**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.

The following agreements have been achieved in this meeting.

Agreement:

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

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

Working Assumption:

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

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

Agreement:

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

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

Agreement:

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

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

Agreement:

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

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

# 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 fine  Proposal 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 & 1-5  About 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: Agree  Proposal 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 ok  Proposal 1-6: not support it since the benefits of sub-group-common are not clear based on last Ran1 meeting discussion. |
| Ericsson | Proposal 1-1: We agree, provided it is also the understanding that the use of a Common Frequency Resource is optional for MBS, i.e. it is possible to use MBS and unicast on the same BWP, without using a CFR.  Proposal 1-2: We disagree. If a CFR is specified, we think it is premature to select option 2B already now. Both solutions 2A and 2B would be able to support similar functionality and more analysis is needed to see which is the most appropriate.  Proposal 1-3: We agree  Proposal 1-4: We agree  Proposal 1-5: We disagree. One CFR in total is enough.  Question 1-6: Yes, this may significantly simplify the solution. |
| Convida | For proposal 1-1, we are OK with it.  For proposal 1-2, we are not OK with the proposal. How to define the common frequency resource is also a question for MBS operation for the RRC idle/inactive UEs. It is obvious that option 2B does not work for RRC idle/inactive UEs when we want to configure a common frequency resource that is wider than the initial BWP (which is the majority companies’ understanding on how the common frequency resource works in RRC idle/inactive states based on our observation). As one of the MBS WI objectives is to ‘keeping maximum commonality between RRC\_CONNECTED state and RRC\_IDLE/RRC\_INACTIVE state for the configuration of PTM reception’. It is not a good decision to agree option 2B for RRC connected UEs and potentially we need to come up with some different design for RRC idle/inactive UEs. For option 2A, as long as the MBS BWP is confined within the unicast BWP and with the same SCS, the MBS BWP can be viewed as a virtual BWP and no BWP switching is needed. Therefore, we propose option 2A should be supported.  For proposal 1-3, 1-4 and 1-5, we think the discussions can be deferred after we make progress and decision on proposal 1-2.  For question 1-6, we are open to discuss sub-group-common PDCCH based MBS scheduling. However, it should fall into the PTM transmission scheme discussion rather than here. |
| FUTUREWEI | Proposal 1-1: we are fine with FL proposal  Proposal 1-2: we are fine with FL proposal  Proposal 1-3: we are fine with FL proposal  Proposal 1-4: Prefer Qualcomm’s wording. But do not understand the necessity of the note  Proposal 1-5: we are fine with proposal |
| Intel | **Proposal 1-1:** The working assumption should be confirmed  **Proposal 1-2:** Agree with FL proposal since the common frequency resource is meant for efficient FDRA for a group of MBS UEs and the easiest way to achieve this is to simply define a common set of parameters via higher layer signaling to enable common understanding of FDRA for the UEs. The BWP configuration, in addition to inviting debate on whether BWP switch is needed and related input from RAN4, also consists of many parameters which may not be needed to enable MBS reception. On concerns of diverging design for IDLE mode UEs receiving low QoS (broadcast) data, if the initial BWP is not sufficient, MBS frequency resource can be configured via SIB (with only the required parameters to monitor CORESET and receive PDSCH).  **Proposal 1-3:** We are ok with the proposal in principle. However the wording in the main bullet may be updated since in the working assumption, it is mentioned that MBS frequency resource is confined within unicast BWP. Therefore, *“…and if a common frequency resource is configured within a dedicated unicast BWP*” may not be necessary.  **Proposal 1-4:** Ok with the main bullet. The NOTE is not needed.  **Proposal 1-5:** The proposal is unclear. Are we agreeing to define UE capability for supporting MBS reception on supported unicast BWPs? If the UE can support multiple BWPs and if BWP switching is not required, it should not be an issue for the UE to support MBS reception based on MBS frequency region configuration on these BWPs.  **Question 1-6:** Our initial thinking is that the use case can be covered by network implementation where the MBS frequency region is identical to dedicated unicast BWP. |
| Lenovo, Motorola Mobility | **Proposal 1-1: We are OK to confirm the working assumption at the first stage.**  **Proposal 1-2: Agree.**  We still have concern on Option 2A.In Option 2A, for a given UE, if the dedicated unicast BWP does not overlap with the MBS specific BWP, the UE has to perform BWP switching back and forth between the MBS specific BWP and the unicast BWP because only a single active BWP is allowed in NR. Even if the MBS specific BWP is configured within the dedicated unicast BWP, since both BWPs may have different bandwidths, and may have different central frequency points, the BWP switching between both BWPs is also required. It is impossible to configure the MBS specific BWP exactly same to each UE’s dedicated unicast BWP, e.g., same bandwidth, same central frequency point, same numerology. Configuring an MBS specific BWP may require UE to frequently perform BWP switching between the MBS specific BWP and the dedicated unicast BWP.  **Proposal 1-3:** Generally agree. BTW, we think the amendment from Intel seems better wording.  **Proposal 1-4: Agree.**  **Proposal 1-5:** Not quite clear to us. If the motivation is about whether one or more common frequency resources can be configured to a UE, we think one is enough.  **Question 1-6:** This is a special case for common frequency resource configuration. It is dependent on gNB configuration and may be transparent to UE. BTW, sub-group-common is still FFS. We can discuss this after the related transmission scheme is determined. |
| vivo | Proposal 1-1 is fine.  Proposal 1-2 is fine.  Proposal 1-3 is fine  For proposal 4, we think we should firstly discuss on the functionality, i.e, whether a UE can receive different MBS services simultaneously?  Proposal 1-5 is fine  Question 1-6: It may be a special case, for example, when common frequency is not configured or is the same as unicast BWP. |
| Apple | Proposal 1-1: We are fine with this proposal.  Proposal 1-2: we prefer Option 2A. as mention by others , Option 2B may not work for IDLE UE case, it can’t configure the common frequency region larger than initial BWP. In addition, with the restriction of 3 CORESETs per BWP, multiple common frequency region doesn’t work, due to each common frequency region require a CORESET.  Proposal 1-3, 1-4, 1-5 can be determined after Proposal 1-2. |
| ETRI | Proposal 1-1: We are fine to confirm the working assumption.  Proposal 1-2: We are fine with the proposal. BWP switching delay seems unavoidable if we choose to support the Option 2A.  Proposal 1-3 ~ 1-6: Can be discussed after decision making on Proposal 1-2. |
| Spreadtrum | Proposal 1-1: fine  Proposal 1-2:  Generally, both option 2A and option 2B could achieve the same functionality. Consideration the controversial, suggest to firstly complete schemes for each option, then decide to choose which one.  Proposal 1-3:  Generally we are fine.  Proposal 1-4: fine  Proposal 1-5: fine  Proposal 1-6: Not necessary |
| Nokia, NSB | Regarding Proposal 1-1: Agree with FL’s proposal.  Regarding Proposal 1-2: Agree with FL’s proposal. In our opinion, this option would be beneficial since it avoids BWP switching and would require less specification effort as compared to option 2A.  Regarding Proposal 1-3: Agree with FL’s proposal. This proposal would address the concerns raised by some companies regarding the pdcch-config issues related to option 2B.  Regarding Proposal 1-4: Agree with FL’s proposal. This topic was raised in our contribution, where we mentioned that the motivation for multiple CFRs for multicast traffic was not clear.  Regarding the note, we would propose to change it to an FFS as follows:   * FFS: The configuration of common frequency resource for broadcast reception that can be used by both RRC\_IDLE/RRC\_INACTIVE UEs and RRC\_CONNECTED UEs.   Regarding Proposal 1-5: We disagree with FL’s proposal since we believe that the common frequency resource for multicast could be confined within one UE dedicated BWP. The motivation for CFRs across different UE-dedicated BWPs is not entirely clear. If this aspect should be studied further, we propose to include it as part of an FFS for Proposal 1-4. We propose the following update to proposal 1-4 (including previously mentioned change):  **Proposal 1-4**:  At most one common frequency resource can be configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.   * FFS: The configuration of common frequency resource for broadcast reception that can be used by both RRC\_IDLE/RRC\_INACTIVE UEs and RRC\_CONNECTED UEs. * FFS: Whether 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.   Regarding Question 1-6: While we are supportive of studying other approaches to scheduling group-common PDSCH, including the use of BWP-specific PDCCH. However, we believe that this approach is valid only in scenarios where BWP-switching needs to be combined with group-common PDSCH scheduling possibly using UE-specific PDCCH. We do not see benefits in concepts that do not consider the configuration of a common frequency resource for MBS. |
| TD Tech, Chengdu TD Tech | Our comments (TD Tech & Chengdu TD Tech):  **Proposal 1-1: We agree with this proposal.**  **Proposal 1-2**: We support option 2A. We have the same comments as ZTE and QC. It’s too early to make the conclusion. An MBS BWP is not a real BWP. The concern on the BWP switching for option 2A doesn’t exist at present.  **Proposal 1-3**: The detailed PDSCH and PDCCH configuration need to be discussed to make the selection between option 2A and option 2B.  **Proposal 1-4**: For the more flexible scheduling of an MBS session, we think more than one common frequency resource can be configured per unicast BWP.  **Proposal 1-5**: We agree with this proposal.  **Question 1-6**: We think there’s no need to consider the following scenario.  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? |
| Moderator | **Proposal 1-1**:  All companies are OK with this proposal.  Based on the Ericsson’s comment in 1st GTW session, an FFS is added whether the use of a common frequency resource for multicast is optional or not  **Proposal 1-2**:  It seems companies still cannot converge on this proposal, 6 companies still insist Option 2A, and 12 companies are OK with it. It seems the down-selection of Option 2A/2B is not so easy. I think we do not to have to wait for the decision of Option 2A/2B and defer all other discussions. We can parallelly discuss other proposals (e.g., 1-2/1-3/1-4/1-5) although they may relate to the decision of Option 2A/2B, so that companies can have better understanding of option 2A/2B, which may facilitate the down-selection of 2A/2B.  Based on the comments in 1st GTW session, proposal 1-2 was further updated to list two options for the indication method of the starting PRB of CFR based on related contributions.  **Proposal 1-3**:  Most companies are OK with this proposal. 2 companies [ZTE, Qualcomm] have concerns on this, 3 companies [Convida, Apple, ETRI] prefer to discuss it after the decision of Option 2A/2B. Considering this proposal is conditioned on Option 2B, we can try to make progress on this so that companies have better understanding on Option 2B. For Option 2A, it seems not necessary to have such a proposal (@LG).  **Proposal 1-4**:  Most companies are OK with this proposal. 4 companies [OPPO, Qualcomm, FUTUREWEI, Chengdu TD Tech] prefer to support more than one CFR per BWP. Convida prefers to defer this discussion. Based on companies’ comments on the note, I think we can remove it for now. Based on Nokia’s comment, I put proposal 1-5 as FFS in proposal 1-4.  **Proposal 1-5**:  4 companies [ZTE, Convida, Apple, ETRI] prefer to defer this discussion.  4 companies [MTK, Ericsson, Lenovo, Nokia] prefer one CFR in total.  Based on Nokia’s comment, I put proposal 1-5 as FFS in proposal 1-4.  **Question 1-6**:  It seems not many companies support to study solutions based on BWP-specific (sub-group-common) PDCCHs scheduling a single group-common PDSCH without defining common frequency resource for MBS. I think we can deprioritize it for now. |

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

**[High] Updated Proposal 1-1(No change)**: The working assumption for common frequency resource is confirmed.

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

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

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

If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the starting PRB and the length of PRBs of the MBS frequency region within a dedicated unicast BWP are configured via RRC signaling.

* The starting PRB is referenced to
  + Option 1: Point A
  + Option 2: the starting PRB of the dedicated unicast BWP
* FFS the detailed signaling

**[High] Updated Proposal 1-3(No change)**:

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

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

If Option 2B is supported, at most one common frequency resource can be configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.

* FFS: If a UE is configured with multiple dedicated unicast BWPs, whether more than one dedicated unicast BWP can be configured with common frequency resource
* FFS: Whether the common frequency resources configured for different dedicated unicast BWPs of a UE can be different or not.

**[High] Proposal 1-7:**

If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs,

* at most N MBS specific BWPs can be configured per UE subject to UE capability.
  + FFS: the value of N
* an MBS specific BWP has to be associated with at least one dedicated unicast BWP.
  + FFS: whether an MBS specific BWP can be associated with more than one dedicated unicast BWP or not.
* at most M MBS specific BWPs can be associated with the same dedicated unicast BWP(s) subject to UE capability.
  + FFS: the value of M
* an MBS specific BWP cannot be activated/deactivated independently.
  + UE monitors an MBS specific BWP only when at least one of its associated dedicated unicast BWP(s) is active.
* an MBS specific BWP has its own bwp-Id which is different from the bwp-Id(s) of the dedicated unicast BWP(s).
  + FFS the number of configured MBS specific BWP(s) is taken into account the maximum number of BWPs that can be configured per serving cell or not
* no BWP switching between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP
* parameters of group-common PDCCH configuration and group-common PDSCH configuration for MBS (e.g., pdcch-Config, pdsch-Config) are configured per MBS specific BWP.

## Company Views (2nd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We are generally fine with the above proposals.  We think that Proposal 1-1 in this email thread is somewhat related to Proposal 4 in AI 8.12.3. It seems good to have common approach for all RRC states and both multicast and broadcast.  We propose to discuss details of Option 2A as well as Option 2B in parallel (since FL said that we can parallelly discuss other proposals) |
| Nokia, NSB | Proposal 1-1 Fine with FL proposal  Proposal 1-2 Fine with FL proposal.  This proposal is beneficial since it avoids BWP switching and, in our opinion,, requires less specification effort when compared to option 2A.  Proposal 1-3 Fine with FL proposal.  This proposal would address the concerns raised by some companies regarding the pdcch-config issues related to option 2B.  Proposal 1-4 Fine with FL proposal  Proposal 1-7 While we support the intent of the proposal, however we would still like to clarify the relation between the MBS specific BWP – in terms of BWP location / start PRB and bandwidth / length of PRBs, and the UE-dedicated BWP.  We also believe that similar to our position in 2B, the values of M and N should be 1 for option 2A. |
| CMCC | We are fine about the above proposals.  The clarification of “no BWP switching between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP” in option 2A is necessary. |
| Vivo | **[High] Updated Proposal 1-1(No change)**: The working assumption for common frequency resource is confirmed.  For multicast of RRC-CONNECTED UEs, a common frequency resource for group-common PDCCH / PDSCH is confined within the frequency resource of a dedicated unicast BWP to support simultaneous reception of unicast and multicast in the same slot   * Down select from the two options for the common frequency resource for group-common PDCCH/ PDSCH   + Option 2A: The common frequency resource is defined as an MBS specific BWP, which is associated with the dedicated unicast BWP and using the same numerology (SCS and CP)     - FFS BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP   + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.     - FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region * FFS whether UE can be configured with no unicast reception in the common frequency resource * FFS on details of the group-common PDCCH / PDSCH configuration * FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities * FFS whether the use of a common frequency resource for multicast is optional or not * FFS whether it is applicable for PTM scheme 2.   We suggest the above change. For PTM scheme 2, we think it is not necessary to discuss CFR and the legacy scheduling mechanism for unicast scheduling can be reused. |
| Samsung | Support all updated proposals. |
| ZTE | Thanks Moderator for the updated proposals. Regarding Proposal 1-7, we think the intention is to help companies to compare Option2A and Option2B. From this perspective, we would suggest to combine the bullets in Proposal 1-7 to Proposal 1-2, 1-3 and 1-4. In this case, companies clearly see the difference between Option2A and Option2B.  For Proposal 1-2, the following wording is proposed from our perspective.  If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the starting PRB and the length of PRBs of the MBS frequency region within a dedicated unicast BWP are configured via RRC signaling.   * The starting PRB is referenced to   + Option 1: Point A   + Option 2: the starting PRB of the dedicated unicast BWP * FFS the detailed signaling   If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of the starting PRB and the length of PRBs of the MBS frequency resource reuses the legacy BWP configuration.  For Proposal 1-3, the following wording is proposed from our perspective.  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   If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of group-common PDSCH and group-common PDCCH reuses the legacy PDSCH and PDCCH configuration, respectively.  For proposal 1-4, the following wording is proposed from our perspective.  If Option 2A or Option 2B is supported, at most one common frequency resource can be configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.   * FFS: If a UE is configured with multiple dedicated unicast BWPs, whether more than one dedicated unicast BWP can be configured with common frequency resource * FFS: Whether the common frequency resources configured for different dedicated unicast BWPs of a UE can be different or not.   For the other bullets in Proposal 1-7, we think we can first focus on the following one, which is the most important and also most controversial point. We can first try to address the following issue and then check the other bullets.  Proposal 1-7:  If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs,   * no BWP switching between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP   For the other bullets in Proposal 1-7, we suggest to discuss them in next week or in next meeting when we have finalized the above issues. |
| LG | **[High] Proposal 1-7:**  We are generally fine with Proposal 1-7 except the following two parts:  We think that gNB should be able to independently activate/deactivate an MBS specific BWP at least when a MBS session starts/stops while connected UEs in the group have already UE’s active unicast BWPs. We propose to change to:    In addition, we propose to support at most one MBS specific BWP in the following for Rel-17, like in Updated Proposal 1-4.   * at most one ~~M~~ MBS specific BWPs can be associated with the same dedicated unicast BWP(s) ~~subject to UE capability~~.   ~~FFS: the value of M~~ |
| Lenovo, Motorola Mobility | Proposal 1-1: Generally agree. Maybe it is better to delete “no change” because a new sub-bullet is added.  Proposal 1-2: agree. We support option 2 to save signalling overhead for indicating the starting PRB.  Proposal 1-3: agree.  Proposal 1-4: agree.  Proposal 1-7: The first step for Option 2A is to clarify the BWP switching issues as mentioned by companies in the first round of discussions. |
| vivo | For Updated proposal 1-1: as comment above.  For Updated Proposal 1-4: Not support.  We think it should be further study whether more than one CFRs can be configured per dedicated BWP. Taking an example:  UE1: interested in MBS service 1 which needs 60MHz  UE2: interested in MBS service 2 which needs 40MHz (different frequency location with MBS service 1)  UE3: interested in MBS service 1 and MBS service 2  If only one CFR can be configured following the Updated Proposal 1-4, UE 1/2/3, a CFR with 100MHz is needed, which will make UE1 and UE2 have to be configured with a large dedicated BWP (100MHz). On the one hand, UE1 or UE2 may not have capability to support 100MHz. On the other hand, it will increase the power consumption of UE1 and UE2.  If more than one CFR can be configured per dedicated BWP, then gNB can configure CFR1 for MBS service 1, and CRF2 for MBS service 2. If group-common PDCCH is used for MBS scheduling, for UE3, it may need to decode DCI with two different sizes which can be based on UE capability. If UE-specific PDCCH is used for MBS scheduling, there is no DCI size issue, because CFR is narrow than UE dedicated BWP.  For the other updated proposals, we are fine to support in principle. |
| OPPO | 1-2:   * Firstly, we suggest to put “UE-specific RRC signaling” back, please note that in option 2B, the common frequency resource is configured within UE dedicated BWP, where cell specific RRC signaling cannot be used. * For the reference point of starting PRB, seems we should clarify that only one option will be down selected. From our perspective, we did not see fundamental difference between the 2 options, either one is fine for us.   The other proposals are fine for us. |
| Qualcomm | We agree with ZTE’s modification to separate Proposal 1-7 into 1-2, 1-3, 1-4 and discuss Option 2A/2B in parallel.  But for 1-4, we cannot agree. Not sure of the potential impact on how to support UE to receive different MBS in a dedicated BWP. It is not just frequency resource configuration, but also related with other CFR configurations, such as GC-PDSCH, number of CORESET for GC-PDCCH, SPS GC-PDSCH. We can discuss 1-4 after deciding the basic configuration of CFR. |
| CATT | We support proposal 1-1, 1-2, 1-3 and 1-4.  Similar view with CMCC, for option 2A and corresponding proposal 7, BWP switching issue should be clarified. |
| MTK | We basically agree with updated proposal 1-1, 1-2, 1-3 and 1-4. We think there is no necessary to support multiple common frequency resource per UE, NW can configure the larger common frequency resource or merge multiple MBS services in higher layer to solve this issue.  Proponents of proposal 1-7 maybe need to clarify majority companies concern about BWP switching issue if MBS specific BWP is defined. |
| Huawei, HiSilicon | Regarding Proposal 1-4 the second FFS, why should it be FFS? I think it is completely up to NW configuration. Different or not in terms of what?  Proposal 1-7: For option 2A, the argument for option 2A is reusing the current BWP framework so as to reduce the spec effort. However, the sub-bullets like “an MBS specific BWP has to be associated with at least one dedicated unicast BWP.” and “at most M MBS specific BWPs can be associated with the same dedicated unicast BWP(s) subject to UE capability” together with the sub-bullet of FFS would lead to more spec effort for example defining the association for many cases of *N* unicast BWP and *M* MBS BWP which in our view deviates from the original spirit of reducing spec effort. |
| Apple | For proposal 1-2, this can apply to both Option 2A and Option 2B. MBS BWP is on top of UE dedicated BWP, thus option 2 can be considered by Option 2A as well.  For proposal 1-4, it can apply to both Option 2A and Option 2B.  For proposal 1-7, one MBS specific BWP per UE dedicated BWP is enough. |
| FUTUREWEI | We are ok is Proposals 1-1 to 1-4 |
| Ericsson | We agree with the FL’s proposals for Proposals 1-1, 1-2, 1-4, 1-7.  Regarding Proposal 1-3 we think Option 2B needs to first be clarified with respect to the role of BWP and common frequency resource. In legacy NR, PDCCH/PDSCHs are configured on a BWP. We think this should apply also to multicast/broadcast. The proposal seems however to imply that PDCCH/PDSCHs are configured on a CFR instead of on a BWP. For 2B, we suggest that the CFR is simply configured as a frequency range within the unicast BWP, with some specified way of interpreting the FDRA. The PDCCH/PDSCHs are then configured on the unicast BWP, as normal, but with a flag for each PDCCH/PDSCH indicating whether or not it applies to and is transmitted in the CFR. With this all PDCCH/PDSCHs would be configured on the unicast BWP, as normal, and still properly handled when applicable for CFR transmission.  In the case of unicast, different BWP-specific RRC profiles are configured for PDSCH-config and a specific configuration is triggered when the corresponding BWP, indexed via BWP-ID, is activated. It needs to be clarified under which BWP such PDSCH-configMBS corresponding to the (2B) common frequency resource is instantiated? How is this common frequency specific RRC profile created?  We should avoid developing the 2B-CFR to be something that is essentially a BWP without formally being one.  Regarding 2A: We note “no BWP switching between the multicast reception in the MBS specific BWP and unicast reception”, which we agree with. In our understanding this implies two simultaneously active BWPs, which is no technical problem, but a deviation from current UE expectations. The new spec needs to clarify the requirement for two active BWPs under certain specified conditions. |
| Convida | We agree with ZTE’s and QC’s suggestion to separate Proposal 1-7 into 1-2, 1-3, 1-4 and discuss Option 2A/2B in parallel. However, the exact wording needs to be further discussed.  For proposal 1-7, We also support to first clarify that the BWP switching is not needed to help make progress on other discussions. |
| Intel | **Proposal 1-2, 1-3, 1-4:** OK with current wording.  **Proposal 1-1:** We agree to add the FFS for PTM Scheme 2 as proposed by vivo. We think that PTM scheme 2 should use normal FDRA for the unicast BWP and not the CFR for the MBS reception. UE can always be scheduled on the CFR since it is contained within the unicast BWP.  Additionally, the intention of the CFR (MBS frequency region) in Option 2B is to provide a methodology to allocate frequency domain resources without requiring a BWP switch or the need to configure a separate BWP which is a heavy configuration i.e., it comes with a lot of related configuration which may not be necessary to enable a group of UEs to receive MBS transmission on a common frequency resource. The CFR for RRC\_IDLE UEs may be limited inside the initial BWP but other options including a separate configured BWP can be further discussed in 8.12.3 and need not have a bearing on the design for RRC\_CONNECTED UEs. Therefore, our preference is Option 2B.  **Proposal 1-7:** For option 2A, the MBS BWP is confined within the UE dedicated BWP, therefore similar to Option 2B, the starting PRB and number of contiguous PRB indication and their relation to the unicast BWP within which they are contained should be clarified. Additionally, the proposal is currently very long. Either separate into multiple proposals or keep sub-bullets as FFS. |
| Spreadtrum | **Fine with Proposal 1-1,1-2,1-3,1-4;**  **Proposal 1-7:**   * **For the third bullet, one MBS BWP is enough, and there is no reasonable reason to support multiple MBS BWP. In Rel-15/16, even if there exists diverse services, e.g., low latency service, high reliability service, high throughput service, they share the same BWP, up to gNB scheulding to support differnent service coexistence.** * **For the fourth bullet, we don’t understand ‘**UE monitors an MBS specific BWP only when at least one of its associated dedicated unicast BWP(s) is active.**’. Why one MBS BWP could be associated with multiple dedicated BWP. Could the proponent clarify this.** * **For other bullets, generally we are fine.** |
| TD Tech, Chengdu TD Tech | From our point of view, option 2A and option 2B are two methods for configuring the common frequency resource for the group common PDSCH/PDCCH for multicast.  Option 2A reuses the BWP related signaling to configure the common frequency resource to avoid the signaling related effort, which doesn’t mean the MBS specific BWP for multicast is a real BWP.  Option 2B uses the new signaling to configure the common frequency resource and thus needs the signalling effort.  No matter which configuraton method (option 2A and option 2B) is used, the common frequency resource for multicast is not a real BWP and thus no BWP switching is needed.  The concept of the common frequency resource for group common PDSCH/PDCCH for multicast is introduced for NR MBS. Therefore, if we reuse the BWP related singalling to configure it, we only need to add an note in 3GPP TS38.331 to indicate that the MBS specific BWP for multicast is not a real BWP and it’s just a part of the associated dedicated BWP. Such note has no influence on the existing BWP types. Such note is enough to avoid the wrong understangding of the MBS specific BWP for multicast of option 2A  Based on the above discussion, we think Proposal 1-1 needs to be updated as below.  **[High] Updated Proposal 1-1(No change)**: The working assumption for common frequency resource is confirmed.  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)     - Add the following note in 3GPP TS 38.331 to indicate that the MBS specific BWP for multicast is not a real BWP and thus no BWP switch is needed for option 2A.   Note: The MBS specific BWP for multicast is not a real BWP. It’s just a part of the associated dedicated unicast BWP.   * + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.     - FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region * FFS whether UE can be configured with no unicast reception in the common frequency resource * FFS on details of the group-common PDCCH / PDSCH configuration * FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities * FFS whether the use of a common frequency resource for multicast is optional or not   Based on the updated Proposal 1-1, the other proposals can be updated. For the proposals 1-2 and 1-3, we agree with ZTE’ view. We re-write proposal 1-2 and proposal 1-3 updated by ZTE as below. We think option 2A and option 2B can be slected based on the updated proposals 1-1， 1-2 and 1-3.For Proposal 1-2, the following wording is proposed from our perspective.  If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the starting PRB and the length of PRBs of the MBS frequency region within a dedicated unicast BWP are configured via RRC signaling.   * The starting PRB is referenced to   + Option 1: Point A   + Option 2: the starting PRB of the dedicated unicast BWP * FFS the detailed signaling   If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of the starting PRB and the length of PRBs of the MBS frequency resource reuses the legacy BWP configuration.  For Proposal 1-3, the following wording is proposed from our perspective.  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   If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of group-common PDSCH and group-common PDCCH reuses the legacy PDSCH and PDCCH configuration, respectively. |
| Moderator | **Proposal 1-1:**  Based on the comments from vivo and Intel, an FFS “whether the common frequency resource is applicable for PTM scheme 2 or not.” is added.  **Proposal 1-2:**  Based on comments from ZTE, Qualcomm, Apple and Convida, both Option 2A and 2B is included.  Based on comment from OPPO, I added “UE-specific” for RRC signalling and made a clarification to down-select one from the two options for indication of starting PRB.  **Proposal 1-3:**  Based on comments from ZTE, Qualcomm and Convida, both Option 2A and 2B is included.  Regarding Ericsson’s comment, I made the following clarification. The current wording is saying “…pdsch-ConfigMBS is configured for the common frequency resource separately from the pdsch-Config for unicast”, the intention is just to say the pdsch-ConfigMBS is needed for multcast, and it does not mean that the pdsch-ConfigMBS is configured in the CFR, it can also be configured in the dedicated unicast BWP similar to the configuration method of pdsch-Config, but I know different companies may have different preference and detailed signaling need further discussion. Considering that the detailed signalling can be discussed later and it may be up to RAN2 design, I think the current wording is more general and we can first try to make some progress, and then we can further discuss the detailed configuration method later based on these propgress.  **Proposal 1-4:**  Vivo and Qualcomm still have concern on it.  Based on the comments from ZTE, Apple and Convida, I added Option 2A.  Regarding Huawei’s comments, I think based on companies’ previous inputs, it is clearly that the FFS parts are not purely based on NW configuration, since some companies still think one CFR per UE is enough.  **Proposal 1-7:**  The current wording is based on my understanding and companies’ comments, and it is just for conclusion and list the assumptions/conditions of Option 2A, which can be used for companies to further study the feasibility of option 2A and corresponding assumptions/conditions.  Many companies have concern on whether the BWP switching is needed or not. I think proponents of Option 2A at least need to convince other companies that no BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated BWP. This issue has been discussed in two meetings, and it seems still controversial. If this issue is not resolved, I don’t know how to continue discussion with Option 2A. |

## Updated Proposals (2nd round of email discussion)

Agreement:

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

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

Agreement:

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

After the 2nd GTW session, in order to make more progress on the decision of CFR, I try to propose a compromised solution for option 2A and option 2B in **proposal 1-1a**. Basically, on the one hand, this option avoids the concerns of proponents of option 2B on the BWP switching, on the other hand, it also has the almost same functionalities of a virtual BWP supported by proponents of option 2B. Companies are encouraged to provide their views on this proposal, and hope we can agree a compromised solution in this meeting. If this compromised proposal is agreed by the group, I will update proposal 1-3~1-7 accordingly. For now, I will fisrt mark proposal 1-3~1-7 as medium priority, but companies still can provide their views on them.

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

From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs includes at least the following functionalities:

* Signaling of starting PRB and bandwidth
* Signaling of one PDSCH-config for MBS (i.e., signaling of PDSCH-Config different from that of dedicated BWP).
* Signaling of one PDCCH-config for MBS (i.e., signaling of PDCCH-Config different from that of dedicated BWP).
* Signaling of SPS-config(s) for MBS (i.e., signaling of SPS-Config different from that of dedicated BWP).
* FFS: Other IEs within BWP-Downlink.
* FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP)
* FFS signaling details.

**[Medium] Updated 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
* If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of group-common PDSCH and group-common PDCCH reuse the legacy PDSCH and PDCCH configuration, respectively.

**[Medium]Updated Proposal 1-4**:

* If Option 2B is supported, at most one common frequency resource can be configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.
  + FFS: If a UE is configured with multiple dedicated unicast BWPs, whether more than one dedicated unicast BWP can be configured with the same common frequency resource
  + FFS whether more than one common frequency resource can be configured per UE subject to UE capability
* If Option 2A is supported, an MBS specific BWP has to be associated with at least one dedicated unicast BWP. For a dedicated unicast BWP, at most one MBS specific BWP can be configured to be associated with it for multicast reception.
  + FFS: whether an MBS specific BWP can be associated with more than one dedicated unicast BWP or not.
  + FFS: whether more than one MBS specific BWP can be configured per UE subject to UE capability.

**[Medium]Updated Proposal 1-7 (for conclusion):**

Option 2A for common frequency resource is based on the following assumptions/conditions. Companies are encouraged to further study the feasibility of option 2A and corresponding assumptions/conditions:

* The frequency resource of an MBS specific BWP is confined within the frequency resource of its associated dedicated unicast BWP and using the same numerology (SCS and CP). This sub-bullet is the same as in the working assumption made in RAN1#103-e.
* UE is required to simultaneously support one active dedicated unicast BWP and one active MBS specific BWP, and no BWP switching is needed between the multicast reception in the MBS specific BWP and unicast reception in its associated dedicated unicast BWP.
* UE monitors an MBS specific BWP only when its associated dedicated unicast BWP is active.
  + FFS: whether/how an MBS specific BWP can be activated/deactivated independently
* an MBS specific BWP has its own bwp-Id which is different from the bwp-Id(s) of the dedicated unicast BWP(s).
  + FFS whether the number of configured MBS specific BWP(s) is taken into account the maximum number of BWPs that can be configured per serving cell or not

## Company Views (3rd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| TD Tech& Chengdu TD Tech | For proposal 1-1:  We have the following comments.   * The BWP switching related dscripton for option 2A shall be deleted from proposal 1-1 because no BWP switching is needed. * The description on reusing the BWP realted signaling to configure the MBS specific BWP can be added, where the MBS specific BWP is not a real BWP. * An MBS specific BWP has its own bwp-Id. But as a faulse BWP, each configured MBS specific BWP(s) can NOT be regarded as the real BWP in the calculation of the number of the BWPs.   The above modification for option 2A can reflect the nature of option 2A and avoid the misunderstanding of option 2A from the first proposal.  **[High] Updated Proposal 1-1**: The working assumption for common frequency resource is confirmed.  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 configuring 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 uses the same numerology (SCS and CP)     - Reuse the BWP related signaling to configure the MBS specific BWP, where the MBS specific BWP is not a real BWP and can NOT be regarded as a real BWP in the calculation of the number of the BWPs.   + Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within the dedicated unicast BWP.     - FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region * FFS whether UE can be configured with no unicast reception in the common frequency resource * FFS on details of the group-common PDCCH / PDSCH configuration * FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities * FFS whether the use of a common frequency resource for multicast is optional or not * FFS whether the common frequency resource is applicable for PTM scheme 2 or not   With the updated proposal 1-1 and proposals 1-2 and 1-3, proposal 1-7 is not needed. From our point of view, as a false BWP, no activation/deactivation is needed for the MBS specific BWP because it’s just a part of the asscocated dedicated unicast BWP. |
| vivo | For proposal 1-4:  We would like to remove “at most” in the mainbullet, and update the 2nd FFS to “FFS whether more than one common frequency resource can be configured per dedicated unicast BWP per UE subject to UE capability”.  because when we have the 2nd FFS for multiple CFR, “at most one” and “more than one” would conflict with each other.  For the other proposals, we are ok with it in principle. |
| Lenovo, Motorola Moblity | We are generally OK with the proposals although we are not sure such parallel discussion would spend more time. |
| Spreadtrum | In principle we are generally fine with all proposals. |
| OPPO | 1-1: for the newly added last FFS, as we have not yet agreed to support PTM scheme 2, as compromise, maybe we can add “(if supported)” after “PTM scheme 2” in the sentence.  1-2: agree.  1-3: agree.  1-4: similar view as vivo, the last FFS is mutually exclusive with repective main bullet, we suggest to down prioritize 1-4 for further discussion.  1-7: agree. |
| CATT  Updated (1.29) | We share the similar view with Lenovo, Moto.  We all know that either 2A or 2B will be down selected, and it will be a little bit more confusing to discuss the detailed mechanism for a option that potentially not be supported in the future.  (1.29)   * I would like to suggest the discussion from RAN1’s design and perspective rather than signaling which is RAN2’s work. According to the discussion by now, RAN1 related design is how to define “starting PRB” and “BW”. The first bullet can be updated by removing “signaling”. * Sub-bullets 2/3/4 seems no specific and detailed design related to RAN1. If they are related to RAN2’s work in the future, there may not be necessary to keep them. I think the intention is trying to capture the physical layer design on BWP for MBS. Then we can update the wording as “physical layer design in details for MBS BWP”. * “FFS: Other IEs within BWP-Downlink” can be removed because IEs work is also related to RAN2 but not RAN1. * “FFS signaling details”: RAN1 can discuss PHY design, and the corresponding signalliing details can up to RAN2 based on RAN1’s design. This sub-bullet can also be deleted. * “at least” in the main bullet: Option 2A/2B have not been decided yet, “at least” implies the following functionalities have to be supported as mandatory.   We propose to update the proposal 1-1a as follows:  **[High] Proposal 1-1a**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs includes ~~at least~~ the following functionalities:   * ~~Signaling of~~ starting PRB and bandwidth * PDCCH/PDSCH and SPS details for MBS. * ~~Signaling of one PDSCH-config for MBS (i.e., signaling of PDSCH-Config different from that of dedicated BWP).~~ * ~~Signaling of one PDCCH-config for MBS (i.e., signaling of PDCCH-Config different from that of dedicated BWP).~~ * ~~Signaling of SPS-config(s) for MBS (i.e., signaling of SPS-Config different from that of dedicated BWP).~~ * ~~FFS: Other IEs within BWP-Downlink.~~ * FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP) * ~~FFS signaling details.~~ |
| LG | We are generally fine with the updated proposals, except Proposal 1-3:  **Updated Proposal 1-3:** It is not clear to us whether we can reuse the legacy PDSCH and PDCCH configuration, respectively for Option 2A at this stage. Whether to reuse the legacy PDSCH and PDCCH configuration can be FFS for Option 2A. |
| Nokia, NSB | We are fine with the updated proposals. However, we have some comments which perhaps require further discussion:  For updated proposal 1-2: If option 2A utilizes: “the configurations of the starting PRB and the length of PRBs of the MBS frequency resource reuse the legacy BWP configuration”, we do not fully understand the relation between MBS BWP and the agreement made in proposal 1-1 related to the common frequency resource being confined within the UE-dedicated BWP. It seems that option 2A requires the definition of an entirely new MBS specific BWP, which has no real relation with the UE-dedicated BWP – even though in practice the frequency resources are confined within the UE-dedicated BWP, and UE would be required to monitor two different BWPs simultaneously. |
| Samsung | We are fine with all proposals. |
| ZTE | First of all, we want to share our views on BWP switching issue under Option 2A.  For receiving unicast and MBS simultaneously, the MBS BWP and unicast BWP can be activated at the same time, which is similar as simultaneous reception in CORESET0 and dedicated unicast BWP if including CORESET0. Following the same restriction of CORESET0 and dedicated unicast BWP, i.e., same numerology and CORESET0 is included within the dedicated unicast BWP, we believe that simultaneous reception is possible, and no BWP switch is needed. More specifically, there is no change of center frequency, RF bandwidth, FFT size and sampling frequency, etc. for receiving MBS in MBS BWP and unicast in unicast BWP.  For the updated proposal 1-4, we think the description of ‘associated’ may not be so clear. So we have the following suggestion,   * If Option 2A is supported, an MBS specific BWP can be configured to be activated together with at least one dedicated unicast BWP. For a dedicated unicast BWP, at most one MBS specific BWP can be configured to be activated together with it for multicast reception.   + FFS: whether an MBS specific BWP can be configured to be activated together with more than one dedicated unicast BWP or not.   + FFS: whether more than one MBS specific BWP can be configured per UE subject to UE capability.   For the updated proposal 1-7, there seems to be some conflict between the third bullet and the subbullet under it. We suggest the following updates,   * FFS: whether an MBS specific BWP can be activated/deactivated independently or should be activated/deactivated together with a dedicated unicast BWP. |
| Ericsson | Proposal 1-3: All PDCCH/PDSCHs are configured on BWPs and for 2B we consider the CFR to be an additional attribute to the BWP configuration, where certain PDCCH/PDSCHs may be associated with the CFR.  In general, it is important to be able to configure UEs with multiple group-common PDCCH/PDSCHs, e.g. with one service each. Both 2A and 2B should therefore allow for this.  We therefore propose the following (E/// updated) text for Proposal 1-3:   * If Option 2B is supported for common frequency resource for multicast of RRC-CONNECTED UEs, and if a dedicated unicast BWP is configured with a common frequency resource,   + one or more group-common PDSCH configurations for MBS (e.g., pdsch-ConfigMBS) are associated with 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 associated with the common frequency resource separately from the pdcch-Config for unicast * If Option 2A is supported for common frequency resource for multicast of RRC-CONNECTED UEs, the configurations of group-common PDSCH and group-common PDCCH reuse the legacy PDSCH and PDCCH configuration, respectively.   + The configuration of the MBS BWP should allow multiple group-common PDCCH/PDSCHs.   Proposal 1-4: We agree  Proposal 1-7: We agree.We note that the second bullet point implies two active BWPs for the UE. We see no issues with this and this just needs to be clarified in the standard (i.e. give the precise conditions when this applies). Regarding activation/deactivation of the MBS BWP we do not see any major issues with this, other than that DCI-based BWP switching need to be signaled (not a mandatory feature currently). On the other hand, such activation/deactivation seems to be an additional refinement that is not absolutely required for 2A, so is not critical to a selection of 2A. With this, we therefore do not see any BWP switch issues for 2A.  Finally, we would also like to comment on the FFS on optional or mandatory status for the CFR:  We see at least two cases where having the CFR optional is important:   1. When only a single BWP is available for MBS and both unicast and multicast are used over the BWP. Both C-RNTI PDCCH/PDSCH and G-RNTI PDCCH/PDSCHs could then be configured on the single BWP, which is no problem /(RAN2 experts say this is trivial). The desired functionality could then be obtained without bothering with the configuration of a CFR. Although such a CFR *could* be configured over the whole BWP this would be rather pointless (at least not always useful) and would require unnecessary complexity. 2. When there are multiple unicast BWPs with some overlap, a CFR may be configured within the overlap zone to allow MBS there for all UEs using the respective different unicast BWPs. However, an individual BWP may also have BWP-specific MBS services, which would need to be configured on the unicast BWP, unless there are multiple CFRs configured for the UE. With one configured CFR some MBS would then be received outside the CFR.   Both these examples show that MBS needs to be received without or outside a CFR, which means that the CFR needs to be optional for the reception of MBS.  **Proposal: The use of a CFR is optional**  We will comment on the new Proposal 1-1a in a later submission |
| MTK | We are generally fine with proposal 1-3 and 1-4 about the option 2B. From our perspective, supporting more than one group common frequency per UE is not necessary, NW implementation can ensure that UE has enough common frequency resource for MBS reception. But, we are open to discuss the FFS in proposal 1-4. We have discussed Opt 2A and 2B for a long time, however, there are still controversial. Whether BWP switching is needed or not is the key controversy point for Opt 2A. From our perspective, if introducing a new MBS BWP ID, it needs to BWP switching because the current specs only support one activate BWP. Anywy, this issue needs to be confirmed by RAN4. About the Moderate suggestion, we have the similar question as OPPO mentioned in e-mail thread. |
| LG | [High] Proposal 1-1a:  First af all, we wonder if the dedicated BWP in P1-1a is UE-dedicated BWP as follows, considering ‘dedicated BWP’ being discussed in AI 8.12.3.   * Signaling of one PDSCH-config for MBS (i.e., signaling of PDSCH-Config different from that of UE-dedicated BWP). * Signaling of one PDCCH-config for MBS (i.e., signaling of PDCCH-Config different from that of UE-dedicated BWP). * Signaling of SPS-config(s) for MBS (i.e., signaling of SPS-Config different from that of UE-dedicated BWP).   In addition, we think that it is also good to have same approach of CFR for RRC\_IDLE/INACTIVE/CONNECTED UEs and broadcast/multicast mode. Thus, we was wondering if we can also add the following proposal as compromise:   * The CFR (common frequency resource) can be configured as either a MBS frequency region or an MBS specific BWP overlapped with the associated unicast/initial BWP based on network configuration:   + The MBS specific BWP is configured when the associated unicast BWP is wider than the associated unicast/initial BWP.   + The MBS frequency region is configured when the associated unicast BWP is smaller than or equal to the associated unicast/initial BWP.   + FFS: whether the MBS specific BWP not overlapped with the associated unicast/initial BWP is configured (only for broadcast). |
| OPPO | [High] Proposal 1-1a:  As agreed in the 2nd GTW session, RAN1 will down select between Opiton 2A and Option 2B, although the downselection is not easy, we do not think to replace Option 2A and Opiton 2B with another compromised option is advisable, as there may be multiple directions for compromise, we may end up with the same situation (i.e. to down select among multiple options). In view of above, we suggest to respect the agreement achieved by meetings of hard discussion.  To break the tie between Option 2A and 2B, we suggest to send an LS to RAN4 to ask if BWP switching is needed for Option 2A, and then to make the decision based on RAN4’s reply, i.e. to select Option 2A if no BWP switching is needed, and Option 2B otherwise. |
| ZTE | Add some further comments for proposal 1-1a. Based on our understanding, moderator is proposing a new approach to progress the discussion here. More specially, we are going to first dicuss the funcationalities of multicast, regarding whethet to apply Optoin 2A or Option 2B to implement these funcationalities can be discussed at a later stage, or can be left to RAN2 dsicussion. **Is this the correct understanding?**  If yes, then we can go with moderator’s approach for progress. In this case, we would like to update the proposal 1-1a as below.  Regarding the subcarrierSpacing and cyclicPrefix, one of the most attractive features of reusing BWP framework is forward compatibility. In the furture, different SCS may be assuemed for multicast and unicast. To keep this forward compatibility, we suggest to add a bullet for “Signaling of subcarrierSpacing and cyclicPrefix”.  Regarding the contents in brackets, we think it may be confusing. The signaling framework itself of PDSCH-Config for MBS may be the same as that for dedicated BWP, but the contents of PDSCH-Config for MBS may be the same as that for dedicated BWP. Based on this understanding, we update the word “different” to “separate”.  **[High] Proposal 1-1a**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs includes at least the following functionalities:   * Signaling of starting PRB and bandwidth * Signaling of one PDSCH-config for MBS (i.e., signaling of PDSCH-Config separate from that of dedicated BWP). * Signaling of one PDCCH-config for MBS (i.e., signaling of PDCCH-Config separate from that of dedicated BWP). * Signaling of SPS-config(s) for MBS (i.e., signaling of SPS-Config separate from that of dedicated BWP). * Signaling of subcarrierSpacing and cyclicPrefix   + Note: In Rel-17, the same subcarrierSpacing and cyclicPrefix are assumed for common frequency resource and dedicated BWP * FFS: Other IEs within BWP-Downlink. * FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP) * FFS signaling details. |
| Huawei, HiSilicon | Thanks FL for the efforts.  Regarding the new proposal 1-1a, it sounds like an attractive attempt to break through the deadlock. We can compromise to take this approach and hofully it can help us out.  **[High] Proposal 1-1a**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs includes at least the following functionalities:   * Signaling of starting PRB and bandwidth * Signaling of one PDSCH-config for MBS (i.e., signaling of PDSCH-Config different from that of dedicated BWP). * Signaling of one PDCCH-config for MBS (i.e., signaling of PDCCH-Config different from that of dedicated BWP). * Signaling of SPS-config(s) for MBS (i.e., signaling of SPS-Config different from that of dedicated BWP). * FFS: Other IEs within BWP-Downlink. * FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP) * FFS signaling details. |
| Ericsson | We thank the FL for the constructive proposal, but think this proposal is going into too much detail, before resolving the high-level issues with 2A/2B.  We are neutral to 2A/2B and would like to suggest a possible way forward. We have therefore tried to merge 2A/2B by taking the starting point is that in both variants one could say that a BWP can be configured with a CFR. This BWP may either be the unicast BWP or another (“MBS”) BWP.  **(E/// updated) Propsal 1-1a:**   1. A BWP can be configured with a Common Frequency Resource (CFR)    * Comment: The BWP may either be an additional (“MBS”) BWP (2A) or the unicast BWP (2B) 2. The frequency range of the configured CFR covers by default the entire BWP (i.e. no additional frequency configuration is required), but can include an optional field to indicate a subset of the BWP. 3. A BWP configured with a CFR is also configured with one or more group-common PDCCH/PDSCHs 4. The configuration of each group-common PDCCH/PDSCH includes a bit, indicating whether the FDRA field should be interpreted according to the full BWP configuration (bit=0) or to the CFR, if smaller than the BWP, (bit=1).    * This allows for PDCCH/PDSCH to be used outside the CFR    * Alternatively, for a CFR smaller than the BWP, all group-common PDCCH/PDSCH could be assumed to have FDRA according to the CFR. With this, the additional bit is not required but there is less flexibility (no PDSCCH/PDSCH outside the CFR) 5. When a BWP, configured with a CFR, is contained within another BWP, and both BWPs use the same SCS and CP, a UE is excepted to have both BWPs active, i.e. without BWP switching.   A few nice things with the above is that:   1. It could satisfy both 2A and 2B proponents 2. It would still be a single solution 3. Possible to use with a single BWP and the CFR covering the entire BWP 4. The CFR is introduced as an additional possible configuration of a BWP. With this nothing is configured on the CFR as such, so the CFR never takes the role of a BWP, which would be confusing.   In addition, we support most of CATT’s comments, e.g. that RAN1 should not discuss how the signaling is done, which is up to RAN2 – only what it should achieve for the PHY. |
| Qualcomm | Thanks for FL’s efforts.  We think so far the discussion on MBS is focused too much on “names” and not on “functionality”. Detractors of option 2A keep bringing up “BWP switching”, when the intention is not to propose BWP switching (it would be a virtual BWP); while detractors of option 2B keep bringing up that we need some configuration apart from the bandwidth region, and we could reuse BWP for that. RAN1 should avoid going down the route where we completely design 2A and 2B, and then decide on it (very inefficient). So we agree with FL’s suggestion to focus on the functionality of the “common frequency resource” (CFR), which could be something in between options 2A and 2B, i.e., it may be less than a BWP, but more than a frequency region. We can discuss whether to need other functionalities and related indication later.  We support Proposal 1-1a with minor change of the wording to align with the agreement Proposal 1-1. Hope it is not controversial. **[High] Proposal 1-1a**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP, includes at least the following functionalities:   * Signaling of starting PRB and bandwidth * Signaling of one PDSCH-config for MBS (i.e., separate from the signaling of PDSCH-Config of the dedicated unicast BWP). * Signaling of one PDCCH-config for MBS (i.e., separate from the signaling of PDCCH-Config of the dedicated unicast BWP). * Signaling of SPS-config(s) for MBS (i.e., separate from the signaling of SPS-Config of the dedicated unicast BWP). * FFS: Other IEs within BWP-Downlink. * FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP) * FFS signaling details. |
| FUTUREWEI2 | We are appreciative of the efforts to drive towards a single approach. However, we did have an agreement for downselecting “• Down select from the two options for the common frequency resource for group-common PDCCH/ PDSCH”. If we focus on the revised proposal instead, then we should defer any discussion on 1-3, 1-4, 1-7 as you mentioned. The compromise is essentially to avoid the “terminology war” where 2A insists to call it a BWP and instead focus on the functionality. If Ericsson is indeed “neutral” to 2A and 2B, then the compromise main bullet should be fine (i.e., we do not call it a BWP). For the other suggestions from Ericsson, we note that number 4 seems is too detailed which we can avoid for now.  So overall we are generally OK with the FL compromise, and are also OK with the Qualcomm update. |
| Moderator | Very appreciated for all your comments and suggestions. I have updated the proposal based on companies’ comments.  Regarding Proposal 1-1a, the intention is to first reach a consensus on the functionalities of CFR, which may be acceptable for both proponents of option 2A and option 2B. Otherwise, we may be stuck by the names and can not make any progress. If the functionalities in proposal 1-1a are agreed, we can further discuss whether RAN1 still needs to down-select between option 2A and 2B, or it can be up to RAN2 design.  Some companies commented that RAN1 should not discuss the signalling.  My intention is just to explain the expected functionalities of CFR by borrowing and refering to the signaling and terminologies in the current BWP which are well-known to all. Based on companies’ comments, I deleted the word ‘signaling’ in the sub-bullets. Of course the final signaling design is up to RAN2, but before that RAN1 may also need to have some discussions on part of them, e.g., the method of indication for starting PRB and length of PRBs. So I think the last ‘FFS signaling details’ should be general enough.  ZTE suggests to add SCS and CP for forward compatibility and assumes Rel-17 only use the same numerology, but it seems not urgent to add SCS and CP in CFR right now if we do not want to support different numerologies in Rel-17, and it is not late to add them in next releases if companies agree to support different numerologies in the future. Based on this, I added “using the same numerology (SCS and CP)” in the main bullet and added “FFS whether different numerology (SCS and CP) can be used or not” in the sub-bullet. Companies can check if it is OK to have such an FFS here.  Regarding LG’s comments and proposal (see below) , I’m not sure if companies are OK to mix the design of RRC\_IDLE/INACTIVE and RRC\_CONNECTED together for now. Hope companies can also express their views on this.   * The CFR (common frequency resource) can be configured as either a MBS frequency region or an MBS specific BWP overlapped with the associated unicast/initial BWP based on network configuration:   + The MBS specific BWP is configured when the associated unicast BWP is wider than the associated unicast/initial BWP.   + The MBS frequency region is configured when the associated unicast BWP is smaller than or equal to the associated unicast/initial BWP.   + FFS: whether the MBS specific BWP not overlapped with the associated unicast/initial BWP is configured (only for broadcast).   Regarding Ericsson’s proposal (see below), I’m not sure it is acceptable for proponents of option 2A/2B. At least my understanding seems different from that ‘the BWP may either be an additional (“MBS”) BWP (2A) or the unicast BWP (2B)’. Hope companies can also express their views on this proposal.   1. A BWP can be configured with a Common Frequency Resource (CFR)    * Comment: The BWP may either be an additional (“MBS”) BWP (2A) or the unicast BWP (2B) 2. The frequency range of the configured CFR covers by default the entire BWP (i.e. no additional frequency configuration is required), but can include an optional field to indicate a subset of the BWP. 3. A BWP configured with a CFR is also configured with one or more group-common PDCCH/PDSCHs 4. The configuration of each group-common PDCCH/PDSCH includes a bit, indicating whether the FDRA field should be interpreted according to the full BWP configuration (bit=0) or to the CFR, if smaller than the BWP, (bit=1).    * This allows for PDCCH/PDSCH to be used outside the CFR    * Alternatively, for a CFR smaller than the BWP, all group-common PDCCH/PDSCH could be assumed to have FDRA according to the CFR. With this, the additional bit is not required but there is less flexibility (no PDSCCH/PDSCH outside the CFR) 5. When a BWP, configured with a CFR, is contained within another BWP, and both BWPs use the same SCS and CP, a UE is excepted to have both BWPs active, i.e. without BWP switching.   Regarding proposal 1-3~1-7, we can defer the discussions to wait for a decision on proposal 1-1a. |

## Updated Proposals (3rd round of email discussion)

**[High] Updated Proposal 1-1a**:

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

* ~~Signaling of~~ starting PRB and ~~bandwidth~~ the length of PRBs
* ~~Signaling of~~ one PDSCH-config for MBS (i.e., ~~signaling of~~ separate from the PDSCH-Config ~~different from that~~ of the dedicated unicast BWP).
* ~~Signaling of~~ one PDCCH-config for MBS (i.e., ~~signaling of~~ separate from the PDCCH-Config ~~different from that~~ of the dedicated unicast BWP).
* ~~Signaling of~~ SPS-config(s) for MBS (i.e., ~~signaling of~~ separate from the SPS-Config ~~different from that~~ of the dedicated unicast BWP).
* ~~FFS: Other IEs within BWP-Downlink.~~
* FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP)
* FFS whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP
* FFS signaling details.

## Company Views (4th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |  |
| --- | --- | --- |
| **Company** | **Comment** | |
| Spreadtrum | Thanks for Moderator’s great effort on harmonizing to move forward.  We share the same view with other companies, to defiene/clarify the commom function for option 2A/option2B may be one way to break the current deadlock. In our understanding, how to configure the signaling is up to RAN2, and in RAN1 we should focus on the function. Thus, we suggest to add the following note:  Note: The terminology of CFR is only aiming for RAN1 discussion, and how to configure is up to RAN2. | |
| OPPO | Firtly, we believe the details in this proposal is needed only for Option 2B, for Option 2A, as CFR is defined as a BWP, starting PRB, length of PRBs, PDCCH/PDSCH configurations, e.t.c. are something a BWP has already had, to discuss and agree again is redundant.  If the proposal is only for Option 2B, “which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP)” in the main bullet and the first bullet should be removed, these have already been agreed. If the last bullet “FFS signaling details” is intended for “the method of indication for starting PRB and length of PRBs” only, this bullet should be removed as well.  Furthermore, “PDSCH-config”, “PDCCH-config”, and “SPS-config(s)” are IEs, seems they should not be called as “functionalities”.  As to the proposal from LG and Ericsson, as both of them are kind of mixture of Option 2A and Option 2B, which is against the agreement made last week, we disagree with them.  Last but not the least, it we add the contents in this proposal to Option 2B, seems Option 2A and Option 2B are essentially the same except the name, given that, we do agree with some other companies that it is inefficient to suspending on the downselection between the 2 options.  In general, we sugget the following:   * For definition of CFR Option 2B is selected, where the ‘MBS frequency region’ is regarded as a virtual BWP. * The ‘MBS frequency region’ is configured with following parameters separate from the respective parameters of the associated dedicated unicast BWP:   ~~From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes at least the following functionalities:~~   * ~~Signaling of starting PRB and bandwidth the length of PRBs~~ * ~~Signaling of~~ Parameters as that in PDSCH-config ~~for MBS (i.e., signaling of separate from the PDSCH-Config different from that of the dedicated unicast BWP)~~. * ~~Signaling of~~ Parameters as that in PDCCH-config ~~for MBS (i.e., signaling of separate from the PDCCH-Config different from that of the dedicated unicast BWP)~~. * ~~Signaling of~~ Parameters as that in SPS-config(s) ~~for MBS (i.e., signaling of separate from the SPS-Config different from that of the dedicated unicast BWP)~~. * ~~FFS: Other IEs within BWP-Downlink.~~ * FFS ~~if~~ other parameter(s) ~~functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP).~~ * FFS whether the numerology (SCS and CP) of ‘MBS frequency region’~~CFR~~ can be different from that of the dedicated unicast BWP * ~~FFS signaling details.~~ | |
| ZTE | We are generally ok with the FL proposal with the following modifications, i.e., to move the “same numerology (SCS and CP)” in the sub-bullet and make the “FFS different SCS…” as a sub-sub-bullet of it.  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP ~~and using the same numerology (SCS and CP)~~, includes ~~at least~~ the following functionalities:   * ~~Signaling of~~ starting PRB and ~~bandwidth~~ the length of PRBs * ~~Signaling of~~ one PDSCH-config for MBS (i.e., ~~signaling of~~ separate from the PDSCH-Config ~~different from that~~ of the dedicated unicast BWP). * ~~Signaling of~~ one PDCCH-config for MBS (i.e., ~~signaling of~~ separate from the PDCCH-Config ~~different from that~~ of the dedicated unicast BWP). * ~~Signaling of~~ SPS-config(s) for MBS (i.e., ~~signaling of~~ separate from the SPS-Config ~~different from that~~ of the dedicated unicast BWP). * Same numerology (SCS and CP) as the decicated unicast BWP.   + FFS whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP * ~~FFS: Other IEs within BWP-Downlink.~~ * FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP) * ~~FFS whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP~~ * FFS signaling details. | |
| Lenovo, Motorola Mobility | We support FL’s proposal.  We also have concern on the case that CFR has different numerologies to the associated dedicated BWP. If this case is supported, it implies that the CFR is on another BWP different to the associated dedicated BWP. It is no dout that the BWP switching will have to be performed when receiving DL unicast and MBS. So we don’t think this case. | |
| CMCC | Support. | |
| Apple | We understand the intention of this proposal is to avoid parallel discussion on option 2A and option 2B. If the concept of CFR is agreed, the following discussion would be easier for everybody. From this point, we support this proposal. we would like to add a new bullet, FFS the COREST for CFR. | |
| LG | We are generally fine with the updated proposal. But, we could also consider the case that CFR is wider than and overlapped with the dedicated unicast BWP or the initial BWP. So, we propose to change to:  From RAN1 perspective, if CFR is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, ~~which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP),~~ includes ~~at least~~ the following functionalities: | |
| CATT | Thanks Moderator for the great effort on the discussion.  We are generally OK with the compromised proposal above, however we still have concerns on two sub-bullets:   * Different numerologies: the main bullet is limited it as same numerology between MBS CFR and the related dedicated unicast BWP. A sub-bullet with “different numerologies” here is not appropriate. As it also mentioned by other companies, it is not supported based on Rel-15/16 NR BWP technology that one BWP supports more than one numerologies. This sub-bullet should be removed from this proposal. Furthermore, the main bullet should keep the definition of “using the same numerology (SCS and CP)” to make this proposal and further design in physical layer clear. * Last sub-bullet: it can be updated to “FFS ~~signaling~~other details”. Similar with the comments on the other sub-bullets about the “signaling” designs/discussions in physical layers. The discussion in RAN1 should be focused on physical layer design, and the corresponding signaling design can be done by RAN2 based on RAN1’s agreements. If there is something needed to be determined by RAN1, “FFS ~~signaling~~other details” does not preclude any further discussion.   The last two sub-bullets can be updated as:   * ~~FFS whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP~~ * FFS ~~signaling~~ other details. | |
| MTK | We are generally fine with the updated proposal. About the FFS “whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP”, from our perspective, if it is supported for MBS capable UE, it definitely needs BWP switching and is not desirable to receive unicast and multicast services simultaneously. So, we suggest to delete this FFS. Besides, we prefer to add a FFS whether to support more than one common frequency resources as listed in previous version for clarifying the CFR number.  **[High] Updated Proposal 1-1a**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes ~~at least~~ the following functionalities:   * ~~Signaling of~~ starting PRB and ~~bandwidth~~ the length of PRBs * ~~Signaling of~~ one PDSCH-config for MBS (i.e., ~~signaling of~~ separate from the PDSCH-Config ~~different from that~~ of the dedicated unicast BWP). * ~~Signaling of~~ one PDCCH-config for MBS (i.e., ~~signaling of~~ separate from the PDCCH-Config ~~different from that~~ of the dedicated unicast BWP). * ~~Signaling of~~ SPS-config(s) for MBS (i.e., ~~signaling of~~ separate from the SPS-Config ~~different from that~~ of the dedicated unicast BWP). * ~~FFS: Other IEs within BWP-Downlink.~~ * FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP) * ~~FFS whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP~~ * FFS whether to support more than one common frequency resources per UE / per dedicated unicast BWP subjected to UE capabilities * FFS signaling details. | |
| Huawei, HiSilicon | Support the proposal.  The numerology should be the same for CFR and unicast BWP, no reason to keep it “if” or even FFS different numerogies. Forward compatibility should not be an argument, it is more important to have a simple and workable MBS feature specified in Rel-17 for commercial success. | |
| Nokia, NSB | We are generally fine with the updated proposal, however we share some of the concerns that OPPO have raised, specifically:  (1) What is the meaning of starting PRB and length of PRBs with a separate BWP for Option 2A?  (2) For option 2A does the FFS regarding SCS and CP numerology still apply.  We would also propose a minor modification for the main proposal, since we think that it should be related to the *configurations* for CFR:  *From RAN1 perspective, the configurations for the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes ~~at least~~ the following functionalities: …* | |
| Vivo | In general support the proposal. The previous agreement that the applicability w.r.t to option 2A/2B is FFS for PTM scheme 2 | |
| Qualcomm | We support FL’s proposal 1-1a.  For the comments from OPPO, we think those functionalities, if not contradictory for both Option 2A and 2B, can be agreed first. How to name it can be the next step.  For the comment from MTK, we think the added FFS is a different issue, which can be discussed separately. | |
| FUTUREWEI4 | In general, we support the proposal. We share similar concerns as other companies regarding the “FFS whether the numerology (SCS and CP) of CFR can be different from that of the dedicated unicast BWP”. The CFR should have the same SCS and SP as the unicast BWP. | |
| Samsung | Agree | |
| Ericsson | If the intention is to find a solution that somehow captures both 2A and 2B then we think it is essential to be very clear what the used concepts mean. One should then use the term CFR in such a way that it has the same meaning in both cases, 2A and 2B. With the current proposal CFR must however be interpreted in different ways - a BWP (2A) or a frequency range (2B) - depending on whether 2A and 2B are intended.  If the intention, on the other hand, is to finally choose *one* of the options 2A and 2B, it may also be important not to hide differences but to be clear about them, e.g. that an additional BWP is used in 2A but not in 2B. We do not see the value in hiding the options – it is better to clearly define them.  We do not see how an agreement on (current) Proposal 1-1a helps in selecting between 2A and 2B! | |
| Moderator | I provided two versions bellow for the updated proposal 1-1a.  The first version is almost the same as the previous one that was discussed in the 4th round, but there are three different parts as shown in the tracking mode.   * The first one is that we changed ‘functionalities’ in the main bullet to ‘configurations’ based on companies’ comments. * The second one is that we deleted the last three FFS points, and use ‘FFS other configurations and details’ to make it more general. * Lastly, we added a note per some companies’ comments to explain that the terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2.   The first version intends to first reach a consensus on the functionalities of CFR, and to avoid being stuck by the names of option 2A and 2B. Whether RAN1 still needs to down-select between option 2A and 2B can be further discussed later or it can be up to RAN2 design.  The second version is to select option 2B first (the first bullet and the first sub-bullet are basically the same as that in the previous agreement), and further clarifies that ‘MBS frequency region’ in option 2B also includes the listed configurations which are the same as in the first version. Basically, in this version, the CFR is identical to ‘MBS frequency region’.  Essentially, there is no difference between these two versions. I think we can choose either one of them to make some progress as soon as possible. Considering that some companies prefer to clearly make down-selection between option 2A and 2B. I want to check with companies whether you are also OK for the second version. You can express you views in the summary or directly in this email thread. Companies can continue their discussion on the other proposals in the summary, and I will update them later.  **[High] Updated Proposal 1-1a (ver-1)**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes the following configurations:   * starting PRB and the length of PRBs * one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP) * one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP) * SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP) * FFS other configurations and details * Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2   **[High] Updated Proposal 1-1a (ver-2)**:  Option 2B is selected for common frequency resource (CFR) for group-common PDCCH/ PDSCH   * Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within a dedicated unicast BWP   + FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region * From RAN1 perspective, besides the starting PRB and the length of PRBs, the ‘MBS frequency region’ also includes the following configurations:   + one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP).   + one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP).   + SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP).   + FFS other configurations and details * Note: The terminology of CFR/‘MBS frequency region’ is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2 | |
| LG | We are not OK with ver-2. We think that the option of the common frequency resource should be holistically applied to all RRC states and both multicast and broadcast.  RAN2 recently agreed that connected UEs can also receive broadcast.   * Both idle/inactive UEs and connected mode UEs can receive MBS services transmitted by NR MBS delivery mode 2 (Broadcast service as already agreed, TBD other). The ability for connected mode UEs to receive this may depend on the network provisioning of the service (e.g. which freq), UE connected mode configuration and UE capabilities. * Assume it is possible to reuse LTE SC-PTM mechanism for the CONNECTED UEs to receive the PTM configuration for NR MBS delivery mode 2, i.e. broadcast based manner.   Since RAN1 previously agreed that 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. In addition, 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.   Therefore, connected UEs can receive broadcast from initial DL BWP or the specific common frequency received by idle/inactive UEs.  Meanwhile, in [104-e-NR-MBS-03] AI 8.12.3, RAN1 is discussing the case where the BWP may be a configured BWP different than the initial BWP. We think that the configured BWP seems not same as Option 2B. Thus, we wonder if propenents of Option 2B think different options between multicast and broadcast for CFR. If they pursue different options for different delivery modes, what is a benefit of using different options for different delivery modes?  Accordingly, **we are not OK with ver-2. But, we are OK with ver-1 for progress. We also want to add the following FFS for Updated Proposal 1-1a:**   * FFS: whether the CFR option is aligned between multicast and broadcast. | |
| ZTE | Thanks moderator for the great effort. From our perspective, Updated Proposal 1-1a (ver-1) is preferred. ver-2 is basically Option 2B, which will lead to the discussion of Option2A vs Option 2B again, which is better to be avoided. | |
| Lenovo, Motorola Mobility | We support ver-2. | |
| Spreadtrum | Fine with ver-1. Ver-2 will draw us back into endless discsussion of Option2A vs. Option2B. | |
| CATT | Thanks moderator for the great effort on leading this discussion.  We support proposal 1-1a (ver-2) as the discussion starting point.  It seems no necessary to copy the agreements on option 2B below the main bullet to agree again. For the FFS part in the previous agreement, the starting PRB and length of PRBs can be another sub-bullet added below.  A updating suggestion on proposal 1-1a (ver-2) can be found as follows.  **[High] Updated Proposal 1-1a (ver-2)**:  Option 2B is selected for common frequency resource (CFR) for group-common PDCCH/ PDSCH   * ~~Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which is configured within a dedicated unicast BWP~~   + ~~FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region~~ * ~~From RAN1 perspective, besides the starting PRB and the length of PRBs, the ‘MBS frequency region’ also includes the following configurations:~~   + starting PRB and the length of PRBs   + one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP).   + one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP).   + SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP).   + FFS other configurations and details * Note: The terminology of CFR/‘MBS frequency region’ is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2 | |
| Apple | Ver-1 is preferred. We concerns the CORESET configuration limitation for Option 2B. | |
| TD Tech, Chengdu TD Tech | **Thank the FL for the great effort for proposal 1. We agree with the proposal below.**  **[High] Updated Proposal 1-1a (ver-1)**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes the following configurations:   * starting PRB and the length of PRBs * one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP) * one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP) * SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP) * FFS other configurations and details * Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2 | |
| OPPO | We support Ver-2.  For Ver-1:   * If companies’ intendtion is to down select to Option 2A, this ver-1 proposal is completely redundant, as the it gives nothing more than a BWP orginally has. * If compnaies’ intention is to use CFR in the proposal to replace Option 2A and Option 2B, i.e. the CFR is not named as BWP, then the agreement made in last week would be reverted, and in this case, the only difference between Ver-1 and Ver-2 is the name. We do not think it is advisable to revert an agreement just for name. | |
| MTK | We support **Updated Proposal 1-1a (ver-2)**. Since we have an agreement about the concept of Option 2B, there is no need to copy it aganin. CATT’s suggestion is fine for us. | |
| Qualcomm | We prefer ver-1, where the intention is to list the **essential common functionalities** for both option 2A and 2B. To answer OPPO’s comment, you said ver-1 is redundant but at least not contradictory to agree ver-1 if Option 2A is selected in future, isn’t it? If so, it is not reverting an agreement to my understanding. Whehter to down-select 2A or 2B is dependend on other details, e.g., whether other BWP parameters/functionalities are needed or not, which we can discuss further. | |
| Nokia, NSB | | It is our understanding that one of the most important goals of defining the common frequency resource is to enable the UE to interpret the GC-PDCCH / DCI in the context of UE-dedicated BWP – within which the CFR is confined, along with other parameters mentioned in both ver-1 and ver-2. Taking all these factors into account, in the interest of progress and reaching an agreement related to CFR during this meeting, we would like to support **Updated Proposal 1-1a (ver-1)**. |
| Convida | | We share the similar view with LG and we think option 2 is not preferred. We also support LG’s proposal on adding a sub-bullet on ‘FFS whether CFR option is aligned between multicast and broadcast’. |
| Ericsson | | We disagree with **[High] Updated Proposal 1-1a (ver-1)**: for several reasons:   1. The proposal is mainly written from a 2B perspective, e.g. “FFS if other functionality of BWP is applicable to CFR (e.g. whether a CSI-RS can be associated to a CFR instead to a BWP)” implies that the CFR is not a BWP, so 2B. 2. With legacy one can configure things on a BWP, that is the existing mechanism. We strongly think this principle should be maintained. We should not go into configuring some “BWP-like” thing such as a CFR (when used in the 2B sense). However, from a 2A perspective, since the MBS BWP is a BWP it is configured as normal. It is therefore virtually impossible to have a 2A/2B neutral description. We believe the selection must first be made between whether a BWP is used or not for the CFR. This is a fundamental and binary decision. 3. We think “includes the following functionalities” should be “**can** include the following functionalities”, since not all of them are always needed, e.g. when the unicast configuration is reused.   Regarding **[High] Updated Proposal 1-1a (ver-2) w**e are fine with agreeing on 2B, but only with some changes of the current proposal, see below:  **[High] Updated Proposal 1-1a (ver-2)**  Option 2B is selected for common frequency resource (CFR) for group-common PDCCH/ PDSCH   * Option 2B: The common frequency resource is defined as an ‘MBS frequency region’ with a number of contiguous PRBs, which ~~is~~ can be configured within a dedicated unicast BWP   + FFS: How to indicate the starting PRB and the length of PRBs of the MBS frequency region * From RAN1 perspective, besides the starting PRB and the length of PRBs, the ~~‘MBS frequency region’ also~~ unicast BWP can also include~~s~~ the following configurations:   + one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP).   + one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP).   + SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP).   + FFS other configurations and details * Note: The terminology of CFR/‘MBS frequency region’ is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2   The first change (“can be” instead of “is”) is to indicate that the CFR is optional.  The second one (“unicast BWP…) is to indicate that the mentioned aspects are configured on a BWP (not a CFR), in line with how these are configured on BWPs in legacy. We should avoid creating a framework of configuring the CFR as such, since this would introduce a completely new type of configuration.  The third one (“can also”) is to indicate that the new configurations (beyond the configuration of CFR itself) are optional.  We support the possibility to use separate MBS configurations from unicast, but think that in many cases the same configuration as for unicast can be used.  From Ericsson we are open both to 2A and 2B, but for both it applies that the CFR needs to be optional, the configuration structure should be kept (i.e. configuration is on BWPs not on non-BWP CFRs) and that it should be possible to reuse the the unicast configurations.  Regarding 2A, the main (only?) obstacle has been that it might require BWP switching of UEs, which of course is not acceptable. However, with 2A the UE may have two active BWPs with no complexity penalty compared with 2B. Support of two active BWPs, for this use case, is also something RAN1 can decide on alone. If that is true, 2A appears superior since it can resuse existing BWP framework and virtually no additional standardization is needed to support the CFR use case. It seems to us that the resistance against 2A is based on a misunderstanding. |
| FUTUREWEI5 | | ver-1 is ok |
| Intel | | Ver-2 is ok for us. Regarding common reception with RRC\_IDLE mode UEs during broadcast, we think Option 2B can work with current discussion in 8.12.3 since the discussion there focuses around the BWP within which the CFR is defined. The CFR can also include CORESET configuration as per ver-2. |
| Moderator | | Thanks for all your comments and suggestions.  Based on the comments so far, regarding1-1a(ver-1), 15 companies can accept it, although some of them may prefer 1-1a(ver-2). It seems OPPO and Ericsson still have concern on it.  Regarding 1-1a(ver-2), it seems most proponents of Option 2A cannot accept it, and it will draw us back to the down-selection of option 2A and option 2B. Ericsson also has different understanding on 1-1a(ver-2). Regarding Ericsson’s update on 1-1a(ver-2), I will further explain my understanding bellow.  Regarding OPPO’s comments that “this ver-1 proposal is completely redundant, as it gives nothing more than a BWP orginally has.”. As I explained previously, this 1-1a(ver-1) aims to list the functionalities of the CFR. For both option 2A and option 2B, these functionalities are needed for the CFR. As you also said, it is obvious that the CFR in option 2A (‘MBS specific BWP’) originally has these functionalities. For the CFR in option 2B (‘MBS frequency region’), these configurations are also needed, that is also the intention of the previous proposal 1-3. Besides these common functionalities of the CFR, the left in option 2A and option 2B is mainly the difference between the names of the CFR, and the controversial BWP switching issue caused by the name of ‘BWP’. From moderator point of view, it seems it is more important to have a consensus on the functionalities of the CFR, which is needed for both option 2A and option 2B. Then, RAN1 can continue discussing other physical layer designs for MBS with the term ‘CFR’. Regarding the down-selection of option 2A and 2B, I agree with Qualcomm that it may also dependent on whether other configurations in the BWP are also needed for the CFR. The final down-selection of Option 2A and 2B and the detailed signaling design for CFR can be up to RAN2 decision as long as RAN1 is clear about the functionalities of the CFR. I do not think the current proposal 1-1a(ver-1) is contradictory with previous agreement.  Regarding Ericsson’s comments on 1-1a(ver-1), my response is the same as above.  Regarding Ericsson’s comments and updates on 1-1a(ver-2), I think basically you are still saying that the CFR is optional, since the second main bullet in your updated version aims to be also applicable for the case that the CFR is not configured. I know that you have different thinking from 1-1a(ver-2) regarding whether the configurations of GC-PDCCH/GC-PDSCH are configured in the CFR or in the dedicated unicast BWP, but at least we need to check if companies are OK with how the configurations of GC-PDCCH/GC-PDSCH is configured under the case when CFR is not configured you proposed. I’m not sure whether the following proposal reflects your original intention. Considering this proposal has impacts on the discussion of proposal 1-1a, and we indeed have an FFS saying that whether the use of CFR is optional or not, and many companies also do not quite understand how can the CFR be optional, I think it would be better that companies can also express their views whether such a proposal is acceptable.  Proposal 1-8: The use of a CFR is optional for multicast of RRC-CONNECTED UEs   * If the CFR is not configured for a dedicated unicast BWP, the dedicated unicast BWP can also include the following configurations:   + one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP).   + one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP).   + SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP).   + FFS other configurations and details   @Nokia, I share the same view as you regarding the following “It is our understanding that one of the most important goals of defining the common frequency resource is to enable the UE to interpret the GC-PDCCH / DCI in the context of UE-dedicated BWP – within which the CFR is confined, along with other parameters mentioned in both ver-1 and ver-2.”  Based on current situation and considering the majority view, I still recommend to try to first agree Proposal 1-1a (ver-1) (Copied bellow with an FFS added per LG’s comments. @LG, please check if it is OK). Otherwise, the only way left for us is that we need to parallelly discuss and complete the option 2A (e.g., we need to reach a consensus on the proposal 1-7 as soon as possible) and 2B, and then we try to down-select between option 2A and option 2B, and we may also need to send LS to RAN4 if companies cannot reach consense on the understanding of option 2A. At the same time, a lot of other issues may not be discussed before we make the decision on the down-selection.  @OPPO@Ericsson, is it acceptable for you to have it as an working assumption?  **[High] Updated Proposal 1-1a (ver-1)**:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes the following configurations:   * starting PRB and the length of PRBs * one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP) * one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP) * SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP) * FFS other configurations and details * FFS whether a unified CFR design is used for RRC\_IDLE/INACTIVE and RRC\_CONNECTED * Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2   I also added a proposal 1-8 to also collect companies views on whether the use of the CFR is optional. |

## Updated Proposals (4th round of email discussion)

**[High] Updated Proposal 1-1a (ver-1)**:

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

* starting PRB and the length of PRBs
* one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP)
* one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP)
* SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP)
* FFS other configurations and details
* FFS whether a unified CFR design is used for RRC\_IDLE/INACTIVE and RRC\_CONNECTED
* Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2

**Initial Proposal 1-8:**

The use of a CFR is optional for multicast of RRC-CONNECTED Ues

* If the CFR is not configured for a dedicated unicast BWP, the dedicated unicast BWP can also include the following configurations:
  + one PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP).
  + one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP).
  + SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP).
  + FFS other configurations and details

## Company Views (5th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We are gerenally fine with Updated Proposal 1-1a (ver-1). However, it is unclear with new FFS in red because RRC\_IDLE/INACTIVE may not receive multicast. Thus, FFS in red can be changed to:   * FFS whether a unified CFR design is also used for broadcast received by RRC\_IDLE/INACTIVE and RRC\_CONNECTED   Regarding Initial Proposal 1-8, we think that the CFR is mandatory for MBS UE, because the configurations in Propsoal 1-8 are CFR configuration, i.e. CFR is a configured resource. But, some configuration of CFR could depend on UE capability. |
| OPPO | First of all, thanks FL for the detailed response. Then I assume that proposal 1-1a is not intended to revert the agreement achived in the last week, and the “CFR” in the proposal is not used to replace Option 2A and Option 2B, downselection between the 2 options are still needed. And the intention of the proposal is only to define a term for the discussion of other physical layer desgins (assuming there are).  If the understanding above is correct, I cannot understand why the proposal includes so many redundant contents, “common frequency resource” was agreed 2 meetings ago, and in the last week we agreed to down slect between Option 2A and 2B for the definition, based on these, arenot “which is confined within the frequency resource of a dedicated unicast BWP”, “using the same numerology (SCS and CP)”, and “starting PRB and the length of PRBs” something that have already been agreed? Why do we need to agree again. For the other bullets in the proposal, which are IEs included in BWP configuration, as some companies also said, they are also imlied by Option 2A. In the end, this proposal is only adding some details for Option 2B.  Furthermore, we do not think this proposal is helpful for downselection, the crux for downselection is whether Option 2A needs BWP switching or not, an agreement on configuration details cannot give an answer, we also do not think RAN2 can make the decision, as BWP switching is not RAN2’s expertise.  The FFS point added by LG is confusing for us, the CFR discussed in this agenda item is configured on dedicated unicast BWP, we are wondering how to apply this design to RRC\_IDLE/INACTIVE mode. |
| ZTE | Regarding proposal 1-8, from our view, configuring PDSCH-config/PDCCH-config/SPS for MBS basically means configuring a CFR. Note that CFR doesn’t only mean a frequency range, it also includes the corresponding configurations for MBS. |
| MTK | We are generally fine with **Updated Proposal 1-1a (ver-1)**.  Not support **Initial Proposal 1-8**, from our perspective, the CFR for muticast UE is mandatory. |
| Lenovo, Motorola Mobility | We are gerenally fine with Updated Proposal 1-1a (ver-1).  Regarding the newly added FFS, we are not sure which WG can decide whether a unified design for both connected and idle/inactive UEs. Is it RAN1 or RAN2?  For Proposal 1-8, we don’t support it. We share same views with other companies that CFR is mandatory for multicast/broadcast. |
| vivo | For [High] Updated Proposal 1-1a (ver-1), We are gerenally fine.  For Initial Proposal 1-8, we don’t support it. We think at least when UE is configured with any parameters of PDSCH-config for MBS, PDCCH-config for MBS, SPS-config(s) for MBS, UE has to be configured with CFR. |
| Apple | We are ok with Proposal 1-1a (ver-1) with LG’s update.  For proposal 1-8, I believe this option was already precluded in previous meeting, this is why we made working assumption on Option 2A and Option 2B, and confirmed in this meeting. |
| Ericsson | We agree with Proposal 1-8 and think this Proposal is the right way forward and should be considered first.  Let’s discuss the optionality and get the arguments on the table. If there are some hidden issues with making the CFR optional, then we will know about this and discuss these. If the discussion shows that there are no issues then we should be able to agree about having some basic configuration without CFR. Then the discussion could continue with what is needed in addition to support CFR. The discussion of CFR cannot be done without considering what is already available without CFR. We have so far not seen any arguments against making the CFR optional.  The need for the CFR arised from the use case with multiple BWPs having some common overlap, where the CFR would cover this overlap zone. For a use case with only a single unicast BWP there is no such need, so fundamentally there is no need to define a CFR in such cases. Nothing prevents configuring also MBS PDCCH/PDSCH on the unicast BWP without CFR. Of course, with an MBS BWP this BWP may have other characteristics than the unicast BWP, but if that is not needed for the use case it should be possible to use MBS without it, i.e. with no CFR.  For Proposal 1-8 we also suggest include, as an option, the possibility to configure the MBS functions (PDCCH, PDSCH, SPS) as part of their unicast counterpart.  We propose to delay discussions on Proposal 1-1a before the question of optionality has been sorted out. |
| CATT | **[High] Updated Proposal 1-1a (ver-1): OK.**  **Initial Proposal 1-8: NOT support.** |
| Nokia, NSB | **[High] Updated Proposal 1-1a (ver-1):** We are fine with this updated proposal and support it.  **Initial Proposal 1-8:** We agree with the views expressed by most of the other companies here and do not support the proposal. In the interest of progress, we are also fine with including the earlier FFS related to optionality of CFR.  As we mentioned earlier, we do not think CFR discussions originated from UEs having multiple BWPs configured, but rather due to the fact that each UE would have different UE-dedicated BWP configurations, in which the group-common PDSCH would be scheduled. We believe that without CFR, PTM scheme 1 will not work due to the different interpretation of GC-PDCCH FDRA field issue which has been discussed extensively earlier. The start PRB and length of PRBs for the CFR – defined in relation to UE-dedicated BWP would enable the UE to interpret the FDRA within GC-PDCCH DCI appropriately in the context of its own BWP. Due to these factors, we do not believe that CFR field is optional. However, with the FFS, the company interested in making this functionality optional can bring solutions during the next meeting highlighting how PTM scheme 1 would work in the context of currently defined UE-dedicated BWP.  Regarding Ericsson’s comment: “For a use case with only a single unicast BWP there is no such need, so fundamentally there is no need to define a CFR in such cases.”  For clarification, is the assumption here that all UEs would have the exact same unicast BWP configuration? If yes, is such an assumption valid for all scenarios – where different UEs would have different unicast traffic requirements / characteristics? |
| Ericsson | @Nokia: Either all UEs have the same unicast BWP configuration, in which case this may be reused for MBS. Or, with different unicast BWP configurations, but the same BW (frequency range) they can all use the same separate MBS configuration, without using a CFR. We agree that the first case has a limited use case, but can still happen and should be supported. The second use case is quite general.  We would like to stress that we do not propose to make UE support of CFR optional, only the use of CFR.  Below, we outline our understanding how we see the MBS configuration and the use of a CRF:  **Proposed framework for the configuration of MBS and CFR**  **Required functionality to support MBS without CFR**  In legacy NR, PDCCH/PDSCH/SPS are configured on the unicast BWP. Without involving a new concept like the CFR, the corresponding PDCCH/PDSCH/SPS for MBS may either reuse the unicast configurations (**Proposal 1-x1**) or use dedicated MBS configurations (**Proposal 1-x2**) configured on the same unicast BWP, using legacy mechanisms. Both types of configurations are straight-forward.  **Proposal 1-x1**  For the configuration of MBS on a unicast BWP the following configurations can be reused   * PDSCH-Configof the dedicated unicast BWP * PDCCH-Config of the dedicated unicast BWP * SPS-Config of the dedicated unicast BWP   Note: This applies for the case where all UEs have the same unicast BWP configuration  **Proposal 1-x2**  For the configuration of MBS on a BWP (unicast BWP or MBS BWP, if agreed) the following new configurations can be used   * one PDSCH-config for MBS (i.e separate from the PDSCH-Configof the dedicated unicast BWP). * one PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP). * SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP).   Note: With this all UEs may have different unicast BWP configurations, as long as they share the same BW, SCS and CP.  It should be noted that Proposal 1-x2 applies to both the unicast BWP (when no CFR is configured) and to the MBS BWP, when this is used. The configurations are the same in both cases, but on different BWPs. With 2A, this MBS-configured BWP is used in addition to the unicast BWP. The same BWP configuration functionality that is applicable for the unicast BWP, in the case of no CFR, is therefore also applicable for 2A, so nothing additional from a specification point of view is required for 2A, with Proposal 1-x2 as a basis, since the MBS BWP is just an ordinary BWP that happens to be configured according to Proposal 1-x2.  **Additional functionality to support CFR (2A or 2B)**  **Additional functionality to support 2A**  With 2A an MBS BWP is configured using Proposal 1-x2 above and contained within the unicast BWP. In addition, the following is required:  With 2A, a UE is expected to receive the unicast BWP and the MBS BWP simultaneously without BWP switching. This implies two active BWPs: the unicast BWP and the MBS MBW contained therein. Both BWPs use the same SCS and CP. This can be agreed by RAN1 alone.  Comment: The two active BWPs is everything that is needed on top of the basic (CFR ignorant) functionality.  **Additional functionality to support CFR – 2B**  With 2B, the unicast BWP is first configured according using Proposal 1-x1 or Proposal 1-x2 above.  In addition, the following configuration is required:  **Proposal 1-x3**  If 2B is agreed, for the configuration of MBS on a unicast BWP, a CFR can additionally be configured, indicating the frequency range of the CFR, which is a contiguous subset of the frequency range of the unicast BWP.   * The CFR is by the standard associated with all G-RNTIs configured on the unicast BWP. This means that any G-RNTI PDCCH that the UE detects will be interpreted (FDRA field) according to the CFR.   Comment: When MBS uses the full bandwidth of the unicast BWP there is no added value to use the CFR, so it does not need to be configured. |
| FUTUREWEI6 | Can accept 1-1a(ver-1). It is a way to get out of the stuck discussion on 2A vs 2B. We do not agree with Proposal 1-8. Forcing all of the UEs in the system to have the exact same BWP configuration just to optionally be able to avoid CFR seems like a corner case, we should work in the direction of using CFR. |
| Qualcomm | We support 1-1a (ver-1).  Regarding OPPO’s comment:   * “why the proposal includes so many redundant contents”: I think it is just to say which dedicated unicast BWP we are referring to when discussing the configuration of a CFR. It is the dedicated unicast BWP containing the CFR with same SCS/CP, rather than other ones. * “as some companies also said, they are also imlied by Option 2A. In the end, this proposal is only adding some details for Option 2B”: The proposal 1-1a is to find the common functionalities for both Option 2A and 2B. The next step would be to further discuss the different configuration(s) if any. * “whether Option 2A needs BWP switching or not, an agreement on configuration details cannot give an answer, we also do not think RAN2 can make the decision, as BWP switching is not RAN2’s expertise”: I agree with you RAN2 cannot make decision on this. I have similar view as Ericsson, “Support of two active BWPs, for this use case, is also something RAN1 can decide on alone”. RAN1 just need to define the association between MBS BWP (if supported) and unicast BWP. We can further discuss the details how to solve the crux in next meeting.   For 1-8, we think CFR configuration should be used to support MBS PTM transmission.   * As RAN1#102-e agreed, “For RRC\_CONNECTED UEs, define/configure common frequency resource for group-common PDSCH”. Our understanding is that CFR includes the GC-PDCCH/PDSCH configuration, i.e., the frequency size, pdsch/pdcch/sps configuration for MBS. The frequency size of CFR can be configured same or smaller than that of unicast BWP. It can be up to RAN2 twhether to define the default configuration of the CFR same as that of unicast BWP if CFR is not configured. * 1-8 seems to directly change the configuration of a dedicated unicast BWP, e.g., more than one pdsch-Config, more than one pdcch-Config, etc.. Not sure whether it would have impact on unicast transmission or not. If not, how to differentiate the configuration for unicast and MBS? Do we need to introduce RNTI-based pdsch-config, pdcch-config, sps-config?   Regarding the corner case, “For a use case with only a single unicast BWP there is no such need, so fundamentally there is no need to define a CFR in such cases.” If just say size of unicast BWP is same and other BWP-configurations are different per UE, the frequency size of CFR can be configured same as that of unicast BWP but keep other CFR-configurations separate from the unicast BWP. |
| Moderator | In the GTW session on 3rd Feb, the following agreement was made:  Agreement:  From RAN1 perspective, the CFR (common frequency resource) for multicast of RRC-CONNECTED UEs, which is confined within the frequency resource of a dedicated unicast BWP and using the same numerology (SCS and CP), includes the following configurations:   * Starting PRB and the number of PRBs * One PDSCH-config for MBS (i.e., separate from the PDSCH-Config of the dedicated unicast BWP) * One PDCCH-config for MBS (i.e., separate from the PDCCH-Config of the dedicated unicast BWP) * SPS-config(s) for MBS (i.e., separate from the SPS-Config of the dedicated unicast BWP) * FFS: Other configurations and details including whether signaling of starting PRB and the length of PRBs is needed when CFR is equal to the unicast BWP * FFS: Whether a unified CFR design is also used for broadcast reception for RRC\_IDLE/INACTIVE and RRC\_CONNECTED * FFS: Whether Coreset(s) for CFR in addition to existing Coresets in UE dedicated BWP is needed * Note: The terminology of CFR is only aiming for RAN1 discussion, and the detailed signaling design is up to RAN2 * Note: This agreement does not negate any previous agreements made on CFR   Then, we can revisit other suspended proposals. Basically, proposal 1-3 is covered by the above agreement. I think proposal 1-7 can be deferred unless companies prefer to further discuss in this meeting.  For proposal 1-4, I made an update as follows. Based on previous rounds of discussions, most companies think one CFR per dedicated unicast BWP is enough, but seems Qualcomm and vivo prefer to allow multiple CFRs per dedicated unicast BWP or defer this discussion. So I want to ask the group if we are OK to defer this discussion or you prefer to make the decision at this meeting.  **[Medium]Updated Proposal 1-4**:   * At most one CFR is configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.   + FFS whether more than one CFR can be configured per UE subject to UE capability |

## Updated Proposals (5th round of email discussion)

**[Medium]Updated Proposal 1-4**:

At most one CFR is configured per dedicated unicast BWP for multicast of RRC-CONNECTED UEs.

* FFS whether more than one CFR can be configured per UE subject to UE capability

## Company Views (6th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | Fine with the proposal. |
| LG | We are fine with the updated proposal. |
| Lenovo,Motorola Mobility | We are fine wth this proposal. |
| OPPO | We suggest to defer the proposal. |
| Huawei, HiSilicon | Support. |
| vivo | We prefer to defer the proposal.  As commented in previous round, we think whether more than one CFRs can be configured per dedicated BWP should further study. Sorry to copy the example:  UE1: interested in MBS service 1 which needs 60MHz  UE2: interested in MBS service 2 which needs 40MHz (different frequency location with MBS service 1)  UE3: interested in both MBS service 1 and MBS service 2  If only one CFR can be configured following the Updated Proposal 1-4, UE 1/2/3, a CFR with 100MHz is needed, which will make UE1 and UE2 have to be configured with a large dedicated BWP (100MHz). On the one hand, UE1 or UE2 may not have capability to support 100MHz. On the other hand, it will increase the power consumption of UE1 and UE2. In addition, it may lead the group-common DCI size larger for UE1 and UE2 comapring to separate CFR for MBS service 1 and service 2.  If more than one CFR can be configured per dedicated BWP based on UE capability, then gNB can configure CFR1 for MBS service 1, and CFR2 for MBS service 2. If group-common PDCCH is used for MBS scheduling, for UE3, it may need to decode DCI with two different sizes which can be based on UE capability. If UE-specific PDCCH is used for MBS scheduling, there is no DCI size issue, because CFR is narrow than UE dedicated BWP. For UE1 and UE2, they don’t have to be configured with a dedicated BWP with 100MHz and is befinical for UE power consumption. From UE perspecitive, we think it is very important to consider power saving. |
| MTK | We are fine with the main bullet. |
| CMCC | Support.  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. |
| Spreadtrum | Support |
| CATT | We only support the main bullet of this proposal. |

## Updated Proposals (6th 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. |
| Ericsson | Proposal 2-1: We disagree. Assuming PTM transmission scheme 1 will support ACK/NACK-based ReTx via PTM-1 or PTP anyway, we do not see enough additional value of also supporting PTM transmission scheme 2 for the initial transmission.  If anything in addition to PTM-1 is supported, we prefer the proposed generalized scheme of PTM-1/PTM-2 (PDCCH G-RNTIx scheduling PDSCH G-RNTIy), since this allows for a single PTM scheme covering both PTM-1 and PTM-2 as special cases and also a wide range of intermediate cases, with arbitrary size of the sub-groups, with no significant complexity.  Proposal 2-2: We agree  Proposal 2-3: We agree  Proposal 2-4: We disagree. We do not see enough benefit of using PTM-2 for retransmissions when both PTM-1 ReTx and PTP ReTx are possible.  Proposal 2-5: We agree |
| Convida | For proposal 2-1: we are OK with it.  For proposal 2-2: we are OK with the main bullet. However, for the meaning of the sub-bullet is not clear to us which needs to be further clarified.  For proposal 2-3: we are OK with it.  For proposal 2-4: we are OK with it.  For proposal 2-5: we are not sure about the proposal. We think further clarification and discussion is needed. |
| FUTUREWEI | Proposal 2-1: do not support the proposal  Proposal 2-2: support the proposal  Proposal 2-3: ok with the proposal  Proposal 2-4: ok with the proposal  Proposal 2-5: We share some of the concerns raised by LGE for proposal 2-5. It may be cleaner to leave the unicast capability and decide on the new additional HARQ capability for MBS. So we first suggest asking how many processes do we envision needing for MBS? |
| Intel | **Proposal 2-1:** This can be discussed once HARQ feedback schemes are agreed in 8.12.2 since the utility for PTM Scheme 2 is mainly when ACK/NACK based feedback is enabled. Otherwise it simply leads to high PDCCH overhead without obvious benefits.  **Proposal 2-2:** OK with Proposal  **Proposal 2-3:** The benefit for this proposal is not clear to us at this point. As with proposal 2-1, PTP is useful if ACK/NACK based feedback is supported for connected mode UEs.  **Proposal 2-4:** OK with proposal 4 if ACK/NACK based HARQ feedback is supported.  **Proposal 2-5:** Agree in principle. The wording “shared and split” in the first sub-bullet is not clear i.e., it may imply that there may be a semi-static splitting of HARQ process IDs between unicast and multicast. If this is the intention, then a separate option should be listed. Shared means 16 HARQ process IDs are used by unicast and multicast without any semi-static split. |
| Lenovo, Motorola Mobility | Proposal 2-2: We are OK with it.  Proposal 2-3: We don’t agree with it. For a given TB with initial transmission based on PTM 1, assuming it is retransmitted to a UE via PTP and to the group of UEs via PTM1, then the UE with PTP retransmission will receive two PDSCHs carrying same TB with same HARQ process ID while scheduled by different DCIs. The UE behavior is not clear. Furthermore, the frequency resource for retransmission is increased too much since some UEs are retransmitted in dedicated frequency resources besides of common frequency resource used for retransmission in PTM 1. The motivation is not quite clear.  Proposal 2-5: OK. |
| vivo | We are fine with the proposals.  For proposal 2-3: further study may be needed whether different retransmission schemes can be supported simultaneously for a UE. |
| Apple | Proposal 2-2, 2-3: Generally, we are ok with the proposals. it could be better to clarify the proposals are applied to HARQ ACK/NACK based feedback scheme. |
| Spreadtrum | Not support 2-1/2-4, we have not seen the necessary to support PTM2.  Not support 2-3, the use case and the benefit is not clear to us.  Fine with 2-2 and 2-5. |
| Nokia, NSB | Regarding **Proposal 2-1**: Agree with FL’s proposal, and with the opinions of CMCC on this topic.  Regarding **Proposal 2-2 and 2-3**: For simplicity, we would propose to combine these proposals into one proposal:  **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. * PTP and PTM retransmission can be used simultaneously for different UEs in the same MBS group.   While we see limited motivation for PTP based retransmission for a PTM transmission, we can agree with this proposal for the sake of progress.  Regarding **Proposal 2-4**: As mentioned in our contribution, we prefer reciprocal transmission / retransmission schemes, since we believe that it would be the simplest option. However, we do agree with CMCC’s motivation for introducing this proposal.  Regarding **Proposal 2-5**: Agree with FL’s proposal. |
| TD Tech & Chengdu TD Tech | **Our comments (TD Tech & Chengdu TD Tech)**  **Proposal 2-1**: We think there’s no need to support PTM transmission scheme 2 for initial transmission of MBS service in RRC\_CONNECTED state.  **Proposal 2-2**: We have a question here. If a UE needs to receive more than one MBS, the HARQ process ID and NDI in DCI format may be not enough for UE to identify the different MBSs. If the HARQ process IDs are shared by more than one MBSs and the unicast service of the UE, the existing HARQ process IDs may be not enough. The new field in DCI format is needed to indicate the different MBSs?  **Proposal 2-3**: We think the follow proposal can be discussed along with Proposal 2-2.  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**: We think the detailed benefits may be discussed for PTM scheme 2 before this proposal is taken.  **Proposal 2-5**: We think the split of the HARQ processes between the different MBSs and the unicast service need further clarification.  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. |
| vivo2 | **For Proposal 2-1:** support it with the following reasons.   1. PTM scheme 2 is easy to support ACK/NACK feedback which is import for MBS service with high Qos requirement. 2. PTM scheme 2 is easier to support multiple MBS services or support unicast and MBS service simultaneously which are supported in LTE.   Compared to PTM scheme 2, PTM scheme 1 has more specification impact and complexity to be address, especially when supporting ACK/NACK, support of simultaneous receptions of MBS and unicast and so on. And it is already being pointed out in FL’s summary both in 8.12.1 and 8.12.2. A table summarizing these is as follows,  **Table 1. Suvery of issues for PTM scheme 1 (yellow denotes it is being included in FL summary)**   |  |  |  |  | | --- | --- | --- | --- | |  | | PTM transmission scheme 1 | PTM transmission scheme 2 | | Search space set | | New CSS type is needed to be introduced, or modification for existing CSS type is needed.  Refer to issue #3 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | Impact on HARQ-ACK feedback | PUCCH resource | Need to address whether separate HARQ-ACK resource configuration from unicast resources is needed and how to configure and indicate these resources.  Refer to Proposal 2.2.1.1 in Huawei’s FL summary | Reuse the legacy mechanism, no additional issue | | HARQ-ACK feedback timing | Same timing, all UEs in an MBS group will feed back HARQ-ACK in the same slot, resulting PUCCH overload and collision | Reuse the legacy mechanism, no additional issue | | TPC | Difficult to indicate different UEs’ TPC using one single DCI | Reuse the legacy mechanism, no additional issue | | Support of simultaneous receptions of MBS and unicast  Or support of multiple MBS service | DAI | Separating DAI counting for group-common PDSCH and unicast PDSCH or separating DAI counting for different MBS services  New mechanism is needed.  Refer to Proposal 2.3.2.1 in Huawei’s FL summary | Reuse the legacy mechanism, no additional issue | | CORESET | If a UE supports multiple MBS services which potentially needs multiple common frequency resources, there would be no enough CORESETs considering the limitations of max of 3 CORESET per serving cell.  Refer to issue #3 proposal 3-1 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | DCI size budget | Since the FDRA is dependent on the CFR of each MBS service, DCI size for different for different MBS services may be different which will bring additional problem on DCI size budget of “3+1”  Refer to issue #3 proposal 3-3 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | BD/CCE | Blind decoding may be increased.  Refer to issue #3 proposal 3-2 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | Overbooking | Priority for SS set for MBS needs to be discussed for overbooking | Reuse the legacy mechanism, no additional issue |   **For proposal 2-2, 2-3**  PTP retransmission for PTM scheme 1 can only be supported when ACK/NACK is supported for PTM scheme 1. Retransmission of PTP should be low prioritized until ACK/NACK for PTM scheme 1 has a conclusion.  **For proposal 2-4**  Same as PTP retransmission, PTM scheme 2 retransmission for PTM scheme 1 can only be supported when ACK/NACK is supported for PTM scheme 1.  In addition, there are different combinations between initial transmission and retransmission. For initial transmission with PTM scheme 1, it can be   * Combination 1: PTM scheme 1 for initial transmission, PTM scheme 1 for retransmission * Combination 2: PTM scheme 1 for initial transmission, PTP for retransmission * Combination 3: PTM scheme 1 for initial transmission, PTM scheme 2 for retransmission   For combination 2, for the UEs which successfully received the initial transmission, they can discard the PDSCH for retransmission. When comparing combination 3 to combination 2, there seems no additional benefit.  **For proposal 2-5**  There seems to be a conflict between “shared” and “split”. We support “shared” between unicast and MBS. |
| Moderator | **Proposal 2-1:**  7 companies [MTK, Samsung, OPPO, Qualcomm, Ericsson, FUTUREWEI] have concern on this proposal, so we can deprioritize it for now.  **Proposal 2-2:**  Most companies are OK with this proposal.  OPPO suggest to suspend this proposal until HARQ feedback scheme for PTM scheme 1 is agreed. I think it does not matter to agree which first since companies can also argue that we need to first agree PTP retransmission before agree ACK/NACK based HARQ-ACK feedback.  MTK propose to add another option that the PTP retransmission with G-RNTI can use the same HARQ process ID with PTM scheme 1 transmission, I added an FFS for this in the updated proposal to see if companies are OK with it.  Nokia propose to combine proposal 2-2 and 2-3 to make progress, I’m not sure whether it is acceptable to others. If more companies propose this, we can try.  **Proposal 2-3:**  6 companies [MTK, Samsung, CATT, Lenovo, vivo, Spreadtrum] have concern on it, so we can deprioritize it for now.  Regarding Huawei’s comment, I want to clarify that proposal 2-3 first discuss whether PTM-1/PTP Re-Tx schemes can be used for different UEs in the same MBS group or not, and proposal 2-4 further discuss whether PTM-1/PTM-2/PTP Re-Tx schemes can be used for different UEs in the same MBS group or not if PTM-2 is further supported for Re-Tx.  **Proposal 2-4:**  7 companies [MTK, Samsung, OPPO, Qualcomm, Ericsson, Spreadtrum] have concern on this proposal, so we can deprioritize it for now.  **Proposal 2-5:**  Most companies are OK with this proposal.  Regarding Qualcomm’s clarification question, the answer is yes, and the proposal is updated to make it clear, and the 2nd sub-bullet is deleted for now.  2 companies [LG, Convida] are not sure about this proposal. FUTUREWEI suggest to discuss how many processes do we envision needing for MBS.  Based on Intel’s comment, I added an FFS, hope we can make some progress on this.  Based on LG and FUTUREWEI’s comments in 1st GTW session, the proposal was further updated to list two options for HARQ process management. |

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

**[Low] Updated 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)

**[High] Updated 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.
* FFS: whether G-RNTI can be used for PDCCH of PTP retransmission

**[Low] Updated 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.

**[Low] Updated 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

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

Regarding HARQ process management, the following two 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

## Company Views (2nd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We are fine with Proposal 2-2 and 2-3.  We are skeptical about benefits of PTM scheme 2.  Regarding Updated Proposal 2-5, we think that HARQ entity is related to RAN2 because HARQ entity modeling has been specified in MAC spec. Thus, we do not need to discuss whether to use same HARQ entity for MBS and unicast.  We think that RAN1 could focus on how to manage HPNs indicated in DCI for a UE receiving MBS and unicast regardless of whether HARQ entities are same or different. Thus, we propose to change to:   * Option 1: HPNs indicated by DCI are shared between MBS and unicast transmission~~, and a same HARQ entity is used by them~~ * Option 2: HPNs indicated by DCI are separated between MBS and unicast~~, and different HARQ entities are used for MBS and unicast,~~ respectively |
| Nokia, NSB | Proposal 2-1: Support, For DCI Alignment & reuse of UL feedback mechanisms.  Proposal 2-2: Support updated version  Proposal 2-3: Support  Proposal 2-4: Support  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.  Proposal 2-5: Support – we support having the time to consider the pros and cons of both options. |
| CMCC | We support the above proposals.  Regarding PTM scheme 2 using as initial transmission scheme, we think PTM scheme 1 may have some limitations in DCI size alignment procedure, which the G-RNTI PDCCH will impact the other PDCCHs’ detection performance. For example, if G-RNTI DCI size is counted in maximum “3”, 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. But for PTM transmission scheme 2, there is no additional DCI size alignment problem and PDCCH detection performance degradation.  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.  Regarding PTM scheme 2 using as re-transmission scheme, it can provide additional benefits over PTP transmitting for re-transmission in some scenarios to improve the PDSCH transmission efficiency since these UEs can share the same group-common PDSCH compared with PTM scheme 1. |
| Vivo | We suggest to make mark proposal 2-1as high priority.  We see quite a lot of specification impact for PTM scheme 1compared to scheme 2.  For example, the PTM scheme 2 does not need to address the followings in Table 2(which has already been identified as an issues for PTM scheme 1, and updated from Table 1 in our previous comment),  Based on that, we suggest the following changes,  **[High] Updated Proposal 2-1**: Support PTM transmission scheme 2 for initial transmission of MBS service in RRC\_CONNECTED state.   * [Reuse same DCI size for unicast and multicast scheduling] * [Keep the “3+1” DCI size budget defined in Rel-15 for Rel-17 MBS] * [for PTM scheme 2 scheduling multicast PDSCH, reuse the legacy FDRA/TDRA table for unicast] * FFS how to differentiate PTP transmission and PTM transmission scheme 2 for a UE, e.g., RNTI or added bit in scheduling DCI * FFS choice of retransmission scheme(s)   **Table 2. Suvery of issues for PTM scheme 1 (yellow denotes it is being included in FL summary)**   |  |  |  |  | | --- | --- | --- | --- | |  | | PTM transmission scheme 1 | PTM transmission scheme 2 | | Common frequency resource | | Need to down-select for option 2A/2B and further details needed.  Refer to issue#1 in CMCC’s FL summary. | Reuse the legacy mechanism, no additional issue.  No need to define CFR, the scheduling DCI used for scheduling MBS PDSCH can reuse the same DCI size and FDRA/TDRA table for unicast. | | Search space set | | New CSS type is needed to be introduced, or modification for existing CSS type is needed.  Refer to issue #3 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | Impact on HARQ-ACK feedback | PUCCH resource | Need to address whether separate HARQ-ACK resource configuration from unicast resources is needed and how to configure and indicate these resources.  Refer to Proposal 2.2.1.1 in Huawei’s FL summary | Reuse the legacy mechanism, no additional issue | | HARQ-ACK feedback timing | Same timing, all UEs in an MBS group will feed back HARQ-ACK in the same slot, resulting PUCCH overload and collision | Reuse the legacy mechanism, no additional issue | | TPC | Difficult to indicate different UEs’ TPC using one single DCI | Reuse the legacy mechanism, no additional issue | | Support of simultaneous receptions of MBS and unicast  Or support of multiple MBS service | DAI | Separating DAI counting for group-common PDSCH and unicast PDSCH or separating DAI counting for different MBS services  New mechanism is needed.  Refer to Proposal 2.3.2.1 in Huawei’s FL summary | Reuse the legacy mechanism, no additional issue | | CORESET | If a UE supports multiple MBS services which potentially needs multiple common frequency resources, there would be no enough CORESETs considering the limitations of max of 3 CORESET per serving cell.  Refer to issue #3 proposal 3-1 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | DCI size budget | Since the FDRA is dependent on the CFR of each MBS service, DCI size for different for different MBS services may be different which will bring additional problem on DCI size budget of “3+1”  Refer to issue #3 proposal 3-3 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | BD/CCE | Blind decoding may be increased.  Refer to issue #3 proposal 3-2 in CMCC’s FL summary | Reuse the legacy mechanism, no additional issue | | Overbooking | Priority for SS set for MBS needs to be discussed for overbooking | Reuse the legacy mechanism, no additional issue | |
| Samsung | Support both high priority proposals 2-2 and 2-5 (with option 1).  Do not support low priority proposals 2-1, 2-3 and 2-4 as there is no need and they will unnecessarily complicate MBS design. |
| ZTE | We support the updated Proposal 2-2 and Proposal 2-5. |
| Lenovo, Motorola Mobility | Proposal 2-2: Agree.  Proposal 2-5: Agree. |
| vivo | For Updated Proposal 2-2  We think it should be low priority until HARQ feedback scheme for PTM scheme 1 is agreed |
| OPPO | 2-2 and 2-5 are fine for us.  2-3 can provide more flexibility for gNB to retransmit a MBS TB to different UEs, it would not increase complexity at UE side as anyhow UE needs to support both. So we support this proposal.  For 2-1 and 2-4, we did see the benefit of PTM scheme 2 comparing to PTM scheme 1 and PTP. |
| Qualcomm | We support 2-2 and 2-3.  For 2-5, we think RAN1 should discuss whether UE can do HARQ combining between initial transmission based on PTM-1 and retransmission based on PTP or not. Unless same HARQ entity is used for PTM-1 and PTP, it is impossible to combine them. HPNs indicated in DCI can be same or different, dependent on the mapping relationship, which can be discussed later.  For 2-1 and 2-4, repeat our comment before that the PTM-2 definition is not clear to us. The current definition only say PTM-2 is used to schedule GC-PDSCH with G-RNTI. What about other parameters, e.g., PTM-2 will use unicast PDSCH config or multicast PDSCH config? We assume it will use multicast config, then the WA in Proposal 1-1 also applies to PTM-2. If not, probably we need better understanding the details of PTM-2. |
| CATT | **Proposal 2-2**: We support the previous proposal from FL in 1st round of discussion. For the sub-bullet FFS on G-RNTI PTP retransmission scheme, the motivation and potential benefit is still not quite clear to us. Because from perspective of per UE, it may the same for receiving PTM scheme 1 DCI (G-RNTI) and PTP DCI (if scrambled with G-RNTI), and the HPN and NDI should be the same for alignment. Furthermore, if the total number of HPNs are separately allocated to MBS services and unicast services, it seems only HPN and NDI are enough for the differentiation.  **Proposal 2-5**: Both two options are not clear to us and further clarifications are needed.   * What is the PHY layer impact by using same/different “HARQ entity”? * Option 1: totally 16 HPNs should supported by a UE? * Option 2: totally 32 HPNs (e.g. 16 for MBS service, and 16 for unicast services) should be supported by a UE? How about the buffer requirement? |
| MTK | Support the proposal 2-2.  We have noticed that CATT’s concern about FFS. We don't agree with CATT’s comments that “Furthermore, if the total number of HPNs are separately allocated to MBS services and unicast services, it seems only HPN and NDI are enough for the differentiation.” Assuming unicast and MBS have separate HPN (e.g., #0,#1,…,#7 for unicast and #8,#9,….#10 for multicast), if UE received unicast data with HPN #1 with C-RNTI all the time, how to differentiate the unicast data is legacy unicast transmission or multicast retransmission? Our solution is that if the retransmission data is for multicast services, the PDCCH is scrambled by GNTI, if the retransmission data is for legacy unicast, the PDCCH is scrambled by C-RNTI. But we are open for this proposal.  For proposal 2-5, we have the similar view with LG. we should focus on how to manage the HPNs within DCI. |
| Huawei, HiSilicon | Regarding proposal 2-2 FFS whether G-RNTI can be used for PDCCH of PTP retransmission, the answer clear to us is no. G-RNTI is shared among UEs, how can the DCI address PTP retransmission?  Regarding proposal 2-5, I guess option 1 intends to propose the HPN pool is shared and up to NW dynamically indicates a HPN number to unicast or multicast, so for a given HPN number, it is either allocated to unicast or multicast. Is it common understanding? For different HARQ entities in option 2, how to understand the “separate” then? |
| Apple | We are ok with updated proposal 2-2, 2-5. |
| FUTUREWEI | For proposal 2-2: we are okay. We are wondering how the G-RNTI can be used for unicast  For proposal 2-5: we are okay. We should decide what the maximum number of HARQ process is for MBS |
| Ericsson | Proposal 2-1: We disagree  Proposal 2-2: We agree, except the FFS. We do not see any issues with just using HARQ ID and NDI.  Proposal 2-3: We agree  Proposal 2-4: We disagree. PTM-2 does not add anything significant.  Proposal 2-5: We agree, with a preference for Option 1 – we do not see any benefit of Option 2, since the gNB may anyway – by implementation – restrict the allocation of HARQ processes according to Option 2. For the UE we do not see any advantages of having separate HARQ entities for PTM and PTP. |
| Convida | Proposal 2-1: We see the benefit of the PTM-2 for some use cases and suggest to not down-prioritize it.  Proposal 2-2: We are OK with it. For the FFS, we think using C-RNTI for PTP retransmission is a better solution.  Proposal 2-5: We are generally fine with the proposal. As commented or questioned by many other companies, we also think that further clarification is needed. |
| Intel | **Proposal 2-1:** We don’t see the motivation to use PTM Scheme 2 for initial transmissions.  **Proposal 2-2:** We think that using PTP or PTM Scheme 2 is mostly useful if ACK/NACK based HARQ feedback is agreed. For NACK only feedback, we do not think this is very useful. To this end, we would like to include the following “FFS: Applicability of PTP based retransmission when ACK/NACK based HARQ feedback is not configured”  **Proposal 2-3, 2-4:** The same comment as in proposal 2-2 hold here i.e., these retransmissions.  **Proposal 2-5:** This proposal does not clarify if the number of HARQ processes is kept unchanged or not. This is the first point to clarify since Option 1 or 2 can be dependent on this. Additionally, we are not sure that option 2 works when PTM scheme 1 based initial transmission needs to be combined with PTP or PTM Scheme 2 based retransmission. If number of HARQ processes are not changed, we think Option 2 has no apparent advantages other than reducing the flexibility of HARQ process allocation. MBS is expected to use limited number of HARQ process IDs and therefore Option 1 is more preferable. |
| Spreadtrum | **For clarification, if proposl 2-2 is supported, does it mean that option 1 in proposal 2-5 is supported by default?** |
| Moderator | **Proposal 2-1:**  Based on the request of vivo and Convida, I change the priority to high, and add three sub-bullets to help companies’ to understand it. But honestly, it seems still controversial.  **Proposal 2-2**  Based on comments from vivo and Intel, a condition “if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1” is added.  Based on comments from CATT, Huawei, Ericsson and Convida, I think the last FFS is controversial. MTK did not answer CATT’s comment that “Because from perspective of per UE, it may the same for receiving PTM scheme 1 DCI (G-RNTI) and PTP DCI (if scrambled with G-RNTI)”, and I also don’t know how to differenciate them.  **Proposal 2-5:**  I tend to agree with Qualcomm’s comment that RAN1 should discuss whether UE can do HARQ combining between initial transmission based on PTM-1 and retransmission based on PTP or not. Unless same HARQ entity is used for PTM-1 and PTP, it is impossible to combine them. The HARQ combining between PTM-1 and PTP re-tx depends on whether PTP re-tx is supported or not, i.e., proposal 2-2, so we can defer this discussion for updated proposal 2-5 (i.e., same HARQ entity or different HARQ entity).  Regarding FUTUREWEI’s comment that we should decide what’s the maximum number of HARQ process for MBS, since few companies have such kind of proposal, I’m not sure whether companies can decide it or not for now. Maybe we can first try the main bullet of the initial proposal 2-5, and add an FFS for the maximum number of HARQ process is for MBS. |

## Updated Proposals (2nd round of email discussion)

**[High] Updated Proposal 2-1**: Support PTM transmission scheme 2 for initial transmission of MBS service in RRC\_CONNECTED state. For PTM scheme 2,

* reuse the same DCI size for unicast and multicast with PTM scheme 2
* keep the “3+1” DCI size budget defined in Rel-15 unchanged
* reuse the legacy FDRA/TDRA table for unicast
* FFS how to differentiate PTP transmission and PTM transmission scheme 2 for a UE
* FFS choice of retransmission scheme(s)

**[High] Updated Proposal 2-2**: For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTP transmission.

* The HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB.
* ~~FFS: whether G-RNTI can be used for PDCCH of PTP retransmission~~

**[Low] Updated Proposal 2-3**: For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and 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.

**[Low] Updated Proposal 2-4**: For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTM scheme 2.

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

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

The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS

* FFS: the maximum number of HARQ processes used for MBS

## Company Views (3rd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | Ok with the updated proposals in general. |
| Lenovo, Motorola Mobility | Proposal 2-2: Agree.  Proposal 2-5: Agree. |
| Spreadtrum | support proposal 2-2, 2-5. |
| OPPO | 2-1: Our negative comments on PTM scheme 2 still hold. For the newly added first sub-bullet, I assme “PTM scheme 2” should be “PTM scheme 1”.  Agree with other proposals. |
| CATT | We are generally OK with proposal 2-1/2-1/2-5. |
| LG | We are fine with the updated proposal 2-2 and 2-3.  We think that it is early to decide Proposal 2-5 because we do not have clear understanding about how HARQ will work for MBS. |
| Nokia, NSB | Regarding **Proposal 2-1** we propose the following minor modification:  Support PTM transmission scheme 2 for initial transmission of MBS service in RRC\_CONNECTED state. For PTM scheme 2,   * reuse the same DCI size for unicast and multicast ~~with PTM scheme 2~~ * keep the “3+1” DCI size budget defined in Rel-15 unchanged * reuse the legacy FDRA/TDRA table for unicast * FFS how to differentiate PTP transmission and PTM transmission scheme 2 for a UE * FFS choice of retransmission scheme(s)   We are fine with the other updated proposals. |
| Samsung | **NOT** support 2-1 with following reasons   * No benefit compared to PTM scheme 1 since it requires huge control channel resources and even bigger if the number if larger * PTM scheme 1 can also reuse same DCI budget, FDRA/TDRA table because no difference between common (MBS) DCI and UE-specific DCI to a UE in the perspective of search space design. * Regarding HARQ-ACK resource issue, we think that Rel-16 URLLC design could be reused as much as possible by assuming, for example, eMBB PUCCH as unicast and URLLC PUCCH as multicast, or vice versa. |
| Ericsson | Proposal 2-1: We disagree both with the content and the priority of the proposal. We think PTM-2 should be of low priority.  We can however reconsider PTM-2 type functionality if it is merged with PTM-1 according to the proposed single generalized PTM scheme (PDCCH G-RNTIx scheduling PDSCH G-RNTIy), which covers both PTM-1 and PTM-2 in a simple way and also allows for much more flexibility than PTM-1 + PTM-2, without any significant specification or implementation complexity, see R1-2101726.  Proposal 2-2: We agree.  Proposal 2-3: We agree with the proposal and also with the low priority.  Proposal 2-4: We disagree with the content, but agree with the low priority.  Proposal 2-5: We agree with the proposal, but think the FFS should be removed, since the allocation of HARQ processes between MBS and unicast is dealt with in 8.12.2. |
| MTK | For proposal 2-2, thanks for other companies’ clarification, we agree with the current modification with deleting the second bullet.  Proposal 2-5: we are fine with this proposal. About the HARQ process number for MBS, we prefer that it’s up to NW configuration. |
| Vivo | For proposal 2-1, we are fine with Nokia’s update.  Thanks for Samsung’s commnets. Please see my reply as following:   * [Samsung] No benefit compared to PTM scheme 1 since it requires huge control channel resources and even bigger if the number if larger   + [vivo] Regarding the benefits, we gave a table in our 1st round comment, we can find that compared to PTM scheme 2, PTM scheme 1 has more specification impacts and complexity to be resolved.   In addition to that, PTM scheme 2 also has some other aspects outperform PTM scheme 1,   1. For PTM scheme 1, the group-common PDCCH does not have a UE-specific PRI field to flexibly indicate UE-specific PUCCH resource, comparing to PTM scheme 2 with UE-specifc PRI indication. Such restriction will result in PUCCH resources flagmentation. 2. As CMCC pointed out in the 1st round commnet, PTM scheme 1 will introduce additional DCI size alignment procedure and make other PDCCH detection performance degradation. But for PTM transmission scheme 2, there is no additional DCI size alignment problem and no PDCCH detection performance degradation.    * [vivo] Regarding the control channel resources issue, I think CMCC’s commnet copied below can slove your concern:  * 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.** * [Samsung] PTM scheme 1 can also reuse same DCI budget, FDRA/TDRA table because no difference between common (MBS) DCI and UE-specific DCI to a UE in the perspective of search space design.   + [vivo] Regarding the DCI budget perspecitive, the DCI size for group-common DCI is dependent on the group-common configurations, such as CFR, PDSCH-configMBS, etc. To keep the DCI size budget of “3+1” , as CMCC analysized that, for PTM scheme 1, if additional DCI size alignment procedure is needed, it will impact other UE’s PDCCH detection performance. But for PTM transmission scheme 2, there is no additional DCI size alignment problem and no PDCCH detection performance degradation in PTM transmission scheme 2, since the DCI size is determined per UE basis.   + [vivo] Regarding the FDRA/TDRA table, I think since the PDCCH is group-common, the FDRA/TDRA has to be group-common, otherwise, it means that the unicast BWP configuration or TDRA table configuration are identical among UEs within a MBS group. But for PTM schme 2, since the CFR is within all UE’s dedicated BWP, it can be up to gNB to indicate FDRA/TDRA based on per UE’s configuration. * [Samsung] Regarding HARQ-ACK resource issue, we think that Rel-16 URLLC design could be reused as much as possible by assuming, for example, eMBB PUCCH as unicast and URLLC PUCCH as multicast, or vice versa.   + [vivo] I guess you are talking about how to do multiplexing/prioritization for HARQ-ACK of multicast and unicast. Not sure your proposed mechanism can work. For PTM scheme 1, the group common PDCCH can only group-wisely indicate the priority of the HARQ-ACK for MBS. However, in some cases, the priority between eMBB and MBS service may be per UE basis. Then it is more appropoiate to adopt PTM scheme 2, i.e., UE-specific PDCCH to indicate the priority of HARQ-ACK for MBS for each UE.   + Moreover, how to flexibly indicate UE-specific PUCCH resource by one group-common PRI with a gourp-specific PRI is still unclear and may need more specification efforts. |
| Qualcomm | We think PTM-2 can be discussed but deprioritized. In the online discussion, vivo said PTM-2 do not need to use CFR, which we don’t understand yet. PTM-2 is to use unicast PDCCH to schedule GC-PDSCH. The parameters for GC-PDSCH should be common for the group of UEs. If GC-PDSCH can be different for the UEs, what is the difference between PTM-2 and PTP?  Also the DCI for PTM-2 needs to be changed, otherwise the UE cannot know the unicast PDCCP is to schedule unicast PDSCH or multicast GC-PDSCH. |
| FUTUREWEI2 | Proposal 2.2: ok  Proposal 2.5: our comment is still that we should decide what the maximum number of HARQ process is for MBS (e.g. 4) |
| Moderator | Regarding proposal 2-1, considering there are sustained objections from companies, I think further offline discussion is needed between two sides, and I will mark it as medium priority. We can focus on high priority proposals for now, but companies still can provide their comments and suggestions on proposal 2-1 if they are interested to do it.  Regarding 2-5, LG thinks it is too early to decide it. Ericsson suggests to delete the FFS part (i.e., the maximum number of HARQ processes for MBS). FUTUERWEI sustains that we should discuss the FFS part, while MTK thinks the maximum number of HARQ processes for MBS is up to network configuration. Considering different companies have different opinions on how to decide the maximum number of HARQ processes for MBS and few proposals were proposed for this, I think keep this FFS is still reasonable. Considering LG’s comment, I hope companies can express their views on whether we need to deprioritize this proposal. |

## Updated Proposals (3rd round of email discussion)

**[Medium] Updated Proposal 2-1**: Support PTM transmission scheme 2 for initial transmission of MBS service in RRC\_CONNECTED state. For PTM scheme 2,

* reuse the same DCI size for unicast and multicast ~~with PTM scheme 2~~
* keep the “3+1” DCI size budget defined in Rel-15 unchanged
* reuse the legacy FDRA/TDRA table for unicast
* FFS how to differentiate PTP transmission and PTM transmission scheme 2 for a UE
* FFS choice of retransmission scheme(s)

**[Low] Updated Proposal 2-3**: For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and 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.

**[Low] Updated Proposal 2-4**: For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTM scheme 2.

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

**[???] Updated Proposal 2-5**:

The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS

* FFS: the maximum number of HARQ processes used for MBS

## Company Views (4th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | Proposal 2-1: Not support. We have not seen the necessarity on top of PTP and PTM1.  Proposal 2-3: Not support. We have not seen the use case and benefit.  Proposal 2-4: Not support.  Proposal 2-5: Support. |
| OPPO | 2-1: if ACK/NACK based HARQ feedback is supported for PTM scheme 1, there is no need to support PTM scheme 2.  2-3: support the proposal, but agree to mark it as low priority.  2-4: disagree with the proposal, agree to mark it as low priority.  2-5: support the proposal, but it is fine for us to mark it as low priority such that companies can study it further. |
| Lenovo, Motorola Mobility | 2-5: support. |
| CMCC | **Updated Proposal 2-1**: Support this proposal.  @ Samsung, Spreadtrum, OPPO.  The advantages of PTM scheme 2 compared with PTM scheme 1 are:   1. No additional DCI size alignment procedure, which will not cause perfrormane degradation of other PDCCHs(e.g, unicast scheduling PDCCHs or DCI 2\_x series PDCCHs), In contrast, for PTM scheme 1, if G-RNTI DCI size is counted in “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 casue UE’s unicast DCI size shuld be aligned 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, this also cuases PDCCH performace degradation.   We want to listedn companies’s view **if there is a better solution to solve PDCCH perfrormane degradation in PTM scheme 1**?   1. More flexible to indicate per-UE HARQ-ACK feedback PUCCH resources, and has no restriction on RRC configuration. In comparion, it is up to RRC configuration of PUCCH indexes and k1 lists to guarantee PUCCH resources are orthogonal among UEs in one MBS group.   Regarding the PDCCH overhead, as we saied: **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.**  Regrading Qualcomm’s comment, please find our reply:  [Qualcomm]PTM-2 is to use unicast PDCCH to schedule GC-PDSCH. The parameters for GC-PDSCH should be common for the group of UEs. If GC-PDSCH can be different for the UEs, what is the difference between PTM-2 and PTP?  [CMCC] There is no need to define separate paramaters for GC-PDSCH in PTM scheme 2, even the UE-specific BWPs and TDRA tables are not totally same for different UEs, it is up to gNB’s implementation to schedule a same PDSCH for different UEs using multiple UE-specific DCIs. That is the GC-PDSCH are the same for different UEs, but the FDRA/TDRA fileds in DCIs are different because PTM scheme 2 uses UE-specific PDCCH.  [Qualcomm]Also the DCI for PTM-2 needs to be changed, otherwise the UE cannot know the unicast PDCCP is to schedule unicast PDSCH or multicast GC-PDSCH.  [CMCC] Addition bits in DCI is a way to differenciate the schudling PDSCH is GC-PDSCH or unicast PDSCH, i.e., DCI inidicates the scrambling of PDSCH. But there is also other solution not modify the DCI format, e.g., using different C-RNTIs, i.e., one C-RNTI is using scheduling unicast PDSCH and another C-RNTI is using scheduling GC-PDSCH.  **Updated Proposal 2-3** Support  **Updated Proposal 2-4** Support  Regarding OPPO’s comment, please find our reply.  [OPPO] 2-1: if ACK/NACK based HARQ feedback is supported for PTM scheme 1, there is no need to support PTM scheme 2.  [CMCC]In addition to the advantages I said above about PTM scheme 2 using as initial transmission scheme, PTM scheme 2 as retransmission can have some advantages than PTM shceme 1, For example, if several cell edge UEs in the same beam direction feedback NACK, using 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 compared with PTP.  **Updated Proposal 2-5**: Support |
| LG | We are fine with the updated proposal 2-3.  Regarding Updated Proposal 2-5 we should deprioritize this proposal for this meeting and until we have more understanding about how HARQ will work for MBS. |
| CATT | For proposal 2-1: we support PTM scheme 2 as initial transmission schemes. Some sub-bullets should be further clarified:   * “FFS how to differentiate PTP transmission and PTM transmission scheme 2 for a UE”: From the perspective per UE, PTP and PTM scheme 2 are the same, including DCI (C-RNTI) and PDSCH, even PTM scheme 2 apply multiple DCIs scheduling the same PDSCH. It seems like no necessary to differentiate PTP and PTM scheme 2 by a UE. * “FFS choice of retransmission scheme(s)”: does this sub-bullet mean how to selecte a retransmission scheme when PTM 2 is used for initial transmission? Or does it mean how to select retransmission schemes regardless of initial transmission scheme? Furthermore, the choice of retransmission scheme is up to gNB, and it is also not needed to indicate for UEs. * I think one of CATT’s proposal “multi-group-common transmission scheme” is not triggered for discussion during this meeting. Both PTM 2 and “multi-group-common” transmission schemes are not determined to be supported in MBS services yet. Since we also demonstrated the benefit in our contribution and email discussion (last meeting), I would like to suggest adding one proposal here in this section to “FFS multi-group-common PDCCH transmission scheme for RRC\_CONNECTED UEs”.   Proposal 2-5:  We support the main bullet but not the sub-bullet with FFS.   * How many HPN can be used for MBS is up to gNB configuration, and there is also no necessary to indicate this number to UEs. gNB can determine the actual HARQ process IDs to MBS based on the real-time available HPNs and unicast HPN consumptions. Considering about the HPN allocation scheme, dynamic or semi-static method can be further discussed/studied, which was proposed by FL in the previous proposal.   **[???] Updated Proposal 2-5**:  The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS   * ~~FFS: the maximum number of HARQ processes used for MBS~~ * FFS: How to allocate the total HARQ process numbers to unicast and multicast.   Proposal 2-3/2-4 can be further discussed based on how to allocate the HARQ processes for unicast and multicast, because the HPN allocation method can impact on the design of retransmission scheme, including HPN/NDI application. |
| MTK | **Updated Proposal 2-5**: Support |
| Huawei, HiSilicon | Proposal 2-1, for PTM2, DCI is scrambled by C-RNTI, assuming it is used for scheduling MBS, are you also assuming UE may also be scheduled by another DCI scrambled by G-RNTI for MBS, otherwise, why talk about “same DCI size” for unicast and multicast?  “reuse the legacy FDRA/TDRA table for unicast” means only one table is configured for unicast or multicast, or the point you want to make is the table can be configured for multicast but the candidate vaues are same for unicast?  Better to discuss the prposals labled as low-prioirty. | |
| Nokia, NSB | We are fine with proposals 2-1, 2-2, 2-3, 2-4 and 2-5. | |
| vivo | Regrading Huawei’s comment, please find our reply:  [Huawei] Proposal 2-1, for PTM2, DCI is scrambled by C-RNTI, assuming it is used for scheduling MBS, are you also assuming UE may also be scheduled by another DCI scrambled by G-RNTI for MBS, otherwise, why talk about “same DCI size” for unicast and multicast?  [vivo]No, the UE is not scheduled by another DCI scrambled by G-RNTI for MBS. “same DCI size” for unicast and multicast means that one DCI format is used to schecdule both unicast and multicast, the DCI size is the same when it is used to schedule unicast and is used to schedule multicast.  [Huawei]“reuse the legacy FDRA/TDRA table for unicast” means only one table is configured for unicast or multicast, or the point you want to make is the table can be configured for multicast but the candidate vaues are same for unicast?  [vivo] “reuse the legacy FDRA/TDRA table for unicast” means that UE can be configured with one table for unicast and multicast. Alternatively, UE can be configured with different TDRA tables for multicast and unicast, but the candidate sfor mutilcast are less that that of unicast, the bitwidth of TDRA can be determined based the TDRA table configuration for unicast.  The technique concerns w.r.t. PTM scheme 2 has been addressed in our 3rd round and 4th round response one by one. In general, PTM scheme 2 can be supported with minimized impact to the HAQR-ACK resource, PDCCH, CFR rand etc. we propose to set proposal 2-1 with high priority. Discussing and addressing technical concerns on supporting proposal 2-1 is useful to understand the full picture of supporting Rel-17 MBS in different ways/use cases.  As we stated the combination of the scheduling and HARQ-ACK feedback in the 2nd round comments, we think PTM scheme 1 with group common scheduling and NACK only feedbak and PTM schem 2 with ue-specific scheduling and ACK/NACK feedback is useful for different use cases. Therefore both can be supported. | |
| Qualcomm | Proposal 2-1: need more discussion for better understanding.  @CMCC: Thanks for the answer. However, based on your explaination, I’m more confused of PTM-2 vs. PTP. The PTP can also schedule same or different PDSCH. The unicast PDSCH is using the unicast PDSCH-config, e.g., TDRA, DMRS/PTRS, scrambling, rate matching pattern, etc.. Unless the network align the unicast PDSCH-config for UEs in the group, how to schedule the same GC-PDSCH. To my understanding, the GC-PDSCH parameters need to be configured for PTM-1 and PTM-2, but not needed for PTP.  Proposal 2-3: Support.  The PTP can be used complementary to PTM-1. The network can choose PTP for a cell-edge UE with unicast beamforming but PTM-1 for other UEs for retransmission.  Proposal 2-4: need more discussion for better understanding.  Proposal 2-5: Support. | |
| FUTUREWEI4 | Proposal 2-1: may be in an ok direction but given the questions may need more discussion on how it works.  Proposal 2-3: ok  Proposal 2-4: ok  Proposal 2-5: Though we still feel it is cleaner to add e.g. 4 or 8 processes for MBS on top of unicast, we can accept this but only if the FFS is included. | |
| Samsung | For progress, PTM scheme 1 should be supported first considering basic scenario where a UE only monitor multicast/broadcast service without requiring HARQ feedback. This is exact/same design as LTE.    For proposal 2-1, Better to discuss the proposals labled as low-prioirty.  Just to follow-up CMCC explanation for PTM scheme 1.   1. No additional DCI size alignment procedure, which will not cause perfrormane degradation of other PDCCHs(e.g, unicast scheduling PDCCHs or DCI 2\_x series PDCCHs), In contrast, for PTM scheme 1, if G-RNTI DCI size is counted in “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 casue UE’s unicast DCI size shuld be aligned 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, this also cuases PDCCH performace degradation.   We want to listedn companies’s view **if there is a better solution to solve PDCCH perfrormane degradation in PTM scheme 1**?  [Samsung] Performance degradation should consider everything. PTM scheme 2 is only considereing DCI size alignmenet issue. But, it is noted that gNB can schedule by selecting proper ALs in order to meet requirement. BTW, PTM scheme 2 requires more PDCCH resource which is understood well to component supporting PTM scheme 2.   1. More flexible to indicate per-UE HARQ-ACK feedback PUCCH resources, and has no restriction on RRC configuration. In comparion, it is up to RRC configuration of PUCCH indexes and k1 lists to guarantee PUCCH resources are orthogonal among UEs in one MBS group.   [Samsung] PTM scheme 1 can provide rather flexible PUCCH resource allocation due to dedicated RRC configuration. BTW, it is noted that no HARQ-ACK mode is also supported for MBS. So, PTM scheme 1 should be prioritized than PTM scheme 2 from our understanding.  Fine with proposal 2-5 since WID clearly mentioned. Keeping HARQ process number is to minimize one of ways to minimize UE hardware impacts.  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).  Deprioritize proposals 2-3 and 2-4. | |
| Ericsson | We disagree with Proposal 2-1 and 2-4. We agree with Proposal 2-3 and 2-5. | |
| TD Tech, Chengdu TD Tech | **Our opinions are listed below.**  **[Medium] Updated Proposal 2-1**: not supported  **[Low] Updated Proposal 2-4**: Not supported.  **The evaluation is needed for proposlas 2-3 and 2-5.**  **Low] Updated Proposal 2-3**: For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and 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.  **[???] Updated Proposal 2-5**:  The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS   * FFS: the maximum number of HARQ processes used for MBS | |
| Moderator | Proposal 2-1:  Based on the discussion, I think more offline discussion is needed. We can first focus on the high priority proposals for now.  Proposal 2-5:  Most companies are OK with this proposal, but LG still prefers to deprioritize the discussion in this meeting and until we have more understanding about how HARQ will work for MBS. CATT prefers to delete the FFS part, while FUTUREWEI insists to keep it. Considering the situation, maybe we can make it an working assumption. If an working assumption is also not acceptable for companies, we will defer the discussion in this meeting. | |

## Updated Proposals (4th round of email discussion)

**[High] Updated Proposal 2-5(Working assumption)**:

The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS

* FFS: the maximum number of HARQ processes used for MBS

## Company Views (5th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Qualcomm | Support it |
| Nokia, NSB | Support it |
| FUTUREWEI5 | ok |
| Intel | OK with the proposal |
| Lenovo, Motorola Mobility | We support this proposal. |
| CATT | We support the main bullet.  The sub-bullet of FFS is also OK because it is for further study. However, it is not clear for us how we are supposed to further study on the maximum number of HARQ for MBS.   * The maximum number is up to gNB configuration based on many conditions, e.g. total number of unicast service/processes, ratio between unicast services and multicast service. gNB can determine the maximum number of HARQ processes for MBS based on real-time conditions. If we are going to discuss/determine the maximum number of HARQ processes for MBS, are we going to determine **a specific value** or **a set of values**? I think the intention of this FFS is to define an upper bound of the values can be supported for MBS. For example, if the maximum number is 4, gNB can apply/configure a number n () as the actual number of HARQ processes for MBS. * Another FFS should be added: How to allocation the HARQ process numbers between unicast and multicast. When the maximum number is determined (e.g. 4), which HPNs can be used for MBS? 0~3 as semi-static configuration for MBS; or any available HPNs can be used dynamically for MBS. This should also be further studied. It is because that semi-static or dynamic method can directly impact on HARQ-ACK retransmission design and selection of retransmission schemes.   **[High] Updated Proposal 2-5(Working assumption)**:  The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS   * FFS: the maximum number of HARQ processes used for MBS * FFS: How to allocate the HARQ process numbers between unicast and multicast. |
| Moderator | I think the second FFS proposed by CATT is reasonable, companies please also check if it is OK for you to have it. |
| LG | Regarding Updated Proposal 2-5, as we initially commented, we are not sure about this proposal. We do not know if the same HARQ entity is shared by MBS and unicast or different HARQ entities are configured for MBS PDSCH and unicast PDSCH in the MAC entity, which seems up to RAN2 discsusion. If the same HARQ entity is shared by MBS and unicast or different HARQ entities at least for multicast, the maximum number of HARQ processes per cell supported by the UE could be kept unchanged for additionally supporting MBS. However, this may increase unnessary interaction with existing unicast transmission and could degrade unicast throughput.  Moreover, it is even unclear how to manage the number of HARQ processes for broadcast HARQ repetitions for UEs in RRC\_CONNECTED as well as UEs in RRC\_IDLE/INACTIVE, because we agreed to support broadcast reception by UE in RRC\_CONNECTED.  Thus, for progress, we propose to modify the updated proposal 2-5 as follows:  *The maximum number of HARQ processes per cell supported by the UE in RRC\_CONNECTED for additionally supporting multicast MBS is deteremined by one of the following options:*   * *Option 1: The maximum number is kept unchanged*   + FFS: How to allocate the HARQ process numbers between unicast and multicast. * *Option 2: An additional maximum number is introduced for MBS*   + *FFS: whether to share or divide the maximum number of HARQ processes between multicast and broadcast.* * FFS: the maximum number of HARQ processes used for MBS * *FFS: the maximum number of HARQ processes supported by the UE in RRC\_CONNEcTED for broadcast* |
| Lenovo, Motorola Mobility | Generally, we are OK with the FFS added by CATT.  Since the allocation fo HARQ process number between unicast and multicast is pure gNB implementation issue, I understand the movitation is to differentiate which HPN is used for multicast or unicast. So I made some modifications from UE’s perspective.  **[High] Updated Proposal 2-5(Working assumption)**:  The maximum number of HARQ processes per cell supported by the UE is kept unchanged for additionally supporting MBS   * FFS: the maximum number of HARQ processes used for MBS * FFS: How to distinguish the HARQ process numbers between unicast and multicast. |
| vivo | Fine with the WA and also fine with the 2nd FFS added by CATT |
| Apple | We are ok with this proposal and CATT’s update |
| Nokia, NSB | We are also fine with CATT’s update with the additional FFS |
| FUTUREWEI6 | The additional FFS from CATT seems to cloud the issue or assume a certain (complicated) way of handling. For CATT's question from our perspective we use separate buffers, if we allocate 4 HARQ processes for MBS, then they are 0 to 3. For the remaining unicast processes for that UE, it would use 0 to 11 (if total kept unchanged) or 0 to 15 (if the MBS are in addition, as is our preference). The Lenovo "distinguish" is better, though it may be best to list Options here as LGE suggested. |
| Qualcomm | A clarification question for the 2nd FFS: we assume the HPN for muticast and unicast here includes the HPN for multicast PTM-1, the HPN for the PTP as the retransmission of PTM-1, and the HPN for unicast PTP for legacy unicast data. Is it common understanding? |
| Moderator | Firstly, I want to remind the group that the following agreement has been made in this meeting.  Agreement:  For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTP transmission.   * The HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB.   Secondly, regarding LG’s update (copied below), I think it is more complicated, and I have some clarification questions.  *Proposal: The maximum number of HARQ processes per cell supported by the UE in RRC\_CONNECTED for additionally supporting multicast MBS is deteremined by one of the following options:*   * *Option 1: The maximum number is kept unchanged*   + FFS: How to allocate the HARQ process numbers between unicast and multicast. * *Option 2: An additional maximum number is introduced for MBS*   + *FFS: whether to share or divide the maximum number of HARQ processes between multicast and broadcast.* * FFS: the maximum number of HARQ processes used for MBS * *FFS: the maximum number of HARQ processes supported by the UE in RRC\_CONNEcTED for broadcast*   For option 1 (*The maximum number is kept unchanged*), I think basically it means maximum 16 HARQ processes are kept, but there could be two different interpretations regarding the candidate valus of the HARQ process ID:   * Alt 1-1: The candidate values of the HARQ process ID indicated in DCI are {0,1,…,15}. In this case, the HARQ process IDs are splited between unicast and multicast dynamically for initial transmission. HARQ combining is possible between initial transmission with multicast (PTM-1) and retransmission with PTP based on the same HARQ process ID. * Alt 1-2: The candidate values of the HARQ process ID indicated in DCI for initial transmission with unicast are {0,1,…,11}, and the candidate values of the HARQ process ID indicated in DCI for initial transmission with multicast are {0,1,…,3}. In this case, the HARQ process IDs are splited between unicast and multicast semi-statically for initial transmission. However, I’m wondering how to do the HARQ combining between initial transmission with multicast (PTM-1) and retransmission with PTP based on the same HARQ process ID if the HARQ process ID falls into {0,1,…,3}? Is it not consistent with the previous agreement?   For option 2 (*An additional maximum number is introduced for MBS*), does it mean that an additional maximum number (e.g., 4) of HARQ processes is introduced for multicast in addition to the maximum number (i.e., 16) of HARQ processes used for unicast? In this case, the total number of HARQ processes for both multicast and unicast is 20. In addition, are these 4 additional HARQ processes are only used for multicast or not? Which one of the follows is your intention regarding the HARQ process ID, or something else?:   * Alt 2-1: The candidate values of the HARQ process ID indicated in DCI are {0,1,…,19}. In this case,   + if these 4 additional HARQ processes are not only used for multicast, then the HARQ process IDs can be splited between unicast and multicast dynamically for initial transmission. Similar to Alt 1-1, HARQ combining is possible between initial transmission with multicast (PTM-1) and retransmission with PTP based on the same HARQ process ID.   + if these 4 additional HARQ processes are only used for multicast, then the HARQ process IDs are splited between unicast and multicast statically for initial transmission, i.e., the candidate values of the HARQ process ID indicated in DCI for initial transmission with unicast are {0,1,…,15}, and the candidate values of the HARQ process ID indicated in DCI for initial transmission with multicast are {16,17,…,19}. HARQ combining is also possible between initial transmission based on PTM-1 and retransmission based on PTP with the same HARQ process ID. However, it seems not necessary that the additional maximum number (e.g., 4) of HARQ processes are only used for multicast transmission, it is more natural to use the total 20 HARQ processes in a dynamic manner as in Alt 1-1 * Alt 2-2: Similar to Alt 1-2, the candidate values of the HARQ process ID indicated in DCI for initial transmission with unicast are {0,1,…,15}, and the candidate values of the HARQ process ID indicated in DCI for initial transmission with multicast are {0,1,…,3}. In this case, the HARQ process IDs are splited between unicast and multicast semi-statically for initial transmission. However, I’m wondering how to do the HARQ combining between initial transmission with multicast (PTM-1) and retransmission with PTP based on the same HARQ process ID if the HARQ process ID falls into {0,1,…,3}? Is it not consistent with the previous agreement?   Could you please clarify your intention so that we can further update the proposal 2-5 to make it more clear? Companies are also encourage to further provide their views on this. |

Please continue discussion in this table

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | It should be fine. It is noted that WID is saying explicitly minimize UE hardware impact.  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). |
| LG | For Alt 1-2 and A2-2, we think that the DCI needs to additionally indicate that the DCI schedules MBS retransmission e.g. explicitly by in the DCI. Thus, for both Alt 1-2 and 2-2, if the candidate values of the HARQ process ID indicated in DCI for initial transmission with multicast are {0,1,…,3}, a retransmission with PTP based on the same HARQ process ID falling into {0,1,…,3} can work.  In addition, we think that the maximum number of HARQ processes supported by the UE can be different than the maximum number of HARQ process numbers indicated by DCI for initial MBS transmission and PTM/PTP retransmisisons. As for Alt 2-1, if 4 additional HARQ processes are only used for multicast, DCI scheduling PTP retransmission can still indicate {0,1,…,3}. But, even if same HARQ process numbers are used for unicast and multicast, it does not necessarily mean that same HARQ processes are shared by unicast and multicast, assuming UE can identify unicast or multicast based on the DCI. UE can have separate MBS specific HARQ processes assigned to {0,1,…,3}. To summary for Alt 2-1, the total 20 HARQ processes for unicast and multicast are used but the candidate values of the HARQ process ID indicated in DCI are {0,1,…,15}. Four of {0,1,…,15} are duplicated for unicast and multicast.  For Option 2, we confirm that an additional maximum number (e.g., 4) of HARQ processes is introduced for multicast in addition to the maximum number (i.e., 16) of HARQ processes used for unicast. We assume that the HARQ processes are not shared between unicast and multicast. Thus, MBS transmission does not restrict the numbe rof unicast HARQ processes. But, we can also think that shared HARQ processes would work for Option 2 as well.  Considering the above comments from moderater, we think that the Updated Proposal 2-5 could be updated for clarity:  *The maximum ~~number of~~ HARQ process~~es~~ numbers indicated by DCI per cell supported by the UE is kept unchanged for additionally supporting MBS*   * *FFS: the maximum ~~number of~~ HARQ process ~~es~~ numbers used for MBS in DCI* |
| OPPO | Fine to make the proposal as working assumption. |
| Huawei, HiSilicon | We are ok with the update from Lenovo |
| CMCC | Similar view as Samsung, it should restrict the additional UE capability in this WI, we prefer option 1. |
| Spreadtrum | Support FL’s proposal |
| CATT | The updated FL’s proposal can be fine for progress. However, I think option 2 is considering about introducing extra requirement on UE hardware. We prefer to support option 1. |

## Updated Proposals (5th 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 / or whether it replaces configured cells with activated/non-dormant BWP DL cells to compute /.
* **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 / or whether it replaces configured cells with activated/non-dormant BWP DL cells to compute /. 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 proposal  Proposal 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. |
| Ericsson | Proposal 3-1: We agree  Proposal 3-2: We agree  Proposal 3-3: We agree  Proposal 3-4: We prefer Option 2. We also suggest to at least agree to use a common search space (and not consider USS in future discussion).  Proposal 3-5: We agree |
| Convida | For proposal 3-1, 3-2, 3-3, 3-4, we are generally OK with them.  For proposal 3-2, we also think “or to define a new DCI format” should be captured in the FFS to leave all the doors open at this stage. |
| Intel | **Proposal 3-1:** Ok with proposal  **Proposal 3-2:** Ok with main bullet which should be Option 1 which can be a default configuration. The FFS should be removed and the sub-bullet should be Option 2 which can be supported for CA capable Ues based on configuration.  **Proposal 3-3:** Ok with proposal  **Proposal 3-4:** Ok with proposal. The FFS for option 1 can simply be “monitoring priority” for now without the examples.  **Proposal 3-5:** For connected mode Ues which can receive high QoS mode delivery, limiting to DCI 1\_0 may not be ideal. Therefore, DCI 1\_1 and 1\_2 should be supported. DCI 1\_0 can be the baseline DCI format for low QoS broadcast delivery which is common with idle mode Ues. |
| Lenovo, Motorola Mobility | Proposal 3-1: We are OK with it.  Proposal 3-2: We are OK with it.  Proposal 3-3: We are OK with it.  Proposal 3-4: We prefer Option 2.  Proposal 3-5: We are OK with it. |
| Vivo | Regarding proposal 3-1, we want to make decision until we have conclusions on issue 1 of common frequency resources. For example, if option 2B is used and UE can be configured with multiple CFR, we are open to increase the supported number of CORESETs.  For proposal 3-2,3-3,3-4, we are ok with it.  For proposal 3-5: currently the size of DCI 1\_0 depends on the configuration of initial DL BWP, for MBS scheduling, we agreed that the FDRA should be determined based on common frequency resource, using DCI 1\_0 for MBS scheduling may make the size of DCI 1-0 increased. We prefer to postpone the discussion, e.g. supported DCI formats can be dicussed after solving the FFS for proposal 3-3. |
| Apple | Proposal 3-1: the assumption of this proposal is Option 2B is supported. If Option 2A is supported, then up to 3 CORESETs can be configured to MBS  Proposal 3-2: We are OK with this proposal.  Proposal 3-3: We are OK with this proposal.  Proposal 3-4: We prefer Option 1. |
| Spreadtrum | Proposal 3-1: fine  Proposal 3-2: fine  Proposal 3-3: fine  Proposal 3-4: fine. Prefer option 1.  Proposal 3-5: fine |
| Nokia, NSB | Regarding **Proposal 3-1**: Agree with FL’s proposal.  Regarding **Proposal 3-2**: Agree with FL’s proposal.  Regarding **Proposal 3-3**: Agree with FL’s proposal.  Regarding **Proposal 3-4**: Agree with FL’s proposal and the comments from CMCC related to this topic.  Regarding **Proposal 3-5**: Agree with FL’s proposal.  For PTM scheme 1, DCI format 1\_0 would be beneficial, and for PTM scheme 2 other DCI formats 1\_x could be utilized. |
| TD Tech & Chengdu TD Tech | **Our comments ( TD Tech & Chengdu TD Tech)**  **Proposal 3-1**: We agree with this proposal.  **Proposal 3-2**: We agree with the proposal.  **Proposal 3-3:** We agree with the proposal.  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:** We prefer option 2.  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:** We agree with the proposal.  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 |
| Moderator | **Proposal 3-1:**  Most companies are OK with this proposal.  Qualcomm thinks it may be different for Option 2A and 2B of common frequency resource, so I limited the whole proposal to Option 2B case. Vivo prefers to defer this discussion.  @ZTE, I think the maximum number of 3 CORESETs is not per serving cell, the current proposal proposes the maximum number of CORESETs per serving cell is not increased for support of MBS.  Hope at least we can make some progress, otherwise we will be stuck by the decision on Option 2A/2B.  **Proposal 3-2:**  Most companies are OK with this proposal. 3 companies [ZTE, Qualcomm, Intel] suggest to also agree the FFS part, but some companies prefer to delete the FFS part. It seems the current proposal is the best we can do for now. Based on Intel’s comment, I made an update.  **Proposal 3-3:**  Most companies are OK with this proposal. Samsung thinks it is not important to make this proposal, and we can continue discussions according to this proposal but a decision should be made once it is determined how the “3+1” limit can be kept. Considering the majority view on this proposal, I keep it unchanged and hope to make some progress.  **Proposal 3-4:**  Companies have different views on the name of the search space set for MBS, also considering that it seems not reasonable that the monitoring priority for MBS is always larger than that for unicast, the proposal is updated to focus on the priority and propose to determine the monitoring priority based on SS indexes of USS sets and search space set(s) for MBS  **Proposal 3-5:**  OPPO and Convida propose to add new DCI format in FFS, Samsung prefers to use DCI format 1-2, vivo prefers to postpone the discussion after solving the FFS for proposal 3-3. Considering the majority view and format 1\_2 is also not precluded, we can discuss it step by step. |

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

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

For Option 2B of common frequency resource, 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.

**[High] Updated 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 based on configuration, which is similar to the method used for multi-DCI based multi-TRP in Rel-16.

**[High] Updated Proposal 3-3 (No change):**

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.

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

For search space set of group-common PDCCH of PTM scheme 1 for multicast in RRC\_CONNECTED state, the monitoring priority is determined based on the search space set indexes of search space set(s) for multicast and USS sets.

**[High] Updated 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 or to define a new DCI format

## Company Views (2nd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We are generally fine with the above proposals. |
| Nokia, NSB | **[High] Updated Proposal 3-1**: Support  **[High] Updated Proposal 3-2**: Support  **[High] Updated Proposal 3-3 (No change):** Support  **[High] Updated Proposal 3-4:** Support  **High] Updated Proposal 3-5:** Support For PTM scheme 1, DCI format 1\_0 would be beneficial, and for PTM scheme 2 other DCI formats 1\_x could be utilized. |
| CMCC | Support the above proposals. |
| Samsung | Support proposals 3-1 to 3-4 (for proposal 3-3, it would have been preferable to agree after determining how it can be supported, not before – and the support is based on proposal 3-5 remaining FFS).  Do not support proposal 3-5. DCI format 1\_2 should be baseline as it offers most flexibility to the gNB for MBS deployment and avoids most specification impacts. |
| ZTE | We support Proposal 3-2, 3-3 and 3-5.  For Proposal 3-1, we would like to clarify the issue for Option2A also. Thus, we suggest the following. If companies have a different understanding on the limits of Option2A, we are also open to discuss.  Proposal 3-1  For Option 2B of common frequency resource, 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.  For Option 2A of common frequency resource, the maximum number of CORESETs per serving cell is not increased for support of MBS, and the maximum number of CORESETs configured for each MBS BWP is 3.  For Proposal 3-4, we are not ok with the updated proposal 3-4 but we can accept the previous version of Proposal 3-4. Even in Rel-15, the unicast scheduling can be scheduled in CSS, which means having the same priority as CSS. We are not sure why MBS should always have lower priority than CSS. We would suggest to FFS this issue. |
| Lenovo, Motorola Mobility | Proposal 3-1: We are OK with it.  Proposal 3-2: We are OK with it.  Proposal 3-3: We are OK with it.  Proposal 3-4: The previous version is preferred. We share same concern with ZTE.  Proposal 3-5: We are OK with it. |
| Vivo | For proposal 3-1/3-2/3-3/3-4: support  For proposal 3-5: not support  If DCI 1\_0 is supported, then we would like to clarify the need to leave an FFS for Updated Proposal 3-3. |
| OPPO | Support the proposals. |
| Qualcomm | In 3-1, we also prefer to add ‘for Option 2A’ in parallel. For Option 2B, it is not purely gNB implementation issue to allocate the CORESETs for MBS. The maximum number of CORESETs per dedicated BWP is limited, which means the maximum number of CORESETs per dedicated BWP is not increased for support MBS.  Proposal 3-1  For Option 2B of common frequency resource, the maximum number of CORESETs per serving cell is not increased for support of MBS, and the maximum number of CORESETs per dedicated BWP is not increased for support MBS.  For Option 2A of common frequency resource, the maximum number of CORESETs per serving cell is not increased for support of MBS, and the maximum number of CORESETs configured for each MBS BWP is same as that of a dedicated BWP. |
| CATT | Generally OK with the proposals. |
| MTK | Support the updated proposal. |
| Huawei, HiSilicon | For proposal 3-1, the point should be not increasing the number due to additionally support of MBS:  For Option 2B of common frequency resource, the maximum number of CORESETs per serving cell is not increased for UE additional support of MBS, and the number of CORESETs configured within the MBS common frequency resource is left to network implementation.  For proposal 3-2 FFS, “based on configuration” is saying the configuration that the number of configured cells is smaller than the number of cells UE reported as UE capability, or saying something else? |
| Apple | We are ok with Proposal 3-1, 3-2, 3-3. For Proposal 3-4, we prefer previous version. |
| Ericsson | We agree with all proposals 3-1 through 3-5. |
| Convida | We are OK with the 5 proposals. |
| Intel | **Proposal 3-1, 3-2, 3-3:** OK with current wording  **Proposal 3-4:** We don’t agree with current proposal. We can be ok with previous version for now. It is not apparent that we need a separate monitoring priority for MBS. The monitoring priority can be kept unchanged from Rel-15/16 and MBS PTM Scheme 1 can have same priority as CSS while PTP and PTM Scheme 2 if supported can have the same priority as USS.  **Proposal 3-5:** Ok to study other DCI formats |
| Spreadtrum | **Fine with Proposal 3-1,3-2,3-3.**  **Proposal 3-4, not support. Delay the discussion after we have defined tht serch space type for MBS.**  **Proposal 3-5, we are not clear about the main bullet. What is the necessary modification?** |
| Moderator | **Proposal 3-1:**  Based on comments from ZTE and Qualcomm, I add Option 2A in this proposal.  A little update is made based on Huawei’s comment.  **Proposal 3-2:**  Regarding Huawei’s clarification question, “based on configuration” means NW can configure CA capable Ues to use the budget of BDs/CCEs of an unused CC for group-common PDCCH. This is based on Qualcomm’s comment in the 1st round.  This proposal seems OK for companies except Huawei’s clarification question.  **Proposal 3-3:**  It seems all companies are OK with it.  **Proposal 3-4**:  Proposal was updated based on comments from ZTE, Lenovo, Apple and Intel  **Proposal 3-5**:  It seems still Samsung and OPPO have concern. Based on majority view, I did not update it.  Regarding Spreadtrum’s question, it is just saying we can consider modifications if it is necessary. |

## Updated Proposals (2nd round of email discussion)

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

* For Option 2B of common frequency resource, the maximum number of CORESETs per serving cell is not increased for UE additionally supporting MBS, and the number of CORESETs configured within the MBS common frequency resource is left to network implementation.
* For Option 2A of common frequency resource, the maximum number of CORESETs per serving cell is not increased for UE additionally supporting MBS, and the maximum number of CORESETs configured for each MBS specific BWP is same as that of a dedicated unicast BWP.

**[High] Updated Proposal 3-2(No change)**:

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

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

**[High] Updated Proposal 3-3 (No change):**

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.

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

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

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

**[High] Updated Proposal 3-5 (No change):**

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 or to define a new DCI format

## Company Views (3rd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | For proposal 3-5, we also have concern and hope it can be low priority. |
| Lenovo, Motorola Mobility | We are OK with above proposals. |
| Spreadtrum | Fine with Proposal 3-1,3-2,3-3,3-4.  For Proposal 5, we are still unclear about what are the necessary modifications. If possible, could the proponents clarify this? If there are no necessary modifications, the main bullet would be invalid. |
| OPPO | Agree with the proposals. |
| CATT | OK with the proposals. |
| LG | We are generally fine with the updated proposals. |
| Nokia, NSB | We are fine with the proposals |
| Samsung | **Fine, but prefer to have WA for 3-3.**  Reason: Prefer to make an agreement after finalizing details on how it works to ensure “3+1” condition.  **NOT support 3-4.**  Reason: In order to minimize specification effort, it should be USS. The only difference between CSS and USS is initialization value of Y\_{-1}. For CSS, this value is 0 while USS is set as C-RNTI. G-RNTI is common understanding for scheduling MBS. We think that G-RNTI can be just used instead of C-RNTI. So, this should not need to be CSS. If we make CSS for MBS, there is no way that provides MBS has higher priority than USS since current specification is saying USS is higher priority than CSS. If we this consider further as second sub-bullet, we think it requires huge specification impact. Instead, just assuming USS is very simple, since it has already related prioritization rule considering USS index. Again, no benefit to have CSS for multicast, it requires huge specification impact.  **NOT support 3-5**  Reason: DCI format 1\_0 could not be flexible design since it should be transmitted also in CSS. If we want to make more flexible design/configuration for MBS, other DCI format should be considered. We think that DCI format 1\_2 seems best option since this is already quite designed very flexibly than DCI format 1\_1. So, we think that it is straightforward to use DCI format 1\_2 as baseline for MBS. |
| Ericsson | We agree with all five Proposals 3-1, 3-2, 3-3, 3-4 and 3-5. |
| MTK | We are ok with the updated proposals |
| Moderator | **Proposal 3-1:**  Although all companies are OK with this proposal, considering it relates to the current proposal 1-1a, I think we should defer this discussion for now.  **Proposal 3-4:**  Samsung insist that USS is more suitable for multicast, so it seems hard to make any progress on search space for now, since all the three options in RAN1#103 (see below) have their proponents. I hope companies can express their views on whether we need to deprioritize this proposal 3-4.  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   **Proposal 3-5**:  Vivo propose to deprioritize this proposal. Samsung also has concern on this proposal and insist DCI format 1\_2 should be used as baseline. I hope companies can express their views on whether we need to deprioritize this proposal 3-5. |

## Updated Proposals (3rd round of email discussion)

**[???] Updated Proposal 3-4:**

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

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

**[???] Updated 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 or to define a new DCI format

## Company Views (4th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | Proposal 3-4: Fine. For monitoring priority, we support option 2.  Proposal 3-5: we have expressed our concern during the previous rounds of email discussions, but not receive the response. We repost our concern below, and hope it could be clarified. Otherwise, we would have to suggest to deprioritize this proposal, to understand the necessarity of the proposal with more time.   * + - For Proposal 3-5, we are still unclear about what are the necessary modifications. If possible, could the proponents clarify this? If there are no necessary modifications, the main bullet would be invalid. |
| OPPO | Given the situation, we agree to deprioritize 3-4 and 3-5. |
| Lenovo, Motorola Mobility | Agree. |
| CMCC | Support.  Prefer option 2 in Proposal 3-4. |
| Apple | We are ok with these proposals. |
| LG | We are fine with the updated proposals. |
| CATT | OK with the two proposals. |
| MTK | We are fine with these two proposals. |
| Nokia, NSB | OK with these updated proposals. For 3-4, we have a preference for option 2. |
| Vivo | For Proposal 3-4: Fine. For monitoring priority, we support option 2.  For Proposal 3-5: we prefer to deprioritize. |
| Qualcomm | Fine with both proposals. |
| Samsung | Okay with proposal 3-4.  Not support proposal 3-5 as reasons we mentioned previously. |
| Ericsson | We agree to both proposals |
| TD Tech, Chengdu TD Tech | We agree with the proposals. |
| Moderator | Proposal 3-4:  All companies are OK with it.  Proposal 3-5:  Considering vivo and Samsung still have concern on this proposal, we can defer this discussion for now, and focus on other high priority proposals.  @Spreadtrum, regarding your question on the necessary modification in the main bullet, my understanding is that there is still uncertainty that the interpretation of FDRA field needs to be changed or not for DCI format 1\_0. Other companies are also encouraged to provide their views. |

## Updated Proposals (4th round of email discussion)

**[High] Updated Proposal 3-4(Stable):**

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

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

## Company Views (5th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Qualcomm | Support it |
| Nokia, NSB | Support it |
| Intel | Ok to support |
| Lenovo, Motorola Mobility | We support this proposal. |
| CATT | OK with the proposal.  **Clarification** on the second FFS, if we are going to down select from the two options, the “FFS” can be removed because anyhow one of the options will be selected. If the two options are both to be supported, and it is up to NW to configure which is used, the “FFS” can be kept as it is. |
| Moderator | @CATT, regarding the second FFS, my intention is to encourage companies further study on these options, then we can discuss how to handle it. I’m not sure we have to make down-selection or not. |
| LG | We are fine the updated proposal. |
| vivo | Fine with the updated proposal. |
| Apple | We are ok with this proposal |
| Moderator | **Proposal 3-1:**  This proposal is about the number of CORESETs that can be configured within the CFR, it is obvious that some companies prefer to increase the maximum number of CORESETs per dedicated unicast BWP, so I think it is pre-mature to make the decision in this meeting, and I suggest to defer this discussion unless more companies prefer to make decision right now.  **Proposal 3-4:**  Seems proposal 3-4 is stable enough, and I will report it to chairman later. |

## Updated Proposals (5th round of email discussion)

**[High] Updated Proposal 3-4(Stable):**

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

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

## Company Views (6th round of email discussion)

Please comment only when you have different views.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | Fine with the proposal. |
| LG | We are fine with the updated proposal. |
| Lenovo,Motorola Mobility | We are fine wth this proposal. |
| OPPO | Agree with the proposal |
| vivo | Agree with the proposal |
| CMCC | OK |
| Spreadtrum | Support |
| CATT | OK.  Thanks FL for the clarification in previous round of discussion. |

## Updated Proposals (6th 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. |
| Ericsson | Proposal 4-1: We agree  Proposal 4-2: We agree  Proposal 4-3: We agree |
| FUTUREWEI | Proposal 4-1: ok with proposal  Proposal 4-2: ok with proposal  Proposal 4-3: ok with proposal. Further clarification about “FFS HARQ-ACK for activation/deactivation” is needed. Does it ask whether HARQ-ACK is needed activation/deactivation? |
| Intel | **Proposal 4-1, 4-2:** Ok with proposal  **Proposal 4-3:** The FFS can be deleted. Details can be handled in 8.12.2 |
| Lenovo, Motorola Mobility | Proposal 4-1: We are OK with it.  Proposal 4-2: We are OK with it.  Proposal4-3: We are OK with it. |
| vivo | Proposal 4-1: not support.  This issue is related with the HARQ-ACK feedback mode for the activation PDCCH (i.e, the first PDSCH after activation). If NACK only is supported, then from gNB’s side, it wouldn’t be able to distinguish between UE receiving the first PDSCH succefully and failing to decode the activation PDCCH. If ACK/NACK is supported, then we need to discuss how to indicate orthognal resources with one PRI which will have large spec imapct acoording to the discussion in AI 8.12.2.  For proposal 4-2: ok  For proposal 4-3: ok with the main bullet.  For the second FFS, we think it is not clear. According to the current SPS mechanism, for the HARQ-ACK for activation/deactivation, it is the same as DG PDSCH. Further clarification about this FFS may be needed. |
| Apple | Proposal 4-1: We are OK with this proposal.  Proposal 4-2: In Rel.15 only one DL SPS can be configured with the UE capability, i.e. FG5-18; In Rel.16, up to 8 SPS configurations is the UE capability of IIOT, i.e., FG12-2. The sub-bullet should make the proposal clear.  Proposal 4-3: We are OK with this proposal. |
| Spreadtrum | Support proposal 4-1, 4-2, 4-3. |
| Nokia, NSB | Regarding Proposal 4-1: Agree with FL’s proposal. Similar to our proposals for dynamic scheduling, we believe that the network should have the flexibility to use both group-common and UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED states.  Regarding Proposal 4-2: Agree with FL’s proposal, with some minor modifications proposed:  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 currently defined for unicast is not increased for supporting MBS.  • How to allocate the total SPS configurations between MBS and unicast is up to network implementation.  Regarding Proposal 4-3: Agree with FL’s proposal |
| TD Tech& Chengdu TD Tech | **Our comments (TD Tech &Chengdu TD Tech)**  **Proposal 4-1**: We agree with the proposal.  **Proposal 4-2**: We agree with the proposal.  **Proposal 4-3**: We agree with the proposal. |
| Moderator | Proposal 4-1: All companies are OK with it  Proposal 4-2: Qualcomm think the 2nd sub-bullet is related to the decision on option 2A/2B for common frequency resource, so move it to FFS for now. Based on Nokia’s comment, a little modification was made for it.  Proposal 4-3: I updated it based on some companies’ comments.  Regarding FUTUREWEI’s question, the answer is YES.  Regarding Apple’s clarification question, I think it is clear that the total number of supported SPS configurations by a UE is not increased because of supporting MBS. |

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

**[High] Updated Proposal 4-1 (No change)**:

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

* 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

**[High] Updated 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 currently defined for unicast is not increased for supporting MBS.
* FFS: How to allocate the total SPS configurations between MBS and unicast.

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

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

* Note: the HARQ-ACK details for SPS PDSCH and activation/deactivation is discussed in AI 8.12.2

## Company Views (2nd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We are fine with the above proposals. |
| Nokia, NSB | **[High] Updated Proposal 4-1 (No change)**: Support  Similar to our proposals for dynamic scheduling, we believe that the network should have the flexibility to use both group-common and UE-specific PDCCH for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED states.  **[High] Updated Proposal 4-2**: Support  In our view, the FFS can be left to network implementation  **[High] Updated Proposal 4-3**: Support |
| CMCC | Support the above proposals. |
| Samsung | Support updated proposals 4-1, 4-2, and 4-3. |
| ZTE | We support Proposal 4-1, 4-2 and 4-3. |
| Lenovo, Motorola Mobility | Proposal 4-1: We are OK with it.  Proposal 4-2: We are OK with it.  Proposal4-3: We are OK with it. |
| vivo | **[High] Updated Proposal 4-1 (No change)**: **not support**  As our comment in the 1st round, the HARQ-ACK issue needs to be solved before we agree to use group-common PDCCH for activation/deactivation  **[High] Updated Proposal 4-2**: Support  Agree with Nokia, the FFS can be left to network implementation  **[High] Updated Proposal 4-3**: Support |
| OPPO | Support the proposals. |
| Qualcomm | For 4-1, 4-2 and 4-3, should add ‘for multicast of RRC\_CONNECTED UEs’. |
| CATT | OK with the proposals.  For **Proposal 4-3**: One clarification is needed.  How to deal with the HARQ based retransmissions? Dynamic scheduling can be used.  If we are going to discuss it in this AI, I would like to suggest adding it in proposal 4-3. |
| MTK | We are ok with the proposal. |
| Huawei, HiSilicon | **Updated 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 currently defined for unicast is not increased due to additionally supporting MBS. |
| Apple | We are ok with the proposals. |
| FUTUREWEI | We are ok with the proposals. For proposal 4-3, the number of HARQ processes for MBS should be considered. |
| Ericsson | We agree with P4-1 and P4-2.  We also agree with P4-3, with the reinsertion of an FFS for HARQ ACK/NACK of SPS activation/deactivation, which is needed for NACK only operation (if agreed). |
| Intel | Ok with the updated proposals |
| Spreadturm | Fine with all proposals |
| Moderator | **Proposal 4-1:**  It seems vivo still has some concern.  **Proposal 4-2:**  Proposal was updated based on comments from Qualcomm and Huawei.  **Proposal 4-3:**  Proposal was updated based on comments from Qualcomm, CATT and Ericsson. |

## Updated Proposals (2nd round of email discussion)

**[High] Updated Proposal 4-1 (No change)**:

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

* 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

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

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

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

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

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

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

## Company Views (3rd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | For proposal 4-1, we sincerely hope proponents of group-common PDCCH or FL can slove our conern on HARQ-ACK for group-common PDCCH activation/deactivation:   1. Whether NACK only is supported? If supported, how to slove the issue that gNB cann’t distinguish between UE receiving the first PDSCH succefully and failing to decode the activation PDCCH   Whether ACK/NACK feedback is supported? If supported, how to indicate the PUCCH resource. |
| OPPO | Agree with the proposals. |
| CATT | OK with the updated proposals. |
| LG | We are fine with the updated proposals. |
| Nokia, NSB | We are fine with the proposals |
| ZTE | We are ok with all the proposals. One minor issue for Proposal 4-2, maybe it is better to add an FFS to further study how to configure SPS under Option 2A and Option2B. For Option 2A, we can directly reuse the current signaling, but we are not sure how to configure it under Option 2B.   * FFS: How to configure SPS under Option 2A and Option 2B |
| Ericsson | We agree with all three proposals 4-1, 4-2 and 4-3. |
| FUTUREWEI2 | We are okay with proposals 4-1, 4-2, 4-3 |
| Moderator | Proposal 4-1:  To address vivo’s concern, I put the proposal conditioned on that ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1. |

## Updated Proposals (3rd round of email discussion)

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

If ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* 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

## Company Views (4th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | Fine |
| OPPO | Agree with the proposal. |
| ZTE | Support the proposal. |
| Lenovo, Motorola Mobility | We are OK with this proposal. |
| CMCC | Support |
| Apple | OK with this proposal. |
| LG | We are fine with the updated proposal. |
| CATT | OK with this proposal. |
| Nokia, NSB | We are OK with this proposal. |
| vivo | We think it is necessary to support UE-spcific PDCCH activation/deactivation. Because we have to consider the case that after a SPS PDSCH transmission has been activated, then a new UE is interested in the MBS or a UE does not want to receive this MBS data, the activation/deactivation PDCCH should not be group-common in that case, it should be UE-specific. Thus, we prefer to discuss and argree UE-specific PDCCH activation/deactivation first and FFS for group-common PDCCH. Otherwise, we want to deprioritize this proposal. |
| Qualcomm | Support ths proposal. |
| FUTUREWEI4 | Support this proposal |
| Samsung | Agree |
| Ericsson | We agree |
| TD Tech, Chengdu TD Tech | We agree with the proposal. |
| Moderator | Proposal 4-1:  Most companies are OK with this proposal, but vivo still prefers to agree UE-specific PDCCH activation/deactivation first and FFS for group-common PDCCH. From moderator perspective, we still can discuss UE-specific PDCCH activation/deactivation later, but companies may need more time to think about it.  @vivo, is it acceptable for you to have it as an working assumption? |

## Updated Proposals (4th round of email discussion)

**[High] Updated Proposal 4-1(Working assumption)**:

If ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* 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

## Company Views (5th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Qualcomm | Support it |
| Nokia, NSB | Support it |
| FUTUREWEI5 | Ok with proposal / WA |
| Lenovo, Motorola Mobility | We support this proposal. |
| CATT | Generally OK with the proposal as WA.  Besides group-common PDCCH, we would also like to consider using UE-specific PDCCH to activate/deactivate SPS for MBS. The current version of proposal is OK.  **Question** on the FFS of UE-specific PDCCH: the main bullet said that it is for PMT scheme 1. How to use UE-specific PDCCH in PTM scheme 1 as it is a sub-sub-bullet under the main bullet. Should it be like follows:  **[High] Updated Proposal 4-1(Working assumption)**:  If ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,   * at least group-common PDCCH is supported   FFS whether UE-specific PDCCH is supported for activation/deactivation.   * FFS whether and how to address the missed activation and deactivation |
| LG | We are fine the updated proposal. |
| vivo | For process, we can live with the WA. We think CATT’s question is valid, the indenting may need to be changed. |
| Apple | We are ok with this proposal. |
| Qualcomm | We prefer original proposal.  We think the 1st FFS is to discuss whether the UE-specific PDCCH for activation/deactivation is needed as a complementary to GC-PDCCH when PTM-1 is used. |
| Moderator | Regarding CATT and Qualcomm’s comments, I tend to use the original one, considering that “for activation/deactivation” is also mentioned in the main bullet. Unless companies have strong view on this, I will report to chairman that this working assumptions is stable. |

## Updated Proposals (5th round of email discussion)

**[High] Updated Proposal 4-1(Working assumption)**:

If ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,

* 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

## Company Views (6th round of email discussion)

Please comment only when you have different views.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | Fine with the proposal. |
| Lenovo,Motorola Mobility | We are fine wth this proposal. |
| OPPO | Fine to make the proposal as working assumption |
| Huawei, HiSilicon | Ok |
| CMCC | OK |
| Spreadtrum | We have one question for clarification. For the main bullet, why it is restricted for the case ‘If ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1’. In our opinion, the proposal could also be applied for the case where NACK-only based HARQ-ACK feedback is supported for PTM scheme 1 |
| CATT | Similar question with Spreadtrum in the main bullet. It seems that SPS activation/deactivation is not related to whether ACK/NACK feedback is supported or not.  We would like to suggest removing it from the main bullet.  **[High] Updated Proposal 4-1(Working assumption)**:  ~~If ACK/NACK based HARQ-ACK feedback is supported~~ for PTM scheme 1, for activation/deactivation of SPS group-common PDSCH for MBS in RRC\_CONNECTED state,   * 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 |

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## Updated Proposals (6th 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? |
| Ericsson | Proposal 5-1: We agree  Proposal 5-2: We agree |
| FUTUREWEI | More discussion may be needed on both proposals, focusing on stating how MBS changes or modifies the current capability. I.e., are we adding simultaneous receptions or not? How many can be ‘taken’ from the current 2/4/7 capability for MBS? We assume no need to prohibit FDM (opt 5) if it was supported before (Qualcomm comment) |
| Intel | We agree with Qualcomm and Futurewei that more discussion is needed on both proposals. We prefer to handle this discussion after additional progress. OK with listing Option 5 (ZTE). |
| Lenovo, Motorola Mobility | Proposal 5-1: We are OK with it.  Proposal 5-2: We are OK with it. |
| Vivo | For proposal 5-1: we are ok with it in principle. We share the same view with Huawei that it may be better to discuss in UE feature part.  For proposal 5-2: agree with ZTE and QC that Case 5 should be added. |
| Apple | We share the views with others, it may be early to make the agreements on these two proposals.  For proposal 5-2, “multiple” is little confusing, we agree something we don’t know. |
| NTT DOCOMO | **Proposal 5-1**: The number of N should be discussed in UE capability agenda in future meeting.  **Proposal 5-2**: We agree with some companies that case 5 should be supported as well. In addition, we prefer to add case 4 so that in CA case, unicast PDSCH is transmitted in a cell and group-common PDSCH in another cell, simultaneously. If case 4/5 are not included, scheduling flexibility would become quite low. |
| Spreadtrum | Not support 5-1. We should keep the same UE capability as Rel-15. It should be up to UE’s capability, not to force UE to support intra-slot multiplexing. For example, if UE could not support up to two unicast PDSCHs in a slot per CC (i.e., FG5-11), then inter-slot TDMed multiplexing between group PDSCH and unicast PDSCH could be considered.  Proposal 5-2, support FL’s proposal. |
| Nokia, NSB | Regarding Proposal 5-1: Agree with FL’s proposal.  Regarding Proposal 5-2: Agree with FL’s proposal. |
| TD Tech& Chengdu TD Tech | **Our comments (TD Tech & Chengdu TD Tech)**  **Proposal 5-1**: We agree with this proposal.  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**: We agree with this proposal.  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 |
| Moderator | Proposal 5-1: 2 company [Samsung, spreadtrum] still prefers to keep the maximum numbers of TDMed PDSCH receptions in a slot same as for Rel-15 UE capability, i.e., N=2 subject to UE capability. 7 companies thinks it’s too early to discuss this. Based on the comments, we can deprioritize this proposal.  Proposal 5-2: All companies are OK this proposal. CATT suggests also to discuss how to handle it when the number of PDSCH receptions in a slot is beyond the UE capability. 5 companies [Qualcomm, ZTE, FUTUREWEI, vivo, NTT DOCOMO] suggest to support case 5, so I list another proposal for case 5. |

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

**[Low]Updated 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, FSS it is mandatory or subject to UE capability
* N=4/7 subject to UE capability

**[High] Updated Proposal 5-2 (No change)**:

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

**[High] Proposal 5-3**:

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 5: support FDM among T group-common PDSCHs in a slot
  + FFS: the value of T

## Company Views (2nd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We are fine with the above proposals. |
| Nokia, NSB | **[Low]Updated Proposal 5-1**: Support  **[High] Updated Proposal 5-2:** Support  **High] Proposal 5-3**: Support |
| CMCC | Support the above proposals |
| NTT DOCOMO | **[Low]Updated Proposal 5-1**: Support  **[High] Updated Proposal 5-2**: Support  **[High] Proposal 5-3**: Support |
| Samsung | Support proposal 5-2. Support for progress proposal 5-1 although it is clear based on the WID that N=2 is a UE capability.  Do not support proposal 5-3. The WID forbids increasing UE hardware complexity.  *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).* |
| ZTE | We support Proposal 5-1, 5-2 and 5-3. |
| Lenovo, Motorola Mobility | Proposal 5-2: We are OK with it.  Proposal 5-3: We are OK with it. |
| Vivo | We are fine with the above FL’s proposals |
| OPPO | Support the proposals. |
| Qualcomm | Agree with 5-2 and 5-3. |
| CATT | Generally OK with proposal 5-2 and proposal 5-3. |
| MTK | Support proposal 5-2. |
| Apple | Generally we are ok with the proposal 5-2, 5-3. |
| FUTUREWEI | Generally. We are ok with proposals 5-2, 5-3. May be better to take them together.  We should clarify the values of M,N,K,L,T etc that are already supported or agreed and which are under further discussion |
| Ericsson | We agree with all Proposals (P5-1, P5-2, P5-3) |
| Intel | Ok with updated proposals |
| Spreadtrum | Proposal 1: Not support. N=2 should be one optional UE capability. We not understand why it could be mandatory.  Proposal 2: case 1/case 2/case 3 should be per CC.  Proposal 3: Not support. Share the same view with Samsung. |
| Moderator | Proposal 5-2:  Proposal was updated based on FUTUREWEI and spreadtrum’s comments.  All companies seem to be OK with it.  Proposal 5-3:  Proposal was updated based on FUTUREWEI and spreadtrum’s comments.  Seems Spreadtrum and Samsung still have concern. Based on majority view, I did not update it. |

## Updated Proposals (2nd round of email discussion)

**[Low]Updated Proposal 5-1 (No change)**:

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, FSS it is mandatory or subject to UE capability
* N=4/7 subject to UE capability

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

**[High] Proposal 5-3(No change)**:

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 5: support FDM among T (T>1) group-common PDSCHs in a slot per CC
  + FFS: the value(s) of T

## Company Views (3rd round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| vivo | Fine with the updated proposals. |
| Spreadtrum | Fine with proposal 5-2.  Not support proposal 5-1,5-3. Obviously they will increase UE complexity, and beyond R15 UE capability. |
| OPPO | Agree with the proposals. |
| CATT | OK with the proposals. |
| LG | We are fine with the updated proposals. |
| Nokia, NSB | We are fine with the proposals |
| Samsung | **NOT** support 5-3.  Reason: - This is against WID objective. It makes UE design quite complex. Please see following description in WID.  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). |
| Ericsson | We agree with all three proposals 5-1, 5-2 and 5-3. We think however it is important to clarify the mandatory nature of N=2 asap, since this affects whether multiplexing of unicast and MBS within a slot is possible by all Ues. |
| MTK | We slightly not support proposal proposal 5-3. If multiple FDMed group common PDSCHs are configured within one slot, it will increase the UE processing complexity as Spreadtrum/Samsung noted. |
| Qualcomm | We support 5-2 and 5-3. 5-3 is not against WID. We have already agreed to support FDM between unicast and multicast subject to UE capability, which is also supported in LTE SC-PTM. |
| FUTUREWEI2 | Our preference as commented before would still be to handle 5-2 and 5-3 together, which can be done by including an FFS value for the FDM that has a lower bound that matches the current agreement (i.e., 1 and 1). Note that we had the following agreement in RAN1#102e  Agreements:   * For RRC\_CONNECFTED 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. |
| Moderator | Proposal 5-2&5-3:  @FUTUREWEI, based on the agreement you listed above, do you mean that we should also at least support FDM among T (T=2) group-common PDSCHs in a slot per CC based on UE capability, and FFS whether T>2 can be supported or not?  @Spreadtrum, Samsung and MTK, is this acceptable to you? |

## Updated Proposals (3rd round of email discussion)

**[Low] Updated 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, FSS it is mandatory or subject to UE capability
* N=4/7 subject to UE capability

**[High] Updated 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 M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC
  + FFS: the value(s) of M
* Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC
  + FFS: the value(s) of N
* Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC
  + FFS: the value(s) of K and L
* Case 5: support FDM among T (T=2) group-common PDSCHs in a slot per CC
  + FFS whether T>2 is supported or not

## Company Views (4th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadturm | Proposal 5-1: not support.  In Rel-15, whether to support more than 1 TDMed unicast PDSCHs in a slot per CC is up to UE capability(i.e., FG5-11/5-11a/5-11b). The MBS WID has clearly descripted that UE complexity should be minimized (e.g. device hardware impact should be avoided). Following Rel-15 UE capability, for MBS N=2 should be based on UE capability, rather than mandatory.  Post related WID objective below for your reference:  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).  Proposal 5-2: To move forward, as compromise, we are fine with FL’s proposal. |
| OPPO | 5-1: support the proposal.  5-2: agree. |
| ZTE | Ok with the proposal. |
| CMCC | Support |
| Apple | Proposal 5-1 seems having overlap with case 2 of proposal 5-2. What is the meaning of “including unicast PDSCH(s) **and/or** group-common PDSCH(s)” in proposal 5-1? |
| LG | We are fine with the updated proposals. |
| MTK | Proposal 5-2: Considering the UE processing complexity, we still think there is no necessity to support case 5 at current satge. Could some proponents of case 5 explain the reason or usecase for supporting case 5? |
| Nokia, NSB | We are fine with the updated proposals. |
| Vivo | Fine with the proposals. |
| Qualcomm | Support 5-2 but defer 5-1. |
| FUTUREWEI4 | @MODERATOR: Thank you for including the FDM agreement as part of the cases for simultaneous reception of unicast PDSCH and group-common PDSCH based on UE capability for RRC\_CONNECTED Ues. We are fine with the FFS for more than 2.  We are fine with 5-2 but would like to defer 5-1. |
| Samsung | Acceptable. |
| Ericsson | We agree with Spreadturm’s comment, i.e. not agree with 5-1 but with 5-2 |
| TD Tech, Chengdu TD Tech | We agree with the proposals. |
| MTK | @ FUTUREWEI: Could you give some clarification why multiple FDMed group common PDSCH is needed? From our understang, there is no mupltiple FDMed unicast PDSCHs within one slot in legacy release. Considering the UE processing complexity and WID restrictions and assumptions, we suggest delete case 5. |
| Moderator | Proposal 5-1:  I updated the proposal based on companies’ comments to make N=1 as mandatory and N=2/4/7 as optional. Although it was marked as low priority, I hope to have another try.  Proposal 5-2:  MTK still has concern on it. Proponents of case 5 may need to address MTK’s clarification question.  Companies are encouraged to continue discussion in 5th round. |

## Updated Proposals (4th round of email discussion)

**[Low] Updated 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=1 as mandatory
* N=2/4/7 subject to UE capability

**[High] Updated 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 M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC
  + FFS: the value(s) of M
* Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC
  + FFS: the value(s) of N
* Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC
  + FFS: the value(s) of K and L
* Case 5: support FDM among T (T=2) group-common PDSCHs using different G-RNTIs in a slot per CC
  + FFS whether T>2 is supported or not

## Company Views (5th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Qualcomm | We think case 5 can be supported in 5-2.  In Rel-16, m-TRP can support FDMed unicast PDSCHs in the same CC. In RAN1#102e, we have agreed FDM of unicast and multicast subject to UE capability, similar as SC-PTM. We don’t see fundamental difference between FDMed PDSCH+GC-PDSCH and FDMed GC-PDSCH+GC-PDSCH.  For 5-1, N=1 is not TDM any more, which can be deleted. For other options, it is not clear the relationship between “FFS: the value(s) of M” in case 1 of 5-2 and N in 5-1. To us, 5-1 is not urgent for now and can be discussed later. |
| Nokia, NSB | As pointed out in the previous round of discussions, there is the following RAN1#1-2e agreement.  Agreements:  • For RRC\_CONNECFTED 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.   We would like FL clarification (and possible rewording) as to the purpose of case 5 ([High] Updated Proposal 5-2), is it to:  Option 1: support FDM for 2 group-common PDSCHs in a slot per CC [*I.e. no unicast – which is somewhat contradictory with the first line of the proposal*]  Option 2: support FDM for up to 2 group-common PDSCH and 1 unicast PDSCH in a slot per CC  Option 3: something else?  If the FL confirms it is Option 1, are the group/FL confident of the Q// comment above about there being no fundamental difference? |
| FUTUREWEI5 | Agree with Qualcomm for 5-1 and 5-2 |
| Intel | The current wording for Case 5 is confusing, and we would like the same clarification as Nokia i.e., T=2 means FDM between 2 GC-PDSCH and one unicast? For the case of only 2 FDM GC-PDSCH, we would like some clarification on why this is needed. |
| Moderator | @Nokia@Intel, My intention is Option 1. Regarding the contradiction, is the following update acceptable?  Regarding your question “are the group/FL confident of the Q// comment above about there being no fundamental difference? ”, my understanding is that there may be some difference between the HARQ-ACK feedback design for the two cases (i.e., FDMed PDSCH+GC-PDSCH and FDMed GC-PDSCH+GC-PDSCH). But hope companies can share their views on this.  **[High] Updated Proposal 5-2**:  At least support the following cases for simultaneous reception of multiple PDSCHs in a slot for MBS based on UE capability for RRC\_CONNECTED Ues   * Case 1: support TDM between M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC   + FFS: the value(s) of M * Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC   + FFS: the value(s) of N * Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC   + FFS: the value(s) of K and L * Case 5: support FDM among T (T=2) group-common PDSCHs using different G-RNTIs in a slot per CC   + FFS whether T>2 is supported or not |
| MTK | We cann’t accept the reason just other NR feature supports similar capability, then NR multicast service also need to support this capability. We don’t see any benefit to support multiple FDMed group common PDSCH reception within one slot. Besides, the agreed WID for MBS have a restriction and assumptions as copied following:   |  | | --- | | 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). |   Considering above reasons, we don’t support case 5. |
| Vivo | We are generally fine with the Updated Proposal 5-2. For case 1, there seems no “multiple PDSCHs in a slot for MBS” which is not consistent with the main bullet. |
| Apple | I would like to clarify Proposal 5 and Proposal 5-2 together.  For Proposal 5, UE PDSCH TDM reception capability is defined as 1/2/4/7, whatever the PDSCH is unicast or MBS PDSCH.  For Proposal 5-2, UE capability for Unicast and MBS PDSCH TDM reception is defined in case 1 and case 3.  How to understanind both proposals? Any relations or limitations between two proposals.  Another comments on case 5 of proposal 5-2, G-RNTI is not defined or used in previous discussion, it could be better to give the explaination or common term to replace. |
| Nokia, NSB | Regarding moderator’s question about HARQ ACK design for the two cases:  We believe that the feedback design can change depending on unicast/multicast and multicast/multicast FDM-ing, especially in case NACK-only feedback is supported, which is quite likely based on the final proposals currently being discussed as part of that topic. In the reliability FL summary, there are proposals that are explicitly mentioning to study some special cases if FDM between multicast and multicast is agreed, which are indications of feedback design changes.  Taking this factor into account and considering the agreement from RAN1 #102-e, we propose the following update, in order to make it apparent regarding the cases for FDM that are supported:  **[High] Updated Proposal 5-2**:  At least support the following cases for simultaneous reception of multiple PDSCHs in a slot for MBS based on UE capability for RRC\_CONNECTED Ues   * Case 1: support TDM between M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC   + FFS: the value(s) of M * Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC   + FFS: the value(s) of N * Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC   + FFS: the value(s) of K and L * Case 5: support FDM among T (T=2) group-common PDSCHs using different G-RNTIs in a slot per CC   + FFS whether T>2 is supported or not * Case 6: support FDM among at least F (F≥1) group-common PDSCH and unicast PDSCH in a slot per CC   + FFS: the value(s) of F |
| Moderator | Proposal 5-1:  Based on companies’ comments, I think we should defer proposal 5-1.  Proposal 5-2:  Based on the discussion, since MTK has concern, I think it may be better to leave case 5 as FFS.  @Apple, regarding the relation between proposal 5-1 and proposal 5-2, my understanding and intention is that the case 1/2/3 in proposal 5-2 are subjected to the limitation in proposal 5-1, e.g., if UE’s capability in proposal 5-1 is N=4, then for case 1/2/3 in proposal 5-2 the maximum number of PDSCHs in a slot should be not lager than 4. Regarding the ‘using different G-RNTIs’ in case 5, it was my mistake that I used a wrong version for case 5, and I will delete it.  @Nokia, I added the case 6 in the proposal. |

## Updated Proposals (5th round of email discussion)

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

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

* Case 1: support TDM between M (M>1) TDMed unicast PDSCHs and one group-common PDSCH in a slot per CC
  + FFS: the value(s) of M
* Case 2: support TDM among N (N>1) group-common PDSCHs in a slot per CC
  + FFS: the value(s) of N
* Case 3: support TDM between K (K>1) TDMed unicast PDSCHs and L (L>1) TDMed group-common PDSCHs in a slot per CC
  + FFS: the value(s) of K and L
* FFS Case 5: support FDM among T (T=2) group-common PDSCHs in a slot per CC
  + FFS whether T>2 is supported or not
* Case 6: support FDM among at least F (F≥1) group-common PDSCH(s) and one unicast PDSCH in a slot per CC
  + FFS: the value(s) of F

## Company Views (6th round of email discussion)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | Firstly, proposal 5-2 should be discussed in UE feature discussion in the end of WID. We think that this is not urgent issue to be decided in this meeting. BTW, considering that we already supported FDM between one unicast PDSCH and one multicast PDSCH, we don’t see any further motivation of having case 5 (even FFS) and 6. |
| OPPO | Fine for us, to discuss the proposal in UE capability discussion phase as suggested by Samsung is also acceptable for us. |
| Huawei, HiSilicon | Also confused why case 5 is FFS because we have agreed to support FDM-ed unciast and multicast. From UE implementation perspective, case 5 and FDM-ed unciast and multicast perhaps has no differences. If case 6 includes F=1, is’t it the case we have agreed FDM-ed unciast and multicast? |
| vivo | For case 5, since we have agreed to support FDM between unicast PDSCH and group-common PDSCH in a slot based on UE capability in RAN1#102e meeting. I just wonder if a UE is capable to receive one unicast PDSCH and one group-common PDSCH in FDM manner, why the UE can’t receive two group-common PDSCH in FDM manner? |
| MTK | As we commented in previous round, we don’t see any motivation to support multiple FDMed group-common PDSCH like case 5 and case 6(F>1). Could some proponents of case 5 clarify what is the motivation to support multiple FDMed group common PDSCH? |
| Spreadtrum | Not support.  We don’t understand why case 6 is proposed again. In 4th round, as compromise, we are fine with case 5. If case 6 is as one option, we are also not OK with case 5. The reason we have commented, and we don’t repeat it again here. |
| CATT | Similar views with other companies that the proposal is related to UE feature/capatility discussion.   * For case 1/2/3, are they separate or one UE feature. If case 3 is supported, it seems case 1 and 2 can be supported as default by UE capability. * For case 5/6 for FDM, extra requirement besides current UE capability is not desired. |

## Updated Proposals (6th 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. |
| Ericsson | We support the FL view to defer the discussion |
| Convida | Agree with FL’s suggestion. |
| FUTUREWEI | ok to postpone |
| Intel | Ok to defer discussion |
| Lenovo, Motorola Mobility | Ok to defer discussion |
| vivo | Ok to defer discussion |
| Apple | Ok to defer discussion |
| Spreadtrum | Ok to defer discussion |
| Nokia, NSB | Ok to defer discussion |
| TD Tech& Chengdu TD Tech | Ok to defer the discussion. |
| Moderator | It’s clear majority think multi-beam operation for multicast can be deferred, so we will not discussed it anymore in this meeting. |

# 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. |
| Ericsson | We disagree. We do not see how this could be captured in RAN1 specifications. In our understanding this issue is discussed by higher layer WGs. |
| Convida | We are not ready to agree on this proposal and we think more discussion and clarification is needed. |
| Intel | This is a RAN2 issue and should not be discussed in RAN1. |
| Lenovo, Motorola Mobility | We don’t think it is right timing and place to discuss in RAN1. |
| vivo | We think it should be RAN2’s issue. |
| Apple | We think this is RAN2 issue and should be discussed there. |
| Spreadtrum | It should be RAN2’s issue. |
| Nokia, NSB | It should be RAN2’s issue. |
| TD Tech& Chengdu TD Tech | We agree with proposal 7-1.  **Proposal 7-1**:  NR MBS UEs support reporting its interested broadcast service under RRC\_CONNECTED state. |
| Moderator | It’s clear that only 3 companies agree with this proposal, and majority think this should be discussed in RAN2 or needs more discussion. Therefore, this issue will not be discussed in this meeting anymore. |

# Proposals for GTW session

# References

1. RP-193248 New WID proposal: NR Multicast and Broadcast Services
2. RP-201038 Revised WID: Core part: NR multicast and broadcast services
3. R1-2100048 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

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| **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 |
| [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 |
| [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 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.  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 |
| [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. |
| [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. |
| [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 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).  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.  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.  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.  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 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.  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 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.  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 |