3GPP TSG-RAN WG1 Meeting #110bis-e R1- 2210412

E-meeting, October 10th-19th, 2022

Agenda Item: 9.10.2

Source: Moderator (Ericsson)

Title: Moderator Summary#3 – Study on XR Specific Capacity Improvements

Document for: Discussion, Decision

# 1 Introduction

This document provides a summary of the contributions submitted to RAN1#110bis-e under Agenda item 9.10.2 regarding the study of candidate enhancement techniques for XR capacity improvements, together with an overview and high level key questions to facilitate the discussions under the following email discussion assigned by Chair:

[110bis-e-R18-XR-02] Email discussion on XR capacity enhancement by October 19 – Sorour (Ericsson)

* Check points: October 14, October 19

Moderator presents the views on the candidate capacity enhancements techniques, based on the “common principle for assessment” that was agreed during the last meeting.

|  |
| --- |
| **Agreement:*** For each candidate capacity enhancement technique for XR traffic, companies are encouraged to consider the following common principle for assessment of the candidate capacity enhancement technique:
	+ Identify the XR-specific issue(s) that the enhancement technique is addressing
	+ Identify the necessity of the enhancement technique to address the issues
	+ Identify whether/how the enhancements provide benefit/performance capacity gain.
		- Consider at least feasibility, complexity, and system level performance evaluations in comparing the enhancement techniques. Power saving gains for a given enhancement technique can optionally be evaluated and considered in addition to these other aspects.
* The baseline scheduling scheme when comparing the proposed capacity enhancements techniques is:
	+ Dynamic scheduling and/or
	+ Semi-persistent scheduling / Configured grant scheduling
		- Note: Companies are encouraged to additionally use DG scheduling as the baseline scheduling scheme when showing the capacity performance gain

**Agreement:*** To support a candidate capacity enhancement technique for XR traffic, capacity performance gain by the technique as compared to baseline should be shown.
	+ Capacity performance gain by the candidate technique as compared to baseline is a necessary condition to consider supporting the candidate technique.

**Agreement:**Rel-17 evaluation methodology for XR capacity enhancement captured in TR 38.838 is used as the baseline evaluation methodology for XR capacity enhancement of Rel-18 SI on XR enhancements.**For future meetings:**Companies are **requested to follow** the following agreement and conclusion from RAN1#109-e. Check final FL summary for details.**Agreement:*** Rel-17 evaluation methodology for XR capacity enhancement captured in TR 38.838 is used as the baseline evaluation methodology for XR capacity enhancement of Rel-18 SI on XR enhancements.

**Conclusion:**Companies are encouraged to use the capacity Excel sheet attached with TR 38.838 in [RP-213652](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_94e/Docs/RP-213652.zip)  for recording the simulation results that are provided in their contributions |

In the following sections, high level summary of companies’ preferences with respect to different enhancement areas are provided. The aim of the discussion is to assess the candidate enhancement techniques and provide valuable inputs for the technical report.

When feasible, few key questions are raised according to the agreed “assessment principle” that is summarized below.

**Summary of assessment principle:**

* **Q1: What are XR-specific issue(s) addressed by the enhancements?**
* **Q2: Whether the enhancement is necessary to address the issues(s)?**
* **Q3: Whether/how the enhancements benefit/performance capacity gain are provided?**
* **Note that capacity performance gain is necessary condition for supporting the enhancements**

This document is the updated version of R1-221041.

## 1.1 First online session

### 1.1.1 Overview of status and recommendations

The following table summarize the status of the discussion by 1st GTW:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Section** | **Proposal** | **Companies' preferences** | **Simulation results** | **Moderator recommendation**  |
| **Yes** | **No** | **Maybe/FFS** |
| **2.1** | **Capacity performance evalutions on need of eCG** | **Ericsson** | **vivo, HW/HiSi, ZTE, CATT** |  | **vivo, HW/HiSi, ZTE, CATT, Ericsson** | Continue discussion on the necessity of eCG schemes.On eCG schemes: priorotize P2-2-1, P2-2-2, P2-3-1, [Topic 2]Note: See details description below. |
| 2.2 | P2-2-1 | ZTE, Google, vivo, Sony, IDC, OPPO, HW/HiSi, Nokia/NSB,QC, Apple, DCM, CMCC, [Sony], [MTK] | Samsung, ~~LG~~, Panasonic, Intel, CATT | FW, ~~CATT~~, ~~MTK,~~ Ericsson, LG | Yes (vivo, HW, ZTE) |
| P2-2-2 | ZTE, Google, Sony, IDC, QC, [Sony], Apple, DCM, CMCC, LG | Samsung, MTK, ~~LG~~, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Nokia/NSB, Intel, CATT | FW, ~~CATT~~ | Yes (ZTE) |
| P2-2-3 | ZTE, Panasonic, Google, Sony, IDC, DCM, LG | Samsung, FW, CATT, MTK, ~~LG~~, ~~Panasonic~~, vivo, Ericsson, OPPO, HW/HiSi, Intel | Nokia/NSB | No |
| P2-2-4 | ZTE, Google, Sony, IDC, QC, Apple, DCM | Samsung, FW, CATT, MTK, ~~LG~~, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Nokia/NSB, Intel | LG | No |
|   |   |   |   |   |   |
| 2.3 | P2-3-1 | ZTE, Panasonic, Google, Intel, Sony, IDC, OPPO, QC, vivo(Alt1 )HW/HiSi(Alt 1), Nokia/NSB(Alt 1), Apple, LG, DCM, CMCC(Alt 1) | Samsung, FW, CATT, MTK, ~~Ericsson~~, Nokia/NSB(Alt 2) | Lenovo, Ericsson (only Alt-1), Samsung (maybe OK w Alt 2) | Yes (ZTE (Alt-1)) |
|   |   |   |   |   |   |
| 2.4 | P2-4-1 | ZTE, LG, Google, vivo, Sony, IDC, OPPO, Lenovo, Nokia/NSB, QC, Apple, CMCC, LG | Samsung, FW, CATT, MTK, ~~Panasonic~~, Ericsson, HW/HiSi, Intel, DCM | Panasonic | No |
|   |   |   |   |   |   |
| 2.5 | Topic1 | All agree w Mod. But results should be captured in TR. |   |   |   |
| Topic2 | Samsung, FW, MTK, LG, Panasonic, Google, vivo, Ericsson, IDC, OPPO, Lenovo, HW/HiSi. Nokia/NSB, QC | CATT |   | Yes (CATT) |
| Topic3 | ZTE, Panasonic, Google. IDC, OPPO, Apple, Sony, LG | Samsung, FW, ~~[~~CATT~~]~~, MTK, ~~LG,~~ vivo, Ericsson, Nokia/NSB, QC | ~~CATT~~, [Lenovo], [Nokia/NSB] | No |
|   |   |   |   |   |   |   |
| 3.1 | P3-1-1 | Google, vivo, Ericsson, IDC, Nokia/NSB, Intel, QC, DCM, CMCC | [Samsung], FW, CATT, MTK, ZTE, LG, OPPO, Lenovo, HW/HiSi | Samsung |   | Discuss at GTW to make decision. |
|   |   |   |   |   |   |   |
| 3.2 | P3-2-1 | Nokia/NSB, QC | FW, CATT, Ericsson, IDC | Samsung, MTK, LG, Google, vivo, HW/HiSi | Yes (Nokia) | Wait for decision regarding 3.1.1 |
| P3-2-2 | Nokia/NSB, QC, | FW, CATT, vivo, IDC | Samsung, MTK, LG, Google, Ericsson, HW/HiSi | Yes (Nokia) |
| P3-2-3 | Lenovo, Nokia/NSB, QC, Apple | FW, CATT, vivo, Ericsson | Samsung, MTK, LG, Google, HW/HiSi | Yes (Nokia) |
|   |   |   |   |   |   |   |
| 3.3 | P3-3-1 | IDC, QC, vivo | Samsung, FW, CATT, MTK, OPPO, Nokia/NSB, Lenovo | [Ericsson], LG, Google, vivo, Intel | Yes(vivo, IDC) | Wait for decision regarding 3.1.1 |
| P3-3-2 | QC | FW, CATT, vivo, OPPO, Nokia/NSB, Lenovo, Ericsson | Samsung, MTK, LG, Google, Intel | No | Low priority |
| P3-3-3 | QC, CMCC | Samsung, FW, CATT, MTK, vivo, Ericsson, OPPO, Lenovo | LG, Google, Nokia/NSB, Intel, LG | No | Low priority |
|   |   |   |   |   |   |   |
| 3.4 | P3-4-1 | ~~ZTE,~~ LG |   | RAN2 (Samsung, FW, MTK, vivo, Ericsson, Sony, IDC,OPPO, Lenovo, HW/HiSi, Nokia/NSB, Intel, QC, ZTE) | Yes | Capture description/assessment/results. No further action. |
| P3-4-2 | FW, ZTE, LG, HW/HiSi | vivo, Ericsson, Lenovo, Nokia/NSB | RAN2(Samsung, CATT, MTK), OPPO, Intel, QC) | Yes (HW) | Continue discussion |
|   |   |   |   |   |   |   |
| 3.5 | P3-5-1 | CATT | RAN2(LG),Ericsson, Nokia/NSB, FW, vivo | ~~FW,~~ MTK~~, vivo~~ | Yes | Continue discussion |
| P3-5-2 | CATT | RAN2(Samsung, FW, MTK, LG, Google, vivo,QC), Nokia/NSB, Ericsson | ~~Ericsson~~ | Yes | Capture description/assessment/results. Conclude no RAN1 impact.Close discussion. |
| P3-5-3 |   | SR/BSR(LG), vivo, Ericsson, Nokia/NSB, QC, FW, CATT, LG | ~~FW~~, MTK | No | Low priority |
| P3-5-4 |   | RAN2(Samsung, FW, MTK, LG, Google, vivo, Ericsson, QC), Nokia/NSB, CATT |   | No | Low priority |
| P3-5-5/P3-5-6 | Samsung, FW, MTK, Google | LG, vivo, Ericsson, ~~Nokia/NSB~~, QC | Nokia/NSB | No | Continue discussion |
|   |   |   |   |   |   |   |
| 4.1 | P4-1-1 | QC, Apple, ZTE | Samsung, FW, MTK, LG, Google, vivo, Ericsson, [Nokia/NSB], CATT | ~~CATT, [Nokia/NSB]~~ | Yes | Continue technical discussion (technical concerns on sim results not resolved yet)Check later this week (likely outcome: close discussion) |
| P4-2-1 | FW | Samsung, CATT, LG, Google, vivo, Ericsson, IDC, Nokia/NSB, CATT |   | Yes | Capture description/assessment/results. Close discussion |
| P4-3-1 | Google, Nokia/NSB, IDC, ZTE, MTK | Samsung, FW, CATT, LG, vivo, Ericsson, ~~MTK~~. QC, OPPO |   | Yes | Continue technical discussion (technical concerns on sim results not resolved yet)Check later this week (likely outcome: close discussion) |
| P4-3-2 | Ericsson, ZTE, MTK | Samsung, FW, CATT, LG, vivo, ~~MTK~~, QC, OPPO |   | Yes | Continue technical discussion (technical concerns on sim results not resolved yet)Check later this week (likely outcome: close discussion) |
| P4-4-1 | MTK, ZTE, LG, vivo, Nokia/NSB, QC, Samsung | FW, CATT, Apple | ~~Samsung~~, Ericsson, Lenovo | Yes | Continue discussion |
| **Note: Moderator observation/recommendation on discussion topics in section 2 :*** Moderator’s observation regarding the discussions on whether/how to support eCG (captured in Section 2):
	+ Based on the performance evaluation results:
		- It is observed that for large PDB (e.g. 30 ms), DG outperforms CG. For small PDB (e.g. 10-15 ms), due to SR delay, CG can perform better than DG.
		- Companies showed that the following schemes can further improve the XR capacity:
		- Hybrid CG-DG without specification impact
		- Pre-scheduling DG based on XR awareness
		- Enhanced CG schemes
			* The eCG schemes are categorized under proposals in sections 2.2 to 2.5 in R1-2210410.
				+ Note that performance evaluation results are only provided for the proposed enhancements under P2-2-1, P2-2-2, P2-3-1 (Alt-1), Topic 2.
	+ Based on the technical discussions so far:
		- There is no consensus yet to support any of the enhanced CG schemes.
			* Opponents are not convinced on the necessity and/or complexity of the enhancements.
* Moderator’s recommendation for continuation of discussion to decide whether/how to support eCG
	+ Moderator suggests prioritizing P2-2-1, P2-2-2, P2-3-1, [Topic 2]
		- Reasons:
			* No evaluation results YET to justify the necessity of the enhancement, when there is evaluation results to question the need.
			* A large number of companies are not in favor of the proposed enhancements.
			* Note: Regarding Topic 2, currently no capacity gain is observed. However, proponent requested to revise results by including SR in baseline to show capacity gain.
	+ For continuation of discussion:
		- Companies are strongly encouraged to provide feedback on comments raised.
			* The proponents of eCG are requested to respond the concern raised by the opponents, specially on the necessity and need of enhancements.
		- Companies are encouraged to consider the constructive suggestions that helps the decision.
			* For example, the suggestion to compare the performance of eCG with hybrid CG-DG (without specification impact).
 |

### 1.1.2 Proposals for 1st Online session

**Proposal A:**

* **For impoving XR capacity performance due to SR delay in dynamic scheduling, the following enhancements techniques can be supported if they are identified to be necessary and beneficial in addition to the exsiitng Rel-17 techniques:**
	+ **Pre-scheduling based on XR awareness (without any RAN1 impact)**
	+ **Enhaced CG (with RAN1 impact)**
* **For impoving XR capacity performance due to SR delay in dynamic scheduling, the enhancements techniques can be supported if they are identified to be necessary and beneficial in addition to the exsiting Rel-17 techniques.**
* **:**
	+ **Pre-scheduling based on XR awareness (without any RAN1 impact)**
	+ **Enhaced CG (with RAN1 impact)**

**Proposal B:**

* **To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:**
	+ **Dynamic indication of the unused CG PUSCH occasions by the UE**
	+ **Dynamic indication to the UE to adjust CG parameters (e.g. MCS, number of symbols, number of PRBs, number of layers)**
	+ **Increase CG PUSCH transmission occasion is a duration**
		- **Alt-1: single CG configuration with multiple PUSCH occasions per CG period**
		- **[Alt-2: single DCI based activation of multiple CG configurations.]**

**Proposal C:**

* **Extend the support of legacy single DCI scheduling multi-PDSCHs for FR2-2, to other SCS in FR1/FR2-1*.***

**Proposal D:**

The following proposed enhancements techniques to improve XR capacity performance are considered low priority during the study:

* **PDCCH skipping indication in the single DCI scheduling multi-PDSCHs that allow for PDCCH skipping after decoding of the multi-PDSCHs**
* **For single DCI scheduling multi-PDSCHs/PUSCHs, support of dynamic change between single TB transmission per PDSCH/PUSCH and TB repetition on multiple PDSCHs/PUSCHs**
* **Study if PHR should be further enhanced based on XR traffic arrival periodicity or UL pose periodicity.**
* **Study mechanism of packet dropping based on the PDB requirement, in order to avoid resource waste due to the out-of-date packets.**

### 1.1.3 Outcome of 1st Online session

The followings were agreed/concluded at the 1st online session:

|  |
| --- |
| **Agreement:**To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE
* Increase CG PUSCH transmission occasions in a duration

**Conclusion**No further discussion in RAN1 for Rel-18 XR to extend the support of legacy single DCI scheduling multi-PDSCHs for FR2-2, to other SCS in FR1/FR2-1*.* |

# 2 SPS and CG enhancements

The followings are agreed/concluded previously:

|  |
| --- |
| **Agreement (RAN1#109-e)**To study whether/how to support a candidate capacity enhancement technique for XR traffic based SPS/CG transmissions, companies are encouraged to consider the following studies:* + - Study enhancements related to multiple PDSCHs SPStransmission occasions in a period
		- Study enhancements related to multiple PUSCHs CG transmission occasions in a period
		- Study enhancements related to dynamic adaptation of SPS/CG parameters/configurations
		- Study enhancements related to non-integer periodicity for SPS/CG transmissions.
		- Note: Other studies are not precluded, as well as the combination of the above studies.
* Follow the *common principle for assessment of the candidate capacity enhancement technique*

**Conclusion (RAN1#110)**There is no consensus in RAN1 on the benefits of enhancing SPS for the purpose of XR capacity enhancement |

The views regarding SPS/CG enhancements for serving XR traffic are summarized and discussed in the following sections.

## 2.1 Capacity performance evaluations for CG enhancements

The Table A in section 2.1 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Companies with simulation results on CG enhancements (5):**

* **Ericsson, Huawei/HiSilicon, vivo, CATT, ZTE/Sanechips**
* **Supportive of CG enahncements:**
	+ **Yes (4): Huawei/HiSilicon, vivo, CATT, ZTE/Sanechips**
	+ **No (1): Ericsson**

**High-level observations:**

* **Only 5 companies have provided simulation results among 24 companies with views on eCG.**
* **The issue for dynamic scheduling is SR delay and/or BSR delay, specialy for low PDB (10-15ms). Hence CG enhancements is discussed.**
* **Key observations:**
* **Ericsson:**
	+ Pre-scheduling DG provides higher capacity than DG, close to Genie. No need for eCG.
		- The assumptions for pre-scheding are considered based on XR wareness and/or learning based implementation.
	+ Hybird CG-DG provides higher capacity than DG, close to Genie. No need for eCG.
		- CG resources are used to indicated incoming data and BSR. Non-empty BSR triggers DG.
* **Huawei/HiSilicon:**
	+ Pre-scheduling DG improves DG performance (no delay due to SR/BSR).
		- The assumptions are considered ideal and not realistic. Hence, need for eCG.
* **Vivo:**
	+ eCG (CG recycling) provides higher capacity than DG. Need for eCG.
* **ZTE/Sanechips**
	+ eCG (adaptation/CG recycling) provides higher capacity than DG. Need for eCG.
* **CATT:**
	+ XR specific CG resources followed by DG enables serving XR UL traffic during DRX off. Claimed benefits are power saving gain and serving XR traffic during DRX off. No capacity gain is provided.

### 2.1.1 First round of Discussion

**Moderator’s suggestiosn for First round of Discussions:**

* **Q1:** Discuss your view on at least the practicality of assumptions for pre-scheduling, hybrid CG-DG and in comparison, with eCG (recycling/adaptation based)
* **Q2:** Discuss your view on eCG proposed by CATT, and whether it should be considered for this agenda item due to lack of capacity performance gain.
* **Q3:** Discuss your view on the necessity/benefit of eCG with considerations on simulation results**.**
* **Q4:** Discuss your view regarding the evaluation results and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TP.
* **Q5:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1: It is clear that DG always outperforms CG for capacity, especially for XR, with or without any CG enhancements; otherwise, the whole NR design is wrong. For latency, there is no issue in FR2 and possibly in FR1 in the NR bands having “sufficient” BW for XR that use 30 kHz. Pre-scheduling may be used as a complementary mechanism in FR1.Q2: Almost all proposals can be analytically considered and that is preferable as it offers clarity. Regarding CATT’s proposal, if XR traffic arrives when the UE is not in Active Time, it is rather clear that the proposal can be beneficial. The question in our opinion is whether the scenario considered by CATT is a valid one and, if so, what is the point of having DRX.Q3: No need for eCG – same reasons as for no need for eSPS.Q4: Results not considering DG should not be captured. Results considering DG need to be discussed in detail for simulation assumptions and their overall relevance. We think that it would be beneficial to allocate some time for such discussions which may anyway be required in order to capture individual results in the TR.  |
| **Futurewei** | Q1: PDCCH/DCI overhead is not the bottleneck for XR capacity as the number of UEs per cell is relatively small. DG should always provide better capacity than CG except when considering the latency introduced by SR/BSR. We are open to study CG related enhancement(s) when capacity improvement is shown.Q2: In CATT simulation results, no performance gain over DG was able to show. And the gain over the baseline CG is due to additional DG. Therefore, we do not see the enhancement proposed it as one for capacity improvement.Q3: We are open to study eCG if capacity gain over DG can be shown.Q4: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| CATT | Q1: The pre-scheduling DG is similar to CATT’s proposed UL XR-PMW shown in Table 3 of R1-2208953 (also captured in section 3.5). The hybrid CG-DG is similar to CATT’s proposed eCG in Q2. We believe these two schemes are good techniques for XR system capacity enhancementQ2: No system capacity gain of enhanced CG is due to the assumption of no SR delay of baseline dynamic scheduling with very dense SR resource configuration. We don’t have time to provide additional results of baseline dynamic scheduling with SR delay. CATT proposal of UL XR-PMW for dynamic scheduling (capatured in section 3.5) comparing with dynamic scheduling with 5 ms delay showed 33.3% system performance gain. We will provide additional results next time for comparing the baseline results with SR delay. Q3: The study should include all evaluation results regarless gain or loss in system capacity in order to make conclusion of the study Q4: All evaluation results should be captured. If there are questions on certain results, such as counter intuitive good performance results, such as UL capacity over 10 UEs, it should have notes to address the analysis and observation.Q5: We like to clarify on vivo’s results of capacity over 10 users with/without resource recycling. Are the results based on MU-MIMO? |
| MTK | Q1: We tend to think hybrid CG-DG in current spec can already achieve good results. We also tend to agree with Samsung that by intuition DG should outperform CG for capacity. We can be open to discuss CG enhancement if RAN1 has common understanding that SR delay and BSR delay is inevitable and dominates PDB. (While this may be possible to be resolved by pre-scheduling as menionted by Samsung and tdoc from Ericsson)Q2: The eCG proposed by CATT seems to suffer 1.7% capacity loss compared to DG. We can be open to consider it after CATT updated their results with SR delay in next meeting.Q3: Currently we do not see the necessity due to lacke of demonstrated compacity gain.Q4: We can capture results which considers DG in TR 38.835.Q5: Whether SR delay and BSR delay is inevitable and dominates PDB. (While this may be possible to be resolved by pre-scheduling as menionted by Samsung and tdoc from Ericsson) |
| **ZTE, Sanechips** | Q1: For pre-scheduling DG, it is dependant of XR awareness information, which is too ideal. Moreover, which kind of information e.g., packet size statistics, actual packet arrival occasion can be obtained is unknown till SA’s conclusion.Secondly, we need to further think that, i.e.,if the periodicity of UL grant of pre-scheduling DG was not aligned with the periodicity of packet arrival, there exists following problems:* Transmission delay (e.g. the pre-granted resource is before the packet arrival)
* Resource waste due to some periodic blank UL grant scheduling no data.

Besides, legacy BSR is conveyed in MAC CE transmitting in PUSCH with target BLER = 1%, implying BSR has a risk of transmission failure and cause extra transmission delay if SR is not transmitted in this case. As to hybrid CG-DG, as CATT points out, in fact it is a kind of eCG.Then, for CG, to be honest, if companies check the summaried results including ZTE,Huawei,CATT,vivo, it really doesn’t make sense to me to say that DG always outperforms CG for capacity.(DG compares with eCG).Q2: Agree with CATT that more results can be provided to justify the benefit of eCG. Given collected result in this time, we think the benefit is from power saving metric. And it’s clear there is a trade-off between capacity and power saving. Q3: According the simulation results, the drawback of dynamic grant baseline is SR-BSR/PUSCH procedure, which cause transmission delay. While **CG has natural advantage of reducing the scheduling/transmission delay.** In our view some CG enhancements have small specification impact, including e.g. multiple CG PUSCHs in a period, resource recycling etc. In additional, we also observed that eCG could bring capacity gain compared to pre-scheduling DG according with realistic simulation assumptions.Q4: From our perspective, all enhancement techniques with reasonable evaluation results should be capture in TR 38.835, no matter they are high priority or low priority. Moreover, the reason for de-prioritizing the techniques should be stated in the document. |
| **LG** | **Q1:** DG always can be utilize suppliementally for CG. However, we think pre-scheduling is a kind of optimistic assumption. Based on current BSR, gNB may not acquire UE buffer information before traffic arrival. If gNB scheduling based on XR-awareness information, DG may not have significant benefit comparing to CG. Scheduling additional resource by dynamic UL grant is always possible even in current specification. **Q2:** In existing system gNB can scheduling additional resource by UL grant or override configured CG resource as well. If CG resources need to be changed permernently, re-activation could be used. We don’t think proposed eCG has significant difference from those exisiting methodology. **Q3:** Same as Q2. **Q4:** Fine to capture. **Q5:** In our view, main use case of CG is pose data traffic, which have static data size with short period. In this case, jitter handling would be the main issue to be solved.  |
| **Panasonic** | Q1: We think the combination of CG and DG is a feasible approach for supporting XR traffics, considering the jitter of data arrivals.Q2: The proposed technique could be further studied and considered.Q3: We think there is no need for further CG enhancements. |
| **Google** | **Q1**: * Pre-Scheduling: The pre-scheduling DG is relying on the gNB full awareness of the UL video frame arrival time and packet size to anticipate with a Pre-Scheduling. The awareness could be via signalling or via UE/gNB learning based implementation. These assumptions could be very difficult to agree at the moment with the lack of inputs from SA2/RAN2 on XR awareness. Also, the learning-based implementation is a very ideal assumption difficult to make at this stage. In terms of capacity enhancement, it shows less than 1% capacity enhancement compared to normal DG for the 30ms PDB required for the UL AR video traffic, which doesn’t justify this enhancement.
* Hybrid CG-DG: UL pose and control information is a periodic traffic with no jitter and can use periodic CG configuration with no enhancement needed. The hybrid CG-DG can be useful for the UL AR video traffic. However, the PDB latency requirement for UL AR traffic is 30ms and the scheme seems to show less than 3% capacity gain compared to the normal DG, which is not enough to justify this enhancement.
* eCG recycling/adaptation based: We think the use of multiple CG PUSCHS is beneficial and the use of adaptation and recycling techniques to improve this scheme is useful. The UE can request to cancel some occasions, add some occasions or to modify some occasions based on the arrival and the awareness of the UL traffic. However, the capacity gain is not very clear from ZTE’s results for the 30ms PDB requirement and vs. DG.

**Q2**: eCG as proposed by CATT where the CG is used and the remaining data is scheduled by DG and the UE switch to monitor PDCCH after sending a non-empty BSR. The capacity results dhow a degradation of 1.7% compared to DG. The enhancement can probably offer power saving gain compared to DG with continuous PDCCH monitoring but doesn’t seem to offer capacity gain**Q3**: We are OK to study eCG if it offers capacity gain compared to DG. **Q4**: Yes, we think the evaluation results should be captured as long as they use the agreed simulation assumptions.  |
| **vivo** | Q1: In our opinion, pre-scheduling can be a feasible way for UL latency reduction, but realistic assumption should be made considering recycling of pre-allocated resources, resource efficiency, etc. Regarding the solution of hybrid CG-DG, it is a natural choice when CG resources are adopted to serve UL traffic. In summary, hybrid CG-DG, as well as DG, can be regarded as the baseline(s) to assess CG related enhancments, i.e. eCG.Q2: Regarding the eCG solution proposed by CATT, since no capacity gain can be achieved compared to DG, we tend to not consider it for capacity enhancement.Q5: Regarding CATT’s comment for clarification, in the simulation, SU-MIMO is assumed for evaluation of the performance of recycling of unused CG resources. |
| **Ericsson** | Q1: * Hybrid CG-DG is based on existing specification. Hence no enhancement is needed and it is not an eCG.
	+ CATT proposal is similar to Hybrid CG-DG, BUT in CATT proposal, UE monitors PDCCH during DRX-OFF (spec impact). That is not the case for hybrid CG-DC (monitoring PDCCH during DRX-ON).
* On Pre-scheduling and assumption of XR awarensse, we don’t think ideal/exact information is needed. A rough understand on XR packet sizes (which can be also obtained by learning imlementaiton is sufficient). What is important is to have an intital grant of reasonable size (not too small). Please see below when we simulated using initial grant as MIN/AVG/Max of XR traffic and obtaining similar results (in contribution, we showed only MIN)

* **ZTE:** On BSR comment on ZTE, it is unclear for us the reason. Consider URLLC where CG is used. If BLER was an issue, it should have been addressed fro URLLC.
* **ZTE:** Ericsson also shows for low PDB, Baseline DG is not always better than CG (note that we used best case of CG for comparison). The issue is SR delay. That’s why we tried to show for XR traffic, we can address SR delay:
	+ Pre-scheduling is statistics of XR is available
	+ Hybird CG-DG (during DRX-ON) is no information is available. Please note we used in this case small CG resources in UL slots.

Q2: CATT proposal is suitable for power saving. No capacity gain is achieved.Q3: We don’t think any eCG is needed. For the recycling schemes, if the additional information is considered in CG-UCI instead of multi-bit, then it is fine. Because this track is more consistent with current spec than changing SR to extend it to multi-bit. Etc.Q4: We think at least the results showing meaningful capacity gain should be captured.  |
| **Sony** | **Q1:** Pre-scheduling and hybrid CG-DG consume a lot of DL capacity (e.g., PDCCH) as well as DL power consumption. These issues have not been taken into account when companies provided simulation results for Pre-scheduling and hybrid CG-DG. For eCG, some eCG proposals do not impact on DL capacity and DL power consumption at all. In addition, eCG has a benefit of mitigating the scheduling delays. **Q2:** All proposals should be on the table until Nov. Companies still have more time to provide more results.**Q3:** The benefits of eCG are to mitigate the scheduling delays while providing performance similar or close to DG, as well as reduction of DL resource consumption (a plus sign). **Q4:** We think we should have a fair treatment where all reasonable simulation results are captured in the TR provided that the baseline DG and CG are also simulated, and regardless of whether some are more favourable than others. |
| **InterDigital** | Q1: In our view, eCG is benefial for improving capacity and can be considered under enhancements related to adaptations of CG, e.g. for indicating any excess CG resources. We share similar understanding with ZTE that Hybrid CG-DG is a type of eCG, where DG resources can be requested when the allocated CG resources are insufficient, e.g. by including BSR when transmitting data with CG resources. Regarding performance gains of CG over DG, from the evaluation results provided by some companies such as Huawei, vivo and ZTE, clearly the savings due to SR/BSR latency are useful for realizing capacity gains, particularly when considering PDB of 10ms for UL video. Q2:We are open for discussing the benefits of eCG with more results as indicated by CATT under the capacity agenda, even though the gains may be in power savings.Q3 - Q4:We think the latency reduction by avoiding SR/BSR are useful for realizing capacity gains for eCG compared to the legacy DG. We think the TR 38.835 should capture the evaluation results of any of the CG enhancement schemes that show gains over the baseline DG, including the conditions when eCG outperforms DG  |
| **OPPO** | Q1: Although PDCCH overhead is not the bottleneck for XR, less detection of PDCCH can reduce the UE power consumption. Therefore, we think eCG can provide benefits for short latency and power saving.Q2: We think CATT’s proposal is a hybrid CG-DG solution.Q3: We are open to study eCG. |
| **Lenovo** | Pre-scheduling, at least if it is not single DCI scheduling multi-PUSCHs in cases that there is any jitter/inaccuracy w.r.t. XR traffic awareness may result in resource wastage.Hybrid CG-DG may impact power saving (e.g., if DRX is configured) due to having CG resources in [many] slots. If gNB knows some traffic statistics or range of some XR paarmeters, the scheme may be more useful. |
| **Huawei/HiSilicon** | Q1: we think Ericsson’s “Hybrid CG-DG” seems to be legacy CG behavior, i.e.g, UE transmits on CG, and wait for dynamic scheduling if there is still remaining data, which is allowed by current spec. We are unclear about the “normal CG” in Ericsson’s simulation, it seems to be a new UE behavior.In short, several companies’ simulation results prove that eCG can provide higher capacity compared with dynamic grant that requires SR/BSR by reducing the transmission delay. And re-allocate the unused PUSCH occasions to other UEs to avoid resource waste can improve capacity performance. Therefore, support eCG.Q3: According to simulation results, eCG can provide higher capacity compared with dynamic grant that requires SR/BSR, especially in tighter PDB.Q4: Simulation results of CG should be captured in TR.  |
| **Nokia, NSB** | **Q1:** The simulation results provided by companies demonstrated that the scheduling delay caused by SR can significantly degrade the performance of XR users. Thus, solutions that minimizes the scheduling delay is of special importance.From the simulation studies provided by companies, Pre-Scheduling DG and CG show the best results over conventional DG. As mentioned by HW, in case of pre-scheduling DG, UE may not be available to receive DCI in every slot (e.g., due to C-DRX, search space set, PDCCH skipping, etc.). Note that use of CG also comes with the advantage of avoiding failure due to UE PDCCH decoding failures as is the case for DG cases. **Q2:** Therefore, CG is shown to be beneficial for XR use cases. During this meeting we need to agree whether the CG enhancements are necessary or not. Currently, two main problems were identified: (1) non-integer periodicity of video and (2) large video frame that can be conveyed over multiple slots.Problem 1 need to be solved to help CG work properly when supporting XR. Problem 2 can be solved by various means, e.g., by allocating multiple TBs per period, multiple CG configurations or by allocating extra resources with DG. We thus propose to concentrate on the proposed solutions and discuss the pros and cons o each of those and decide whether the enhancements are needed to support large video frame.**Q4:** We also agree to capture the results and the observations related to CG following the assesment to TR 38.835. |
| **Intel** | Q1: Similar view as other companies that pre-scheduling assumes some XR traffic related awareness information which is not clear at the moment to what extent it can be assumed available. Hybrid CG-DG is not new scheme and can be implementend based on specification.Q2: We agreed that capacity gain is a necessary condition for RAN1 endorsementQ3: Open if capacity gain is shownQ4: Results showing meaningful capacity gain with reasonable/practical assumptions should be captured |
| **Qualcomm** | **Q1.** Some of the simulated schemes have ideal assumptions or assumptions with underlying standards impact. For example, the prescheduling scheme assume the gNB knows the packet distribution and arrival time. The simulations from Huawei show that CG is useful.  **Q2.** Considering that simulation results showed no performance gains then suggest to down prioritize. However, this is similar to one of our earlier proposals to have increased PDCCH monitoring around SPS/CG. The idea was to save power (and capacity wrt CG). Would be interesting to see PSG for this. **Q3.** We think CG enhancements are useful for capacity and power savings **Q4.** Agree that simulation results should be captured.  |

### 2.1.2 Second round of Discussion

**Summary of comments/clarifcations:**

* + For large PDB, DG always overperform CG. For small PDB, some areas CG perform better.
	+ Hybrid DG-CG by Ericsson is not an eCG scheme. It does not rely on XR awareness.
	+ XR-PMW by CATT is an eCG scheme (due to support of PDCCh monitoring during DRX off).
	+ Pre-scheduling by Ericsson does not require ideal/exact information of XR traffic (see MIN/AVG/MAX) results.
	+ All simulations try to address at least SR and/or BSR delay.
	+ Two different observations:
		- Ericsson results: See e.g. Hybrid CG-DC. No need for eCG.
		- Vivo/ZTE/Huawei/HiSilcon/CATT: Not considered e.g. hybrid CG-DG. Need for CG eCG.
	+ Performance should be compared to DG.
	+ Question to CATT (by Samsung): Whether the scenario considered by CATT is a valid one and, if so, what is the point of having DRX.
	+ Note: CATT simulations: SR-less. Hence larger capacity in baseline DG as compared to others. CATT plans to provde updated simulation results next meeting.

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Continue discussion for the 2nd round**
	+ **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
	+ **If no consensus on support of eCG is achieved by the ends of 2nd round, down-priorotize this topic for further study.**
	+ **Capture the description of simulated schemes with corresponding simulation results and key assumptions and findings, in this meeting.**
* **Note that CATT plans to update the baseline simulation results next meeting.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **ZTE, Sanechips** | **Thanks moderator for this recommendation proposal, we can’t support it.** Do we really need to close the study of section 2.1, 2.2, 2.3, 2.4 by the ends of 2nd round ? Note CG enhancement is in the scope of SID, and 5 companies have provided results, 24 companies provided their solutions in this meeting.More importantly, 4 companies provided evaluation results of CG enhancement. * HW/Vivo/ZTE have provided significant capacity performance of eCG compared to baseline DG.
* CATT planed to update the result of eCG with SR delay as baseline DG.

Then for **“Summary of comments/clarifcations”:**We’d like to have following corrections and questions:* For large PDB, DG ~~always~~ overperform CG. For small PDB, ~~some areas~~ CG perform better.

W.r.t hybrid CG-DG, we think there’re specification impacts. E.g.,at least hybrid CG-DG relies on XR-awareness, without that, the gNB has no idea how to configure CG periodicity. W.r.t pre-scheduling, could the moderator clarify whether or not XR packet size statistics, e.g. MIN/MAX/AUG is needed ?At last, for XR-awareness information, we share similar views as google’s comments in the 1st round. i.e., which kind of information can be obtained is unknown till SA’s conclusion, and it’s not easy to get the information via implementation, e.g.,gNB may spend time measuring the XR traffic information while it may be inappropriate for the coming traffic. |
| **vivo** | Based on first round discussion and the simulation results, we think it will be helpful to capture some general observations for DG and CG, as FL summarized. For example,* For large PDB, DG overperform CG.
* For small PDB, CG with some enhancements performs better than DG
* For DG, performance is depending on the scheduling delay.

Besides, we have a comment for pre-scheduling DG. To make pre-scheduling DG useful, gNB needs to be aware of the UL video frame arrival, as well as statistics for frame sizes. This may be done by assistance information reporting from UE, or estimated by gNB through a period which may not be easy implementation. Before that, gNB can only rely on SR/BSR from UE to perform scheduling until gNB is aware of necessary characteristics of UL traffic, otherwise pre-scheduling does not work.  |
| **Nokia, NSB** | We propose to start collecting the results and observations related to CG and eCG during this meeting. The pros and cons of the CG/eCG as compared to DG based on technical arguments and simulation results will help us to reach a conclusion. Any down-prioritization decisions shall be based on technical concerns and/or lack of benefits as compared to negative effects. |
| **MTK** | We are open to keep eCG in the radar and wait for updated results from CATT in the next meeting. The observations from vivo seems reasonable to us:* For large PDB (e.g. 30ms), DG overperform CG.
* For small PDB (e.g. 10ms), CG with some enhancements can perform better than DG

At the same time, we think it is important to capture the assumed values of SR delay and BSR delay for each company result since the assumed values can have large impact on the resulted gain of eCG. |
| **Samsung** | Support the suggestion by the moderator.In general, it would be good to first identify what Rel-17 can do, whether any enhancement is needed and, if so, the corresponding ‘delta’ over Rel-17. As the moderator commented, having CG and DG is possible in Rel-17. Also, prescheduling can be indicated for more than one slot and DCI overhead is a non-issue for XR (and, for this case, it would only occur once). Further, for the purposes of capacity, it would be beneficial for proponents of eCG to explain how link adaptation is performed and, if it is, the corresponding benefits over DG. Many of the ‘eCG’ proposals seem to attempt to introduce substabtial complexity in order to mimic what DG can readily do when that is both unnecessary and not fundamentally possible. No issue with capturing all results from every possible proposal in the TR (other than the resulting TR size) but it is probably unavoidable to have a discussion about what those results assumed or did not assume, and what is the delta over Rel-17 capabilities, if any conclusion is to be made.  |
| **Ericsson** | **@ZTE/Other eCG proponets:** Please see some clarifications below:* **Regarding comments on hybrid CG-DG:** As we mentioned in our contribution and initial round, no information on XR awareness is considered. Using TDD pattern DDDSU, we have used “small CG” resource in every UL slot, to avoid large resource utilization.
* **Hybrid scheduling based configured and dynamic grant (Hybrid CG-DG):**
	+ The scheduling is based on a combined use of configured and dynamic grants. SR resources are not used. Instead. CG resources are configured with minimum size in every UL slot in order to transmit BSR and small amount of data when new data arrives. Whenever XR packet arrives in a buffer, the UE uses the nearest possible CG occasion for BSR transmission and possibly small amount of data. The network can thus use the BSR to provide dynamic grants for the following data transmission. No knowledge of XR traffic periodicity is assumed. See Figure 4.
	+ **It is not clear why ZTE suggests hybrid CG-DG has spec impact and needs XR awareness. We appreciate if ZTE clarifies.**
	+ We used TDD pattern and tested different configuraitions as we explained and used the best for CG. Because no matter the arrival time of XR traffic with non-integer periodicity, the transmission depends on UL opportunity in TDD pattern.
* **Regarding pre-scheduling:** We had observed HW also simulated pre-scheduling, assuming “ideal BSR”. In their contribution, it was then concluded that pre-scheduling is not realistic, and hence the need eCG was justified. Therefore, we share our view that pre-scheduling can be realistic, and why.
	+ For periodicity, is can be learned (see vivo’s comment). Also, keep in mid that NW operation is not limited in PHY layer. A lot of information are provided to accommodate best resource alaocaiton to users with different QoS. Additionally, pre-scheudling is widely used in NW.
		- **Question back to ZTE:** In your simulaitons, you have used periodicity of 16.5 ms for legacy CG. **Isnt that based on XR awareness?** Then, for enhancements, you use same periodicity but increasing number of TO per period if we understood correctly. So, it seems to us that both for legacy CG and eCG, XR awareness is used. Just to be clear, we think that is fine but it is not clear to use why it is used as an argument against our simulation.
	+ For the initial grant size, our comment was that it does not need to be “ideal”. As long as it is reasonable, it works fine. For that, we showed that we tested in **simulation** MIN, or AVG, or MAX and obtained the same results, and all better as compared if we had used an initial small grant. For example, if we use 100-300 kbits, instead of 200-300bits, it works fine, and close to optimum. We all know XR packet sizes are large. In practice, if we know we have an XR user, we can use a “reasonable large initial grant” (even if 3gpp doesn’t reach any XR awareness outcome!) Back to original point, we tried to show that we disagree that pre-scheduling does not work in practice due to lack of “ideal” information.
* **Questions to ZTE/Nokia/../proponets of eCG:** Our main concern isthe enhancementswith dynamic adaptation for CG. Samsung has explained well the reasons. It was also asked in initial round by FW and Samsung if proponets could provide more information on dynamic adaptation.

To summarize, in our view, the SR delay for DG can be addressed by existing specifications. We tried to show this by two examples. Therefore, we are not convinced on the need for eCG to address SR delay in DG. |
| **CATT** | **Clarification to Moderator.** * We like to clarify that CATT’s UL XR-PMW is a pre-configured PDCCH monitoring cycle of dynamic scheduling similar to Ericsson’s pre-scheduling scheme, which PDCCH monitoring cycle are customized for XR with semi-static configuration to align with the XR traffic generation cycle without any need of SR.
* CATT’s eCG proposal is the CG+DG with BSR enhancement. BSR will be included in PUSCH at each CG occasion. The PDCCH monitoring for DG is pre-configured after each CG to allocate the UL resource based on UE reported BSR at each cycle. Our eCG results are slightly outperformed by DG because we assume 0 SR delay. Thus, you can categorize CATT’s eCG to CG+DG. If you would decide whether to further discuss eCG, you could exclude CATT’s proposal from eCG and considered it as CG+DG with BSR enhancement on the triggering condition to customize for XR.

**Answer to Samsung,** * DRX is configured for the control of PDCCH monitoring for the robust traffic arrivals, such as eMBB delay insensitive traffic, of all serving cells in achieving UE power saving. For periodic traffic, UL CG and DL SPS had been introduced for periodic traffic arrival and small variation in packet size to disassociate the PDCCH monitoring control by DRX for the robust traffic arrival. Thus, the UL XR-PMW is a pre-configured PDCCH monitoring occasions aligned with XR traffic generation cycle for dynamic grant without SR to allocate radio resource based on the XR packet size at each cycle. This will minimize the impact of PDCCH monitoring control by DRX for other traffic and customize the PDCCH monitoring for XR
 |
| **Futurewei** | We are supportive of moderator’s suggestion. Furthermore, as we commented before, CG has the advantage of potentially lower latency without the need of SR/BSR while loss the flexibility of dynamic resource allocation, link adaptation, etc. Therefore, there is a possibility that CG (including eCG) can outperform currently possible schemes supported by R17 specifications by using both CG and DG. The key is to show such gain from eCG comparing to best implementation of CG+DG under reasonable assumptions. To reach a consensus, significant time and effort should be taken to discuss the simulation results in detail. What Nokia proposed is also ok to us. Though we have not seen convincing results and argument for eCG, we are still open for more discussions. |
| **Qualcomm** | We agree with ZTE comment. We don’t think there is a need to deprioritize CG especially there we have simulation results showing capacity gains. We prefer at this point to keep eCG discussions open. |
| **Sony** | We do not agree this bullet “**If no consensus on support of eCG is achieved by the ends of 2nd round, down-priorotize this topic for further study.”**We think if no consensus is reached, we continue to study to analyse and provide simulation results until next meeting (business as usual!).We are ok to capture the description of proposed enhancement techniques with corresponding simulation results, if available. |
| **Intel** | We are open to further discuss if there is practical benefit and results showing capacity gains for eCG schemes compared to baselines, such as plain DG. Vivo’s suggestions to capture the general observations on CG and DG seem reasonable to us. Perhaps, benefit of CG over DG in terms of allowing transmission outside DRX active time can also be captured as CATT pointed out.Clarification question: Is there any RAN1 spec impact for the pre-scheduling scheme? If so, it will be great if **@Ericsson** could explain.We also think that hybrid CG+DG scheme does not seem have any new spec impact. |
| **DOCOMO** | We agree with Nokia to capture the simulation results and make decisions based on technical reasons. And we share similar understanding as Intel that the RAN1 spec impact for pre-scheduling and hybrid CG+DG scheme is not clear. |
| **OPPO** | We are fine to capture evaluation summary as listed in comments from vivo and MTK. The normal procedure for RAN1 to determine which solution is picked for WI recommendation and which is not is done in the last meeting of SI. Given the FL suggestion of down-prioritization is a big switch to turn-down all CG-related solutions, it seems to provide no advantages to the SI to have such big-scale down-prioritization one-meeting earlier just due to temporarily no consensus to support at this time.  |
| **Huawei/HiSilicon** | We think Ericsson’s “Hybrid CG-DG” seems to be legacy CG behavior, i.e., UE transmits on CG, and wait for dynamic scheduling if there is still remaining data, which is allowed by current spec. We think Ericsson’s “Genie DG” is not the actual upper bound for UL capacity. Ericsson’s Genie DG assumes BSR is available with zero delay at the scheduler when a new packet arrives in the UE buffer. That is, UE still need to wait for DCI scheduling to transmit UL frame after UL frame arrives, which will decrease the capacity. For example, as shown in the below figure, if frame arrives in slot 7, first transmission will be at slot 12 as per Ericsson’s “Genie DG”. While for CG, the first transmission can be at slot 7, thus bringing capacity gain. Therefore, we think Ericsson’s “Genie DG” is not the actual upper bound for UL capacity, i.e., there is still room for capacity enhancement under CG.Regarding “Pre-scheduling” by Ericsson, it seems to assume that UE is available to receive DCI in every slot. But in real application, C-DRX, or PDCCH search space set, or PDCCH skipping may be applied for power saving, so it is possible that UE cannot receive the pre-scheduling DCI sometimes since UE may fall into sleep state.Therefore, we think CG enhancements still needs to be considered since there are room for capacity improvement. |
| **LG** | We support to capture the evalution results provided in this meetings. We also think down-prioritizing is a bit premature. At least benefit of CG in terms of PDB has been shown by contributions. In the case that we cannot reach a consensus, we are open to keep discussion. We think spec impact for pre-scheduling and hybrid CG+DG scheme is not clear. |

### 2.1.3 Third round of Discussion

**Summary of 2nd round of discussions:**

Based on the performance evaluation results:

* It is observed that for large PDB (e.g. 30 ms), DG outperforms CG. For small PDB (e.g. 10-15 ms), due to SR delay, CG can perform better than DG.
* Companies showed that the following schemes can further improve the XR capacity:
	+ Hybrid CG-DG without specification impact
	+ Pre-scheduling DG based on XR awareness
	+ Enhanced CG schemes (including Hybrid CG-DG with specification impact)

There is no consensus yet to support any of the enhanced CG schemes.

The following is also agreed that priorizes two categories of eCG techniques as in P2-2-1 and P2-3-1, among the other proposed techniques.

**Agreement:**

To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:

* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE
* Increase CG PUSCH transmission occasions in a duration

**Moderator’s recommendation for discussion:**

* **Recommendation:**
	+ Continue the discussion. Please review the questions raised and provided feedback. Regarding CG enhancements, please focus on the CG enhancements in P2-2-1a, P2-3-1a as agreed to be prioritized for study.

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

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| **Company** | **Comment** |
| **Futurewei** | It is up to the proponents to show convincing performance benefits to move forward. |
| **Samsung** | Fine to continue discussion but it would be good for proponents to provide some basic rationale for how CG can be applicable/beneficial for XR.For capacity, given that DCI overhead relative to XR packet sizes is practically zero and link adaptation (resource allocation, MCS, MIMO layers, …) can typically increase capacity by over 100%, how can CG be beneficial even under ideal assumptions for predictable/non-varying packet sizes?For latency, if CG is used, why isn’t Rel-17 CG sufficient? For example, a gNB can activate one or more CGs, a UE can provide data upon arrival (and can include BSR and other XR-related info that RAN2 may define - e.g. for multiple flows of a PDU set), and the gNB can then deactivate CG, switch to DG, and repeat. In our opinion, use of any CG to reduce latency is unlikely. In FR2 (expected for XR due to BW availability) SR can be used. In FR1, operators do not have sufficient BW to deploy XR in bands using 15 kHz SCS (and cannot preallocate BW for video traffic) while at 30 kHz the SR-based latency can be tolerable to avoid capacity loss from preallocated resources for video traffic, there are ways to reduce latency in some cases (e.g. P3-5-5/P3-5-6), and the bigger problem is the scarcity of UL resources as current UL-DL configs are typically DL-heavy while XR traffic is more symmetric. A description of the general operation with CG is also needed. For example, how does a gNB know the size of CG resources to reserve by RRC, what is the number of UEs that can be supported with reserved resources and unknown traffic arrival time for ~30 Mbps per UE, how can resources be adapted based on FOV changes and user activity with update rates similar to those of pose/control information, etc. |
|  |  |

## 2.2 Adaptation of CG parameters/configurations

The Table B in section 2.2 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions. Please note that for some enhancements techniques, companies have provided simulations results.

**Status of inputs in the contributions:**

* **Companies with view (16):** Huawei/HiSilicon\*, vivo\*, Nokia/NSB, IDC, QC, ZTE/Sanechips\*, Ericsson\*, CATT, ChinaTelecomm, OPPO, TCL, Sony, CMCC, Apple, Samsung, DCM
	+ **Supportive (13)**: Huawei/HiSilicon\*, vivo\*, Nokia/NSB, IDC, QC, ZTE/Sanechips\*, ChinaTelecomm, OPPO, TCL, Sony, CMCC, Apple, DCM
	+ **Not supportive (3):** Ericsson\*, CATT, Samsung
* **Companies with evalution results (4):** Huawei/HiSilicon\*, vivo\*, ZTE/Sanechips\*, Ericsson\*

**High-level observations:**

* **Only 4 companies have provided simulation results among 16 companies with views on eCG based on dynamic adaptation.**
* **Variety of adaptation schemes are proposed. Not clear how to relate the performance evaluation results to a specific proposed enhancement.**
* **High-level categorization of the proposals on dynamic adaptations of CG configuraitons**
	+ **Group 1:** Dynamic indication of the unused CG PUSCH occasions by the UE to improve XR capacity performance
		- **Supported:** HW/HiSi\*, vivo\*, ZTE/Sanechips\*, Nokia/NSB, QC, IDC, China Telecom
		- **Not supported:** Ericsson\*, CATT, Samsung
	+ **Group 2:** Dynamic indication to the UE to adjust CG parameters (e.g. MCS, number of symbols, number of PRBs, number of layers) to improve XR capacity performance
		- **Supported:** DCM, ZTE/Sanechips\*, TCL, CMCC
		- **Not supported:** Ericsson\*, CATT, Samsung
	+ **Group 3:** Dynamic indication to the UE to modify PUSCH occasions (increase/descrease and/or advance/delay) to improve XR capacity performance
		- **Supported:** IDC, [QC]
		- **Not supported:** Ericsson\*, CATT, Samsung
	+ **Group 4:** Dynamic indication from the UE for adjusted CG parameters (e.g. MCS, number of symbols, number of PRBs, number of layers) to improve XR capacity performance
		- **Supported:** Sony, Appple, QC, OPPO, [Lenovo]
		- **Not supported:** Ericsson\*, CATT, Samsung

### 2.2.1 First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 2-2-1:** Dynamic indication of the unused CG PUSCH occasions by the UE to improve XR capacity performance is beneficial.
* **Proposal 2-2-2:** Dynamic indication to the UE to adjust CG parameters (e.g. MCS, number of symbols, number of PRBs, number of layers) to improve XR capacity performance is beneficial.
* **Proposal 2-2-3:** Dynamic indication to the UE to modify PUSCH occasions (increase/descrease and/or advance/delay) to improve XR capacity performance is beneficial.
* **Proposal 2-2-4:** Dynamic indication from the UE for adjusted CG parameters (e.g. MCS, number of symbols, number of PRBs, number of layers) to improve XR capacity performance is beneficial.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** Moderator recommends to down prioritize Proposal 2-2-3 and Proposal 2-2-4 due to lack of supporting capacity performance evaluation results by propoents.
	+ What is your view on Moderator’s recommendation?
* **Q2:** What is your view on direction of Proposal 2-2-1 and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q3:** What is your view on direction of Proposal 2-2-2 and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q4:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q5:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

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| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1/Q2/Q3: We do not agree with further consideration for any of the proposals as there cannot be any benefit over DG, particularly for XR. For example, what is the benefit over DG for “Dynamic indication to the UE to adjust CG parameters (e.g. MCS, number of symbols, number of PRBs, number of layers)”? RAN1 may first discuss any benefits of few selected eCG proposals over DG.A specification impact and how a proposal can be implementable/testable needs to be dscribed. For example, how will a UE determine that it needs fewer resources? Packet size is not enough for such determination and robustness of such UE estimation (e.g. to variations in link quality) need to be discussed for impact on capacity/QoS. How can a gNB trust various UEs to make decisions for spectrum allocation? How will the UE behavior be tested and what motivation does a UE have to not always indicate need for maximum resources? Given that a NW needs to plan for worst case, how many UEs can be supported with CGs based on maximum resources? How will link adaptation be performed differently from DG? There are several more aspects to be discussed for each individual eCG proposal.Q4: Advantages over DG need to first be described/explained and agreed before capturing any results in TR 38.835. |
| **Futurewei** | Q1: WE are ok to down prioritize 2-2-3 and 2-2-4. Q2: For 2-2-1, a few questions on the proposed scheme. For example, how often the dynamic indication needs to be sent and how fast it should be applied to obtain the potential benefit? What should be the criteria for the UE to send such indication?Q3: For 2-2-2, a few questions on the proposed scheme. For example, how often the dynamic indication needs to be sent? What should be the criteria for the gNB to decide the adjustment? How is this better than directly using DG?Q4: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately.  |
| **CATT** | Q1: WE are ok to down prioritize 2-2-3 and 2-2-4. Q2/Q3: We have question on how gNB sends the dynamic indication and how/when UE would receive the indication if there is no UL grant for retransmission. Q4: All results should be captured. If there are questions on some results, they should have a note for clarification.  |
| MTK | **Q1:** We are ok to down prioritize 2-2-3 and 2-2-4.**Q2:** For Proposal 2-2-1, we think UE assistantce information (UAI) to indicate unused CG resource to NW may be useful for NW to more efficiently manage the scheduling resource. However, we this this is better to be discussed in RAN2 since UAI belongs to RAN2.**Q3:** We do not see necessity/benefit for Proposal 2-2-2. If NW wants to dynamically adjust the MCS, number of symbols, …, NW can just use DG.**Q4:** Results can be captured with description about advantages over DG to be described/explained. |
| **ZTE, Sanechips** | In our opinion, we should firstly focus on the necessity of CG enhancement, instead of down selecting the detailed techniques.Q1: Disagree. We are open to study Proposal 2-2-3 and 2-2-4Q2: Support Proposal 2-2-1Q3: Support Proposal 2-2-2Q4: From our perspective, all enhancement techniques with reasonable evaluation results should be capture in TR 38.835, no matter they are high priority or low priority. Moreover, the reason for de-prioritization should be clarified in brief, for the enhancement techniques with low priority. Q5: We should firstly focus on the necessity of CG enhancement, instead of down selecting the detailed techniques |
| **LG** | **Q1:** We are fine to accept FL’s recommendation. One following question is whether 2-2-4 can be considered in SR/BSR enhancement if the indication of UE is formed as SR or BSR. **Q2/Q3:** Same as 2.1.1, In existing system gNB can scheduling additional resource by UL grant or override configured CG resource as well. If CG resources need to be changed permernently, re-activation could be used. We don’t think proposed CG proposal has significant difference from those exisiting methodology.**Q4:** With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. |
| **Panasonic** | Q1: We are fine with the recommendation.Q2: The inidication for releasing the upcoming CG PUSCH requires knowing the exact time of data arrival, which is not feasible according to the agreement.Q3: We do not see a need for dyanimic adjustment for CG resources, such as MCS.Q5: We think the Proposal 2-2-3 could be further studied to align the CG PUSCH to XR traffic. |
| **Google** | **Q1**: We see benefit in Proposal 2-2-3 and Proposal 2-2-4 and we agree with ZTE. The listed proposals are detailed techniques for CG enhancement and we need first to agree whether CG enhancement is beneficial/needed and should be studied (like we did for SPS) and then decide about the detailed techniques to explore and ask for evaluation for each technique.**Q2**: UE sends BSR information on the first CG PUSCH. Hence gNB can have the information of the data waiting for scheduling and can know which CG PUSCH occasions will be unused and can be re-used for other scheduling. Unless the UE is doing some discarding (e.g. close to expiry data) that the gNB is not aware of and the UE indicates that it can release some CG PUSCHs. Alternatively, the UE can provide further assistance information like amount of high and low priority data (e.g. based on the PDU set importance and PSDB) in the buffer and gNB can cancel/add resources based on that.**Q3**: We Proposal 2-2-2 and think it is useful if the gNB get information about the priority of the data, the remaining delay, … For example, an enhanced BSR can signal such assistance information and based on that the gNB can adjust CG parameters. **Q4**: Yes, we think the evaluation results should be captured as long as they use the agreed simulation assumptions.  |
| **Vivo** | Q1: WE are OK to down prioritize 2-2-3 and 2-2-4.Q2: Based on our simulation results, we support Proposal 2-2-1.Q3: In our opinion, CG (re-)activation in existing NR specification can achieve the target of adjusting CG parameters. Besides, how frequent to perform CG (re-)activation is up to gNB implementation. It is unclear to us what the enhancement is and how much additional capacity gain it can achieve compare to legacy mechanism. |
| **Ericsson** | Q1: Support to down prioritize 22.3/4.Q2: If the indication is via CG-UCI, we could be OK to study further, since the container is already exists and spec impct is minimum. Having said that, we don’t see it improves capacity over DG, but in principle, providing assistance to gNB via CG-UCI can be useful.Q3: Not supporting 2-2-2. As we showed, DG already provided best performance. No need to introduce adaptation in CG, when we can achieve the same goal with other means as we showed. |
| **Sony** | **Q1:** Disagree. We are open to study proposals 2-2-3 and 2-2-4. Companies still have more time to provide results.**Q2:** Support Proposal 2-2-1**Q3:** In our view proposal 2-2-2 is like CG Type 2 where network can modify the resource allocation of the CG resource. So it is not an enhancement. **Q4:** Simulation Results should be captured in the TR 38.835 provided that the baseline DG and CG are also simulated. |
| **InterDigital** | **Q1:** We share same view with ZTE and Google; proposals 2-2-3 and 2-2-4 should not be down-prioritized at this stage, and should be considered as part of enhancements related to eCG. **Q2:** Support proposal 2-2-1**Q3:** Support proposal 2-2-2**Q4:** We prefer capturing the evaluation results of the enhancement schemes related to adaptation of CG in the TR |
| **OPPO** | Q1: We are OK to down-prioritize Proposal 2-2-3 and 2-2-4. Q2: We support Proposal 2-2-1 if multiple PUSCH transmission occasions in each period is supported. The unused CG PUSCH occasions can be indicated by CG-UCI transmitted in the first CG PUSCH in each period.Q3: We are OK to down-prioritize Proposal 2-2-2, since it can be achcived by current DG overriding CG. |
| **Lenovo** | Schemes with simulation results should be prioritized. Proposal can be updated to include “if CG enhancement for XR is supported”. |
| **Huawei/HiSilicon** | Q1: we are ok to down prioritize 2-2-3 and 2-2-4. Q2: For 2-2-1, we support. When an UL XR video frame arrives, the UE can know the video frame size and thus the number of PUSCH occasions needed to transmit the video frame. If there are one or more unused PUSCH occasions, the UE can indicate the unused CG PUSCH occasions to the gNB to avoid resource waste, which has capacity gain.Q3: For 2-2-2, companies should clarify how often the dynamic indication needs to be sent? How is this better than directly using DG?Q4: Results for Proposal 2-2-1 should be captured. |
| **Nokia, NSB** | Q1: We do not agree with proposal 2-2-4: UE can continue sending the CSI reports and gNB will be able to adjust the parameters via DCI if necessary. Not clear what is needed on top of already supported solution.More clarification about Proposal 2-2-3 is needed to understand the motivation of the proposal.Q2: We agree with proposal 2-2-1. However, we first need to decide on the solution to support large frame size in order to recommend this to WI.Q3: We do not agree with proposal 2-2-2: The currect CG design allows to send DCI and modify the parameters if necessary. Not clear what is needed on top of already supported solution.Q4: We support capturing the results of proposal 2-2-1 and related observations to TR 38.835. |
| **Intel** | Q1/Q2/Q3: Agree to down prioritize.Q4: Results showing meaningful capacity gain with reasonable/practical assumptions should be captured |
| **Qualcomm** | Q1: We are not ok with deprioritizing 2-2-4. We agree with Apple that this has potential capacity and power saving enhancements Q2: for 2-2-1, this may be very useful in terms of freeing up CG resources that were previously reserved for a UE when not needed by that UE. This can be beneficial in terms with regards to the resource overhead as well as UL beam reservation for FR2, since freeing up that resource would un-reserve the beam in that direction and gNB can use some other beam for some other UE.  Q3: for 2-2-2, this may be useful for 1. Reducing the need for additional DG resources if preconfigured CG is not enough for the data by allowing flexible CG resources, and 2. Avoid overbooking resources if data is less than the CG resource allocation. Q4: We think companies evaluation results should be captured  |

### 2.2.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| **P2-2-1** | **Companies (9):**ZTE, Google, vivo, Sony, IDC, OPPO, HW/HiSi, Nokia/NSB, QC | **Companies (4):**Samsung, LG, Panasonic, Intel | **Companies (4):**FW, CATT, MTK, Ericsson |
| **P2-2-2** | **Companies (5):**ZTE, Google, Sony, IDC, QC | **Companies (10):**Samsung, MTK, LG, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Nokia/NSB, Intel | **Companies (2):**FW, CATT |
| **P2-2-3** | **Companies (5):**ZTE, Panasonic, Google, Sony, IDC | **Companies (11):**Samsung, FW, CATT, MTK, LG, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Intel | **Companies (1):**Nokia/NSB |
| **P2-2-4** | **Companies (5):**ZTE, Google, Sony, IDC, QC | **Companies (12):**Samsung, FW, CATT, MTK, LG, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Nokia/NSB, Intel |   |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Continue discussion for the 2nd round**
	+ **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
	+ **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
	+ **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | We support P2-2-4. For P2-2-1, with the agreed evaluation assumption DDDSU, then it is quite likely multiple PUSCH ccasions will be mapped to different S or UL slots which have DL slots in between. Then DG for the subsequent PUSCHs can be used. Then somehow the discussion of DRX (e.g., whether a PDCCH to schedule a subsequent PUSCH is possible) comes into the picture. We note the use case of P2-2-4 is more straightforward. Maybe P2-2-1 and P2-2-1 should be considered together?  |
| **ZTE, Sanechips** | **As companies commented, we should postpone detailed discussion after decision in section 2.1.** Secondly, for proposal 2-2-1~2-2-4 etc., companies are encouraged to provide enhancement techniques and/or simulation results to analyze/show capacity gain. It is not proper to down-prioritize any detailed schemes at this stage.  |
| **Vivo** | We support P2-2-1.To further clarify, dynamic indication of UCI or BSR carried on CG PUSCH can be used to inform the gNB whether a CG PUSCH resource can be recycled or not. Once UL packet arrives, CG transmission for the UL packet can be perfomed, along with indication of UCI or BSR in the CG transmission to inform the unnecessary CG resources afterwards. Therefore, gNB can be aware of which resources can be recycled timely by the dynamic indication.From our simulation results, it can be seen when PDB is 10 ms, scheduling delay for DG has great impact on the performance, since gNB does not have information of UL packet arrival and packet size until BSR reporting from UE. Besides, it can be seen that enhanced CG with resource recycling can achieve a system capacity close to DG with 3 ms scheduling delay, and higher than that of DG scheduling with 5 ms scheduling delay, due to the benefit of delay reduction for data transmissions. |
| **Nokia, NSB** | We agree to down-prioritize Proposal 2-2-2 – it is not clear why the existing functionality cannot support what is proposed. We also suggest down-prioritizing 2-2-4 – no simulation results have been shown as well as it is not clear why current way of operation is insufficient. Regarding proposal 2-2-1 and 2-2-4 we agree with companies that we need to decide first whether the CG and eCG are beneficial or not. This could be done by collecting the observations during this meeting based on simulation results. Then the essential enhancements needed can be concluded. |
| **MTK** | According to current companies’ stands summarized by feature lead, we would suggest to keep 2-2-1 only if possile. The next question for 2-2-1 may be, would UE assistantce information (UAI) or NW indication be more useful? Do we need both or just one of them? |
| **Samsung** | We continue to not support any proposal for “eCG” as none of them establishes a necessity to consider mechanisms beyond the ones available in Rel-17. If needed, initial latency can be addressed based on Rel-17 CG and/or prescheduling. After that everything can be done by DG and there is no conceivable reason why any eCG would outperform DG.Even assuming that a Rel-17-based CG-PUSCH configuration is used, instead of pure DG and/or prescheduling, a gNB can obtain BSR (and any other information that RAN2 decides) from the CG-PUSCH. If any need, the gNB can even activate the CG-PUSCH when Active Time starts and deactivate it when switching to DG. Therefore, it should first be understood why Rel-17 mechanisms are not sufficient and an explanation of possible gains from simulation results of a proposed enhancement should be provided by proponents. A deprioritization of proposals would certainly help the discussion in order to focus and compare the most promising “eCG” proposal with what is possible in Rel-17, including by simulation results, in RAN1#111.  |
| **CATT** | We don’t support 2-2-1, 2-2-2, 2-2-3, and 2-2-4 because dynamic indication of CG configurations, such as unused resources, CG parameters, PUSCH monitoring occasion, required L1 signaling, which UE would not monitor when CG is configured.  |
| **Futurewei** | After the 1st round of discussions, our view for these set of proposals does not change. We think 2-2-3 and 2-2-4 should be down prioritized. Questions and concerns for 2-2-1 and 2-2-2 from us and other companies were not addressed. We are ok to capture the proposals and evaluations results if they are following the agreed assumptions and common principle.  |
| **Qualcomm** | Agree with Apple’s comment. We think 2-2-1, 2-2-2, 2-2-4 are useful. |
| **Sony** | We also support P2-2-4. In our view this proposal is needed as the current way of operation is insufficient. The proposal is to adjust CG parameters, for example the current CG resource can not handle variable packet sizes, so what is needed is to increase or decrease the CG resource to handle variable packet sizes without incurring scheduling delays (like SR/BSR). In addition, the eCG proposed here will save DL capacity (e.g, PDCCH) as well as DL power consumption compared to pre-scheduling and hybrid CG-DG. Furthermore, the proposal also avoids resource wastage which inturn reduces interferences.We do not agree this bullet “**If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.”** We don’t see the need to down-prioritize any of the proposed techniques. We should continue to analyze all proposals 2-2-1 to 2-2-4 and provide simulation results until next meeting. We are ok to capture the description of proposed enhancement techniques with corresponding simulation results, if available. |
| **Intel** | We think if L1 signaling is needed anyways for enhancing CG, then DG should be preferred. And in our view, hybrid CG + DG scheme is already a competitive scheme which can perform better than DG. We prefer to see what performance gain can be observed for eCG compared to hybrid CG + DG scheme. We are open to consider eCG schemes if there is capacity gain of course.  |
| **DOCOMO** | We are open to study 2-2-1 to 2-2-4. |
| **OPPO** | We think at least P2-2-1 should be promoted for further discussion as in a normal RAN1 discussion procedure, given it has largest counting of YES and smallest counting of NO.  |
| **Panasonic** | We think Proposal 2-2-3 is useful and can be used for adjusting the non-integer periodicity. Better not to depriotorize it now. |
| **Huawei/HiSilicon** | Proposal 2-2-1 needs to be prioritized.Then multiple PUSCH occasions in a CG period is beneficial to reduce the latency. If the number of PUSCH occasions is not large enough to transmit the current frame, additional dynamic scheduling is needed, resulting in extra delay and reduced capacity. In order to avoid the extra delay caused by additional dynamic scheduling, the number of PUSCH occasions should be configured according to a relatively large size of XR frame. To avoid resource waste, mechanisms to allow re-allocate the unused PUSCH occasions within one CG period can be considered. |
| **CMCC** | We support Proposal 2-2-1 and 2-2-2. |
| **LG** | We can accept the study 2-2-2 and 2-2-3 as an enhancement of DG-CG overidding techniques for now. At the same time, We don’t see the need to down-prioritize any of the proposed techniques at this stage. It should be first to check the details and benefit of each proposals.  |
| **Moderator** | Summary of 2nd round of discussion:

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P2-2-1 | **Companies (13):**ZTE, Google, vivo, Sony, IDC, OPPO, HW/HiSi, Nokia/NSB, QC, Apple, DCM, CMCC, [Sony], [MTK] | **Companies (3):**Samsung, ~~LG~~, Panasonic, Intel, CATT | **Companies (3):**FW, ~~CATT~~, ~~MTK,~~ Ericsson, LG |
| P2-2-2 | **Companies (10):**ZTE, Google, Sony, IDC, QC, [Sony], Apple, DCM, CMCC, LG | **Companies (10):**Samsung, MTK, ~~LG~~, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Nokia/NSB, Intel, CATT | **Companies (1):**FW, ~~CATT~~ |
| P2-2-3 | **Companies (7):**ZTE, Panasonic, Google, Sony, IDC, DCM, LG | **Companies (9):**Samsung, FW, CATT, MTK, ~~LG~~, ~~Panasonic~~, vivo, Ericsson, OPPO, HW/HiSi, Intel | **Companies (1):**Nokia/NSB |
| P2-2-4 | **Companies (7):**ZTE, Google, Sony, IDC, QC, Apple, DCM | **Companies (11):**Samsung, FW, CATT, MTK, ~~LG~~, Panasonic, vivo, Ericsson, OPPO, HW/HiSi, Nokia/NSB, Intel | **Companies (1):**LG |

**Agreement:**To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE
* Increase CG PUSCH transmission occasions in a duration

Based on the agreement above and the views for 2nd round of discussion, Moderator drives the discussion on P2-2-1 in the next round. |

### 2.2.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P2-2-1 | **Companies (13):**ZTE, Google, vivo, Sony, IDC, OPPO, HW/HiSi, Nokia/NSB, QC, Apple, DCM, CMCC, [Sony], [MTK] | **Companies (3):**Samsung, ~~LG~~, Panasonic, Intel, CATT | **Companies (3):**FW, ~~CATT~~, ~~MTK,~~ Ericsson, LG |

**Moderator’s recommendation for discussion:**

The following was agreed during the online session.

**Agreement:**

To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:

* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE
* Increase CG PUSCH transmission occasions in a duration
* **During the online session, it was requested to provide more details on the P2-2-1. Based on the input contributions by proponets, Moderator could identify three alternatives as shown in updated Proposal 2-2-1a.**

**Proposal 2-2-1a:** Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE can be supported to improve XR capacity performance. The following alternatives are identified for dynamic indication.

* Alt-1: Dynamic indication based on CG-UCI
* Alt-2: Dynamic indication based on new dedicated UCI
* Alt-3: Dynamic indication based on MAC CE

**Recommendation:**

Continue discussion and share your view on P2-2-1a and its alternatives. Please consider the discussion in section 2.1.3. Please answer clearly these questions:

* **Q1:** OK to update the agreement as the following (Proposal A1)? In case, you prefer other alternatives, please indicate.

**Proposal A1: Update the following agreement as the following:**

**Agreement:**

To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:

* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE. The following alternatives are identified for dynamic indication.
	+ Alt-1: Dynamic indication based on CG-UCI
	+ Alt-2: Dynamic indication based on new dedicated UCI
	+ Alt-3: Dynamic indication based on MAC CE
* Increase CG PUSCH transmission occasions in a duration
* **Q2:** Which alternative is preferred in Proposal A1**?**
* **Q3:** Do you support **Proposal 2-2-1a?**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | Questions and concerns for 2-2-1 from previous rounds of discussions were not addressed. Before agreeing to support, convincing performance benefits need to be shown. About Q1, we think it is better not spending time to update the agreement. Study these alternatives is probably ok if these are the proposals from proponents. On Q2, we have not investigated these alternatives, so no preference at this point. On Q3, at this point, we are not ready to support. |
| **Intel** | Q1: We prefer not to update the agreement. Companies are open to study different optionsQ2, Q3: We are not convinced of the benefits of the options at the moment. But open to consider, if there is significant gain with reasonable assumptions. One comment is since one of the reason of using CG was to reduce latency, we are wondering why/how MAC CE is a suitable option compared to L1 signaling. Typically MAC CE signaling is slower, takes about 3ms. |
| **Samsung** | Q1/Q2: It doesn’t matter.Q3: We continue to not support. Let assume the indication is by some new UCI. That UCI basically says how much data the UE needs to transmit next time (e.g. it is some sort of L1 BSR). Then, using such UCI, why can’t the gNB use DG, perform link adaptation, and dimension resources based on “global” resource requirements on the cell at the given slot? How can it be assumed, for CG, that if a UE indicates an increase in resources, that increase will always be available on the cell, that previous RRC configurations can remain invariant, and that the UE can transmit without any ‘OK’ from the gNB? That is the whole point why the gNB performs the scheduling, instead of each UE being self-scheduled (and without link adaptation) by making whatever decisions the UE wants and then just indicating to the gNB what resources the UE will use based on some prior RRC configuration, which is essentially what the proposal is about. Why would DG (with BSR, when needed, in the PUSCH) be worse than P2-2-1(a)? There are also other aspects, such as the testing and even the specification (not the concept) for P2-2-1(a) but that discussion is skipped for now as e-meeting spacetime is limited. |
|  |  |

## 2.3 Multiple PUSCHs transmission occasions in a CG period

The Table C in section 2.2 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions. Please note that for some enhancements techniques, companies have provided simulations results.

**Status of inputs in the contributions:**

* **Companies with view (14):** CATT, vivo\*, Intel, IDC, QC, ZTE/Sanechips\*, Ericsson\*, China Telcom, OPPO, Lenovo, CMCC, LG, Google, Samsung, DCM
	+ **Supportive of enhancements (11)**: vivo\*, Intel, IDC, QC, ZTE/Sanechips\*, China Telecom, Lenovo, CMCC, LG, Google, DCM
	+ **Not supportive (3):** Ericsson\*, CATT, Samsung
* **Companies with evalution results (3):** vivo\*, ZTE/Sanechips\*, Ericsson\*

### 2.3.1 First round of Discussion

**High level proposals based on input contributions:**

**Proposal 2-3-1:**

* The following enhancement techniqure(s) is beneficial to improve XR capacity performance
	+ Alt-1: single CG configuration with multiple PUSCH occasions per CG period
	+ Alt-2: single DCI based activation of multiple CG configurations.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 2-3-1 and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details/alternatives for the next round of the discussions.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Do not support. Similar comments as for 2.2.1 apply for Q1 and Q2. |
| **Futurewei** | It is not clear to us how these multiple PUSCH occasions will be utilized by the UE and how it will perform better than DG.  |
| **CATT** | We are not clear on the system capacity gain from proposal.  |
| **MTK** | We are not clear on the system capacity gain for this proposal. |
| **ZTE, Sanechips** | Q1: Support Proposal 2-3-1. We are open to study both Alt-1 and Alt-2.We should firstly focus on the necessity of CG enhancement, instead of down selecting the detailed techniques. |
| **LG** | **Q1: Support.** We think it could be useful to jitter handling and serving video traffic.**Q2:** Same as before, fine to capture. |
| **Panasonic** | We think the mentioned enhancements could be beneficial and should be further studied. |
| **Google** | We support Proposal 2-3-1 and both alternatives can be studied.  |
| **Vivo** | We support Alt-1 of proposal 2-3-1. For Alt-2, we think the motivation for Alt-2 is for signaling overhead reduction. Meanwhile the complexity involved in DCI format design should be considered. |
| **Ericsson** | Same view as Samsung, FW, others. Not support. |
| **Sony** | We think the enhancements as described in Proposal 2-3-1 can still be considered and further studied. |
| **InterDigital** | Support proposal 2-3-1 (both Alt-1 and Alt-2) |
| **OPPO** | As mentioned in 2.1.1, less detection of PDCCH can reduce the UE power consumption, so we support Alt-1 and open to Alt-2. |
| **Lenovo** | If CG enhancement is supported (e.g., gains shown w.r.t. a hybrid CG-DG), the alternatives are fine. |
| **Huawei/HiSilicon** | Q1: We support Alt-1. Results should be captured.Alt-2 seems just saving DCI overhead, and does not bring capacity gain. |
| **Nokia, NSB** | We do not support Alt-2 since single activation will require a lot of DCI overhead as every CG configuration can have different PRBs, MCS, etc. Alt-1 with the design similar to multi-PUSCH scheduling with single DCI seems more reasonable if we want to support multi TB per period to transmit video frame. |
| **Intel** | We think it is beneficial. For UL video, e.g., in case it arrives outside DRX ON, at least initial PUSCHs transmissions can be made by CG. Open to consider both Alt-1/2  |
| **Qualcomm** | We think it is useful, the first Alt-1 is useful when for single flow with larger burst size and the second Alt-2 is useful for multiple flow case. In order to take full advantage of these enhancements, a study of more dynamic PUSCH occasions parameters may be needed (e.g., cancelling un-used occasions, etc.)  |

### 2.3.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P2-3-1 | **Companies (11):**ZTE, Panasonic, Google, Intel, Sony, IDC, OPPO, QC, vivo(Alt1 ), HW/HiSi(Alt 1), Nokia/NSB(Alt 1) | **Companies (6):**Samsung, FW, CATT, MTK, Ericsson, Nokia/NSB(Alt 2) | **Companies (10):**Lenovo |

**Among the proponets, some companies prefer only Alt-1, and disagree with Alt-2. Moderator suggests considering only Alt-1.**

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Continue discussion for the 2nd round**
	+ **Proponets are requested to indicate if Alt 1 can be prioritized.**
	+ **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
	+ **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | We are open to P2-3-1. |
| **ZTE, Sanechips** | As companies commented, we should postpone detailed discussion after decision in section 2.1.  |
| **vivo** | We support P2-3-1.Multiple CG occasions in a CG period is beneficial to reduce the latency of CG, thus can potentially improve the performance over the legacy CG. Besides, compared to multiple CG configurations where multiple activation signaling is needed, the signaling overhead can also be reduced by supporting multiple CG occasions in a CG period.Futhermore, with multiple PUSCH occasions in a CG period and enhanced CG with recycling of unused resources, our simulation results show that CG can achieve benefit of capacity improvement compared to DG. The method similar to R16 NR-U CG with multiple CG occasions in a period, as well as configuring multipled CG configurations with same periodicity, can be used. The spec impact can be minimized. |
| **Nokia , NSB** | We agree to collect the observations first and then decide on the essential enhancements. |
| **MTK** | We agree to collect the observations first and then decide on the essential enhancements. The decision can be made after decision in section 2.1 as mentioned by ZTE. |
| **Samsung** | Based on our opinion that no CG enhancement is needed over Rel-17, we support depriotizing P2-3-1. If P2-3-1 is kept for further consideration, we would prefer Alt.2 as it is more consistent with Rel-17 and is functionally equivalent to Alt.1 (i.e., although not a proponent, the answer to the moderator’s question to deptioritize Alt. 1 is ‘yes’). |
| **CATT** | We don’t support either alternative. We don’t see the multiple CG locations would provide any system capacity gain comparing the DG.  |
| **Futurewei** | After the 1st round of discussions, our view for these set of proposals does not change. Questions and concerns for 2-3-1 from us and other companies were not addressed. We are ok to capture the proposals and evaluations results if they are following the agreed assumptions and common principle. |
| **Qualcomm** | We support 2-3-1. We think multi-PUSCH in CG is useful to reduce latency and reduce activation signaling. |
| **SONY** | We support P2-3-1. |
| **Intel** | We support P 2-3-1.  |
| **DOCOMO** | We support P 2-3-1. |
| **Huawei/HiSilicon** | Support Alt 1 in P 2-3-1.Multiple PUSCH occasions in a CG period is beneficial to reduce the latency, which can improve the performance. Alt-1 has already been supported in R16 NR-U. The spec impact of applying Alt-1 to XR should be very small. |
| **CMCC** | We support Proposal 2-3-1 and prefer Alt-1. Due to the large data sizes of XR traffic frames, configuring multiple PUSCH transmission occasions in a CG period is benifical to improve XR capacity performance. For Alt-2, since up to 8 SPS/CG configurations are supported in the current specification, configuring multiple SPS/CG configurations for UE to handle XR service may have a negative effect on the CG configurations associated with other types of services. |
| **LG** | We support P 2-3-1. |

### 2.3.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P2-3-1 | **Companies (15):**ZTE, Panasonic, Google, Intel, Sony, IDC, OPPO, QC, vivo (Alt1) HW/HiSi (Alt 1), Nokia/NSB(Alt 1), Apple, LG, DCM, CMCC(Alt 1) | **Companies (5):**Samsung, FW, CATT, MTK, ~~Ericsson~~, Nokia/NSB (Alt 2) | **Companies (3):**Lenovo, Ericsson (only Alt-1), Samsung (maybe OK w Alt 2) |

**Moderator’s recommendation for discussion:**

The following was agreed during the online session.

**Agreement:**

To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:

* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE
* Increase CG PUSCH transmission occasions in a duration
* **During the online session, it was requested to provide more details on the P2-2-1. Based on the input contributions by proponets, Moderator could identify three alternatives as shown in updated Proposal 2-3-1a.**

**Proposal 2-3-1a:** Increasing CG PUSCH transmission occasions in a duration can be supported to improve XR capacity performance, based on the following alternatives:

* ~~The following enhancement techniqure(s) is beneficial to improve XR capacity performance~~
	+ Alt-1: single CG configuration with multiple PUSCH occasions per CG period
		- Alt-1a: using multi-slot TDRA for a CG configuration
	+ Alt-2: single DCI based activation of multiple CG configurations.

**Recommendation:**

Continue discussion and share your view on P2-3-1a and its alternatives. Please consider the discussion in section 2.1.3. Please answer clearly these questions:

* **Q1:** OK to update the agreement as the following (Proposal A2)? In case, you prefer other alternatives, please indicate.

**Proposal A2: Update the following agreement as the following:**

**Agreement:**

To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:

* + - Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE.
		- Increase CG PUSCH transmission occasions in a duration, based on the following alternatives:
			* Alt-1: single CG configuration with multiple PUSCH occasions per CG period
				+ Alt-1a: using multi-slot TDRA for a CG configuration
			* Alt-2: single DCI based activation of multiple CG configurations.
* **Q2:** Which alternative is preferred in Proposal A2**?**
* **Q3:** Do you support **Proposal 2-3-1a?**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | Questions and concerns for 2-2-1 from previous rounds of discussions were not addressed. Before agreeing to support, convincing performance benefits need to be shown. On Q1, we think that the group should not spend time trying to update the agreement. These alternatives may be ok if they are what proponents want to study. On Q2, we do not have a preference and are open for discussion. On Q3, we are not ready to support. |
| **Intel** | Q1: Updating agreement may not be necessaryQ2: We are open to consider both, but have slight preference towards Alt-1Q3: Yes |
| **Samsung** | Q1/Q2: It doesn’t matter.Q3: We continue to not support Proposal 2-3-1(a). Most reasons are as described for Proposal 2-2-1(a) and in the response in section 2.1. The disadvantages are now multiplied due to the multiple CG PUSCH occasions/configurations. Proposal 2-3-1(a) will consume all available UL resources with very low utlilization and cannot possibly offer any increase in capacity.  |

## 2.4 Non-integer periodicity for CG transmissions

The Table D in section 2.4 of R1-2214010 lists the proposals in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions. Please note that for some enhancements techniques, companies have provided simulations results.

**Status of inputs in the contributions:**

* **Companies with view (20):** Huawei/HiSilicon\*, vivo\*, Nokia/NSB, IDC, QC, ZTE/Sanechips\*, Ericsson\*, China Telcom, OPPO, TCL, Sony, Lenovo, NEC, CMCC, Panasonic, LG, Apple, Google, Samsung, DCM
	+ **Supportive of enhancements (17)**: vivo\*, Nokia/NSB, IDC, QC, ZTE/Sanechips\*, China Telcom, OPPO, TCL, Sony, Lenovo, NEC, CMCC, Panasonic, LG, Apple, Google, Samsung, DCM
	+ **Not supportive (3):** Huawei/HiSilicon\*, Ericsson\*, Samsung
* **Companies with evalution results (4):** Huawei/HiSilicon\*, vivo\*, ZTE/Sanechips\*, Ericsson\*

### 2.4.1 First round of Discussion

**High level proposals based on input contributions:**

**Proposal 2-4-1:**

* Enhancements related to match the periodicity for CG transmissions with non-interger periodicity of XR traffic is beneficial to improve XR capacity performance.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 2-4-1 and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details/alternatives for the next round of the discussions.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Do not support. Similar comments as for 2.2.1 apply for Q1 and Q2. |
| **Futurewei** | This is also discussed under power saving agenda item. Though it may have power saving benefit, we do not see it as capacity improvement scheme. |
| **CATT** | We don’t see the benefit in capacity enhancement |
| **MTK** | We tend to agree with Futurewei. We do not see clear benefit in capacity enhancement. |
| **ZTE, Sanechips** | Q1: Suppport Proposal 2-4-1. |
| **LG** | **Q1:** Support. Non-interger periodicity has clear benefit to serve periodic traffic by avoiding redundant resource allocation with reducing latency. Based on the contributions, the flexibility of periodicity can be obtain by only few minor specification changes. **Q2**: Same as before, fine to capture the proposal.  |
| **Panasonic** | We think the relevant enhancement could bring power saving gain but not much capacity gain. |
| **Google** | We support the Proposal. |
| **Vivo** | We think non-integer periodicity for CG needs to be considered. |
| **Ericsson** | Q1: Not support. We showed with our simulations that non-interger periodicity is not an issue. |
| **Sony** | Q1: Suppport Proposal 2-4-1. The quasi-periodicity of XR transmissions can also be reflected in layer 1 operation (e.g., enhancements of CG). |
| **InterDigital** | We support proposal 2-4-1 |
| **OPPO** | Support Proposal 2-4-1. We think eCG can provide benefits for short latency and power saving. |
| **Lenovo** | Ok |
| **Huawei/HiSilicon** | Non-integer periodicity issue can be solved by configuring multiple CG configurations. No need for more enhancements. |
| **Nokia, NSB** | Simulation results have shown the benefits from CG. It is therefore important to identify the necessary enhancements to support XR with CG. Non-integer periodicity is already considered as an issue for C-DRX in Power saving domain. This enhancement is also necessary for CG and should be considered. The solution can be the same as for non-integer periodicity in C-DRX. We support Proposal 2-4-1. |
| **Intel** | Not a critical issue |
| **Qualcomm** | We support non-integer periodicity for CG to match with XR traffic  |

### 2.4.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P2-4-1 | **Companies (10):**ZTE, LG, Google, vivo, Sony, IDC, OPPO, Lenovo, Nokia/NSB, QC | **Companies (8):**Samsung, FW, CATT, MTK, Panasonic, Ericsson, HW/HiSi, Intel |   |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Continue discussion for the 2nd round**
	+ **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
	+ **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
	+ **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | We support P2-4-1. |
| **ZTE, Sanechips** | As companies commented, we should postpone detailed discussion after decision in section 2.1.  |
| **vivo** | We think it is important to align between CG occasions for XR UL traffic and the XR traffic periodicity. We understand it could be achieved by current existing, e.g., multiple CG configurations. Having said that, we are ok if majority companies don’t consider non-integer periodicity for CG. |
| **Nokia, NSB** | We can start by collecting the observations into TR and that will help us to agree on the necessary enhancements. |
| **MTK** | We still think P2-4-1 is more like a power saving enhancement scheme rather than a capacity enhancement scheme. However, we think Nokia’s suggestion is reasonable:* We can start by collecting the observations into TR and that will help us to agree on the necessary enhancements.
 |
| **Samsung** | We support to deprioritize P2-4-1.The targeted scenario is one where DG is even more beneficial and CG is even more problematic. CG intends to reduce DCI overhead (never an issue for XR) or reduce latency (not relevant for the scenario of P2-4-1). |
| **CATT** | We don’t see the benefit of this proposal in XR capacity enhancement |
| **Futurewei** | After the 1st round of discussions, our view for these set of proposals does not change. Questions and concerns for 2-4-1 from us and other companies were not addressed. We are ok to capture the proposals and evaluations results if they are following the agreed assumptions and common principle. |
| **Qualcomm** | We support P2-4-1. |
| **Sony** | We support P2-4-1. |
| **Intel** | We don’t see much benefit for this proposal |
| **DOCOMO** | We don’t think the benefit would be much. |
| **OPPO** | We support P2-4-1. |
| **Panasonic** | We agree that supporting non-integer periodicity for CG is beneficial, but maybe the gain would be for power saving. We think it can be studied more. |
| **Huawei/HiSilicon** | Non-integer periodicity issue can be solved by configuring multiple CG configurations. The necessity for enhancements seems not strong. |
| **CMCC** | We support Proposal 2-4-1. Although this non-integer periodicity issue can be solved by using multiple sets of SPS/CG configurations. However, it is not an efficient way due to the decrease in resource efficiency. We think the configuration of a CG periodicity set/pattern is an efficient solution to address this issue. |
| **LG** | We support P2-4-1. It has almost no specification impact and clear benefit.  |
| **Moderator** | Summary of 2nd round of discussion:

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P2-4-1 | **Companies (13):**ZTE, LG, Google, vivo, Sony, IDC, OPPO, Lenovo, Nokia/NSB, QC, Apple, CMCC, LG | **Companies (8):**Samsung, FW, CATT, MTK, ~~Panasonic~~, Ericsson, HW/HiSi, Intel, DCM | **Companies (1):**Panasonic |

**Agreement:**To study whether/how the enhanced CG candidate techniques are necessary and beneficial for improving XR capacity, focus at least on the following techniques:* Dynamic indication of the unused CG PUSCH occasion(s) or resource(s) by the UE
* Increase CG PUSCH transmission occasions in a duration

Based on the agreement above and the views for 2nd round of disucsison, Moderator does not drive this discussion. |

## 2.5 Other enhancements

The Table E in section 2.5 of R1-2214010 lists the proposals in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions. Please note that for some enhancements techniques, companies have provided simulations results.

**Status of inputs in the contributions:**

* **Topic 1: SPS enhancements:**
* **Supporting SPS enhancements (5): CATT\*, ZTE/Sanechips\*, IDC, Sony, China Telcomm**
* **Not supporting SPS enhancements (4): Futurewei, Huawei/HiSilicon, Ericsson, Samsung**
* **Topic 2: PDCCH monitoring occasions during DRX-OFF:**
* **Supported: TCL, CATT\*, Panasonic**
* **Topic 3: XR multiple flows differentiation with CG transmission**
* **Supported: Intel\*, Sony**

### 2.5.1 First round of Discussion

**High level proposals based on input contributions:**

**Topic 1: SPS enhancements:**

* The proposed enhancements suggest configuring PDCCH monitoring occasions after SPS PDSCH transmission occasions. The performance evaluation results by CATT show power saving gain, but no capacity gain. The performance evaluation results by ZTE show gain as compared to legacy SPS, and not DG. Other enhancemnts such as support of CBG for SPS and Type-1 activation are suggested.
* Few companies have expressed concerns on support of any SPS enhancementsfor XR capacity improvements emphasizing that the DCI overhead is not a bottle-neck for XR capacity.
* **Moderator’s recommendation for Topic 1:**
	+ **Per conclusion in RAN1#110, SPS enhancements for XR capacity improvements is down prioritized.**

**Topic 2: PDCCH monitoring occasion during DRX OFF**

* CATT has provided simulation results for the proposed enhancements for both DL and UL (see section 2-1), showing power saving gain, but no capacity gain.
* **Moderator’s recommendation for Topic 2:**
	+ **Configuration of PDCCH monitoring occasions during DRX-off for XR capacity improvements is down prioritized**

**Topic 3: XR multiple flows differentiation with CG transmission**

* **Moderator’s recommendation for Topic 3:**
	+ **Companies feedback regarding this topic is needed.**

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on **Moderator’s recommendation for Topic 1**?
* **Q2:** What is your view on **Moderator’s recommendation for Topic 2**?
* **Q3:** Discuss your view regarding the proposed enhancements in **for Topic 3**
* **Q4:** Discuss your view regarding the proposed enhancements/recommendations and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q5:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1: Agree with moderator – RAN1 already concluded.Q2: Agree with moderator. Given the almost certainly short DRX cycle for XR, if proposal 2 was to apply, what would be the meaning of having DRX?Q3: No need for the proposed enhancements – CG is even less appropriate for multiple flows as that is another dimension for the dynamic nature of XR.Q4: RAN1 discussion/conclusion for simulation assumptions and feasibility and for the benefits over DG is first needed. |
| **Futurewei** | Q1: Agree that this is already concluded.Q2: Agree with moderatorQ3: With multiple flows, it is even more difficult to see the capacity benefit of CG over DG.Q4: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: We are OK with the proposal deprioritize SPS. Q2: We don’t agree with the proposal. PDCCH monitoring at DRX OFF is the enhancement of dynamic scheduling to support XR and other traffic in the same time. The PDCCH monitoring at DRX OFF is one technique of C-DRX enhancement to align the PDCCH monitoring cycle with the XR traffic cycle. Q3: The trunking efficiency is reduced for XR multiple flow differentiation with CG. We need performance results to justify the proposed techniques. Q4: All results should be captured in the TR |
| **MTK** | Q1: Agree with moderator – RAN1 already concluded. Q2: Tend to agree with moderator. To us this is more like a power enhancement scheme. Besides, RAN2 is desining semi-static DRX periodicity enhancement to match XR traffic, so the XR traffic aligning with CDRX (PDCCH monitoring) may not still be an issueQ3: We do not see evident capacity gain for the proposed enhancementsQ4: Discuss your view regarding the proposed enhancements/recommendations and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.Q5: We are ok to capture the results if the comparison baseline is DG |
| **ZTE, Sanechips** | Q1: Agree with Moderator’s recommendation for Topic 1. But we think the evaluations on SPS enhancement can be captured in TR38.835 as illustrated in Q4.Q3: We are open to study CG enhancement on multiple streams model. However, due to limited time unit, RAN1 has not yet had any conclusions for CG enhancement for single stream model. We suggest to focus on the discussion on 2.1~2.4. Moreover, the XR multiple streams differentiation is more likely for XR-awareness transmission, which is in charged by RAN2. We can wait for RAN2’s conclusions on XR-awareness transmission |
| **LG** | **Q1, Q2:** Agree with moderator’s assement. **Q3:** multi-flow is XR use case clearly, but the issue is hard to be identified since it highly depends on what kind enhancement would be done in this AI. We don’t think it is necessary to down-prioritize at this stage. It would be better to keep this for future discussion. **Q4:** Same as before. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal.  |
| **Panasonic** | Q1: We are fine with the proposal.Q2:We are fine with the proposal.Q3: We are fine with the proposal. Flow differentiation is required to meet different QoS. |
| **Google** | **Q1, Q2**: We agree with the moderator’s recommendation.**Q3**: UL pose and control information is a periodic traffic with no jitter and can use CG configuration with no enhancement needed. UL AR video would need a different CG with some enhancement to handle the varying packet sizes and the jitter.  |
| **vivo** | Q1: Support moderator’s recommendation.Q2: Support moderator’s recommendation.Q3: Currently multi-CG configurations be used to address multi-flow case. What will be enhanced and the spec impact need more clarifications. |
| **Ericsson** | Q1: Agree w ModeratorQ2: Agree with Moderator. To CATT, the fact that there is no capacity gain, it is clear this proposal does not belong to capacity gain agenda. It should be discussed in power saving.Q3: Agree with others. Moreover, such differentiation is more RAN2 topic than RAN1.  |
| **Sony** | The conclusion made in RAN1#110 did not explicitly mention to down-prioritize SPS enhancements. The discussion and evaluation related to SPS enhancement can still be captured in the TR. |
| **InterDigital** | Q1 and Q2:Agree with Moderator’s recommendationQ3:Ok for studying CG enhancements for supporting multiple flows. We think configuring different CG configurations with different periodicties that are aligned with the periodicities of different UL flows (e.g. pose, video) are beneficial for improving capacity. |
| **OPPO** | Q1/Q2: Agree with moderator.Q3: Multiple flows differentiation with CG transmission can be solved if the followings are supported:* Single CG configuration with multiple PUSCH occasions per CG period;
* Dynamic indication of the unused CG PUSCH occasions.
 |
| **Lenovo** | Q1&Q2: agree with ModeratorQ2: can concludeQ3: maybe RAN2 can discuss this first |
| **Huawei/HiSilicon** | Q1: Agree with moderator – RAN1 already concluded.Q2/3: Agree with moderator. |
| **Nokia, NSB** | We support Moderator’s recommendation for Topic 1&2.As per Topic 3, more justification is need to see the benefits from the enhacnements and already existing possibility to activate multiple CGs per different flow if needed. |
| **Qualcomm** | Agree on views.   |

### 2.5.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| Topic1 | All agree w Mod.  |   |   |
| Topic2 | **Companies (14):**Samsung, FW, MTK, LG, Panasonic, Google, vivo, Ericsson, IDC, OPPO, Lenovo, HW/HiSi. Nokia/NSB, QC | **Companies (1):**CATT |   |
| Topic3 | **Companies (5):**ZTE, Panasonic, Google, IDC, OPPO | **Companies (8):**Samsung, FW, [CATT], MTK, LG, vivo, Ericsson, Nokia/NSB | **Companies (3):**CATT, [Lenovo], [Nokia/NSB] |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Topic 1:**
	+ **No need for more discussions.**
	+ **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**
* **Topic 2:**
	+ **CATT, as the only proponet is requested to provide feedback and discuss for the 2nd round on Topic 2:**
		- **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
		- **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
		- **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**
* **Topic 3:**
	+ **Proponets are requested to provide feedback and discuss for the 2nd round on Topic 3, and share the plans for providing simulatin results, if any:**
		- **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
		- **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
		- **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | We support the study of topic 3.  |
| **ZTE, Sanechips** | As companies commented, we should postpone detailed discussion after decision in section 2.1.  |
| **Nokia, NSB** | We propose to deprioritize the topics 1-3 and concentrate on the enhancements that are beneficial to XR capacity improvements proven by simulation results. |
| **MTK** | We support moderator suggestions. If no quick consensus can be achieved, we can first draw observations for these enhancements and make decision later. |
| **Samsung** | We support the moderator’s suggestion. For topic-3, as mentioned in the first round, the scenario is one where DG is ideal and CG will be even more problematic and rather irrelevant. |
| **CATT** | For Topic 2: PDCCH monitoring occasion during both DRX ON and OFF is included in the of DL/UL XR-PMW proposal for dynamic grant, CG enhancement based on CG+DG with BSR enhancement, SPS enhancement based on SPS+preconfigured DG. The PDCCH monitoring for DG is pre-configured at each cycle aligned with XR packet generation cycle and disassociated with any PDCCH monitoring control by DRX, which is used for robust traffic type. The pre-configured DG for CG/SPS enhancement is allocted after each CG/SPS resource allocation. The UL XR-PMW for PDCCH monitoring at both DRX ON and OFF is the pre-scheduling scheme with semi-static configured PDCCH monitoring aligned with XR packet generation cycle. We observe 33% system capacity gain of UL XR-PMW comparing to DG with 5 ms SR delay. DRX is configured for the control of PDCCH monitoring for the robust traffic arrivals, such as eMBB delay insensitive traffic, of all serving cells in achieving UE power saving. For periodic traffic, UL CG and DL SPS had been introduced for periodic traffic arrival and small variation in packet size to disassociate the PDCCH monitoring control by DRX for the robust traffic arrival. Thus, the XR-PMW is a pre-configured PDCCH monitoring occasions aligned with XR traffic generation cycle for dynamic grant without SR to allocate radio resource based on the XR packet size at each cycle. This will minimize the impact of PDCCH monitoring control by DRX for other traffic and customize the PDCCH monitoring for XRFor topic 3: The trunking efficiency is reduced for XR multiple flow differentiation with CG. We don’t see the need.  |
| **Futurewei** | We support moderator’s suggestion. For topic 3, after 1st round discussion, our view does not change. Questions and concerns were not addressed. |
| **Qualcomm** | We support moderator suggestions |
| **Sony** | We support the study of topic 3. Multi multiple flows is a typical characteristic of XR, and different flows show different parameters of traffic model and QoS. Take AR with model 3B for illustration, one potential issue on CG configuration for UL I-stream and P-stream would be a same periodicity but different resource allocation (RA). Thus, it is needed to differ which stream the CG activation DCI with same CG index is for. In other words, multiple flows differentiation with CG transmission is needed at least when reusing same CG index for different flows in pursuit of efficiency. |
| **LG** | We support Topic 3. Maybe our comment has mis-leaded.  |

### 2.5.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| Topic1 | All agree w Moderator. But results should be captured in TR. |   |   |
| Topic2 | Samsung, FW, MTK, LG, Panasonic, Google, vivo, Ericsson, IDC, OPPO, Lenovo, HW/HiSi. Nokia/NSB, QC | CATT |   |
| Topic3 | **Companies (8):**ZTE, Panasonic, Google, IDC, OPPO, Apple, Sony, LG | **Companies (8):**Samsung, FW, ~~[~~CATT~~]~~, MTK, ~~LG,~~ vivo, Ericsson, Nokia/NSB, QC | **Companies (2):**~~CATT~~, [Lenovo], [Nokia/NSB] |

**Moderator’s recommendation for discussion:**

**Action point to Moderator (with respect to Topic 1 and Topic 2):**

* **Summarize SPS enhancements results in contributions R1-2208953 (CATT) and R1-2209198 (ZTE) and request for review to be endorsed as Observation.**
	+ **Moderator aims to provide the summary for review by Monday Oct. 17.**
* **Summarize CG enhancements results in contributions R1-2208953 (CATT) and request for review to be endorsed as Observation.**
	+ **Moderator aims to provide the summary for review by Monday Oct. 17.**

**Recommendation:**

**Topic 3: XR multiple flows differentiation with CG transmission**

* **The views are split regarding down prioritization of this topic.**
* **Continue discussion in third round and express if your view has changed. The propoents are specially requested to address the comments raised, e.g.:**
	+ Lack of simulation results ot show perofmrnace gain
	+ The trunking efficiency is reduced for XR multiple flow differentiation with CG.
	+ Doable with current spec.
	+ Flow differentiation is a RAN2 topic.
	+ With multiple flows, it is even more difficult to see the capacity benefit of CG over DG.

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | Our view have not changed and do not support Topic 3. |
| **Intel** | Do not support |
| **Samsung** | Do not supportDisadvantages of previous proposals are multiplied.  |

# 3 Dynamic scheduling/grant enhancements

The followings are agreed/concluded previously:

|  |
| --- |
| **Agreement (RAN1#109-e):**To study whether/how to support a candidate capacity enhancement technique for XR traffic based dynamic scheduling/grant transmissions, companies are encouraged to consider the following studies:* + - Study enhancements related to extending capability of single DCI scheduling multi-PDSCHs/PUSCHs for FR2-2 to FR1/FR2.
		- Note: whether and how to discuss enhancements may depend on the outcome of Rel-17 B52.6G UE feature discussion
		- Study enhancements related to HARQ-ACK and/or CBG transmissions for single DCI scheduling one or multi PDSCH(s).
		- Study enhancements related to allowing different configurations per PDSCH/PUSCH
		- Study enhancement related to scheduling request and/or BSR with the focus on L1 enhancements.
		- Note: Other studies are not precluded as well as the combination of the above studies.
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Agreement (RAN1#110):**RAN1 to make decision on the following in RAN1#110bis-e* Support single DCI scheduling multi-PDSCHs/PUSCHs which is currently supported for FR2-2 to other SCS in FR1/FR2.

**Agreement (RAN1#110):**Whether/how to enhance BSR to improve capacity performance of XR traffic is within RAN2 scope and is not handled by RAN1.* Note that companies should indicate if and what BSR enhancement is assumed in their RAN1 proposals on CG and DG enhancements.
* RAN1 can evaluate BSR enhancement to improve capacity performance.
 |

The views regarding DG enhancements for serving XR traffic are summarized and discussed in the following sections.

## 3.1 Extension of multi-slot PxSCHs from FR2-2 to FR1/FR2

The Table F in section 3.1 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (15):** Futurewei, Huawei/HiSilicon, CATT, vivo\*, Intel\*, MTK, Nokia/NSB, IDC, QC, ZTE/Sanechips\*, Ericsson, CMCC, Panasonic, LG, [Samsung]
	+ **Supportive of enhancements (10)**: vivo\*, Intel\*, Nokia/NSB, IDC, QC, Ericsson, CMCC, Panasonic, LG, Samsung
* **Not supportive (5):** Futurewei, Huawei/HiSilicon, CATT, MTK, ZTE/Sanechips\*
* **Companies with evaluation results (3):** vivo\*, Intel\*, ZTE/Sanechips\*

**High-level observations:**

* The Proponents’ main reason is that due to large XR packet sizes, it is reasonable to use a single DCI to schedule the XR TBs in multiple slots. The performance maybe improved by supporting the flexibility.
* The opponents’ main reason is that the PDCCH overhead is not a bottleneck for XR capacity. Hence, supporting multi-slot PxSCHs is not beneficial.
* 3 companies, vivo, ZTE/Sanechips and Intel have provided simulation results.
	+ Vivo shows capacity gain when PDCCH overhead is used by data, however ZTE does not show any gain.

### 3.1.1 First round of Discussion

**High level proposals based on input contributions:**

**Proposal 3-1-1:**

* **Support single DCI scheduling multi-PDSCHs which is currently supported for FR2-2 to other SCS in FR1/FR2-1*.***

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** Provide your analysis to understand the difference between ZTE/Sanechips and vivo simulation results.
* What is your view on direction of Proposal 3-1-1 and the necessity/benefit of the proposed enhancements?
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1: DCI rates (~1 Kbps) are several (4-5) orders of magnitude less than data rates (10s Mbps) for XR. That removes from consideration any PDCCH/DCI enhancements for the purpose of capacity. Therefore, based on simple analytical considerations, there is no need to spend time discussing specific simulation assumptions/accuracy of evaluations for Q1. Q2: We prefer to have the option to apply “as is” the multi-PXSCH scheduling from FR2-2 to FR1/FR2 and to postpone for now a decision to include/exclude (can still be concluded at this meeting). Whether anything needs to be captured in the TR can be discussed later.  |
| **Futurewei** | Q1: Agree with Samsung’s analysis. No need to consider further Proposal 3-1-1.Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: We don’t see the benefit of Proposal 3-1-1. The results of performance gain from contributions are way too optimistic even with 2 symbols of PDCCH used for PDSCH in single DCI scheduled multiple PDSCH. The loss of link adaptation gain and inflexible of retransmission among PDSCH HARQ by single DCI scheduling multiple PDSCH would limit the performance. Q2: All results should be captured. Some over-optimistic results should have note and observation for clarification.  |
| **MTK** | Q1: We don’t see clear benefit for Proposal 3-1-1. The results from vivo which assumes “PDCCH overhead is used by data” is not really practical from our perspective. The results from ZTE seems more reasonable to us.Q2: The results can be captured if the evaluation assumption is clearly explained in the TR. |
| **ZTE, Sanechips** | Q1: In fact we have similar observation as vivo in the contributions: the capacity performance of 1 DCI scheduling multiple PDSCHs is highly correlated with the PDCCH overhead assumptions. If ideal assumption for PDCCH overhead saving is considered, considerable capacity gain of 1 DCI scheduling multiple PDSCHs can be obtained, while if realistic assumption for PDCCH overhead saving are considered, marginal capacity gain or no capacity gain of 1 DCI scheduling multiple PDSCHs is obtained.And in our contribution, the two different assumption for PDCCH overhead saving are considered: * Realistic assumption in R1-2209198: Considering multiple UEs are waiting for scheduling in one slot, PDCCH overheads cannot be saved in the PDSCH except the first PDSCH, where there are PDCCH monitoring occasions for other UEs.
* Ideal assumption in R1-2207062: the PDSCHs except the first PDSCHs can re-use the PDCCH overhead to transmit data.

The results for these two assumptions are summarized as follow:

|  |  |  |  |
| --- | --- | --- | --- |
| **Assumption** | **Techniques** | **Capacity** | **Capacity gain** |
| Realistic assumption | 1 DCI scheduling one PDSCH | 9.1 | - |
| 1 DCI scheduling multiple PDSCHs | 9.4 | -13.18% |
| Ideal assumption | 1 DCI scheduling one PDSCH | 9.1 | - |
| 1 DCI scheduling multiple PDSCHs | 7.9 | 3.29% |

We also find that **Ericsson, vivo and ZTE/Sanechips** has provided some negative capacity performance of 1 DCI scheduling multiple PDSCHs compared to 1 DCI scheduling 1 PDSCH in some cases. As a result, basically the observation of negative capacity performance of 1 DCI scheduling multiple PDSCHs in the cases is reasonable.Q2: Disagreed. |
| **LG** | **Q1:** We share similar view to Samsung, as long as the PDCCH/DCI overhead is not an issue for XR services. Regarding evaluation results, based on the current specification, the symbols for PDCCH can be utilized as PDSCH resource by gNB’s scheduling. If it is considered in evaluation, the result should be better than other evaluation not considering that. **Q2:** Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | **Q1**: We support for Proposal 3-1-1. Single DCI scheduling multiple PDSCHs/PUSCHs can have capacity gain thanks to the PDCCH overhead reduction that can be re-used for PDSCHs/PUSCHs scheduling as shown in vivo results. Also, the scheme comes with minimum specification effort as it will be extended from Fr2-2, hence our support for Proposal 3-1-1  |
| **vivo** | Q1: Thanks for ZTE’s clarification.Indeed some ideal assumptions are adopted for our simulation. We would like to further clarify our evaluation results that we did not consider any other PDCCH that may occupy the CORESET(s) than scheduling DCI, e.g. broadcast PDCCH. With the existence of such PDCCH other than scheduling DCI, the reserved X(1 or 2) symbol(s) may not be fully utilized for PDSCH scheduling if not used for scheduling DCI. Therefore the potential performance gain by multi-PDSCH scheduling shown in the evaluation can be viewed as the upper bound. Q2: We think the proposed enhancements with evaluation results, especially those showing potential performance gain, can be captured in the TR. Necessary clarification if any can be included. Whether and how to draw observation and conclusion based on the captured techiques and evaluation results can be discussed separately. |
| **Ericsson** | Q1: We are OK to enable support of multi-PxSCH “as it is”, tha tis without enhancements to FR1/FR2-1. The capacity gain, if any, is limited for any enhancement and we should be consistent in our decisions.  |
| **InterDigital** | Q1: We think the extension of single DCI scheduling multiple-PDSCH is useful for addressing issues related to transmission of large PDU sets, where any savings from PDCCH overhead reduction that can be used for data can result in capacity improvement. In this regard we support proposal 3-1-1. |
| **OPPO** | Q1: Agree with other companies. No need to further enhance the multi-PxSCH scheduling. |
| **Lenovo** | Similar to SPS, PDCCH is not the bottleneck in XR scenario, and such extension is not likely needed. In general, wondering if entire 1 or 2 symbol PDCCH (full BW) overhead assumption is a bit conservative?  |
| **Huawei/HiSilicon** | Q1: disagree with Proposal 3-1-1.Single DCI scheduling multiple PXSCHs has been studied in Rel-17 B52.6GHz with the benefit of control signaling overhead saving. Multiple PDSCHs scheduled by single DCI have the same MCS and frequency domain allocation indication, which may decrease the XR capacity due to the variable channel condition. In addition, inflexible retransmission may cause extra delay which would also limit the capacity. Moreover, according to R17 XR evaluation, the bottleneck of XR capacity lies in the data channel rather than the control channel. Therefore, this topic can be down-prioritized.Q2: This topic can be down-prioritized. |
| **Nokia, NSB** | Q1: the difference is coming from vivo’s assumption of giving the resources for PDCCH to PDSCH if the former is not used. We support Proposal 3-1-1. It helps reduce the DCI overhead and is considered advantages for transmission of larger XR payloads that does not fit into a single TTI. We support having captured single-DCI multi-PDSCH scheduling options for FR1 in the TR.Moreover, when sparse PDCCH monitoring is configured to save power, multi-PxSCH scheduling can greatly affect the capacity since the scheduling delay is significantly reduced.Q2: We agree to capture observations and results to TR 38.835. |
| **Intel** | Q1: Ok to consider support of existing solution as is to FR1/FR 2-1 |
| **Qualcomm** | Q1: We think that the capacity gains from vivo are useful. They are showing that Case 3 is useful for capacity as unoccupied coreset can be used for PDSCH. Something that can already be supported.  We support the proposal 3-1-1. We think it is useful for XR burst transmission and reduces the overhead of DCI scheduling. Q2: We think companies effort should be respected.  |

### 3.1.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-1-1 | **Companies (7):**Google, vivo, Ericsson, IDC, Nokia/NSB, Intel, QC | **Companies (9):**[Samsung], FW, CATT, MTK, ZTE, LG, OPPO, Lenovo, HW/HiSi | **Companies (1):**Samsung |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
* **If no consensus is achieved by the ends of 2nd round for any of these proposals, conclude that:**
	+ **There is no consensus to support legacy single DCI scheduling multi-PDSCHs for FR2-2 to other SCS in FR1/FR2-1*.***

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **ZTE, Sanechips** | We agree with this suggestion. |
| **Vivo** | We support P3-1-1.Based on our simulation, the ratio of multi-PDSCH transmission slots (excluding the first PDSCH transmission slot) over the total scheduled slots is around 40%. If the saved PDCCH resources can be used for PDSCH transmission, the capacity performance can be improved. Even though some of the saved PDCCH resources in these multi-PDSCH transmission slots may not be used for PDSCH transmission due to other scheduling DCI transmission, from our simulation results, compared to single-PDSCH scheduling, multi-PDSCH scheduling can achieve capacity gain when 1 or 2 symbol CORESET is adopted.Regarding the multi-PDSCH scheduling, we would like to note that the scheduling algorithm has great effect on the performance. For example, the critera to adopt multi-PDSCH scheduling and how many slots would be allocated for mutli-PDSCH scheduling, need to carefully determined. In our simulation, the scheduler determines in a first slot multi-PDSCH scheduling is used when more than Y% (e.g., 50%) of the whole frequency bandwidth is allocated in the first slot but there are still data to be transmitted. |
| **Nokia, NSB** | We think that the same approach as for CG shall be applied here. We first agree on the observations from the simulation results. This will help to see the benefits of multi-PxSCH scheduling with single DCI. Extension to lower SCS and frequency range brings more flexibility when using this feature for XR with minor spec impact. Moreover, since multi-PUSCH already supports lower SCS and frequency range, we do not see there is a problem extending it for multi-PDSCH as well. |
| **MTK** | We support the FL suggestion. If there is no quick consensus, we can first agree on the observations from the simulation results as suggested from Nokia. |
| **Samsung** | Support the FL suggestion. It should be clear that there are no XR capacity gains from multi-PXSCH scheduling, not even 0.01%.We are OK to keep the option to support ‘as is’ the Rel-17 multi-PXSCH scheduling from FR2-2 in FR1/FR2 but corresponding discussions can be deprioritized.  |
| **CATT** | We support the proposal. |
| **Futurewei** | We support moderator’s suggestion and no need to consider further 3-1-1. |
| **Qualcomm** | We think single DCI scheduling multi-PDSCH is useful for other SCS in FR1/FR2-1. Particularly the capacity gains from vivo show performance gain.   |
| **Intel** | We are supportive of the proposal  |
| **DOCOMO** | We are fine with the proposal. |
| **OPPO** | Given the number of companies saying YES or NO, we are fine with FL suggestion. |
| **Huawei/HiSilicon** | Support the FL suggestion.  |
| **CMCC** | We support Proposal 3-1-1. Due to the large and varying packet sizes of XR traffic frames, the network may often need to allocate several TBs (slots) to deliver a DL/UL video/scene frame. In this case, multiple DCIs need to be sent to allocate resources for UE when utilizing the normal DG, which will cause high DCI overhead. Therefore, the single DCI scheduling multi-PDSCHs/PUSCHs supported in FR2-2 and NR-U is a natural choice to serve XR traffic. |
| **LG** | We are fine with the proposal.  |
| **Moderator** | Regarding P3-1-1, the following was concluded:**Conclusion**No further discussion in RAN1 for Rel-18 XR to extend the support of legacy single DCI scheduling multi-PDSCHs for FR2-2, to other SCS in FR1/FR2-1.This discussion is closed. |

## 3.2 Enhancements of CBG and/or HARQ-ACK feedback

The Table G in section 3.2 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (11):** vivo\*, QC, ZTE/Sanechips, Lenovo, Rakuten, Nokia/NSB, Samsung, LG, InterDigital, Google, Apple
* **Companies with evaluation results (1):** vivo\*

**High-level observations:**

* **Proposed enhancement for early/Multiple HARQ-ACK feedback reporting for multi-slot PDSCHs scheduling**
	+ Vivo\*, QC, ZTE/Sanechips, Lenovo, Rakuten
* **CBG support for multi-slot PDSCH scheduling (when supported)**
	+ Support: Nokia/NSB, Samsung
	+ Not support: LG
* **Proposed enhancement for CBG based HARQ-ACK feedback reporting**
	+ Alt-1: CBG overhead reduction, e.g., Per CBG HARQ-ACK feedback for erroneous TBs
		- Nokia/NSB, Lenovo
	+ Alt-2: Mapping TB related XR information to corresponding CBG
		- Lenovo
	+ Alt-3: Flexibility in number of CBGs per TB
		- InterDigital, Google
	+ Alt-4: CBG based transmission to support QoS enhancement at lower layers.
		- Apple

### First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 3-2-1:** **Early/Multiple HARQ-ACK feedback reporting for multi-slot PDSCHs scheduling is beneficial to improve XR capacity performance.**
* **Proposal 3-2-2:** **CBG support for multi-slot PDSCH scheduling (when supported) is beneficial to improve XR capacity performance.**
* **Proposal 3-2-3:** **Enhancement for CBG based HARQ-ACK feedback reporting) is beneficial to improve XR capacity performance. Examples of enhancements are listed below.**
	+ Alt-1: CBG overhead reduction, e.g Per CBG HARQ-ACK feedback for erroneous TBs
	+ Alt-2: Mapping TB related XR information to corresponding CBG
	+ Alt-3: Flexibility in number of CBGs per TB
	+ Alt-4: CBG based transmission to support QoS enhancement at lower layers.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** Moderator recommends prioritizing Proposal 3-2-1 and Proposal 3-2-2 for discussions due to availability of simulation results and/or more supporting companies.
	+ What is your view on Moderator’s recommendation?
* **Q2:** What is your view on direction of Proposal 3-2-1, Proposal 3-2-2 and Proposal 3-2-3, and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q3:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q4:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q3: Suggest to first conclude on the support of multi-PXSCH. If concluded, OK to focus on the more fundamental aspects captured in Q1 as they were also discussed in R17 for B52.  |
| **Futurewei** | Q1-Q2: we do not see the need or potential to have multi-PXSCH for XR capacity improvement. Q3: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1-Q2: We need to see the performance gain before we further discuss the proposed schemes. Q3: All results should be captured with note for clarification.  |
| **MTK** | Q1-Q2: (Same as Samsung) Suggest to first conclude on the support of multi-PXSCH. If concluded, OK to focus on the more fundamental aspects captured in Q1 as they were also discussed in R17 for B52. Q3: We are ok to capture the results if the comparison baseline is DG. |
| **LG** | It should be discussed after 3.1.1 Q3: Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | We see benefits in the listed proposals but we are aligned with Samsung to first conclude on the support of multi-PDSCHs/PUSCHs scheduling before diving into the details.  |
| **Vivo** | Q1: For Proposal 3-2-1, if there is conclusion in section 3.1.1, further study on the feasibility and potential benefit of earlier HARQ-ACK feedback can be considered.Q2: For proposal 3-2-2 and 3-2-3, the benefit needs to be justified by evaluation. Regarding Proposal 3-2-2, it should be noted that there are a lot of issues for enhancements related to CBG based re-transmission and HARQ-ACK reporting, in conjuction with multi-PDSCH scheduling. Besides, most of these issues were discussed extensively during Rel-16 NR-U and Rel-17 B52.6GHz with the conclusion of not supporting. |
| **Ericsson** | Q1: OK with prioritization suggestion. Then agree with Samsung that we need to focus on support of multi-slot PDSCH (since main use case scenarions are FR1/FR2-2).Q2: We are OK to support 3-2-2 if there is strong majority. Please see our simulation results in section 4.3 shows similar performance between TB based and CBG based. So, the capacity gain is not clear to us.Regarding other proposals, we don’t see the need. For example for 3-2-1, if there is TDD pattern, it can use both single-slot and multi-slot PDSCH scheduling, to enable early feedback. (for example for n=0,..,2 multi-slot, for slot n=4,.. multi/single slot)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Dn=0 | Dn=1 | Dn=2 | U n=3 | Dn=4 | Dn=5 | Dn=6 | Un=7 |

 |
| **InterDigital** | Q1 – Q2:We do not see the need for prioritizing proposals 3-2-1 and 3-2-2 related to multi-slot PDSCH scheduling. We think proposal 3-2-3 on the enhancements for CBG based HARQ-ACK should also be the focus of the study/discussion, as these enhancements apply even for the baseline single PDSCH scheduling. |
| **OPPO** | Q1/Q2: We think there is no need to further enhance the multi-PXSCH scheduling. |
| **Lenovo** | The schemes with simulation results should be prioritized. |
| **Huawei/HiSilicon** | Q1-Q3: Suggest to first conclude on the support of multi-PXSCH. Then, performance gain should be given before we further discuss the topic. |
| **Nokia, NSB** | We support proposals 3-2-1, 3-2-2, 3-2-3 as CBG-based transmission has proven to be useful for XR use cases with transmission of large payloads. This should be supported also for single-DCI multi-PDSCH scheduling options. Having Early/Multiple HARQ-ACK feedback reporting for multi-slot PDSCHs scheduling is beneficial to HARQ loop latencies, and a consequence, help the overall improve XR capacity performance. |
| **Qualcomm** | We think that enhancements for multi-PXSCH are useful. Therefore, we are supporting of multi-HARQ ACK, dynamic indication of change of configuration and adaptive configuration.  |

### Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-2-1 | **Companies (2):**Nokia/NSB, QC, Lenovo | **Companies (4):**FW, CATT, Ericsson, IDC | **Companies (6):**Samsung, MTK, LG, Google, vivo, HW/HiSi |
| P3-2-2 | **Companies (2):**Nokia/NSB, QC | **Companies (4):**FW, CATT, vivo, IDC | **Companies (6):**Samsung, MTK, LG, Google, Ericsson, HW/HiSi |
| P3-2-3 | **Companies (3):**Lenovo, Nokia/NSB, QC | **Companies (4):**FW, CATT, vivo, Ericsson | **Companies (5):**Samsung, MTK, LG, Google, HW/HiSi |

**Moderator’s recommendation for discussion:**

**Moderator suggests postponing this discussion after decision on regarding the proposal in section 3.1.1.**

* **Meanwhile, companies can provide any additional comment below.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | We support the study of P3-2-3  |
| **ZTE, Sanechips** | Agree. |
| **Vivo** | We are fine to postpone the discussion of P3-2-3 after the decision for section 3.1.1. |
| **Nokia, NSB** | We agree with the moderator’s recommendation. We first need to agree whether multi-PxSCH scheduling with single DCI brings benefits for XR operation and then we need to decide on necessary enhancements. Overall, we are supportive of early HARQ and CBG support for multi-PxSCH scheduling. CBG-based transmission is useful for XR use cases with transmission of large payloads, so it should be supported also for single-DCI multi-PDSCH scheduling options. Having Early/Multiple HARQ-ACK feedback reporting for multi-slot PDSCHs scheduling is beneficial to HARQ loop latencies, and as a consequence, help the overall improve XR capacity performance. |
| **MTK** | We support moderator’s suggestion. |
| **Samsung** | Support the moderator’s suggestion. |
| **CATT** | We are OK with moderator’s proposed WF |
| **Futurewei** | We support moderator’s suggestion. |
| **Qualcomm** | Support moderator suggestion |
| **Intel** | We support moderator’s suggestion. |
| **DOCOMO** | Support moderator suggestion. |
| **OPPO** | We support moderator’s suggestion. |
| **Huawei/HiSilicon** | Support the FL suggestion.  |
| **LG** | We support moderator’s suggestion. |
| **Moderator** | **Based on views expressed during the previous round and the outcome of 1st online session (see section 1.1.3), the discussion on P3-2-1 and P-3-2-2.****P3-2-3 is updated to Proposal 3-2-3a to reflect only single-slot PDSCH scheduling case.** * **Proposal 3-2-3a:** Enhancement for CBG based HARQ-ACK feedback reporting for single-slot PDSCH scheduling by single DCI is beneficial to improve XR capacity performance. Examples of enhancements are listed below**.**
	+ Alt-1: CBG overhead reduction, e.g Per CBG HARQ-ACK feedback for erroneous TBs
	+ Alt-2: Mapping TB related XR information to corresponding CBG
	+ Alt-3: Flexibility in number of CBGs per TB
	+ Alt-4: CBG based transmission to support QoS enhancement at lower layers.

**The discussion in next round is focused on Proposal 3-2-3a.**  |

### 3.2.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-2-3 | **Companies (4):**Lenovo, Nokia/NSB, QC, Apple | **Companies (4):**FW, CATT, vivo, Ericsson | **Companies (5):**Samsung, MTK, LG, Google, HW/HiSi |

**Moderator’s recommendation for discussion:**

**Please discuss you views on Proposal 3-2-3a and the corresponding alternative (Alt-1 to Alt-4), with respect to performance gain and complexity to conclude whether any of the proposed enhancements are beneficial to be recommended. For detailed information on example alternatives, please see section 3.2.1 and Table G in section 3.2 of R1-2214010.**

**Proposal 3-2-3a:** Enhancement for CBG based HARQ-ACK feedback reporting for single-slot PDSCH scheduling by single DCI is beneficial to improve XR capacity performance. The following alternatvies for enhancements are listed below**.**

* + Alt-1: CBG overhead reduction, e.g Per CBG HARQ-ACK feedback for erroneous TBs
	+ Alt-2: Mapping TB related XR information to corresponding CBG
	+ Alt-3: Flexibility in number of CBGs per TB
	+ Alt-4: CBG based transmission to support QoS enhancement at lower layers.

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | We do not support continue discussing this direction after the conclusion of 3-1-1. |
| **Intel** | Agree with Futurewei |
| **Samsung** | Do not support“Alt-1: Per CBG HARQ-ACK feedback for erroneous TBs” is about reducing HARQ-ACK overhead, does not relate to XR capacity enhancements, and … doesn’t work. It is N/A for Type-1 CB and results to unknown Type-2 CB size at the gNB.“Alt-2: Mapping TB related XR information to corresponding CBG” is functionally equivalent but more complex than having separate PDSCHs for separate TBs (and using legacy CBGs per separate TB).“Alt-3: Flexibility in number of CBGs per TB” relates to HARQ-ACK payload reduction as, to minimize CBG size for retransmissions, a gNB can set a large CBG granularity. It is not relevant to XR capacity, a gain, if any, would be marginal and has error cases in the HARQ-ACK CB construction (wourd require new/non-simple spec support to fix them).“Alt-4: CBG based transmission to support QoS enhancement at lower layers” is unclear. It seems to be about using CBG for retransmission of a packet for which the latency would be exceeded for the retransmission? The whole purpose of that and how it relates to CBGs is unclear.  |

## 3.3 Enhancements of parameters/configurations of multi-slot PDSCHs

The Table H in section 3.3 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (8):** vivo\*, InterDigital\*, QC, TCL, Ericsson, Sony, Rakuten, CMCC
* **Companies with evaluation results (2):** vivo\*, InterDigital\*

**High-level observations:**

* **Applying different parameters (e.g., MCS, FDRA, TDRA, number of PxSCHs) for multi-PxSCHs scheduled by a single DCI**
	+ Support: Vivo\*, InterDigital\*, QC, TCL, Ericsson, Sony, Rakuten
* **PDCCH skipping indication in the single DCI scheduling multi-PDSCHs allows for PDCCH skipping after decoding of the multi-PDSCHs**
	+ Support: QC
* **For single DCI scheduling multi-PDSCHs/PUSCHs, support of dynamic change between single TB transmission per PDSCH/PUSCH and TB repetition on multiple PDSCHs/PUSCHs**
	+ Support: CMCC
* ..

### 3.3.1 First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 3-3-1:** **Applying different parameters (e.g.,** **MCS, FDRA, TDRA, number of PxSCHs) for multi-PxSCHs scheduled by a single DCI is beneficial to improve XR capacity performance.**
* **Proposal 3-3-2:** **PDCCH skipping indication in the single DCI scheduling multi-PDSCHs allows for PDCCH skipping after decoding of the multi-PDSCHs that is beneficial to improve XR capacity performance.**
* **Proposal 3-3-3:** **For single DCI scheduling multi-PDSCHs/PUSCHs, support of dynamic change between single TB transmission per PDSCH/PUSCH and TB repetition on multiple PDSCHs/PUSCHs, is beneficial to improve XR capacity performance.**

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** Moderator recommends prioritizing Proposal 3-3-1 for discussions due to availability of simulation results and/or more supporting companies.
	+ What is your view on Moderator’s recommendation?
* **Q2:** What is your view on direction of Proposal 3-3-1, Proposal 3-3-2 and Proposal 3-3-3, and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q3:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q4:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1: Do not support proposal 3-3-1. For any further consideration of 3-3-1, proponents should describe the DCI format design together with DCI overhead savings considering possible DCI size matching in order to maintain the “3+1” DCI size budget (and preferably, in conjunction with other Rel-18 WIs that are directly applicable for XR such as multi-cell scheduling using a single DCI). Q1-Q3: Similar comment as for CBG enhancements in 3.2.1 – first need to conclude on whether to support multi-slot PXSCH scheduling.  |
| **Futurewei** | Q1-Q2: we do not see the need or potential to have multi-PXSCH for XR capacity improvement.Q3: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1/Q2: We don’t see the benefit of proposed scheme.Q3: all results should be captured with note.  |
| **MTK** | Q1: We do not see clear benefit for Proposal 3-3-1. If NW wants to dynamically change MCS, FDRA, TDRA, …, why not NW just use single PxSCH scheduling?Q2: We do not see clear benefit for Proposal 3-3-1/3-3-3. If NW wants to dynamically change the paramteters…, why not NW just use single PxSCH scheduling?Q3: We agree with Samsung -- first need to conclude on whether to support multi-slot PXSCH scheduling. If the results are to be captured, the comparison baseline should be reasonable chosen and explained in the TR. |
| **LG** | It should be discussed after 3.1.1 Q3: Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | Same as discussion in 3.2, we see benefits in the listed proposals but we need to first conclude on the support of multi-PDSCHs/PUSCHs scheduling before diving into the details. |
| **vivo** | Q1: If multi-PDSCH scheduling is considered for XR, the proposed enhancement in proposal 3-3-1 can be considered, since they can provide more flexibility of scheduling for multi-PDSCH transmission. Besides, capacity gain can be achieved based on our simulation results.Q2: For proposal 3-3-2, it seems the proposed enhancement is addressing power saving rather than capacity improvement. Maybe it is more proper to discuss whether it is beneficial or not for power saving in agenda 9.10.1. Regarding Proposal 3-3-3, from our perspective, there is no need for considering repetition due to that coverage issue is not the focus of this agenda. |
| **Ericsson** | Q1: OK to prioritized.Q2: * On 3-3-1, as proponet, we are supportive. But, as mentioned earlier, we are OK to enable support of multi-PxSCH “as it is”, that is without enhancements to FR1/FR2-1. The capacity gain, if any, is limited for any enhancement and we should be consistent in our decisions. Therefore, we stay neutral regarding this enhancement.
* On 3-3-2: We don’t support. No capacity gain is shown, and intuitively, it seems to be more a power saving feature than capacity improvement,
* On 3-3-3: We don’t support. NW can already switch using single slot on multi-slot DCI. Repetition is also can be dynamically indicated. It is not clear to use the gain that the proposed enhancement offers.
 |
| **InterDigital** | Support proposal 3-3-1 and Moderator’s recommendation. Using flexible parameters for the different PxSCHs results in better alignment with the XR traffic and matches with the flexibility of DG minus the high PDCCH overhead. |
| **OPPO** | Q1/Q2: We think there is no need to further enhance the multi-PxSCH scheduling. |
| **Lenovo** | The proposals need to be updated to clearly indicate whether they are needed for the extension from FR2-2 to FR1/FR2.Proposal 3-3-2 may not much needed for FR2-2?Proposal 3-3-3 if only applicable to FR2-2, assuming channel conditions do not change much across TBs, may not be needed. |
| **Huawei/HiSilicon** | Q1-Q3: Suggest to first conclude on the support of multi-PXSCH. Then, performance gain should be given before we further discuss the topic. |
| **Nokia, NSB** | The enhancement in Proposal 3-3-1 needs to be further studied to see whether the gains from flexible parameters can motivate the considerable DCI overhead. Proposal 3-3-2 seems more for power saving not fo capacity thus the motivation to further study is not clear. Enhancements in Proposal 3-3-3 are mainly seen important for the uplink where repetition may sometimes be needed due to potential uplink coverage challenges. |
| **Intel** | Q1-Q2: Open to consider if there is performance gain Q3: Results showing meaningful capacity gain with reasonable/practical assumptions should be captured |
| **Qualcomm** | Similar to our reasoning above for the previous two questions. We think enhancements for multi-PXSCHs are useful.  |
| **SONY** | Q1: Similar view as the moderator, we support Proposal 3-3-1.Q2: On Proposal 3-3-1, the focus is to ensure high reliability. Hence, PDB can be met. |

### 3.3.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-3-1 | **Companies (2):**IDC, QC | **Companies (7):**Samsung, FW, CATT, MTK, OPPO, Nokia/NSB, Lenovo | **Companies (5):**[Ericsson], LG, Google, vivo, Intel |
| P3-3-2 | **Companies (1):**QC | **Companies (7):**FW, CATT, vivo, OPPO, Nokia/NSB, Lenovo, Ericsson | **Companies (5):**Samsung, MTK, LG, Google, Intel |
| P3-3-3 | **Companies (1):**QC | **Companies (8):**Samsung, FW, CATT, MTK, vivo, Ericsson, OPPO, Lenovo | **Companies (4):**LG, Google, Nokia/NSB, Intel |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Continue discussion for the 2nd round**
	+ **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
	+ **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
	+ **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **ZTE, Sanechips** | We suggest to postpone this discussion after decision in section 3.1.  |
| **vivo** | We support P3-3-1.Currently, fixed FDRA is used for multi-PDSCH transmission. The restriction of single FDRA indication may lead to performance loss. Since XR video frame size is large and there could be more than one PDSCH scheduled in a slot. So how to make use of the resources more efficiently in each slot is important. Therefore, more than one FDRA indication can be contained in a scheduling DCI, and each scheduled PDSCH may correspond to respective FDRA indication. From our evaluation results, compared to legacy multi-PDSCH scheduling with a single FDRA indication commonly applied to each scheduled PDSCH, respective FDRA indication for each scheduled PDSCH can make more flexible use of discrete frequency domain resources, increase the chance of multi-PDSCH scheduling, and thus save more PDCCH overhead.We are fine to postpone the discussion after the decision for section 3.1.1. |
| **Nokia, NSB** | As for Section 3.2.2 we think we first need to agree on the benefits of multi-PxSCH scheduling by collecting the observations and then identify a set of essential enhancements to better support XR. |
| **MTK** | Companies’ preference collected by feature lead toward this enhancement seems negative. If no quick consensus can be achieved, we can act as suggested by Nokia. |
| **Samsung** | Support the moderator’s suggestion.  |
| **CATT** | The discussion should be postpone after the discussion of Section 3.1.1 is concluded |
| **Futurewei** | We support moderator’s suggestion. We do not see the potential to have multi-PXSCH for XR capacity improvement. |
| **Qualcomm** | We can postpone the discussion till after discussion in section 3.1.1 but in general we are in favor of adaptation of FDRA.  |
| **Intel** | Postpone discussion till decision is made on Proposal in 3.1 |
| **DOCOMO** | We suggest to postpone this discussion after decision in section 3.1. |
| **OPPO** | Given the number of companies saying YES or NO, we are fine with FL suggestion. |
| **Huawei/HiSilicon** | Similar with 3.2.2, suggest postponing this discussion after decision on regarding the proposal in section 3.1.1 |
| **CMCC** | For proposal 3-3-3, we think it is beneficial to improve resource efficiency to improve the XR service capacity. For example, one DCI scheduling 4 TBs with HPN#1, #2, #3, and #4 in the initial transmission, but the TBs with HPN #2 and #4 are not correctly received by UE. There are two ways for gNB to retransmit, i.e., Opt 1) using two one TB scheduling DCI to retransmit TB with HPN#2 and HPN#4; Opt 2) using single DCI to transmit 4 TBs with HPN#1, #2, #3, and #4. For Opt 1), additional PDCCH resource is needed. For Opt 2), considering the HPN number is continuous, gNB needs to retransmit 4 TBs, which leads to a waste of resources of TB with HPN #1 and #3. Proposal 3-3-3 is a balanced method, in which gNB can use one DCI to schedule 2 TBs using 4 resources, as TB1 with HPN#2, TB1 repetition with HPN#2, TB2 with HPN#4, TB2 repetition with HPN#4, especially considering the TBs with HPN#2 and #4 are not received correctly for the first time, the repetition can improve the reception performance. Thus we think this scheme can both save PDCCH resources and can also improve resource efficiency. In addition, this way is not used to improve the coverage performance as Vivo commented. For Ericsson and MTK’s comments, considering the single DCI scheduling multi TBs cannot be configured with TB repetition simultaneously in the current specification, the way using single DCI scheduling is not a good solution and occupies additional PDCCH resources. |
| **LG** | We suggest to postpone this discussion after decision in section 3.1. |
| **Moderator** | Regarding P3-3-1, P3-3-2 and P3-3-3, due to the Conclusion in section 1.1.3, the corresponding disucsison is closed.This discussion is closed. |

## SR and/or BSR enhancements

The Table I in section 3.4 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (9):** **Huawei/HiSilicon\*, Vivo\*, CATT\*, ZTE\*, TCL, Apple, Ericsson, LG, InterDigitial**
* **Companies with evaluation results (4):** **Huawei/HiSilicon\*, Vivo\*, CATT\*, ZTE\***

**High-level observations:**

* Study enhanced BSR mechanisms for capacity improvement of XR traffic.
	+ Support: Vivo\*, CATT\*, ZTE\*, Ericsson, LG, InterDigital
* **Study multi-bits SR for XR traffic for capacity improvement of XR traffic.**
	+ **Support:** Huawei/HiSilicon\*, Apple, TCL. LG
	+ **Not Support:** Ericsson
* On multi-bits enhancements, additional discussion is needed regarding the concerns raised by opponents.

### 3.4.1 First round of Discussion

**High level proposals based on input contributions:**

* Proposal 3-4-1: It is beneficial to study enhanced BSR mechanisms for capacity improvement of XR traffic.
	+ Support: Vivo\*, CATT\*, ZTE\*, Ericsson, LG, InterDigital
* Proposal 3-4-2: It is beneficial to study multi-bits SR mechanisms for capacity improvement of XR traffic.
	+ **Support:** Huawei/HiSilicon\*, Apple, TCL. LG
	+ **Not Support:** Ericsson

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 3-4-1 and Proposal 3-4-2, and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
	+ **Moderator recommends endorsing** Proposal 3-4-1.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q2: Suggest to leave conclusions to RAN2 – this is outside the RAN1 role/expertise. RAN2 is aware of the topics, they were discussed in the previous RAN2 meeting, and there are RAN2 Tdocs with relevant proposals for this meeting.  |
| **Futurewei** | Q1: BSR enhancement should be discussed in RAN2. About multi-bits SR (proposal 3-4-2), it can be beneficial to indicate from the UE to the gNB the UL traffic information in a timely manner via multi-bits SR.Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: The performance results with BSR enhancement had been shown. The final BSR enhancement would be determined by RAN2Q2: Multi-bit BSR would be decided by RAN2 |
| **MTK** | Q1-Q2: (Same view as Samsung) Suggest to leave conclusions to RAN2 – this is outside the RAN1 role/expertise. RAN2 is aware of the topics, they were discussed in the previous RAN2 meeting, and there are RAN2 Tdocs with relevant proposals for this meeting. |
| **ZTE, Sanechips** | Support Proposal 3-4-1 and Proposal 3-4-2. |
| **LG** | Q1: the necessity seems clear since most of proposals assumes gNB knows UE traffic characteristic. SR can support responsive indication from UE side, with simplified information. BSR would have larger information size to indicate detailed traffic property for further scheduling. We think both can be kept in RAN1 and proposal 3-4-2 may need to be discussed in RAN2 first. Q2: Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | We also suggest to leave this topic to RAN2 |
| **vivo** | **Q1:** BSR enhancement can be recommended for XR capacity improvement and the detailed designed can be handled by RAN2.With enhanced BSR report, we don’t see the need for multi-bits SR. |
| **Ericsson** | Q1: Support, but also OK with other companies’ suggestions that record the results. But we also would like to record our concerns, as explained in contribution on multi-bit SR that we are not supportive.Q2: We support 3-4-1 and do not support 3-4-2. |
| **Sony** | Q1-Q2: We support 3-4-1. But, this topic should be lead by RAN2. RAN1 provides comments if there are any requests from RAN2. |
| **InterDigital** | Support Proposal 3-4-1 and moderator’s recommendation. The details/design of enhanced BSR can be handled by RAN2  |
| **OPPO** | Q1: BSR should be discussed in RAN2. We are open to proposal 3-4-2 if performance gain is shown by multi-bits SR. |
| **Lenovo** | BSR enhancements should be discussed in RAN2. We don’t see the need for SR enhancements, e.g. multi-bit SR. The concept of multi-bit SR was already discussed in the beginning of Rel-15. However instead of introducing a multi-bit SR it was concluded to introduce different SR configurations. The current NR scheme, i.e. mapping of LCHs to SR configurations, allows UE to indicate some traffic related information to gNB with a single-bit SR. |
| Huawei/HiSilicon | Q1: For Proposal 3-4-1, although BSR enhancement is RAN2’s impact, RAN1 can evaluate BSR enhancement to show the capacity gain. For Proposal 3-4-2, SR enhancement can be considered since SR has RAN1’s impact. And according to our simulation results, it is beneficial to study multi-bits SR mechanisms for capacity improvement of XR traffic.Q2: The proposed SR/BSR enhancements should be captured in TR 38.835. Our simulation results show that UE indicating the gNB of the data arrival time can improve the XR capacity. |
| Nokia, NSB | Q1: We agree that BSR enhancements are beneficial for XR use cases. Details of BSR enhancements shall be directed to RAN2. RAN1 shall focus on RAN1 part and prioritize it given the limited time left for this SI.We do not support Proposal 3-4-2. The numerical results of Pre-Scheduling DG and CG already showed the capacity close to Genie (when gNB aware about the precise traffic arrival and packet size). Therefore, the challenges coming from changing the SR design are not justified. |
| **Intel** | Q1-Q2: Suggest to leave conclusions to RAN2 – this is outside the RAN1 role/expertise. |
| Qualcomm | Ok to consider BSR enhancements; we think BSR enhancements should be discussed in RAN2. Same comment for SR enhancements. Note that in the past RAN1 meeting the following agreement was made:  Agreement: Whether/how to enhance BSR to improve capacity performance of XR traffic is within RAN2 scope and is not handled by RAN1. Note that companies should indicate if and what BSR enhancement is assumed in their RAN1 proposals on CG and DG enhancements. RAN1 can evaluate BSR enhancement to improve capacity performance  |

### 3.4.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-4-1 | **Companies (2):**ZTE, LG |   | **Companies (12):**Impacts RAN2:Samsung, FW, MTK, vivo, Ericsson, Sony, IDC, OPPO, Lenovo, HW/HiSi, Nokia/NSB, Intel, QC |
| P3-4-2 | **Companies (4):**FW, ZTE, LG, HW/HiSi | **Companies (4):**vivo, Ericsson, Lenovo, Nokia/NSB | **Companies (6):**Impacts RAN2:Samsung, CATT, MTK, OPPO, Intel, QC |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **On Proposal 3-4-1:**
	+ **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**
* **On Proposal 3-4-2:**
	+ **Continue discussion for the 2nd round**
		- **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
		- **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
		- **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | On P3-4-2 multiple bit SR is a proper RAN1 topic as physical channel design is involved. |
| **ZTE, Sanechips** | Currently RAN2 has specific discussion on BSR enhancement. We can follow previous agreement for BSR enhancement. |
| **Vivo** | We support P3-4-1.For P3-4-2, it seems enhanced SR would be used for enabling delay aware scheduling by sending traffic information like remaning delivery time in the SR. However, it is not clear how the traffic information or the delay information can be conveyed by SR. Besides, BSR is more apprioprate to carry the delay information, which is already agreed to be enhanced. |
| **Nokia, NSB** | We agree that BSR enhancements are beneficial for XR use cases. Details of BSR enhancements shall be directed to RAN2. RAN1 shall focus on RAN1 part and prioritize it given the limited time left for this SI. RAN2 shall be the main editor of “BSR enhancement text” for the TR.Given the simulation results, provided by comoanies, there is no need to further enhance SR as pre-scheduling or CG+DG or eCG already works well. SR is also under MAC specification and shall not be further discussed in RAN1. We highly recommend to focus on RAN1 issues and start preparing the observations for those. |
| **MTK** | Our view is similar as last round. For multi-bit SR, if there is RAN1 impact, we can first draw observations and then decide. |
| **Samsung** | We suggest to drop further discussion and leave the issues to RAN2.RAN2 already discussed and is discussing P3-4-1. RAN2 can also make a decision whether P3-4-2 is beneficial and, if so, RAN1 can do any necessary work. |
| **CATT** | We commented that we support P3-4-1 in first round. For P3-4-2, it is RAN2 topic. No further discussion in RAN1 and leave it to RAN2 |
| **Futurewei** | Our view is the same as in the 1st round. BSR related discussion should be for RAN2. For 3-4-2 multi-bits SR, it has the benefit to report to the gNB UL traffic information in a timely manner and hence some potential for better performance. |
| **Qualcomm** | RAN2 can follow up on BSR enhancements |
| **SONY** | We support 3-4-1. Again, it should be discussed in RAN2. |
| **Intel** | We suggest to leave this to RAN2. |
| **DOCOMO** | We think it should be discussed in RAN2. |
| **Huawei/HiSilicon** | For Proposal 3-4-1, BSR enhancement should be captured in TR although it is RAN2’s impact. RAN1 can evaluate BSR enhancement to show the capacity gain to indicate whether the enhancement is necessary.For Proposal 3-4-2, SR enhancement can be considered since SR belongs to RAN1 scope. And according to our simulation results, it is beneficial to study multi-bits SR mechanisms for capacity improvement of XR traffic. |
| **LG** | We support 3-4-1. Regarding 3-4-2, whether it is RAN2 topic or not is depending on what would be transmitted in multi-bit SR. We are open to discuss.  |

### 3.4.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-4-1 | **Companies (2):**~~ZTE~~, LG |   | **Companies (12):**Impacts RAN2:Samsung, FW, MTK, vivo, Ericsson, Sony, IDC, OPPO, Lenovo, HW/HiSi, Nokia/NSB, Intel, QC, ZTE |
| P3-4-2 | **Companies (6):**FW, ZTE, LG, HW/HiSi, OPPO, Apple | **Companies (10):**vivo, Ericsson, Lenovo, Nokia/NSBRAN2 topic:Samsung, CATT, Intel, DCM, MTK, Google | **Companies (1):**OPPO |

**Moderator’s recommendation for discussion:**

**Action point to Moderator (with respect to P3-4-1):**

* **Summarize BSR enhancements evaluation results in contributions R1-2208953 (CATT) and R1-2208661 (vivo) and request for review to be endorsed as Observation.**
	+ **Moderator aims to provide the summary for review by Monday Oct. 17.**

**Regarding P3-4-2: Moderator recommends following the majority view and down-priortize this discussion in RAN1, and also, capture the simulation results. Please indicate if there is any objection to this recommendation.**

**If proponets do not support Moderator’s recommnendation above, they are requested to address the concern raised:**

* + The topic is a RAN2 topic and being discussed and should be decided by RAN2.
	+ Leave it to RAN2 and RAN1 can take action if requested by RAN2.
	+ With BSR enhancement, not clear the need for multi-bit SR.
	+ Motivation for CG enhancement was SR delay. Not clear why should be enhanced.
	+ The concept of multi-bit SR was already discussed in the beginning of Rel-15. However instead of introducing a multi-bit SR it was concluded to introduce different SR configurations. The current NR scheme, i.e. mapping of LCHs to SR configurations, allows UE to indicate some traffic related information to gNB with a single-bit SR.
	+ The numerical results of Pre-Scheduling DG and CG already showed the capacity close to Genie (when gNB aware about the precise traffic arrival and packet size). Therefore, the challenges coming from changing the SR design are not justified.

**Continue the discussion in third round and aim to conclude whether to support this enhancement or not.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Intel** | Support moderator’s recommendation  |
| **Samsung** | Do not support moderator’s recommendation for P3-4-1. RAN2 can discuss P3-4-1 (it already started). No action is appropriate or needed in RAN1. RAN1 cannot endorse simulation results in an observation as the topic (BSR enhancements) is outside RAN1 expertise. Proponents can submit the simulation results to RAN2. Support the moderator’s recommendation for P3-4-2. |
|  |  |

## Other enhancements

The Table G in section 3.5 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Selection of few additional proposed enhancements:**

* **Introduce XR-dedicated PDCCH monitoring window (XR-PMW) for DL/UL that is monitored irrespective of DRX ON/OFF**
	+ Support: CATT\* (with simulation results)
* **Introduce XR-specific *playoutDelayForMediaStartup* for XR awareness scheduling**
	+ Support: CATT\* (with simulation results)
* **Proposal 7: Study if PHR should be further enhanced based on XR traffic arrival periodicity or UL pose periodicity.**
	+ Support: Lenovo
* ***Study mechanism of packet dropping based on the PDB requirement, in order to avoid resource waste due to the out-of-date packets.***
	+ Support: NEC
* ***Proposal 2: Under CA with different TDD patterns, data retransmission can take place on the carrier different from its initial transmission.***
	+ Support: MediTek
* **Proposal 3: Consider mechanisms to satisfy the PDB in the sub-6 GHz NR (TDD) bands such as enabling HARQ retransmission of a TB on a different cell than the cell of the initial TB transmission.**
	+ Support: Samsung
* …..

### First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 3-5-1: Introduce XR-dedicated PDCCH monitoring window (XR-PMW) for DL/UL that is monitored irrespective of DRX ON/OFF**
	+ Support: CATT\* (with simulation results)
* **Proposal 3-5-2: Introduce XR-specific *playoutDelayForMediaStartup* for XR awareness scheduling**
	+ Support: CATT\* (with simulation results)
* **Proposal 3-5-3: Study if PHR should be further enhanced based on XR traffic arrival periodicity or UL pose periodicity.**
	+ Support: Lenovo
* **Proposal 3-5-4: Study mechanism of packet dropping based on the PDB requirement, in order to avoid resource waste due to the out-of-date packets.**
	+ Support: NEC
* **Proposal 3-5-5: Under CA with different TDD patterns, data retransmission can take place on the carrier different from its initial transmission.**
	+ Support: MediTek
* **Proposal 3-5-6: Consider mechanisms to satisfy the PDB in the sub-6 GHz NR (TDD) bands such as enabling HARQ retransmission of a TB on a different cell than the cell of the initial TB transmission.**
	+ Support: Samsung
* …..

**Moderator’s comments:**

* **Moderator recommends prioritizing Proposal 3-5-1 and Proposal 3-5-2, due to availability of simulation results.**
	+ **Proponent (CATT) is kindly requested to provide clarifications regarding following comments:**
		- **Proposal 3-5-1:** SU-MIMO is used as baseline, but MU-MIMO is used for enhancement schemes. It is not clear if the capacity gain due to MU-MIMO. CATT RAN1#109-e R1-2206385 shows with MU-MIMO as baseline, there is no capacity gain for enhancements but power saving gain.
		- **Proposal 3-5-2:** The proposed enhancements seem to be higher layers. Is the RAN1 design part related to Proposal 5 in the contribution?

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 3-5-1 to Proposal 3-5-6, and the necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
	+ **Moderator recommends prioritizing Proposal 3-5-1 and Proposal 3-5-2.**
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q3: A general comment is that simulation results should not be the only criterion to consider proposals particularly as, even for proposals with simulation results from more than one company, there has been no discussion/agreement/calibration on simulation assumptions for a particular scheme nor on its relevance.Many proposals do not require new simulations. For example, it should be clear that it is beneficial for capacity that a gNB has an up-to-date CSI report in order to schedule a UE when the UE enters Active Time and that CSI report should not be provided ~5 msec later. That was OK for eMBB, it is not OK for XR. Similar with beam management, particularly given that FR2 would be a main deployment scenario for XR given the BW availability (and unavailability in FR1) – it is not possible for a UE to enter Active Time with a poor beam. Asking for simulation results for the above is proactically equivalent to saying that CSI reporting or beam management are unnecessary. Some of the proposals, e.g. 3-5-2/3-5-4, fall under RAN2’s expertise. Proposals 3-5-5 and 3-5-6 are probably the same proposal and aim for a structural mechanism for latency reduction – no simulation results are needed – any tradeoffs can be fully determined by analysis. |
| **Futurewei** | Q1: 3-5-2 / 3-5-4 seems to be RAN2 issue and without RAN1 impact. For 3-5-3It is yet to see how and how much 3-5-3 can improve XR capacity. Are 3-5-5 and 3-5-6 similar proposals? There is potential benefit of cross-carrier/cell HARQ to reduce latency and hence improve capacity. About 3-5-1, similar question as the moderator. In addition, we do not see how the proposed scheme can do better than DG.Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | **Q1:** For 3-5-1, the XR-PMW scheme has the benefit of gNB pairing in the optimization of the MU-MIMO performance comparing to normal MU-MIMO scheme. We showed about similar performance of XR-PMW with MU-MIMO comparing to dynamic grant with MU-MIMO. However, we followed RAN1 agreements using SU-MIMO as the baseline. For 3-5-2, the XR-specific playoutDelayForMediaStartup for XR awareness scheduling is the de-jitter techniques at gNB scheduler. The gNB obtains the playoutDelayFor MediaStartup from UE XR application layer via RRC. However, the de-jitter techniques of gNB scheduler is for physical layer to measure the delay jitter at the gNB and dynamic adapt the gNB scheduling algorithm based on the measured delay jitter to optimize link adaptation gain. RAN1 impacts of the proposed scheme is to collect the statistic of XR packet arrival in delay and delay jitter along with UE’s CSI feedback for scheduler to optimize the system performance with the system performance gain from 25.8% - 103.6%. **Q2:** The system performance gain is the strong evidence and the results should be captured in the TR. The results and system performance gain had been clearly analyzed in the contribution. Companies are welcomed to verify the results.  |
| **MTK** | Q1: * 3-5-2 /3-5-4 seems to be RAN2 issue and without RAN1 impact.
* It is yet to see how and how much 3-5-3 can improve XR capacity.
* About 3-5-5 and 3-5-6, there is potential benefit of cross-carrier/cell HARQ to reduce latency and hence improve capacity, and we urge companies to take a look.
* About 3-5-1, we think the table 1 from CATT can use 16.67 ms CDRX period as baseline, similar to table 3 from CATT; at the same time, it would be more certain about the capacity gain if more than one companies can provide input/evaluation.

Q2: We think results can be captured with evaluation assumption clear explained in the TR. |
| **LG** | **Q1:** 3-5-1/2/3 seems releated to RAN2. 3-5-4 are related to SR/BSR enhancement. For 3-5-5/6, we see an amount of specification impact comparing expected benefits. **Q2:** Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | 3-5-2 and 3-5-4 are RAN2 topics. 3-5-5 and 3-5-6 are very similar and have the potential to improve latency and reliability by giving more flexibility for HARQ retransmissions in TDD mode.  |
| **vivo** | Q1: Proposal 3-5-2 and 3-5-4 are related to XR-awareness which is handled by RAN2.It seems proposal 3-5-1 is addressing power issue rather than capacity. Maybe it needs more clarifications. To ensure the capacity, sufficient long on duration needs to be configured for DRX, e.g., to cover the jitter range. It is not clear that how the proposed enhancement in proposal 3-5-1 benefit for capacity improvement.For proposal 3-5-3, 3-5-5 and 3-5-6, the performance gain on XR capacity needs to be clarified by evaluation results, according to the agreements. |
| **Ericsson** | Q1: * Proposal 3-5-1: Consideirng CATT clairfcaiton, we see the enhancement as a power saving feature, and not capacity gain. Hence, for this agenda, we are not supportive of the proposal.
* Proposal 3-5-2: Considering CATt clarification, the RAN1 related procedures is about CSI measurement. So, the question is whether this part (CSI measurement) should be handled differently? We are fine to capture this feature in TR as a scheme that shows how XR awareness is used (higher layer aspects). But it seems there is no RAN1 impact. Feedback from CATT is appreciated.

Q2:* Proposal 3-5-3: Similar to FW, it is not clear to us the necessity and benefit of the feature. So, we cant support this proposal.
* Proposal 3-5-4: We agree with others that the impact is on higher layers. What RAN1 can do is to study performance evaluation results (like other schemes, for example CATT). Due to lack of performance evaluation, the need to disucs sin RAN1 is not clear.
* Proposal 3-5-5/3-5-6: We agree with others that these two proposals can be merged. Our view is that although technically, this feature would be beneficial, we think it has considerable impact on RAN2, as well as current implementations, also at NW side. That’s why we are hesitant at this stage.
 |
| **Nokia, NSB** | We do not support Proposal 3-5-1 to 3-5-6. Proposals 3-5-3 to 3-5-6 does not have simulation results and justification that the enhancements are needed.Proposal 3-5-1 shows worse results if we compare MU-MIMO without and MU-MIMO with enhancements.Proposal 3-5-2 does not seem to have a RAN1 impact. |
| **Qualcomm** | Agree with other companies that 3-5-2 / 3-5-3/ 3-5-4 may be better discussed in RAN2. In regards to 3-5-5 and 3-5-6 it would be good if the supporting companies can provide simulation results that prove benefit. All proposals should be treated similarly when it comes to their consideration with or without simulation results.  |

### 3.5.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-5-1 | **Companies (1):**CATT | **Companies (3):**LG, Ericsson, Nokia/NSB | **Companies (3):**FW, MTK, vivo |
| P3-5-2 | **Companies (1):**CATT | **Companies (8):**Samsung, FW, MTK, LG, Google, vivo, QC, Nokia/NSB | **Companies (1):**Ericsson |
| P3-5-3 |   | **Companies (5):**LG, vivo, Ericsson, Nokia/NSB, QC | **Companies (2):**FW, MTK |
| P3-5-4 |   | **Companies (9):**Samsung, FW, MTK, LG, Google, vivo, Ericsson, QC, Nokia/NSB |   |
| P3-5-5/P3-5-6 | **Companies (4):**Samsung, FW, MTK, Google | **Companies (5):**LG, vivo, Ericsson, Nokia/NSB, QC |   |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Proposal 3-5-1 and P3-5-2:**
	+ **CATT, as the only proponet is requested to provide feedback and discuss for the 2nd round, including clarification on RAN1 spec impact regarding P3-5-2 :**
		- **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
		- **If no consensus is achieved by the ends of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
		- **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**
* **Proposal 3-5-3 and Proposal 3-5-4:**
	+ **Down-priorotize these proposals and close the discussion.**
* **Proposal 3-5-5/6:**
	+ **Proponets are requested to provide feedback and discuss for the 2nd round, and share the plans for providing simulatin results, if any.**
		- **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **vivo** | We suggest to deprioritze P3-5-1 to P3-5-6. |
| **Nokia, NSB** | We agree to down prioritize Proposal 3-5-3 and 3-5-4.We suggest discussing Proposals 3-5-5 and 3-5-6 when the simulation results are available.We propose not to further discuss Proposal 3-5-1 since no capacity gains are shown.We see no RAN1 impact from Proposal 3-5-2. We highly recommend focusing on RAN1 enhancements and be mindful of time left for this SI for the sake of progress. Thus, we suggest not to discus this further. |
| **MTK** | For Proposal 3-5-5/6, we would check whether we can provide simulation results in next meeting. For now, we are fine with moderator suggestions. |
| **Samsung** | For proposal 3-5-5/6, it is clear that latency reduction can be achieved – the value depends on the SCS (e.g. ~2 msec at 15 kHz and ~1 msec for 30 kHz). The proposals are a direct extension of the Rel-17 PUCCH cell switching to PUSCH. The only question is whether for XR it is worth to reduce latency by having a common HARQ pool for some cells. It is unlcear what simulation results are needed for that. The latency reduction is structural, and therefore larger than what any ‘eCG’ can offer, while the specification impact is marginal compared to possible ones from eCG. |
| **CATT** | For Proposal 3-5-1, DL XR-PMW is customized for XR and optimize for UE pairing of MU-MIMO, which could achieve 85% capacity gain over the baseline of dynamic scheduling always on with SU-MIMOUL XR-PMW is the pre-scheduling scheme with pre-configured PDCCH monitoring occasions aligned with XR traffic cycle. UL XR-PMW shows capacity gain 33% over UL dynamic grant with 5 ms SR delay.For Proposal 3-5-2, XR playout buffer uses the UE report initial playout delay information from RRC for extending the XR PDB at the gNB scheduler. The gNB would collect the statistic, such as average delay and delay jitter, of XR packet arrival for each UE to incorporate with UE CSI feedback to optimize the link adaptation gain and perform de-jitter function, such as jitter reduction, and reshuffle in order delivery for out-of-order XR packet arrival, of XR packets received at the UE. We support moderator’s proposal on 3-5-3, 3-5-4, For 3-5-5, 3-5-6. We are OK to further discuss when the evalution results with positive system performance gain. |
| **Futurewei** | For 3-5-1 and 3-5-2, we do not see the RAN1 impact or how it can improve XR capacity. We agreed to down prioritize 3-5-3 and 3-5-4. For 3-5-5 and 3-5-6, it can reduce the latency and hence capacity of XR. We suggest supporting it. |
| **LG** | For 3-5-4, maybe it would be necessary based on XR-awareness progress by RAN2. In this case, RAN2 may trigger the discussion for RAN1. We suggest to deprioritze P3-5-1/2/3/4/5/6 in general. |

### 3.5.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P3-5-1 | **Companies (1):**CATT | **Companies (5):**RAN2(LG), Ericsson, Nokia/NSB, FW, vivo | **Companies (1):**~~FW,~~ MTK~~, vivo~~ |
| P3-5-2 | **Companies (1):**CATT | **Companies (9):**RAN2(Samsung, FW, MTK, LG, Google, vivo, QC), Nokia/NSB, Ericsson | ~~Ericsson~~ |
| P3-5-3 |   | **Companies (8):**SR/BSR(LG), vivo, Ericsson, Nokia/NSB, QC, FW, CATT, LG | **Companies (1):**~~FW~~, MTK |
| P3-5-4 |   | **Companies (10):**RAN2(Samsung, FW, MTK, LG, Google, vivo, Ericsson, QC), Nokia/NSB, CATT |   |
| P3-5-5/P3-5-6 | **Companies (4):**Samsung, FW, MTK, Google | **Companies (4):**LG, vivo, Ericsson, ~~Nokia/NSB~~, QC | **Companies (1):**Nokia/NSB |

**Moderator’s recommendation for discussion:**

**Regarding Proposal 3-5-1: Introduce XR-dedicated PDCCH monitoring window (XR-PMW) for DL/UL that is monitored irrespective of DRX ON/OFF**

* The baseline is SU-MIMO, while the enhancement is done for MU-MIMU. Hence, it is not clear whether the capacity gain is due to MU-MIMO or XR-PMW. In last meeting, MU-MIMO was used and no capacity gain, but power saving gain was shown. Moderator suggests capturing the results and close the discussion this meeting. If in next meeting, new results using SU-MIMO for both baseline and enhancements, or MU-MIMO for both baseline and enhancement show capacity gain, the topic can be discussed again, the results can be updated.

**Regarding Proposal 3-5-2: Introduce XR-specific *playoutDelayForMediaStartup* for XR awareness scheduling**

* With respect to RAN1 impact, CATT explains as:
	+ *“For Proposal 3-5-2, XR playout buffer uses the UE report initial playout delay information from RRC for extending the XR PDB at the gNB scheduler. The gNB would collect the statistic, such as average delay and delay jitter, of XR packet arrival for each UE to incorporate with UE CSI feedback to optimize the link adaptation gain and perform de-jitter function, such as jitter reduction, and reshuffle in order delivery for out-of-order XR packet arrival, of XR packets received at the UE.”*
* However, Moderator similarly to other companies fail to identify the RAN1 impact. Collection of statistics and incorporating with CSI for further actions such as LA, etc., are gNB procedures. Therefore, Moderator suggests capturing the results and conclude the discussion.

**Action point to Moderator (with respect to P3-5-1 and 3-5-2):**

* **Summarize XR-PMW and XR-specific *playoutDelayForMediaStartup* enhancement evaluation results in contributions R1-2208953 (CATT) and request for review to be endorsed as Observation.**
	+ **Moderator aims to provide the summary for review by Monday Oct. 17.**

**Regarding Proposal 3-5-3 and Proposal 3-5-4: Based on the companies’ views, these topics are down-priorotized. Please indicate if there is any objection to this recommendation.**

**Regarding Proposal 3-5-5/3-5-6: The views are split regarding this enhancement. Moderator recommends continuing discussion in the third round. Proponets are encouraged to provide more details and address the raised concerns.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | On 3-5-5/3-5-6, no technical issue has been raised in the previous rounds of discussions. There is a request to show simulation results. It is clear intuitively that cross-carrier HARQ can reduce latency which translates to potential capacity gain for XR traffic. How much gain is to be shown by simulation.  |
| **Intel** | Support moderator’s view on 3-5-3 and 3-5-4. We are not sure Proposal 3-5-5/3-5-6 are XR specific solutions |
| **Samsung** | Support the moderator’s suggestions.We support proposals 3-5-5/3-5-6. The reason is PUSCH latency reduction. A practically identical mechanism was specified in Rel-17 for PUCCH. The Rel-17 specifications are simple and they should be even simpler for PUSCH as several aspects for the PUCCH are not relevant for the PUSCH – i.e. the RAN1 impact would be minimal given the Rel-17 support for PUCCH. As proposals 3-5-5/3-5-6 can offer larger latency reduction with smaller specification impact than other proposals motivated by possible latency reduction, if 3-5-5/3-5-6 is deprioritized, there is no apparent reason for RAN1 to continue discussing latency reduction beyond what can be achieved by Rel-17 or, at least, latency-related proposals would have to be more effective and simpler than 3-5-5/3-5-6. |

# Other capacity enhancements

The followings are agreed/concluded previously:

|  |
| --- |
| **Agreement:**The following lists the candidate enhancements techniques for link adaptation to improve XR capacity that are proposed by companies RAN1#109-e. * At least the proponents are encouraged to justify the corresponding capacity benefits for XR traffic for considering potential study of these candidate enhancements techniques.
	+ Delta MCS
	+ Soft HARQ-ACK feedback
	+ Cooperative MIMO scheme via precoding technique – bi-directional training
	+ Enhanced link adaptation for CBG-based transmission
	+ CSI report enhancements to address the different BLER requirements of different XR flows
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Agreement:**The following lists the candidate enhancements techniques based on measurement-gap link to improve XR capacity that are proposed by companies RAN1#109-e. * At least the proponents are encouraged to justify the corresponding capacity benefits for XR traffic for considering potential study of these candidate enhancements techniques.
	+ Dynamic L1 based MG activation/deactivation.
	+ Reuse current R16/R17 RRM relaxation condition to allow scheduling in MG to transform the R16/R17 RRM power saving gain into capacity gain.
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Agreement:**The following lists the candidate enhancements techniques to improve XR capacity that are proposed by companies RAN1#109-e. * At least the proponents are encouraged to justify the corresponding capacity benefits for XR traffic for considering potential study of these candidate enhancements techniques.
	+ Inter-UE/intra-UE multiplexing techniques, including e.g. finer granularity preemption indication
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Agreement:*** Deprioritize the study of CQI report for different BLER and/or different XR traffic to improve XR capacity performance.

**Agreement:*** Deprioritize the study of intra/inter UE prioritization/multiplexing enhancements to improve XR capacity performance.
 |

The views regarding these enhancements for serving XR traffic are summarized and discussed in the following sections.

## 4.1 Delta MCS and Soft HARQ-ACK feedback

The Table K in section 4.1 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (8):** Qualcomm\*, Apple, Nokia/NSB, MediaTek, Futurewei, Ericsson, Samsung, LG
	+ **Supportive ([3])**: Qualcomm\*, Apple, [Nokia/NSB]
	+ **Not supportive (5):** MediaTek, Futurewei, Ericsson, Samsung, LG
* **Capacity performance results (2):** Futurewei, Qualcomm

### 4.1.1 First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 4-1-1: Support of soft HARQ-ACK for capacity enhancement of XR capacity.**

**Moderator’s observation:**

* The proponent (QC) has provided extensive simulation results, showing large capacity gain.
* The opponent, Futurewei has also provided evaluation results showing capacity loss.
	+ Discussion is needed to understand the reason for difference.
* Other companies than Apple/QC are not supportive of this enhancement.
* The proposal can be discussed to address the comments and issues for the initial round of discussions.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 4-1-1, necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q3: That is another case where simulation results from proponents show (large) gains while it is already known from Rel-17 that such gains are questionable (if any), the requirements to achieve them are unrealistic, and the schemes are not testable as everything is up to UE implementation. |
| **Futurewei** | Q1: Our simulation follows strictly the agreed assumption baseline and we explained in our contribution why no gain is observed. Therefore, we do not see the benefit of the proposal and still have the similar questions since R17 discussion.Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: Both capacity gain and lose had been shown. We need to understand how the gain is obtained before we could further discuss this proposal. Q2: All results should be captured. |
| **MTK** | Q1: Tend to agree with Samsung. To our understanding this discussion also happens in R17 URLLC and it seems hard to achieve consensus.Q2: We think results can be captured with evaluation assumption clearly explained in the TR, e.g., how the soft values are derived. |
| **ZTE, Sanechips** | Support Proposal 4-4-1. |
| **LG** | **Q1: Not support.** It is already known that the performance gains are totally UE implementation specific, and as Futurewei mentioned, the requirement is also quite high. It is hard to say that the feature would be benefial for the sysyem in the practical situation. **Q2:** Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | We don’t support Proposal 4-4-1. This proposal has been discussed an exhausted in Rel-17 URLLC with no convergence.  |
| **Vivo** | Q1: The proposed enhancement in proposal 4-1-1 has been discussed in R17 URLLC session. The main concern is the impact on UE complexity and processing time. It seems the situation is not changed much since then. So we suggest proposal 4-1-1 is deprioritized for XR capacity.Q2: We think the proposed enhancements with evaluation results, especially those showing potential performance gain, can be captured in the TR. Necessary clarification if any can be included. Whether and how to draw observation and conclusion based on the captured techiques and evaluation results can be discussed separately. |
| **Ericsson** | Q1: We believe the main difficulty in Rel-17 (that still exists), is that both measures are relative, and that UE has no knowledge of what target BLER the gNB aimed for which means that a reference point (BLER) is needed. Since companies did not manage to agree on a new reference point and the details of these schemes in Rel-17, we believe there is no hope that this will change in Rel-18. Also considering FW’s feedback, we think we should down-prioritze this topic.   |
| **Nokia, NSB** | We suggest having enhancements in Proposal 4-1-1 compared against CBG-based HARQ transmission cases. We are also fine to deprioritize Proposal 4-1-1 in Rel-18. |
| **Qualcomm** | Q1: our evaluations have followed the agreed evaluation methodologies. We also explained in our contribution text why the proposed solution has capacity gain for the latency stringent XR traffic. Q2: yes, evaluation results should be captured in TR 38.835 if they follow evaluation methodologies.  |

### 4.1.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-1-1 | **Companies (3):**QC, Apple, ZTE | **Companies (8):**Samsung, FW, MTK, LG, Google, vivo, Ericsson, [Nokia/NSB] | **Companies (2):**CATT, [Nokia/NSB] |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
* **If no consensus is achieved by the end of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
* **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | First we appreciate QC and Futurewei to provide evaluation results. QC provides positive evaluation results on Delta MCS/soft HARQ-ACK. Focusing on Futurewei’s evaluation, in its contribution it is noted “One reason for the performance degradation caused by the soft HARQ scheme is as follows. The CQI feedback is inaccurate and delayed, which causes inaccuracy of MCS assignment. Due to the instantaneously changing channel conditions and interference fluctuation, sometimes the MCS assignment is way too aggressive thus the received SINR in the initial transmission is far from the required SINR meeting the target BLER. In these situations, higher number of redundant transmissions “n” is requested by the UE. However, as the channel and interference fluctuate, it is with a high probability that a smaller “n” (e.g., n=1) should have been sufficient. The unnecessarily higher “n” would result in a waste of system resources and delaying transmission of other XR data packets in the queue, therefore causing a performance degradation. In the simulations, we observed a higher Resource Utilization (RU) ratio for soft HARQ-ACK scheme, which indicates a waste of system resources caused by the unnecessarily higher “n”.” We have a few comments:1. It seems the estimate of “n” is on the high side, so some adjustment e.g., a fudge factor can be added to estimate “n” more accurately.
2. Futurwei’s evaluation actually uses the number of recommended redundancy transmissions as in slot n, slot n+1, slot n+2. An alternative strategy can be the retransmission is in slot n but with two times PRBs for retransmission.
3. It also looks the simulation uses some MIMO transmission scheme in the evaluation, perhaps it can be clarified whether SRS is transmitted to probe interference for all retrasnmsissions in slot n, n+1, n+2, …, or is it just transmitted once prior to slot n to probe the interference for slot n?
 |
| **vivo** | We suggest to deprioritize P4-1-1. |
| **Nokia, NSB** | OK to deprioritize Proposal 4-1-1 in Rel-18. As commented also by others, we acknowledge that alike proposals were discussed in Rel-17 without reaching conclusions on what to standardize. If continuing with more studies of soft HARQ, we suggest having enhancements in Proposal 4-1-1 compared against CBG-based HARQ transmission cases. |
| **MTK** | We support moderator’s suggestion. |
| **Samsung** | Support the moderator’s suggestion. |
| **CATT** | We are OK with moderator’s proposal. |
| **Futurewei** | Thanks to Apple for the questions on our simulation results. On 1), it is actually very difficult (if possible) to have an accurate estimation of “n” since it depends on the situation (interference and channel) of the initial transmission and re-transmission slots; On 2), this may be done for some situation but most likely all PRBs are assigned to the XR TB already and the packet size is large; On 3), for this set of simulation results, we only use ZF based MU-MIMO for both baseline and the soft HARQ-ACK schemes, so no SRS is used for interference probing.Overall, we are not convinced of the potential of 4-1-1 for XR capacity improvement. |
| **Qualcomm** | We have seen that when the DL NACK to retransmission delay assumptions are important in showing gains. Perhaps that is why Futurewei results are bit pessimistic. |
| **OPPO** | Support the moderator’s suggestion. |
| **LG** | We suggest to deprioritize P4-1-1. |

### 4.1.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies’ preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-1-1 | **Companies (3):**QC, Apple, ZTE | **Companies (9):**Samsung, FW, MTK, LG, Google, vivo, Ericsson, Nokia/NSB, CATT | **~~Companies (2):~~**~~CATT, [Nokia/NSB]~~ |

**Moderator’s recommendation for discussion:**

* **Majority of companies prefer to down-prioritze this topic. The concern is the Rel-17 issues are still in place. FW/Apple/QC have exchangeds feedback to identify the reason for different results.**
* **Recommendation:**
	+ **Due to the exchanged technical views and ongoing discussions, Moderator recommends continuing the discussion in the next round focusing at least on resolve the technical issues.**
		- **However, if the situation does not change after the next round, since this topic is known from Rel-17, Moderator suggests to down-priorotize the topic and capture the results.**
	+ **Please indicate if there is any objection to this direction and recommendation for down-prioritization, in case needed.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussions are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | Based on our evaluation results and the discussions before (in R18 and R17), we do not see the potential of 4-1-1 to improve XR capacity. The technical issues (since R17 discussions) are listed in our contribution and pasted here again:* The lack of capability to deal with CSI state variation caused by bursty interference and/or change of subband/beam/spatial layers between the time when report/feedback is measured and the time when data packet is transmitted,
* The uncertainty on deriving report/feedback as it also depends on whether soft-combining between initial transmission and retransmission should be considered,
* Potential mis-alignment between assumed BLER target at UE and actual operating BLER target,
* Potential impact on UE processing timeline, and
* Potential impact of additional UL overhead and related feedback channel reliability.
 |
| **Intel** | We suggest to down prioritize the topic |
| **Samsung** | We suggest to down-prioritize. There are several problems. One is that for delta-MCS/soft-ACK to even be applicable, a number of conditions need to hold (e.g. see x9749 or final conclusions for Rel-17 URLLC discussions) which are impossible in general and even more so for XR. |

## 4.2 Cooperative MIMO scheme via precoding technique

The Table L in section 4.2 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (2):** Futurewei\*, Ericsson
	+ **Supportive**: Futurewei\*
	+ **Not supportive:** Ericsson (in XR, OK in MIMO)
* **Capacity performance results (1):** Futurewei\*

### 4.2.1 First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 4-2-1: *Cooperative MIMO via DL interference probing based on SRS enhancements to improve XR system capacity for TDD* is beneficial.**

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 4-2-1, necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q3: It is not realistic to consider the proposal in XR.  |
| **Futurewei** | Q1: we’ve provided extensive simulation results, analysis, and description of the proposal. Significant benefits of XR capacity gain are shown. The scheme should be considered for XR capacity improvement.Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: The synchronization of data, the transmission state, and HARQ among TRPs is the most challenged issue in the proposed scheme. The proposed scheme coud be used for any traffic data and not limited to XR. Q2: All results should be captured.  |
| **MTK** | Q1: The capacity gain seems good but only reported by one company and not sure whether it is specific to XR. We would be open to consider this enhancement if majority of companies think so.Q2: The results can be captured with evaluation assumptions clearly explained in the TR. |
| **LG** | We think it can be considered as an issue of general MIMO discussion. We don’t think this issue is not XR specific issue.  |
| **Google** | This propsal is not addressing an XR pseicifc limitation and it s generic to any type of data. Not sure if it should be discussed under XR AI. |
| **vivo** | Q1: The proposed enhancement in proposal 4-2-1 should be discussed in MIMO session. Besides, Proposal 4-2-1 is not addressing an XR specific issue based on our understanding.Q2: See the reply in section 4.1.1. |
| **Ericsson** | Q1. We are fine to report this results in TR. Indeed high capacity gain is shown. As we mentioned previously, our concern is more on logistics if this enhancement is to be treated in XR WI where needs the expertise in MIMO.  |
| **InterDigital** | Same view as Google. We no not see how this enhancement is best suited for addressing only XR-specific issues. |
| **Nokia, NSB** | Defer MIMO enhancements to the dedicated 3GPP MIMO item. |

### 4.2.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-2-1 | **Companies (1):**FW | **Companies (8):**Samsung, CATT, LG, Google, vivo, Ericsson, IDC, Nokia/NSB |   |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
* **If no consensus is achieved by the end of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
* **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **vivo** | We suggest to deprioritize P4-2-1. |
| **Nokia, NSB** | We agree to down-prioritize the topic. |
| **Samsung** | Support the moderator’s suggestion. |
| **CATT** | We are OK with moderator’s proposal |
| **Futurewei** | The concerns we got from other companies in first round are basically the following: a) this is a MIMO related enhancement; b) this is not XR-specific as it can improvement performance for any traffic. As stated in our contribution, the fundamental issue is the combination of high data rate (30 Mbps or higher), low packet delay budget, and high reliability (99% or higher), of the XR traffics. Other issues such as PDCCH/DCI overhead, jitter of package arrival, non-integer periodicity, variable burst sizes, multi-streams, etc., are secondary to system capacity improvement. At least for dynamic scheduling, these are not the real issue. To address this fundamental issue, real improvement of capacity should be achieved without lowing the data rate, delay, and reliability requirements. The necessity of the technique lies in its effectiveness to handle XR traffic with stringent requirements on data rate, delay, and reliability to achieve higher capacity. The fact that the proposal improves capacity for XR as well other traffic is a good thing and should not be used to against it. Where the nominal work is to be done is up to the RAN plenary to decide. |
| **OPPO** | We are OK with moderator’s proposal |
| **LG** | We suggest to deprioritize P4-2-1. |

### 4.2.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-2-1 | **Companies (1):**FW | **Companies (9):**Samsung, CATT, LG, Google, vivo, Ericsson, IDC, Nokia/NSB, CATT |   |

**Moderator’s recommendation for discussion:**

**Action point to Moderator (with respect to P4-2-1):**

* **Summarize *Cooperative MIMO via DL interference probing based on SRS* enhancement evaluation results in contributions R1-2208377 (Futurewei) and request for review to be endorsed as Observation.**
	+ **Moderator aims to provide the summary for review by Monday Oct. 17.**

**As proponet clarified, the decision on the home WI would be up to plenary, Moderator understands that it is acceptable to the proponet to capture the evaluation results that show capacity gain, and then, close the discussion at this meeting. If this understanding is incorrect, please notify the Mdoerator.**

**To be used for review of the summary, when available.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | As the study item is going to end soon and no real technical concern has been raised so far, we are ok to close the discussion and capture the scheme with results of capacity gain and observastions. And the decision on the home WI is then up to plenary. |
| **Intel** | This is not a XR specific solution. We suggest to deprioritize |
| **Samsung** | We generally agree with comments made by Futurewei in the previous round regarding XR capacity. However, without considering at this time the details, in our opinion the proposed scheme is not appropriate for XR in FR1 because:1. The evaluations seem to assume non-collocated cells with ideal backhaul which is typically not the case in reality.
2. The supportable number of XR UEs per cell in FR1 is small and MU-MIMO pairing opportunities will be few, if any, including for inter-cell pairings.
3. MU-MIMO pairing opportunities will be further reduced as packet arrivals for UEs will be random and, unlike eMBB, scheduling cannot be delayed to synchronize them, further reducing the applicability of MU-MIMO.
4. In actual deployments, MU-MIMO is well known to be sensitive to channel prediction with throughput gains being substantially smaller than simulated ones. That may be OK for eMBB having latency tolerance for retransmissions in order to achieve throughput gains but it is not so for XR. The channel prediction problem would be larger for inter-cell cooperative MIMO.
5. Inter-cell co-operative MIMO may in theory be useful for UEs with low SINRs but XR requirements are unlikely to be met by such UEs.
6. It would be more appropriate to consider the proposed scheme as part of an SI for MIMO to increase capacity in order to avoid having single-company results, sufficient time to debate details, and sufficient time to potentially specify the proposed scheme – none of those is applicable for the XR SI/WI.
 |

## 4.3 Enhanced CQI based on CBG or DMRS

The Table M in section 4.3 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (4):** Nokia/NSB\*, Ericsson\*, Futurewei
	+ **Supportive eCQI based CBG (1)**: Nokia/NSB
		- **Not supportive (3):** Futurewei, Ericsson
	+ **Supportive eCQI based DMRS (1)**: Ericsson\* (new simulation results)
* **Capacity performance results (1):** Nokia/NSB\*, Ericsson\*

### 4.3.1 First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 4-3-1: Enhanced CQI based on CBG transmission improves the link adaptation and is beneficial for improving XR capacity performance.**

* **Proposal 4-3-2: DMRS based CQI improves the link adaptation and is beneficial for improving XR capacity performance.**

**Moderator’s observation:**

* eCQI based CBG:
	+ Both Nokia and Ericsosn have provided extensive analysis and evaluations on eCQI based CBG where have different views. Futurewei as well provided views on this enhancements.
	+ Moderator recommends companies review the input contributions and discuss.
* eCQI based DMRS:
	+ Ericsson has provided extensive analysis and simulation results for this enhancements. It seems the analysis and evaluations jointly covers the eCQI based CBG.
	+ Moderator recommends companies review the input contributions and discuss.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on direction of Proposal 4-3-1 and Proposal 4-3-2, necessity/benefit of the proposed enhancements? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q3: DMRS-based CQI has been considered under MIMO over many releases (going back to LTE) and was not agreed. There are several reasons for that and it is not realistic to re-consider under XR. For CBG-based CQI, unless different CBGs correspond to different QoS flows, TB-based CQI is fundamentally preferable. If different CBGs correspond to different QoS, the DCI format design needs to be discussed together with any benefit over using separate DCIs for separate QoS flows. In our opinion, no further consideration is justified for either proposal.  |
| **Futurewei** | Q1: These proposals were discussed in previous releases extensively. It is preferred not to re-discuss again.Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: We should not re-open the issue dropped in MIMO session. Q2: All results should be captured.  |
| **MTK** | Q1: The capacity gain seems good but only reported by one company. We would be open to consider this enhancement if majority of companies think so.Q2: The results can be captured with evaluation assumptions clearly explained in the TR. |
| **ZTE, Sanechips** | We are open to the Proposal 4-3-1 and Proposal 4-3-2 |
| **LG** | **Q1:** We share views from Samsung and Futurewei. We also think gNB can consider CBG even with existing CQI.**Q2:** Same as others. With repect to companies’ effort, we are fine to capture proposals when the performance has been shown or can be clearly expected. We think the same principle can be applied for all of the proposal. |
| **Google** | With the large UL/DL video packets in XR, the use of CBG is very important to improve the system capacity. Also, enhancements to the CBG mechanisms are needed. CBG-based CQI reporting could be further studied.  |
| **vivo** | Q1: We think proposal 4-3-1 and 4-3-2 should be deprioritized for XR capacity study.For proposal 4-3-1, the benefit of CBG based transmission with CBG based CQI reporting compared to TB based retransmission with legacy subband CQI reporting (at most 4 bits) is not clear, while it may burden UE with more complexity and computation.For proposal 4-3-2, it is showed that with 90% target BLER where there will be high probability for retransmission, DMRS-based CSI reporting with HARQ-ACK (if not impact the latency) may be useful. However, if target BLER is typically set as 10%, then there will be no more than 10% retransmission. UE needs to measure CSI based on DMRS with high probability. When considering the increased latency to generate CQI based on DMRS, the beneifit will be vanished due to the short PDB of XR traffic. Meanwhile, this also causes increased UE power consumption.Q2: Same reply as section 4.1.1 |
| **Ericsson** | Q1: We are not supportive of 4-3-1. As proponets, we are supportive of 4-3-2. Based on the input contribution (Nokia), we would like to provide few feedbacks:* Regarding eCQI based CBG, it is important to see as baseline the performance of legacy CBG (only TB based is provided).
* We would like to know the assumption on target BLER and OL.
* In Nokia’s contribution when SINR distribution for CBG and TB are shown (Figure 1), the difference in SINR for the CB difference is (6-7 dB), but for CBG is **maximum 1 dB** as Nokia shows. To us, this means that some CBs in the CBG has good quality while other has worse. So even if VRBs is not used (not clear for us if it is used in Nokia’s result) it will be rather lucky that frequency selective interference happen such that CBs that suffer all belongs to same CBGs while other CBs in other CBGs succeed.
* We explained in our contribution that the reason why CBG-based re-transmissions only give a small capacity improvement compared to TB-based is due to that error curves versus SINR are “knee-like”. Only a small change in SINR can change BLEP from close to 1 to 1e-5.
	+ This further has the consequence that for almost all transmissions either all CBGs are successfully decoded or none of the CBGs could be correctly decoded. In fact, for less than 3% for InH (6% for Uma) of the transmissions, the number of in-correctly decoded CBGs is different from 0 and $n\_{CBG}$.
	+ This means that the occasions where CBG-based re-transmission can reduce the resource consumption compared to TB-based re-transmission are rather rare for the InH and UMa scenarios.
 |
| **InterDigital** | We are open for discussing Proposal 4-3-1 |
| **Nokia, NSB** | Q1: We support Proposal 4-3-1 as we have shown capacity improvements while using CBG-based transmission with an enhanced CQI scheme compared to TB-based and legacy CQI scheme. We have also introduced the specification impact of the enhanced CQI scheme (mainly on 3GPP TS 38.214 clause 5.2.2.1). We believe that it is necessary to update the current CQI determination mechanism to fit better with CBG based transmission. Specifically, for the XR use cases, most of the times full bandwidth is allocated for one UE and due to large channel fading variation among the code blocks, there is a need for an enhancement that takes this variations and unequal CB (and CBG) error probabilities into account. From the Ericsson tdoc, it seems that i.i.d. errors of CBGs are assumed (?), while our sim results show that CBG errors actually vary within one TB. Regarding Proposal 4-3-2, our understanding is that the DMRS based CQI can only happen when there is a PDSCH transmission. This would result in a periodicity of 16.7 ms for a typical XR UE which could lead to outdated channel measurement data.Q2: Yes, we support capturing the results and related observations to TR 38.835. |
| **Qualcomm** | Similar to other companies views prefer not to reconsider. |

### 4.3.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-3-1 | **Companies (4):**Google, Nokia/NSB, IDC, ZTE | **Companies (8):**Samsung, FW, CATT, LG, vivo, Ericsson, MTK, QC |   |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions.**
* **If no consensus is achieved by the end of 2nd round for any of these proposals, down-priorotize the proposed technique for further study.**
* **Capture the description of proposed enhancements techniques with corresponding simulation results, if available, and key assumptions and findings, in this meeting.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **vivo** | We suggest to deprioritize P4-3-1. |
| **Nokia, NSB** | In response to Ericsson’s comments from round 1:* We have the comparison results for legacy CBG as well. The results for PDB=15ms and 30Mbps are as follows:

And similarly, for 45Mbps:As shown, the performance of legacy CQI is slightly better for CBG compared to TB (in line with Ericsson’s observation). However, the true effect of CBG-based transmission is obtained by use of an enhanced CQI that reacts to each individual CBGs SINR and error probability. The BLER target of the legacy CQI is 10% and the rest of the parameters for eCQI are listed in the simulation’s excel file. VRB assumption is not used in our simulations. In response to vivo: All the presented results for the legacy CQI are with the subband CQI reporting. The performance of the wideband CQI is worst (expected). Here, we show one result to compare the subband, wideband and CBG based CQI methods:* Where a scenario with 30Mbps and 15ms is shown and two first curves (blue and red) are for wideband and subband CQI schemes, respectively. (both have 10% BLER). One remark here is that in eCQI, only one index is reported while for the subband mode, several indices are reported. Thus, overhead of eCQI is lower than the subband mode. It is true that the eCQI has slightly higher complexity at the UE, but given the performance gain, it should be justified.

In summary, we therefore continue to support Proposal 4-3-1 as it is shown with extensive sim results to offer capacity improvements from using CBG-based transmission with an enhanced CQI scheme compared to TB-based and legacy CQI scheme. This should be captured in the TR. We have also described the modest specification impact of the enhanced CQI scheme (mainly on 3GPP TS 38.214 clause 5.2.2.1). |
| **MTK** | We are open to consider enhacements which show capacity gain. Maybe we can first plan to draw observations based on company inputs from both side. |
| **Samsung** | Support the moderator’s suggestion. |
| **CATT** | Thanks Nokia for further clarification. However, the results of system performance gain seems marginal. We support moderator’s proposed resolution.  |
| **Futurewei** | We support moderator’s suggestion. Based on the experience in R17 related discussions, we prefer not to re-discuss again. |
| **Qualcomm** | We suggest to deprioritize. We also think that this has been extinseivly studied and gNB can consider CBG even with existing CQI.  |
| **OPPO** | Support the moderator’s suggestion. |
| **Ericson** | **@vivo: We missed to provide feedback on initial round regarding your comment:**First, we like to emphazise that although 10% BLER target appears to be a general assumption that it is a suitable targete for eMBB and XR traffic, it’s often not the best one. In many scenarios, as the scenarios InH and Uma for XR performance evaluations, better performance is obtained using a higher BLER target. As shown in our contribution 10% target BLER give worse capacity than e.g. 22% BLER.Of course, DMRS-based CSI puts more burden on UE to determine and report the DMRS-based CSI. However, UE already need to do channel estimation on the DMRS in the process of decoding the PDSCH. When determining DMRS-based CSI the remaining extra work for UE is to estimate noise and interference and combine the channel and interference estimates to a CQI value. It should also be noted that for DMRS-based CSI the UE does not need to evaluate different ranks and pre-coders which is a major contributor to the large CSI processing time for legacy CSI reporting. Therefore, we believe it to be realistic and preferable to have same timing as for HARQ-ACK potentially with restriction to UE Capability 1. We agree that having a longer processing time for DMRS-based CSI than HARQ-ACK will reduce the gain, but we believe the gain will persist at least for XR having relaxed latency requirements that allows for several re-transmissions.**@Nokia:** Thanks for providing the basedline GBC results. The main point that we are making is the error is randomized over CBG. Then, a target TB BLER, would result in an equivalent targer CBG. Of course, in practice, none of these are exact. To do randomization of error, we asked if VRB to PRB is used.What we struggle to understand is that : * We showed that better performance for legacy is obtained with a higher BLER than 10%. It seems Nokia has the view that the gain is from enhanced CSI rather than from a better BLER target
	+ Please see our analysis in contributions, as well as comment to vivo that higher TBLER does not mean worst performance.
* **In other words, if the gain is from enhanced CSI, the gain should persist even with legacy operation with a better BLER target. Then, do we need eCQI based CBG or we can operate with a different target BLER?**

That’s why we are not convinced with the need for enhancement. |
| **LG** | Fine with the moderator’s suggestion and suggest to to deprioritize |

### 4.3.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-3-1 | **Companies (5):**Google, Nokia/NSB, IDC, ZTE, MTK | **Companies (8):**Samsung, FW, CATT, LG, vivo, Ericsson, ~~MTK~~, QC, OPPO |   |
| P4-3-2 | **Companies (3)**Ericsson, ZTE, MTK | **Companies (7)**Samsung, FW, CATT, LG, vivo, ~~MTK~~, QC, OPPO |   |

**Moderator’s recommendation for discussion:**

* **Majority of companies prefer to down-prioritze this topic. The proponets of both proposals have provided capacity performance gain, but still technical discussions are ongoing.**
* **Recommendation:**
	+ **Moderator recommends to continue the discussion in the next round focusing at least on resolving the technical issues.**
		- **However, if the situation does not change after the next round, Moderator suggests to down-priorotize the topic and capture the result, if requested.**
	+ **Please indicate if there is any objection to this direction and recommendation for for down-prioritization, in case needed.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | Our view remains unchanged from last round. |
| **Samsung** | We do not support further discussion on P4-3-1/P4-3-2.Reasons were outlined in previous rounds. The functionality of P4-3-1 can be realized in Rel-17 and the intention seems to be to save DCI overhead, which is not an issue, at the expense of substantial specification and implementation complexity. P4-3-2 has been considered under MIMO in multiple occasions in the past and was not agreed – there is nothing apparently different about XR that would make past conclusions for eMBB inapplicable. Similar to the co-operative MIMO proposal, P4-3-2 would be more appropriate to potentially consider under a MIMO SI for capacity improvements.  |
|  |  |

## 4.4 Enhancements based Measurement gap

The Table N in section 4.4 of R1-2214010 lists short descriptions, and the proposals and observations in the contributions submitted in this meeting. For more detailed descriptions and discussions please refer to the corresponding companies’ contributions.

**Status of inputs in the contributions:**

* **Companies with view (5):** Qualcomm, Nokia/NSB\*, MediaTek\*, Futurewei, Ericsson
	+ **Supportive ([4])**: Qualcomm, Nokia/NSB\*, MediaTek\*
	+ **Not supportive (1):** Futurewei, Ericsson
* **Capacity performance results (2):** Nokia/NSB\*, MediaTek\*

### 4.4.1 First round of Discussion

**High level proposals based on input contributions:**

* **Proposal 4-4-1: Support enhancements on RRM to relax scheduling restcition during MG**
	+ **Proposal (Nokia):** The UE-to-gNB signaling to make the gNB scheduler aware of when s-MeasureConfig induced scheduling restrictions apply could be realized with higher-layer signaling such MAC CE or RRC signaling. RAN2 shall be asked for further guidance.
	+ **Proposal (Nokia):** For UEs configured with inter-frequency measurement gaps, solutions where the gNB can signal the UE to skip a measurement gap (to avoid scheduling restrictions) shall be captured in the TR. The gNB-2-UE signaling for this may be realized via a compact DCI format to have fast signaling
	+ **Proposal (MTK):** Support a more dynamic DCI/MAC-CE based MG activation/deactivation or MG setting (including duration and period) change for XR capacity enhancement**.**
	+ **Proposal (QC):** MG should be enhanced by handling the priority of data packets or dynamically activating/deactivating the MG occasions from gNB.

**Moderator’s observation and suggestions for discussions:**

* Enhancements of scheduling restriction due to RRM is proposed by Nokia/NSB and MTK and Qualcomm.The proponents provided extensive analysis and performance evaluation results.
* Two companies (Futurewei and Ericsson) have raised concern on the applicability of scenarios and impact on other WGs.
* Moderator suggests using the initial discuss to address the concern raised by opponents.

**Moderator’s suggestion for First round of Discussions:**

* **Q1:** What is your view on necessity/benefit of the proposed enhancements under **Proposal 4-4-1** for **scheduling restrictions based on RRM**? Please note that based on your feedbacks, the proposals can be updated with more details for the next round of the discussions.
* **Q2:** Discuss your view regarding the proposed enhancements and whether they should be captured in TR 38.835. If yes, feel free to provide suggestions on corresponding TPs.
* **Q3:** Discuss any clarification/correction/comment/question helping the discussion and needed decisions.

**Note: For discussions, please ensure the information provided in companies contributions are taken into account.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Samsung** | Q1-Q2: We are supportive to discuss the applicable scenarios. Once that is concluded, it should be clear whether the proposal for scheduling restrictions based on RRM (or probably the reverse – i.e. skip RRM) is beneficial to support.  |
| **Futurewei** | Q1: it is intuitively understandable that with measurement gap the system performance degrades for any traffic including XR traffic and reusing some of the resource configured for MG can potentially bring back some of the performance loss. Note that dynamic indication may not always work for example when the XR data arrives during the MG. In addition, questions like the proper configuration of the MG, applicable scenarios, and the impact to RRM measurement need to be answered and RAN2 and RAN4 may need to get involved. Q2: In general, we think companies’ effort should be respected and captured when evaluations were performed according to the agreed simulation assumptions and the agreed common principles. It is better to have a consistent manner on whether/how to capture results with proper observation and conclusion than discussing each individual proposal/result separately. |
| **CATT** | Q1: This is more implementation issue than standard issue since the measurement gap and the XR resource allocations are controlled by the gNB. Q2: All results should be capatured.  |
| **MTK** | Q1: The simulation results from MTK/Nokia show evident capacity gain with MG/SMTC scheduling enhancement. QC also provides very nicely drawn figure to explain the issue. To us, this issue is worthy of an enhancement in the WI phase, since **this issue is XR-specific**, and the **capacity gain is evident**. As 5G NR is a mobile network, MG is always necessary under some mobility scenarios. Moreover, Nokia mentions SMTC scheduling restriction due to beam management which would also have strong impact on capacity for FR2. **If we want to support XR with mobile user or FR2 user, an enhancement to scheduling availability for MG/SMTC seems helpful.** * As for RAN2/RAN4 involvement, if RAN1 agrees on direction, it can be further discussed in RAN plenary when devising the WI description.

Q2: The restuls can be captured with evaluation assumptions clear explained in the TR. |
| **ZTE, Sanechips** | We are open to Proposal 4-4-1.  |
| **LG** | **Q1:** Fine to discuss in general. However, the trade-off should be identified and need to be answered by other WGs. For example, a contribution proposed that the trade-off is hand-over failure. Cosidering those performance degradation, RAN2 should be involded at least. Otherwise, it would be necessary to leave the issue to RAN2.  |
| **vivo** | Q1: We support to study the enhancements on RRM to relax scheduling restcition during MG. In our opinion, it is beneficial for both network capacity performance and UE power saving by dynamically skipping MG of UE.Q2: We think the proposed enhancements with evaluation results, especially those showing potential performance gain, can be captured in the TR. Necessary clarification if any can be included. Whether and how to draw observation and conclusion based on the captured techiques and evaluation results can be discussed separately. |
| **Ericsson** | Q1: In this case, showing capacity gain when one can use 6ms for scheduling is evident.However, as we mentione din our contributions, we have two main concerns: the applicability of the scenarios, and impact on other WGs. We appreciate if propoents provide feedback.  |
| **Lenovo** | It can be discussed how often such events/measurement occur in typical situations, and whether XR data transmission is important or e.g., inter-frequency measurement (e.g., for cell-edge UEs) also whether communication is restricted in all symbols or e.g., just within SSB symbols and 1 symbol before and after consecutive SSB symbols. RAN4 should be involved. |
| **Nokia, NSB** | We support Proposal 4-4-1. The benefit of having such enhancements is presented in our tdoc with performance results. Support that such enhancements are captured in the TR.We propose to modify the proposal to capture FR2 related restrictions:* **Proposal 4-4-1: Support enhancements on RRM to relax scheduling restcition for intra-frequency RRM without MGs and for inter-frequency RRM with MGs**

Q2: Yes, we support capturing the results and related observations to TR 38.835 |
| **Qualcomm** | We are supportive of studying this. |

### 4.4.2 Second round of Discussion

**Summary of 1st round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-4-1 | **Companies (6):**MTK, ZTE, LG, vivo, Nokia/NSB, QC | **Companies (2):**FW?, CATT | **Companies (3):**Samsung, Ericsson, Lenovo |

**Moderator’s recommendation for discussion:**

**Moderator suggests the following.**

* **Companies are encouraged to review the 1st ruound of discussions and follow-up if more clairfications/questions are needed in the 2nd round of discussions. For example:**
	+ **Clarifcaitons on scenarios**
	+ **Impact on other WGs**
	+ **..**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Apple** | It seems such a proposal didn’t arise for URLLC which can arguably have more stringent requirements than XR, we wonder why it is proposed here. In any case, RAN4 should be invovled in any such study (currently only RAN1/RAN2 are included from RAN side for Rel-18 SI). RAN1 should refrain from venturing judgment on matters outside our expertise. Of course, to acknowledge companies’ hardwork, the results can be captured in TR as company views.  |
| **vivo** | We support Proposal 4-4-1.Since XR traffic requires high data rate and short latency and there could be jitter for packet arrival, it may be difficult for gNB to avoid the overlapping of the measurement gap and the XR resource allocations by configuration or implementation. Hence, dynamic indication to relax scheduling restcition during MG can be beneficial. |
| **Nokia, NSB** | To summarice Nokia proposed two approaches:* UE based scheduling restrictions avoidance, where UE would indicate if the expected scheduling restritions (due to expected intra-frequency measurements based on SMTC in FR2) can be omitted. Note this is related to scenario without measurement gaps, and would be based on UE decision/indication (e.g. based on *s-MeasureConfig* threshold) on the need of said scheduling restrictions.
* Network based scheduling restrictions avoidance due to inter-freq meas. gaps where network would indicate or configure a pattern, when UE would be expected to prioritize PDSCH/PUSH reception even if they would collide with measurement gap.

Thus, we continue to support enhancements on RRM to relax scheduling restriction for intra-frequency RRM without MGs and for inter-frequency RRM with MGs as it is shown to offer attractive benefits. We therefore suggest that the problem and possible solution directions are captured in the TR. Solutions for supporting enhancements on RRM to relax scheduling restriction during MG would basically be relevant for any scenarios with mobility. So both applicable to Urban (Dense) areas and indoor hotspot. |
| **MTK** | We try to reply to moderator suggestion:* **Clarifcaitons on scenarios**: XR applications with mobility demands. For example, cloud gaming on bus, AR applications with mobile users (say pokemon go). Also, Nokia contribution mentions SMTC scheduling restriction due to beam management in FR2, and this would apply to all FR2 XR users.
* **Impact on other WGs**: In Rel-17, RAN4 was working on some BWP based MG enhancement to address the issue of MG for intra-band measurement (more accurately, intra-band measurement where the active BWP does not contain the SSB). The MG can be turned on when UE switches to a BWP which does not contain SSB, and turned off when UE switches to a BWP which contains SSB. Therefore, we think a dynamic MG activation/deactivation would not impose strong efforts to RAN4 with the experience from R17. RAN4 can step in later to define requirements after RAN1/RAN2 finish the design, just like many other RAN1/RAN2 features.

As for Apple’s comment, URLLC application normally does not require mobility (say sensor) and is targeting a lower data rate than eMBB; we think this is the reason this kind of proposals were not mentioned in URLLC.  |
| **Samsung** | Support focusing on further discussion on the proposal and the associated scenarios at this meeting. We think the proposal can be potentially beneficial for XR and support further consideration. |
| **Lenovo** | Ok to further discuss. Couple of comments:1. within the SMTC window, transmission/reception may be allowed in symbols that do not contain SSB or containg SSBs that are not indicated to be measured (e.g., according to “*SSB-ToMeasure*”). So, RAN4 should be consulted on typical scenarios/ *SSB-MTC periodcity/duration*. According to 38.133 clause 9.2.5.3.1(FR1)/9.2.5.3.3(FR2):
	1. When the UE performs intra-frequency measurements in a TDD band, the following restrictions apply due to SS-RSRP or SS-SINR measurement
		1. The UE is not expected to transmit PUCCH/PUSCH/SRS on *SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be mea*sured within SMTC window duration.
	2. The following scheduling restriction applies due to SS-RSRP or SS-SINR measurement on an FR2 intra-frequency cell:
		1. If deriveSSB-IndexFromCell is enabled the UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on SSB symbols to be measured, and on K data symbol(s) before each consecutive SSB symbols to be measured and K data symbol(s) after each consecutive SSB symbols to be measured within SMTC window duration.
		2. If deriveSSB-IndexFromCell is not enabled and the SCS of data and SSB symbols are smaller than 960kHz, the UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on all symbols within SMTC window duration.
		3. If deriveSSB-IndexFromCell is not enabled and the SCS of data or SSB symbols is 960kHz, the UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI SSB symbols to be measured, and on K’ data symbol(s) before each consecutive SSB symbols to be measured and K’ data symbol(s) after each consecutive SSB symbols to be measured within SMTC window duration.
2. How much performance impact (e.g., handover failure rate increase) of skipping MG is tolerable for XR service (RAN1/RAN2)
 |
| **CATT** | This issue still more implementation related since the configured measurement gap and XR scheduling could be controlled by gNB without any impact of XR performance. |
| **Futurewei** | As we stated in 1st round, reuseing some of the MG can of course improve performance. This is a generic improvement, not specifically for XR traffic. Furthermore, how/when dynamic indication to activate/deactivate MG is not clear. Questions like the proper configuration of the MG, applicable scenarios, and the impact to RRM measurement need to be answered and RAN2 and RAN4 may need to get involved. |
| **Qualcomm** | We think this is an important issue and agree with MTK’s response. Usecases requiring mobility appears to be more with XR such as for CG. Morevoer RAN4 does not study XR traffic and RAN performance. Instead that’s the job of RAN XR SI. |
| **LG** | Though issue are in RAN1, the impact would be in all other WG. MG always can impact on periodic, frequent, and latency-sensitive traffic, so it could be XR-specific. However, the drawbacks are not in RAN1. We think other WG should involve.  |

### 4.4.3 Third round of Discussion

**Summary of 2nd round of discussions:**

|  |  |
| --- | --- |
| **Proposal** | **Companies' preferences** |
| **Yes** | **No** | **Maybe/FFS** |
| P4-4-1 | **Companies (7):**MTK, ZTE, LG, vivo, Nokia/NSB, QC, Samsung | **Companies (3):**FW, CATT, Apple | **Companies (2):**~~Samsung~~, Ericsson, Lenovo |

**Moderator’s recommendation for discussion:**

**Action point to Moderator (with respect to P4-4-1):**

* **Summarize *RRM based scheduling* enhancement evaluation results in contributions R1-2209536 (Nokia) and R1-2209518 (MediaTek), and request for review to be endorsed as Observation.**
	+ **Moderator aims to provide the summary for review by Monday Oct. 17.**

**Recommendation:**

* **Majority of companies ar ein favor of this enhancement. Quesitons were raised on scenarios and impact on other WGs. The proponenets have provided clarifications on scenarios, and impact on other WG. There are still comments that the proponets are requested to attend.**
* **Recommendation:**
	+ **Moderator recommends to continue the discussion in the next round focusing at least on resolving the technical issues.**
		- **However, if there is no strong concern, Moderator suggests to priorotize this enhancement.**
	+ **Please indicate if there is any objection to this direction and recommendation for prioritization, in case needed.**

**Note: For discussions, please ensure the information provided in companies contributions and previous round of discussion are considered.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| **Futurewei** | As we stated before, reuseing some of the MG can of course improve performance. This is a generic improvement, and nothing specifically for XR traffic. Furthermore, how/when dynamic indication to activate/deactivate MG is not clear. Questions like the proper configuration of the MG, applicable scenarios, and the impact to RRM measurement need to be answered and RAN2 and RAN4 may need to get involved. Overall, we do not agree to prioritize this enhancement for XR capacity improvement. |
| **Samsung** | We support the suggestion by the moderator. RAN1 can further discuss the importance/relevance of scenarios where the proposal can offer capacity gains and whether there are offsetting Rel-17 mechanisms. We think it is clear that the proposal can potentially provide capacity gains. |
|  |  |

# 5 Others

Few enhancement topics were down-prioritized last meeting; however, companies proposed those enhancements at this meeting.

* SPS enhancements
* Intra-UE/Inter-UE prioritization.

Moderator have not treated those proposals. If proponents have concern, please use this section to share your view.

### First round of Discussions

Please share your views on the proposals that you prefer to be discussed. Please also use this section to share your view on any issue that needs to be discussed.

|  |  |
| --- | --- |
| Company | Comments |
| **ZTE, Sanechips** | **We prefer to discuss section 2.1.1 and section 3.1.1 firstly, which are the critical issues and have the widest interests and evaluation results. And of course it is the right way to provide some proposals for section 2.1.1 after collection of views of the 1st round.** |
| **Moderator** | Hopefully the plan for next phase addresses your preference. |
|  |  |
|  |  |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | [**R1-2208377**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208377.zip) | XR Capacity Evaluation and Enhancements | FUTUREWEI |
| 2 | [**R1-2208402**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208402.zip) | Discussion on capacity enhancements for XR | Ericsson |
| 3 | [**R1-2208421**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208421.zip) | Discussion on XR-specific capacity enhancements techniques | Huawei, HiSilicon |
| 4 | [**R1-2208661**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208661.zip) | Discussion on XR specific capacity enhancements | vivo |
| 5 | [**R1-2208782**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208782.zip) | Discussion on XR specific capacity enhancement for NR | China Telecom |
| 6 | [**R1-2208863**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208863.zip) | Discussion on XR specific capacity enhancements techniques | OPPO |
| 7 | [**R1-2208953**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208953.zip) | NR enhancement for XR capacity improvement | CATT |
| 8 | [**R1-2209000**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209000.zip) | XR-specific capacity enhancements techniques | TCL Communication Ltd. |
| 9 | [**R1-2209070**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209070.zip) | Discussion on XR specific capacity enhancement techniques | Intel Corporation |
| 10 | [**R1-2209113**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209113.zip) | Considerations on XR-specific capacity enhancements | Sony |
| 11 | [**R1-2209129**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209129.zip) | XR-specific Capacity Enhancement Techniques | Lenovo |
| 12 | [**R1-2209156**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209156.zip) | Discussion on XR-specific capacity enhancements | NEC |
| 13 | [**R1-2209198**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209198.zip) | XR specific capacity enhancements | ZTE, Sanechips |
| 14 | [**R1-2209355**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209355.zip) | Discussion on XR-specific capacity enhancements techniques | CMCC |
| 15 | [**R1-2209388**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209388.zip) | Discussion on XR capacity enhancement techniques  | Panasonic |
| 16 | [**R1-2209457**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209457.zip) | Discussion on XR-specific capacity enhancement techniques | LG Electronics |
| 17 | [**R1-2209518**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209518.zip) | On XR specific capacity improvement enhancements | MediaTek Inc. |
| 18 | [**R1-2209536**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209536.zip) | XR-specific capacity enhancements | Nokia, Nokia Shanghai Bell |
| 19 | [**R1-2209598**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209598.zip) | XR-specific capacity enhancements techniques | Apple |
| 20 | [**R1-2209620**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209620.zip) | Discussion on XR-specific capacity improvements | Rakuten Symphony |
| 21 | [**R1-2209642**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209642.zip) | On XR-specific capacity enhancements techniques | Google Inc. |
| 22 | [**R1-2209658**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209658.zip) | Discussion on XR-specific capacity enhancements techniques | InterDigital, Inc. |
| 23 | [**R1-2209749**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209749.zip) | Considerations on Capacity Improvements for XR | Samsung |
| 24 | [**R1-2209920**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209920.zip) | Discussion on XR specific capacity improvement enhancements | NTT DOCOMO, INC. |
| 25 | [**R1-2210003**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210003.zip) | Capacity enhancement techniques for XR | Qualcomm Incorporated |