the same as the most recent use of the HPID, legacy NDI toggling is used to indicate new data or retransmission.
* *NTT Dococmo*
	+ Proposal 11: RAN1 should discuss whether to consider different NDI values in the UE group for a certain HARQ PID before performing an initial PTM transmission.
	+ Observation 4: Regarding the interpretation method of NDI, both options may cause the problem of incorrectly soft-combining a unicast TB and a multicast TB due to PDCCH miss detection.

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

* *Ericsson*
	+ Observation 3 When the PDCCH of the PTM initial transmission is missed, a PTP retransmission of PTM may result in data corruption in the HARQ buffer depending on the NDI of the last PTP transmission prior to the PTM initial transmission
	+ Observation 4 The proposed new UE rule allows for all three cases (1), (2) and (3) to be solved with no loss of performance for the UE and with a minimum of specification and UE impact. The additional overhead for the network is very small (negligible).
	+ Observation 5 Adding one DCI bit in the C-RNTI DCI to signal a PTP retransmission of an earlier PTM initial transmission would solve case (1) but not case (3) and would have significant specification impact.
	+ Proposal 5 No DL Uu interface specification impact to solve the identified issues related to a missed initial PTM PDCCH followed by a PTP retransmission.
	+ Proposal 6 The UE may be configured to use the following new Uu interface UE rule and procedure:
		- For a given HARQ process (HPID),
			* when a UE, configured with G-RNTI, receives a C-RNTI with a HPID, and the latest earlier received transmission of the same HPID (C-RNTI or G-RNTI)
				+ had the same NDI as the current C-RNTI
				+ was ACK’ed by the UE
			* THEN
				+ The UE flushes the HARQ buffer, introduces the new data in the HARQ buffer, attempts to decode and sends ACK/NACK based on the result.
* *Huawei, HiSilicon*
	+ Proposal 9: Support DCI scheduling PTP transmission indicates whether the transmission is for unicast (re)transmission or for multicast retransmission.
		- For UE configured with multiple G-RNTIs, the DCI should further differentiate the PTP transmission is for which G-RNTI retransmission.
* *OPPO*
	+ Proposal 6: It is up to gNB to avoid NDI collision between multicast and unicast crossed scheduling with the same HPID.
	+ Proposal 7: There is no necessary to introduce any mechanism to differentiate the HPID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *ZTE*
	+ Proposal 13: Regarding how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast,
		- The value of the NDI in the PTP PDCCH for scheduling the retransmission of multicast TB is toggled relative to the NDI in the UE’s latest PTP PDCCH for scheduling a unicast TB with the same HPID.
* *vivo*
	+ Proposal 5: For HARQ process management, there is no need differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *NEC*
	+ Proposal 4: Reuse the redundant field in the first DCI format and the second DCI format, if they are same as current DCI format 1\_0 and DCI format 1\_1, to indicate the transmission corresponding to unicast service or multicast service.
* *Nokia*
	+ Proposal-18: Repurpose existing unused fields such as ‘Identifier for DCI formats’, ‘TPC command for scheduled PUCCH’ for both DCI formats 1\_0 and 1\_1, and ‘Carrier indicator’ and ‘Bandwidth part indicator’ for DCI format 1\_1, for indicating PTP retransmission of PTM initial transmission.
* *CMCC*
	+ Proposal 16. Support using a DCI field in DCI format 1\_0/1\_1 with C-RNTI to differentiate the HPN is used for unicast transmission or for multicast PTP retransmission.
* *Intel*
	+ Proposal 10: A UE does not expect PTM Scheme 1 based initial transmission or a PTP based retransmission of a MBS TB using a HARQ process number which is in use for an ongoing unicast transmission.
* *Qualcomm*
	+ Proposal 13: For HARQ process management,
		- Support dynamic HPID management for unicast and multicast can be supported without increasing soft buffer size.
			* If the HPID for multicast is configured with NACK-only or no HARQ-ACK feedback, PTP cannot be used for PTM retx. So, PTP with the same HPDI can be used for unicast data transmission only.
			* If the HPID for multicast is configured with ACK/NACK-based feedback, the PTP with the same HPID can be used for PTM retransmission and select Alt1 or Alt2 subject to UE capability.
				+ Alt1: PTP with the same HPID cannot be used for unicast data
				+ Alt2: PTP with the same HPID can be used for unicast data, one DCI bit is used to differentiate PTP for multicast retransmission and PTP for unicast
* *Xiaomi*
	+ Observation 1: There is no issue on differentiating the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* *Google*
	+ Observation 1: For PTP retransmission, the transmission received by UE-b in Phase-3 is a mistake gNB behavior. The soft-combining mistake can be avoid if the gNB is properly configured.
	+ Observation 2: Error case may happen due to insufficient number of HARQ processes (i.e. HARQ process starvation) and mistake gNB behavior. Since companies have no problem on the maximum number of HARQ process, there is no need to introduce features to differentiate MBS and unicast transmission in physical layer.
	+ Observation 3: For HARQ process and NDI differentiation for MBS and unicast
		- If the differentiation is configured by RRC, it restricts the gNB on controlling UE soft buffer utilization.
		- If the differentiation is scheduled by DCI, the result is identical to increasing the maximum number of HARQ processes.
	+ Proposal 1: HARQ ID starvation on supporting MBS and unicast can be resolved based on networks implementation, e.g. configuring PTP only or using HARQ enabling/disabling.
	+ Proposal 2: If further enhancement on handling HARQ ID starvation issue is needed, increase the maximum number of HARQ processes.

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

* *Huawei, HiSilicon*
	+ Proposal 11: 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 5: When PTM scheme 1 is used as initial transmission, PTM scheme 1 and PTP are not supported to be used simultaneously for the same TB for different UEs in the same multicast group.
* *Spreadtrum*
	+ Proposal 2: If initial transmission for multicast is based on PTM transmission scheme 1, not simultaneously support PTM1 and PTP together as the retransmission scheme.
* *vivo*
	+ Proposal 4: 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 9: PTM scheme 1 retransmission and PTP retransmission cannot be used simultaneously for different UEs in the same MBS group.
* *FUTUREWEI*
	+ Proposal 5: Different retransmission schemes (e.g., PTM scheme 1 and PTP) can be used simultaneously for different UEs in the same group.
		- The same HARQ process ID and NDI bit (not toggled) are used to signal transmission of the same TB.
		- The soft combining of the same TB from the PTM scheme 1 and PTP retransmissions is left up to UE implementation.
* *CMCC*
	+ Proposal 12. PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group.
	+ Proposal 13. 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.
* *LGE*
	+ Proposal 10: Upon receiving PTP retransmission of a TB with a HPN, UE expects PTP retransmission of the TB after sending NACK to the TB.
		- It is up to UE whether to additionally receive retransmission of the same TB on group common PDSCH with the same HPN and non-toggled NDI.
* *Lenovo*
	+ Proposal 2: 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.
* *Xiaomi*
	+ Proposal 14: Do not support PTM scheme 1 based retransmission and PTP scheme based retransmission simultaneously for dynamic MBS transmission in the same MBS group.
* *Ericsson*
	+ Observation 6: 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.
	+ Observation 7 Soft-combining PTM and PTP can be much more efficient than independent PTM and PTP transmissions.
	+ Proposal 7 Based on UE capability, a UE in a G-RNTI-based scheduling group may receive both PTM and PTP with same HARQ process, within the same HARQ-ACK feedback bundling window determined via dlDataToUL-ACK.
	+ Observation 8 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 8 Within the same HARQ feedback cycle, a UE may assume that two PDSCH transmitted with the same HARQ process ID corresponds to the same transport block, irrespective of NDI or RNTI used, for the purpose of combining.

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

* *Huawei, HiSilicon*
	+ Proposal 10: For multicast services, when UE is scheduled to receive a PTM1 initial transmission and a PTP retransmission with the same HPN at the same time, UE should receive the PTP retransmission.
* *CATT*
	+ Proposal 10: For a given HARQ process number, a UE is not expected to receive a new TB with the same HARQ process number before the completion of the transmission of a previous TB.
* *Qualcomm*
	+ Proposal 13: For HARQ process management,
		- Not support OOO between PTM-1 and PTP for a given HPID
* *LGE*
	+ Proposal 11: After transmitting PTP retransmission with a HPN, it is up to gNB whether group common DCI with the same HPN and a toggled NDI can be transmitted to schedule new TX of group common PDSCH.
		- If new TX has a lower priority than the PTP retransmission, a UE does not receive new TX of group common PDSCH before successfully sending ACK to PTP retransmission.
		- If new TX has a higher priority than the PTP retransmission, a UE receives new TX of group common PDSCH even before successfully sending ACK to PTP retransmission.
		- Otherwise (e.g. if new TX has an equal priority with the PTP retransmission), a UE does not receive new TX of group common PDSCH before successfully sending ACK to PTP retransmission.
	+ Proposal 12: After transmitting unicast transmission with a HPN, it is up to gNB whether group common DCI with the same HPN and a toggled NDI can be transmitted to schedule new TX of group common PDSCH.
		- If new TX has a lower priority than the unicast transmission, a UE does not receive new TX of group common PDSCH before successfully sending ACK to unicast transmission.
		- If new TX has a higher priority than the unicast transmission, a UE receives new TX of group common PDSCH even before successfully sending ACK to unicast transmission.
		- Otherwise, a UE does not receive new TX of group common PDSCH before successfully sending ACK to unicast transmission.
	+ Proposal 13: After transmitting group common PDCCH/PDSCH with a HPN, it is up to gNB whether UE specific DCI with the same HPN and a toggled NDI can be transmitted to schedule new TX of unicast PDSCH.
		- If new TX has a lower priority than the group common transmission, a UE does not receive new TX of unicast PDSCH before successfully sending ACK to the group common PDSCH.
		- If new TX has a higher priority than the group common transmission, a UE receives new TX of unicast PDSCH even before successfully sending ACK to the group common PDSCH.
		- Otherwise, a UE receives new TX of unicast PDSCH even before successfully sending ACK to the group common PDSCH.
* *Lenovo*
	+ Proposal 3: For a given HARQ process number, a UE is not expected to receive a new TB with the same HARQ process number before the completion of the transmission of a previous TB.

### **PTM scheme 2**

* *OPPO*
	+ Proposal 4: PTM scheme 2 is NOT supported as a (re)transmission scheme for NR MBS.
* *Spreadtrum*
	+ Proposal 1: For RRC\_CONNECTED UEs for NR MBS, not support PTM2 transmission scheme.
* *vivo*
	+ Proposal 3: For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast.
* *Nokia*
	+ Observation-7: Having a UE-specific PDCCH that can schedule UEs to use a group-common PDSCH is desirable for the following reasons:
		- In scenarios where there is a low density of users receiving multicast traffic with high data rates and requiring uplink feedback, gNB will have the flexibility to choose the appropriate control channel signaling mechanism
		- Enables the support of seamless mobility and switching from multicast to unicast
		- Enables simultaneous BWP switching and scheduling of MBS PDSCH resources using the same DCI
		- For SPS, it ensures the reliable reception of the SPS activation, deactivation and modification messages.
	+ Observation-8: In order to support both signaling options to access the same group-common PDSCH, new signaling mechanisms will be required to allow the network to configure and modify on a dynamic basis the use of either PTM schemes 1 or 2.
	+ Proposal-9: For RRC\_CONNECTED UEs, support UE-specific PDCCH with CRC scrambled by a C-RNTI for dynamic scheduling and CS-RNTI for SPS, to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on a common RNTI.
	+ Proposal-10: The same group-common PDSCH for PTM transmission can be simultaneously accessed by:
		- A set of UEs using the same group-common PDCCH with CRC scrambled by a common RNTI, or
		- A set of UEs, where each UE uses a UE-specific PDCCH with CRC scrambled by a C-RNTI or CS-RNTI
	+ Proposal-11: The network can dynamically modify the signaling using Alt 1 / group-common or Alt 2 / UE-specific PDCCH to configure a UE to access a group-common PDSCH.
* *Intel*
	+ Proposal 7: PTM Scheme 2 should be supported when ACK/NACK based HARQ feedback is configured or enabled for the UEs within a group.
	+ Proposal 8: Only one among PTP or PTM Scheme 2 can be supported for UE specific retransmission when the initial transmission was based on PTM Scheme 1. The support of PTP or PTM Scheme 2 can be configured by UE-specific RRC signaling. Different UEs in a group can potentially support different retransmission schemes but not both simultaneously.
	+ Proposal 9: The HARQ process ID is used to associate PTM Scheme 2 based retransmission with the initial transmission using PTM Scheme 1. The UE does not expect to receive a unicast transmission using the same HARQ process ID as the ongoing MBS transmission.
* *Convida*
	+ Proposal 1: PTP transmission and PTM transmission scheme 2 should be supported for initial transmission for MBS.
	+ Proposal 2: PTM transmission scheme 2 should be supported for retransmission for MBS.
	+ Proposal 3: 1-bit field is introduced in the DCI format for the UE to distinguish between the UE-specific PDCCH scheduling the MBS PDSCH and scheduling the unicast PDSCH.
* *Xiaomi*
	+ Proposal 13: Do not support PTM transmission scheme 2.
* *ASUSTeK*
	+ Proposal 6: PTM transmission scheme 2 for initial transmissions and retransmissions is supported for multicast.
* *Ericsson*
	+ Observation 9: PTM-1 is more efficient than PTM-2 for initial transmission and retransmissions of group-common PDSCH
	+ Observation 10: PTP is more efficient than PTM-2 for retransmission to individual UEs
	+ Proposal 9: PTM-2 based initial transmission is not supported.
	+ Proposal 10: PTM-2 based retransmission is not supported.

## Initial Proposals based on contributions

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

***Summary***

In RAN1#106-e, several companies raise a similar issue that NDI conflict may occur for PTM reception, when different UEs have different “latest” NDI bit status for the HPID. As explained in [28], before receiving the G-RNTI DCI, two different UEs may have each received a TB using the same HPID, which for UE1 resulted in NDI bit status ‘0’ whereas for UE2 in NDI bit status ‘1’. When the gNB uses the same HPID for a new TB, with a G-RNTI that both UEs belong to, it is then logically impossible to toggle the NDI in a way that would satisfy the toggling rule for both UEs. This issue is not limited to previous reception via C-RNTI. The same conflict may arise when the earlier RNTIs are different G-RNTIs or G-RNTI and C-RNTI combinations. In my understanding, this issue may happen unless the HARQ processes are semi-statically split among unicast and different multicast services, which means a HPID can only be exclusively used by C-RNTI or one of the multiple G-RNTIs. It has been agreed in RAN1#104 meeting that how to allocate HARQ processes between unicast and multicast is up to gNB. If gNB dynamically allocates HARQ processes among unicast and different multicast services, this issue may happen.

In RAN1#106-e, one question was asked to collect companies’ views on this issue, i.e., to rely on gNB implementation to avoid such issue (option 1) or to resolve this issue with potential specification enhancement (option 2), 10 companies preferred option 1 and 10 companies preferred option 2 during the discussion. Based on contributions submitted in this meeting, 5 companies (Ericsson, CATT, Nokia, CMCC, APT) propose to resolve this issue with potential specification enhancement, while 1 company (Samsung) thinks that HPN process sharing between unicast PDSCHs and multicast PDSCHs can be handled by gNB implementation without actual scheduling constraints for the Rel-17 framework. Some companies pointed out that flexibility and performance of multicast and unicast may be severely compromised unless special support for handling of HARQ processes and NDIs is introduced in Rel-17. It will be impossible to add such enhancements in later releases in a backwards-compatible way. The same question (initial Question 4-1a) as discussed in last meeting will be asked again in this meeting to check whether the situation changes compared to last meeting.

***Initial Proposals***

**Initial Question 4-1a**: Regarding the NDI conflict issue that different UEs in a group may have different NDI values for a certain HPID before performing an initial PTM transmission, which option should be adopted?

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

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

***Summary***

Regarding the FFS in RAN1#105-e that whether/how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast (as illustrated in the following figure), it is moderator’s understanding that it depends on the discussion result of question 4-1a, and only when the answer of the question 4-1a is option 2 (i.e., based on specification enhancement), the issue in the following figure may exist, since the issue is based on an assumption that multicast and unicast can share the same HPID dynamically and the NDI toggling rule should be enhanced, i.e., it needs to be specified how UE-b in the following figure interprets the case that the current PTM-1 reception and the previous PTP reception use the same NDI=1 and the same HPID.



Based on contributions submitted in this meeting, companies’ views diverge.

* 1 company [Ericsson] proposes to define a new Uu interface UE rule and procedure to solve this issue, i.e., for a given HPID, when a UE, configured with G-RNTI, receives a C-RNTI with a HPID, and the latest earlier received transmission of the same HPID (C-RNTI or G-RNTI) had the same NDI as the current C-RNTI and was ACK’ed by the UE, then, the UE flushes the HARQ buffer, introduces the new data in the HARQ buffer, attempts to decode and sends ACK/NACK based on the result.
* Some companies [OPPO, vivo, Xiaomi, Intel? Google?] think there is no need to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.
* Some companies [Huawei, CATT, Nokia? CMCC, Qualcomm] propose to introduce DCI bit(s) to differentiate PTP (re)transmission for unicast and PTP retransmission for multicast.
* 1 company [ZTE] thinks the value of the NDI in the PTP PDCCH for scheduling the retransmission of multicast TB is toggled relative to the NDI in the UE’s latest PTP PDCCH for scheduling a unicast TB with the same HPID.

Moderator suggests to discuss this issue after we have conclusion on Question 4-1a. If the decision is option 1 (i.e., rely on gNB implementation to avoid such issue), then we do not need to discussion this issue. If the decision is option 2 (i.e., Resolve this issue with potential specification enhancement), then based on what NDI toggling rule to be defined for the enhancement we can further discuss whether/how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast.

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

***Summary***

Regarding whether PTM-1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group, 5 companies [OPPO, Spreadtrum, CATT, Lenovo, Xiaomi] do not support this, 3 companies [Futurewei, CMCC, Ericsson] propose to support this, 1 company [Huawei] thinks it is up to gNB to retransmit the failed TB via PTM scheme 1 or PTP, and UE does not need to be configured with PTM scheme 1 or PTP or both for retransmission. 1 company [LGE] proposes that upon receiving PTP retransmission of a TB with a HPID, UE expects PTP retransmission of the TB after sending NACK to the TB, and it is up to UE whether to additionally receive retransmission of the same TB on group common PDSCH with the same HPN and non-toggled NDI. Considering the situation does not change much compared to last meeting, moderator suggests to postpone the discussion in this meeting.

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

***Summary***

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

### **PTM scheme 2**

***Summary***

Regarding PTM scheme 2, 4 companies propose to support PTM-2 for initial transmission or retransmission, while 4 companies propose to not support it. It seems the situation does not change much compared with the last meeting. Moderator proposes to postpone the discussion.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | Proposal 4-1a: Option 1 is preferred.In case of Option 2, addressing the conflicting among multiple MBS services may need more standardization effort. |
| LG | **Initial Question 4-1a**: We prefer Option 2.In our view, as specified in Rel-15/16, UE should interpret NDIs in unicast DCIs only across unicast PDCCHs. Meanwhile, UE should interpret NDIs in multicast DCIs only within same G-RNTI, not across G-RNTIs/unicast. Thus, NDIs for multicast DCIs and NDIs for unicast DCIs should be independently and separately handled. In details:* + - * a NDI value for unicast DCI and a NDI value for subsequent group common DCI can be same or different. Besides, a NDI value for group common DCI and a NDI value for subsequent unicast DCI can be same or different.
			* For same G-RNTI, the NDI value should be same for a same TB for group common DCIs and PTP retransmissions.
 |

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

# Issue #5: SPS for MBS

## Background and submitted proposals

***Submitted Proposals***

### **SPS configuration**

* *ZTE*
	+ Proposal 16: Multiple G-CS-RNTIs can associate with the same SPS-config.
* *vivo*
	+ Proposal 6: For an SPS PDSCH configuration, it is indicated as a group-common SPS by RRC configuration.
	+ Proposal 7: When a UE is configured with SPS-configs in CFR, G-CS-RNTI is configured per SPS-config.
		- Multiple G-CS-RNTIs associated with one SPS-config is not supported.
* *CATT*
	+ Proposal 18: It is not necessary to support multiple G-CS-RNTIs associated with one SPS-config.
* *OPPO*
	+ Proposal 8: It is not supported that multiple G-CS-RNTIs associated with one SPS-config.
* *Nokia*
	+ Observation-5: Currently there is no limitation in the specifications that would prevent the same SPS-config index to be used by different G-CS-RNTIs to activate a particular SPS pattern.
	+ Proposal-7: Multiple G-CS-RNTIs can be associated with one SPS-config index.
	+ Observation-9: Configuration of uplink HARQ feedback for SPS-based MBS can be inherited from SPS for unicast in combination with uplink feedback for non-SPS-based MBS.
* *FUTUREWEI*
	+ Proposal 9: Support of more than one SPS group-common PDSCH configuration.
* *Xiaomi*
	+ Proposal 15: Do not support multiple G-CS-RNTIs associated with one SPS-config.
* *Samsung*
	+ Observation 10: Associating multiple G-CS-RNTIs with one SPS-Config unicast PDSCH requires new UE hardware.
	+ Proposal 7: Consider a UE capability for Rel-17 MBS to support one or more SPS-Config per RNTI.
* *MediaTek*
	+ Proposal 18: Not support multiple G-CS-RNTIs associated with one SPS-config.
* *Intel*
	+ Proposal 21: For DL SPS configuration for NR MBS
		- Group common PDCCH is used for SPS activation with HARQ ID field set to all 0’s and RV field set to 00 for the TB being scheduled
		- PUCCH resource for HARQ feedback may be configured via RMSI, OSI or RRC
		- For SPS release, similar group common PDCCH can be used with HARQ ID set to all 0s, MCS and FDRA set all 1’s and RV set 0. For SPS release DCI, UE can be configured with PUCCH resource via RRC
		- The PUCCH resources for HARQ feedback for SPS PDSCH as well as the SPS release DCI can be UE-specific for ACK/NACK based feedback or a common PUCCH resource can be configured for the case when NACK-only feedback is configured.
	+ Proposal 22: Only one G-CS-RNTI is associated with one SPS-config
* *Qualcomm*
	+ Proposal 14: No need of explicit configuration of associating G-CS-RNTI with a SPS-Config-Multicast.
		- It is up to gNB on how to associate between G-CS-RNTI and SPS-Config-Multicast.
* *ASUSTeK*
	+ Proposal 3: SPS multicast PDSCH receptions are not interrupted in a CFR when switching between two BWPs if the CFR can be shared between the two BWPs.
* *Ericsson*
	+ Proposal 20: G-CS-RNTI is configured per SPS configuration. If not configured, the UE assumes CS-RNTI is used for PDSCH.
	+ Proposal 21: CS-RNTI and G-CS-RNTI can be configured for the same SPS configuration.
	+ Proposal 22: 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 23: Only one G-CS-RNTI is supported per SPS configuration.

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

* *Huawei, HiSilicon*
	+ Proposal 12: Support Alt 3: Retransmit the activation command via MAC-CE for reliability of multicast SPS.
* *OPPO*
	+ Proposal 9: UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH is not considered in Rel-17 MBS.
	+ Proposal 10: Retransmission of activation command via GC-PDCCH can be considered when ACK/NACK-based feedback scheme is enabled for multicast SPS.
* *Spreadtrum*
	+ Proposal 6: Regarding the reliability of the group-common PDCCH activation of SPS group-common PDSCH, at least one of Alt.1 and Alt.2 could be supported.
* *ZTE*
	+ Proposal 17: UE-specific PDCCH is not needed for activation/deactivation of an SPS GC-PDSCH given that group-common PDSCH has already been supported.
	+ Proposal 18: NR MBS supports to retransmit the activation command via GC-PDCCH.
* *vivo*
	+ Proposal 8: For activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state, UE-specific PDCCH is supported
	+ Proposal 9: For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support Alt 1and Alt 2.
		- Alt 1: retransmit the activation command via group-common PDCCH.
		- Alt 2: retransmit the activation command via UE-specific PDCCH.
* *CATT*
	+ Proposal 14: UE-specific PDCCH can be also used for SPS activation for MBS for RRC\_CONNECTED UEs.
	+ Proposal 15: Both Alt 1 and Alt 2 can be supported for reliability of the group-common PDCCH retransmitted activation of SPS group-common PDSCH.
* *Nokia*
	+ Proposal-8: For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support Alt 1 whereby missed SPS activation/deactivation could be handled using blind repetition of the SPS group-common PDCCH activation / deactivation messages – in case HARQ NACK-only feedback is utilized, and both Alt 1 and Alt 2 using UE-specific or group-common PDCCH for SPS group-common PDSCH – if HARQ ACK/NACK feedback option is used.
	+ Observation-6: 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-9: 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-7: Having a UE-specific PDCCH that can schedule UEs to use a group-common PDSCH is desirable for the following reasons:
		- In scenarios where there is a low density of users receiving multicast traffic with high data rates and requiring uplink feedback, gNB will have the flexibility to choose the appropriate control channel signaling mechanism
		- Enables the support of seamless mobility and switching from multicast to unicast
		- Enables simultaneous BWP switching and scheduling of MBS PDSCH resources using the same DCI
		- For SPS, it ensures the reliable reception of the SPS activation, deactivation and modification messages.
	+ Observation-8: In order to support both signaling options to access the same group-common PDSCH, new signaling mechanisms will be required to allow the network to configure and modify on a dynamic basis the use of either PTM schemes 1 or 2.
	+ Proposal-9: For RRC\_CONNECTED UEs, support UE-specific PDCCH with CRC scrambled by a C-RNTI for dynamic scheduling and CS-RNTI for SPS, to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on a common RNTI.
	+ Proposal-10: The same group-common PDSCH for PTM transmission can be simultaneously accessed by:
		- A set of UEs using the same group-common PDCCH with CRC scrambled by a group-common RNTI – such as G-CS-RNTI / G-RNTI, or
		- A set of UEs, where each UE uses a UE-specific PDCCH with CRC scrambled by a C-RNTI or CS-RNTI
	+ Proposal-11: The network can dynamically modify the signaling using Alt 1 / group-common or Alt 2 / UE-specific PDCCH to configure a UE to access a group-common PDSCH.
* *MediaTek*
	+ Proposal 19: UE-specific PDCCH with G-CS-RNTI is optional supported for activation of MBS group common PDSCH.
	+ Proposal 20: MBS SPS activation/deactivation’s feedback mechanism only support ACK/NACK based HARQ feedback mode.
* *FUTUREWEI*
	+ Proposal 7: At least UE-specific PDCCH is supported for deactivation of SPS group-common PDSCH.
	+ Proposal 8: Re-sending of the activation command via group-common PDCCH (Alt1) and UE-specific PDCCH (Alt 2) should be supported.
* *CMCC*
	+ Proposal 17. For reliability of the group-common PDCCH activation of SPS group-common PDSCH, support retransmitting the activation command via UE-specific PDCCH.
* *Samsung*
	+ Observation 11: For SPS GC-PDSCH activation/deactivation, the agreement from RAN1#104-bis-e to support GC-PDCCH is sufficient.
* *Qualcomm*
	+ Proposal 15: For SPS GC-PDSCH activation/release,
		- Support UE-specific ACK/NACK-based feedback.
		- Support UE-specific PDCCH in addition to GC-PDCCH.
		- Support separate activation of SPS GC-PDSCH by using GC-PDCCH or UE-specific PDCCH.
		- Support joint and separate release of SPS GC-PDSCH by using GC-PDCCH or UE-specific PDCCH.
* *LGE*
	+ Proposal 14: For group common SPS, UE specific confirmation to group common SPS (de-)activation can be supported by PUCCH A/N.
		- UE specific PUCCH resource is allocated by DCI indicating SPS (de-)activation.
	+ Proposal 15: For group common SPS activation/deactivation to multiple UEs in a group, (de)activation DCI can be repeated on multiple CORESETs with same TCI state or different TCI states.
	+ Proposal 16: For a UE not confirming SPS activation, gNB can schedule PTP initial transmission of missed TB(s).
	+ Proposal 17: After group common SPS activation, all UEs autonomously release the group common SPS right after a pre-determined slot
		- The pre-determined time is determined by RRC and/or DCI.
* *ASUSTeK*
	+ Proposal 4: NR multicast supports using a UE-specific PDCCH to activate an SPS multicast PDSCH configuration.
* *Chengdu TD Tech*
	+ Proposal 6：SPS GC-PDCCH for the activation/deactivation of a SPS GC-PDSCH resource can be transmitted more than once.
	+ Proposal 7: The PUCCH resource for the HARQ-ACK feedback of SPS GC-PDSCH is used by UE to indicate whether or not SPS GC-PDCCH is decoded correctly.
* *Convida*
	+ Proposal 5: UE-specific PDCCH should be supported for activation/deactivation DCI for MBS SPS.
	+ Proposal 6: PTM transmission scheme 2 should be considered for the MBS SPS PDSCH retransmission.
	+ Proposal 7: Retransmitting the activation command via both group-common PDCCH and UE-specific PDCCH should be supported, i.e., both Alt.1 and Alt.2 should be supported.
* *Lenovo*
	+ Proposal 25: 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 26: 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 27: For group-common SPS configuration activated by group-common PDCCH, gNB can retransmit the group-common PDCCH if no ACK is detected from one UE.
* *NTT Dococmo*
	+ Proposal 16: Use ACK/NACK based feedback for HARQ-ACK feedback for activation/deactivation of SPS group-common PDSCH regardless of feedback configuration/indication for SPS group-common PDSCH.
	+ Observation 5: If a UE stops receiving SPS PDSCH without a deactivation command, it can lead to a mismatch in the HARQ-ACK feedback bits.
	+ Proposal 17: Support UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH.
* *Ericsson*
	+ Proposal 14 group PDCCH SPS activation re-transmission is supported
	+ Proposal 15 Upon receiving a retransmission of the activation command for SPS group common PDSCH, a UE having already previously received successfully the activation command for the same SPS configuration should discard the activation command retransmission and proceed its SPS reception based on the first successfully received activation command.
	+ Conclusion: the network can retransmit the PDSCH(s) associated with any missed SPS activation command via unicast scheduled PDCCH/PDSCH.
	+ Proposal 17: For deactivation, a further group deactivation order or a UE specific PDCCH deactivation order can be sent to UEs not responding to the group de-activation PDCCH.
	+ Proposal 18: For deactivation, UE specific PDCCH deactivation order can be used to deactivate a group-based SPS.
	+ Observation 14: Unicast PDCCH scrambled with C-RNTI is not supported for group-common PDSCH
	+ Proposal 19: Do not support unicast PDCCH scrambled with CS-RNTI for activation of group SPS PDSCH.
* *Xiaomi*
	+ Observation 2: UE-specific deactivation for SPS group common PDSCH brings ambiguity on the to-be-deactivated SPS PDSCH.
	+ Proposal 17: For reliability of the group-common PDCCH activation of SPS group-common PDSCH, retransmit the activation command via UE-specific PDCCH.

### **Retransmission of SPS GC-PDSCH**

* *OPPO*
	+ Proposal 11: PTM scheme 1 and PTP are not supported to be used as retransmission scheme simultaneously for a given SPS group-common PDSCH.
* *Spreadtrum*
	+ Proposal 5: Not support simultaneously scheduling unicast and group-common retransmission for SPS group-common PDSCH.
* *CATT*
	+ Proposal 16: PTM scheme 1 retransmission and PTP retransmission cannot be used simultaneously for different UEs in the same MBS group.
	+ Proposal 17: The UE(s) missing detection the activation of SPS group-common PDSCH for MBS and corresponding SPS group-common PDSCH can receive retransmission of the SPS group-common PDSCH scheduled by G-CS-RNTI scrambling DCI.
* *FUTUREWEI*
	+ Proposal 6: The retransmission scheme for a given SPS group-common PDSCH can be either PTM scheme 1 or PTP for different UEs in the same group.
* *CMCC*
	+ Proposal 18. PTM transmission scheme 1 and PTP can be used as retransmission for SPS group-common PDSCH.
* *Ericsson*
	+ Proposal 24: PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group
	+ Proposal 25: The simultaneous reception of PTP and PTM retransmission for a given UE is up to UE implementation, pending a UE capability.
	+ Proposal 26 The UE is expected to provide HARQ-ACK feedback for all PDCCH associated with a PDCCH activation or deactivation command for SPS whatever UE is configured to send ACK/NACK HARQ feedback, NACK-only HARQ feedback, or no HARQ feedback at all.
	+ Proposal 27 The UE can be configured to either transmit HARQ-ACK feedback, NACK-only feedback, or no HARQ feedback at all for the SPS PDSCH not corresponding to a SPS PDCCH activation or deactivation.
	+ Observation 15 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 28 The SPS UL feedback framework for the SPS scheduled (i.e. PDCCH-less) PDSCH is the same as for non-SPS MBS PDSCH scheduling.
* *Xiaomi*
	+ Proposal 16: Do not support PTM scheme 1 based retransmission and PTP scheme based retransmission simultaneously for SPS MBS transmission in the same MBS group.

### **Other SPS related Proposals**

* *Nokia*
	+ Observation-10: Significantly higher spectral efficiency can be achieved when relying heavily on HARQ retransmissions compared to operation with conventional first HARQ transmission BLER targets for the worst UE in the cell.
	+ Proposal-12: Support HARQ retransmissions on SPS-allocated resources.
	+ Proposal-13: Add in-band control signaling on PDSCH to facilitate retransmissions on SPS-allocated PDSCH resources.
	+ Observation-11: The conventional NDI definition is not ideal in terms of the impact that an NDI decoding error has on the reliability of the MBS data delivery via SPS, especially when the NDI error occurs on the first transmission of a MAC PDU.
	+ Proposal-14: At least for delivery of MBS traffic over SPS allocated resources, a new NDI definition is used that is toggled between HARQ transmissions belonging to one MAC PDU to HARQ transmissions belonging to the next MAC PDU on the same HARQ process. Further enhancements of in-band control signaling in case of SPS are FFS.
* *LGE*
	+ Proposal 18: For a group common SPS configuration, UE can be optionally configured with either pdsch-AggregationFactor or TDRA table with repetitionNumber as part of the TDRA table.
	+ Proposal 19: Discuss whether different TCI states can be configured for group common SPS received by different UE, e.g. different slots of group common SPS PDSCH repetitions or different SPS configurations can be associated to different TCI states for the same group of UEs.

## Initial Proposals based on contributions

### **SPS configuration**

***Summary***

In RAN1#106-e, it was agreed that, if a SPS-config for MBS is configured in CFR, one G-CS-RNTI is associated with the SPS-config. However, 1 company [QC] raises that no need to explicitly configure the G-CS-RNTI in a SPS-Config-Multicast and no need to limit the 1-to-1 mapping between G-CS-RNTI and SPS-Config-Multicast. In NR Rel-16, a value of the HPN field in a DCI format indicates an activation for a SPS PDSCH with a value mapping to the sps-ConfigIndex in a SPS-Config. When a UE monitors a GC-PDCCH with CRC scrambled by G-CS-RNTI, the HPID field in the activation GC-PDCCH can be used to indicate which SPS-Config-Multicast is activated. Regarding this, moderator provides **Initial Question 5-1a** to collect views from companies.

Regarding whether to support multiple G-CS-RNTIs associated with one SPS-config, 7 companies [vivo, OPPO, Xiaomi, MTK, Intel, Ericsson, CATT] propose not to support it. 2 companies [ZTE, Nokia] propose to support it, 1 company [Samsung] thinks associating multiple G-CS-RNTIs with one SPS-Config requires new UE hardware. This issue relates to the understanding of question 5-1. Moderator suggests **initial proposal 5-1b**.

***Initial Proposals***

**Initial Question 5-1a**: Regarding the association between a G-CS-RNTI and a SPS-Config-Multicast, which of the follows is your understanding?

* Option 1: The association is explicitly configured by RRC signalling, e.g., the G-CS-RNTI is configured in the SPS-Config-Multicast.
* Option 2: The association is indicated by the activation GC-PDCCH for SPS GC-PDSCH, i.e., a value of the HARQ process number field in a GC-PDCCH indicates an activation for a SPS GC-PDSCH configuration for multicast with a same value as provided by *sps-ConfigIndex* in a *SPS-Config*.

**Initial proposal 5-1b:** Do not support multiple G-CS-RNTIs associated with one SPS-config in Rel-17 MBS.

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

***Summary***

Regarding UE-specific PDCCH for activation/deactivation of SPS GC-PDSCH for MBS, about 11 companies [Spreadtrum, vivo, CATT, Nokia, Futurewei, CMCC, Qualcomm, Convida, MediaTek, NTT Docomo, ASUSTek] support it, and 3 companies [OPPO, ZTE, Samsung] do not support it, and 1 company [Ericsson] supports UE-specific PDCCH for deactivation and does not support UE-specific PDCCH for activation. Based on majority view, moderator suggests **initial proposal 5-2a**.

For reliability of the GC-PDCCH activation of SPS group-common PDSCH, 3 alternatives were listed for further study in previous meetings. Based on contributions submitted in this meeting, it seems 11 companies [Spreadtrum, vivo, CATT, Nokia, Futurewei, CMCC, Qualcomm, Convida, MediaTek, NTT Docomo, ASUSTek] support both Alt1 (GC-PDCCH) and Alt2 (UE-specific PDCCH), 4 companies [OPPO, ZTE, Samsung, Ericsson] support only Alt1, and 1 company [Huawei] supports Alt3 (MAC-CE). Based on majority view, moderator suggests **initial proposal 5-2b**.

***Initial Proposals***

**Initial proposal 5-2a:** Support UE-specific PDCCH for activation/deactivation of SPS GC-PDSCH for multicast for RRC\_CONNECTED UEs.

**Initial proposal 5-2b:** For reliability of the group-common PDCCH activation of SPS group-common PDSCH, both Alt 1 and Alt 2 are supported.

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

### **Retransmission of SPS GC-PDSCH**

***Summary***

Regarding whether PTM-1 retransmission and PTP retransmission for SPS GC-PDSCH can be used simultaneously for different UEs in the same MBS group, this situation is similar as for non-SPS group-common PDSCH, 4 companies [OPPO, Spreadtrum, CATT, Xiaomi] do not support it and 3 companies [Futurewei, CMCC, Ericsson] support it. Moderator suggests to postpone the discussion in this meeting.

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | Proposal 5-1a: Option 2 is preferred to reuse legacy mechanism. Option 1 is also acceptable to us.Proposal 5-1b: OK.Proposal 5-2a: Don’t support. The prerequisite of such proposal is to agree confirmation of GC-PDCCH for SPS activation. It is not reasonable to agree this proposal without the prerequisite.Proposal 5-2b: Don’t support. The prerequisite of such proposal is to agree confirmation of GC-PDCCH for SPS activation. It is not reasonable to agree this proposal without the prerequisite. For the 3rd bullet, we are not sure about “SPS GC-PDSCH corresponding to a SPS activation PDCCH” means. Is it not “SPS GC-PDSCH without PDCCH scheduling”? |
| LG | **Initial Question 5-1a**: We prefer Option 1.**Initial proposal 5-1b:** OK. Do not support multiple G-CS-RNTIs associated with one SPS-config in Rel-17 MBS.**Initial proposal 5-2a:** We prefer not to support UE-specific PDCCH for activation/deactivation of SPS GC-PDSCH for multicast.**Initial proposal 5-2b:** We support Alt 1. We also think that only ACK/NACK based HARQ-ACK feedback is supported for activation DCI and release DCI, even though NACK only based feedback is configured for SPS PDSCH without PDCCH scheduling. |

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

# Issue #6: Simultaneous operation with unicast reception

## Background and submitted proposals

***Submitted Proposals***

* *vivo*
	+ Proposal 2: 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 29: When the simultaneous reception of unicast and multicast is beyond a UE’s capability, the dropping rule should be considered.
	+ Proposal 30: When the UE simultaneous receives TDMed SPS PDSCH of unicast and multicast in a slot, it is suggested to receive the SPS group-common PDSCH of multicast in high priority, eg, adding offset to SPS PDSCH of unicast.
	+ Proposal 31: When FDMed SPS PDSCH of unicast and FDMed SPS group-common PDSCH in a slot, the rules for SPS PDSCH reception in Rel-16 can be used as a baseline of FDMed SPS PDSCH of unicast and FDMed SPS group-common PDSCH reception.
	+ Proposal 32: When FDMed SPS PDSCH of unicast and FDMed SPS group-common PDSCH in a slot, it is suggested to receive the SPS group-common PDSCH of multicast in high priority, eg, adding offset to SPS PDSCH of unicast.
* *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.
* *CMCC*
	+ Proposal 23. 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.

## 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** |
| LG | It seems beneficial to support Case 5 at least for a UE receiving both broadcast and multicast based on capability. If such capability is introduced, it could be also used for FDMed multicast and multicast in a slot. |
|  |  |

# Issue #7: Other issues

## Background and submitted proposals

***Submitted Proposals***

* *ZTE*
	+ Proposal 19: RAN1 further studies whether to support HARQ-ACK feedback for broadcast service for UEs under RRC\_CONNECTED state.
* *Intel*
	+ Proposal 23: For NR MBS support of multi-layer MIMO transmission with rank adaptation (from UE perspective) is supported.
	+ Proposal 24: For groupcast transmission, all UEs within the group share the same DM-RS port(s). Additionally, UEs receiving unicast transmission are multiplexed on remaining orthogonal DM-RS ports.
* *ASUSTeK*
	+ Observation 2: A UE may only be configured to monitor multicast PDCCHs of PTM scheme 1 on a PCell.
	+ Observation 3: When a UE requires more and more MBS/multicast services, the traffic on the PCell may become congested.
	+ Proposal 5: RAN1 further studies the possibilities of supporting carrier aggregation and cross-carrier scheduling for multicast.
* *LGE*
	+ Proposal 20: UE configured with CA can support reception of multicast transmission depending on UE capability.

## Initial Proposals based on contributions

***Summary***

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

## Company Views (1st round of inputs)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | It seems good to clarify whether CFR can be configured at a SCell for UE configured with CA. |
|  |  |

# 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. R1-2108723 Resource configuration and group scheduling for RRC\_CONNECTED UEs Huawei, HiSilicon, CBN
4. R1-2108804 Group Scheduling Aspects for Connected UEs FUTUREWEI
5. R1-2108851 Discussion on Mechanisms to Support Group Scheduling for RRC\_CONNECTED UEs ZTE
6. R1-2108926 Discussion on MBS group scheduling for RRC\_CONNETED UEs Spreadtrum Communications
7. R1-2109001 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED Ues vivo
8. R1-2109067 Discussion on group Scheduling mechanism for RRC\_CONNECTED UEs OPPO
9. R1-2109135 Discussion on Group Scheduling Mechanisms for RRC\_CONNECTED Ues NEC
10. R1-2109194 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs in MBS CATT
11. R1-2109303 Discussion on group scheduling mechanisms CMCC
12. R1-2109316 Group Scheduling Mechanisms to Support 5G Multicast / Broadcast Services for RRC\_CONNECTED Ues Nokia, Nokia Shanghai Bell
13. R1-2109387 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UE Xiaomi
14. R1-2109515 Support of group scheduling for RRC\_CONNECTED UEs Samsung
15. R1-2109538 On group scheduling mechanism for RRC\_CONNECTED UEs Lenovo, Motorola Mobility
16. R1-2109567 Discussion on NR MBS group scheduling for RRC\_CONNECTED UEs MediaTek Inc.
17. R1-2109633 NR-MBS Group Scheduling for RRC\_CONNECTED UEs Intel Corporation
18. R1-2109701 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs NTT DOCOMO, INC.
19. R1-2109767 Group scheduling related questions for RRC\_CONNECTED UEs TD Tech
20. R1-2109823 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs FGI, Asia Pacific Telecom
21. R1-2109983 Support of group scheduling for RRC\_CONNECTED UEs LG Electronics
22. R1-2110056 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Apple
23. R1-2110074 Discussion on common frequency resource configuration for multicast of RRC\_CONNECTED UEs ETRI
24. R1-2110118 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Convida Wireless
25. R1-2110210 Views on group scheduling for Multicast RRC\_CONNECTED UEs Qualcomm Incorporated
26. R1-2110249 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs Google Inc.
27. R1-2110255 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs ASUSTeK
28. R1-2110355 Mechanisms to support MBS group scheduling for RRC\_CONNECTED Ues Ericsson

# Appendix 1: Agreements in #102 e-meetings

**RAN1#102-e**

Agreements:

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

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

Agreements:

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

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

Agreements:

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

Agreements:

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

Agreements:

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

Agreements:

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

# Appendix 2: Agreements in #103 e-meetings

**RAN1#103-e**

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

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

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

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

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

**Working assumption:**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

* FFS PUCCH format

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

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

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

* FFS details

Agreements:

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

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

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

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

* FFS details.

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

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

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

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

# Appendix 3: Agreements in #104 e-meetings

**RAN1#104-e**

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

Agreement:

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

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

Working Assumption:

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

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

Agreement:

For RRC\_CONNECTED UEs, more than one SPS group-common PDSCH configuration for MBS can be configured per UE subject to UE capability

* The total number of SPS configurations supported by a UE currently defined for unicast is not increased due to additionally supporting MBS.
* FFS: How to allocate the total SPS configurations between MBS and unicast.

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Working assumption:

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

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

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

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

**RAN1#104b-e**

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

Agreement:

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

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Conclusion:

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

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

Agreement:

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

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

Agreement:

Include the following in the LS to RAN2:

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

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

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

Agreement:

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

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

Agreement:

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

Conclusion:

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

Agreement:

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

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

Agreement:

Confirm the working assumption:

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

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

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

Agreement:

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

Agreement:

Two priority indexes are introduced for multicast, with

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

# Appendix 5: Agreements in #105 e-meetings

**RAN1#105-e**

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

Agreement:

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

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

Agreement:

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

Agreement:

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

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

Working assumption:

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

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

Agreement:

For multicast of RRC\_CONNECTED UEs, further study

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

Agreement:

Confirm the working assumption:

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

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

Agreement:

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

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

Agreement:

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

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

Working assumption:

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

Agreement:

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

* FFS for SPS activation/deactivation.

Agreement:

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

Agreement:

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

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

Agreement:

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

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

**Conclusion:**

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

assumption:

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

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

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

Agreement:

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

Agreement:

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

* FFS details of FDRA.

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

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

**Conclusion:**

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

# Appendix 6: Agreements in #106 e-meetings

**RAN1#106-e**

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

Agreement:

Confirm the working assumption with the following update:

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

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

Note: The deleted FFSs can be discussed in another AI.

Agreement:

For multicast of RRC-CONNECTED UEs, align the size of the first DCI format for GC-PDCCH with DCI format 1\_0 with CRC scrambled by C-RNTI monitored in CSS.

Agreement:

Confirm the following working assumption:

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

Agreement:

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

* the starting PRB is referenced to Point A, i.e., the starting PRB is a PRB determined by *subcarrierSpacing* of the associated BWP and *offsetToCarrier* corresponding to this subcarrier spacing, similar as how *locationAndBandwidth* of a BWPis indicated as described in TS 38.331.
* FFS: Indication mechanism.

Agreement:

For LBRM and TBS determination for GC-PDSCH:

* The maximum number of layers can be provided by *maxMIMO-Layers* in *PDSCH-Config* for MBS in CFR; if not provided, a default value is defined.
	+ FFS the default value.
* The maximum modulation order can be determined from mcs-Table in PDSCH-Config for MBS in CFR;
	+ FFS: if *mcs-Table* in *PDSCH-Config* for MBS is not configured in CFR, a value determined from *mcs-Table* in *PDSCH-Config* for unicast in the active DL BWP is used; if the *mcs-Table* in *PDSCH-Config* for unicast is not configured, Table 5.1.3.1-1 in TS38.214 is used (similar as the default value in R16).
* xOverhead can be provided in PDSCH-Config for MBS in CFR; if not provided, a default value of zero is used.
* The number of PRBs is determined based on the size of CFR.

Agreement:

The first DCI format for GC-PDCCH uses the same fields as DCI format 1\_0 with CRC scrambled by C-RNTI with the following modifications:

* At least ‘Identifier for DCI formats’ is not needed.
	+ FFS: Whether the field should be ignored and reserved, or should be removed.
* For FDRA determination, down-select from following options:
	+ Option 1:
		-  is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
		- For resource indication value (*RIV*) of downlink resource allocation type 1, the resource blocks that can be indicated are
			* the resource blocks in the CORESET 0 if CORESET 0 is configured for the cell; and
			* the resource blocks in the initial DL bandwidth part if CORESET 0 is not configured for the cell.
	+ Option 2:
		-  is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
		- For resource indication value (*RIV*) of downlink resource allocation type 1, the similar scheme as for the case that the DCI size for DCI format 1\_0 in USS is derived from the size of DCI format 1\_0 in CSS but applied to an active BWP is used.
			* FFS details, e.g., if the size of CFR (i.e. $N\_{CFR}$) is larger than the size of CORESET0/initial DL bandwidth part, the resource indication value (*RIV*) is defined as in section 5.1.2.2.2 in TS38.214, where K is the maximum value from set {1, 2, 4, 8} which satisfies $K\leq \left⌊N\_{CFR}/N\_{BWP}^{initial}\right⌋$;otherwise, $K=1.$
	+ Option 3:  is given by the size of CFR in the active DL BWP

Agreement:

The second DCI format for GC-PDCCH uses the same fields as DCI format 1\_1 with the following modifications:

* At least ‘Identifier for DCI formats’ and ‘SRS request’ are not needed.
	+ FFS whether the fields should be ignored and reserved, or should be removed.
* Note: At least the configurable fields in DCI format 1\_1 remain configurable for the second DCI format

Agreement:

For initializing scrambling sequence generator for GC-PDCCH with the second DCI format,

* $n\_{ID}$ equals the higher layer parameter *pdcch-DMRS-ScramblingID* if it is configured in the CORESET in a CFR used for the GC-PDCCH;$n\_{ID}=N\_{ID}^{cell}$ otherwise.
* FFS: Values for $n\_{RNTI}$. Choices include one or more of the following:
	+ Alt1: G-RNTI used for the GC-PDCCH.
	+ Alt2: 0
	+ Alt3: Other fixed values

Agreement:

If a SPS-config for MBS is configured in CFR, one G-CS-RNTI is associated with the SPS-config.

* FFS: Multiple G-CS-RNTIs associated with one SPS-config

Agreement:

For FDRA determination of the first DCI format for GC-PDCCH, down-select from Option 2 and updated Option 3.

* + Option 2:
		-  is given by
			* the size of CORESET 0 if CORESET 0 is configured for the cell; and
			* the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
		- For resource indication value (*RIV*) of downlink resource allocation type 1, the similar scheme as for the case that the DCI size for DCI format 1\_0 in USS is derived from the size of DCI format 1\_0 in CSS but applied to an active BWP is used.
			* FFS details, e.g., if the size of CFR (i.e. $N\_{CFR}$) is larger than the size of CORESET0/initial DL bandwidth part, the resource indication value (*RIV*) is defined as in section 5.1.2.2.2 in TS38.214, where K is the maximum value from set {1, 2, 4, 8} which satisfies $K\leq \left⌊N\_{CFR}/N\_{BWP}^{initial}\right⌋$;otherwise, $K=1.$
	+ Option 3:  is given by the size of CFR in the active DL BWP
		- If the size of the first DCI format for GC-PDCCH prior to truncation is larger than the size of DCI format 1\_0 monitored in CSS, the bit width of the FDRA field in the first DCI format for GC-PDCCH is reduced by truncating the first few most significant bits such that the size of the first DCI format for GC-PDCCH equals the size of DCI format 1\_0 monitored in CSS.
		- FFS: Whether the removed/reserved fields can be repurposed for FDRA
		- FFS: Solution for the case where the size of the first DCI format for GC-PDCCH prior to padding is smaller than the size of DCI format 1\_0 monitored in CSS.

Conclusion:

The specification impact of having a new Type-x CSS for GC-PDCCH in RRC\_CONNECTED state can be studied and discussed further.

Agreement:

For initializing scrambling sequence generator for GC-PDSCH scheduled by the second DCI format for multicast received in Type-x CSS,

* $n\_{ID}$ equals the higher layer parameter *dataScramblingIdentityPDSCH* if it is configured in *PDSCH-Config* in a CFR used for GC-PDSCH and the RNTI equals the G-RNTI or G-CS-RNTI;$n\_{ID}=N\_{ID}^{cell}$ otherwise.
* $n\_{RNTI}$ corresponds to the RNTI associated with the GC-PDSCH transmission (i.e., the G-RNTI used by the scheduling GC-PDCCH, or the G-CS-RNTI used by the SPS GC-PDSCH activation PDCCH)

Agreement:

For initializing sequence generator for DMRS of GC-PDCCH with the second DCI format received in Type-x CSS,

* $N\_{ID}$ equals the higher layer parameter *pdcch-DMRS-ScramblingID* if it is configured in the CORESET in a CFR used for the GC-PDCCH; $N\_{ID}=N\_{ID}^{cell}$ otherwise.

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

Agreement:

For UE supporting both unicast and multicast, the *pdsch-HARQ-ACK-Codebook/pdsch-HARQ-ACK-CodebookList* can be separately configured for multicast from that for unicast.

Agreement:

When UE is configured Type-1 codebooks for unicast and multicast with different priorities, respectively, the UE separately generates each of the Type-1 codebooks.

* FFS: How UE is configured one codebook for unicast and one codebook for multicast and the two codebooks are of different priorities.

Agreement:

For a UE configured with Type-1 HARQ-ACK codebook,

* If UE is not configured to receive FDM-ed unicast and multicast, Type-1 HARQ codebook is generated as the agreement for TDM-ed unicast and multicast.
* If UE is configured to receive FDM-ed unicast and multicast, Type-1 HARQ codebook is generated as the agreement for FDM-ed unicast and multicast.

Agreement:

For UEs supporting ACK/NACK-based HARQ-ACK feedback for multicast and unicast, the following values are unchanged compared to unicast in Rel-16:

* + The maximum number of PUCCH resources sets in each *PUCCH-Config*,
	+ The maximum number of PUCCH resources in a PUCCH resource set in each *PUCCH-Config*,
	+ The maximum number of UCI information bits for the first PUCCH resource set.
	+ The total number of PUCCH resources from all *PUCCH-Config/PUCCH-ConfigurationList*.
	+ Note:
		- This applies to both cases of whether or not UE is configured optionally with a separate *PUCCH-Config or PUCCH-ConfigurationList* for multicast.
		- The case of NACK-only based is discussed separately.

Agreement:

When UE is configured with the *pdsch-HARQ-ACK-Codebook/pdsch-HARQ-ACK-CodebookList* for ACK/NACK based feedback for multicast, it is applied to all G-RNTIs configured to UE.

Agreement:

For the separate *PUCCH-ConfigurationList* that is optionally configured to UE for NACK-only based HARQ-ACK feedback for multicast,

* + The separate *PUCCH-ConfigurationList* for multicast configuration can be a list which includes up to 2 *PUCCH-Config* configurations corresponding low priority feedback and high priority feedback, respectively.
	+ FFS: how to handle the case when separate *PUCCH-ConfigurationList* is not configured to UE for NACK-only based HARQ-ACK feedback for multicast.

Agreement:

The priority index is,

* for the second DCI format for GC-PDCCH, optionally configured to be included in the DCI format. If not configured, the priority index is not included in the DCI format and is low priory by default.
* for the first DCI format for GC-PDCCH, down-select from:
	+ - Alt1: Optionally configured to be included in the DCI format. If not configured, the priority index is not included in the DCI format and is low priory by default.
		- Alt2: Always low priority, i.e., the priority index is not included in the DCI format.

Agreement:

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

Agreement:

When more than one NACK-only based feedback are available for transmission in the same PUCCH slot, down-select from the following alternatives:

* + Alt1: Support UE multiplexing the HARQ-ACK bits by transforming NACK-only into ACK/NACK HARQ bits.
	+ Alt2: Support sub-slot based PUCCH for this case.
	+ Alt3: Support UE transmitting more than one slot-based PUCCHs in the same PUCCH slot.
	+ Alt4: Define combination of NACK-only which corresponds to a specific sequence or a PUCCH transmission.
	+ Alt5: NACK-only bundling

Agreement:

When UE supports and is configured with more than one G-RNTI,

* + for Type-2 codebook construction, DAI is separately counted per G-RNTI.
	+ Type-2 codebook is constructed by concatenating Type-2 sub-codebook of each RNTI following the ascending order of the G-RNTI value.

Agreement:

Update the WA made in RAN1#105-e meeting regarding enabling/disabling HARQ-ACK feedback as follows:

Working assumption:

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

* RRC signaling configures the enabling/ disabling function of group-common DCI indicating the enabling /disabling ACK/NACK based HARQ-ACK feedback.
	+ If RRC signaling configures the function of group-common DCI based indication, group-common DCI indicates (explicitly or implicitly) whether ACK/NACK based HARQ-ACK feedback is enabled/disabled
	+ Otherwise, enabling/disabling ACK/NACK based HARQ-ACK feedback is configured by RRC signaling.
	+ FFS details on RRC signaling and group-common DCI indicating.
* FFS whether/how this option is extended to apply to NACK-only based feedback and multiple G-RNTI cases.
* FFS the relation to the HARQ-ACK codebook types and HARQ-ACK codebook construction.
* FFS the relation to the enabling/disabling ACK/NACK based HARQ-ACK feedback for retransmission.
* FFS whether/how to allow UE not to react to the DCI signaling, but instead follow UE-specific RRC configuration for HARQ feedback.
* FFS whether/how to apply it to SPS group-common PDSCH.
* UE capability for enabling/ disabling function of group-common DCI indicating the enabling /disabling ACK/NACK based HARQ-ACK feedback is introduced and FFS details.
* Note: It is up to network implementation to avoid any potential HARQ ACK mismatch between different UEs in the same multicast group

Agreement

For UE supports both ACK/NACK-based and NACK-only based HARQ-ACK feedback for multicast SPS PDSCH without PDCCH scheduling, select one or more of the following alternatives:

* + Alt1: HARQ-ACK feedback option is configured per SPS configuration index.
	+ Alt2: HARQ-ACK feedback option is indicated in the SPS activation DCI.
	+ Note: enabling/disabling HARQ-ACK feedback for multicast SPS can be discussed separately.

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

Agreement:

From RAN1 perspective, the CFR for broadcast reception of RRC\_IDLE/INACTIVE UEs, includes at least the following configurations:

* One set of parameters configured for PDSCH for broadcast reception with GC-PDSCH
* One set of parameters configured for PDCCH for broadcast reception with GC-PDCCH
* FFS: whether some parameters configured for PDSCH/PDCCH are optional/needed for the supported cases of CFR.
* FFS: If necessary, depending on the cases supported, starting PRB and the number of PRBs
	+ The reference for starting PRB is Point A. (Following the same approach to determine reference for starting PRB as that defined in AI8.12.1.)

Conclusion:

There is no specification support in Rel-17 for broadcast reception with RRC\_IDLE/RRC\_INACTIVE UEs with configured/defined CFRs for group-common PDCCH/PDSCH with smaller size than the initial BWP, where the initial BWP has the same frequency resources as CORESET0 (i.e., Case B).

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs, for broadcast reception, if searchSpace#0 is configured for MTCH, the mapping between PDCCH occasions and SSBs is the same as for SIB1.

Agreement:

Study and reach an agreement by RAN1#106b-e on whether Alt1 and Alt2 for MCCH change notification indication can accommodate at least 2 bits for the notification of MCCH configuration changes due to a session start and the notification of MCCH configuration changes of an ongoing session (including session stop).

Agreement:

The DCI format for GC-PDCCH scheduling a GC-PDSCH carrying MCCH/MTCH at least includes the following fields for broadcast reception with UEs in RRC\_IDLE/INACTIVE state:

* FDRA field
* TDRA field
* Modulation and coding scheme
* Redundancy version
* FFS:
	+ MCCH change notification (if supported and only for MCCH),
	+ RB numbering starts from the lowest RB of the CFR and support of resource allocation with granularity of single or multiple RBs.
	+ HARQ process number and New data indicator
	+ VRB-to-PRB mapping
	+ other fields if needed.

Agreement

Only one CFR can be configured for group-common PDCCH/PDSCH carrying MCCH for broadcast reception with UEs in RRC\_IDLE/INACTIVE state.

Agreement

For broadcast reception with UEs in RRC\_IDLE/INACTIVE state, the DCI size of GC-PDCCH scheduling a GC-PDSCH carrying MCCH/MTCH is aligned with DCI format 1\_0 with CRC scrambled by C-RNTI in the CSS.

Agreement:

For broadcast reception, RRC\_IDLE/RRC\_INACTIVE UEs can use the same bandwidth configurations for the CFR of GC-PDCCH/PDSCH carrying MCCH and the CFR of GC-PDCCH/PDSCH carrying MTCH.

* FFS: use of different bandwidth configurations for the CFR of GC-PDCCH/PDSCH carrying MCCH and the CFR of GC-PDCCH/PDSCH carrying MTCH

Conclusion:

For broadcast reception with RRC\_IDLE/RRC\_INACTIVE UEs, there is no specification support in Rel-17 of different CSS types for GC-PDCCH scheduling MCCH and MTCH.

Agreement:

Study whether the Type-x CSS supported for multicast in RRC\_CONNECTED can be reused as baseline for broadcast in RRC\_IDLE/RRC\_INACTIVE for GC-PDCCH scheduling MCCH and MTCH.

Agreement:

For RRC\_IDLE/RRC\_INACTIVE UEs with broadcast reception, if common search space other than searchSpace#0 is configured for MTCH, the mapping of PDCCH monitoring occasions to SSBs can be configured with a rule.

* The existing rule defined for OSI in TS 38.331 is used as starting point to define the above rule.

# Appendix 7: Agreements in RANP#93 e-meetings

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

Agreement:

* The following aspects can be considered to be within the scope of the Rel-17 MBS WID and can be further discussed in the WGs with the aim of minimizing specification impacts:
	+ Configurable scrambling sequence initialization for PDCCH/PDSCH and DMRS sequence generator initialization for PDCCH/PDSCH for broadcast transmission (as supported for RRC\_CONNECTED UE).
	+ Configuring TRS as QCL sources for broadcast transmission (as supported for RRC\_CONNECTED UE).
* Note: For broadcast transmission, the presence of TRS would be optional from a network perspective.
* Note: Any SFN operation is transparent to the UE

Agreement (Updated proposal from RAN1#106e):

For a configured/defined CFR for GC-PDCCH/PDSCH carrying MCCH and MTCH for broadcast reception with UEs in RRC IDLE/INACTIVE state.

* Support Case-C
* Support at least one of Case D and Case E.
	+ Down-selection to be made at RAN1#106b-e
* Note: Case C, D and E are defined in previous agreements