**3GPP TSG RAN WG1 Meeting #103-e R1-200xxxx**

**E-meeting, October 26-November 13, 2020**

**Agenda Item: 8.12.2**

**Source: Moderator (Huawei)**

**Title: FL summary on improving reliability for MBS for RRC\_CONNECTED UEs**

**Document for: Discussion and Decision**

# Introduction

This summary summarizes the contributions submitted in AI 8.12.2 to discuss how to improve the reliability for MBS for RRC\_CONNECTED UEs.

Regarding this aspect, the following agreements were made during the RAN1#102-e meeting.

*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 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*

This summary includes three high level aspects to address HARQ-ACK feedback, PDSCH repetition, and CSI feedback as agreed in the last meeting. In each of high level issue, a sub-level list of issues are organized.

For each of listed issue, proposal(s) is/are suggested from moderator’s perspective according to the submitted individual company’s proposal(s). Companies are welcome to make comments in the table “collect views”. The proposals may be updated in a second round according to the comments collected in the previous round so as to strive to converge to consensus.

People can use “navigation pane” to quickly overview the organization of the summary and proposal(s) for each issue for discussion and provide views/comments into the table of “collect view” under each proposal.

# HARQ-ACK feedback

## HARQ-ACK feedback option

Background

The last meeting agreed HARQ-ACK feedback is supported and to FFS the detailed HARQ-ACK feedback solution, e.g., ACK/NACK, NACK-only based.

*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.*

Submitted Proposals

* (Futurewei) Proposal 2:
  + Support NACK-only HARQ-ACK operation.
* (Futurewei) Proposal 4:
  + UE-specific, ACK-NACK based feedback is supported at least for small groups
* (Huawei) Proposal 1:
  + ACK/NACK feedback mode should be adopted to NR MBS as baseline.
* (Huawei) Proposal 2:
  + NACK only feedback mode could apply to use cases for a large number of UEs and even IDLE/ INACTIVE states.
* (Chengdu TD-Tech) Proposal 1:
  + HARQ-ACK feedback with the shared PUCCH resource is supported for the PTM bearer of MBS.
* (Chengdu TD-Tech) Proposal 2:
  + ACK/NACK feedback with the dedicated PUCCH resource is supported for the PTM bearer of MBS.
* (Vivo) Proposal 2:
  + For RRC\_CONNECTED UE, both NACK only and ACK/NACK feedback are supported for multicast.
* (CMCC) Proposal 1:
  + First decide whether to support multiplexing between HARQ-ACK feedback for PTM and PTP and other UCIs before making the decision to support ACK/NACK based HARQ-ACK feedback for group-common PDCCH based group scheduling.
* (CMCC) Proposal 3:
  + ACK/NACK based HARQ-ACK feedback for UE-specific PDCCH based group scheduling can be supported.
* (CMCC) Proposal 4:
  + NACK-only based HARQ-ACK feedback for group-common PDCCH based group scheduling can be supported.
* (CMCC) Proposal 5:
  + NACK-only based HARQ-ACK feedback for UE-specific PDCCH based group scheduling can be supported, especially for the case with large number of UEs in a MBS group.
* (LG) Proposal 1:
  + Support the following solutions based on configuration for support of MBS HARQ feedback:
    - Solution 1: NACK-only HARQ feedback on PUCCH.
    - Solution 2: HARQ feedback enabled/disabled indicator in DCI
    - Solution 3: UL Configured Grant for HARQ feedback
    - Solution 4: RACH based HARQ feedback
* (Samsung) Proposal 1:
  + HARQ-ACK feedback for MBS PDSCH receptions is as for unicast PDSCH receptions. FFS for NACK-only HARQ-ACK feedback.
* (OPPO) Proposal 4:
  + The following options can be considered for Broadcast/Multicast service
    - Option 1: NACK only feedback, shared NACK resource
    - Option 2: ACK and NACK feedback, separate ACK and NACK resource
    - Option 3: ACK and NACK feedback, shared NACK resource and separate ACK resource.
    - Option 4: ACK and NACK feedback, shared ACK resource and separate NACK resource.
* (Potevio) Proposal 2:
  + ACK/NACK based HARQ-ACK feedback mechanism should be more suitable for the case with fix number of UEs in a group.
* (Potevio) Proposal 3:
  + NACK only based feedback should be used for cases with a large number of UEs receiving MBS.
* (ZTE) Proposal 8:
  + NR MBS should at least support ACK/NACK feedback.
* (Nokia) Proposal 4:
  + NACK-only feedback on group-common PUCCH resources along with CSI reporting is used as the HARQ-ACK feedback solution for PTM operation for UEs in RRC\_CONNECTED mode.
* (Google) Proposal 1:
  + Support ACK/NACK based HARQ feedback as the baseline feature for Rel. 17 MBS. NACK-only based HARQ feedback can also be supported for UL resource limited system.
* (Lenovo) Proposal 1:
  + Both Option 1 (group-NACK transmission) and Option 2 (UE-specific ACK/NACK transmission) are supported for NR MBS.
* (Lenovo) Proposal 3:
  + Switching between Option 1 (group-NACK transmission) and Option 2 (UE-specific ACK/NACK transmission) are supported for NR MBS.
* (MediaTek) Proposal 1:
  + HARQ feedback Opt 1 should be supported in order that gNB can use unicast or multicast based retransmission for each UE.
* (MediaTek) Proposal 2:
  + HARQ ACK/NACK feedback mode can be configured when UEs in one MBS group are relatively small.
* (MediaTek) Proposal 3:
  + Common NACK only feedback mode should be configured when more UEs exist in one MBS group.
* (MediaTek) Proposal 4:
  + Separate NACK only feedback mode should be configured for reducing ACK UE’s power consumption.
* (MediaTek) Proposal 5:
  + NR multicast HARQ-ACK feedback can support more than one HARQ feedback mode based on different usage scenarios.
* (Intel) Proposal 2:
  + For RRC\_CONNECTED UEs, NR MBS supports both ACK/NACK based and NACK-only HARQ feedback. The configuration of ACK/NACK and NACK only mode can be done using the following options
    - Option 1: Semi-static RRC configuration of ACK/NACK or NACK only mode
    - Option 2: The configured PUCCH resource can contain additional indication that the UE is expected to transmit only NACK on the configured resource
    - Option 3: If UE has no dedicated PUCCH resource configuration, the UE uses cell-specific PUCCH resource and is expected to only transmit NACK
* (Convida) Proposal 1:
  + Different HARQ feedback schemes should be considered for NR multicast for the UEs in RRC\_CONNECTED state. Shared ACK-NACK based scheme can be considered as another alternative of the NACK only based scheme.
* (Convida) Proposal 2:
  + Supporting HARQ feedback for NR broadcast service to improve the reliability can be considered for the UEs in RRC\_CONNECTED state.
* (Qualcomm) Proposal 1:
  + For RRC\_CONNECTED UEs, support both group NACK and UE-specific ACK/NACK for HARQ feedback and corresponding retransmission.
    - FFS: PUCCH resource allocation for multicast feedback
    - FFS: Type 1, 2, 3 HARQ-ACK codebook for multicast feedback
* (Ericsson) Proposal 1:
  + The HARQ feedback solution for PTM is an ACK/NACK based solution where each UE in a PTM group has its own PUCCH resource to send HARQ feedback

### 1st round discussion

FL’s Comments

From the submitted contributions, there is a clear majority view of supporting both ACK/NACK and NACK-only based HARQ-ACK feedback for RRC\_CONNECTED UE. No company proposed to not support the other option between these two when proposing one option as the baseline, but rather some propose to consider or FFS the other option. 1 company proposes ACK/NACK based is for UE-specific PDCCH based group but whether for group-common PDCCH depends on UCI multiplexing of PTP and PTM.

7 companies proposed PUCCH resource related aspects for the proposed HARQ-ACK option(s). For example, PUCCH resource for NACK-only can be group-common or separate resources. For ACK/NACK, each UE has its own PUCCH resource, UEs can share a common resource for ACK and/or a different common resource for NACK. PUCCH resource will be discussed in section 2.2 specifically.

Further, companies analysed or proposed which option is supported in which cases. For example, ACK/NACK based feedback is deemed to be supported for small groups and otherwise NACK-only based is supported.

When both options are supported, 2 companies proposes to switch or configure between ACK/NACK and NACK-only with three options. 1 company proposed also RACH based HARQ feedback and UL configured grant for HARQ feedback.

FL’s Proposal:

#### Proposal 2.1: (HARQ-ACK options)

For RRC\_CONNECTED UEs, support both ACK/NACK based and NACK-only based HARQ-ACK feedback for multicast.

* For ACK/NACK based,
  + From per UE perspective, UE feedback ACK or NACK.
  + From UEs within the group perspective, ACK resources are not shared and NACK resources are not shared.
* For NACK-only based,
  + From per UE perspective, UE only feedback NACK.
  + From UEs within the group perspective, NACK resources are shared.
* FFS other HARQ-ACK feedback options

Collect views:

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| **Company** | **Comments** |
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## HARQ-ACK feedback resource

Background

Resources for HARQ-ACK feedback was not discussed in the last meeting. Resources may depend on the HARQ-ACK feedback options also. In addition, when discuss HARQ-ACK feedback resource for MBS, the proposals need to clarify the discussion is from per UE perspective which may receive both unicast and MBS, or from UEs within the group perspective, for which the resource for UEs within the group may be common or different.

Submitted Proposals

* (Futurewei) Proposal 1:
  + A common PUCCH resource for MBS HARQ feedback is defined.
    - This common PUCCH resource is in addition to any PUCCH that NR unicast may have.
    - The common PUCCH resource is indexed based on the HARQ process number
    - The common-RNTI scrambled DCI PRI field indicate orthogonal PUCCH resources per HARQ process ID to transmit UL feedback.
* (Futurewei) Proposal 5:
  + If there are unicast and multicast TBs in the same slot, the HARQ-ACK feedback mechanism should allow more than one PUCCH with HARQ-ACK in the same slot and/or to consider multiplexing/prioritization
* (Chengdu TD-Tech) Proposal 1:
  + HARQ-ACK feedback with the shared PUCCH resource is supported for the PTM bearer of MBS.
* (Chengdu TD-Tech) Proposal 2:
  + ACK/NACK feedback with the dedicated PUCCH resource is supported for the PTM bearer of MBS.
* (CATT) Proposal 5:
  + For HARQ-ACK feedback mechanism in MBS, the following methods can be considered:
* UE-specific PDCCH to indicate PUCCH resources for common PDSCH.
* Group-common PDCCH to indicate PUCCH resource for common PDSCH.
* Multiple group-common PDCCHs to indicate PUCCH resources for common PDSCH.
* Group-common PDCCH to indicate UE-specific periodic PUCCH resources.
* DCI of UE-specific PDCCH to indicate PUCCH resources for MBS.
* (OPPO) Proposal 1:
  + For Broadcast service, a shared PUCCH resource for all UEs to do UL feedback is preferred.
* (OPPO) Proposal 2:
  + For Groupcast service, both shared and separate PUCCH resource among UEs within the group are supported.
* (Apple) Proposal 1:
  + Configure each UE in the group a dedicated PUCCH resource for MBS service.
* (ZTE) Proposal 1:
  + Regarding ACK/NACK feedback for NR MBS, an orthogonal PUCCH resource should be determined for each UE in the same MBS group sharing the same K1 and PRI.
* (ZTE) Proposal 2:
  + Regarding ACK/NACK feedback for NR MBS, UE determines the PUCCH resource for ACK/NACK feedback for NR MSS based on the last unicast PDCCH if UE receives both unicast and multicast at the same time.
* (ZTE) Proposal 7:
  + If NACK-only feedback is supported for NR MBS, at least the following issues should be addressed.
    - PUCCH resource configuration and determination
    - Time domain overlapping between multiple NACK only PUCCHs
    - Time domain overlapping between NACK only PUCCH and unicast PUCCH/PUSCH
    - Processing order of NACK only related multiplexing
* (Ericsson) Proposal 2:
  + Dedicated PUCCH resource is configured for PTM traffic HARQ feedback for each UE in PTM group.

### 1st round discussion

FL’s Comments

7 companies discussed PUCCH resource for HARQ-ACK feedback for MBS. Some companies see it from per UE perspective and some others from all UEs within the group perspective. Also, depending on the option for HARQ-ACK feedback, PUCCH resource for MBS might be different.

Given there is no clear majority view, FL lists the options for collecting companies’ view and suggests discussing the two proposals separately, for ACK/NACK based and NACK-only based, respectively.

FL’s Proposal

#### Proposal 2.2-1: (ACK/NACK based)

For ACK/NACK based HARQ-ACK feedback, PUCCH resource is,

* from per UE perspective,
  + Option 1: shared with PUCCH resource for unicast
  + Option 2: separate from PUCCH resource for unicast
* from UEs within the group perspective, orthogonal among the UEs

Collect views:

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| **Company** | **Comments** |
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#### Proposal 2.2-2: (NACK-only based)

For NACK-only based HARQ-ACK feedback, PUCCH resource is,

* + from per UE perspective, separate from PUCCH resource for unicast
  + from UEs within the group perspective, common among the UEs

Collect views:

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| **Company** | **Comments** |
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## HARQ-ACK codebook

Background

HARQ-ACK codebook was not discussed in the last meeting. This discussion is about how the HARQ-ACK feedback is generated, including the cases of UE receiving unicast and MBS and the cases of UE receiving more than one MBS.

Submitted Proposals

* (CATT) Proposal 6:
  + Rel-17 MBS HARQ-ACK codebook determination can reuse the current NR Type-1 semi-static and Type-2 dynamic codebook determination mechanism as baseline.
* (CATT) Proposal 7:
  + Joint codebook determination is considered when Type-1 codebook is used for both MBS and unicast.
* (CMCC) Proposal 2:
  + If ACK/NACK based HARQ-ACK feedback is to be supported for group-common PDCCH based group scheduling, and if no more than one PTM PDSCH are FDMed in one slot, both semi-static HARQ-ACK codebook and dynamic HARQ-ACK codebook can be considered for PTM.
* (CMCC) Proposal 6:
  + Do not support semi-static HARQ-ACK codebook design when multiple PTM PDSCHs are FDMed in one slot.
* (ZTE) Proposal 3:
  + Regarding ACK/NACK feedback for NR MBS for UEs only receiving MBS service, consider the following mechanisms.
    - Semi-static HARQ-ACK codebook based on the SLIVs
    - Dynamic HARQ-ACK codebook. UE generates one sub-codebook per MBS service and concatenates all the sub-codebooks together.
* (ZTE) Proposal 4:
  + Regarding ACK/NACK feedback for NR MBS for UEs receiving both unicast and MBS service, UE generates sub-codebook for unicast and MBS service separately and concatenates the sub-codebooks together.
* (Intel) Proposal 4:
  + Further study the following options for MBS HARQ codebook design
    - Joint codebook with unicast
    - Separate HARQ codebook for NR MBS
* (Ericsson) Proposal 3:
  + When dynamic HARQ feedback codebook is configured, the DAI in PDCCH is counted independently between PTP and PTM and between different PTM group which can be distinguished according to the RNTI used for PDCCH.

### 1st round discussion

FL’s Comments

5 companies submitted proposals regarding the HARQ-ACK codebook for MBS.

Regarding HARQ-ACK codebook for MBS, both type 1 and type 2 codebooks can be supported, but 1 company proposed type 1 codebook is not supported when more than one PTM are FDM-ed in the same slot. 1 company proposed details on how to generate dynamic codebook for UE receiving more than one MBS.

Regarding HARQ-ACK codebook determination for MBS and unicast, joint codebook or separate codebook are two options. 1 company proposed how to generate the joint codebook. 1 company proposed the DAI counting is independently between unicast and MBS.

FL suggests separately discussing the two cases, one for codebook for MBS and the other for codebook for MBS and unicast.

FL’s Proposal

#### Proposal 2.3-1: (codebook type for MBS)

Both Type-1 and Type-2 codebook are supported for MBS,

* FFS HARQ-ACK codebook if more than one MBS PDSCH are FDM-ed within one slot.
* FFS HARQ-ACK codebook if UE supports more than MBS services.

Collect views:

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| **Company** | **Comments** |
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#### Proposal 2.3-2: (codebook for MBS and unicast)

For HARQ-ACK codebook determination, when HARQ-ACK feedback is available for both unicast and MBS, further down-select among:

* Option 1: generate a joint codebook for both MBS and unicast
* Option 2: generate codebook for MBS separately from codebook for unicast
* Option 3: combination of Option 1 and Option 2.
* FFS details.

Collect views:

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| **Company** | **Comments** |
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## UCI multiplexing/prioritization

Background

This was not discussed in the last meeting. Current specification supports two types of HARQ-ACK feedback corresponding to different priorities. The HARQ-ACK feedback with the same priority will be multiplexed and different priorities will be prioritized. When discussing the HARQ-ACK feedback for MBS, some relevant issues need to be discussed. For example, whether MBS is one priority or can be more than one priority; what the priority is between unicast and MBS; is it multiplexing or prioritizing between feedback for unicast and MBS when determining the feedback resources.

Submitted Proposals

* (Futurewei) Proposal 6:
  + For the cases when HARQ-ACK feedback is available for both unicast and multicast transmissions, the multiplexed or prioritized HARQ-ACK is sent in UE-specific PUCCH resource and not in common PUCCH resource.
* (Huawei) Proposal 6:
  + Priority indication and/or configuration schemes should be introduced for NR MBS. Moreover, the prioritization and multiplexing rules defined in URLLC can be the starting point for NR MBS.
* (Vivo) Proposal 6:
  + Regarding HARQ-ACK for multicast PDSCH, the followings need to be discussed/decided.
    - Aggregated HARQ-ACK feedback, i.e., 1-bit HARQ-ACK for multiple PDSCHs can be considered
    - In case of simultaneous multicast and unicast traffic for the same UE, whether HARQ-ACK for multicast PDSCH and unicast PDSCH can be multiplexed in one HARQ-ACK CB
* (CATT) Proposal 8:
  + The current multiplex mechanism (i.e. concatenates the TB-based HARQ-ACK codebook followed by the CBG-based HARQ-ACK codebook) can be reused for MBS and unicast codebook determination.
* (Samsung) Proposal 7:
  + Support configuration between multiplexing and prioritization of MBS HARQ-ACK feedback and unicast UCI.
* (OPPO) Proposal 6:
  + Multiplexing HARQ-ACK information for unicast and one/multiple MBMS in a single feedback channel should be supported.
* (ZTE) Proposal 5:
  + Regarding ACK/NACK feedback for NR MBS for UEs receiving both unicast and MBS service, the existing multiplexing methods can be reused between unicast and MBS.
* (Qualcomm) Proposal 2:
  + Support multiplexing of UE-specific ACK/NACK for unicast and multicast transmission based on UE capability.
    - FFS: Type 1, 2, 3 HARQ-ACK codebook for multiplexing unicast and multicast feedback

### 1st round discussion

FL’s Comments

8 companies submitted proposals regarding the relation between HARQ-ACK feedback for MBS and HARQ-ACK feedback for unicast when the feedback occasions are in the same slot.

For discussing UCI multiplexing (especially for HARQ-ACK feedback) between unicast and MBS, we also need to discuss the priority for MBS and the priority between unicast and MBS also unless HARQ-ACK feedback for MBS is always multiplexed with unicast.

Since this issue is firstly discussed in this work item, and there is no clear majority view. FL suggests the following proposals for further discussion.

FL’s Proposal

#### Proposal 2.4-1: (Priority for MBS and unicast)

Number of priority for MBS is, for further down-selection, options are:

* Option 1: One
* Option 2: two
* Option 2: More than two
* FFS the priority between MBS and unicast

Collect views:

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| **Company** | **Comments** |
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#### Proposal 2.4-2: (multiplexing/prioritizing)

For the cases of HARQ-ACK feedback is available for MBS and unicast, for determining the PUCCH resource, down-selection will be done among:

* Option 1: Multiplexing is applied
* Option 2: Prioritizing is applied
* Option 3: Combination of Option 1 and Option 2

Collect views:

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| **Company** | **Comments** |
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## Enable/disable HARQ-ACK feedback

Background

The last meeting agreed the following:

*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.*

Submitted Proposals

* (Futurewei) Proposal 7:
  + HARQ-ACK feedback enabling and disabling is supported.
* (Huawei) Proposal 3:
  + Disabling and enabling HARQ feedback should be introduced to NR MBS which can help with a good trade-off between HARQ feedback overhead and system reliability for NR MBS.
* (Huawei) Proposal 4:
  + Disabling and enabling HARQ feedback is indicated by DCI.
* (Huawei) Proposal 5:
  + The function of enabling/disabling HARQ-ACK feedback is optional.
* (Vivo) Proposal 1:
  + HARQ-ACK feedback for multicast should be RRC configurable.
* (CATT) Proposal 4:
  + A UE can only feedback HARQ-ACK information according to its interested/received MBS services.
* (Samsung) Proposal 3:
  + A gNB can be configured by higher layers a UE whether or not to report HARQ-ACK information for SPS PDSCH receptions.
* (OPPO) Proposal 5:
  + Zone and communication range based HARQ-ACK feedback should be considered for Broadcast/Multicast service.
* (Nokia) Proposal 8:
  + HARQ-ACK feedback can be optionally disabled and / or enabled per UE.
* (Lenovo) Proposal 2:
  + HARQ-ACK feedback for MBS can be enabled or disabled.
* (MediaTek) Proposal 8:
  + NR multicast HARQ-ACK feedback can be disabled.
* (MediaTek) Proposal 9:
  + NR multicast HARQ-ACK disable/enable indicator can be defined in DCI with 1bit.
* (Intel) Proposal 1:
  + For NR MBS, HARQ feedback should be configurable i.e., it can be enabled or disabled. The following options can be considered for such configuration
    - Semi-static configuration through RRC signaling
    - Dynamic indication using a single bit in the scheduling DCI for the groupcast transmission
* (Convida) Proposal 3:
  + HARQ feedback enabling and disabling should be supported in NR multicast and broadcast.
* (Qualcomm) Proposal 3:
  + For RRC\_CONNECTED UEs, HARQ-ACK feedback can be optionally enabled/disabled by RRC signaling.
    - The configuration of HARQ-ACK feedback can be configured for a given G-RNTI (corresponding to a service) or for a UE receiving a service.

### 1st round discussion

FL’s Comments

12 companies submitted proposals regarding enabling/disabling HARQ-ACK feedback for MBS. Basically all companies support enabling/disabling the HARQ-ACK feedback for MBS.

2 companies propose DCI indicates enabling/disabling, 3 companies propose higher layer signalling or RRC configures it, and 1 company proposes both options can be considered.

Also, 3 companies propose enabling/disabling function is optional. 1 company propose Zone and communication range based HARQ-ACK feedback should be considered for MBS.

FL’s Proposal

#### Proposal 2.5:

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

* Option 1: DCI indicates enabling/disabling
* Option 2: RRC configures enabling/disabling
* FFS how to implement enabling/disabling optionally

Collect views:

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| **Company** | **Comments** |
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## Retransmission

Background

Retransmission was not discussed in the last meeting. The HARQ-ACK feedback option may also affect how to retransmit MBS, i.e., via PTP or PTM.

Submitted Proposals

* (Futurewei) Proposal 3:
  + Allow scheduling more than one MBS TBs within a single DCI.
* (ZTE) Proposal 6:
  + Both PTM-based and PTP-based retransmissions can be considered for NR MBS.
* (Google) Proposal 2:
  + Support UE-specific PDCCH scheduling broadcast/multicast PDSCH for MBS initial transmission and retransmission.
* (MediaTek) Proposal 10:
  + HARQ feedback Opt 1 should be supported in order that gNB can use unicast or multicast based retransmission for each UE.
* (MediaTek) Proposal 11:
  + For common NACK only feedback mode, the retransmission only support multicast mechanism.
* (Intel) Proposal 5:
  + For ACK/NACK based HARQ operation, support UE specific CBG based retransmission. Other advanced retransmission schemes are not precluded.
* (Ericsson) Proposal 4:
  + PTP based retransmissions can be soft combined with earlier PTM transmissions

### 1st round discussion

FL’s Comments

6 companies submitted proposals regarding the retransmission for MBS. Basically, retransmission for MBS can be group-common or via unicast. For NACK-only based HARQ-ACK feedback and the resource for NACK-only are shared, retransmission will be group-common. For the case of NACK-only resource are specific from UEs within the group perspective, retransmission can be group-common or UE-specific. For the cases of ACK/NACK based HARQ-ACK feedback, retransmission can be group-common or UE-specific.

Therefore, the retransmission for MBS may depend on the HARQ-ACK feedback option or the resources for HARQ-ACK feedback. We either discuss this issue when the discussion of feedback options and feedback resources have progress, or keep the retransmission discussion in general or high level. At this stage, FL suggests the latter.

FL’s Proposal

#### Proposal 2.6:

Retransmission of group-common PDSCH for MBS 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
* Option 3: both option 1 and option 2
* FFS CBG based retransmission

Collect views:

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| **Company** | **Comments** |
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# PDSCH repetition

Background

The last meeting agreed the following:

*Agreements:*

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

Submitted Proposals

* (Futurewei) Proposal 8:
  + For broadcast, if slot-level repetition is the only method for improving reliability, this feature can be enabled. FFS for multicast.
* (Huawei) Proposal 7:
  + The PDSCH repetition mechanism and CSI feedback mechanism used in NR unicast can be applied to NR MBS without any enhancements.
* (Vivo) Proposal 13:
  + For PDSCH repetition of group-common PDSCH, the PDSCH repetition factors for different MBS services should be separately configured.
* (CATT) Proposal 9:
  + To support multi-beam transmission in MBS, gNB can transmit same MBS data on all SSB beams.
* (CATT) Proposal 10:
  + UE can receive MBS data from neighbor SSB-beam, and the soft-combination is used to improve the reliability of MBS receptions.
* (CMCC) Proposal 7:
  + For slot-based PDSCH repetition for NR MBS, the repetition number is configured by RRC signalling.
* (Apple) Proposal 2:
  + To enhance the MBS reception reliability, the following schemes can be considered for RRC\_CONNECTED UEs
    - Dynamic indication of MBS PDSCH repetition number
    - Frequency hopping
    - Cross-slot channel estimation
    - Enhanced CSI report
* (ZTE) Proposal 9:
  + Slot-level repetition of group-common PDSCH is supported for UEs in RRC\_IDLE/INACTIVE states.
* (Nokia) Proposal 5:
  + Slot-level blind transmissions with different redundancy versions are followed by adaptive HARQ feedback-based retransmissions, in order to reduce PUCCH resource consumption without decreasing the performance of the system significantly compared to fully adaptive scheme with only adaptive HARQ-based retransmissions.
* (Lenovo) Proposal 4:
  + The number of transmission repetitions for MBS PDSCH is configured by RRC signaling.
* (Intel) Proposal 7:
  + NR MBS supports dynamic indication of number of repetitions for PDSCH transmissions with slot-based repetitions
* (Qualcomm) Proposal 4:
  + Support independent repetition configuration for GC-PDSCH with different G-RNTIs.
* (Qualcomm) Proposal 5:
  + Support semi-static and dynamic slot-level repetition for GC-PDSCH.
    - Semi-static and dynamic repetition for GC-PDSCH are not simultaneously configured for the GC-PDSCH associated with same G-RNTI
    - FFS: gap in between repeated GC-PDSCH slots
* (Ericsson) Proposal 5:
  + The Rel.16 NR unicast framework for PDSCH repetition is reused for multicast/PTM.

### 1st round discussion

FL’s Comments

12 companies submitted proposals regarding PDSCH repetition for MBS for improving reliability.

1 company proposed slot-level repetition is only for broadcast and FFS for multicast. It is unclear so far what broadcast and multicast mean and what the difference is in RAN1. FL suggest discussing it later when the difference is clearer and maybe guidance from RAN2 is needed. Also, RRC\_CONNECTED UE is the focus for the discussion of this agenda.

There are some proposals that repetition number is indicated by RRC, DCI, or RRC/DCI but not simultaneously. Also, there is single proposal related to SSB based beams, a single proposal for blind transmission, and a single proposal related to configuration for different MBS services.

Per FL’s understanding, PDSCH aggregation configured by RRC is supported since Rel-15 and Rel-16 introduced that PDSCH repetition can be indicated also via DCI as agreed for URLLC in mTRP but which seems mTRP specific, for example, 38.214 states the follows:

When a UE is configured by the higher layer parameter *repetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n*-r16*, the UE may expect to be indicated with one or two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* together with the DCI field "*Time domain resource assignment*' indicating an entry which contains *repetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocation-r16* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)"*.

Since the last meeting has agreed to support slot-level repetition for group-common PDSCH, whether the repetition is referring to Rel-15 slot aggregation, Rel-16 repetition for mTRP or something different from Rel-15 and Rel-16 can be further discussed.

FL’s Proposal

#### Proposal 3:

For slot-level repetition for group-common PDSCH, for indicating the repetition number, further down-select among:

* Opt 1: by DCI
* Opt 2: by RRC
* Opt 3: either Opt 1 or Opt 2.
* FFS independently configured for different GC-PDSCH with different G-RNTIs.
* FFS relation with SSB.

Collect views:

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |

# CSI feedback

Background

The last meeting agreed the following:

*Agreements:*

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

Submitted Proposals

* (Huawei) Proposal 7:
  + The PDSCH repetition mechanism and CSI feedback mechanism used in NR unicast can be applied to NR MBS without any enhancements.
* (CATT) Proposal 1:
  + CSI measurement/ report, if applied, for MBS can reuse the Rel-15 mechanism in unicast. CSI report for unicast and MBS is not differentiated by UE.
* (CMCC) Proposal 8:
  + CSI feedback mechanism in Rel-15/16 can be used for NR MBS, and no additional enhancements are needed.
* (ZTE) Proposal 10:
  + Further study whether enhancement is needed for existing CSI reporting mechanism and reporting quantity so that network can choose the most appropriate PMI/RI for multicast transmission that is targeting a group of UEs.
* (Nokia) Proposal 1:
  + In case NACK-only based HARQ feedback on group-common PUCCH resources is used as the feedback mechanism of multicast transmission, CSI reporting by the UEs is used to perform link adaptation.
* (Nokia) Proposal 2:
  + When using NACK-only based HARQ feedback along with CSI reporting, CQI measurements are done based on actual (time-averaged) BLER measurements at the UEs, rather than (instantaneous) CSI-RS measurements.
* (Nokia) Proposal 3:
  + New compact CSI report formats are defined for multicast transmission, where only a CQI or CQI along with an RI can be reported, and these formats are used in CSI reporting when NACK-only based HARQ feedback on group-common PUCCH resources is used.
* (Nokia) Proposal 6:
  + For PTM, an rBLER target is used, instead of an iBLER target.
* (Nokia) Proposal 7:
  + The configuration for CQI reporting for PTM is extended to include not only the reliability target but also the number of HARQ transmissions per transport block after which the reliability target should be met.
* (Intel) Proposal 6:
  + No further enhancements to NR CSI feedback mechanism is needed for NR MBS
* (Qualcomm) Proposal 6:
  + For RRC\_CONNNECTED UES, configure the CSI-RS resource per Multicast BWP
    - CSI-RS bandwidth is limited within the Multicast BWP.
    - CSI-RS power is associated with GC-PDSCH power
* (Qualcomm) Proposal 7:
  + Support GC-PDCCH to trigger A-CSI-RS transmission in Multicast BWP.
* (Ericsson) Proposal 6:
  + The existing Rel. 15/16 framework of CSI feedback is reused for multicast/PTM with no further additions.

### 1st round discussion

FL’s Comments

8 companies submitted proposals regarding the CSI feedback. 5 companies propose CSI measurement and report for unicast is sufficient so no further enhancement is needed. 1 company proposes FFS whether enhancement is needed. 1 company proposed new CSI report formats and new CQI measurement for NACK-only based HARQ-ACK feedback. 1 company proposed some enhancements related to CSI-RS configuration, A-CSI-RS transmission triggering, and SRS configuration.

Given this situation, FL suggests either concluding no enhancement or FFS. Maybe more discussion or clarification is needed since the enhancement is firstly proposed, FL proposes FFS for the 1st round discussion.

FL’s Proposal

#### Proposal 4:

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

Collect views:

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |

# Other miscellaneous proposals

Submitted Proposals

PUCCH format

* (CATT) Proposal 2:
  + Different PUCCH format can be configured by gNB to adapt different coverage requirement.

Impact on DCI contents

* (Samsung) Proposal 4:
  + The DCI format scheduling MBS PDSCH reception does not include a TPC command field.

Configuration perspective

* (Samsung) Proposal 5:
  + A gNB can provide separate configurations of open-loop power control parameters for PUCCH transmission with unicast HARQ-ACK and for PUCCH transmission with MBS HARQ-ACK.

HARQ process management

* (Google) Proposal 3:
  + Clarify the HARQ process assignment (e.g. HARQ ID) when a UE indicates parallel MBS services with HARQ in the MBS interest indication message.
* (Intel) Proposal 3:
  + For NR MBS, no additional HARQ processes are defined and MBS shares HARQ process ID with unicast i.e., the total of 16 HARQ processes is unchanged.

Other techniques for reliability

* (Qualcomm) Proposal 8:
  + Support beam management for multicast assisted by unicast connection.
* (Qualcomm) Proposal 9:
  + Consider SRS configuration for CSI measurement of multicast transmission in Multicast BWP.

Proposals may be in RAN2’s charge

* (CATT) Proposal 4:
  + A UE can only feedback HARQ-ACK information according to its interested/received MBS services.

Proposals in AI 8.12.1/8.12.3 charge

* (LG) Proposal 2:
  + Allow gNB to use UE specific scheduling of a MBS TB by CSS Type 3 or USS with C-RNTI in UE’s active BWP.
* (ZTE) Proposal 9:
  + Slot-level repetition of group-common PDSCH is supported for UEs in RRC\_IDLE/INACTIVE states.

FL’s Comments

There are some other miscellaneous proposals proposed but from a single or a couple of companies. FL suggests discussing them later when more companies are interested in or can be discussed in other above issues, other agendas, or other WGs when applicable.

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