**3GPP TSG RAN WG1 #102-e R1-200xxxx**

**e-Meeting, 17th - 28th August, 2020**

**Agenda item:** 8.12

**Source:** Moderator (CMCC)

**Title:** Phase 2 moderator summary on NR Multicast and Broadcast Services

**Document for:** Discussion/decision

# Introduction

As announced by chairman, one email thread is planned to discuss high-level aspects for NR MBS in this meeting.

[102-e-NR-MBS-01] Email discussion/approval using R1-2007001 as a starting point, focusing on high-level aspects – Fei (CMCC)

* By 8/19 – Classification of high priority/medium priority items for this e-Meeting
* By 8/24 – high priority items
* By 8/27 - medium priority items

The initial moderator summary is provided in R1-2007001 which can be found in the inbox. The issues in the summary are classified into two tiers.

The first tier issues are the ones for the high level concept and can be considered as starting point for this meeting, which are summarized in table 1 below and the details can be found in section 2 in R1-2007001.

The second tier issues are low priority issues and are mainly the ones for details or further step issues set up on the conclusion of the first tier issues, which are targeted to be discussed in the following meeting but some of them can also be discussed in this meeting upon the first tier issues are concluded. The summary and the details for the second tier issues can be found in section 3 in R1-2007001.

**Table 1: The first tier issues**

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| **Sub-agenda** | **Issues (summary in section 2 in R1-2007001)** |
| Group scheduling for RRC\_CONNECTED UEs | **Issue 1 (Question 1 in R1-2007001)**: Regarding the two high level group scheduling mechanisms, i.e., group-common PDCCH based group scheduling and UE-specific PDCCH based group scheduling, whether down selection is needed or both of them can be considered for MBS for RRC\_CONNECTED UEs? |
| **Issue 2 (Question 2 in** **R1-2007001)**: Please share your views on the following two alternatives for frequency resource configuration for MBS for RRC\_CONNECTED UEs.• Alternative 1: Introduce a MBS specific BWP• Alternative 2: Define a MBS common frequency resource confined within UE’s active BWP. |
| **Issue 3 (Question 3 in** **R1-2007001)**: Whether the simultaneous operation with unicast reception in the WID means a UE is required to receive multicast PDSCH and unicast PDSCH simultaneously in one slot? If the answer is YES, which multiplexing type(s) of simultaneous reception of unicast PDSCH and multicast PDSCH in a slot can be supported in NR MBS? e.g., TDM, FDM, SDM. |
| Reliability improvement for RRC\_CONNECTED UEs | **Issue 4 (Proposal 1 in R1-2007001, with little update)**: For RRC\_CONNECTED UEs, HARQ-ACK feedback is supported for multicast without additional evaluation for it, i.e., no evaluation is needed to justify whether HARQ-ACK feedback is needed. |
| **Issue 5 (Proposal 2 in R1-2007001, with little update)**: For RRC\_CONNECTED UEs, consider following reliability improvement mechanisms for MBS.• CSI feedback, FFS whether modification is needed on top of existing CSI feedback mechanism for unicast• PDSCH repetition, FFS whether spec impact is implied |
| **Issue 6 (Question 4 in R1-2007001, with little update)**: Whether a common evaluation methodology and assumptions are necessary for NR MBS? If the answer is YES, what’s the purpose of the evaluation? And what’s your suggestion on the common evaluation methodology and assumptions? |
| Basic functions for MBS for RRC\_IDLE/RRC\_INACTIVE UEs | **Issue 7 (Proposal 3 in R1-2007001)**: For UE in IDLE/INACTIVE state, the frequency resource for PTM transmission is• Alt 1: Initial BWP• Alt 2: Configured with larger size to cover initial BWP• Alt 3: Configured to be within initial BWP |
| **Issue 8 (Proposal 4 in R1-2007001)**: Multi-beam/beam-sweeping operation is supported for PTM in IDLE/INACTIVE state. |

According to Chairman’s guidance, this email thread will be organized in three phases:

* Phase 1: by 8/19, classification of high priority/medium priority items for this e-Meeting based on the summarized first tier issues.
* Phase 2: by 8/24, discuss and conclude the high priority items.
* Phase 3: by 8/27, discuss and conclude the medium priority items.

In phase 1, based on companies’ views, the following high/medium priority items have been classified for this meeting:

* High priority:
	+ Issue 1/4/6
* Medium priority:
	+ Issue 2/3/5

For phase 2, companies are invited to provide their views on the high priority issues for this e-Meeting in section 3. Moderator will provide the observation and proposal on the high priority issues in section 2 based on companies’ inputs.

# Observation and Proposal for Phase 2

15 companies have provided their views on high priority issue 1/4/6, the following observation is made based on these inputs:

**Observation**:

* **For issue 1:**
	+ 9 companies [vivo, CMCC, LG, Nokia, OPPO, BBC, Intel, Spreadtrum, CATT] think both option 1 and option 2 can be considered for RRC\_CONNECTED UEs. One of them [OPPO] suggests to make the definition of two group scheduling schemes clearer.
	+ 4company [QC, Huawei, HiSilicon,MTK] thinks at least option 1 should be supported, and FFS for option 2.
	+ 4 companies [TD Tech, ZTE, Ericsson, Convida] support option 1 only.
* **For issue 4:**
	+ 14 companies support the proposal.
	+ 1 company [ZTE] suggests to evaluate the potential gain of HARQ-ACK feedback. 1 company [Nokia] thinks additional evaluation is desirable to compare different HARQ-ACK schemes with some minimum reliability targets. 1 company [Intel] thinks potential gains for HARQ-ACK feedback and the specific HARQ-ACK schemes to be used can be further studied and evaluated.
* **For issue 6:**
	+ 8 companies [vivo, CMCC, OPPO, QC, Spreadtrum, Huawei, HiSilicon,MTK] think the motivation to agree on common evaluation methodology and assumptions at current stage is not clear. One of them mentioned the evaluation methodology and assumptions may be different for different proposed schemes.
	+ 1 company [E///] thinks it is not urgent to agree on common evaluation methodology and assumptions at current stage, and such agreements may be made when the need arises.
	+ 7 companies [TD Tech, LG, Convida, Nokia, ZTE, Intel, BBC] think it is good to have common evaluation methodology and assumptions. The purpose could be, e.g., to verify whether other reliability improvement schemes except HARQ-ACK feedback are needed [TD Tech, LG, Convida], or to enable meaningful comparisons of different reliability improvement schemes from different companies [Nokia, ZTE, Intel], or to select a specific solution for HARQ-ACK feedback [BBC].

Based on the above observation, the following initial proposals are made:

* **Potential Proposal 1 for issue 1**: Both group-common PDCCH based group scheduling and UE-specific PDCCH based group scheduling can be considered for MBS for RRC\_CONNECTED UEs.
	+ The general description of two group scheduling mechanisms are clarified as follows:
		- Group-common PDCCH based group scheduling:
			* For RRC\_CONNECTED UEs in the same MBS group, the PDSCH of a MBS TB is common for the group of UEs and it is scheduled by a group-common PDCCH with CRC scrambled by a common RNTI (e.g., G-RNTI, sub-G-RNTI).
		- UE-specific PDCCH based group scheduling:
			* For RRC\_CONNECTED UEs in the same MBS group, the PDSCH for a MBS TB is common for the group of UEs, and it is scheduled by each UE-specific PDCCH with CRC scrambled by UE-specific RNTI (e.g., C-RNTI, MCS-C-RNTI, etc.) for each UE.
* **Potential Proposal 2 for issue 4:** For RRC\_CONNECTED UEs, HARQ-ACK feedback is supported for multicast and no additional evaluation is needed to justify this.
* **Potential Proposal 3 for issue 6:** Take the following high level evaluation methodology and assumptions as starting point for potential evaluations in MBS.
	+ System-level simulation is recommended
	+ Evaluation scenarios: Rural and Dense-Urban scenarios for FR1 defined in TR38.901.
	+ FFS: Which traffic model is used
		- Option 1: CBR traffic model
		- Option 2: Periodic deterministic traffic model
		- Option 3: Full buffer
	+ FFS: Performance metrics
	+ FFS: The details of the simulation assumptions
	+ FFS: Which reliability improvement scheme(s) needs evaluation
		- Note: No evaluation is needed to justify the support of HARQ-ACK feedback for RRC\_CONNECTED UEs

Companies can comments directly in the email thread or in the table below.

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| **Company** | **Comment** |
| Huawei/HiSilicon | For proposal 1, if option 1 is supported, I fail to see the necessity to additionally support option 2 at this stage. Since no companies object option 1, at least we can agree on option 1 and FFS on option 2. (Note: there are some typos in the proposal 1 basically for RNTIs..)Ok with proposals 2&3.  |
| MTK | For issue 1:For NR MBS, group-common PDCCH based group scheduling can be a basic mechanism, which can reduce PDCCH resource overhead and access more UEs. So, we share the same view with QC/HW, at least optional 1 is supported and option 2 is FFS.For issue 4:In R16 V2X groupcast communication, it had already introduced the HARQ-ACK feedback mechanism to ensure the reliability. So, it is best to reuse HARQ-ACK feedback mechanism directly and no need to spend extra time to evaluate it. We can mainly focus on how to design the feedback mechanism in NR MBS. For issue 6:As our mentioned in Phase 1 stage and issue 4 above, we think there is no need to do any simulation evaluation for MBS. So, I suggest to revise proposal 3 based on newest comments. |
| CATT | For proposal 1:* Both options can be supported based on different scenarios, e.g. different number of UE receiving the same MBS. Both options have its benefit in terms of specific scenarios, e.g. HARQ resource indication, signaling overhead. The network can decide which kind of scheduling mechanism can be used. Additionally, both options should also consider about PUCCH resources for HARQ feedback.
	+ Group-common PDCCH to schedule PDSCH + Group-common PUCCH
	+ Group-common PDCCH to schedule PDSCH + UE-specific PUCCH
	+ UE-specific PDCCH to schedule PDSCH + UE-specific PUCCH
	+ UE-specific PDCCH to schedule PDSCH + Group-common PUCCH
* For Group common PDCCH, we also think sub-group-common PDCCH can be applied when the number of UEs in the same MBS group is too large and the locations of UEs are scattered. So we would like to suggest to add sub-G-RNTI in the e.g. in the bracket.

We are fine of proposal 2 and proposal 3. |
| vivo | We are fine with proposals 1&2.For proposal 1, it is saying both group scheduling mechanism “can be considered”, rather than “are supported”, there is no need to put option 2 in FFS. As commented by many companies, the decision on which group scheduling mechanism should be supported should not only consider the overhead of PDCCH, but also the other aspects, e.g., the standardization effort or spec impact to support HARQ-ACK feedback if it is supported, etc. Now, it seems everybody is ok to support HARQ-ACK for MBS, but there are many variants of HARQ-ACK feedback, we haven’t made decision on which one(s) to be supported. If only group-specific NACK feedback is supported, I admit option 1 may be enough. But if UE-specific HARQ-ACK feedback is supported, the pros for option 2 is very clear. In that case, option 2 should be supported. So, no need to do down selection now.For proposal 3, we still don’t find the reason to have this evaluation methodology and assumptions based on the proposal. In our view, the first thing we should be clear is the purpose of evaluation. If there is no clear purpose now, I think we don’t need to take time on it and there are so many FFS need to be solved if we support this. If proponents think evaluation is needed for some potential enhancements later, they can report the evaluations. |
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# Companies’ Views on high priority issues in Phase 2

***Group scheduling mechanisms for RRC\_CONNECTED UEs***

Based on companies’ submitted contributions, two group scheduling mechanisms were proposed. The first is group-common PDCCH based group scheduling, which is similar to LTE SC-PTM transmission. In this mechanism, CRC of PDCCH is scrambled by a common RNTI (e.g., G-RNIT) and the PDSCH is also scrambled by the common RNTI. Nine companies proposed to consider this mechanism for MBS.

The second is UE-specific PDCCH based group scheduling. In this mechanism, CRC of PDCCH is scrambled by C-RNTI, but different PDCCHs schedule a group common PDSCH for a group of UEs. From UE’s perspective, it is the same as unicast transmission. Three companies proposed to also consider this mechanism.

One company proposed to also consider sub-G-RNTI PDCCH based group scheduling, in which sub-G-RNTI can be used to scramble a sub-group common PDCCH for a small group scheduling. This mechanism seems to fall into group-common PDCCH based group scheduling in high level, if any difference, the details can be considered in later stage.

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| **group scheduling mechanisms** | **Companies** |
| Option 1: group-common PDCCH based group scheduling | Huawei, Nokia, QC, Convida, ZTE, Intel, CATT, CMCC, LG |
| Option 2: UE-specific PDCCH based group scheduling | CMCC, vivo, CATT |

**[High priority] Issue 1 (Question 1 in R1-2007001)**: *Regarding the two high level group scheduling mechanisms, i.e., group-common PDCCH based group scheduling and UE-specific PDCCH based group scheduling, whether down selection is needed or both of them can be considered for MBS for RRC\_CONNECTED UEs?*

Please share your views and comments in the table.

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| **Company** | **Comment** |
| TD Tech, Chengdu TD Tech | Support Option 1 : group-common PDCCH based group schedulingComments on option 2:The PDSCH for unicast is bit-scrambled by C-RNTI. The group common PDSCH is impossible to be entirely same as the PDSCH for unicast.When the number of UEs is large, the PDCCH resource consumed becomes larger than the PDCCH resource used for beam-sweeping in Option 1.  |
| vivo | We think both of them can be considered for MBS for RRC\_CONNECTED UEs for the following reasons:1. group-common PDCCH based group scheduling can be a basic scheduling mechanism, considering there may be quite lots of UEs in an MBS group, this mechanism is beneficial for PDCCH overhead reduction. But this mechanism will introduce many efforts when HARQ-ACK feedback is supported.
2. UE-specific PDCCH based group scheduling can also be used in some cases, for example, the case that number of MBS UEs is medium and the MBS service reliability requirement is high, i.e., HARQ-ACK is needed for the service. In this case, there is no has no PDCCH blocking issue. Then UE-specific PDCCH can benefit from scheduling and HARQ-ACK feedback perspective as summarized in the following table.

In our view, group-common PDCCH mechanism will have large spec impact / standardization effort for HARQ-ACK feedback, multiplexing / prioritization between multicast and unicast, etc. It is more suitable for an MBS with no HARQ-ACK feedback or with only group-specific NACK only feedback. UE-specific PDCCH mechanism can the minimize spec impact / standardization effort for these aspects and is a good scheduling scheme for MBS PDSCH retransmission. Therefore, no down select is needed.Table 1 Comparisons of groupcast PDCCH and unicast PDCCH

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|  | group-common PDCCH | UE-specific PDCCH |
| PDCCH overhead | Low  | high |
| Search space configuration | Larger spec impact | No spec impact |
| DCI size alignment | If DCI 1\_1/1\_2 is used, it may have impact on DCI size alignmentIf DCI 2\_x is used, other group common DCI need to align the DCI payload size with it, which may reduce the PDCCH performance | Same as unicast PDSCH, no additional impact |
| Impact on HARQ-ACK feedback | PUCCH resource | Hard to indicate orthogonal PUCCH resources due to the same PRI value.  |
| 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  |
| TPC | Difficult to indicate different UEs’ TPC using one single DC |
| Impacts when considering simultaneous receptions of MBS PDSCH and unicast PDSCH  | DAI | Separating DAI counting for groupcast PDSCH and uncast PDSCH |
| HARQ-ACK Codebook | Separate or joint HARQ-ACK codebook needs to be discussed/specified |
| if separate codebook for MBS PDSCH and unicast PDSCH, multiplexing/prioritization of different codebooks needs to be discussed |
| RNTI | if UE is interested in multiple MBS services, UE needs to monitor a PDCCH with multiple g-RNTIs |

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| CMCC | Both group-common PDCCH based group scheduling and UE-specific PDCCH based group scheduling can be supported for MBS for RRC\_CONNECTED UEs.It is noteworthy that the decision on which group scheduling mechanism should be supported should not only consider the overhead of PDCCH, but also the other aspects, e.g., the standization effort or spec impact to support HARQ-ACK feedback if it is supported, the PUCCH resource utilization efficiency for HARQ-ACK feedback, etc.From the comparison in the following table, we can see that, on the one hand, the PDCCH overhead of UE-specific PDCCH based scheme is larger than that of group common PDCCH based scheme, on the other hand, the standardization efforts for UE-specific PDCCH based scheme to support ACK-NACK based HARQ feedback is much less than group common PDCCH based scheme.

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|  | Group common PDCCH based scheme | UE-specific PDCCH based scheme |
| PDCCH overhead | Small  | **Larger** |
| PUCCH resource configuration for HARQ-ACK | **Less configuration flexibility, less PUCCH resource utilization efficiency and larger spec impact*** For ACK/NACK feedback, network needs to configure orthogonal PUCCH resources for UEs in the same group by RRC so that a single PRI field in DCI can optionally be used to select separate PUCCH resource for each UE. This will cause that NW has to reserve a certain amount of dedicated PUCCH resources for multicast transmission which cannot be shared with unicast transmission.
* Separate PUCCH resource configurations for multicast and unicast may be needed, which will introduce additional spec impact.
 | More Flexible, more efficiency and little spec impact* The same as for unicast.
 |
| HARQ-ACK multiplexing for multicast and unicast / HARQ-ACK codebook construction | **More complicated and large spec impact*** If HARQ-ACK multiplexing for multicast and unicast in a slot is supported, the joint codebook construction procedure is much more complicated and will induce more spec impact whether for semi-static or dynamic HARQ-ACK codebook.
* If HARQ-ACK multiplexing for multicast and unicast in a slot is not supported, HARQ-ACK for multicast or unicast has to be dropped which may impact the performance, or it has to be based on network implementation to avoid collision of HARQ-ACK feedback for multicast and unicast, which will introduce additional scheduling restriction.
 | NO spec impact* Can reuse Rel-15/Rel-16 HARQ codebook construction procedure.
 |

Considering the pros and cons of these two group scheduling schemes, we think they can be used for different use cases. * For the case with relatively less number of UEs in a MBS group (but multicast still has advantage on spectral efficiency compared with unicast transmission), it is more suitable to use UE-specific PDCCH group scheduling together with ACK/NACK based HARQ-ACK feedback to improve reliability with little spec impact and managable PDCCH / PUCCH overhead.
* For the case with large number of UEs in a MBS group, it is more suitable to use group common PDCCH scheduling for which NACK only based HARQ-ACK feedback can be used to improve reliability with small PDCCH / PUCCH overhead.

Therefore, we think both two group scheudling mechanisms can be supported. |
| LG | We think that group scheduling with G-RNTI is beneficial for the newtork especially when multiple UEs interested in a service can receive same TBs of the service via same time/frequency resources. However, it would not be always possible for certain UEs. Thus, it is also good to consider UE specific scheduling with C-RNTI. |
| Nokia | For RRC Connected mode UEs, in general we prefer option 1, because of the lower downlink signaling overhead. However, we can envisage of some scenarios where option 2 may also be beneficial to support additional feedback from certain UEs. In those scenarios, the UE could be configured with an additional USS to support additional UE specific reliability information. |
| ZTE | We suggest to support group-common PDCCH only.Compared with UE-specific PDCCH, group-common PDCCH can save lots of resources as all UEs in one group share the same PDCCH. Besides, for broadcast for RRC\_IDLE/RRC\_INACTIVE UEs, only group-common PDCCH (or more specifically, cell-common PDCCH) can be applied. It is preferred to keep commonality between broadcast and multicast. That is, group-common PDCCH needs to be supported anyway considering broadcast service scheduling, and more standardization work will be needed for additional support for UE-specific PDCCH. We would also like to mention that the UE-specific PDCCH based solution may have RAN2 impact. Based on our understanding, UE MAC layer needs to know the G-RNTI (corresponding to a type of service/logical channel) of each PDSCH. If UE-specific PDCCH based solution is introduced, then how can the network indicate the G-RNTI to the UE?  |
| OPPO | Both options should be considered.Option 1 is beneficial in terms of PDCCH overhead reduction, however, there are some cases where gNB cannot transmit group-common PDCCH to a specific UE, e.g. UE active BWP is different from MBS BWP, or to multiplex HARQ-ACK for unicast and MBS in a single PUCCH, therefore UE-specific PDCCH is also needed. Furthermore, it is preferable to make the definition of group-common PDCCH and UE-specific PDCCH clearer, from our point of view, group-common PDCCH should be transmitted in CSS and scrambled by a RNTI shared by multiple UEs (e.g. G-RNTI), while UE-specific PDCCH should be at least transmitted in USS, as to the RNTI for scrambling the PDCCH, it should not be restricted to C-RNTI only at this stage. |
| Qualcomm | At least Option 1 should be supported, since Option 1 is more flexible to schedule a common PDSCH for a small group or a large group of UEs with the same PDCCH overhead. Option 2 does not scale for a very large number of UEs.FFS Option 2, which may be useful to schedule PDSCH for a small group of UEs or to schedule the retransmission of multicast data.  |
| Ericsson | We prefer option 1 (group-common PDCCH based group scheduling), and see no need to further study “UE-specific PDCCH based group scheduling” |
| BBC | At this stage we propose to consider both options. Various companies mention that Option 1 has benefits for a large group of UEs while Option 2 has benefits for reduced number of UEs. However, it is not clear to us the number of UEs best supported by each option. Therefore, down-selection or support of both options could be confirmed after more studies have been conducted. |
| Intel | Both CSS and USS based scheduling should be supported. * Group common PDCCH based scheduling can be considered as the baseline. As mentioned before, this option is good for the cases when large number of UEs are grouped to receive multicast PDSCH. Type 3 CSS can be used with addition of at least a G-RNTI to the set of RNTIs which can scramble the DCI of the monitored PDCCH. Alternately a new CSS type can also be defined. This mechanism has the advantage of lower overhead, but support of HARQ will be limited to possibly NACK-only on a shared PUCCH resource. This can still be ok since network only needs to detect at least one NACK in order to trigger retransmission.
* USS can be used when the number of UEs is lower and the overhead due PDCCH is acceptable. With this mechanism ACK/NACK based HARQ can also be supported. Furthermore, USS can also be used for potentially scheduling retransmission to a sub-group of users. The RNTI for monitoring a multicast PDCCH should not however be limited to only C-RNTI.
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| Convida | We support to do down selection between option1 and option2. We support option 1 Group-common PDCCH based group scheduling. Group common PDCCH has advantage of lower signalling overhead. In addition, group common PDCCH can be considered as a universal approach which can be applied to both multicast and broadcast use cases.  |
| Spreadtrum | Both options have advantages respectively, Group-common PDCCH based group scheduling is beneficial for PDCCH overhead reduction, but needs more standardization work for HARQ feedback; UE-specific PDCCH based group scheduling has little spec impact, but has more PDCCH overhead. Based on the latest agreements from RAN2:* Focus initially on NR SA, TBD to what extent other scenarios NR DC, NE DC can be supported.
* Confirm Will support PTM transmission in a cell.
* Confirm that We will, for multicast services introduce support for PTP and PTM transmission of shared traffic delivered by 5GC, at least for connected mode (does not exclude other cases)
* For a UE, gNB dynamically decides whether to deliver multicast data by PTM or PTP (Shared delivery)

It seems that both options from RAN1 should not be excluded to support PTP and PTM transmission. |
| Huawei/HiSilicon | Both options are discussed as above. Option 1 in our opinion should be the essence of PTM so should be at least supported. On top of option 1, whether option 2 is supported needs justification. Therefore, we suggest we can conclude at least option 1 is supported and FFS on option 2.  |
| CATT | Both options can be supported in NR MBS for different use cases. The pros and cons are anaylyzed in many contributions for both options, and each option has its own advantages in specific scenarios. There is no need to limit just one scheduling mechanism for NR MBS, and flexibility should be considered by supporting both options.For sub-group-common PDCCH based group scheduling, as FL mentioned that it seems to be defined as group-common PDCCH scheduling in high level. There is some difference between sub-group-common PDCCH and group-common PDCCH, e.g. use cases and RNTI definitions. To make sure that any other potential scheduling mechanism is not precluded, the sub-group scheduling mechanism should be added.While considering the two options, how to indicate/utilize PUCCH resources for HARQ-ACK feedback should be also taken into account. Different cases can be classified as:* Group-common PDCCH to schedule PDSCH + Group-common PUCCH
* Group-common PDCCH to schedule PDSCH + UE-specific PUCCH
* UE-specific PDCCH to schedule PDSCH + UE-specific PUCCH
* UE-specific PDCCH to schedule PDSCH + Group-common PUCCH
 |
| Samsung | Group-common PDCCH should be supported. I think we can more focus on the essential scheduling for multicast. |

***Reliability improvement mechanisms for RRC\_CONNECTED UEs***

Based on companies’ submitted contributions, three reliability improvement mechanisms have more supporters than others as illustrated in the following table, including HARQ-ACK feedback, CSI feedback and PDSCH repetition.

Regarding HARQ-ACK feedback, nine companies suggested to support it for at least multicast for RRC\_CONNECTED state, some companies [Huawei, HiSilicon] have submitted some simulation results for justifying the benefits of HARQ-ACK feedback, one company proposed to study the potential gain and standardization impact for HARQ-ACK feedback,

Regarding CSI-feedback, six companies proposed that CSI feedback can be supported to improve reliability. Four of them [CMCC][VIVO][CATT][ZTE] think the existing CSI-RS configuration and CSI feedback mechanism for unicast can be directly used for MBS without additional spec impact. Two of them [QC][E///] think some modifications may be needed.

Regarding PDSCH repetition, some of the proponents think the existing PDSCH repetition mechanism for unicast can be reused for MBS.

Regarding multi-beam/beam sweeping operation, two companies [Sony, CATT] mentioned it in the sub-agenda for reliability improvement. Beam sweeping was also raised in some contributions for RRC\_IDLE/INACTIVE UEs and two other companies [ZTE, LG] also raised similar issue for group scheduling, it can be discussed later in which sub-agenda it should be discussed.

Each of other potential mechanisms only have one proponent, including conservative scheduling based on network implementation, multi-DCI based M-TRP transmission and HARQ-based time-interleaving.

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| **Reliability improvement mechanisms** | **Companies** |
| HARQ-ACK feedback | CMCC, Huawei, OPPO, vivo, CATT, Convida, QC, E///, Samsung, Nokia  |
| CSI feedback | CMCC, E///, CATT, vivo, QC, ZTE |
| PDSCH repetition | CMCC, ZTE, Intel, vivo, LG, Nokia |
| Multi-beam/beam sweeping operation  | CATT, Sony  |
| Conservative scheduling (network implementation) | ZTE, Nokia |
| Multi-DCI based M-TRP transmission | LG |
| HARQ-based time-interleaving | BBC |

 **[High priority] Issue 4 (Proposal 1 in R1-2007001, with little update)**: *For RRC\_CONNECTED UEs, HARQ-ACK feedback is supported for multicast without additional evaluation for it, i.e., no evaluation is needed to justify whether HARQ-ACK feedback is needed.*

Please share your views and comments in the table.

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| **Company** | **Comment** |
| TD Tech and Chengdu TD Tech | The views and comments of ours are listed in the table below.

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| **Reliability improvement mechanisms** | **Companies: TD Tech and Chengdu TD Tech** |
| HARQ-ACK feedback | supported |
| CSI feedback | Comments: The further discussion and simulation are needed to make the decision. |
| PDSCH repetition | Supported |
| Multi-beam/beam sweeping operation  | Supported |
| Conservative scheduling (network implementation) | Comments: The further discussion and simulation results are needed to make the decision. |
| Multi-DCI based M-TRP transmission | Comments: The further discussion and simulation results are needed to make the decision. |
| HARQ-based time-interleaving | Comments: The further discussion and simulation results are needed to make the decision. |

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| vivo | We support the proposal.Diffentent from LTE, NR MBS support many use cases, and some case, such as V2X or Industry applications have very high reliabiility requirement, e.g. 99.9999%. It is impossible to meet this requirement simply using link adaption based on CSI feedback only or automatic repetition. Considering this perspective, HARQ-ACK is anyway needs to be supported. No evaluation is needed to justify this considering the limited TU for MBS WI.Table 1. Requirements for different MBS use cases

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| --- | --- | --- |
| MBS use cases | Latency | Reliability |
| V2X | 5-100ms | 90% to 99.9999% |
| Live Video | 150ms | 99.9% |
| IOT Software update | Latency Tolerant | Higher reliability is beneficial |
| Industry applications | 0.5ms | 99.9999% |

 |
| CMCC | Support the proposal.* In Rel-13 LTE SC-PTM, simulations had been carried out to evaluate the gain of HARQ-ACK feedback and justify that HARQ-ACK can improve the reliability. The evaluations for SC-PTM aimed at supporting multicast/broadcast service for group communications as defined in 3GPP TS 22.468 and mission critical push to talk as defined in 3GPP TS 22.179, which are consistent with the requirement mentioned in the WID of NR MBS. In addition, considering both R17 NR MBS and LTE SC-PTM aim to support single cell multicast/broadcast, we think the evaluation results and observation for HARQ-ACK feedback in LTE SC-PTM are also applicable for R17 NR MBS.
* In addition, NR MBS also aims to support more services which may require much higher reliability, e.g., V2X applications. The higher reliability the service requires, the more adavatages can be expected from HARQ-ACK feedback.

Therefore, we think the HARQ-ACK feedback should be supported for CONNECTED UEs, and no additional evaluation is needed to justify whether to support it. |
| LG | If legacy UE specific scheduling is used for a multicast TB, it can already support HARQ-ACK feedback. Thus, HARQ-ACK feedback can be supported for multicast without additional evaluation at least for UE specific scheduling. |
| Nokia | Additional evaluation for HARQ-ACK is desirable, preferably with some minimum reliability to target.In our view, there are many variants of HARQ-ACK feedback that could be supported. We would like to see evaluations of these techniques compared against each other (justifying a common set of simulation assumptions) and against some minimum reliability targets.Subject to those evaluations, RAN1 can then make an informed decision about the support of HARQ-ACK. |
| ZTE | We suggest to evaluate the potential gain for HARQ-ACK for NR MBS first.In LTE SC-PTM, some preliminary evaluations on spectrum efficiency between ‘SC-PTM with CQI and HARQ ACK/NACK feedback’ and ‘SC-PTM with CQI feedback only and eOLLA’ had been done. Conclusions were made in TR 36.890 as follows.

|  |
| --- |
| Conclusions...SC-PTM performance in terms of spectral efficiency was evaluated by the simulations. The performance analysis results in the following conclusions:- Link adaptation allowed by the availability of UL feedback provides significant gains when the number of receiving UEs is rather small and decreases with increasing group size. HARQ with retransmissions can further improve the spectral efficiency in some scenarios but these improvements are small. It has not been concluded whether the gains provided by HARQ and retransmission are worth of the increased complexity of the system.  |

For NR MBS, the deployment scenarios have changed compared with LTE SC-PTM. The simulation assumptions, e.g., frequency, bandwidth, traffic model and antenna configuration, etc., should be updated accordingly.It is questionable on whether/under which conditions/how much gain can be achieved by supporting HARQ-ACK feedback under the new simulation assumptions. So some more careful evaluations on the gain of supporting HARQ-ACK feedback in NR MBS can be done prior to specific mechanism design. With more careful evaluation, companies can even compare the potential performance gain between different HARQ-ACK solutions, which is also beneficial to subsequent technical discussion if HARQ-ACK is supported. |
| OPPO | Support.HARQ feedback has already been supported in groupcast of NR sidelink as an effective mechanism to improve sidelink reliability, this can be used as baseline for HARQ feedback design in MBS. |
| Qualcomm | For multicast service with high reliability requirement (e.g., smart grid control for group communications and IoT applications, V2X applications, etc.), it is necessary to support L1 retransmission based on HARQ-ACK feedback to receive multicast transmission in RRC\_CONNECTED state. We believe it is not sufficient to rely on link adaptation using CQI feedback only to combat bursty interference. Based on the previous LTE study and the proposals so far, we think HARQ-ACK feedback should be supported for NR multicast (no need further simulation-based evaluation just for this). We can further discuss the details in upcoming meetings, e.g. whether to support NAK-based or ACK/NAK-based.  |
| Ericsson | We agree that HARQ-ACK should be supported without additional evaluation to justify this. The particular solution for HARQ-ACK is however FFS |
| BBC | We also agree that HARQ-ACK can be supported for RRC\_CONNECTED without additional evaluation. However, the specific HARQ-ACK solution needs to be selected based on further studies. |
| Intel | Configurable HARQ/ACK feedback can be supported for RRC\_CONNECTED UEs i.e., it may be switched off by configuration. This can be useful for cases when RRC\_IDLE UEs are also supported in the group or repetition is used as a reliability mechanism. Potential gains for HARQ/ACK, as well as the specific HARQ/ACK technique to be used can be further studied and evaluated. |
| Convida | Support the proposal. HARQ-ACK feedback can be assumed as the baseline in support of reliability enhancement. No additional evaluation may be needed. However, it is not clear if HARQ-ACK feedback will be suitable for all reliability vs latency combinations of MBS use cases, since HARQ-ACK feedback may have some impacts on latency in some cases although reliability could be improved. For reliability enhancement, additional methods such as PDSCH repetitions could also be considered.  |
| Spreadtrum | We also agree that HARQ-ACK can be assumed as the baseline for RRC\_CONNECTED without additional evaluation. HARQ-ACK solution needs be further studied. |
| Huawei/HiSilicon | We support the proposal.  |
| CATT | We agree with the proposal.* To improve the reliability, HARQ-ACK and SCI feedback should be considered. There is no additional evaluation needed.
* The gain of HARQ-ACK feedback is depending on the number of UEs and channel condition. It is suggested that gNB decide the enable/disable of UEs based on CSI reporting.
 |
| Samsugn | We support FL’s proposal. |

***Evaluation***

Regarding evaluation, four companies have contributions on evaluation in the “Others” sub-agenda. One company [ZTE] provided the evaluation results to support CSI feedback, one company [Huawei] provided the evaluation results to support HARQ-ACK feedback, one company [Nokia] proposed the methodology and assumptions for evaluation of different UL feedback schemes, and one company [E///] proposed the methodology and assumptions for evaluation of different PTM features.

Before we discuss a common evaluation methodology and assumptions, we need to first determine the purpose of the evaluation campaign.

**[High priority] Issue 6 (Question 4 in R1-2007001, with little update)**: *Whether a common evaluation methodology and assumptions are necessary for NR MBS? If the answer is YES, what’s the purpose of the evaluation? And what’s your suggestion on the common evaluation methodology and assumptions?*

Please share your views and comments in the table.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| TD Tech and Chengdu TD Tech | The related simulaiton is needed to prove the corresponding method is nessesary for the NR MBS. The simulation assumptions shall be discussed to ensure that the simulation results from the different companies can be compared with each other. |
| vivo | From our understanding, a common evaluation methodology and assumptions are not necessary for NR MBS. As above proposed, HARQ-ACK for MBS should be supported without evaluation. Then, the motivation to spend much time to do evaluation is not clear to us. |
| CMCC | Not necessary.As the FL summary about reliability improvement mechanisms for RRC\_CONNECTED UEs above, HARQ-ACK feedback, CSI feedback and PDSCH repetition are three major mechanisms. * For HARQ-ACK feedback, as our comment in issue 4, no evaluation is needed to justify whether HARQ-ACK feedback is needed.
* For CSI feedback and PDSCH repetition, they are also efficient ways to improve reliability, and we think the spec impact is small and even none.

Therefore, we think there is no strong motivation to do any evaluation for NR MBS, and all these three reliability improvement mechanisms can be supported. |
| LG | Some assumptions for evaluations are already provided by a few companies in AI 8.12.5. Thus, it seems good to have common evaluation methodology and assumptions to justify a certain solution, if we cannot easily draw the benefit of the solution or reach an agreement on support of it. |
| Nokia | Yes, to enable a fair, efficient and meaningful comparison of different reliability techniques from different companies. Note, as part of these assumptions/methodology, we would like to see a baseline unicast scenario defined, to allow differences between different simulations to be more readily identified. |
| ZTE | Yes. As mentioned in our tdoc x5437, there are different candidate mechanisms to improve the reliability of NR MBS, e.g., HARQ-ACK, CSI feedback and repetition. The simulation results can further guide the subsequent discussion on whether/how to support reliability improvement. Further, the simulation results can provide some useful information for the operators who are interested in the MBS, e.g., which mechanism to deploy in the practical network if multiple mechanisms are specified for reliability improvement.Regarding the common evaluation methodology and assumptions, we have the following comments.* Using system-level simulations
* The Rural and Dense-Urban scenarios can be evaluated considering the main target use cases of Public safety and Mission critical.
* Full buffer or periodic deterministic traffic model can be used.
* Spectral efficiency or user experienced data rate can be considered as the performance metric.
* The details of the simulation assumptions can be fully discussed in the following e-mail discussion.
 |
| OPPO | Although common evaluation methodology and assumptions are helpful for performance comparison, from procedure point of view, the evaluation methodology work is not part of the WI and it will take up a lot of effort in RAN1, especially evaluation work is not considered when allocating TUs for this WI in RAN. In our view, evaluation results can be provided by companies with evaluation assumptions elaborated as some companies already done, it is not appropriate to go into detailed evaluation methodology and assumptions discussion. |
| Qualcomm | At current stage, we are not sure what the common simulation methodology and assumption will be used for. The evaluation may be needed to compare detailed mechanisms for potential enhancement. It would be preferable to first list up the options with clear description and then to discuss the assumption for further comparison, e.g. if there is a proposed new MIMO codebook for multicast, then we need evaluation to see the relative gain to the existing codebook.Depending on the scheme, evaluation methodology may be based on LLS or SLS. The evaluation assumption may be also variant for different RRC states. For example, if we want to consider implementation-SFN deployments for IDLE mode reception, the assumption would be different than the ones that are being proposed, and probably closer to the methodology used in TR 36.776. |
| Ericsson | We think most aspects of this WI can be agreed on without computer simulation-based evaluations, since most functionality is expected to be legacy PTP functionality that is adapted to the PTM case, or can be decided based on other type of evaluation. However, there may be cases where such computer simulations are necessary. In these cases it is important to have a common methodology and assumptions. There is however no urgency in agreeing this. Such agreements may be made when the need arises. |
| BBC | As in our response to Issue 4, we do not think simulations are needed to confirm the gains of HARQ-ACK. However, simulations may be needed to select a specific solution of HARQ-ACK. In which case, we think a common evaluation methodology and assumptions are necessary for NR MBS. |
| Intel | Baseline simulation assumptions are good to have. For evaluations for reliability improvements, especially CQI feedback, repetition and HARQ/ACK schemes, it might be advantageous to agree on baseline SLS assumptions with respect to traffic models, deployment scenarios etc., to align results from companies for fair comparison. |
| Convida | As discussed in issue 4, we think HARQ-ACK feedback should be supported without further evaluation. However, whether HARQ-ACK feedback alone is sufficient in order to meet reliability versus latency requirements for all NR MBS use cases might need some further evaluation.  |
| Spreadtrum | For HARQ-ACK feedback, major companies think no further evaluation is need. For other reliability mechanisms, if supported, we also think there is no strong motivation to do any evaluation. |
| Huawei/HiSilicon | As commented to issue 4, we don’t see necessity of evaluations for HARQ-ACK nor other techniques so far. If later on, evaluation is needed for some potential enhancement within the WID scope, proponents can report the evaluations.  |
| CATT | We do not observe the necessity of evaluation for NR MBS, e.g. HARQ-ACK feedback. |
| Samsung | We think RAN1 may not need evaluation in some topics.If evaluation is needed, then the common assumption is needed. However, before that, we need to have the common understanding of the purpose of the evaluation, e.g., in order to compare what.  |

# Appendix A: Second tier issues summarized in R1-2007001

**Table A.1: Summary of second tier issues of group scheduling for RRC\_CONNECTED UEs**

|  |  |
| --- | --- |
| **Second tier issues** | **Possible questions or proposals** |
| 3.1.1 Configuration of group scheduling for multicast/broadcast | Question: Whether broadcast and multicast need to be differentiated for RRC\_CONNECTED UEs? If the answer is YES, whether the same configuration mechanism of group scheduling for Broadcast is applied for both RRC\_CONNECTED UEs and RRC\_IDLE/INACTIVE UEs? |
| Proposal: For RRC\_CONNECTED UEs, at least part of the parameters for multicast configuration is received by dedicated RRC signaling. |
| 3.1.2.1 CORESET configuration for MBS | Proposal: For group common PDCCH based group scheduling and a MBS common frequency resource configured with in UE’s active DL BWP, the CORESET is configured within the MBS common frequency resource. |
| Proposal: For group common PDCCH based group scheduling and a MBS common frequency resource configured with in UE’s active DL BWP, the CORESET for MBS is configured per BWP. |
| 3.1.2.2 Search space configuration for MBS | Proposal: Consider the following options for search space configuration for MBS for RRC\_CONNECTED UEs:• Option 1: CSS (existing CSS type or new defined CSS type)• Option 2: USS |
| 3.1.2.3 DCI format for MBS | Proposal: Consider the following options for DCI format for MBS for RRC\_CONNECTED UEs:• Option 1: DCI format 1\_0• Option 2: DCI format 1\_1• Option 3: DCI format 2\_x• Option 4: New DCI format |
| 3.1.2.4 Blind decoding related issues | Proposal: The maximum number of monitored PDCCH candidates and non-overlapped CCEs per slot are not increased for MBS. |
| Proposal: Keep the “3+1” DCI size budget for MBS with group common PDCCH based group scheduling. |
| 3.1.2.5 Multi-beam/beam sweeping operation | Proposal: Support multi-beam/beam sweeping operation for MBS PDCCH/PDSCH for RRC\_CONNECTED UEs. |
| 3.1.3 Simultaneous operation with unicast reception | Proposal: The UE is expected to process maximum two transport blocks for simultaneous reception of unicast PDSCH and multicast PDSCH. |
| 3.1.4 Other issues | Proposal: Support DL SPS for MBS for RRC\_CONNECTED UEs. |
| Proposal: Support multi-layer MIMO for MBS PDSCH for RRC\_CONNECTED UEs. |
| Question: Whether modifications are needed for QCL framework in order to support MBS transmission? |
| Proposal: Introduce a new reception type of PDCCH and PDSCH for MBS for RRC\_CONNECTED UEs, if group common PDCCH based group scheduling is supported. |
| Question: Whether to support receiving MBS service on a Scell? |
| Question: Whether to support SFBC for MBS? |

**Table A.2: Summary of second tier issues of reliability improvement for RRC\_CONNECTED UEs**

|  |  |
| --- | --- |
| **Second tier issues** | **Possible questions or proposals** |
| 3.2.1 HARQ-ACK feedback | Proposal: Consider the following two alternatives for HARQ-ACK feedback for RRC\_CONNECTED UEs:* Alternative 1: ACK/NACK based HARQ-ACK feedback
* Alternative 2: NACK-only based HARQ-ACK feedback
 |
| Proposal: HARQ-ACK feedback for NR MBS should be RRC configurable if it is supported for RRC\_CONNECTED UEs. |
| Proposal: Both PTM-based and PTP-based retransmissions can be supported for NR MBS for RRC\_CONNECTED UEs. |
| Question: Whether multiplexing of HARQ-ACK of unicast and multicast transmission should be supported for UEs receiving both unicast and multicast service. |
| Question: Whether prioritization of HARQ-ACK of unicast and multicast transmission should be supported for UEs receiving both unicast and multicast service. |
| 3.2.2 CSI feedback | Proposal: Consider to support following schemes for NR MBS:* Option 1: Single port transmission
* Option 2: Open-loop spatial multiplexing
* Option 3: Closed-loop spatial multiplexing
 |
| 3.2.3 Other issues | Question: Whether it is needed to discuss the reliability requirements for NR MBS from RAN1 perspective? If the answer is YES, then whether the reliability requirements are RRC state dependent and whether the reliability requirements for multicast and broadcast traffic are the same or not? |
| Question: If it is decided to discuss the reliability requirements for NR MBS in RAN1, then how to define the reliability requirements? |

**Table A.3: Summary of second tier issues of MBS for RRC\_IDLE/RRC\_INACTIVE UEs**

|  |  |
| --- | --- |
| **Second tier issues** | **Possible proposals** |
| CORESET for PTM | For UE in IDLE/INACTIVE state, the CORESET for PTM is * Alt 1: CORESET0
* Alt 2: Configurable
 |
| Search space for PTM | For UE in IDLE/INACTIVE state, the search space for PTM is * Alt 1: One(s) of existing common search space
* Alt 2: A new type of CSS set
 |
| Multi-beam operation | Monitoring occasions for PTM is associated with SSB. |
| HARQ-ACK | Whether HARQ-ACK feedback is supported for PTM for UE in IDLE/INACTIVE state:Alt 1: Supported but NACK onlyAlt 2: Not supported |
| Search spaces for SIBx/MCCH if defined | Search spaces for SIBx/MCCH needs to be discussed.  |
| MCS table and number of layers | MCS table to be used and how many layers are used should be configured |

# Appendix B: Summary of Phase 1 discussion

Seventeen companies have provided their views on the classification of priorities for this meeting in phase 1 discussion. The statistics are shown in the table below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Issue 1(Question 1 in R1-2007001) | Issue 2(Question 2 in R1-2007001) | Issue 3(Question 3 in R1-2007001) | Issue 4(Proposal 1 in R1-2007001) | Issue 5(Proposal 2 in R1-2007001) | Issue 6(Question 4 in R1-2007001) | Issue 7(Proposal 3 in R1-2007001) | Issue 8(Proposal 4 in R1-2007001) |
| # High | 17 | 8 | 7 | 14 | 6 | 9 | 2 | 2 |
| # Medium |  | 8 | 10 | 3 | 11 | 7 | 7 | 6 |
| # Low |  | 1 |  |  |  | 1 | 8 | 9 |

The following observations can be drawn from companies’ views:

* Issue 1/4/6: More than half of the companies think these three issues should be high priority items.
* Issue 2/3/5: Less than half of the companies think these three issues should be high priority items, but almost all of the companies think they should be at least medium priority items.
* Issue 7/8: About half of the companies think these issues should be low priority. It is explicitly mentioned in Chairman’s notes that no plan to treat 8.12.3 in this meeting.

Based on the above observation, the following proposal is made on the classification of high/medium priority items for this meeting:

**Proposal: The following high/medium priority items are classified for this meeting:**

* **High priority:**
	+ **Issue 1/4/6**
* **Medium priority:**
	+ **Issue 2/3/5**

# References

1. R1-2007001 FL summary on NR Multicast and Broadcast Services Moderator (CMCC)
2. RP-193248 New WID proposal: NR Multicast and Broadcast Services
3. RP-201038 Revised WID: Core part: NR multicast and broadcast services
4. R1-2005249 Resource configuration and group scheduling for RRC\_CONNECTED UEs Huawei, HiSilicon
5. R1-2005406 Discussion on mechanisms to support group scheduling for RRC\_CONNECTED UEs vivo
6. R1-2005436 Mechanisms to Support Group Scheduling for RRC\_CONNECTED UEs ZTE
7. R1-2005531 Group Scheduling Mechanisms to Support 5G Multicast / Broadcast Services for RRC\_CONNECTED Ues Nokia, Nokia Shanghai Bell
8. R1-2005589 Considerations on MBMS group scheduling for RRC\_CONNECTED UEs Sony
9. R1-2005693 Discussion on group scheduling mechanism for RRC\_CONNECTED UEs in MBS CATT
10. R1-2005898 Group Scheduling for NR-MBS Intel Corporation
11. R1-2006013 Group scheduling for NR Multicast and Broadcast Services OPPO
12. R1-2006173 On Mechanisms to support group scheduling for RRC\_CONNECTED UEs Samsung
13. R1-2006233 Discussion on group scheduling mechanisms in NR MBS CMCC
14. R1-2006320 Support of group scheduling for RRC\_CONNECTED UEs LG Electronics
15. R1-2006631 On group scheduling mechanism for NR multicast and broadcast Convida Wireless
16. R1-2006830 Views on group scheduling for Multicast RRC\_CONNECTED UEs Qualcomm Incorporated
17. R1-2006918 Mechanism for group scheduling of RRC\_CONNECTED UEs in NR Ericsson
18. R1-2005250 Mechanisms to improve reliablity for RRC\_CONNECTED UEs Huawei, HiSilicon
19. R1-2005407 Discussion on mechanisms to improve reliability for RRC\_CONNECTED UEs vivo
20. R1-2005437 Mechanisms to Improve Reliability for RRC\_CONNECTED UEs ZTE
21. R1-2005532 Mechanisms for 5G Multicast / Broadcast Reliability Improvements for RRC\_CONNECTED Ues Nokia, Nokia Shanghai Bell
22. R1-2005590 Considerations on MBMS reliability for RRC\_CONNECTED UEs Sony
23. R1-2005694 Discussion on reliability improvement mechanism for RRC\_CONNECTED UEs in MBS CATT
24. R1-2005899 Mechanisms to Improve Reliability for NR-MBS Intel Corporation
25. R1-2006014 UL feedback for RRC-CONNECTED UEs in MBMS OPPO
26. R1-2006174 On Mechanisms to improve reliability for RRC\_CONNECTED Ues Samsung
27. R1-2006234 Discussion on reliability improvement in NR MBS CMCC
28. R1-2006321 Mechanisms to improve reliability of Broadcast/Multicast service LG Electronics
29. R1-2006632 On reliability enhancement for NR multicast and broadcast Convida Wireless
30. R1-2006831 Views on UE feedback for Multicast RRC\_CONNECTED UEs Qualcomm Incorporated
31. R1-2006863 HARQ-based time-interleaving for NR Multicast/Broadcast BBC
32. R1-2006919 Mechanisms to improve reliability for RRC\_CONNECTED UEs receiving PTM transmission Ericsson
33. R1-2005272 Discussion on multicast support for IDLE/INACTIVE UEs Huawei, HiSilicon
34. R1-2005408 Discussion on basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs vivo
35. R1-2005438 Basic Functions for Broadcast or Multicast for RRC\_IDLE or RRC\_INACTIVE UEs ZTE
36. R1-2005533 Basic Functions for Broadcast / Multicast for RRC\_IDLE / RRC\_INACTIVE Ues Nokia, Nokia Shanghai Bell
37. R1-2005695 Discussion on basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs CATT
38. R1-2006015 Discussion on enhancements for IDLE and INACTIVE state UEs OPPO
39. R1-2006175 On Basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs Samsung
40. R1-2006235 Discussion on NR MBS in RRC\_IDLE RRC\_INACTIVE states CMCC
41. R1-2006322 Basic function for broadcast/multicast LG Electronics
42. R1-2006832 Views on group scheduling for Multicast RRC\_IDLE/INACTIVE UEs Qualcomm Incorporated
43. R1-2006920 Basic functions for broadcast/multicast for RRC\_IDLE/RRC\_INACTIVE UEs Ericsson
44. R1-2005439 Preliminary Simulation Results of Rel-17 MBS ZTE
45. R1-2005534 Simulation assumptions and evaluation scenarios for 5G Multicast Services Nokia, Nokia Shanghai Bell
46. R1-2006016 PUCCH resource allocation for UL feedback in MBMS OPPO
47. R1-2006236 On R17 NR MBS WI CMCC
48. R1-2006410 Performance evaluation of HARQ for NR multicast Huawei, HiSilicon
49. R1-2006658 Other issues for Rel-17 MBS vivo
50. R1-2006861 MIMO support in NR Multicast/Broadcast BBC
51. R1-2006921 Assumptions for Performance Evaluations of NR-MBS Ericsson