**3GPP TSG RAN WG1 #104-e R1-210XXXX**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item:** 8.12.1

**Source:** Moderator (CMCC)

**Title:** Summary#1 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 objective 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#104-e:

[104-e-NR-MBS-01] Email discussion/approval on mechanisms to support group scheduling for RRC\_CONNECTED UEs with checkpoints for agreements on Jan-28, Feb-02, Feb-05 – Fei (CMCC)

In this contribution, we summarize the related issues and proposals based on the contributions submitted in RAN1#104-e under the agenda item 8.12.1 [3]-[25]. 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, related proposals and a short summary 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 discussions 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, i.e. by UTC 1/25 23:59. Moderator will try to update the proposals based on companies’ inputs on a daily basis.

# Issue #1: Common Frequency Resource for MBS

## Background and submitted proposals

***Background***

In RAN1#103-e, the following working assumption was made for common frequency resource for multicast of RRC-CONNECTED UEs.

**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

***Submitted Proposals***

* **FUTUREWEI**
	+ Proposal 1: Select Option 2B for the common frequency resource for group-common PDCCH/ PDSCH.
	+ Proposal 2: The starting location for the common frequency resource is referenced to Point A and its size is in PRBs.
	+ Proposal 3: A UE supports unicast reception in the common frequency resource.
	+ Observation 1: further clarification on the meaning of “more than one common frequency resources” is needed.
* **ZTE**
	+ Proposal 1: Both frequency domain range and the corresponding MBS transmission parameters are configured for common frequency resource.
		- RAN1 strives for a unified method to provide configuration for common frequency resource for UEs in different RRC states and for both multicast and broadcast.
		- RAN1 strives for a method with forward compatibility, e.g., configuring different numerologies for unicast and MBS in the future release.
	+ Proposal 2: MBS BWP is defined as common frequency resource for MBS transmission.
		- In Rel-17 NR MBS, the MBS BWP is confined within UE’s unicast BWP, and the numerology is the same as unicast BWP.
	+ Proposal 3: A BWP ID is configured for the MBS BWP for activating/deactivating it dynamically and independently.
	+ Proposal 4: In Rel-17, RAN1 focuses on one common frequency resource (i.e., MBS BWP) per UE instead of more than one.
* **OPPO**
	+ Proposal 2: Common frequency resource is configured within dedicated unicast BWP, and the numerology of the common frequency resource is same as the dedicated unicast BWP. It is up to RAN2 to decide how to configure the common frequency resource.
	+ Proposal 3: Configuring a UE with no unicast reception in the common frequency resource is not supported.
	+ Proposal 4: Support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities.
	+ Proposal 5: Support to configure a dedicated MBS BWP for group-common PDCCH/PDSCH transmission.
* **Huawei**
	+ Proposal 2: For common frequency resource for group-common PDCCH / PDSCH for scheduling MBS which is confined within the frequency resource of a dedicated unicast BWP,
		- it is up to gNB to schedule unicast or MBS within the ‘MBS frequency region’,
		- PDSCH configuration pdsch-Config is separately configured for NR MBS.
* **CATT**
	+ Observation 1: BWP switching is needed between MBS specific BWP and dedicated unicast BWP according to Rel-15/16 principle because they are two independent BWPs and configurations.
	+ Observation 2: MBS specific BWP may not be feasible when a UE can support to be configured with only one BWP.
	+ Proposal 2: Option 2B, MBS frequency region, is supported to define MBS common frequency resource for RRC\_CONNECTED UEs.
	+ Proposal 3: For configuration of MBS frequency region, the indication of the starting PRB can be based on the starting point of dedicated unicast BWP or the starting point of the carrier.
	+ Proposal 4: The current SLIV indication mechanism can be reused for MBS frequency region indication of starting PRB and length of PRBs.
	+ Observation 3: It is up to gNB implementation to configure whether a dedicated unicast BWP can contain MBS common frequency resource or not.
	+ Proposal 5: It is supported that a UE can receive unicast in the common frequency resource.
	+ Proposal 6: If configured, at most one MBS common frequency resource is supported per UE/per dedicated unicast BWP based on UE capability.
* **Vivo**
	+ Proposal 1: For RRC\_CONNECTED UEs, when defining/configuring common frequency resource for group-common PDCCH/PDSCH, Option 2B is preferred.
		- Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.
* **Nokia**
	+ Observation-4: The key difference between option 2A and 2B is related to the RRC signalling of the common frequency resources:
		- Option 2A requires the signalling of MBS specific BWP with parameters possibly taken from current BWP configurations.
		- Option 2B requires the signalling of the MBS frequency region – in terms of the starting PRB and length of PRBs within each UE’s dedicated unicast BWP.
		- The impact of option 2A on the number of BWPs that can be configured for a UE needs to be studied and clarified.
	+ Observation-5: The motivation for configuring UEs with no unicast reception within the MBS CFR needs to be further clarified.
	+ Observation-6: Multiple common frequency resources can be configured per UE based on gNB implementation – even though the motivations for doing so are not clear, with the maximum limit dependent on UE capabilities and available system resources.
	+ Observation-7: For multicast traffic, the motivation for configuring multiple CFRs per UE requires further clarification, and for broadcast traffic, there are potential benefits in terms of power savings from having multiple overlapping CFRs configured per UE, depending on UE capabilities and traffic characteristics.
	+ Proposal-6: Agree on selecting option 2B for configuring multicast common frequency resources, due to the additional complexities involved in the use of option 2A related to BWP switching.
	+ Proposal-7: The key requirement for option 2B is to signal the starting PRB and the length of PRBs for the MBS CFR, whereas the signalling details could be RAN2 decision.
* **MTK**
	+ Proposal 2: Network implementation guarantee the allocation of common frequency resource for UEs in connected mode to receive the PTM transmission.
	+ Proposal 3: Not support more than one common frequency resources for NR MBS.
* **Intel**
	+ The working assumption can be confirmed with Option 2B. The starting PRB index and number of PRBs can be jointly configured to the UE by RRC or SIB signaling
	+ The UE expects no restriction on unicast reception within the MBS frequency region contained within the active DL BWP of the UE
	+ One common frequency resource per UE/ per dedicated BWP is sufficient for scheduling MBS transmissions
* **Lenovo**
	+ Proposal 1: An MBS frequency region with contiguous PRBs confined within the dedicated unicast BWP is configured for MBS, i.e., Option 2B is supported.
	+ Proposal 2: The starting PRB index and the number of contiguous PRBs of the MBS frequency region are configured within the dedicated unicast BWP via RRC signaling.
	+ Proposal 5: RB numbering within the common frequency region is with reference to the lowest RB of the common frequency region.
	+ Proposal 6: The number of bits for frequency domain resource assignment indicator in DCI is determined based on the bandwidth of the common frequency region.
* **Spreadtrum**
	+ Proposal 1: For the common frequency resource for group-common PDCCH/ PDSCH, support option 2A.
	+ Proposal 2: UE can be configured with or without unicast reception in the common frequency resource.
	+ Proposal 3: Support only one common frequency resources per dedicated unicast BWP per UE.
* **LG**
	+ Proposal 4: Support Option 2A, possibly with a wider MBS specific BWP than the initial DL BWP or UE’s active DL BWP
	+ Proposal 5: Support a MBS specific BWP with a different numerology than that of the initial DL BWP or UE’s active DL BWP, if Option 2A is agreed.
	+ Proposal 6: Consider one of the following sub-options for Option 2A:
		- Option 2A-1: BWP switching between MBS specific BWP and UE’s active BWP is NOT supported. UE is allowed to simultaneously activate one MBS specific BWP and one UE’s active BWP.
		- Option 2A-2: BWP switching between MBS specific BWP and UE’s active BWP is supported. UE can activate only one of MBS specific BWP and one UE’s active BWP at a time.
	+ Proposal 7: Connected UE should maintain at least one UE’s active BWP as specified in REL-15/16.
	+ Proposal 8: MBS capable UE activates only one MBS DL BWP at a time for REL-17.
* **ETRI**
	+ Proposal1: The option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP should be supported for the common frequency resource.
	+ Proposal2: RRC configuration is used for configuration of MBS frequency region including indication of the starting PRB and the length of the PRBs.
* **CMCC**
	+ Proposal 1. The working assumption in RAN1 #103-e meeting about the common frequency for group-common PDCCH/PDSCH can be confirmed.
	+ Proposal 2. Support Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.
	+ Proposal 3. gNB can configure the offset from the starting PRB of the MBS frequency region to the starting PRB of the dedicated unicast BWP and the length of PRBs counting from the starting PRB of the MBS frequency region.
	+ Proposal 4. UE cannot be configured with no unicast reception in the common frequency resource.
	+ Proposal 5. For PTM transmission scheme 1, dedicated physical layer parameters for group-common PDSCH e.g., TDRA table, DMRS configuration, etc., can be configured under the configuration of common frequency resource.
	+ Proposal 6. Support only one common frequency resource per dedicated unicast BWP.
	+ Proposal 22. The common frequency resource for group-common PDSCH can be optionally configured for PTM transmission scheme 2. If type 0 frequency domain resource allocation is used, the RBG size and RBG numbering for FDRA indication in the UE-specific DCI are determined based on the size of common frequency resource instead of UE’s active BWP.
	+ Proposal 23. For PTM transmission scheme 2, dedicated physical layer parameters for group-common PDSCH e.g., TDRA table, DMRS configuration, etc., can be configured under the configuration of common frequency resource.
* **Samsung**
	+ Proposal 2: Consider a common frequency resource within the active DL BWP for subsequent discussions on MBS.
* **Apple**
	+ Proposal 1: MBS specific BWP is configured for common frequency resource for group-common PDSCH.
* **Convida**
	+ Proposal 3: Dedicated MBS BWP (option 2A) should be supported for RRC\_CONNECTED UEs in NR MBS.
* **Qualcomm**
	+ Observation 1: Most of the parameters related to PDCCH/PDSCH reception are configured per BWP. Reusing the BPW signalling to define the common frequency resource for MBS allows for flexible configuration for GC-PDCCH and GC-PDSCH.
	+ Proposal 1: For RRC\_CONNECTED UEs, common frequency resource is defined as an MBS specific BWP (Option 2A).
		- UE can monitor an MBS BWP if it is full within the associated unicast BWP and with same numerology, where no BWP switching when receiving unicast and multicast.
		- One or more MBS BWPs can be configured per UE subject to UE capability.
		- One or more MBS BWPs can be configured per dedicated BWP subject to UE capability.
	+ Proposal 2: For RRC\_CONNECTED UEs, parameters of GC-PDSCH and GC-PDCCH are configured per MBS BWP.
* **CHENGDU TD TECH**
	+ Proposal 1: Use MBS BWP to indicate the common frequency resource for group-common PDCCH/PDSCH within a unicast BWP. Reuse the BWP configuration signalling to configure an MBS BWP. UE can receive the data on the active DL BWP and the data on the MBS BWP within the active DL BWP simultaneously with no BWP switch.
	+ Proposal 2: A unicast BWP can be area specific.
	+ Proposal 3: An MBS BWP can be area specific.
	+ Proposal 4: An MBS BWP can be used to transmit the unicast service of UE. UE can have a unicast service outside of the MBS BWP on the active DL BWP.
	+ Proposal 5: More than one MBS BWPs can be configured per unicast BWP.
	+ Proposal 6: More than one MBS BWPs can be configured per DL BWP per UE.
* **Ericsson**
	+ Observation 4 With Option 2A, the UE would need to have two simultaneously active BWPs, which is preferable to BWP switching.
	+ Observation 5 With Option 2B, there is significant specification work related to the configuration of the new common frequency resource
	+ Observation 6 Option 2A and 2B can probably be made to work but both would imply significant specification work.
	+ Observation 7 By using BWP-specific PDCCHs, the targeted use case, with multiple BWPs with MBS in the overlap, can be supported with very small specification impact (if any).
	+ Proposal 5 We propose that 3GPP studies solutions based on BWP-specific (sub-group-common) PDCCHs scheduling a single group-common PDSCH with the aim of selecting solutions at the next meeting.

## Initial Proposals based on contributions

***Summary***

Regarding the working assumption for common frequency resource, at least 17 companies preferred to confirm it. One company [Ericsson] proposes to use BWP-specific (sub-group-common) PDCCHs based group scheduling scheme without defining common frequency resource for MBS, in which UEs can be configured to use different G-RNTIs for PDCCH and PDSCH.

Regarding down-selection of Option 2A/2B, 10 companies [FUTUREWEI, Huawei, CATT, vivo, Nokia, Intel, Lenovo, ETRI, CMCC, Samsung] propose to confirm 2B for common frequency resource, while 7 companies [ZTE, Spreadtrum, LG, Apple, Convida, Qualcomm, Chengdu TD Tech] propose to confirm 2A for common frequency resource.

Regarding Option 2A, different companies still have different views on whether BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP. Most companies supporting Option 2B think BWP switching may be needed. Among companies supporting Option 2A, most companies think BWP switching is not needed, and 1 company [LG] thinks there could be different sub-options as follows.

- Option 2A-1: BWP switching between MBS specific BWP and UE’s active BWP is NOT supported. UE is allowed to simultaneously activate one MBS specific BWP and one UE’s active BWP.

- Option 2A-2: BWP switching between MBS specific BWP and UE’s active BWP is supported. UE can activate only one of MBS specific BWP and one UE’s active BWP at a time.

Among companies supporting Option 2A, one company [ZTE] proposes the MBS specific BWP can be activated/deactivated independently from the dedicated unicast BWP, one company [Qualcomm] thinks the MBS specific BWP can be regarded as a virtual BWP and the UE monitors an MBS specific BWP only when its associated dedicated unicast BWP is active.

Regarding Option 2B, one company [Qualcomm] thinks that it is not clear how to provide the configuration of group-common PDCCH/PDSCH to the UE. Regarding this, two companies [Huawei, CMCC] propose that group-common PDSCH configuration for MBS (e.g., *pdsch-ConfigMBS*) can be configured separately from the *pdsch-Config* of unicast in the dedicated unicast BWP which includes an MBS frequency region, and whether additional group-common PDCCH configuration for MBS (e.g., *pdcch-ConfigMBS*) can be configured can be further studied.

Regarding Option 2B, most companies think that the starting PRB and the length of PRBs of the MBS frequency region can be configured via RRC signalling, some companies propose that the starting PRB can be referenced to Point A or starting point of the dedicated unicast BWP, some companies propose that the current SLIV indication mechanism can be reused, and some companies propose the detailed signaling is up to RAN2 decision.

Regarding the FFS whether UE can be configured with no unicast reception in the common frequency resource, almost all the companies think that it is up to network implementation to schedule unicast in the common frequency resource or not.

3 companies [OPPO, Qualcomm, Chengdu TD Tech] propose that more than one common frequency resource can be configured per dedicated unicast BWP subject to UE capability, but some companies think that the motivation needs to be clarified, and at least six companies [ZTE, CATT, MTK, Intel, Spreadtrum, CMCC] propose that at most one common frequency resource can be configured per dedicated unicast BWP.

4 companies [OPPO, Qualcomm, Chengdu TD Tech, CMCC] propose that more than one common frequency resource can be configured per UE subject to UE capability, but 5 companies [ZTE, CATT, MTK, Intel, Spreadtrum] propose that one common frequency resource is enough for a UE. It may need more clarifications that whether more than one dedicated unicast BWP of a UE can be configured with common frequency resource subject to UE capability.

***Initial Proposals***

Based on the majority view, the following moderator recommendations are made.

[Moderator’s recommendation]

**Proposal 1-1**: The working assumption for common frequency resource is confirmed.

**(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

**Proposal 1-2**:

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 are configured via RRC signaling, and the detailed signaling is up to RAN2 decision

**Proposal 1-3**:

If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, and if a common frequency resource is configured within a dedicated unicast BWP,

* a group-common PDSCH configuration for MBS (e.g., pdsch-ConfigMBS) is configured for the common frequency resource separately from the pdsch-Config for unicast
	+ FFS whether a group-common PDCCH configuration for MBS (e.g., pdcch-ConfigMBS) is configured for the common frequency resource separately from the pdcch-Config for unicast

**Proposal 1-4**:

At most one common frequency resource can be configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.

* Note: this does not take into account the common frequency resource for broadcast reception that can be used by both RRC\_IDLE/RRC\_INACTIVE UEs and RRC\_CONNECTED UEs.

**Proposal 1-5**:

More than one dedicated unicast BWPs of a UE can be configured with common frequency resource subject to UE capability.

* FFS whether the common frequency resources configured for different dedicated unicast BWPs of a UE can be different or not.

**Question 1-6**:

Whether 3GPP needs to study solutions based on BWP-specific (sub-group-common) PDCCHs scheduling a single group-common PDSCH without defining common frequency resource for MBS?

## Company Views (1st round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | Regrading **Proposal 1-1**: Agree with FL’s proposal.Regrading **Proposal 1-2**: Agree with FL’s proposal. The most important motivation of supporting option 2B is three is no BWP switching time between MBS common frequency resource and UE-specific active BWP.Regrading **Proposal 1-3**: Agree with FL’s proposal. Considering different UEs in one MBS group may have different unicast PDSCH configurations, e.g., different TDRA tables, it is necessary to configure a common PDSCH-config for group-common PDSCH for UEs in the same MBS group to align UEs’ interpretation of group-common PDCCH.Regrading **Proposal 1-4**: Agree with FL’s proposal. The motivation of support multiple common frequency resources is not clear, since multiple multicast services for one UE can all be transmitted in the same MBS frequency resource. In addition, considering the DCI size of group-common PDCCH is also associated to the bandwidth of common frequency resource, there will be more than one DCI sizes of group-common PDCCH for one UE if more than one common frequency resources are configured per dedicated unicast BWP and causes more spec effort on DCI size alignment procedure.Regrading **Proposal 1-5**: Agree with FL’s proposal. It should not restrict supporting only one unicast BWP contains the MBS common frequency resource. Regrading **Question 1-6**: We think the BWP-specific (sub-group-common) PDCCHs is a special case of current PTM transmission scheme, which the common frequency resource equals with UE-specific BWP. Therefore, the discussion of common frequency resource is independent from sub-group-common PDCCH transmission scheme, but we are fine to discuss it. |
| Huawei, HiSilicon | Proposal 1-1 is fine.Proposal 1-2 is fine.Proposal 1-3 is fineProposal 1-4 main bullet is fine. A question for the note, why is this note needed? Assuming NW can manage to configure to RRC connected UE a common resource where multicast can be scheduled as well as the broadcast, is there problem for it??Proposal 1-5 seems unclear. Is it UE capability for unicast BWP supporting or additional capability on top to support multicast? In our understanding, if UE has the capability of supporting the unicast BWP and UE supports multicast, it seems nature for UE to support a common frequency resource for receiving multicast in that unicast BWP. In any case, it seems the discussion in UE feature phase, so we don’t need this proposal at this moment in our opinion.  |
| ZTE | Regarding **proposal 1-1**, it is fine to confirm this working assumption. Regarding **proposal 1-2 and 1-3**, we propose to define the common frequency resource via MBS BWP (Option 2A) due to the following reasons.* Option 2A can straightforwardly support to configure parameters different from unicast parameters for multicast transmission. For example, using PDCCH-config and PDSCH-config under MBS BWP for MBS transmission parameters configuration, which is independent of unicast transmission. While for option 2B, it seems only related to how to configure the frequency range for multicast transmission. However, the determination of other transmission parameters still needs further discussion.
* Option 2A has forward compatibility. With BWP framework, it is straightforward to configure different parameters for unicast and multicast, including different numerologies for unicast and multicast in the future for SFN if needed.
* It is not possible to configure a common frequency region larger than the DL BWP, which means Option 2B can NOT be used for IDLE UEs. However, Option 2A can also be applied to IDLE/INACTIVEs to support a MBS BWP larger than the initial DL BWP.
* No BWP switching is needed as long as that MBS BWP and unicast BWP share the same SCS and MBS BWP fully contains or is fully contained by unicast BWP.

Regarding FL **proposal 1-4**, we are ok with the proposal. If companies prefer to support more than one common frequency resource, it can also be supported subjected to UE capability.We propose to defer the discussion of **proposal 1-5** until the decision on Option 2A and Option 2B is made since the configuration of Option 2A and Option 2B is different.Regarding **Question 1-6**, it seems the solution can be totally up to network implementation. Not sure whether we need to specify anything for this solution. Besides, it is not clear how to configure different parameters for unicast and multicast if common frequency resource is not configured. |
| MTK | Proposal 1-1,1-2 and 1-3:Considering simultaneously reception b/w unicast and multicast based on UE capability, no switching delay b/w these two transmission are common understanding. We still have concern that Opt 2A will introduce BWP switching delay because it defines a MBS specific BWP. Anyway, it needs RAN4’s discussion and confirmation if Opt 2A defined. In contrast, common frequency resource within dedicated unicast BWP doesn’t need BWP switching, which is preferable. It’s up to NW configuration on how to allocate the common frequency resource for different UE’s MBS reception.Proposal 1-4 & 1-5About the common frequency resource configuration, we still think there is no obvious motivation for defining multiple frequency resource. Besides, multiple MBS common frequency resource will cause low resource utilization due to reserved too many resource for MBS. Thus, we prefer at most one common frequency resource can be configured per dedicated unicast BWP and per UE. |
| Samsung | Generally OK with all proposals.Would also be OK to only confirm the WA (Proposal 1-1) and leave a decision for Option 2A vs. Option 2B for later (also related to Question 1-6), after additional aspects related to specifications are determined, in order to make sure that the simpler option is selected. At the moment, Option 2B appears simpler. |
| OPPO | Proposal 1-1, acceptable for us.Proposal 1-2, we suggest to add one sub-bullet that “common frequency resource configuration can be identical as the associated dedicated unicast BWP”.Proposal 1-3, agree, however we suggest to clarify that “The starting PRB and the length of PRBs of the MBS frequency region are configured via UE-specific RRC signaling”.Proposal 1-4, RAN1 has no need to make such restriction, if UE needs to support multiple MBS services simultaneously, a common frequency resource can be configured for each MBS service.Proposal 1-5, agree.Question 1-6, if common frequency resource configuration can be identical to the associated dedicated unicast BWP, seems the solution implied in this question has already been covered. |
| LG | **Proposal 1-1**: We are fine with this proposal.**Proposal 1-3**: We are generally fine with this proposal. This can be also applied to Option 2A.*If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, and if a common frequency resource is configured within a dedicated unicast BWP, or if Option 2A is supported** *a group-common PDSCH configuration for MBS (e.g., pdsch-ConfigMBS) is configured for the common frequency resource separately from the pdsch-Config for unicast*

**Proposal 1-4**: We are fine with this proposal.**Proposal 1-5**: We agree that more than one dedicated unicast BWPs of a UE can be configured with common frequency resource. For example, while performing legacy unicast BWP switching, the UE may still receive the same group common PDCCH/PDSCH on the common frequency resource. However, we are not sure that such configuration depends on UE capability. Thus, we propose to change to:*More than one dedicated unicast BWPs of a UE can be configured with common frequency resource ~~subject to UE capability~~.** *FFS whether this configuration depends on UE capability.*
* *FFS whether the common frequency resources configured for different dedicated unicast BWPs of a UE can be different or not.*

**Question 1-6**: We prefer to focus on PTM scheme 1 and PTP transmission for Rel-17.  |
| CATT | Agree with **Proposal 1-1.**Agree with **Proposal 1-2**. To configure the MBS frequency region, the straightforward way is adding higher layer parameters (i.e. the starting PRB and the length of PRBs) to the dedicated unicast BWP configuration. The current SLIV indication mechanism can be further applied. Option 2A is not supported because BWP switching cannot be avoided.Agree with **Proposal 1-3**. It is up to gNB implementation to configure whether a dedicated unicast BWP can contain MBS common frequency resource or not. When a common frequency resource is configured within a dedicated unicast BWP, the group-common PDSCH/PDCCH configuration for MBS should be configured. We are OK with **Proposal 1-4 and Proposal 1-5**.As discussed in CMCC’s views, the scenarios and the benefit of support more than one common frequency resource is not clear for us. To support receiving the MBS services, it is obvious that one or more dedicated unicast BWP should be configured with the common frequency resource based on the gNB implement. Regarding **Question 1-6**: We are OK with it. The number of PDCCH transmissions in sub-group-common PDCCH scheduling decreases largely by comparing with the UE-specific PDCCH scheduling scheme. The details of the solutions that without configuring the common frequency resource should be discussed. |
| Qualcomm | Proposal 1-1: AgreeProposal 1-2 and Proposal 1-3: we have concern on Option 2B. Instead, we prefer Option 2A because:* We agree with ZTE that Option 2A can straightforwardly support to configure parameters different from unicast parameters for multicast transmission. Reusing the BWP functionality, it is up to gNB implementation to configure the parameters for MBS transmission, independent of unicast transmission. However, Option 2B only defines the frequency range but the other essential parameters, such as FDRA indication, PDSCH-config, PDCCH-config, seem require separate discussion (e.g., the pdsch-config for MBS in Proposal 1-3 is naturally supported if Option 2A is used). Option 2B complicates the RAN1/2 discussion, which we think it is totally unnecessary.
* Option 2A is the unified design the common frequency resource configured for broadcast and multicast reception. For IDLE/INACTIVE UEs, there is no dedicated BWP. An MBS BWP if different than initial DL BWP should be configured for broadcast reception. If it is larger than initial DL BWP, the SLIV way to indicate FDRA cannot work. For CONN UEs, at least a dedicated BWP will be configured to provide RRC signaling, which provides the MBS BWP configuration within a dedicated BWP. The FDRA of MBS BWP is to reuse the BWP way.
* No BWP switching is needed to receive unicast in active dedicated BWP and multicast in the MBS BWP at same time if we keep the MBS BWP within the dedicated BWP using same numerology. It is similar for IDLE/INACTIVE/CONN UEs to receive broadcast in an MBS BWP and SIB/paging in initial BWP if MBS BWP contains the initial BWP using same numerology.

Proposal 1-4: We have concern and prefer to delay it after the discussion of Proposal 1-2/1-3. The UE groups of different MBS services could be different due to different MBS interests. Since we allow a UE to receive different MBS services and unicast simultaneously, all the UEs in different UE groups have to use same configuration of MBS common frequency resource if a UE is belonging to the UE groups for different MBS services. For different MBS services, at least the PDSCH TDRA, PDSCH repetitions, MIMO layers, and MCS table could be different based on the MBS QoS requirement, e.g., the configuration for broadcast and multicast can be different and the configuration for different multicast services can be different as well.Therefore, we prefer to modify it as:Proposal 1-4: More than one common frequency resource can be configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs subject to UE capability.Proposal 1-5: looks okProposal 1-6: not support it since the benefits of sub-group-common are not clear based on last Ran1 meeting discussion. |

## Updated Proposals (1st round of email discussion)

To be added…

# Issue #2: Transmission scheme for MBS

## Background and submitted proposals

***Background***

In RAN1#103-e, the following agreements regarding initial transmission schemes and retransmissions were achieved.

**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?

***Submitted Proposals***

* **FUTUREWEI**
	+ Proposal 4: Support both PTM transmission scheme 2 and PTP transmission for retransmission(s).
* **ZTE**
	+ Proposal 10: Regarding HARQ process management, the following three options can be considered for further down selection,
* Option 1: HPNs are shared between MBS and unicast transmission, and a same HARQ entity is used by them;
* Option 2: HPNs are separated between MBS and unicast, and different HARQ entities are used for MBS and unicast, respectively;
* Option 3: HPNs are separated for unicast and each MBS service, and an MBS service specific HPN entity is required for each MBS service.
	+ Proposal 11: Rel-17 MBS supports both PTP transmission and PTM transmission scheme 1 for retransmission.
	+ Proposal 12: Corresponding with different HPN management options, different indication methods of MBS TB in PTP retransmission can be considered to associate with PTM initial transmission,
		- Option 1: HPN used for initial transmission;
		- Option 2: HPN used for initial transmission and distinguishing indication between MBS and Unicast;
		- Option 3: HPN used for initial transmission and distinguishing indication among unicast and different MBS services.
* **OPPO**
	+ Proposal 1:
		- If gNB can distinguish HARQ feedback of each UE within the group in PTM transmission scheme 1, PTP can be used for re-transmission;
		- The PDCCH scheduling the PTP transmission is scrambled with the same G-RNTI as the PTM scheme 1.
	+ Proposal 7: Support of using UE specific PDCCH transmitted on dedicated unicast BWP to schedule group common PDSCH on another BWP.
* **Huawei**
	+ Proposal 1: PTP can be supported for scheduling retransmission of MBS.
	+ Proposal 7: The configurable number of maximum HARQ process number is kept unchanged for UE supporting MBS reception, and
		- the total number of HARQ processes for initial transmissions are shared and split between unicast and MBS;
		- the HARQ process number for retransmission is kept the same as for initial transmission.
* **CATT**
	+ Proposal 1: UE-specific PDCCH and multi-group-common PDCCH group scheduling is supported in NR MBS.
	+ Observation 4: From UE’s perspective, PTM transmission scheme 2 used as retransmission is considered as initial transmission, if the DCI for initial transmission using PTM scheme 1 is missed by the UE.
	+ Proposal 7: When PTM transmission scheme 1 is used for initial transmission, either PTM scheme 2 or PTP can be supported for retransmission(s) for the whole group of UEs.
	+ Proposal 8: A single retransmission scheme is used for all the UEs in the same group for a TB, and it is up to gNB to determine which scheme is used.
	+ Proposal 9: PTM scheme 2 and PTP can be combined as retransmission schemes for all the UEs in the same group for a TB.
	+ Proposal 10: When supporting both MBS service and unicast service receptions by a UE, the buffer capability is not supposed to be increased.
	+ Proposal 11: It is supported that a HPN can only be used for either MBS service or unicast service at a time.
	+ Proposal 12: The HPNs used for multicast service and unicast service can be determined by gNB through semi-static configuration or dynamic allocation.
* **Vivo**
	+ Proposal 3: A UE can be configured with multiple common RNTIs for PDSCH scrambling for different Broadcast/Multicast services.
	+ Observation 1: The retransmission scheme with dynamically selected C-RNTI/g-RNTI brings about 6.23% and 1.11% gain in term of RU compared to the g-RNTI only and C-RNTI retransmission scheme respectively.
	+ Observation 2: For the cell spectral efficiency, the performances of the three kinds of MBS HARQ retransmission schemes are similar.
	+ Proposal 4: For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast.
	+ Proposal 6: For the retransmission of group-common PDSCH for MBS service, UE-specific PDSCH scheduled by UE-specific PDCCH can be used.
* **Nokia**
	+ Observation-1: 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 signalling 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
	+ Observation-2: In order to support both signalling options to access the same group-common PDSCH, new signalling 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.
	+ Observation-3: Use of different schemes for initial transmission and retransmission would introduce significant complexity both at the gNB and UE in order to maintain the association between the transmission and retransmission of the same TB.
	+ Observation-8: 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-1: Agree to limit the PTM transmission schemes to currently defined schemes 1 and 2, and not investigate further schemes for dynamic scheduling as part of this WID.
	+ Proposal-2: For RRC\_CONNECTED UEs, support UE-specific PDCCH with CRC scrambled by a C-RNTI to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on a common RNTI.
	+ Proposal-3: The same group-common PDSCH for PTM transmission can be accessed either by:
		- A set of UEs using the same group-common PDCCH with CRC scrambled by a common RNTI
		- A set of UEs, where each UE uses a UE-specific PDCCH with CRC scrambled by a C-RNTI
		- A mix of the UEs, where some of them use UE-specific PDCCH and others use group-common PDCCH
	+ Proposal-4: The network can dynamically modify the signalling used to configure a UE to access a group-common PDSCH.
	+ Proposal-5: Agree to limit the transmission and retransmission of the same TB to using a single transmission scheme.
* **MTK**
	+ Proposal 1: The PTP mechanism can be supported for multicast service retransmission.
* **Intel**
	+ PTP and/or PTM Scheme 2 should be supported only when ACK/NACK based HARQ feedback is configured or enabled for the UEs within a group.
	+ 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.
	+ The HARQ process ID is used to associate PTP or 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.
	+ Different group RNTIs corresponding to high and low QoS delivery modes are configured for RRC\_CONNECTED UEs
	+ For NR MBS transmission
		- Define a new RNTI, namely SC-RNTI for scrambling the CRC of DCI scheduling a PDSCH mapped to the MCCH containing multicast configuration information
		- Define a new RNTI, namely the SC-N-RNTI for scrambling the CRC of the DCI notifying a change in the multicast configuration.
		- Define a new group RNTI, namely G-RNTI for scrambling the CRC of DCI scheduling a PDSCH carrying the multicast data corresponding to MTCH
	+ NR MBS uses PDSCH Mapping Type A with DM-RS Type 1 as a baseline. PDSCH Mapping Type B and use of Type 2 DM-RS are not precluded
	+ For NR MBS support of multi-layer MIMO transmission with rank adaptation (from UE perspective) is not precluded.
	+ 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.
	+ Advanced transmission schemes like multiuser superposition transmission (MUST) for improving group spectral efficiency are not precluded
* **Google**
	+ Observation 1: To support PTM scheme 1, UE has to handle the MBS BWP and MBS search space configured by a base station. On the other side, PTM scheme 2 applies simpler RRC signalling, which may be beneficial for UE that has lower capability (e.g. cannot support additional search space).
	+ Observation 2: To support PTM transmission scheme 2, UE should be able to distinguish MBS and UE-specific transmissions scheduled by the same DCI format (e.g. according to a new field or FDRA field in the DCI format).
	+ Proposal 1: For initial transmission, PTM transmission scheme 2 can be supported for UE with lower capability.
	+ Observation 3: In terms of traffic offloading and retransmission optimization, PTP retransmission can offload control and data traffics to UE-specific resources, and provides retransmission optimization in single UE granularity.
	+ Observation 4: In terms of data transmission, the spectrum efficiency of PTM scheme 1 and 2 are identical. However, if the initial transmission uses PTM scheme 1, the advantage of PTM scheme 2 on adopting simpler RRC signalling is no longer exist.
	+ Proposal 2: Support retransmission by using the same scheme as the initial transmission or by using PTP for UE-specific optimization.
	+ Proposal 3: The association between PTM and PTP to the same TB can base on the HARQ process ID and NDI field in the DCI format.
	+ Proposal 4: If multiple retransmission schemes are supported, and a UE receives both group-common and UE-specific PDCCHs that schedule retransmissions of the same TB, the base station can expect that the UE receives the PTP scheduled retransmission and skips the PTM. It also refers that the UE only reports HARQ-ACK based on the DCI scheduling the PTP retransmission.
* **Lenovo**
	+ Proposal 3: PTP based retransmission is supported when initial transmission is based on PTM transmission scheme 1.
	+ Proposal 4: For same TB, HARQ process ID in the UE-specific DCI is same to that in the group-common DCI.
* **Spreadtrum**
	+ Proposal 4: For RRC\_CONNECTED UEs for NR MBS, not support PTM2.
* **LG**
	+ Proposal 1: support PTP based MBS PDSCH transmission for the same TB transmitted by PTM scheme 1.
	+ Proposal 2: DCI scheduling MBS TB indicates the association between PTM scheme 1 and PTP transmitting the same TB.
	+ Proposal 3: support TDM among multiple group-common PDSCHs of the same TB with selectively different RSs in a slot assuming that different UE in the same group may receive same or different PDSCHs of the same TB.
* **CMCC**
	+ Observation 1. The DCI size alignment procedure for PTM transmission scheme 1 will cause the performance degradation of other PDCCHs.
	+ Observation 2. PTM transmission scheme 1 and scheme 2 are not mutually exclusive and can be used in different scenarios. PTM transmission scheme 1 is much suitable for the case network operator has concern about PDCCH overhead. PTM transmission scheme 2 is much suitable for the case network operator has concern about PDCCH performance degradation.
	+ Proposal 16. For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 1, PTP transmission for retransmission(s) can be supported only if there is significant performance gain compared with dynamic switch between PTP and PTM.
	+ Proposal 21. For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast service.
	+ Proposal 26. For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 2, retransmission(s) can use PTM transmission scheme 2 or PTP transmission.
* **Samsung**
	+ Proposal 1: No restriction is introduced for the DCI formats that can schedule a TB reception for a HARQ process to a UE - both a DCI format in a group-common PDCCH and a DCI format in UE-specific PDCCH can be used.
	+ Observation 1: Group-common PDCCH/PDSCH configuration is according UE-specific PDCCH/PDSCH configuration.
* **Apple**
	+ Observation: PTM re-transmission via PTP or PTM is depending on the HARQ-ACK feedback design.
	+ Proposal 2: PTM re-transmission mechanism is waiting for the outcome of the HARQ-ACK feedback design.
* **Convida**
	+ Proposal 1: UE-specific PDCCH with CRC scrambled by C-RNTI is supported to schedule the PDSCH for MBS in addition to the group-common PDCCH for RRC\_CONNECTED UEs in NR MBS.
	+ Proposal 2: Mechanism needs to be introduced for the UE to distinguish between the UE-specific PDCCH scheduling the MBS PDSCH and the PDSCH carrying the payload for unicast service.
* **Qualcomm**
	+ Proposal 8: Support to select PTP and/or PTM scheme 1 for retransmission if PTM scheme 1 is initial transmission.
		- PTP schedules multicast retransmission with HARQ process ID associated with that of PTM scheme 1.
		- Retransmission schemes based on PTP and PTM-1 can be supported simultaneously for different UEs in the same group.
* **CHENGDU TD TECH**
	+ Proposal 12: Not to support PTM transmission scheme 2 for the retransmission of the PTM bearer.
	+ Proposal 13: It’s better not to support the PTP bearer for the retransmission of the PTM bearer.
* **Ericsson**
	+ Observation 1 The UE HARQ process buffers are common for the PTP and PTM transmissions.
	+ Observation 2 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 3 The current PTM transmission schemes 1&2 may be harmonized and generalized by allowing different G-RNTIs for PDCCH and PDSCH. This single generalized scheme could cover a wider range of use cases than either of current PTM transmission scheme 1 and 2. It can also be used to solve the multiple overlapping BWPs use case in a much simpler way than the existing Options 2A and 2B.
	+ Proposal 1 For retransmission, the UE can receive the MBS PDSCH via PTP and/or PTM-1. The HARQ process indicated in DCI associates the PTM-1 transmission and the PTP retransmission.
	+ Proposal 2 For the reception of PTP and PTM-based MBS data in parallel for the same UE, downselect between the following option
		- a. The UE is not expected to be configured to receive the same HARQ process over PTM and PTP within the same HARQ processing window.
		- b. The network is allowed to transmit PDSCH with the same HARQ process over PTP and PTM in the same PDSCH-to-HARQ time frame. The UE, by implementation, can chose to decode either or both. The network monitors both PTP and PTM and expects to receive at least one of the two HARQ responses.
		- c. The network is allowed to transmit PDSCH with the same HARQ process over both PTP and PTM in the same PDSCH-to-HARQ time frame, but the UE is configured with a priority rule (i.e. it does not transmit on the PUCCH resources for both PTP and PTM leg) to send HARQ feedback. The network expects the HARQ feedback only over the prioritized PUCCH resource for HARQ feedback.
	+ Proposal 3 PTM-2 based retransmission of PTM-1 based multicast is not supported.
	+ Proposal 4 Current PTM transmission schemes 1&2 are harmonized into a single generalized PTM transmission scheme characterized by the possibility to RRC configure UEs to use different G-RNTIs for PDCCH and PDSCH. As a special case the G-RNTI may also be the same, as in current PTM transmission scheme 1.
* **ASUSTeK**
	+ Proposal 1: For NR MBS group-scheduling, a reference TDRA table for mapping the group-common PDSCH transmission occasion in time domain needs to be identified and known to corresponding group of UEs.
	+ Observation 1: Using the default TDRA tables, the cell-specific TDRA table, or the UE-specific TDRA table may not be possible/feasible or may limit the flexibility/capacity of NR MBS group-scheduling.
	+ Proposal 2: A “group-common TDRA table” is configured per MBS group for NR MBS group-scheduling.

## Initial Proposals based on contributions

***Summary***

Regarding initial transmission for MBS, 6 companies [CATT, CMCC, vivo, Nokia, Google, Convida] propose to also support PTM transmission scheme 2 for RRC\_CONNECTED UEs, 1 company [Spreadtrum] proposes not to support it. 1 company [CATT] proposes to support multi-group-common PDCCH group scheduling for MBS. 1 company [Ericsson] proposes to harmonize PTM transmission schemes 1&2 into a single generalized PTM transmission scheme characterized by the possibility to RRC configure UEs to use different G-RNTIs for PDCCH and PDSCH.

Regarding whether to support PTP for retransmission if initial transmission is based on PTM scheme 1, 12 companies [FUTUREWEI, ZTE, CATT, OPPO, Huawei, vivo, MTK, Intel, Lenovo, LG, Qualcomm, Ericsson] propose to support PTP for retransmission, 1 company [CMCC] proposes that PTP for retransmission(s) can be supported only if significant gain can be observed compared with dynamic switch between PTP and PTM, 1 company [Nokia] proposes to limit the transmission and retransmission of the same TB to using a single transmission scheme.

Regarding how to indicate the association between PTM scheme 1 and PTP transmitting the same TB, 8 companies [ZTE, Huawei, CATT, Intel, Lenovo, Ericsson, LG, Qualcomm] propose to use HARQ process ID indicated in DCI for the association, and 1 company [Google] proposes to use HARQ process ID and NDI indicated in DCI. I think it may be the common understanding that the NDI needs to be used for the association.

Regarding whether to support PTM scheme 2 for retransmission if initial transmission is based on PTM scheme 1, 4 companies [FUTUREWEI, CATT, CMCC, Intel] propose to support it, while 2 companies [Ericsson, Chengdu TD Tech] propose to not support it.

Regarding whether different retransmission schemes can be supported simultaneously for different UEs in the same group if multiple retransmission schemes are supported, companies’ views are diverged. 1 company [Nokia] proposes to limit the transmission and retransmission of the same TB to using a single transmission scheme, 2 companies [Intel, Qualcomm] think different UEs in a group can potentially support different retransmission schemes, 1 company [CATT] proposes a single retransmission scheme is used for all the UEs in the same group for a TB.

Regarding HARQ process management, 1 company [ZTE] proposes three options, one of the options is also supported by another 3 companies [Huawei, CATT, Ericsson] who propose that the configurable number of maximum HARQ process number is kept unchanged for UE supporting MBS reception, and the total number of HARQ processes for initial transmissions are shared and split between unicast and MBS.

***Initial Proposals***

Based on the majority view, the following moderator recommendations are made.

[Moderator’s recommendation]

**Proposal 2-1**: Support PTM transmission scheme 2 for initial transmission of MBS service in RRC\_CONNECTED state.

* FFS how to differentiate PTP transmission and PTM transmission scheme 2 for a UE
* FFS choice of retransmission scheme(s)

**Proposal 2-2**: For RRC\_CONNECTED UEs, 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.

**Proposal 2-3**: For RRC\_CONNECTED UEs, if PTM scheme 1 is used for initial transmission, PTM scheme 1 retransmission and PTP retransmission can be used simultaneously for different UEs in the same MBS group.

**Proposal 2-4**: For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTM scheme 2.

* FFS: whether different retransmission schemes can be supported for different UEs in the same MBS group

**Proposal 2-5**: The configurable number of maximum HARQ process number is kept unchanged for UE supporting MBS reception, and

* the total number of HARQ processes for initial transmissions are shared and split between unicast and MBS;
* the HARQ process number for retransmission is kept the same as for initial transmission.

## Company Views (1st round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | Regarding **Proposal 2-1**: Agree with FL’s proposal. PTM transmission scheme 1 and scheme 2 are not mutually exclusive and can be used in different scenarios. For PTM 1, the DCI size alignment procedure will impact the other PDCCHs’ detection performance. For example, if G-RNTI DCI size is counted in maximum “3”, for one UE, the G-RNTI DCI size should be aligned with other UEs in the same MBS group, and aligned with unicast C-RNTI DCI size at meanwhile. This will introduce additional DCI size alignment procedure to align unicast DCI size with G-RNTI DCI size, and cause performance degradation of unicast DCI if the payload size is increased. If G-RNTI DCI size is counted in “1”, all the other DCI size (DCI format 2\_0, 2\_1, 2\_4, 2\_5, 2\_6) and G-RNTI DCI size should be aligned to the maximum DCI size among these. In addition, the support of 2\_x series DCI formats are also different among UEs in the same MBS group. It may be difficult for network to configure the DCI size(s). But for PTM transmission scheme 2, there is no additional DCI size alignment problem and PDCCH detection performance degradation in PTM transmission scheme 2. In addition, the most advantage of PTM scheme 2 is that the HARQ-ACK feedback related design for unicast in Rel-15/16, e.g., PUCCH configuration and indication, UCI multiplexing can be maximally reused, so that less spec effort is needed. Regarding the PDCCH overhead of PTM transmission scheme 2, we think the PDSCH resources overhead of PTM transmission scheme 2 has already been reduced a lot compared with unicast / PTP transmission. From operator’s perspective, the PDCCH overhead of PTM transmission scheme 2 is acceptable for some scenarios, especially when the UE number is not large.Therefore, Due to some limitations of PTM transmission scheme 1, PTM transmission scheme 2 is a supplementary scheme, which can provide more flexibility and choice for operators. For example, if operator has concern about PDCCH overhead, PTM transmission scheme 1 can be utilized and if operator has concern about other PDCCH performance degradation, PTM transmission scheme 2 can be utilized.Regrading **Proposal 2-2**: Agree with FL’s proposal.Regarding **Proposal 2-3**: Agree with FL’s proposal. Regarding **Proposal 2-4**: Agree with FL’s proposal. PTM transmitting scheme 2 can provide additional benefits over PTP transmitting for re-transmission in some scenarios. For example, if several cell edge UEs in the same beam direction feedback NACK, one alternative is to use PTP transmitting for re-transmission to improve the reliability, another better alternative is to use PTM transmitting scheme 2 for re-transmission to improve the reliability and at the same time improve the transmission efficiency since these UEs can share the same group-common PDSCH.Regarding **Proposal 2-5**: Agree with FL’s proposal. |
| Huawei, HiSilicon | Support proposal 2-2, 2-5. One question for proposal 2-3/2-4. The FFS under proposal 2-4 I guess is saying PTM1 and PTM2 by “different retransmission schemes”. What is the reason to FFS this case but propose to support PTM1 and PTP can be used simultaneously for different UE in the same group under proposal 2-3?  |
| ZTE | We are supportive of proposal 2-2.Regarding proposal 2-3, ok with it. But it is not clear how to handle the situation when UE receives the same TB via PTM scheme 1 and PTP, the detailed UE behavior needs to be FFS.Regarding proposal 2-4, we suggest to defer the discussion until PTM transmission scheme 2 for initial transmission has been determined.We are fine with proposal 2-5. |
| MTK | Proposal 2-1: Comparing with PTP, we still think there is no motivation for introducing PTM scheme 2. But we are open and can more further discussion.Proposal 2-2:Assuming only little NACKed UE, PTP retransmission is more preferable due to more accurate/targeted transmission. But how to combine PTP and PTM scheme 1 is a critical issue. As discussed in our contribution (R1-2100614), a combined HARQ process is allowed at UE to receive the PDSCH data from PTM scheme 1 and PTP. The method that HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB may be is the one option for combining the PTP and PTM reception data. However, if there are multiple MBS PDSCH, it will be more complexity to indicate the association b/w MBS PTM scheme 1 initial transmission and PTP retransmission. Therefore, we can consider another solution that PTP retransmission’s HARQ process number within DCI format whose CRC scrambled with G-RNTI is the same with that of PTM scheme 1. We suggest the proposal can be modified as follows:**Proposal 2-2**: For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTP transmission.* Opt 1: The HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB.
* Opt 2: The PTP retransmission with G-RNTI can use the same HARQ process ID with PTM scheme 1 transmission.

Proposal 2-3:Not support this proposal. The motivation for supporting PTM scheme 1 and PTP simultaneous transmission is not clear. Since it has used PTM scheme 1 retransmission that all the UE in the same MBS group can receive the retransmission data, the PTP simultaneous retransmission makes no sense.Proposal 2-5:As our commented in proposal 2-1, we still think there is no motivation for introducing PTM scheme 2. But we are open and can more further discussion. |
| Samsung | Do not support Proposals 2-1/2-4. PTM 2 is unnecessary. The MBS design should not be made unnecessarily complex with multiple options.Support Proposals 2-2/2-5.Do not support Proposal 2-3. No apparent need for it. |
| OPPO | Proposal 2-1, if ACK/NACK based feedback can be supported for PTM scheme 1, we did not see the benefit of PTM scheme 2, but it may complicate the DCI design to differentiate PTP and PTM.Proposal 2-2, if gNB cannot distinguish ACK/NACK from each individual UE in the MBS group, there is no point to switch to PTP re-transmission, so we suggest to suspend this proposal until HARQ feedback scheme for PTM scheme 1 is agreed.Proposal 2-3, same as comment for Proposal 2-2.Proposal 2-4, this proposal is also related to HARQ feedback scheme for PTM scheme 1 as that for Proposal 2-2, furthermore, even gNB can distinguish ACK/NACK feedback from each individual UE, we did not see the benefit of using PTM scheme 2 for re-transmission.Proposal 2-5, agree. |
| LG | **Proposal 2-1**: The benefit of PTM scheme 2 seems related to support of ACK/NACK based HARQ feedback or PDCCH/PDSCH on the same common frequency resource. We prefer to deprioritize PTM scheme 2 until the related aspects become clear.**Proposal 2-2**: We are fine with this proposal.**Proposal 2-3**: We are fine with this proposal.**Proposal 2-4**: We prefer to deprioritize PTM scheme 2. See our view on Proposal 2-1.**Proposal 2-5**: We are not sure about this proposal. We wonder if the same HARQ entity can be shared by MBS and unicast. Alternatively, different HARQ entities would be configured for MBS PDSCH and unicast PDSCH in the MAC entity in the network side. Similarly, UE is configured with different corresponding HARQ entities for MBS PDSCH and unicast PDSCH. Thus, the number of maximum HARQ process number can be separately configured (e.g. as in NR sidelink). |
| CATT | Agree with the main-bullet of **Proposal 2-1**.Actually, when PTM scheme 2 is supported as retransmission scheme, it implies that PTM scheme 2 is supported as initial transmission scheme. For example, when initial Tx (PTM 1) is missed by UEs, retransmission (PTM 2) is received and considered as initial transmission.**Proposal 2-2:** OK.**Proposal 2-3:** We still prefer to use one scheme for all the UEs as the retransmission scheme.**Proposal 2-4:** The main bullet is agreeable for us, but the sub-bullet in FFS part is not preferred.**Proposal 2-5**: OK. |
| Qualcomm | Support Proposal 2-2 and 2-3.For Proposal 2-1 and 2-4, we think the PTM-2 definition is not clear enough. The current definition on PTM-2 only mentions G-RNTI for GC-PDSCH. The other parameters of GC-PDSCH will use unicast configuration or multicast configuration? For Proposal 2-5, need some clarifications. * + - The motivation of the main bullet is to say no UE capability of additional HARQ process numbers for multicast?
		- The first subbullet is to say share or split the HARQ process number for initial transmission of unicast and initial transmission of multicast using PTM-1?
		- The second subbullet may need to be deferred since we haven’t decided retransmission schemes yet.
 |

## Updated Proposals (1st round of email discussion)

To be added…

# Issue #3: PDCCH configuration for MBS

## Background and submitted proposals

***Background***

In RAN1#103-e, the following agreements were achieved.

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: 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 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: 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: 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.)

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.

***Submitted Proposals***

* **FUTUREWEI**
	+ Proposal 7: FFS if a new DCI format is needed or if an existing DCI format(s) can be modified.
	+ Proposal 8: A decision on the supported resource allocation type(s) for MBS is needed.
	+ Proposal 9: The support of lower spectral efficiency MCS table should be allowed for MBS.
	+ Proposal 10: The support of FBRM should be allowed for MBS.
	+ Proposal 11: the number of HARQ processes for MBS should be at least the number of SPS processes supported for MBS.
	+ Observation 4: The DCI field PDSCH-to-HARQ\_feedback timing indicator can reuse the DCI format 1\_0 or DCI format 1\_1 method of indicating when the UE should transmit HARQ-ACK bits.
* **ZTE**
	+ Proposal 5: Regarding Rel-17 NR MBS
		- Define a new Type x-PDCCH CSS set for the group common PDCCH.
		- At most 3 CORESETs can be configured within the MBS BWP.
		- Define association between PDCCH MOs and SSBs or CSI-RSs for group-common PDCCH transmission.
	+ Proposal 7: For MBS group PDCCH,
		- DCI format 1\_0 can be defined as a baseline DCI format.
		- An optional DCI format based on either DCI format 1\_1 or DCI format 1\_2 can be further supported for capacity improvement.
	+ Proposal 8: For MBS group PDCCH,
		- The monitoring priority of search space set for MBS is the same as existing Rel-15/16 CSS.
		- The budget of BDs/CCEs of an unused CC for group-common PDCCH can be used for UEs supporting CA capability in Rel-17 MBS.
	+ Proposal 9: Regarding DCI size alignment used for group-common PDCCH,
		- DCI format 1\_0: Current mechanism can be reused for aligning the size of DCI format 1\_0 for group-common PDCCH and unicast PDCCH.
		- DCI format 1\_x: it is counted as other RNTI (i.e., “1” in the “3+1” budget), and gNB will ensure that the number of DCI sizes does not exceed budget.
* **OPPO**
	+ Proposal 8: A new DL DCI format should be defined for the scheduling of group-common PDSCH.
	+ Proposal 9: For a UE receiving group-common PDSCH transmitted with PTM scheme 1 a TPC-PUCCH-RNTI different from that for unicast should be configured.
	+ Proposal 10: The maximum number of CORESTs within one serving cell and the BD/non-overlapped CCE limit are not increased for support of MBS.
	+ Proposal 11: A new common search space set is defined for group-common PSCCH transmission, the monitoring priority of the new CSS set is configurable.
* **Huawei**
	+ Proposal 3: For CORESETs, search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state,
* number of CORESET(s) for scheduling MBS is up to gNB configuration, and
* the ID to determine the CCE indexes of the search space set can be zero or G-RNTI.
	+ Proposal 4: DCI formats 1\_0, 1\_1 and 1\_2 can be used for scheduling MBS with necessary modifications, and new DCI format is not needed:
		- For a common MBS frequency region for MBS configured within dedicated unicast BWP and a group-common PDCCH based scheduling, the FDRA field in DCI is dimensioned per the common MBS frequency region.
	+ Proposal 5: The existing “3+1” DCI size budget should be kept for MBS and DCI size for MBS should be aligned with the existing DCI format being scheduled.
	+ Proposal 6: Re-distributing the BD/CCE limit among serving cells can be supported subject to UE capability.
* **CATT**
	+ Proposal 18: When MBS frequency region (Option 2B) is supported, up to one CORESET can be configured specifically for MBS service on a dedicated unicast BWP.
	+ Proposal 19: When MBS frequency region (Option 2B) is supported, shared CORESET by MBS service and unicast service can be supported on a dedicated unicast BWP.
	+ Proposal 20: 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.
* **Vivo**
	+ Proposal 7: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state,
		- Reuse the existing CSS type(s) in Rel-15/16
		- The monitoring priority of search space set for multicast can be configurable
* **Nokia**
	+ Observation-9: It would be beneficial to maintain currently defined limits for the number of CORESETs, in order to minimize UE and gNB complexity and to ensure backward compatibility.
	+ Proposal-14: There need not be any explicit limits in terms of the number of CORESETs for group-common PDCCH that is allowed within the CFR for group-common PDSCH, and the number of CORESETs configured within the MBS CFR should be left to gNB implementation.
	+ Proposal-15: Agree on option 1 as the baseline option for Rel-17 MBS and further study the impacts and benefits of introducing option-2.
	+ Proposal-18: Discuss and agree on a new search space type with flexible monitoring priority and simplified PDCCH candidate Hash function.
	+ Proposal-19: Propose to have the SS configuration and UE monitoring for 5G NR multicast to depend on the multicast service types, i.e. high-priority multicast services are configured in CSS – with no modifications for multicast, and low-priority multicast services are configured in USS – with modifications.
	+ Proposal-20: Agree to reuse existing Rel-15/16 monitoring priority framework for CSS and USS.
	+ Proposal-21: Monitoring priority for the new multicast search space could be flexibly configured and should be based on the SS index.
* **MTK**
	+ Proposal 4: Not increase the total existing number of CORESET and search space for NR MBS scheduling.
	+ Proposal 5: Type 3-PDCCH CSS with little modification (e.g., support G-RNTI) can be reused for multicast group common PDCCH monitoring.
	+ Proposal 6: Keep the BDs/CCEs limits per slot per serving cell defined in Rel-15 for Rel-17 MBS.
	+ Proposal 7: Keep the “3+1” DCI size defined in Rel-15 for Rel-17 MBS.
	+ Proposal 8: DCI format 1\_X can be as a baseline for multicast group-common PDSCH scheduling.
* **Intel**
	+ For PTP or PTM scheme 2, the CORESET scheduling MBS (re)transmission can be configured outside the MBS frequency region
	+ For determining BD/CEE limits for NR MBS in Rel-17, Option 1 should be supported for UEs without CA capability and Option 2 should be supported for UEs with CA capability. Down-selection is not necessary
	+ Search space set configuration for monitoring DCI scheduling multicast PDSCH can have the following options:
		- Re-use NR Type 3 CSS configuration while additionally supporting monitoring of DCI with CRC scrambled by SC-RNTI, SC-N-RNTI and G-RNTI
		- Alternately, define new NR CSS Type 4 for monitoring multicast DCI with CRC scrambled by SC-RNTI, SC-N-RNTI and G-RNTI
	+ For RRC\_CONNECTED UEs groupcast PDCCH can also be monitored in USS
	+ The monitoring priority of search space set for multicast is the same as existing Rel-15/16 CSS and USS (if supported)
	+ DCI Format for scheduling NR MBS transmissions:
		- Delivery Mode 1 (high QoS): DCI formats 1\_1, 1\_2 can be used. If needed, a compact DCI format for multicast scheduling can be defined
		- Delivery Mode 2 (low QoS): DCI format 1\_0 can be used since the group of UEs can also include RRC\_IDLE/INACTIVE mode UEs
	+ The group-common DCI format for MBS transmission is included in the scheduling DCI size budget of 3 for UEs and UEs can perform size alignment for other DCI formats if MBS DCI size exceeds other scheduling DCI in its active BWP.
* **Lenovo**
	+ Proposal 7: A common CORESET is configured within the common frequency region for MBS for the group of UEs.
	+ Proposal 8: A common search space is configured associated with the common CORESET for MBS for the group of UEs.
	+ Proposal 9: DCI format 1-0 with CRC scrambled by G-RNTI is used as the group-common DCI.
	+ Proposal 10: For DCI size alignment, DCI format with CRC scrambled by G-RNTI is counted as the DCI format with CRC scrambled by C-RNTI.
* **Spreadtrum**
	+ Proposal 5: For BD/CCE limit for Rel-17 MBS, both option 1 and option 2 could be supported.
	+ Proposal 6: For search space type for Rel-17 MBS, support option 1, i.e., Define a new search space type specific for multicast.
	+ Proposal 7: For the monitoring priority of search space set, support option 1, i.e., the monitoring priority of search space set for multicast is the same as existing Rel-15/16 CSS.
* **LG**
	+ Proposal 9: For a single carrier, the maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 can be increased for MBS capable UEs.
	+ Proposal 10: support CSS Type 3 for group common PDCCH for connected UEs as well as idle/inactive UEs.
	+ Proposal 11: support additional new CSS type 4 for multicast of which monitoring priority is handled like USS.
* **CMCC**
	+ Proposal 7. Define a new CSS type for group-common PDCCH of PTM transmission scheme 1 for multicast in RRC\_CONNECTED state.
	+ Proposal 8. The monitoring priority of new CSS type for multicast is the same as existing Rel-15/16 USS.
	+ Proposal 9. For UEs without CA capability, 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.
	+ Proposal 10. For UEs with CA capability, both 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 and Option 2: the budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs can be supported for Rel-17 MBS, and it is based on UE’s capability to support Option 1 or Option 2.
	+ Proposal 11. Maximum 3 CORESETs for group-common PDCCH can be configured within the common frequency resource.
	+ Proposal 12. The CORESET(s) for group-common PDCCH are counted in the number of maximum 3 CORESETs per DL BWP.
	+ Proposal 13. For PTM transmission scheme 1, both fallback DCI format 1\_0 and non-fallback DCI format 1\_1/1\_2 could be considered with new interpretations.
	+ Proposal 14. Keep the “3+1” DCI size budget as in Rel-15/16 when PTM transmission scheme 1 is enabled.
	+ Proposal 15. For PTM transmission scheme 1, decide whether the DCI size associated with G-RNTI should be counted in the DCI size budget associated with C-RNTI or counted in the DCI size budget associated with all RNTIs.
	+ Proposal 24. For PTM transmission scheme 2, non-fallback DCI format 1\_1/1\_2 could be considered, and one or more additional bits in DCI is defined to differentiate that the scheduled PDSCH’s scrambling initialization is based on C-RNTI or G-RNTI(s).
	+ Proposal 25. For PTM transmission scheme 2, keep the same maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell as in Rel-15 when R17 NR MBS is enabled.
	+ Proposal 29. For RRC\_CONNECTED UEs, a new type CSS is supported for group-common PDCCH for broadcast.
	+ Proposal 31. Only the PDCCHs for scheduling the broadcast service has been reported by RRC\_CONNECTED UE are counted in the monitored CSS PDCCH candidates and non-overlapping CCEs in a slot or span.
* **Samsung**
	+ Proposal 6: The maximum number of CORESETs per cell for either or both MBS PDCCH and unicast PDCCH is same as in Rel-16.
	+ Proposal 8: The Rel-16 search space equation with Y\_(p,-1)=n\_RNTI is used for MBS PDCCH.
	+ Proposal 9: The monitoring priorities of search space sets for MBS PDCCH are determined according to the corresponding search space set indexes as for USS sets in Rel-16.
	+ Proposal 10: If the number of DCI format sizes is as in Rel-16, the size of the DCI format scheduling MBS PDSCH is counted together with the sizes of unicast DCI formats. The sizes of the fields of the DCI format are configurable.
	+ Proposal 11: For the purposes of MBS, consider increasing to 5 the number of sizes for DCI formats that a UE can be configured to monitor PDCCH.
	+ Proposal 12: The DCI format for MBS PDSCH is based on DCI format 1\_2.
	+ Observation 2: Option 2 needs to be clarified for whether it requires a new UE capability to increase $M\_{PDCCH}^{max,slot,μ}$/$C\_{PDCCH}^{max,slot,μ}$ or whether it replaces configured cells with activated/non-dormant BWP DL cells to compute $M\_{PDCCH}^{total,slot,μ}$/$C\_{PDCCH}^{total,slot,μ}$.
* **Apple**
	+ Proposal 4: Define a new common search space type for multicast.
	+ Proposal 5: Maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 is unchanged for Rel-17 MBS.
* **Qualcomm**
	+ Proposal 3: For RRC\_CONNECTED UEs, more than one CORESET for GC-PDCCH can be configured per MBS BWP.
		- Keep the maximum total number of CORESETs per MBS BWP same as that of unicast BWP.
		- Keep the maximum total number of CORESETs per UE unchanged.
	+ Proposal 4: For RRC\_CONNECTED UEs, CSS and/or USS for GC-PDCCH can be configured per MBS BWP.
		- Reuse legacy priority rules for mapping CSS and USS sets for GC-PDCCH in case of overbooking. Option 1 or 2 is dependent on which SS type is configured for GC-PDCCH.
			* 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
	+ Proposal 5: For RRC\_CONNECTED UEs, at least DCI format 1\_0 and 1\_1 can be used for GC-PDCCH.
		- DCI size is aligned between GC-PDCCH and unicast PDCCH using the same DCI format.
	+ Proposal 6: For RRC\_CONNECTED UEs, support both 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.
* **CHENGDU TD TECH**
	+ Proposal 7: The CORESETs and search spaces on an area specific MBS BWP can be area specific.
	+ Proposal 8: On a unicast BWP with at least one MBS BWP, there’s no requirement for increasing the number of the CORESETs per unicast BWP from the MBS BWP(s).
	+ Propoal 9: The maximum number of the monitored PDCCH candidates and the non-overlapped CCEs per slot per serving cell defined in Rel-15 is kept unchanged for Rel-17 MBS.
	+ Proposal 10: Reuse the existing CSS types for MBS.
	+ Proposal 11: The monitoring priority of each search space for MBS is the same as the existing Rel-15/16 CSS.
* **Ericsson**
	+ Observation 13 The common search space can be reused for scheduling group common PDCCH of PTM-1
	+ Observation 14 A basic multicast DCI format, based on legacy DCI format 1\_0, could be defined, which may be used in the CSS without requiring additional Blind decoding and without requiring DCI size alignment between unicast and multicast.
	+ Proposal 14 The CORESET for group common PDCCH is part of the already existing CORESET capability of the UE. No additional CORESET capability is defined for MBS only.
	+ Proposal 15 Non fallback DCI for MBS is configured in the common search space, together with the non-fallback DCI for unicast. Fallback DCI for MBS is also configured in the common search space.
	+ Proposal 16 The priority of search space for multicast is higher than UE specific search space but lower than the existing common search space defined in R15/R16.
	+ Proposal 17 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.
	+ Proposal 18 A new DCI format for MBS downlink scheduling is introduced e.g. DCI 1\_3.
		- a. The fields are the same as for DCI 1\_1 , with the addition of a field for padding bits for the group scheduling DCI size alignment purpose. The number of padding bits ranges from 0 to Nd, where Nd is the difference between the largest configurable size for DCI 1\_1 and the smallest configurable size for DCI 1\_1
		- FFS: Discuss MBS fallback DCI
	+ Proposal 19 In the existing alignment procedure, an additional step is taken by the UE to align its DCI 1\_1 with DCI 1\_3 when DCI 1\_3 is configured.
		- a. FFS alignment for MBS fallback DCI

## Initial Proposals based on contributions

***Summary***

Regarding the FFS point for number of CORESET(s) for group-common PDCCH within the common frequency resource, it seems the majority prefer that the maximum number of CORESETs within one serving cell is not increased for support of MBS, and the number of CORESETs configured within the MBS common frequency resource is left to gNB implementation.

Regarding BDs/CCEs limit for Rel-17 MBS,

* 7 companies [OPPO, CATT, Nokia, MTK, Apple, Ericsson, Chengdu TD Tech] propose to keep the maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 unchanged for Rel-17 MBS (i.e., Option 1).
* 4 companies [ZTE, Intel, Spreadtrum, Qualcomm] propose that, 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 (i.e., Option 2).
* 2 companies [Huawei, CMCC] propose that Option 2 can be supported based on UE capability.
* 1 company [Samsung] proposes that Option 2 needs to be clarified for whether it requires a new UE capability to increase $M\_{PDCCH}^{max,slot,μ}$/$C\_{PDCCH}^{max,slot,μ}$ or whether it replaces configured cells with activated/non-dormant BWP DL cells to compute $M\_{PDCCH}^{total,slot,μ}$/$C\_{PDCCH}^{total,slot,μ}$. Another 1 company [LG] proposes BDs/CCEs limit can be increased for MBS capable UEs.

Regarding the DCI size budget, 3 companies [Huawei, MTK, CMCC] propose to keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS. 1 company [Samsung] proposes to consider increasing DCI size budget to 5.

Regarding search space set of group-common PDCCH, 8 companies [ZTE, Apple, Nokia, Intel, Spreadtrum, CMCC, LG, OPPO] propose to define a new Type X CSS, 6 companies [vivo, Chengdu TD Tech, MTK, Intel, LG, Qualcomm] think existing CSS type can be reused with possible modifications. Few companies think existing USS can also be reused with possible modifications.

Regarding the monitoring priority of MBS search space set, if a new Type X CSS is defined, some companies think the monitoring priority of MBS search space set is the same as existing Rel-15/16 CSS, some companies propose that the monitoring priority of MBS search space set can be configurable based on the SS index, i.e., network can configure a lower or higher SS index than USS index for MBS search space to change its monitoring priority compared to USS.

Regarding the DCI format for MBS, companies’ views are diverged. 2 companies [OPPO, Ericsson] propose to define a new DCI format, 8 companies [Qualcomm, ZTE, Huawei, Intel, CMCC, MTK, Lenovo, Samsung] propose to reuse existing DCI format 1\_x. It seems majority can accept that at least DCI format 1\_0 can be reused for group-common PDCCH with necessary modifications for Rel-17 MBS.

***Initial Proposals***

Based on the majority view, the following moderator recommendations are made.

[Moderator’s recommendation]

**Proposal 3-1**:

The maximum number of CORESETs per serving cell is not increased for support of MBS, and the number of CORESETs configured within the MBS common frequency resource is left to network implementation.

**Proposal 3-2**:

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 subject to UE capability, which is similar to the method used for multi-DCI based multi-TRP in Rel-16.

**Proposal 3-3:**

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.

**Proposal 3-4:**

For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, down-select from the following options.

* Option 1: Define a new Type X CSS
	+ FFS: whether the monitoring priority is the same as existing Rel-15/16 CSS or is configurable based on the SS indices of USS and the new type CSS
* Option 2: Reuse the existing CSS type(s) in Rel-15/16
	+ FFS: which CSS type(s) and whether modifications are needed

**Proposal 3-5:**

For group-common PDCCH of Rel-17 MBS, at least DCI format 1\_0 can be reused with necessary modifications.

* FFS whether other DCI formats (e.g., DCI format 1\_1/1\_2) can be reused with necessary modifications

## Company Views (1st round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | Regarding **Proposal 3-1**: Agree with FL’s proposal.Regarding **Proposal 3-2**: Agree with FL’s proposal.To keep Rel-15 BDs/CCEs limit as the baseline is better for future commercial deployment of NR MBS. We also support option 2 as optional UE’s capability.Regarding **Proposal 3-3**: Agree with FL’s proposal.Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS is useful for future commercial deployment of NR MBS. Regarding **Proposal 3-4**: Agree with FL’s proposal.We prefer option 1 to define a new Type X CSS, and the monitoring priority is configurable based on the SS indices of USS and the new type CSS which gives gNB more flexibility.Regarding **Proposal 3-5**: Agree with FL’s proposal.We also support DCI format 1\_1 and DCI format 1\_2, which can schedule multi-layer group-common PDSCH transmission. |
| Huawei, HiSilicon | Ok with proposal 3-1, 3-2, 3-3.Regarding proposal 3-4, it seems more straightforward to discuss the ID for obtaining the search spaces sets instead of getting stuck in struggling what the name should be, since it has been noted that the monitoring priority should be separately further discussed. Regarding proposal 3-5, ok with main bullet in principle, but what the concern is to support DCI format 1\_1/1\_2 if that is supported for unicast. |
| ZTE | Regarding proposal 3-1, we propose to increase the maximum number of CORESETs to 6. Currently, up to 3 CORESETs can be configured. Considering that the frequency region used for multicast and unicast can be different, it may be too restrictive to keep up to 3 CORESETs per serving cell. Regarding proposal 3-2, we propose to confirm the FFS point and endorse it together with the main bullet.We are fine with proposal 3-3 and proposal 3-4. We are basically fine with proposal 3-5. But the “necessary modifications” is not very clear. One reason may be that the detailed function of MBS is still not finalized. |
| MTK | Proposal 3-1:Support this proposalProposal 3-2:Support the main bullet.If all UEs in one MBS group support CA, the FFS in the sub-bullet can be suitable. However, there may some UEs don’t support CA in the same MBS group, it is not suitable to define this restriction. Considering the general case, the main bullet is enough.Proposal 3-3:Support the proposal.Considering the UE processing complexity, keeping the Rel-15 DCI size budget is desirable.Proposal 3-4:Support this proposal.There are five common search space types in Rel-15/Rel-16 NR PDCCH scheduling, each search space type has its own characteristic. The Type 3-PDCCH CSS configured for DCI format with CRC scrambled by C-RNTI can monitor PDCCH in a common manner. Besides, there is no need to introduce a new type CSS, the type 3-PDCCH CSS with some little modification (e.g., add the DCI format with CRC scrambled by G-RNTI) may be desirable for MBS common search space configuration.Proposal 3-5: Support this proposal.DCI format 1\_0 can be as a baseline for MBS services, but not preclude the possibility of DCI format 1\_1/1\_2, which can be further discussion. |
| Samsung | Support Proposal 3-1 and Proposal 3-2 (no need for the FFS)Premature/not important to agree on Proposal 2-3 – discussions can continue according to Proposal 2-3 but a decision should be made once it is determined how the “3+1” limit can be kept. Do not support Proposal 3-4. MBS PDSCH scheduling cannot always have higher priority for PDCCH monitoring than unicast PDSCH and there is no need to introduce new CCS types to do that – it can be achieved by Rel-16 specifications and just viewing the search space as USS. Further discussion is needed.Do not support Proposal 3-5. DCI format 1\_2 is the natural choice that minimizes specification impact and gNB complexity to support MBS. |
| OPPO | Proposal 3-1~3-4, agree.Proposal 3-5, basically fine, but we prefer to add “or to define a new DCI format” to the end of the sub bullet.  |
| LG | **Proposal 3-1**: We are fine with this proposal.**Proposal 3-3**: We are fine with this proposal.**Proposal 3-4**: We are fine with this proposal.**Proposal 3-5:** We are fine with this proposal. |
| CATT | Agree with **Proposal 3-1**, **Proposal 3-2, Proposal 3-3, and Proposal 3-5**Regarding **Proposal 3-4,** agree with FL’s proposal. We are fine with both options as long as the priority of the SS for MBS can be adjusted according to the MBS services. |
| Qualcomm | Proposal 3-1: understanding may be different for Option 2A and Option 2B for MBS common frequency resource. If Option 2B is agreed, the total number of CORESETs for unicast and multicast is limited per dedicated BWP (e.g., up to 3); while if Option 2A is agreed, the total number of CORESETs for multicast is limited per MBS BWP (e.g., up to 3). The number of CORESETs for unicast and multicast will be counted separately but the total number of CORESETs per serving cell will be not changed. Is it correct understanding? Proposal 3-2: we support Option 1 and Option 2 based on per-UE configuration and per-UE capability. Different UEs in the same UE group can be configured to use Option 1 or Option 2. If a UE not supporting CA, it only can be configured with Option 1. If a UE supporting CA and Option 2 as well, it can be configured with Option 1 or Option 2.Proposal 3-3: fine with the proposal.Proposal 3-4: The names of Option 1 and 2 are confusing. If the G-RNTI is used to modify the existing CSS, it is a Type-X CSS and similar as CSS priority. If the G-RNTI is used to modify the existing USS, it is similar as the USS priority based on SS ID.Proposal 3-5: We are fine with DCI format 1\_0. But DCI format 1\_1 is also needed at least for multi-layer MIMO transmission. |

## Updated Proposals (1st round of email discussion)

To be added…

# Issue #4: SPS for NR MBS

## Background and submitted proposals

***Background***

In RAN1#103-e, the following agreements were achieved.

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

***Submitted Proposals***

* **FUTUREWEI**
	+ Observation 2: Support both group-common PDCCH and UE-specific PDCCH for SPS group-common PDSCH activation/deactivation.
	+ Proposal 6: support more than one SPS group-common PDSCH configuration.
	+ Observation 3: how a SPS process could be used for re-transmission needs further discussion.
* **ZTE**
	+ Proposal 13: For SPS-based MBS transmission, the following features are supported,
		- UE-specific activation/deactivation
		- More than one SPS group-common PDSCH configuration for MBS transmissions
		- Uplink feedback for SPS group-common PDSCH
		- Retransmission of SPS group-common PDSCH, the design for the retransmission for PTM transmission scheme 1 can be reused for it
* **OPPO**
	+ Proposal 6: Support more than one SPS group common PDSCH for a UE, the SPS should be activated/deactivated by group-common PDCCH scrambled by the corresponding CS-RNTI.
* **Huawei**
	+ Proposal 9: For SPS group-common PDCCH for MBS for RRC\_CONNECTED UEs,
		- support group-common PDCCH for SPS activation/deactivation,
		- retransmission of MBS SPS group-common PDSCH should be further studied,
		- more than one SPS group-common PDSCH configuration per UE can be supported,
		- SPS specific uplink feedback resource can be configured per SPS configuration.
* **CATT**
	+ Proposal 13: Both group-common PDCCH and UE-specific PDCCH (if supported) can be used for SPS activation for MBS for RRC\_CONNECTED UEs.
	+ Proposal 14: Group-common PDCCH is used for SPS deactivation for MBS for RRC\_CONNECTED UEs.
	+ Proposal 15: It is supported that more than one SPS group-common PDSCH configuration per UE based on its capability.
	+ Proposal 16: The total number of supported SPS procedures by a UE is not increased when both multicast and unicast are supporting SPS. How to allocate the total SPS procedures between multicast and unicast is up to network implementation.
	+ Proposal 17: Dynamic scheduling mechanism is used for HARQ-ACK feedback retransmission(s) of SPS group-common PDSCH.
* **Vivo**
	+ Proposal 5: For MBS for RRC\_CONNECTED UEs, for SPS group-common PDSCH, the followings are suggested.
		- Support more than one SPS group-common PDSCH per UE.
		- HARQ-ACK for SPS group-common PDSCH is supported and can be configured.
		- Using UE-specific PDCCH for the SPS group-common PDSCH activation/deactivation
			* FFS: Group-common PDCCH can be used for the SPS group-common PDSCH activation/deactivation.
		- If NACK only feedback is configured for SPS group-common PDSCH,
			* group-common PDSCH scheduled by group-common PDCCH can be used for the SPS group-common PDSCH retransmission
		- If ACK/NACK feedback is configured for SPS group-common PDSCH,
			* UE-specific PDSCH scheduled by UE-specifc PDCCH can be used for the SPS group-common PDSCH retransmission
			* FFS: group-common PDSCH scheduled by UE-specifc PDCCH can be used for the SPS group-common PDSCH retransmission
* **Nokia**
	+ Proposal-8: Support both group-common PDCCH and UE-specific PDCCH for SPS group-common PDSCH activation / deactivation.
	+ Proposal-19: Investigate further whether a special group-common RNTI needs to be defined for SPS vs. dynamic scheduling.
	+ Proposal-10: Utilize limitations such as eight SPS configurations per BWP for group-common PDSCH SPS configurations per UE.
	+ It needs to be further studied whether the total number of SPS configurations should be limited independently for unicast and MBS.
	+ Proposal-11: Inherit uplink feedback configuration for SPS-based MBS in straightforward manner from SPS for unicast in combination with uplink feedback configuration for non-SPS-based MBS.
	+ Proposal-12: There should be a way to transmit retransmissions on SPS-allocated resources.
	+ Proposal-13: Possibilities to add in-band control signalling on PDSCH to facilitate retransmissions on SPS-allocated PDSCH resources should be studied.
* **Intel**
	+ 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 if ACK/NACK based feedback is supported or configured or a common PUCCH resource can be configured for the case when NACK-only feedback is supported or configured.
* **Spreadtrum**
	+ Proposal 8: Support group-common PDCCH for SPS group-common PDSCH activation/deactivation.
* **CMCC**
	+ Proposal 17. Group-common PDCCH is used as the activation/deactivation PDCCH for SPS group-common PDSCH.
	+ Proposal 18. At least NACK-only based HARQ-ACK feedback is supported for SPS group-common PDSCH.
	+ Proposal 19. At least PTM transmission scheme 1 is used as retransmission for SPS group-common PDSCH.
	+ Proposal 20. Support more than one SPS group-common PDSCH configurations per UE.
* **Samsung**
	+ Proposal 3: Activation/deactivation of MBS SPS PDSCH is by a DCI format with a new RNTI (G-RNTI).
	+ Proposal 4: Support multiple MBS SPS PDSCH configurations.
	+ Proposal 5: HARQ-ACK report and retransmissions of MBS SPS PDSCH are supported as for unicast SPS PDSCH.
* **Apple**
	+ Proposal 3: Same solution can be applied for both SPS re-transmission and PTM re-transmission.
* **Qualcomm**
	+ Proposal 7: For RRC\_CONNECTED UEs, support one or more SPS GC-PDSCH configurations per MBS BWP.
		- At least GC-PDCCH can be used for SPS GC-PDSCH activation/deactivation.
		- FFS UE-specific PDCCH for SPS GC-PDSCH activation/deactivation.
* **CHENGDU TD TECH**
	+ Proposal 14: Use the group common PDCCH for the SPS group common PDSCH activation/deactivation.
	+ Proposal 15: More than one SPS group common PDSCH can be configured per SPS RB of the PTM bearer.
	+ Proposal 16: Use PTM scheme 1 for the retransmission of the SPS group common PDSCH.
	+ Proposal 18: G-RNTI and SPS G-RNTI are configured for an MBS.
	+ Proposal 19: For each SPS RB of the PTM bearer, the following items need to be supported.
		- Configure at least one SPS group common PDSCH for each SPS RB of the PTM bearer
		- PDCCH with CRC scrambled with SPS G-RNTI is used to activate/de-activate one SPS group common PDSCH.
		- SPS G-RNTI is used in the bit scrambling of the SPS group common PDSCH.
* **Ericsson**
	+ Observation 10 Group-based SPS need to separately address UEs missing the original SPS activation PDCCH
	+ Observation 11 The activation recovery message needs to contain slot, MCS information of the original activation
	+ Observation 12 For the SPS-PDSCH following an activation commands, the mechanism to support HARQ and HARQ less or NACK only can reuse what is designed for PDCCH based MBS PDSCH scheduling.
	+ Proposal 6 Group common PDCCH is used to activate/deactivate SPS group common PDSCH
	+ Proposal 7 For group based SPS, UEs missing the PDCCH activation message are sent an activation recovery message via MAC-CE containing the original PDCCH information and the slot number where it was transmitted. For deactivation, a MAC CE deactivation order can be sent to UEs not responding to the de-activation PDCCH.
	+ Proposal 8 For group based SPS, UEs missing the PDCCH activation message can recover the PDSCH slots missed during the recovery procedure via C-RNTI based PTP.
		- a. FFS: recover lost PDSCH(s) via group transmission (PTM-1 or PTM-2)
	+ Proposal 9 Multiple group-based SPS configuration are supported, conditioned to UE capability
	+ Proposal 10 The UE is expected to provide feedback via HARQ for all PDCCH associated with a PDCCH activation or deactivation order for SPS
	+ Proposal 11 RRC configures each UE in the group an additional time offset so that when UEs receive group common PDCCH activate/deactivate command, they can acknowledge this command in different slots to avoid PUCCH resource congestion.
	+ Proposal 12 The UE can be configured to either transmit or not transmit HARQ for the SPS PDSCH not corresponding to a SPS PDCCH activation or deactivation.
	+ Proposal 13 The SPS UL feedback framework for the SPS scheduled PDSCH is the same as for PDCCH based MBS PDSCH scheduling.

## Initial Proposals based on contributions

***Summary***

Regarding the activation/deactivation method for SPS group-common PDSCH for MBS, 11 companies [FUTUREWEI, OPPO, Huawei, Nokia, Intel, Spreadtrum, CMCC, Samsung, Qualcomm, Chengdu TD Tech, Ericsson] propose to use group-common PDCCH, 4 companies [FUTUREWEI, ZTE, vivo, Nokia] propose to also support UE-specific PDCCH. 1 company [CATT] proposes to use group-common PDCCH for activation and UE-specific PDCCH for deactivation.

Regarding whether to support more than one SPS group-common PDSCH configuration per UE, 12 companies [FUTUREWEI, ZTE, OPPO, Huawei, CATT, vivo, Nokia, CMCC, Samsung, Qualcomm, Chengdu TD Tech, Ericsson] are supportive. 1 company [CATT] proposes that this can be based on UE capability and the total number of supported SPS configurations by a UE is not increased for supporting MBS, and how to allocate the total SPS configurations between MBS and unicast is up to network implementation.

Regarding whether and how uplink feedback could be configured, 9 companies [ZTE, Huawei, CATT, vivo, Nokia, Intel, CMCC, Samsung, Ericsson] propose to support HARQ-ACK feedback for SPS group-common PDSCH for MBS, and the detailed HARQ-ACK feedback scheme and retransmission scheme can be based on the progress of HARQ-ACK feedback discussion for PTM scheme 1.

***Initial Proposals***

Based on the majority view, the following moderator recommendations are made.

[Moderator’s recommendation]

**Proposal 4-1**:

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

* at least group-common PDCCH is supported
	+ FFS whether UE-specific PDCCH is supported
	+ FFS whether and how to address the missed activation and deactivation

**Proposal 4-2**:

More than one SPS group-common PDSCH configuration for MBS can be configured per UE subject to UE capability

* The total number of supported SPS configurations by a UE is not increased for supporting MBS.
* How to allocate the total SPS configurations between MBS and unicast is up to network implementation.

**Proposal 4-3**:

Support HARQ-ACK feedback for SPS group-common PDSCH for MBS

* FFS the detailed HARQ-ACK feedback scheme(s) and retransmission scheme(s)
* FFS HARQ-ACK for activation/deactivation

## Company Views (1st round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | Regarding **Proposal 4-1**: Agree with FL’s proposal. The using of group-common PDCCH for SPS activation/deactivation can reduce NW signalling overhead.Regarding **Proposal 4-2**: Agree with FL’s proposal.Regarding **Proposal 4-3**: Agree with FL’s proposal. We think the HARQ-ACK feedback schemes and retransmission schemes should be the same as dynamic group-common PDSCH scheduling.  |
| Huawei, HiSilicon | Proposal 4-1, “states”-> “state”,Ok with proposal 4-2.Proposal 4-3, ok with the main bullet. The FFS bullets can be deleted. Instead, the sub-bullet can be a note that the HARQ-ACK details is discussed in AI 8.12.2.  |
| ZTE | Regarding proposal 4-1, without UE-specific activation/deactivation, network has to resend the group-common activation/deactivation if there is new UEs coming into this group or leaving this group. Thus, we propose to also support UE-specific activation/deactivation.We are fine with proposal 4-2 and proposal 4-3. |
| MTK | Support proposal 4-1, 4-2 and 4-3. |
| Samsung | Support 4-1, 4-2 and 4-3.  |
| OPPO | 4-1, basically fine for us, but does the second FFS mean something similar as the second FFS of Proposal 4-3, if so one of them should be removed.4-2 and 4-2 are fine for us. |
| LG | **Proposal 4-1**: We are fine with this proposal.**Proposal 4-2**: We are fine with this proposal.**Proposal 4-3**: We are fine with this proposal. |
| CATT | **Proposal 4-1:** OK.**Proposal 4-2:** OK**Proposal 4-3:** OK with the main bullet. The sub-bullet can be FFS details.In our contribution, one more clarification is needed.UE-specific PDCCH can be used to indicate PUCCH resource (e.g. ACK/NACK based feedback) per UE as well as activate SPS procedure(s). Thus, both UE-specific PDCCH and group-common PDCCH for SPS activation are supported, and group-common PDCCH for SPS for deactivation is supported. |
| Qualcomm | We support Proposal 4-1.For Proposal 4-2, we are fine with the main bullet and 1st subbullet. The second subbullet is not clear, which is related with Option 2A or Option 2B for MBS common frequency resource. If Option 2B is agreed, the SPS config per dedicated BWP is limited, which means the SPS number for unicast and multicast will be split within the limit per dedicated BWP; if Option 2A is agreed, the SPS config for MBS is per MBS BWP but the max total number of SPS for unicast and multicast **per UE** is not changed.For Proposal 4-3, probably the HARQ feedback and retransmission for SPS should be discussed in 8.12.2. |

## Updated Proposals (1st round of email discussion)

To be added…

# Issue #5: Simultaneous operation with unicast reception

## Background and submitted proposals

***Background***

In RAN1#103-e, the following agreements were achieved.

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

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

***Submitted Proposals***

* **FUTUREWEI**
	+ Proposal 5: Determine the number of HARQ processes when configured to receive MBS.
* **Huawei**
	+ Proposal 8: For simultaneous reception of unicast PDSCH and group-common PDSCH in a slot, support the following cases:

• 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

* **CATT**
	+ Proposal 21: When the simultaneous reception of unicast and multicast is out of a UE’s capability, a dropping principle should be considered.
* **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 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 5: support FDM among multiple group-common PDSCHs in a slot
* **Nokia**
	+ Proposal-16: Agree not to introduce any new limitations / requirements in terms of the maximum number of PDSCHs in a slot simultaneously received per UE.
	+ Proposal-17: Prioritize the support for TDM between one or more unicast and group-common PDSCHs over the FDM options.
* **Spreadtrum**
	+ Proposal 9: For simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs,
		- The capability signaling is optional;
		- Support TDM between M TDMed unicast PDSCHs and one group-common PDSCH in a slot
			* FFS: the value of M
			* FFS: per CC, or across CC
		- Support TDM among K group-common PDSCHs in a slot
			* FFS: the value of K
			* FFS: per CC, or across CC
		- Support TDM between L TDMed unicast PDSCHs and T TDMed group-common PDSCHs in a slot
			* FFS: the value of L, T
			* FFS: per CC, or across CC
		- Support FDM between one group-common PDSCH and one unicast PDSCH in a slot
			* FFS: per CC, or across CC
* **CMCC**
	+ Proposal 32. 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 1: TDM between multiple TDMed unicast PDSCHs and one group-common PDSCH in a slot
		- Case 2: TDM among multiple group-common PDSCHs in a slot
		- Case 3: TDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
	+ Proposal 33. The maximum number of PDSCHs in a slot simultaneous received per UE can be 2, 4, or 7 based on UE capability, and regardless that the PDSCH is unicast PDSCH or group-common PDSCH.
	+ Proposal 34. The support of following cases for simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs can be with low priority in Rel-17.
		- Case 4: FDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot
		- Case 5: FDM among multiple group-common PDSCHs in a slot
* **Qualcomm**
	+ Proposal 9: Consider the UE capability for the number of PDSCHs simultaneously received in a slot.
	+ Proposal 10: Further discuss the potential RAN1 impact related with the configuration of G-RNTI(s) and the interaction between G-RNTI and C-RNTI for PDSCH reception, including:
		- Aspects related to simultaneous reception of G-RNTI(s) and C-RNTI
		- Aspects related to simultaneous reception of multiple G-RNTIs.
		- Aspects related to retransmission of packets between G-RNTI(s) and C-RNTI.
* **Ericsson**
	+ Observation 8 The support of case 1-5 depends on the UE capabilities to monitor multiple PDCCH candidates with different G-RNTI and C-RNTI
	+ Observation 9 The support of intra-slot TDM cases for MBS are up to UE capability.
* **Samsung**
	+ Proposal 7: The number of TDM (MBS or unicast) PDSCH receptions is same as for the corresponding Rel-16 UE capability. FDM PDSCH receptions (MBS or unicast) are not supported.

## Initial Proposals based on contributions

***Summary***

Regarding the simultaneous reception in a slot,

* 5 companies [FUTUREWEI, Qualcomm, Nokia, CMCC, Samsung] propose to discuss the UE capability for the total number of PDSCHs simultaneously received in a slot, and it may also need to be considered whether the capability is per UE, per band, per CC or per band-of-BC.
* 3 companies [Nokia, CMCC, Samsung] propose that the maximum numbers of TDMed PDSCH receptions in a slot are kept the same as for Rel-16 UE capability, i.e., the maximum number of TDMed PDSCH receptions in a slot including unicast PDSCH and/or group-common PDSCH can be 2, 4, or 7 per CC based on UE capability.

Regarding the 5 cases for simultaneous reception of unicast PDSCH and group-common PDSCH in a slot, 5 companies [Huawei, vivo, Nokia, CMCC, Samsung] proposes at least case 1/2/3 can be supported based on UE capability, and companies have different views on whether to support case 4/5.

1 company [CATT] proposes when the simultaneous reception of unicast and multicast is out of a UE’s capability, a dropping principle should be considered.

***Initial Proposals***

Based on the majority view, the following moderator recommendations are made.

[Moderator’s recommendation]

**Proposal 5-1**:

For Rel-17 MBS UE, the maximum number of TDMed PDSCH receptions, including unicast PDSCH(s) and/or group-common PDSCH(s), that can be supported in a slot per CC is N, where

* N=2 as mandatory
* N=4/7 subject to UE capability

**Proposal 5-2**:

At least 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 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

## Company Views (1st round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | Regarding **Proposal 5-1**: Agree with FL’s proposal.Regarding **Proposal 5-2**: Agree with FL’s proposal.  |
| Huawei, HiSilicon | Ok with proposal 5-1 in principle, but it should be discussed in UE feature phase in our opinion. Ok with proposal 5-2, but wondering whether we should need one more additional proposal that how many configurations associated with different G-RNTIs UE supports? This issue affects the HARQ-ACK codebook construction in AI 8.12.2.  |
| ZTE | We are fine with proposal 5-1.Regarding proposal 5-2, the following case discussed in previous meeting can also be supported.Case 5: support FDM among multiple group-common PDSCHs in a slot |
| MTK | Ok with proposal 5-1 and 5-2 |
| Samsung | Do not support Proposal 5-1. The WID captures the *following*. Therefore, the maximum numbers of TDMed PDSCH receptions in a slot should be kept same as for Rel-15 UE capability.Restrictions and assumptions:In order to facilitate implementation and deployment of the feature, the overall implementation impact should be limited, and the UE complexity should be minimized (e.g. device hardware impact should be avoided). OK with Proposal 5-2 (assuming the UE capability). |
| OPPO | 5-1 and 5-2 are fine for us. |
| LG | **Proposal 5-1**: We are fine with this proposal.**Proposal 5-2**: We are fine with this proposal. |
| CATT | **Proposal 5-1:** OK. But it is up to UE capability.**Proposal 5-2**: OK. But there is no need to discuss it case by case. Furthermore, the solutions should be discussed when the simultaneous scheduled PDSCHs are beyond UE’s capability. |
| Qualcomm | It’s too early to discuss Proposal 5-1 before other fundamental issues.For Proposal 5-2, agree with ZTE that Case 5 should be added. Since the FDM-ed unicast and GC-PDSCH in a slot based on UE capability has been agreed, the FDM-ed GC-PDSCHs in a slot can be supported as well? |

## Updated Proposals (1st round of email discussion)

To be added…

# Issue #6: Multi-beam operation

## Background and submitted proposals

***Submitted Proposals***

* **ZTE**
	+ Proposal 6: Beam sweeping transmission should be supported in Rel-17 NR MBS
		- Considering full beam sweep for broadcast transmission.
		- Considering partial beam sweep for multicast transmission.
* **Sony**
	+ Proposal 1: Support the use of beam sweeping and beam report to identify suitable beams to provide PDCCH and NR\_MBS contents delivery for RRC\_CONNECTED UEs.
	+ Proposal 2: The network shall configure beam location and periodicity of beam sweeping for PDCCH and NR\_MBS contents delivery.
	+ Proposal 3: The UE shall report preference of NR\_MBS content and beam(s) in which the NR\_MBS content can be provided.
	+ Proposal 4: Configure multiple beam sweeping resources for same NR\_MBS session(s) delivery and group common PDCCH.
* **CHENGDU TD TECH**
	+ Proposal 20: For all the RBs of the PTM bearer except the SPS RBs, the following items need to be supported.
		- Each time the PTM bearer is scheduled, the group common PDCCH with CRC scrambled with G-RNTI and the group common PDSCH with G-RNTI used in the bit scrambling are transmitted N1 times in each related beam coverage area with N1>=1. Support one of the two methods below or support both methods below.
			* Method 1: The PDCCH/PDSCH occasion for each beam coverage area of the B beam coverage area is allocated. But if there’s no UE in a beam coverage area, the PDCCH/PDSCH is not really transmitted in the related PDCCH/PDSCH occasion.
			* Method 2: The PDCCH/PDSCH occasion is allocated only for each beam coverage area with at least one UE. The PDCCH/PDSCH is only transmitted in the beam coverage area with at least one UE.

## Initial Proposals based on contributions

***Summary***

Considering only 3 companies mentioned the multi-beam operation for MBS in RRC\_CONNECTED state and the proposals are diverged, and also considering that the beam sweep operation will be discussed for RRC\_IDLE/INACTIVE UEs in AI 8.12.3, I think we can defer the discussion of multi-beam operation for RRC\_CONNECTED UEs and wait for more progress in RRC\_IDLE/INACTIVE states. Companies can provide their suggestions on this, and if more companies prefer to discuss it in this meeting, we can discuss it in the next round.

## Company Views (1st round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | We can defer this issue after the accomplishment of group-common PDCCH/PDSCH design and the process of beam sweeping in RRC\_IDLE/INACTIVE states. |
| ZTE | Since the beam sweeping operation may be different from that in IDLE/INACTIVE, we would prefer to have some discussions on this issue in this meeting. But if majority companies prefer to defer the discussion, we are also ok with it. |
| MTK | Postpone this discussion. |
| Samsung | Deprioritize FR2. The WID captures the *following*.*Restrictions and assumptions:**FR2: we assume that there are no issues to provide Multicast / Broadcast transmissions in FR2. If any enhancements is needed it should be treated with lower priority compared to the minimum set of objectives above.* |
| OPPO | Agree with FL’s suggestion. |
| LG | We already agreed that 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. Accordingly, the multi-beam operation for broadcast MBS would be applied to RRC\_CONNECTED UEs as well as RRC\_IDLE/RRC\_INACTIVE UEs.Thus, we suggest to focus on multi-beam operation for broadcast MBS in this meeting. We could further discuss multi-beam operation for multicast MBS based on contributions at next meetings. |
| CATT | The discussion on this issue can be deferred. |
| Qualcomm | Ok to postpone the discussion. |

## Updated Proposals (1st round of email discussion)

To be added…

# Issue #7: Broadcast for RRC\_CONNECTED UEs

## Background and submitted proposals

***Submitted Proposals***

* **ZTE**
	+ Proposal 14: NR MBS UEs support reporting its interested broadcast service under RRC\_CONNECTED state.
	+ Proposal 15: RAN1 further studies whether to support HARQ-ACK for broadcast service for UEs under RRC\_CONNECTED state.
* **CMCC**
	+ Proposal 27. 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.
	+ Proposal 28. For broadcast reception, the group-common PDCCH and the corresponding scheduled group-common PDSCH are transmitted in UE-specific active BWP which are 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 29. For RRC\_CONNECTED UEs, a new type CSS is supported for group-common PDCCH for broadcast.
	+ Proposal 30. RRC\_CONNECTED UE should inform gNB the broadcast service that it is receiving or is interested to receive.
	+ Proposal 31. Only the PDCCHs for scheduling the broadcast service has been reported by RRC\_CONNECTED UE are counted in the monitored CSS PDCCH candidates and non-overlapping CCEs  in a slot or span.

## Initial Proposals based on contributions

***Summary***

2 companies [ZTE, CMCC] propose that UE can report its interested broadcast services under RRC\_CONNECTED state in NR MBS. Except this, considering the discussion of broadcast for RRC\_CONNECTED UEs is related to the discussion of broadcast for RRC\_IDLE/INACTIVE UEs, I think we can defer other discussions of broadcast for RRC\_CONNECTED UEs. Companies can provide their suggestions on this.

***Initial Proposals***

Based on the majority view, the following moderator recommendations are made.

[Moderator’s recommendation]

**Proposal 7-1**:

NR MBS UEs support reporting its interested broadcast service under RRC\_CONNECTED state.

## Company Views (1st round of email discussion)

Companies can provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CMCC | Regarding **Proposal 7-1**: Agree with FL’s proposal.One important motivation to report interested broadcast service under RRC\_CONNECTED state is solving the alignment of counting monitored BDs/CCEs for CSS between gNB and UE. As the agreement in RAN1 #103-e meeting, CSS is used for scheduling broadcast service. In Rel-15/16, all configured CSS PDCCHs are counted into the monitored BD/CCEs and the left BD/CCEs capability are used for USS for RRC\_CONNECTED UEs. But for Rel-17 broadcast services, it’s up to UE to receive it or not, that is UE may not receive some configured broadcast CSS group-common PDCCHs. If the same PDCCH overbooking rule in Rel-15/16 is re-used for RRC\_CONNECTED UEs, the BD/CCEs will be occupied by these non-received broadcast CSS and the USS scheduling opportunity is reduced.RRC\_CONNECTED UEs can inform gNB its interested broadcast service, which is similar to LTE MBMS interest indication procedure. Only the group-common PDCCHs in new CSS for broadcast, which has been reported in the MBS interest indication procedure, are counted in the monitored BD/CCEs for CSS. In this way, the non-monitored broadcast group-common PDCCHs will not occupy the monitored BD/CCEs capability and the USS scheduling opportunity will not be reduced. |
| Huawei, HiSilicon | Need more discussion. Not sure RAN1 is a proper WG to take the initiative to discuss this issues. May be better to discuss the issue as CMCC mentioned after seeing more progress on search spaces set and monitoring priority for multicast/groupcast.  |
| ZTE | Support the FL proposal. If UE doesn’t report its interested broadcast, network may not be able to guarantee the number of PDSCHs per slot doesn’t exceed UE’s capability.  |
| Samsung | Not clear what RAN1 impact is involved with this proposal. It might be better to revisit this issue after making some details on other aspects.  |
| OPPO | Given that only 2 companies discussed this issue, it is premature to make any decision on this. |
| LG | **Proposal 7-1**: We wonder if this is related to RAN2, assuming that this report is very similar to LTE MBMS interest indication. Meanwhile, it seems good to clarify that we can assume that the network knows whether UE receiving unicast PDCCH/PDSCH is also receiving broadcast MBS PDCCH/PDSCH. |
| CATT | This issue needs more discussion. |
| Qualcomm | It is a RAN2 issue to our understanding. |

## Updated Proposals (1st round of email discussion)

To be added…

# Proposals for GTW session

To be added…

# 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. R1-2100048 Discussion on PDCCH aspects for group scheduling FUTUREWEI
4. R1-2100106 Discussion on mechanisms to Support Group Scheduling for RRC\_CONNECTED UEs ZTE
5. R1-2100144 Group scheduling for NR Multicast and Broadcast Services OPPO
6. R1-2100189 Resource configuration and group scheduling for RRC\_CONNECTED UEs Huawei, HiSilicon
7. R1-2100354 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs in MBS CATT
8. R1-2100469 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs vivo
9. R1-2100510 Group Scheduling Mechanisms to Support 5G Multicast / Broadcast Services for RRC\_CONNECTED Ues Nokia, Nokia Shanghai Bell
10. R1-2100613 Discussion on NR MBS group scheduling for RRC\_CONNECTED UEs MediaTek Inc.
11. R1-2100674 NR-MBS Group Scheduling for RRC\_CONNECTED UEs Intel Corporation
12. R1-2100698 Views on group scheduling for NR MBS Google Inc.
13. R1-2100768 Discussion on group scheduling mechanism for NR MBS Lenovo, Motorola Mobility
14. R1-2100805 Discussion on MBS group scheduling for RRC\_CONNECTED UEs Spreadtrum Communications
15. R1-2100872 Considerations on MBS group scheduling for RRC\_CONNECTED UEs Sony
16. R1-2100906 Support of group scheduling for RRC\_CONNECTED UEs LG Electronics
17. R1-2100956 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs ETRI
18. R1-2101063 Discussion on group scheduling mechanisms CMCC
19. R1-2101234 On mechanisms to support group scheduling for RRC\_CONNECTED UEs Samsung
20. R1-2101359 Discussion on group scheduling mechanism for RRC\_connected UEs Apple
21. R1-2101424 On group scheduling mechanism for NR multicast and broadcast Convida Wireless
22. R1-2101487 Views on group scheduling for Multicast RRC\_CONNECTED UEs Qualcomm Incorporated
23. R1-2101579 Discussion on group scheduling for RRC\_CONNECTED UEs CHENGDU TD TECH LTD.
24. R1-2101658 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs ASUSTeK
25. R1-2101726 Mechanisms to support 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: Summary of proposals in RAN1#104-e

|  |  |  |
| --- | --- | --- |
| **Tdoc** | **Source** | **Proposals** |
| [3]R1-2100048 | FUTUREWEI | Proposal 1: Select Option 2B for the common frequency resource for group-common PDCCH/ PDSCH.Proposal 2: The starting location for the common frequency resource is referenced to Point A and its size is in PRBs.Proposal 3: A UE supports unicast reception in the common frequency resource.Observation 1: further clarification on the meaning of “more than one common frequency resources” is needed.Proposal 4: Support both PTM transmission scheme 2 and PTP transmission for retransmission(s).Proposal 5: Determine the number of HARQ processes when configured to receive MBS.Observation 2: Support both group-common PDCCH and UE-specific PDCCH for SPS group-common PDSCH activation/deactivation.Proposal 6: support more than one SPS group-common PDSCH configuration.Observation 3: how a SPS process could be used for re-transmission needs further discussion.Proposal 7: FFS if a new DCI format is needed or if an existing DCI format(s) can be modified.Proposal 8: A decision on the supported resource allocation type(s) for MBS is needed.Proposal 9: The support of lower spectral efficiency MCS table should be allowed for MBS.Proposal 10: The support of FBRM should be allowed for MBS.Proposal 11: the number of HARQ processes for MBS should be at least the number of SPS processes supported for MBS.Observation 4: The DCI field PDSCH-to-HARQ\_feedback timing indicator can reuse the DCI format 1\_0 or DCI format 1\_1 method of indicating when the UE should transmit HARQ-ACK bits. |
| [4]R1-2100106 | ZTE | **Common frequency resource**Observation 1: Compared with ‘MBS frequency region’, MBS BWP is a more appropriate solution to configure common frequency resource considering the comparison shown in Table-1.**Proposal 1**: Both frequency domain range and the corresponding MBS transmission parameters are configured for common frequency resource. * RAN1 strives for a unified method to provide configuration for common frequency resource for UEs in different RRC states and for both multicast and broadcast.
* RAN1 strives for a method with forward compatibility, e.g., configuring different numerologies for unicast and MBS in the future release.

**Proposal 2**: MBS BWP is defined as common frequency resource for MBS transmission.* In Rel-17 NR MBS, the MBS BWP is confined within UE’s unicast BWP, and the numerology is the same as unicast BWP.

**Proposal 3**: A BWP ID is configured for the MBS BWP for activating/deactivating it dynamically and independently. **Proposal 4**: In Rel-17, RAN1 focuses on one common frequency resource (i.e., MBS BWP) per UE instead of more than one.**Detailed design of group-common PDCCH****Proposal 5**: Regarding Rel-17 NR MBS* Define a new Type x-PDCCH CSS set for the group common PDCCH.
* At most 3 CORESETs can be configured within the MBS BWP.
* Define association between PDCCH MOs and SSBs or CSI-RSs for group-common PDCCH transmission.

**Proposal 6**: Beam sweeping transmission should be supported in Rel-17 NR MBS* Considering full beam sweep for broadcast transmission.
* Considering partial beam sweep for multicast transmission.

**Proposal 7**: For MBS group PDCCH, * DCI format 1\_0 can be defined as a baseline DCI format.
* An optional DCI format based on either DCI format 1\_1 or DCI format 1\_2 can be further supported for capacity improvement.

**Proposal 8**: For MBS group PDCCH, * The monitoring priority of search space set for MBS is the same as existing Rel-15/16 CSS.
* The budget of BDs/CCEs of an unused CC for group-common PDCCH can be used for UEs supporting CA capability in Rel-17 MBS.

**Proposal 9**: Regarding DCI size alignment used for group-common PDCCH, * DCI format 1\_0: Current mechanism can be reused for aligning the size of DCI format 1\_0 for group-common PDCCH and unicast PDCCH.
* DCI format 1\_x: it is counted as other RNTI (i.e., “1” in the “3+1” budget), and gNB will ensure that the number of DCI sizes does not exceed budget.

**Detailed design of group-common PDSCH****Proposal 10**: Regarding HARQ process management, the following three options can be considered for further down selection, * Option 1: HPNs are shared between MBS and unicast transmission, and a same HARQ entity is used by them;
* Option 2: HPNs are separated between MBS and unicast, and different HARQ entities are used for MBS and unicast, respectively;
* Option 3: HPNs are separated for unicast and each MBS service, and an MBS service specific HPN entity is required for each MBS service.

**Proposal 11**: Rel-17 MBS supports both PTP transmission and PTM transmission scheme 1 for retransmission.**Proposal 12**: Corresponding with different HPN management options, different indication methods of MBS TB in PTP retransmission can be considered to associate with PTM initial transmission, * Option 1: HPN used for initial transmission;
* Option 2: HPN used for initial transmission and distinguishing indication between MBS and Unicast;
* Option 3: HPN used for initial transmission and distinguishing indication among unicast and different MBS services.

**Detailed designs of SPS-based MBS transmission****Proposal 13:** For SPS-based MBS transmission, the following features are supported, * UE-specific activation/deactivation
* More than one SPS group-common PDSCH configuration for MBS transmissions
* Uplink feedback for SPS group-common PDSCH
* Retransmission of SPS group-common PDSCH, the design for the retransmission for PTM transmission scheme 1 can be reused for it

**Enhancement of Broadcast for RRC\_CONNECTED UEs****Proposal 14**: NR MBS UEs support reporting its interested broadcast service under RRC\_CONNECTED state. **Proposal 15**: RAN1 further studies whether to support HARQ-ACK for broadcast service for UEs under RRC\_CONNECTED state. |
| [5]R1-2100144 | OPPO | Proposal 1: * If gNB can distinguish HARQ feedback of each UE within the group in PTM transmission scheme 1, PTP can be used for re-transmission;
* The PDCCH scheduling the PTP transmission is scrambled with the same G-RNTI as the PTM scheme 1.

Proposal 2: Common frequency resource is configured within dedicated unicast BWP, and the numerology of the common frequency resource is same as the dedicated unicast BWP. It is up to RAN2 to decide how to configure the common frequency resource.Proposal 3: Configuring a UE with no unicast reception in the common frequency resource is not supported.Proposal 4: Support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities.Proposal 5: Support to configure a dedicated MBS BWP for group-common PDCCH/PDSCH transmission.Proposal 6: Support more than one SPS group common PDSCH for a UE, the SPS should be activated/deactivated by group-common PDCCH scrambled by the corresponding CS-RNTI.Proposal 7: Support of using UE specific PDCCH transmitted on dedicated unicast BWP to schedule group common PDSCH on another BWP.Proposal 8: A new DL DCI format should be defined for the scheduling of group-common PDSCH.Proposal 9: For a UE receiving group-common PDSCH transmitted with PTM scheme 1 a TPC-PUCCH-RNTI different from that for unicast should be configured.Proposal 10: The maximum number of CORESTs within one serving cell and the BD/non-overlapped CCE limit are not increased for support of MBS.Proposal 11: A new common search space set is defined for group-common PSCCH transmission, the monitoring priority of the new CSS set is configurable. |
| [6]R1-2100189 | Huawei, HiSilicon | Proposal 1: PTP can be supported for scheduling retransmission of MBS.Proposal 2: For common frequency resource for group-common PDCCH / PDSCH for scheduling MBS which is confined within the frequency resource of a dedicated unicast BWP, * it is up to gNB to schedule unicast or MBS within the ‘MBS frequency region’,
* PDSCH configuration pdsch-Config is separately configured for NR MBS.

Proposal 3: For CORESETs, search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state,* number of CORESET(s) for scheduling MBS is up to gNB configuration, and
* the ID to determine the CCE indexes of the search space set can be zero or G-RNTI.

Proposal 4: DCI formats 1\_0, 1\_1 and 1\_2 can be used for scheduling MBS with necessary modifications, and new DCI format is not needed:* For a common MBS frequency region for MBS configured within dedicated unicast BWP and a group-common PDCCH based scheduling, the FDRA field in DCI is dimensioned per the common MBS frequency region.

Proposal 5: The existing “3+1” DCI size budget should be kept for MBS and DCI size for MBS should be aligned with the existing DCI format being scheduled.Proposal 6: Re-distributing the BD/CCE limit among serving cells can be supported subject to UE capability.Proposal 7: The configurable number of maximum HARQ process number is kept unchanged for UE supporting MBS reception, and * the total number of HARQ processes for initial transmissions are shared and split between unicast and MBS;
* the HARQ process number for retransmission is kept the same as for initial transmission.

Proposal 8: For simultaneous reception of unicast PDSCH and group-common PDSCH in a slot, support the following cases:* 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

Proposal 9: For SPS group-common PDCCH for MBS for RRC\_CONNECTED UEs,* support group-common PDCCH for SPS activation/deactivation,
* retransmission of MBS SPS group-common PDSCH should be further studied,
* more than one SPS group-common PDSCH configuration per UE can be supported,

SPS specific uplink feedback resource can be configured per SPS configuration. |
| [7]R1-2100354 | CATT | Proposal 1: UE-specific PDCCH and multi-group-common PDCCH group scheduling is supported in NR MBS.Observation 1: BWP switching is needed between MBS specific BWP and dedicated unicast BWP according to Rel-15/16 principle because they are two independent BWPs and configurations.Observation 2: MBS specific BWP may not be feasible when a UE can support to be configured with only one BWP.Proposal 2: Option 2B, MBS frequency region, is supported to define MBS common frequency resource for RRC\_CONNECTED UEs.Proposal 3: For configuration of MBS frequency region, the indication of the starting PRB can be based on the starting point of dedicated unicast BWP or the starting point of the carrier.Proposal 4: The current SLIV indication mechanism can be reused for MBS frequency region indication of starting PRB and length of PRBs.Observation 3: It is up to gNB implementation to configure whether a dedicated unicast BWP can contain MBS common frequency resource or not.Proposal 5: It is supported that a UE can receive unicast in the common frequency resource.Proposal 6: If configured, at most one MBS common frequency resource is supported per UE/per dedicated unicast BWP based on UE capability.Observation 4: From UE’s perspective, PTM transmission scheme 2 used as retransmission is considered as initial transmission, if the DCI for initial transmission using PTM scheme 1 is missed by the UE.Proposal 7: When PTM transmission scheme 1 is used for initial transmission, either PTM scheme 2 or PTP can be supported for retransmission(s) for the whole group of UEs.Proposal 8: A single retransmission scheme is used for all the UEs in the same group for a TB, and it is up to gNB to determine which scheme is used.Proposal 9: PTM scheme 2 and PTP can be combined as retransmission schemes for all the UEs in the same group for a TB.Proposal 10: When supporting both MBS service and unicast service receptions by a UE, the buffer capability is not supposed to be increased.Proposal 11: It is supported that a HPN can only be used for either MBS service or unicast service at a time.Proposal 12: The HPNs used for multicast service and unicast service can be determined by gNB through semi-static configuration or dynamic allocation.Proposal 13: Both group-common PDCCH and UE-specific PDCCH (if supported) can be used for SPS activation for MBS for RRC\_CONNECTED UEs.Proposal 14: Group-common PDCCH is used for SPS deactivation for MBS for RRC\_CONNECTED UEs.Proposal 15: It is supported that more than one SPS group-common PDSCH configuration per UE based on its capability.Proposal 16: The total number of supported SPS procedures by a UE is not increased when both multicast and unicast are supporting SPS. How to allocate the total SPS procedures between multicast and unicast is up to network implementation.Proposal 17: Dynamic scheduling mechanism is used for HARQ-ACK feedback retransmission(s) of SPS group-common PDSCH.Proposal 18: When MBS frequency region (Option 2B) is supported, up to one CORESET can be configured specifically for MBS service on a dedicated unicast BWP.Proposal 19: When MBS frequency region (Option 2B) is supported, shared CORESET by MBS service and unicast service can be supported on a dedicated unicast BWP.Proposal 20: 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.Proposal 21: When the simultaneous reception of unicast and multicast is out of a UE’s capability, a dropping principle should be considered. |
| [8]R1-2100469 | vivo | Observation 1: The retransmission scheme with dynamically selected C-RNTI/g-RNTI brings about 6.23% and 1.11% gain in term of RU compared to the g-RNTI only and C-RNTI retransmission scheme respectively.Observation 2: For the cell spectral efficiency, the performances of the three kinds of MBS HARQ retransmission schemes are similar.Proposal 1: For RRC\_CONNECTED UEs, when defining/configuring common frequency resource for group-common PDCCH/PDSCH, Option 2B is preferred.* + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.

Proposal 2: For simultaneous reception of unicast PDSCH and group-common PDSCH in a slot for RRC\_CONNECTED UEs, support the following cases.* 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 5: support FDM among multiple group-common PDSCHs in a slot

Proposal 3: A UE can be configured with multiple common RNTIs for PDSCH scrambling for different Broadcast/Multicast services.Proposal 4: For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast.Proposal 5: For MBS for RRC\_CONNECTED UEs, for SPS group-common PDSCH, the followings are suggested.* Support more than one SPS group-common PDSCH per UE.
* HARQ-ACK for SPS group-common PDSCH is supported and can be configured.
* Using UE-specific PDCCH for the SPS group-common PDSCH activation/deactivation
	+ FFS: Group-common PDCCH can be used for the SPS group-common PDSCH activation/deactivation.
* If NACK only feedback is configured for SPS group-common PDSCH,
	+ group-common PDSCH scheduled by group-common PDCCH can be used for the SPS group-common PDSCH retransmission
* If ACK/NACK feedback is configured for SPS group-common PDSCH,
	+ UE-specific PDSCH scheduled by UE-specifc PDCCH can be used for the SPS group-common PDSCH retransmission
	+ FFS: group-common PDSCH scheduled by UE-specifc PDCCH can be used for the SPS group-common PDSCH retransmission

Proposal 6: For the retransmission of group-common PDSCH for MBS service, UE-specific PDSCH scheduled by UE-epecfic PDCCH can be used.Proposal 7: For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, * Reuse the existing CSS type(s) in Rel-15/16
* The monitoring priority of search space set for multicast can be configurable
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| [9]R1-2100510 | Nokia, Nokia Shanghai Bell | Observation-1: Having a UE-specific PDCCH that can schedule UEs to use a group-common PDSCH is desirable for the following reasons:1. In scenarios where there is a low density of users receiving multicast traffic with high data rates and requiring uplink feedback, gNB will have the flexibility to choose the appropriate control channel signalling mechanism
2. Enables the support of seamless mobility and switching from multicast to unicast
3. Enables simultaneous BWP switching and scheduling of MBS PDSCH resources using the same DCI

Observation-2: In order to support both signalling options to access the same group-common PDSCH, new signalling 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.Observation-3: Use of different schemes for initial transmission and retransmission would introduce significant complexity both at the gNB and UE in order to maintain the association between the transmission and retransmission of the same TB.Observation-4: The key difference between option 2A and 2B is related to the RRC signalling of the common frequency resources:* Option 2A requires the signalling of MBS specific BWP with parameters possibly taken from current BWP configurations.
* Option 2B requires the signalling of the MBS frequency region – in terms of the starting PRB and length of PRBs within each UE’s dedicated unicast BWP.
* The impact of option 2A on the number of BWPs that can be configured for a UE needs to be studied and clarified.

Observation-5: The motivation for configuring UEs with no unicast reception within the MBS CFR needs to be further clarified.Observation-6: Multiple common frequency resources can be configured per UE based on gNB implementation – even though the motivations for doing so are not clear, with the maximum limit dependent on UE capabilities and available system resources.Observation-7: For multicast traffic, the motivation for configuring multiple CFRs per UE requires further clarification, and for broadcast traffic, there are potential benefits in terms of power savings from having multiple overlapping CFRs configured per UE, depending on UE capabilities and traffic characteristics.Observation-8: 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.Observation-9: It would be beneficial to maintain currently defined limits for the number of CORESETs, in order to minimize UE and gNB complexity and to ensure backward compatibility.Proposal-1: Agree to limit the PTM transmission schemes to currently defined schemes 1 and 2, and not investigate further schemes for dynamic scheduling as part of this WID.Proposal-2: For RRC\_CONNECTED UEs, support UE-specific PDCCH with CRC scrambled by a C-RNTI to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on a common RNTI.Proposal-3: The same group-common PDSCH for PTM transmission can be accessed either by:* A set of UEs using the same group-common PDCCH with CRC scrambled by a common RNTI
* A set of UEs, where each UE uses a UE-specific PDCCH with CRC scrambled by a C-RNTI
* A mix of the UEs, where some of them use UE-specific PDCCH and others use group-common PDCCH

Proposal-4: The network can dynamically modify the signalling used to configure a UE to access a group-common PDSCH.Proposal-5: Agree to limit the transmission and retransmission of the same TB to using a single transmission scheme.Proposal-6: Agree on selecting option 2B for configuring multicast common frequency resources, due to the additional complexities involved in the use of option 2A related to BWP switching.Proposal-7: The key requirement for option 2B is to signal the starting PRB and the length of PRBs for the MBS CFR, whereas the signalling details could be RAN2 decision.Proposal-8: Support both group-common PDCCH and UE-specific PDCCH for SPS group-common PDSCH activation / deactivation.Proposal-19: Investigate further whether a special group-common RNTI needs to be defined for SPS vs. dynamic scheduling.Proposal-10: Utilize limitations such as eight SPS configurations per BWP for group-common PDSCH SPS configurations per UE.* It needs to be further studied whether the total number of SPS configurations should be limited independently for unicast and MBS.

Proposal-11: Inherit uplink feedback configuration for SPS-based MBS in straightforward manner from SPS for unicast in combination with uplink feedback configuration for non-SPS-based MBS.Proposal-12: There should be a way to transmit retransmissions on SPS-allocated resources.Proposal-13: Possibilities to add in-band control signalling on PDSCH to facilitate retransmissions on SPS-allocated PDSCH resources should be studied.Proposal-14: There need not be any explicit limits in terms of the number of CORESETs for group-common PDCCH that is allowed within the CFR for group-common PDSCH, and the number of CORESETs configured within the MBS CFR should be left to gNB implementation.Proposal-15: Agree on option 1 as the baseline option for Rel-17 MBS and further study the impacts and benefits of introducing option-2.Proposal-16: Agree not to introduce any new limitations / requirements in terms of the maximum number of PDSCHs in a slot simultaneously received per UE.Proposal-17: Prioritize the support for TDM between one or more unicast and group-common PDSCHs over the FDM options.Proposal-18: Discuss and agree on a new search space type with flexible monitoring priority and simplified PDCCH candidate Hash function.Proposal-19: Propose to have the SS configuration and UE monitoring for 5G NR multicast to depend on the multicast service types, i.e. high-priority multicast services are configured in CSS – with no modifications for multicast, and low-priority multicast services are configured in USS – with modifications.Proposal-20: Agree to reuse existing Rel-15/16 monitoring priority framework for CSS and USS.Proposal-21: Monitoring priority for the new multicast search space could be flexibly configured and should be based on the SS index. |
| [10]R1-2100613 | MediaTek Inc. | Proposal 1: The PTP mechanism can be supported for multicast service retransmission.Proposal 2: Network implementation guarantee the allocation of common frequency resource for UEs in connected mode to receive the PTM transmission.Proposal 3: Not support more than one common frequency resources for NR MBS.Proposal 4: Not increase the total existing number of CORESET and search space for NR MBS scheduling.Proposal 5: Type 3-PDCCH CSS with little modification (e.g., support G-RNTI) can be reused for multicast group common PDCCH monitoring.Proposal 6: Keep the BDs/CCEs limits per slot per serving cell defined in Rel-15 for Rel-17 MBS.Proposal 7: Keep the “3+1” DCI size defined in Rel-15 for Rel-17 MBS.Proposal 8: DCI format 1\_X can be as a baseline for multicast group-common PDSCH scheduling. |
| [11]R1-2100674 | Intel Corporation | 1. PTP and/or PTM Scheme 2 should be supported only when ACK/NACK based HARQ feedback is configured or enabled for the UEs within a group.
2. 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.
3. The HARQ process ID is used to associate PTP or 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.
4. Different group RNTIs corresponding to high and low QoS delivery modes are configured for RRC\_CONNECTED UEs
5. The working assumption can be confirmed with Option 2B. The starting PRB index and number of PRBs can be jointly configured to the UE by RRC or SIB signaling
6. The UE expects no restriction on unicast reception within the MBS frequency region contained within the active DL BWP of the UE
7. One common frequency resource per UE/ per dedicated BWP is sufficient for scheduling MBS transmissions
8. For PTP or PTM scheme 2, the CORESET scheduling MBS (re)transmission can be configured outside the MBS frequency region
9. For determining BD/CEE limits for NR MBS in Rel-17, Option 1 should be supported for UEs without CA capability and Option 2 should be supported for UEs with CA capability. Down-selection is not necessary
10. Search space set configuration for monitoring DCI scheduling multicast PDSCH can have the following options:
	* Re-use NR Type 3 CSS configuration while additionally supporting monitoring of DCI with CRC scrambled by SC-RNTI, SC-N-RNTI and G-RNTI
	* Alternately, define new NR CSS Type 4 for monitoring multicast DCI with CRC scrambled by SC-RNTI, SC-N-RNTI and G-RNTI
11. For RRC\_CONNECTED UEs groupcast PDCCH can also be monitored in USS
12. The monitoring priority of search space set for multicast is the same as existing Rel-15/16 CSS and USS (if supported)
13. DCI Format for scheduling NR MBS transmissions:
	* Delivery Mode 1 (high QoS): DCI formats 1\_1, 1\_2 can be used. If needed, a compact DCI format for multicast scheduling can be defined
	* Delivery Mode 2 (low QoS): DCI format 1\_0 can be used since the group of UEs can also include RRC\_IDLE/INACTIVE mode UEs
14. The group-common DCI format for MBS transmission is included in the scheduling DCI size budget of 3 for UEs and UEs can perform size alignment for other DCI formats if MBS DCI size exceeds other scheduling DCI in its active BWP.
15. 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 if ACK/NACK based feedback is supported or configured or a common PUCCH resource can be configured for the case when NACK-only feedback is supported or configured.
16. For NR MBS transmission
	* Define a new RNTI, namely SC-RNTI for scrambling the CRC of DCI scheduling a PDSCH mapped to the MCCH containing multicast configuration information
	* Define a new RNTI, namely the SC-N-RNTI for scrambling the CRC of the DCI notifying a change in the multicast configuration.
	* Define a new group RNTI, namely G-RNTI for scrambling the CRC of DCI scheduling a PDSCH carrying the multicast data corresponding to MTCH
17. NR MBS uses PDSCH Mapping Type A with DM-RS Type 1 as a baseline. PDSCH Mapping Type B and use of Type 2 DM-RS are not precluded
18. For NR MBS support of multi-layer MIMO transmission with rank adaptation (from UE perspective) is not precluded.
19. 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.
20. Advanced transmission schemes like multiuser superposition transmission (MUST) for improving group spectral efficiency are not precluded
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| [12]R1-2100698 | Google Inc. | Observation 1: To support PTM scheme 1, UE has to handle the MBS BWP and MBS search space configured by a base station. On the other side, PTM scheme 2 applies simpler RRC signalling, which may be beneficial for UE that has lower capability (e.g. cannot support additional search space).Observation 2: To support PTM transmission scheme 2, UE should be able to distinguish MBS and UE-specific transmissions scheduled by the same DCI format (e.g. according to a new field or FDRA field in the DCI format).Proposal 1: For initial transmission, PTM transmission scheme 2 can be supported for UE with lower capability.Observation 3: In terms of traffic offloading and retransmission optimization, PTP retransmission can offload control and data traffics to UE-specific resources, and provides retransmission optimization in single UE granularity.Observation 4: In terms of data transmission, the spectrum efficiency of PTM scheme 1 and 2 are identical. However, if the initial transmission uses PTM scheme 1, the advantage of PTM scheme 2 on adopting simpler RRC signalling is no longer exist. Proposal 2: Support retransmission by using the same scheme as the initial transmission or by using PTP for UE-specific optimization.Proposal 3: The association between PTM and PTP to the same TB can base on the HARQ process ID and NDI field in the DCI format.Proposal 4: If multiple retransmission schemes are supported, and a UE receives both group-common and UE-specific PDCCHs that schedule retransmissions of the same TB, the base station can expect that the UE receives the PTP scheduled retransmission and skips the PTM. It also refers that the UE only reports HARQ-ACK based on the DCI scheduling the PTP retransmission. |
| [13]R1-2100768 | Lenovo, Motorola Mobility | Proposal 1: An MBS frequency region with contiguous PRBs confined within the dedicated unicast BWP is configured for MBS, i.e., Option 2B is supported.Proposal 2: The starting PRB index and the number of contiguous PRBs of the MBS frequency region are configured within the dedicated unicast BWP via RRC signaling.Proposal 3: PTP based retransmission is supported when initial transmission is based on PTM transmission scheme 1. Proposal 4: For same TB, HARQ process ID in the UE-specific DCI is same to that in the group-common DCI. Proposal 5: RB numbering within the common frequency region is with reference to the lowest RB of the common frequency region.Proposal 6: The number of bits for frequency domain resource assignment indicator in DCI is determined based on the bandwidth of the common frequency region.Proposal 7: A common CORESET is configured within the common frequency region for MBS for the group of UEs.Proposal 8: A common search space is configured associated with the common CORESET for MBS for the group of UEs.Proposal 9: DCI format 1-0 with CRC scrambled by G-RNTI is used as the group-common DCI.Proposal 10: For DCI size alignment, DCI format with CRC scrambled by G-RNTI is counted as the DCI format with CRC scrambled by C-RNTI. |
| [14]R1-2100805 | Spreadtrum Communications | Proposal 1: For the common frequency resource for group-common PDCCH/ PDSCH, support option 2A.Proposal 2: UE can be configured with or without unicast reception in the common frequency resource.Proposal 3: Support only one common frequency resources per dedicated unicast BWP per UE.Proposal 4: For RRC\_CONNECTED UEs for NR MBS, not support PTM2.Proposal 5: For BD/CCE limit for Rel-17 MBS, both option 1 and option 2 could be supported.Proposal 6: For search space type for Rel-17 MBS, support option 1, i.e., Define a new search space type specific for multicast.Proposal 7: For the monitoring priority of search space set, support option 1, i.e., the monitoring priority of search space set for multicast is the same as existing Rel-15/16 CSS.Proposal 8: Support group-common PDCCH for SPS group-common PDSCH activation/deactivation.Proposal 9: For simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs,* The capability signaling is optional;
* Support TDM between M TDMed unicast PDSCHs and one group-common PDSCH in a slot
	+ FFS: the value of M
	+ FFS: per CC, or across CC
* Support TDM among K group-common PDSCHs in a slot
	+ FFS: the value of K
	+ FFS: per CC, or across CC
* Support TDM between L TDMed unicast PDSCHs and T TDMed group-common PDSCHs in a slot
	+ FFS: the value of L, T
	+ FFS: per CC, or across CC
* Support FDM between one group-common PDSCH and one unicast PDSCH in a slot

FFS: per CC, or across CC |
| [15]R1-2100872 | Sony | Proposal 1: Support the use of beam sweeping and beam report to identify suitable beams to provide PDCCH and NR\_MBS contents delivery for RRC\_CONNECTED UEs.Proposal 2: The network shall configure beam location and periodicity of beam sweeping for PDCCH and NR\_MBS contents delivery.Proposal 3: The UE shall report preference of NR\_MBS content and beam(s) in which the NR\_MBS content can be provided.Proposal 4: Configure multiple beam sweeping resources for same NR\_MBS session(s) delivery and group common PDCCH. |
| [16]R1-2100906 | LG Electronics | Proposal 1: support PTP based MBS PDSCH transmission for the same TB transmitted by PTM scheme 1.Proposal 2: DCI scheduling MBS TB indicates the association between PTM scheme 1 and PTP transmitting the same TB.Proposal 3: support TDM among multiple group-common PDSCHs of the same TB with selectively different RSs in a slot assuming that different UE in the same group may receive same or different PDSCHs of the same TB. Proposal 4: Support Option 2A, possibly with a wider MBS specific BWP than the initial DL BWP or UE’s active DL BWPProposal 5: Support a MBS specific BWP with a different numerology than that of the initial DL BWP or UE’s active DL BWP, if Option 2A is agreed.Proposal 6: Consider one of the following sub-options for Option 2A:* Option 2A-1: BWP switching between MBS specific BWP and UE’s active BWP is NOT supported. UE is allowed to simultaneously activate one MBS specific BWP and one UE’s active BWP.
* Option 2A-2: BWP switching between MBS specific BWP and UE’s active BWP is supported. UE can activate only one of MBS specific BWP and one UE’s active BWP at a time.

Proposal 7: Connected UE should maintain at least one UE’s active BWP as specified in REL-15/16.Proposal 8: MBS capable UE activates only one MBS DL BWP at a time for REL-17.Proposal 9: For a single carrier, the maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 can be increased for MBS capable UEs.Proposal 10: support CSS Type 3 for group common PDCCH for connected UEs as well as idle/inactive UEs.Proposal 11: support additional new CSS type 4 for multicast of which monitoring priority is handled like USS. |
| [17]R1-2100956 | ETRI | Proposal1: The option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP should be supported for the common frequency resource.Proposal2: RRC configuration is used for configuration of MBS frequency region including indication of the starting PRB and the length of the PRBs. |
| [18]R1-2101063 | CMCC | Multicast group scheduling mechanism:Observation 1. The DCI size alignment procedure for PTM transmission scheme 1 will cause the performance degradation of other PDCCHs.Observation 2. PTM transmission scheme 1 and scheme 2 are not mutually exclusive and can be used in different scenarios. PTM transmission scheme 1 is much suitable for the case network operator has concern about PDCCH overhead. PTM transmission scheme 2 is much suitable for the case network operator has concern about PDCCH performance degradation. Proposal 1. The working assumption in RAN1 #103-e meeting about the common frequency for group-common PDCCH/PDSCH can be confirmed.Proposal 2. Support Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.Proposal 3. gNB can configure the offset from the starting PRB of the MBS frequency region to the starting PRB of the dedicated unicast BWP and the length of PRBs counting from the starting PRB of the MBS frequency region.Proposal 4. UE cannot be configured with no unicast reception in the common frequency resource.Proposal 5. For PTM transmission scheme 1, dedicated physical layer parameters for group-common PDSCH e.g., TDRA table, DMRS configuration, etc., can be configured under the configuration of common frequency resource.Proposal 6. Support only one common frequency resource per dedicated unicast BWP.Proposal 7. Define a new CSS type for group-common PDCCH of PTM transmission scheme 1 for multicast in RRC\_CONNECTED state.Proposal 8. The monitoring priority of new CSS type for multicast is the same as existing Rel-15/16 USS.Proposal 9. For UEs without CA capability, 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.Proposal 10. For UEs with CA capability, both 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 and Option 2: the budget of BDs/CCEs of an unused CC can be used for group-common PDCCH to count the number of BDs/CCEs can be supported for Rel-17 MBS, and it is based on UE’s capability to support Option 1 or Option 2.Proposal 11. Maximum 3 CORESETs for group-common PDCCH can be configured within the common frequency resource.Proposal 12. The CORESET(s) for group-common PDCCH are counted in the number of maximum 3 CORESETs per DL BWP.Proposal 13. For PTM transmission scheme 1, both fallback DCI format 1\_0 and non-fallback DCI format 1\_1/1\_2 could be considered with new interpretations.Proposal 14. Keep the “3+1” DCI size budget as in Rel-15/16 when PTM transmission scheme 1 is enabled. Proposal 15. For PTM transmission scheme 1, decide whether the DCI size associated with G-RNTI should be counted in the DCI size budget associated with C-RNTI or counted in the DCI size budget associated with all RNTIs.Proposal 16. For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 1, PTP transmission for retransmission(s) can be supported only if there is significant performance gain compared with dynamic switch between PTP and PTM.Proposal 17. Group-common PDCCH is used as the activation/deactivation PDCCH for SPS group-common PDSCH.Proposal 18. At least NACK-only based HARQ-ACK feedback is supported for SPS group-common PDSCH.Proposal 19. At least PTM transmission scheme 1 is used as retransmission for SPS group-common PDSCH.Proposal 20. Support more than one SPS group-common PDSCH configurations per UE. Proposal 21. For RRC\_CONNECTED UEs, support PTM transmission scheme 2 for multicast service.Proposal 22. The common frequency resource for group-common PDSCH can be optionally configured for PTM transmission scheme 2. If type 0 frequency domain resource allocation is used, the RBG size and RBG numbering for FDRA indication in the UE-specific DCI are determined based on the size of common frequency resource instead of UE’s active BWP.Proposal 23. For PTM transmission scheme 2, dedicated physical layer parameters for group-common PDSCH e.g., TDRA table, DMRS configuration, etc., can be configured under the configuration of common frequency resource.Proposal 24. For PTM transmission scheme 2, non-fallback DCI format 1\_1/1\_2 could be considered, and one or more additional bits in DCI is defined to differentiate that the scheduled PDSCH’s scrambling initialization is based on C-RNTI or G-RNTI(s).Proposal 25. For PTM transmission scheme 2, keep the same maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell as in Rel-15 when R17 NR MBS is enabled.Proposal 26. For RRC\_CONNECTED UEs, if initial transmission for multicast is based on PTM transmission scheme 2, retransmission(s) can use PTM transmission scheme 2 or PTP transmission.Broadcast service reception for RRC\_CONNECTED UEs:Proposal 27. 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.Proposal 28. For broadcast reception, the group-common PDCCH and the corresponding scheduled group-common PDSCH are transmitted in UE-specific active BWP which are 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 29. For RRC\_CONNECTED UEs, a new type CSS is supported for group-common PDCCH for broadcast.Proposal 30. RRC\_CONNECTED UE should inform gNB the broadcast service that it is receiving or is interested to receive.Proposal 31. Only the PDCCHs for scheduling the broadcast service has been reported by RRC\_CONNECTED UE are counted in the monitored CSS PDCCH candidates and non-overlapping CCEs  in a slot or span.Simultaneous operation with unicast:Proposal 32. 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 1: TDM between multiple TDMed unicast PDSCHs and one group-common PDSCH in a slot
* Case 2: TDM among multiple group-common PDSCHs in a slot
* Case 3: TDM between multiple TDMed unicast PDSCHs and multiple TDMed group-common PDSCHs in a slot

Proposal 33. The maximum number of PDSCHs in a slot simultaneous received per UE can be 2, 4, or 7 based on UE capability, and regardless that the PDSCH is unicast PDSCH or group-common PDSCH. Proposal 34. The support of following cases for simultaneous reception of unicast PDSCH and group-common PDSCH in a slot based on UE capability for RRC\_CONNECTED UEs can be with low priority in Rel-17.* 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
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| [19]R1-2101234 | Samsung | Proposal 1: No restriction is introduced for the DCI formats that can schedule a TB reception for a HARQ process to a UE - both a DCI format in a group-common PDCCH and a DCI format in UE-specific PDCCH can be used. Proposal 2: Consider a common frequency resource within the active DL BWP for subsequent discussions on MBS.Proposal 3: Activation/deactivation of MBS SPS PDSCH is by a DCI format with a new RNTI (G-RNTI). Proposal 4: Support multiple MBS SPS PDSCH configurations. Proposal 5: HARQ-ACK report and retransmissions of MBS SPS PDSCH are supported as for unicast SPS PDSCH. Proposal 6: The maximum number of CORESETs per cell for either or both MBS PDCCH and unicast PDCCH is same as in Rel-16. Proposal 7: The number of TDM (MBS or unicast) PDSCH receptions is same as for the corresponding Rel-16 UE capability. FDM PDSCH receptions (MBS or unicast) are not supported.Proposal 8: The Rel-16 search space equation with Y\_(p,-1)=n\_RNTI is used for MBS PDCCH.Proposal 9: The monitoring priorities of search space sets for MBS PDCCH are determined according to the corresponding search space set indexes as for USS sets in Rel-16.Proposal 10: If the number of DCI format sizes is as in Rel-16, the size of the DCI format scheduling MBS PDSCH is counted together with the sizes of unicast DCI formats. The sizes of the fields of the DCI format are configurable. Proposal 11: For the purposes of MBS, consider increasing to 5 the number of sizes for DCI formats that a UE can be configured to monitor PDCCH.Proposal 12: The DCI format for MBS PDSCH is based on DCI format 1\_2. |
| [20]R1-2101359 | Apple | Proposal 1: MBS specific BWP is configured for common frequency resource for group-common PDSCH.Observation: PTM re-transmission via PTP or PTM is depending on the HARQ-ACK feedback design. Proposal 2: PTM re-transmission mechanism is waiting for the outcome of the HARQ-ACK feedback design.Proposal 3: Same solution can be applied for both SPS re-transmission and PTM re-transmission.Proposal 4: Define a new common search space type for multicast.Proposal 5: Maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot per serving cell defined in Rel-15 is unchanged for Rel-17 MBS. |
| [21]R1-2101424 | Convida Wireless | Proposal 1: UE-specific PDCCH with CRC scrambled by C-RNTI is supported to schedule the PDSCH for MBS in addition to the group-common PDCCH for RRC\_CONNECTED UEs in NR MBS.Proposal 2: Mechanism needs to be introduced for the UE to distinguish between the UE-specific PDCCH scheduling the MBS PDSCH and the PDSCH carrying the payload for unicast service.Proposal 3: Dedicated MBS BWP (option 2A) should be supported for RRC\_CONNECTED UEs in NR MBS. |
| [22]R1-2101487 | Qualcomm Incorporated | Observation 1: Most of the parameters related to PDCCH/PDSCH reception are configured per BWP. Reusing the BPW signalling to define the common frequency resource for MBS allows for flexible configuration for GC-PDCCH and GC-PDSCH.Proposal 1: For RRC\_CONNECTED UEs, common frequency resource is defined as an MBS specific BWP (Option 2A).* UE can monitor an MBS BWP if it is full within the associated unicast BWP and with same numerology, where no BWP switching when receiving unicast and multicast.
* One or more MBS BWPs can be configured per UE subject to UE capability.
* One or more MBS BWPs can be configured per dedicated BWP subject to UE capability.

Proposal 2: For RRC\_CONNECTED UEs, parameters of GC-PDSCH and GC-PDCCH are configured per MBS BWP.For CORESET/SS configuration:Proposal 3: For RRC\_CONNECTED UEs, more than one CORESET for GC-PDCCH can be configured per MBS BWP.* Keep the maximum total number of CORESETs per MBS BWP same as that of unicast BWP.
* Keep the maximum total number of CORESETs per UE unchanged.

Proposal 4: For RRC\_CONNECTED UEs, CSS and/or USS for GC-PDCCH can be configured per MBS BWP.* Reuse legacy priority rules for mapping CSS and USS sets for GC-PDCCH in case of overbooking. Option 1 or 2 is dependent on which SS type is configured for GC-PDCCH.
	+ 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

Proposal 5: For RRC\_CONNECTED UEs, at least DCI format 1\_0 and 1\_1 can be used for GC-PDCCH.* DCI size is aligned between GC-PDCCH and unicast PDCCH using the same DCI format.

Proposal 6: For RRC\_CONNECTED UEs, support both 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.

For SPS GC-PDSCH configuration:Proposal 7: For RRC\_CONNECTED UEs, support one or more SPS GC-PDSCH configurations per MBS BWP. * At least GC-PDCCH can be used for SPS GC-PDSCH activation/deactivation.
* FFS UE-specific PDCCH for SPS GC-PDSCH activation/deactivation.

For UE-specific PDCCH vs. GC-PDCCH:Proposal 8: Support to select PTP and/or PTM scheme 1 for retransmission if PTM scheme 1 is initial transmission.* PTP schedules multicast retransmission with HARQ process ID associated with that of PTM scheme 1.
* Retransmission schemes based on PTP and PTM-1 can be supported simultaneously for different UEs in the same group.

For simultaneous reception of unicast and multicast:Proposal 9: Consider the UE capability for the number of PDSCHs simultaneously received in a slot. Proposal 10: Further discuss the potential RAN1 impact related with the configuration of G-RNTI(s) and the interaction between G-RNTI and C-RNTI for PDSCH reception, including:* Aspects related to simultaneous reception of G-RNTI(s) and C-RNTI
* Aspects related to simultaneous reception of multiple G-RNTIs.
* Aspects related to retransmission of packets between G-RNTI(s) and C-RNTI.
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| [23]R1-2101579 | CHENGDU TD TECH LTD. | * On BWP configuration:

Proposal 1: Use MBS BWP to indicate the common frequency resource for group-common PDCCH/PDSCH within a unicast BWP. Reuse the BWP configuration signalling to configure an MBS BWP. UE can receive the data on the active DL BWP and the data on the MBS BWP within the active DL BWP simultaneously with no BWP switch.Proposal 2: A unicast BWP can be area specific.Proposal 3: An MBS BWP can be area specific.Proposal 4: An MBS BWP can be used to transmit the unicast service of UE. UE can have a unicast service outside of the MBS BWP on the active DL BWP.Proposal 5: More than one MBS BWPs can be configured per unicast BWP.Proposal 6: More than one MBS BWPs can be configured per DL BWP per UE.* On CORESET and search space:

Proposal 7: The CORESETs and search spaces on an area specific MBS BWP can be area specific.Proposal 8: On a unicast BWP with at least one MBS BWP, there’s no requirement for increasing the number of the CORESETs per unicast BWP from the MBS BWP(s).Propoal 9: The maximum number of the monitored PDCCH candidates and the non-overlapped CCEs per slot per serving cell defined in Rel-15 is kept unchanged for Rel-17 MBS.Proposal 10: Reuse the existing CSS types for MBS.Proposal 11: The monitoring priority of each search space for MBS is the same as the existing Rel-15/16 CSS.* On Group scheduling:

Proposal 12: Not to support PTM transmission scheme 2 for the retransmission of the PTM bearer.Proposal 13: It’s better not to support the PTP bearer for the retransmission of the PTM bearer.Proposal 14: Use the group common PDCCH for the SPS group common PDSCH activation/deactivation.Proposal 15: More than one SPS group common PDSCH can be configured per SPS RB of the PTM bearer.Proposal 16: Use PTM scheme 1 for the retransmission of the SPS group common PDSCH.Proposal 17: No extra requirement is needed for improving UE’s capability to support the following scenarios.* 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
* Maximum number of PDSCHs in a slot simultaneously received per UE is kept unchanged.

Proposal 18: G-RNTI and SPS G-RNTI are configured for an MBS.Proposal 19: For each SPS RB of the PTM bearer, the following items need to be supported.1. Configure at least one SPS group common PDSCH for each SPS RB of the PTM bearer
2. PDCCH with CRC scrambled with SPS G-RNTI is used to activate/de-activate one SPS group common PDSCH.
3. SPS G-RNTI is used in the bit scrambling of the SPS group common PDSCH.

Proposal 20: For all the RBs of the PTM bearer except the SPS RBs, the following items need to be supported.1. Each time the PTM bearer is scheduled, the group common PDCCH with CRC scrambled with G-RNTI and the group common PDSCH with G-RNTI used in the bit scrambling are transmitted N1 times in each related beam coverage area with N1>=1. Support one of the two methods below or support both methods below.
	* Method 1: The PDCCH/PDSCH occasion for each beam coverage area of the B beam coverage area is allocated. But if there’s no UE in a beam coverage area, the PDCCH/PDSCH is not really transmitted in the related PDCCH/PDSCH occasion.
	* Method 2: The PDCCH/PDSCH occasion is allocated only for each beam coverage area with at least one UE. The PDCCH/PDSCH is only transmitted in the beam coverage area with at least one UE.
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| [24]R1-2101658 | ASUSTeK | Proposal 1: For NR MBS group-scheduling, a reference TDRA table for mapping the group-common PDSCH transmission occasion in time domain needs to be identified and known to corresponding group of UEs. Observation 1: Using the default TDRA tables, the cell-specific TDRA table, or the UE-specific TDRA table may not be possible/feasible or may limit the flexibility/capacity of NR MBS group-scheduling. Proposal 2: A “group-common TDRA table” is configured per MBS group for NR MBS group-scheduling. |
| [25]R1-2101726 | Ericsson | Observation 1 The UE HARQ process buffers are common for the PTP and PTM transmissions.Observation 2 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 3 The current PTM transmission schemes 1&2 may be harmonized and generalized by allowing different G-RNTIs for PDCCH and PDSCH. This single generalized scheme could cover a wider range of use cases than either of current PTM transmission scheme 1 and 2. It can also be used to solve the multiple overlapping BWPs use case in a much simpler way than the existing Options 2A and 2B.Observation 4 With Option 2A, the UE would need to have two simultaneously active BWPs, which is preferable to BWP switching.Observation 5 With Option 2B, there is significant specification work related to the configuration of the new common frequency resourceObservation 6 Option 2A and 2B can probably be made to work but both would imply significant specification work.Observation 7 By using BWP-specific PDCCHs, the targeted use case, with multiple BWPs with MBS in the overlap, can be supported with very small specification impact (if any).Observation 8 The support of case 1-5 depends on the UE capabilities to monitor multiple PDCCH candidates with different G-RNTI and C-RNTIObservation 9 The support of intra-slot TDM cases for MBS are up to UE capability.Observation 10 Group-based SPS need to separately address UEs missing the original SPS activation PDCCHObservation 11 The activation recovery message needs to contain slot, MCS information of the original activationObservation 12 For the SPS-PDSCH following an activation commands, the mechanism to support HARQ and HARQ less or NACK only can reuse what is designed for PDCCH based MBS PDSCH scheduling.Observation 13 The common search space can be reused for scheduling group common PDCCH of PTM-1Observation 14 A basic multicast DCI format, based on legacy DCI format 1\_0, could be defined, which may be used in the CSS without requiring additional Blind decoding and without requiring DCI size alignment between unicast and multicast.Based on the discussion in the previous sections we propose the following:Proposal 1 For retransmission, the UE can receive the MBS PDSCH via PTP and/or PTM-1. The HARQ process indicated in DCI associates the PTM-1 transmission and the PTP retransmission.Proposal 2 For the reception of PTP and PTM-based MBS data in parallel for the same UE, downselect between the following optiona. The UE is not expected to be configured to receive the same HARQ process over PTM and PTP within the same HARQ processing window.b. The network is allowed to transmit PDSCH with the same HARQ process over PTP and PTM in the same PDSCH-to-HARQ time frame. The UE, by implementation, can chose to decode either or both. The network monitors both PTP and PTM and expects to receive at least one of the two HARQ responses.c. The network is allowed to transmit PDSCH with the same HARQ process over both PTP and PTM in the same PDSCH-to-HARQ time frame, but the UE is configured with a priority rule (i.e. it does not transmit on the PUCCH resources for both PTP and PTM leg) to send HARQ feedback. The network expects the HARQ feedback only over the prioritized PUCCH resource for HARQ feedback.Proposal 3 PTM-2 based retransmission of PTM-1 based multicast is not supported.Proposal 4 Current PTM transmission schemes 1&2 are harmonized into a single generalized PTM transmission scheme characterized by the possibility to RRC configure UEs to use different G-RNTIs for PDCCH and PDSCH. As a special case the G-RNTI may also be the same, as in current PTM transmission scheme 1.Proposal 5 We propose that 3GPP studies solutions based on BWP-specific (sub-group-common) PDCCHs scheduling a single group-common PDSCH with the aim of selecting solutions at the next meeting.Proposal 6 Group common PDCCH is used to activate/deactivate SPS group common PDSCHProposal 7 For group based SPS, UEs missing the PDCCH activation message are sent an activation recovery message via MAC-CE containing the original PDCCH information and the slot number where it was transmitted. For deactivation, a MAC CE deactivation order can be sent to UEs not responding to the de-activation PDCCH.Proposal 8 For group based SPS, UEs missing the PDCCH activation message can recover the PDSCH slots missed during the recovery procedure via C-RNTI based PTP.a. FFS: recover lost PDSCH(s) via group transmission (PTM-1 or PTM-2)Proposal 9 Multiple group-based SPS configuration are supported, conditioned to UE capabilityProposal 10 The UE is expected to provide feedback via HARQ for all PDCCH associated with a PDCCH activation or deactivation order for SPSProposal 11 RRC configures each UE in the group an additional time offset so that when UEs receive group common PDCCH activate/deactivate command, they can acknowledge this command in different slots to avoid PUCCH resource congestion.Proposal 12 The UE can be configured to either transmit or not transmit HARQ for the SPS PDSCH not corresponding to a SPS PDCCH activation or deactivation.Proposal 13 The SPS UL feedback framework for the SPS scheduled PDSCH is the same as for PDCCH based MBS PDSCH scheduling.Proposal 14 The CORESET for group common PDCCH is part of the already existing CORESET capability of the UE. No additional CORESET capability is defined for MBS only.Proposal 15 Non fallback DCI for MBS is configured in the common search space, together with the non-fallback DCI for unicast. Fallback DCI for MBS is also configured in the common search space.Proposal 16 The priority of search space for multicast is higher than UE specific search space but lower than the existing common search space defined in R15/R16.Proposal 17 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.Proposal 18 A new DCI format for MBS downlink scheduling is introduced e.g. DCI 1\_3.a. The fields are the same as for DCI 1\_1 , with the addition of a field for padding bits for the group scheduling DCI size alignment purpose. The number of padding bits ranges from 0 to Nd, where Nd is the difference between the largest configurable size for DCI 1\_1 and the smallest configurable size for DCI 1\_1FFS: Discuss MBS fallback DCIProposal 19 In the existing alignment procedure, an additional step is taken by the UE to align its DCI 1\_1 with DCI 1\_3 when DCI 1\_3 is configured.a. FFS alignment for MBS fallback DCI |